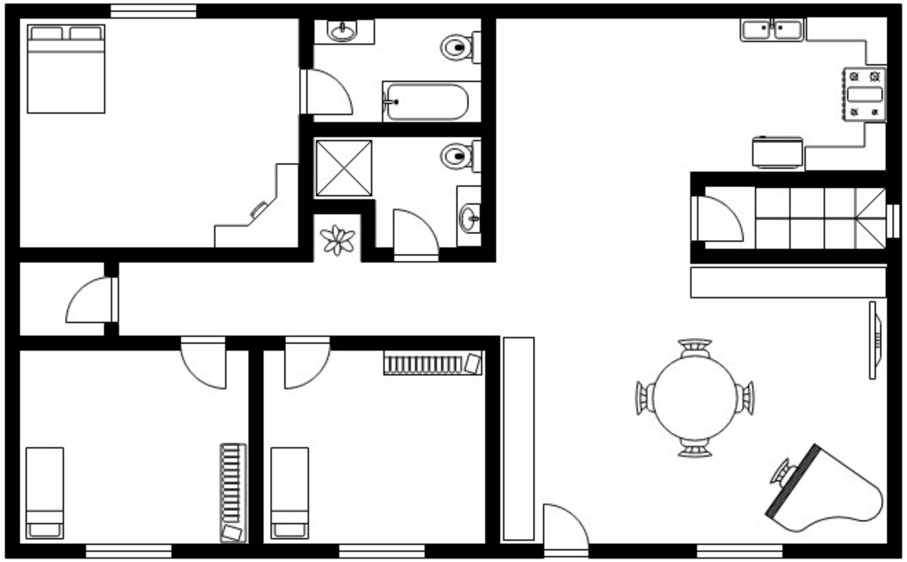
Machine Learning

- Learning from Data
- Models
- Features and Targets
- Dimensions of Machine Learning

Regression

Donnerstag, 13. Januar 2022 14:25

Estimating Appartment Prices



Features? -----------------------> Target: Price

Regression: Predicting a real number value

Classification

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Kind of Iris Plant

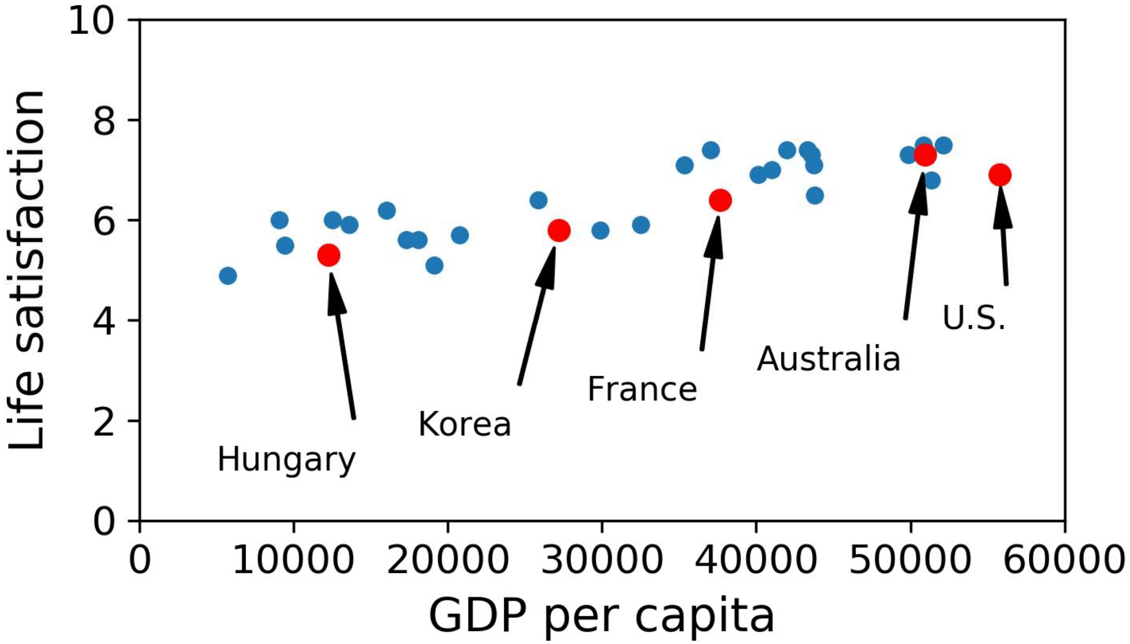
Features? -----------------------> Target: Kind

Classification: Predicting a label

Life Satisfaction

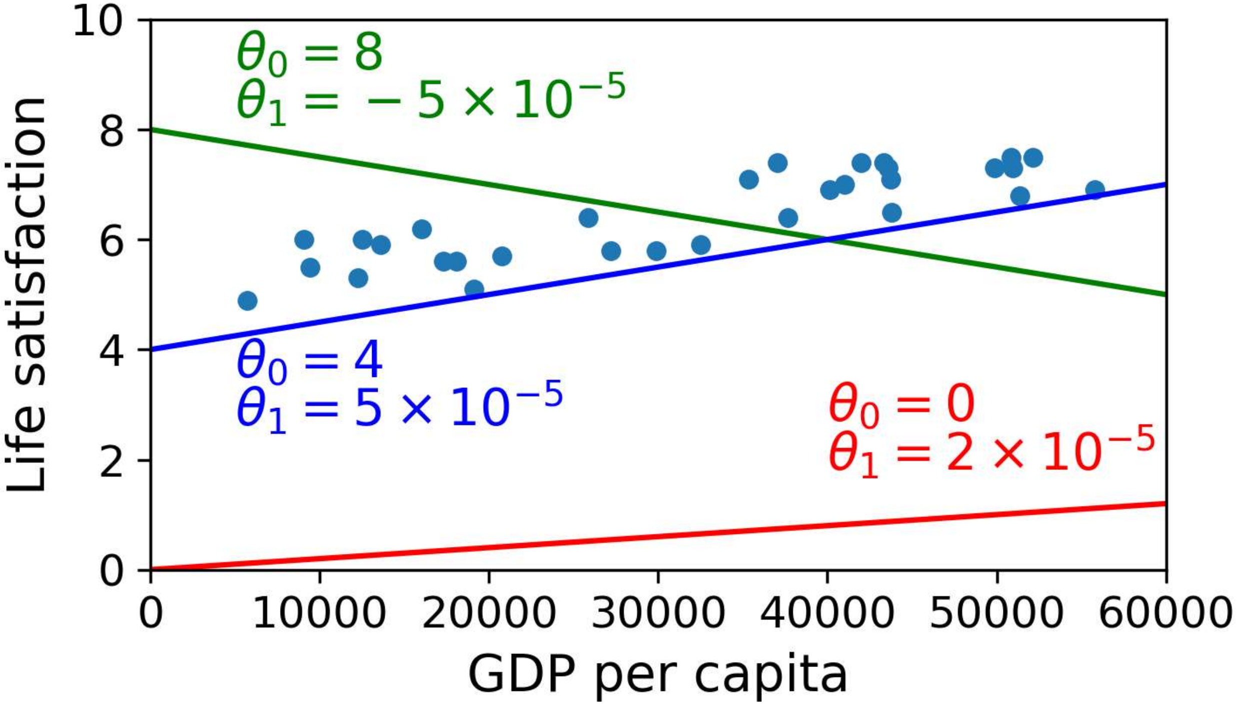
Donnerstag, 6. Mai 2021 09:58

Is there a trend?



