

Welcome

FUNDAMENTALS OF AI



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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

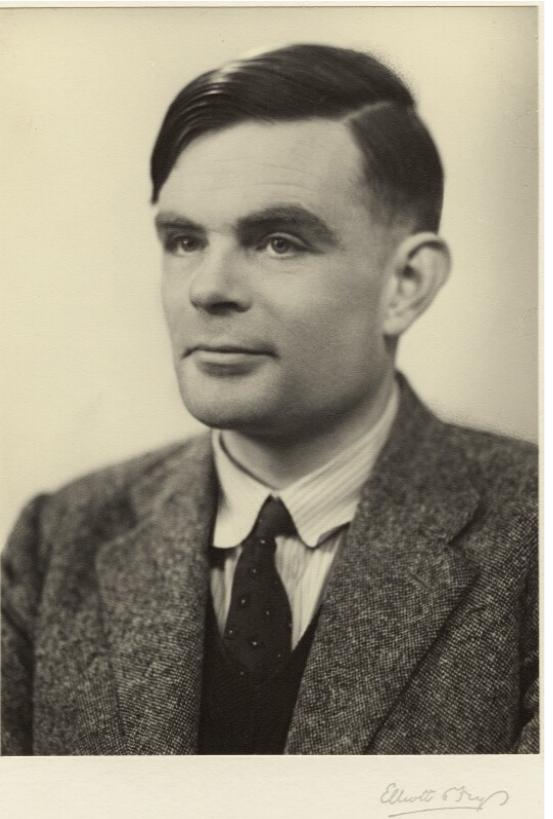
Decades of science fiction have primed people to conjure a very specific image when the subject of **artificial intelligence** arises: The malevolent ...

