Machine Learning & Optimization @ ORTEC

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Science & **Education Officer** at ORTEC.

Professor of Business Analytics at the Amsterdam Business School, UvA.

Editor in Chief of STAtOR, the 'glossy' of the Netherlands Society of Statistics and Operations Research.

Member of the **steering committee** of the EURO working group on the Practice of Operations Research.

Today

23:28 – 02:27

2 hr 53 min

Ok. Ik hoop dat ze nu rustig slaapt...

23:57

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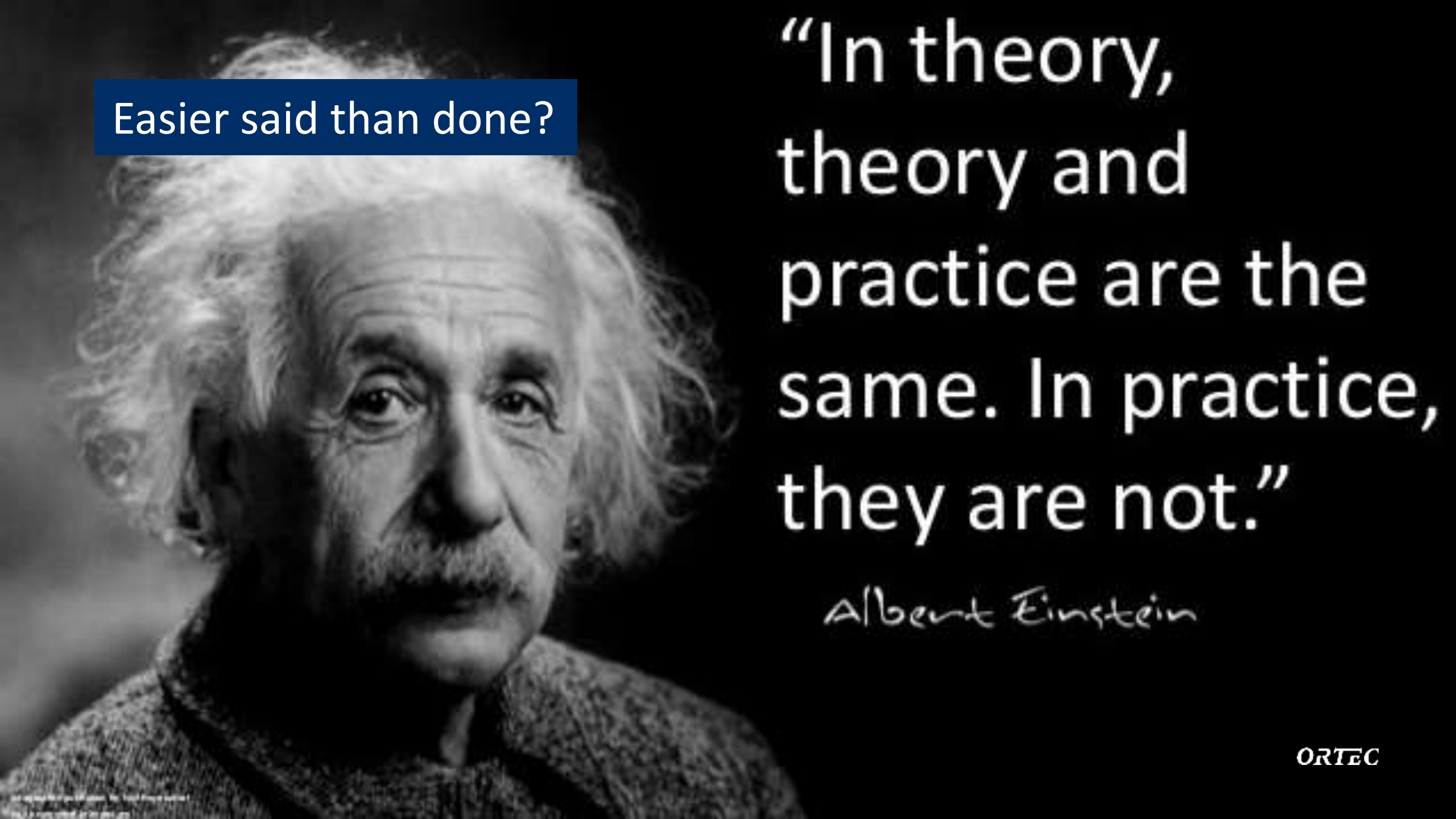
Keynote IJCA conference on AI and Optimization, August 2021

"

AI can improve, or even replace, traditional optimization

"

ORTEC's CTO Patrick Hennen


Easier said than done?
“In theory, theory and practice are the same. In practice, they are not.”
Albert Einstein
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Some things to consider… ? (not complete)

TRADITIONAL OPTIMIZATION

Pros:

- Not so much data required
- Fixed model, no learning (a little tuning)
- Decisions made are explainable and traceable

Cons:

- Does not adapt by itself, human intervention needed
- Difficult to deal with uncertainty
- Complex to deal with multiple goals

OPPORTUNITY OF AI

Pros:

