Module 3

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UTM UNIVERSITI TEKNOLOGI MALAYSIA

MLDS MACHINE LEARNING FOR DATA SCIENCE

Who Am I?

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Founder, CTO at Appoint AI

Graduate Research Assistant at UTM MLDS

Curator at Machine Learning Weekly - mlweekly.com

AppointAI

UTM MLDS MACHINE LEARNING FOR DATA SCIENCE

ML

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What We've Learned in Previous Modules

- Anaconda Package Manager
- Install and run code on Jupyter
- Version Controlling Concept
- Git
- GitHub and GitHub Desktop

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What We've Learned in Previous Modules

- Statistics
- Linear Algebra
- Optimization
- Bayes Rule
- Maximum Likelihood, Gradient Descent, ...

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What We've Learned in Previous Modules

- Python Basics (Syntax, Arrays, Loops, Functions and etc)
- Numpy
- Matplotlib
- Exploratory Data Analysis
- SciPy - Scientific Computing Toolkit

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Workshop Materials

GitHub: **UTMMLDS**

https://github.com/utmmlds

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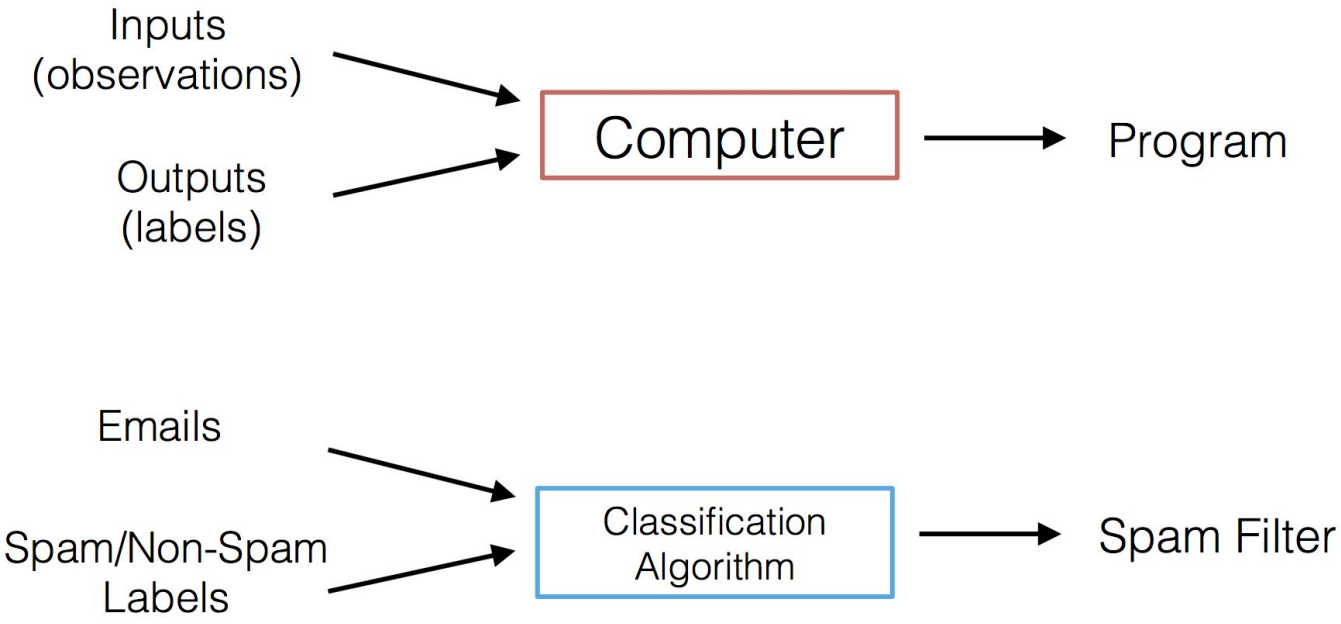
What is Machine Learning?



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3 Types of Learning

- Supervised
- Unsupervised
- Reinforcement

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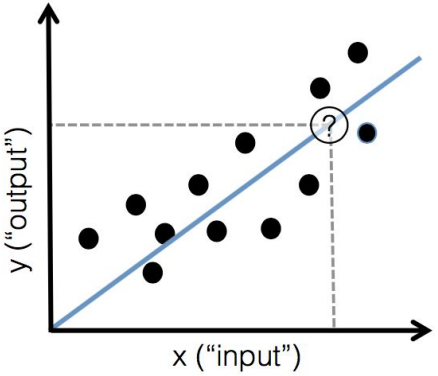
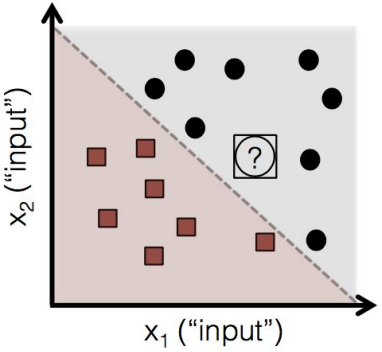
Working with Labeled Data

Supervised Learning

Regression



Classification



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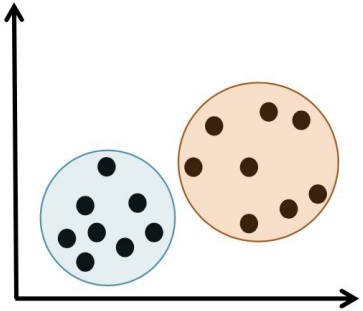
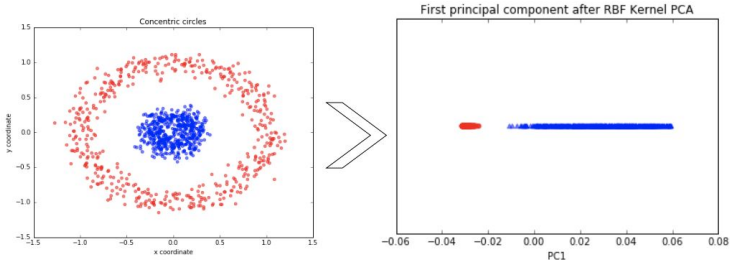
Working with **Un**labeled Data

Unsupervised Learning

Clustering



Compression



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Topics

1. Introduction to Machine Learning
2. **Linear Regression**
3. Introduction to Classification
4. Feature Preprocessing & scikit-learn Pipelines
5. Dimensionality Reduction: Feature Selection & Extraction
6. Model Evaluation & Hyperparameter Tuning

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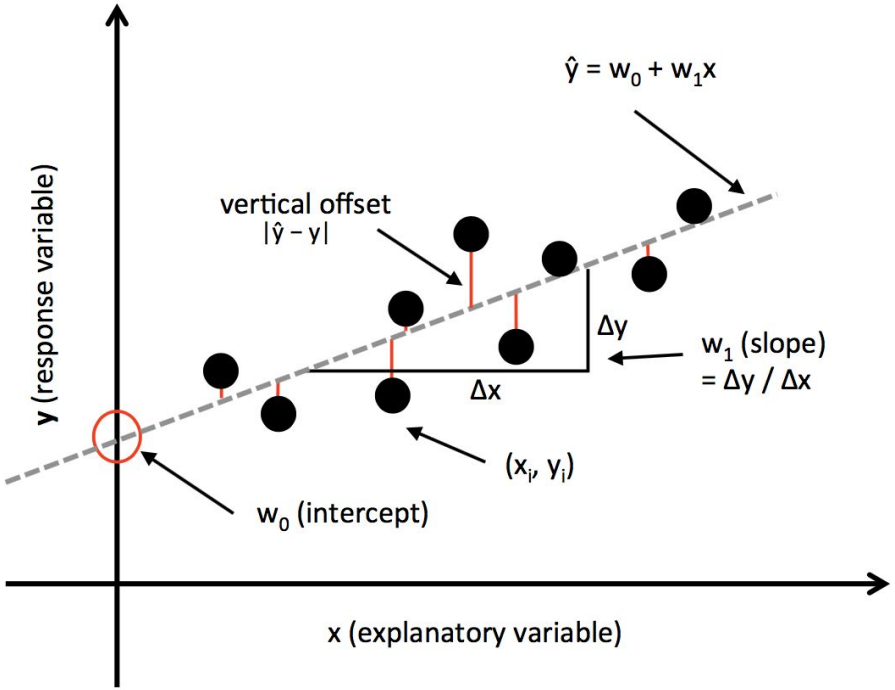
Simple Linear Regression



