Introduction to Machine Learning

Introduction to Machine Learning

What this lecture will cover

- An overview of what Artificial Intelligence can do from a business perspective
  - The focus will be on Machine Learning techniques
- A vertical slice of two ML techniques
  - The goal is to highlight the main processes, tasks, and challenges

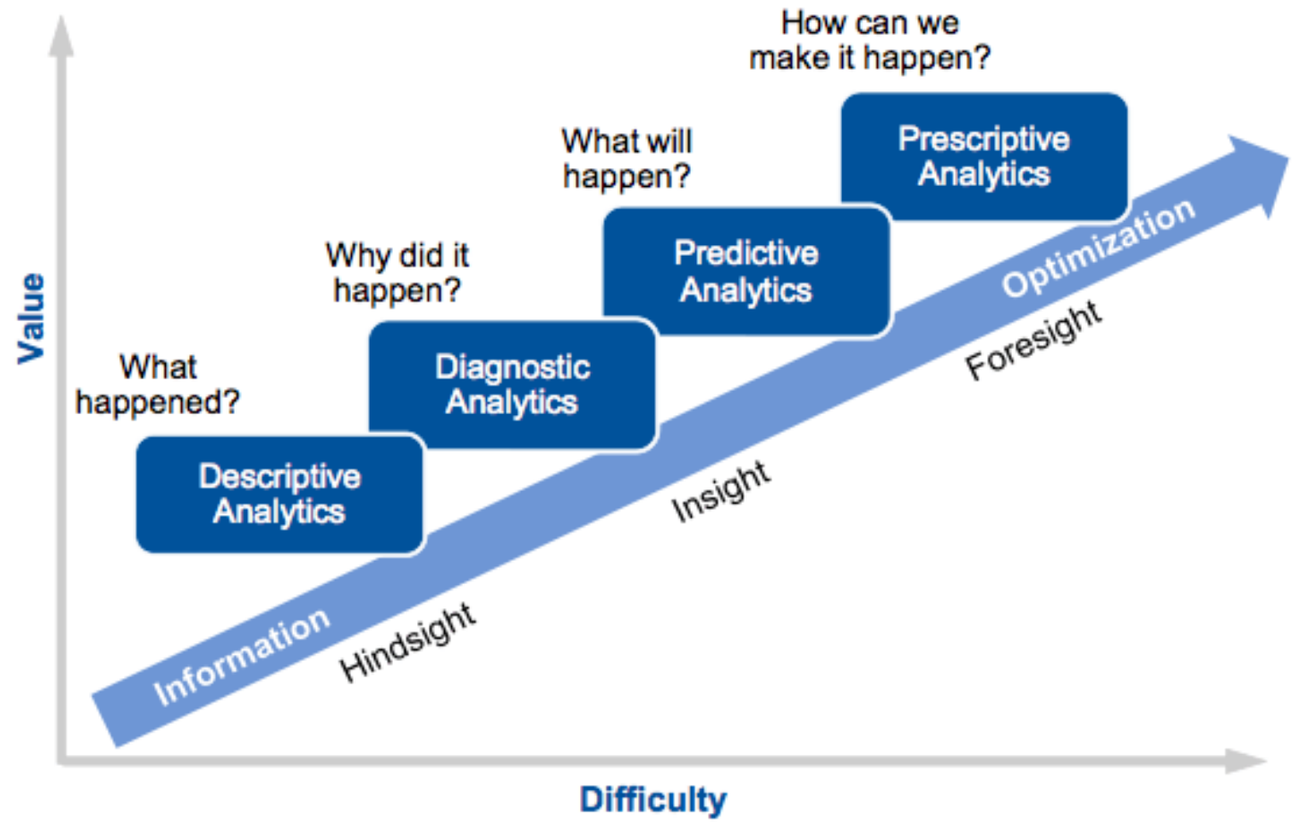
How the content will be tackled

- The first will be purely theoretical (slides)
- ...But the second will be technical!
  - This can be hard if you have very little coding experience
  - Just focus on the main concepts
  - ...And if you can code, you'll be able to try some experiments

What can AI do from an Industrial Perspective?