- Learns and adapts itself
- Deal with uncertainty
- Easier to model multiple goals

Cons:

- Lot of data required
- Time needed to train and learn
- Models can become black boxes (unexplainable)

Keynote EURO 28, Poznan, 2016

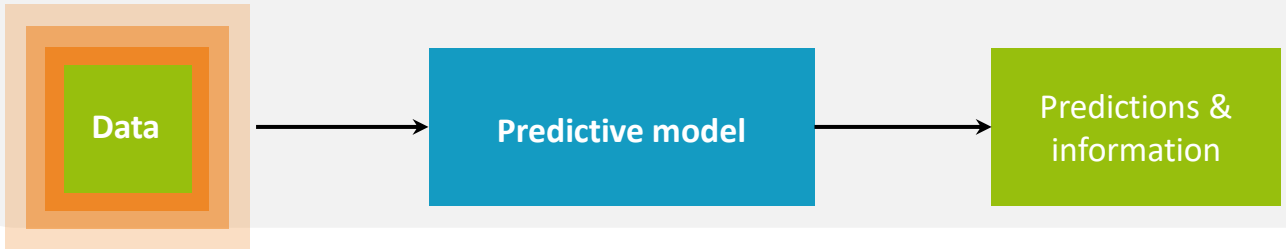
The highest impact comes from the model

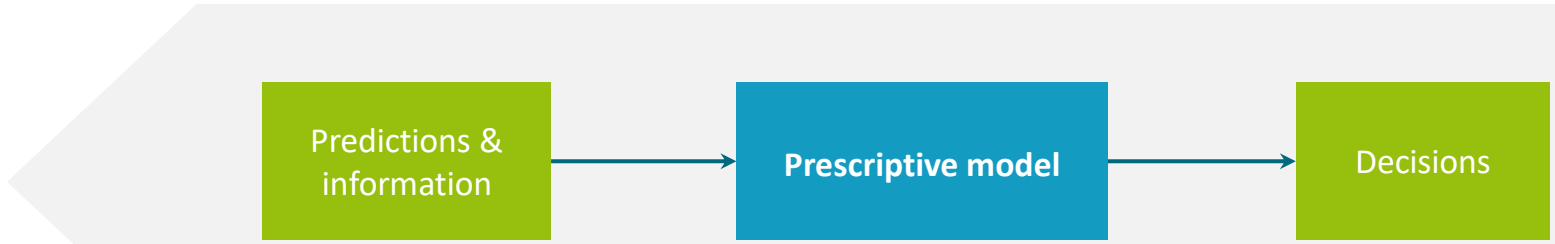
ORTEC's CSO Gerrit Timmer video of the keynote

Machine learning and optimization both enable data-driven decision support

Ronald Buitenhek
(Uncertainty Program)

