# Overview of Machine Learning Methods

**Prasanna Balaprakash**

Mathematics and Computer Science Division &

Leadership Computing Facility

Argonne National Laboratory

Argonne Training Program on Extreme-Scale Computing (ATPESC)

Aug 5th, 2017

# Acknowledgments

http://adilmoujahid.com/posts/2016/06/introduction-deep-learning-python-caffe/

https://en.fabernovel.com/insights/tech-en/ai-for-dummies

https://sebastianraschka.com/blog/2016/model-evaluation-selection-part2.html

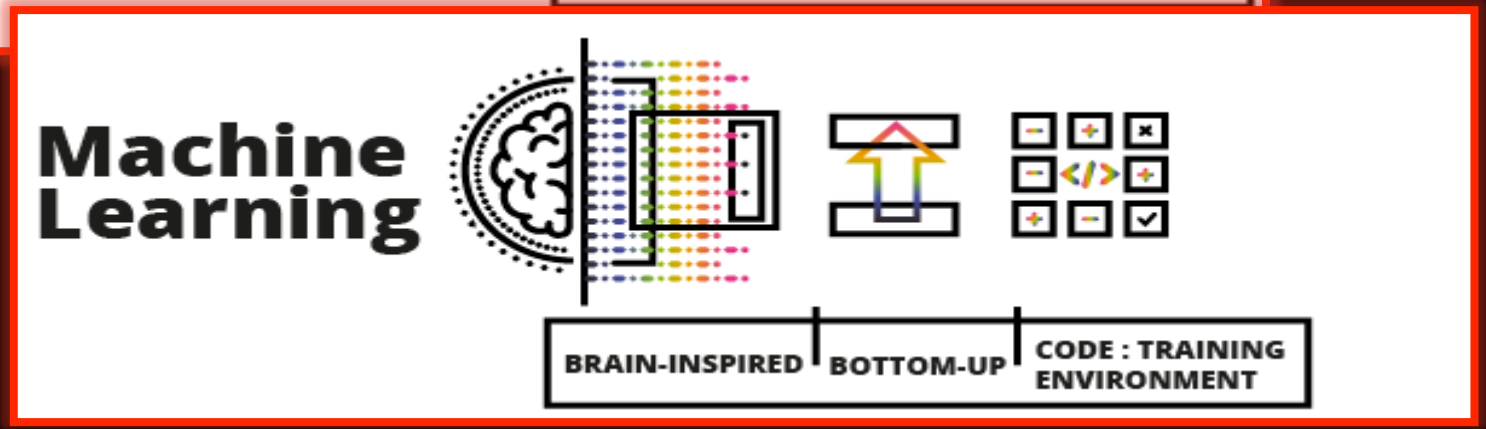
http://scott.fortmann-roe.com/docs/BiasVariance.html

http://videolectures.net/deeplearning2015_vincent_machine_learning/

# Machine learning

Born from the ambitious goal of artificial intelligence

- Two historically opposed approaches

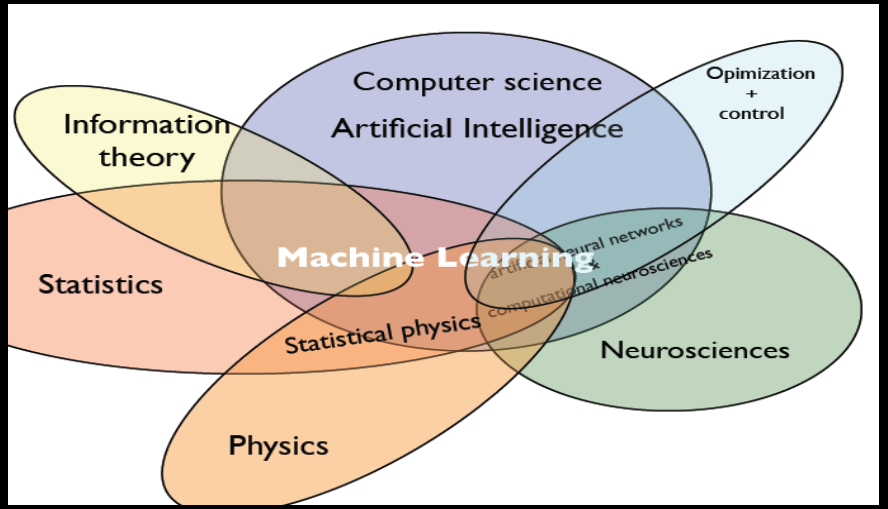
# Machine learning

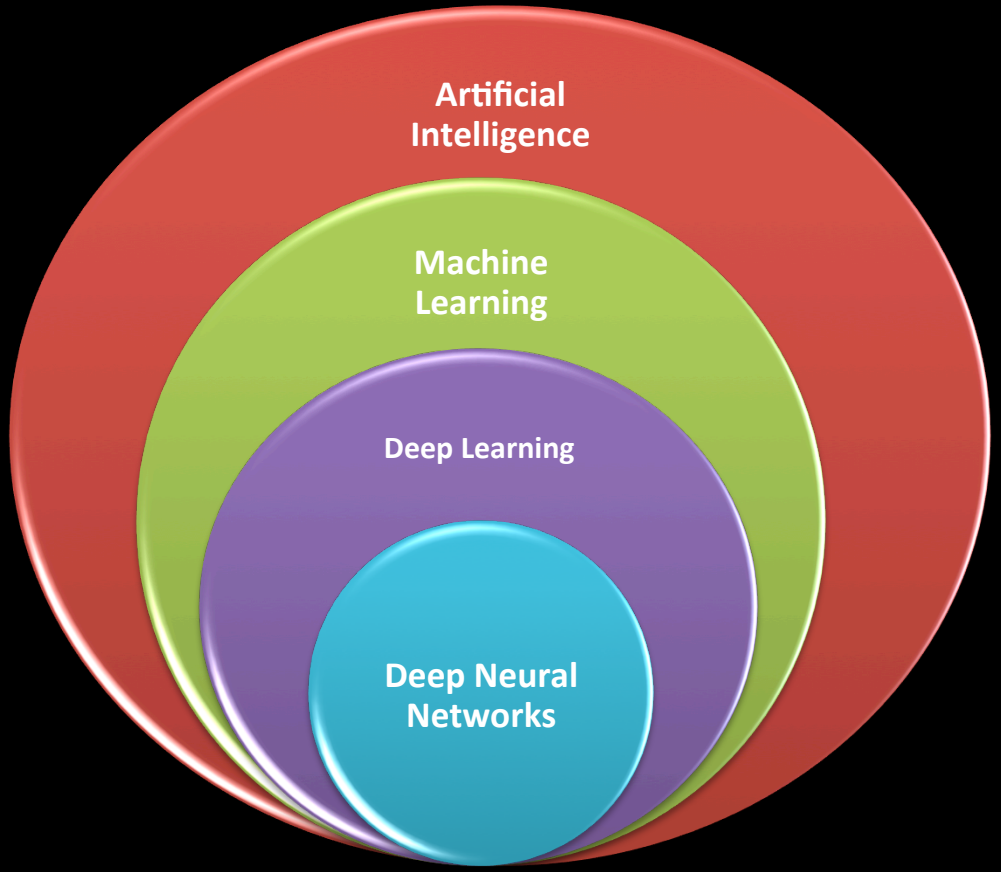
Gives computers the ability to learn without being explicitly programmed