AI = Artificial Intelligence



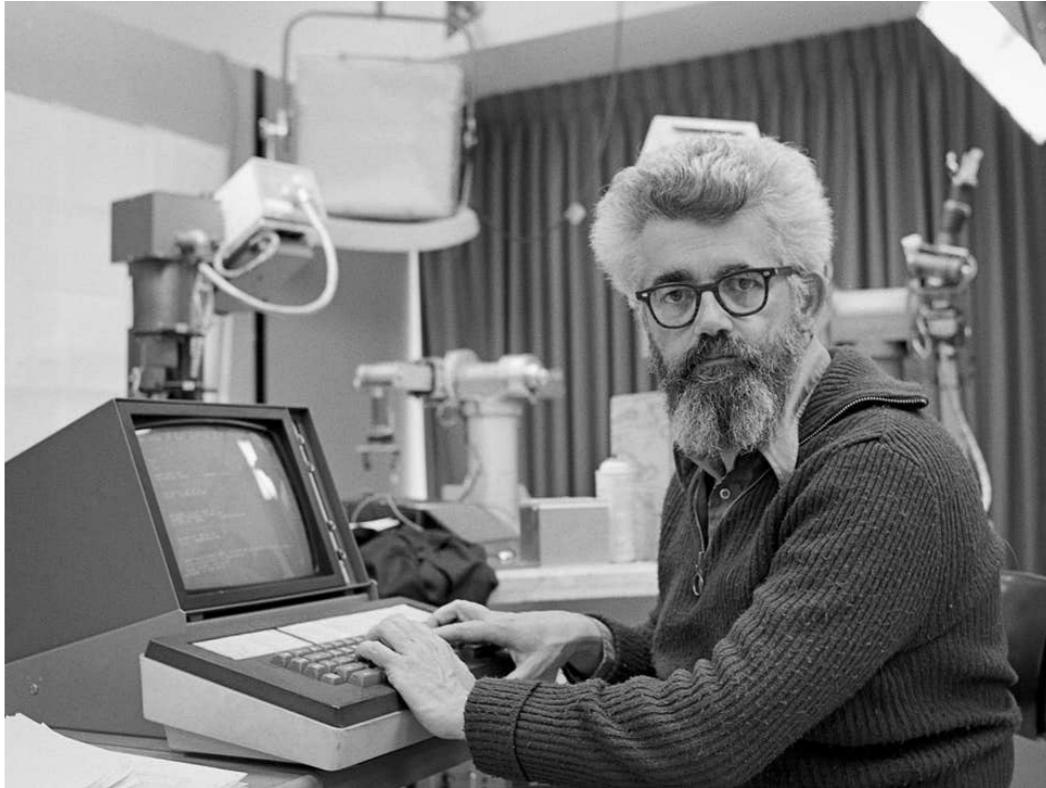
The Beginnings

Alan Turing



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

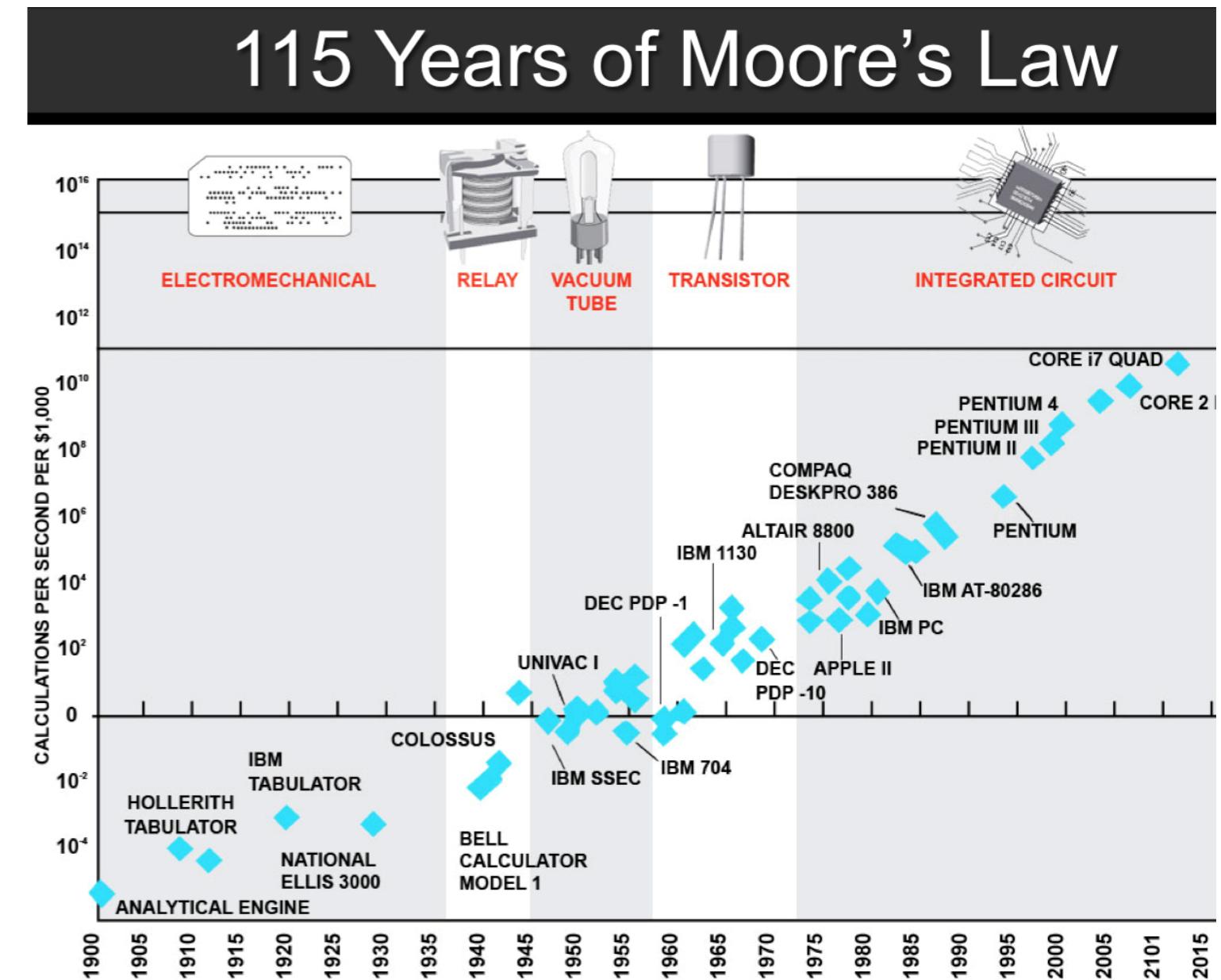
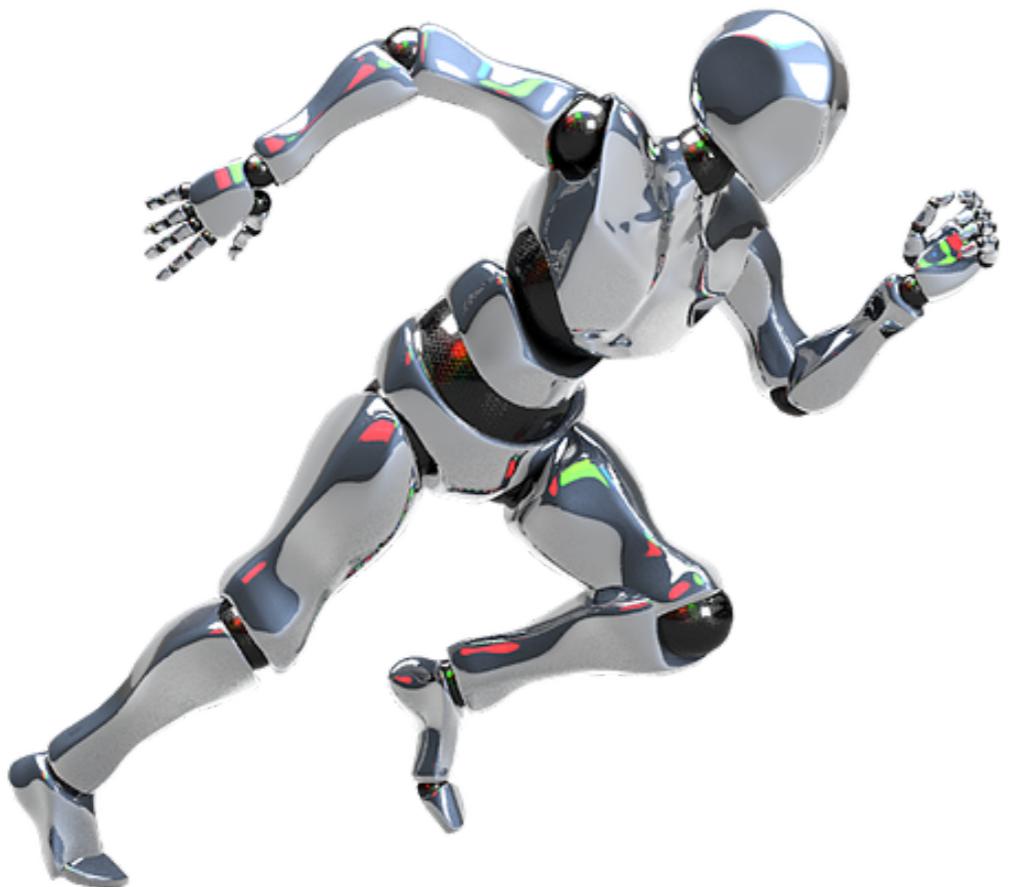
John McCarthy