A good starting point: business analytics

Figure 2. Gartner Analytic Ascendancy Model



Source: Gartner (March 2012)

Descriptive Analytics

Key question: "what is happening?"

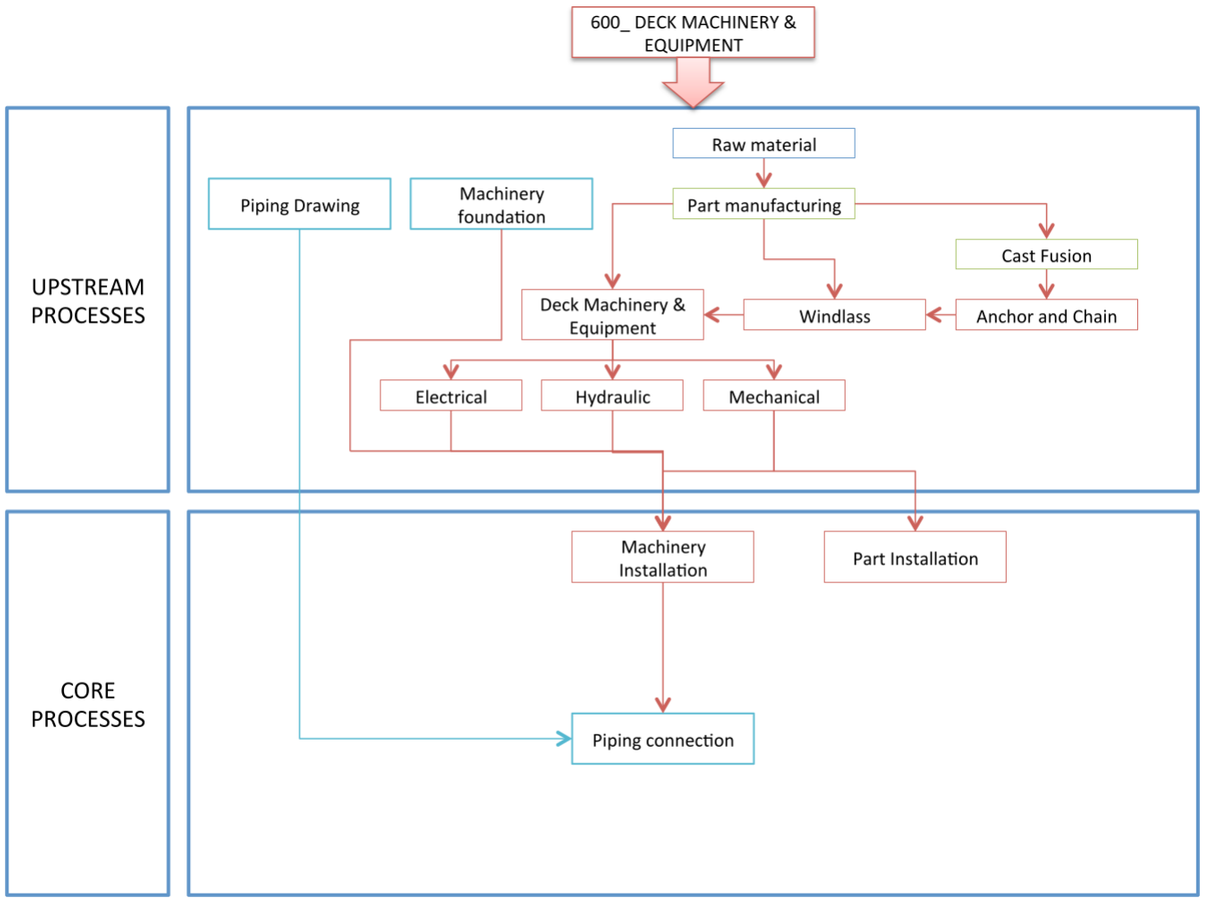
- They are all about presenting the available data
- ...In a way that helps a human obtaining insights

A few examples:

- Visualization consoles
- Most Business Intelligence solutions
- Geographical Information Systems
- ...

