

ECE 884 Deep Learning

Lecture 3: Machine Learning Basics - 2

01/26/2021

Logistics

- Slack workspace
- Google sheet
- Final project:
 - Our goal: submit a poster to top-tier academic conferences.
 - To identify the topic of your project, do a thorough literature review.
 - Think about novelty: how your idea is different from existing ones.
 - Think about impact: how your idea would advance the state of the art.

Review of last lecture

- What is Machine Learning?
- Supervised Learning Pipeline
 - Features
 - Hypothesis Space of the function
 - Types of Data Sets: training vs. testing

Today's lecture

- Other flavors of machine learning

Supervised Learning

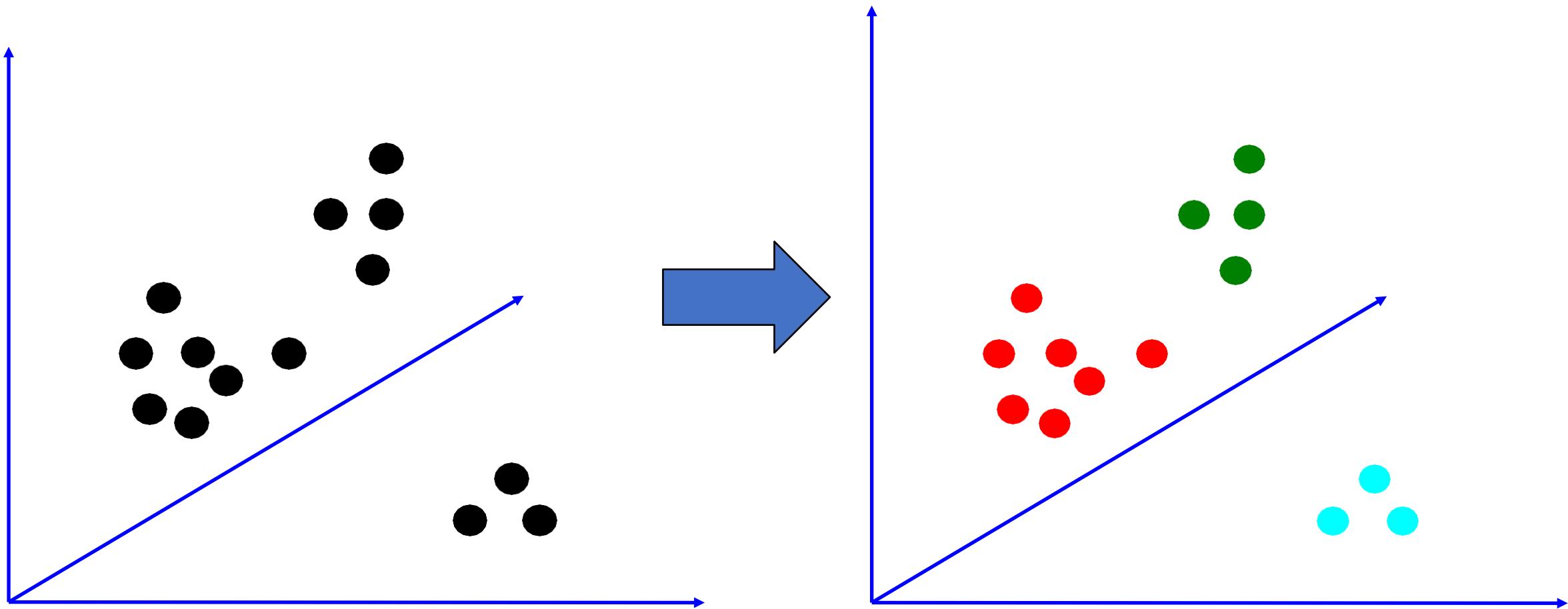
- Given inputs (data-label pairs), learn a model to predict output
- Labeled data is available
- Labeled data is clean (classification problem)
- No restrictions* on type of input and labels

Unsupervised Learning

- Given just data as input (no labels), learn some sort of *underlying structure*..
 - Goal is often vague or subjective (compared to supervised learning, where labels define the goals)
 - Also known as exploratory/descriptive data analysis

