CS480/680 Machine Learning Lecture 1: May 6th, 2019

Course Introduction

Pascal Poupart

Outline

- Introduction to Machine Learning
- Course website and logistics

Instructor

Professor

Pascal Poupart

15+ years experience
in Machine Learning

Principal Researcher

RBC Borealis AI

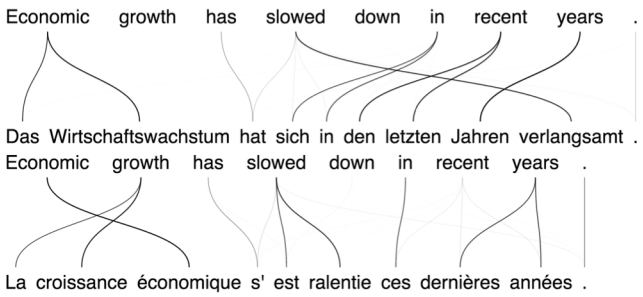
- Research institute funded by RBC
- 5 research centers:
  - Montreal, Toronto, Waterloo, Edmonton and Vancouver

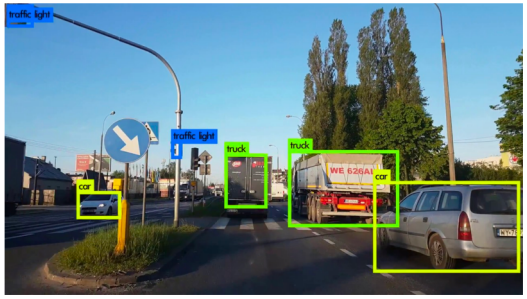
- 80 researchers:
  - Integrated (applied & fundamental) research model
    - ML, RL, NLP, computer vision, private AI, fintech
- We are hiring!

Machine Learning

- Traditional computer science
  - Program computer for every task

- New paradigm
  - Provide examples to machine
  - Machine learns to accomplish a task based on the examples





Definitions

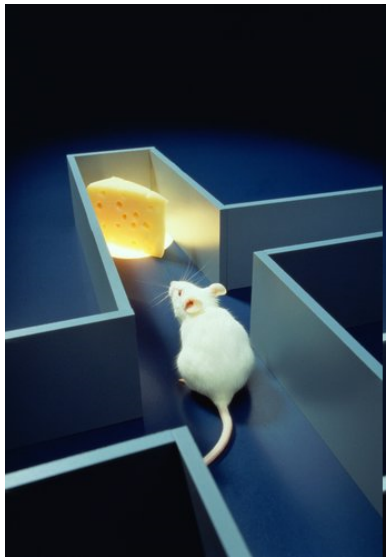
- Arthur Samuel (1959): **Machine learning** is the field of study that gives computers the ability to learn without being explicitly programmed.

- Tom Mitchell (1998): A computer program is said to **learn** from experience E with respect to some class of tasks T and performance measure P, if its performance at tasks in T, as measured by P, improves with experience E.

Three Categories

Supervised learning

Reinforcement learning

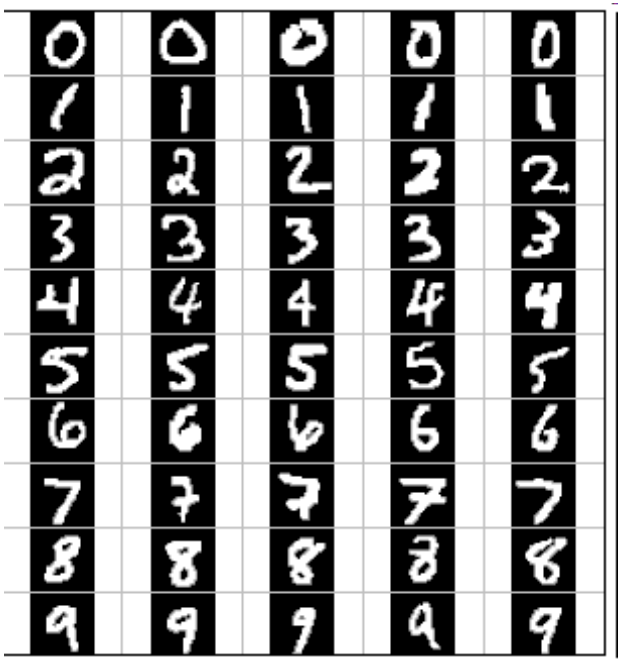


Unsupervised learning

Supervised Learning

- Example: digit recognition (postal code)

