BREAKOUT SESSION 5: 2ND MACHINE AGE

Machine Learning in Storage Logistics

EUROPEAN
FORUM
ALPBACH

Monika Kofler

25 August, 2017

ABOUT ME

2002 – 2006: Software Engineering for Medicine

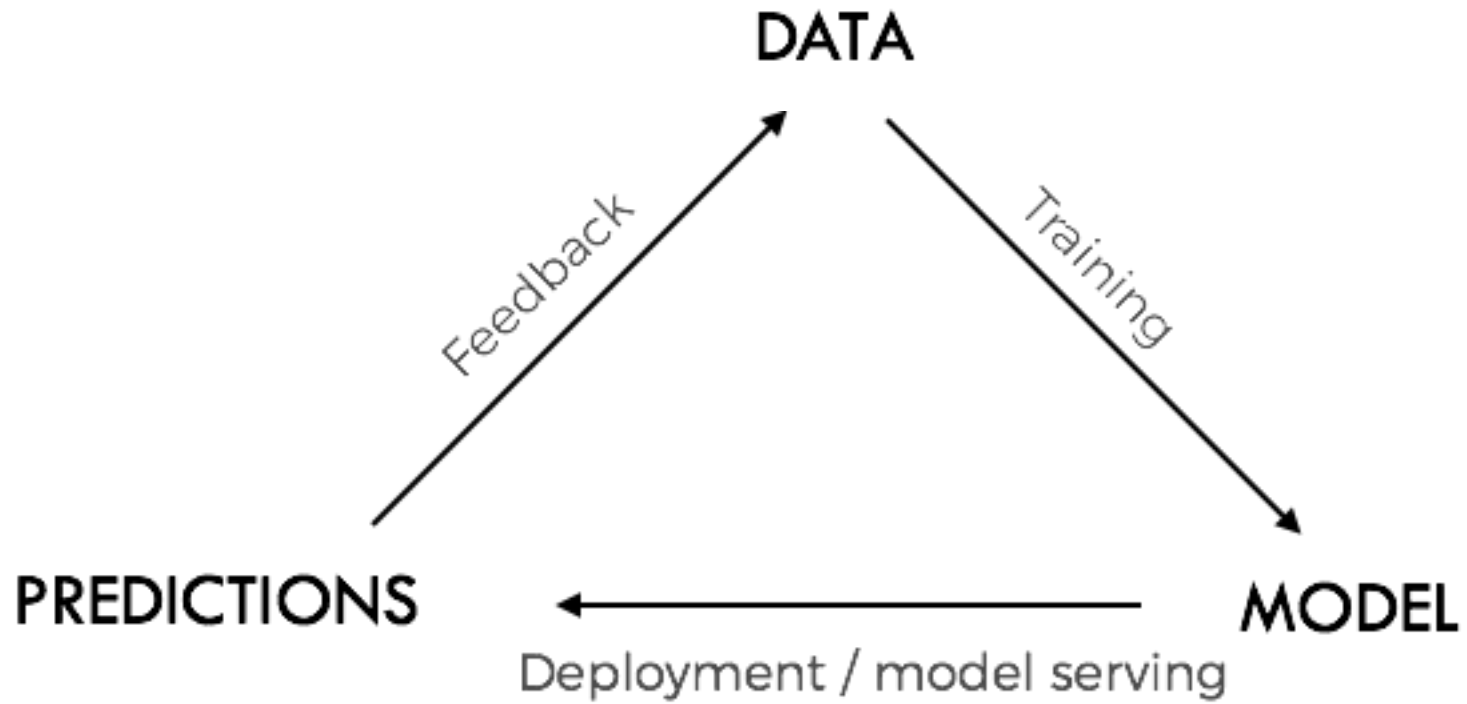University of Applied Sciences Upper Austria

