

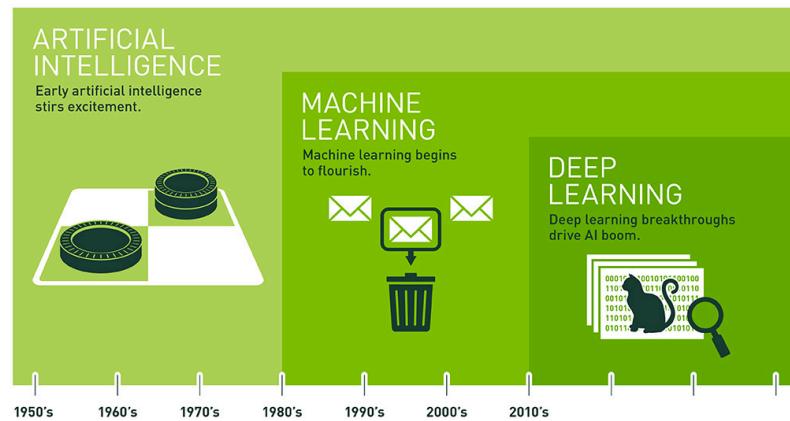
# Machine Learning

## CSC 461: Machine Learning

Fall 2021

Prof. Marco Alvarez  
University of Rhode Island

## AI vs ML vs DL



Since an early flush of optimism in the 1950s, smaller subsets of artificial intelligence – first machine learning, then deep learning, a subset of machine learning – have created ever larger disruptions.

<https://news.developer.nvidia.com/on-demand-webinar-deep-learning-demystified/>

## A (short) history of AI/ML

### ► 1940-1950: Early days

- ✓ 1943: McCulloch & Pitts: Boolean circuit model of brain
- ✓ 1950: Turing's "Computing Machinery and Intelligence"

### ► 1950—70: Excitement: Look, Ma, no hands!

- ✓ 1950s: Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
- ✓ 1956: Dartmouth meeting: "Artificial Intelligence" adopted
- ✓ 1965: Robinson's complete algorithm for logical reasoning

### ► 1970—90: Knowledge-based approaches

- ✓ 1969—79: Early development of knowledge-based systems
- ✓ 1980—88: Expert systems industry booms
- ✓ 1988—93: Expert systems industry busts: "AI Winter"

### ► 1990—2012: Statistical approaches + subfield expertise

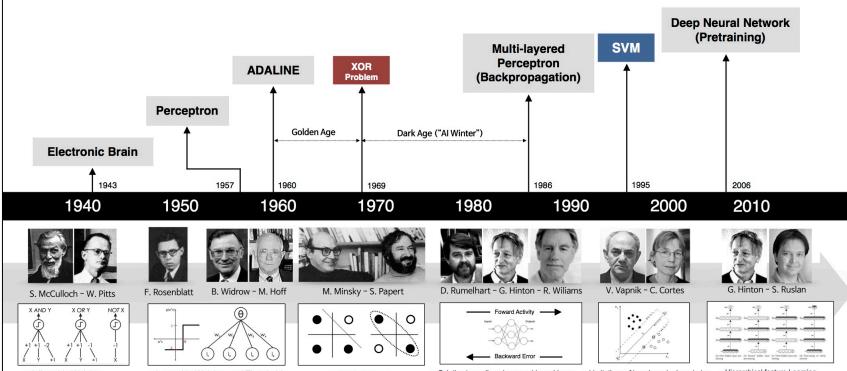
- ✓ Resurgence of probability, focus on uncertainty
- ✓ General increase in technical depth
- ✓ Agents and learning systems... "AI Spring"?