Linear model: $sat = \theta_0 + \theta_1 * gdp\_per\_capita$

Finding good models?
How is "good" defined



Best Model via Linear Regression

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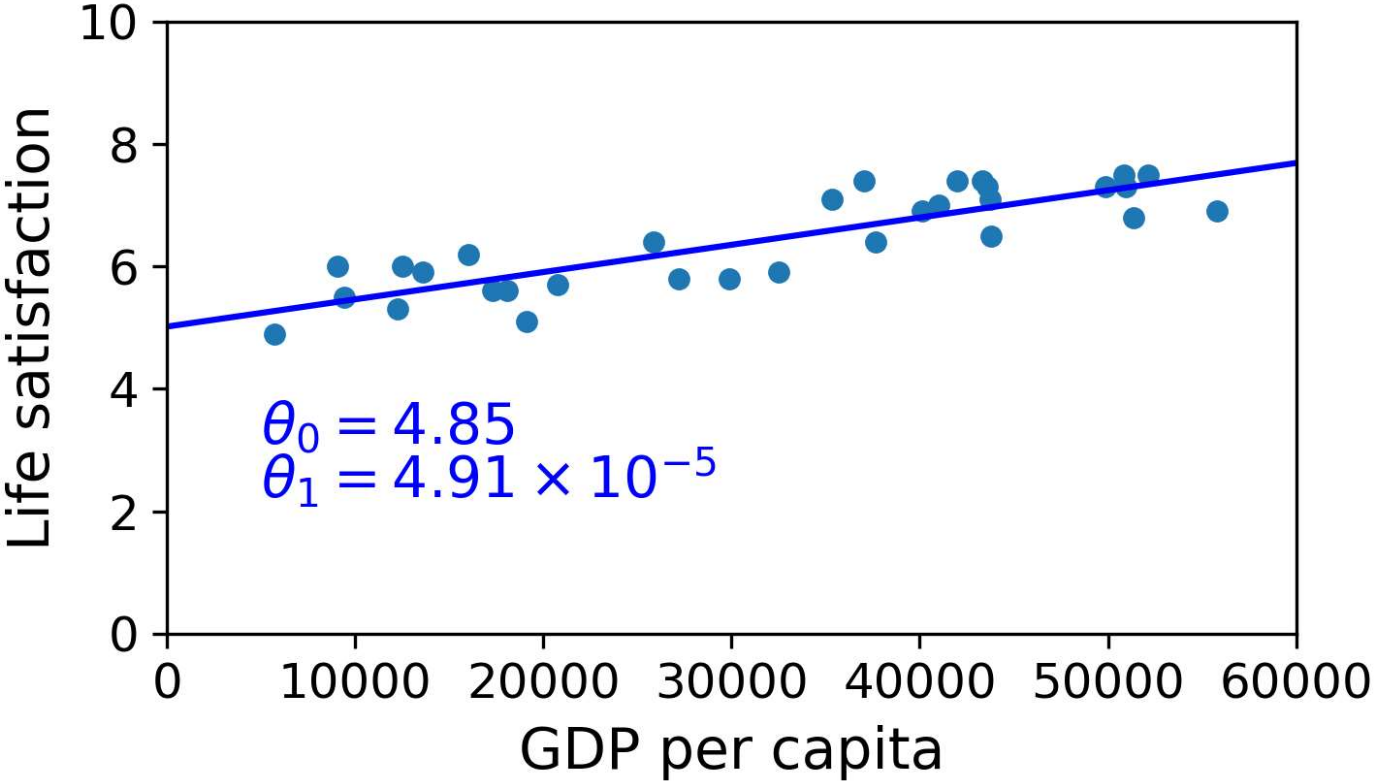

Prediction

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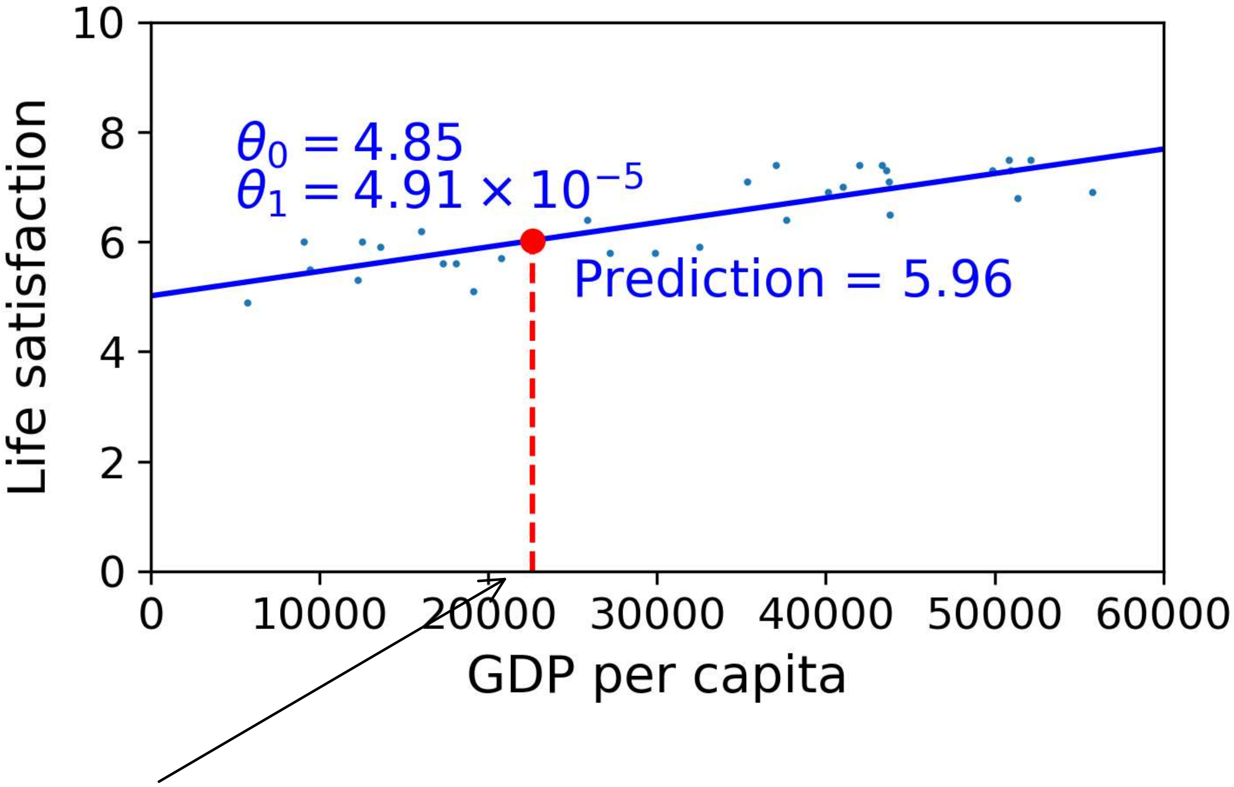

