Machine Learning (IN2064)

Lecture 1: Introduction

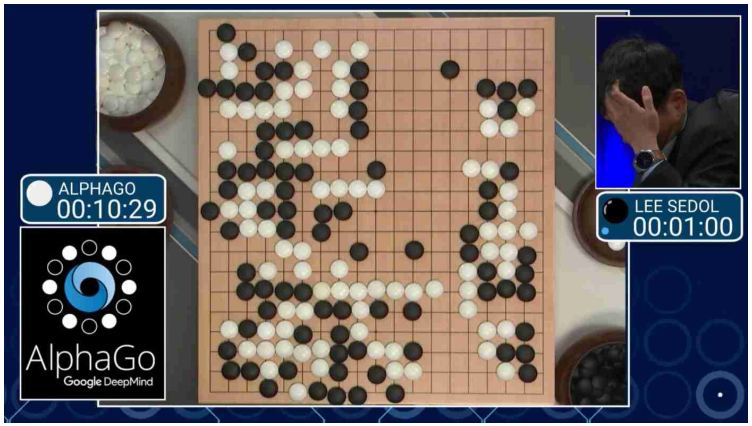
Prof. Dr. Stephan Günnemann

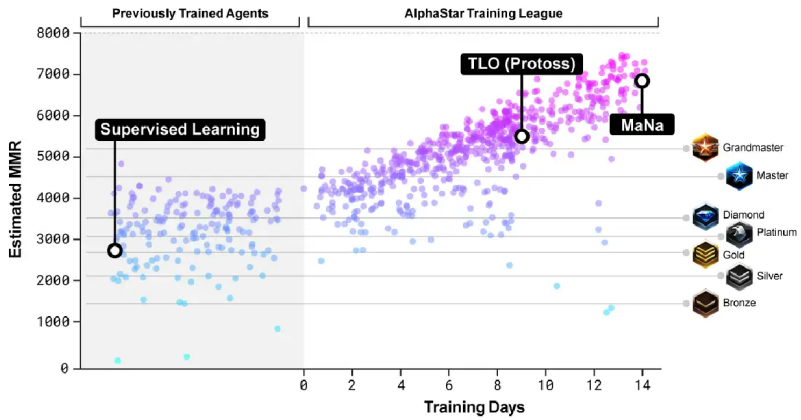
Data Analytics and Machine Learning
Technical University of Munich