### ► 2012—...: Excitement: Look, Ma, no hands again?

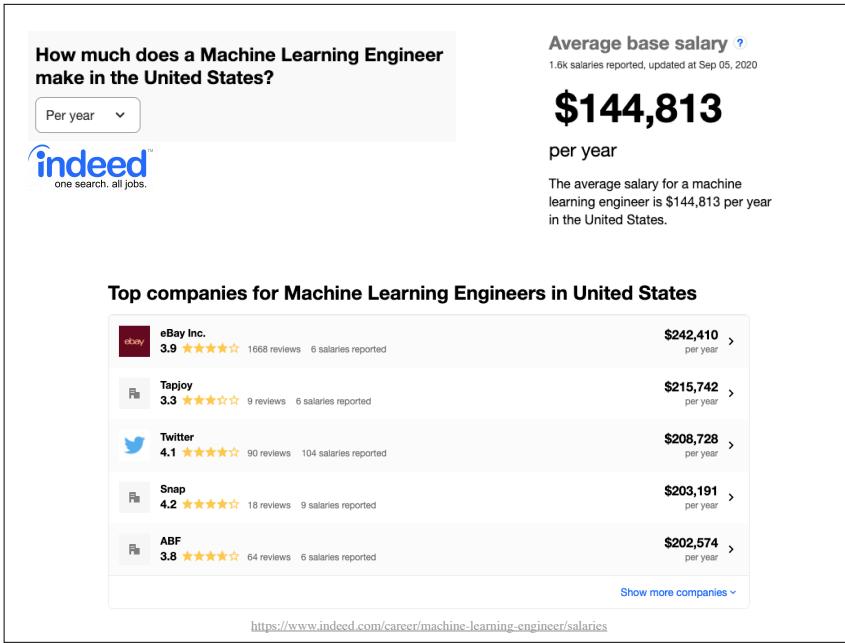
- ✓ Big data, big compute, neural networks
- ✓ Some re-unification of sub-fields
- ✓ AI used in many industries

from: CS 188: Introduction to Artificial Intelligence, Berkeley

## Milestones in AI/ML

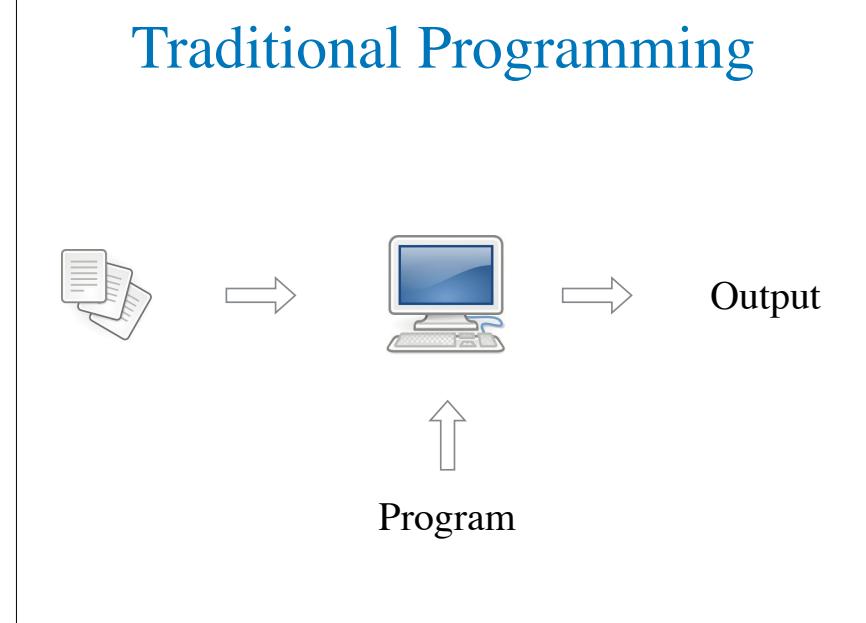


[http://beamandrew.github.io/deeplearning/2017/02/23/deep\\_learning\\_101\\_part1.html](http://beamandrew.github.io/deeplearning/2017/02/23/deep_learning_101_part1.html)



