# INTRODUCTION TO DATA SCIENCE

Lectures based on:

- E. Fox and C. Guestrin, „Machine Learning and Data Analysis”, Univ. of Washington
- M. Cetinkays-Rundel, „Data Analysis and Statistical Inference”, Univ. of Duke

13/10/2021

WFAiS UJ, Informatyka Stosowana

I stopień studiów

# What is Data Science?



**Is mainly about extracting knowledge from data (terms "data mining" or "Knowledge Discovery in Databases" are highly related). It can be about analyzing trends, building predictive models, … etc.**

**Is an agglomerate of data collection, data modeling and analysis, a decision making, and everything you need to know to accomplish your goals. Eventually, it boils down to the following fields/skills:**

- **Computer science:**

**Algorithms, programming (patterns, languages etc.), understanding hardware & operating systems, high-performance computing'**

- **Mathematical aspects:**

**Linear algebra, differential equations for optimization problems, statistics**

- **Few others:**

**Machine learning, domain knowledge, and data visualization & communication skills**

# Data Science and Machine Learning?



**Machine learning** algorithms are algorithms that learn (often predictive) models from data. I.e., instead of formulating "rules" manually, a machine learning algorithm will learn the model for you.

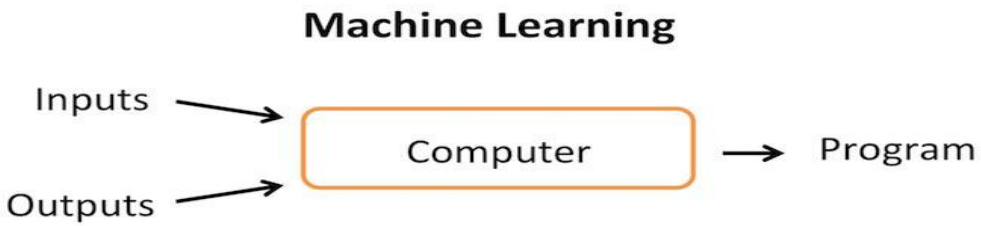
**Machine learning** - at its core - is about the use and development of these learning algorithms. **Data science** is more about the extraction of knowledge from data to answer particular question or solve particular problems.

**Machine learning is often a big part of a "data science" project**, e.g., it is often heavily used for exploratory analysis and discovery (clustering algorithms) and building predictive models (supervised learning algorithms). However, in **data science**, you often also worry about the collection, wrangling, and cleaning of your data (i.e., data engineering), and eventually, you want to draw conclusions from your data that help you solve a particular problem.

# Traditional programming paradigm and Machine Learning




*Machine Learning is the field of study that gives computers the ability to learn without being explicitly programmed*
– Arthur Samuel (1959)