Take GDB per capita and predict sat

Learning from Data - Problems

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- Not enough data
- Data is not representative
- Bad data quality
- Irrelevant features
- Overfitting
- Underfitting

Data not representative

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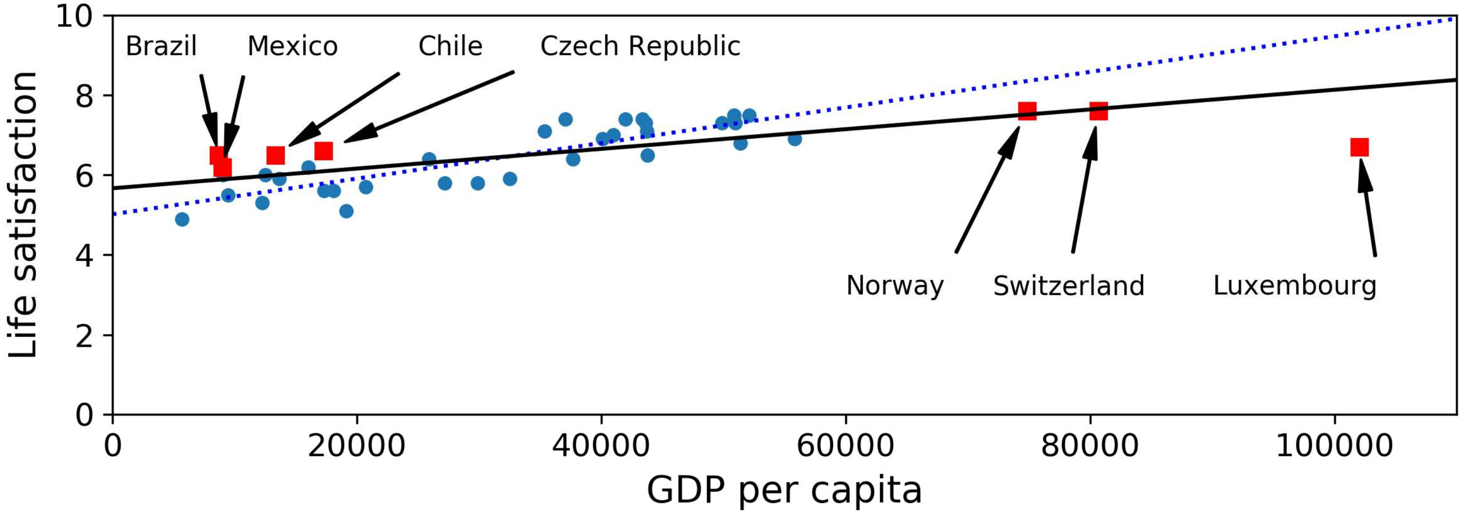
Adding Brasil, Mexico, …, Norway, … changes model
Linear model does not really fit



Countries with high GDP per capita but lower sat
Countries with low GDP per capita but higher sat

Overfitting

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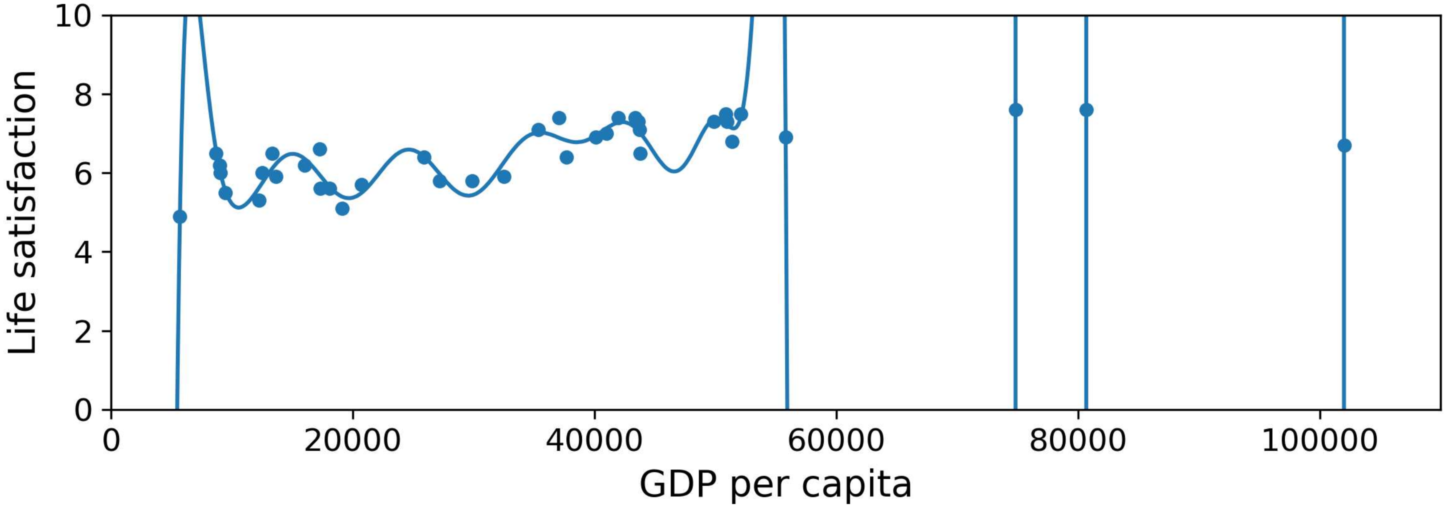
Komplex model
Polynomial with high degree



Goal:

- Find relationship between features and targets
- Discover patterns
- Find correlations

Common terms:

- Machine Learning
- Data Mining
- Statistical Learning

Reasons why learning from data

- Constructing an abstraction for the relationship between features and targets (model)
- Complex problems where algorithmic formulation is hard
- Environments where data changes continuously
- Problems that require a long list of complicated rules