- 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**.

¹ 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

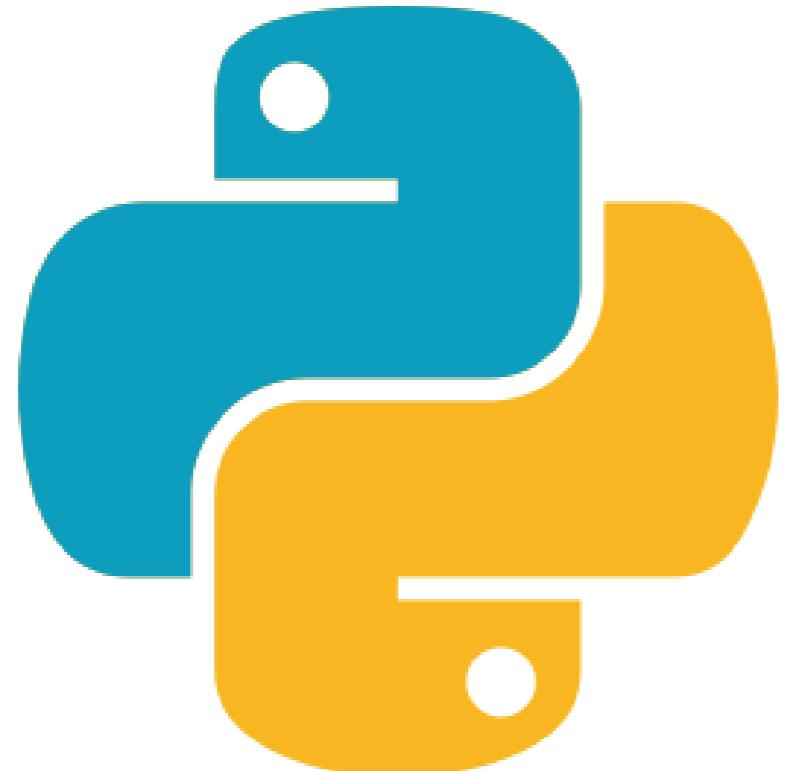
MACHINE LEARNING

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 = ??



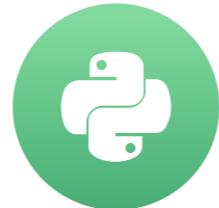
- **simple and beautiful**
- **flexible**
 - dynamically typed and allowing both object-oriented and functional programming
- **versatile**
 - used for crunching data, making websites, programming toys...
- **the most popular language among Data Scientists and Data Engineers.**

