TPPE74
Design and Development of Manufacturing Operations

Lecture 6

AI and machine learning

2021

TOP Trending Technologies

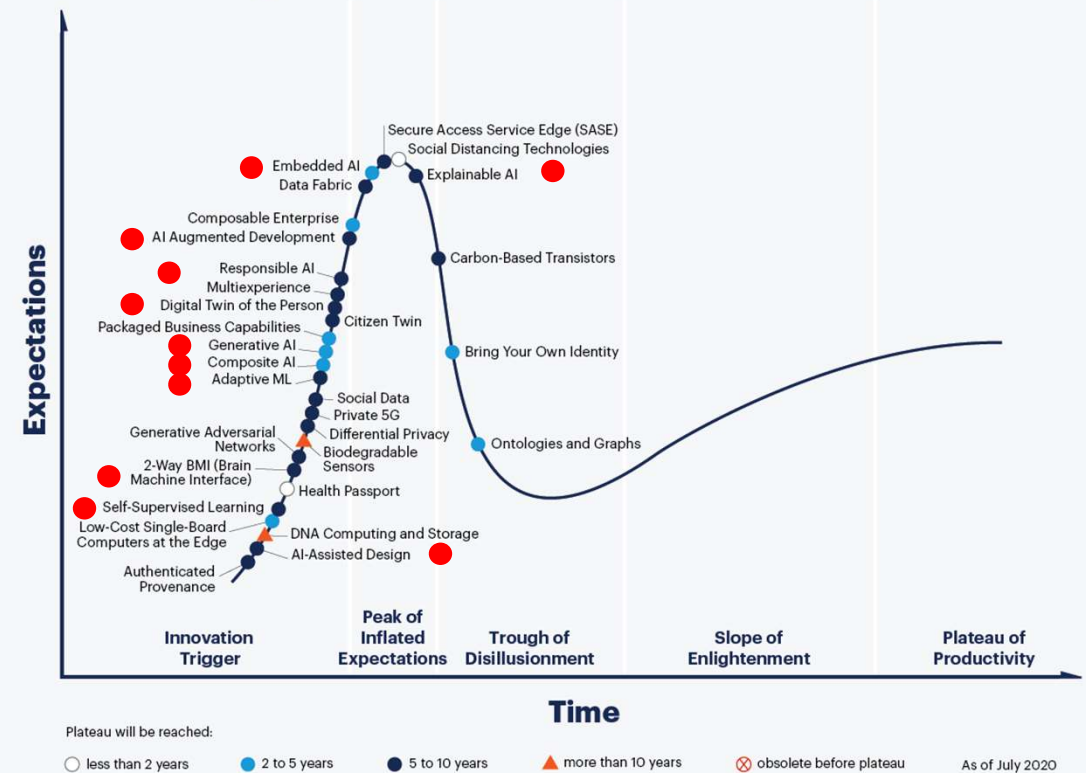AI has been and continues to be one of the most promising areas for technology development

Within 2 – 10 years

These technologies will actually be utilized by the time todays students graduate

AI > 34 %

Over 34 % of all emerging technologies is within AI and machine learning so a general understanding will be of importance for almost working within tomorrows business enviroment


Hype Cycle for Emerging Technologies, 2020

Expectations

Secure Access Service Edge (SASE)
Social Distancing Technologies
Embedded AI
Data Fabric
Explainable AI
Composable Enterprise
AI Augmented Development
Carbon-Based Transistors
Responsible AI
Multiexperience
Digital Twin of the Person
Citizen Twin
Packaged Business Capabilities
Generative AI
Composite AI
Bring Your Own Identity
Adaptive ML
Social Data
Private 5G
Generative Adversarial Networks
Differential Privacy
Biodegradable Sensors
Ontologies and Graphs
2-Way BMI (Brain Machine Interface)
Health Passport
Self-Supervised Learning
Low-Cost Single-Board Computers at the Edge
DNA Computing and Storage
AI-Assisted Design
Authenticated Provenance

Innovation Trigger — Peak of Inflated Expectations — Trough of Disillusionment — Slope of Enlightenment — Plateau of Productivity

Time

Plateau will be reached:
○ less than 2 years   ● 2 to 5 years   ● 5 to 10 years   ▲ more than 10 years   ⊗ obsolete before plateau   As of July 2020

gartner.com/SmarterWithGartner

Source: Gartner
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Gartner.

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Aim of this lecture
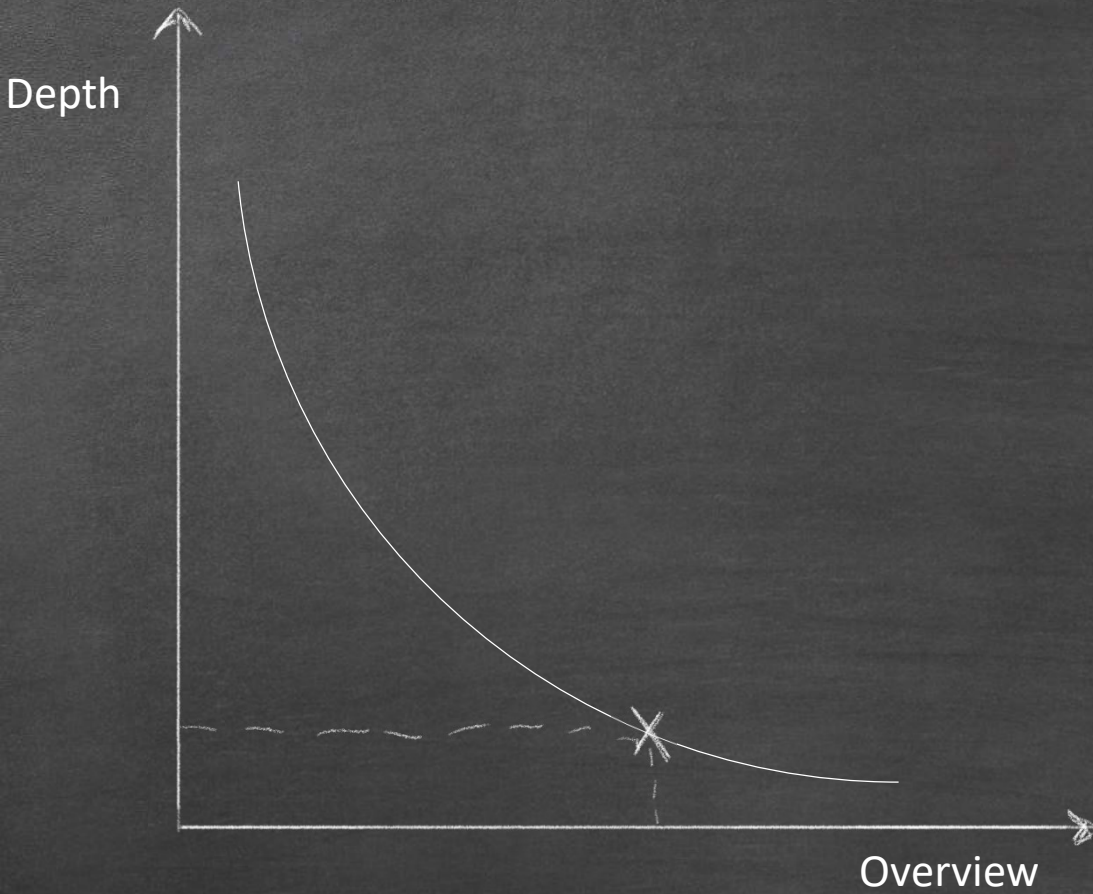
# Eskil Rehme