www.cs.cit.tum.de/daml/

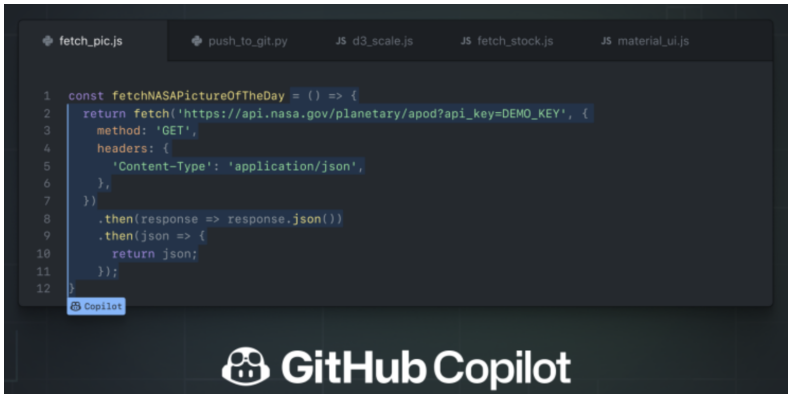
Winter term 2022/2023

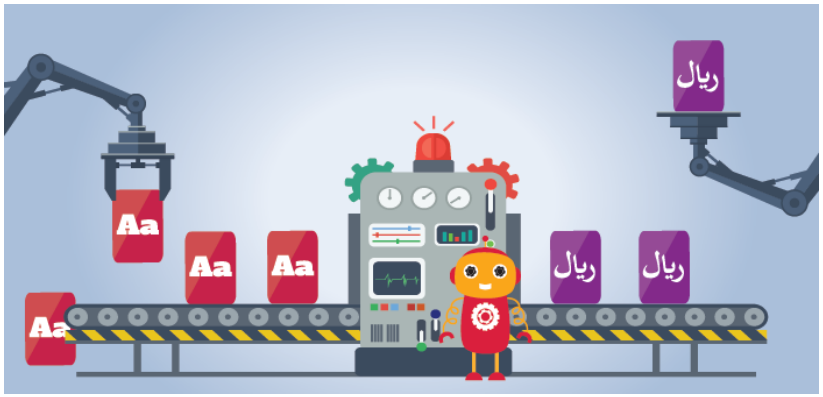
Game playing





Natural language processing



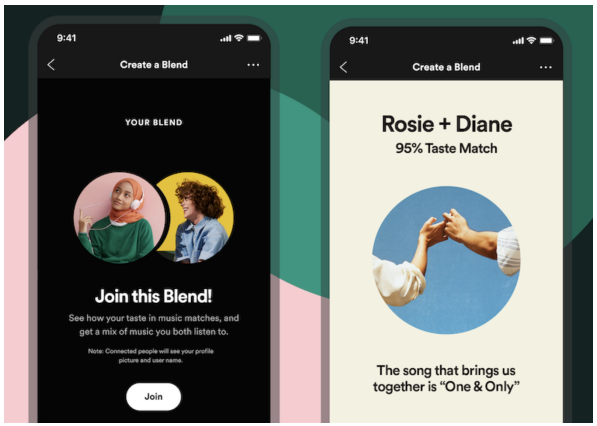


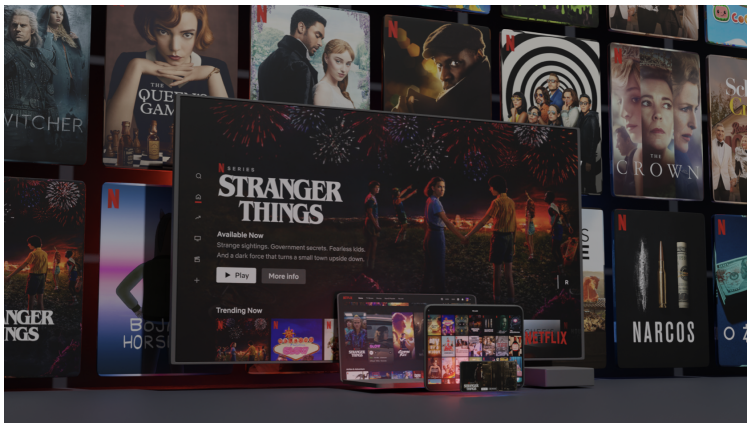
COPYWRITING SUMMARIZATION PARSING UNSTRUCTURED TEXT CLASSIFICATION TRANSLATION

Create promo copy for the FamilyTime mobile application. It allows unlimited