**Traditional Programming**


**Machine Learning**

# Machine learning



# Machine learning

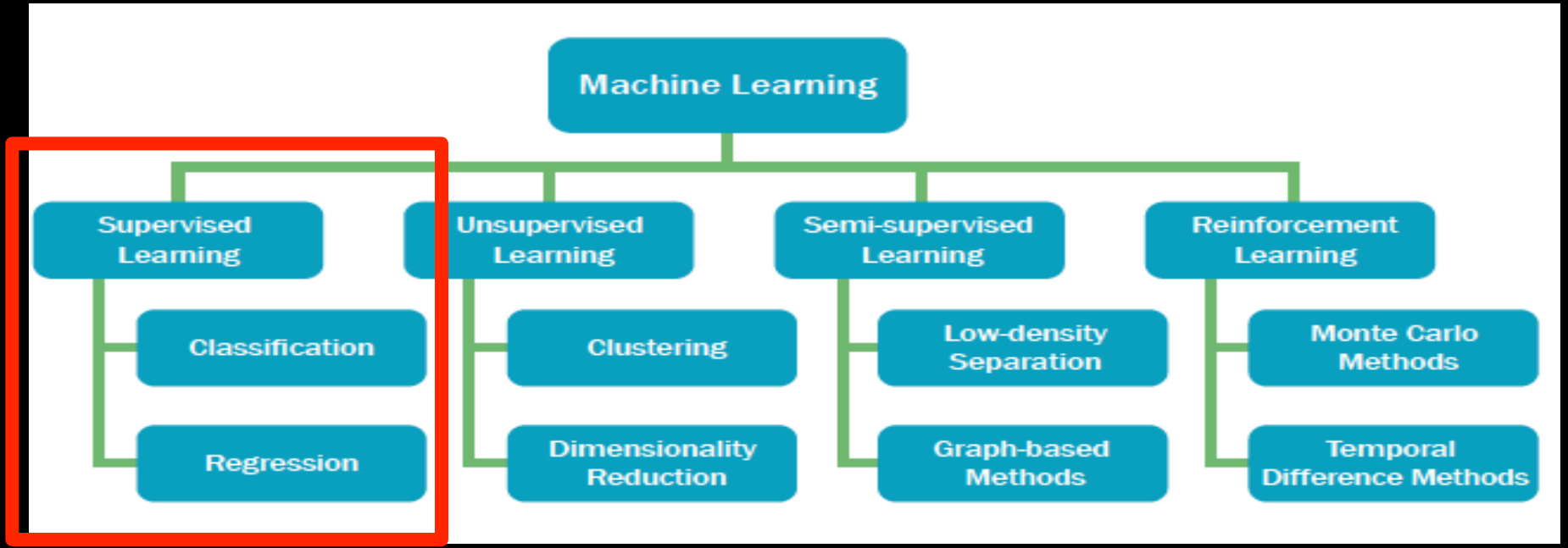
## Magic, no, more like gardening

- **Seeds** = Algorithms
- **Nutrients** = Data
- **Gardener** = You
- **Plants** = Programs

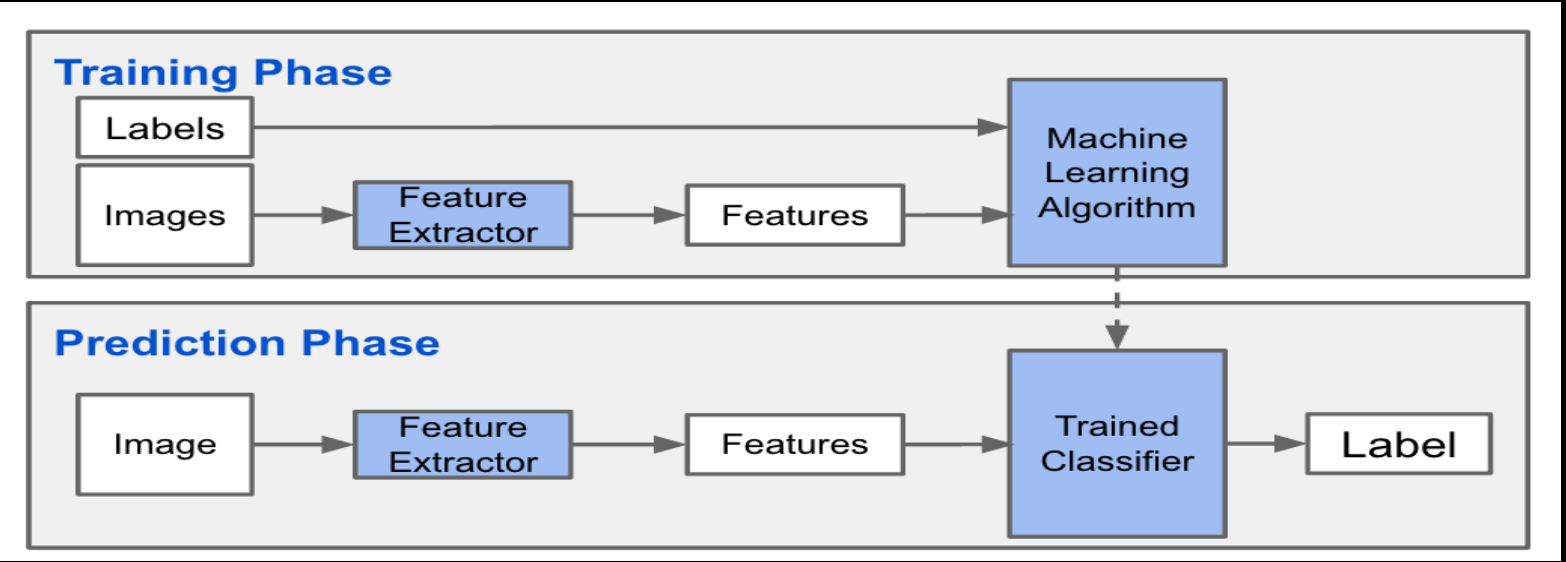
In ML, data as a **list of examples** (or turn it into one)