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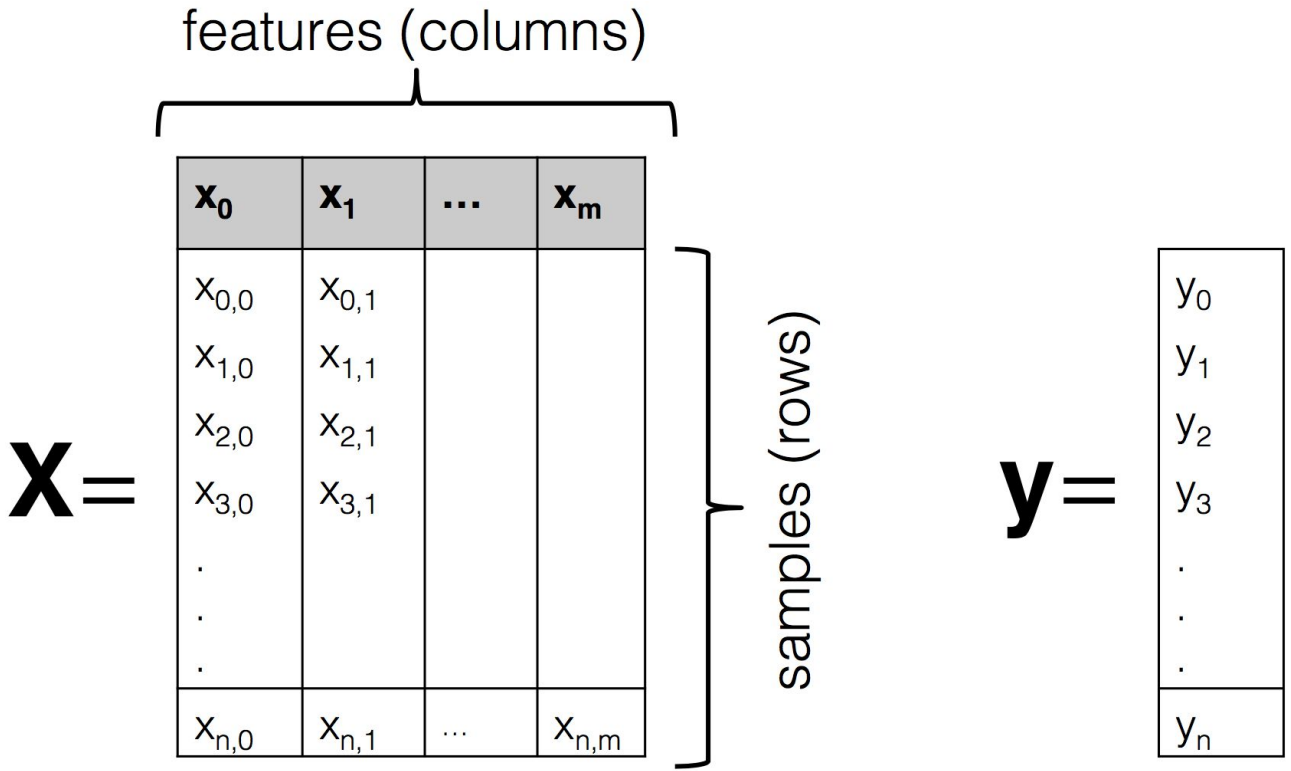
Data Representation



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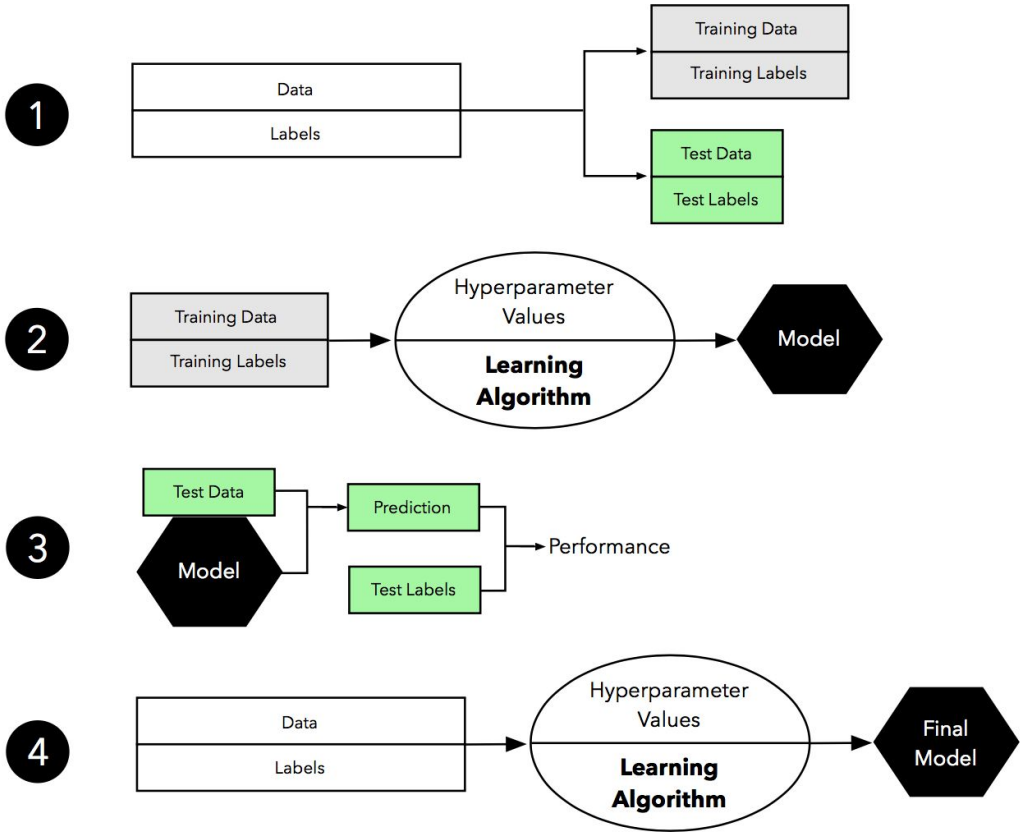
“Basic” Supervised Learning Workflow



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Coding Time!

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Topics

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Scikit-learn API

```
class SupervisedEstimator(...):
    def __init__(self, hyperparam, ...):
        ...
    def fit(self, X, y):
        ...
        return self
    def predict(self, X):
        ...
        return y_pred
    def score(self, X, y):
        ...
        return score
    ...
```

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Iris Dataset

Iris-Setosa

Iris-Setosa

Iris-Versicolor

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Iris Dataset

features (columns)

$\mathbf{X} =$

	sepal length [cm]	sepal width [cm]	petal length [cm]	petal width [cm]
1	5.1	3.5	1.4	0.2
2	4.9	3.0	1.4	0.2
50	6.4	3.5	4.5	1.2
	.			
	.			
	.			
150	5.9	3.0	5.0	1.8

samples (rows)

$\mathbf{y} =$

setosa
setosa
versicolor
.
.
.
virginica

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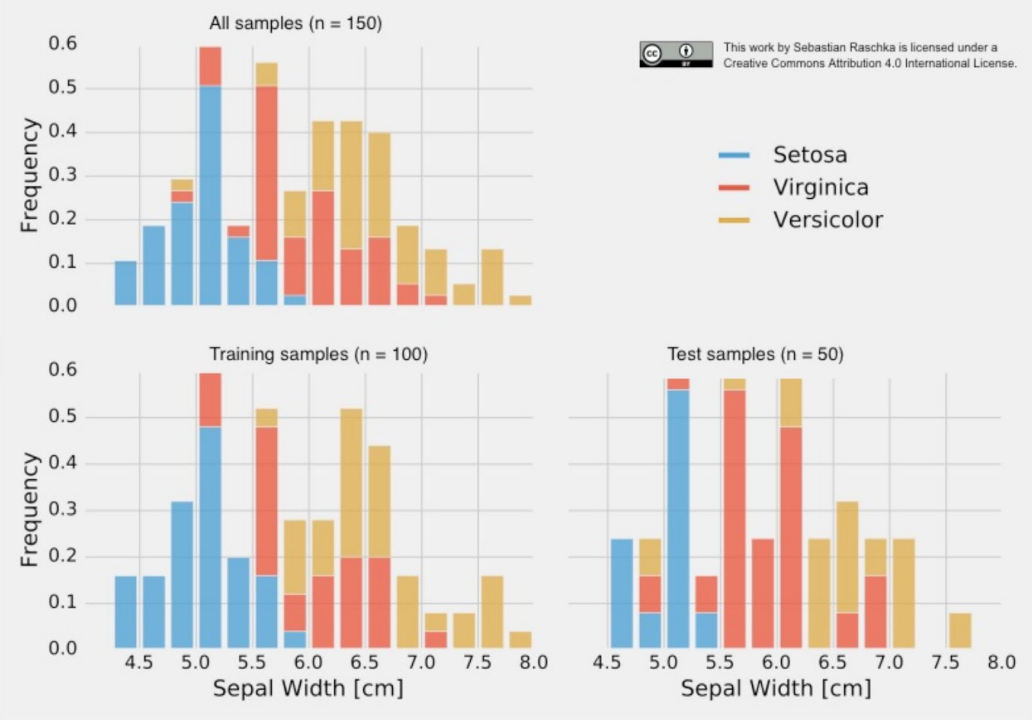
Note about Non-Stratified Splits



