Applied AI in Python

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Artificial Intelligence

"Computer systems that have some of the qualities that the human brai n has, such as the ability to understand and produce language, recogniz e or create pictures, solve problems, and learn; the study or creation of systems"

— Cambridge Dictionary

"Defining AI is not easy; in fact, there is no generally accepted definition of the concept …

In its strictest definition, AI stands for the imitation by computers of the intelligence inherent in humans ….

AI is that it is a technology that enables machines to imitate various complex human skills. This, however, does not give is much to go on … "

— Mission AI. Springer

"The field of artificial intelligence, or AI, is concerned with not just understanding but also building intelligent entities—machines that can compute how to act effectively and safely in a wide variety of novel situations. ...

Some have defined intelligence in terms of fidelity to human performance, while others prefer an abstract, formal definition of intelligence called rationality—loosely speaking, doing the "right thing". "

— Artificial Intelligence: A modern approach

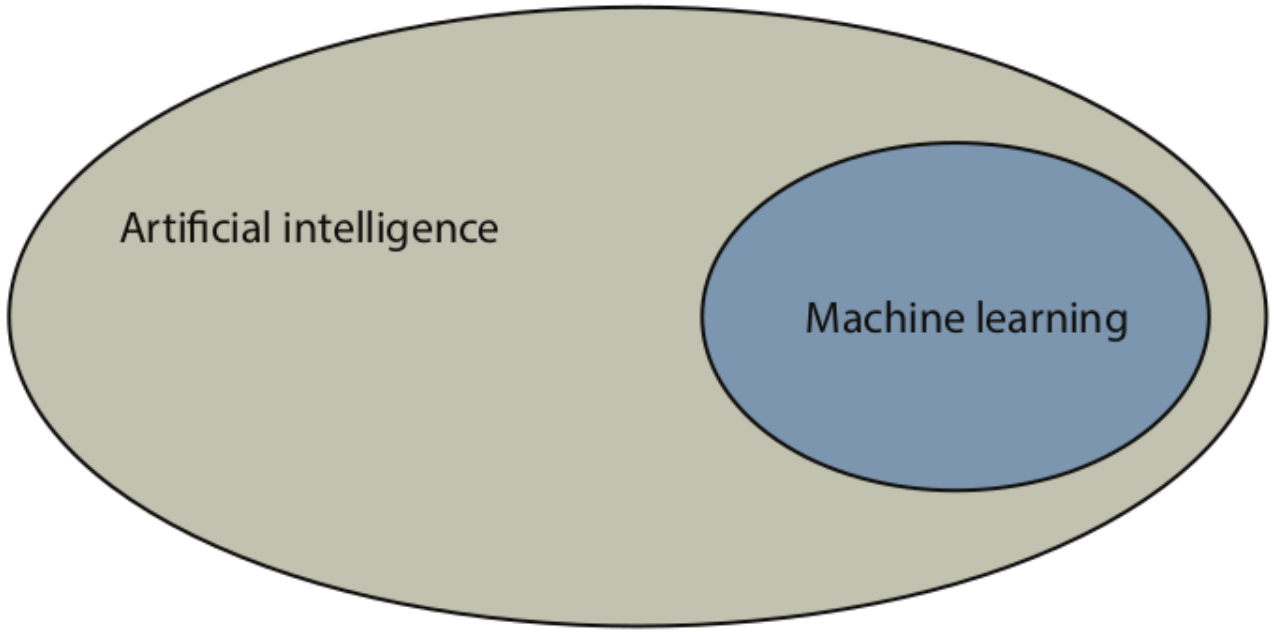

I make decisions based on **experience**.
I make decisions based on **data**.