uploading, special filters and makes it easy to create albums of photos and videos. It runs on iOS and Android:

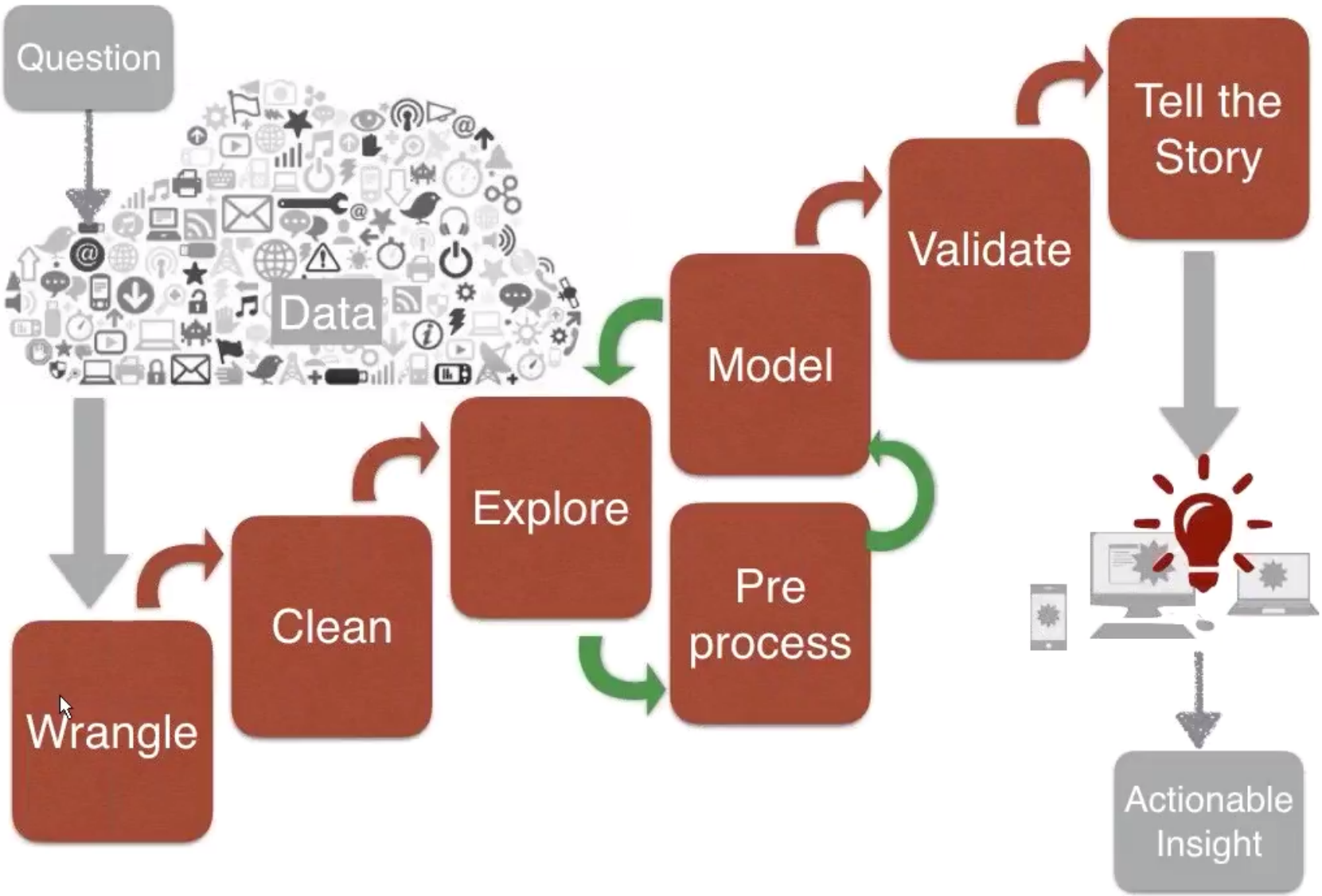
FamilyTime is the perfect app to share and create memories with your family. FamilyTime is a free, unlimited photo and video editor that allows you to create albums of your memories. It has a special filter for the perfect summer look and is so simple to use.

