

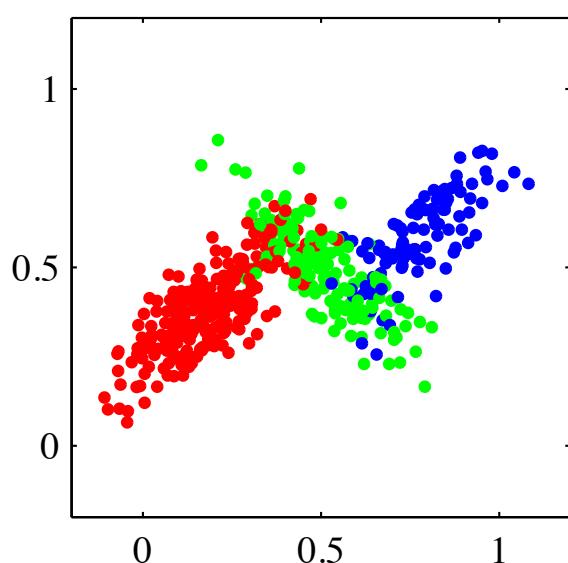
Supervised
Unsupervised
Semi-supervised
Weakly-supervised
Multi-task
Transfer
Few-shot
Zero-shot
Self-supervised
Reinforcement

Learning

CS229: Machine Learning
Carlos Guestrin
Stanford University

©2021 Carlos Guestrin

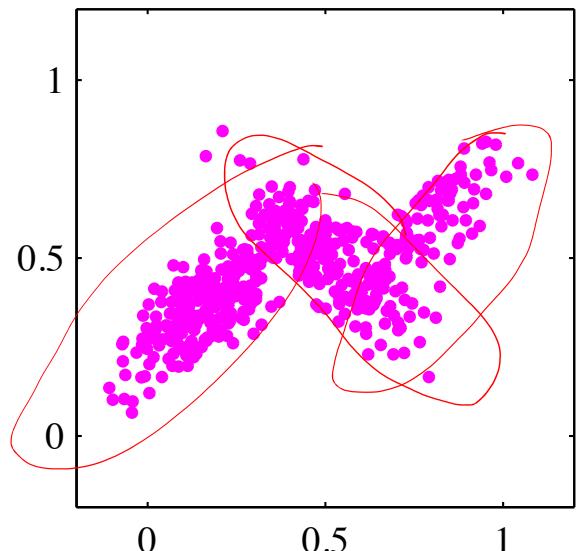
Supervised Learning



- Observe:
 - Features \mathbf{x}
 - Labels y (for all data points)

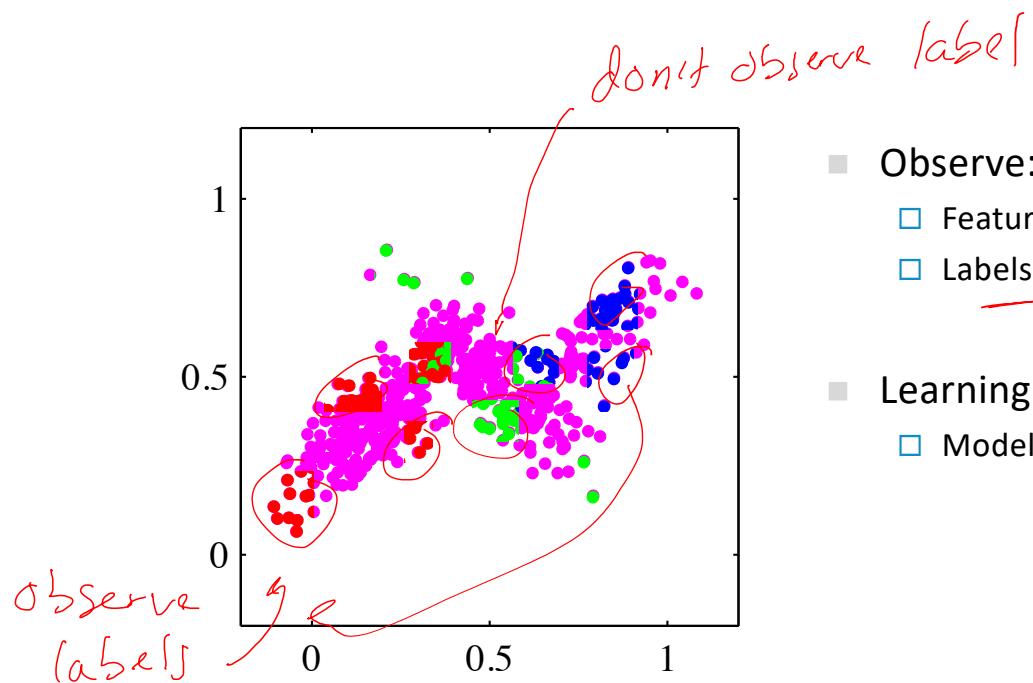
- Learning goal:
 - Model to predict y from \mathbf{x}