Artificial intelligence

— The set of all tasks in which a computer can make decisions

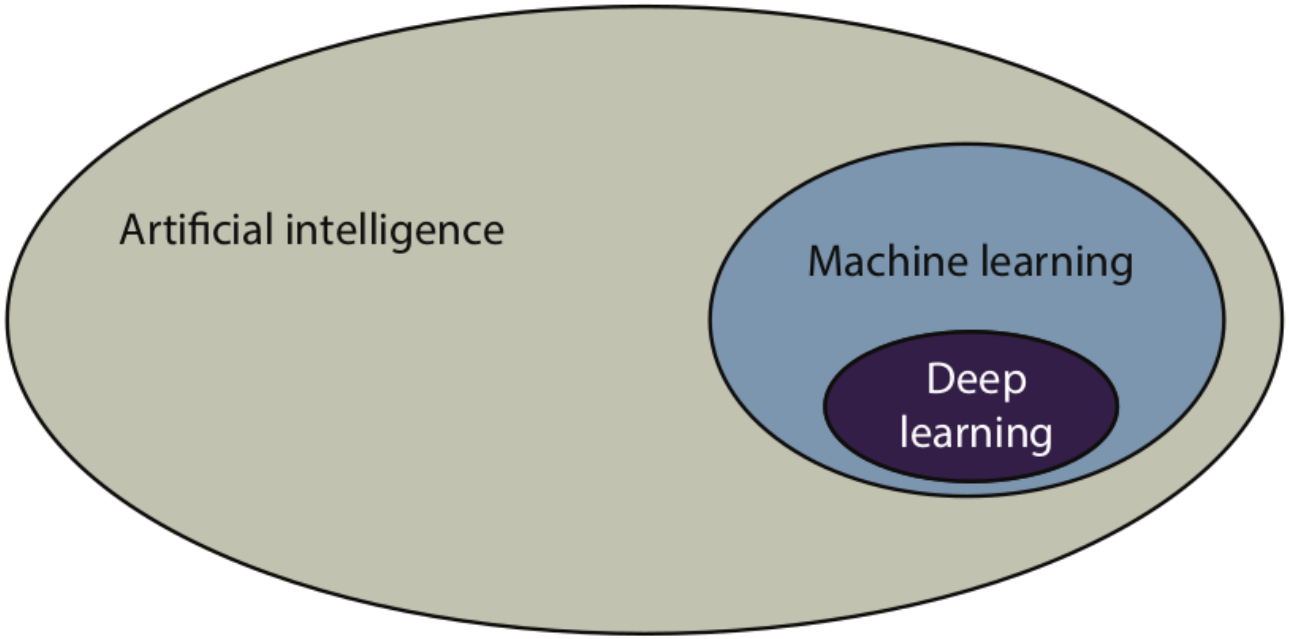
Machine learning

— The set of all tasks in which a computer can make decisions based ***on data***



Deep Learning

— The field of machine learning that uses certain objects called ***neural networks***



The three apps we are recommending

Example #1

Recommender App

Platform	Age	App
iPhone	15	Atom Count
iPhone	25	Check Mate Mate
Android	32	Beehive Finder
iPhone	35	Check Mate Mate
Android	12	Atom Count
Android	14	Atom Count

A dataset with users of an app store. For each customer, we record their platform, age, and the app they downloaded.

Atom Count

Beehive Finder

Check Mate Mate

The three apps we are recommending

Example #1

Recommender App

Platform	Age	App
iPhone	Young	Atom Count
iPhone	Adult	Check Mate Mate
Android	Adult	Beehive Finder
iPhone	Adult	Check Mate Mate
Android	Young	Atom Count
Android	Young	Atom Count