- ideally **many examples**
- preferably with each example a **vector** (or first turn it into one!)

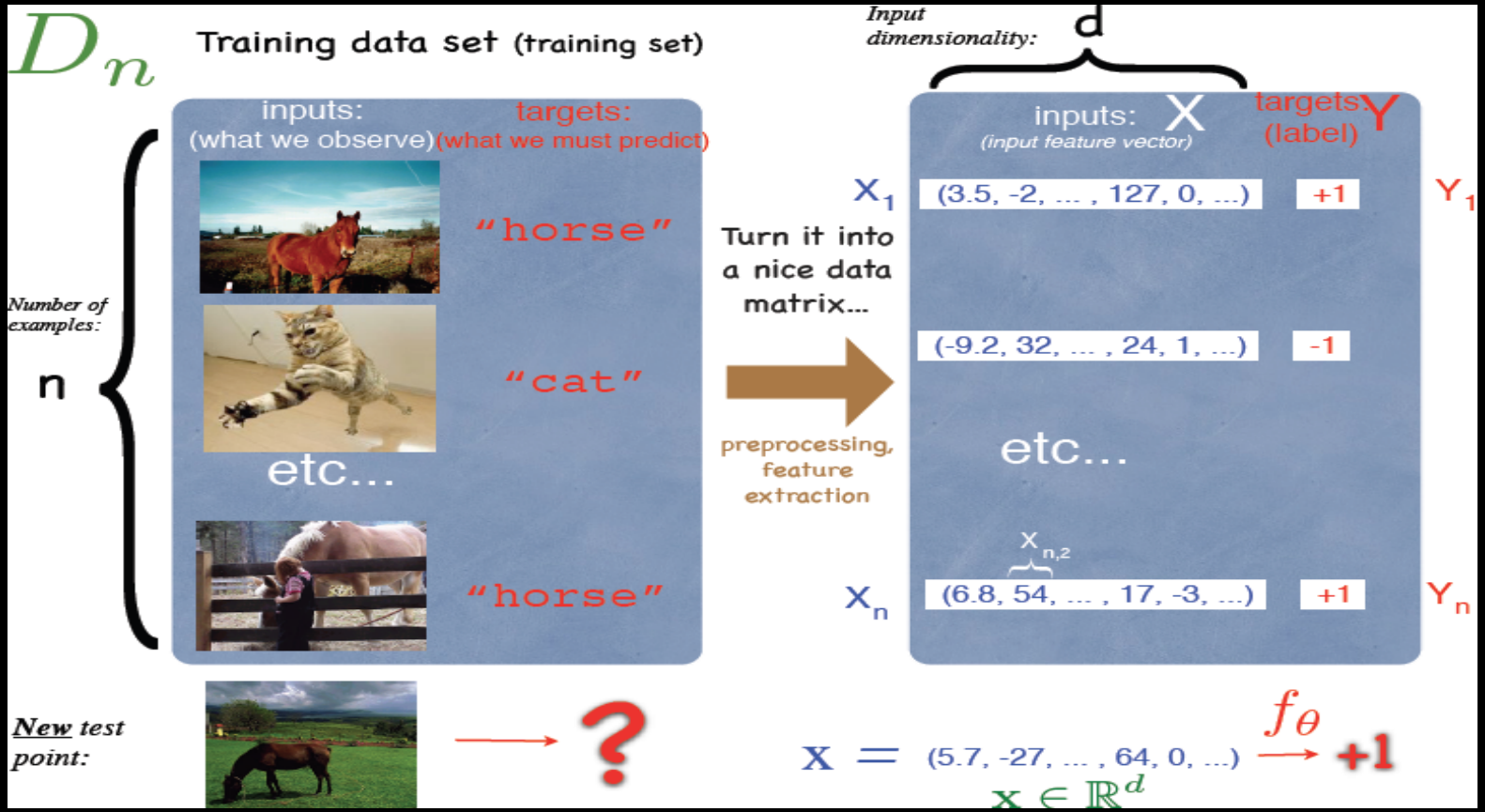
# Machine learning



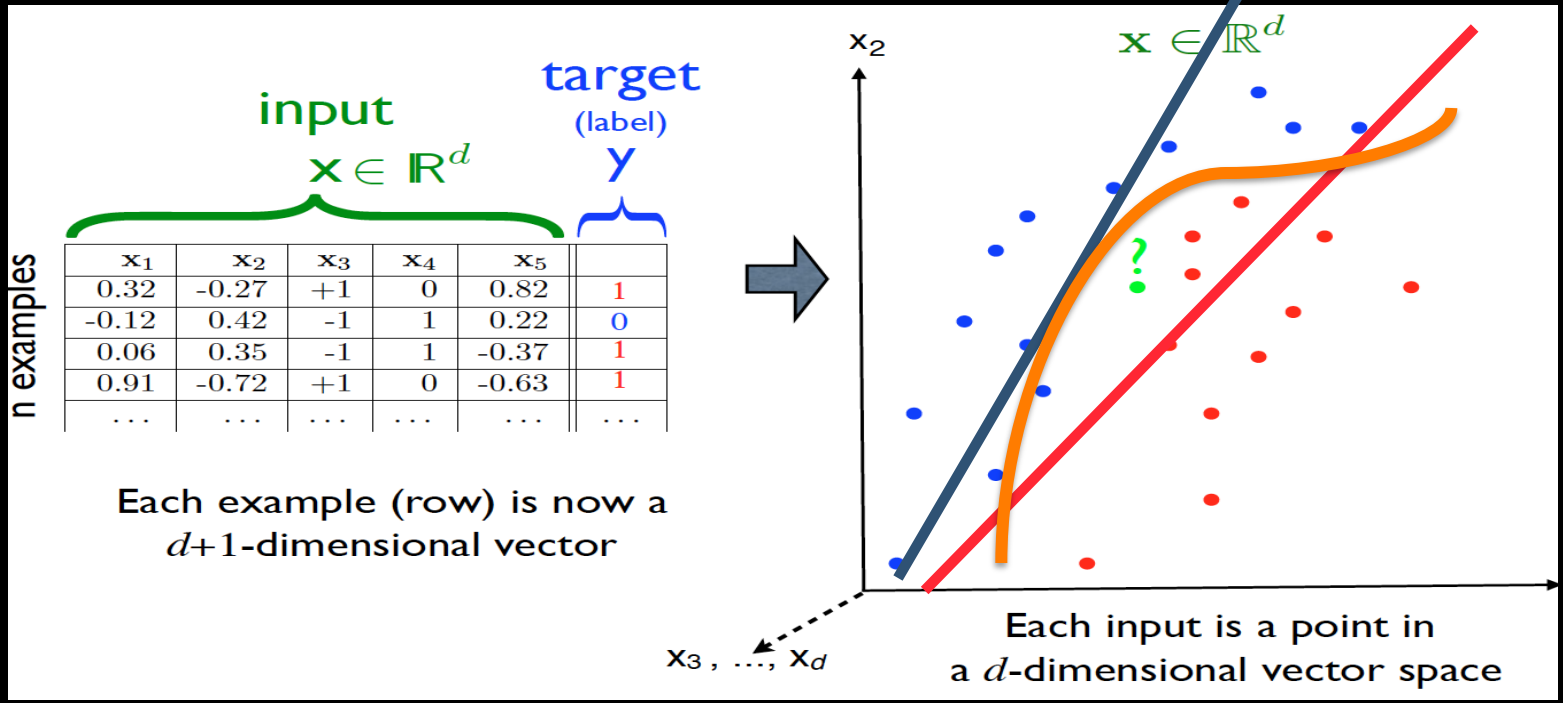
# Supervised learning



# Classification



# Classification

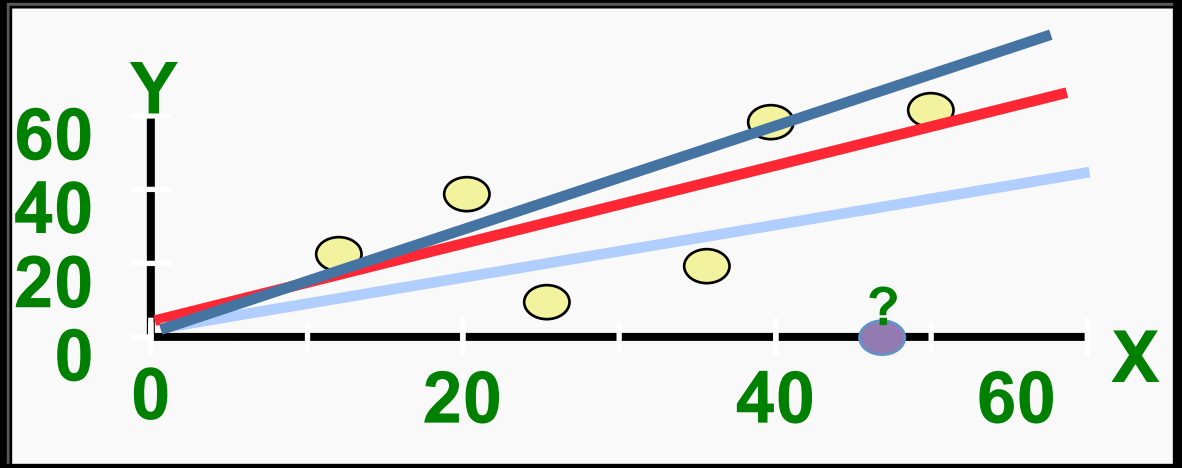