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

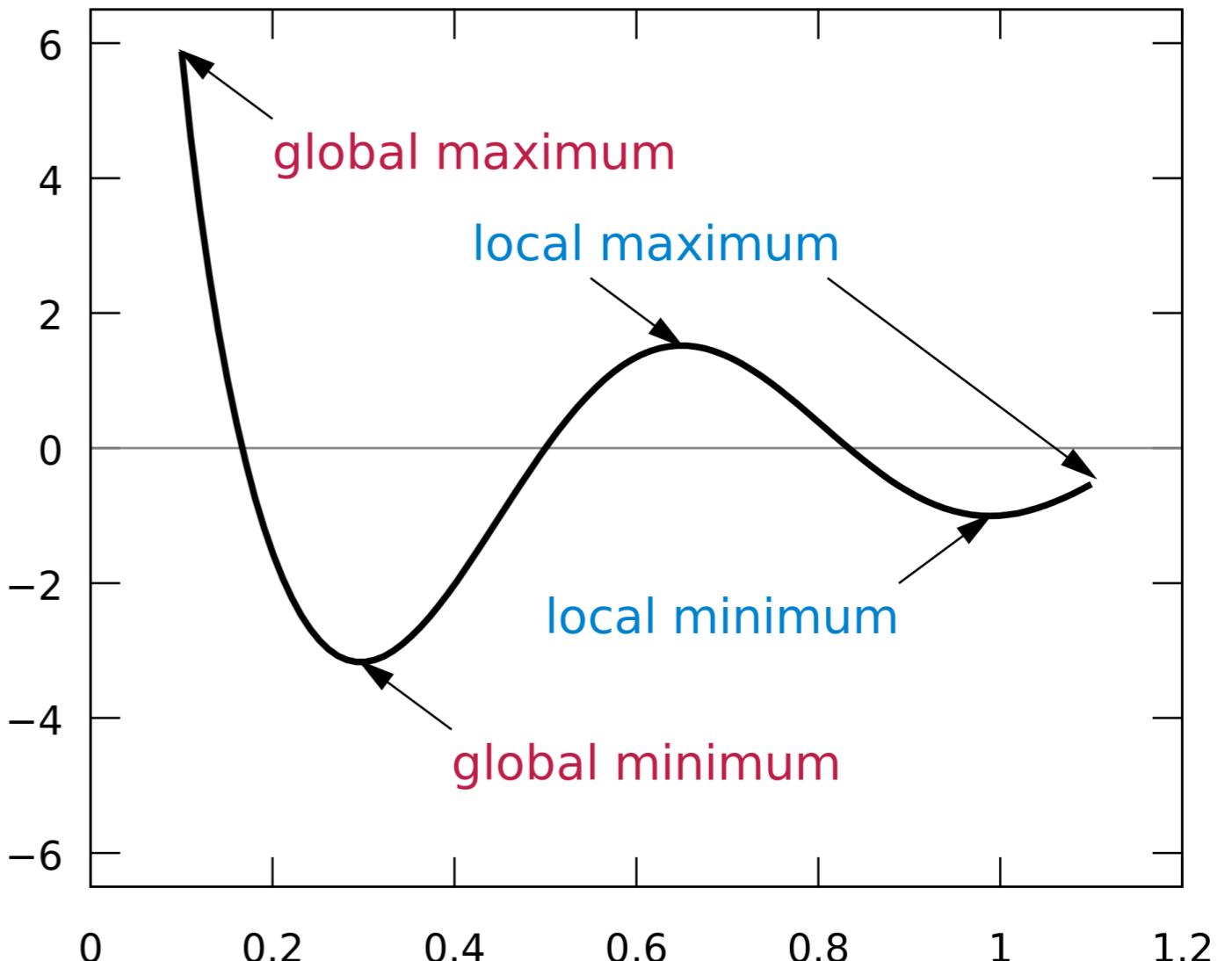
Fitting = mathematical optimization

Ingredients

1. Optimization algorithm
2. Cost function
3. Data

Common Python syntax