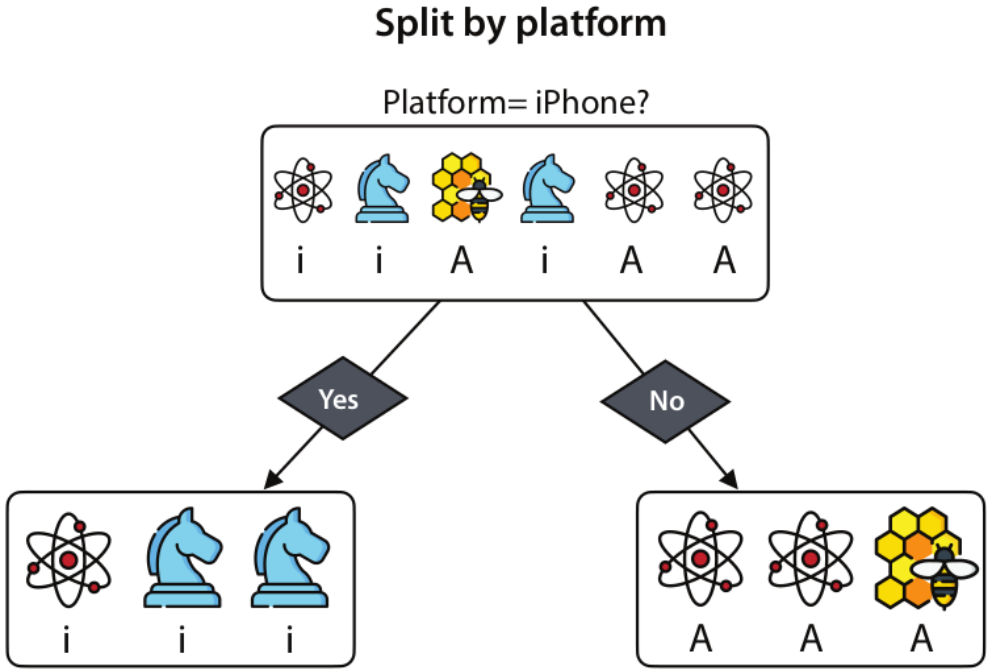
A simplified version of the dataset, where the age column has been simplified to two categories, "young" and "adult"

The three apps we are recommending

Example #1

Recommender App

Question 1:
Does the user use an iPhone or Android?

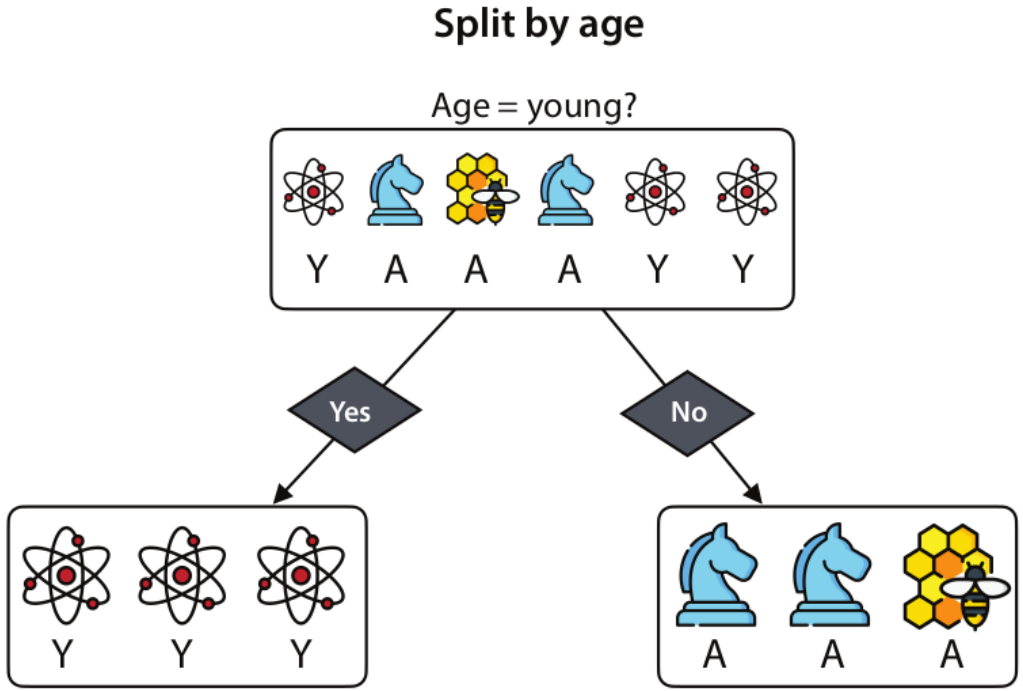


The three apps we are recommending

Example #1

Recommender App

Question 2:
Is the user young or adult?