2015: PhD in Computer Science

Member of the Heuristic and Evolutionary Algorithms Lab (heal.heuristiclab.com). Applied research projects for partners in the automotive and steel industry.
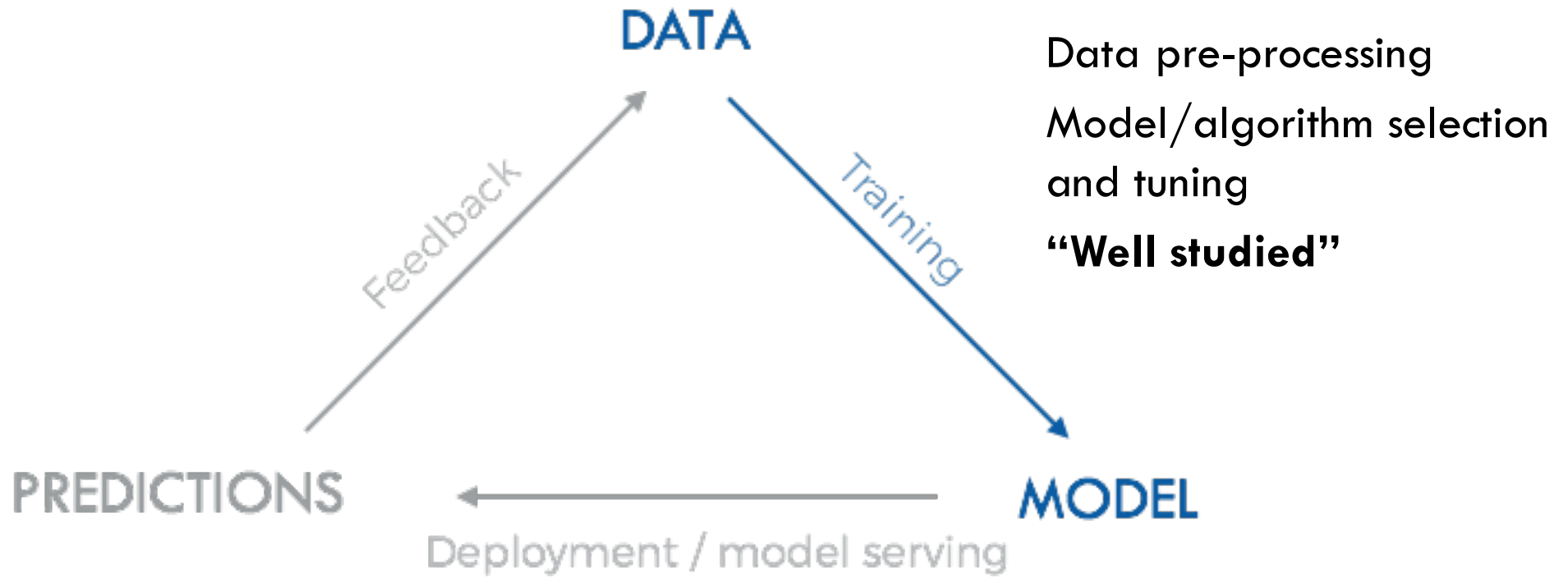
Since late 2014

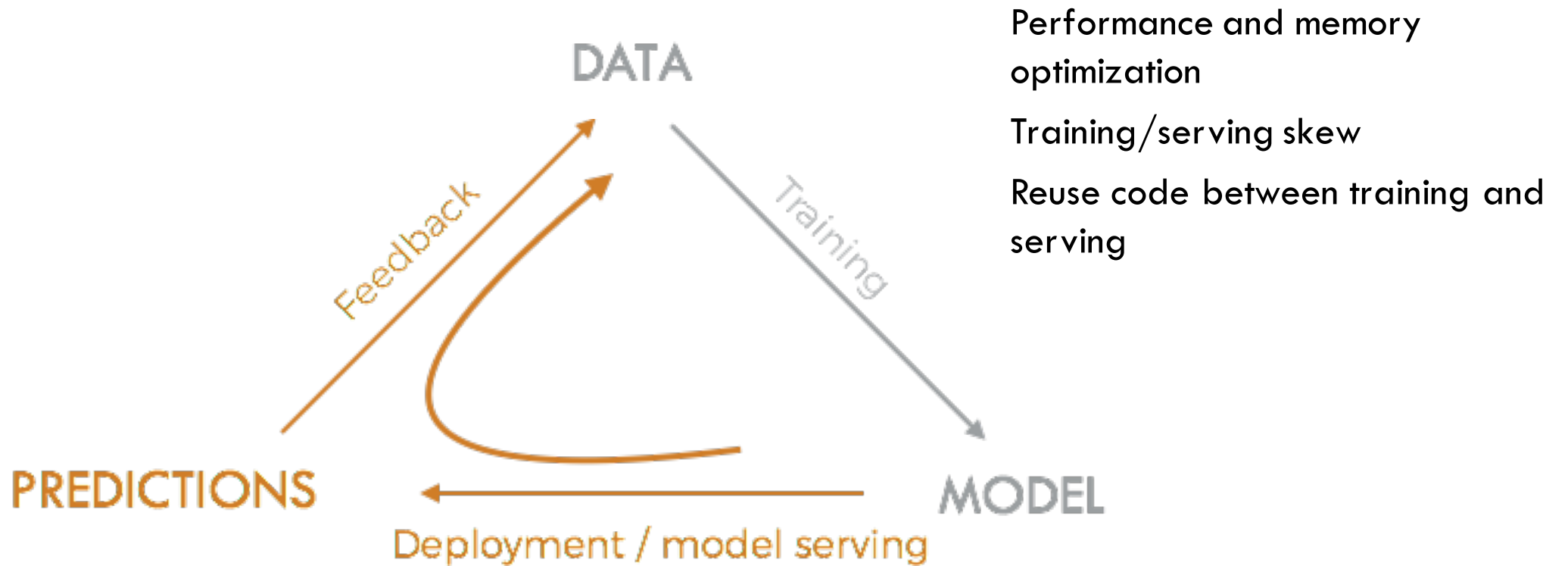Amazon software development engineer/manager on projects with Machine Learning focus.