- Simplest approach: memorization



Supervised Learning

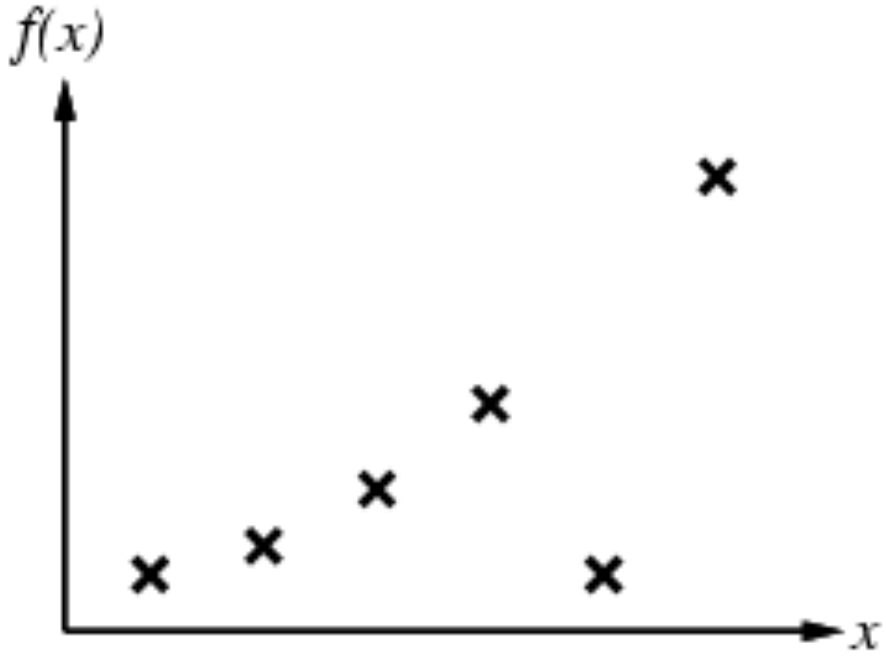
- Nearest neighbour:

More Formally

- Inductive learning (for supervised learning):
  - Given a training set of examples of the form $(x, f(x))$
    - x is the input, $f(x)$ is the output
  - Return a function h that approximates f
    - h is called the hypothesis

Prediction

- Find function h that fits f at instances x



Prediction

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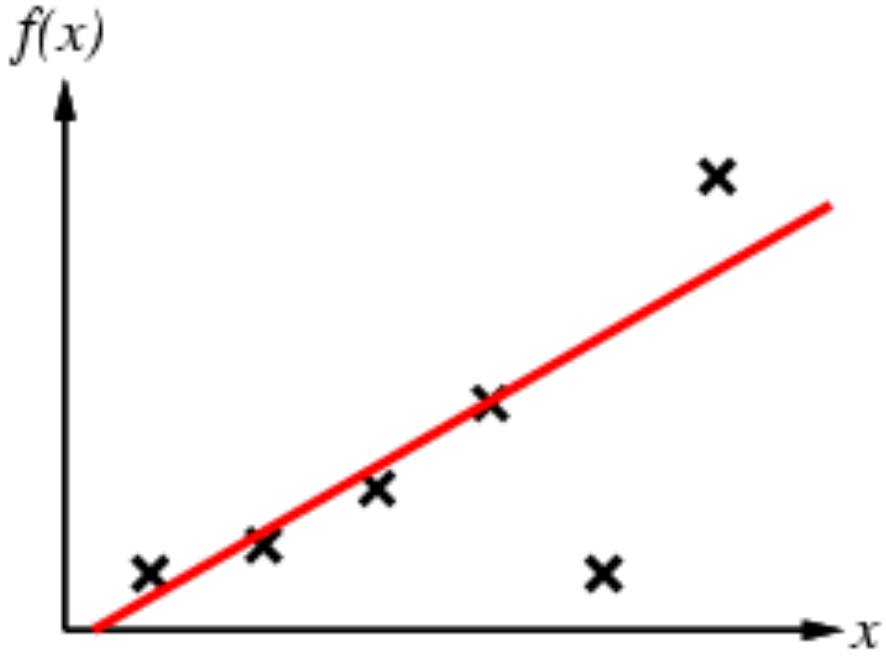