- training set → 38 x Setosa, 28 x Versicolor, 34 x Virginica
- test set → 12 x Setosa, 22 x Versicolor, 16 x Virginica

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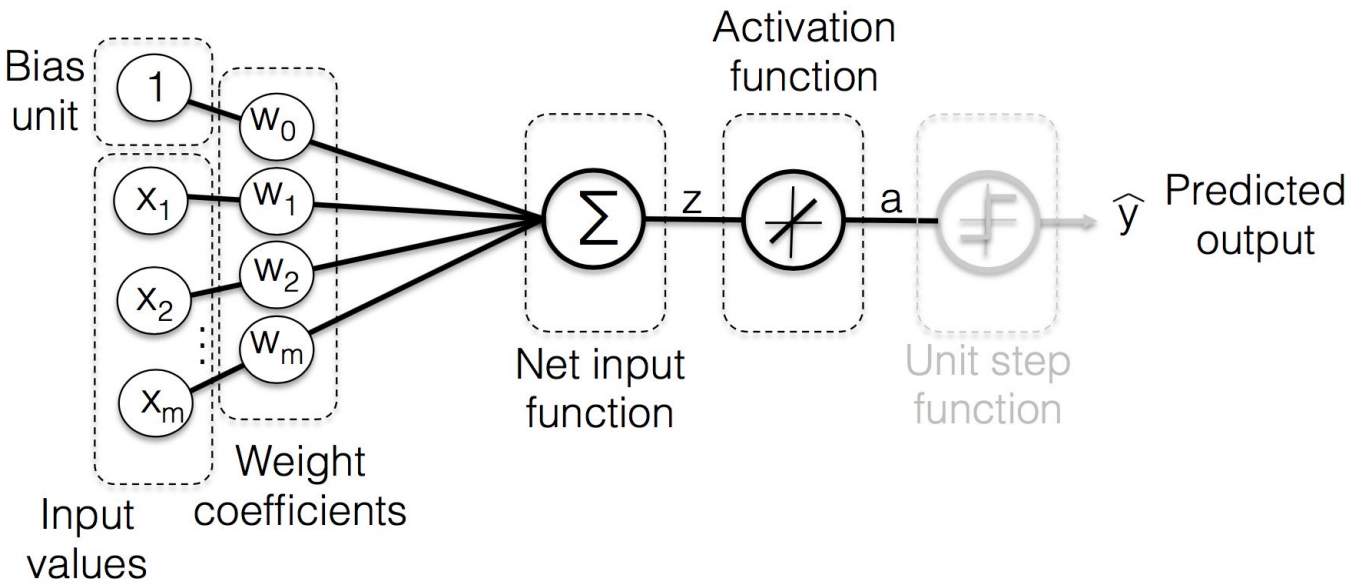
Linear Regression Recap



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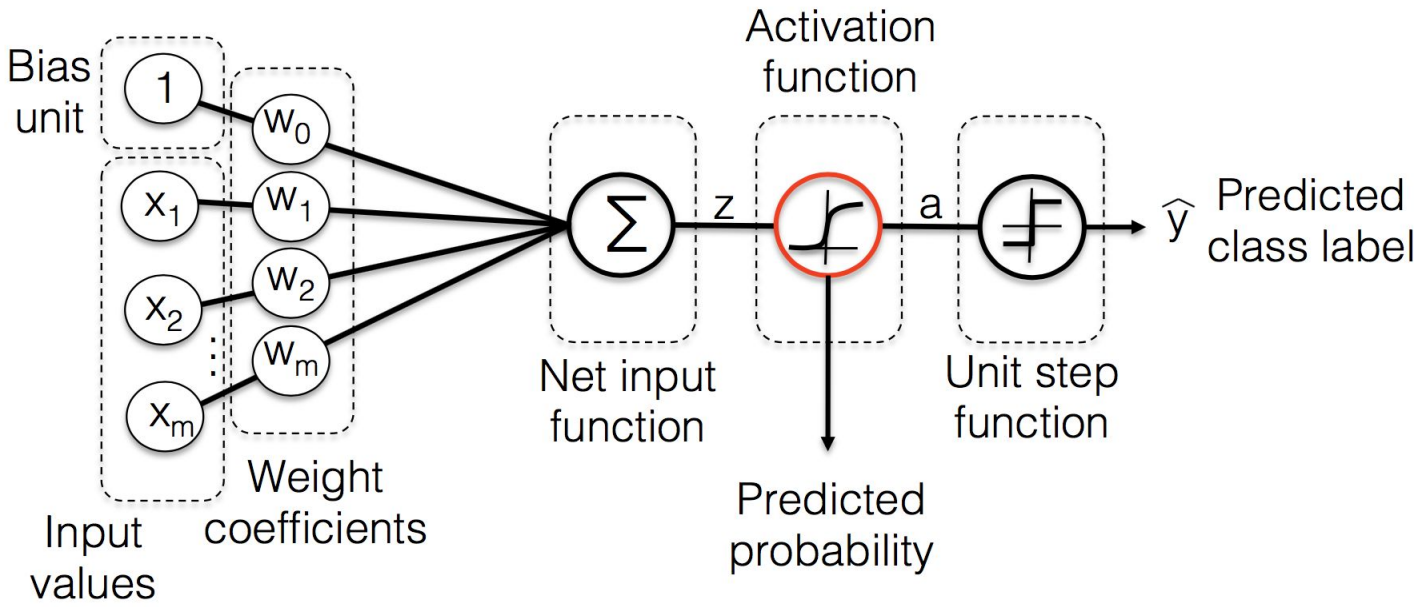
Logistic Regression, a Generalized Linear Model



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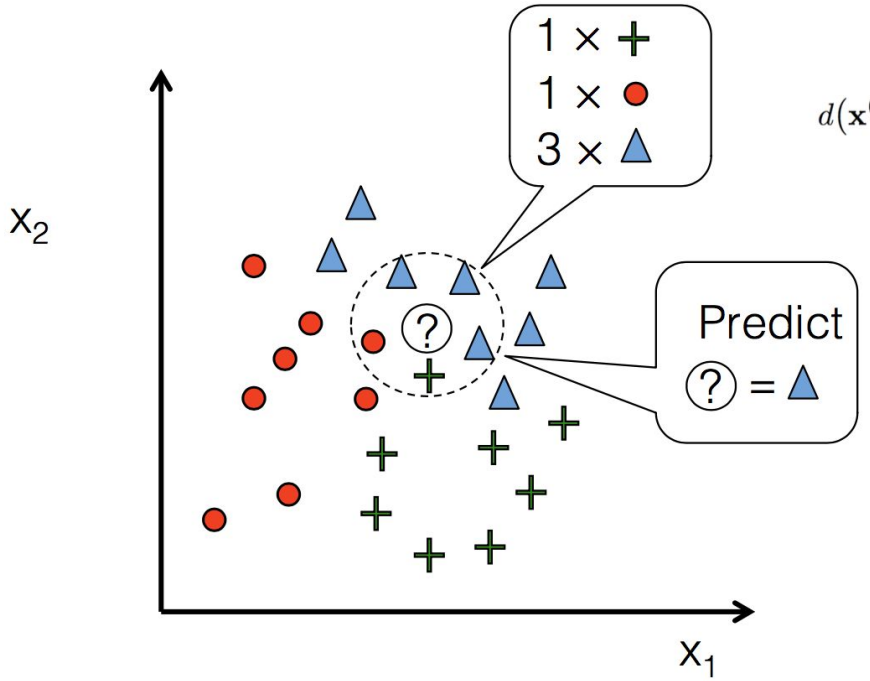
A “Lazy Learner:” K-Nearest Neighbors Classifier



$$d(\mathbf{x}^{(i)}, \mathbf{x}^{(j)}) = \sqrt[p]{\sum_k |x_k^{(i)} - x_k^{(j)}|^p}$$