Unsupervised Learning: Clustering

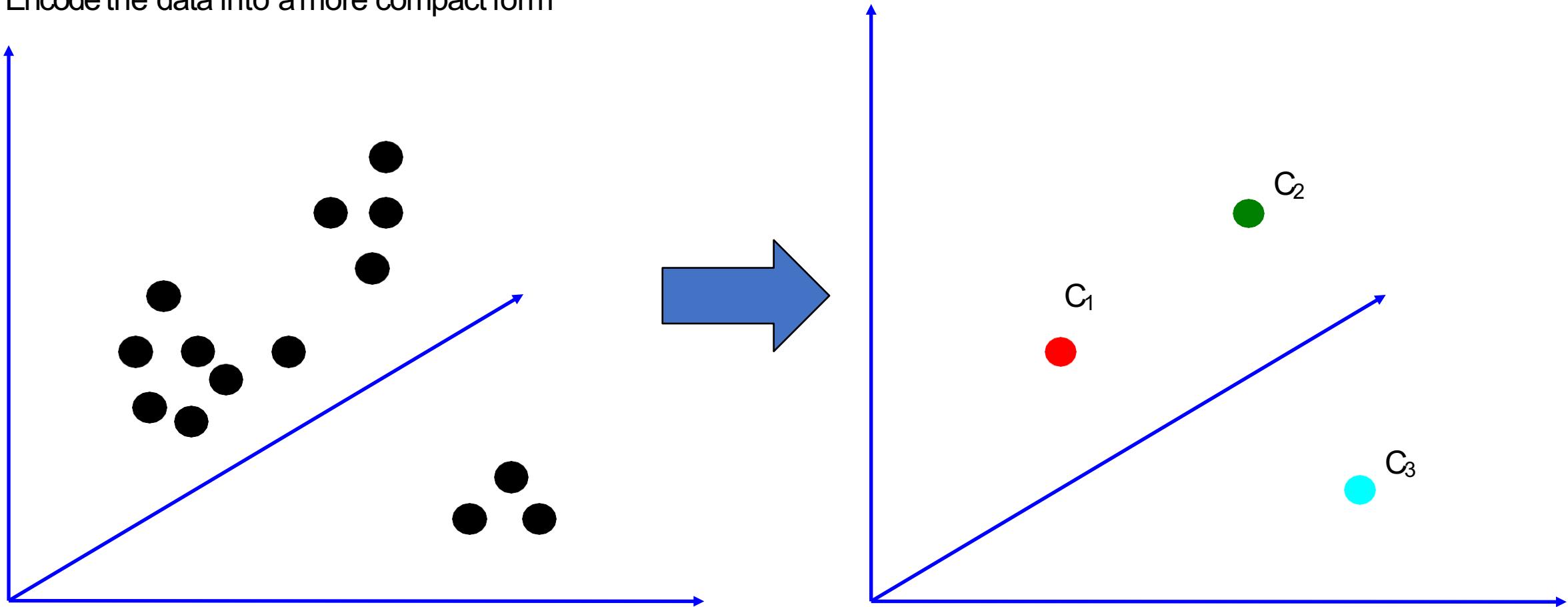
- Discover groups of “similar” data points



Unsupervised Learning: Quantization

Quantization or data compression

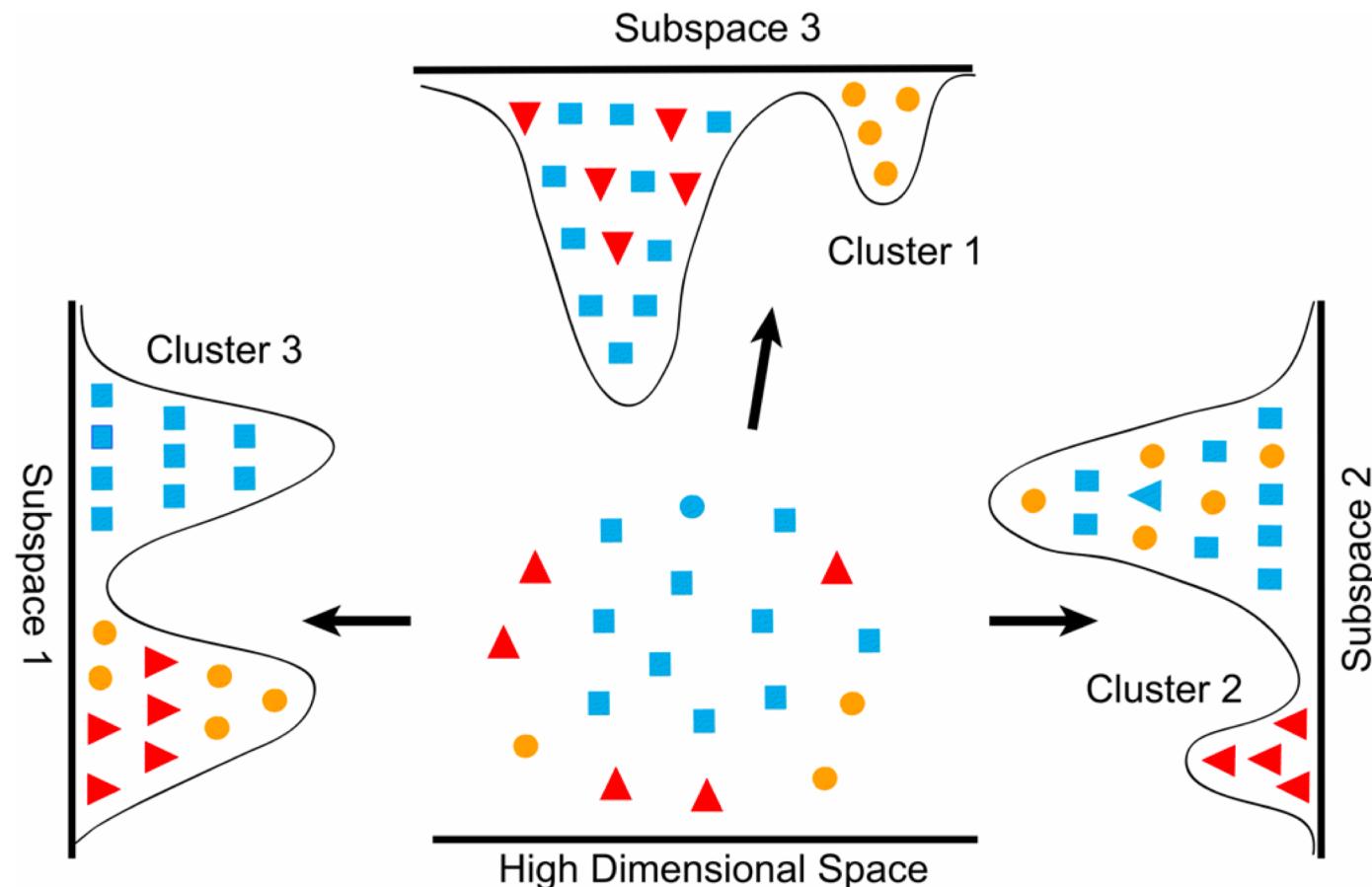
- Encode the data into a more compact form



