ASSOCIAZIONE ITALIANA DI RICERCA OPERATIVA

Operations Research Applications 2017

AIRO – Associazione Italiana di Ricerca Operativa

Summary

Introduction

This booklet collects a selection of case studies reports describing applications developed by research scientists and professionals of the Italian Operations Research Society (AIRO) and is one of the results of an initiative which aims at disseminating and promoting the use of quantitative techniques, and in particular those of Operations Research (O.R.), in the society and in the industry.

The applications collected prove the multidisciplinary of O.R. In the following the 74 collected applications are grouped into 5 macro areas: Logistics and Transportation (23 applications), Production Systems (13 applications), Services and Society (20 applications), Energy and Environment (16 applications), and Information and Communication Technology (2 applications).

To ease the identification of the main characteristics of each application, several data have been collected: application field, used methodology, results and result type, keywords, year of activity, budget, funding source, and for some of them we included the Italian translation. In this way, the book can provide a useful reference guide on how Operations Research can be useful and to identify potential research and development partners among the members of AIRO.

By examining the 74 reports, several trends can be gathered. In particular, a growing penetration of O.R. in the private sector and in the spinoffs proposing O.R.-based tools and services can be identified. In fact, more than 30% (Figure 1) of the applications has been submitted by private companies and more than 60% of applications are paid by private funding. The result type can be classified as a software prototype or product in more than 50% of cases, as depicted in Figure 2.

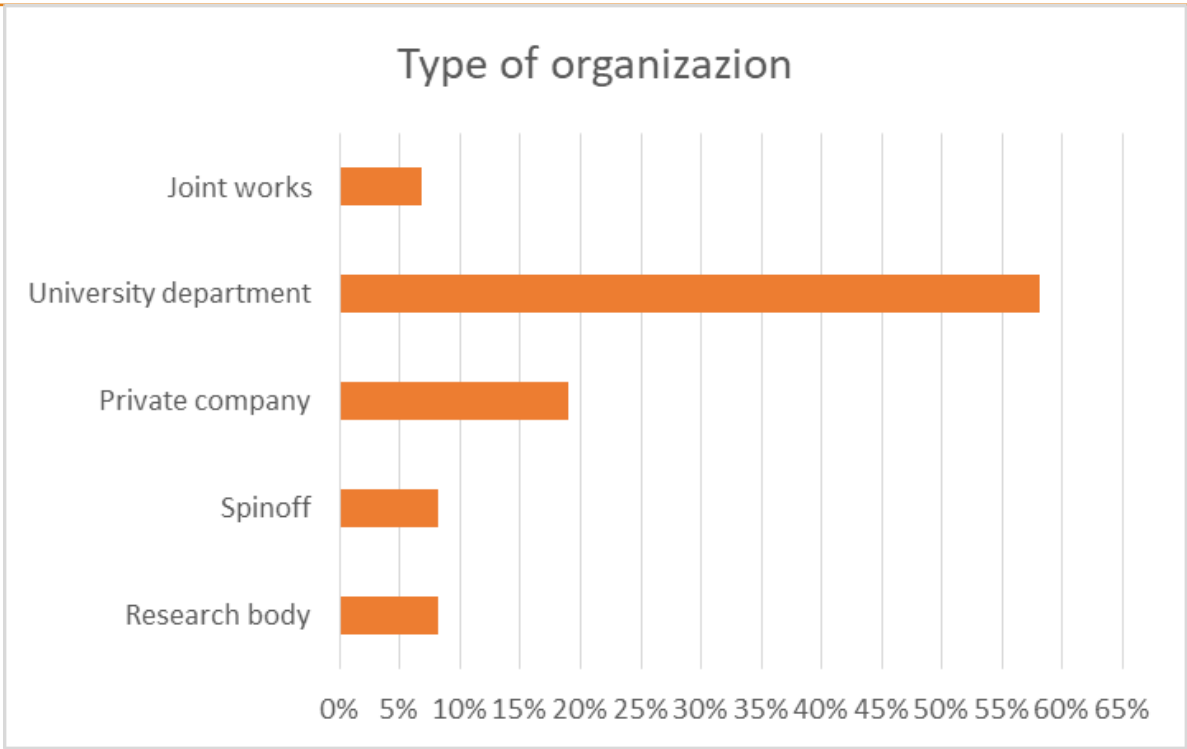

Figure 1: Survey for type of organization

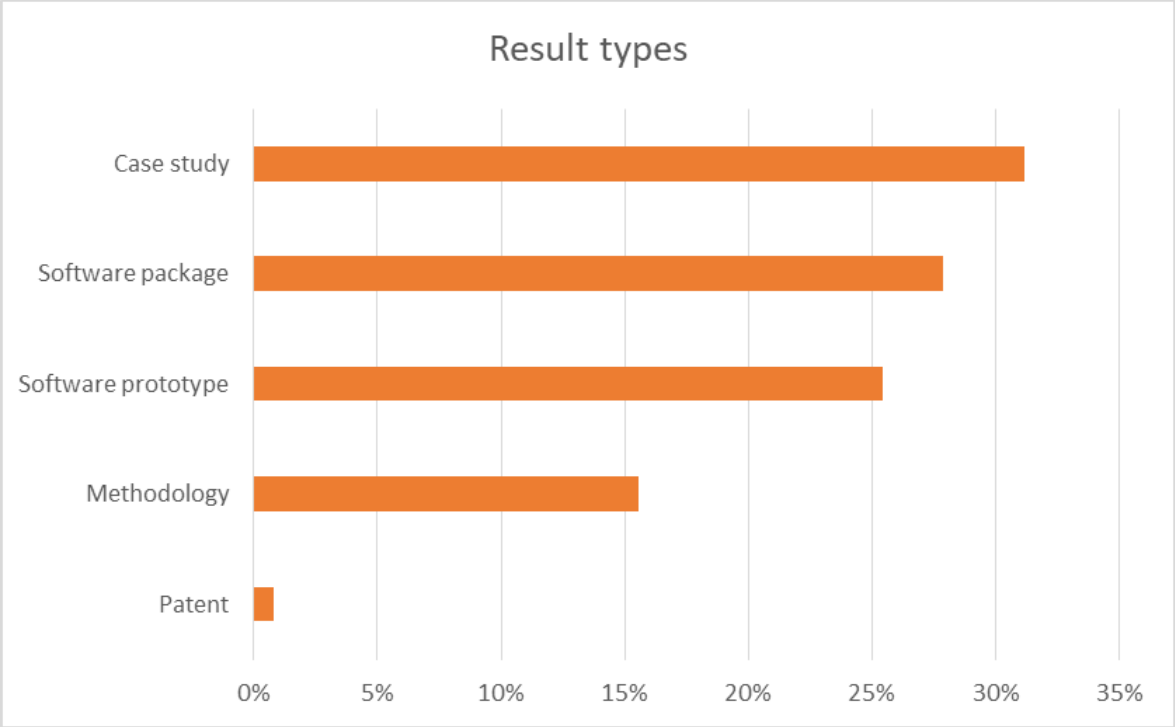

Figure 2: Cumulative percentage of result types

More in detail, it can be observed an interesting variety of application fields in which O.R. has been successfully used. While logistics / transportation, and production systems cover a big share of this collection, it is worth noting the considerable amount of services and environment related application (Figure 3).

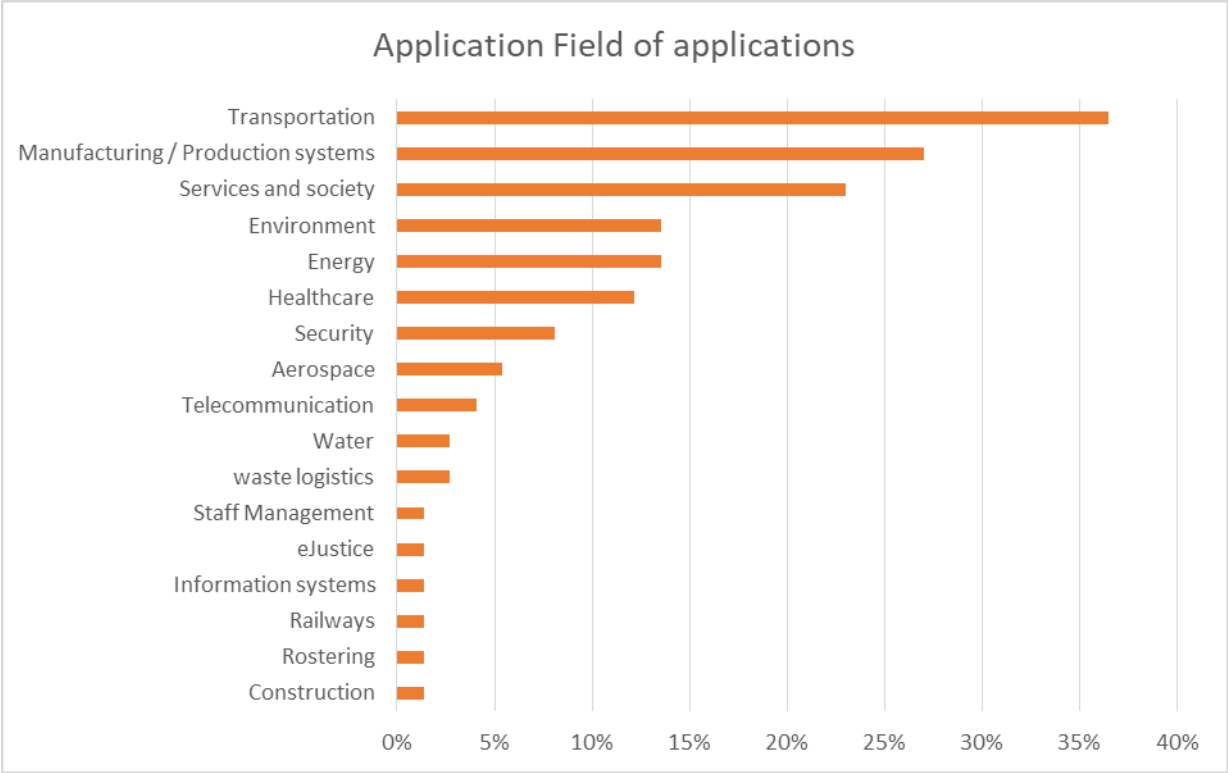

Figure 3: Application field of collected responses

The vitality of the O.R. methodologies is demonstrated also by the several and different solution approaches adopted by researchers and professional. While heuristics and metaheuristics confirm their effectiveness in solving real-world problems, as depicted in Figure 4, other approaches are often effectively used (such as exact approaches, simulation, machine learning, etc).

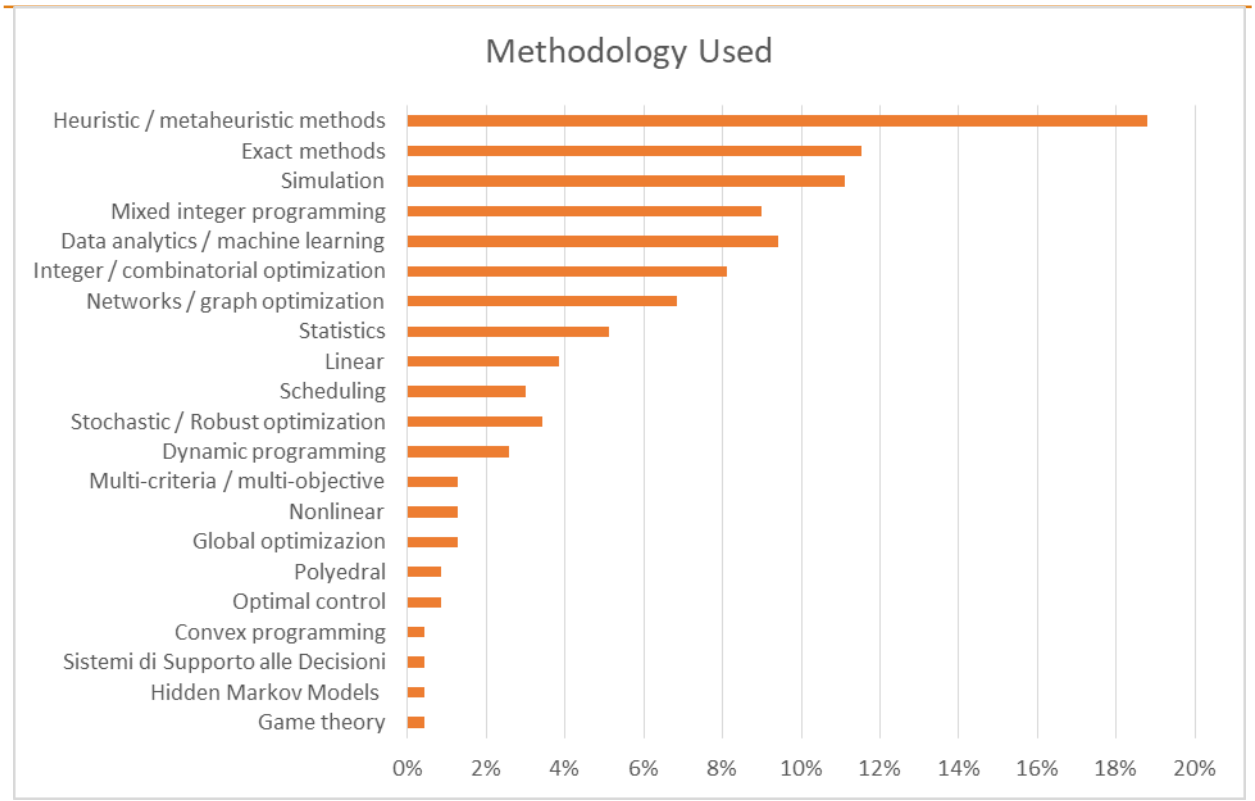

Figure 4: Cumulative percentage of used methodologies

AIRO will continue collecting case studies and reports of successful O.R. applications which are made available through its website http://www.airo.org/index.php/it/attivita/airo-industria/risultati-questionario and through new updated editions of this volume.

2017, July

Manlio Gaudioso, Giuseppe Stecca, Daniele Vigo (members of the AIRO applications committee)

Introduzione

Questo booklet raccoglie una selezione di reports che descrivono applicazioni sviluppate da ricercatori e professionisti dell'Associazione Italiana di Ricerca Operativa (AIRO). Esso rappresenta uno dei risultati di un'iniziativa il cui scopo è la disseminazione e la promozione dell'uso di tecniche quantitative, ed in particolare della Ricerca Operativa (R.O.) nella società e nell'industria.

Le applicazioni collezionate tramite survey provano la multidisciplinarietà della R.O. Nel seguito vengono presentate 74 schede di applicazioni raggruppate in 5 macro aree: Logistica e Trasporti (23 applicazioni), Sistemi di Produzione (13 applicazioni), Servizi e Società (20 applicazioni), Energia ed Ambiente (16 applicazioni), e Information and Communication Technology (2 applicazioni).

Per facilitare l'identificazione delle maggiori caratteristiche di ogni applicazione, sono stati raccolti diversi campi: campo di applicazione, metodologia utilizzata, risultato e tipologia di risultato, keywords, anno di attività, budget, tipologia di finanziamento; alcuni di questi campi sono disponibili in Italiano ed in Inglese. In questo modo il booklet può fornire una utile guida di riferimento su come la Ricerca Operativa può essere utile e su come identificare possibili partners di ricerca e sviluppo tra i membri dell'AIRO.

Dall'esame dei 74 reports si possono fare diverse considerazioni. In particolare si può identificare una crescente penetrazione della R.O. nel settore privato e negli spinoff come fornitori di soluzioni di R.O. In fatti, più del 30% (Figura 1) delle applicazioni sono state sottomesse da soggetti privati e più del 60% delle applicazioni sono pagate tramite fondi privati. Il tipo di risultato può essere classificato come prototipo o prodotto software in più del 50% dei casi, come mostrato in Figura 2.

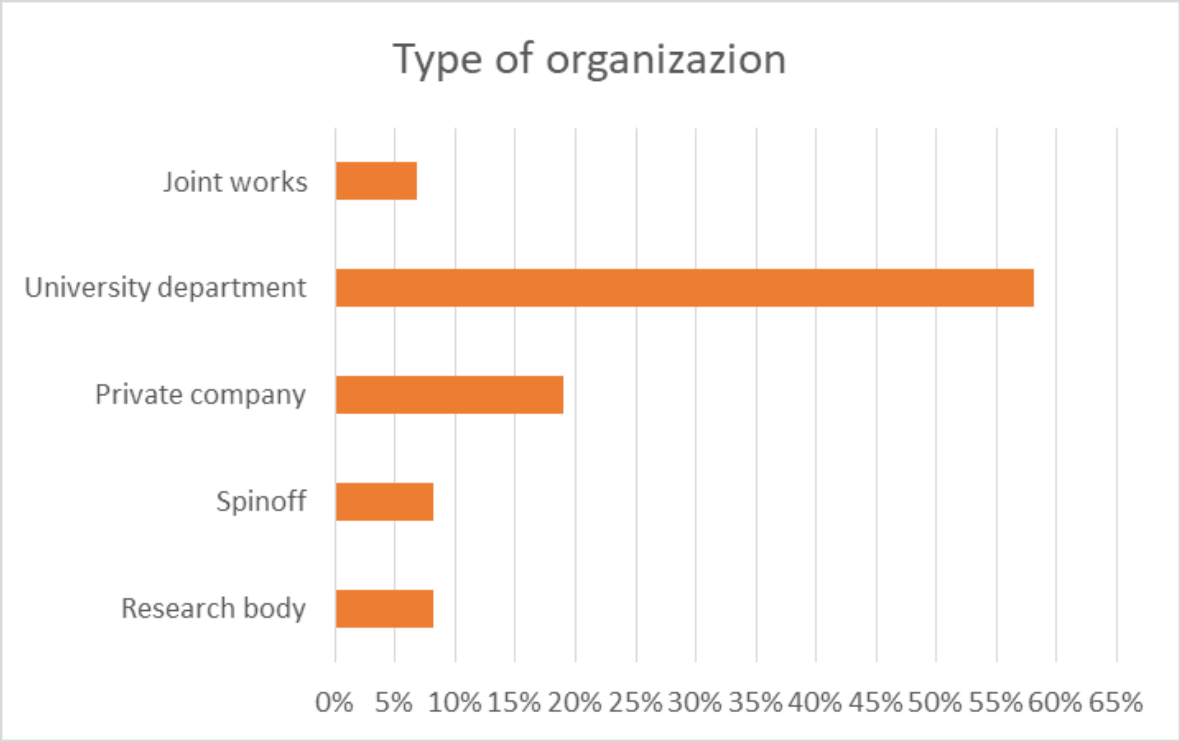

Figura 1: Survey per tipo di organizzazione

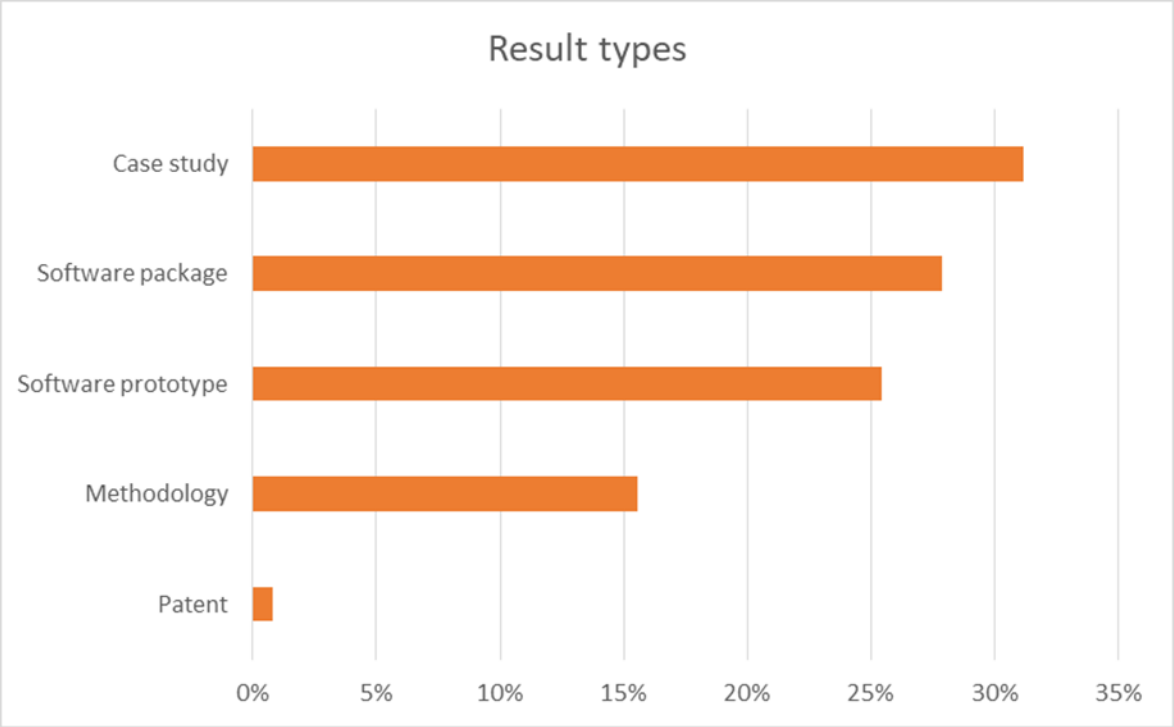

Figura 2: Percentuale cumulate per tipologia di risultato

Analizzando più in dettaglio i report può essere osservata un'interessante varietà di campi di applicazioni in cui la R.O. è stata applicate con successo. Se logistica / trasporti e sistemi di produzione coprono una grossa fetta della selezione di applicazioni, vale la pena notare la considerevole percentuale di applicazioni collegate ai servizi e all'ambiente (Figura 3).

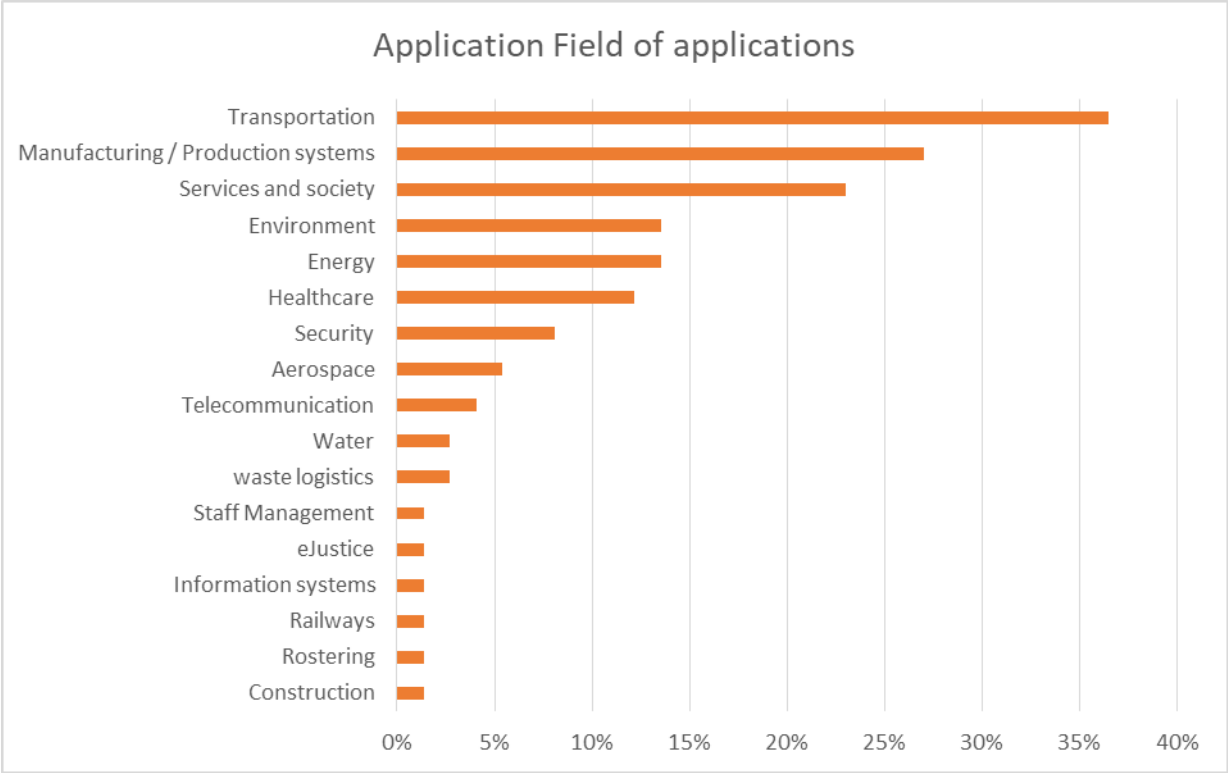

Figura 3: Campo di applicazione dei report raccolti

La vitalità delle metodologie R.O. è dimostrata anche dalle molte e differenti tipologie di approcci adottate da ricercatori e professionisti. Se le euristiche e meta-euristiche confermano la loro efficacia nel risolvere problemi reali, si può notare che altri approcci, come mostrato in Figura 4, sono molto usati in modo altrettanto efficace (come ad esempio approcci esatti, simulazione, machine learning, ecc.).

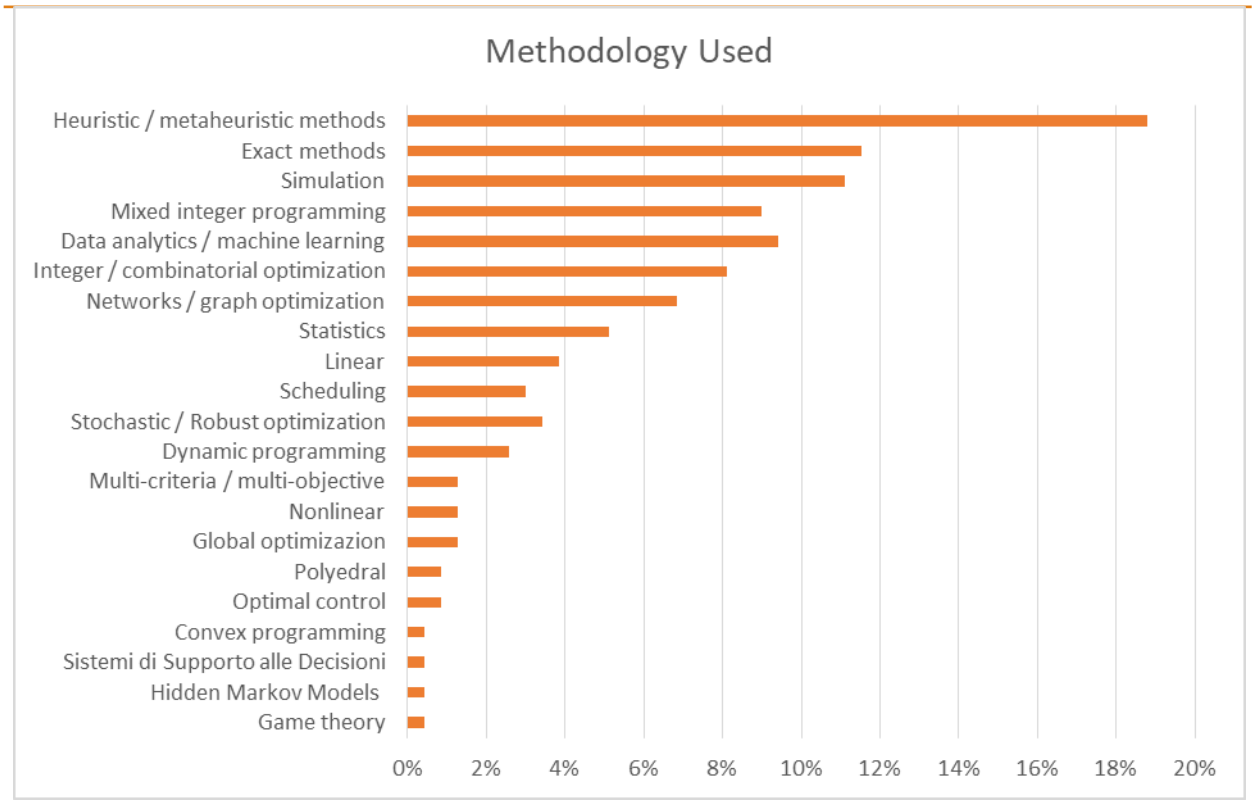

Figura 4: Percentuale cumulate di metodologie utilizzate

AIRO continuerà a collezionare casi di studio e reports di applicazioni R.O. di successo che sono rese disponibili tramite l'indirizzo sito web http://www.airo.org/index.php/it/attivita/airo-industria/risultati-questionario e tramite nuove edizioni aggiornate di questo volume.