Machine learning focus: turn observations into information

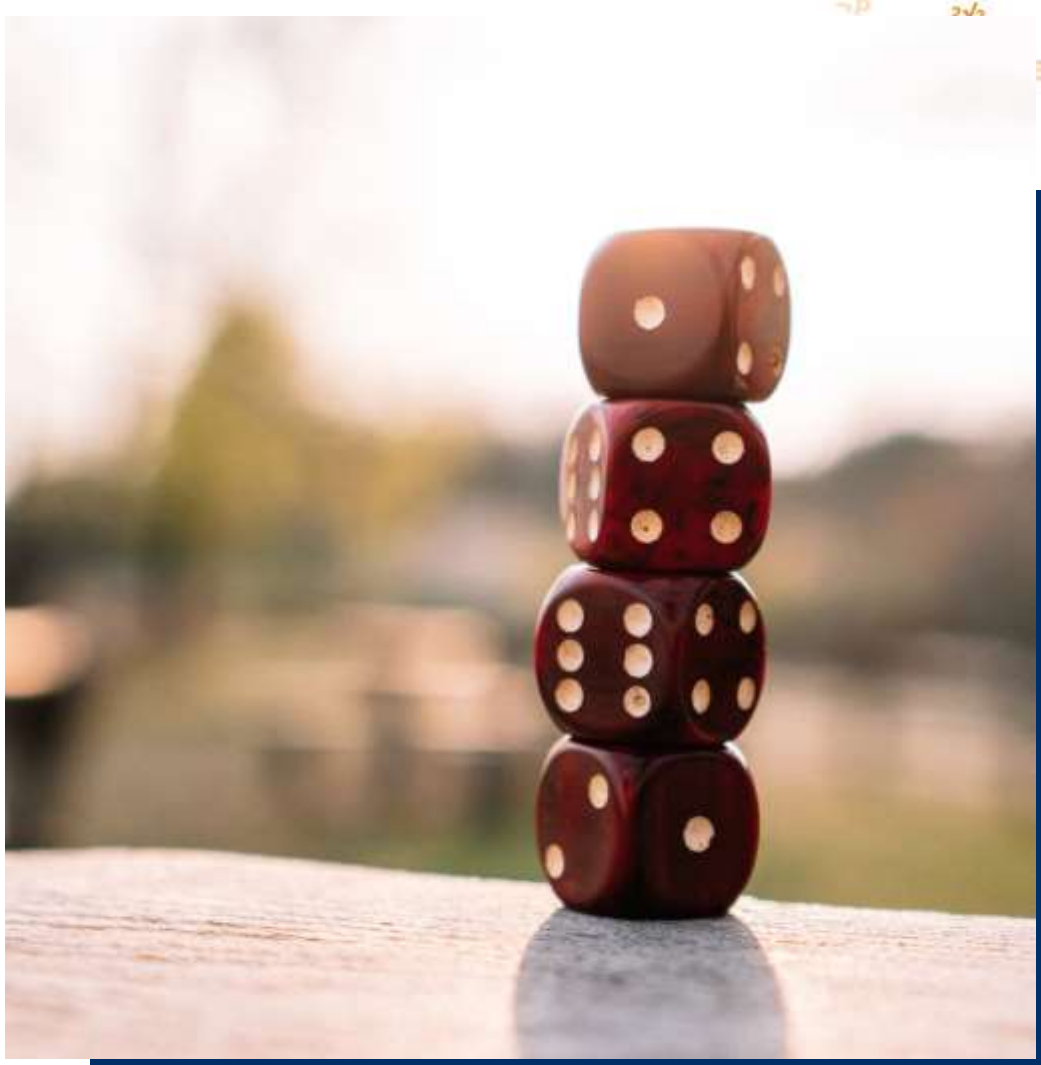




Optimization focus: make decisions based on information

There is only one certainty

- Everything is uncertain!



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More of an art than a craft…

The highest uncertainty comes from the model

Rogier Emmen
(CoE Data Science)

Sander Vlot
(CoE Optimization)

ORTEC's Centers of Excellence (there are more)

Where most of the methodological attention is

All data is uncertain

And we tend to treat it as deterministic and reliable

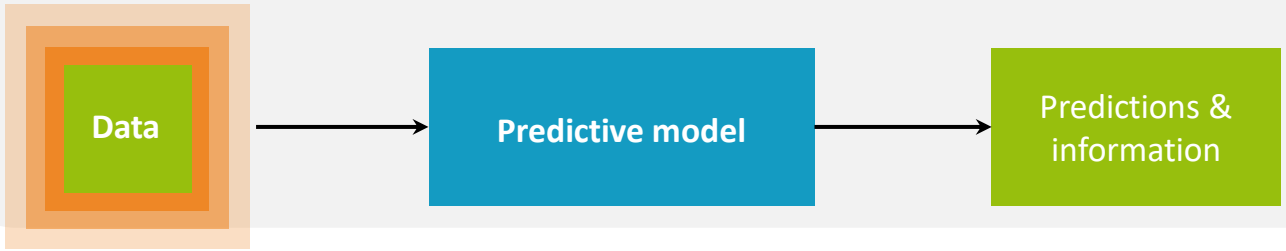
It does not end at the solution

What humans do is uncertain

And we may be tempted to consider that it is beyond our scope

Machine Learning ideal for automating clear, tedious and difficult tasks

Machine learning focus: turn observations into information



- Pictures of declared bills to data for immediate processing.
- Recorded phone calls to text for dispatching to the right person.
- Pictures of seeds for automatic classification.
- Anomaly (failure) prediction based on sensor data.
- Chatbots on several domains.
- Etc

Optimization focus: make decisions based on information

Some attempts to replace classical optimization (by mostly deep RL)