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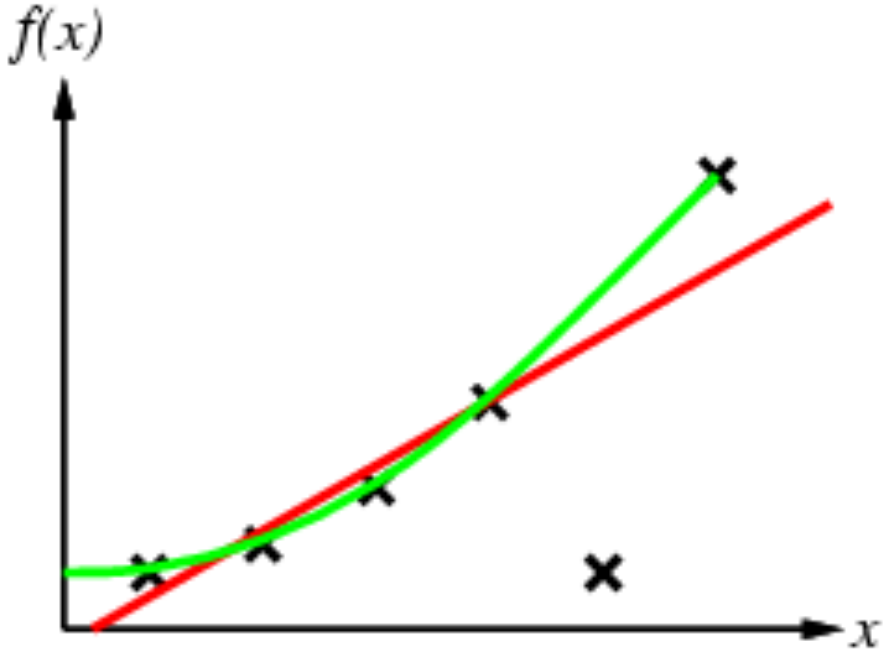

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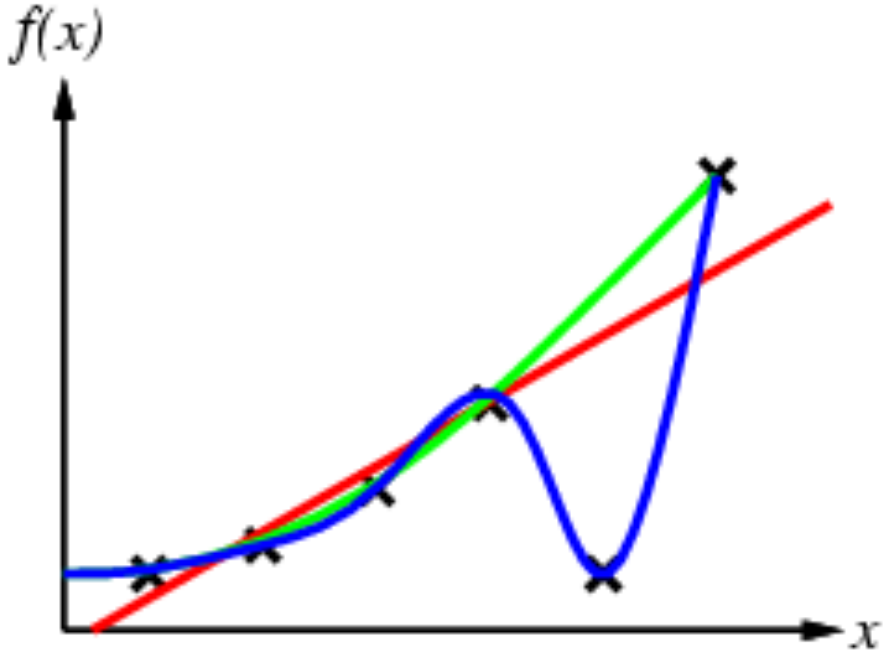