Example Spam Filter - Rule-based

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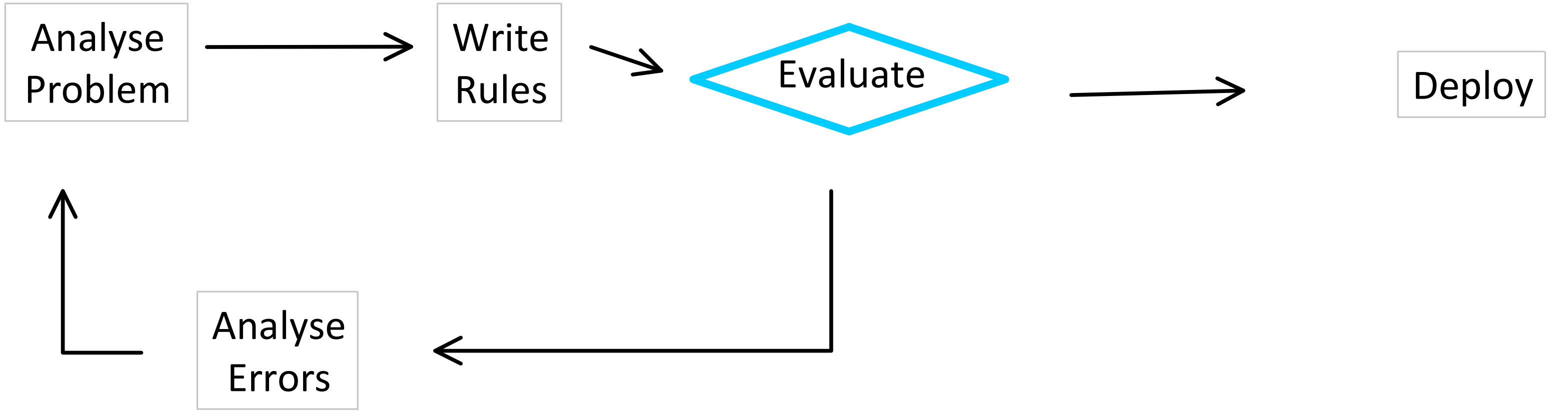
Analysis of spam emails, identifiction of offensive words and phrases



Long list of rules - not easily maintainable
Adaption to changes are hard to do

Example Spam Filter - Learned from Data

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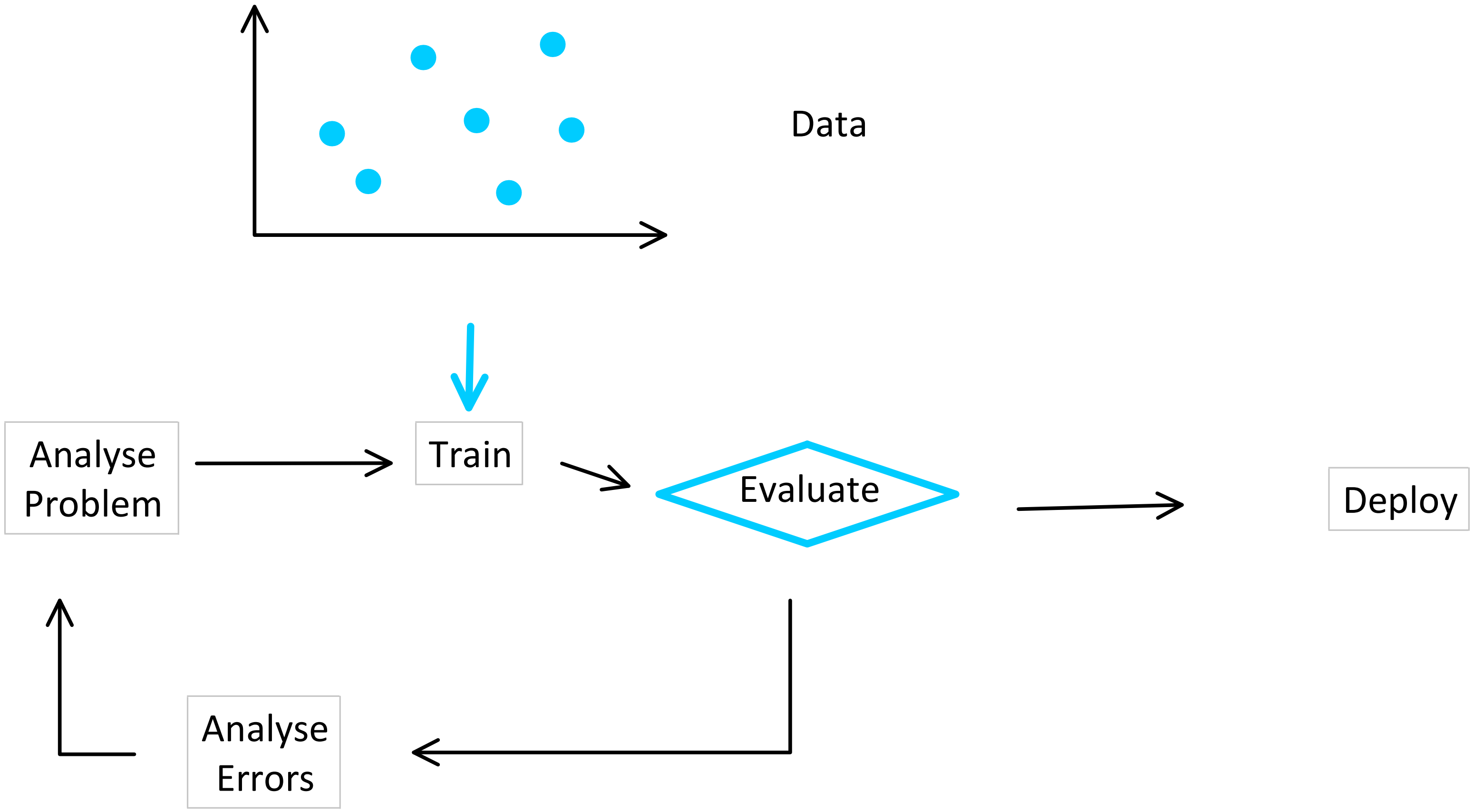
Identification auf words and phrases by learning from data using suitable algorithms.



Data

Analyse Problem

Train

Evaluate

Deploy

Analyse Errors

Adaption to changes much easier: just take new data and learn again

Features and Targets

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Features

- Attributes that characterize a particular instance/object
- Also called predictors

Targets

- Scalar value in case of regression
- Nominal value in case of classification

Features / Targets

Regression

Bedrooms	Bathrooms	Latitude	Longitude	Price
1	1	40.71	-73.94	3055
…	…	…	…	…

Classification

Income	Job	IsMarried	Age	Loan
…	…	…	…	Yes
…	…	…	…	No

Feature values, vectors, matrix

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x1	=
x2	=
…	
xm	=

x11	x12	x13	…	x1n
x21	x22	x23	…	x2n
…				
xm1	xm2	xm3	…	xmn

y1
y2
…
ym

X

y

xi	Feature vector
xij	Feature value
yi	Target value
X	Feature matrix
y	Target vector

- All entries must be numbers, i.e. all feature and target values must be transformed into numbers
- Each feature vector is one instance/object