Web, ads and recommendations

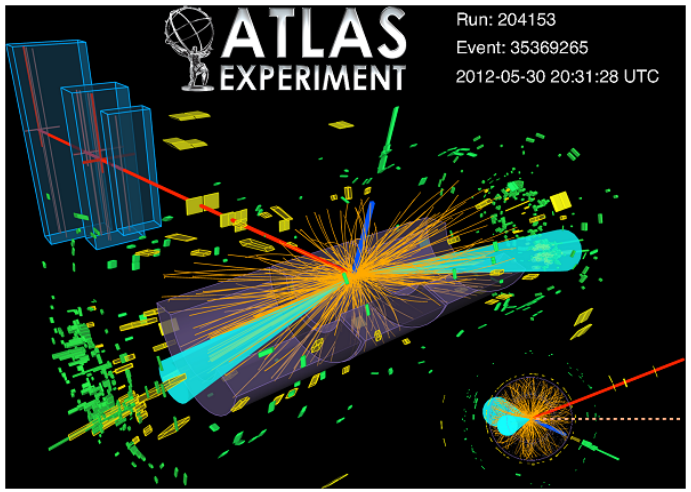


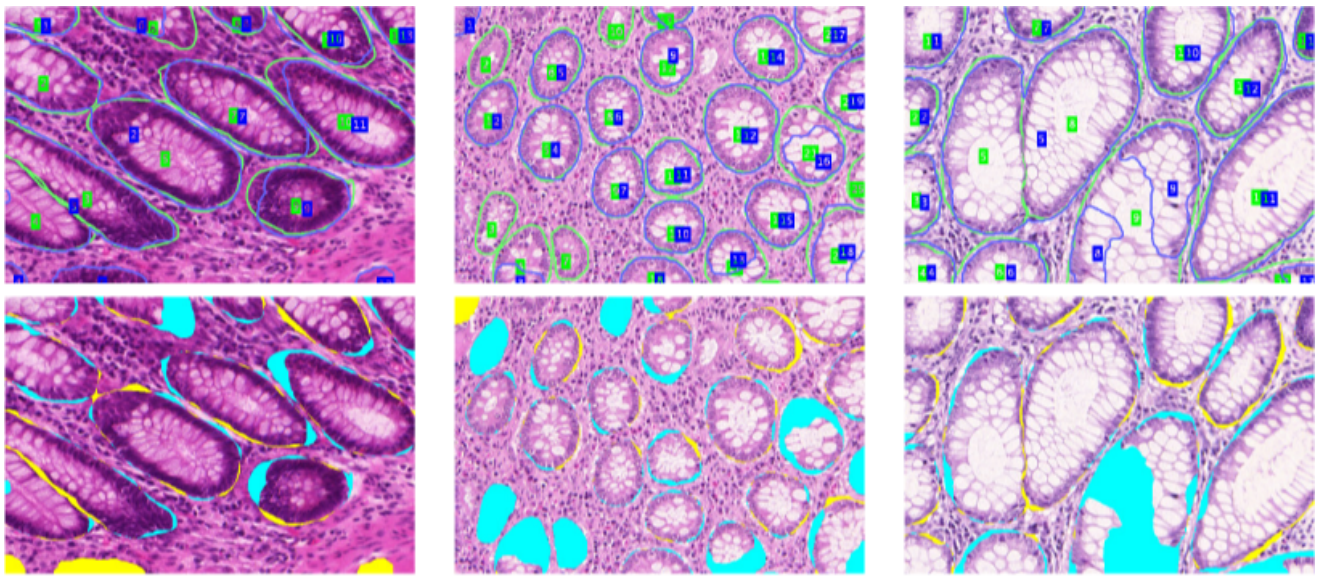


Data science



Physics, biology and medicine





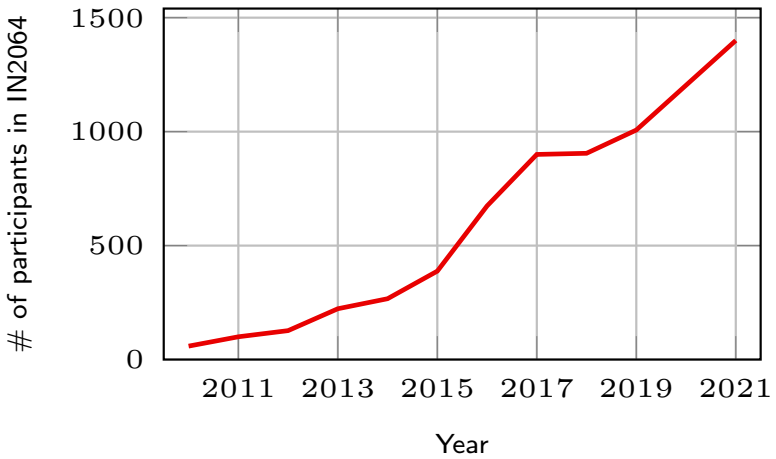
(d) benign (e) benign (f) malignant

What unites all these technologies?

- Computer vision
- Natural language processing
- Recommender systems
- Computational advertising
- Robotics
- Artificial intelligence
- Data science
- Bioinformatics
- Many other fields

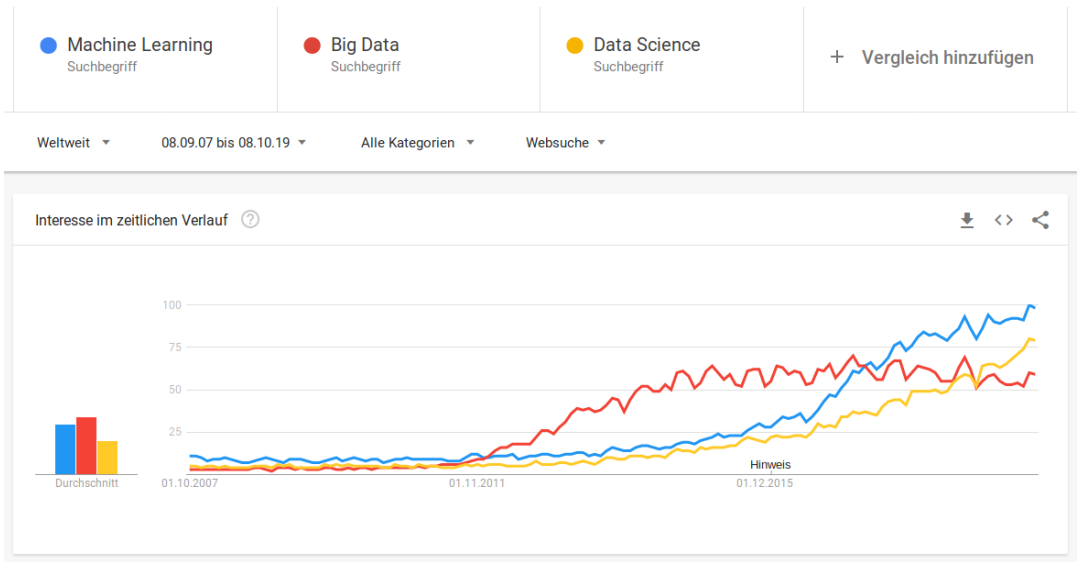
} All are using Machine learning

Hot topic


# of participants in IN2064
1500
1000
500
0
2011
2013
2015
2017
2019
2021
Year


Science
AAAS
SPECIAL ISSUE
ARTIFICIAL
INTELLIGENCE


nature
At last — a computer program that can beat a champion Go player
ALL SYSTEMS GO
SONGBIRDS A LA CARTE
SAFEGUARD TRANSPARENCY
WHEN GENES GOT 'SELFISH'