Luglio 2017

Manlio Gaudioso, Giuseppe Stecca, Daniele Vigo (membri del comitato AIRO per le applicazioni).

Logistics and Transportation

1. ON-TIME European Project (Optimal Networks for Train Integration Management across Europe)

Progetto Europeo ON-TIME (Reti ottimali per la gestione integrata dei treni attraverso l'Europa)

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Application field: Transportation

Keywords: Train Timetabling, Infrastructure Utilization, Delay Minimization, Robustness, Algorithms

Abstract: The ON-TIME project developed new methods and processes to help maximizing the available capacity on the European railway network and to decrease overall delays in order to both increase customer satisfaction and ensure that the railway network can continue to provide a dependable, resilient and green alternative to other modes of transport. In the project, specific emphasis was placed on approaches for alleviating congestion at bottlenecks. The considered case studies include passenger and freight services along European corridors and on long distance main-line networks and urban commuter railways.

Abstract (it): Nell'ambito del progetto ON-TIME sono stati sviluppati nuovi metodi e processi per consentire la massimizzazione della capacità disponibile nelle reti ferroviarie europee e per diminuire globalmente i ritardi, in modo da aumentare la soddisfazione dei clienti e garantire che la rete ferroviaria possa continuare a fornire una alternativa ecologica affidabile e flessibile ad altri mezzi di trasporto. Nel progetto, enfasi particolare e stata data ad approcci che riducessero la congestione nei colli di bottiglia. I casi studio considerati comprendono servizi passeggeri e merci lungo corridoi europei e su linee principali a lunga percorrenza o suburbane pendolari.

From - To: 2014 -

Objectives: 1) Improved management of the flow of traffic through bottlenecks to minimise track occupancy times 2) To reduce overall delays through improved planning techniques that provide robust and resilient timetables 3) To reduce overall delays and thus service dependability through improved traffic management techniques that can recover operations

Methodologies used: Exact methods, Heuristic / metaheuristic methods, Integer / combinatorial optimization, Dynamic programming, Stochastic / Robust optimization

Results: Through collaboration with the Erasmus University of Rotterdam, TU Delft and TU Dresden, the OR group at the University of Bologna developed a three-level framework for stable robust and energy-efficient timetables, and demonstrated it on a case-study of the Dutch railway network. In addition, we developed an exact railway timetable rescheduling approach for handling large-scale disruptions, such as track blockage, and tested it on a heavily used part of the Dutch railway network, showing that the model is able to find optimal solutions in short computation times. Finally, we developed a heuristic algorithm for the analysis of robustness, delay propagation and capacity saturation in a railway node, and tested it on real-world data of the Italian railways.

Result type: Case study

References and links: V. Cacchiani, D. Huisman, M. Kidd, L. Kroon, P. Toth, L. Veelenturf, J. Wagenaar. An Overview of Recovery Models and Algorithms for Real-time Railway Rescheduling. Transportation Research Part B, 63, 15-37, 2014

V. Cacchiani, F. Furini, M.P. Kidd. Approaches to a real-world train timetabling problem in a railway node. Omega, 58, 97-110, 2016

R.M.P. Goverde, N. Besinovic, A. Binder, V. Cacchiani, E. Quaglietta, R. Roberti, P. Toth. A Three-Level Framework for Performance-Based Railway Timetabling. Transportation Research Part C, 67, 62-83, 2016

L.P. Veelenturf, M.P. Kidd, V. Cacchiani, L.G. Kroon, P. Toth. A railway timetable rescheduling approach for handling large scale disruptions. Transportation Science, 50(3), 841-862, 2016

2. Auto-carrier transport optimization

Ottimizzazione del trasporto su bisarca

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Organization: University of Modena and Reggio Emilia - Department of Sciences and Methods for Engineering

Application field: Logistics, Transportation

Keywords: Vehicle Routing, Loading, Auto-Carrier

Abstract: Our project focused on a distribution problem arising in the automotive field and faced by the company Gruppo Mercurio srl. In this problem, cars, trucks and other vehicles have to be loaded on auto-carriers and then delivered to dealers. The solution of the problem involves both the computation of the routing of the auto-carriers along the road network and the determination of a feasible loading for each auto-carrier. We have solved the problem by means of an iterated local search metaheuristic, making use of several local search strategies for the routing part, as well as enumeration techniques for the loading part. The metaheuristic has been embedded into a software with a user-friendly interface.

Abstract (it): Il nostro progetto si è concentrato su un problema di distribuzione nel campo automobilistico, affrontato dall'azienda Gruppo Mercurio srl. In questo problema, automobili, camion e altri veicoli devono essere caricati su bisarche e poi consegnati ai concessionari. La soluzione del problema coinvolge sia il calcolo del percorso delle bisarche lungo la rete stradale, sia la determinazione di un carico possibile per ogni bisarca. Abbiamo risolto il problema per mezzo di una metaeuristica di tipo iterated local search, facendo uso di diverse strategie di ricerca locale per la parte di routing, nonché di tecniche di enumerazione per la parte di carico. La metaeuristica è stata incorporata in un software con un'interfaccia user-friendly.

From - To: 2011 -

Objectives: Minimize costs. Support daily decision process in Gruppo Mercurio.

Methodologies used: Heuristic / metaheuristic methods

Results: Development of an algorithm that can compute feasible loadings on auto-carriers and minimum cost routes. Improvement of the daily decision process concerning distribution in Mercurio srl. Development of a software with a user-friendly interface.

Result type: Case study, Software prototype

References and links: Dell'Amico M, Falavigna S, Iori M, "Optimization of a Real-World Auto-Carrier Transportation Problem", Transportation Science 49: 402-419 (2015).

3. Earthwork Optimization for the Construction of Autostrada Pedemontana Lombarda

Ottimizzazione della movimentazione terra nella costruzione dell'Autostrada Pedemontana Lombarda

Author: Mauro Dell'Amico

Email: mauro.dellamico@unimore.it

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Application field: Logistics, Transportation, Construction

Keywords: decision support, linear programming, earthwork, construction logistics

Abstract: Our project was developed as part of the activities related to the construction of Autostrada Pedemontana Lombarda. The construction of a highway includes various earthwork activities (digging, filling, recycling, dumping, ...), that must be done in different periods of the construction process. The goal of our project was to devise a support tool that aids construction managers to schedule the earthwork activities, determining the amount of quantity of each material that must be moved in a given time period, from a given origin to a given destination, so as to obtain a target profile at minimum cost in the planning horizon. To this aim, we developed optimization models by linear programming and network flow. We then embedded the models into a decision support tool.

Abstract (it): Il nostro progetto è stato sviluppato nell'ambito delle attività relative alla costruzione dell'Autostrada Pedemontana Lombarda. La costruzione di un'autostrada comprende varie attività di movimentazione terra (scavo, riempimento, riciclaggio, scarico, ...), che devono essere fatte in diversi periodi del processo di costruzione. L'obiettivo del nostro progetto era quello di ideare uno strumento di supporto che aiutasse i gestori nel programmare le attività di movimentazione, determinando la quantità di ogni materiale che deve essere trasferita in un dato periodo di tempo, da una data origine ad una data destinazione, in modo da poter ottenere un target a costo minimo nell'orizzonte temporale pianificato. A questo scopo, abbiamo sviluppato alcuni modelli di ottimizzazione che fanno uso della programmazione lineare e dei metodi di ottimizzazione su reti. Abbiamo poi incorporato questi modelli in uno strumento di supporto alle decisioni.

From - To: 2013 -

Objectives: Development of models to optimize flows of several materials in a long planning horizon. Implementation of a decision support system.

Methodologies used: Linear, Networks / graph optimization

Results: Results show his significant savings can be obtained by using the developed mathematical models and solution algorithms. The implemented tool allows decision makers to simulate several decisions and plan the process in the best way.

Result type: Case study, Software prototype

References and links: Dell'Amico M, Fuellerer G, Hoefinger G, Iori M, Novellani S, "A decision support system for highway construction: the Autostrada Pedemontana Lombarda", Interfaces 46: 245-263 (2016).

Bogenberger C, Dell'Amico M, Fuellerer G, Hoeflinger G, Iori M, Novellani S, Panicucci B, "Two-Phase Earthwork Optimization Model for Highway Construction", Journal of Construction Engineering and Management 141: 05015003-1 – 05015003-11 (2015).

4. Optimal maintenance of berth cranes in a maritime container terminal

Ottimizzazione della manutenzione delle gru di banchina in un terminale marittimo

Author: Manlio Gaudioso

Email: manlio.gaudioso@dimes.unical.it

Organization: Università della Calabria - DIMES - Dipartimento di Ingegneria Informatica, Modellistica Elettronica e Sistemistica

Application field: Logistics, Transportation

Keywords: operations scheduling, mixed integer programming, heuristics

Abstract: The project refers to optimal management of periodic maintenance of berth cranes in the Gioia Tauro maritime container terminal. According to the law requirements and the ongoing berth planning, the optimal scheduling of the maintenance operations on a given time horizon has been considered. The objective has been the downtime minimization, the maximization of the priorities satisfaction and the balanced use of workforce, characterized by a given skill mix. The resulting optimization model is of the mixed integer linear programming where each crane is considered in terms of its components, which are individually subject to maintenance activities. A heuristics has been

designed, implemented and tested on real data. It has been also incorporated into the operational information system of the terminal.

Abstract (it): Il progetto ha riguardato la gestione della manutenzione ordinaria di apparati complessi, come le gru di banchina, nel terminale marittimo per container di Gioia Tauro. In relazione agli obblighi di legge e alle situazioni operative circa la pianificazione degli attracchi delle navi, si è studiata l'ottimizzazione dello scheduling delle attività in manutenzione su un orizzonte temporale assegnato con l'obbiettivo di minimizzare i tempi di fuori servizio, soddisfare le priorità, garantire il miglior equilibrio possibile nell'impiego della manodopera, distinta in relazione alle sue competenze differenziate.
E' stato definito un modello matematico di ottimizzazione a variabili miste nel quale ciascuna gru viene analizzata nei singoli componenti ciascuno dei quali è soggetto a possibili attività manutentive sull'orizzonte temporale considerato. Un algoritmo euristico è stato progettato e testato sui dati reali e incorporato nel sistema informatico di gestione operativa del terminale.

From - To: 2014 -

Objectives: To design, test and incorporate into the operational system a mixed integer programming model for optimizing maintenance operations of berth cranes in the Gioia Tauro maritime container terminal.

Methodologies used: Heuristic / metaheuristic methods, Linear, Mixed integer programming, Scheduling

Results: A computer package for optimal management of maintenance of berth cranes in the Gioia Tauro maritime container terminal.

Result type: Case study, Software prototype

References and links:

5. Conflict solution algorithms applied to railways traffic regulation

Algoritmi di conflict solutions applicati al traffico ferroviario

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Organization: OPTIT Srl - OPTIT Srl

Application field: Transportation, Railways

Keywords: Conflict solution, railways

Abstract: Definition of conflict solution algorithms for the Traffic Management System of a leading global player in the Industry. The first phase of the project was carried out jointly with the Operations Research group of the University of Bologna.

Abstract (it): Elaborazione di algoritmi di risoluzione dei conflitti ferroviari da integrare nei Traffic Management System di azienda leader mondiale del settore. Progetto svolto, nei primi due anni, in stretta collaborazione con il gruppo di Ricerca Operativa dell'Università di Bologna.

From - To: 2013 -

Objectives: The aim of the project is the definition of a Global Mode conflict solution algorithm that embeds some leading edge, very innovative paradigms, intended to substitute the current approach used by the TMS. The solution has been successfully applied to several specific business cases in various European countries, providing evident advantages with respect of the previous methodologies.

Methodologies used: Heuristic / metaheuristic methods, Dynamic programming, Networks / graph optimization

Results: Algorithms for conflict solutions to be embedded in the customer's TMS solution.

Result type: Software package

References and links:

6. CONtainer TRAnshipment STation (CONTRAST)

CONtainer TRAnshipment STation (CONTRAST)

Author: Paolo Ventura

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Organization: CNR-IASI - Istituto di Analisi ed Informatica 'A. Ruberti'

Application field: Logistics, Transportation

Keywords: Minimizing reshuffle operations, Container yard, Container movements

Abstract: CONTRAST is a project developed together with Aresoft s.r.l., University of Genova, and University "La Sapienza" of Rome. The object of the project was the realization

of a software package for managing some crucial logistic issues arising in the container yard of an intermodal transport hub.

Abstract (it): CONTRAST è un progetto sviluppato assieme ad Aresoft s.r.l., Università degli Studi di Genova ed Università di Roma 'La Sapienza'. Oggetto del progetto è stata la realizzazione di un software per la gestione ottimizzata dei container all'interno di un'area di stoccaggio.

From - To: 2013 - 2015

Objectives: Object of the CONTRAST project was the realization of a software package for managing some crucial logistic issues arising in the container yard of an intermodal transport hub. Such a software, usable via web by the station operators, allows an optimized management of the movements of containers and cranes within the yard, minimizing, at the same time, the number of reshuffle operations performed together with the total distance covered by the cranes.

Methodologies used: Exact methods, Heuristic / metaheuristic methods, Integer / combinatorial optimization

Results: A software package has been developed, capable to manage the movements of cranes and containers when new containers arrive at the stocking yard and when some of them have to be retrieved from the yard.

Result type: Software package

References and links:

7. Optimization techniques for the management of the automotive transhipment terminal at the Gioia Tauro port

Tecniche e sistemi di ottimizzazione nella gestione del terminale marittimo di trasbordo per autovetture di Gioia Tauro

Author: Maria Flavia Monaco

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Organization: Università della Calabria - Dipartimento di ingegneria Informatica, Modellistica, Elettronica e Sistemistica (DIMES)

Application field: Logistics

Keywords: Automotive terminal, logistics, mathematical models, scheduling, heuristics

Abstract: The project concerns the optimal management of the main logistic processes at the Gioia Tauro automotive terminal. The ICOBLG yard is composed by two big areas: one devoted to transshipment, the other to the import flow. The transshipment area is composed by parking lines of variable length. The in/out flow of cars is performed in batches and no reallocation is allowed. The aim is to assign the arriving car batches to the yard lines so as to optimize the storage space and the loading/discharging time. The problem has been modeled as a Rectangular Packing on a rolling horizon. In the import yard the parked cars are picked-up individually, so producing the fragmentation of the free space. Therefore, the reallocation of given sets of cars becomes necessary to de-fragment some yard area in view of the next import flows. The housekeeping moves are performed by drivers, with the help of shuttle vehicles. The problem has been modeled as an ILP and solved by a heuristic algorithm based on a decomposition approach. Finally, the Vehicle Processing Center activities consist of customization, inspection and car repairs, if needed.

Abstract (it): La ricerca ha riguardato la gestione degli attracchi delle navi, del piazzale e delle attività del Centro Servizi nel terminale marittimo per autovetture di Gioia Tauro. Il piazzale ICOBLG è costituito da due macroaree: una dedicata al transshipment, l'altra al flusso di import. L'area di transshipment è suddivisa in linee di parcheggio di lunghezza variabile. Le auto in ingresso/uscita sono raggruppate in lotti e la riallocazione non è consentita. L'obiettivo è assegnare i lotti in arrivo a righe di piazzale in modo da ottimizzare lo spazio e la velocità di carico-scarico. Il problema è stato modellato come problema di Rectangular Packing su orizzonte temporale rullante. Nel piazzale di import le auto sono prelevate singolarmente; ciò genera la frammentazione dello spazio libero. Per compattare le aree occorre riallocare le vetture (housekeeping). Tali operazioni sono affidate ai driver e ad una o più navette. Il problema è stato affrontato mediante la decomposizione in sotto-problemi di routing e dial-a-ride. Infine, le attività del Centro Servizi consistono nella customizzazione, ispezione ed eventuale riparazione delle auto.

From - To: 2010 - 2013

Objectives: To design, test and apply the proposed optimization algorithms for the management of the main logistic processes at the Gioia Tauro automotive terminal: vessels to berth allocation; assignment of parking areas to car batches in the transshipment yard; scheduling of drivers and shuttle vehicles performing housekeeping moves in the import yard; scheduling of ordinary and extraordinary services of the Vehicle Processing Center.

Methodologies used: Heuristic / metaheuristic methods, Integer / combinatorial optimization, Scheduling

Results: Software prototypes implementing the algorithms for the optimal operative management of the automotive transshipment terminal at the Gioia Tauro port.

Result type: Software prototype

References and links:

8. An Integrated Algorithm for Shift Scheduling Problems for Local Public Transport Companies

Un algoritmo integrato per la risoluzione di problemi di scheduling per aziende di trasporto pubblico locale

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Organization: Università della Calabria - Dipartimento di Ingegneria Meccanica Energetica e Gestionale

Application field: Transportation

Keywords: Vehicle Scheduling; Crew Scheduling; Simulated Annealing; Local Search

Abstract: This paper presents an integrated approach to solve two shift scheduling problems for local public bus companies: the first one aims at finding a schedule for vehicles, given a set of rides to do; the second one aims at assigning drivers to vehicle schedules. The first subproblem to be faced is the Multiple Depot Vehicle Scheduling Problem that is known to be NP-hard. Therefore, heuristic algorithms are needed to find feasible solutions for real-life instances. In this work a starting solution for this problem is found by using a greedy algorithm. This solution is then improved by a simulated annealing strategy that exploits several local search techniques. The second problem to deal with is the Crew Scheduling Problem where each trip is assigned to a driver. This problem is still NP-Hard. In this paper an initial solution for the Crew Scheduling Problem is firstly found with a classical sequential approach. This solution is then modified by changing the allocation of trips on vehicles in order to minimize the combined objective function. Both the problems have been modelled taking into account as more real-world constraints as

possible. Several constraints take into account the European Union restrictions related to how the driver shifts must be composed. The proposed problem is different from the ones presented in the literature, as the mathematical model, and the related algorithm, are designed based on real world-requirements. Computational results have been carried out on large real–word instances. The results show that the proposed algorithm is able to find quickly good solutions within a limited computational time.

Abstract (it): Questo articolo presenta un approccio integrato per la risoluzione di due problemi di schedulazione per aziende di trasporto pubblico locale: l'obiettivo del primo problema consiste nella schedulazione di un set di veicoli per un dato insieme di corse da eseguire; il secondo problem mira a definire dei turni di lavoro per un insieme di autisti. Il primo sottoproblema affrontato è un problema di schedulazione di veicoli multi-deposito che è noto essere NP-hard. Pertanto, sono necessari algoritmi euristici per la ricerca di soluzioni ammissibili per istanze basate su contesti reali. Una soluzione di partenza per questo problema può essere identificata utilizzando un algoritmo avido. Questa soluzione può essere successivamente migliorata tramite un approccio di tipo simulated annealing che sfrutta diverse tecniche di ricerca locale. Il secondo problema da affrontare è il problema di schedulazione degli autisti in cui ogni corsa è assegnato ad un specifico autista. Questo problema è anche esso NP-Hard. In questo articolo una soluzione iniziale per il problema di schedulazione degli autisti è identificata utilizzando un approccio sequenziale. Questa soluzione viene quindi modificata modificando l'allocazione delle corse sui veicoli al fine di ridurre al minimo la funzione obiettivo combinata dei due problemi. Entrambi i problemi sono stati modellati tenendo conto diversi vincoli applicativi. Alcuni di questi vincoli tengono conto delle restrizioni definite dall'Unione europea relativi ad alcuni attributi che un generico turno di lavoro deve soddisfare. Il problema proposto è diverso da quelli presentati in letteratura, in quanto il modello matematico e il relativo algoritmo sono progettati in base ad un maggior numero di vincoli applicativi. I risultati computazionali sono stati condotti su grosse istanze basate su dati reali. I risultati mostrano che l'algoritmo proposto è in grado di trovare rapidamente buone soluzioni entro un tempo limitato di calcolo.

From - To: 2015 - 2017

Objectives: La definizione dei turni di servizio del personale è un problema estremamente sentito nella gestione delle Aziende di Trasporto. Tipicamente tale compito è assolto da personale specializzato in grado di individuare "manualmente" soluzioni che spesso non rappresentano la scelta ottimale in termini di costo aziendale e che richiedono tempi piuttosto lunghi per essere calcolate. Al costo in termini di tempo si aggiunge, inoltre, il costo del personale addetto alla turnazione. È, quindi, evidente l'interesse a dotarsi di un sistema software in grado di automatizzare il processo dell'elaborazione dei turni del personale, offrendo in tempi ragionevoli (spesso molto inferiori a quelli richiesti dal

personale addetto) soluzioni di buona qualità in termini di costo. L'ottimizzazione di problemi di schedulazione è un tema di notevole interesse per aziende di trasporto pubblico in quanto una grossa percentuale delle voci di costo dell'azienda sono direttamente attribuiti all'utilizzo degli autisti e dei veicoli a disposizione dell'azienda (chilometri di trasferimento, numero di veicoli, numero di autisti, tempo totale di lavoro e di guida degli autista ecc.).

Methodologies used: Heuristic / metaheuristic methods

Results: I vantaggi derivanti dall'utilizzo di un efficace software di ottimizzazione l'elaborazione dei turni sono molteplici: - Possibilità di ottenere risultati in tempi brevi - Verificabilità della correttezza dei risultati in tempi brevi - Valutazione immediata della qualità delle soluzioni - Risparmio di risorse (tempo, risorse umane da destinare ad altri processi). Tali vantaggi sono stati valutati quantitativamente utilizzando dei dati reali ricevuti dalla regione Calabria e testati per un periodo sufficientemente lungo di tempo.

Result type: Methodology, Software prototype

References and links:
http://www.sciencedirect.com/science/article/pii/S0305048316304789

9. ILDIF: Integration of Forward and Reverse Logistics for Fresh Products

ILDIF: Integrazione della Logistica Diretta e Inversa del Fresco

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Organization: University of Brescia - Department of Economics and Management

Application field: Logistics

Keywords: Distribution of fresh production; Collection of organic waste; Routing; Consolidation.

Abstract: ILDIF proposes an innovative distribution service for fresh products to restaurants, bars and groceries located in urban centers. It is well known that these activities require frequent (even daily) refilling of fresh products. Such supply involves a heavy transport activity. This is typically an ad-hoc service, not coordinated with other activities and as such is particularly costly both economically and socially. The purpose of ILDIF is to study a distribution strategy that minimizes the socio-environmental impact through: 1.

use of ecological vehicles; 2. integration of the distribution service with waste collection services, in particular the collection of organic waste; 3. reduction of traffic by implementing load consolidation strategies and optimizing the routes.

Abstract (it): Il progetto ILDIF propone un servizio innovativo di distribuzione del fresco presso attività di ristorazione, bar e grande distribuzione situate in centri urbani. E' noto come le attività di ristorazione richiedano un rifornimento frequente (anche giornaliero) di prodotti freschi. Tale approvvigionamento comporta una fitta attività di trasporto. Si tratta tipicamente di un servizio ad-hoc, non coordinato con altre attività e in quanto tale particolarmente dispendioso sia dal punto di vista economico sia da quello socio-ambientale. Lo scopo di ILDIF è lo studio di una strategia di distribuzione che ottimizzi l'impatto socio-ambientale grazie a: 1. utilizzo di veicoli ecologici; 2. integrazione del servizio di trasporto del fresco con servizi di raccolta rifiuti, in particolare il servizio di raccolta di materiale organico di scarto; 3. riduzione del traffico veicolare grazie all'implementazione di strategie di consolidamento dei carichi e di ottimizzazione dei percorsi.

From - To: 2014 - 2016

Objectives: The aim of ILDIF is to propose an innovative distribution service that exploits synergies with the organic waste collection service (reverse logistics) and optimizes vehicle load throughout the entire route. The activities carried out in the context of ILDIF are the following:

1. Territory analysis. Study of the current state of food distribution strategies at the commercial activities of a district in the city of Brescia.
2. Formalization of the problem and study of the state of the art. Formalize the problem as an optimization problem.
3. Identification and development of simulation software.
4. Analysis and evaluation of the service. Simulation studies related to service delivery in the scenarios identified in the previous phases.

Methodologies used: Heuristic / metaheuristic methods

Results: The results of the simulation studies show that the implementation of the new service would reduce the number of vehicles in the urban area, the total distance traveled and the travel time of the vehicles, indicating that it is possible to exploit synergies between the food distribution service and waste collection in order to improve the well-being of the citizens. The main limit to the development of this service emerged in the analysis of the territory. In fact, the answers given to the questionnaires submitted show that most of the caterers and bartenders interviewed do not intend to change the current methods of supplying foodstuffs. These considerations suggest the importance of a local government

introducing a system of incentives to push the adherence of restaurateurs and bartenders to a centralized service.

Result type: Case study

References and links:

10. Optimal trajectory and velocity planning for autonomous vehicles

Pianificazione ottima di traiettorie e velocità per veicoli autonomi

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Application field: Transportation

Keywords: Trajectory planning, velocity planning, dynamic programming

Abstract: In this project dynamic programming techniques are employed to plan trajectories for autonomous vehicles, in particular for autonomous parking. Once the trajectory has been detected, optimization techniques are also developed to plan the velocity along it in such a way that the physical limits of the vehicle are not exceeded and the running time is minimum.

Abstract (it): In questo progetto si studiano tecniche di programmazione dinamica per la pianificazione di traiettorie per veicoli autonomi, con particolare riferimento al parcheggio autonomo. Una volta pianificata la traiettoria, si studiano anche tecniche di ottimizzazione per pianificare la velocità da tenere lungo essa in modo da rispettare i limiti fisici del veicolo e da percorrerla in un tempo minimo.

From - To: 2015 -

Objectives: Develop a software which is able to compute the trajectory and the velocity along it within computing times acceptable for the users

Methodologies used: Exact methods, Nonlinear, Dynamic programming, Optimal control, Convex programming

Results: Application for a patent currently under evaluation

Result type: Patent

References and links:

11. Disruption and delay management in local public transport

Gestione dei ritardi e delle anomalie di servizio nel trasporto pubblico locale

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Organization: Politecnico di Milano - DEIB

Application field: Transportation

Keywords: local public transport, disruption management, recovery actions, crew scheduling reoptimization

Abstract: We developed a decision support tool to assist a local public transportation company in tackling service delays and small disruptions. We consider different ways to assess and improve the regularity of the service, and we propose a simulation based optimization system that can be effectively used in a real-time environment taking into account both vehicle and driver shifts. In particular, we describe a tabu-search procedure for the online vehicle scheduling optimizing the regularity of the service and a column generation approach for the consequential crew re-scheduling minimizing the driver extra-time. The system is going to be delivered for the application to urban surface lines of Azienda Trasporti Milanese (ATM) of Milan.

Abstract (it): Abbiamo sviluppato un sistema per il supporto alle decisioni di una azienda di trasporto pubblico locale nell'affrontare le irregolarità di servizio. Consideriamo vari modi di valutare e migliorare la regolarità di servizio e proponiamo un sistema di ottimizzazione basato sulla simulazione che possa venire utilizzato in tempo reale e che tenga conto dello scheduling dei mezzi e del personale. IN particolare proponiamo una euristica tabu search per la riottimizzazione dello scheduling dei veicoli e una column generation per la riottimizzazione del personale. Il sistema è in fase di applicazione alla rete di trasporto di superficie della Azienda Trasporti Milanese (ATM) of Milan.

From - To: 2012 -

Objectives: Increase the service regularity in a frequency system. Reduce the cost of extra allowances for the driver due to delays

Methodologies used: Heuristic / metaheuristic methods, Mixed integer programming, Data analytics / machine learning, Simulation

Results: The prototype tool has sensibly improved the service regularity in the lines where it has been applied during the highly critical EXPO 2015 period. The system has also reduced the cost due to extra allowances to the drivers.

Result type: Case study, Software prototype

References and links: The tool has been awarded with the best application during AIRO 2016 conference.