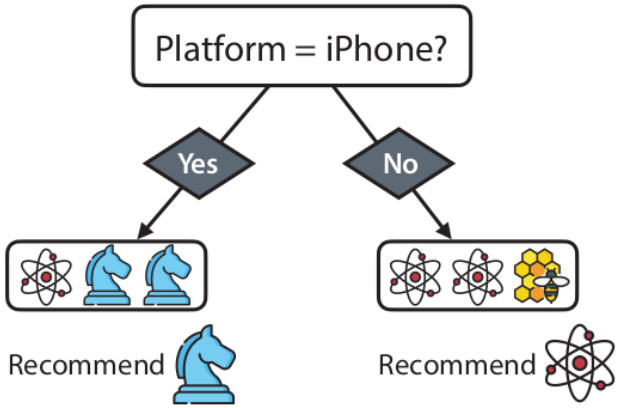
The three apps we are recommending

Example #1

Recommender App

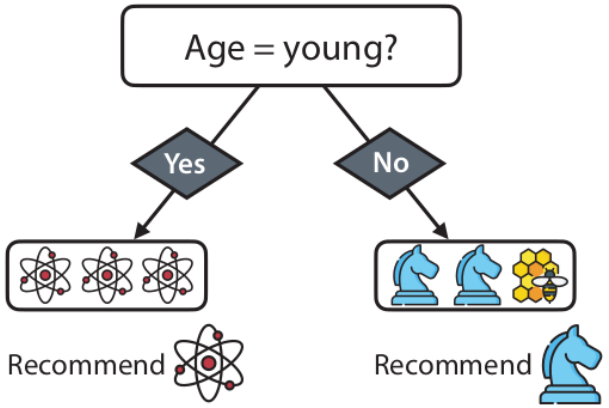
How often is each classifier correct?

Classifier 1: By platform



Correct 4 out of 6 times
Accuracy: 66.67%

Classifier 2: By age



Correct 5 out of 6 times
Accuracy: 83.33%

Atom Count

Beehive Finder

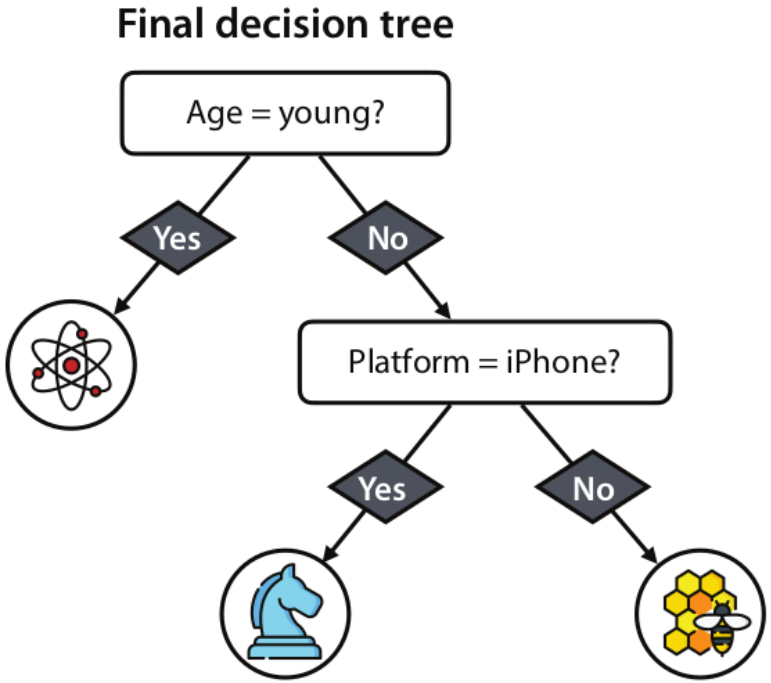
Check Mate Mate

The three apps we are recommending

Example #1

Recommender App

But way can do even better …



Now our classifier is always right

Example #1

Recommender App

- ML algorithms are able to construct an optimal decision tree for given data
- Scikit-Learn provides various implementations of these algorithms. See Decision Trees
- Does not rely on Deep Learning