# Regression

input $x \in \mathbb{R}^d$ | target (label) $y$

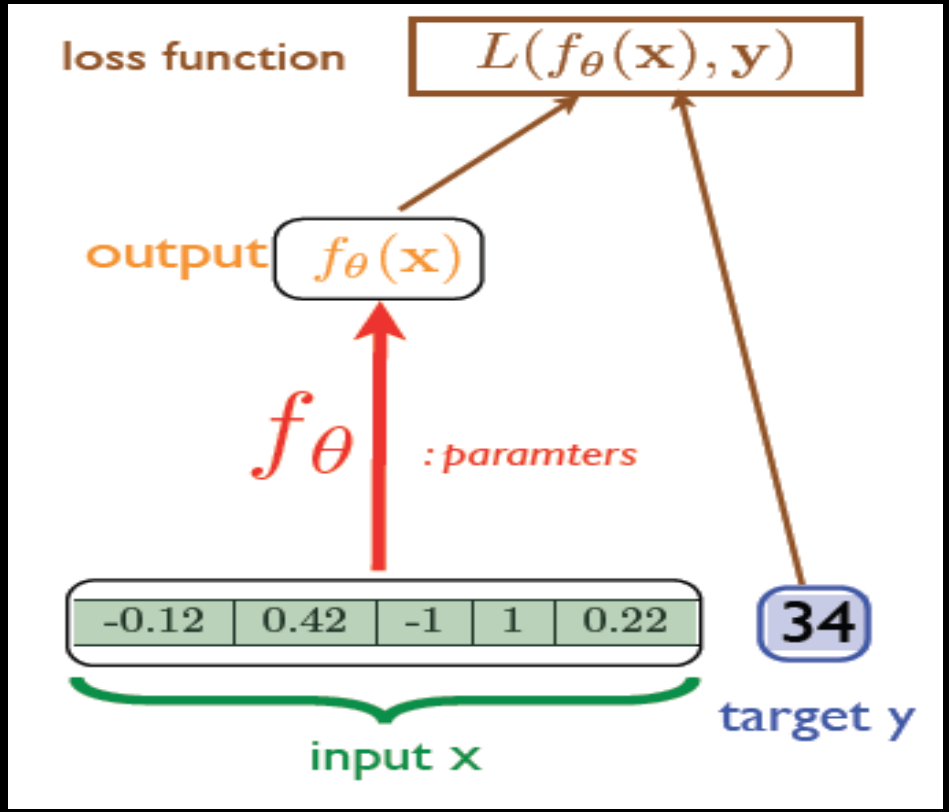
n examples

| $x_1$ | $x_2$ | $x_3$ | $x_4$ | $x_5$ | $t$ |
|---|---|---|---|---|---|
| 0.32 | -0.27 | +1 | 0 | 0.82 | 113 |
| -0.12 | 0.42 | -1 | 1 | 0.22 | 34 |
| 0.06 | 0.35 | -1 | 1 | -0.37 | 56 |
| 0.91 | -0.72 | +1 | 0 | -0.63 | 77 |