12. Optimization of ship itineraries for a cruise company

Ottimizzazione degli itinerari di navi da crociera

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Application field: Transportation

Keywords: cruise itinerary, two-objective optimization, MILP

Abstract: We tackle the problem of a cruise company which manages a ships fleet, and aims to optimizing the cruise itineraries in a given maritime area in order to minimize the itinerary costs due to fuel and port costs, and to maximize some attractiveness index of the itinerary. The problems turns out to be a bi-objective optimization problem. As to the first objective, the fuel consumption depends nonlinearly on the speed of the cruise ship; the speed depends on the distances between the ports and the deadlines for entering and leaving the port; the port cost depends on the port and on the services provided by the port. As to the second objective, it is evaluated by giving a rating to each port. The constraints of the problem are due to the cruise duration, to the minimum and maximum numbers of ports to be visited, to the allowable time window for the stay in the port, to the time windows for arrival and departure in the port. The decision variables specify the ports to be visited by each ship in each day, the arrival and departure times, which determine the itinerary of each cruise, and the navigation speed of each ship between two given ports. The problem has been modelled as a MILP with two objective, whose solution gives the Pareto efficient frontier in the space costs-attractiveness.

Abstract (it):

From - To: 2014 -

Objectives: The optimization of the cruise itineraries in a given maritime area in order to minimize the itinerary costs due to fuel and port costs, and to maximize some attractiveness index of the itinerary.

Methodologies used: Mixed integer programming

Results: The minimization of the fuel costs correspond to less fuel consumption, with a benefit in terms of resources efficiency and clean environment. The maximization of the ports attractiveness is a challenge for port authorities to improve the ports logistic and touristic infrastructures. From the economic points of view, minimizing the costs of the cruises and maximizing the itineraries attractiveness for the costumer gives a competitive advantage to the cruise company.

Result type: Case study, Software package

References and links:

13. SMArt platform to enabling high performance processes in faSHion's supply chains (SMASH)

Progettazione e sviluppo di una piattaforma tecnologica di supporto alle decisioni nella filiera logistica della moda (SMASH)

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Organization: University of Brescia - Department of Economics and Management

Application field: Logistics, Manufacturing / Production systems

Keywords: Supply Chain Management, Decision Support System, Fashion

Abstract: This project involves the design and development of a decision support system, called SMASH, that, based on using analytical, mathematical optimization and simulation techniques, as well as big data, aims at integrating and improving the processes of design, production and distribution of the supply chain in the Fashion industry, also adopting the perspective of a circular economy. The driving elements of the platform focus on the

paradigms of predictive-collaboration and risk-based management, concentrating on improving the forecasting process, which is particularly complex in the fashion industry, but enables the management of risk related to unavoidable forecasting errors as well as other factors, including exchange rate fluctuations, customs duties, and production costs. The platform integrates forecasting techniques, mathematical optimization and simulation, and the control of production / automation processes.

Abstract (it): Il progetto prevede l'ideazione e lo sviluppo di una piattaforma tecnologica di supporto alle decisioni, denominata SMASH, basata su tecniche analitiche, di ottimizzazione e simulazione, e con il ricorso all'utilizzo di big data, finalizzata ad integrare e migliorare i processi di design, produzione e distribuzione nella filiera logistica del Fashion, anche in un'ottica di economia circolare. L'elemento portante della soluzione insiste sul predictive-collaboration e sul risk-based management, mettendo al centro delle decisioni la previsione che, nell'ambito del fashion, è particolarmente complessa ma che abilita la gestione del rischio derivante dagli inevitabili errori predittivi e da altri fattori, quali ad esempio la variabilità dei cambi, dei dazi e dei costi di produzione. Nella piattaforma si integrano tecniche predittive, di ottimizzazione e simulazione stocastica ed il controllo dei processi di produzione/automazione.

From - To: 2017 -

Objectives: The goal of this project is to design and develop a decision support system that will enable a relevant improvement of the forecasting ability (more accurate, more detailed, continuously updated and shared among several decision makers). The platform will also enable the management of risk over the entire supply chain, and particularly the risk related to miscalculated purchases and erroneous allocation of stocks. It will simplify the decision process and improve the cooperation among the decision makers involved in the supply chain. It will improve the control and management of the production process, as well as optimize the distribution process.

Methodologies used: Data analytics / machine learning, Simulation

Results: It is a work in progress.

Result type: Case study, Software package

References and links:

14. Optimization models for designing a new cruise itinerary

Modelli di ottimizzazione per la progettazione di un nuovo itinerario crocieristico

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Organization: University of Genova - Department of Economics and Business Studies

Application field: Transportation

Keywords: Route design, Mixed integer programming models, cruise itinerary, customer satisfaction, scenarios analyses

Abstract: This work has been carried out in collaboration with the company's Itinerary Planning Office. It concerns the design of a new cruise itinerary. The itinerary is defined as a sequence of ports to be visited, chosen among a set of possible ports. The day and time of arrival and departure for each port are defined. Each itinerary must have certain levels of security, both in terms of geopolitical security and facility security. Another key aspect is the level of accessibility of the ports. The aim of the company is to determine a route in order to maximize the attractiveness of the product for customers, the revenue from excursions and those resulting from onboard services that are offered both during navigation and the period of Stop at ports, and minimize travel costs (harbor and fuel costs). This problem has been addressed by developing some combinatorial optimization models that have been implemented and solved by commercial solver (CPLEX - Gurobi). Retrospective tests are ongoing for model validation.

Abstract (it): Il presente lavoro, svolto in collaborazione con l'Itinerary Planning Office della società, riguarda la progettazione di un nuovo itinerario crocieristico. L'itinerario viene definito come sequenza di porti da visitare, scelti tra un insieme di porti disponibili; per ogni porto viene definito il giorno e l'ora di arrivo e di partenza. Ogni itinerario deve avere certi livelli di sicurezza, sia in termini di sicurezza geopolitica, sia in termini di sicurezza delle facilities. Un altro aspetto fondamentale è il livello di accessibilità dei porti. L'obiettivo dell'azienda è determinare un itinerario in modo tale da massimizzare l'attrattività e l'appealing del prodotto per il cliente, i ricavi derivanti dalle escursioni e quelli derivanti dai servizi a bordo che vengono offerti sia durante la navigazione sia durante i periodi di sosta nei porti, e minimizzare i costi del viaggio (costi di porto e di carburante). Tale problema è stato affrontato sviluppando diversi modelli di ottimizzazione combinatoria, che sono stati

implementati e risolti con risolutori commerciali (CPLEX – Gurobi). Sono in corso test retrospettivi per la validazione dei modelli.

From - To: 2017 -

Objectives: The aim of this work is to develop mathematical models for the definition of new cruise itineraries. In particular, the focus of the analysis is a Day by Day planning, taking as input the outputs of the Long Term Plan, and Cruise by Cruise planning. For example, the duration of the cruise, the date of starting with the festivities and weekends and the homeport, the harbor considered as the initial and final port of the itinerary, are inputs for the day by day planning . Day-by-day planning has a great impact on the results of the company, and much attention is paid to this type of decisions. The idea is to use the mathematical models to carry out scenarios analysis for leading the choices of the firm.

Methodologies used: Integer / combinatorial optimization

Results: Preliminary tests on the models seem to yield good results. Models validation is underway through retrospective tests. Moreover, scenario analysis will be carried out to provide the company with different solutions to be analyzed. The scenario analysis will also enable to identify which elements (involved in this complex decision-making process) the company needs to pay more attention, and in what sectors / markets the company will act with various interventions (maketing, pricing etc)

Result type: Case study

References and links:

15. ALS-Opti: an optimization module to support the order scheduling for transport and haulage companies

ALS-Opti: un modulo di ottimizzazione per la schedulazione degli ordini in aziende di trasporto

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Application field: Logistics, Transportation

Keywords: transportation, optimization, contaier drayage problem

Abstract: Container logistics has become of basic importance in the last two decades and in turn the short distance container transportation, both from an initial consignee to a terminal (seaport or railway hub station) and from a terminal to a final receiver performed by trucks. This door-to-door service is usually referred to as container drayage service and it is responsible for a significant portion of the total transportation cost. The drayage transport has the following basic elements: a fleet of trucks with different characteristics, a set of truck depots, a set of orders, i.e., requests of moving a container. Many additional conditions must be complied with, concerning the matching of container type with truck characteristics, the service hours regulations for drivers, etc. The set of the above elements makes the drayage problem very complex, to the point that it could be impossible to satisfy all the given orders with a limited sized fleet of trucks. This is why in practice decision makers can delay some orders (possibly paying a penalty) or even refuse some of them (thus giving up the relative income). ALS-Opti is an optimization module to support the order scheduling for transport and haulage companies with the necessity of decreasing operating costs and maximizing vehicles utilization, considering different constraints, such as the service hours regulation for drivers.

Abstract (it): Negli ultimi due decenni, gran parte del trasporto merci è effettuato utilizzando container. Oltre al loro trasporto su lunga distanza, è divenuto cruciale anche il breve trasporto dei container da uno stabilimento ad un terminal (porto o terminal ferroviario) e viceversa. Questo servizio porta a porta è detto "container drayage" ed è responsabile di buona parte del costo totale del trasporto. Il container drayage è costituito dai seguenti elementi di base: una flotta di camion con diverse caratteristiche, un insieme di depositi, un insieme di ordini, ossia richieste di muovere un container. Ci possono essere anche altre condizioni da considerare come la possibilità tecnica di accoppiare un container ad un camion, gli orari di servizio degli autisti, ecc. Tali elementi rendono il problema del trasporto breve di container molto complesso e spesso le aziende di trasporto, avendo una flotta limitata di camion, sono costrette a ritardare degli ordini di trasporto o addirittura a rifiutarli. ALS-Opti è un modulo di ottimizzazione in grado di aiutare le aziende di trasporto ad assegnare gli ordini di trasporto alla flotta di camion disponibili considerando vari vincoli, come ad esempio gli orari di lavoro degli autisti, minimizzando i costo operativi e aumentando l'utilizzazione dei veicoli.

From - To: 2014 - 2015

Objectives: The main objective of ALS-Opti is to determine which truck performs which order while maximizing the number of assigned orders and minimizing a given generalized cost function, which takes into account as main part the total distance travelled by a truck. The aim is helping the container trucking company operators in their daily operations of

assigning container transportation orders to the available fleet of trucks. To this aim, a heuristic algorithm based on the rolling horizon approach is implemented.

Methodologies used: Heuristic / metaheuristic methods

Results: ALS-Opti is an optimization module to support the order scheduling for transport and haulage companies with the necessity of decreasing operating costs and vehicles utilization. A tailored optimization algorithm allocates the received transport orders to the vehicles based on their actual availability. This software is estimated to reduce the operating costs up to 8%. ALS-Opti can handle large problems with hundreds of trucks and thousands of requests, and it can be easily integrated in corporate software, while the assignment output can be graphically displayed by using mapping applications: vehicle equipment and type, driver characteristics (licences, remaining working hours, and so on), requirements of the order. Also, the optimization module can assign new orders in real time based on the actual fleet assets availability. Supervisor presence is expected to confirm or modify the overall assignment result.

Result type: Software package

References and links:

16. Analisys and development of a model for the evaluation and optimization of the activities related to supply and inventory management of a petroleum company

Analisi e sviluppo di un modello per la valutazione e l'ottimizzazione delle attivita' di gestione inventariale e di supply di una compagnia petrolifera

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Application field: Logistics, Transportation

Keywords: decision support, simulation, logistics

Abstract: The project aims to study and develop a simulation based model for evaluating and optimizing the inventory and supply management activities of a petroleum company operating in Italy. The activities under consideration concern the supply of petroleum products to "primary" depots, used by the company to supply its marketing. The study is aimed at designing the primary supply model (warehousing, transit, primary transport, ...) and identifying optimal operating conditions from both the economical and operational sides. The study focuses on the analysis of parameters affecting supply logistics activities (e.g., managing inventory levels at major depots, primary transportation planning, …), and on the analysis of the variance of the inventory levels taking into account the level of service that the supply can guarantee to marketing and the operating and economic conditions necessary for this purpose. The project was conducted in collaboration with Dr. Pasquale Carotenuto (p.carotenuto@iac.cnr.it) of IAC-CNR, the National Italian Research Council.

Abstract (it): Il progetto ha l'obiettivo di studiare e sviluppare un modello di simulazione per la valutazione e l'ottimizzazione delle attività di gestione inventariale e di supply di una compagnia petrolifera operante in Italia. Le attività oggetto dello studio riguardano il supply di prodotti petroliferi nei depositi "primari", utilizzati dalla compagnia per rifornire il proprio marketing e le attività logistiche che ne derivano. Lo studio è volto alla costruzione del modello di supply primario (gestione dei depositi, dei transiti, del trasporto primario, …) e individuazione delle condizioni ottimali di esercizio sia economiche che operative. Lo studio si concentra sull'analisi dei parametri che incidono sulle attività logistiche di supply (es. gestione dei livelli di inventario presso i principali depositi, trasporto primario, transiti, …), sullo studio della varianza del processo di gestione inventariale facendo riferimento al "livello di servizio" che il supply può garantire al marketing ed alle condizioni, operative ed economiche, necessarie a tal fine (es. minimo stoccaggio necessario, safety stock, …). Il progetto è stato condotto in collaborazione con l'Ing. Pasquale Carotenuto (p.carotenuto@iac.cnr.it) dell'IAC-CNR.

From - To: 2010 - 2011

Objectives: Development of simulation based models to optimize primary fuel oil transportation planning and inventory levels at depots in a medium term planning horizon. Implementation of a simulation based decision support system.

Methodologies used: Simulation, Stochastic / Robust optimization, Statistics

Results: The simulation provide insights to obtain significant reductions of the variance of inventory levels at logistics facilities of the petroleum company. The implemented tool allows decision makers to simulate the impact of several decisions in order to plan the process in the best way.

Result type: Case study, Software prototype

References and links: D. Bosso, P. Carotenuto, S. Giordani, L. Locurcio, G. Minotti, D. Secli, "Study for the Inventory Variance Reduction of the Primary Depots of a Petroleum Company", in: Proceedings of the 18th International Sysmposium on Logistics, ISL 2013, Vienna, Austria, 7-10 July 2013, pp. 44-48. P. Carotenuto, S. Giordani, A. Zaccaro, "A Simulation Based Approach for Evaluating the Impact of Maritime Transport on the Inventory Levels of an Oil Supply Chain", in: Proceedings of the 17th Meeting of the EURO Working Group on Transportation, EWGT2014, Sevilla, Spain, 2-4 July 2014, Transportation Research Procedia, 3 (2014) 710-719.

17. Design and development of a software for the tactical secondary level fuel oil distribution planning

Progettazione e implementazione di un software di pianificazione della distribuzione secondaria di livello tattico di oli carburante

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Application field: Logistics, Transportation

Keywords: decision support, optimization, logistics

Abstract: The objective of the project is to study periodic vehicle routing models for tactical optimization of the secondary fuel oil distribution, consisting in determining the fuel oil procurement plans of a set of petrol stations and planning the delivering routes of petrol products to the stations along a certain planning horizon. The study is aimed at the development of metaheuristic optimization algorithms and the implementation of a decision support software that allows the evaluation and optimization of the secondary fuel oil distribution of a petroleum company operating in the Italian territory. The project was conducted in collaboration with Dr. Pasquale Carotenuto (p.carotenuto@iac.cnr.it) of IAC-CNR, the National Italian Research Council.

Abstract (it): L'obiettivo del progetto è lo studio di modelli di vehicle routing periodico per l'ottimizzazione a livello tattico della distribuzione secondaria di oli carburante che consiste nel pianificare i piani di rifornitura settimanale di oli carburante di un insieme di stazioni di rifornimento e ottimizzare i percorsi delle autobotti per il rifornimento delle

stazioni. Lo studio è finalizzato allo sviluppo di algoritmi di ottimizzazione basati su metaeuristiche e alla implementazione di un software di supporto alle decisioni che consente la valutazione e l'ottimizzazione delle attività tattiche di distribuzione secondaria degli oli carburante di una compagnia petrolifera operante nel territorio italiano. Il progetto è stato condotto in collaborazione con l'Ing. Pasquale Carotenuto (p.carotenuto@iac.cnr.it) dell'IAC-CNR.

From - To: 2014 - 2014

Objectives: Development of a decision support tool for the optimization of the secondary fuel oil distribution from a depot to a set of petrol station in a short-medium term planning horizon.

Methodologies used: Heuristic / metaheuristic methods, Integer / combinatorial optimization

Results: The tool is capable to: optimize the weekly plan of fuel oil distribution, make what-if analysis in case of reconfiguration/changing of fuel oil demands, distribution plans, and petrol stations.

Result type: Case study, Software prototype

References and links: P. Carotenuto, S. Giordani, S. Massari, F. Vagaggini, "Periodic capacitated vehicle routing for retail distribution of fuel oils", in: Proceedings of the 18th Meeting of the EURO Working Group on Transportation, EWGT2015, Delft, The Netherlands, 14-16 July 2015, Transportation Research Procedia, 10 (2015) 735-744. P. Carotenuto, S. Giordani, S. Massari, F. Vagaggini, "A multi-depot periodic vehicle routing model for petrol station replenishment", in: J. Zak et al. (eds.), Advanced Concepts, Methodologies and Technologies for Transportation and Logistics, Advances in Intelligent Systems and Computing (series), Volume 572, Springer International Publishing (2017). P. Carotenuto, S. Giordani, D. Celani, "Planning Retail Distribution of Fuel Oils", in: Proceedings of the 20th Meeting of the EURO Working Group on Transportation, EWGT2017, Budapest, Hungary, 4-6 September 2017, Transportation Research Procedia, (2017) to appear.

18. Warehouses Transportation & Distribution

Warehouses Transportation & Distribution

Author: Raffaele Maccioni

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Organization: ACT Operations Research - ACT Operations Research

Application field: Aerospace, Economics and finance, Healthcare, Logistics, Marketing, Manufacturing / Production systems, Military, Services and society, Transportation

Keywords: Warehouses, Transportation, Distribution

Abstract: The products in this suite enable an effective management of logistics, transportation and supply chain by dynamic simulation and math-optimization technologies. Warehouse and distribution centers benefit by our OPT Warehouse tools set, including modules to simulate warehouses and complex distribution centers. You can optimize the design of processes and facilities, or optimize the operations (slotting, picking, sorting, etc). In case of intensive automations our HI-Swarm (set of tools enable higher productivities. OPT Net combined with network simulation, is the solution to design and analyze supply chains. To support the Transport Management our fleet routing and scheduling constitutes the backbone of an advanced Transport Management System.

Abstract (it): The products in this suite enable an effective management of logistics, transportation and supply chain by dynamic simulation and math-optimization technologies. Warehouse and distribution centers benefit by our OPT Warehouse tools set, including modules to simulate warehouses and complex distribution centers. You can optimize the design of processes and facilities, or optimize the operations (slotting, picking, sorting, etc). In case of intensive automations our HI-Swarm (set of tools enable higher productivities. OPT Net combined with network simulation, is the solution to design and analyze supply chains. To support the Transport Management our fleet routing and scheduling constitutes the backbone of an advanced Transport Management System.

From - To: 2016 -

Objectives: The core products belonging to the WT&D suite are: OPTslotting (OPTsl) OPTheight (OPTh) OPTstock (OPTst) OPT Net(OPTn) (supply chain optimization & simulation) DQC (Dynamic Quality Control) HI Swarm (Handling by intelligent swarms – for automated handling processes) OPTrunner (OPTr) OPTcalendar (OPTc) OPTvessel (OPTv)

Methodologies used: Exact methods, Heuristic / metaheuristic methods, Integer / combinatorial optimization, Data analytics / machine learning, Simulation, Statistics

Results: The core products belonging to the WT&D suite are: OPTslotting (OPTsl) OPTheight (OPTh) OPTstock (OPTst) OPT Net(OPTn) (supply chain optimization & simulation) DQC (Dynamic Quality Control) HI Swarm (Handling by intelligent swarms – for automated handling processes) OPTrunner (OPTr) OPTcalendar (OPTc) OPTvessel (OPTv)

Result type: Software package

References and links: http://www.act-operationsresearch.com

19. Cruise Analytics

Cruise Analytics

Author: Raffaele Maccioni

Email: Raffaele.Maccioni@act-OperationsResearch.com

Organization: ACT Operations Research - ACT Operations Research

Application field: Logistics, Transportation, Cruise

Keywords: Cruise

Abstract: Cruises Lines can now benefit from a a vertical suite of math-technologies to support their decisions from the Itinerary Planning to the Revenue Management to the Customers Intelligence. The Cruise Itinerary Planning (CIP) module of the Magellano software suites a management Decision Support System (DSS) based on advanced techniques of Operations Research. It allows the itinerary planning of cruises, including route, calculation of costs, market attractiveness and estimation of revenues. Cruise itinerary planning is an extremely complex problem due to the presence of several operational constraints, e.g. ship dimension, fuel cost and consumption, ports distances, speed and embark/debark time windows.

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From - To: 2016 -

Objectives: The Cruise Itinerary Planning (CIP) module of the Magellano software suites a management Decision Support System (DSS) based on advanced techniques of Operations Research. It allows the itinerary planning of cruises, including route, calculation of costs, market attractiveness and estimation of revenues.

Methodologies used: Exact methods, Heuristic / metaheuristic methods, Integer / combinatorial optimization, Data analytics / machine learning, Simulation, Statistics

Results: The Cruise Itinerary Planning (CIP) module of the Magellano software suites a management Decision Support System (DSS) based on advanced techniques of Operations Research. It allows the itinerary planning of cruises, including route, calculation of costs, market attractiveness and estimation of revenues.

Result type: Software package

References and links: http://www.act-operationsresearch.com

20. SMART - A double dynamic fast algorithm to support multi-vehicle demand responsive transportation system

SMART – un algoritmo doppiamente dinamico per sistemi di trasporto a chiamata

Author: Pasquale Carotenuto

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Organization: Consiglio Nazionale delle Ricerche - Istituto per le Applicazioni del Calcolo 'M. Picone'

Application field: Transportation

Keywords: Transportation planning, Public transport, Demand Responsive Transportation System, Vehicle routing, Dial a Ride

Abstract: The aim of the project was to define a two level heuristic algorithm working in near real-time to solve a multi-vehicle many-to-many Dial-A-Ride Problem (DARP). The implemented algorithm is ready to support a Demand Responsive Transportation System (DRTS) requiring a fast evaluation of an efficient vehicles scheduling and to quickly provide a response to customers. The insertion heuristic is double dynamic in near real-time and the objective function consists in minimizing the difference between requested and scheduled time for pick-up and delivery. At the first level the heuristic provides an answer to any customer web-request: if the reservation request can be accepted, it is inserted in a vehicle schedule, otherwise it is rejected. At the second level, in the elapsed time between a request and the following one, the algorithm tries to re-optimize the solution previously obtained.

Abstract (it): Si è realizzato un algoritmo euristico a due livelli per risolvere, con tempi di risposta estremamente contenuti, un Problema di Dial-A-Ride (DARP) multi-veicolo. Questo algoritmo è quindi maturo per supportare un Sistema di Trasporto a chiamata (in inglese Demand Responsive Transportation System - DRTS) in cui si debba valutare rapidamente il piano d'esercizio per la flotta di veicoli e fornire prontamente una risposta agli utenti. L'euristica di inserzione è doppiamente dinamica in tempo quasi reale e la funzione obiettivo consiste nel ridurre al minimo la differenza tra il tempo richiesto di prelievo e consegna e quello programmato. Al primo livello, all'arrivo via web di una richiesta di un cliente, l'euristica restituisce una risposta circa la possibilità di inserire tale richiesta nelle prenotazioni accettate, e quindi nella schedula di un veicolo, oppure rifiuta la richiesta stessa. Al secondo livello, nel tempo intercorrente tra una richiesta e la successiva, si cerca di ri-ottimizzare la soluzione precedentemente ottenuta.

From - To: 2014 - 2016

Objectives: In this project, a software for the management of a Demand Responsive Transportation System has been developed with the aims to promote the integration of flexible transport systems with conventional on rail (regional and subway) transport and urban or suburban bus services. This software is an interesting tool both for the planning phase of a transport system for the "last mile" that for the operating phase. A further development perspective of the project is the management of a mixed fleet, consisting of electric vehicles and traditional vehicles. In this way, the new prototype will take into account, in the model and in the resolution algorithms, all the operational constraints that the use of electric vehicles impose.

Methodologies used: Heuristic / metaheuristic methods

Results: The result of the project is a web application ready to be used in a Demand Responsive Transportation System. The application must be integrated and tested with the system components that realize localization, monitoring and communication with the vehicle, and the middle-ware software for the component integration.

Result type: Software package, Software prototype

References and links: - Carotenuto P., C. Cis And Storchi G., "Hybrid genetic algorithm to approach the DaRP in a demand responsive passenger service", "INFORMATION CONTROL PROBLEMS IN MANUFACTURING 2006" Proceedings of the 12th IFAC International Symposium, Elsevier Science, ISBN: 978-0-08-044654-7, v.3 pp.349-354, 2006.

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- Carotenuto P., Martis F., "Innovative flexible services for people transportation", accepted in the Proceeding of 20th EURO Working Group on Transportation Meeting, EWGT 2017, 4-6 September 2017, Budapest, Hungary.

21. Multimodal, multiobjective shortest paths

Cammini minimi multimodali, multiobiettivo

Author: Fabio Schoen

Email: fabio.schoen@unifi.it

Organization: Università degli Studi di Firenze - DINFO

Application field: Logistics, Transportation

Keywords: shortest path, pareto

Abstract: Develpopement of algorithms and software for shortest paths in urban graphs, when public as well as private transport is considered; bike trails are also taken into account, as well as multiple and conflicting objective functions

Abstract (it): Sviluppo di algoritmi e software per la ricerca di cammini in grafi urbani in presenza di trasporto pubblico e privato, di presenza di piste ciclabili, di obiettivi multipli e contrastanti

From - To: 2010 -

Objectives: To develop advanced optimization techniques for large scale multimodal shortest path algorithms

Methodologies used: Exact methods, Heuristic / metaheuristic methods, Integer / combinatorial optimization, Networks / graph optimization

Results: -

Result type: Case study, Software package

References and links:

22. Algorithms for optimal order assignment and replenishment

Algoritmi per l'assegnazione ottimale di ordini ed il replenishment

Author: Fabio Schoen

Email: fabio.schoen@unifi.it

Organization: Università degli Studi di Firenze - DINFO

Application field: Logistics, Manufacturing / Production systems

Keywords: optimal replenishment, retail, reorder point, simulation

Abstract: Optimization methods fot optimal retail order assignment, optimal order quantity and replenishment

Abstract (it): Algoritmo di ottimizzazione per le decisioni tattiche di assegnazione degli ordini al dettaglio da parte della produzione e per la decisione relativa ai livelli ed alla tempistica di replenishment

From - To: 2015 - 2016

Objectives: To develop an optimization algorithm for optimal replenishment

Methodologies used: Exact methods, Heuristic / metaheuristic methods, Mixed integer programming, Data analytics / machine learning, Simulation

Results: undisclosed

Result type: Case study, Methodology, Software package

References and links:

23. Automatic control of tramway headways

Studio di politiche di regolazione automatica del distanziamento su linee tramviarie

Author: Fabio Schoen

Email: fabio.schoen@unifi.it

Organization: Università degli Studi di Firenze - DINFO

Application field: Transportation

Keywords: Headway, tramway, simulation, optimal distance

Abstract: This research was devoted to study headway control policies for tramways where consecutive vehicles try to maintain a constant time distance

Abstract (it): Lo studio ha riguardato le politiche di distanziamento ottimale tra veicoli consecutivi su una linea tramviaria in cui i mezzi viaggiano cercando di mantenere un distanziamento temporale costante

From - To: 2013 - 2013

Objectives: To develop both a simulator of tramway lines managed by different control policies and to develop and experiment an optimal headway control rule in presence of several sources of randomness

Methodologies used: Exact methods, Heuristic / metaheuristic methods, Simulation, Networks / graph optimization

Results: We deveoped both the simulator and the optimal control strategy

Result type: Case study, Methodology, Software package

References and links:

Production Systems

24. Development of an algorithm for the optimal loading of a trunk

Sviluppo di un algotimo per il caricamento ottimo di un bagagliaio

Author: Claudio Sterle

Email: claudio.sterle@unina.it

Organization: University 'Federico II' of Naples - Department of Electrical Engineering and Information Technology

Application field: Manufacturing / Production systems

Keywords: loading; three-dimensional packing; heuristic

Abstract: We tackled a three-dimensional non-convex domain loading problem arising in the car manifacturer industry. The aim is to efficiently load identical small boxes into a highly irregular non convex domain (the car trunk). The boxes to be loaded have a particular shape. If d is the length of the smallest edge of the box, its dimensions are d ×nd×md, n ≤ m, with n and m integer values. This loading problem arises from an industrial design problem where it is necessary to obtain good solutions with very low computation time. We propose a fast heuristic based on an approximate representation of the non-convex domain in terms of cubes of dimension d and on the decomposition of the whole problem in several two-dimensional subproblems related to 'planes' of height d. The proposed heuristic shows good performances in terms of quality of solution and computation times and improves the solution already used by the company.