Visualization of Features and Targets

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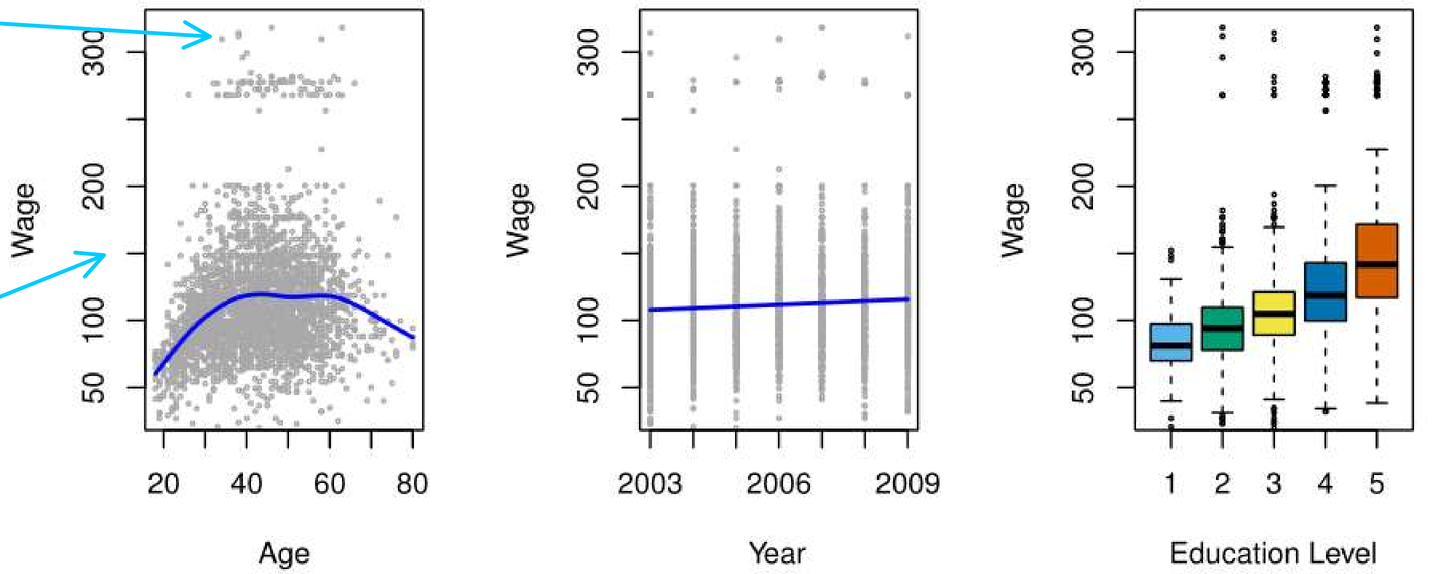
each point is one person (object, instance)



Scatterplot

Boxplot

Learn from Training Data

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Learning should

- be as accurate as possible
- generalize to new data as good as possible

Conflicting goals!

Learning Regimes

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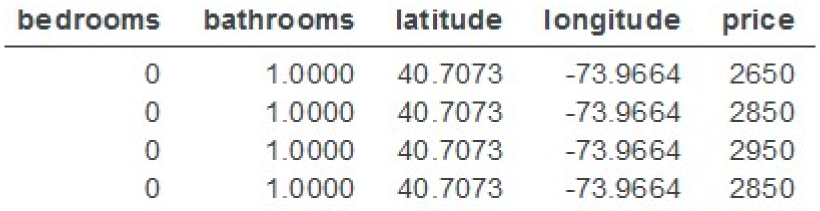
Freitag, 18. Juni 2021 09:41

Just remember target value wrt. feature combination

- Good accuracy
- Bad generalization
- Combinations might not exist
- Combinations might not be unique



bedrooms	bathrooms	latitude	longitude	price
0	1.0000	40.7073	-73.9664	2650
0	1.0000	40.7073	-73.9664	2850
0	1.0000	40.7073	-73.9664	2950
0	1.0000	40.7073	-73.9664	2850

Build coarse grained groups, e.g. price per bedrooms and bathroom combinations

- Bad accuracy
- Good generalization

Bedrooms	Bathroom	Price
1	1	3000
2	1	3700
1	2	3010
…	…	…

Learn from neighbors
(k nearest neighbor)

- Powerful
- But must store complete training data set
- No real learning
- Finding nearest neighbors requires search, might be slow

Build a linear model:

Price = w0 +
w1*bedrooms +
w2*bathrooms +
w3*latitude +
w4*longitude

Might be not suitable: higher number of bathrooms doesn't mean higher price

Dimensions of Machine Learning

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Supervision

- Supervised
- Unsupervised
- Semisupervised
- Reinforcement Learning

Data Usage

- Batch
- Online

Method

- Instance-Based
- Model-Based

Supervised - Regression

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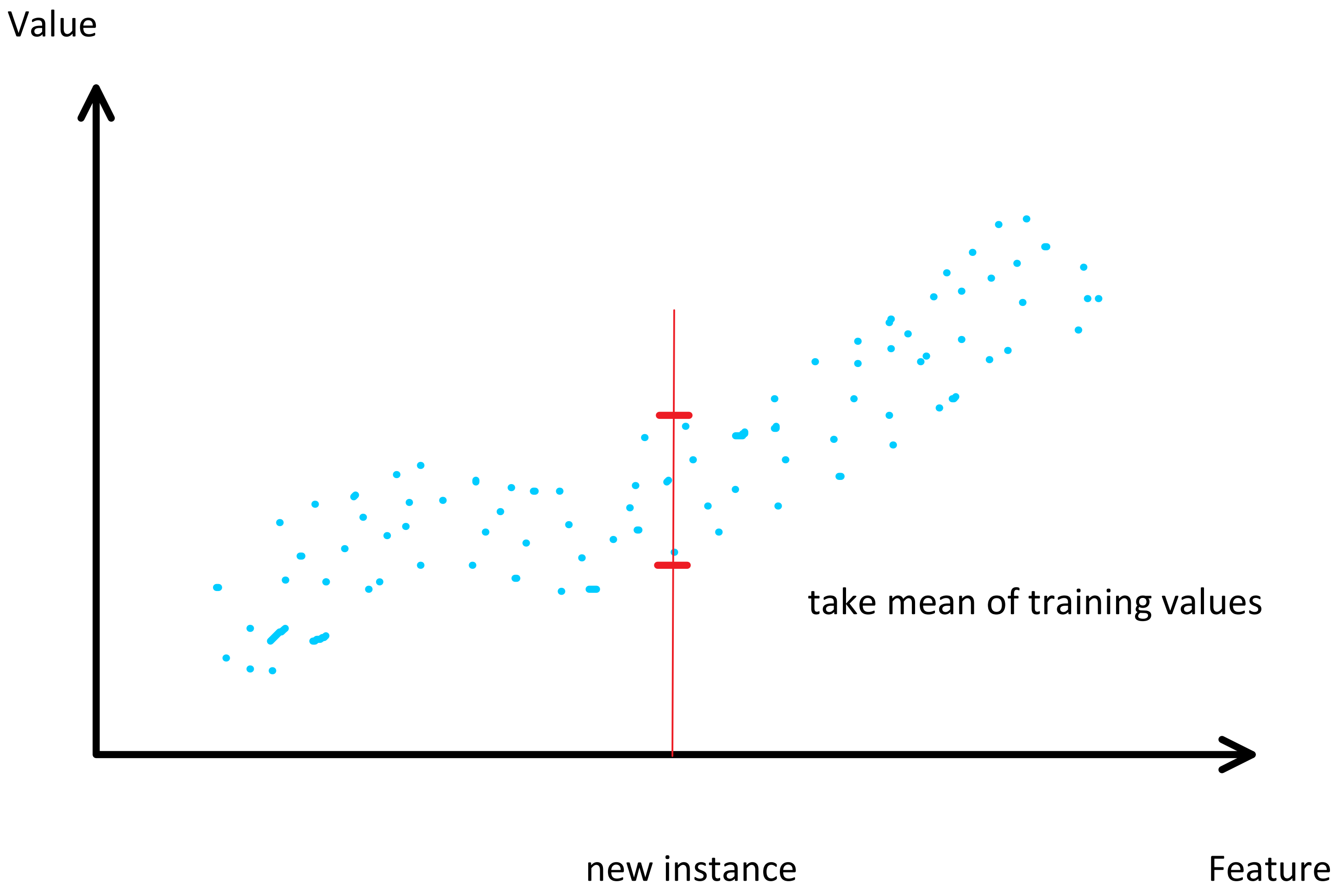
Features of instances + target values