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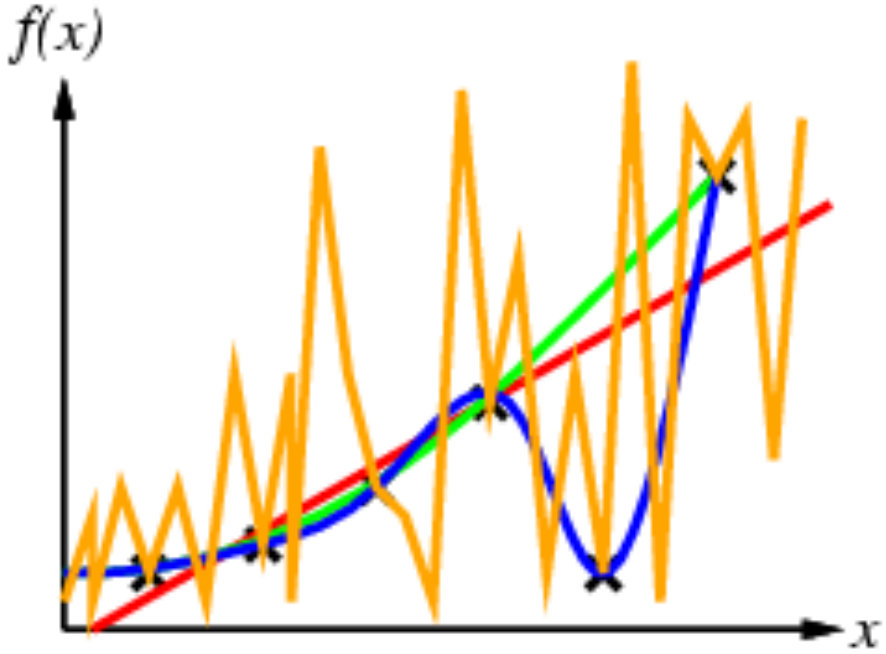


Generalization

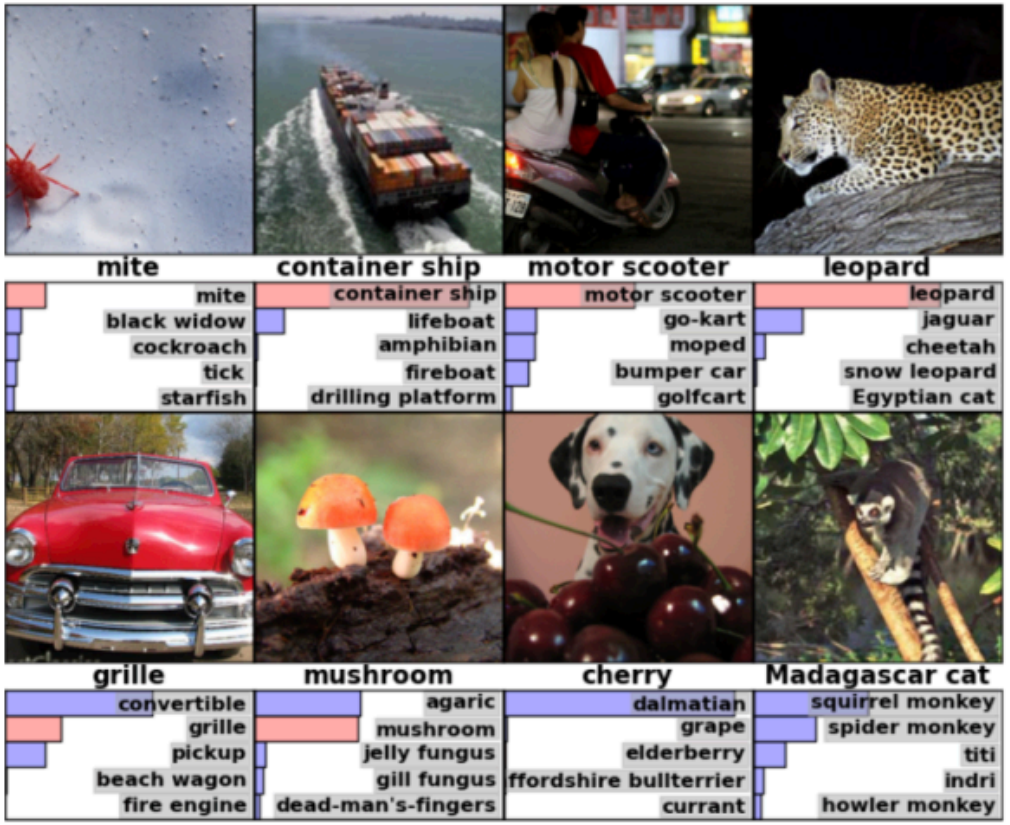
- Key: a good hypothesis will generalize well (i.e. predict unseen examples correctly)