Unsupervised Learning: Dimensionality Reduction

Dimensionality reduction, manifold learning

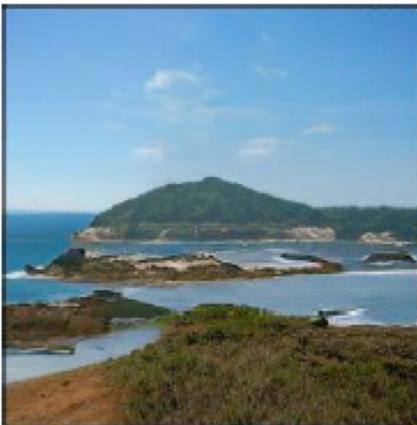
- Discover a lower-dimensional surface on which the data lives



Unsupervised Learning: Learning Data Distribution

Learning to sample (e.g., GANs or Generative Adversarial Networks)

- Produce samples from a data distribution that mimics the training set



Extremes of Learning Paradigms

Supervised
Learning

Unsupervised
Learning



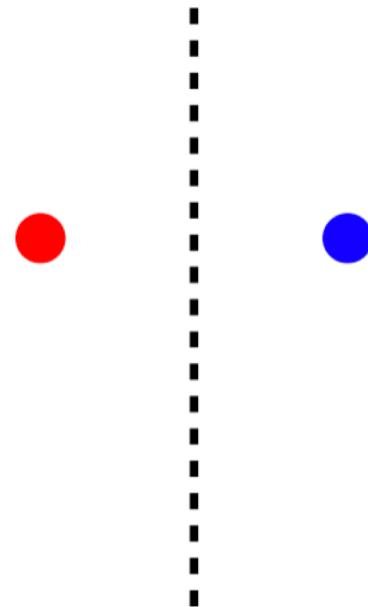
- Needs nice, clean labels
- All data needs to be labeled
- Labels correspond to task of interest

- No labels
- No labels
- How does this work?

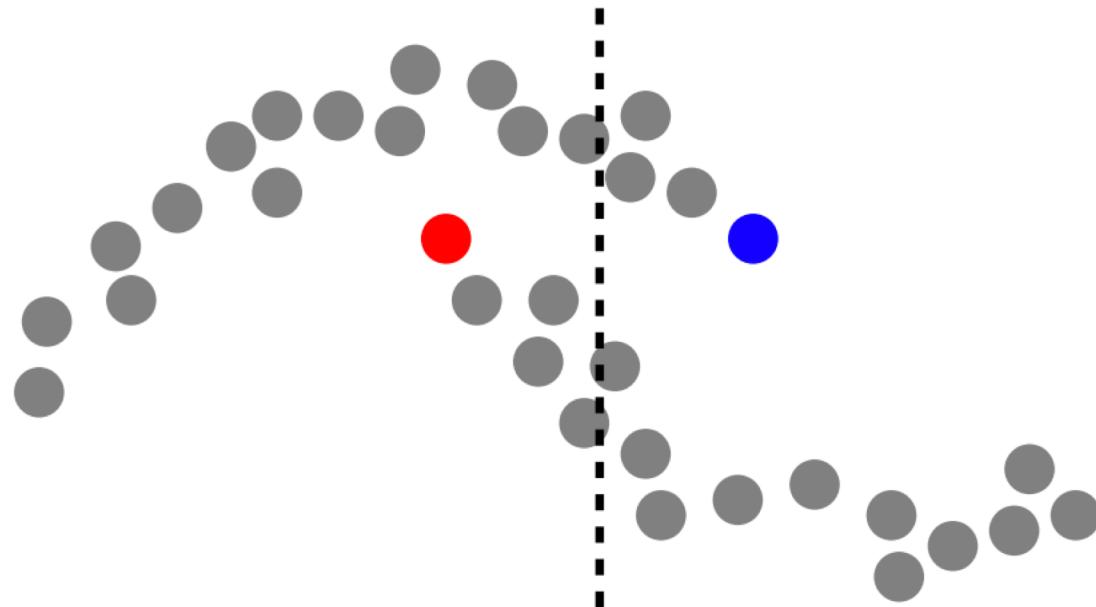
Semi-supervised Learning (SSL)