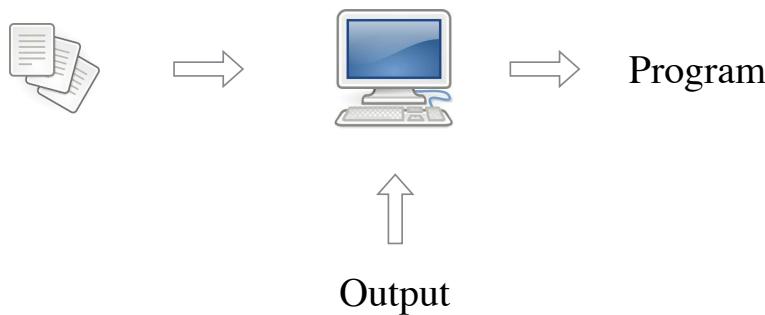
## What is Machine Learning?

- Machine Learning is ... [Mitchell]
  - ✓ the study of computer algorithms that learn from experience **E** with respect to a particular task **T** and performance metric **P**
- Remember the badges problem?
  - ✓ can you identify **E**, **T** and **P**?



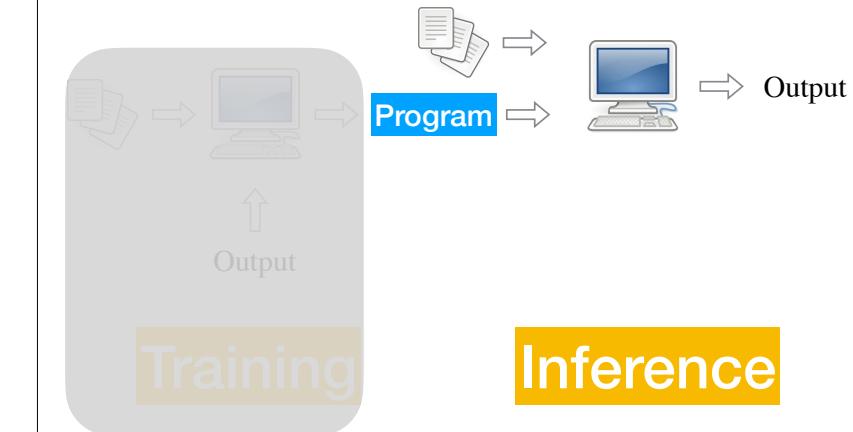
# Machine Learning

(Supervised)



# Machine Learning

(Supervised)



## Applications ...



### INTERNET & CLOUD

Image Classification  
Speech Recognition  
Language Translation  
Language Processing  
Sentiment Analysis  
Recommendation

### MEDICINE & BIOLOGY

Cancer Cell Detection  
Diabetic Grading  
Drug Discovery

### MEDIA & ENTERTAINMENT

Video Captioning  
Video Search  
Real Time Translation

### SECURITY & DEFENSE

Face Detection  
Video Surveillance  
Satellite Imagery

### AUTONOMOUS MACHINES

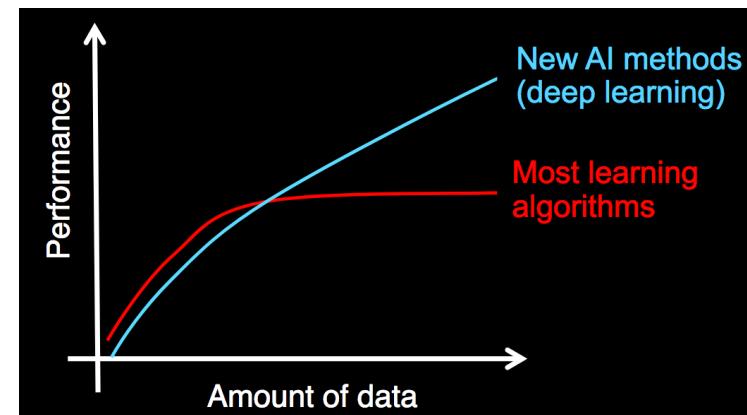
Pedestrian Detection  
Lane Tracking  
Recognize Traffic Sign