Data Scientist @ Implema

- Linköping
- MSc in Industrial Engineering & Management
- Implema since 2017
- Analytics
  - Data Science

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Agenda lecture

1. Difference between AI and machine learning
2. Definition
3. Real life applications of AI and Machine learning
4. Machine learning: Why now?
5. Machine learning: An overview
6. Decision making: When to use
7. Decision making: When not to use
Break
8. Different flavours of machine learning, clustering, regression and classification
9. Different learning methods
8. Machine learning in operations management
9. Examples
10. Machine learning in Wearhouse management
11. Examples
12. Outro

Difference between AI and machine learning
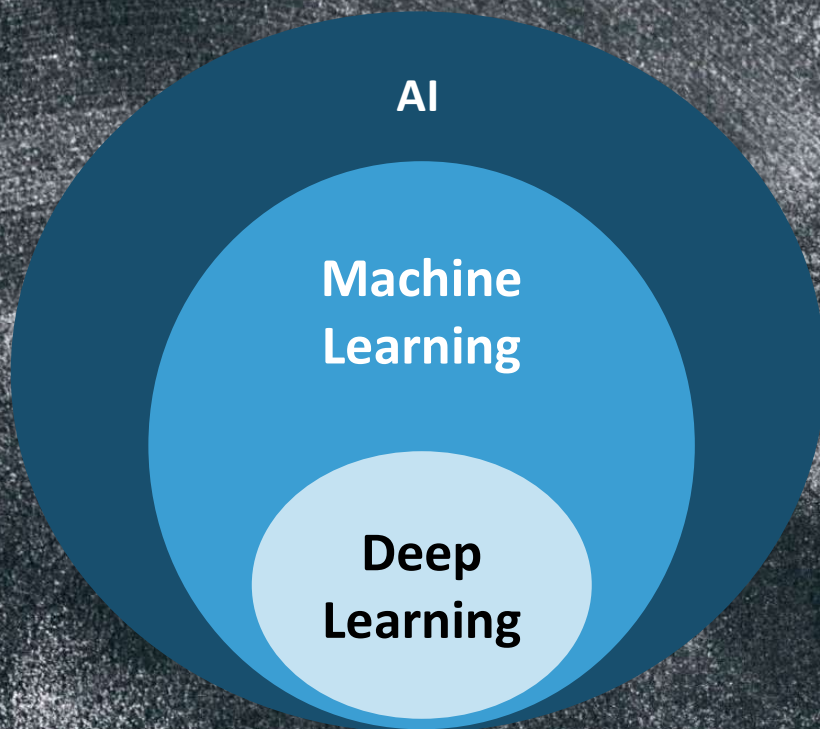
Definition

Leading AI textbooks define the field as the study of "intelligent agents": any device that perceives its environment and takes actions that maximize its chance of successfully achieving its goals[4]

Machine learning (ML) is the study of computer algorithms that improve automatically through experience and by the use of data.[3]

Real life AI Applications.

Chatbots

"Old" chess computers

Real life ML Applications.

The recommendation algorithm Netflix uses

Google Maps estimated time of arrival

Image recognition

QUIZ

Insight, when people talk of AI…

They often mean machine learning

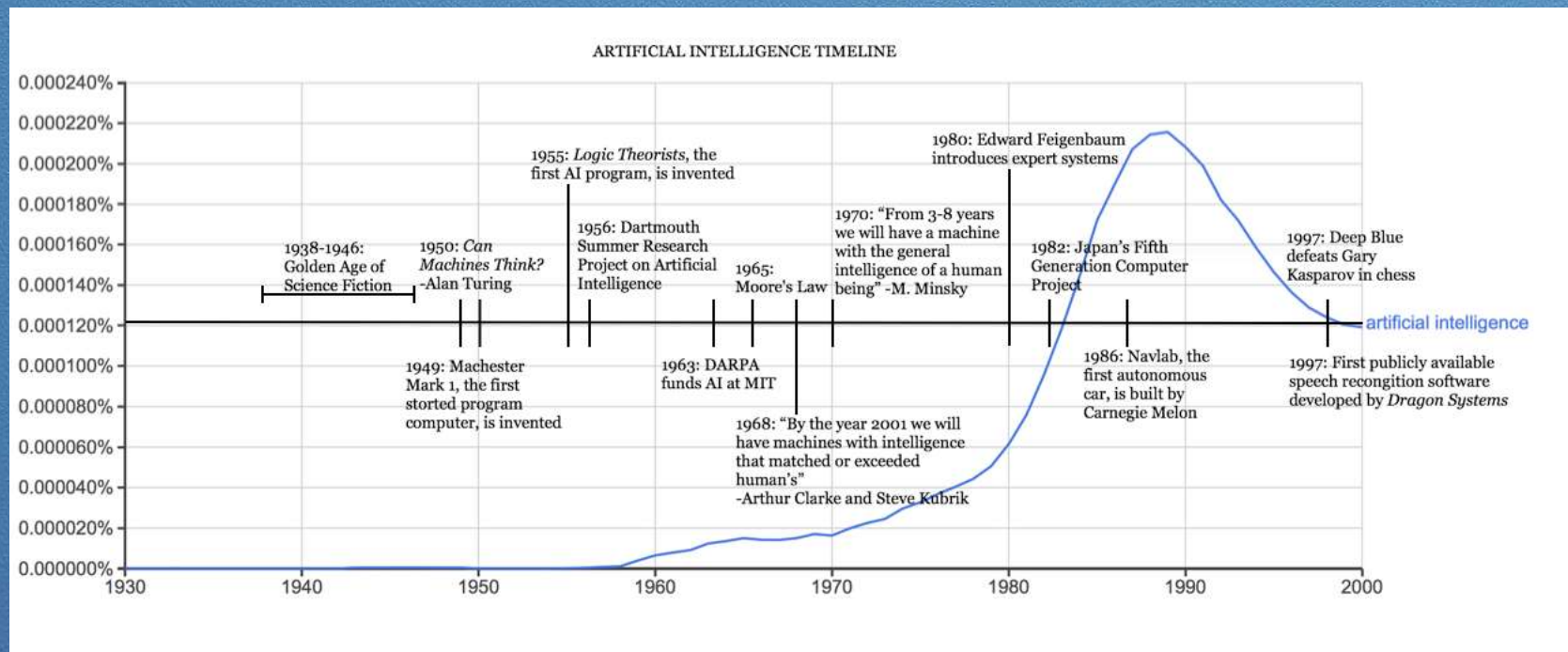'I was terrible at crosswords so I built
an AI to do them'

