

# Impactful Research Opportunities in AI

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TKI Dinalog

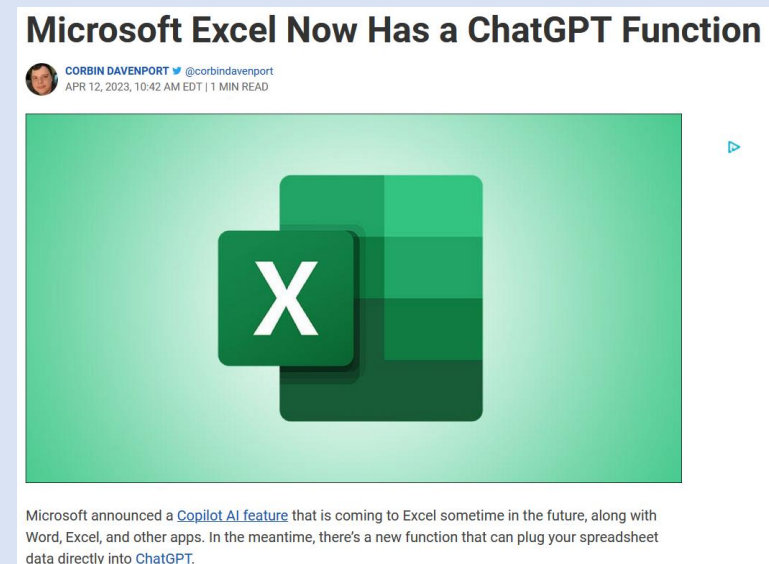
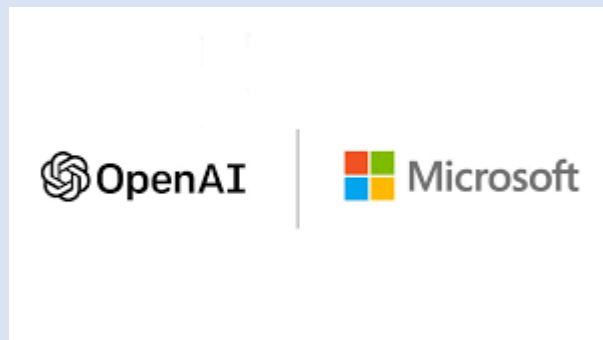
Rotterdam School of Management

# Huge impact AI

- **AI is one of the most important things humanity is working on. It is more profound than, I dunno, electricity or fire.** Sundar Pichai, CEO of Alphabet
- **We're at the beginning of a golden age of AI.** Jeff Bezos, Founder and Executive Chairman of Amazon
- **AI is the defining technology of our times.** Satya Nadella, CEO of Microsoft

# AI accessible for everyone

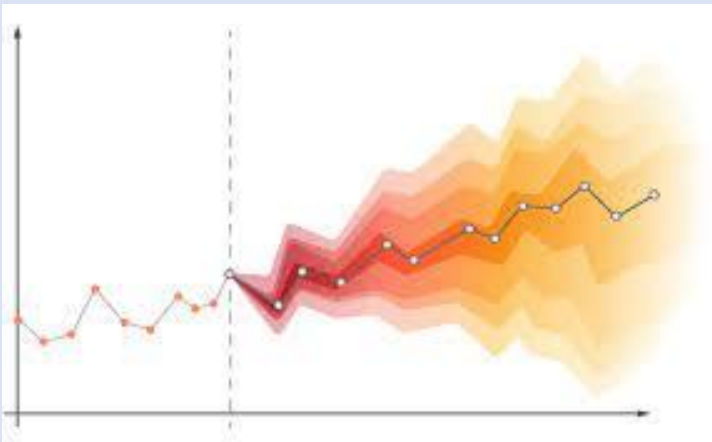
- Excel still most used data analysis tool in business with 750 million users.
- Integration of OpenAI tools in Excel and ERP systems



# Impact on operations and logistics



- Complex planning decisions
- Opportunities for processes automation
- Demand and supply forecasting



Promising application area!

# AI unlikely to replace humans in OM

- Augmenting human capabilities
- Combining powers of AI and humans
- Collaboration of human and machines

# AI is general – easy to employ technology.

- Specify goals/ preferences
- Collect raw data
- Built decision making tool/ model

**AI Model**

- Output solutions

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Black box?