Abstract (it): E' stato affrontato lo studio di un problema di packing/loading tridimensionale nell'ambito dell'industria automobilistica. I problemi di packing/loading in generale consistono nel trovare il posizionamento ottimo di oggetti di dimensioni ridotte (item) all'interno di un contenitore di grandi dimensioni (bin) in modo da massimizzare il volume utilizzato. Nel caso specifico oggetto di studio, il problema di loading tridimensionale è caratterizzato da un bin non convesso (il bagagliaio di un auto) e da item costituiti da parallelepipedi aventi tutti la stessa dimensione (d ×nd×md, n ≤ m, con n ed m interi). E' stato sviluppato un algoritmo euristico per il packing/loading di un dominio non convesso, basato sulla discretizzazione del dominio stesso. La soluzione calcolata è sempre non peggiore di quella ottenuta dalla procedura aziendale. L'elemento di forza

dell'algoritmo proposto risiede nella rapidità di esecuzione. Sulle istanze reali fornite dall'azienda esso ha richiesto un tempo di calcolo di pochi secondi contro le ore richieste dalla procedura aziendale.

From - To: 2008 -

Objectives: - automating the procedure for the computation of the number of small boxes that can be packed within the car trunk; - developing a procedure which could be easy managed and modified by the company technicians; - developing a solving approach which could return a good feasible solution with very low computation time, since a trunk packing problem has to be solved each time a new trunk design is provided by the designers

Methodologies used: Heuristic / metaheuristic methods

Results: - Development of an optimization tool based on a fast and easy heuristic to solve the trunk packing problem and more in general a three-dimensional non-convex domain loading problem, where the small items to be used have regular shapes (parallelepipids).

Result type: Case study, Software prototype

References and links: - Boccia M., di Muro S., Mosca F., Sforza A., Sterle C.. "A fast heuristic for a three-dimensional non-convex domain loading problem". 4OR A Quarterly Journal of Operations Research, DOI 10.1007/s10288-010-0133-9, (2010).

25. Production planning for a shared production line

Pianificazione di una linea di produzione condivisa

Author: Giovanni Giallombardo

Email: giallo@dimes.unical.it

Organization: Università della Calabria - Dipartimento di Ingegneria Informatica, Modellistica, Elettronica e Sistemistica (DIMES))

Application field: Logistics, Manufacturing / Production systems

Keywords: product rotation, set up time management, lotsizing, scheduling

Abstract: Production planning for the FIX2 line of FATER SpA, a leading company in diaper production for all market segments, has been considered. The production line is shared by several different products and so it is operated in a rotation fashion, with variable size lots

being produced within a given time cycle. The objective has been the optimization of the total production and inventory costs. Special attention has been paid to fixed costs, mainly dependent on the set up costs that are, in turn, related to the operations sequence. Optimal calculation of both lotsizes, time cycle and production scheduling has been obtained.

Abstract (it): Il problema considerato è la pianificazione della produzione della linea FIX2 della FATER SpA, azienda leader nella produzione di diverse tipologie di pannolini che coprono tutti i segmenti di mercato. La linea di produzione costituisce una risorsa condivisa, nel senso che le singole tipologie vengono realizzate a lotti, sulla base di un processo di utilizzo a rotazione dei macchinari. E' stato sviluppato un modello di ottimizzazione con l'obiettivo di contenimento dei costi complessivi di produzione e stoccaggio concentrando in particolare l'attenzione sui costi fissi, largamente dipendenti dai costi di approntamento (setup) della linea, a loro volta funzione del sequenziamento delle produzioni. Il modello definito è del tipo produzione a rotazione ed ha l'obiettivo di ottimizzare la dimensione del lotto di ciascuno dei prodotti, l'intervallo di tempo che intercorre tra l'inizio di due cicli immediatamente successivi di produzione e il sequenziamento dei prodotti.

From - To: 2013 -

Objectives: Implementation of a decision support software system, for FATER SpA, to allow the production planner to define appropriately the lotsizes, the time cycle and the product scheduling in the area of diaper production.

Methodologies used: Exact methods, Scheduling

Results: The production planning package has been delivered to FATER SpA and it is currently in use.

Result type: Case study, Software package

References and links:

26. Tactical and operational planning of agricultural tractors

Pianificazione tattica e operativa per la produzione di trattori agricoli

Author: Massimo Paolucci

Email: massimo.paolucci@unige.it

Organization: IROI Srl - DIBRIS - University of Genova

Application field: Manufacturing / Production systems

Keywords: Production Planning, Mixed Model Production, MIP heuristics

Abstract: The problem of tactical (long term) and operational (medium term) planning for the production of different families of agricultural tractors has been addressed. Two sets of objectives have been jointly taken into account, in particular, a set related to commercial aspects (satisfaction of customer demand) and another set related to production operational criteria (stability of production). The considered planning model is multi-product and multi-level. A flexible MIP model for the two types of planning was developed that makes it possible the definition of custom constraints by means of the planning operators. The presence of multiple objectives has been addressed through a lexicographical priority approach. The realized algorithm implements a rolling horizon decomposition approach with a fix and optimize strategy.

Abstract (it): E' stato affrontato il problema di definire la pianificazione tattica (lungo periodo) e operativa (media periodo) per la produzione di trattori agricoli di diverse famiglie cercando di ottimizzare un insieme di obiettivi relativi ad aspetti commerciali (soddisfazione della domanda dei clienti) e produttivi (stabilità della produzione). Il modello di pianificazione considerato è di tipo multi-prodotto e multi-livello. E' stato sviluppato un modello MIP di tipo flessibile per i due tipi di pianificazione, poiché si è reso possibile la definizione di vincoli personalizzati da parte degli operatori. L'aspetto multi-obiettivo è stato affrontato attraverso un approccio a priorità lessicografica. L'algoritmo realizzato realizza una decomposizione rolling horizon con una strategia fix and optimize.

From - To: 2009 - 2010

Objectives: The project objective was to provide the production company with a planning tool supporting the activity of production managers. Planning was basically a manual activity requiring long time and it was based on the use of spreadsheets.

Methodologies used: Heuristic / metaheuristic methods, Mixed integer programming, Multi-criteria / multi-objective

Results: The tool allows to define in short time plans, comparing the effects of different priority orders for the considered objectives, so permitting the decision maker to identify the desired compromise between commercial and production contrasting targets (i.e., following as much as possible the dynamic of demand versus maintain the production as much stable as possible).

Result type: Case study, Software prototype

References and links:

27. Inventory stock mix optimization for spare parts management

Ottimizzazione delle scorte in magazzino per parti di ricambio

Author: Massimo Paolucci

Email: massimo.paolucci@unige.it

Organization: IROI Srl - DIBRIS - University of Genova

Application field: Manufacturing / Production systems

Keywords: Inventory management, safety stock, stochastic linear programming

Abstract: In the automotive, service parts stock management is a part of the process to ensure that right spare parts are in the warehouse at the right place and time with respect to a customer demand. Customer satisfaction can be measured by the First Fill Rate Value (FFRV), i.e., the ratio between the order items satisfied by the available inventory and the total number of received order items. This value is evaluated for different spare parts, taking into account production and cost constraints. The problem of optimal planning the safety stock levels in spare parts inventory over a planning horizon was considered. The proposed solution to this inventory optimization problem is based on the definition and solution of a stochastic linear programming problem: in such an approach the quality constraints are based on a piece-wise linear regression of the FFRV identified on the basis of the analysis of historical data. The implemented solution method is based on the generation of scenarios.

Abstract (it): Nel settore automobilistico, la gestione delle scorte di parti di ricambio è necessaria per assicurare la presenza dei ricambi in magazzino per soddisfare la domanda dei clienti. Tale soddisfazione è misurata per mezzo del First Fill Rate Value (FFRV), ossia il rapporto tra gli articoli ordinati soddisfatti dal magazzino disponibile e il numero totale di articoli ordinati. Questo valore viene valutato per le diverse parti di ricambio, considerando costi e vincoli della produzione. Il problema affrontato consiste nella pianificazione ottimale dei livelli di sicurezza delle parti di ricambio in magazzino su un dato orizzonte temporale. La soluzione proposta è basata sulla definizione di un problema di programmazione lineare stocastico: in tale approccio i vincoli di qualità sono stati modellati per mezzo di una regressione lineare a tratti del FFRV identificato sulla base dell'analisi dei dati storici disponibili. Il metodo di soluzione implementato è basato sulla generazione di scenari.

From - To: 2009 - 2010

Objectives: The project objective is to develop an algorithm to be included into a demand planning system in order to estimate the right safety stock levels for a large number of spare parts for an agricultural automotive industry producing tractors so that the spare part demand from customers was has much as possible satisfied at the minimum inventory cost.

Methodologies used: Exact methods, Linear, Stochastic / Robust optimization

Results: The developed algorithm was experimented on real cases and it allowed to improve the spare part inventory planning, reducing the safety stock levels so that it was possible to achieve a cost saving of about 15%.

Result type: Case study, Software prototype

References and links:

28. Virtualization of serial production. Ensure the robustness and persistence of the process by means of the optimization

Virtualizzazione della produzione di serie. Garantire la robustezza e la costanza del processo con l'ottimizzatore

Author: Francesca Maggioni

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Organization: University of Bergamo - Management, Economics and Quantitative Methods

Application field: Manufacturing / Production systems

Keywords: ottimizzazione robusta; produzione di serie

Abstract: The aim of this research activity was to determine the optimal parameters in order to improve the casting configuration for metallurgical processes that would reduce the presence of air entrainment in the jet to obtain the best quality of the same. The research has highlighted the importance of determining the optimal solution through robust optimization tools that allow a less sensitive solution to matherial variations during the production process, making the output totally reliable for serial productions. This analysis was carried out using the PAM-OPT software.

Abstract (it): L'obiettivo di tale attività di ricerca è stata quella di determinare i parametri ottimali al fine di migliorare la configurazione del ramo di colata per processi metallurgici che consenta di ridurre la presenza di inglobamenti d'aria nel getto al fine di ottenere la migliore qualità dello stesso. La ricerca ha evidenziato l'importanza della determinazione della soluzione ottimale tramite strumenti di ottimizzazione robusta che consentano di ottenere una soluzione meno sensibile a variazioni durante il processo produttivo rendendo l'output totalmente affidabile per produzioni di serie. Tale analisi è stata effettuata utilizzando il software PAM-OPT.

From - To: 2016 - 2016

Objectives: Determine the optimal parameters in order to improve the casting configuration for metallurgical processes that would reduce the presence of air entrainment in the jet to obtain the best quality of the same. Robust optimization tools that allow a less sensitive solution to matherial variations during the production process have been adopted.

Methodologies used: Nonlinear, Stochastic / Robust optimization, Multi-criteria / multi-objective

Results: For different starting configurations the optimal parameters for metallurgical processes have been determined. The results reduce the presence of air entrainment in the jet obtaining the best quality of the same for a serial production.

Result type: Methodology, Software package

References and links:

29. Enhancing Sales Forecasting Methods and Optimizing Matherial Requirement Planning to reduce warehouse inventory

Potenziamento dei metodi di previsione delle vendite e programmazione ottimale dell'approvvigionamento di materie prime e di altri materiali per la minimizzazione delle giacenze di magazzino

Author: Francesca Maggioni

Email: francesca.maggioni@unibg.it

Organization: University of Bergamo - Management Economics and Quantitative Methods

Application field: Logistics, Manufacturing / Production systems

Keywords: mrp, forecasting, optimization

Abstract: In this project we provide a tool that could enhance and support on the one hand the sales forecasting methods, on the other hand, the optimal programming of raw material supply and packing materials in order to minimize the level of inventory of the Centrale del Latte di Vicenza. The collaboration was born thanking to the "Sportello matematico per l'Industria Italiana" of the IAC-CNR Institute. The project has been done in collaboration of prof. Luca Bertazzi.

Abstract (it): In questo progetto è stato realizzato uno strumento che potenzi e supporti da un lato i metodi di previsione delle vendite, e dall'altro la programmazione ottimale dell'approvvigionamento di materie prime e di materiali per l'imballaggio al fine di minimizzare il livello delle giacenze di magazzino della Centrale del Latte di Vicenza. La collaborazione è nata tramite il progetto 'Sportello matematico per l'Industria Italiana' dell'Istituto IAC-CNR. Il progetto è stato svolto in collaborazione del prof. Luca Bertazzi.

From - To: 2015 - 2017

Objectives: L'obiettivo del progetto realizzato è stato quello di fornire alla Centrale del Latte di Vicenza uno strumento che potesse potenziare e supportare da un lato i metodi di previsione delle vendite, e dall'altro la programmazione ottimale dell'approvvigionamento di materie prime e di materiali per l'imballaggio al fine di minimizzare il livello delle giacenze di magazzino.

Methodologies used: Heuristic / metaheuristic methods, Simulation, Stochastic / Robust optimization, Scheduling

Results: E' stato fornito alla Centrale del Latte di Vicenza uno strumento che prende in input la serie storica di tutti i prodotti forniti dall'azienda e crea in output un foglio di lavoro contenente per ciascun prodotto il metodo predittivo utilizzato e la previsione di domanda per le prossime 6 osservazioni future. Lo strumento può essere utilizzato dall'azienda in maniera autonoma, aggiornando settimana dopo settimana il file di input con le nuove osservazioni e facendo ricalcolare al file le previsioni future. E' stato inoltre prodotto uno strumento software in grado di replicare e di migliorare, attraverso l'uso di un modello di ottimizzazione, l'attuale metodo MRP utilizzato dall'azienda per la pianificazione degli approvvigionamenti di materie prime e di materiali per l'imballaggio e il confezionamento.

Result type: Case study, Software package

References and links:

30. ALS-Plan: a Decision Support System for scheduling the production operations in steelmaking companies

ALS-Plan: un sistema di supporto alle decisioni per la schedulazione delle operazioni in acciaierie

Author: Walter Ukovich

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Organization: AutoLogS s.r.l. - Spinoff of the Polytechnic of Bari and of the University of Trieste

Application field: Manufacturing / Production systems

Keywords: scheduling, steelmaking, optimization, simulation

Abstract: The iron and steel industry is one of the major industries in the world economy since it provides raw materials for many other important industries. Iron ore, scrap and some other factors are transformed into steel products in a multi-stage process. ALS-Plan focuses on the Steelmaking and Casting (SMC) process, i.e., processing of the hot metal to steel with a well-defined chemical composition and solidifying the steel to slabs. In the SMC process, scheduling decisions concern the allocation, sequencing, and timing of charges on the corresponding facilities from steelmaking to casting production. ALS-Plan is a Decision Support System developed for scheduling the production operations in steelmaking companies: this tool optimizes the number of castings and the scheduling of burden loads in the operations for the production of steel from melting furnaces, including also the ingot casting and ladle scheduling. The main objective of the scheduling is to maximize the outputs i.e., the number of charges per day, due to the bottleneck situation in a just-in-time concept.

Abstract (it): L'industria del ferro e dell'acciaio è una delle più importanti nell'economia mondiale poiché fornisce il materiale grezzo necessario ad altre importanti industrie. Minerale ferroso, rottami ed altro sono trasformati in acciaio in un processo multi-fase. ALS-Plan si focalizza sul processo di fusione e colata dell'acciaio, ovvero la trasformazione del metallo fuso in acciaio con una ben definita composizione chimica, solidificandolo in lastre. Durante il processo, le decisioni di schedulazione riguardano l'allocazione, la sequenza e la temporizzazione delle cariche sui diversi macchinari usati. ALS-Plan è un Sistema di Supporto alle Decisioni sviluppato per la schedulazione delle operazioni di

produzione nelle acciaierie: questo strumento ottimizza il numero di colate e la schedulazione delle cariche nelle operazioni per la produzione dell'acciaio dai forni di fusione alle macchine di colata continua, considerando inoltre la colata in lingotti e la schedulazione delle siviere. Il principale obiettivo è la massimizzazione dell'output, ossia il numero di cariche al giorno, in base ai colli di bottiglia in un'ottica just-in-time.

From - To: 2012 - 2015

Objectives: ALS-Plan is motivated by the necessity of solving the complex scheduling problems in Steel-Making and Casting (SMC) plants. Usually, the scheduling is performed on the basis of experience and informal coordination, but often such an approach exhibits some drawbacks as the complexity of the manufacturing system increases. Thus computerized scheduling systems are increasingly necessary. The main objective of the scheduling is to maximize the outputs i.e., the number of charges per day, due to the bottleneck situation in a just-in-time concept. To this aim, ALS-Plan is devoted to help decision makers in selecting the optimal schedules of the operations also in the cases in which unpredictable events may occur. The main modules of the presented DSS are an optimization module, based of a Mixed Integer Linear Programming model, and a simulation module, able to verify and validate the proposed schedules by what if analyses and stochastic input parameters.

Methodologies used: Exact methods, Mixed integer programming, Simulation

Results: ALS-Plan is a Decision Support System developed for scheduling the production operations in steelmaking companies: this tool optimizes the number of castings and the scheduling of burden loads in the operations for the production of steel from melting furnaces. The tool allows the reduction of 10% of the number of tundish changes and production times, by an appropriate ladle scheduling. In fact, the ladles and their contents are very important: burdens loads are assigned to the ladles base on the chemical composition of the steel to produce. The system is implemented based on the customer process: a preliminary analysis step is necessary to customize the system. It encompasses two components: Simulation to evaluate the times of provided schedules, Optimization to compute the optimized schedules. The proposed simulation module can be applied off-line or on-line. For the off-line application, the simulation can validate the schedule proposed by the optimization module by considering stochastic operation times and forecasting eventual critical situations such as incompatible waiting times in the buffers. In addition, the simulation can be used in real-time, in order to face the unpredictable events occurring in the system, such as the machine failures and blocking. In such a case, the reschedule of the charges can be modified by the optimization module or, alternatively, by the shop floor production managers that on the basis of their experience can provide different solutions. Due to the short time to take a decision, the simulation is a good tool to verify and validate the schedule modification.

Result type: Software package

References and links:

31. A network flow based heuristic approach for optimising AGV movements

A network flow based heuristic approach for optimising AGV movements

Author: Giuseppe Confessore

Email: giuseppe.confessore@cnr.it

Organization: Consiglio Nazionale delle Ricerche - Consiglio Nazionale delle Ricerche

Application field: Logistics, Manufacturing / Production systems

Keywords: heuristics, optimization, AGV movements

Abstract: Automated Guided Vehicles (AGVs) are driverless carriers that automatically navigate along planned paths by means of several guidance and control methods. This paper proposes an approach for solving the dispatching problem in an AGV system. The problem is modelled through a network by relying on the formulation of a Minimum Cost Flow Problem. In the defined graph, the nodes represent transportation tasks and AGVs while the arcs consider, through the associated weights, several system's aspects such as pick, drop, and travel times, battery recharging, capacity constraints, congestion and error issues. Two objectives can be achieved: (i)minimisation of the average time for carrying out transportation tasks or (ii) maximisation of the utilisation degree of AGVs. The modelling and solution approach adopted has provided a novel Vehicle–Initiated dispatching rule and parameters settings for the dynamic assignments of transportation missions to AGVs. The decision making process concurrently and dynamically considers several factors. The results show a relevant reduction in the average time for transportation order fulfilment and a decrease in its variability. The proposed approach has been exploited for optimising the AGVs performance in a pharmaceutical production system.

Abstract (it): Automated Guided Vehicles (AGVs) are driverless carriers that automatically navigate along planned paths by means of several guidance and control methods. This paper proposes an approach for solving the dispatching problem in an AGV system. The problem is modelled through a network by relying on the formulation of a Minimum Cost Flow Problem. In the defined graph, the nodes represent transportation tasks and AGVs while the arcs consider, through the associated weights, several system's aspects such as pick, drop, and travel times, battery recharging, capacity constraints, congestion and error

issues. Two objectives can be achieved: (i)minimisation of the average time for carrying out transportation tasks or (ii) maximisation of the utilisation degree of AGVs. The modelling and solution approach adopted has provided a novel Vehicle–Initiated dispatching rule and parameters settings for the dynamic assignments of transportation missions to AGVs. The decision making process concurrently and dynamically considers several factors. The results show a relevant reduction in the average time for transportation order fulfilment and a decrease in its variability. The proposed approach has been exploited for optimising the AGVs performance in a pharmaceutical production system.

From - To: 2011 - 2011

Objectives: The work is aimed at obtaining efficiency improvements while minimising either the average time for completing a transportation task or the total empty travel times of AGVs (i.e., vehicles utilisation) depending on the user needs. After having implemented the proposed approach in the software application for AGVs control in a real production system and analyzed the actual system performance, relevant performance levels were observed, fully in accordance with the estimates obtained by simulation experiments in the design phase. The dispatcher that was implemented can be classified as an on line central control system (see also Vis 2006; Le-Anh and De Koster 2006). The proposed approach was implemented for developing an innovative software application for the optimisation of AGV systems' performance. The optimiser was successfully tested and installed in a pharmaceutical plant by ACT Operations Research.

Methodologies used: Heuristic / metaheuristic methods, Integer / combinatorial optimization

Results: The adopted approach has provided a novel Vehicle–Initiated dispatching rule and parameters settings for the dynamic assignments of transportation missions to single load AGVs. The optimisation policies exploitable by the users through the new dispatching rule can consider as distinct objectives: (i) the minimisation of the average time of transportation order fulfilment and (ii) the maximisation of the vehicles' utilisation. Thementioned optimisationmodalities have been implemented in theAGVsystem of a pharmaceutical production plant. The results obtained from the data collection of the real system show a relevant reduction in the average time for transportation order fulfilment due to the bettermaterial handling strategy and a substantial decrease in its variability. Another indicator confirmed the improved performance levels: the number of transportation mission carried out over a time unit.

Result type: Case study, Software package

References and links:

32. Inventory & Replenishment

Inventory & Replenishment

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Organization: ACT Operations Research - ACT Operations Research

Application field: Economics and finance, Healthcare, Logistics, Marketing, Manufacturing / Production systems, Services and society, Transportation

Keywords: Inventory, Replenishment

Abstract: If the inventory management, balancing stock investments and service level is important in your business, ACT OR is proud to provide you an advanced predictive and optimization set of products to reach superior results. In fact, reducing the inventory costs guarantying the service level is the goal of our tool for warehouses and distribution centers.

Abstract (it): If the inventory management, balancing stock investments and service level is important in your business, ACT OR is proud to provide you an advanced predictive and optimization set of products to reach superior results. In fact, reducing the inventory costs guarantying the service level is the goal of our tool for warehouses and distribution centers.

From - To: 1996 -

Objectives: The core products belonging to the I&R suite are: Before!Predictive Analytics (B!PA) OPTreplenishement (OPTr) OPTshipping (OPTs) OPTbuy (OPTb)

Methodologies used: Exact methods, Heuristic / metaheuristic methods, Integer / combinatorial optimization, Data analytics / machine learning, Simulation, Statistics

Results: The core products belonging to the I&R suite are: Before!Predictive Analytics (B!PA) OPTreplenishement (OPTr) OPTshipping (OPTs) OPTbuy (OPTb)

Result type: Software package

References and links: http://www.act-operationsresearch.com

33. Workforce Optimization And Simulation

Workforce Optimization And Simulation

Author: Raffaele Maccioni

Email: Raffaele.Maccioni@act-OperationsResearch.com

Organization: ACT Operations Research - ACT Operations Research

Application field: Aerospace, Energy, Economics and finance, Government, Healthcare, Logistics, Marketing, Manufacturing / Production systems, Military, Security, Services and society, Transportation, Telecommunication

Keywords: Workforce

Abstract: Workforce Optimization and Simulation (WO&S) The innovative Predictive workforce planning and scheduling is the ACT OR answer for the customers that want to optimize the utilization of their teams and resources.

Abstract (it): Workforce Optimization and Simulation (WO&S) The innovative Predictive workforce planning and scheduling is the ACT OR answer for the customers that want to optimize the utilization of their teams and resources.

From - To: 1996 -

Objectives: Characterized by extreme flexibility the workforce suite fits needs of multiple type of business like Logistics, Stores Management etc. The core products belonging to the (WO&S) suite are: WorkForce planning (WFp) WorkForce scheduling (WFs) Major and reputable companies already embraced the ACT OR technology and services. Ask more, do not hesitate to contact us… or discover the characteristics trough a simple click on the product name

Methodologies used: Exact methods, Heuristic / metaheuristic methods, Integer / combinatorial optimization, Simulation, Statistics

Results: Characterized by extreme flexibility the workforce suite fits needs of multiple type of business like Logistics, Stores Management etc. The core products belonging to the (WO&S) suite are: WorkForce planning (WFp) WorkForce scheduling (WFs) Major and reputable companies already embraced the ACT OR technology and services. Ask more, do not hesitate to contact us… or discover the characteristics trough a simple click on the product name

Result type: Software package

References and links: http://www.act-operationsresearch.com

34. Manufacturing

Manufacturing

Author: Raffaele Maccioni

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Organization: ACT Operations Research - ACT Operations Research

Application field: Manufacturing / Production systems

Keywords: Manufacturing

Abstract: The suites of products for Manufactures includes the dynamic process simulation, the demand forecast, the production planning and scheduling based on the innovative risk-based approach.

Abstract (it): The suites of products for Manufactures includes the dynamic process simulation, the demand forecast, the production planning and scheduling based on the innovative risk-based approach.

From - To: 1996 -

Objectives: The suites of products for Manufactures includes the dynamic process simulation, the demand forecast, the production planning and scheduling based on the innovative risk-based approach.

Methodologies used: Exact methods, Heuristic / metaheuristic methods, Integer / combinatorial optimization, Simulation, Statistics

Results: The suites of products for Manufactures includes the dynamic process simulation, the demand forecast, the production planning and scheduling based on the innovative risk-based approach.

Result type: Software package

References and links: http://www.act-operationsresearch.com

35. MIDA - Machine Intelligence for Diagnosis Automation

MIDA - Machine Intelligence for Diagnosis Automation

Author: Fabio Schoen

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Organization: Università degli Studi di Firenze - DINFO

Application field: Logistics, Manufacturing / Production systems

Keywords: Machine learning, predictive mainteinance, data science, optimization

Abstract: The analysis of time series obtained in real time from mechanical engines is the input for a novelty detection tool for automatic diagnosis and predictive mainteinance

Abstract (it): Analisi di serie temporali provenienti da dati raccolti on line sul funzionamento di motori a combustione alimentano uno strumento di novelty detection per la diagnosi automatica e la prevenzione di guasti

From - To: 2012 - 2015

Objectives: To develop an automatic alert system based on real time data bases on machine learning

Methodologies used: Heuristic / metaheuristic methods, Data analytics / machine learning

Results: -

Result type: Case study, Methodology, Software prototype

References and links:

36. Pattern Configurations for Bank Cheque Printing

Configurazione ottimale di pattern di stampa

Author: Raffaele Cerulli

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Organization: Università di Salerno - Matematica

Application field: Manufacturing / Production systems

Keywords: Cutting problem, mixed integer programming, heuristic algorithm

Abstract: The problem we solved arises in large-scale manufacturing of bank cheques. Due to security reasons, the cheques must be printed on special (expensive) paper. The first step in the printing process is to prepare the plates that will be used by the composing machine. If the imprint (image) of a particular cheque is on a plate, each time the composing machine uses this plate a new cheque of this type is produced. Each plate has a predefined number of positions to be impressed. Due to delivery due dates, there is an additional constraint requiring each cheque not to be present in more than a predefined number of different plates. There are two different production costs that have to be considered: overproduction costs and printing costs. Each overproduced cheque can be either destroyed or stored in a proper location under surveillance. Both these alternatives have a huge environmental impact, indeed, on the one hand, paper waste is produced, while, on the other hand there is a huge energy consumption. The problem consists in defining the pattern (i.e. the configuration of cheque images) of each plate to be used and the corresponding frequency, such that total costs are minimized.