Performance - set 1

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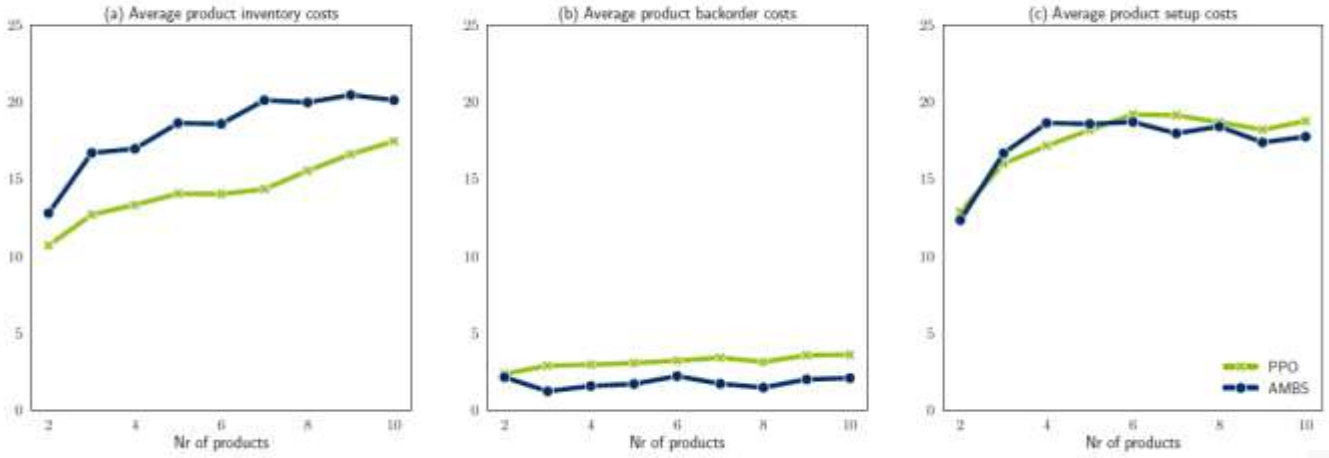
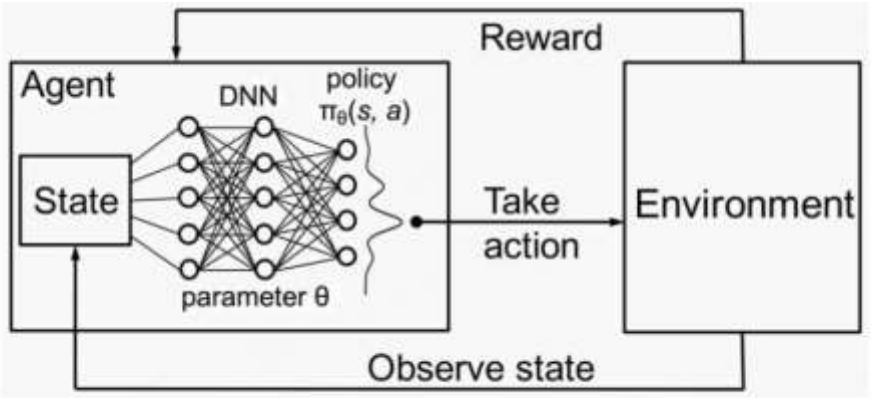


- PPO is outperforming benchmark heuristic (avg 5.96 %)

Wouter Kool

Capacitated Lot Sizing Problem with high uncertainty by Proximal Policy Optimization

Lotte van Hezewijk



https://medium.com/@vishnuvijayanpv/deep-reinforcement-learning-artificial-intelligence-machine-learning-and-deep-learning-e52cb5974420

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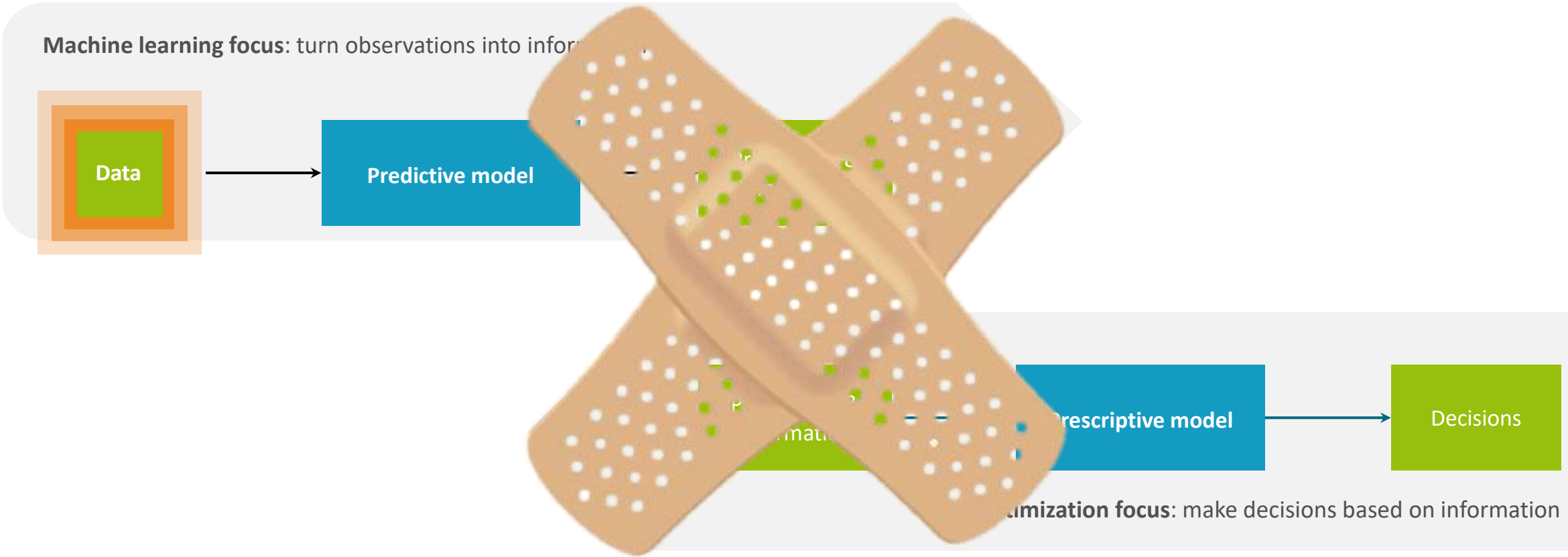
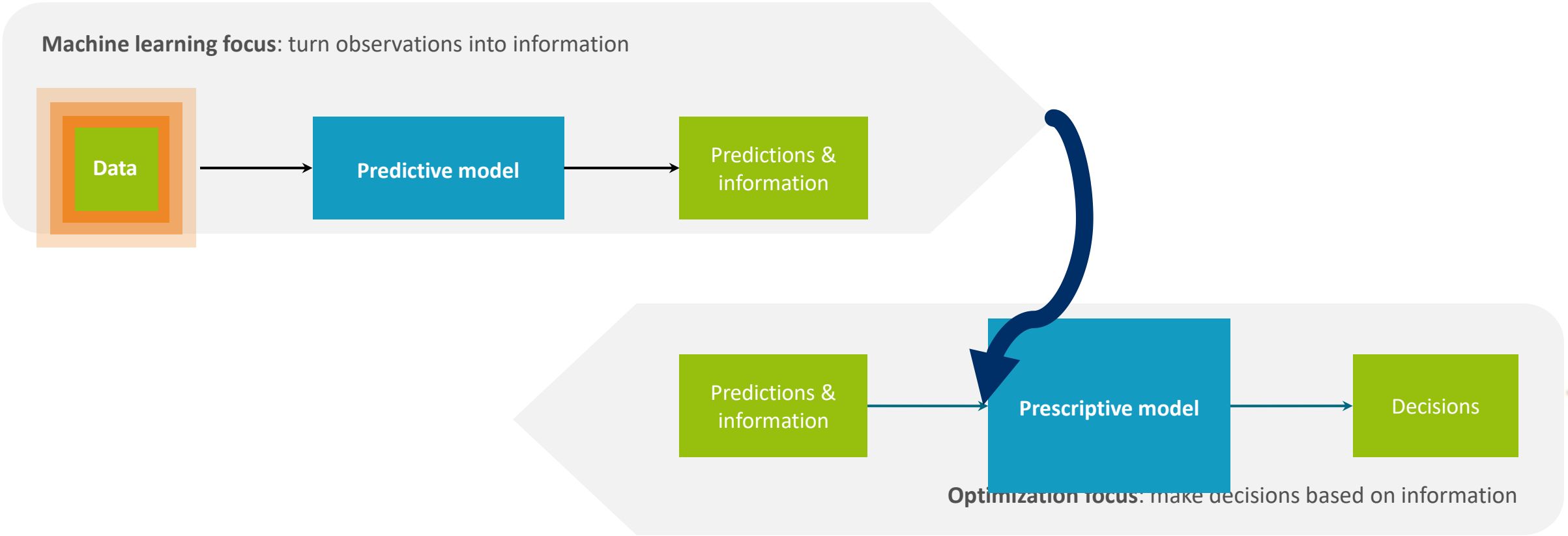
Somme attempts to heal the fracture