Poisoned Penne

Crosswords may seem like a strange thing to task AI with solving but in fact
they represent a very fertile playground for machine learning.

Example above from BBC

AI and Machine Learning: an overview

Why now?

ARTIFICIAL INTELLIGENCE TIMELINE

6* (sourced 2021) https://sitn.hms.harvard.edu/flash/2017/history-artificial-intelligence/

AI and machine learning: an overview

Why now?

GPU release sale price / SP FLOPS over Time

Figure 2. https://aiimpacts.org/2019-recent-trends-in-gpu-price-per-flops/
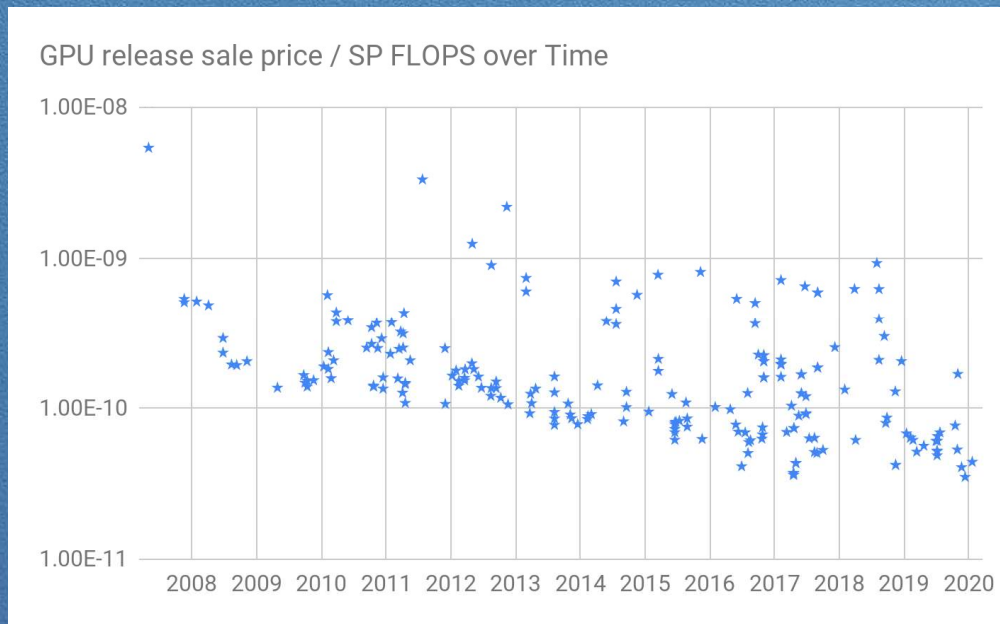
Average Real $ / GB of DRAM
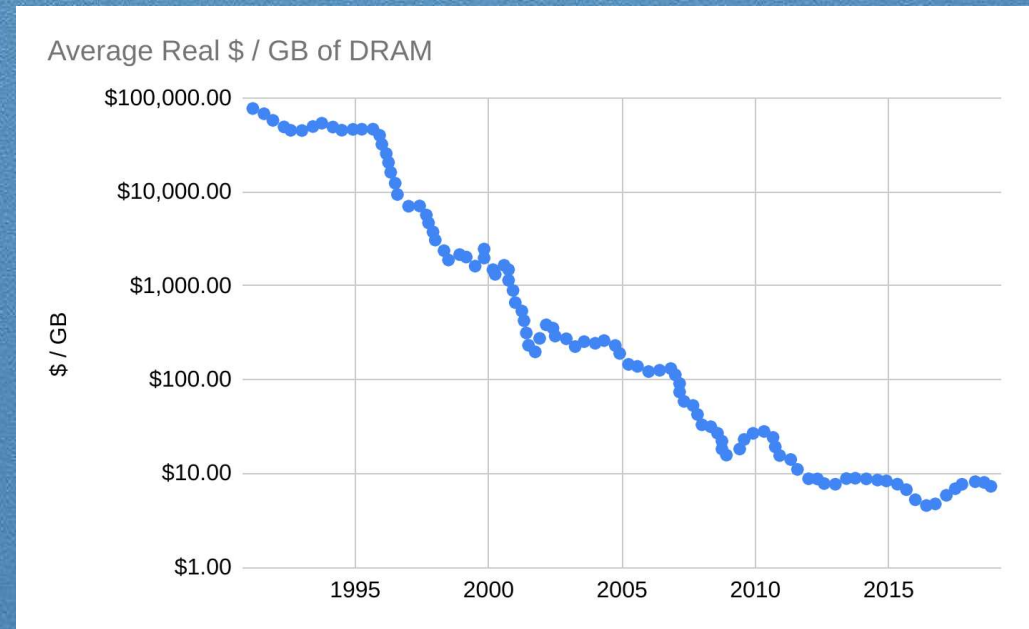
Figure 2. Average $ / GB of DRAM from 1991 to 2019 according to Objective Analysis. Dollars are 2020 dollars

AI and machine learning: an overview

Why now?

Computational power + Data
= ???

Machine learning:

Basic assumption: there are patterns in data

Find the curve that describes your data

At it's most basic the problem you are trying to solve is to find the curve that best describes your data.