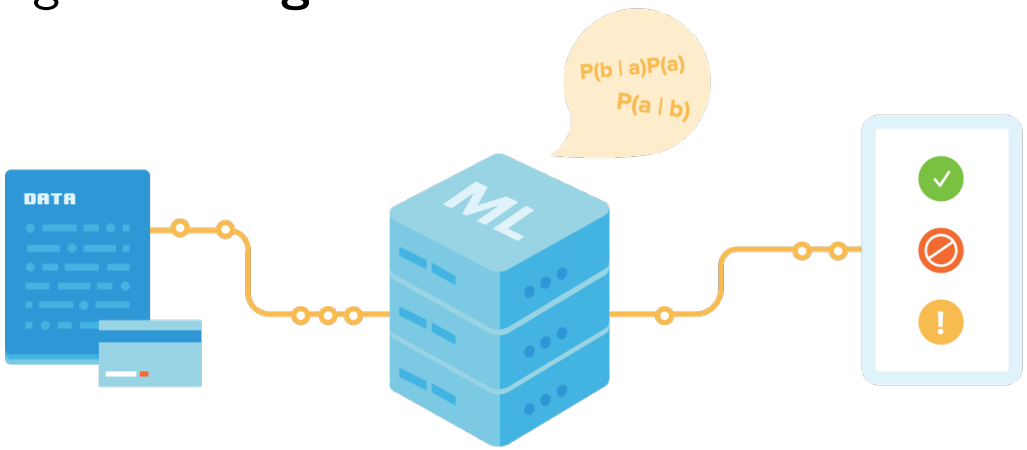

Machine Learning
Suchbegriff
Big Data
Suchbegriff
Data Science
Suchbegriff
Vergleich hinzufügen
Weltweit
08.09.07 bis 08.10.19
Alle Kategorien
Websuche
Interesse im zeitlichen Verlauf
100
75
50
25
Durchschnitt
01.10.2007
01.11.2011
01.12.2015
Hinweis

What is Machine Learning?

Simple example - classify transactions into legitimate and fraudulent.

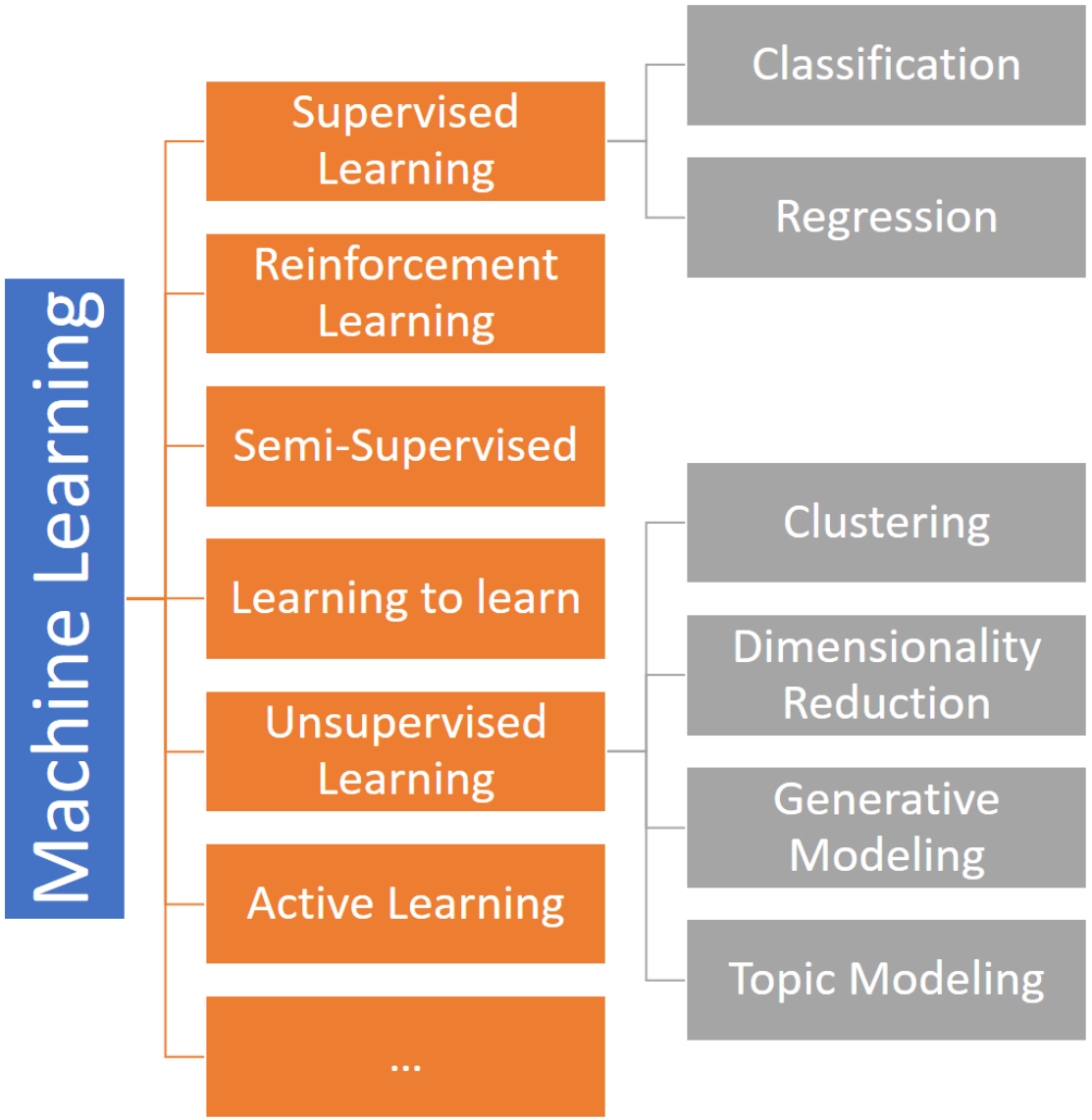
Rule-based approaches - **rules** handcrafted by human experts