MACHINE LEARNING PIPELINE

MACHINE LEARNING PIPELINE

DATA

Feedback

Training

Deployment / model serving

PREDICTIONS

MODEL

Data pre-processing

Model/algorithm selection and tuning

"Well studied"

MACHINE LEARNING PIPELINE

DATA

Feedback

Training

PREDICTIONS

Deployment / model serving

MODEL

Performance and memory optimization

Training/serving skew

Reuse code between training and serving

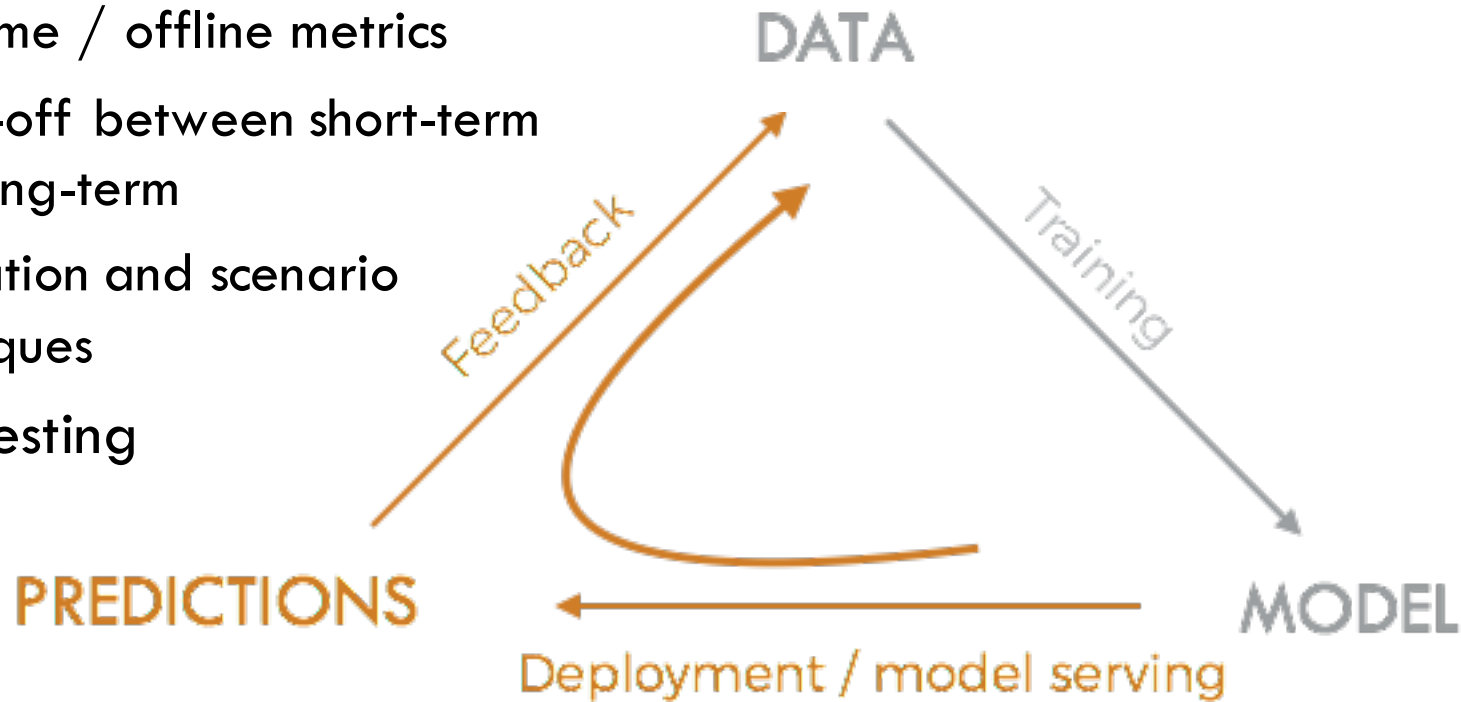Deploy new technology stack: 3-6 months

MACHINE LEARNING PIPELINE

Business metrics often differ from real-time / offline metrics

Trade-off between short-term and long-term

Simulation and scenario techniques

A/B testing

DATA

Feedback

Training

PREDICTIONS

MODEL

Deployment / model serving

EXAMPLE: APPLYING META-HEURISTICS TO OPTIMIZE STORAGE IN WAREHOUSES

Thesis download:

http://heal.heuristiclab.com/theses

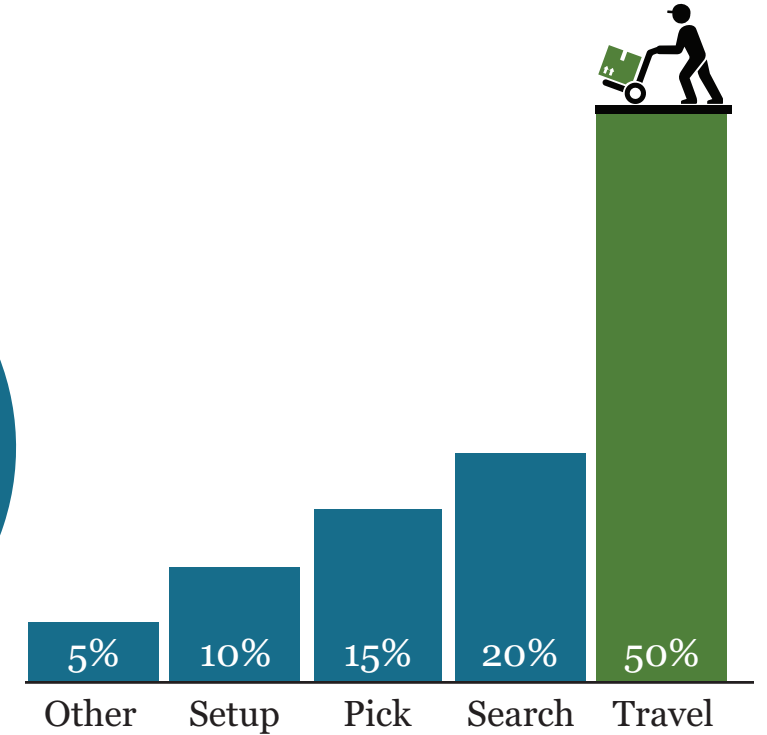# WHAT IS THE BUSINESS OPPORTUNITY?