In theory every case where there is a pattern between some input variables and a output variables machine learning could be the **tool** of choices

In the simplest form

Fit the line

One of the simplest cases thinkable is one where you are trying to predict a variable Y based on a input variable X
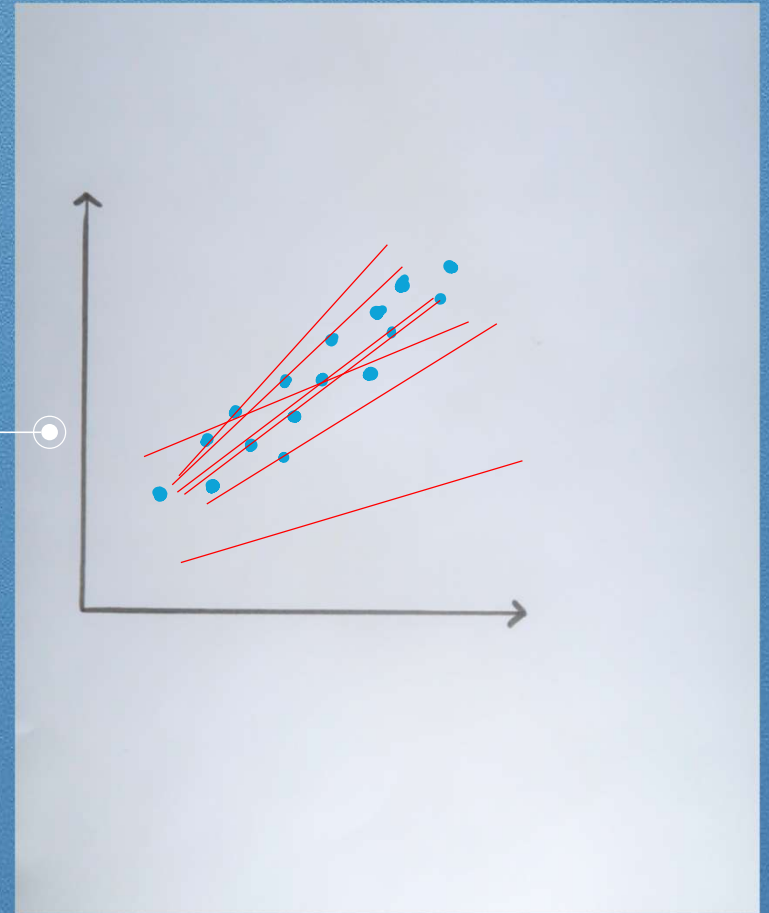
Machine learning is no mystery. It's just quite computational and data heavy

GPT3: one of the most advanced
3.14E23 FLOPS of computing for **training**
≈ 23527 years on a Intel Core i5-9500

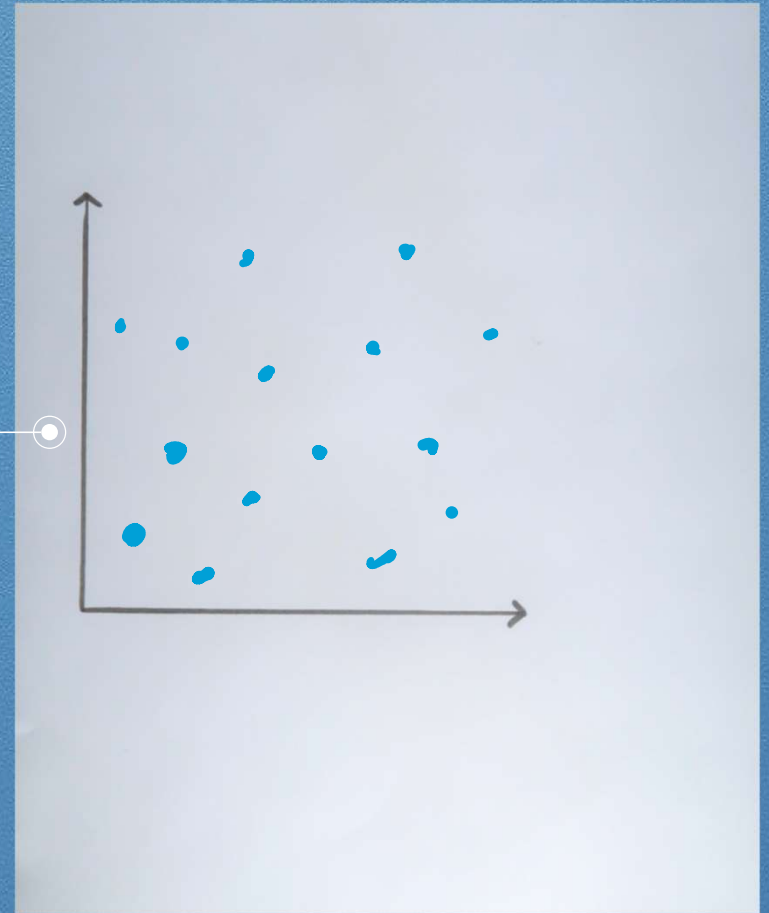Machine learning: when to use

Explainable

Predictive

When to use

☐ You cannot write exact rules

☐ There is an connection between X&Y

☐ You have enough data

☐ You want predictive power over explainability

☐ You have a problem that's worth solving

QUIZ

Decision making:
rule of thumb when not to use

$Y \perp\!\!\!\perp X$

It's not always true that two variables depended on each other. If you have a dataset where there is no pattern between them. machine learning is not the way forward.
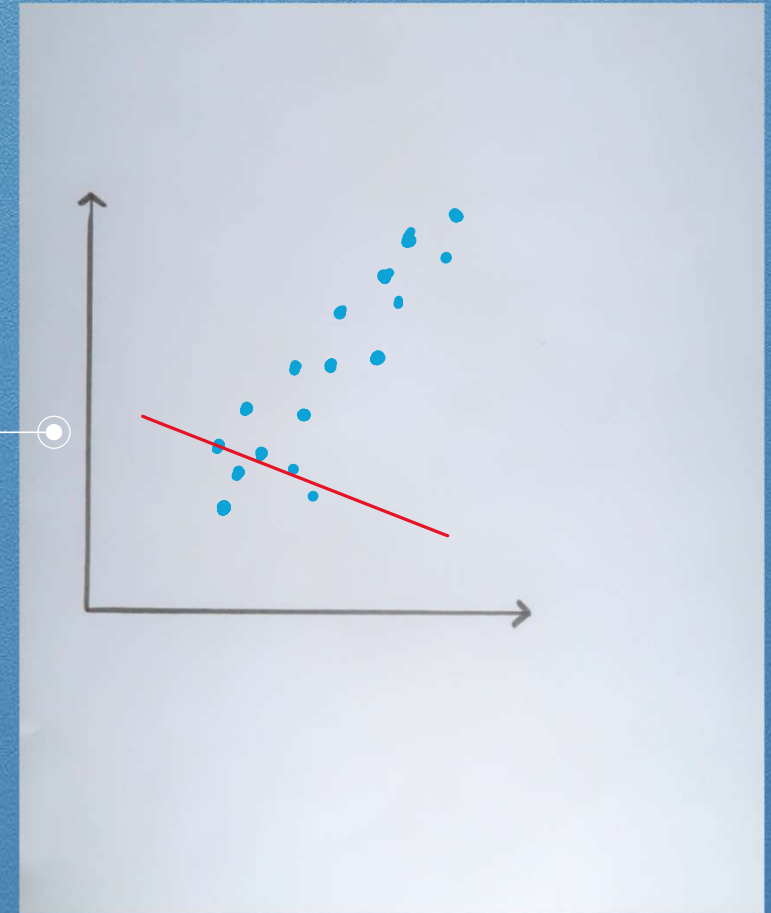
Decision making:
rule of thumb when not to use