| ... | ... | ... | ... | ... | ... |

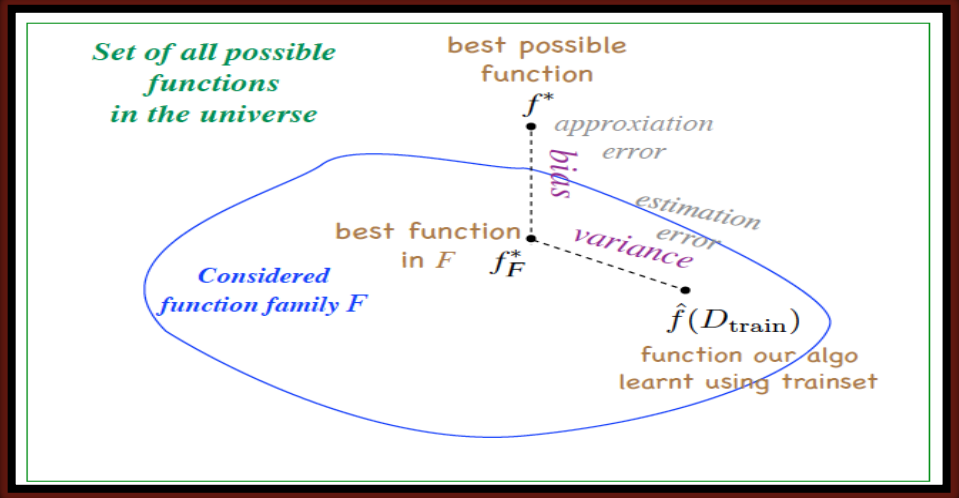


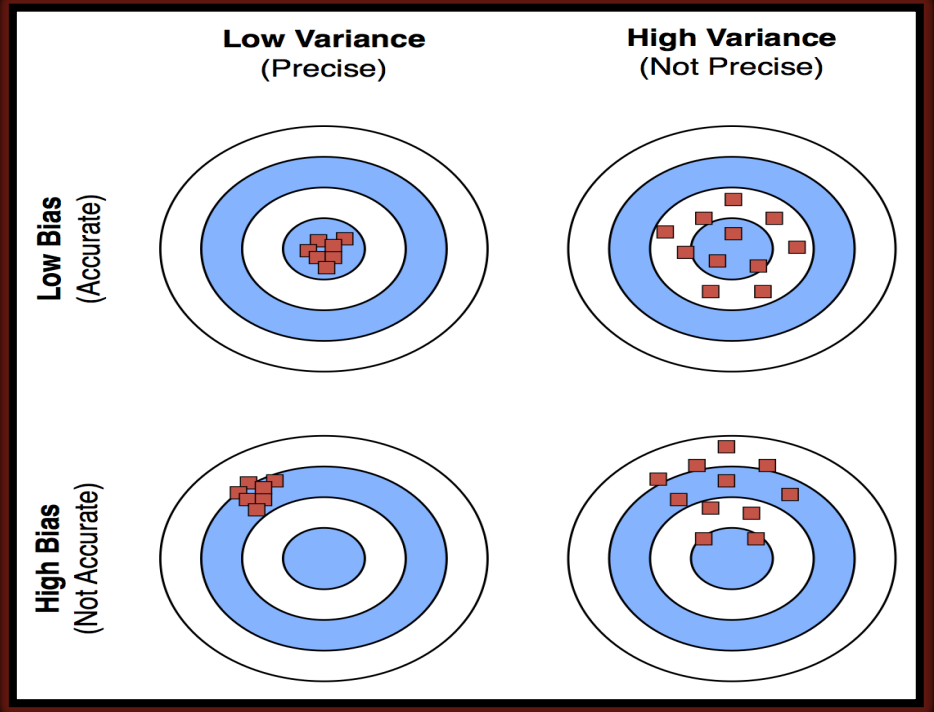
# Supervised learning: Generic framework

- 3 elements
  - **function family**
  - **loss function**
    - measure how wrongly the model predicts
  - **search for the best function**
    - **mathematical optimization**