# We are not there yet

(Tempering the hype)

# Inventory management

## Can Deep Reinforcement Learning Improve Inventory Management? Performance on Lost Sales, Dual-Sourcing, and Multi-Echelon Problems

Joren Gijsbrechts, Robert N. Boute, Jan A. Van Mieghem, Dennis J. Zhang

The algorithm performs **in line with the myopic one-period** policy but cannot match the performance of the myopic two-period or the capped base-stock policy.

....

We can thus conclude that the A3C algorithm, with limited modification, develops good policies for the lost sales inventory problem yet cannot beat the best-performing heuristics.

# Inventory management

## Can Deep Reinforcement Learning Improve Inventory Management? Performance on Lost Sales, Dual-Sourcing, and Multi-Echelon Problems

Joren Gijsbrechts, Robert N. Boute, Jan A. Van Mieghem, Dennis J. Zhang

[...]we evaluated the A3C algorithm on approximately 250 hyperparameter settings.....thus required about 3,000 “runs.” This resulted in total training costs of around **\$2,500** ..... for approximately 2,000 additional runs, resulting in an additional cost of around **\$1,500**. For our benchmarks. ....their running time in minutes or hours rather than in days or weeks as is the case for the A3C algorithm.

# Transportation

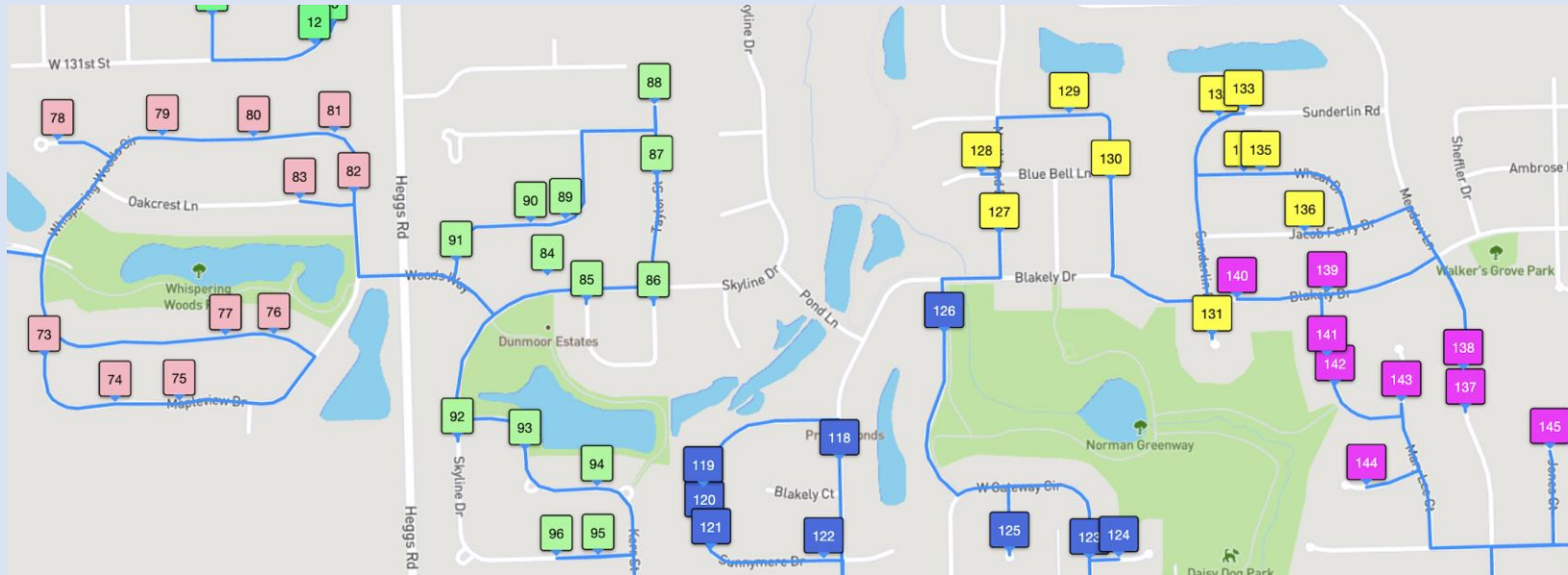
Amazon Routing Research Challenge 2021



.... to encourage participants to develop innovative approaches leveraging **artificial intelligence, machine learning, deep learning, computer vision**, and other **non-conventional** methods...