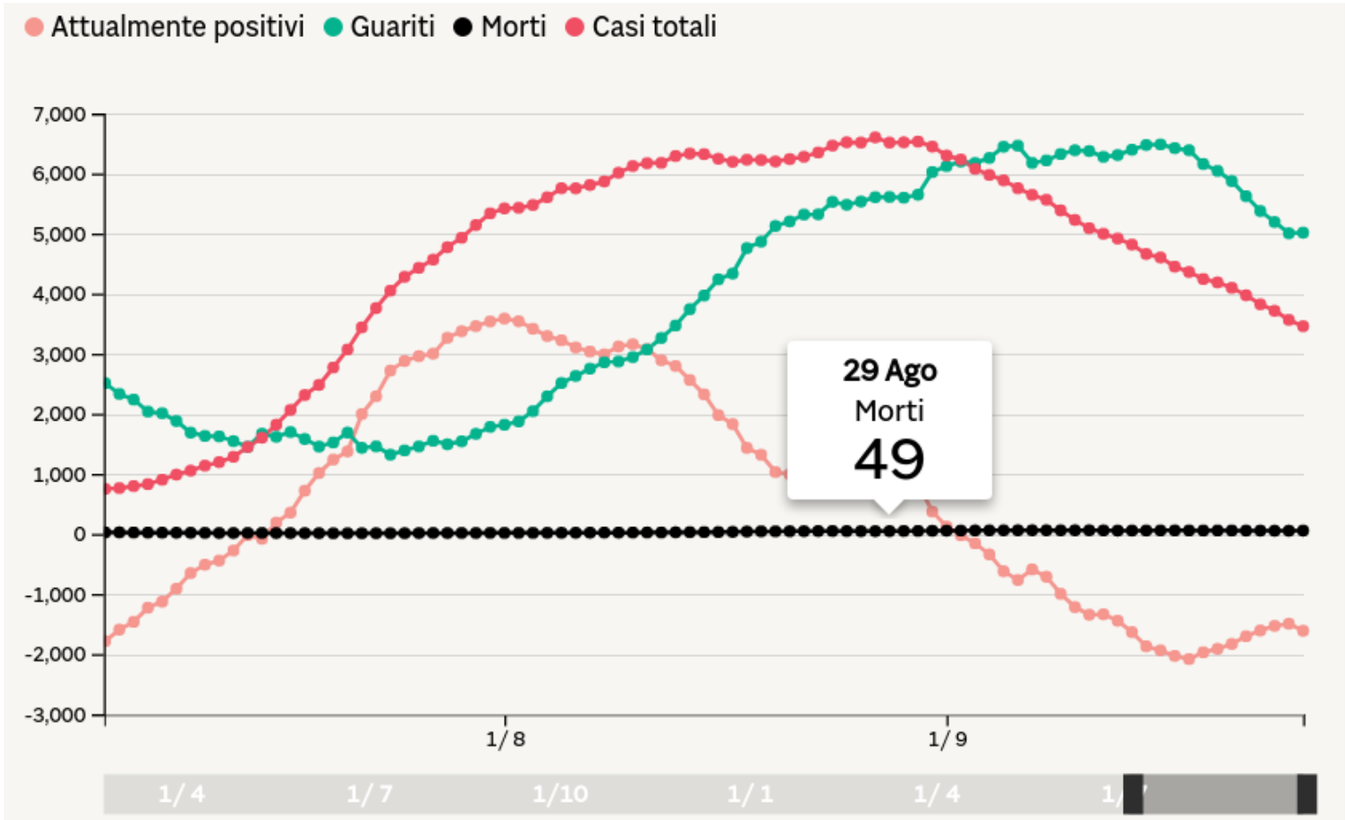
Descriptive Analytics

A more in-depth example: business process visualization



Descriptive Analytics

A more in-depth example: case trends for the COVID-19 pandemic



(credit: Sole 24 Ore)

Diagnostic Analytics

Key question: "whay did it happen?"