Learning the objective function



From Dinalog SensLog to Accelerator Sensory data for sustainable logistics

- Learning fuel consumption from sensory data, weather, traffic, etc

Distance objective:	Total distance:	10313 km
	Total duration:	146 hours
	Total fuel:	3165 L

Fuel objective:	Total distance:	11754 km
	Total duration:	166 hours
	Total fuel:	2885 L

Jasper van Doorn

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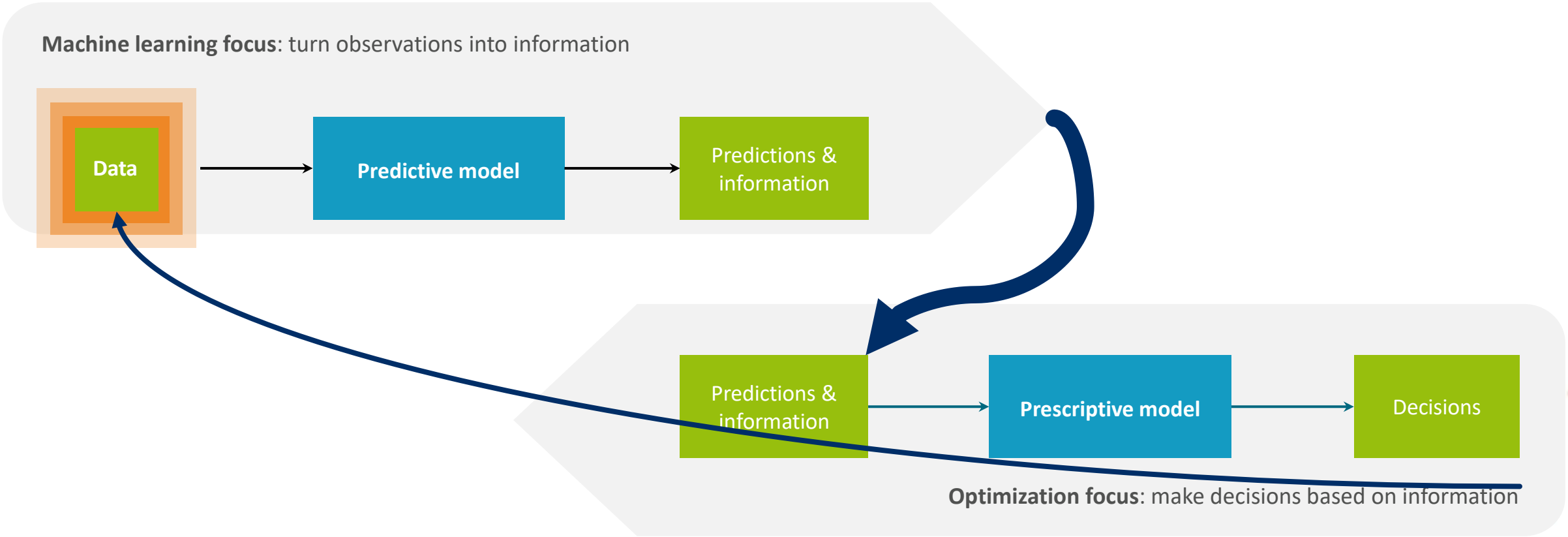
Learning how to predict better from past performance