To small dataset

If you have a too small dataset this makes it much harder for the algorithm to generalize. Keep in mind that machine learning is a process of induction. The model can only capture what it has seen.
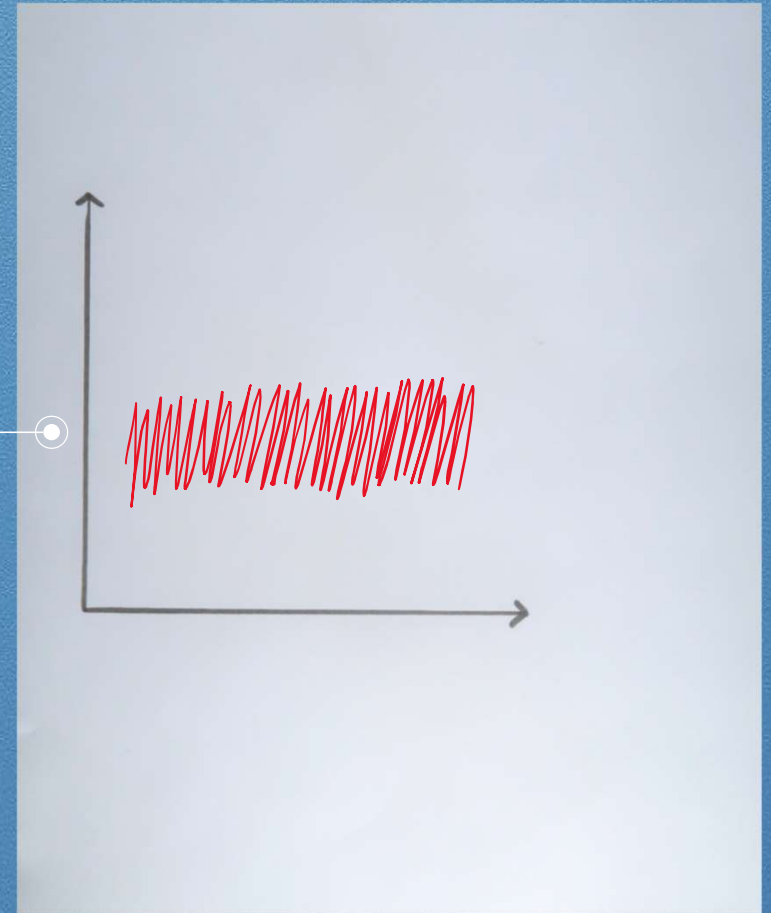
Solution: gather more data

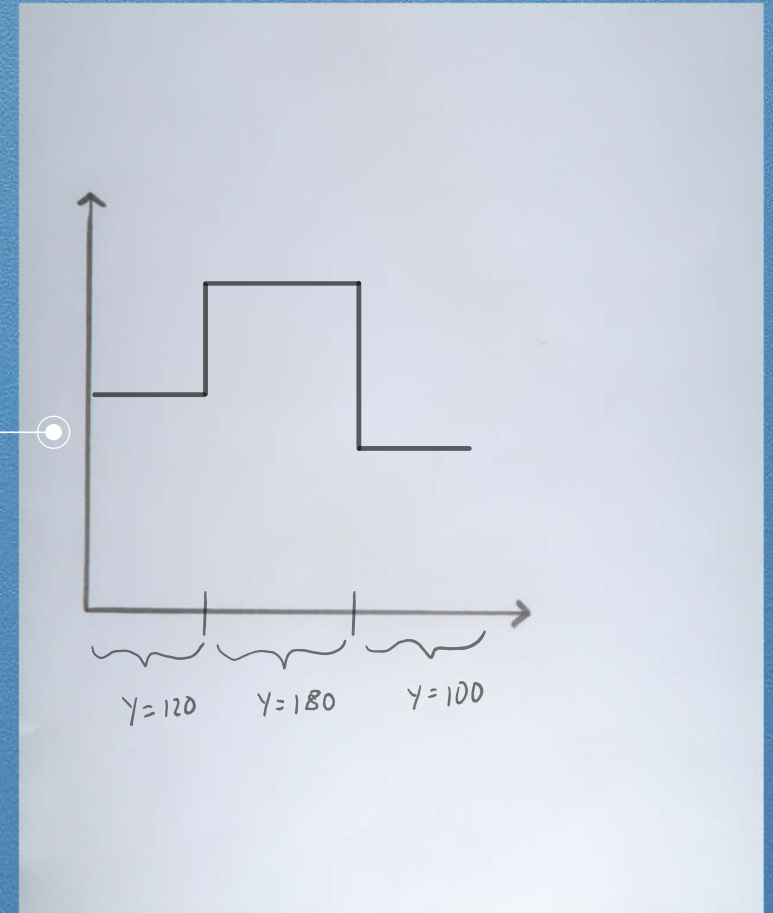# Decision making
rule of thumb when not to use

Noisy data

Noisy data are data that is corrupted, or distorted, or has a low Signal-to-Noise Ratio. This means that it's quit probable that the algorithm won't generalize very well.