- Ockham's razor: prefer the simplest hypothesis consistent with data

ImageNet Classification

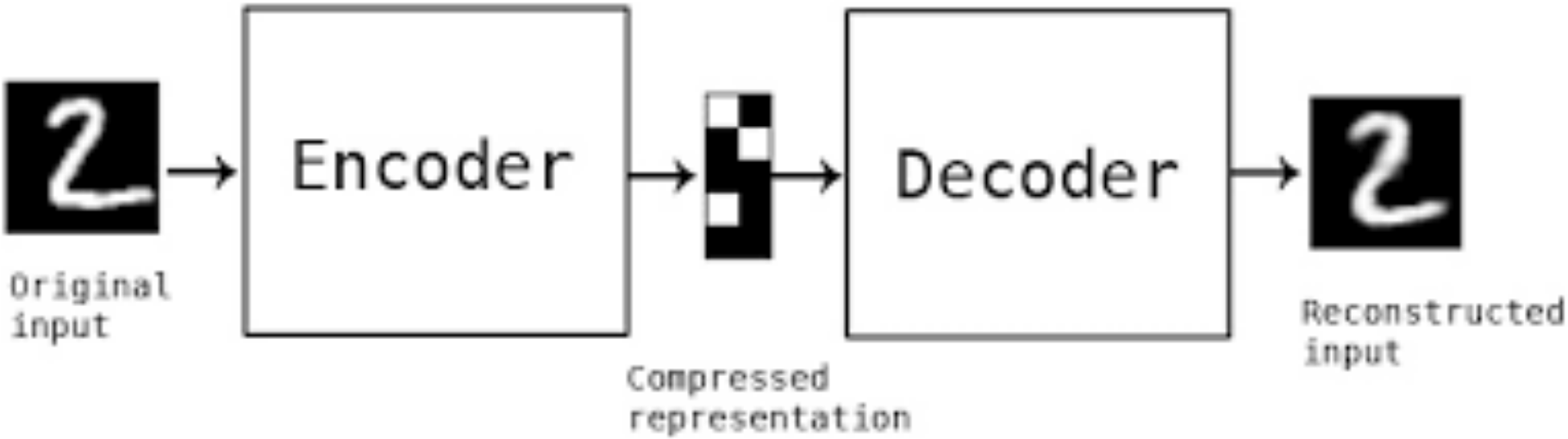
- 1000 classes
- 1 million images

- Deep neural networks (supervised learning)