Deep Learning and HPC, NVIDIA, 2017

## Data and Machine Learning

Data is the most important part

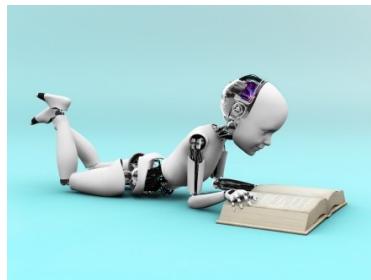
Quality &  
Quantity



from: CS229: Machine Learning, Stanford

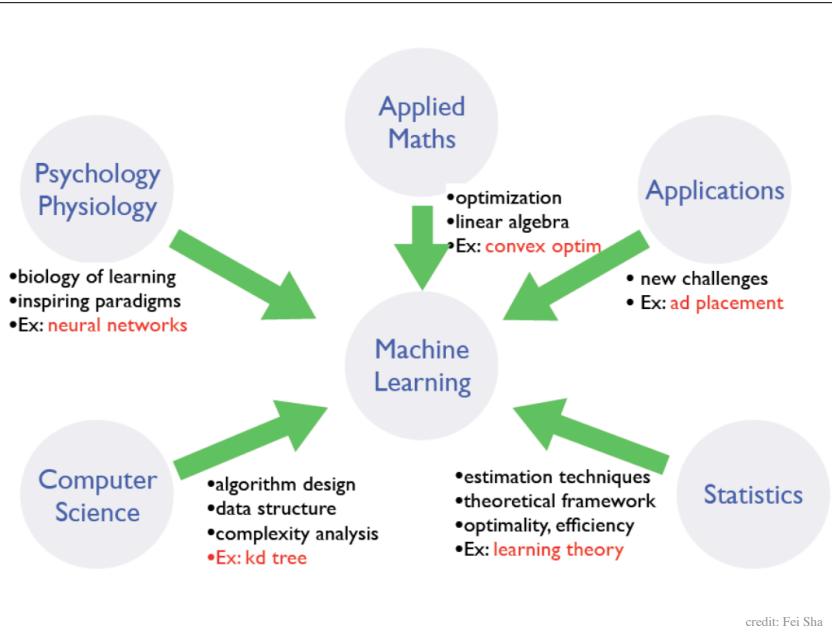
## Why ML is so popular?

- Recent progress in algorithms and theory
- Growing amounts of data
- Computational power
- Industry investment
- Great applications



## When to use Machine Learning?

- Need for automation
  - ✓ automate things humans can do (e.g. speech recognition)
  - ✓ difficult/expensive things for humans (e.g. process huge amounts of data)
- Need for custom models
  - ✓ e.g. personalized medicine, spam filters

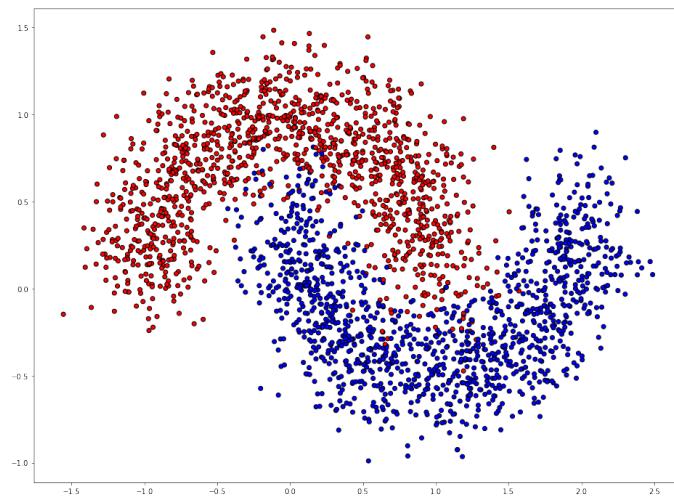


## Major Paradigms

- **Supervised learning**
  - ✓ training data and labels
  - ✓ classification, regression
- **Unsupervised learning**
  - ✓ training data (no labels)
  - ✓ clustering, dimensionality reduction, density estimation
- **Reinforcement learning**
  - ✓ rewards from actions