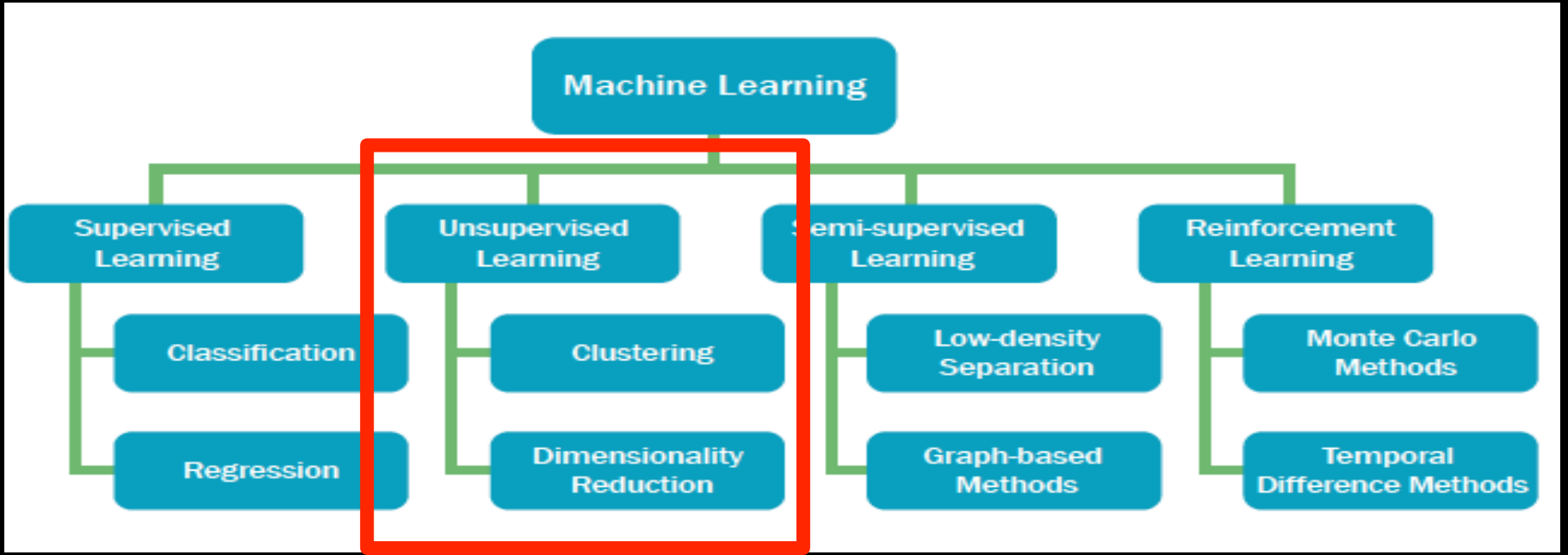
# Bias variance tradeoff




- All supervised learning algorithms ***seek to reduce bias and variance*** in a different way
- ***No free lunch***: no single algorithm will work well on all data set

# Machine learning

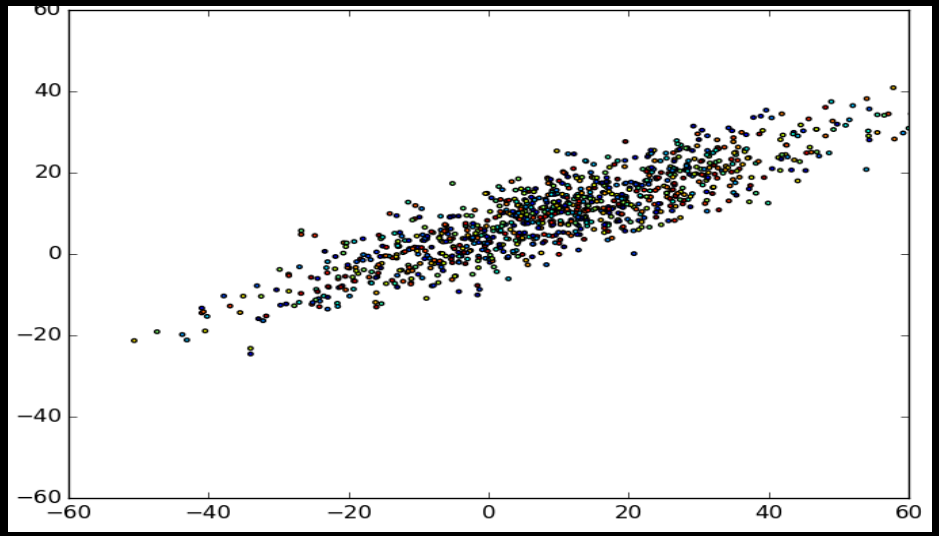


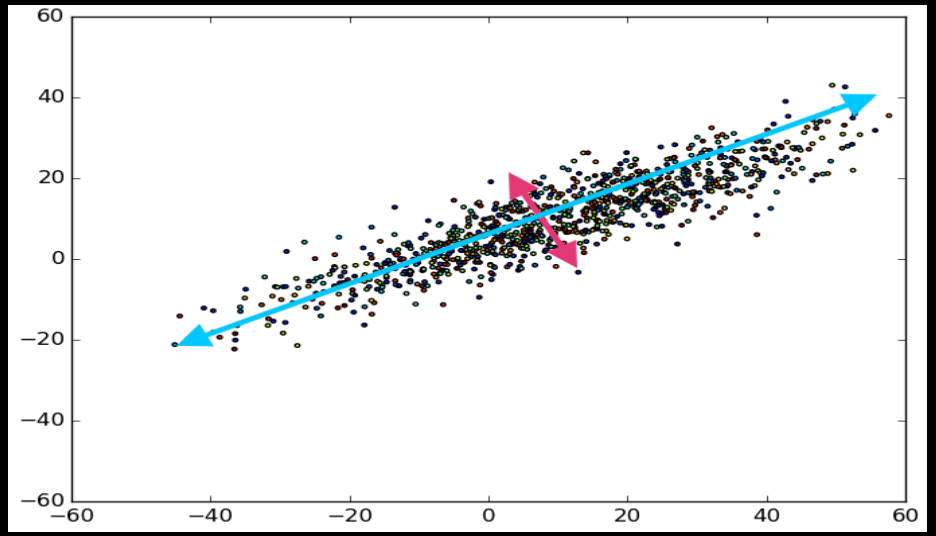
# Clustering

- No explicit prediction target
- Use the inherent structures in the data to best ***organize the data into groups*** of maximum commonality (e.g. k-Means)