Abstract (it): Il problema che abbiamo risolto sorge nella produzione su vasta scala di assegni bancari. Per motivi di sicurezza, gli assegni devono essere stampati su carta speciale. Il primo passo nel processo di stampa è quello di preparare le lastre (matrici) per il processo di stampa. Se l'immagine di un assegno è su una lastra, ogni volta che la macchina di stampa usa questa lastra viene prodotto un nuovo assegno di questo tipo. Ogni lastra ha un numero predefinito di posizioni. Ogni assegno non può essere presente in più di un numero predefinito di lastre diverse. Ci sono due diversi costi di produzione: costi di sovrapproduzione e costi di stampa. Ogni assegno prodotto in eccesso può essere distrutto o conservato in un locale appropriato sotto sorveglianza. Entrambe queste alternative hanno un enorme impatto ambientale; da un lato c'è uno spreco di carta, dall'altro c'è un enorme consumo di energia. Il problema consiste nel definire il pattern (cioè la configurazione delle immagini degli assegni) di ogni lastra ed il numero di volte in cui tale lastra deve essere utilizzata per la stampa in modo da minimizzare i costi totali di produzione.

From - To: 2001 - 2004

Objectives: Development of a heuristic algorithm able of organize banking printing production printing schemes.

Methodologies used: Heuristic / metaheuristic methods, Integer / combinatorial optimization

Results: We developed an algorithm to solve this real world problem that is strictly related to the cutting stock problem with pattern minimization. Such a problem is addressed actually by a large cheque manufacturer in Southern part of Italy. We define a very efficient heuristic to solve it.

Result type: Software prototype

References and links: Raffaele Cerulli; Renato De Leone; Monica Gentili (2014). Finding Pattern Configurations for Bank Cheque Printing. PROCEDIA: SOCIAL & BEHAVIORAL SCIENCES. Vol. 108. Pag.219-234 ISSN:1877-0428.

Services and Society

37. Development of a decision support system for daily carpooling

Sviluppo di un sistema di supporto alle decisioni per carpooling quotidiano

Author: Manuel Iori

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Organization: University of Modena and Reggio Emilia - Department of Sciences and Methods for Engineering

Application field: Services and society, Transportation

Keywords: carpooling, ridesharing, vehicle routing, heuristics, CO2 emissions

Abstract: Our project objective was the development an integrated web application, to be used by the employees of Coopservice scrl to organize carpooling crews on a daily basis, so as to reach a common workplace. We implemented a solution tool that looks for possible crews by the use of quick heuristic algorithms. The algorithms have been embedded into a web application, to provide users with possible carpooling solutions. The application was equipped with a map visualization and a communication tool, to allow users to exchange information and organize common trips.

Abstract (it): Il nostro progetto ha avuto come obiettivo lo sviluppo di un'applicazione web integrata, da utilizzare da parte dei dipendenti di Coopservice scrl al fine di organizzare trasporti condivisi (carpooling) su base giornaliera, in modo da raggiungere un luogo di

lavoro comune. Abbiamo implementato uno strumento risolutivo che cerca possibili viaggi condivisi mediante l'uso di veloci algoritmi euristici. Gli algoritmi sono stati incorporati in un'applicazione web per fornire agli utenti le soluzioni possibili per il carpooling. L'applicazione è stata dotata di una visualizzazione cartografica e si uno strumento di comunicazione, per consentire agli utenti di scambiare informazioni e organizzare i viaggi condivisi.

From - To: 2014 -

Objectives: Development of a decision support system to help employees of a company organize daily carpooling. Determine possible reduction in terms of CO2 emissions.

Methodologies used: Heuristic / metaheuristic methods

Results: Development of algorithms to organize daily carpools. Implementation of a user-friendly web-baed interface for employees. Results show how significant savings can be obtained in terms of CO2 emissions.

Result type: Case study, Software prototype

References and links: Bruck PB, Incerti V, Iori M, Vignoli M, "Minimizing CO2 emissions in a practical daily carpooling problem", Computers & Operations Research 81: 40-50 (2017).

38. Methodological Tool for Railway Infrastructure Protection

METRIP - Tool metologico per la protezione delle infrastrutture critiche ferroviarie

Author: Claudio Sterle

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Organization: University 'Federico II' of Naples - Department of Electrical Engineering and Information Technology

Application field: Security

Keywords: critical infrastructure protection, optimal sensor location, sensor networks, optimization tool

Abstract: Nowadays a RIS can be considered as one of the most critical infrastructures, as dramatically emphasized by Madrid and London episodes. Indeed, due to the nature of mass transportation, which precludes the passengers' screening and identification, RIS are easy object of terrorist and criminal attacks. All these threats contribute to increase

insecurity of citizens (further they provide economic lost to for railway operators). For this reason great relevance has to be addressed to the problem of protecting a railway infrastructure system (RIS). This requires the development of models and tools to support the design of a protection system, in order to cover, monitor and/or control a region of interest by wireless sensor networks (WSN). This problem, in the most general case it consists in determining the number and the location of one or more kind of sensors with the aim of covering all the region of interest or a significant part of it.

Abstract (it): La protezione delle infrastrutture critiche è un tema molto attuale. In questo contesto, sono state affrontate diverse problematiche nell'ambito del progetto METRIP (Methodological Tool for Railway Infrastructure Protection), svolto in collaborazione con Ansaldo STS, Università Campus Bio-Medico di Roma, University of Kent e SEPSA (attualmente inglobata in E.A.V. s.r.l.). Obbiettivo finale del progetto era la realizzazione di un tool prototipale, di supporto ai progettisti, per la realizzazione di sistemi di monitoraggio e controllo delle infrastrutture ferroviarie. In particolare grande rilevanza è stata data alla problematica della progettazione di una rete di sensori per il monitoraggio e controllo di una area di interesse. E' stato sviluppato un approccio grid based per la localizzazione di sensori per il monitoraggio di un area di interesse (two dimensional coverage). Questo problema è stato ampiamente affrontato in letteratura (sensor placement problem). L'approccio è stato realizzato sviluppando una procedura ad hoc, basata su considerazioni geometriche, per effettuare la coverage analysis, e sull'utilizzo di formulazioni ILP (covering models) per risolvere i diversi problemi di copertura emergenti (risolti tramite utilizzo di un software di ottimizzazione).

From - To: 2013 -

Objectives: - developing a methodology for the optimal coverage of an area of interest, taking into account the geometry of the area and the security constraints and requirements arising in a railway infrastructure; - developing a scalar and modular solving approach; - developing of a prototypal tool to be used by the security managers and operators to support their design decisions.

Methodologies used: Exact methods, Integer / combinatorial optimization

Results: We propose a unified and stepwise solving approach for two and three dimensional coverage problems to be used for omni-directional and directional sensor networks. The proposed approach is based on schematizing the region of interest and the sensor potential locations by a grid of points and representing the sensor coverage area by a circle or by a circle sector. On this basis, the WSN problem reduces to a optimal coverage problem and can be formulated by integer linear programming (ILP) models. We will resume the main ILP models used in our approach, providing also a discussion on some straight extensions and variants which allow to take into account the specific features of

the sensors, related monitoring tasks and strategic decisions in WSN design. A prototypal tool has been developed to support the security managers and operators in their decision process.

Result type: Case study, Methodology, Software prototype

References and links: http://metrip.unicampus.it/ Book: Railway Infrastructure Security. Setola, R., Sforza, A., Vittorini, V., Pragliola, C. (Eds). Springer, ISBN 978-3-319-04425-5, 2015.

39. Operating-room planning and scheduling problems

Pianificazione delle sale operatorie

Author: Paola Cappanera

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Organization: University of Florence - Dipartimento di Ingegneria dell'Informazione

Application field: Healthcare, Logistics

Keywords: health care, operating room, master surgical scheduling, optimisation

Abstract: This project focuses on the Master Surgical Scheduling (MSS) problem, which consists in determining (i) the specialty to assign to each operating room and session for each day of the planning horizon and (ii) the number and type of surgeries to be performed in each operating room session. Indeed, the operating theatre is one of the most critical functional areas in a hospital and solving an MSS problem is noticeably complex, requiring the simultaneous consideration of the following issues: (i) different types of surgeries, with different priority levels; (ii) different types of resources, such as ORs, personnel, postsurgical units; (iii) the randomness associated with parameters; and (iv) conflicting priorities of stakeholders. This project aims at formulating mathematical models to support this process, develop and implement an operating room scheduler in a real hospital addressing the practical problems arising from model utilisation, and providing evidence of model implementation.

Abstract (it): Tale progetto affronta il problema di Master Surgical Scheduling (MSS), che consiste nel determinare (i) la specialità da assegnare ad ogni sala operatoria e ad ogni sessione in ogni giorno dell'orizzonte di pianificazione e (ii) il numero e la tipologia di interventi da effettuare in ogni sessione. Il blocco operatorio è una delle aree funzionali più critiche in un ospedale e la risoluzione del MSS è estremamente complessa poichè

richiede di considerare congiuntamente: (i) molteplici tipologie di interventi chirurgici, con differenti livelli di priorità; (ii) molteplici risorse; (iii) la variabilità insita nei parametri; (iv) priorità spesso in conflitto tra loro, dei diversi attori coinvolti. Il progetto ha come obiettivo quello di formulare modelli di ottimizzazione a supporto delle decisioni, sviluppare e implementare uno schedulatore in un contesto reale, affrontando quindi i problemi pratici derivanti dall'utilizzo dei modelli e dando evidenza dei risultati ottenuti.

From - To: 2014 -

Objectives: Despite the ever-increasing number of optimization models proposed in the state-of-the-art literature to address operating room scheduling problems, studies reporting the results achieved with the implementation of these models are very scarce. This project aims at filling this gap. Specifically, the project consists in: (i) develop optimisation models to address the Master Surgical Scheduling (MSS) problem, (ii) design an operating room scheduler, and (ii) implement them in a real context, i.e. in one of Europe's most renowned children's hospitals.

Methodologies used: Exact methods, Mixed integer programming, Simulation, Scheduling

Results: This project led to full implementation of a surgery groups-based scheduling process supported by optimization models and scheduling software, and all the stakeholders in the MSS process are now familiar with this concept. Inside the hospital, surgeries are often referred by the name of their surgery group. The scheduler is used by the Bed Manager and by the head of the Planning Department to assess the impact of every single scheduling decision. Everyone agrees that the scheduling process is now under control and that a better balanced utilisation of the resources has significantly smoothed operations, both in the operating theatre and in the postsurgical wards. Overall, the project has led to an increase in operating-room efficiency and improved equity, robustness and long-term orientation of the scheduling process.

Result type: Case study, Methodology, Software package

References and links: 1. P. Cappanera, F. Visintin, C. Banditori, Addressing conflicting stakeholders priorities in surgical scheduling by goal programming, Flexible Services and Manufacturing Journal, in press, 2016, doi:10.1007/s10696-016-9255-5. 2. F. Visintin, P. Cappanera, C. Banditori, Evaluating the impact of flexible practices on the master surgical scheduling process: an empirical analysis, Flexible Services and Manufacturing Journal, 28(1), 182-205, 2016. 3. P. Cappanera, F. Visintin, C. Banditori, Comparing resource balancing criteria in master surgical scheduling: a combined optimisation-simulation approach, International Journal of Production Economics, 158, 179-196, 2014. 4. C. Banditori, P. Cappanera and F. Visintin A combined optimisation-simulation approach to

the master surgical scheduling problem, IMA Journal of Management Mathematics, 24(2), 155 – 187, 2013.

40. Smart Drug Supply Chain Management

Logistica INtelligente del FArmaco (LINFA)

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Email: paola.cappanera@unifi.it

Organization: University of Florence - Dipartimento di Ingegneria dell'Informazione

Application field: Healthcare, Logistics

Keywords: drug supply chain management, demand forecasting, optimization models

Abstract: LINFA project aims at designing mathematical models and methods to support decision making in the supply chain management of drugs, medical devices and other materials. The project focuses on problems arising in a single department of an hospital with the twofold objectives of: (i) coping with the complexity arising from different real contexts, and (ii) adopt a building-block architecture according to which the results obtained for the single department can be used to address case-studies with increasing level of complexity, i.e. warehouse located inside the department, warehouse of the whole hospital, the depot(s) that are in charge of stocking and replenishing drugs for all the hospitals located in a given area, such as a district or a region inside the National Healthcare System. Specifically, the projects is organized in the following tasks: (1) Demand forecasting (2) Models and algorithms for optimal inventory management (3) Models for management of cooperating virtual warehouses.

Abstract (it): Il Progetto LINFA (Logistica INtelligente del FArmaco) ha l'obiettivo scientifico di definire metodi e modelli per il supporto alle decisioni relative alla logistica distributiva del farmaco, dei dispositivi e di altro materiale all'interno della catena logistica. Sarà data enfasi particolare alla logistica del farmaco a livello del singolo reparto ospedaliero, non solo per sviluppare modelli utili in diversi contesti reali, ma anche per sviluppare e poter testare alcune metodologie che, seppur sviluppate in scala micro, restano valide e costituiscono un punto di partenza per l'estensione a contesti più ampi, quali l'eventuale magazzino di reparto, la farmacia o magazzino di ospedale, il deposito (o i depositi) centrali regionali. Nello specifico, il progetto si compone delle seguenti attivita': 1) Previsione della domanda 2) Metodi e modelli per la gestione ottimizzata delle scorte locali 3) Analisi e valutazione di modelli di gestione di magazzini di reparto virtuali distribuiti

From - To: 2016 -

Objectives: LINFA aims at increasing efficiency, efficacy and predictive capabilities of the processes regulating the supply chain management of drugs and medical devices by means of a pool of predictive and optimization models.

Methodologies used: Exact methods, Heuristic / metaheuristic methods, Mixed integer programming, Data analytics / machine learning, Networks / graph optimization

Results: LINFA is an ongoing project funded by Regione Toscana. One of its main expected result is the design of a decision support system to cope with the complexity of the replenishment process involving drugs and medical devices from a set of warehouses, possibly cooperating and virtual, to a set of departments.

Result type: Case study, Methodology

References and links:

41. Optimization of Staff Management for Desk Customer Relations Services at Heracomm

Ottimizzazione della gestione delle risorse di sportello cliente di Hera Comm

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Organization: OPTIT Srl - OPTIT Srl

Application field: Rostering

Keywords: Customer Relations Management, Sla_ Management, Forecasting, Integer Linear Pro-gramming

Abstract: SPRINT is a large and important project that in the years 2010---11 led to the development and deployment of a complete Decision Support System for the management of Staff operating the Desk at Hera Comm, the commercial company of Gruppo Hera, serving more than 3.5 million people in six provinces. The Customer Contact Desks employ about 200 employees and manage some 750,000 requests per year at high service level standards. The increase in demand together with the requirements of keeping high service standards and controlling the costs led Hera Comm to an ambitious process

renovation project, which involved the design and integration of advanced forecasting and planning tools. Optit designed a very innovative system that incorporates innovative and finely tailored algorithms both for the forecasting and for the quick and effective optimization of personnel scheduling. The prototypes of the algorithms were extensively tested on pilot desks and the excellent results convinced Hera Comm management to proceed with the implementation of a full system. Optit implemented this in only four months, following the high industrial standards required to integrate with the complex information systems of the company.

Abstract (it): Il progetto SPRINT(Sistema Previsionale Integrato Normalizzazione Tempi), svolto negli anni 2010-2011, ha portato allo sviluppo ed implementazione di un sistema di supporto alle decisioni per la gestione del personale di staff del Servizio Clienti Sportello presso Hera Comm, la società commerciale del Gruppo Hera, che offre servizi a più di 3,5 milioni di persone suddivise in sei province. Il Servizio Clienti Sportello impiega circa 200 dipendenti e gestisce circa 750.000 richieste all'anno con livelli di servizio elevati. L'aumento della domanda, insieme all'esigenza di mantenere alti standard di servizio e controllare i costi, ha portato Hera Comm a perseguire un ambizioso processo di rinnovamento con il design e l'integrazione di strumenti avanzati di previsione e di pianificazione. Optit ha definito e realizzato un sistema innovativo che incorpora algoritmi di ricerca operativa elaborati per rispondere alle specifiche esigenze del cliente, sia per la previsione che per la rapida definizione ottimizzata dei turni. Gli algoritmi prototipali sono stati testati in modo esteso su sportelli pilota e gli eccellenti risultati hanno convinto Hera Comm alla piena implementazione del sistema. La realizzazione è stata portata a termine in soli quattro mesi, rispettando gli elevati standard industriali richiesti per l'integrazione con i sistemi informativi dell'azienda.

From - To: 2010 -

Objectives: The main requisites of SPRINT were twofold: firstly, to give planners the access to forecasting and optimization tools in a user friendly environment that offers support to guide the system to the desired solutions. Secondly, to achieve a good integration in the chain of processes for planning, management and control of customer contact desks. As to quantitative objectives of SPRINT, the target was the improvement of four main business KPIs taking 2009 values as a baseline (reported in brackets hereafter): reduction of at least 20% of the Mean Waiting Time (MWT) for the customers (was 16 min); reduction of at least 25% of PCW40, the Percentage of Customer Waiting more than 40 minutes (was 9%); increase of the Customer Satisfaction Index (CSI) for Desk Services (was 71).

Methodologies used: Mixed integer programming, Data analytics / machine learning, Simulation

Results: The application of SPRINT within Hera Comm has brought the following results: • a quick and generalized improvement in the planning process, not only in terms of speed but also for the good balance of efficacy and efficiency of the solutions. • greater efficacy of the human resources devoted to planning activities. Furthermore, the inclusion of a structured planning process within the DSS made consistently more homogeneous the behavior of the planners and favored the diffusion of managerial culture within the middle management.

As for the quantitative impacts, to be better measured at an aggregate level, SPRINT has widely overcome all the initial targets. In fact, all SLA-related KPIs (namely, Mean Waiting Time (MWT) for the customers; Percentage of Customer Waiting more than 40 minutes (PCW40); Customer Satisfaction Index (CSI) for Desk Services), were greatly improved during the first year of use: MWT -36%, PCW -49% and CSI + 8%.

Result type: Software package

References and links: http://pubsonline.informs.org/doi/abs/10.1287/inte.2014.0763?journalCode=inte

42. ILP for the optimal reconstruction of census data

PLI per la ricostruzione ottima di informazioni censuarie

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Application field: Information systems, Services and society

Keywords: Discrete Optimization, Data Mining, Census data

Abstract: In the case of censuses or other large-scale surveys, the obtained data may contain several types of errors or missing values. The datasets are huge, and an automatic reconstruction of the corrupted information is needed. In particular, we solved the following problems: - Check the compatibility plan of a Census (that is a set of logical rules). This is obtained by encoding rules into linear inequalities and by using a polyhedral mathematics approach to detect inconsistent or redundant rules. - Identify inconsistent data and reconstruct the information that was lost. This is obtained by minimizing changes while respecting intra-record rules using integer linear programming. - Restore the

consistency of numerical data that are being reconstructed and are subject also to mathematical rules connecting many records (balancing). This is obtained through mixed integer linear models. These techniques have been used by Istat to process data from the censuses of: Italian Population 2001; Italian Agriculture 2010; Italian Population 2011. Results are very good both from the computational and from the data quality point of view.

Abstract (it): Nel caso di censimenti o altre grandi indagini, i dati ottenuti possono contenere errori o valori mancanti. Questi dataset sono enormi, ed è necessaria una ricostruzione automatica dell'informazione corrotta. In particolare, abbiamo risolto i seguenti problemi: - Controllare il piano di compatibilità di un Censimento (che è un insieme di regole logiche). Ciò è ottenuto convertendo le regole in disequazioni lineari e usando approcci poliedrali per individuare regole inconsistenti o ridondanti. - Identificare i dati inconsistenti e ricostruire l'informazione persa. Ciò è ottenuto minimizzando i cambiamenti ma rispettando regole intra-record mediante programmazione lineare intera. - Ripristinare la consistenza di dati numerici che vengono ricostruiti e sono legati anche da relazioni matematiche tra molti record (bilanciamento). Ciò è ottenuto usando modelli di programmazione mista intera. Queste tecniche sono state usate dall'Istat per i dati dei censimenti di: Popolazione Italiana 2001, Agricoltura Italiana 2010; Popolazione Italiana 2011. I risultati sono molto buoni sia dal punto di vista computazionale che da quello della qualità dei dati.

From - To: 2001 - 2015

Objectives: In the case of Censuses or other large-scale surveys, the obtained data may contain errors or missing values. Since these datasets are huge, an automatic reconstruction of the corrupted information is needed. Specific objectives are the following: - The compatibility plan is a set of rules used to filter the data obtained for the Census. These rules are often assembled from several sources, and they may contain inconsistencies (sets of rules that cannot be verified together) or redundancies (rules that are already implied by sets of other rules). We want to detect and correct these situations. - The above rules are used to filter the data, identifying so the records containing errors. For each of these records, we want to optimally identify its erroneous fields (they are not simply the set of inconsistent fields), and then optimally reconstruct the information that should be in these fields but that was lost (and not simply replace it with predefined values). - Restore the consistency of numerical data that are being reconstructed, but which are subject not only to rules binding the fields of one record, but also to rules connecting many records (balancing).

Methodologies used: Integer / combinatorial optimization, Mixed integer programming, Polyedral, Data analytics / machine learning, Statistics

Results: These techniques have been used by Istat to process data from the Censuses of: Italian Population 2001; Italian Agriculture 2010; Italian Population 2011. Results are very good both from the computational and from the data quality point of view, and show the practical effectiveness of the described techniques. Several journal articles describe the different techniques developed.

Result type: Methodology, Software prototype

References and links: Several journal articles describe the different techniques developed to solve the described problems: 1. R. Bruni, Discrete Models for Data Imputation, Discrete Applied Mathematics vol. 144(1), 59-69, 2004. 2. R. Bruni, Error Correction for Massive Data Sets, Optimization Methods and Software vol. 20(2-3), 295-314, 2005. 3. G. Bianchi, R. Bruni, A Reale, Balancing of Agricultural Census Data by Using Discrete Optimization, Optimization Letters vol. 8(4), 1553-1565, 2014. 4. G. Bianchi, R. Bruni, A. Reale, A Combinatorial Optimization Approach to the Selection of Statistical Units, Journal of Industrial and Management Optimization vol. 12(2), 515-527, 2016. 5. G. Bianchi, R. Bruni, A. Reale, F. Sforzi, A Min-Cut Approach to Functional Regionalization, with a Case Study of the Italian Local Labour Market Areas. Optimization Letters vol. 10(5), 955-973, 2016.

43. PROACTIVE (PRedictive reasOning and multi-source fusion empowering AntiCipation of attacks and Terrorist actions In Urban EnVironmEnts)

PROACTIVE (PRedictive reasOning and multi-source fusion empowering AntiCipation of attacks and Terrorist actions In Urban EnVironmEnts)

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Application field: Security

Keywords: decision support systems,terrorist modelling , intent inferencing , Hidden Markov Models

Abstract: The main goal of PROACTIVE is to research a holistic citizen-friendly multi sensor fusion and intelligent reasoning framework enabling the prediction, detection, understanding and efficient response to terrorist interests, goals and courses of actions in an urban environment. To this end, PROACTIVE will rely on the fusion of both static knowledge (i.e. intelligence information) and dynamic information (i.e. data observed from sensors deployed in the urban environment). PROACTIVE enables the fusion of multi-sensor data with contextual information (notably 3D digital terrain data). Moreover, the PROACTIVE framework incorporates advanced reasoning techniques (such as adversarial reasoning based on game theory and simulation). This reasoning kernel will has been adapted to the terrorist domain, in order to facilitate prediction and anticipation of actions and goals of the terroristic entities.

Abstract (it): L'obiettivo principale di PROACTIVE è la realizzazione di un sistema di data fusion multi-sensoriale e di un framework che consenta la previsione, il rilevamento, la comprensione e la risposta efficace di interessi terroristici e gli obiettivi in ambiente urbano. A tal fine, PROACTIVE si basa sulla fusione di conoscenze sia statica (cioè informazioni di intelligence) e informazioni dinamiche (cioè i dati osservati da sensori distribuiti nell'ambiente urbano). PROACTIVE consente la fusione di dati multi-sensoriali con informazioni contestuali. Inoltre, PROACTIVE incorpora tecniche di 'advanced reasoning' basate sulla teoria dei giochi e simulazione. Questo kernel ragionamento è stato adattato al dominio terrorismo, al fine di facilitare la previsione e la previsione di azioni e gli obiettivi delle entità terroristiche.

From - To: 2012 - 2015

Objectives: PROACTIVE will produce a set of best practices and blueprints, which will contribute to a common EU approach to terrorist prevention in an urban environments. The main analytical PROACTIVE topics are: - design and development reasoning for terrorist modelling and intent inferencing for decision support by dynamically capture and predict terrorist interests, goals, rationale, and courses of action under uncertainty through machine learning and Bayesian networks. - achieve Terrorist Intent Inferencing (TII) trhu the fusion of the observables information from sensors and intelligence sources regarding the terrorists , - infer terrorist intent and goals - predict terrorist courses of action (COA)

Methodologies used: Data analytics / machine learning, Simulation, Game theory, Hidden Markov Models

Results: The Terrorist Reasoning Kernel objectives are: - design and develop reasoning algorithms for terrorist modelling - Predict severity of real-time threat events using machine learning approaches considering external information and historical events. Identifdication of suspicious situations through pattern detection techniques - design of a

DSS to support alert level evaluation and threat detection strategy - clustering techniques for the prediction of the physical environment alert levels

Result type: Case study, Methodology, Software prototype

References and links: http://www.fp7-proactive.eu/ [1] I. Giordani, F. Archetti, "Models and architectures for emergency management, Journal of Ambient Intelligence and Humanized Computing" doi:10.1007/s12652-016-0417-9, (2016) [2] R. Sormani, F. Archetti, I. Giordani, "Criticality assessment of terrorism related events at different time scales", Journal of Ambient Intelligence and Humanized Computing, doi:10.1007/s12652-016-0416-x, (2016) [3] R. Sormani, J. Soldatos, S. Vassilaras, G. Kioumourtzis, G. Leventakis , I. Giordani, F. Tisato, "A serious game empowering the prediction of potential terrorist actions", (2016) Journal of Policing, Intelligence and Counter Terrorism, Volume 11, Issue 1, pages 30-48, 2016. [4] S.Petris, C.Georgoulis, J. Soldatos, I. Giordani, R. Sormani and D. Djordjevic, "Predicting Terroristic Attacks in Urban Environments: An Internet-of-Things Approach", International Journal of Security and Its Applications, Vol.8, No.4 (2014), pp.195-218 [5] F. Archetti, D. Djordjevic, I. Giordani, R. Sormani, F. Tisato, "A Reasoning Approach for Modelling and Predicting Terroristic Attacks in Urban Environments", In the proceedings of the 48th Annual International Carnahan Conference on Security Technology (ICSST2014), Rome, Italy – October 13-16, 2014, ISBN 978-1-4799-3531-4

44. From Pallets to Puppies: Using Insights from Logistics to Save Animals

Dai pallet ai cuccioli: come la logistica puo' salvare salvare gli animali

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Application field: Logistics

Keywords: allocation, animals

Abstract: With ten locations, Kentucky Humane Society (KHS) is the largest pet adoption agency in Kentucky. Each day they must decide which animals to send to which adoption center so that each animal has the best chance of being adopted as soon as possible. Until recently, KHS used staff opinion to assign animals to its various locations. Wanting to add a science-based approach, KHS asked researchers at the University of Louisville to apply

their research to optimize the allocation process with the goal of maximizing adoptions and decreasing length of stay.