Example #2

Dimensionality Reduction

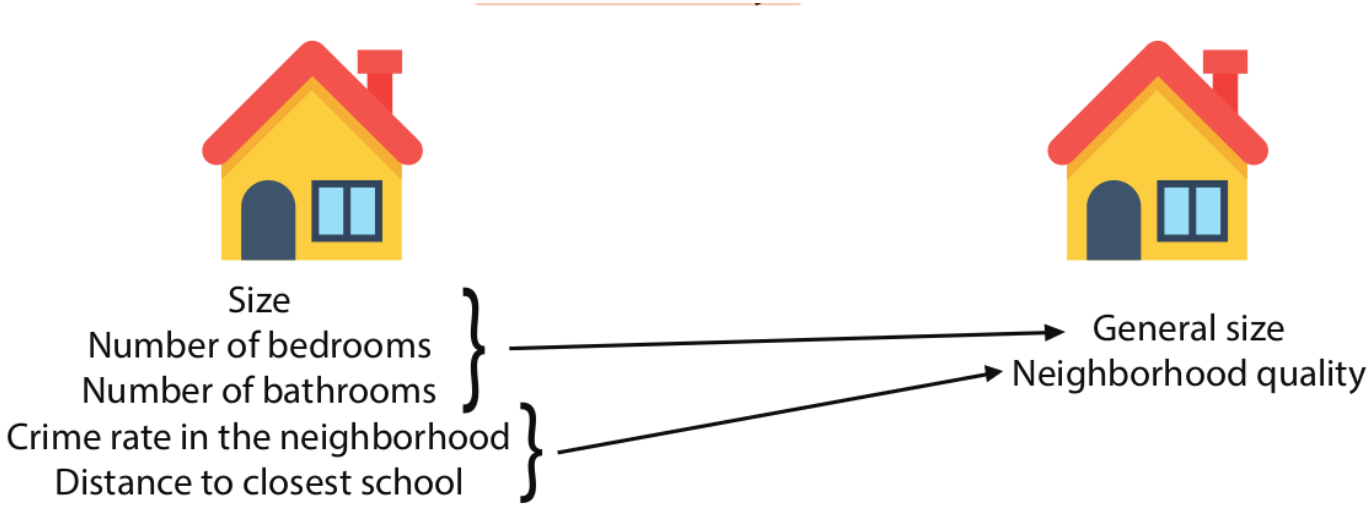
We are given some housing data ...

Size	Number of Bedrooms	Number of Bathrooms	Crime rate	Distance to school
160 m2	3	7	0.5	5 km
40 m2	1	3	1.8	1.8 km
71 m2	1	4	1.1	2.3 km
...				