Sebastian Raschka, 2016

# Outline of the course



- **Exploratory Data Analysis:** introduction

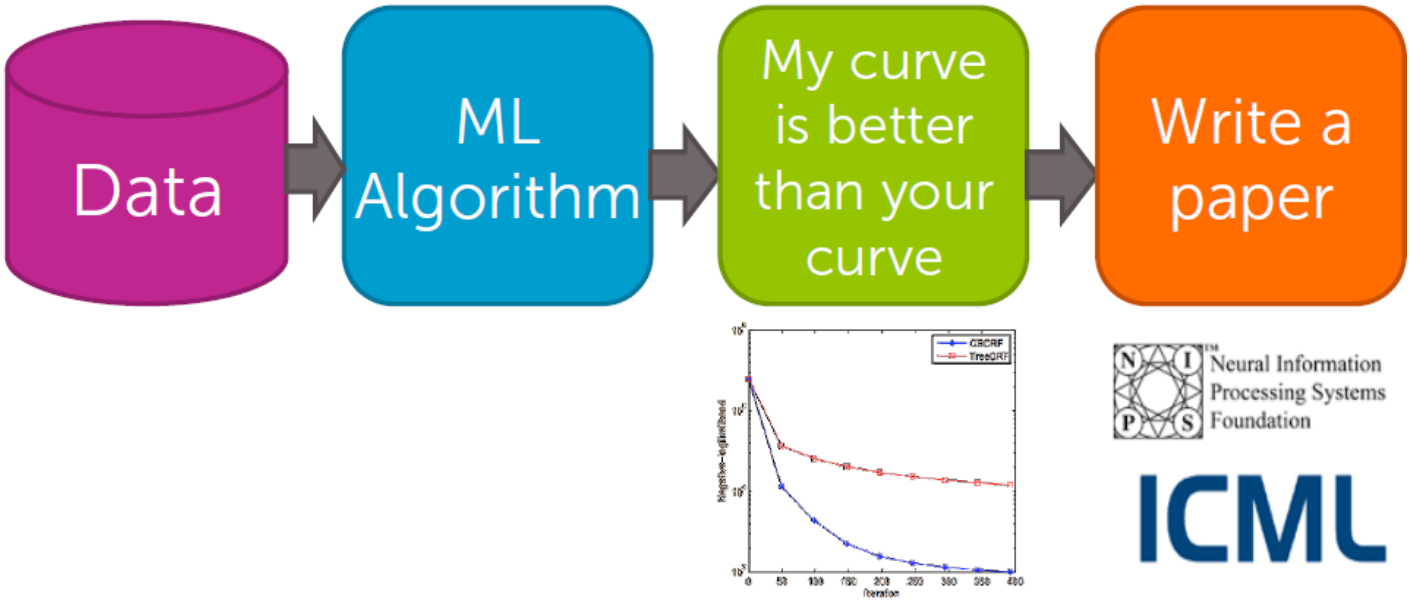
  → today

- **Data Analysis** with **Machine Learning** algorithms:
  - Regression (October)
  - Classification (December/January)
  - Retrieval &Clustering (January)
- For 5 weeks (~November) course will be given by prof. P. Bialas. Exact topic to be defined.

# Analyse data with Machine Learning



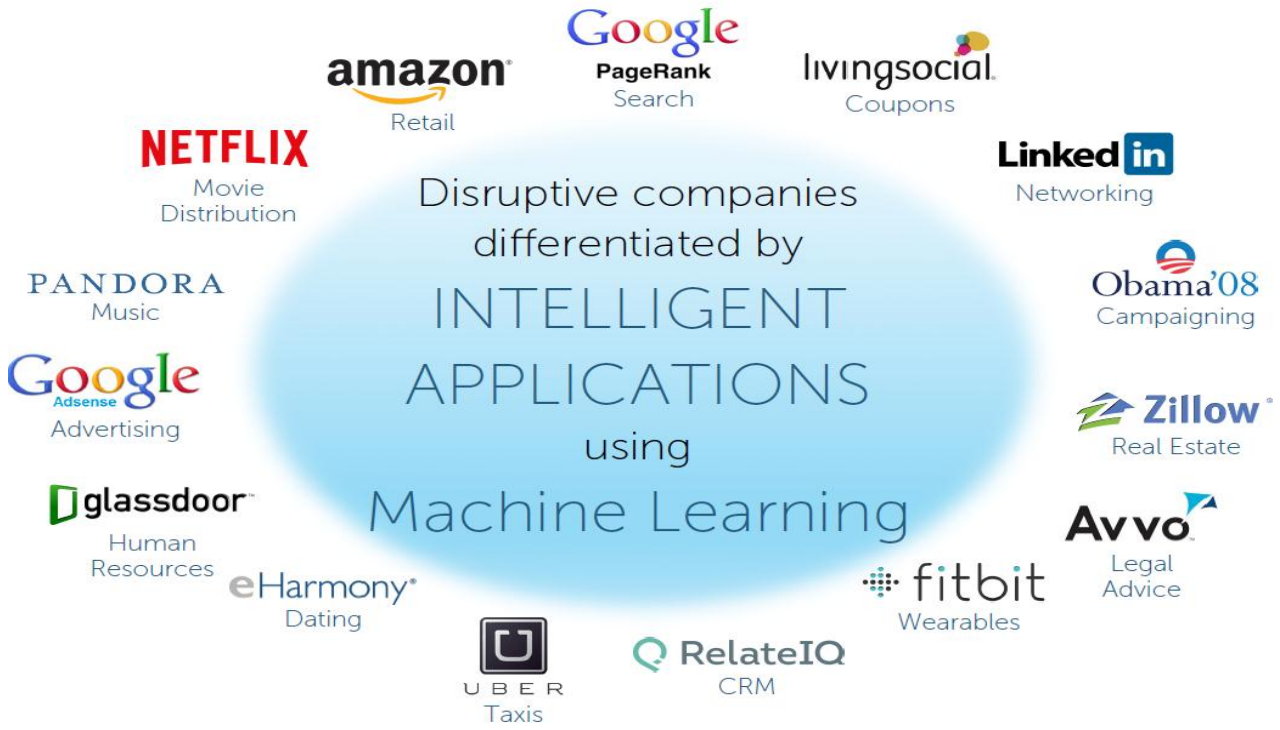
- **Machine learning is changing the world.**
- **Old view**