U of L developed a preliminary optimization model for the dog allocation problem, and KHS has been using the model to manage its daily allocation decisions since the beginning of 2017. The optimization model assigns animals to adoption locations so that the overall expected length of stay (LOS) across all KHS facilities is minimized, without exceeding the holding capacity of any of the facilities. Consequently, space is freed up more quickly and more dogs are adopted each year. Initial results indicate that by using this preliminary optimization model, KHS will be able to decrease the overall LOS by over 10%, which will translate into approximately 10 additional dog adoptions per month.

Abstract (it): Kentucky Humane Society (KHS) è la più grande agenzia di adozione per animali in Kentucky. Ogni giorno il personale dell'agenzia deve decidere come allocare gli animali (pronti per essere adottati) nei suoi 10 centri di adozione in modo da massimizzare la probabilita' di adozione di ogni animale. Fino a poco tempo fa, questa decisione veniva presa sulla base della esperienza pluriennale del personale dell'agenzia. Nel 2016, l'agenzia ha rischiesto l'assistenza di ricercatori presso l'Università di Louisville per ottimizzare questo processo di allocazione. Gli studiosi dell'Universita' di Louisville hanno sviluppato ed implementato un modello di ottimizzazione. Il modello assegna gli animali nei 10 luoghi di adozione con l'obiettivo di minimizzare il tempo di permanenza di ogni animale nel centro in cui viene allocato, rispettando i vincoli di capacita' di ogni centro di adozione. KHS ha cominciato ad utilizzare il modello dall'inizio del 2017. I primi risultati indicano un decremento della permanenza media degli animali nei vari centri di adozione del 10%. Decremento che si traduce in circa 10 adozioni aggiuntive al mese.

From - To: 2016 -

Objectives: Optimizing the animal allocation process for KHS.

Methodologies used: Exact methods, Integer / combinatorial optimization

Results: Initial results indicate that by using this preliminary optimization model, KHS will be able to decrease the overall LOS by over 10%, which will translate into approximately 10 additional dog adoptions per month.

Result type: Methodology, Software prototype

References and links:

45. NEUROSTAR – NEUROscience and Systems, Technologies and Advanced procedures for early diagnosis/prognosis and functional Recuperation/compensation of disabilities in subjects with severe acquired brain damage

NEUROSTAR: Neuroscienze e sistemi, tecnologie e procedure avanzate per diagnosi/prognosi precoci e recupero/contenimento del danno funzionale in soggetti con gravi disabilità da patologie acquisite del sistema nervoso centrale

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Application field: Healthcare

Keywords: Processi Decisionali Clinici, Sistemi di Supporto alle Decisioni Cliniche, Analisi di Dati Biomedici e Clinici, Machine Learning, Problemi di Classificazione

Abstract: NEUROSTAR is a multidisciplinary project aimed at design and develop innovative research and technologies able to: - support pre-clinical and early diagnosis; - support early prediction of outcome; - identify and describe functional conditions favoring spontaneous recuperation and neuro-rehabilitation; - design/apply advanced decision making algorithms to be applied in the identification of objective diagnostic/prognostic criteria and integrated systems/procedures supporting decision in the medical domain; - implement advanced informatics or ambient intelligence systems recording/managing large datasets to monitor online clinical/functional conditions, circadian/ultradian rhythmicities/cycles, and spontaneous or condition-dependent fluctuations, in subjects with degenerative and progressively invalidating disorders of the central nervous system (Parkinson's disease, Alzheimer's dementia, multiple sclerosis) or with acquired brain damage (mainly stroke or trauma) resulting in severe, persistent functional impairment

(vegetative or minimal conscious states, hemiparesis, severe posttraumatic conditions, etc.) suitable of sensory-motor-cognitive neuro-rehabilitation.

Abstract (it): NEUROSTAR è un progetto multidisciplinare inteso a sviluppare approcci di ricerca e tecnologie per: - permettere diagnosi precliniche/precoci; - supportare protocolli di previsione prognostica precoce; - valutare le condizioni ottimali alla neuroriabilitazione del soggetto; - progettare/applicare algoritmi avanzati di supporto alle decisioni e fornire sistemi integrati di supporto alle decisioni nel dominio medico-clinico di riferimento; - implementare sistemi di monitoraggio delle condizioni cliniche e funzionali e delle ritmicità circadiane/ultradiane, con possibilità di raccolta di grandi quantità di dati (clinici e funzionali) in popolazioni di soggetti con malattie del sistema nervoso centrale a sintomatologia progressivamente invalidante (malattia di Parkinson, demenza di Alzheimer, sclerosi multipla) oppure con danni cerebrali acquisiti (prevalentmente stroke o trauma encefalico) con esiti invalidanti stabilizzati (stato vegetativo, minimal conscious state, emiparesi, gravi sindromi postraumatiche, etc.), con indicazioni alla neuroriabilitazione motoria, sensitiva-sensoriale e/o cognitiva.

From - To: 2011 - 2015

Objectives: Disegno e sviluppo di una piattaforma tecnologica di servizi a supporto della gestione clinica integrata e della riabilitazione funzionale e cognitiva di pazienti con malattie neurodegenerative e con conseguenze da gravi cerebrolesioni acquisite. In particolare, disegno e sviluppo di servizi di supporto alla diagnosi precoce della Sclerosi Multipla e del morbo di Parkinson.

Methodologies used: Data analytics / machine learning, Sistemi di Supporto alle Decisioni

Results: Sistemi software prototipali di servizi di supporto alla decisione diagnostica relativamente a specifici casi di studio (Sclerosi Multipla e Parkinson)

Result type: Case study, Software prototype

References and links: www.progettoneurostar.it

46. Electronic Justice Relationship Management

Gestione elettronica delle relazioni con la giustizia

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Application field: eJustice

Keywords: eMediation, machine learning, decision models, integer linear programming

Abstract: eJRM, acronym of electronic Justice Relationship Managemet, represents an Italian ongoing initiative aimed at dealing with semantic representation and machine learning reasoning mechanisms for improving the awareness of citizens to personally evaluate the outcome of a potential litigation, to be guided to a non-conflict settlement and to be assisted in selecting the eventual legal support. The main goal of eJRM consists in the development of a platform for managing the relationships between citizen and justice system in order to radically improve two main processes: • Online Trial: online management of activities related to the mediation process (eFolder management, virtual room meetings, online template filling, etc..) • Self-Litigation: capability of a citizen to autonomously classify (Case Discovery), formalize (Case Definition) and solve (Case Resolution) a dispute with a third party, with no involvement of legal actors (judges, clerks and lawyers).

Abstract (it): eJRM, acronimo di electronic Justice Relationship Managemet, rappresenta un'iniziativa italiana il cui scopo è la definizione di rappresentazioni semantiche ed algoritmi di machine learning per migliorare la consapevolezza dei cittadini nel valutare la propria posizione personale e prendere decisioni rispetto ad una potenziale disputa legale, valutare l'esito di percorso giudiziale, essere guidato in un accordo stragiudiziale ed essere assistito nella scelta di eventuali legali rappresentanti. In particolare eJRM propone l'ideazione e la dimostrazione di una Piattaforma Informatica specializzata nel dominio giuridico come elemento abilitante il conseguimento delle seguenti innovazioni di processo: - Online Trial: gestione completamente on-line delle attività connesse allo svolgimento di alcune tipologie di controversie giuridiche; - Online Alternative Dispute Resolution: capacità per un comune Cittadino di classificare (Case Discovery), formalizzare (Case Definition) ed essere guidato alla risoluzione (Case Resolution) di un contenzioso attraverso l'utilizzo della rete e delle modalità alternative di composizione delle controversie, quale l'istituto della mediazione.

From - To: 2011 - 2015

Objectives: The main goals of the project are: 1- A smart assistant able to guide the disputants to provide the right information about their case to enable either "artificial" or "human" reasoning mechanism concerned with eMediation. 2 - glancing at similar cases to understand rights and duties, relevant norms, times and costs of potential in-court-proceedings and prospective outcomes of the dispute. 3 - managing critical situations, i.e. optimization of the mediation strategies to be adopted by the mediator for improving the possibility to achieve an agreement among disputants.

Methodologies used: Exact methods, Heuristic / metaheuristic methods, Linear, Integer / combinatorial optimization, Data analytics / machine learning, Dynamic programming, Multi-criteria / multi-objective

Results: 1- An interactive and self-administered interviewing system has been designed in order to collect useful information for enabling an eMediation process. Disputants respond to a sequence of questions on their specific case: the system selects pertinent questions depending on the disputants's individual responses. 2 - Inference mechanisms, based on dynamic programming, to identify relevant norms from natural language descriptions provided by citizens (Information Extraction). 3 - Machine Learning mechanisms to identify court decision closely related to the litigation described by the disputant. 4 - Mediator decision model, based on linear programming, for suggesting the optimal strategy to be adopted for improving the flexibility of the parties and achieve an agreement among them.

Result type: Case study, Software prototype

References and links:

47. Ground Resources Roster Planning

Pianificazione turni del personale di terra di un aeroporto

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Organization: CNR - IASI

Application field: Aerospace, Staff Management

Keywords: Ground Resources, Polyhedral methods

Abstract: In this work Staff Scheduling Problems for large organizations that provide continuous services to customers are formulated and efficiently solved. We describe an Integer Programming approach for a class of such problems, where solutions have to obey a number of constraints related to workload balancing, shift compatibility, and distribution of days off. We consider the associated polytope and study its structure, determining some classes of inequalities that are facet-inducing for special subproblems and other valid classes. In addition, we design special branching rules that break the symmetries that arise in the solution space and have a large impact in the efficiency of the method. The validity of this approach has been ascertained by extensive computational tests; moreover, the method has been implemented by the OR Department of an airline company, where it is used to solve ground staff management problems.

Abstract (it): Analisi, formulazione e implementazione di un algoritmo poliedrale per il problema della gestione della turnazione del personale di terra di un aeroporto. In collaborazione con il dipartimento di Ricerca Operativa di Alitalia.

From - To: 1999 - 1999

Objectives: The project have been used to manage the ground staff of Alitalia for the Fiumicino Airport.

Methodologies used: Exact methods, Mixed integer programming, Polyedral

Results: The activity produced two papers and two presentations at AGIFORS conferences where it have been awarded of the Best Technical Presentation award.

Result type: Software prototype

References and links: G. Felici, C. Gentile, ''A Polyhedral Approach for the Staff Rostering Problem'', Management Science vol. 50 (3), p. 381-393, 2004 (ISSN 0025-1909). G. Broggio, S. Falcomatà, G. Felici, C. Gentile, B. Paoletti, "An optimization framework for ground staff roster management using integer programming", in "Handbook of Airline Operations" (Gail F. Butler , Martin R. Keller, eds.), McGraw-Hill, New York (2000), ch. 24, p. 349-369 (ISBN 007-982386-6).

48. A cloud-based system to protect against industrial multi-risk events

Sistema cloud-based per la protezione da eventi multi-rischio industriali

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Application field: Environment, Logistics, Security, Services and society

Keywords: emergency logistics, location-allocation, optimization, risk events

Abstract: Industrial areas frequently present a high concentration of production operations which are source of anthropic risks. This work is part of the outcomes of the Research Project SIGMA - sensor Integrated System in cloud environment for the Advanced Multi-risk Management. SIGMA intends to acquire, integrate and compute heterogeneous data, coming from various sensor networks in order to provide useful insights for the

monitoring, forecasting and management of risk situations through services provided to citizens and businesses, both public and private. The optimization module is able to solve the emergency logistics problem of providing heterogeneous resources (such as equipments, personel, materials) from different locations to risk events. The prototype solution is detailed by a use case application in an industrial area located in the region of Sicily, Italy. The problem has been modelled as a modified Capacitated Facility Location Problem (CFLP) and a Mixed Integer Linear Programming Model has been developed by use of CPLEX Optimization Studio. The prototype is embedded in a web based application, which is integrated in the SIGMA platform. The network has been built by using a geographic information system.

Abstract (it): Le aree industriali presentano spesso un'alta concentrazione di produzioni fonte di rischio antropico. Questo lavoro è parte dei risultati del progetto di ricerca SIGMA - Sistema integrato di sensori in ambiente cloud per la gestione multirischio avanzata. Lo scopo di SIGMA è quello di acquisire, integrare, ed elaborare dati eterogenei, provenienti da varie network di sensori, in modo da fornire utili informazioni per il monitoraggio, la previsione e la gestione di situazioni di rischio. Il modulo di ottimizzazione è capace di risolvere il problema di logistica di emergenza tramite la fornitura di risorse eterogenee (equipaggiamenti, personale, materiali, etc) da differenti località ai luoghi in cui sono localizzati eventi di rischio. La soluzione prototipale è stata dettagliata rispetto ad un caso applicativo relativo ad un'area industriale della Sicilia. Il problema è stato modellato come una variante di Capacitated Facility Location Problem (CFLP) e il relativo Mixed Integer Linear Programming Model è stato implementato tramite CPLEX Optimization Studio. Il prototipo è stato integrato in un'applicazione web based inserita a sua volta all'interno della piattaforma SIGMA. Il network logistico è stato implementato utilizzando un sistema informativo georeferenziato.

From - To: 2012 - 2015

Objectives: Optimize the location and allocation of rescue personnel and resources. Minimize the logistics cost constrained to the provision of a predefined set of resources for the mitigation of the given risk events.

Methodologies used: Exact methods

Results: The system is able to minimize the logistics cost constrained to the provision of a predefined set of resources for the mitigation of the given risk events.

Result type: Software prototype

References and links: Stecca, G., Puliafito, A., Simonetti, M., Mariotta, G. and Sciuto, P., 2016. A cloud-based system to protect against industrial multi-risk events. Procedia CIRP, 41, pp.650-654.

49. Health workforce: towards a forecasting model for Emilia-Romagna

Risorse umane in sanità per una previsione dei fabbisogni in Emilia-Romagna

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Organization: Università di Bologna - Dipartimento di Ingegneria dell'Energia Elettrica e dell'Informazione 'Guglielmo Marconi' - DEI

Application field: Healthcare

Keywords: human resources in health, optimization, system dynamics

Abstract: Italian regional health authorities negotiate annually the number of residency grants to be financed by the National government. This study provides regional decision-makers with a simulation-optimization model to forecast the regional need of medical specialists. We carried out a literature review on workforce forecasting models in health outlining their key assumptions and limitations. Subsequently we presented an in depth analysis of available databases at regional level to understand the medical labour market. Finally we implemented a System dynamics model to project the evolution of the supply of medical specialists and the impact of three demand scenarios across the planning horizon (2030). Demand scenarios account for different drivers: demography, service utilization rates (ambulatory care and hospital discharges) and hospital beds. Based on the simulation results, a MIP model computes potentially effective assignments of residency grants to medical specializations.

Abstract (it): In Italia le autorità sanitarie regionali sono chiamate annualmente a negoziare il numero di borse per accesso alle scuole di specializzazione medica finanziate a livello nazionale. Questo studio fornisce ai decisori regionali un modello di simulazione-ottimizzazione per la previsione del fabbisogno regionale di specialisti medici. In principio abbiamo analizzato la letteratura scientifica sui modelli di previsione della forza lavoro in sanità elencandone ipotesi e limitazioni. Successivamente abbiamo analizzato i database disponibili a livello regionale per descrivere e comprendere il mercato del lavoro medico. Infine abbiamo implementato un modello di simulazione System Dynamics per proiettare l'evoluzione della forza lavoro al 2030 in base a tre scenari di domanda. Gli scenari di domanda considerano come driver: demografia, tassi di utilizzo dei servizi e posti letto ospedalieri. Sulla base dei risultati della simulazione, un modello MIP calcola gli assegnamenti più efficaci di borse alle specialità mediche.

From - To: 2013 -

Objectives: The final goal, and the contribution, of this study is to provide a Decision Support System for health workforce planning and forecasting so as to foresee future shortages or surpluses through a proper management of residency grant allocations under budget constraints in the Emilia-Romagna Region. In order to meet the objectives the decision-making model, which will support regional planners, has to be separated in two main components. A simulation model, which describes the health workforce supply and demand behavior over time, and an optimization model that evaluates the imbalances emerging from the simulation model and suggests an optimal funding strategy in order to reduce the gap between human health resources availability and requirements.

Methodologies used: Mixed integer programming, Simulation

Results: The methodology proposed in this paper has obtained much attention. A first presentation of the related work has been made available by Agenzia Sanitaria e Sociale dell'Emilia-Romagna through the publication of Dossier n. 239/2014 (Lodi et al, 2014a). In addition, the Emilia-Romagna experience and methodology has been discussed in the Work Package 5 of the EU "Joint Action Health Workforce Planning and Forecasting" (EUHWForce, 2014) of which the Italian Ministry of Health was responsible. In June 2017 the simulation-optimization model has been updated and the demand and allocation scenarios has been analyzed and discussed for supporting the definition of the number of residency grants that Emilia-Romagna Region will negotiate with the Ministry of Health for 2017-2020 period.

Result type: Case study

References and links: 1. A. Lodi, P. Tubertini, R. Grilli, A. Mazzochetti, C. Ruozi, and F. Senese, "Risorse umane in sanità per una previsione dei fabbisogni in Emilia-Romagna", Agenzia Sanitaria e Sociale regionale dell' Emilia Romagna Dossier n. 239/2014, 2014 (http://assr.regione.emilia-romagna.it/it/servizi/pubblicazioni/dossier/doss239) 2. F. Senese, P. Tubertini, A. Mazzochetti, A. Lodi, C. Ruozi and R. Grilli, "Forecasting future needs and optimal allocation of medical residency positions: the Emilia-Romagna Region case study", Human Resources for Health 13:7, 2015 3. A. Lodi, P. Tubertini, R. Grilli, A. Mazzochetti, C. Ruozi and F. Senese, "Needs Forecast and Fund Allocation of Medical Specialty Positions in Emilia-Romagna (Italy) by System Dynamics and Integer Programming", Health Systems 2016, 5, pp. 213 - 236

50. Revenue, Sales & Promotions

Revenue, Sales & Promotions

Author: Raffaele Maccioni

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Organization: ACT Operations Research - ACT Operations Research

Application field: Energy, Economics and finance, Logistics, Marketing, Manufacturing / Production systems, Services and society, Transportation, Telecommunication

Keywords: Revenue, Sales, Promotions

Abstract: Revenue management and price optimization is a core-activity in any market oriented company operating in different industries (Retails, Fast Fashion, Chain Store, Car Rentals, Web Business, etc.). The goal of our suite is to provide, to the revenue managers, advanced analytics, using a unique combination and integration of predictive, optimization and simulation models. While the analytics tools are complex the results are always presented in an intuitive way.

Abstract (it): Revenue management and price optimization is a core-activity in any market oriented company operating in different industries (Retails, Fast Fashion, Chain Store, Car Rentals, Web Business, etc.). The goal of our suite is to provide, to the revenue managers, advanced analytics, using a unique combination and integration of predictive, optimization and simulation models. While the analytics tools are complex the results are always presented in an intuitive way.

From - To: 1996 -

Objectives: The core products included in the RS&P suite are: Dynamic Price Optimizer (DPO) the multi-paradigm predictive platform (Before!), the customers and market profiling analytics (CMP), the promotion optimization and what-if analysis platform (Before!Promo): The Impact Item Analysis (IIA). Major and reputable companies already embraced the ACT OR technology and services.

Methodologies used: Heuristic / metaheuristic methods, Data analytics / machine learning, Simulation, Stochastic / Robust optimization, Statistics

Results: The core products included in the RS&P suite are: Dynamic Price Optimizer (DPO) the multi-paradigm predictive platform (Before!), the customers and market profiling analytics (CMP), the promotion optimization and what-if analysis platform (Before!Promo): The Impact Item Analysis (IIA). Major and reputable companies already embraced the ACT OR technology and services.

Result type: Software package

References and links: http://www.act-operationsresearch.com

51. Healthcare Analytics

Healthcare Analytics

Author: Raffaele Maccioni

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Organization: ACT Operations Research - ACT Operations Research

Application field: Healthcare

Keywords: Healthcare

Abstract: Hospitals, Research Centers, might improve their operations by the simulation-optimization products of the ACT OR's H-Care suite. Forecast of patients flows, scheduling of resources (teams, surgery rooms).

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From - To: 1996 -

Objectives: Hospitals, Research Centers, might improve their operations by the simulation-optimization products of the ACT OR's H-Care suite. Forecast of patients flows, scheduling of resources (teams, surgery rooms).

Methodologies used: Exact methods, Heuristic / metaheuristic methods, Simulation, Statistics

Results: Hospitals, Research Centers, might improve their operations by the simulation-optimization products of the ACT OR's H-Care suite. Forecast of patients flows, scheduling of resources (teams, surgery rooms).

Result type: Software package

References and links: http://www.act-operationsresearch.com

52. ALS-3Dviewmeas – System for automatic measuring, modelling and geo-referencing of countryside items (buildings, asphalt holes, waste bins ...) by integration of GPS, multi-scan LIDAR and panorama photos.

ALS-3Dviewmeas – Sistema per la misurazione, modellazione e georeferenziazione automatizzata di elementi paesaggistici (edifici, buche stradali, cassonetti rifiuti ...) mediante integrazione di GPS, LIDAR multiscan e fotografia a 360°

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Organization: AutoLogS Srl - Spinoff of the Polytechnic of Bari and of the University of Trieste

Application field: Environment, Security, Services and society

Keywords: LIDAR, monitoring, GPS, 360° photo, photo measure

Abstract: Systems for distance measurement by laser (LIDAR) even multisensory are more and more diffuse and affordable in price. Same is for 360° cameras systems which, on the roof of a car, allow with 2 or more synchronized cameras to take at regular intervals panorama photos of everything is around (as used for Google Street View). This allows imagining several new practical developments using a combination of such systems, paired with a high-precision GPS giving accurate geo-referencing of images and measurements together with their time sync.

Abstract (it): I sistemi di rilevamento distanze mediante laser (LIDAR) anche multi sensore stanno diffondendosi rapidamente, con consistenti cali nei prezzi dei sistemi. Lo stesso vale per i sistemi combinati per acquisizione di foto a 360°, che montati ad esempio sul tetto di una vettura permettono con 2 o più macchine fotografiche sincronizzate di acquisire ad intervalli regolari foto panoramiche di tutto quanto è intorno alla vettura (sistemi analoghi sono usati per Google Street View). Questo permette di immaginare molti nuovi sviluppi applicativi che utilizzino in combinazione questi sistemi, accoppiati ad un GPS ad alta

precisione che fornisca una accurata geo-referenziazione delle immagini e delle misure acquisite nonché ne garantisca la sincronizzazione.

From - To: 2015 - 2016

Objectives: The combination of multi-scan LIDAR system, 360° photos and accurate GPS geo-referencing, all of them at a relatively affordable price, allows for a huge number of possible practical applications. Some examples are environmental monitoring, buildings monitoring and evaluation, urban monitoring, security, creation of databases of geo-referenced items (like light pillars, waste bins, holes in street asphalt and any information useful for city management). The important thing in order to be able to combine the data from the two sources (photos and LIDAR) is to have them accurately synchronized using the GPS system as time-sync signal source. A post processing of the GPS information with statistical analysis allows overcoming some small signal errors and achieving an accurate geo-referencing. The large quantity of data coming from LIDAR can be analysed with specialized SW. Panorama photos can be a precious source of information too. A user can review a virtual tour, identify items of interest, and mark their position or measure their visible width or height. This kind of measurement from photos is usually done with 3D photos by triangulation, but the panorama photo already contains information that is not simply 2D.

Methodologies used: Data analytics / machine learning, Statistics

Results: ALS-3Dviewmeas is a SW capable of integrating data from LIDAR multi scan systems and panorama 360° camera systems. A GPS system acts as a trigger to both data acquisition systems and its data are recorded and processed in order to improve accuracy of geo referencing. A user-friendly interface allows the user to review a camera acquisition and identify items of interest. With some simple "point/click" actions, it is possible to identify with good precision the position of the items and add annotations (e.g., "Large hole in asphalt near waste bin. To be repaired ASAP."). Positioning and annotations can be exported as CSV file or as KML file which allows viewing items positions and annotations on Google Earth or similar maps systems. It is also possible to make some limited measurements like height from floor level or width. These measurements are made with a simple "click/drag" from a single photo. Contrary to most similar systems, it is not necessary to identify a same point from two different photos. This allows for a much easier and quick interface. The SW is currently effectively in use for a continuous operation of monitoring of holes in asphalt in a province in Italy.

Result type: Software package

References and links:

53. Scheduling the Italian National Volleyball Tournament

Calendario del Campionato Italiano Nazionale di Pallavolo

Author: Veronica Piccialli

Email: veronica.piccialli@uniroma2.it

Organization: University of Rome Tor Vergata - Department of Civil Engineering and Computer Science Engineering

Application field: Sport

Keywords: Sports scheduling, round robin tournament, mixed integer programming, volleyball

Abstract: Until the 2015/16 season, the schedule of the Italian Volleyball tournament was made through a combination of an automated system to define the home-away patterns and a manual process to assign to each team a pattern, taking into account the stadium availabilities, the national and international tournaments and other organisational constraints. Since the 2016/17 season, thanks to the collaboration with the GOL (Global Optimization Laboratory) of the University of Florence and the University of Rome Tor Vergata, the optimal schedule (in terms of both fairness and stadium attendance) is produced by solving a suitable mixed integer linear programming problem. The effectiveness of the approach has been tested on seasons 2013/14, 2014/15 and 2015/16, and the quality of the produced schedules have been validated by the Italian Volleyball League. For the 2016/17 season, and from then on, the official schedule has been produced using the approach proposed.

Abstract (it): Fino alla stagione 2015-16, i calendari agonistici della Lega Pallavolo Serie A sono stati sviluppati basandosi su un software in grado di elaborare matrici di sequenze tra partite in casa ed esterne, in cui inserire manualmente i blocchi imposti dagli impegni dei palasport, dalle trasferte europee e dalle sequenze di numerosi vincoli organizzativi. Dalla stagione 2016/17, grazie a una proficua collaborazione tra la Lega Volley di Serie A, il GOL (Global Optimization Laboratory) dell'Università di Firenze e l'Università di Tor Vergata, il calendario ottimo (in termini di bilanciamento del calendario e con un occhio all'obiettivo di riempire i palasport) viene prodotto tramite risoluzione di un opportuno modello di programmazione lineare mista. L'efficacia è stata prima testata sui calendari delle stagioni precedenti, e la qualità dei calendari prodotti validata dallo staff della Lega

Volley, che ha deciso di adottare dalla stagione 2016/17 il calendario soluzione del nostro modello.

From - To: 2015 -

Objectives: In Italy, there are some standard requirements which the schedule of the tournament must satisfy and others which are introduced or modified year by year by the League, but the main requirements are those of fair and balanced schedules for all teams in order to maximize the attractiveness of the tournament, television audience and the indoor stadium attendance. As a result, there are a number of hard and soft constraints that the schedule must satisfy and that may differ from year to year. Until the 2016-17 season, the Italian Volleyball League employed a combination of a computer-based system to determine the home and away pattern, and manual operations to assign each pattern to a team. This process was painful and clearly suboptimal. Therefore the aim of the collaboration was to define an automatic support decision system able to suggest different feasible schedules among which the Italian Volleyball League could choose the best one.

Methodologies used: Exact methods, Linear, Mixed integer programming

Results: Thanks to our contribution, from now on the scheduling of the Italian Volleyball tournament is built by an automated system. The schedule is obtained as the exact solution of a mixed integer linear programming problem that takes into account all the constraints imposed by the championship rules (it is a mirrored round robin problem) and aims to a fair and balanced schedule for each team, in such a way to maximize the competitiveness of the tournament, the indoor stadium attendance and the television audience (especially in some relevant dates, like the 26th of December). As a first step, the solutions obtained by the mathematical programming approach have been tested on seasons 2013/14, 2014/15 and 2015/16 (where other schedules were used) and successfully applied to produce the official schedule of the 2016/17 tournament.