Machine learning - **learning from data**



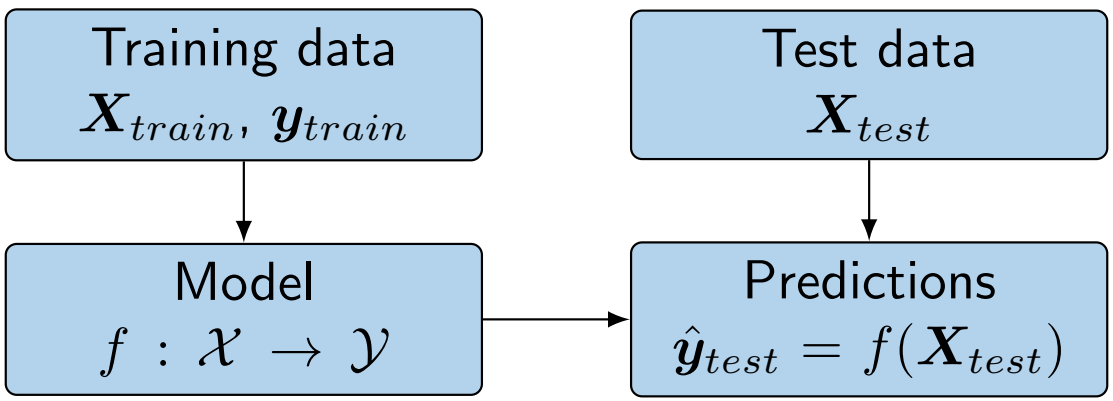
Figures adapted from https://siftscience.com/sift-edu/prevent-fraud

Types of ML problems



Supervised learning

- Given training samples $\boldsymbol{X}_{train} = \{\boldsymbol{x}_1, ..., \boldsymbol{x}_N\} \subseteq \mathcal{X}$
- with corresponding targets $\boldsymbol{y}_{train} = \{y_1, ..., y_N\} \subseteq \mathcal{Y}$
- Find a function f that generalizes this relationship, i.e. $f(\boldsymbol{x}_i) \approx y_i$.
- Using f, make predictions $\hat{\boldsymbol{y}}_{test}$ for the test data $\boldsymbol{X}_{test}$.



Supervised learning: Classification

If the targets y_i represent categories, the problem is called classification.