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



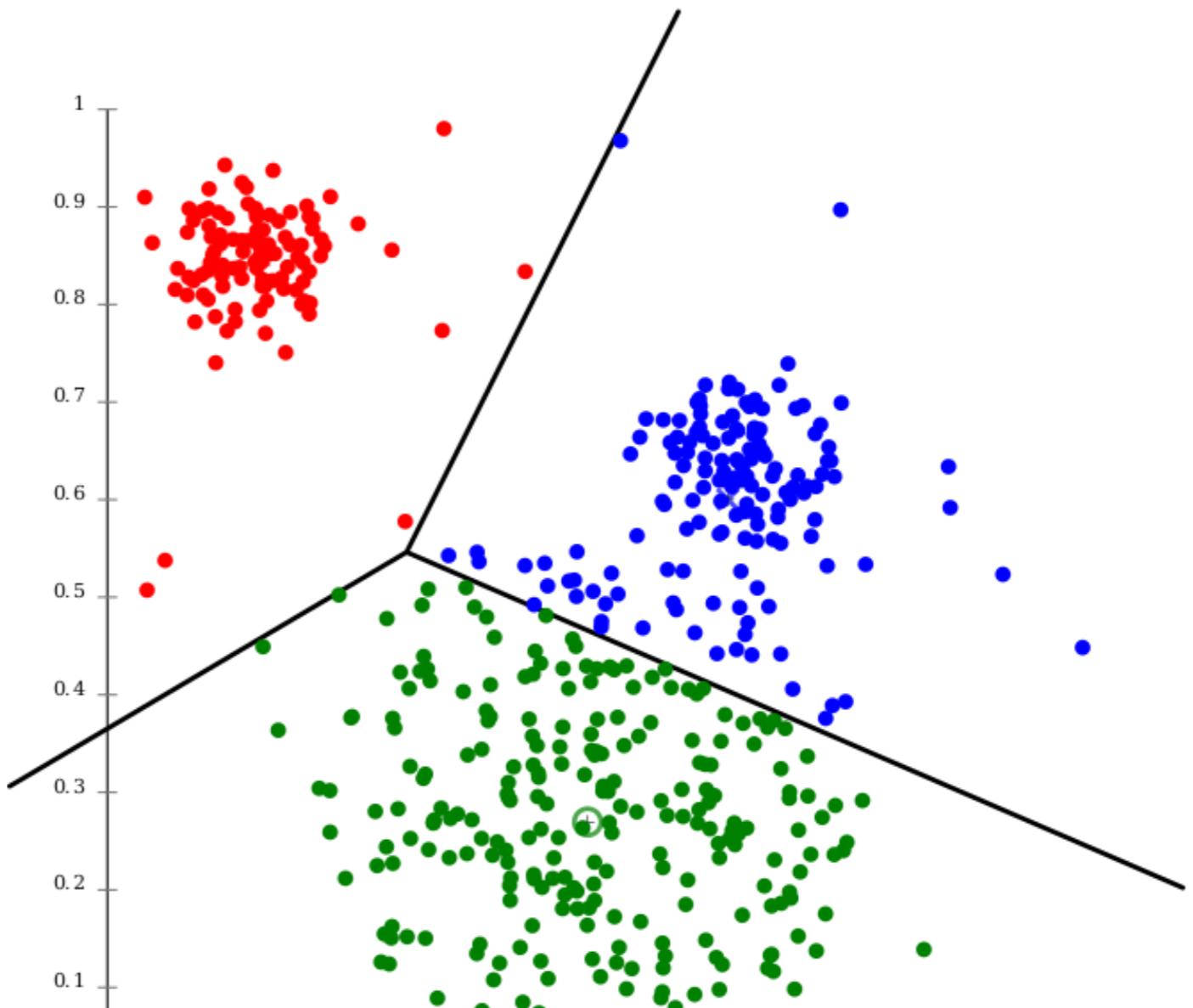
Parameters and hyperparameters

1. Model parameters

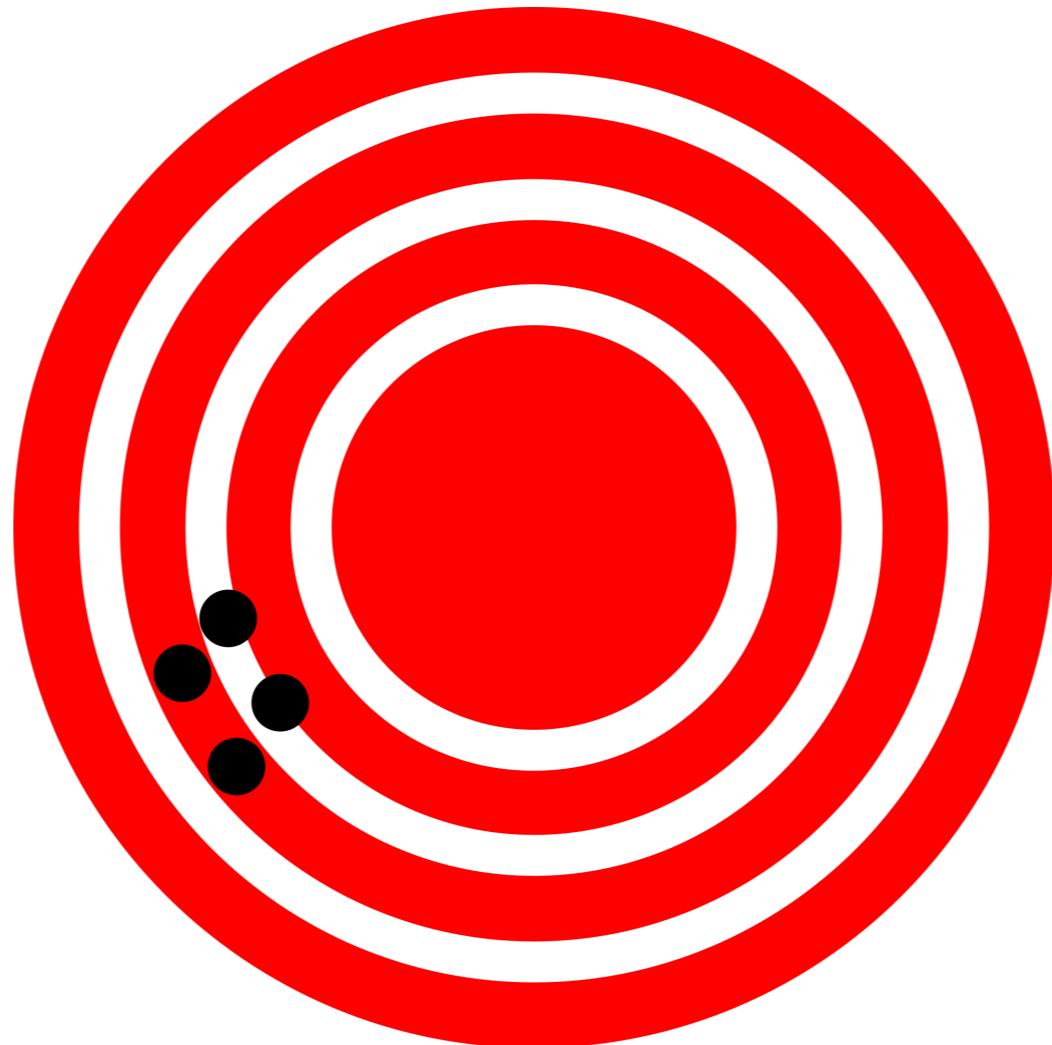
- learned at the fitting time, fast, automated