Result type: Methodology

References and links: http://www.legavolley.it/VediPagina.asp?ContentId=60306

54. LINFA - Intelligent Logistics for pharmaceutic drugs

LINFA - Logistica Intelligente del Farmaco

Author: Fabio Schoen

Email: fabio.schoen@unifi.it

Organization: Università degli Studi di Firenze - DINFO

Application field: Healthcare, Logistics, Manufacturing / Production systems, Services and society

Keywords: forecasting, replenishment, inventory, prescriptive analytics

Abstract: Development of forecasting methods for the usage of pharmaceutical drugs in an hospital ward based on historical data on past drug consumption as well as on ward situation. Replenishment policies for drugs based on the optimization of inventory and the minimization of urgent re-orders

Abstract (it): Sviluppo di metodologie di previsione dell'utilizzo di farmaci basati su serie storiche del consumo e della degenza in un reparto ospedaliero. Sviluppo di politiche di riordino orientate alla minimizzazione delle scorte e dei riordini urgenti

From - To: 2016 -

Objectives: To develop algorithms and software to solve optimal inventory replenishment problems based on advanced optimization and machine learning techniques

Methodologies used: Exact methods, Heuristic / metaheuristic methods, Mixed integer programming, Data analytics / machine learning, Simulation, Stochastic / Robust optimization

Results: research is active

Result type: Methodology, Software package

References and links:

55. Prestige

Prestige

Author: Fabio Schoen

Email: fabio.schoen@unifi.it

Organization: Università degli Studi di Firenze - DINFO

Application field: Services and society

Keywords: smart tourist, routing

Abstract: The project concerned the development of an app by which an hotel manager can provide services to the cutomers. Our group developed a routing engine to suggest a touristic route

Abstract (it): Il progetto ha riguardato lo sviluppo di una app tramite la quale il gestore di un albergo può fornire e ricevere informazioni dai clienti. Il ruolo del nostro gruppo è stato quello di sviluppare un motore di routing per consigliare il turista

From - To: 2014 - 2014

Objectives: To develop a routing algorithm for visiting a set of touristic attractions respecting time windows and minimizing wasted time

Methodologies used: Heuristic / metaheuristic methods, Data analytics / machine learning, Simulation, Networks / graph optimization

Results: a standard routing algorithm has been implemented in Java and interfaced with the ap

Result type: Case study

References and links:

56. Multi-period street scheduling and sweeping

Creazione di rotte per la pulizia di strade soggette a vincoli di parcheggio

Author: Carmine Cerrone

Email: carmine.cerrone@unimol.it

Organization: Università del Molise - Bioscienze e Territorio (DiBT)

Application field: Services and society, Transportation

Keywords: Arc Routing, Vehicle Routing, Street Sweeping, Genetic Algorithms

Abstract: In the street-sweeper problem, we seek to sweep the sides of city streets in a way that minimises the distance travelled by the street sweepers. Typically, street sweepers are blocked by parked cars that prevent the curb from being swept. We consider a problem posed to us by Washington, DC where the parking constraints are multi-period decision variables. For example, suppose the city wishes to sweep its streets over two days with available parking on at least one side of each street on each day. Before the city considers

how to sweep its streets, it must first decide which street sides to make available for parking on each day in a way that obeys the parking constraint on both days. We present a genetic algorithm that generates high-quality solutions and discuss managerial implications.

Abstract (it): Nel problema della pulizia delle strade, cerchiamo un modo per pulire i lati delle strade in modo da minimizzare la distanza percorsa dalle spazzatrici meccaniche. Le auto parcheggiate lungo i margini delle strade, sfortunatamente spesso impediscono di effettuare questo lavoro. Noi abbiamo affrontato un problema proposto dalla città di Washington DC, in cui al fine di ottimizzare le rotte delle pulitrici nei diversi giorni di lavoro, è possibile modificare i divieti di parcheggio lungo le strade. Ad esempio supponiamo che si vogliano pulire tutte le strade in due giorni di lavoro, consentendo per ogni giornata che almeno un lato di ogni strada sia libero per il parcheggio. Per risolvere questo problema abbiamo sviluppato un algoritmo genetico capace di produrre soluzioni di buona qualità.

From - To: 2013 - 2014

Objectives: Develop a heuristic algorithm able to produce multiple routes for the sweepers, taking into accounts the parking constraints.

Methodologies used: Heuristic / metaheuristic methods

Results: A genetic algorithm that generates high-quality solutions

Result type: Case study, Software prototype

References and links: Cerrone, C., Dussault, B., Golden, B., & Wasil, E. (2014). Multi-period street scheduling and sweeping. International Journal of Metaheuristics, 3(1), 21-58.

Energy and Environment

57. Optimal allocation of sensor meaurements for the design of a reliable diagnostic system

Problema di allocazione ottima delle misure di un sistema diagnostico

Author: Claudio Sterle

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Organization: University 'Federico II' of Naples - Department of Electrical Engineering and Information Technology

Application field: Energy, Manufacturing / Production systems

Keywords: optimal allocation; diagnostic system; reliable system design

Abstract: The magnetic diagnostic system plays a crucial role in a Tokamak reactor and, more generally, in any magnetically confined fusion device. Indeed, all the essential quantities for plasma control are computed by a number of processing nodes, starting from the magnetic fluxes and fields acquired by this diagnostic system. This paper presents the tool for oPtImal Measurement Probes Allocation (PIMPA) in a magnetic diagnostic system. PIMPA is based on the solution of an integer linear programming problem, and aims at maximizing the reliability of the diagnostic system against the failure of one or more of the processing nodes. Although in this paper, PIMPA is introduced for the optimal allocation among the processing nodes of the magnetic probes, it can be easily extended to any diagnostic system. A case study that considers a distributed and scalable architecture for the ITER Tokamak is presented to show the effectiveness of the proposed approach.

Abstract (it): E' stato studiato, in relazione al tokamak ITER, un problema di ottimizzazione per l'allocazione dei sensori in sistemi di acquisizione dati, il cui obiettivo è quello di massimizzare l'affidabilità complessiva del sistema nei confronti dei guasti delle singole unità di acquisizione. Il problema è stato affrontato nell'ambito di una collaborazione di ricerca con l'agenzia F4E (Fusion for Energy). Il problema è stato formulato tramite un modello di programmazione lineare intera che costituisce una particolare variante dello Generalized Assignment Problem (GAP), e sfrutta la ridondanza dei sistemi di misura delle grandezze magnetiche. Il problema è stato poi ulteriormente approfondito per tenere conto non solo dell'allocazione dei sensori nelle unità di acquisizione, ma anche nelle singole board di memoria che costituiscono queste ultime. Si è quindi sviluppato un approccio sequenziale basato sulla risoluzione di due GAPper i due sottoproblemi di allocazione. L'approccio è stato presentato al 28th Symposium on Fusion Technology, SOFT2014.

From - To: 2013 -

Objectives: - studiyng the problem of the optimal allocation of the probe measurements to maximize the reliability of a diagnostic system - improve the available solution approach, based on a heuristic method - integrate new security and design requirements in the proposed solving approach

Methodologies used: Exact methods, Mixed integer programming

Results: - development of an original ILP formulation for the optimal allocation problem under investigation; - exact solutions of real instances obtained by data coming from an already existing tokamak (up to 1000 probe measurements)

Result type: Case study, Methodology

References and links:

58. OptiTLR – Decision support system for the strategic development of district heating networks

OptiTLR – Sistema di supporto alle decisioni per lo sviluppo ottimizzato di reti di teleriscaldamento

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Organization: OPTIT Srl - OPTIT Srl

Application field: Energy

Keywords: Optimization, district heating, network design

Abstract: District heating is an important asset to leverage on towards the energy transition; nevertheless, huge investment costs (related not only to infrastructures but also to operations) require a careful planning. As such, heat distribution is a strategic business issue, related to the design of the district heating network, that can be either the extension of an existing network or the design of a completely new network from scratch; in both cases, the board of management aims at maximizing the Net Present Value (NPV) of the investment. OptiTLR is a decision support system that allows a quick generation of alternative scenarios to support the decision making process. The system has been developed by Optit Srl on algorithms and models defined by the University of Bologna.

Abstract (it): Il teleriscaldamento urbano è considerato una delle leve per migliorare la sostenibilità delle nostre città; ai molteplici benefici di carattere ambientale che esso offre si affiancano costi molto elevati, dovuti non solo alla realizzazione delle infrastrutture necessarie (ossia gli impianti di produzione di energia e le reti interrate di distribuzione) ma anche alla gestione operativa, che deve soddisfare una domanda fortemente variabile nel corso della giornata e dei diversi periodi dell'anno. Per conseguire l'efficienza

economica, pertanto, è importante sviluppare strumenti innovativi di supporto alle decisioni che permettano la valutazione di scenari strategici od operativi per la pianificazione e la gestione delle reti di teleriscaldamento. Il gruppo di Ricerca Operativa del Dipartimento di Ingegneria dell'Energia Elettrica e dell'Informazione (DEI) - Università di Bologna ha sviluppato modelli di ottimizzazione per risolvere questo problema di business; Optit Srl, spin – off accreditato della medesima università, ha curato lo sviluppo industriale di tali modelli andando a definire un prototipo e successivamente un sistema di supporto alle decisioni chiamato OptiTLR.

From - To: 2014 -

Objectives: OptiTLR supports networks managers to answer to the following main questions: • commercial development: given a district heating grid and its current users, who are the best new users to encourage to join in order to maximize the NPV of the system, respecting its thermo-hydraulic constraints? The same issue can be considered where there is a saturated grid: if there are users that do not completely exploit the contractual power, would it be advantageous to change their contracts and make part of their power available for new users, without expanding the grid? • strategic development: given two or more grid expansion configurations (e.g., new backbones), and a set of prospects, which subset maximizes the NPV? In this business issue, commercial drivers must find a compromise with technical constraints (i.e., with the thermo-hydraulic consistency of the network).

Methodologies used: Exact methods, Mixed integer programming, Networks / graph optimization

Results: OptiTLR has been successfully used by two of the largest Italian multi-utility companies. Namely, the main key success factors of this application are: • quick generation of results: users are allowed to generate and compare as many different network configurations as they want in a relatively short period of time (about five new configurations per hour). This extremely simplifies what-if analysis activities and the decision process itself. • Interconnection between two different perspectives: commercial staff and technicians find in the same tool a support for their respective activities, each one getting results compliant with the others goals/constraints. • High number of decision variables within the model, allowing decision makers to perform many kinds of what-if analyses.

Result type: Software package

References and links:
https://pdfs.semanticscholar.org/761f/8fb2cf124ad57681973f717f151dbe0613ef.pdf
http://link.springer.com/chapter/10.1007%2F978-3-319-43916-7_4

59. OptiWasteFlow – Optimization of waste flow

OptiWasteFlow - Ottimizzazione del flusso del rifiuto

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Organization: OPTIT Srl - OPTIT Srl

Application field: Logistics, waste logistics

Keywords: Optimization, waste logistics

Abstract: Waste collection and disposal are a very complex and major issue, having social, environmental and economic impacts. Optimization techniques really fit this kind of complexity: in a waste logistic chain, flows of waste (urban and or industrial) are processed in treatment plants before reaching their final destination. Therefore, waste is moved upon routes that connect different cities/regions, implying costs that affect the national economy. OptiWasteFlow is the solution developed by Optit Srl for the optimized allocation of waste flows to treatment plants. OptiWasteFlow allows working on two levels: • a strategic level: covers a time lapse of four to five years with a yearly detil and takes into account the possibility to close existing plants/ build new ones (what-if analysis); • a tactical level: in a time horizon of one year, the budget of the plant Is defined (on a monthly basis) and the revised budget (on a weekly basis).

Abstract (it): La raccolta e lo smaltimento dei rifiuti solidi urbani (RSU) rappresentano un importante problema nella società contemporanea, non solo a causa degli impatti sociali ed ambientali, ma anche per effetto dei costi elevati. La complessità del problema ben si presta ad essere affrontata con tecniche di ottimizzazione sviluppate nel campo della Ricerca Operativa: in una filiera tipo i rifiuti, siano essi di tipo urbano piuttosto che industriale, passano attraverso impianti di trattamento prima di arrivare alla destinazione finale; di conseguenza, i flussi di rifiuti seguono direttrici che collegano città/regioni diverse con reti multi livello, con costi logistici e di trasformazione che impattano sull'economia nazionale. OptiWasteFlow è la soluzione sviluppata da Optit Srl per l'ottimizzazione dell'allocazione dei flussi di rifiuti verso gli impianti di trattamento. Essa consente di operare su due livelli: • un livello strategico, con un orizzonte di pianificazione di 4 anni con dettaglio annuale (piano industriale) e la possibilità di definire molteplici scenari con analisi what-if; • un livello tattico, con orizzonte annuale, per definire il budget (con

dettaglio mensile) ed il revised budget sulla base dei valori a consuntivo (con dettaglio settimanale).

From - To: 2013 -

Objectives: OptiWasteFlow supports managers for the optimal allocation of waste to the available plants, producing a solution that balances saturation of plants and logistics costs reduction, aiming at improving the total profit. The DSS allows the visualization of solutions using a GIS and the generations of reports filtering data accordingly. Advantages of such an approach are multiple, particularly: • strengthening of the process and replicability of the methodology, improved capacity of managing complex scenarios, guaranteeing data traceability; • improvement of efficiency and efficacy of the planning process: in a few weeks several different scenarios are generated for evaluation, and reaction to external factors is easier and quicker; • non negligible profits, both for logistics costs and treatment ones; return on investment is a few months.

Methodologies used: Heuristic / metaheuristic methods, Mixed integer programming, Networks / graph optimization

Results: Most important results obtained using OptiWasteFlow are: • quicker multi-year planning: before two employees had to work for two weeks to define the industrial plan and the yearly budget, now only one employee for two days is necessary to carry out the same tasks; • the number of waste movements from one plant to another has been decreased (about several hundreds of thousands of euros saved, corresponding to less energy consumption and less impact on environment). Recently the DSS has been evolved with a collaboration module that allows the access to different users (logistics, markets, plants), becoming an integrated working platform for planning and monitoring of the service with a single transport order detail.

Result type: Software package

References and links:

60. OptiRoute – Decision support system for optimizing waste collections trips

OptiRoute – Sistema di supporto alle decisioni per l'ottimizzazione dei percorsi di raccolta rifiuti

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Application field: Logistics, Waste logistics

Keywords: Optimization, waste collection, vehicle routing, waste logistics

Abstract: Planning of waste collection and disposal services is a very complex issue, both on a logistic level and an industrial one. Collection planning involves a number of sub-phases each one calling for a solution of a specific optimization problem. OptiRoute is a decision support system for supporting waste collection services in urban and extraurban areas. OptiRoute can support all the phases of waste collection, particularly the definition of frequencies, the dimensioning of collecting stations and trips scheduling. OptiRoute can manage complex problems, made of thousands of points with different emptying frequencies, defining trips and working shifts for trucks on a one-or-more-weeks horizon.

Abstract (it): La raccolta e lo smaltimento dei rifiuti solidi urbani (RSU) rappresentano un importante problema nella società contemporanea, non solo a causa degli impatti sociali ed ambientali, ma anche per effetto dei costi elevati. La pianificazione della raccolta coinvolge numerose fasi, ciascuna delle quali richiede la soluzione di specifici problemi di ottimizzazione. OptiRoute è un sistema di supporto alle decisioni in grado di supportare la pianificazione dei servizi di raccolta dei rifiuti in ambito urbano ed extraurbano. Il sistema è in grado di supportare tutte le fasi del processo di pianificazione illustrato in Figura 1, ed in particolare le fasi da 3 a 5. OptiRoute è in grado di gestire problemi di grande dimensione che coinvolgono migliaia di cassonetti da servire, con frequenze di servizio diverse, e di organizzare i viaggi di raccolta ed i turni di lavoro per i mezzi coinvolti su un orizzonte temporale di una o più settimane

From - To: 2013 -

Objectives: OptiRoute is a software for supporting waste collection services in urban and extraurban areas and allows manager to answer to the following questions: • what is the minimum emptying frequency necessary for every bins location/zone? • What and how many bins are necessary to have a specific frequency in a zone? The answer to these questions affects costs and quality of the service (that depends on the number of bins and on the emptying frequency) and in many cases doesn't need the exact definition of trips. In fact frequently the collection service in peripheral areas and/or peak period is outsourced. The subcontractor in these cases is interested in defining the level of service (that is the emptying frequency) and the cost, leaving the definition of trips to the contractor. Promising results obtained in these experiences have led to further evolve optimization algorithms for the definition of collection trips. This implies the solution of a periodic vehicle routing problem with numerous operations constraints based on the specific context. Major challenges in this case have to be faced, due both to the bigger dimension of the problem (mean cities have thousands of collection points) and to the lack

of necessary information, as one way roads, turn restriction and maximum speed of different roads.

Methodologies used: Heuristic / metaheuristic methods, Mixed integer programming, Networks / graph optimization

Results: OptiRoute is based on an open source GIS (Geographical Information System) technology for cartographic data management and for an easy to use visualization of trips; as such, OptiRoute offers numerous features (one way roads, turn limitations, speed limits, possible trucks movements close to collecting locations and intersections), as long as the upload from GPS tracks and export to other cartographic systems and navigators. The system enables the reiteration of the process allowing a feedback between phases to change parameters of each module and manually change solutions obtained at each step. This allows to converge rapidly to the solution desired by the planning manager. Other features are the evaluation of CO2 emissions of trips and the support for the generation of working trucks/drivers shifts, obtained aggregating services of different trips (e.g. different recycling waste such as plastic, paper, organic,...) in valid working days. OptiRoute allows users with no expertise in OR to propose improvements to the actual trips and to support the redefinition of collecting areas to improve the productivity of the service or to simulate a what-if approach, changing operations conditions: different loads of trucks, different unloading points, different working shifts durations, new collection operations.

Result type: Software package

References and links:

61. OptiEPM – Decision support system for energy production optimization

OptiEPM – Sistema di supporto alle decisioni per l'ottimizzazione della produzione di energia

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Application field: Energy

Keywords: Optimization, energy production, CHP, cogeneration

Abstract: OptiEPM is a decision support system for short, medium and long term optimization of energy production plants connected whether to district heating/cooling

networks or to private customers for energy service (e.g. hospitals): this implies serving heat/cool/electricity demands while aiming at maximizing the EBITDA (Earnings Before Interest, Taxes, Depreciation, and Amortization) of the plant. Traditional (manual) management becomes weaker and weaker as the complexity of the plant/network grows: the more the alternatives for heat/cool production, the more difficult the management. Hence, Decision Support Systems (DSS) are necessary to support decision makers in finding the optimal solution.

Abstract (it): Il gestore di un impianto di produzione di energia termica (e spesso anche frigorifera) si trova di fronte alla necessità di soddisfare la domanda di riscaldamento (e raffrescamento) che può provenire da una rete di teleriscaldamento oppure da un edificio. Se l'impianto è dotato di diverse tipologie di macchine che producono calore (freddo) a partire da diverse fonti, il gestore deve decidere quali fonti utilizzare nel corso della giornata per soddisfare la domanda e, al contempo, ottimizzare il margine di impianto. Le numerose variabili in gioco rendono la decisione complessa e ovviamente, al crescere della complessità dell'impianto, cresce di pari passo la difficoltà di redigere "a mano" un piano di produzione ottimale. Il sistema OptiEPM è una soluzione di supporto alla programmazione di breve, medio e lungo termine degli impianti di cogenerazione asserviti a reti di teleriscaldamento o alla fornitura in energy service per clienti pubblici e privati (ad es. ospedali).

From - To: 2015 -

Objectives: OptiEPM is a decision support system targeted to plant managers that have to solve the following business problem: serving one or more demands (heat demand mainly, but also cool demand and/or electricity demand if the plant is connected to a building or to an industrial facility) by producing energy using different machines, depending on the plant configuration, in order to maximize the profit of the plant. Consequently, the decision-making process must take into account a number of variables, namely: • costs, profits and fiscal advantages (if any) of each energy source; • technical constraints of the plant itself and of the machines; • regulatory constraints; • _ ordinary and extraordinary maintenance requirements. Also, if the electricity produced by the plant is sold to the National Electricity Network, there is an additional variable (the selling price) and an additional constraint (the amount of electricity committed to the market the day before for the following day). As such, decision making for energy production is a complex job, and this complexity increases for bigger plants and if more production alternatives are offered.

Methodologies used: Heuristic / metaheuristic methods, Mixed integer programming

Results: The introduction of OptiEPM has enabled the possibility to manage a holistic view of the plant in the same system, simplifying both the daily tasks of the managers and the

budgeting process; the user-friendly interface allows an easy access to information and quick changes to parameters when necessary. Also, after two years, the following remarks can be pointed out: • the DSS has proved its effectiveness, raising profits by about 5%-10% per year; this is a direct consequence of the more precise machines scheduling, compared to manual management that tends to set machines monthly or, at best, weekly; • the best results are in mid seasons (i.e., spring and autumn), because the probability of unstable weather is higher and manual operations are less responsive to unexpected weather conditions; • OptiEPM allows the plant manager to perform what-if analyses to determine the best period for ordinary maintenance operations; • the possibility of performing what-if analyses also allows operators to evaluate how to manage other types of constraints, such as the number of working hours of the engines before extraordinary maintenance operations. For example, one plant manager has decided to limit daily working hours of the engines to avoid the need for an extraordinary maintenance operation before the end of the energy service contract.

Result type: Software package

References and links: http://link.springer.com/chapter/10.1007%2F978-3-319-43916-7_4

62. ICEWATER

ICEWATER

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Application field: Energy, Environment

Keywords: forecasting, clustering, time series, parameters optimization

Abstract: ICeWater will increase the stability of freshwater supply to citizens in urban areas by adjusting the water supply to the actual consumption, while minimizing energy consumption through smart-grid integration and water spillage through leak detection. ICeWater uses wireless sensor networks for water flow monitoring and it provides a decision support system for the water utilities so that supply and demand patterns can be matched in real-time. As an additional benefit, leakage can be predicted with statistical methods so that water network damages can be mended even before they occur (fix-before-break). The demand management and consumption information is accessible online to the relevant actors in the water supply chain (including consumers) and allows

dynamic pricing schemes with nudge-pricing to motivate behavioural change in customers causing critical consumption patterns.

Abstract (it): Icewater aumenterà la stabilità delle forniture di acqua dolce per i cittadini delle aree urbane regolando la fornitura di acqua per il consumo effettivo, riducendo al minimo il consumo di energia attraverso l'integrazione smart-grid e il rilevamento di perdite. Icewater utilizza reti di sensori wireless per il monitoraggio del flusso di acqua e fornisce un sistema di supporto alle decisioni per i servizi idrici in modo che i modelli di domanda e offerta possono essere abbinati in tempo reale. Inoltre, la perdita può essere prevista con metodi statistici in modo da consentire una manutenzione anche in termini predittivi. Le informazioni di gestione della domanda e dei consumi è accessibile on-line per gli attori rilevanti nella catena di approvvigionamento di acqua (compresi i consumatori) e permette la determinazione di sistemi di tariffazione dinamica per motivare il cambiamento comportamentale degli utenti.

From - To: 2012 - 2015

Objectives: The main objective is to develop a decision support systems based on sensor data to allow the optimization of the water grid network operations (pumping schedules, pressure etc.).Services for asset management, such as predicting deterioration, leakage detection and leakage localization functionalities, will be integrated in the DSS. This has been achieved using clustering methods, in particular spectral clustering and support vector classification and regression. These tools have allowed to leverage new smart metering into the following objectives: a better understanding of the consumers, improvment of the effectiveness of the asset management and flexible pricing schemes.

Methodologies used: Data analytics / machine learning, Simulation, Global optimizazion, Scheduling, Statistics

Results: - Demand management systems using metering infrastructure and an analysis of real-time consumption patterns and network operation - Decision support systems which use consumption data and other relevant parameters (e.g. energy costs in the smart electric grid) sampled in real-time (as well as historical data) to enable real-time decision making for the water distribution network operator in order to reduce operational expenses as well as meet the demand for water re-sources. -Services for supporting asset management by predicting deterioration (enabling a "fix before break" approach) and providing leak detection and localization functionalities.

Result type: Case study, Methodology, Software prototype

References and links: http://www.icewater-project.eu

63. RESOLUTE - RESilience management guidelines and Operationalization appLied to Urban Transport Environment

RESOLUTE - linee guida per gestione della resilienza e loro operazionalizzazione alle reti di trasporto urbano

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Application field: Environment, Logistics, Security, Services and society, Transportation

Keywords: resilience management, urban transportation networks, network analysis, resource allocation

Abstract: Resilience of Urban Transportation Networks has been gaining increasing importance in view of man-made (terrorists acts) or natural emergencies (earthquakes, floods). Moreover, large sets of real-time sensors data require the application of sophisticated machine learning methods. Network analysis is alsp playing in RESOLUTE a major role with respect to modelling infrastructures, multimodalities, flows/traffic, and dynamic changes to the graph associated to the UTS in order to simulate cascading effects, evaluate impact and anticipate modifications in flows. Main challenges addressed are the optimization of bus-bridging and scheduling, (re-)routing, allocation of resources during the emergency management (e.g. ambulances allocation) and design/expansion/rehabilitation of the UTS and service level.

Abstract (it): La resilienza delle reti di trasporto urbano sta diventando sempre più importante in vista delle emergenze sia 'man-made' (quali atti terroristici) o naturali (quali terremoti e inondazioni). Inoltre, datasets di grandi dimensioni, provenienti da sensori richiedono l'applicazione di sofisticati metodi di apprendimento automatico. Network analysis ha un ruolo importante in RESOLUTE per quanto riguarda la modellazione e l'analisi delle infrastrutture, multi-modalità, flussi di traffico, e cambiamenti dinamici in modo da simulare effetti a cascata, valutarne l'impatto e anticiparne i cambiamenti nei flussi. I risultati principali ottenuti sono l'ottimizzazione del bus-bridging e dello scheduling, ri-routing, allocazione delle risorse durante la gestione delle emergenze (ad

esempio l'assegnazione ambulanze) e il design / espansione / riabilitazione della rete di trasporti e del livello di servizio.

From - To: 2015 - 2018

Objectives: RESOLUTE has the objective of achieving higher sustainability of operations in European Urban Transportation Systems. This requires new solutions adapted to the ongoing transformation of urban environments driven by ecological, human and overall safety and security needs, as well as the growing importance of mobility within every human activity. Sustainability is rapidly becoming an imperative need across all economic and social domains and this requires overall heightened operational efficiency, mainly by optimizing the allocation and utilization of available resources (organizational technical and human), whilst striving to continuously minimize any source of waste, namely incidents, accidents and other operational failures. RESOLUTE aims to adapt and adopt these concepts from the definition of guidelines to their operationalization by addressing the management of the Critical Infrastructure (CI) associated to the UTS through the implementation of the RESOLUTE Collaborative Resilience Assessment and Management Support System (CRAMSS).

Methodologies used: Data analytics / machine learning, Simulation, Networks / graph optimization, Scheduling

Results: The main result is a decision support system named CRAMSS (Collaborative Resilience Assessment and Management Support System), including optimization modules for bus-bridging and scheduling, optimal re-routing and allocation of resources.

Result type: Case study, Software prototype

References and links: http://www.resolute-eu.org/

64. DATA4WATER

DATA4WATER

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Application field: Environment, Services and society, Water

Keywords: smart water, water resource management, water-energy nexus optimization, multiple-waters optimization

Abstract: DATA4WATER is developing new methods finalized to the water domain in the following areas: - network analysis for the resilience of water distribution networks – both at physical (infrastructure/asset) and service level - optimization of water-energy usage (optimal pump scheduling) - online generation of machine learning algorithms for water demand/quality forecasting models, and the optimization of their hyper-parameters - optimization of the allocation of “multiple waters” (i.e. water from sources with different quality features) in order to satisfy quality and security of the users.