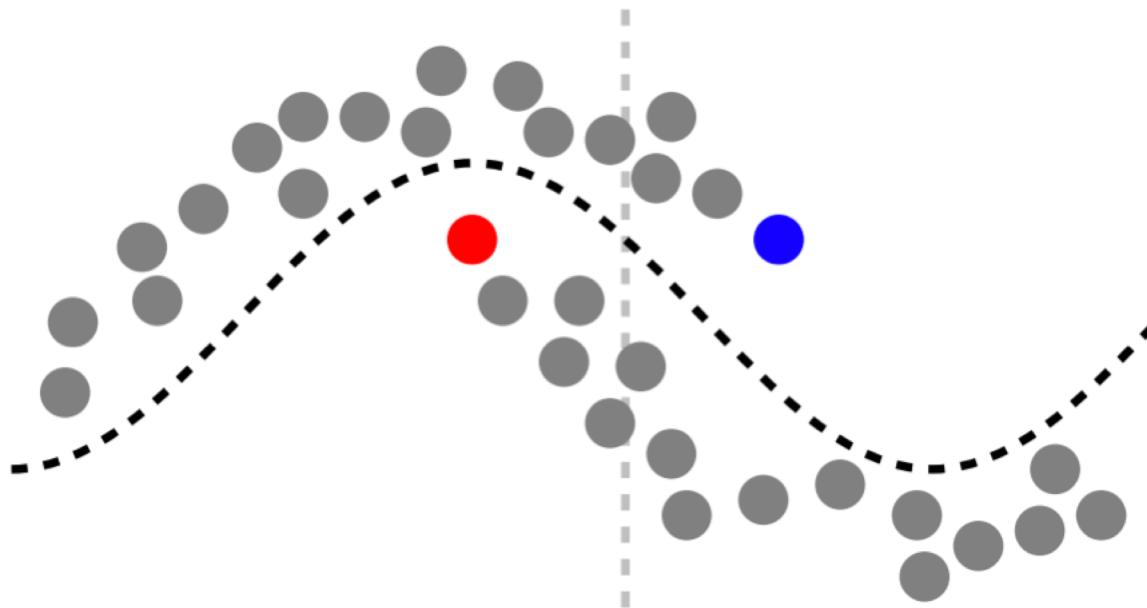
Semi-supervised Learning (SSL)



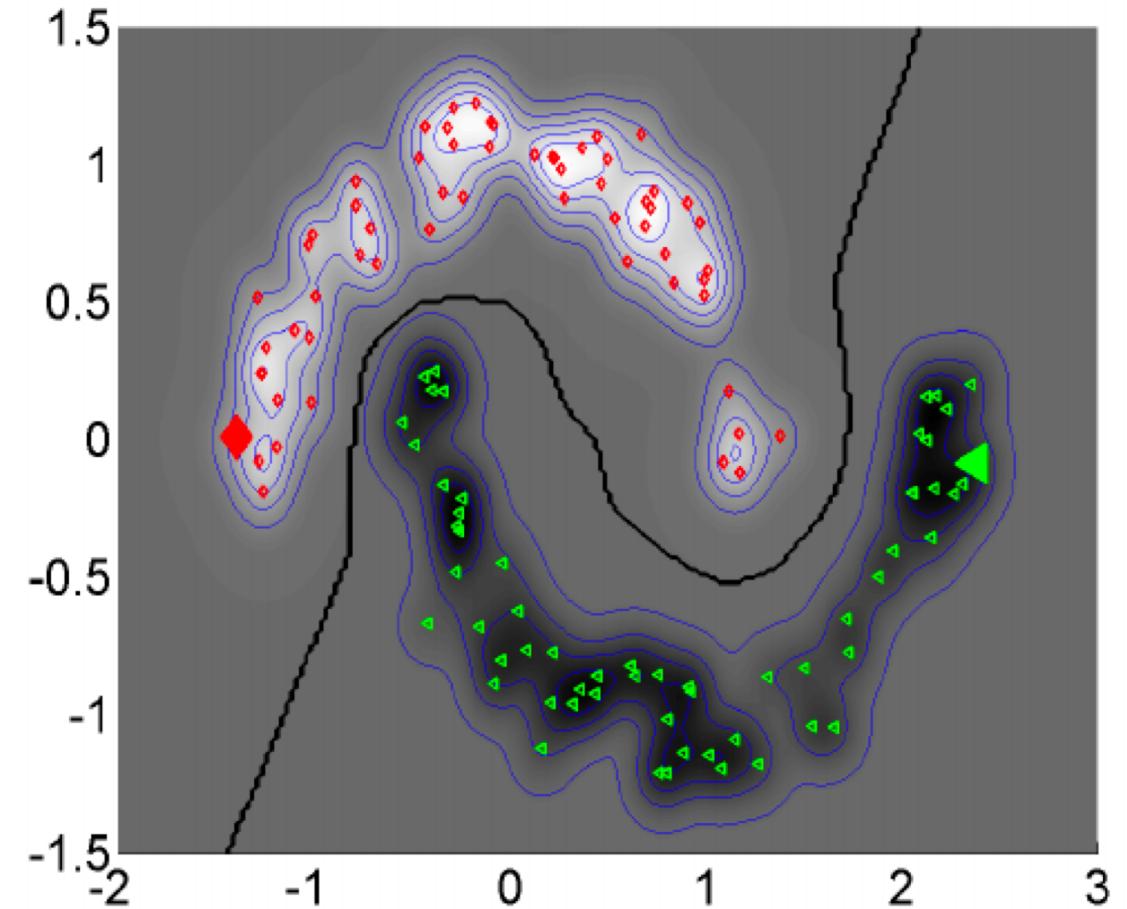