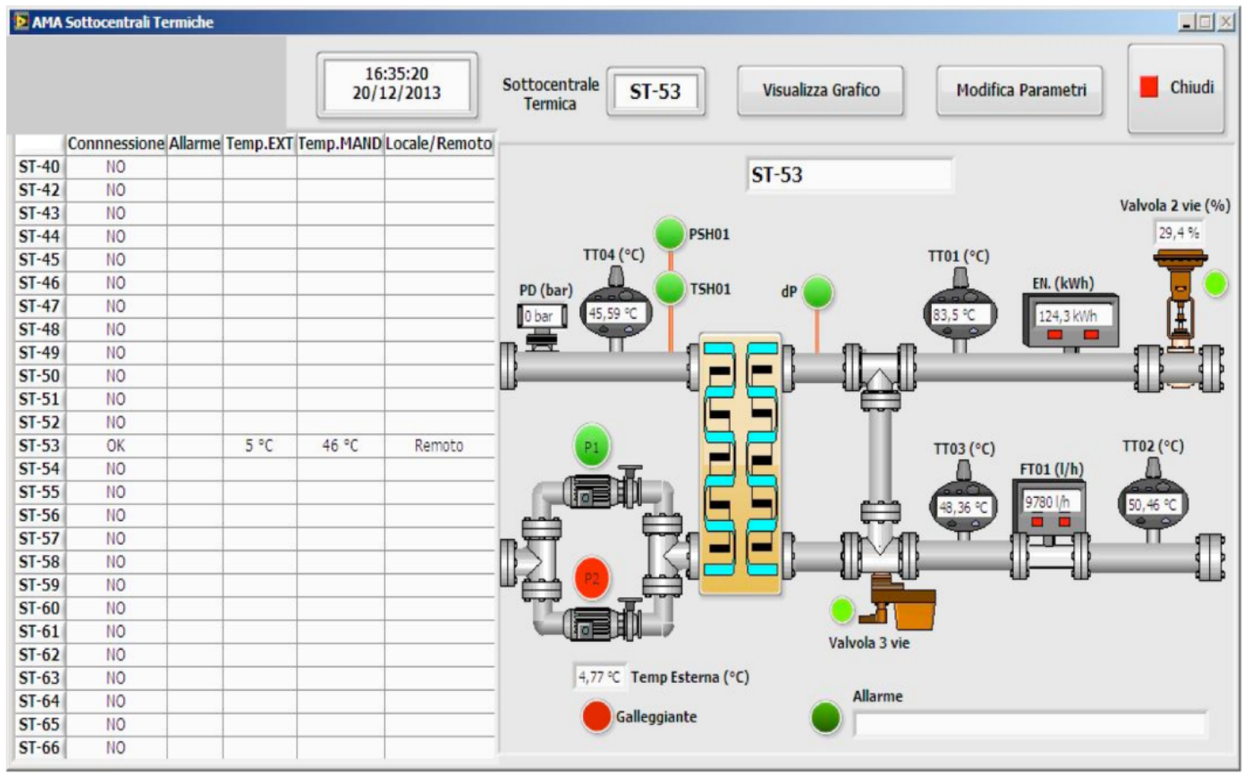
- They are all about explaining data in terms of simpler mechanisms
- ...Or about detecting patterns

A few examples:

- Anomaly detection/identification in industrial equipment
- Detecting recurring patterns or item set in sales data
- Support for medical diagnosis
- ...

Diagnostic Analytics

A more in-depth example: anomaly detection in an industrial plant



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Predictive Analytics

Key question: "what will happen?"