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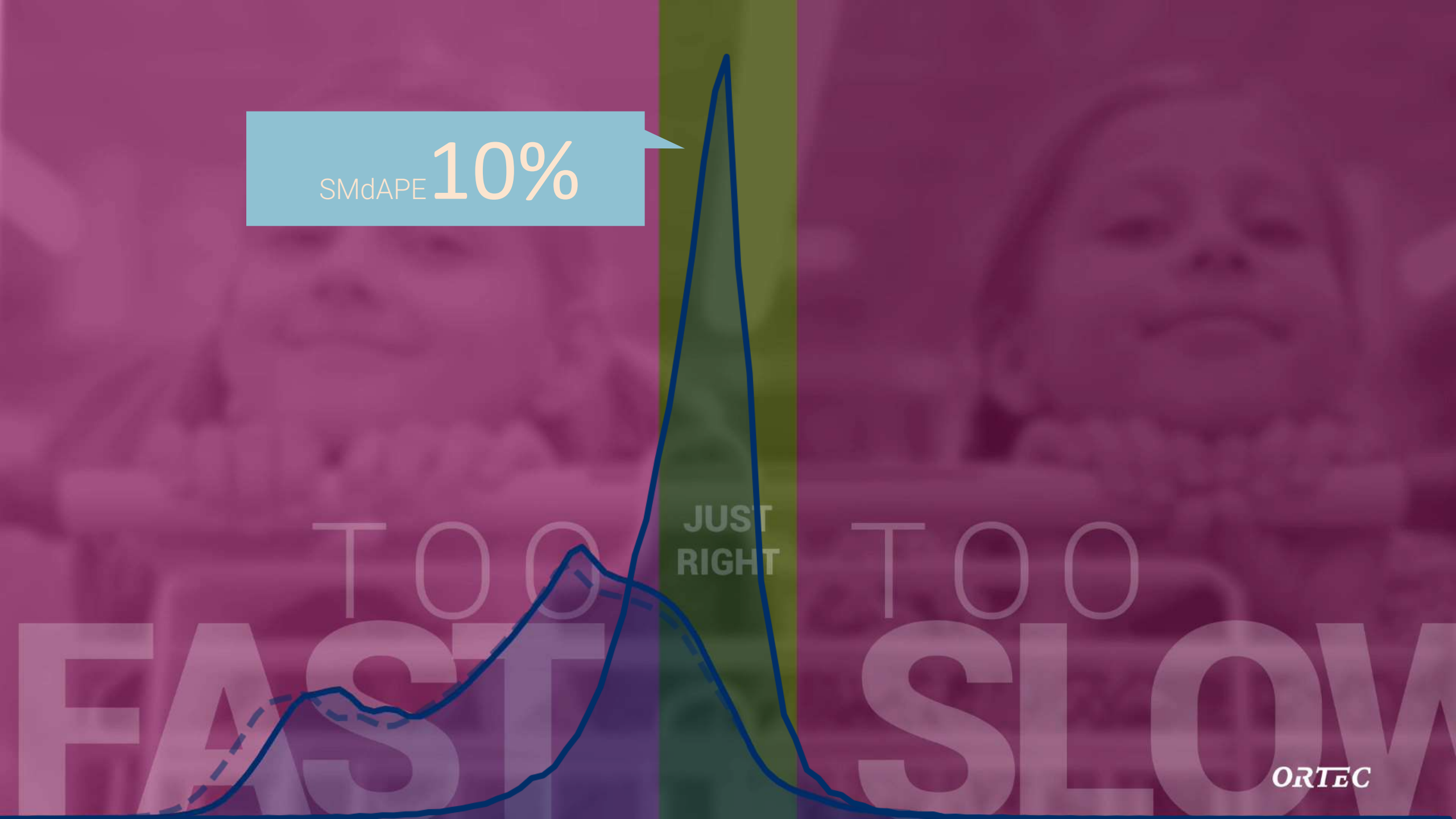
SMdAPE 10%
TOO FAST
JUST RIGHT
TOO SLOW
ORTEC