A typical picker walks around **10km per day.**

Goal: Improve efficiency by reducing the travel time/distance in order picking.
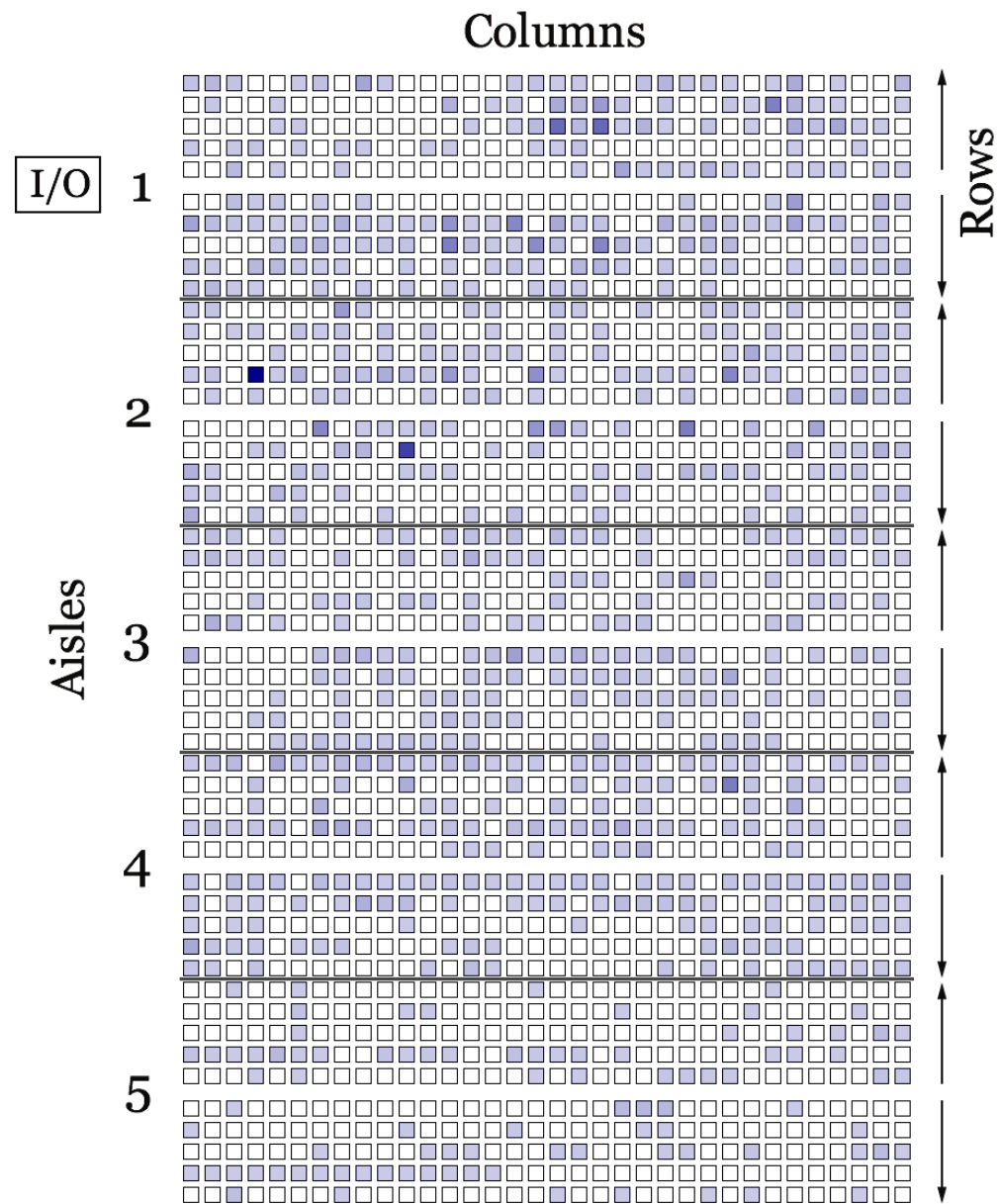
Advantage: Easy to change.

