

# Welcome

## AI FUNDAMENTALS



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# About me

- MSc in Signal Processing and Control Systems Design.
- 5 years of applying AI to solve real-world business problems across a range of industries.
- Specialties: predictive control, text mining and computer vision.

# What is all the AI fuss about?

Just top 3 AI-related news on Friday, September 6th 2019:



**Artificial intelligence** is changing every aspect of war

**The Economist** - 22 hours ago

AI is “poised to change the character of the future battlefield”, declared America’s Department of Defence in its first AI strategy document, ...



Forget The Future, AI Will Take Us Back To The Past

**Forbes** - 3 hours ago

AI is the future, and it's also the past. Not just in the sense of having been developed in previous years and decades, but also in the sense of ...



How agencies can best prepare for AI: 'Build a data team'

**Federal News Network** - 17 hours ago

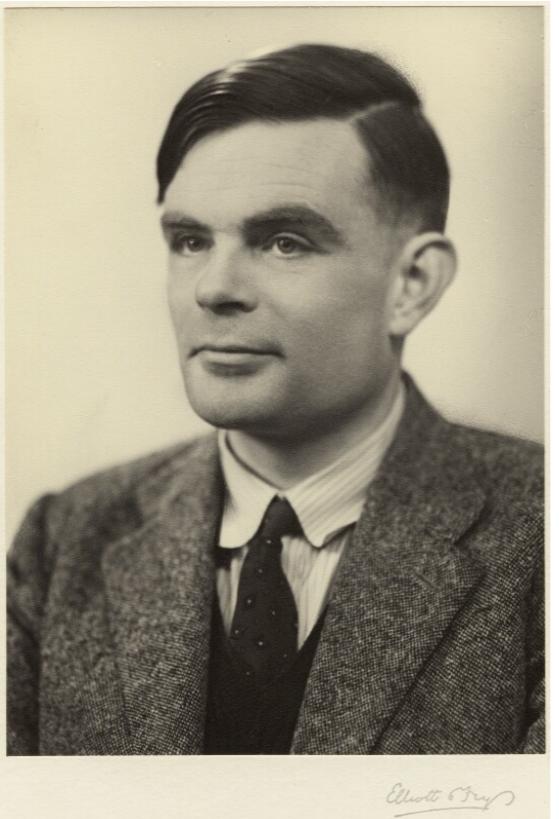
Decades of science fiction have primed people to conjure a very specific image when the subject of **artificial intelligence** arises: The malevolent ...

# AI = Artificial Intelligence



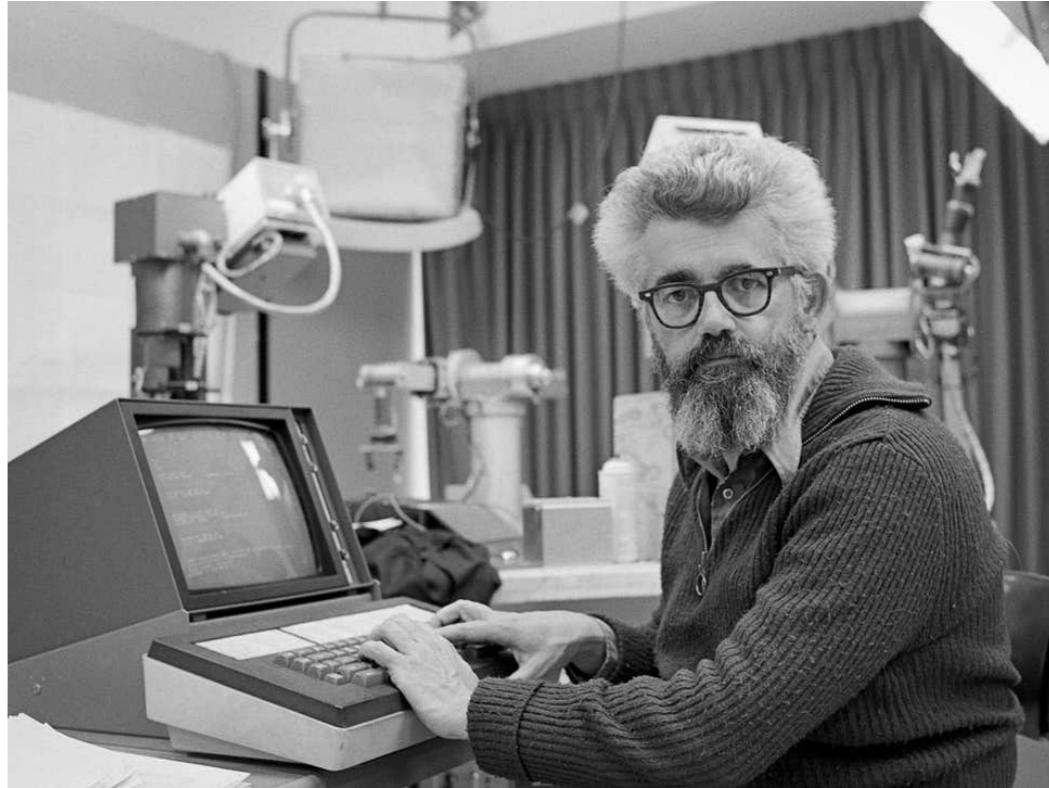
# The Beginnings

Alan Turing



- Helped crack the Enigma machine in WWII
- Created the "Turing test"