Example #2

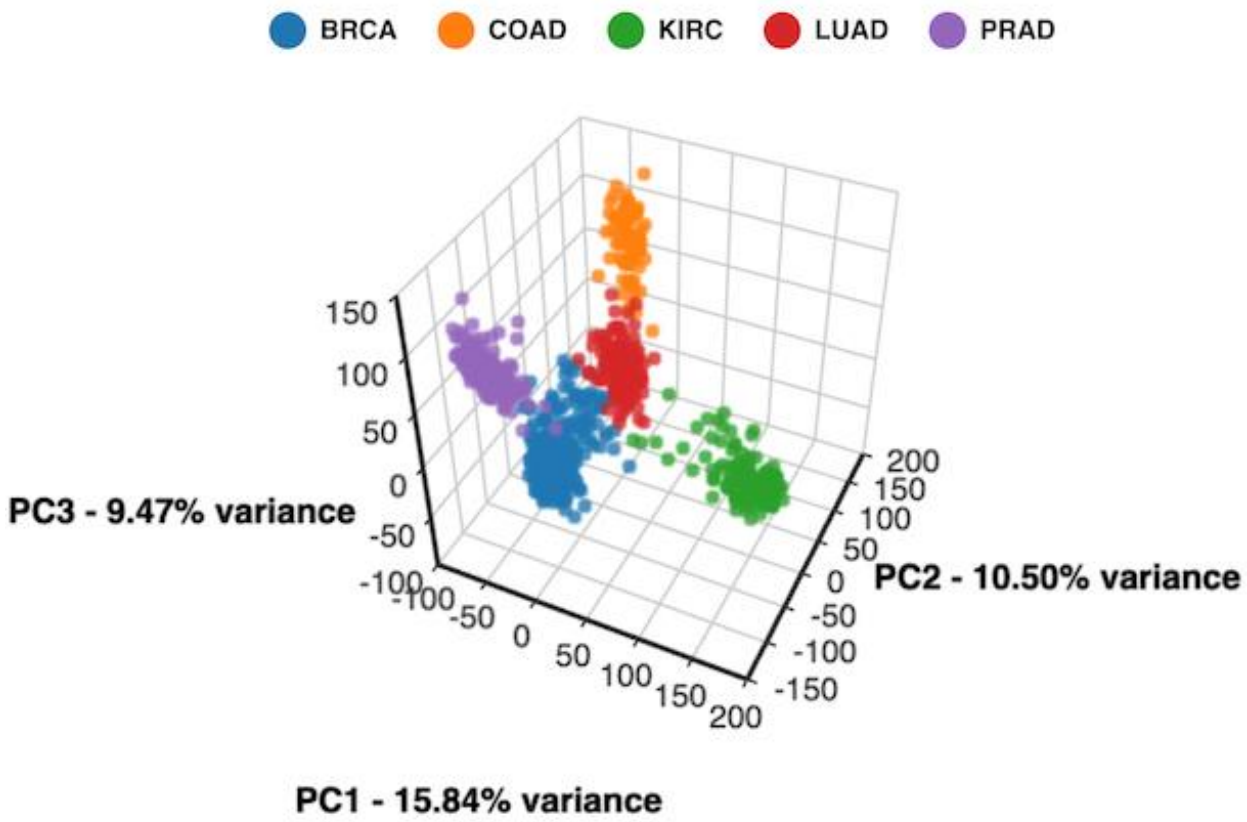
Dimensionality Reduction

How can we simplify this data?



Example #2

Dimensionality Reduction



*Example of Dimensionality Reduction with **Principal Component Analysis (PCA)***