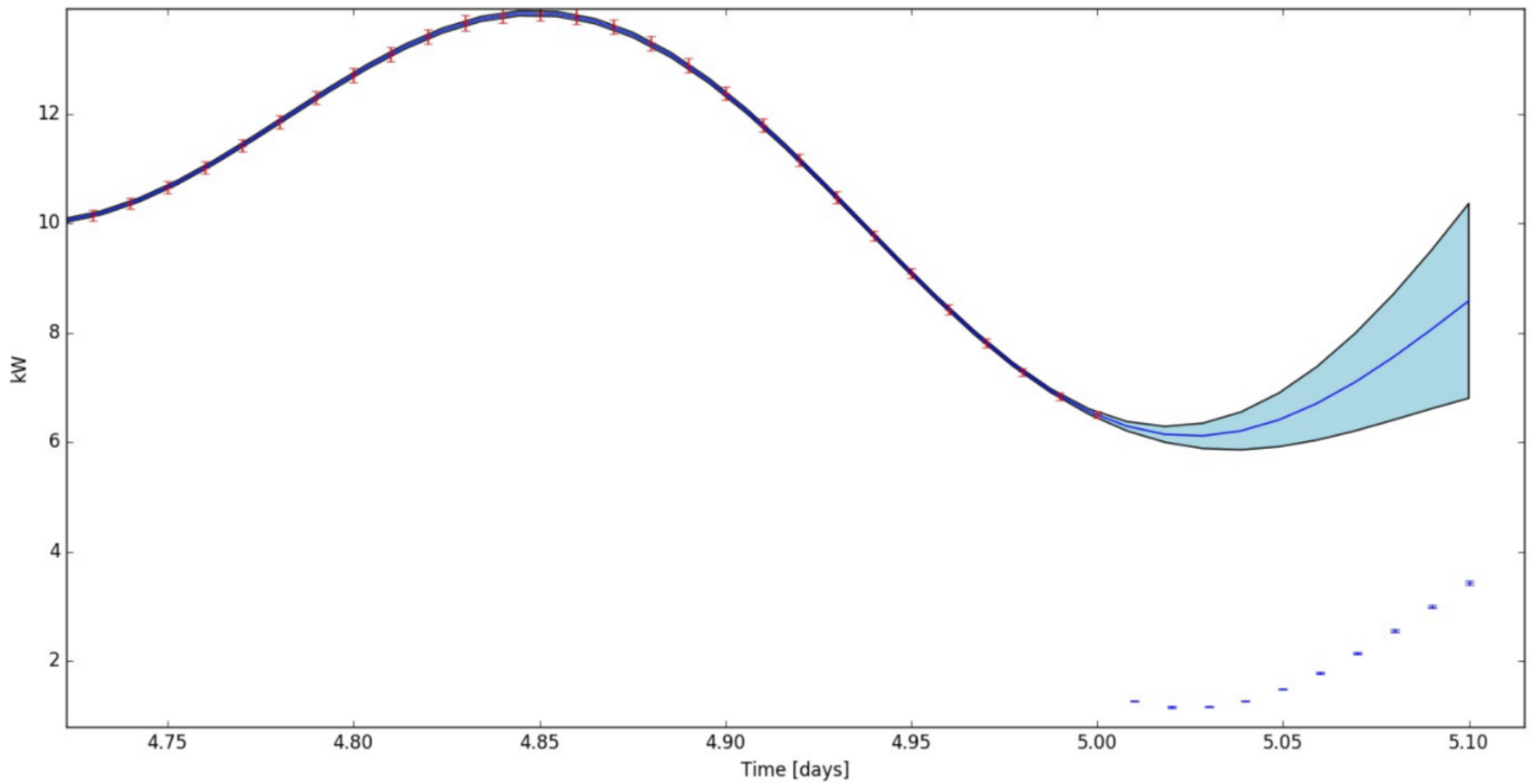
- They are all about predicting trend
- ...Or assessing impacts

A few examples:

- Weather forecasts
- Sales prediction
- Remaining Useful Life estimation of industrial equipment
- ...

Predictive Analytics

A more in-depth example: short-range prediction of energy consumption



Prescriptive Analytics

Key question: "what should you do?"