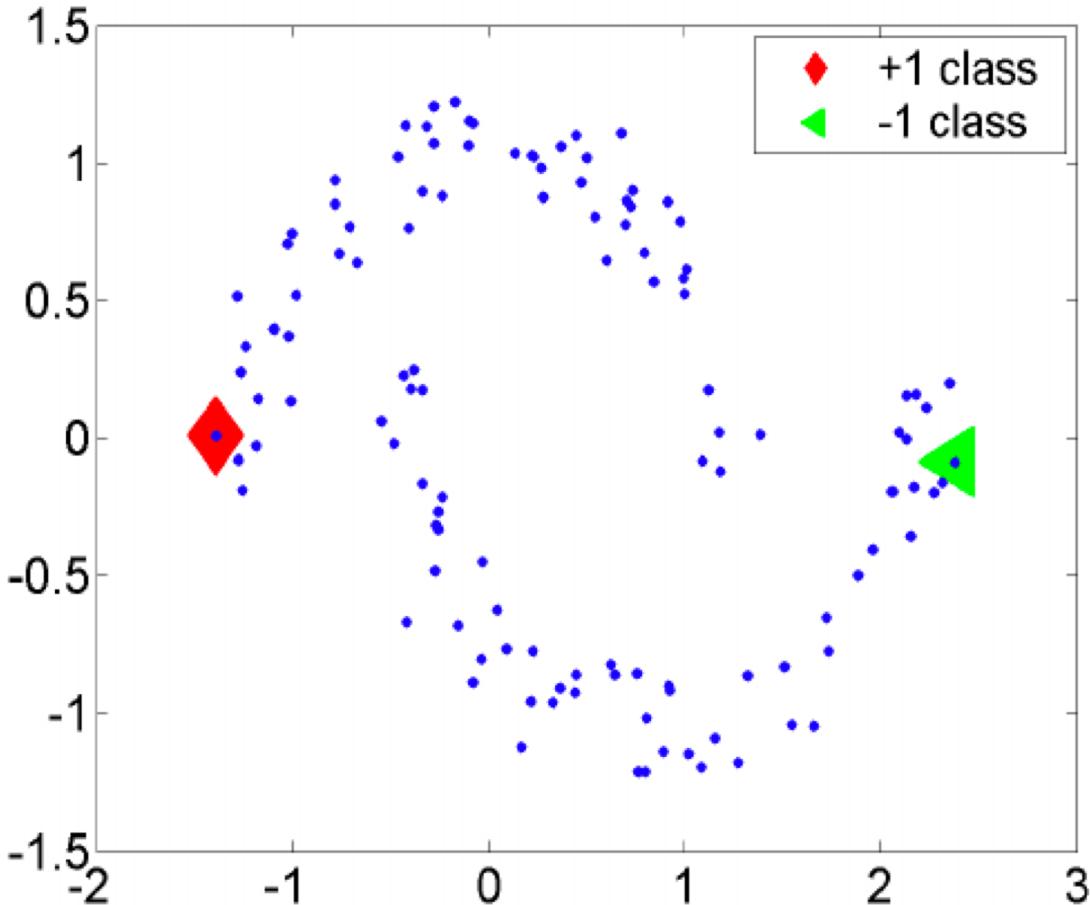
Semi-supervised Learning (SSL)