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

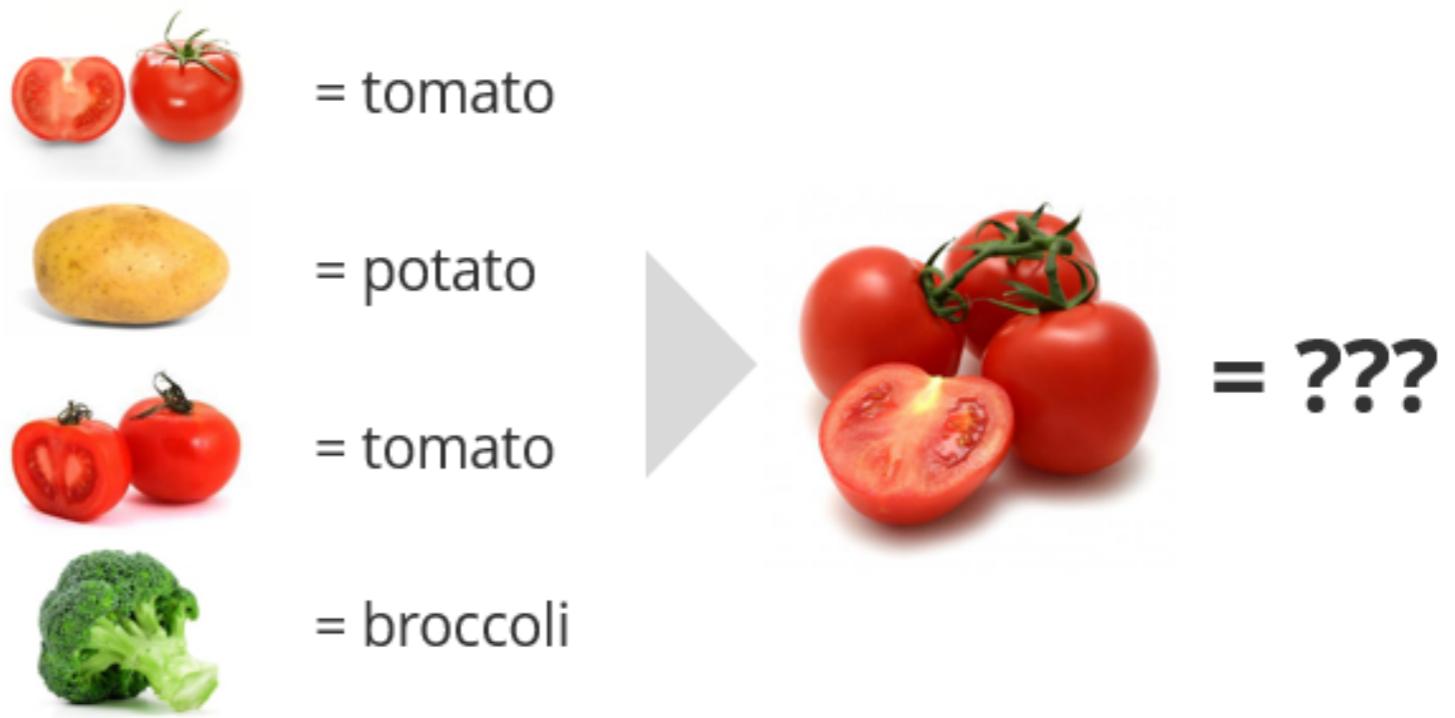
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Supervised Learning

