AI and Beyond AI in Industrial Engineering

Time: July 4th, 2019, 9.30-15.15 hours

Location: TU/e Campus, Atlas -1.210

On the occasion of the graduation of Sjors Jansen and Joost de Kruijff as PhD's in Industrial Engineering on July 4th and 5th, 2019, PhD committee members team up to present their research:

Feryal Erhun, Judge Business School, Cambridge University, United Kingdom
Erik Demeulemeester, Faculty of Economics and Business, KU Leuven, Belgium
Dan Trietsch PhD, independent researcher, Auckland, New Zealand
Herbert Meyr, Supply Chain Management Department, University of Hohenheim, Germany
Johann Hurink, Faculty of Electrical Engineering, Mathematics & Computer Science, University of Twente, The Netherlands

The symposium is chaired by Ton de Kok, School of Industrial Engineering, Eindhoven University of Technology, The Netherlands.

With the recent developments in Artificial Intelligence (AI), it is important to position scientific Industrial Engineering challenges in this context. The extreme complexity of strategic, tactical and operational decision making under uncertainty in operations management, e.g. in project management and supply chain management, has fostered six decades of scientific research in close collaboration with industry.

The variety of contributions to the symposium are exemplary for this scientific research in OR/IE/OM.

The methodological perspective of AI, and in particular recent advances in (deep) reinforcement learning, holds a promise for further steps towards decision support from board room to shop floor.

The symposium closes with an open discussion on synergies between AI and OR/IE/OM.

Program Symposium

Time	Title presentation	Presenter
09.30	AI and Beyond AI in Industrial Engineering	Ton de Kok
10.00	Optimizing Capital Investment Decisions at Intel Corporation	Feryal Erhun
10.45	Break	
11.15	On determining the optimal proactive-reactive policy for the serial RCPSP with stochastic activity durations	Erik Demeulemeester
12.00	Customized Mass Transit	Dan Trietsch
12.45	Lunch	
13.30	Demand fulfillment in multi-stage customer hierarchies	Herbert Meyr
14.15	Electric Vehicle Charging within Decentralized Energy Management	Johann Hurink
15.00	Discussion on synergies between AI and IE research	Ton de Kok

Registration fee: € 25,-

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AI and beyond AI in Industrial Engineering

Ton de Kok
School of Industrial Engineering
Eindhoven University of Technology
The Netherlands

Recently there is a renewed interest in Artificial Intelligence as a means to support and automate operational decision making within companies. Data is available abundantly and data is generated real-time at an ever higher speed. CPU speeds and data storage no longer create obstacles for the application of more or less generic (self-learning) algorithms that can create information out of this data, and use this information to predict and prescribe. In the area of Operations Research and Operations Management, algorithms developed are problem- and model-specific. We discuss the differences and similarities between the AI perspective and the OR/OM perspective and provide suggestions for synthesis of the two perspectives.

Optimizing Capital Investment Decisions at Intel Corporation

Feryal Erhun
Judge Business School
Cambridge University
United Kingdom

Intel Corporation spends billions of dollars annually on manufacturing equipment. With long lead times from equipment suppliers and high complexity in forecasting market demand, optimizing capital investment decisions is a significant managerial challenge. In this talk, I will describe Intel's “Capital Supply Chain Velocity Program” for ordering, shipping, and installing production equipment. At the core of this Velocity Program is a procurement framework called dual-mode equipment procurement (DMEP), which we have developed in collaboration with Intel, utilizing dual sourcing and option contracts to optimize capital investments. DMEP seamlessly combines statistical forecasting with Monte Carlo simulation and stochastic programming, and includes built-in scenario and sensitivity analysis capabilities to support Intel’s strategic, tactical, and executional procurement decisions. The Velocity Program and DMEP have benefited Intel hundreds of millions of dollars in cost savings and at least 2 billion dollars in revenue upside during 2008 financial crisis. It has also enabled a risk sharing mechanism with suppliers.

