Final Project:
Application of RL in supply chain management

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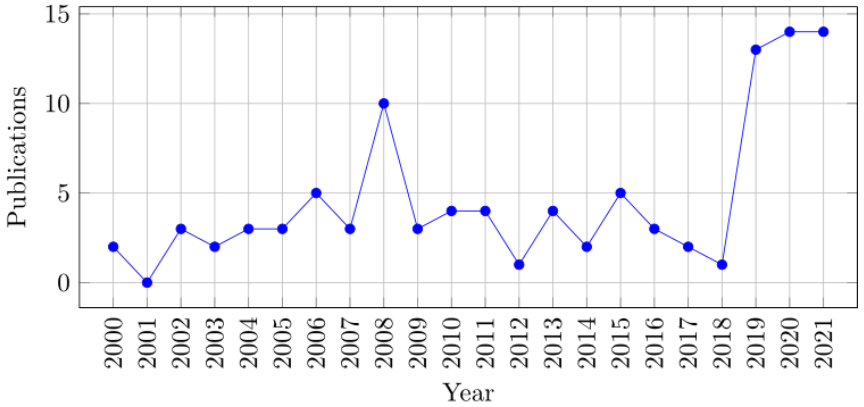
Current application areas of reinforcement learning in SCM

Rising number of publications using RL for:

- Inventory management
- Vehicle rescheduling
- Job scheduling
- Transportation / vehicle routing
- Forecasting
- Dynamic pricing
- Supplier selection
- …



The objectives and scope of the final project

- In your groups, you will work on one specific problem area of supply chain management to:
  - Define the problem and the Markov-Decision-Process
  - Obtain public data / generate data for your problem
  - Implement a reinforcement learning algorithm in python (Q-learning)
  - Discuss results
- Submission documents
  - Written report
  - (Running) python code
- Exercise sheet summary in ILIAS

Timeline (Proposal)

22.06. (today)	06.07.	20.07.	18.08.
Start	Possibility to discuss problem definition / MDP (upon appointment)	Possibility to discuss implementation challenges (upon appointment)	Submission of code and written report

- Per group, request appointments via mail (alternative dates possible upon request)
- Earlier submission possible
- Submission via mail to pirmin.fontaine@ku.de and daniel.muellerklein@ku.de
- In case of questions, please reach out to daniel.muellerklein@ku.de

Overview of topics

Choose **one** of the following topics (details next):

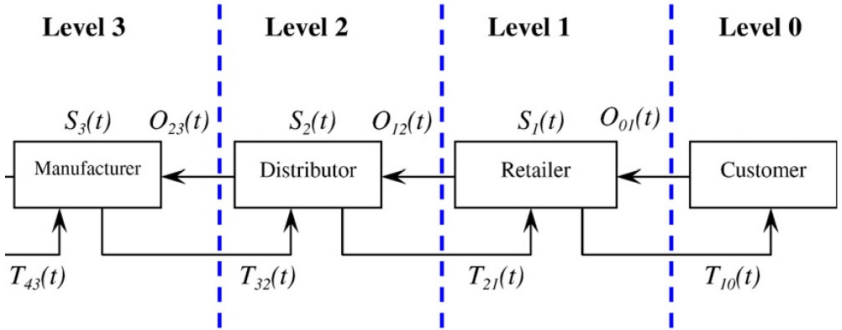
- Inventory management
- Vehicle rescheduling
- Job scheduling

For each topic, you receive a scientific paper as implementation example.

In your groups,

- Discuss on how to simplify the problem
- Check for assumptions / insights that help your implementation
- Discuss on how to simplify the algorithms / implementation

Topic 1 – Inventory management (1/2)



- Beer game for inventory management across multiple levels
- Various uncertainties regarding demand and other environmental factors
- Objective to minimize total inventory costs

Topic 1 – Inventory management (2/2)