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Categorical Variables

color	size	price	class label
red	M	$10.49	0
blue	XL	$15.00	1
green	L	$12.99	1

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Encoding Categorical Variables

color	size	price	class label
red	M	$10.49	0
blue	XL	$15.00	1
green	L	$12.99	1

red	blue	green
1	0	0
0	1	0
0	0	1

size
0
2
1

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Feature Normalization

Min-max scaling

$$X_{norm} = \frac{X - X_{min}}{X_{max} - X_{min}}$$

Z-score standardization

$$z = \frac{x - \mu}{\sigma}$$

feature	minmax	z-score
1.0	0.0	-1.46385
2.0	0.2	-0.87831
3.0	0.4	-0.29277
4.0	0.6	0.29277
5.0	0.8	0.87831
6.0	1.0	1.46385

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Scikit-learn API

```
class UnsupervisedEstimator(...):
    def __init__(self, ...):
        ...
    def fit(self, X):
        ...
        return self
    def transform(self, X):
        ...
        return X_transf
def predict(self, X):
        ...
        return pred
```

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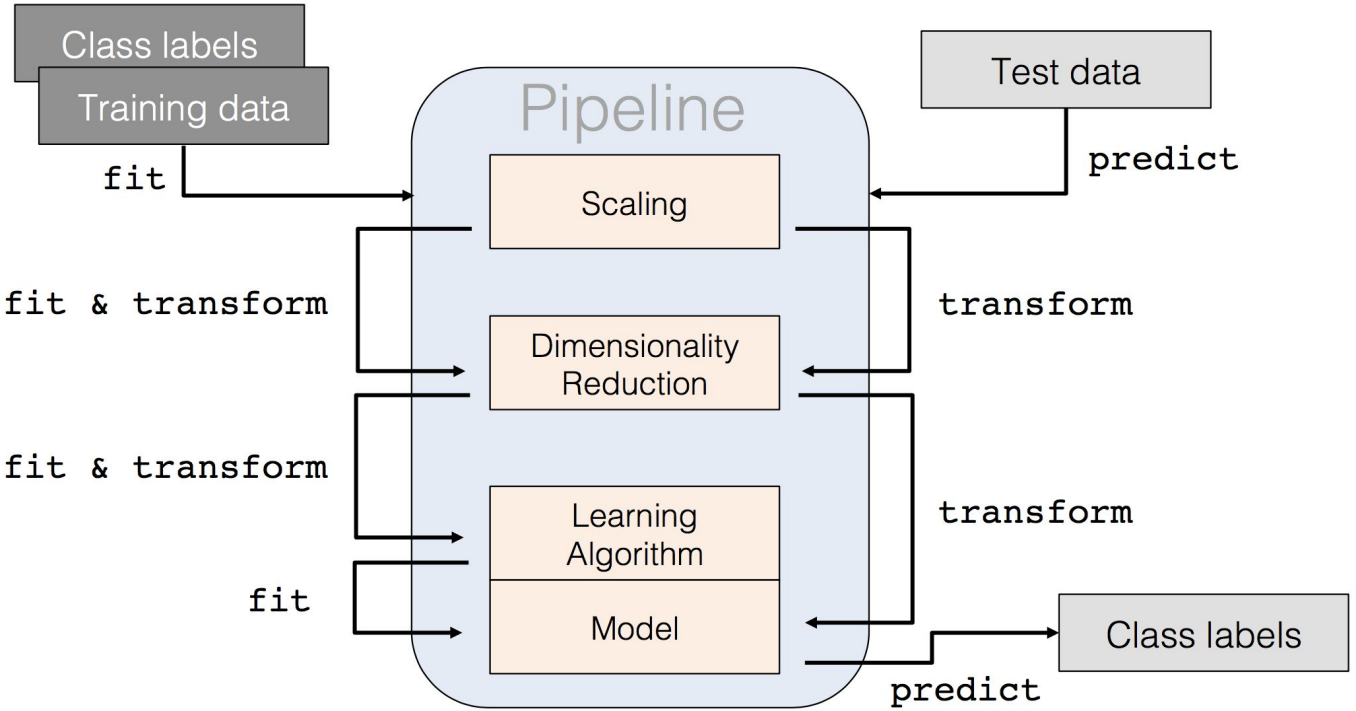
Scikit-learn Pipelines



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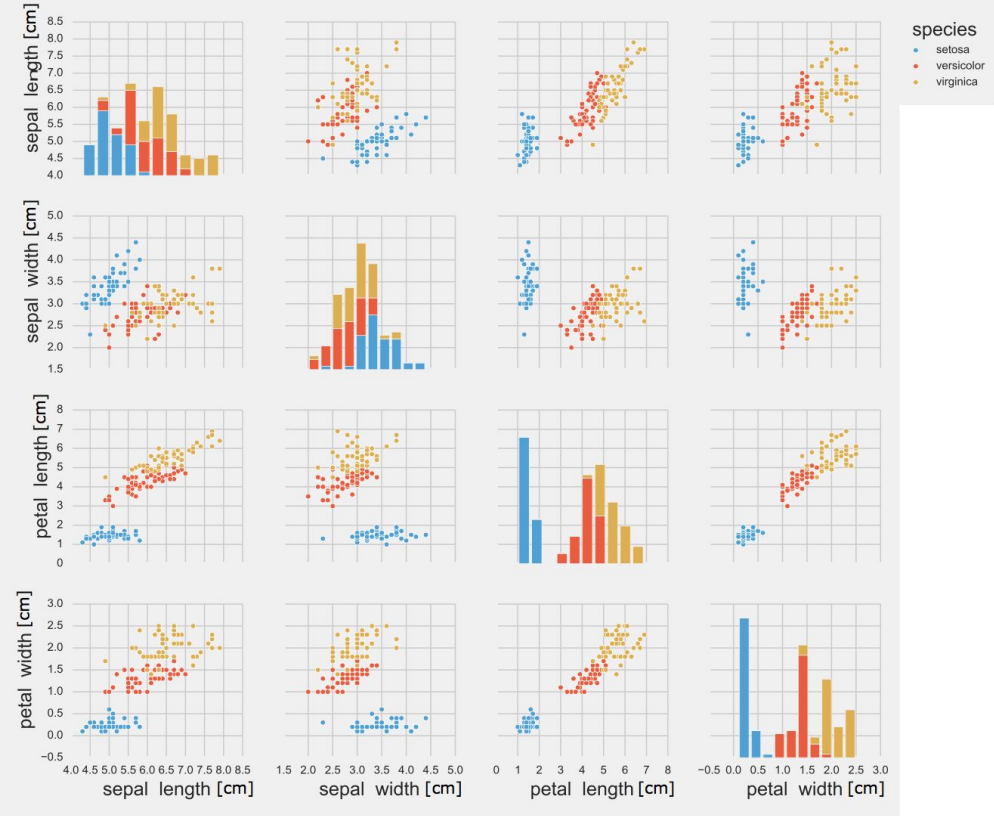
Dimensionality Reduction – why?