- They are all about providing suggestions
- ...Or about directly controlling a system

A few examples:

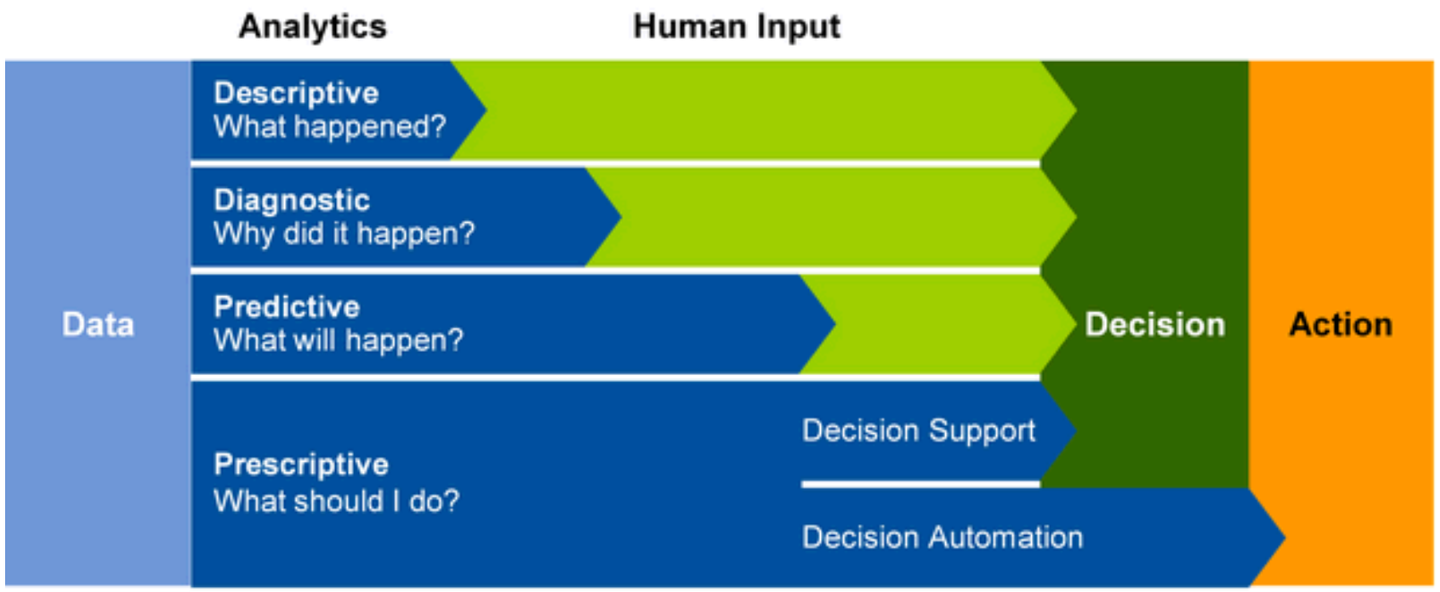
- Production scheduling
- Optimizing factory layouts
- Optimizing supply chains
- ...

Prescriptive Analytics

A more in-depth example: controlling collaborative industrial robots

Business Analytics

In terms of how far we push automation:



Business Analytics

From a the perspective of main employed techniques

- Descriptive Analitics
  - Statistics, Dimensionality reductions, Advanced visualization
- Diagnostic Analytics
  - Machine Learning, Data Mining
- Predictive Analytics
  - Machine Learning, Simulation
- Prescriptive Analytics
  - Constrained Optimization, Machine Learning (some)

Our focus will be on Machine Learning

Machine Learning

A few facts about Machine Learning

- It's a field within AI (Artificial Intelligence)
- Goal: taking advantage of data to automate or improve a task
- Typically works by constructing a model

Two broad classes of techniques

- Symbolic methods
  - More interpretable models
  - Often require some expert knowledge
- Sub-symbolic methods
  - Typically more robust
  - No expert knowledge needed
  - Less interpretable

Machine Learning

Some examples of symbolic methods:

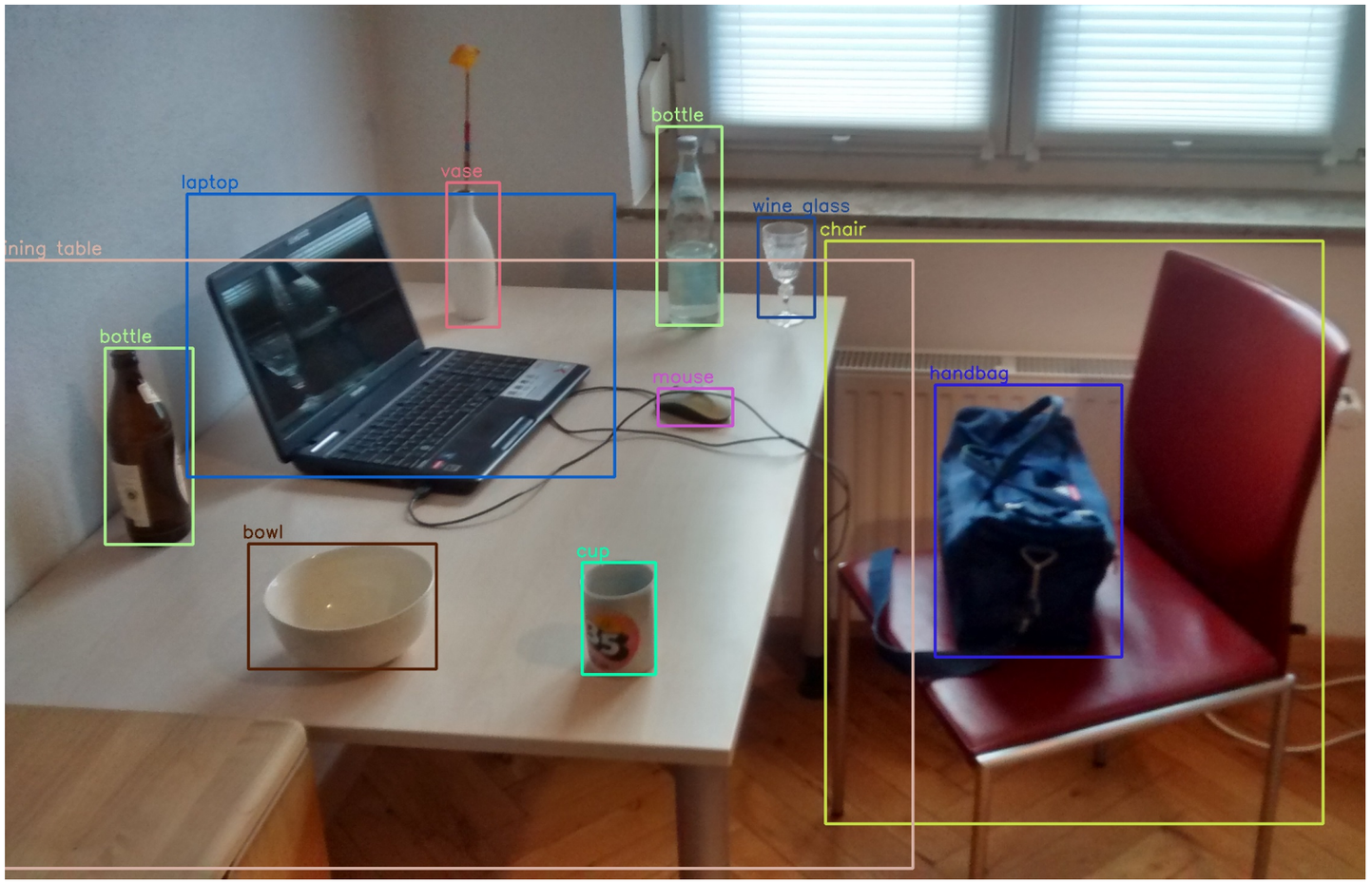
- Decision Trees (and ensembles)
- Rule-based approaches
- Bayesian networks
- Inductive logic programming
- Linear models?
- ...