# Supervised Learning

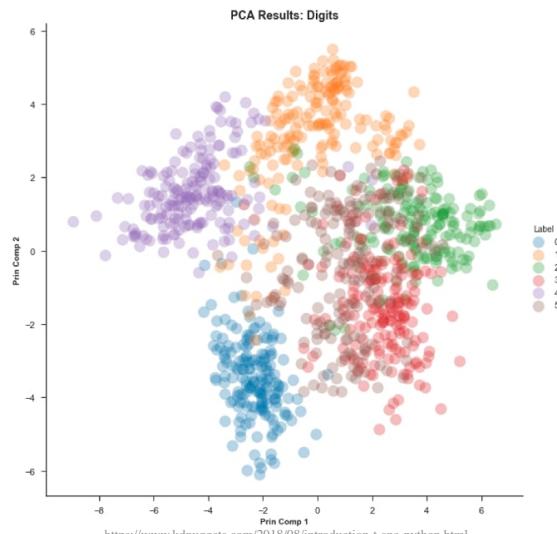
## Binary classification



## Data?

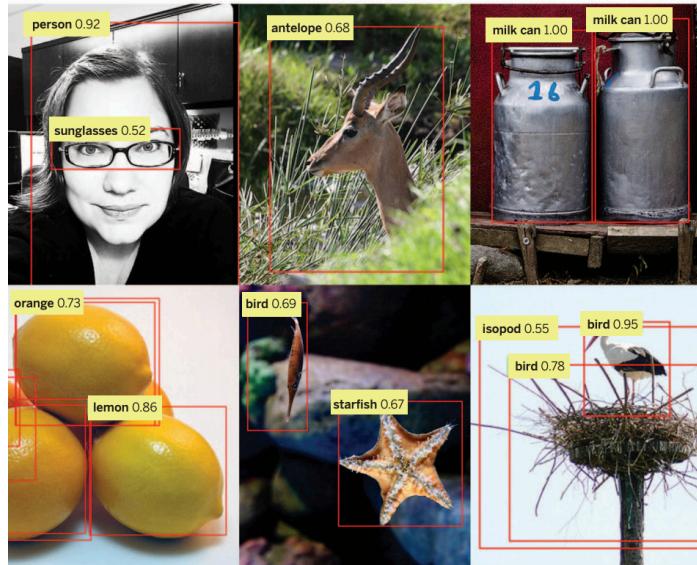
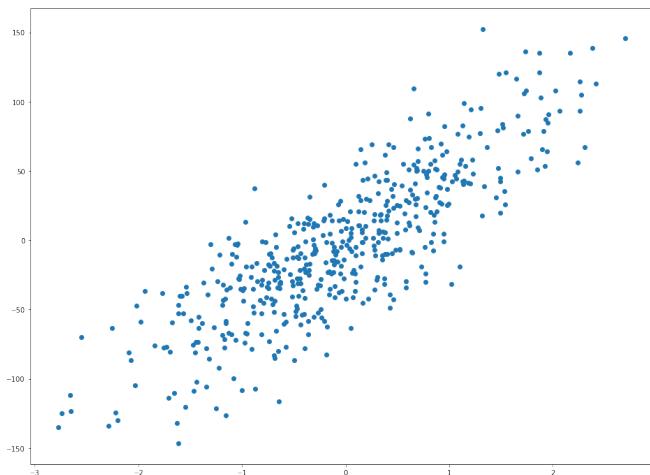
```
array([[ 0.24277092,  0.89098144],      array([[0],
[-0.57961074,  0.50618765],           [1],
[ 0.24259841,  0.12209649],           [1],
[ 1.68348295, -0.10059047],          [1],
[ 2.00696736, -0.79306007],          [1],
[ 1.56891881,  0.30515286],          [0],
[ 0.1314049 , -0.35704446],          [1],
[ 2.14017386,  0.33933491],          [1],
[-1.03087047,  1.52609949],          [0],
[-0.38504321,  1.24209655],          [0],
[-1.20252537,  0.56167652],          [0],
[ 0.08590311,  0.68265315],          [1],
[ 0.88074085, -0.11759523],          [1],
[ 0.32558238,  0.4181143 ],          [1],
[-0.74202798,  0.68847344]]),      [0]])
```