Decision making
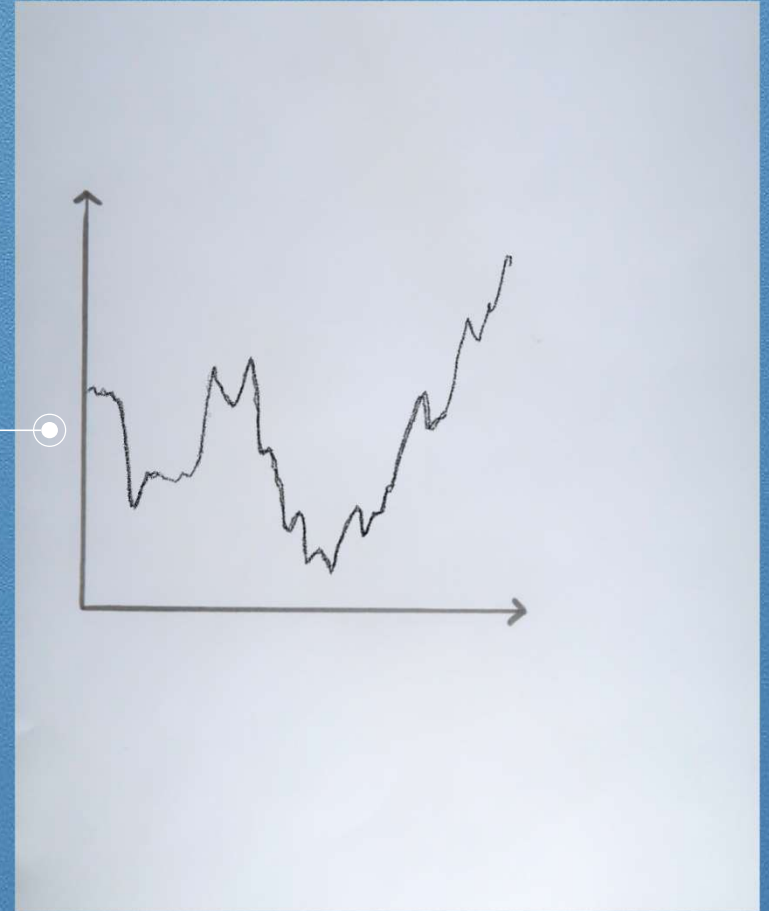# rule of thumb when not to use

A few exact rules

If you can state your problem in a way that is strictly logical. Then use logic instead. However if the rules becomes to many than machine learning might be a viable tool

Decision making
rule of thumb when not to use

Nonstationary

If your data is not a useful window into tomorrow's world. ML is probably not the right way to go
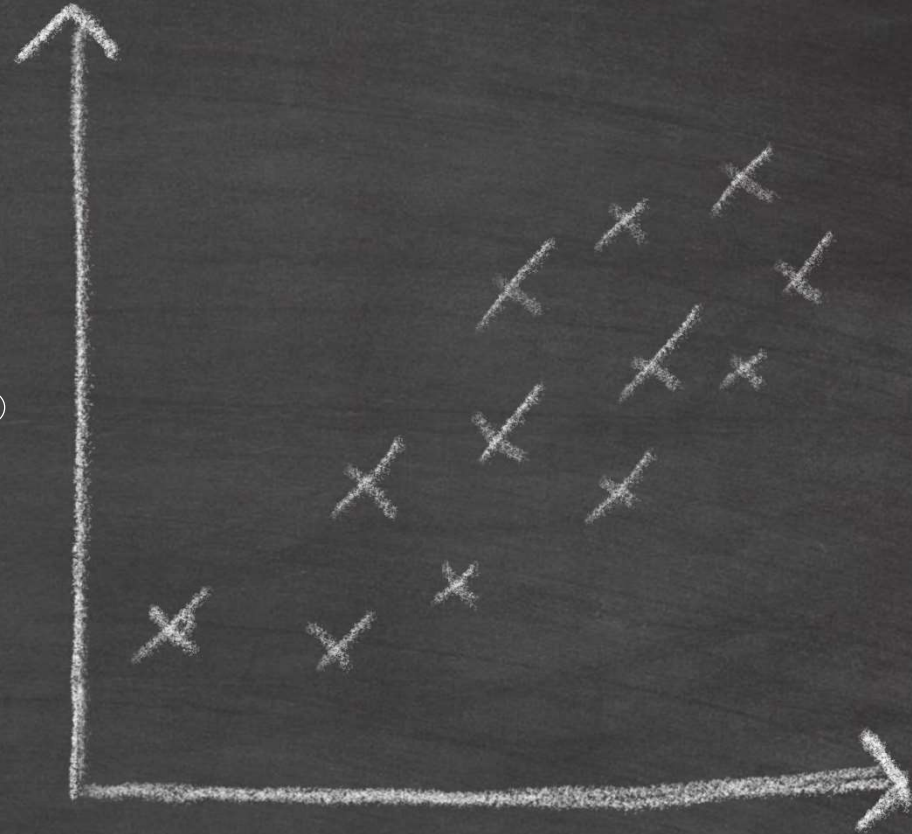
Break

QUIZ

Different approaches are used for different problems

Regression

Continues values

If you can state your problem in a way that you want a continues variable as your answer you're likely dealing with a regression problem.

Example you want to predict the value of an apartment based on it's size, number of rooms, etc.

Classification

Separate classes

If you state your problem in a way that you want an category as an answer you are likely dealing with a classification problem.

Example, P - is this a high risk customer or low risk customer? Use purchases order history, age etc to predict the outcome.
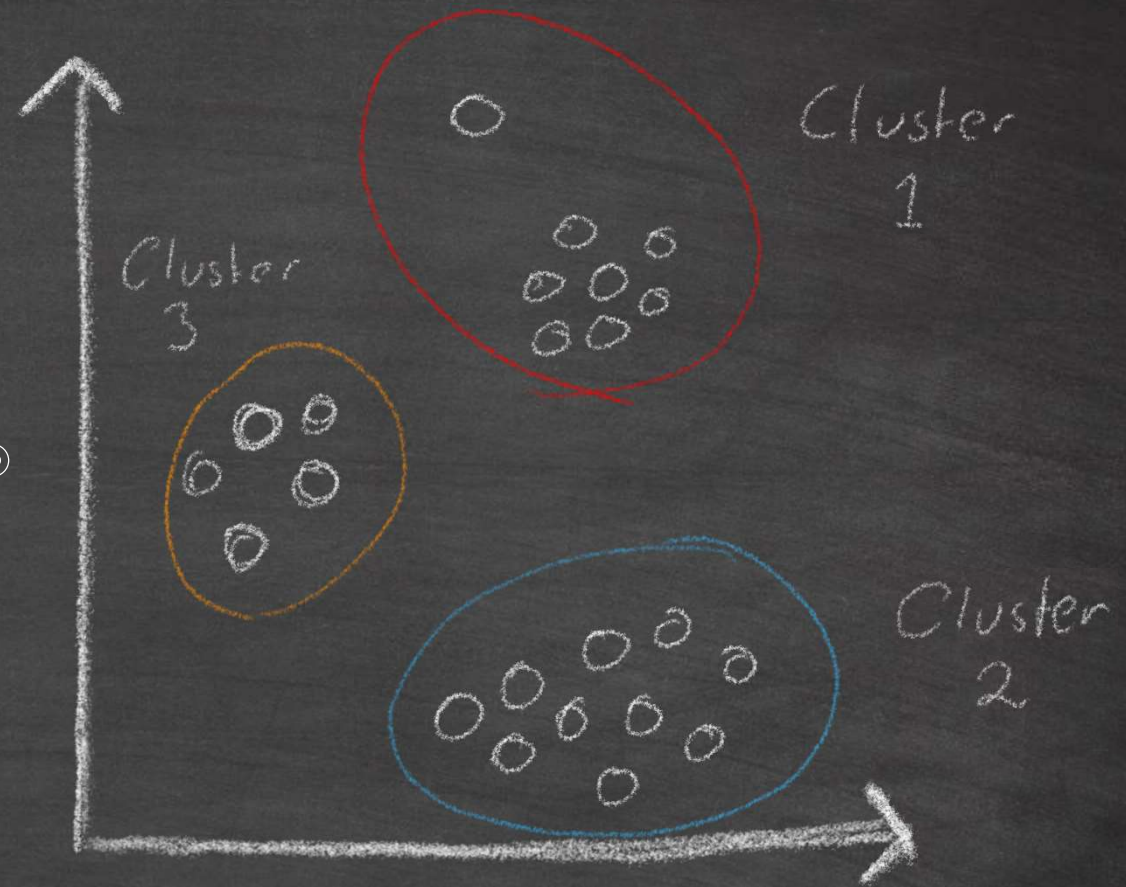
Clustering