Supervised - Classification

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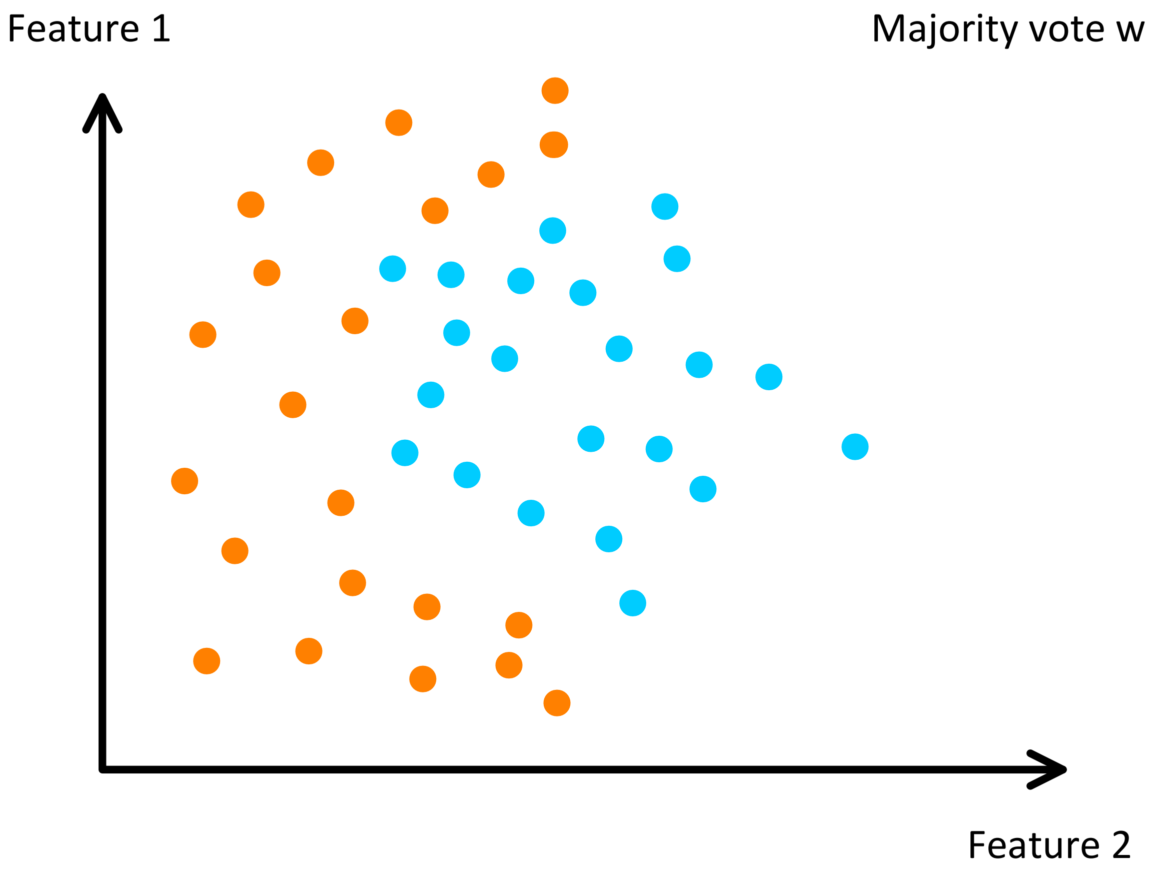

Majority vote wrt. neighbors

Class tags:

- Class1: orange
- Class2: blue

Unsupervised - Clustering

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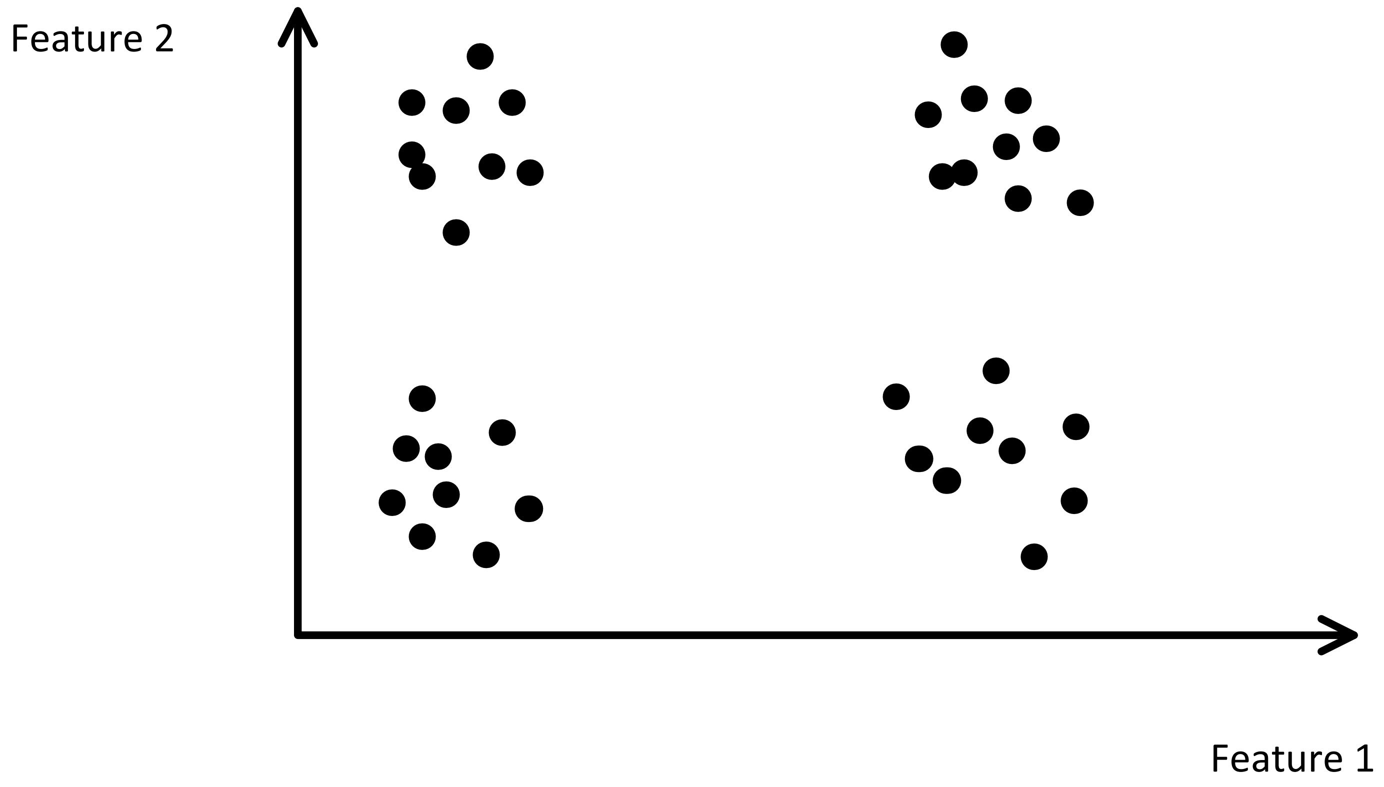
Features of instances and no class tags