## Multiclass classification



<https://www.kdnuggets.com/2018/08/introduction-t-sne-python.html>

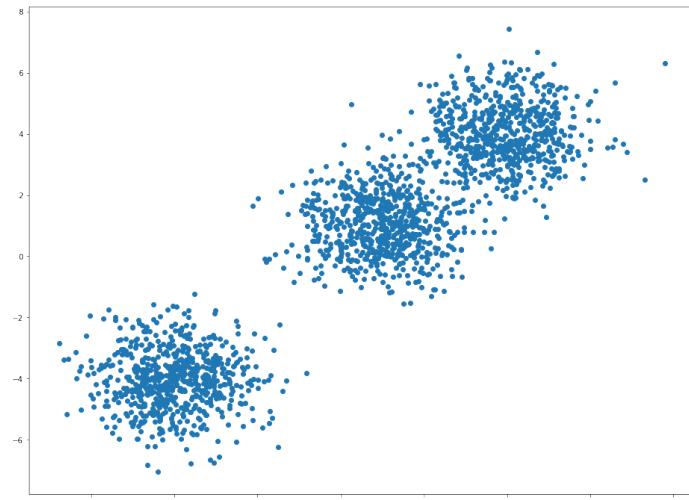
## Regression



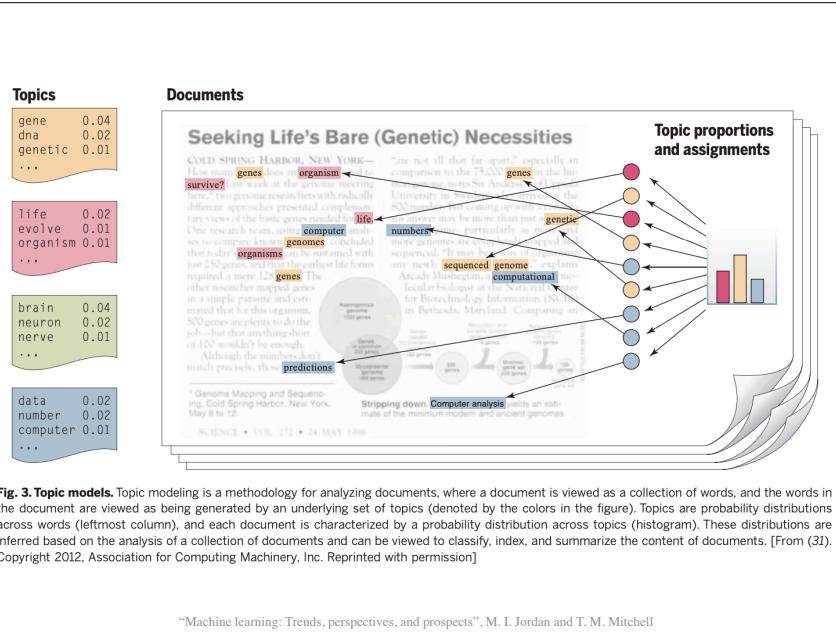