# Machine learning is changing the world



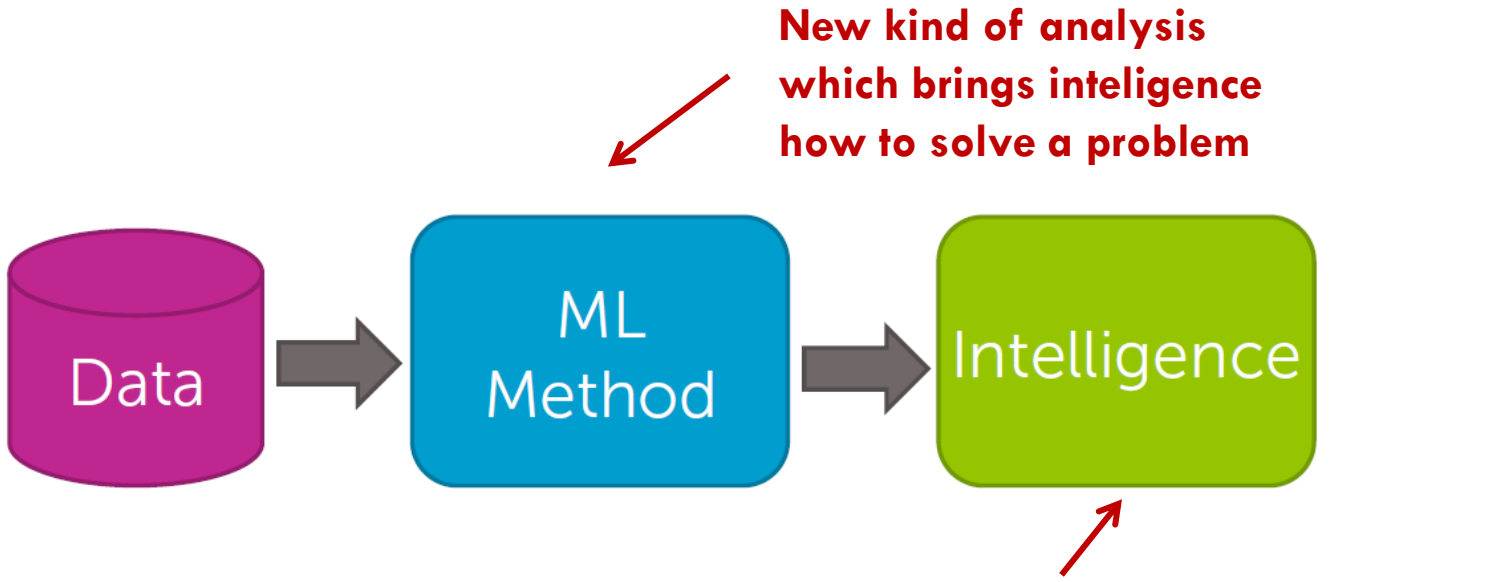
- **Current view: disruptive inteligent applications are used by leading comercial companies**