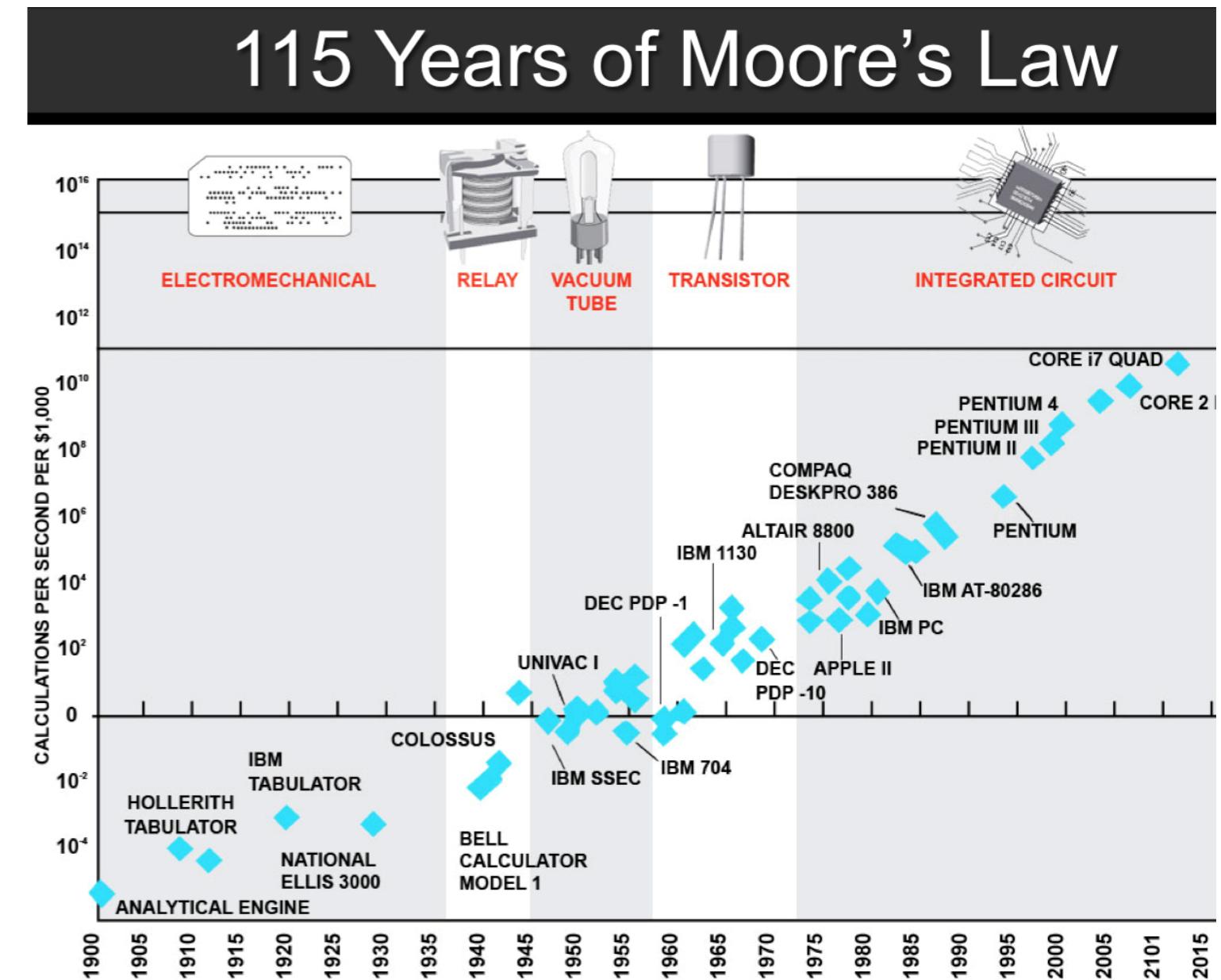
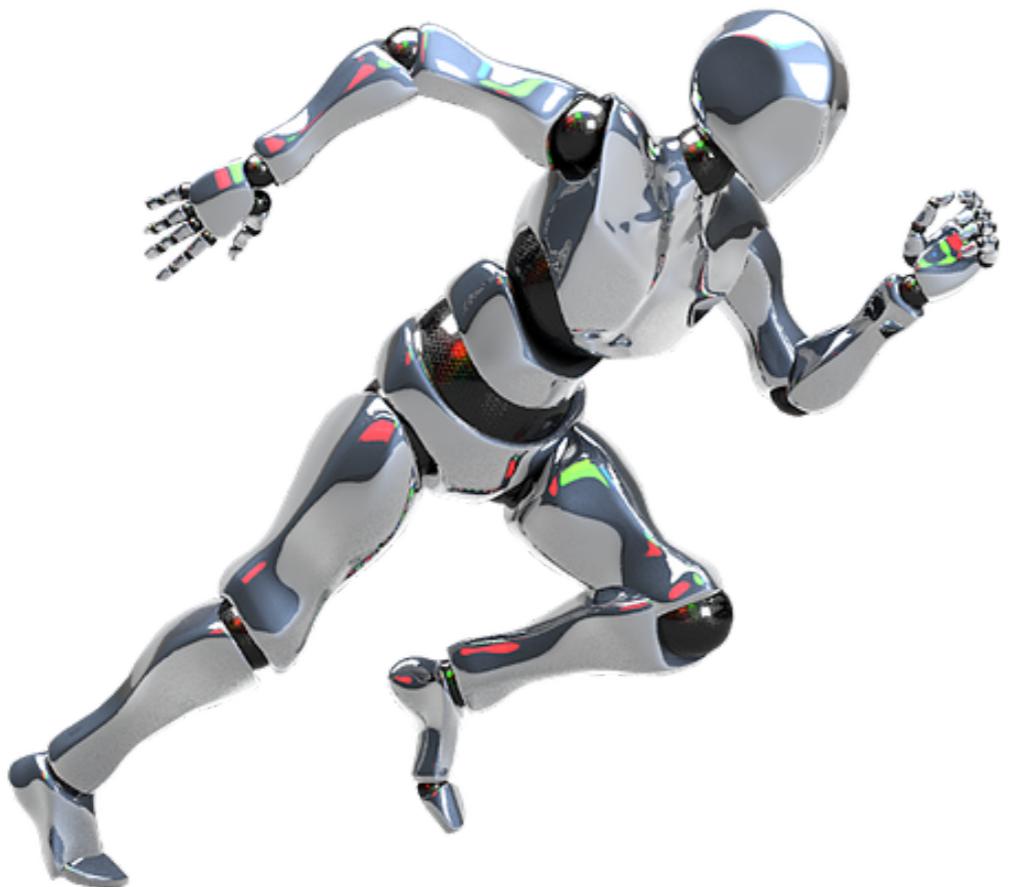
John McCarthy