Semi-supervised Learning (SSL)

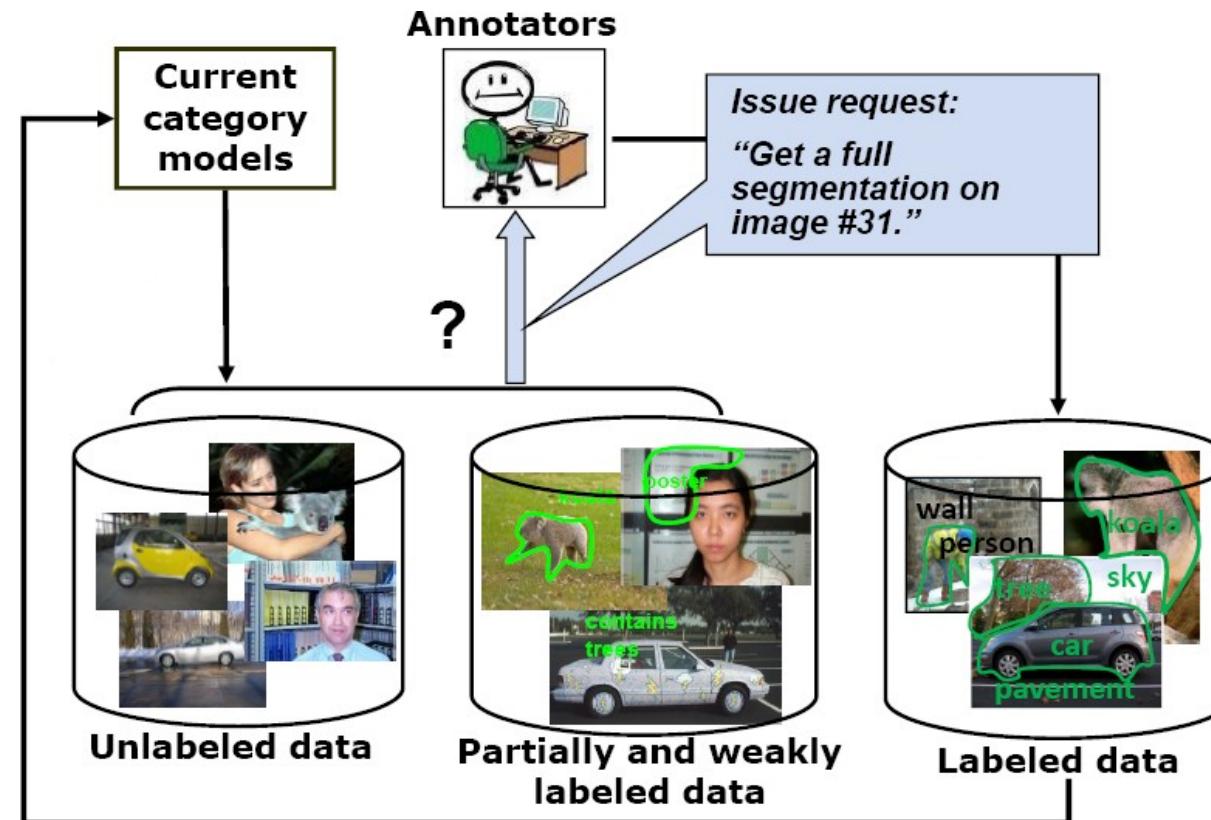


Semi-supervised Learning (SSL)



Active Learning

- Human in the loop to ask questions/labels



Self-supervised Learning

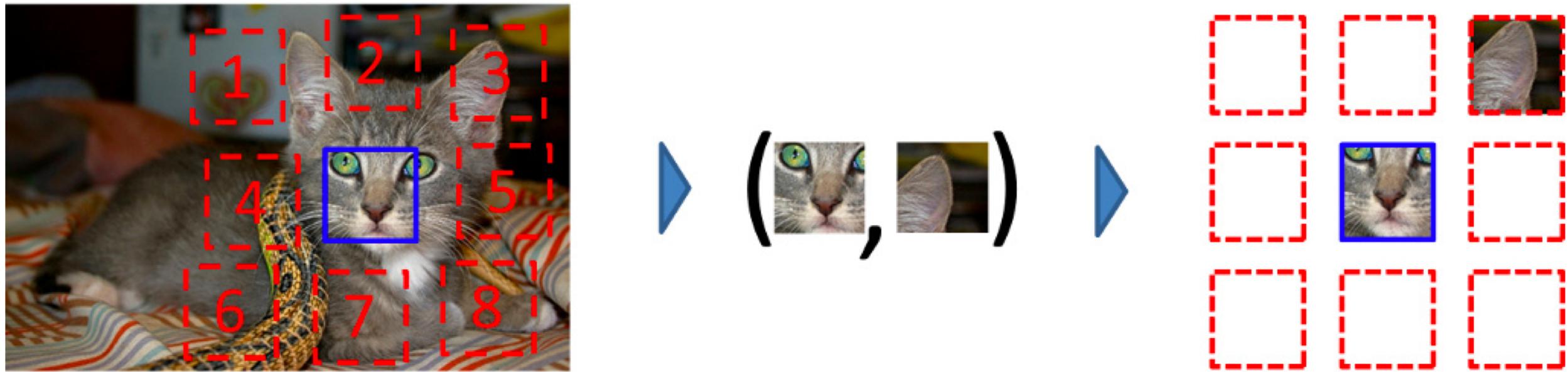
- Proxy-tasks (e.g., image colorization):

- Use supervision naturally arising from data
- No human provided labels



Self-supervised/Predictive Learning

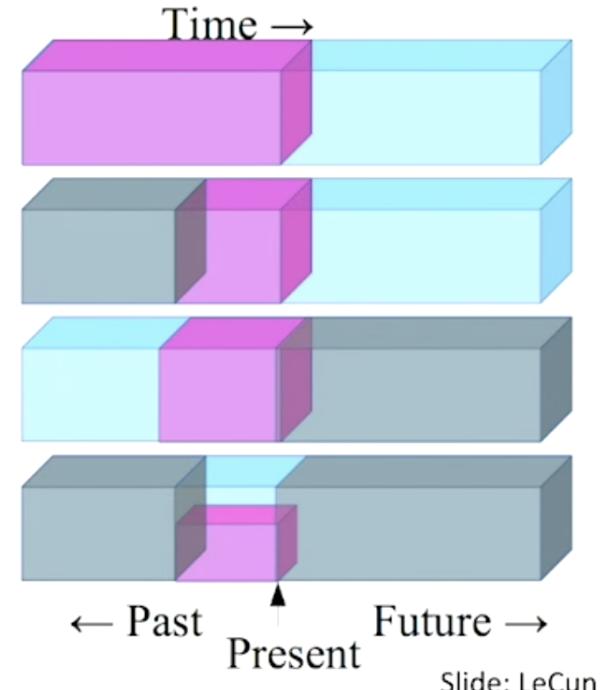
- Proxy-tasks (e.g., context prediction):
 - Use supervision naturally arising from data
 - No human provided labels



Self-supervised/Predictive Learning

- Natural Language Processing

- ▶ Predict any part of the input from any other part.
- ▶ Predict the **future** from the **past**.
- ▶ Predict the **future** from the **recent past**.
- ▶ Predict the **past** from the **present**.
- ▶ Predict the **top** from the **bottom**.
- ▶ Predict the **occluded** from the **visible**
- ▶ **Pretend there is a part of the input you don't know and predict that.**