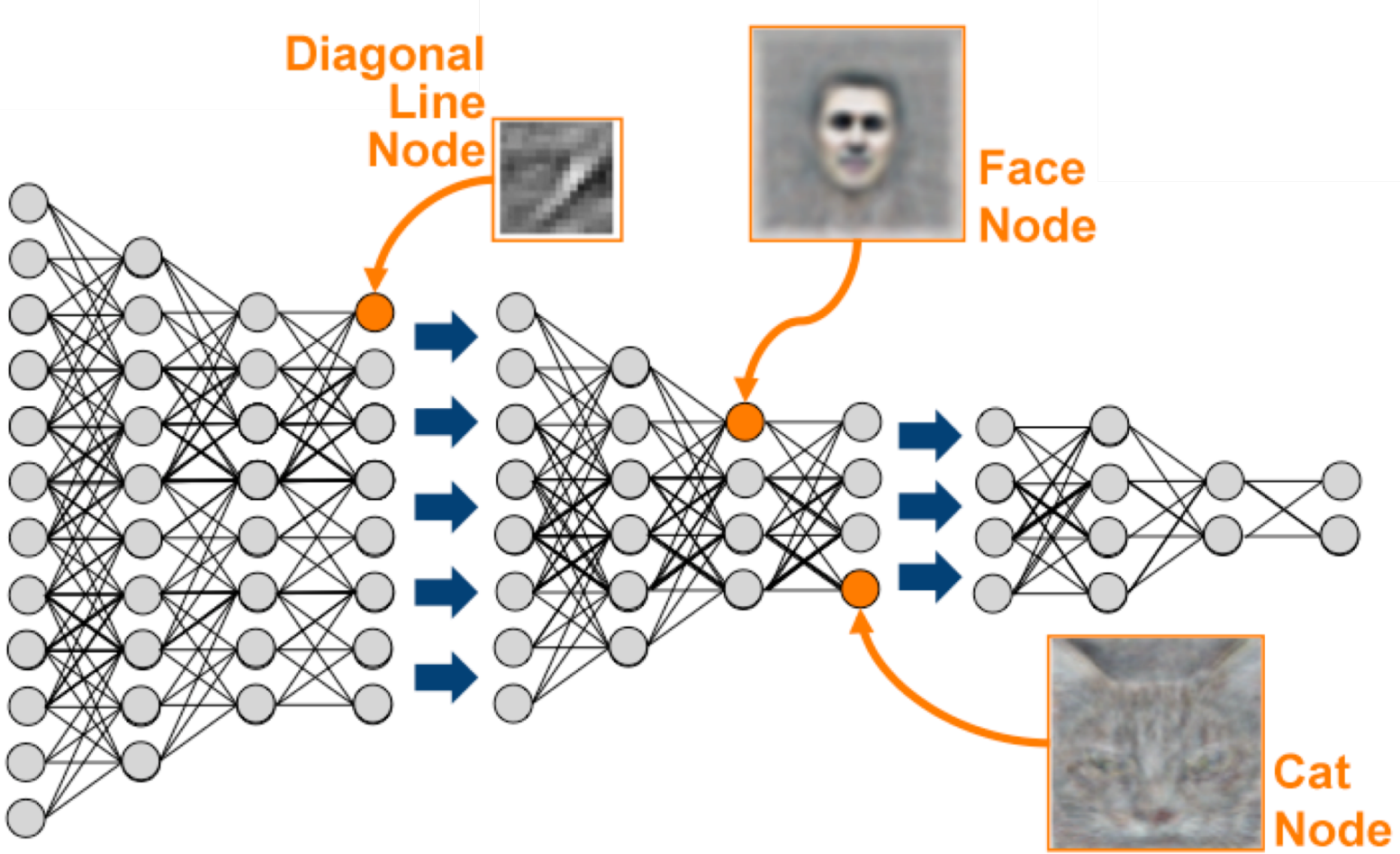
Unsupervised Learning

- Output is not given as part of training set
- Find model that explains the data
  - E.g. clustering, compressed representation, features, generative model