Find sets of data with strong coupling
and large distance between sets

Unsupervised - Anomaly Detection

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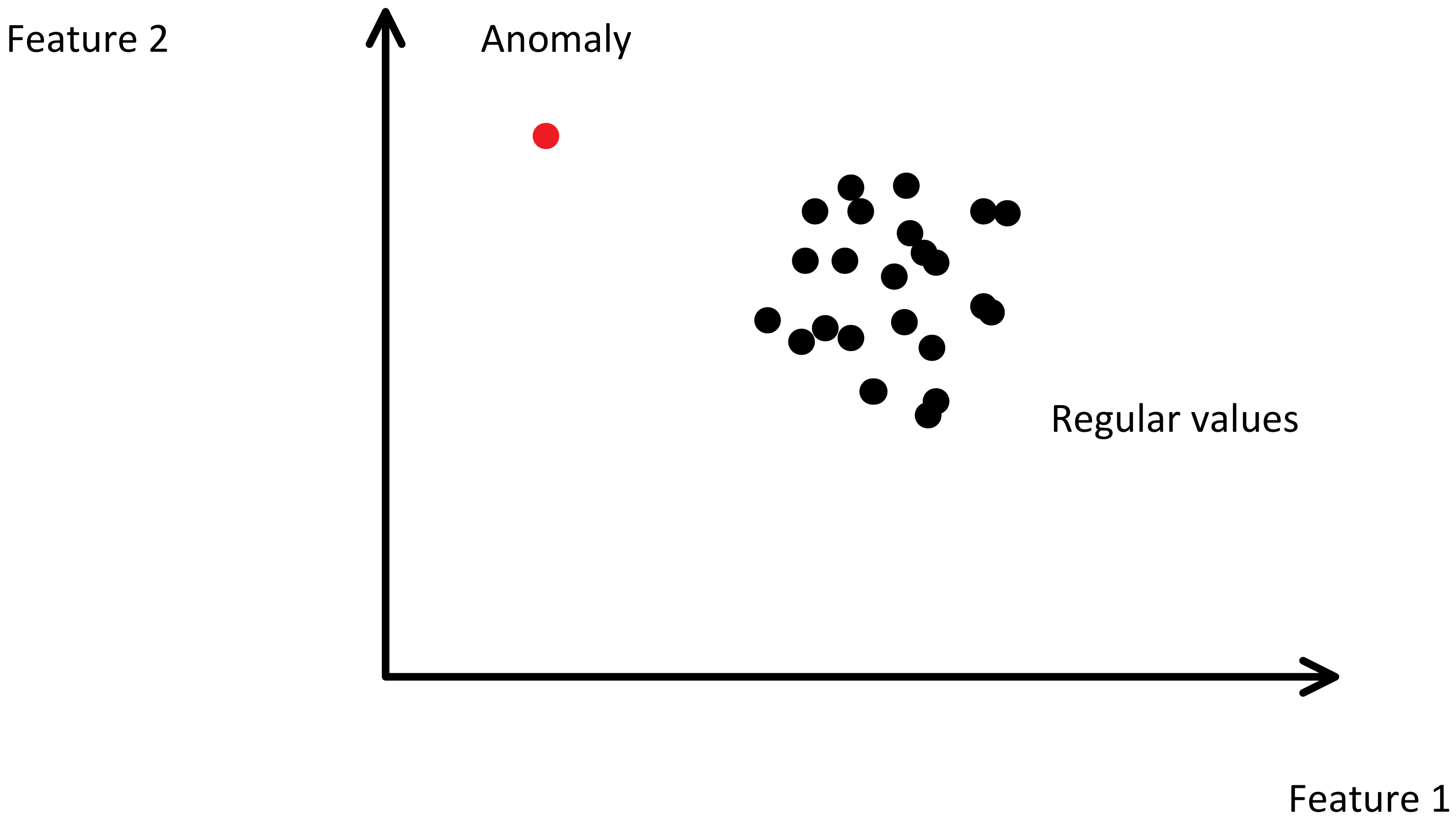
Features of instances

Compute cluster of regular instances

Calculate distance



Unsupervised - Association Learning

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Market Basket Analysis
Learning of rules

{ Milk, Bread } -> { Butter }

{ PC, Monitor, Graphics Card } -> { PC Game }

Friday evening
{ Beer } -> { Diapers }

Semi Supervised

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Example: Identification of persons on your private fotos

- Upload of fotos
- System detects same persons on different fotos (unsupervised)
- You tag with name (supervised)

Reinforcement Learning

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- Agent observes environment
- Chooses action according to strategy
- Executes action
- Gets reward or punishment
- Learns from feedback - adopts strategy
- Repeat until optimal solution found (or at least a satisfying solution)

Data Usage

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Batch Learning

- Take all data at once and learn from it
- Complete new take if data changes
- Requires long execution time and ressources in case of large training data set

Online Learning

- Incremental usage of data
- Single data points or minibatches
- Faster adoption to new data
- More volatile models