Abstract (it): DATA4WATER sta sviluppando nuovi metodi finalizzati al dominio dell'acqua nelle seguenti aree: - Analisi della rete per la resilienza delle reti di distribuzione dell'acqua - sia a livello fisico (infrastrutture / attività) sia a livello di servizio - Ottimizzazione del nesso acqua-energia (scheduling ottimale dei sistemi di pompaggio) - Generazione 'online' di algoritmi di apprendimento automatico per la previsione dei consumi idrici e della qualità dell'acqua, e l'ottimizzazione dei loro iper-parametri - Ottimizzazione della ripartizione dei 'multi-waters' (vale a dire l'acqua da sorgenti con caratteristiche di qualità differenti), al fine di soddisfare la qualità e la sicurezza degli utenti.

From - To: 2016 - 2018

Objectives: The main objective of DATA4WATER is to enhance the scientific and technological abilities in the field of smart, data driven e-services in water management. As a H2020 TWINNING project, the aim is to also raise staff’s research profile as well as the one of the institutions involved contributing to the development of a new, interdisciplinary research domain. Networking activities, not only within scientific communities, but also involving relevant stakeholders, in particular, utilities are aimed at identifying use cases to design and validate innovative solutions based on ICT, data analysis, simulation and optimization

Methodologies used: Linear, Nonlinear, Data analytics / machine learning, Dynamic programming, Simulation, Global optimizazion, Networks / graph optimization

Results: Machine Learning Methods for forecasting; global optimization for water management

Result type: Methodology

References and links: http://data4water.pub.ro/
https://www.researchgate.net/publication/280066424_Network_Analysis_For_Resilience_Evaluation_In_Water_Distribution_Networks
http://www.sciencedirect.com/science/article/pii/S1877705815026600
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http://aqua.iwaponline.com/content/64/5/567

65. PILGRIM (ICT platform for the management of the water distribution network in Milan)

PILGRIM (Piattaforma ICT per la gestione della rete idrica Milanese)

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Application field: Environment, Services and society, Water

Keywords: smart water, water quality monitoring, predictice analytics, prescriptive analytics

Abstract: Water quality and safety have been gaining importance in the smart water paradigm. This requires the deployment of network of sensors whose design requires tools from network analysis. The stream of data generated by the sensors are analyzed first in a exploratory stage and subsequently by Machine Learning algorithms. Special emphasis is on the global optimization of machine learning model's hyper-parameters.

Abstract (it): La qualità e la sicurezza della risorsa acqua stanno guadagnando importanza nel paradigma 'smart water'. Ciò richiede l'impiego di reti di sensori la cui progettazione richiede strumenti di 'network analysis'. Il flusso di dati generati dai sensori viene analizzato inizialmente in una fase esplorativa e successivamente da algoritmi di machine learning. Particolare attenzione è sulla ottimizzazione globale di iper-parametri del modello di apprendimento.

From - To: 2016 - 2018

Objectives: - Optimization of wireless sensor networks for monitoring water quality - Design of an ICT platform for asset management - Machine Learning methods and algorithms to support demand forecasting and energy optimization - Deployment of diagnostic tools

Methodologies used: Heuristic / metaheuristic methods, Data analytics / machine learning, Dynamic programming, Simulation, Global optimizazion, Networks / graph optimization

Results: The main result is a ICT platform which integrates several machine learning, optimization and simulation engines, and will be deployed in Milano water distribution network.

Result type: Case study, Methodology, Software prototype

References and links:

66. H2OLeak: Water Leaks localization system within water supply networks

H2OLeak: sistema per la localizzazione delle perdite nelle reti di distribuzione idrica

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Application field: Environment

Keywords: water supply networks, simulation, machine learning, sectorization

Abstract: The H2O Leak project is addressing innovative solutions to assist the water systems Operators in the pursuit of a more efficient distribution networks and to guarantee proper management of water resources. In particular, a sw platform has been developed which integrates optimization, simulation and machine learning techniques for solving the sectorization and leak detection problems.

Abstract (it): Il progetto H2O Leak propone soluzioni innovative per supportare le decisioni degli operatori delle reti di distribuzione idrica al fine di ottimizzare la gestione delle risorse idriche. In particolare è stata sviluppata una piattaforma sw che utilizzando i dati acquisiti da sensori e da GIS integra metodi di ottimizzazione, simulazione e machine learning per la settorizzazione della rete e la rilevazione delle perdite.

From - To: 2010 - 2012

Objectives: The project is aimed at designing and developing an innovative technological platform for supporting a rational and integrated management of urban water distribution systems. It integrates already available and robust technological solutions, such as

Supervisory Control And Data Acquisition (SCADA) systems, Geographical Information Systems (GIS) and Business Intelligence tools, with advanced analytical methodologies to support managers in their decision making activities, enabling prompt and proactive actions that may reduce costs while guaranteeing high customers satisfaction.

Methodologies used: Heuristic / metaheuristic methods, Simulation, Networks / graph optimization

Results: During the project we developed computational approaches to address three main problems: (i) automatic districts identification to obtain the "optimal" partition of a water distribution system into virtually independent sub-networks, (ii) computational localization of leaky pipelines through the analysis of flows and pressures measured at the entry points of each district and (iii) regression models for estimating the loss intensity of the leak to improve localization effectiveness by further reducing the set of pipelines to be checked physically.

Result type: Case study, Methodology, Software prototype

References and links:

67. Waste Flow Optimization: An Application in the Italian Context

Ottimizzazione del Flusso del Rifiuto: un'applicazione nel contesto Italiano

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Organization: Optit S.r.l. - Optit S.r.l.

Application field: Environment, Logistics, Services and society, Transportation

Keywords: OR in Service Industries, Waste Management, Network Flow, Combinatorial Optimization

Abstract: Over the last few decades, the overall social impact of solid waste management has increased yet further, raising a range of both economic and environmental issues. Waste logistic networks have become complex and challenging as the straightforward source-to-landll management switched to multi-echelon networks in which waste ows generally go through more than one preliminary treatment before reaching their nal destinations. In this paper we propose mixed integer linear formulations, and related resolution methods, as a way of tackling problems arising in waste logistic management,

with an application in a real-world case study. In response to the actual needs of a major Italian waste operator, we introduce the modeling of some relevant features of these problems, such as digester facilities, transportation economies of scale and temporary waste storages.

Abstract (it): Negli ultimi decenni, l'impatto sociale della gestione del flusso del rifiuto è aumentata sensibilmente, con conseguenti questioni sociali e ambientali. Congiuntamente si è assistito al passaggio da una modalità operativa diretta, in cui il rifiuto viene indirizzato alla discarica in assenza quasi totale di intermediazioni, a una modalità indiretta in cui il rifiuto attraversa svariati trattamenti preliminari prima di raggiungere destinazioni finali differenziate. Tale mutamento ha reso complessa e sfidante la gestione delle reti logistiche del flusso del rifiuto. In questo lavoro proponiamo formulazioni di programmazione mista lineare intera, e relativi metodi risolutivi, come un'alternativa per la gestione ottimizzata di tali reti logistiche. I metodi e modelli proposti saranno applicati ad un caso studio reale. In risposta alle reali necessità di uno dei principali gestori di rifiuti nel panorama italiano, introduciamo la modellazione di alcuni aspetti rilevanti in questo ambito come digestori, economie di scala per costi di trasporto, e stoccaggio temporaneo dei rifiuti.

From - To: 2013 - 2017

Objectives: The main goal of this work is to study operations research methods that are able both to provide cost-cutting solutions for the waste operator and to fast evaluate alternative scenarios in quick response to modifications in network features. Besides, a crucial aspect is to make such methodologies accessible to the industry. This requires the definition of a proper Decision Support System that can be adopted by practitioners to easily formulate, run, and update complex combinatorial optimization programs.

Methodologies used: Heuristic / metaheuristic methods, Linear, Mixed integer programming, Networks / graph optimization

Results: In this paper, we have proposed mathematical models for addressing the waste flow allocation problem in a medium to long-term horizon of planning. We have shown MILP formulations used in a Decision Support System developed by an IT consulting company for one of the main Italian waste operators. The use of operation research methods by the waste operator led to a more accurate planning, and consequently to more cost-efficient solutions with remarkable returns in terms of profits.

Result type: Case study, Software package

References and links: http://www.optit.net/

68. DOMUS Energy - Automation systems for the cooperative energy brokerage service

DOMUS Energia - Sistemi domotici per il servizio di brokeraggio energetico cooperativo

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Application field: Energy

Keywords: smart grid, electricity market, optimization

Abstract: The aim of the project is to define innovative integrated systems with the electricity market consisting of appropriate energy brokerage services for user's aggregations, so to achieve a reduction of the electricity procurement tariffs. The system exploits the information and communication technologies to support intelligent networks (smart grids) as key tools to enable simultaneously: • a more rational use of energy and, consequently, transmission and distribution systems; • energy savings; • the exploitation of renewable energy sources and their integration with traditional sources; • the participation in the market by active demand response management systems.

Abstract (it): Ill progetto mira a definire sistemi innovativi di interazione con il mercato libero dell'energia consistenti in opportuni servizi di brokeraggio energetico per aggregazioni di utenti dotati eventualmente di una limitata capacità di produzione (prosumers). L'obiettivo è quello pervenire ad una riduzione delle tariffe di approvvigionamento sfruttando le tecnologie ICT per supportare le reti intelligenti (smart grids) intese quale strumento fondamentale per consentire simultaneamente: • l'uso più razionale dell'energia e, conseguentemente, dei sistemi di trasmissione e distribuzione; • il risparmio energetico; • lo sfruttamento ottimale delle fonti rinnovabili da parte dell'utente e la loro integrazione con le fonti tradizionali; • la partecipazione al mercato mediante sistemi di gestione della domanda attiva.

From - To: 2013 -

Objectives: The main aim of the project is the design of a decision support system powered by the ICT technologies for the optimal management of the distributed resources

of a coalition of producers/consumers (prosumers). The project involves different groups within the DIMEG at University of Calabria which contribute to the definition of the integrated system on the basis of their specific competences. In particular, the Operations Research group within DIMEG is involved in the definition and solution of the stochastic optimization problems representing the main decision problems.

Methodologies used: Integer / combinatorial optimization, Stochastic / Robust optimization

Results: Decision support models for the resource management and the definition of optimal procurement plans for a coalition of prosumers,

Result type: Software prototype

References and links:

69. Electrical energy demand optimal forecasting

Previsione ottima della domanda di energia elettrica

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Organization: ACTOR srl, spinoff of Sapienza University of Rome - Working group on demand forecasting

Application field: Energy

Keywords: Electrical energy demand, machine learning, optimal forecasting

Abstract: The new deregulated market of the electrical energy requires that the market operators, both traders and resellers, make use of new ICT based tools that, by a monitoring of the consumers' consumption, allow a much more in-depth knowledge of the logics and of the behaviors of the energy demand and of the possibility to offer additional services, beyond the simple sale of the energy as a commodity, with more and more competitive prices.

This application concerns the design and implementation of a predictive software for the forecasting of the demand of the retail market, able to significantly improve (more than 30%) the accuracy of the demand plans that the traders/resellers have to present to the Electrical Network Authority, so as to limit the penalties that are applied when the planned and the real consumptions differ.

The development of the application is based on machine learning tools, aiming to detect the environmental and the behavioral variables more correlated with the demand of electrical energy, and to characterize the terms of the correlation so as to forecast the consumptions on a 24 hours horizon.

Abstract (it): Il nuovo mercato liberalizzato dell'energia elettrica impone agli operatori del mercato all'ingrosso/dettaglio (Traders/Resellers) nuovi strumenti su basi ICT che, attraverso il monitoraggio del consumatore, consentano loro una conoscenza molto più avanzata delle logiche e dei comportamenti della domanda di energia e della possibilità di offrire servizi aggiuntivi alla semplice vendita dell'energia come commodity, a prezzi sempre più competitivi.

L'applicazione riguarda la progettazione e realizzazione di un software predittivo per la previsione dei consumi del mercato retail che consenta di migliorare in modo significativo (oltre il 30%) la precisione dei piani di consumo che i Trader/Reseller sono tenuti a presentare al Gestore della Rete Elettrica, in modo da contenere le penalità applicate per la differenza tra i suddetti piani ed i consumi reali.

Lo sviluppo dell'applicazione si basa su strumenti di machine learning, che consentano di individuare le variabili ambientali e comportamentali maggiormente correlate con i consumi di energia elettrica, e consentano di caratterizzare i termini della correlazione ai fini della previsione dei consumi su un orizzonte 24 ore.

From - To: 2016 -

Objectives: A forecast of the elecrical energy demand with greater accuracy.

Methodologies used: Data analytics / machine learning

Results: It is a work in progress.

Result type: Case study, Software package

References and links:

70. Design and implementation of the TESEO platform

Definizione e implementazione della piattaforma TESEO

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Organization: University of Brescia - Department of Economics and Management

Application field: Energy

Keywords: Mixed Integer Linear Programming, Cogenerazione, Trigenerazione, Progettazione Centrali

Abstract: This project involved the design and implementation of a software package, called TESEO, that by solving Mixed Integer Linear Programming (MILP) models aims at determining an optimal design for complex cogeneration-trigeneration plants, given the demands of steam, high-temperature and low-temperature heat, and electricity. The TESEO package is intended as a decision-support system for strategic planning, supporting a decision-maker in the evaluation of the expected economic outcomes of a new plant by comparing different scenarios where the individual machines can vary (in size and model) in response to different evolutions of thermal and electrical loads. Specifically, the MILP models employed determine the operating parameters that minimize the cost of running the plant, ensuring that all the above-mentioned demands are satisfied. The result is used for the economic evaluation of the project.

Abstract (it): L'attività del progetto ha riguardato lo sviluppo ed implementazione di un pacchetto software, denominato TESEO, che attraverso la risoluzione di modelli di Programmazione Lineare misto-Intera (PLI), permette la progettazione ottimale di centrali di cogenerazione-trigerazione complesse, dato il valore delle domande di vapore di processo, calore ad alta temperatura, calore a bassa temperatura ed energia elettrica. Il pacchetto TESEO fornisce un supporto strategico ad un decisore, permettendogli di valutare preventivamente il risultato economico della gestione della nuova centrale, paragonando diversi scenari in cui possono variare le dimensioni delle singole macchine a fronte di diverse evoluzioni del carico termico ed elettrico. Nello specifico i modelli di PLI utilizzati determinano i parametri di funzionamento che rendono minimo il costo di gestione della centrale, garantendo il soddisfacimento dei carichi dell'utenza. Il risultato, riportato su un orizzonte temporale di medio-lungo periodo, viene utilizzato per l'analisi economica del progetto.

From - To: 2010 - 2011

Objectives: The main goal of this project was three-fold. Firstly, to capture by means of Mixed Integer Linear Programming (MILP) models the functioning of a cogeneration-trigeneration plant. Secondly, the identification of the most suitable solution approach for those MILP models. Thirdly, the design and implementation of a software package that could be used as a decision-support system for strategic planning.

Methodologies used: Exact methods, Mixed integer programming

Results: The software package implemented has been used in the strategic planning of several cogeneration and trigeneration plants located in the North of Italy. According to the funding company, it facilitated enormously the evaluation of the economic outcomes related to new plant configurations.

Result type: Software package

References and links:

71. ALS-Collect: a decision support system for the shift scheduling and the collection routing of the urban and suburban waste management

ALS-Collect: un sistema di supporto alle decisioni per la schedulazione dei turni di lavoro e l'ottimizzazione dei percorsi per la raccolta rifiuti urbana e suburbana

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Application field: Environment, Logistics, Services and society, Transportation

Keywords: Waste collection, OR in Service Industries, Optimization

Abstract: Waste collection in urban and extra-urban areas is a complex and ever-changing problem. From collection of a single kind of waste we have now differentiated waste collection (generic, paper, plastic, etc.) with different modalities: door-to-door, traditional with team of operators, semi-automated with single-operator trucks. Even the trucks used for collection change and their use poses new different problems. Hence, there is a need of new decisional instruments as support to the waste collection management. ALS-Collect is born as an answer to the needs in the territory of Trieste. The peculiar area (city between sea and hills, densely inhabited city centre, outskirts with far away towns, boroughs with narrow streets) allowed considering, analysing and solving different problems. ALS-Collect was created to be extremely flexible and adaptable in front of different operative needs. ALS-Collect allows designing the turns of waste collection even in front of complex problems with thousands of collection point, different collection schedules and different

truck types, considering the accessibility of the street network and the allowed manoeuvres in the programmed turn according to truck characteristics.

Abstract (it): La raccolta dei rifiuti in ambito urbano ed extraurbano è un problema complesso e in continua evoluzione. Dalla raccolta di un unico tipo di rifiuto (indifferenziato) si è passati alla raccolta di rifiuti differenziati (RSU, carta, plastica, ecc.) con svariate modalità: porta a porta, tradizionale con squadra di operatori, semi-automatizzato con mezzi mono-operatore. Anche i veicoli utilizzati per la raccolta non sono più gli stessi e il loro utilizzo pone problemi sempre diversi. Da qui nasce l'esigenza di nuovi strumenti decisionali di supporto alla gestione della raccolta dei rifiuti. ALS-Collect nasce come risposta ad un'esigenza reale sorta nel territorio della provincia di Trieste. Le peculiarità del territorio (città stretta tra mare e colline, centro cittadino densamente popolato, periferia con paesi distanti tra loro, quartieri con strade strette) hanno permesso di considerare, analizzare e risolvere diversi problemi operativi. ALS-Collect è stato creato per essere molto flessibile ed adattabile alle più diverse esigenze operative. ALS-Collect permette di progettare i turni di raccolta dei rifiuti anche a fronte di problemi molto complessi con migliaia di punti di raccolta, caratterizzati da differenti frequenze di raccolta e con diverse tipologie di veicoli, tenendo in considerazione rete stradale accessibile e manovre consentite nel giro programmato secondo le caratteristiche del mezzo.

From - To: 2014 - 2015

Objectives: ALS-collect is a decision support system for the shift scheduling and the collection routing of the urban and suburban waste management. ALS-collect comes from a real case study characterized by several operational issues. In particular, since its first application is on the territory of the province of Trieste, characterizes by a long and irregular shape, with level and hilly ground where some streets are suited only for smaller vehicles, information on the topology of the considered area is of fundamental importance. Therefore, the first question that ALS-collect wants to answer is the real feasibility of a shift and of its routing. The end-users, like drivers, in order to accept a new shift, need a routing that considers the real topology of the area, such as feasibility of the manoeuvres, width of a road suitable for the used vehicle, etc. On the other side, a company that manages the waste collection wants to reduce the number and the length of shifts respecting all the constraints coming from the frequency of the collection of each bin, duty hours, etc.

Methodologies used: Heuristic / metaheuristic methods, Networks / graph optimization

Results: ALS-Collect is a Decision Support System for the shift scheduling and the collection routing of the urban and suburban waste management, but it can also be nicely used for delivering other logistic services, such as goods pick-up and delivery. ALS-collect is for companies that manage the waste collection also in very large zones, both door-to-door and mechanical street collection schemes. Its main characteristics are its flexibility in

order to add new constraints and the attention on the acceptability of drivers of the solutions. Its application can produce real benefits: for real clients it led to an improvement in reducing the total number of shifts of about 10%. ALS-collect works with different typologies of vehicles, introduces penalties based on turning directions and intake sides, and assumes road maps with one-way streets. The software is based on: open source geographical maps that can be enriched with specific information provided by the client (e.g., streets that are not accessible to all the typologies of vehicles), positions of waste separation areas and streets to serve can be provided by GPS data, optimization models of the routes. Moreover, in order to provide a complete service to the client, it offers graphical tools for the management of: waste separation areas (in the case of unexpected positions, the graphical interface allows to modify them), shifts and routes visualization, shifts change.

Result type: Software package

References and links:

72. Energy Oil & Gas

Energy Oil & Gas

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Organization: ACT Operations Research - ACT Operations Research

Application field: Energy, Environment, Manufacturing / Production systems, Services and society

Keywords: Energy, Oil, Gas.

Abstract: For the Energy Oil & Gas the suite includes modules to support plants and control logic simulation, the optimization of logistics operations, like for example shipping by fleets of Vessels or Trucks, the optimization of trading activities.

Abstract (it): For the Energy Oil & Gas the suite includes modules to support plants and control logic simulation, the optimization of logistics operations, like for example shipping by fleets of Vessels or Trucks, the optimization of trading activities.

From - To: 1996 -

Objectives: Process Simulators, Training Simulators, Shipping Optimization (trucks and Vessels), Demand Forecasts and Trading and Revenue Optimization are modules of our Energy Oil & Gas suites.

Methodologies used: Heuristic / metaheuristic methods, Simulation, Optimal control, Statistics

Results: Services to support the specification, procurement, detailed design, validation, testing and commissioning of the control and protection systems (DCS, ESD, BMS, MMS etc.). Support to the Functional Safety design and validation. Simulation as a design and validation tool for control and protection strategies, and training aid for plant operation. Application of math-based optimization for Advanced Process Control (APC) of industrial plants. Fields of operation: Energy, Petrochemical, Oil & Gas, Renewable and Green Energy.

Result type: Methodology, Software package

References and links: http://www.act-operationsresearch.com

INFORMATION AND COMMUNICATION TECHNOLOGY

73. Two-Dimensional Packing Problems in Telecommunications

Problemi di impaccamento bidimensionale in telecomunicazioni

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Application field: Telecommunication

Keywords: Telecommunications; Optimal packing; Heuristic algorithms

Abstract: In telecommunication systems adopting the IEEE 802.16/WiMAX standard, a fixed station transmits and receives data packets to and from other stations, and all transmissions are performed using [time x frequency] rectangular frames, where the packets are stored as rectangles. The fixed station must maximize the frame utilization by deciding which packets will be included in the next transmission phase, arranging each selected packet into one or more rectangular regions, and allocating the resulting regions

to the frame without overlapping. It was proved that the problem is strongly NP-complete, but its optimization version can be approximated with worst-case performance guarantee in polynomial time. The planned system had to be implemented using sets of standard PCs, with extremely tough technological constraints: in particular, each instance had to be completely solved within 1 millisecond. The problem was satisfactorily solved through ad-hoc heuristic algorithms.

Abstract (it): Nei sistemi di telecomunicazioni che adottano lo standard IEEE 802.16/WiMAX, una stazione fissa trasmette e riceve pacchetti di dati per e da altre stazioni, e tutte le trasmissioni vengono effettuate utilizzando [tempo x frequenza] frames rettangolari, dove i pacchetti sono immagazzinati come rettangoli. La stazione fissa deve massimizzare l'utilizzo del frame decidendo quali pacchetti verranno inclusi nella prossima fase di trasmissione, arrangiando ogni pacchetto selezionato in uno o più regioni rettangolari, e allocando le regioni risultanti al frame senza sovrapposizione. E' stato dimostrato che il problema è fortemente NP-completo, ma la sua versione ottimizzata può essere approssimata con garanzia di performance al peggio in tempo polinomiale. Il sistema pianificato deve essere implementato utilizzando dei PCs standard, con vincoli tecnologici estremamente difficili: in particolare, ogni istanza deve essere risolta completamente entro 1 millisecondo. Il problema è stato in modo soddisfacente tramite un algoritmo euristico ad-hoc.

From - To: 2009 - 2013

Objectives: Development of heuristic algorithms able to compute a feasible solution of good quality within one millisecond on a standard PC. Implementation and experimental evaluation on realistic scenarios.

Methodologies used: Heuristic / metaheuristic methods, Integer / combinatorial optimization

Results: Two heuristic algorithms were developed: a recursive algorithm based on the alternate execution of two very fast greedy procedures and an adaptation of a classical method for the generalized assignment problem. They were implemented in C language, and experimentally evaluated on realistic scenarios. For all instances the proposed algorithms produced, within the 1 millisecond time limit, solutions of value very close to the theoretical optimum.

Result type: Software prototype

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74. KnowLedge-based EFB for green flight trAjectory decisioN aid

KnowLedge-based EFB for green flight trAjectory decisioN aid

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Organization: University of Trieste - Department of Engineering and Architecture

Application field: Aerospace

Keywords: Electronic Flight Bag, Weather decision making, Trajectory optimization

Abstract: An Electronic Flight Bag (EFB) is an electronic display system intended primarily for cockpit / flightdeck or cabin use. It has been designed to replace the traditional pilot flight bag and to reduce or eliminate the need for paper and other reference materials in the cockpit. Since an EFB can also display a variety of aviation data and perform basic calculations, the idea is to integrate in an EFB information on weather data and a planning tool. Indeed, during a flight, often weather information is not very refined, and it is impossible to know the level of hazard that the encountered phenomenon poses. Thus, pilots decide to evade with greater detour the potentially dangerous area, even if in reality it would pose very little hazard. These detours involve higher polluting emission due to the longer trajectory, higher fuel consumption, and ultimately, a greater impact on the environment. The idea is to suggest to the pilot optimized parts of trajectory in terms of CO2, NOx and noise reduction, while unforeseen events (i.e. weather changes) happened. Therefore, an EFB of class 2, type B, was customized in order to show weather data provided by the a polarimetric weather radar and to show the results of a planning tool that computes parts of a trajectory, in case of unforeseen events. This project was developed in collaboration with CNIT-RaSS.

Abstract (it): Un electronic flight bag (EFB) è un dispositivo elettronico sviluppato per cabine di pilotaggio di aerei. E' stato progettato per rimpiazzare il tradizionale bagaglio a mano del pilota e per ridurre o eliminare il bisogno di carta o altro materiale in cabina. Un EFB può inoltre visualizzare una gran quantità di dati avionici e può eseguire dei calcoli.

Date queste capacità, l'idea è di integrare in un EFB informazioni meteorologiche e un sistema di pianificazione di traiettorie. Infatti durante il volo, spesso le informazioni meteo non sono molto accurate ed è impossibile conoscere il livello di pericolo di un fenomeno. Quindi, i piloti normalmente decidono di eseguire una manovra ampia per evitare un fenomeno pericoloso, anche se nella realtà il pericolo potrebbe essere basso. Queste manovre possono però portare a consumi ed emissioni molto alte se la nuova traiettoria è molto lunga e quindi anche l'impatto ambientale andrebbe valutato. L'idea è suggerire al pilota nuove traiettorie ottimizzate in termini di riduzione di carburante, CO2 e NOx nel caso eventi non previsti obblighino ad un cambio di rotta. Quindi un EFB di classe 2, tipo B, è stato customizzato per mostrare dati meteorologici provenienti da un radar polarimetrico e per mostrare i risultati di un sistema di pianificazione che calcola parti di traiettorie, in caso di eventi imprevisti. Questo progetto è stato sviluppato in collaborazione con CNIT-Rass.

From - To: 2012 - 2014

Objectives: The main objective of the project was to develop a custom knowledge-based EFB (Electronic Flight Bag) with SW packages implementing polarimetric weather radar post-processor and Q-AI (Quasi Artificial Intelligence) agent algorithms, for green trajectory optimization (reduction of CO2 and NOX emissions as well as noise pollution), in collaboration with CNIT-RaSS. The EFB was also customized to include an ad hoc Graphical User Interface (GUI) for output presentation and pilot interaction and custom I/O interfaces to radar processor, external sensors/systems/database and the Mission/Flight simulator.

Methodologies used: Heuristic / metaheuristic methods, Networks / graph optimization

Results: The proposed enhancement in EFB class 2 type B consists in two main aspects: - The weather representation is extended respect to classical weather radar acquisition, in term of distance covered by the forecast and in term of better understanding of the condition near the aircraft. With radar polarimetry it is possible to understand more accurately what lies within the core of a phenomenon, and to classify different types of hydrometeors like hail (one of the most dangerous weather phenomena), rain (usually non-dangerous) or snow. With this knowledge, it is possible to calculate more efficient routes that take into consideration the estimated level of risk (e.g. evading hail dominated zones or penetrating non-turbulent rainfalls). - The online planning algorithms are capable of using the more accurate weather representation to compute in a fixed amount of computational time a novel trajectory that reduces the emissions of CO2, NOx and Noise. Due to constraints on the allowable computational time resulting from the requirement of operating in real time, exact algorithms providing the really optimal trajectory could be hardly devised, unless very simplified models are adopted. So in order to deal with realistic representations of the situation to be managed, approximate algorithms are used, which

can provide “reasonably good” viable solutions in reduced times, although without guaranteeing their effective optimality. Several heuristic optimization algorithms can be used, and in the given amount of time the Q-AI provides quasi-optimal solutions to the trajectory planning problem.

Result type: Software prototype

References and links:

Authors