Find patterns in data

If you state your problem in a way that you want the answer to be this data points has most in common.

Example, P – Which components in your operations management system has the most similar characteristics. Base weight, material, use etc for prediction
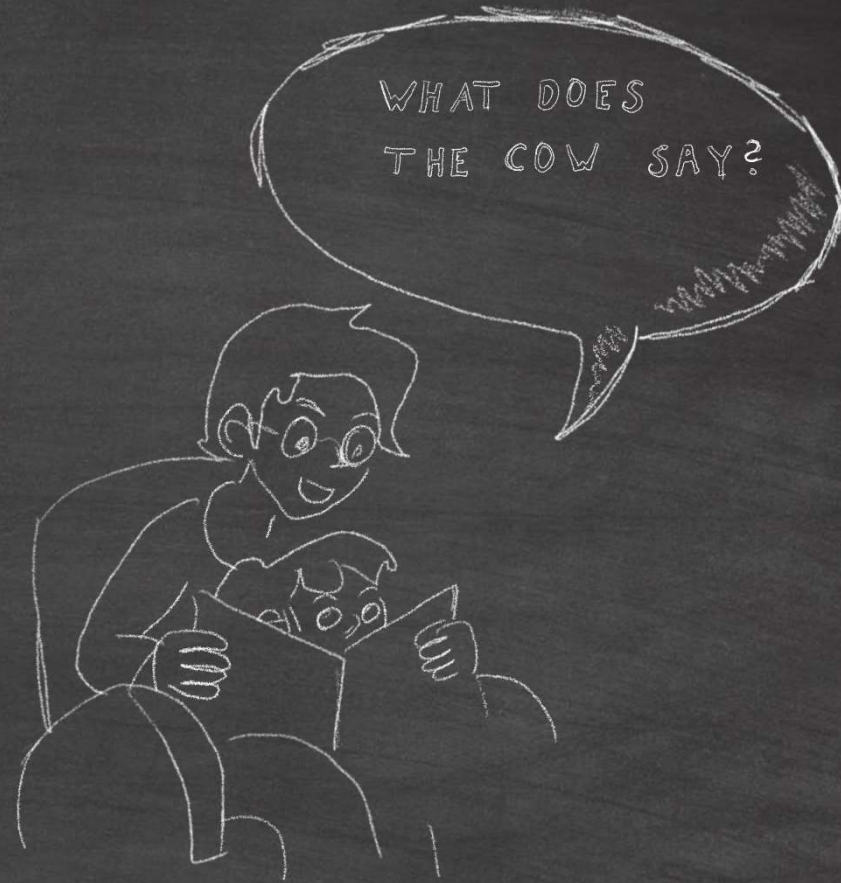
Different learning techniques
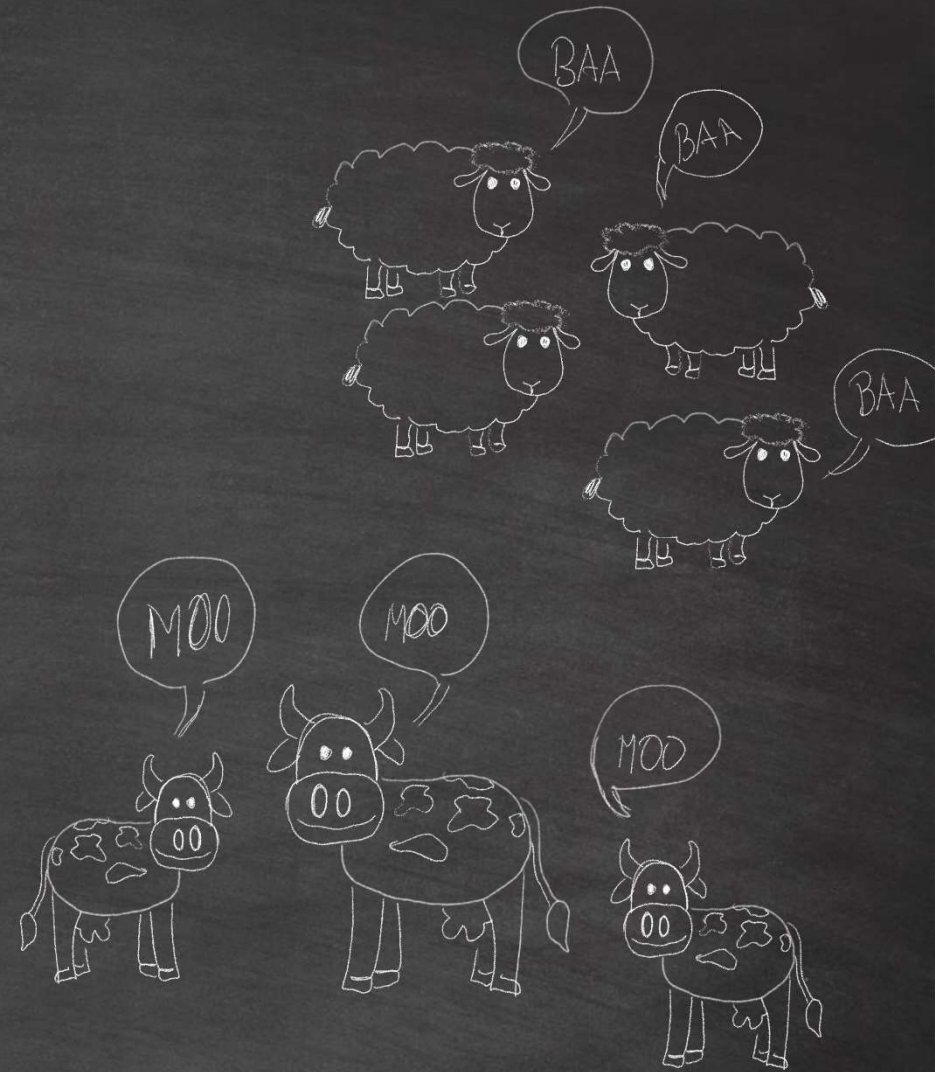
Supervised Learning