....participants will be asked to **generate route sequences** that .....by learning from actual routes (6100) that were operated by actual experienced drivers

# Transportation




Max training time: 12 hours




Max application time: 4 hours

# Transportation

220 teams, 71 different universities, 22 countries

**Winning Team Award: US\$100,000** 

Team: **Just Passing Through** Submission Score: **0.0248**

 <p><b>WILLIAM COOK</b> University of Waterloo, Canada Professor</p>	 <p><b>STEPHAN HELD</b> University of Bonn, Germany Professor</p>	 <p><b>KELD HELSGAUN</b> Roskilde University, Denmark Professor Emeritus</p>
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Winners (and 2-3) used conventional optimization methods



General challenge – operations management problems are \$%^& hard!

But there are other issues as well

# Bias

[HOME](#) > [TECH CONTRIBUTORS](#)

## **Some Amazon Prime services seem to exclude many predominantly black zip codes**

- Historical data is output of a certain process
- Using it as input can introduce or reproduce biased decision making

# Incomplete data

## **When the Shoes Don't Fit**

Retailers Caught Flat-Footed

Many retailers haven't changed their size selections in years. *Some stock just one pair of size 12s a year, because they stocked and sold one pair the year before.*

# Algorithm aversion

- Retail store managers may not follow order advices generated by an automated inventory replenishment system (Donselaar et., 2010)
- Research on trust in AI recommendations, Algorithm aversion (Kim et al, 2021, Dietvorst et al, 2015)
- A lot of (anecdotal) evidence that planners and workers deviate from system recommendations (e.g., order picking, delivery..)

# Concluding remarks

- Huge potential
- Many remaining challenges
- Need to do **research, explore, play and test** on real problems in the real world – companies, government and academics

# Some potential directions

- How to best train?



- How to increase trust/understanding?
- How to make more accessible?

# Funding/ Innovation agenda

- AI is recognized as important element in the innovation agenda for the Netherlands. One of the “Key technologies” in the mission theme of “Digital Technologies”.

- Key players/ initiatives:

Dutch AI coalition => AiNed Programme  
Funding via RVO, NWO  
Topsectors, TKI Dinalog



# Intermezzo: mission-driven innovation

- 4 mission themes
  - Energy transition and sustainability
  - Agriculture, water and food
  - Health and health care
  - Security
- Key enabling technologies
- Earning capacity of NL
  
- Problem-driven innovation!



09.50-10.20	Registration			EXPO
10.20-10.40	Opening: AI and Operations Management Willem van Jaarsveld, Eindhoven University of Technology			EXPO
10.40-11.10	Impactful Research Opportunities in AI Niels Agatz, Scientific Director Dinalog			EXPO
11.10-11.25	Break			
11.25-12.00	Reinforcement Learning for Data-Driven Logistics Martijn Mes, University of Twente			EXPO
12.00-12.45	Poster pitches			EXPO
12.45-14.00	Walking lunch & poster session			EXPO
14.00-15.50	Parallel session EXPO	Parallel session Centrale	Parallel session Strickershuis	
14.00-14.30	Human-AI Interaction in Supply Chain Decision-Making Christina Imdahl, Eindhoven University of Technology	Machine Learning for Time Slot Management in e-Grocery Liana van der Hagen & Thomas Visser, Erasmus University Rotterdam & ORTEC	Integrated Production and Transportation Scheduling in the Compound Feed Industry Viktor Klein & Jasper van Doorn, Equans & CWI	
14.30-14.35	Move to next session	Move to next session	Move to next session	
14.35-15.05	Opportunities and Challenges in Applying Deep Reinforcement Learning to Support Production-Inventory Planning at ASML Tijn Fleuren & Maarten Hendriks, Tilburg University & ASML	Trust in AI Recommendations in Supply Chain Planning Eirini Spiliotopoulou, Tilburg University	Collaborative Picking Guided by DRL: A Collaboration Between Industry and Academia Luca Begnardi & Kasper Hendriks, Eindhoven University of Technology & Vanderlande	
15.05-15.25	Break			
15.25-15.55	Kick-starting AI Initiatives in a Community of Practice: A Toolbox Developed with 9 Companies Sebastian Piest & Marcel Wousterse, University of Twente & Deltago	The Use of OR and AI for Workforce Planning in Call Centers and Health Care Ger Koole, VU Amsterdam	Post Covid Challenges in the Airline Industry and the Role of Demand for AI Dennis Prak & Ali Poursaeidesfahani, University of Twente & KLM	
15.55-16.00	Move to next session	Move to next session	Move to next session	
16.00-17.15	Conclusions, poster session & drinks			EXPO