Receiving 10%

Storage 15%

Shipping 20%

Order Picking 55%

Operating expenses
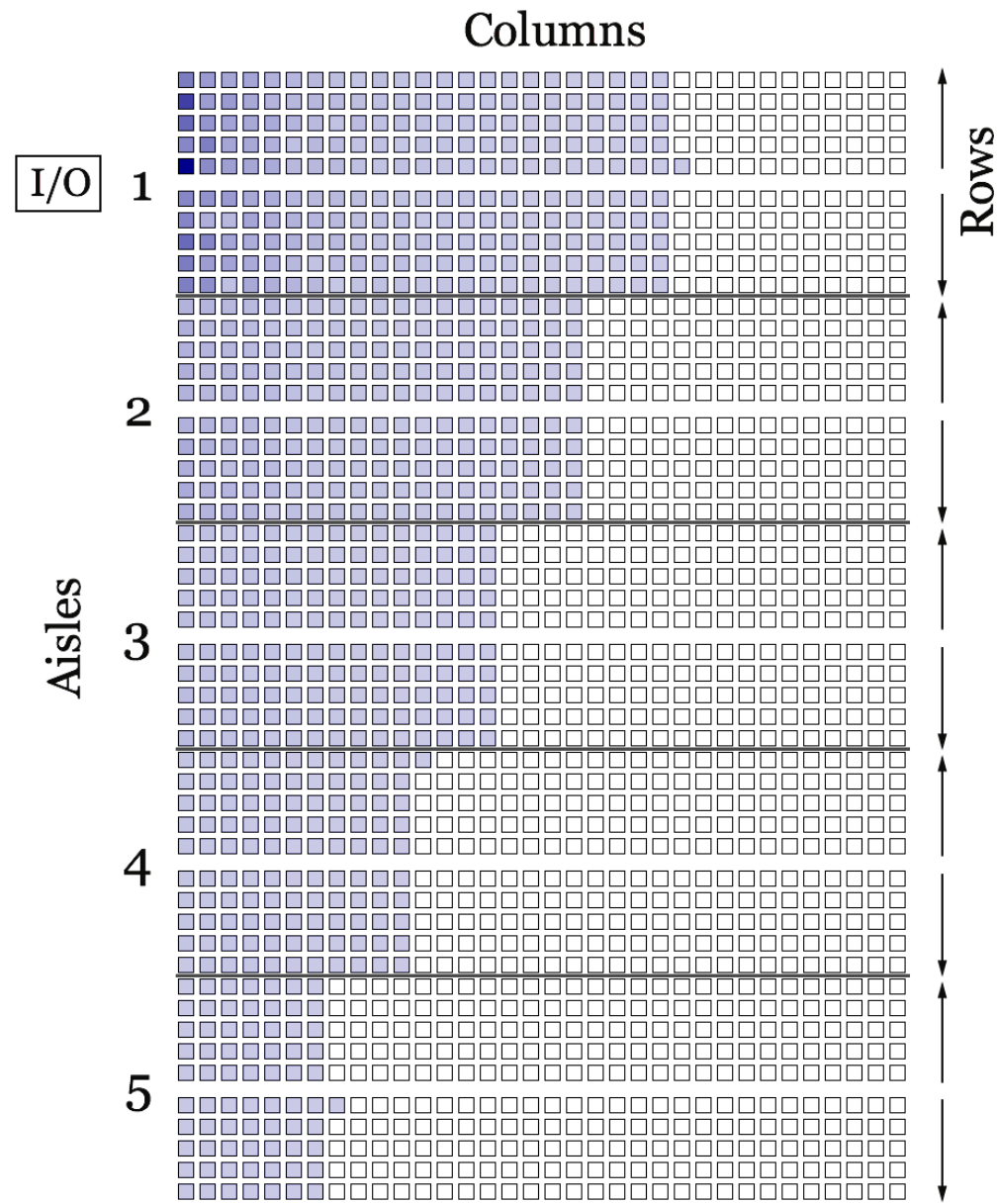
5% Other

10% Setup

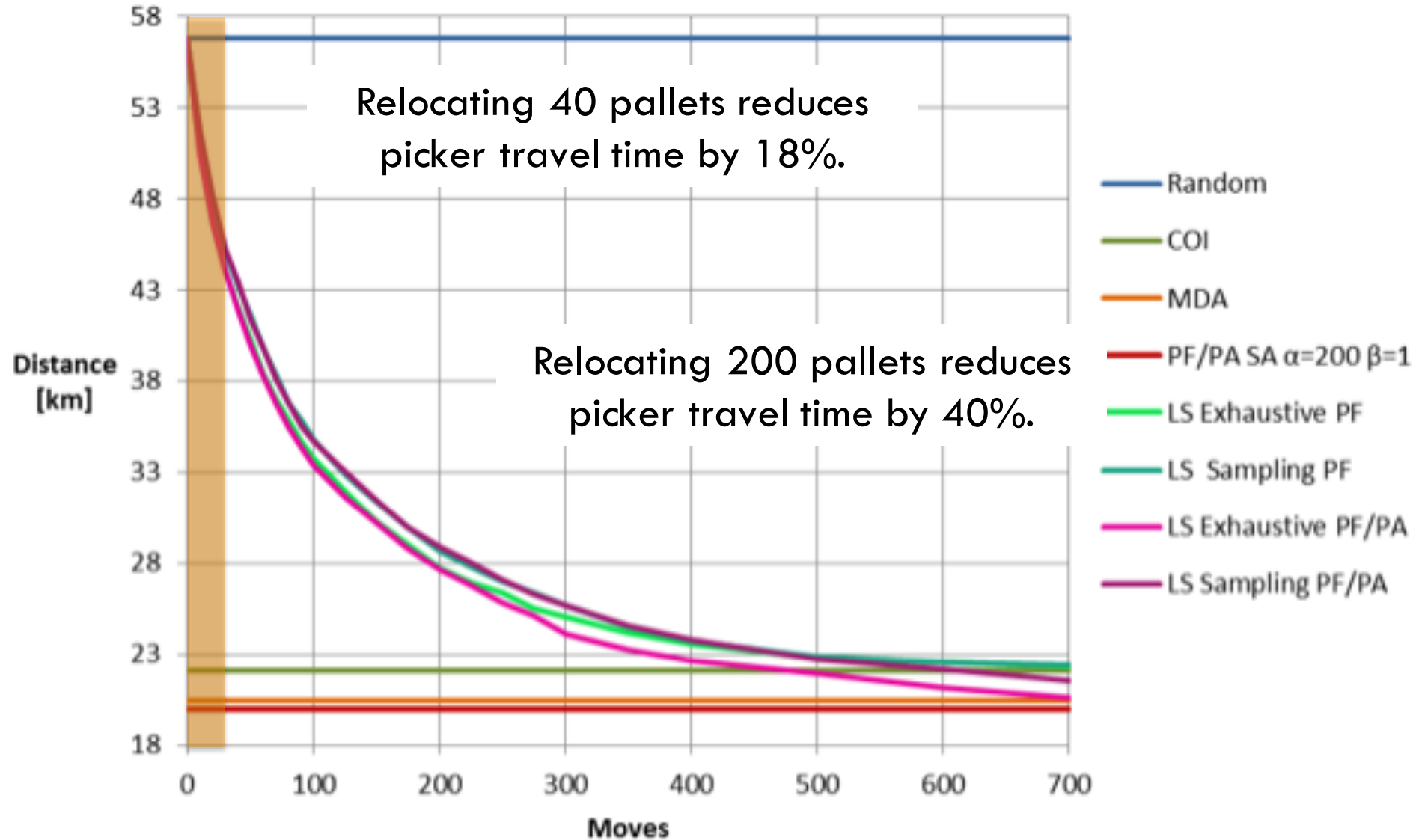15% Pick

20% Search

50% Travel
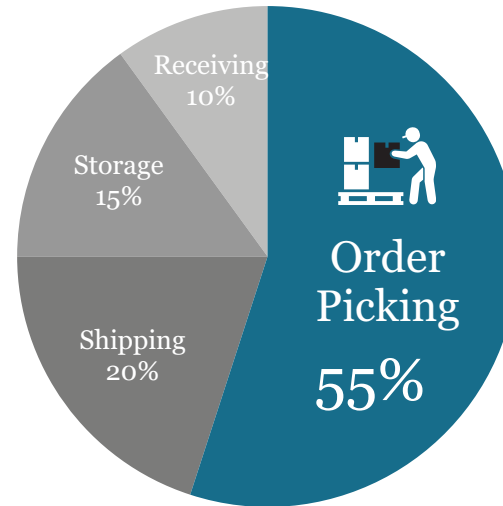
Time spent by order picker

OpenView Picks: Original

OpenView Picks: Optimised

Convergence behavior of greedy local search