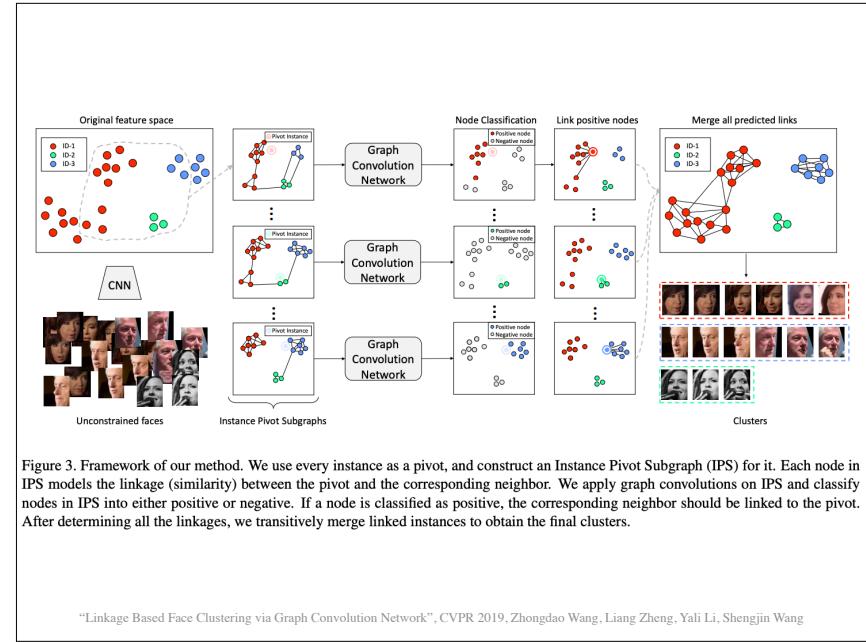
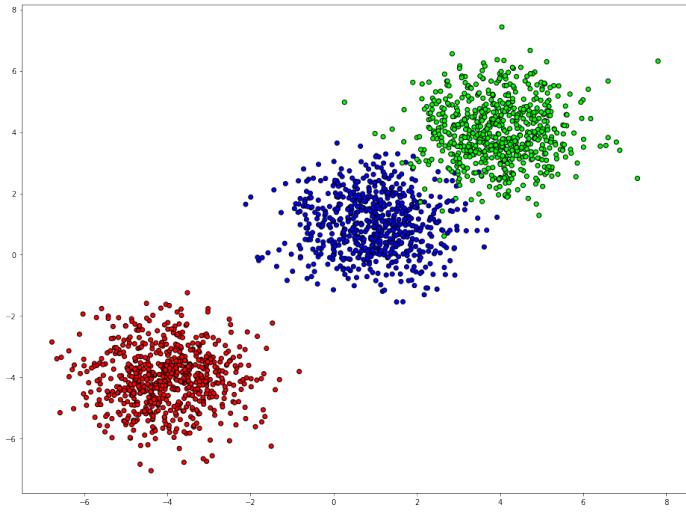
"Machine learning: Trends, perspectives, and prospects", M. I. Jordan and T. M. Mitchell