- Organized the first AI conference in 1956.
- Created the Lisp programming language.



# The revolution



# Alpha Go by Google



# Autonomous cars



# Art



# What is Intelligence?

Intelligence is:

... the ability to **reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience**.

<sup>1</sup> Source: <http://www1.udel.edu/educ/gottfredson/reprints/1997mainstream.pdf>

# What is AI?

- General AI (aka "strong AI")
  - Still only science-fiction
- Narrow AI (aka "weak AI")
  - 99% of AI
  - One-trick horse
  - a.k.a. Machine Learning

## ARTIFICIAL INTELLIGENCE

A program that can sense, reason,  
act, and adapt

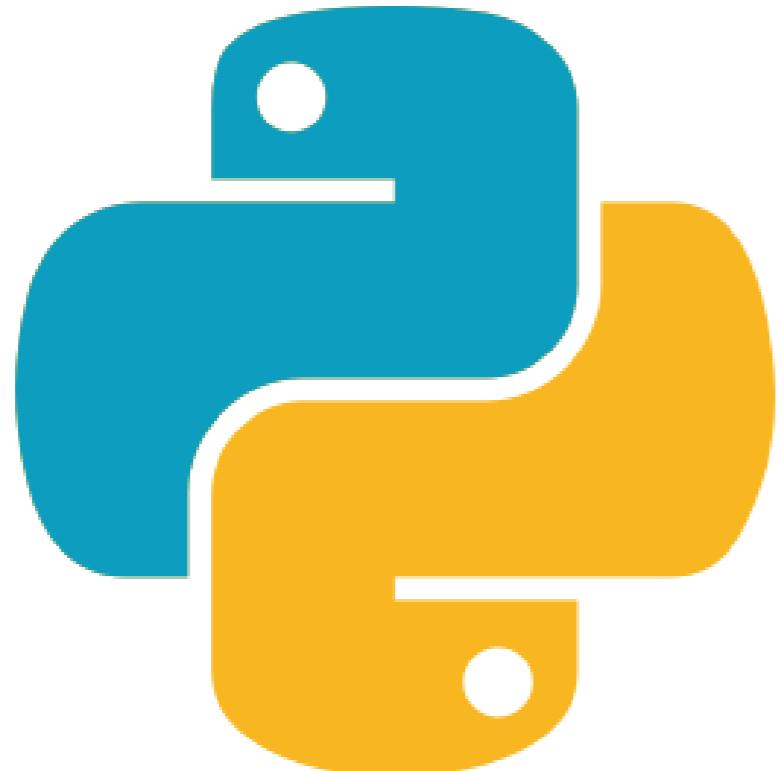
## MACHINE LEARNING

Algorithms whose performance improve  
as they are exposed to more data over time

## DEEP LEARNING

Subset of machine learning in  
which multilayered neural  
networks learn from  
vast amounts of data

# Machine Learning + Python = Perfect match



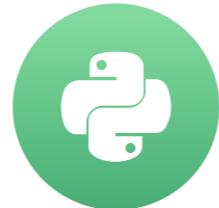
- **simple and beautiful**
- **flexible**
  - dynamically typed and allowing both object-oriented and functional programming
- **versatile**
  - used for crunching data, making websites, programming toys...
- **the most popular language among Data Scientists and Data Engineers.**

To infinity and  
beyond!

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# All models are wrong but some are useful

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# What is a model?

- A simplified representation of a process or a system



- Complexity and accuracy requirements defined by the application

# How do we build one?



1. Define the problem
2. Collect the data
3. Configure & fit the model
4. Use it!

# Define the problem

Poor problem definition = highway to disaster

## Key questions

1. What is the pain point
2. How do we create value by solving this problem? (value proposition)
3. How do we know if we've succeeded or failed?