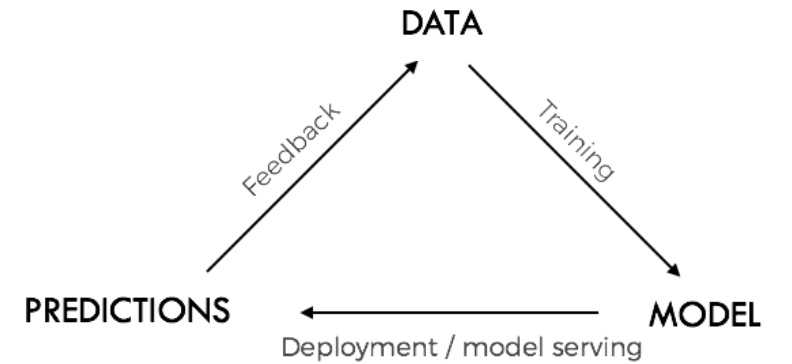
Relocating 40 pallets reduces picker travel time by 18%.

Relocating 200 pallets reduces picker travel time by 40%.

Distance [km]

Moves

- Random
- COI
- MDA
- PF/PA SA α=200 β=1
- LS Exhaustive PF
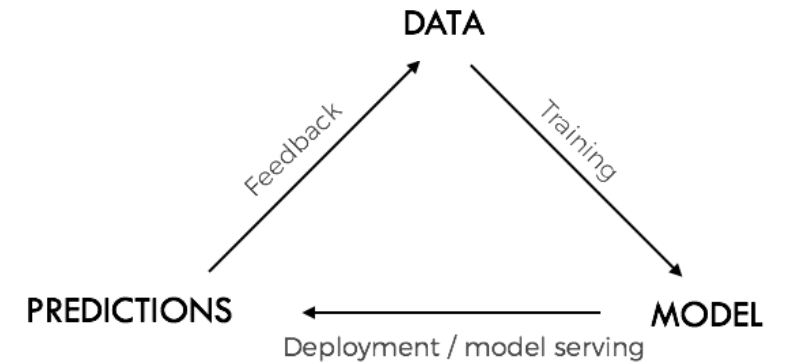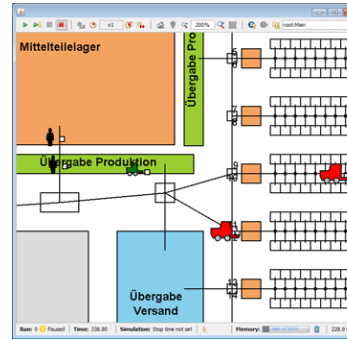- LS Sampling PF
- LS Exhaustive PF/PA
- LS Sampling PF/PA