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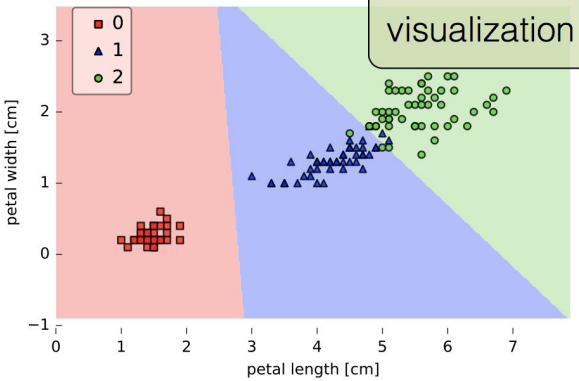
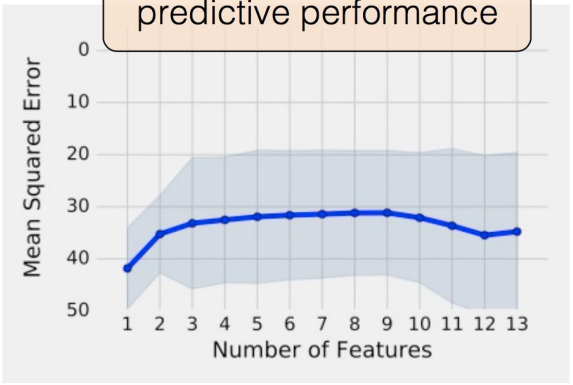
Dimensionality Reduction – why?



visualization & interpretability

storage & speed



predictive performance

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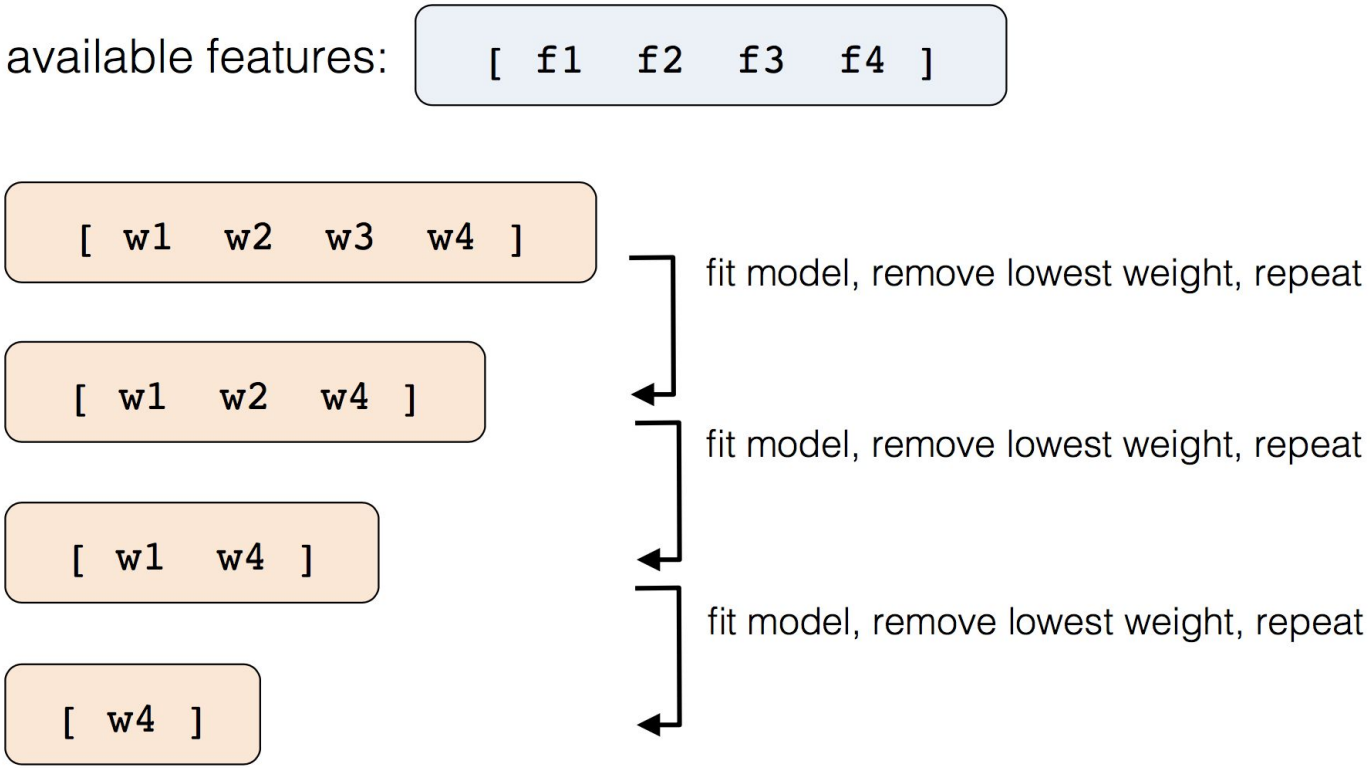
Recursive Feature Elimination



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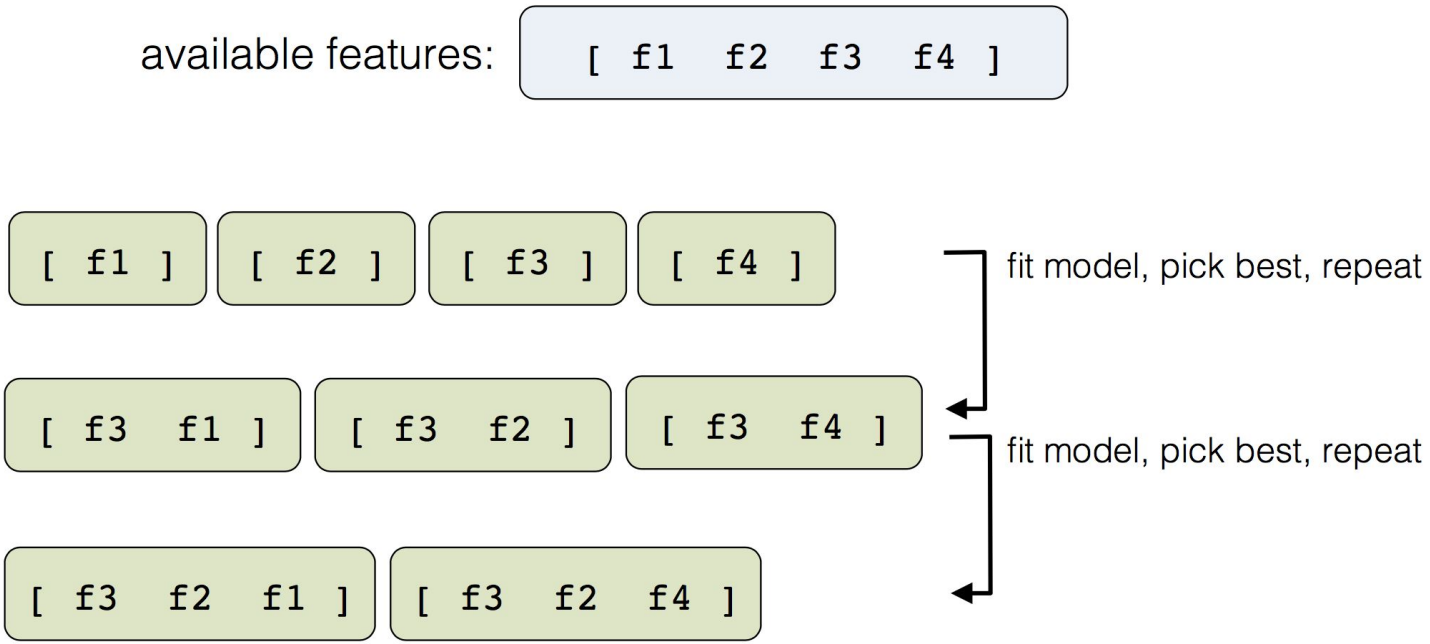
Sequential Feature Selection



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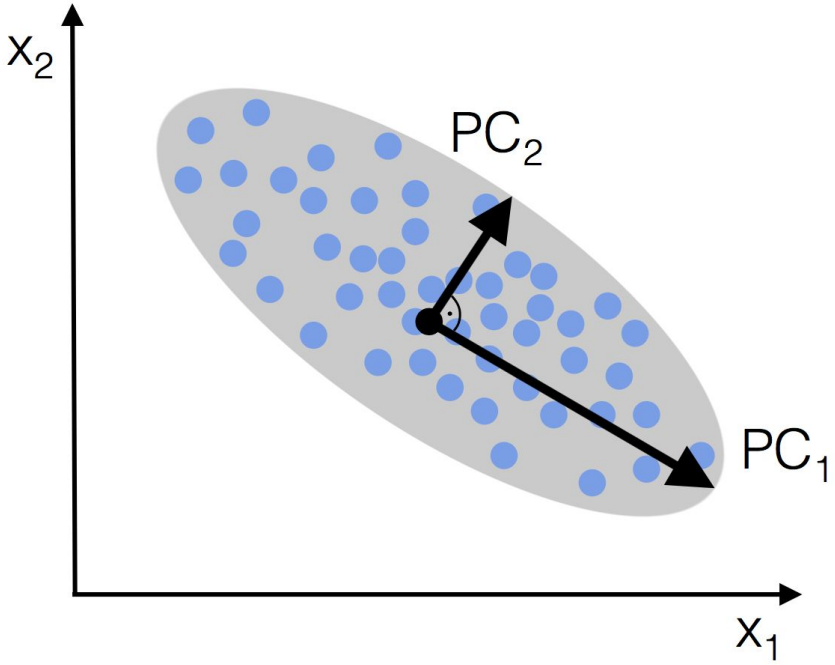
Principal Component Analysis