Instance-Based Learning

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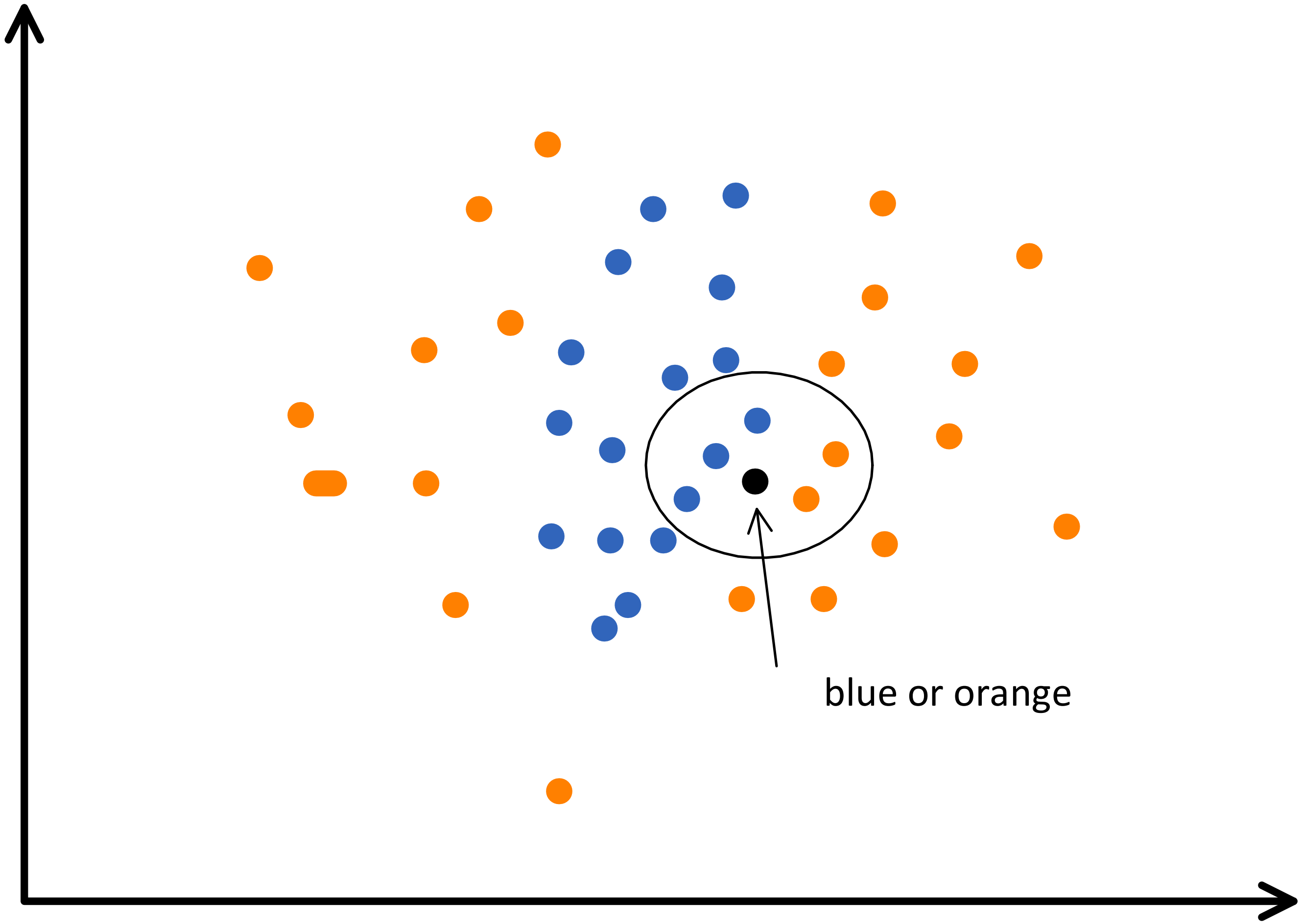
Similarity to training data



Keep all training data

Use distance metrics

Model-Based Learning

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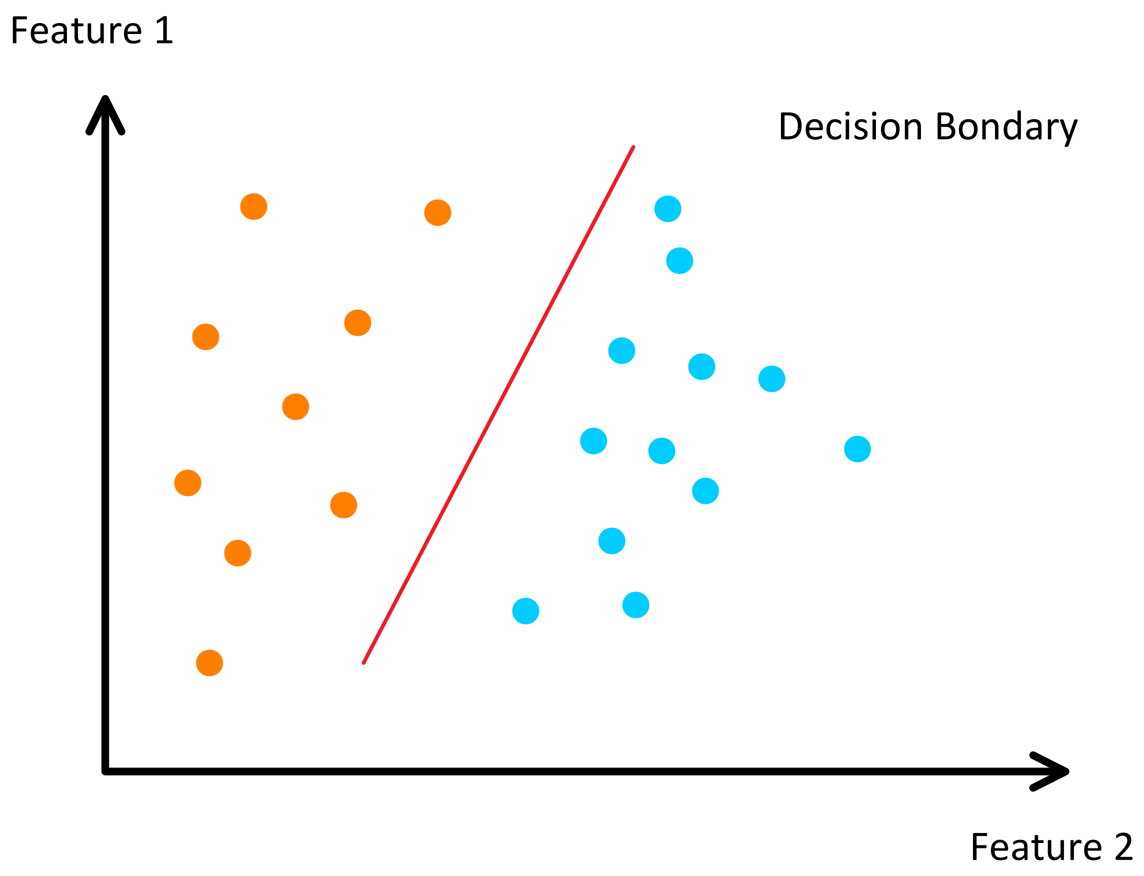

No storage of trainings data
Just keeping model parameters, e.g. slope and intercept of separating line

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