Slide: LeCun

Self-supervised/Predictive Learning

- Natural Language Processing

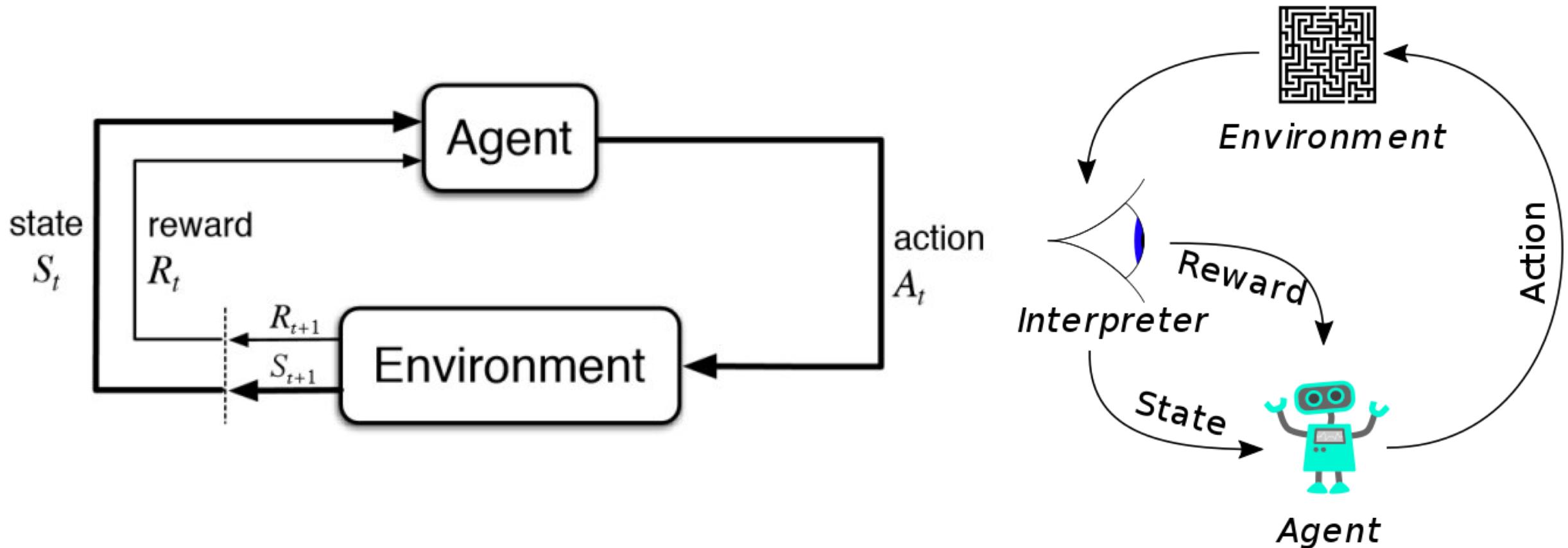
Randomly
masked A quick [MASK] fox jumps over the [MASK] dog

Predict ↓ ↓

Predict A quick brown fox jumps over the lazy dog

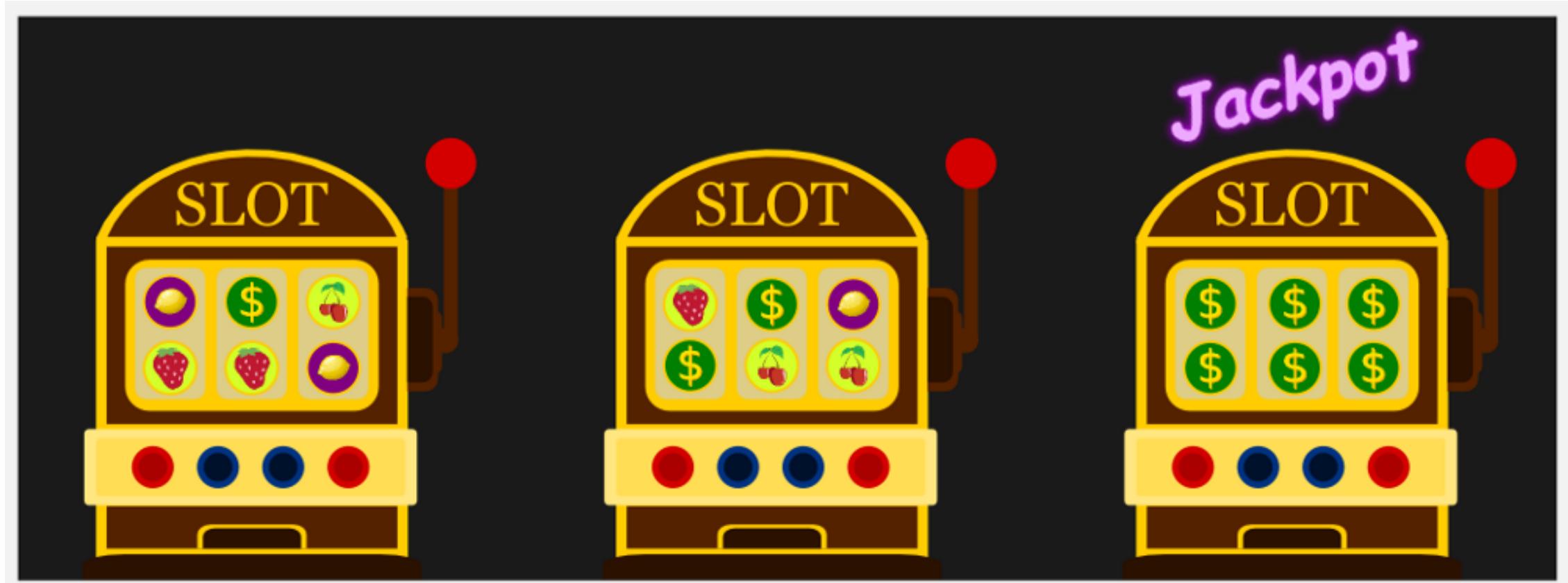
Reinforcement Learning

- Learn in an interactive environment by *sequential trial and error* using feedback/rewards from its own actions and experiences