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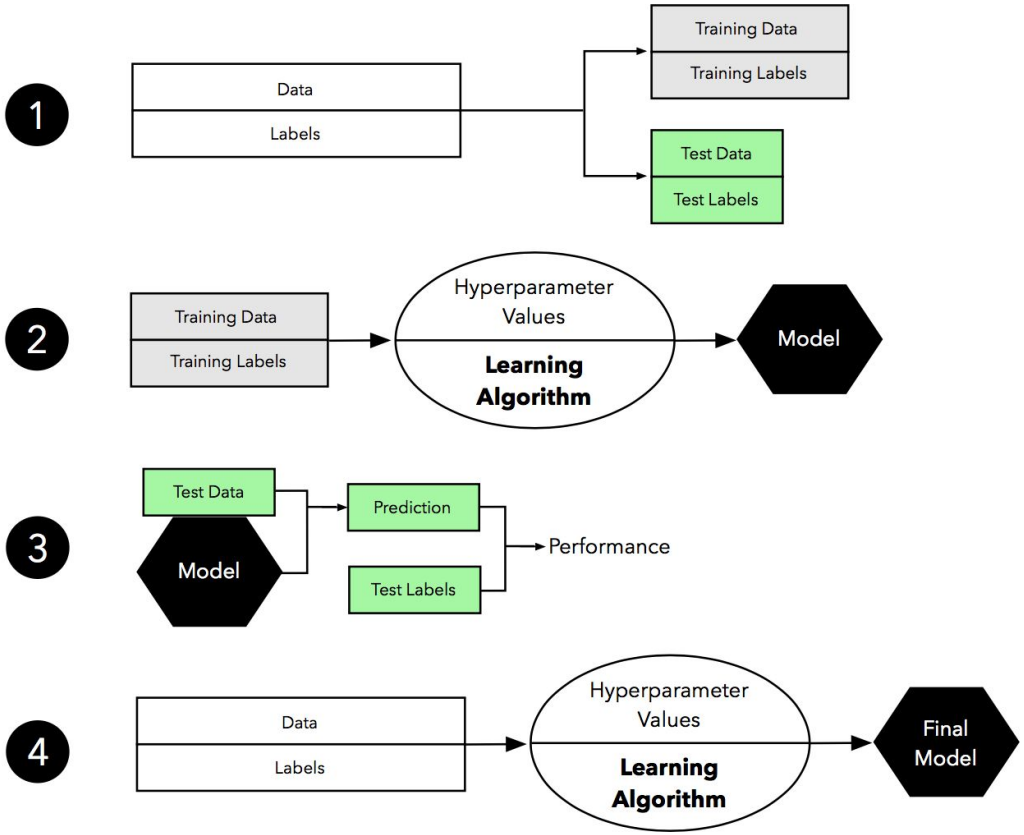
“Basic” Supervised Learning Workflow



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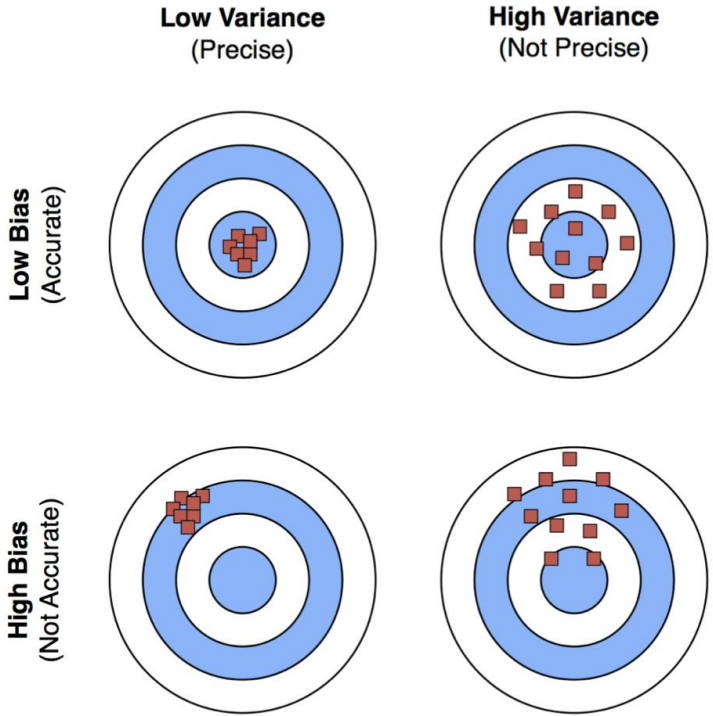
Bias and Variance



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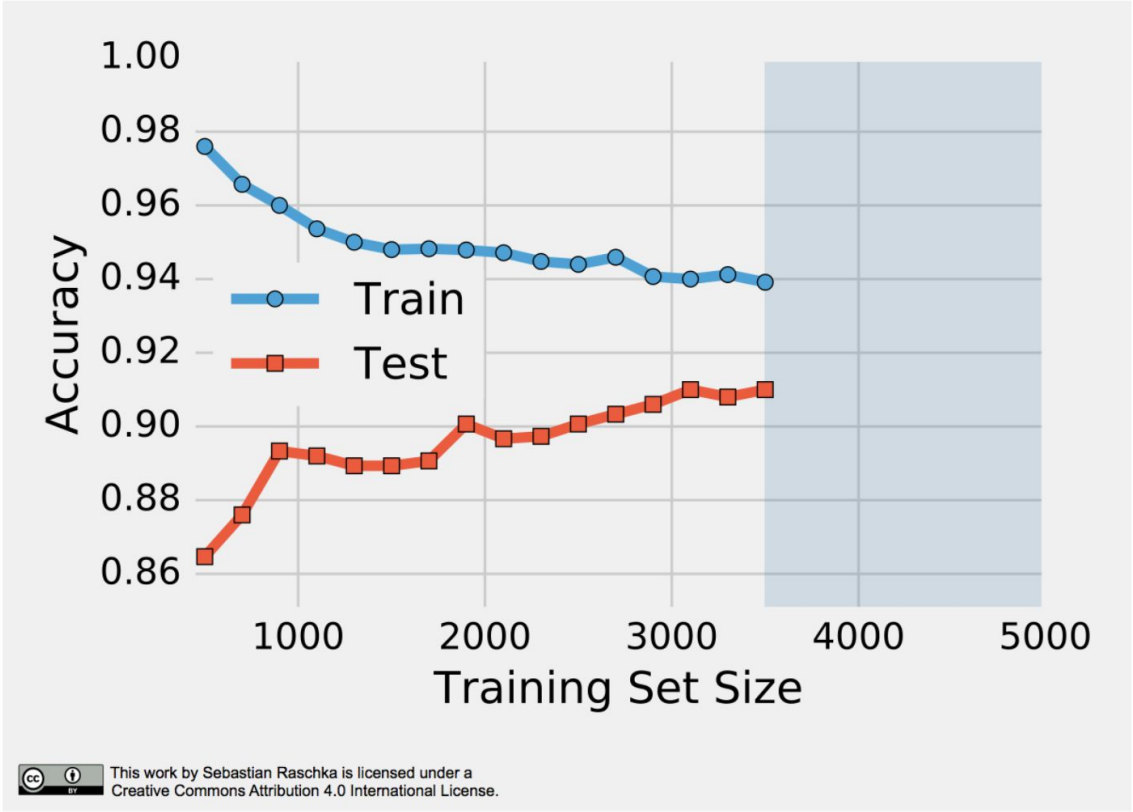
Learning Curves