# Configure the model

1. Specify the technical problem
2. Select the model type
3. Select the specific algorithm

## Example

```
model = DecisionTreeClassifier()
```

# Fit the model

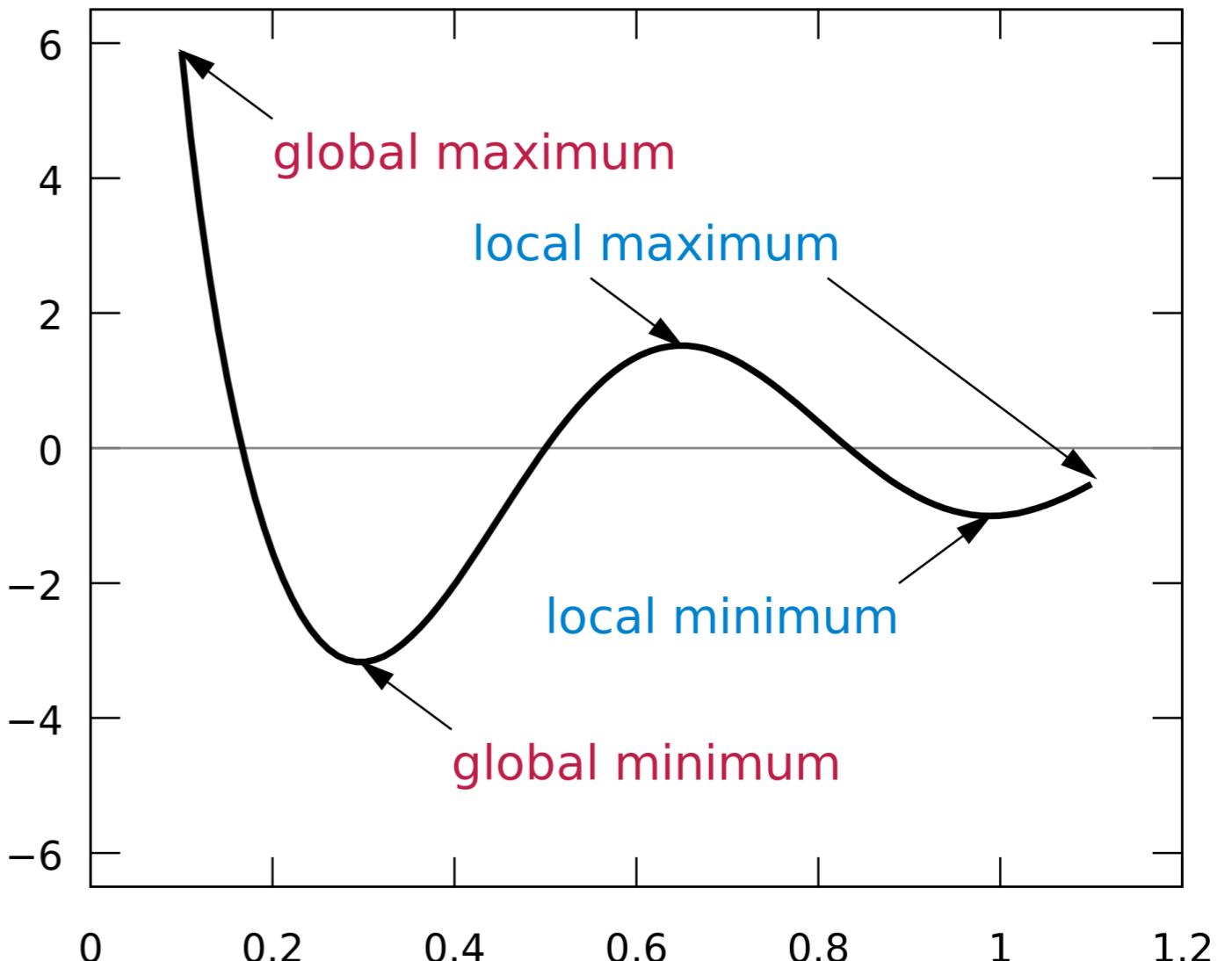
Fitting = mathematical optimization

## Ingredients

1. Optimization algorithm