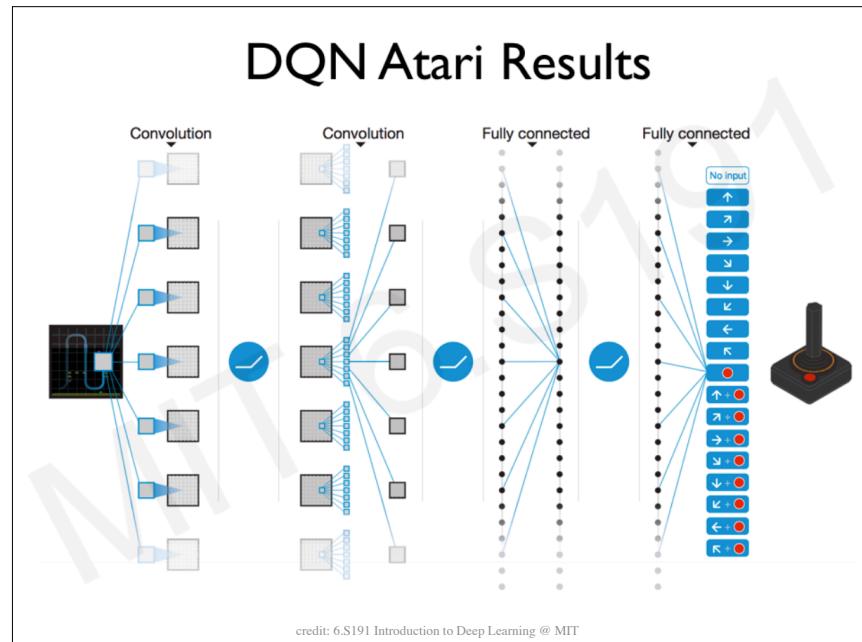
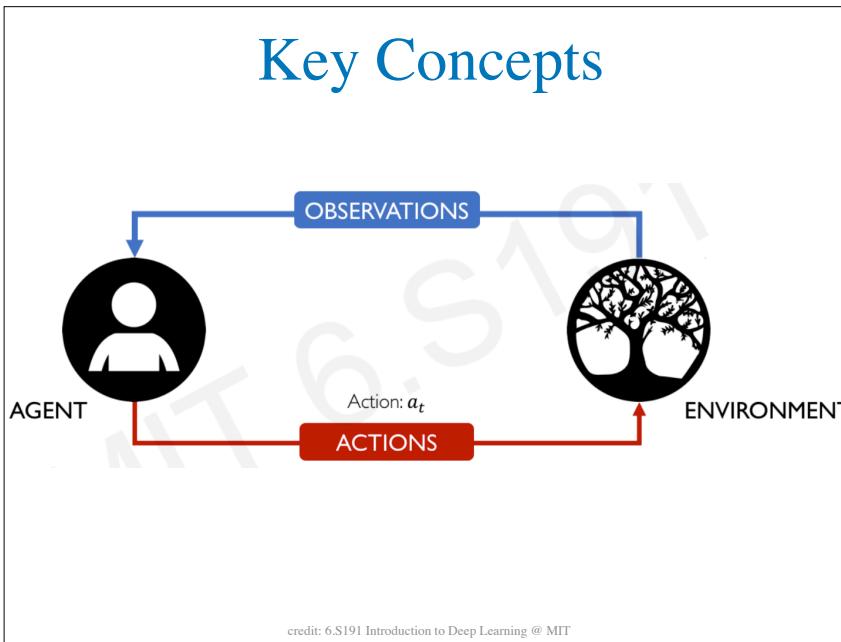
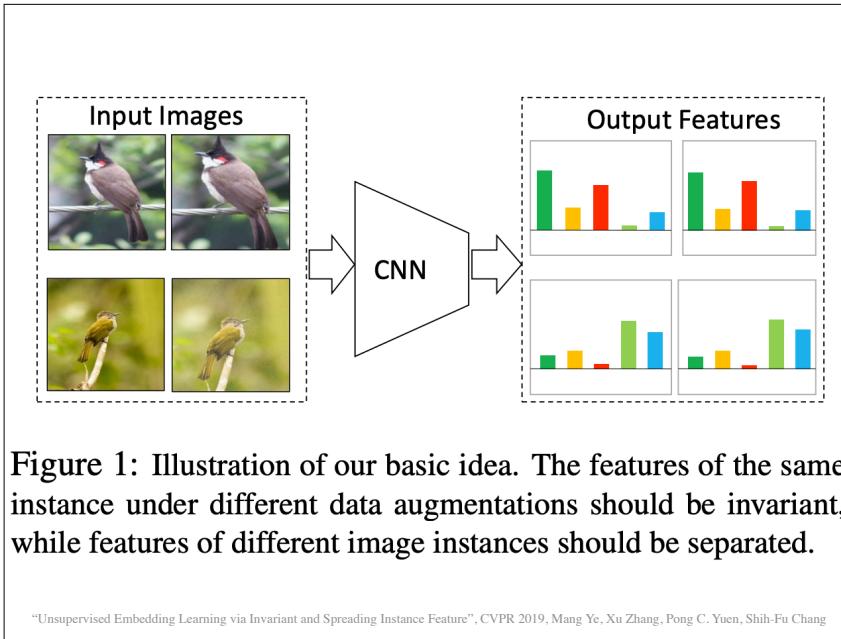
## Unsupervised Learning

## Unsupervised learning



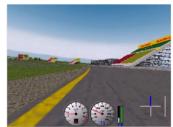
# Unsupervised Learning







(a)



(b)



(c)



(d)



(e)



(f)