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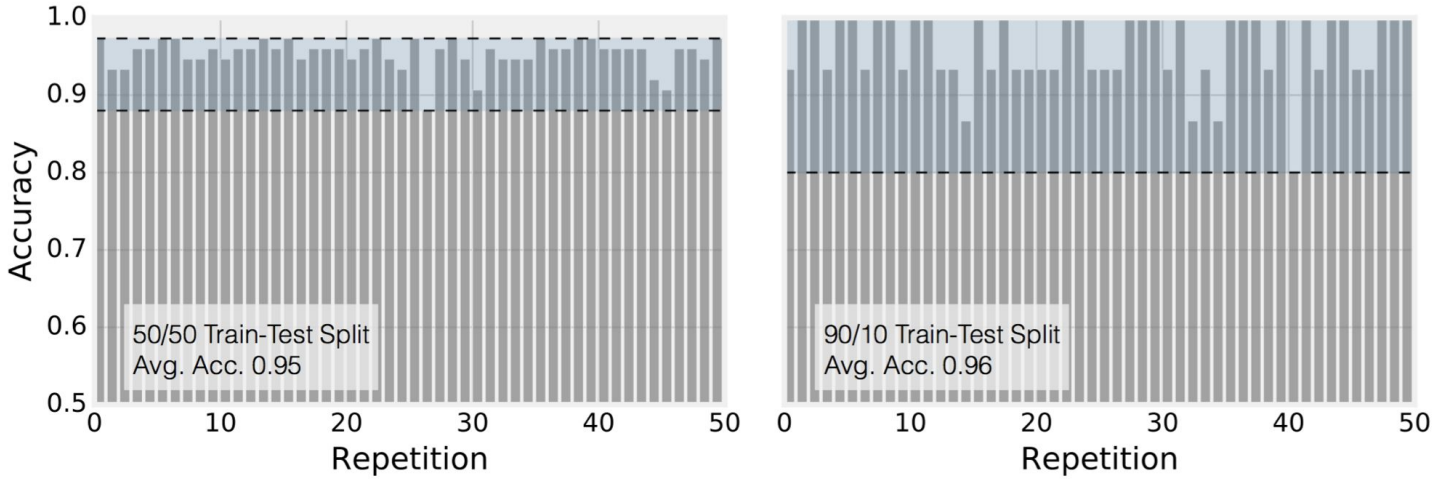
Repeated Holdout



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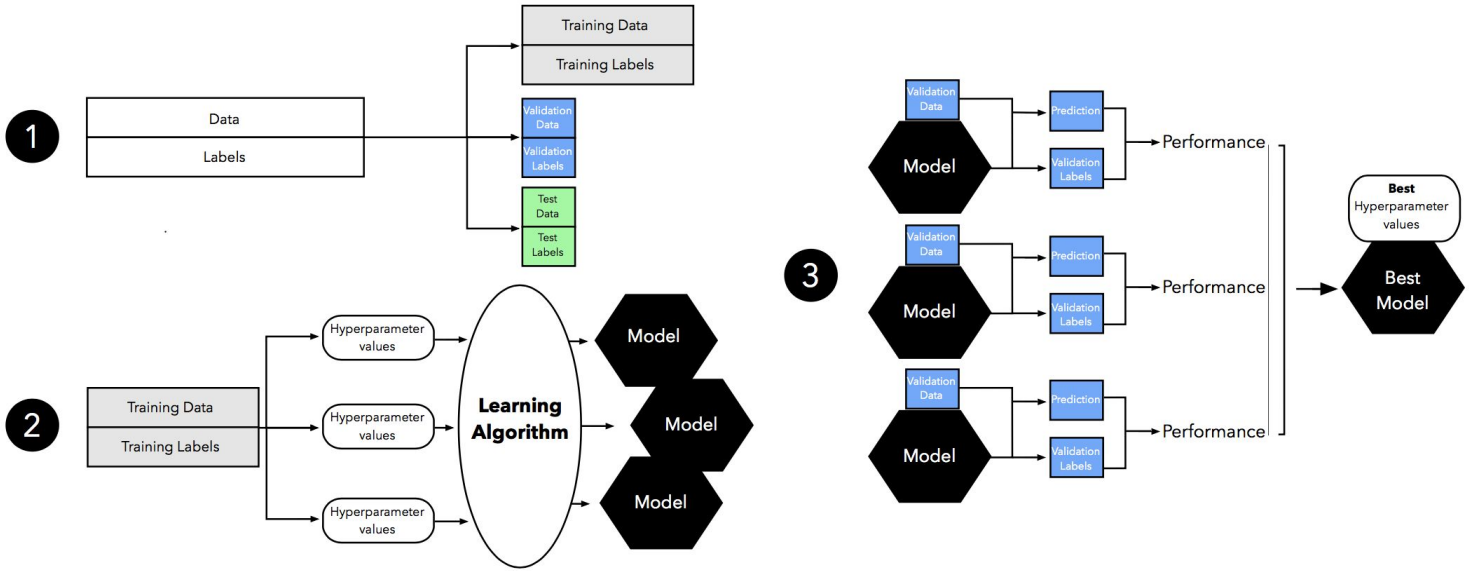
Holdout and Hyperparameter Tuning I



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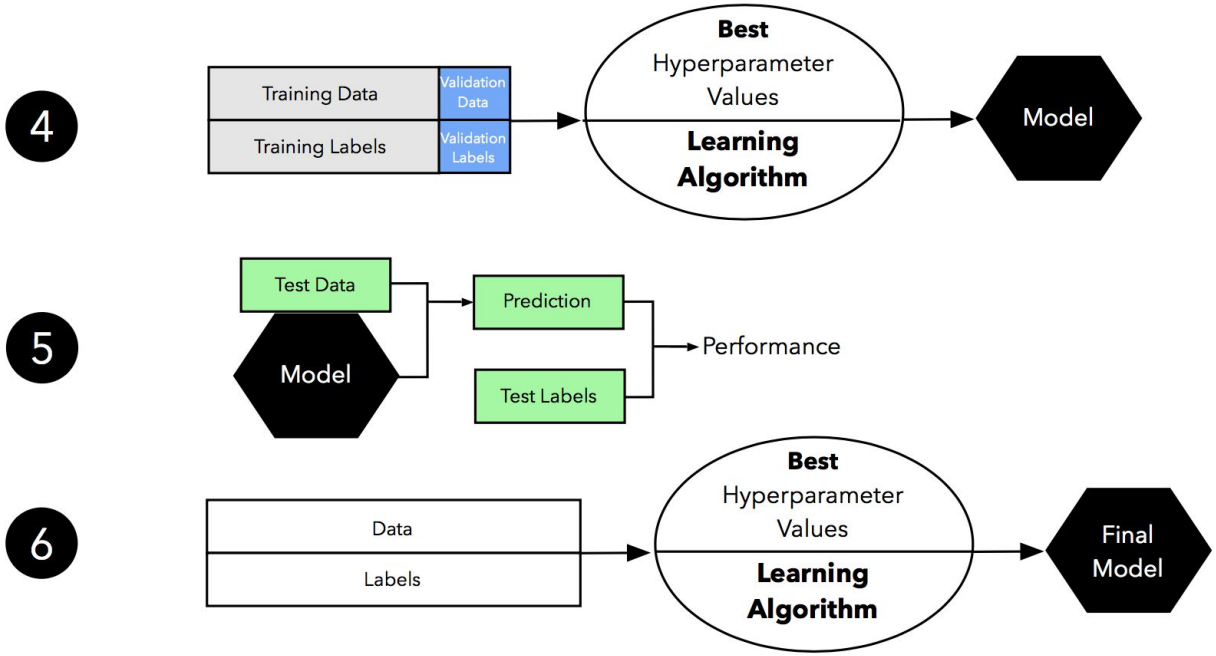
Holdout and Hyperparameter Tuning II



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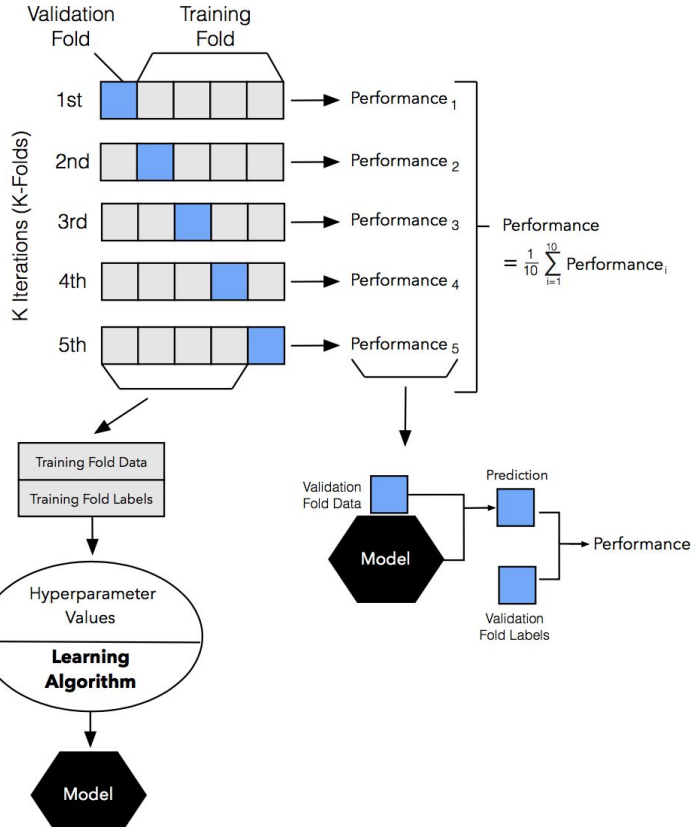
K-fold Cross-Validation