2. Cost function
3. Data

## Common Python syntax

```
model.fit(inputs, outputs)
```



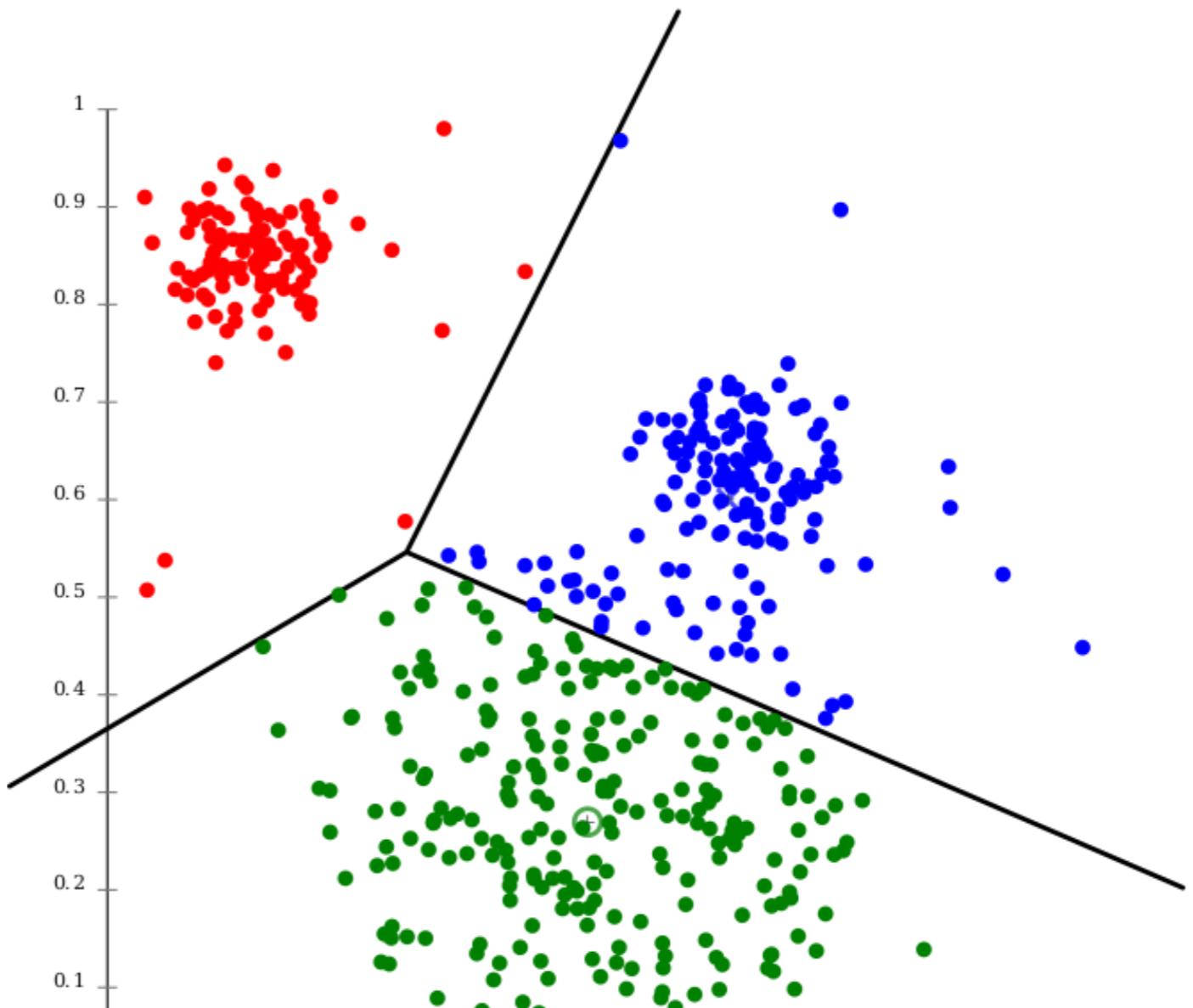
# Parameters and hyperparameters

## 1. Model parameters

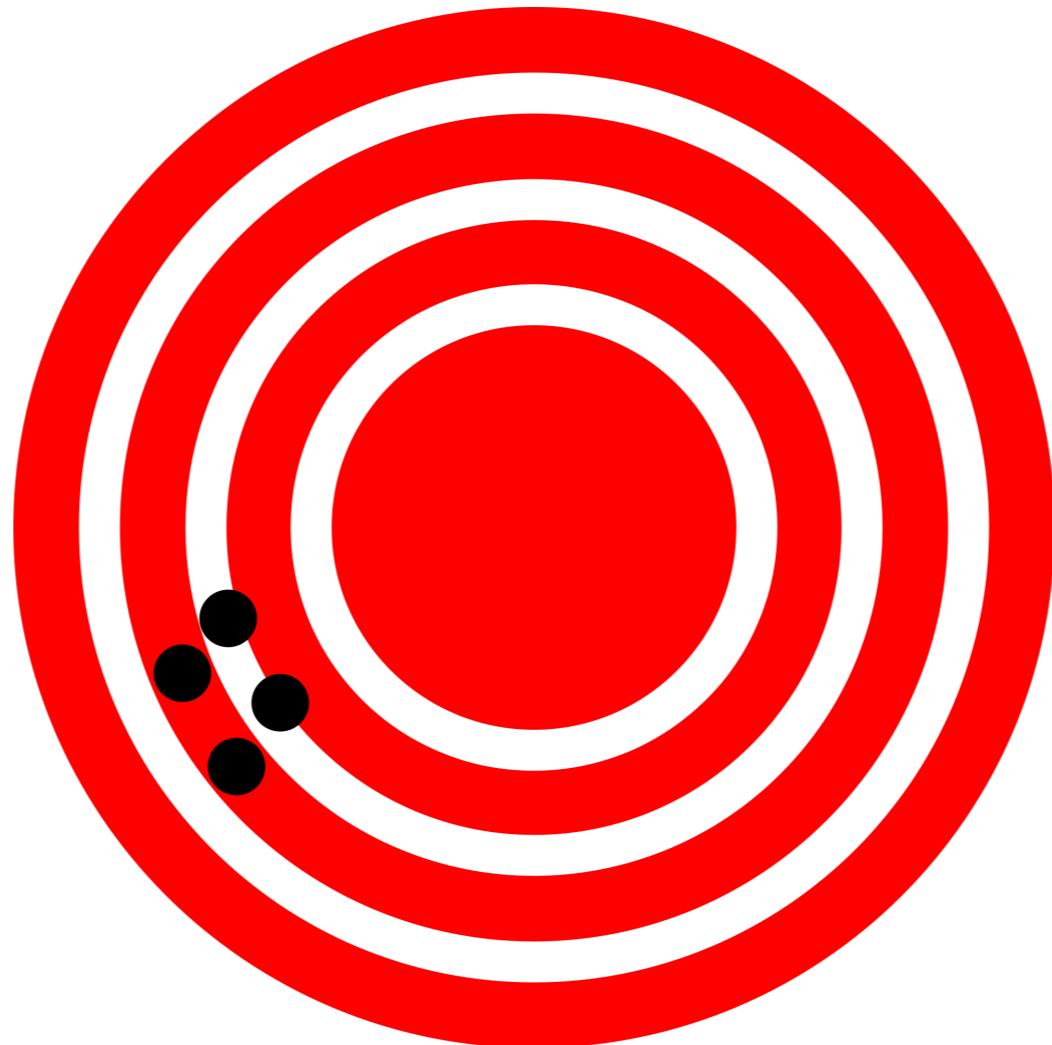
- learned at the fitting time, fast, automated