# Machine learning

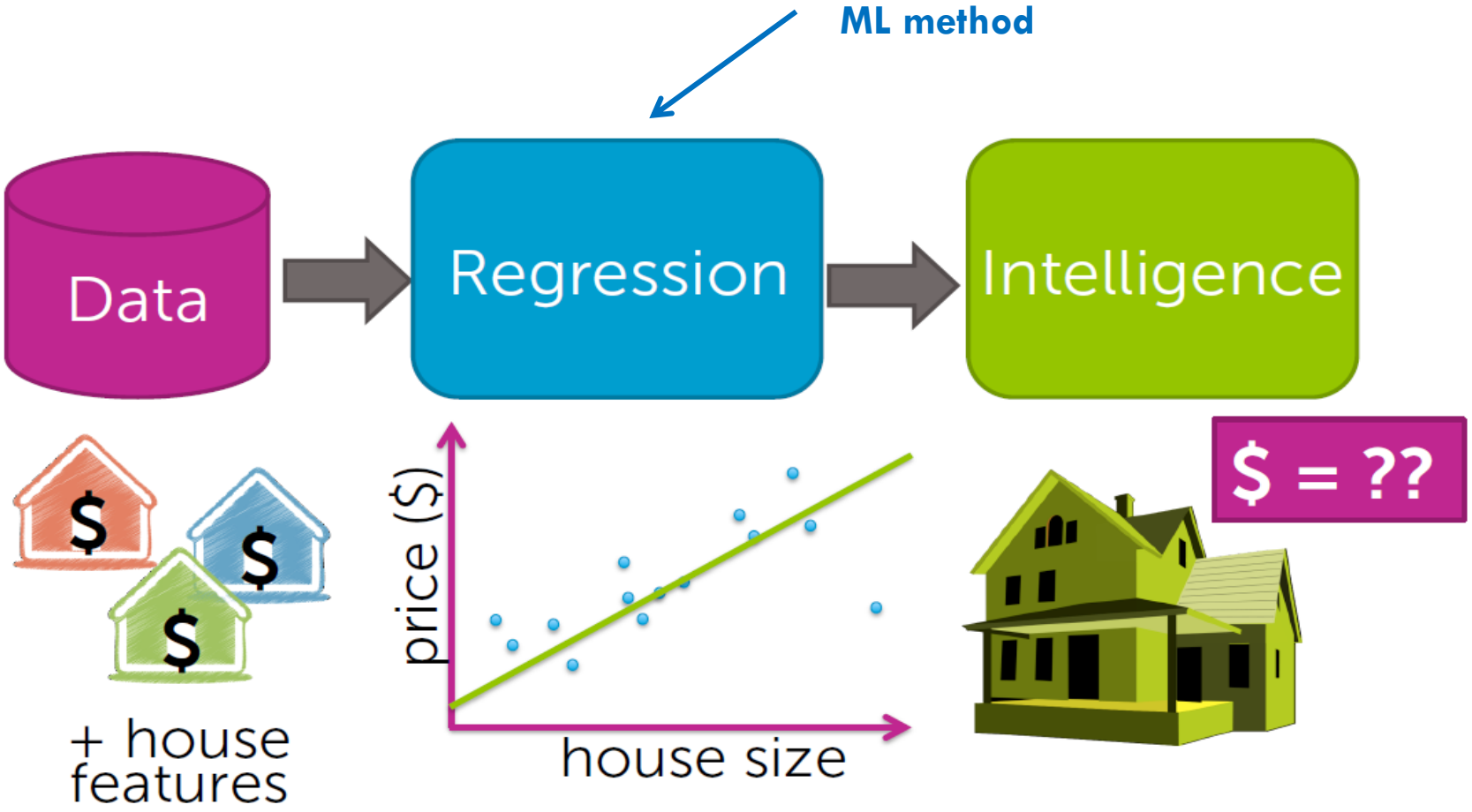


- **Data → inteligence pipeline**



# Case study 1: Prediction





# Prediction: Predicting house prices



**Models**

- Linear regression
- Regularization: Ridge (L2), Lasso (L1)

**Algorithms**

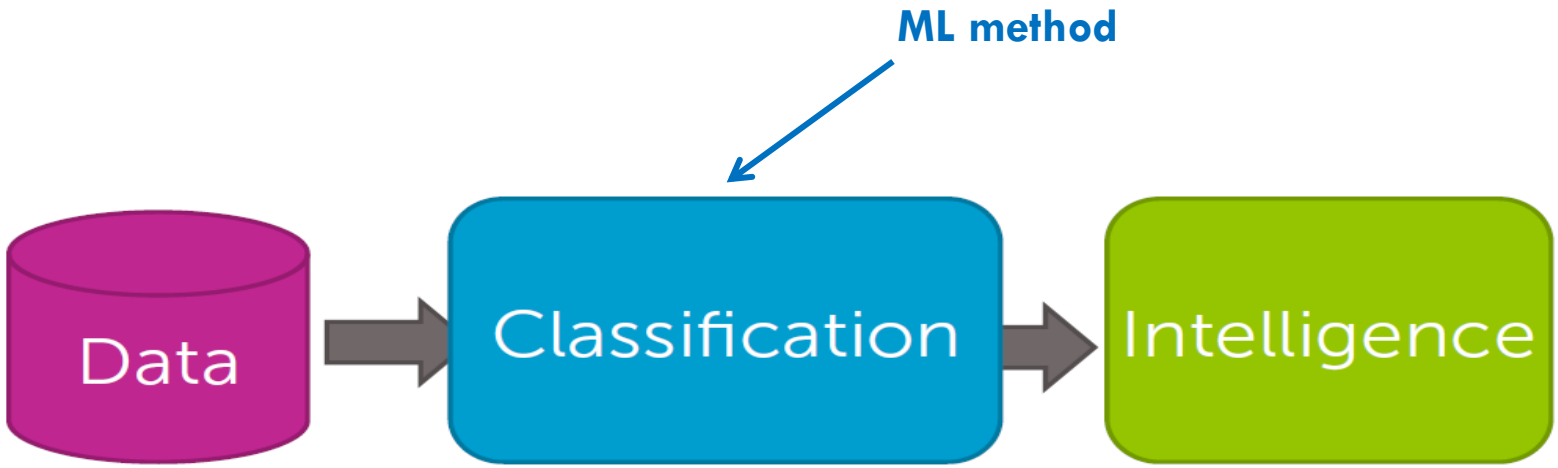
- Gradient descent
- Coordinate descent

**Concepts**

- Loss functions, bias-variance tradeoff, cross-validation, sparsity, overfitting, model selection