Examples

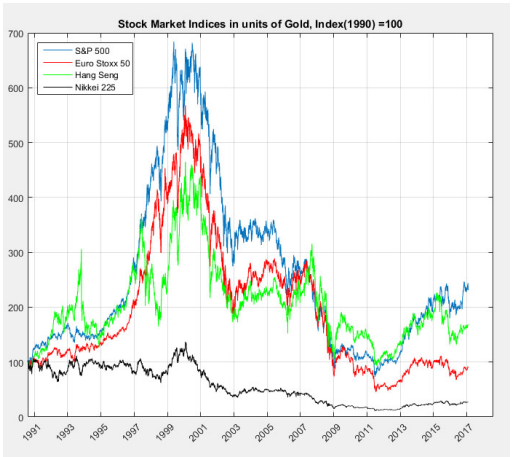
- Handwritten digit recognition
- Transaction classification (fraud, valid)
- Object classification (cat, dog, hotdog, ...)
- Cancer detection

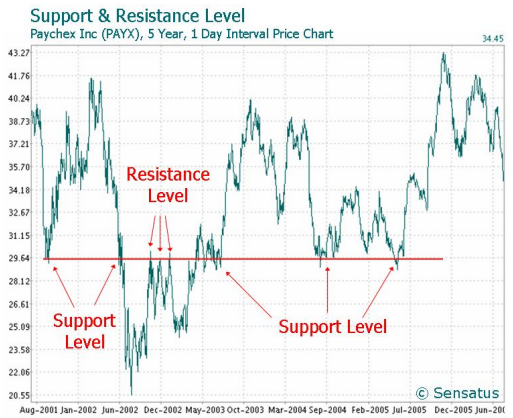
Supervised learning: Regression

If the targets y_i represent continuous numbers, the problem is called regression.

Examples

- Stock market prediction
- Demand forecasting
- User involvement measurement
- Revenue analysis



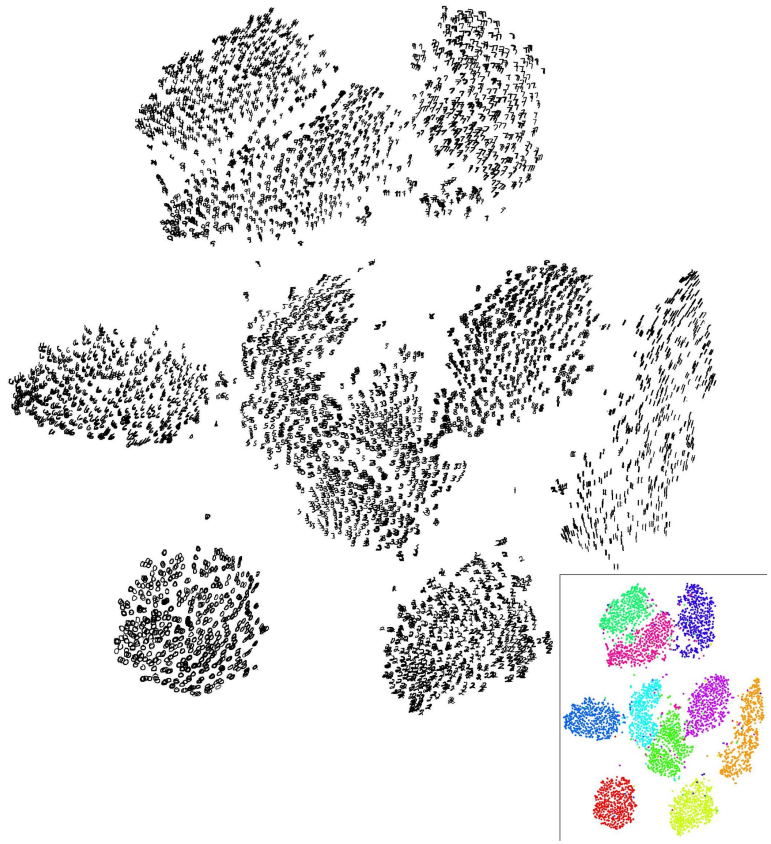


Unsupervised learning

Unsupervised learning is concerned with finding structure in unlabeled data.

Typical tasks

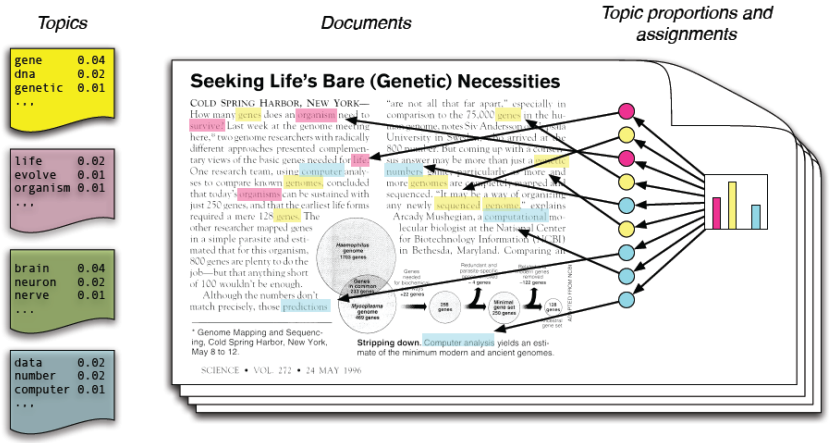
- Clustering
  - Group similar objects together
- Dimensionality reduction
  - Project down high-dimensional data



Unsupervised learning

Typical tasks - continued

- Generative modeling
  - (Controllably) generate new "realistic" data
- Topic models
  - Discover hidden semantic structures in text.