## 2. Hyperparameters

- defined prior to fitting, slow and costly optimization process



# Reality check



Danger: Overfitting

# Performance evaluation

## Holdout train/test splitting

```
X_train, X_test, y_train, y_test = train_test_split(inputs, outputs, test_size=0.4)
```

## Model fitting

```
model.fit(X_train, y_train)
```

## Model testing and evaluation

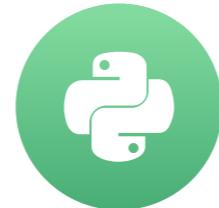
```
y_predicted = model.predict(X_test)
accuracy = accuracy_score(y_test , y_predicted)
```

# Let's dive in!

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# Three flavors of Machine Learning

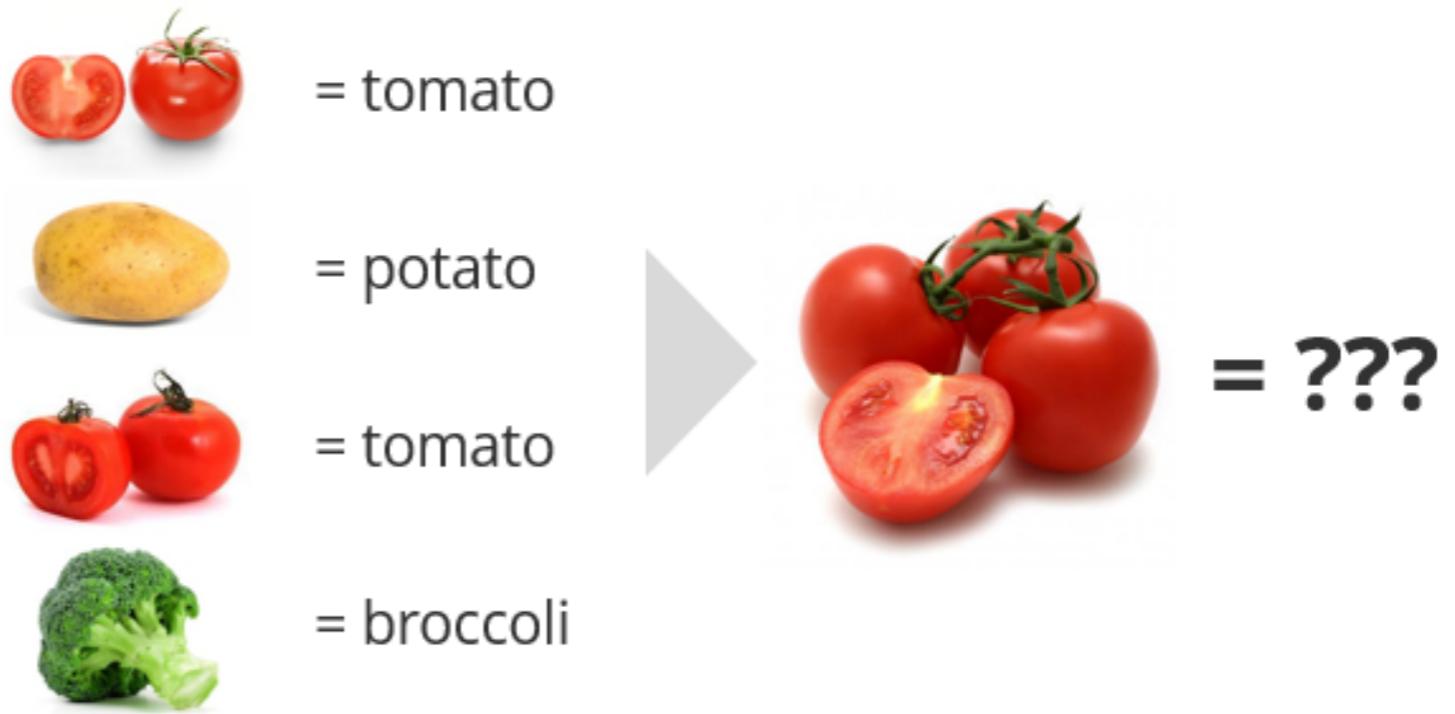
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# Supervised Learning

- Most used flavor of Machine Learning
- Applications
  - Performance prediction
  - Purchase behavior modeling
  - Risk modeling



# Regression vs. Classification

Regression



Classification



# Supervised algorithms

## Regression (quantities)

```
from sklearn.linear_model \
import (LinearRegression,
Lasso,
Ridge)

from statsmodels.tsa.arima_model \
import ARIMA
```