¤ 13409,53
violations

Solved **all violations**
and reduced costs by **2,1%**

Martijn den Hoedt
Veit Batz
Bas den Heijer
Pim Agterberg
Huib Trommel
Chantal Eckhardt

¤ 13121,
no rule violations

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Additional work

- Constraint learning in workforce scheduling
- Learning stop times in routing
- Automatic model configuration, several domains
- etc

Many more ORTEC contributors to this presentation

- Many other ORTEC colleagues besides those already mentioned inspired this presentation, with the risk of forgetting some (and my apologies) I list in alphabetic order those that I remember, with my great thank you!
  - Anna Tossenberger
  - Goos Kant
  - Leendert Kok
  - Laurens Fijn van Draat
  - …

AI and MP are best friends forever

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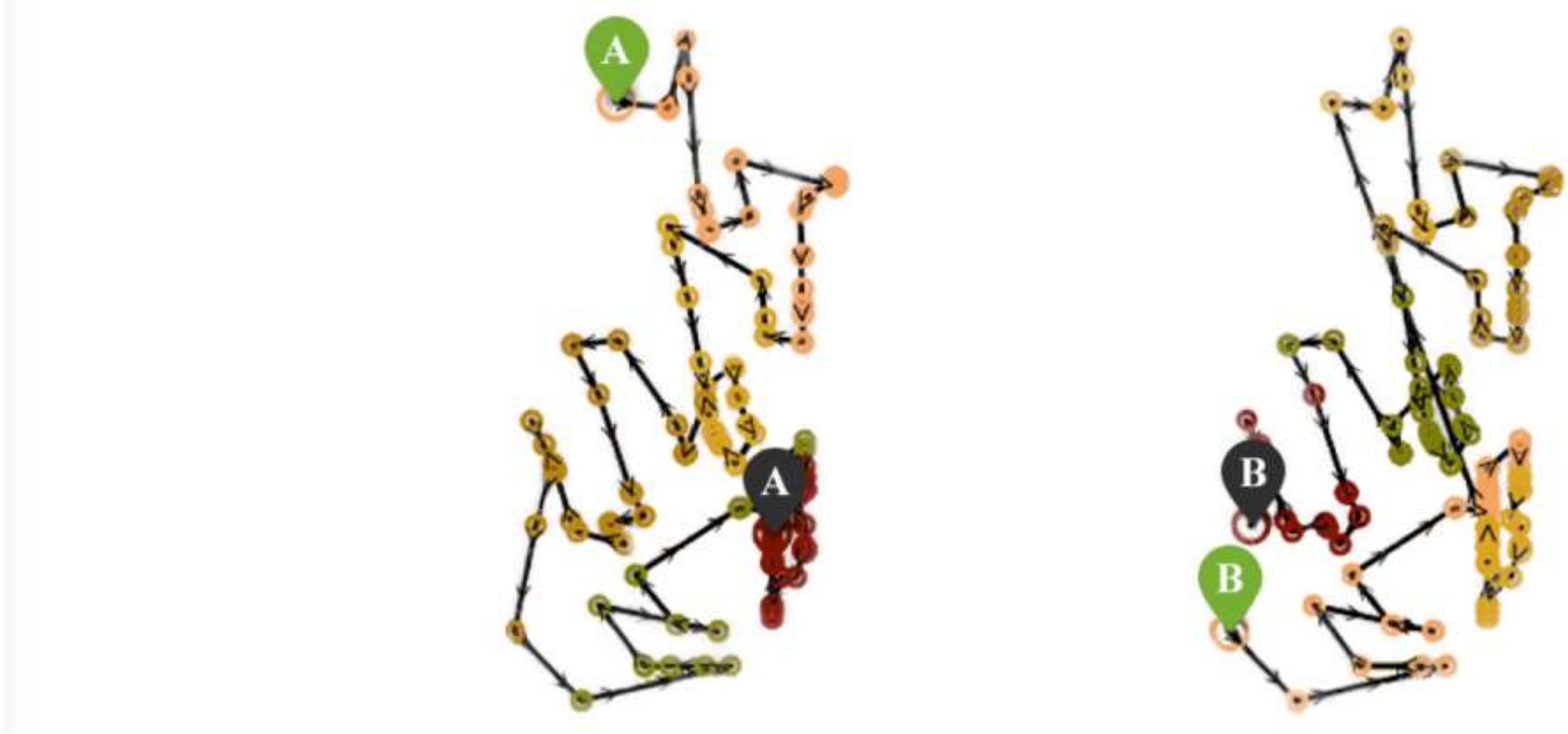
Some exciting things happening close to ORTEC

The driver has the last word on the route

- https://www.amazon.science/blog/amazon-mit-team-up-to-add-driver-know-how-to-delivery-routing-models



Three universal TSP heroes received $100,000 from Amazon

Bill Cook

Stephan Held

Keld Helsgaun

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Three local heroes at the ABS receive my huge appraisal!