Example #2

Dimensionality Reduction

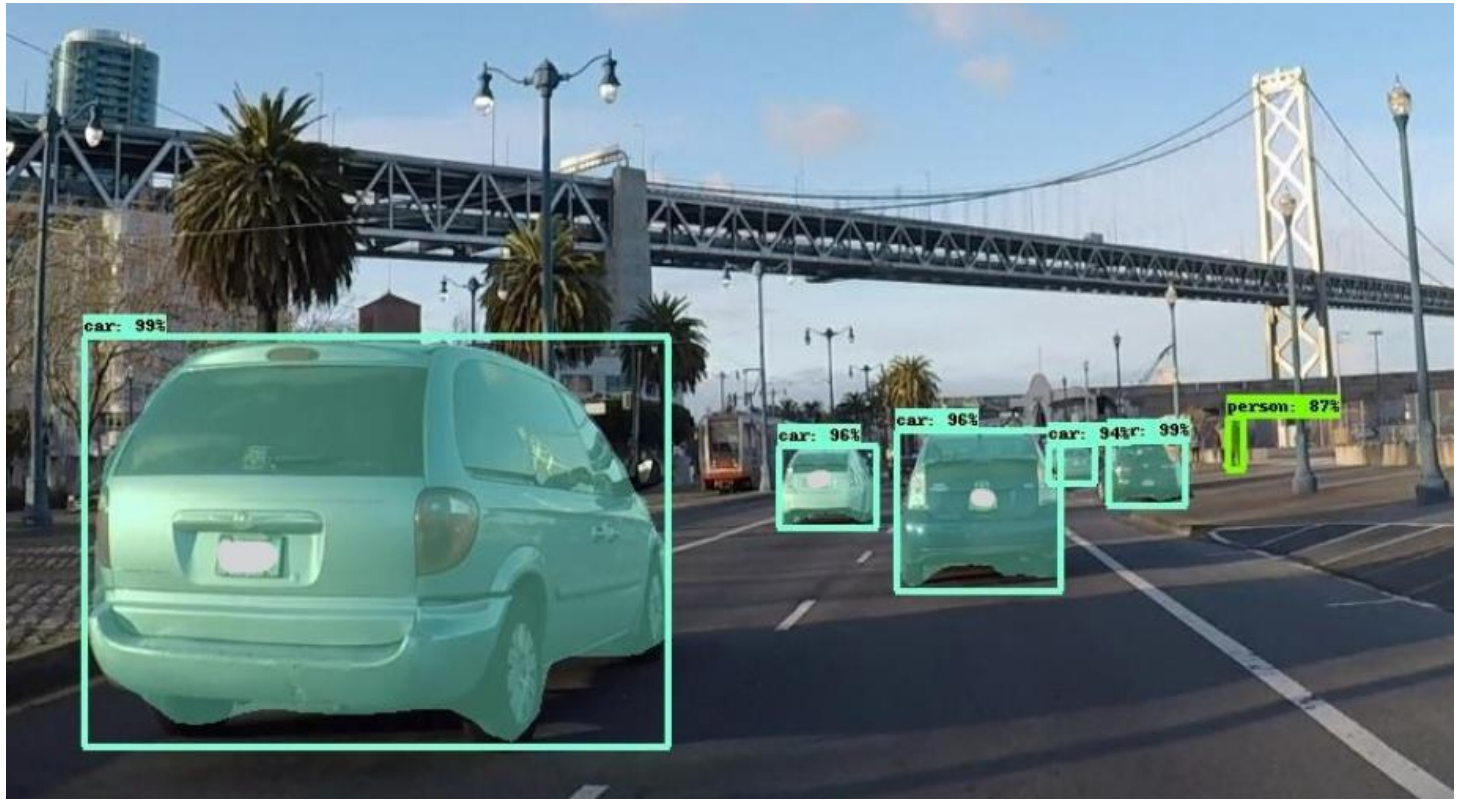
- Often used as preprocessing technique or simply to visualize data
- Some well-known dimensionality reduction techniques: (*)
  - PCA
  - T-SNE
  - ICA