## Classification (categories)

```
from sklearn.linear_model \
import LogisticRegression

from sklearn.naive_bayes \
import GaussianNB

from sklearn.tree \
import DecisionTreeClassifier

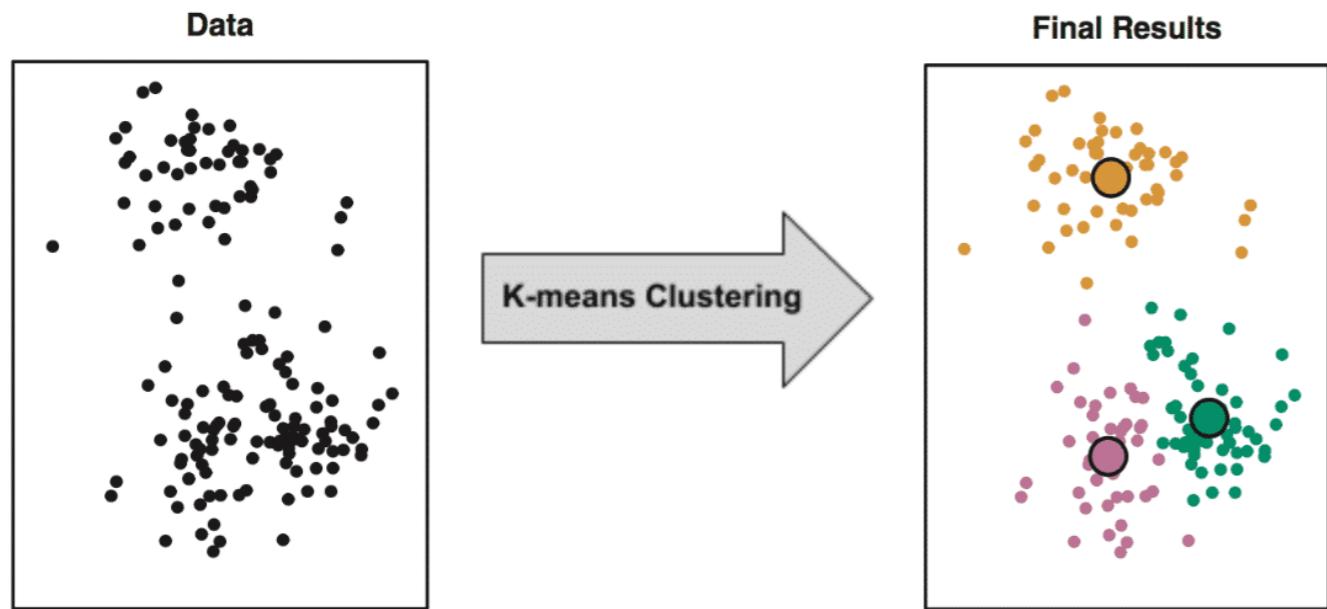
from sklearn.ensemble \
import RandomForestClassifier
```

# Unsupervised Learning



- Unlabeled data.
- No labels => No supervision.
- Only input relationships examined.

# Unsupervised learning: Clustering



**Clustering ? Classification!**

Classification = Model learns **existing groups**.

Clustering = Model **discovers** groups on its own.