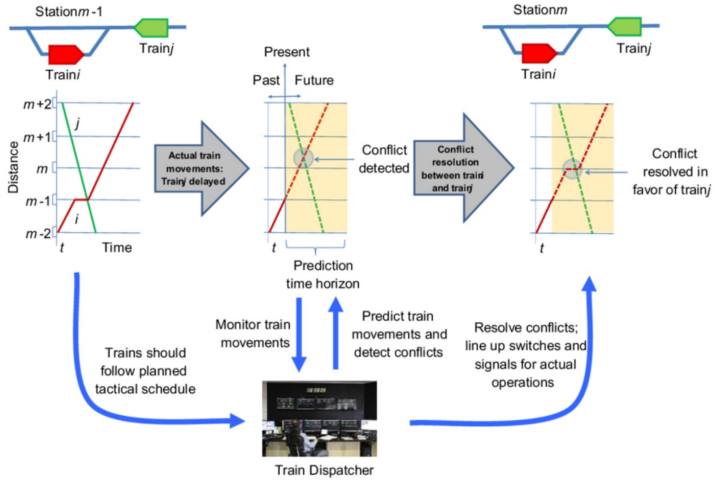
- Each level as separate agent
- Different levels co-operate and communicate
- However, each level (agent) needs specific ordering system (no centralized decision making)
- RL good ordering policies under complex scenarios
- Example:

Chaharsooghi, S. K., Heydari, J., & Zegordi, S. H. (2008). A reinforcement learning model for supply chain ordering management: An application to the beer game. *Decision Support Systems, 45(4), 949-959.*

Table 4
Comparison of inventory cost of RLOM with two other algorithms

	Main test problem	Test problem 1	Test problem 2	Test problem 3
1-1 policy	7463	5453	8397	7826
GA-based algorithm	2555	**3109**	4156	4330
RLOM	**2417**	3169	**4038**	**4205**

Topic 2 – Vehicle rescheduling (1/2)

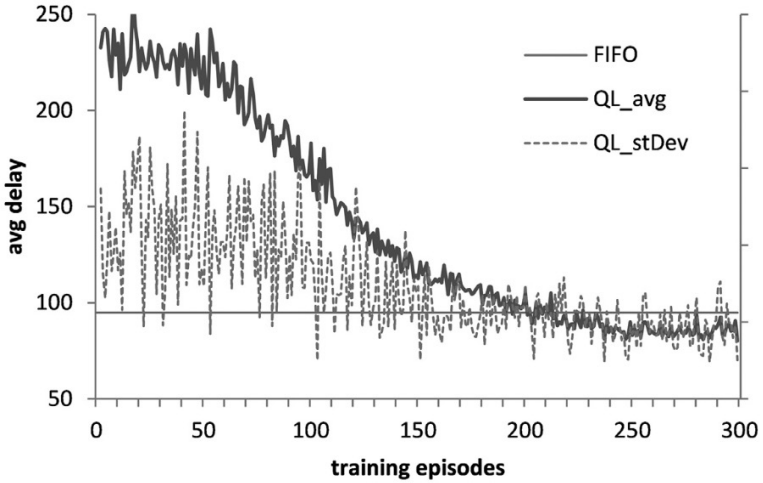


- In railway traffic, timetables specify expected departure / arrival times
- Disruptions and unexpected events require rescheduling
- Objective to maintain overall punctuality (expected – actual arrival time)

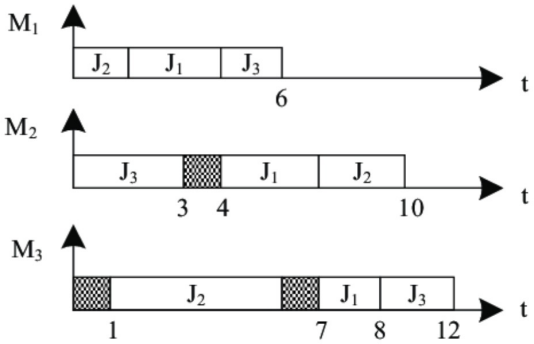
Topic 2 – Vehicle rescheduling (2/2)

- In practice, dispatchers manually reschedule, e.g., changing order of departure
- RL algorithm outperforms random walk or standard rules for rescheduling
- Example:

  Šemrov, D., Marsetič, R., Žura, M., Todorovski, L., & Srdic, A. (2016). Reinforcement learning approach for train rescheduling on a single-track railway. *Transportation Research Part B: Methodological, 86, 250-267.*



Topic 3 – Production scheduling (1/2)



- Completing a set of jobs on a limited number of resources
- Job routing and job sequencing
- Different (and competing) objectives in practice

Topic 3 – Production scheduling (2/2)

- Dispatching rules to solve sequencing problem
- Priority rule for jobs waiting
- Varying objectives and uncertain jobs
- RL algorithm able to learn to favor the best-known dispatching rule (analytical solution)
- Example:

  Wang, Y. C., & Usher, J. M. (2005). Application of reinforcement learning for agent-based production scheduling. *Engineering applications of artificial intelligence*, *18*(1), 73-82.