- 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

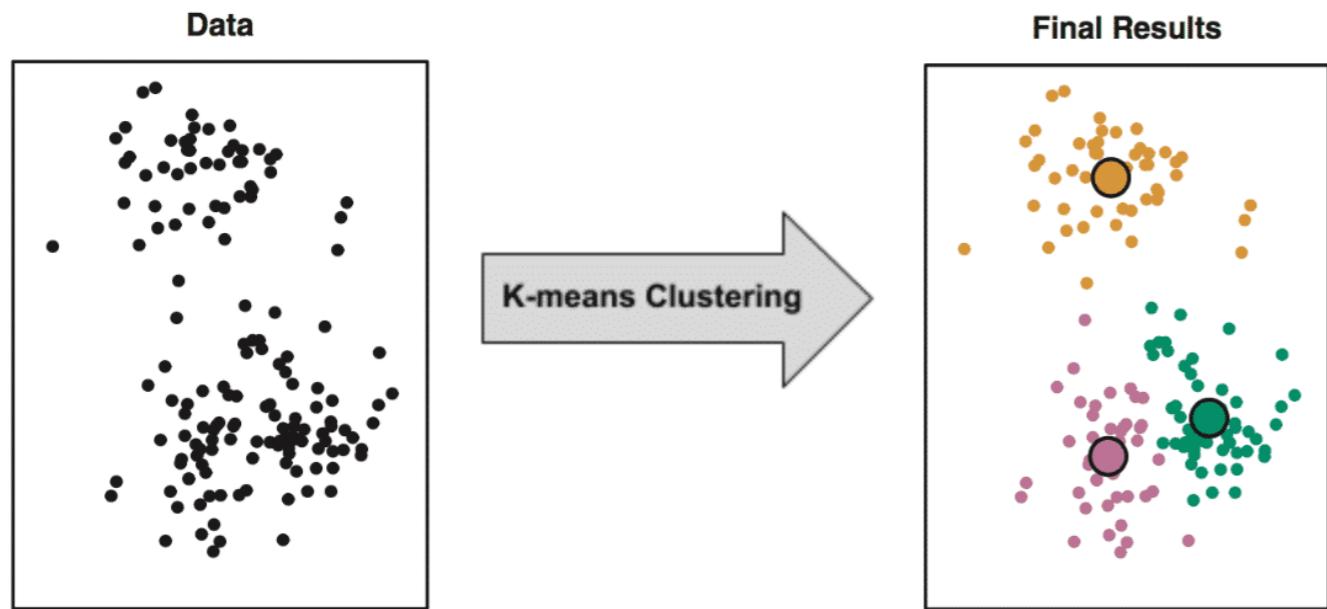
from sklearn.ensemble \
import RandomForestClassifier
```

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

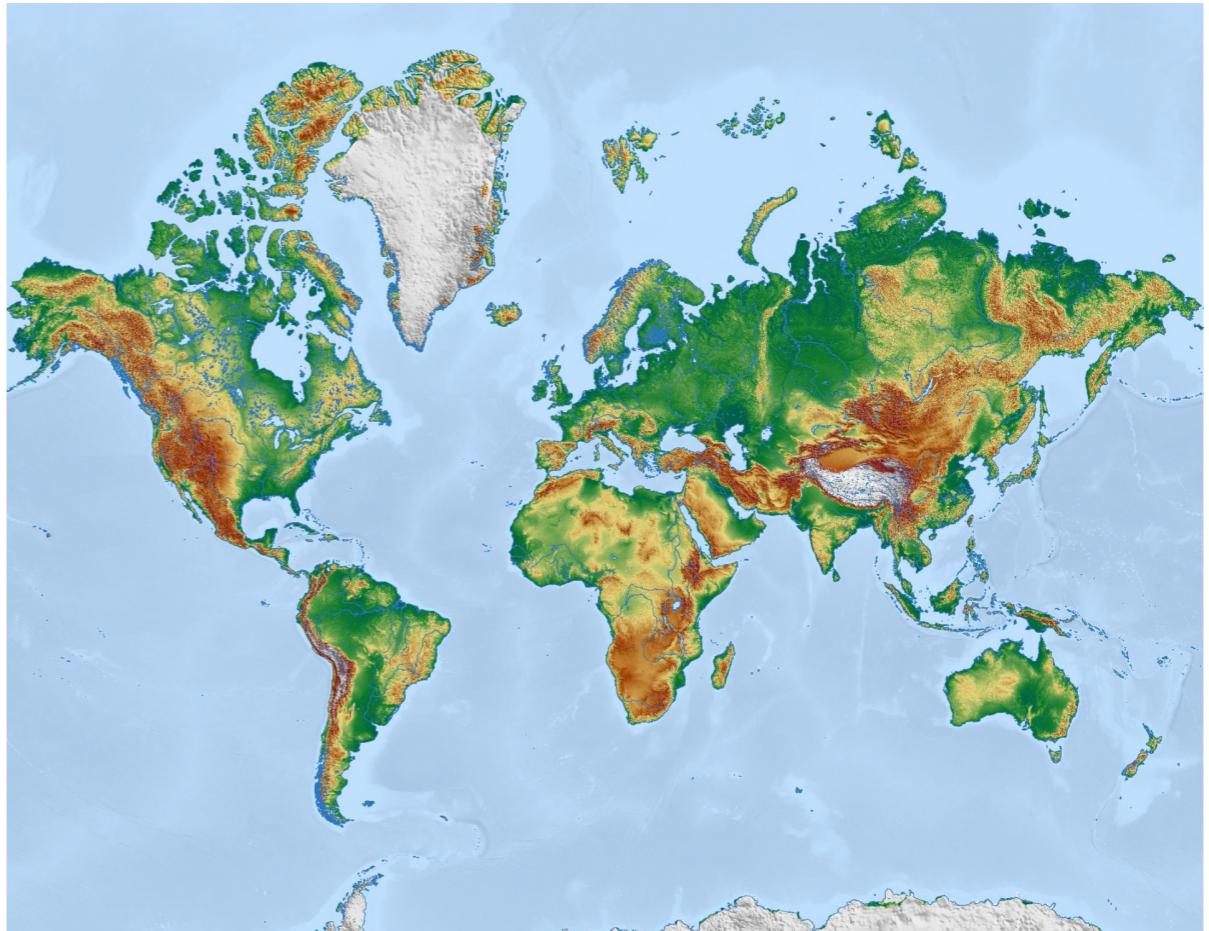


Second-degree (partial) block



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
```