On determining the optimal proactive-reactive policy for the serial RCPSP with stochastic activity durations

Erik Demeulemeester
Faculty of Economics and Business
KU Leuven
Belgium

When considering the resource-constrained project scheduling problem (RCPSP) with stochastic activity durations, the recent literature mainly considers two different approaches. On the one hand, researchers have focused on proactive and reactive project scheduling, where proactive planning attempts to build a stable project plan that takes the possible disruptions as much as possible into account, while the reactive planning procedures are called every time the disruption changes the baseline schedule such that it cannot be executed anymore as planned. On the other hand, a lot of research has been done on the stochastic RCPSP that introduces scheduling policies that decide at each of the stages of a multi-stage decision process which activities selected from the set of precedence and resource feasible activities have to be started. Recently, Davari and Demeulemeester have introduced an integrated proactive and reactive project scheduling problem for the RCPSP with uncertain durations and developed different Markov Decision Process models to solve this NP-hard problem. This means that not only a good baseline schedule is determined, but also several good continuations in case certain combinations of the activity durations occur that prohibit the baseline schedule or an already adapted schedule from being executed as planned. In this presentation, I will indicate in which cases of the problem truly optimal policies can be constructed and what can be learnt from these policies.

Customized Mass Transit

Dan Trietsch PhD
Independent researcher
Auckland
New Zealand

To encourage commuters and other day-travelers to utilize privately- or publicly-owned mass transit modes (such as vans, buses, light-rail, trains and ferries), we must make it possible to obtain door-to-door service and make it easier to plan and pay for trips. Customized Mass Transit[1] (CMT) is a web-based solution that coordinates trips and utilizes multiple modes. The system relies on the existing and currently-developing electronic infrastructure; e.g., it would make extensive use of cell phones and their built-in GPS capabilities. At its core, it requires advanced scheduling algorithms of the type we have been developing in the last few years.

A typical trip might start by a dial-a-ride shuttle taking a commuter from home to the train station (alongside others). After a train ride, the commuter might ride a bus or another shuttle to the office. Payment might be coordinated by the CMT service provider (which is just one way to make the service highly profitable). Advantages of the service to the commuter include convenience (no stop-and-go driving, looking for parking, etc), cost savings (no need to purchase that third car, less expenses on gas, etc) and, depending on the modes involved, even time savings (by using fast car-pool and bus lanes, fast trains, etc). Advantages to service providers include higher utilization of equipment. Advantages to society include energy savings, reduced congestion and the ability to use electricity and modern energy-saving solutions (such as hybrids) more extensively and earlier than would be the case if we had to wait for the current fleet of conventional vehicles to be replaced.

Demand fulfillment in multi-stage customer hierarchies

Herbert Meyr
Supply Chain Management Department
University of Hohenheim
Germany

In Make-To-Stock production systems final products have to be on stock when customer orders arrive. If demand has been underestimated and customers are heterogeneous, a company has to decide whether a low priority order should be served now or the scarce stock should be reserved for higher priority orders that might potentially arrive at a later point in time. This planning task is called Demand Fulfillment. The speaker will briefly review a decade of research on Demand Fulfillment at his department and be more elaborate on deterministic models for multi-stage customer hierarchies.

Electric Vehicle Charging within Decentralized Energy Management

Johann Hurink
Faculty of Electrical Engineering, Mathematics & Computer Science
University of Twente
The Netherlands

To reach the climate goals our energy systems have to undergo a fundamental change. Where in the past the energy mainly was generated in large power plants using fossil fuels, in the future a large part of the generation will result from small plants in decentralized locations using uncontrollable renewable sources. This leads to a loss of control over a larger fraction of the generation. To be able to compensate for this loss in flexibility on the generation side, we have to create and use flexibility on the consumption side. This has led to the concept of ‘Smart Grids’ and ‘Decentralized Energy Management (DEM)’ is seen as a key element for these Smart Grids.

A second important element within the energy transition is the large scale introduction of electric vehicles (EVs). Charging these vehicles on the one hand may put a large burden on the existing distribution grid, but on the other hand is also a flexible consumption which may be an important element for DEM. Therefore proper charging strategies have to be introduced.

In this talk we give some introduction on DEM and especially the possible role of EVs. Furthermore, we present an online EV scheduling approach with discrete charging rates that does not require detailed predictions of this uncertain data. Instead, the approach requires only a prediction of a single value that characterizes an optimal offline EV schedule. Simulation results show that our approach is robust against prediction errors in this characterizing value and that this value can be easily predicted.