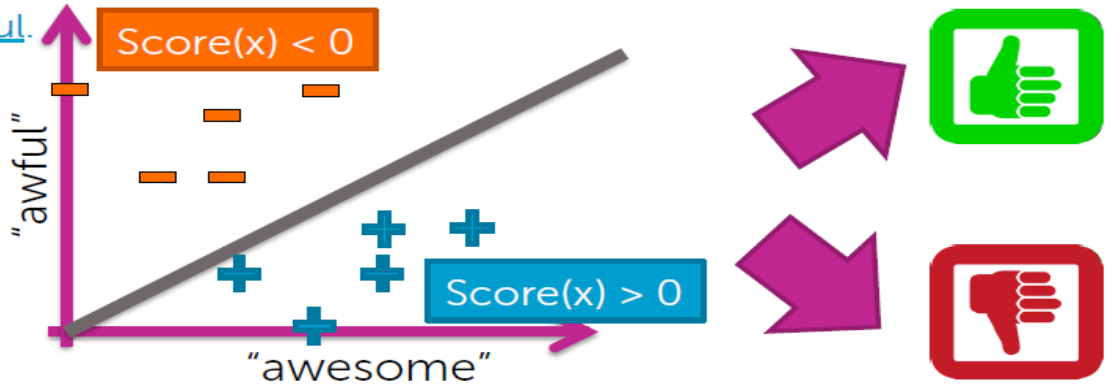
# Case study 2: Classification






Sushi was awesome,
the food was awesome,
but the service was awful.

All reviews:

# Classification: Sentiment analysis



**Models**

- Linear classifiers (logistic regression, SVMs, perceptron)
- Kernels
- Decision trees

**Algorithms**

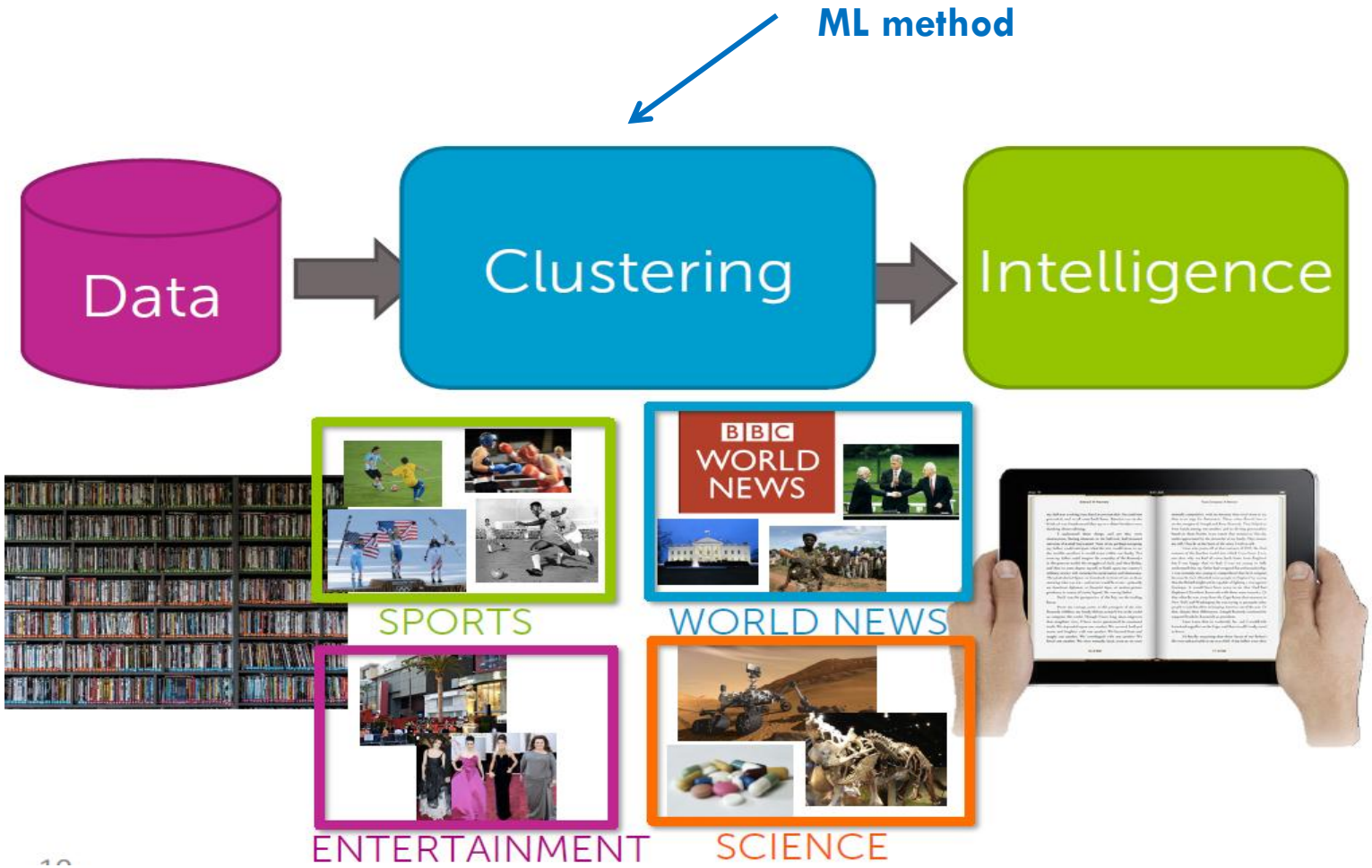
- Stochastic gradient descent
- Boosting