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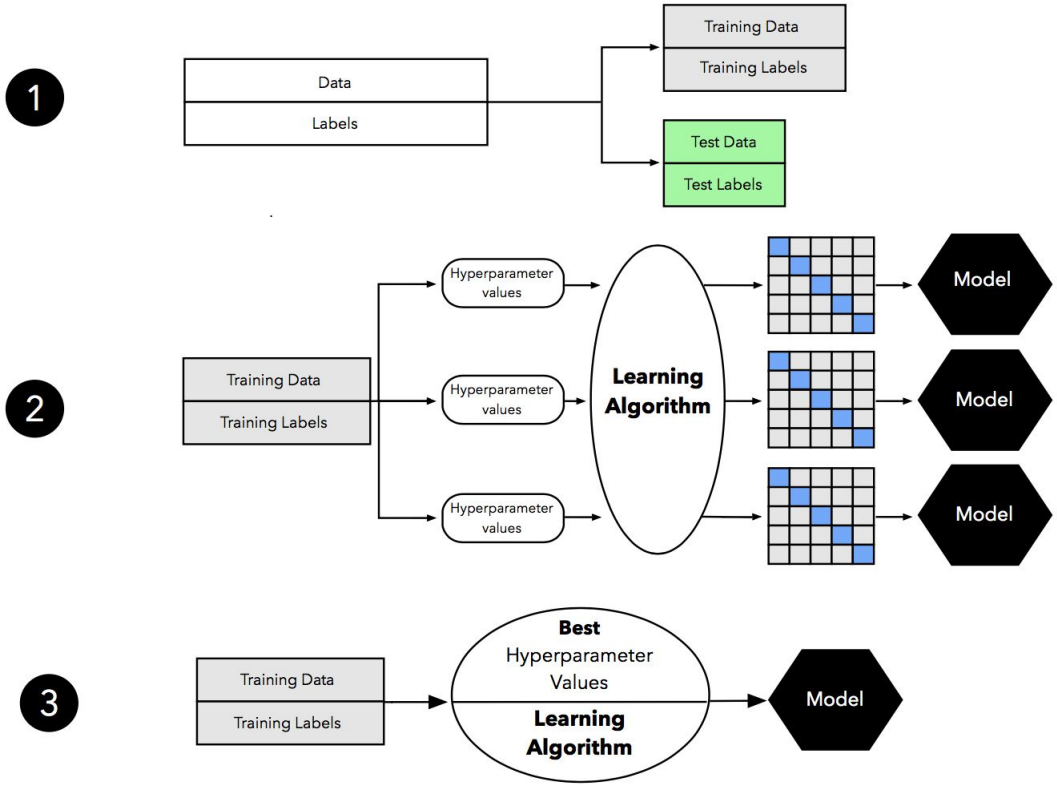
K-fold Cross-Validation Workflow I



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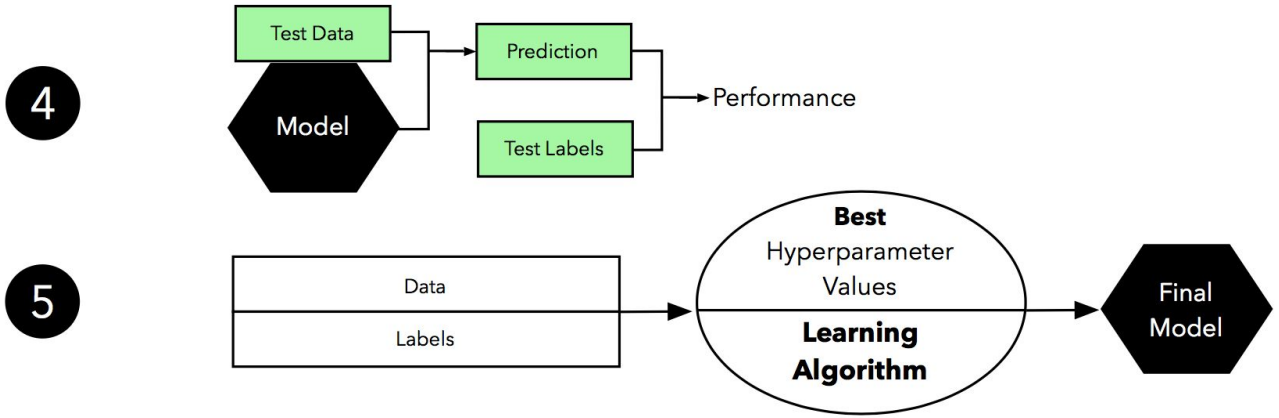
K-fold Cross-Validation Workflow II



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Performance Metrics

http://scikit-learn.org/stable/modules/model_evaluation.html

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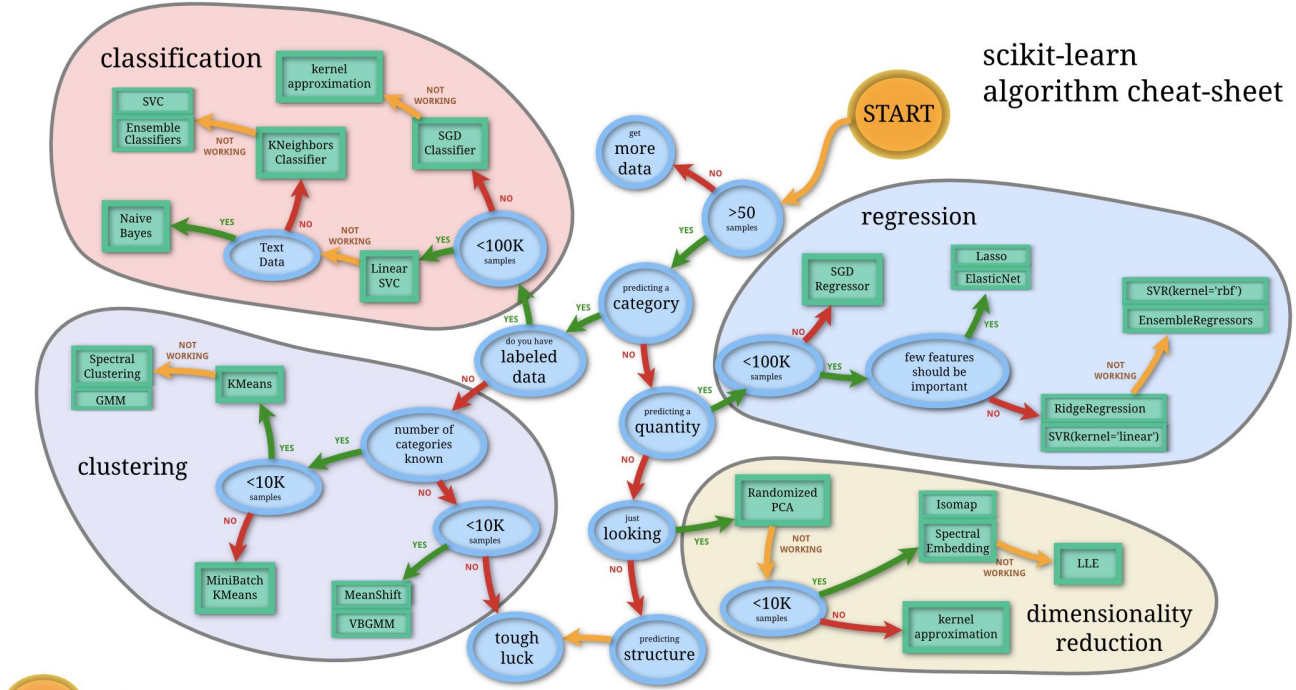
Further Resources - Andreas' "cheat sheet"



Thanks!

Machine Learning for Data Science Interest Group
Advanced Informatics School
Universiti Teknologi Malaysia

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May 2017