Reinforcement Learning

- Multi-arm Bandit



Reinforcement Learning

- Recommendation Systems

EVERYTHING is a Recommendation

The image shows a composite of two screenshots. On the left is the Netflix homepage, displaying 'Recently Watched' shows like 'BETTER OFF TED', 'ARCHER', 'MAD MEN', 'DOCTOR WHO', 'ARRRESTED DEVELOPMENT', and 'BETTER OFF TED' again. Below this is the 'Top 10 for Michael' section featuring 'COMEDY BANG! BANG!', 'SUPERNATURAL', 'SPACED', 'DR. HORRIBLE'S SING-ALONG BLOG', 'ALPHAS', and a detailed view of the 'ALPHAS' show page. At the bottom is the 'Popular on Netflix' section with shows like 'The Walking Dead', 'New Girl', 'BOB'S BURGERS', 'Agents of S.H.I.E.L.D.', 'Frasier', and 'The Big Bang Theory'. A large red 'NETFLIX' logo is at the bottom. On the right is a screenshot of a Huffington Post article titled 'Netflix's New 'My List' Feature Knows You Better Than You Know Yourself (Because Algorithms)'. The article discusses how Netflix's recommendation system uses user data to suggest personalized content. It includes a photo of the Netflix headquarters building with a large 'NETFLIX' sign.

NETFLIX Watch Instantly - Just for Kids - Taste Profile - DVDs

Recently Watched

BETTER OFF TED ARCHER MAD MEN DOCTOR WHO ARRRESTED DEVELOPMENT BETTER OFF TED

Top 10 for Michael

COMEDY BANG! BANG! SUPERNATURAL SPACED DR. HORRIBLE'S SING-ALONG BLOG ALPHAS

ALPHAS

2011-2012 TV-14 2 Sessions

A team of individuals gifted with extraordinary neurodivergent abilities is tasked with solving a series of high-profile crimes. Among them are an autistic man whose mind works as fast as a computer and an FBI agent with super strength. More Info

Starring: David Strathairn, Ryan Cartwright
Creators: Zak Penn, Michael Kamow

+ My List

Popular on Netflix

The Walking Dead New Girl BOB'S BURGERS Agents of S.H.I.E.L.D. Frasier The Big Bang Theory

NETFLIX

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Could Iron Man's Lab Soon Be A Reality?

Facebook To Introduce New Photo Feature

Our Trip to Valentine's Day

Our Trip to Valentine's Day

Facebook To Introduce New Photo Feature

Netflix's New 'My List' Feature Knows You Better Than You Know Yourself (Because Algorithms)

The Huffington Post | By Dino Grandoni | 08/21/2013 1:44 pm EDT | Updated: 08/22/2013 8:31 am EDT

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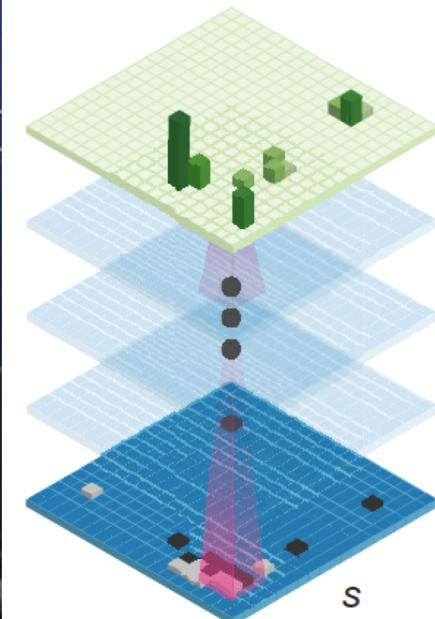
Reinforcement Learning

- Go game



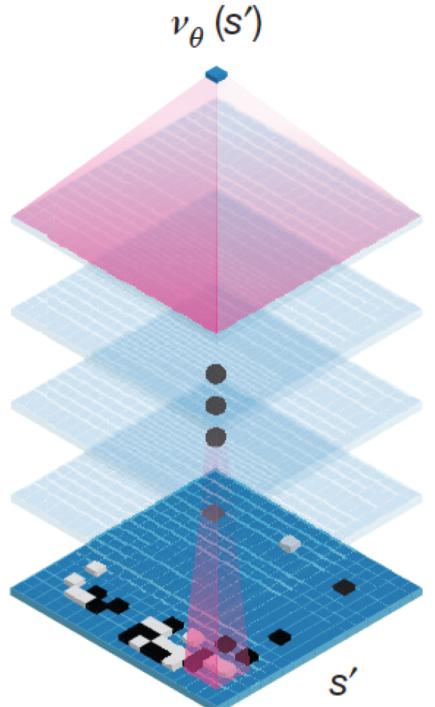
Policy network

$$p_{\sigma/p}(a|s)$$



Value network

$$v_{\theta}(s')$$



Focus of this Course

Supervised Learning

Any Question ?