**Concepts**

- Decision boundaries, MLE, ensemble methods, random forests, CART, online learning

# Case study 3: Clustering





# Clustering: Finding documents



**Models**

- Nearest neighbors
- Clustering, mixtures of Gaussians
- Latent Dirichlet allocation (LDA)

**Algorithms**

- KD-trees, locality-sensitive hashing (LSH)
- K-means
- Expectation-maximization (EM)

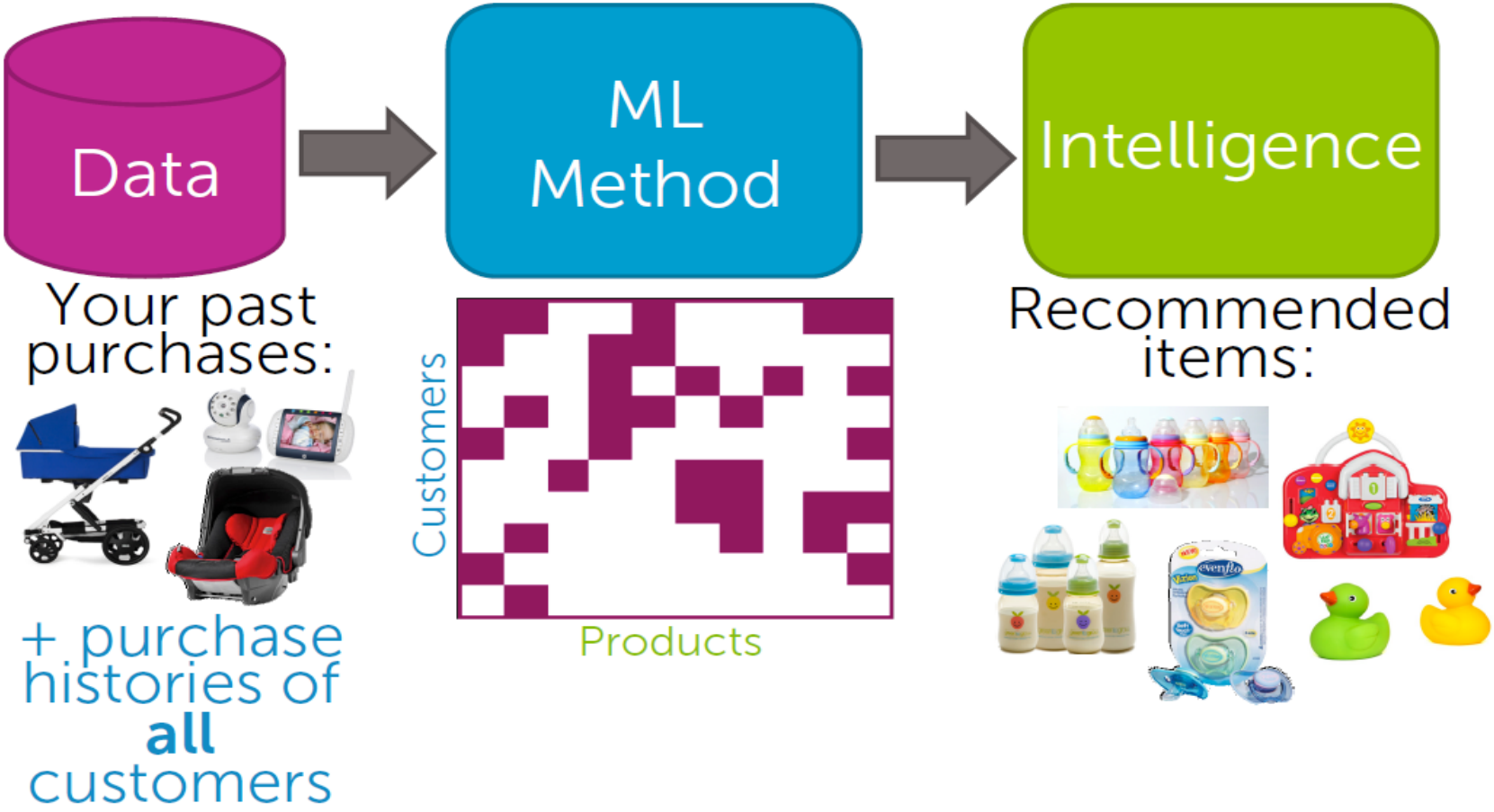
**Concepts**

- Distance metrics, approximation algorithms, hashing, sampling algorithms, scaling up with map-reduce

# Case study: Product recommendation

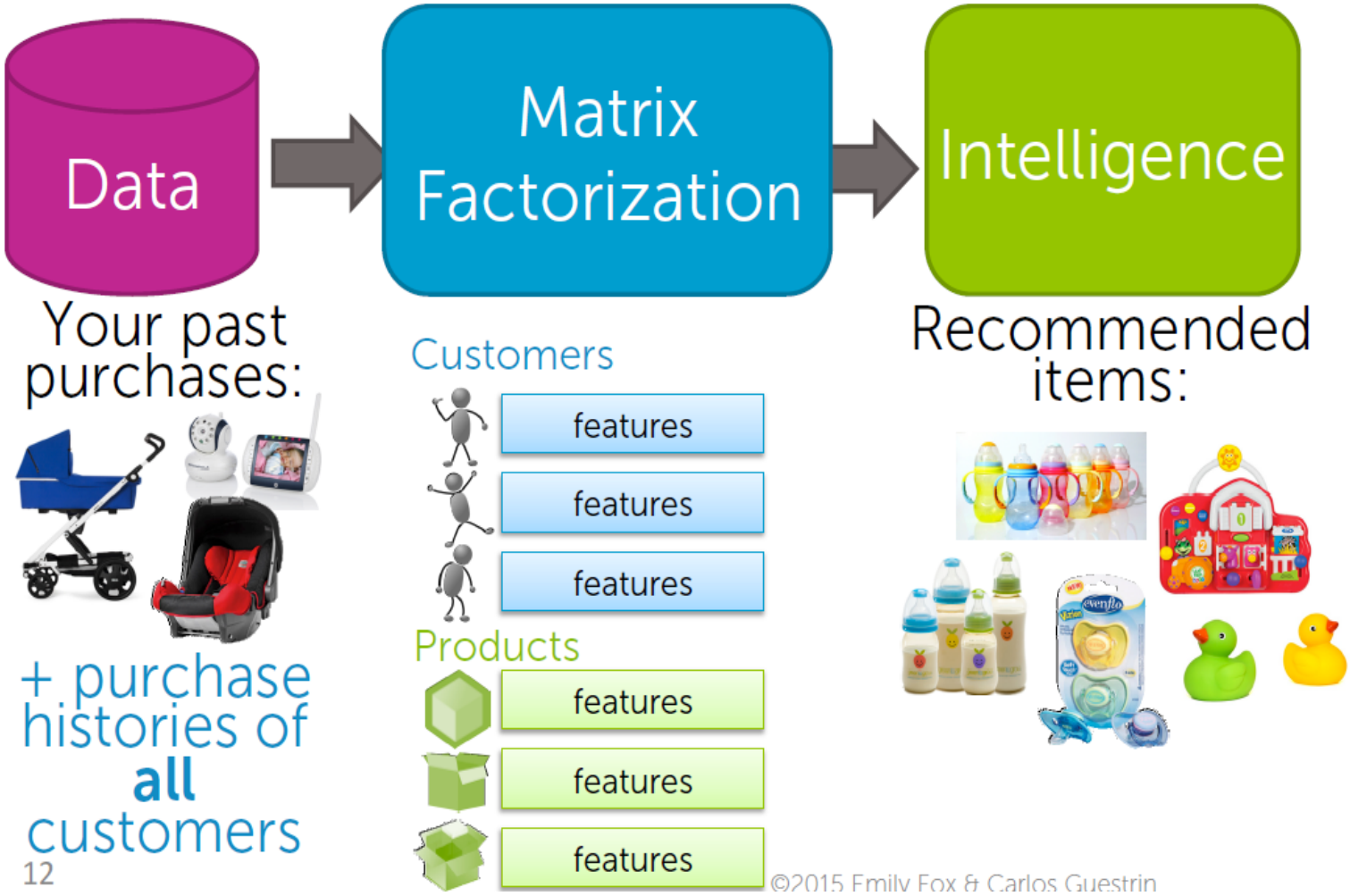
## (not covered in this course)