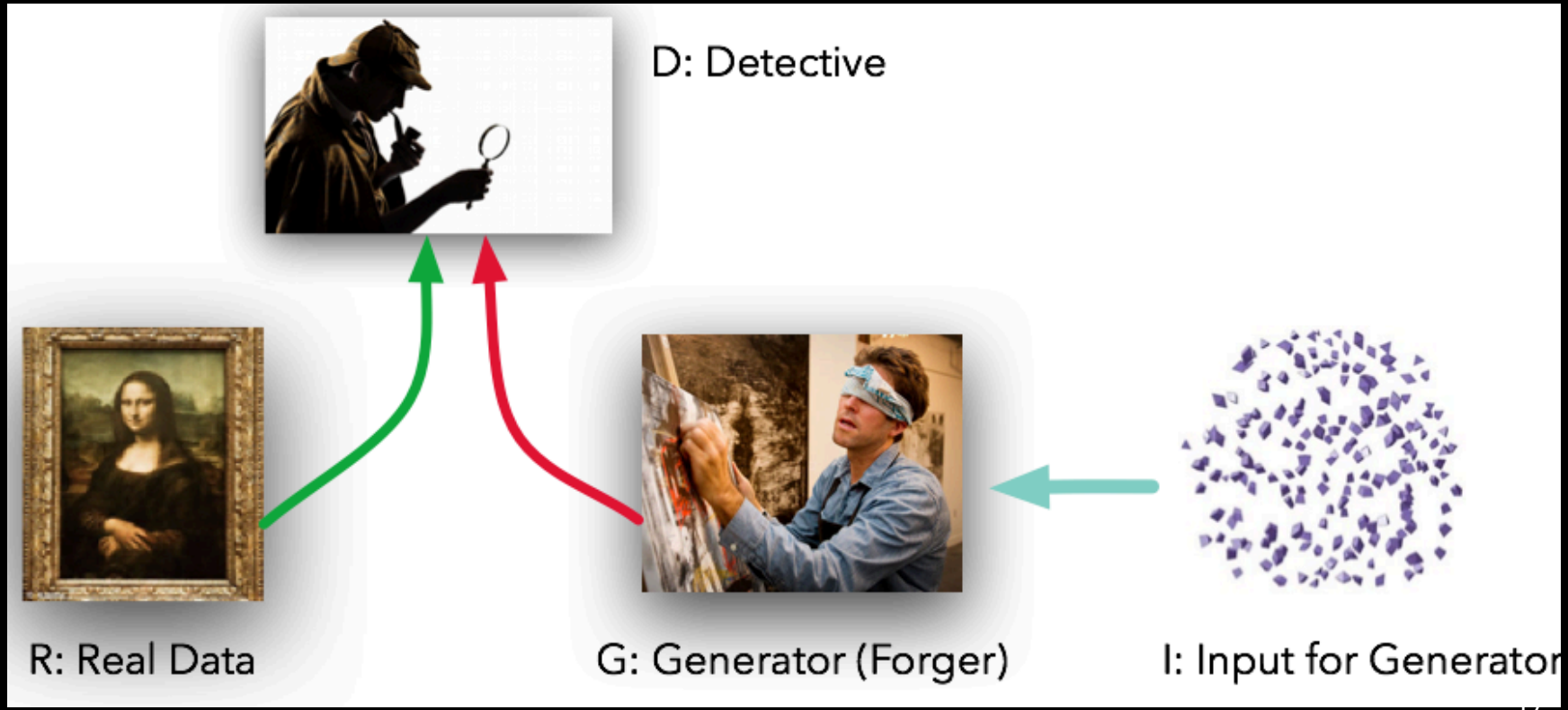
# Dimension reduction

- **No explicit prediction target**
- Exploit the inherent structure in the data to **summarize or describe data using less information** (e.g. Principle Component Analysis)