Some examples of sub-symbolic methods:

- Support vector machines
- Neural Networks (and all variants)
- Linear models?
- ...

Examples of ML Applications

Object recognition

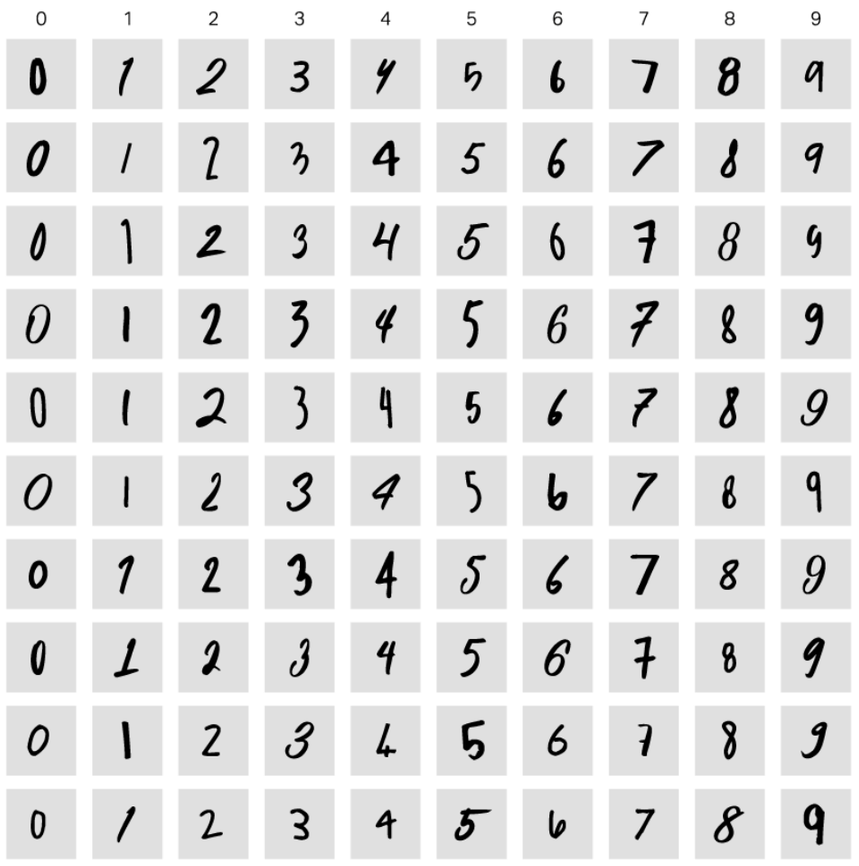


Examples of ML Applications

Image segmentation

Examples of ML Applications

Digit recognition



Examples of ML Applications

Playing "Go"

Examples of ML Applications

Playing computer games

Examples of ML Applications

Playing quiz games

Examples of ML Applications

Answering complex questions

Q: Who is Elon Musk

A: Who is Elon Musk? Elon Musk made a name for himself at Tesla, where he transformed the auto industry. In 2009, the entrepreneur and founder of Tesla Motors was named the "World's Most Hated Person." Today, Musk is the richest man on Earth;

Examples of ML Applications

More on the industrial side...

- Detecting faulty equipment
- Estimating component Remaining Useful Life
- Quality control
- Estimating sales/gains/costs
- Traffic forecasting
- Detecting posture
- Autonomous driving
- Analyzing text
- Generating text
- ...

The Remainder of the Lecture

The remainder of this lecture

...Will contain vertical slices on a few simple Machine Learning methods

- We will tackle simplified, but still realistic problems
- We will encounter some of the typical challenges for data-driven methods
- ...And we will address them using state-of-the-art tools
- We will see actual code, using the Python language
- If you don't know how to code, just try to focus on the main ideas

The goal is not making you a data science expert

...But to understand how these approaches work in practice

- Perhaps you will not apply Machine Learning yourself
- ...But you understand better which language an ML expert speaks