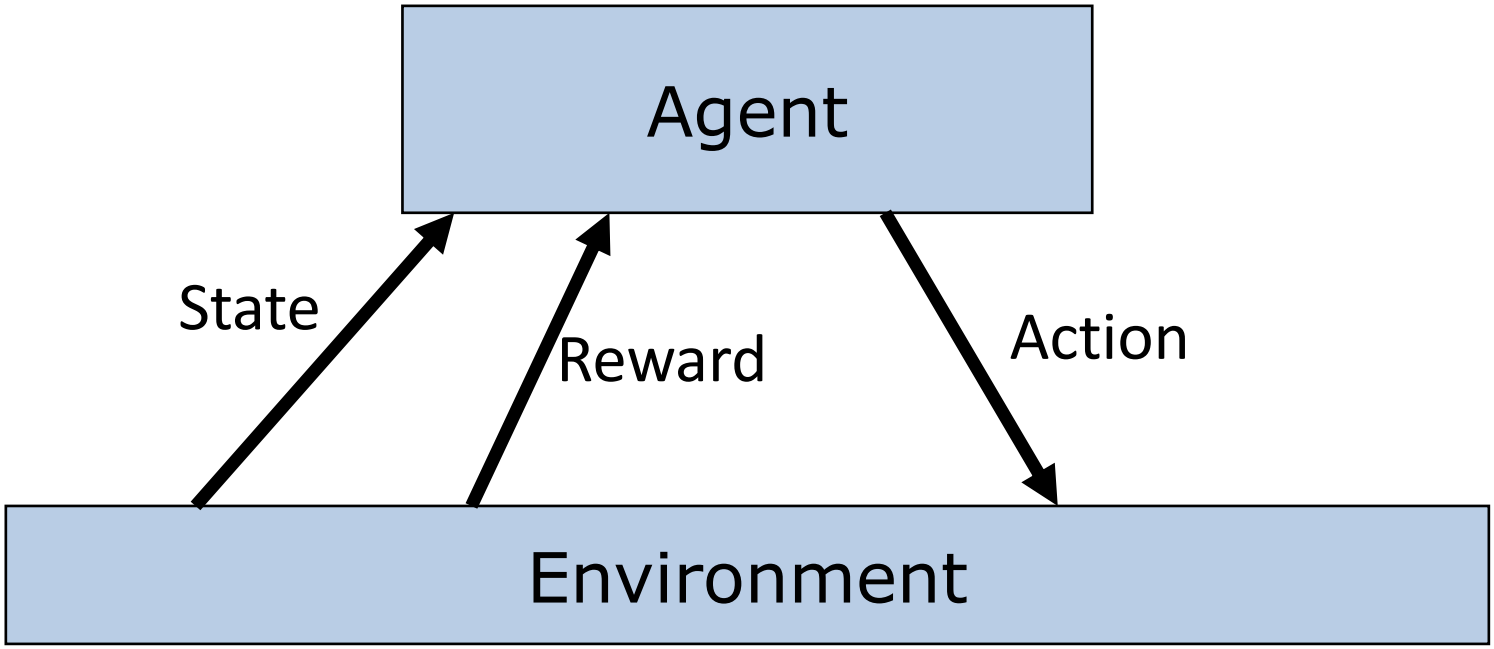


Unsupervised Feature Generation

- Encoder trained on large number of images



Reinforcement Learning



Goal: Learn to choose actions that maximize rewards

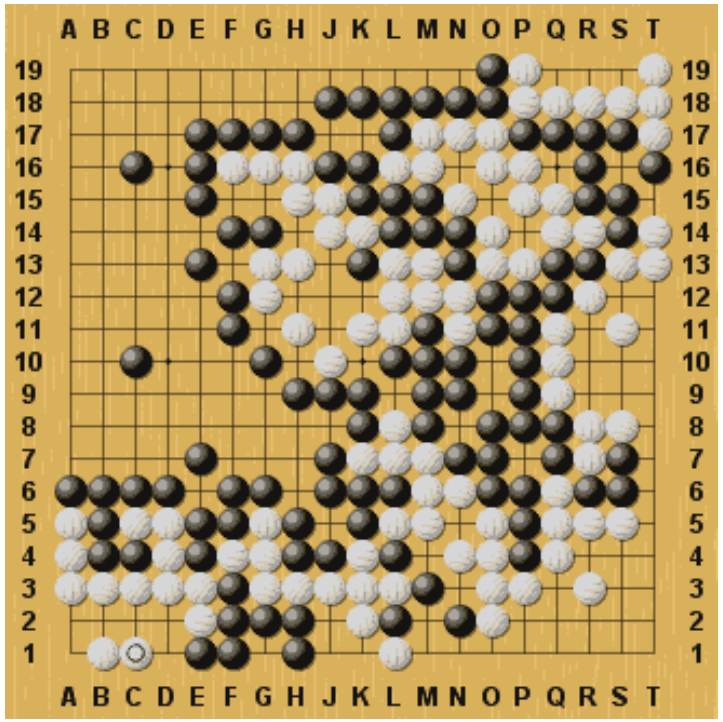
Animal Psychology

- Reinforcements used to train animals
- Negative reinforcements:
  - Pain and hunger
- Positive reinforcements:
  - Pleasure and food

- Let's do the same with computers!
  - Rewards: numerical signal indicating how good actions are
    - E.g., game win/loss, money, time, etc.

Game Playing

- Example: Go (one of the oldest and hardest board games)



- **Agent:** player
- **Environment:** opponent
- **State:** board configuration
- **Action:** next stone location
- **Reward:** +1 win / -1 loose

- 2016: AlphaGo defeats top player Lee Sedol (4-1)
  - Game 2 move 37: AlphaGo plays unexpected move (odds 1/10,000)

Applications of Machine Learning

- Speech recognition
  - Siri, Cortana
- Natural Language Processing
  - Machine translation, question answering, dialog systems
- Computer vision
  - Image and video analysis
- Robotic Control
  - Autonomous vehicles
- Intelligent assistants
  - Activity recognition, recommender systems
- Computational finance
  - Stock trading, portfolio optimization

This course

- **Supervised** and **unsupervised** machine learning

- But not reinforcement learning
- See CS885 Spring 2018
  - Website: https://cs.uwaterloo.ca/~ppoupart/teaching/cs885-spring18/
  - Video lectures: https://www.youtube.com/playlist?list=PLdAoL1zKcqTXFJniO3Tqqn6xMBBL07EDc