TEXT PROMPT an armchair in the shape of an avocado. . . .

AI-GENERATED IMAGES

Edit prompt or view more images↓

Other categories

- Reinforcement learning
  - Learning by interacting with a dynamic environment. Goal is to maximize rewards obtained by performing "desirable" actions.
- Semi-supervised learning
  - Learning to combine lots of unlabeled data with a few labeled examples for further prediction tasks.
- Active learning
  - Learn while obtaining labels by querying an oracle.
- Learning to learn (meta-learning)
  - Learning to construct better models for ML. Operates one level above the standard ML techniques.
- Learning to rank
  - What are the relevant items for a given query? (e.g. Netflix, web search, ad placement)
- And many more...

General information

Staff

- Lecturer: Prof. Dr. Stephan Günnemann
- Teaching assistants:
  Marin Bilos, Nicholas Gao, Simon Geisler, Lukas Gosch, Jan Schuchardt, Johanna Sommer
- Group website: `www.cs.cit.tum.de/daml/`

Details

- 8 ECTS, Language - English
- Open for both Bachelor and Master students
- Doesn't count for Wirtschaftsinformatik (Information Systems) students
- Doesn't stack with IN2332 in your curriculum

Piazza

- Register at `http://piazza.com/tum.de/fall2022/in2064`
  Access code: `ml2022`
- All announcements will be made on Piazza.
- All course material will be uploaded to Moodle.
- You will miss important information if you don't register.

Use Piazza to ask questions - your emails will likely not be answered.

Schedule & Logistics

- Lecture slides, lecture video and exercise sheet for topic of week N are uploaded before Monday of week N.
- Monday & Tuesday: lecture for week N
- Wednesday morning: Q & A for week N
- Wednesday afternoon: exercise for week $N-1$
- Exercise solutions are published on Moodle.

Grading

Exam

- Written final exam, probably in February
- Most likely in-person exam
- 120 minutes
- One handwritten two-sided A4 sheet with notes

Planned weekly schedule

Week	Date	Topic
1	Oct 17	Introduction, basic concepts
2	Oct 24	k-nearest neighbors, decision trees
3	Oct 31	Probabilistic inference
4	Nov 7	Linear regression
5	Nov 14	Linear classification
6	Nov 21	Optimization
7	Nov 28	No Lecture
8	Dec 5	Deep learning 1
9	Dec 12	Deep learning 2
10	Dec 19	Support Vector Machines
11	Jan 9	Dimensionality Reduction 1
12	Jan 16	Dimensionality Reduction 2
13	Jan 23	Clustering
14	Jan 30	Buffer

Contents

- This is an introductory, theoretical Machine Learning course
  - There will be a fair amount of theory and mathematics
  - We will focus on fundamental Machine Learning concepts
  - We will mostly discuss independent (iid) data

- Next semester, we will cover (even) more advanced topics (IN2323)
  - Generative models
  - Robustness
  - Sequential data
  - Graphs & networks
    - $\rightarrow$ These are the core research topics of our group :-)

What this course is not about

- This is not a pure Deep Learning course
  - look at IN2346, IN2349 instead
- This is not a course about Big Data (Hadoop, etc.)
  - look at IN2326 instead
- This is not an applied Data Science / Business Analytics course
  - look at IN2028, IN2339 instead

Recommended reading

Our official reading recommendation:

- Christopher M. Bishop, *Pattern Recognition and Machine Learning*. Springer, Berlin, New York, 2006 (free, online version available).

but we also like:

- Kevin Murphy, *Machine Learning: A probabilistic perspective*. MIT Press, 2012.

What's next?

Brush up on your linear algebra, calculus, and probability theory knowledge.

Read

- `http://cs229.stanford.edu/section/cs229-linalg.pdf`
- `http://cs229.stanford.edu/summer2020/cs229-prob.pdf`
- Bishop [ch. 1.2.0 - 1.2.3, 2.1 - 2.3.0]
- Solve the math refresher (exercise sheet 1)