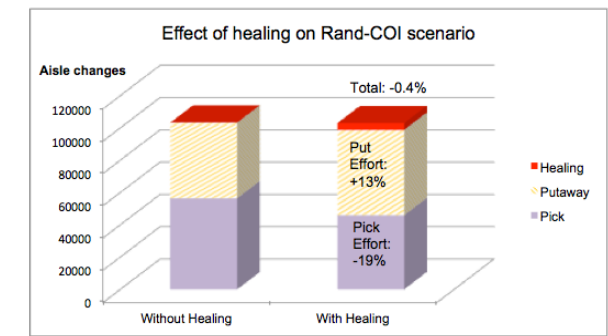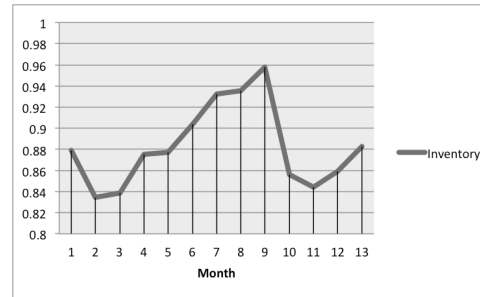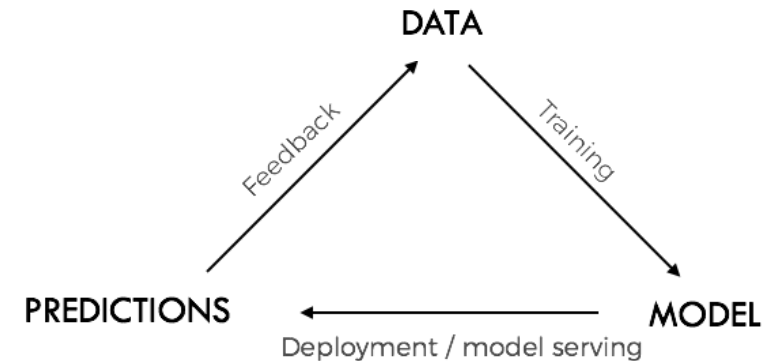# START THE MACHINE LEARNING PIPELINE
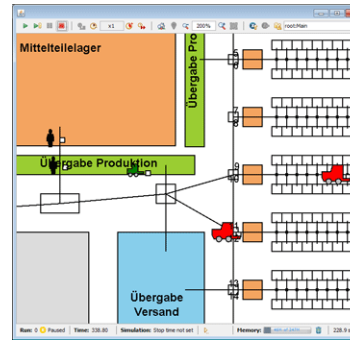
START THE MACHINE LEARNING PIPELINE

First cycle: Simulation model to get additional metrics. Issue: Congestion

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First cycle: Simulation model to get additional metrics. Issue: Congestion