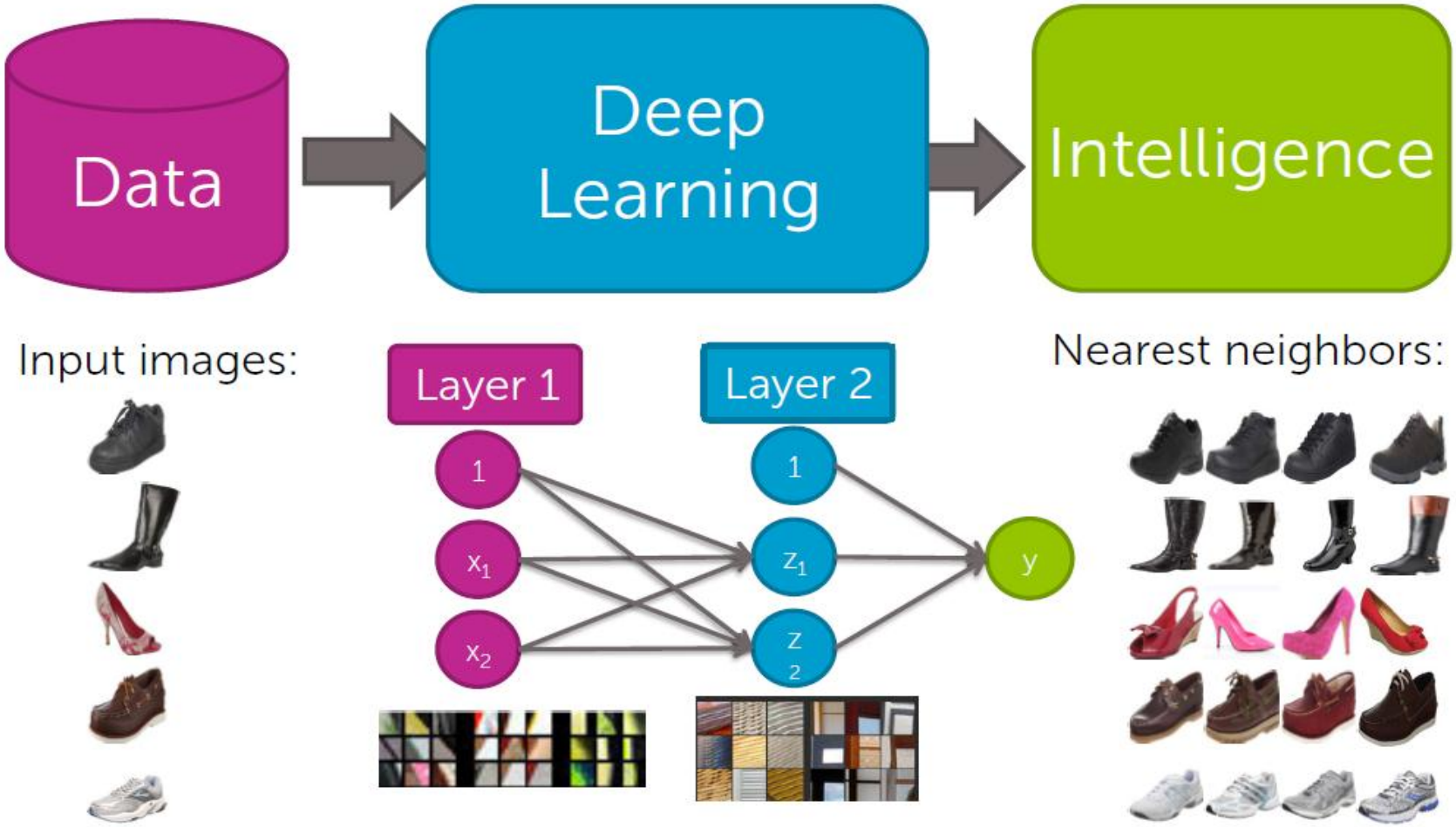
# Case study: Product recommendation (not covered here)





# Case study: Visual product recommender (not covered in this course)





# Deploing inteligence module



**Case studied are about building, evaluating, deploying inteligence in data analysis.**