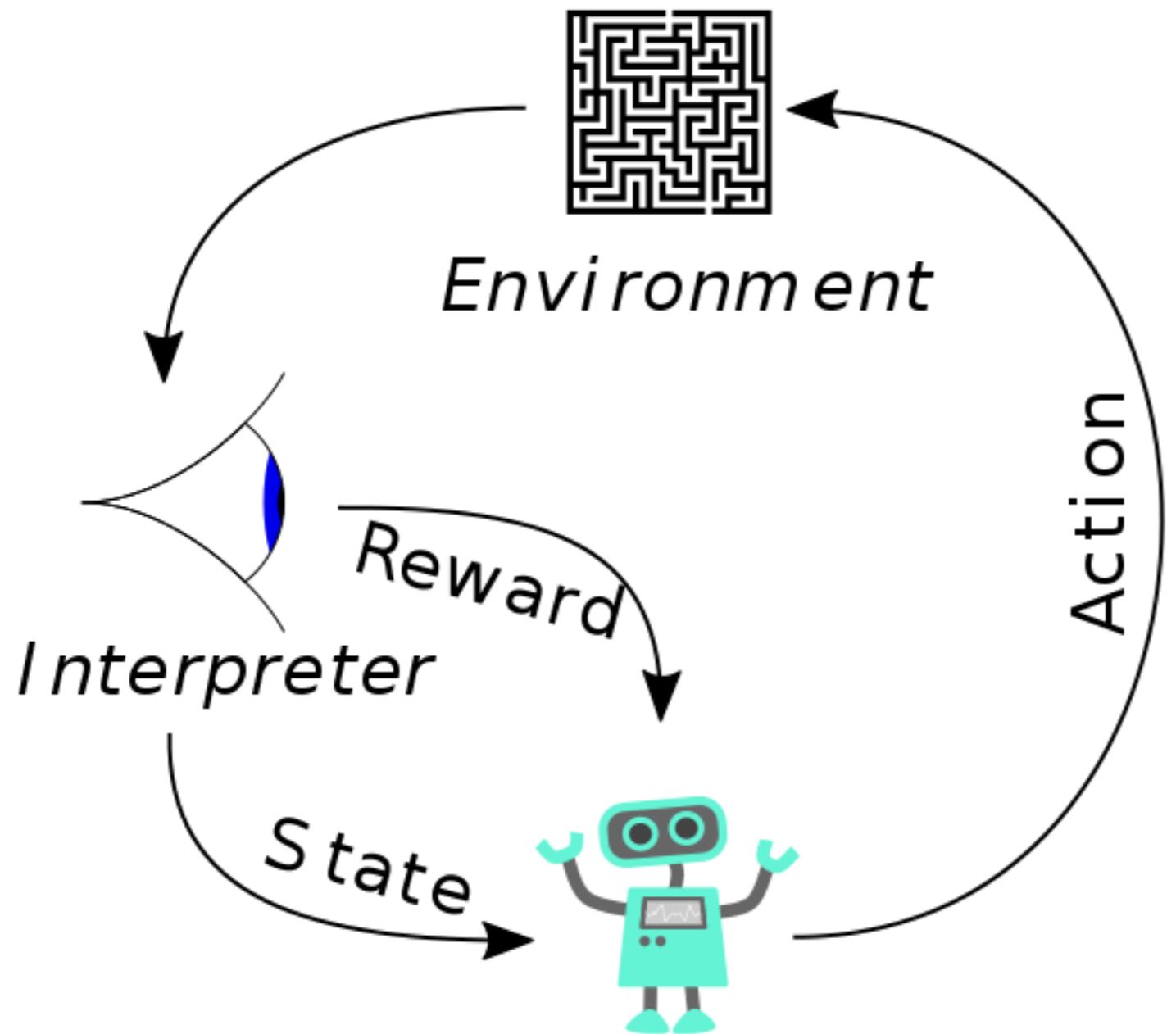
Dimensionality reduction

```
# 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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