(*) These do not rely on DL

Example #3

Autonomous driving

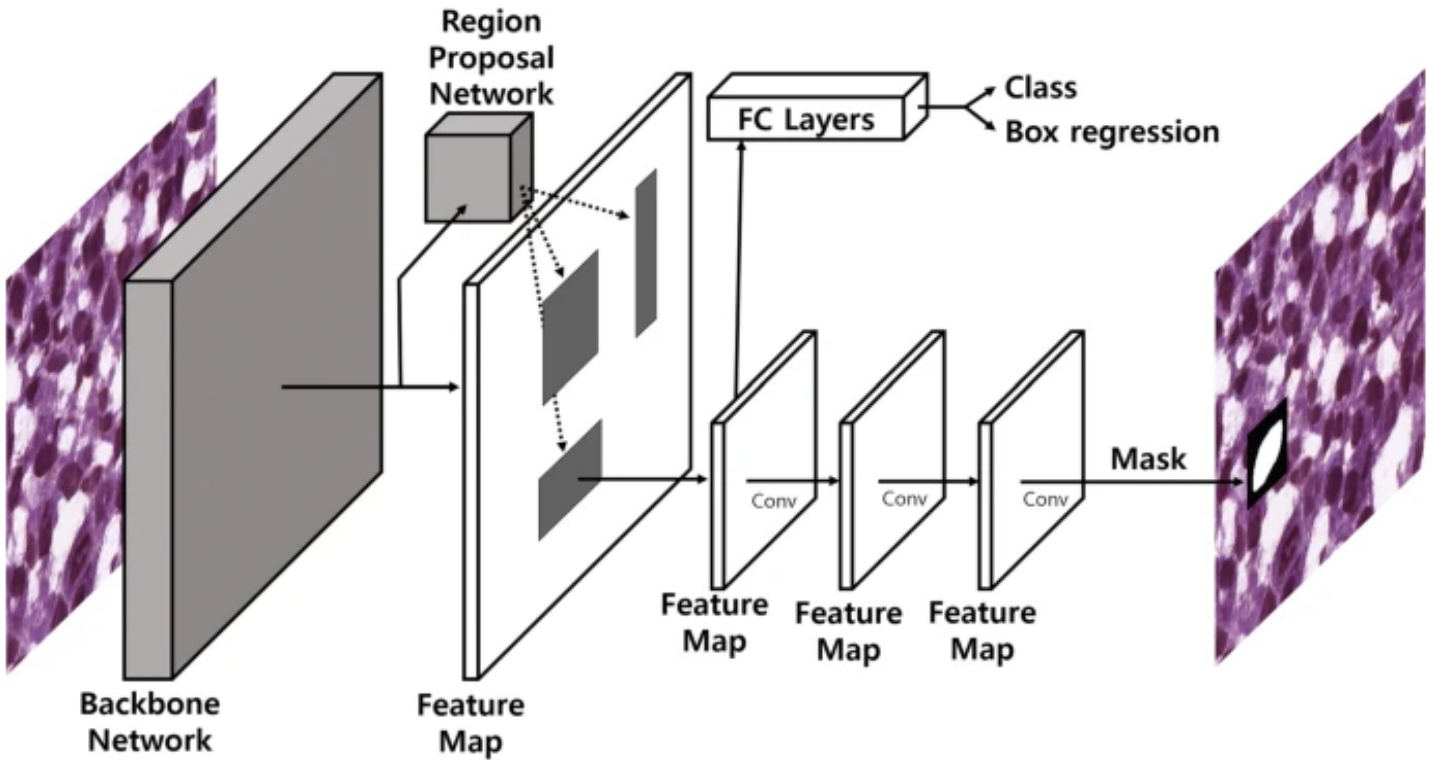
Localize objects in an image and determine the type and shape



Example #3

Autonomous driving

Now we need to apply neural networks!



Basic structure of ***Mask R-CNN***

Example #3

Autonomous Driving

- This example can be approached by training a Mask R-CNN
- NNs typically achieve exceptional performance on image data (often better than humans)
- **Caveat:** The success of NNs heavily depends on the availability of a large amount of high-quality data!

Goal of this course

Learn how to apply ML on real-world problems

- What are appropriate tools?
- How do I choose a ML model?
- How do I evaluate whether the ML model performs well?
- How do I visualize my data and the results?

Tools and Frameworks that are covered

- **Python**
- **Numpy + Pandas** for managing data
- **seaborn + matplotlib** for data visualization
- **scikit-learn** for classical supervised + unsupervised ML
- **PyTorch** for supervised DL
- **Tensorboard** for monitoring DL training progress

Important remarks

- **Attendance is mandatory**. Our are allowed to be absent four times.
- There is no need to send me e-mails telling me when or why our are absent.

- All course related information will be posted at github.com/dsoellinger/teaching

Grading

- The finale grade is composed of **one test** and **2-3 practical homework exercises**
- A positive test grade is required to pass the course.
- Homework exercises will be concerned with solving some "real-world" problem with ML learning

Copyright Notice

Most pictures shown in this slides are taken from the book ***Grokking Machine Learning*** written by Luis G. Serrano.