Donato Maragano

Mayukh Ghosh

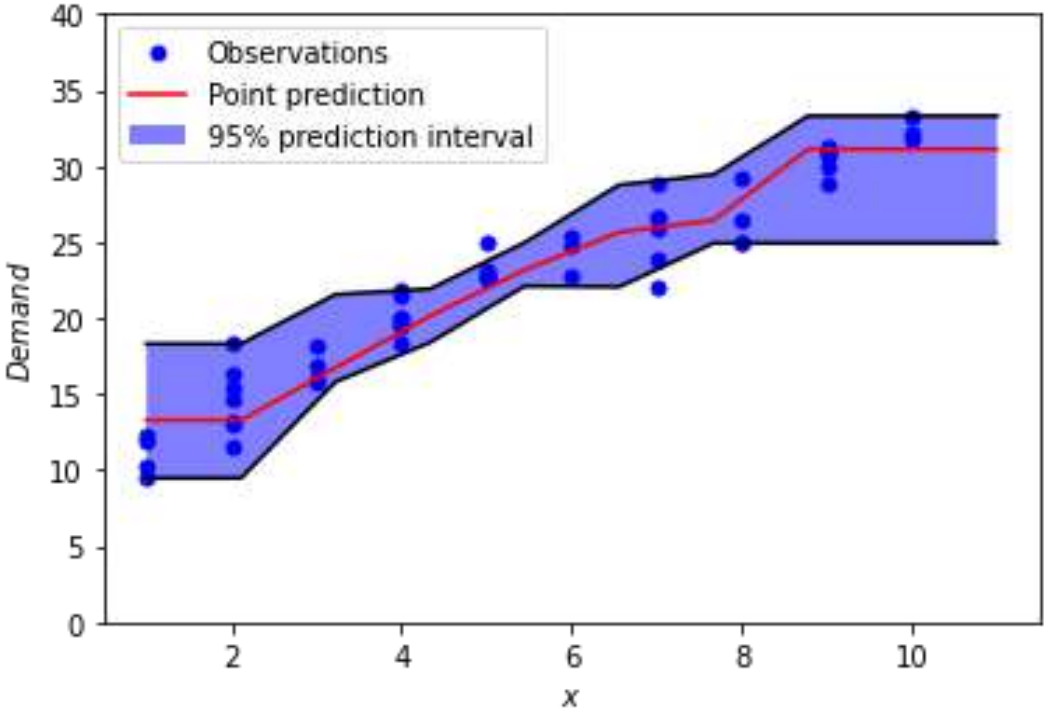
Roshan Mahes

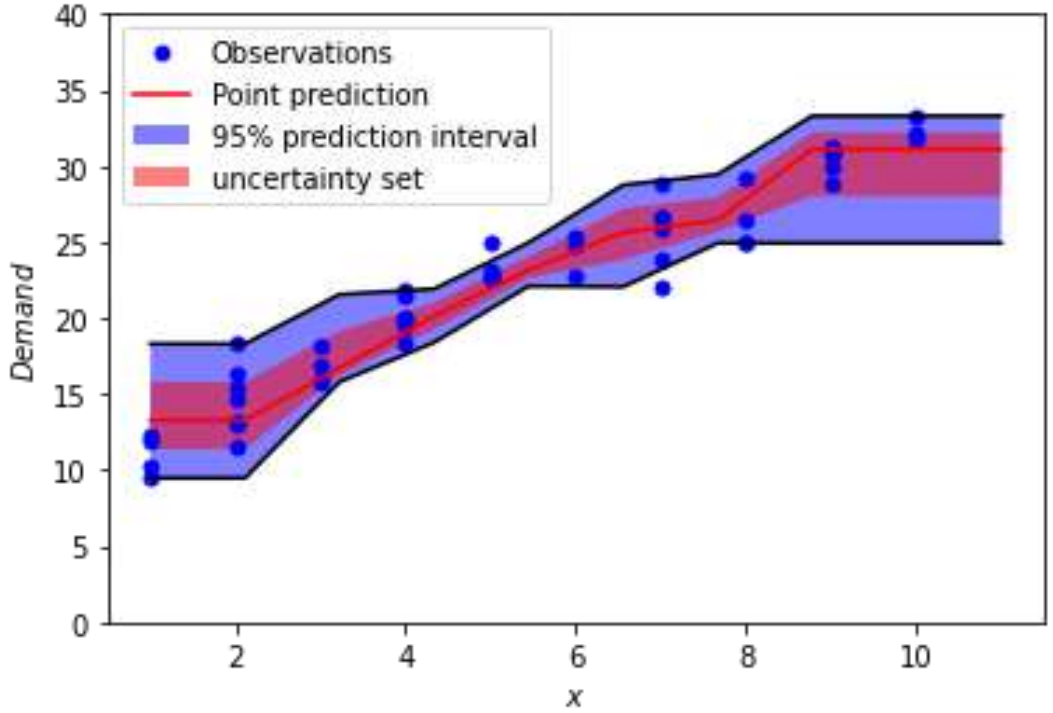
scores

The Last Mile Routing Research Challenge is hosted by Amazon and scientifically supported by the MIT Center for Transportation & Logistics

Some fruit hanging low on the Python ecosystem

Krzysztof Postek





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