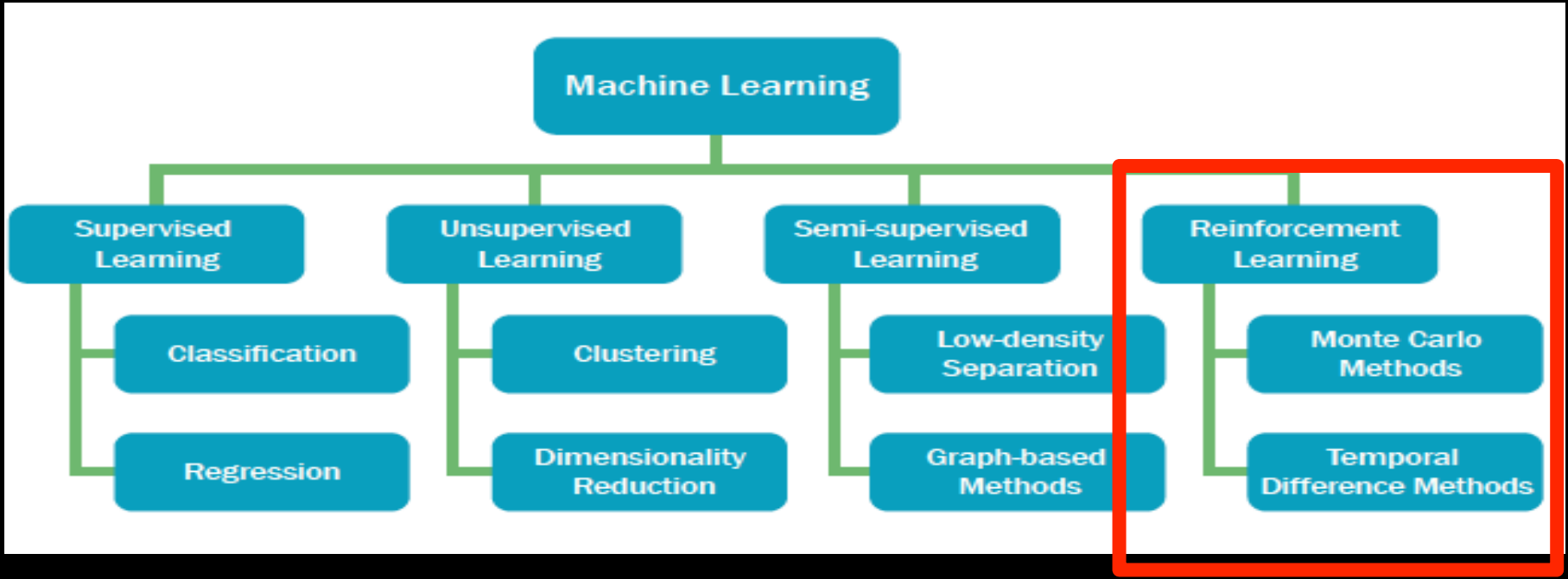



# Generative Adversarial Networks

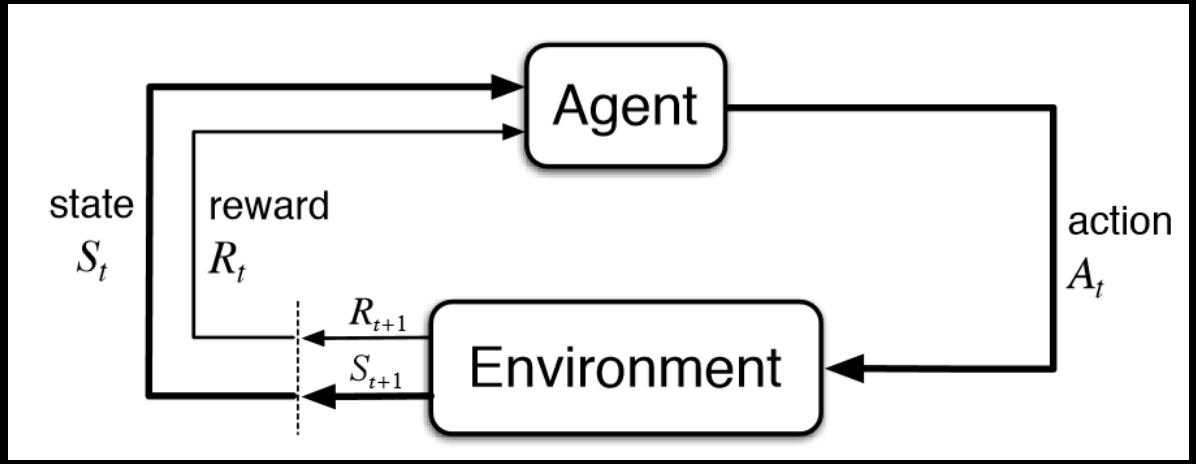


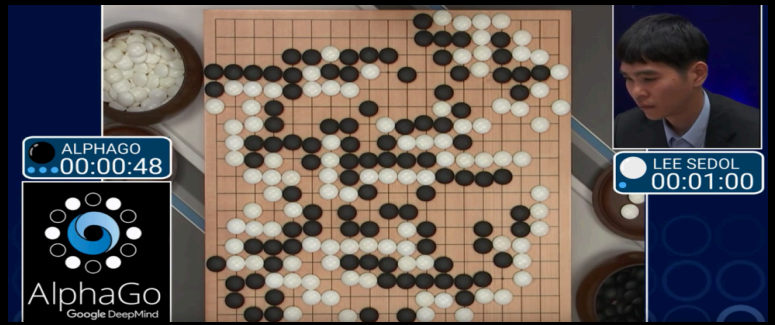
# Generative Adversarial Networks

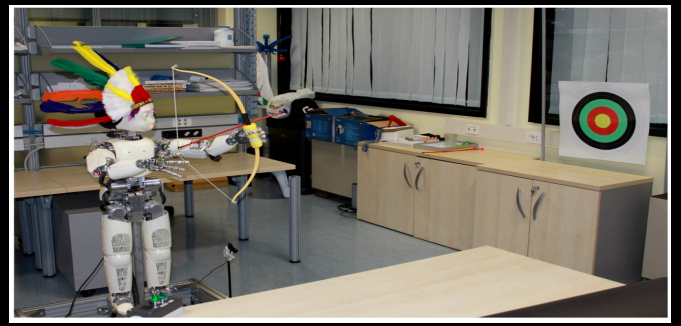
# Machine learning



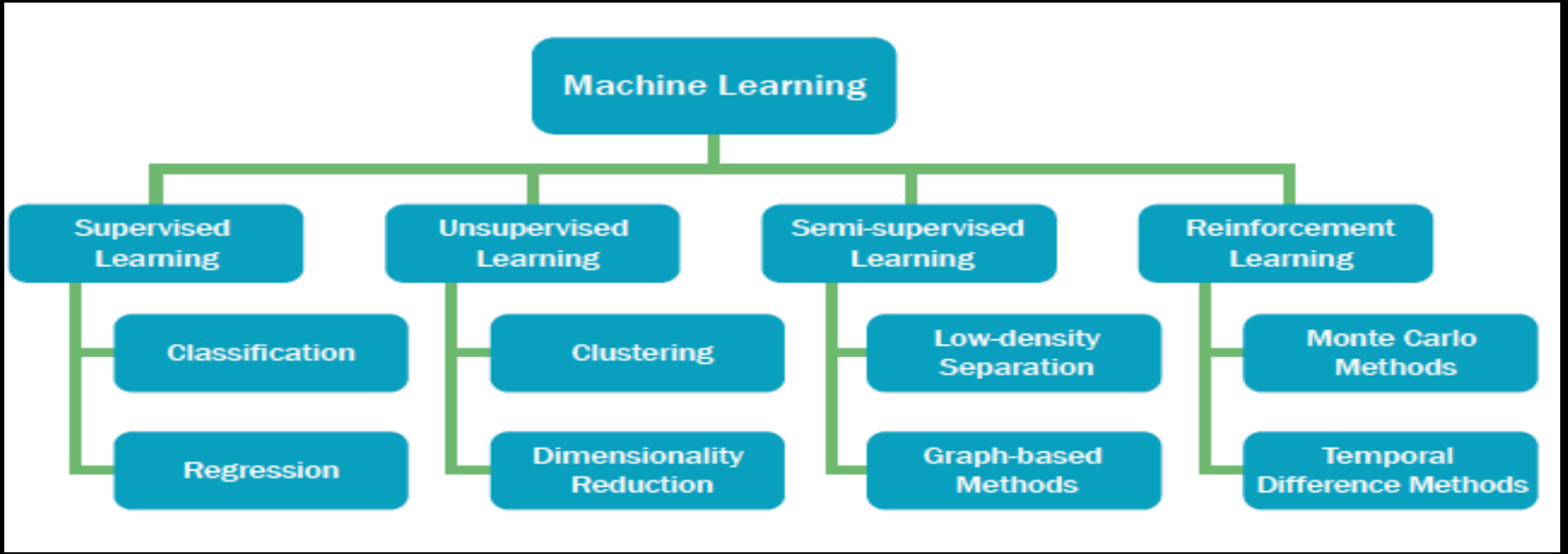
# Reinforcement learning



# Machine learning



# Thank You

www.mcs.anl.gov/~pbalapra