Second cycle: Quantify impact of changing demand over time. Includes incoming demand and re-locations. Issue: Too greedy!
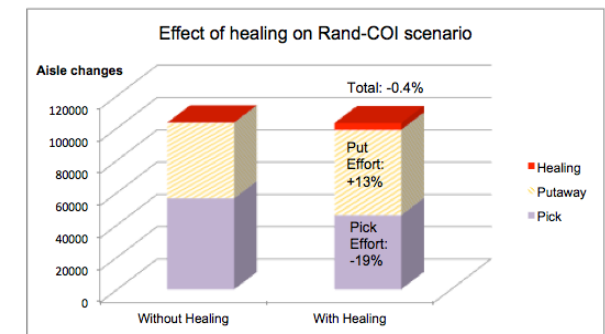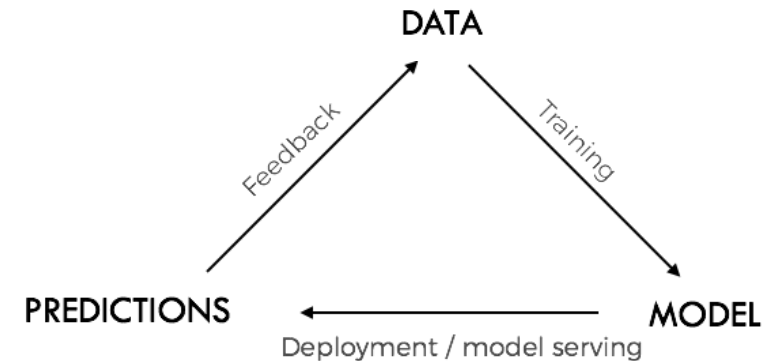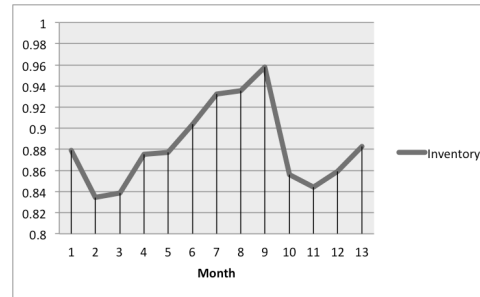
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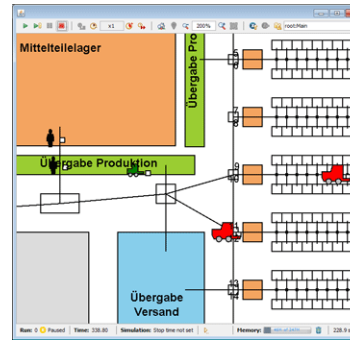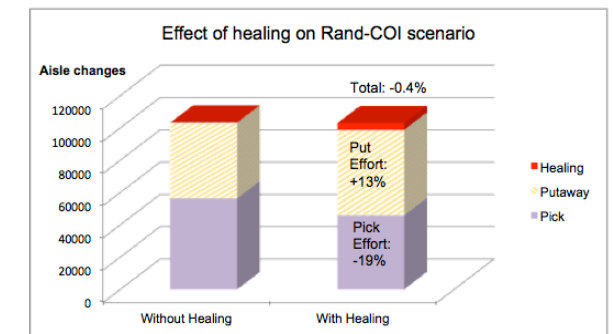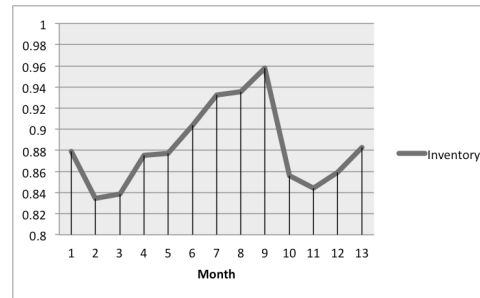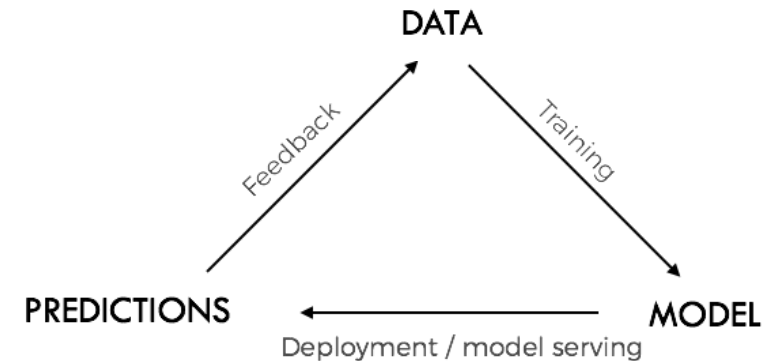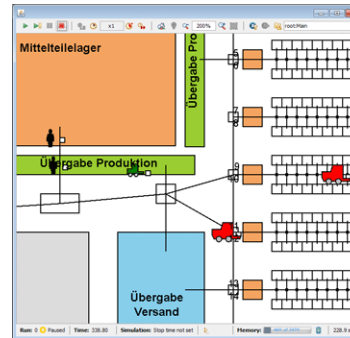
Third cycle: Robust storage.

START THE MACHINE LEARNING PIPELINE

First cycle: Simulation model to get additional metrics. Issue: Congestion

Second cycle: Quantify impact of changing demand over time. Includes incoming demand and re-locations. Issue: Too greedy!

Third cycle: Robust storage.

Forth cycle: Include up- and down-stream processes (order schedule and transport). Issue: Picking efficiency is not the bottleneck anymore.

WHAT IF WE CHANGE...

Warehouse Location Problem

Warehouse Layout Optimization

Warehouse Automation

Picker Routing and Order Batching

Storage Location Assignment

Integrated Problems

→ Procurement
→ Packing
→ Transport to Customer or Production Site

EXAMPLE: GMAIL SMART REPLY

Kannan, A., Kurach, K., Ravi, S., Kaufmann, T., Tomkins, A., Miklos, B., Corrado, G. et al. (2016). Smart reply: Automated response suggestion for email. KDD '16 August 13-17, 2016, San Francisco, CA, USA.

NON-ALGORITHMIC CHALLENGES IN MACHINE LEARNING

GROUND WORK: RESEARCH

Open research community: Sharing of ideas (via publications) and even code (Open Source frameworks)

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SCARCE RESOURCES

DATA

Better/more data beats better algorithms.

TALENT

Customize approaches to business context and data.

GROUND WORK: RESEARCH

Open research community: Sharing of ideas (via publications) and even code (Open Source frameworks)

SCARCE RESOURCES

DATA

Better/more data beats better algorithms.

Challenges:
Access and acquisition
Data quality and integrity
Volume and velocity
Security and protection
Bias

TALENT

Customize approaches to business context and data.

Challenges:
Development
Acquisition/Retention
Inter-disciplinary

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