You want to map input to output

Unsupervised

You want to find patterns in the data structure

Reinforcement learning

Agents take <u>actions</u> in an environment in order to maximize the notion of cumulative reward

Machine learning in operations management

Case 1

Predictive maintenance

Machine learning in Inventory management

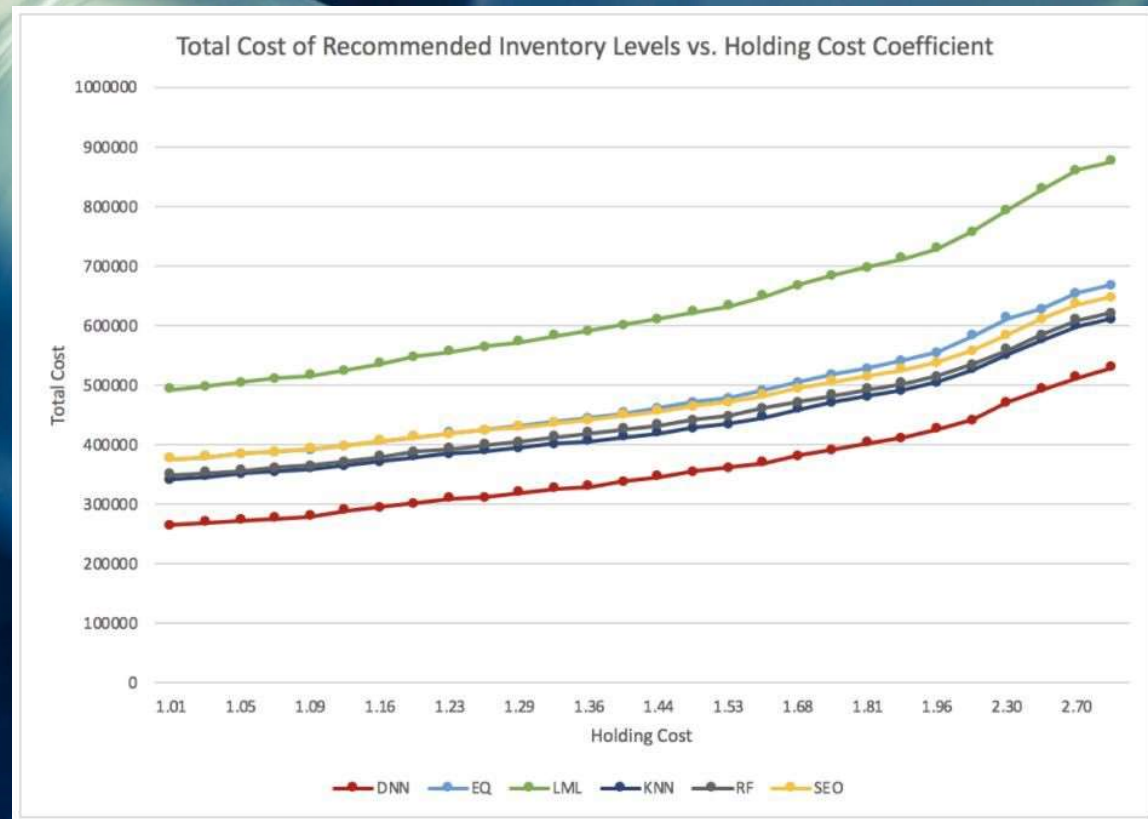# Case 2

PRODUCT TRACKING

Machine learning in Inventory management

Case 3

STOCK PREDICTION

Total Cost of Recommended Inventory Levels vs. Holding Cost Coefficient

Machine learning in Warehouse management

Case 4

STOCK PREDICTION

SUMMARY

Machine learning is an increasingly important area.

It is a highly flexible tool that can be applied in a vast variety of situations

It's important to understand when to and why AI and ML should be applied so that you can take the best decisions for your organisation.

THANKS!

Machine learning in production logistics

https://towardsdatascience.com/optimization-of-a-weekly-production-plan-with-python-and-gurobi-part-1-d1257ad29a9

https://hackernoon.com/five-successful-ai-and-ml-use-cases-in-manufacturing-ac3a30ol

https://idapgroup.com/blog/machine-learning-in-logistics-and-supply-chain/

•Automating quality testing using machine learning is increasing defect detection rates up to 90%.
Reducing supply chain forecasting errors by 50% and lost sales by 65% with better product availability is achievable with machine learning.

https://www.sciencedirect.com/science/article/pii/S036083522030485X

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Machine learning in production logistics

https://vas3k.com/blog/machine_learning/

Source
1* (Gartner, 2021) https://www.gartner.com/smarterwithgartner/5-trends-drive-the-gartner-hype-cycle-for-emerging-technologies-2020/
2* (IBM, 2021) https://www.ibm.com/cloud/blog/ai-vs-machine-learning-vs-deep-learning-vs-neural-networks

3* *Mitchell, Tom* (1997). *Machine Learning*. New York: McGraw Hill. *ISBN* *0-07-042807-7*. *OCLC* *36417892*.
4* (Wikipedia 2021) https://en.wikipedia.org/wiki/Artificial_intelligence

5* https://www.bbc.com/news/technology-56934716

6* (sourced 2021) https://sitn.hms.harvard.edu/flash/2017/history-artificial-intelligence/

7* MIT 2021 https://www.technologyreview.com/2019/11/11/132004/the-computing-power-needed-to-train-ai-is-now-rising-seven-times-faster-than-ever-before/

8* (hämtad 2021) https://towardsdatascience.com/introduction-to-machine-learning-algorithms-linear-regression-14c4e325882a

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