# Unsupervised learning: Anomaly detection

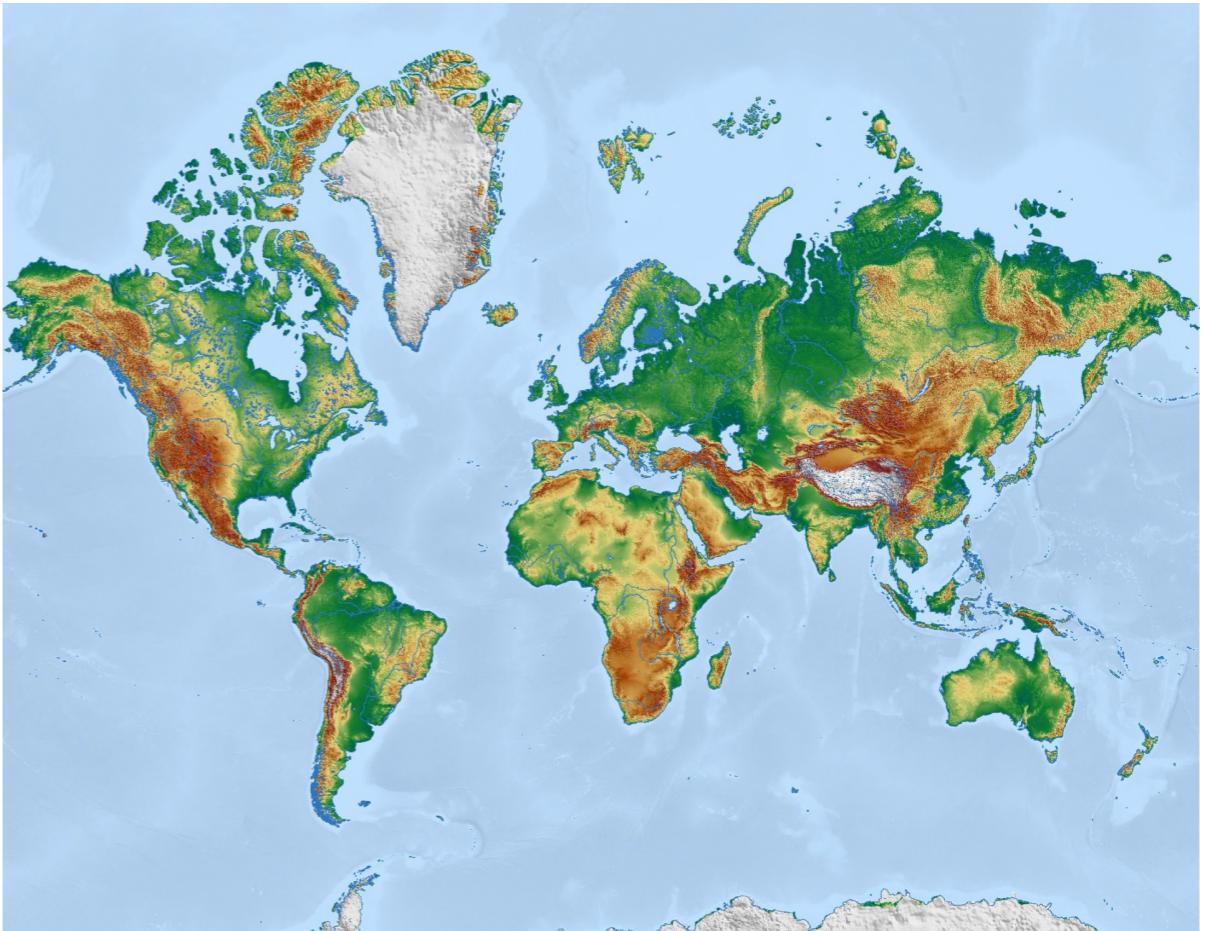


Second-degree (partial) block



Atrial fibrillation

# Unsupervised learning: Dimensionality reduction



# Unsupervised algorithms

## Clustering

```
# K-Means clustering  
from sklearn.cluster import KMeans  
  
# Mean-shift clustering  
from sklearn.cluster import MeanShift  
  
# DBSCAN  
from sklearn.cluster import DBSCAN
```

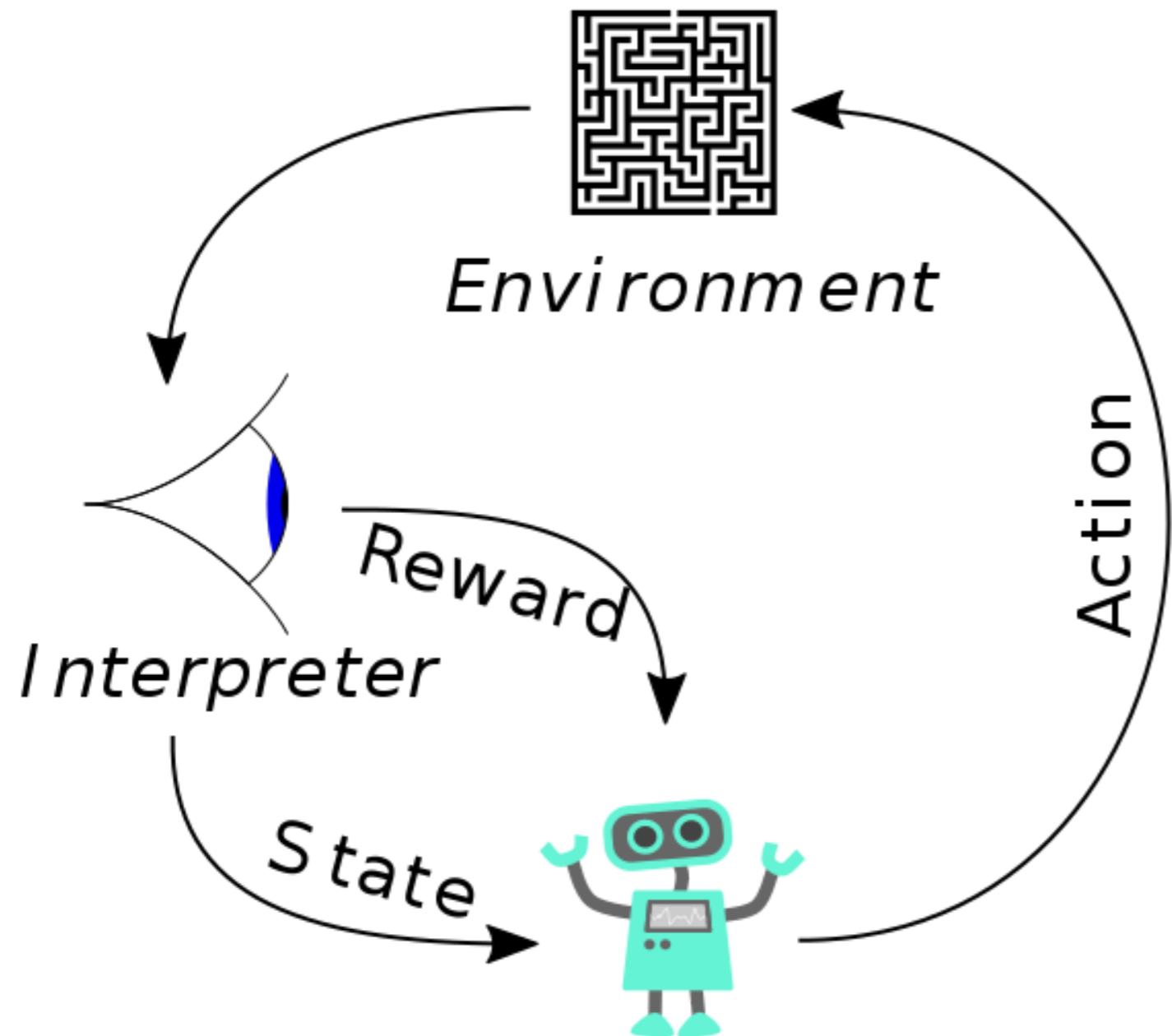
## Dimensionality reduction

```
# Principal Component Analysis  
from sklearn.decomposition import PCA  
  
# Manifold learning  
from sklearn.manifold import Isomap
```

## Anomaly detection

```
# Isolation forests  
from sklearn.ensemble \  
import IsolationForest
```

# Reinforcement learning



- "Learning by doing"
- "Reward and punishment"

# Recap time!

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