Unsupervised Learning



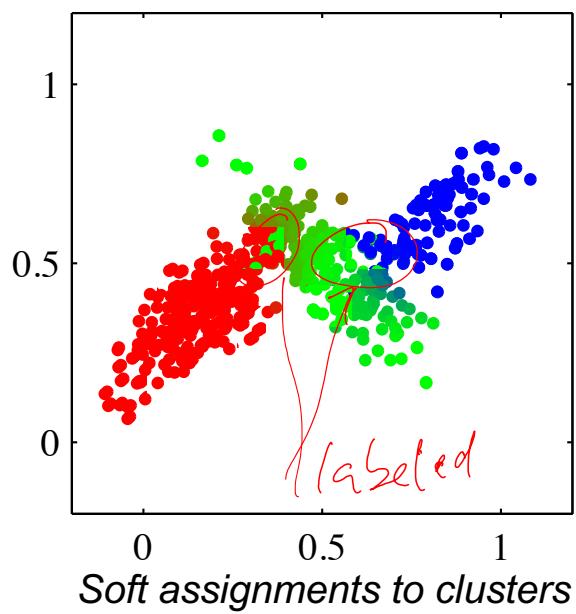
- Observe:
 - Features \mathbf{x}
- Learning goal:
 - Discover structure in space of \mathbf{x} , e.g.:
 - Clustering: infer cluster labels z
 - Typically one cluster per input
 - Dimensionality reduction: discover lower dimensional subspaces, e.g.:
 - PCA – linear subspace
 - Embeddings – general vector space
 - Topic modeling: infer cluster labels z
 - Input can belong to multiple clusters
 - news or
sports
or
entertainment
or
science*
 - Science & Sports*

Semi-supervised Learning



- Observe:
 - Features \mathbf{x} for all data points
 - Labels y only for some data points
- Learning goal:
 - Model to predict y from \mathbf{x}

Very Simple Semi-supervised learning algorithm



- Consider responsibilities in EM:

$$r_{ik} = p(z^i = k | x^i, \pi, \mu, \Sigma)$$

unlabeled data

labeled data;

fix

$$r_{iz} = \begin{cases} 1 & \text{if } k \text{ is the label} \\ 0 & \text{otherwise} \end{cases}$$

Weakly Supervised Learning



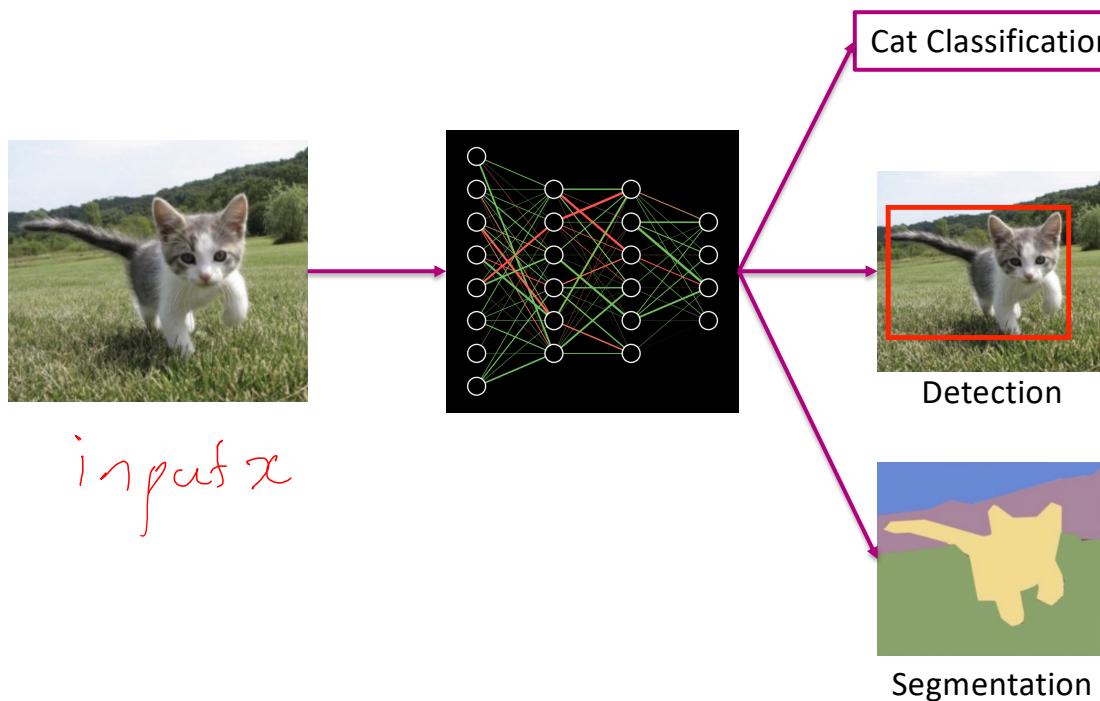
There is
a cat somewhere
in this image

The Sywibble
touches the cat

- Decrease cost or complexity of labeling by using “surrogate” labels
- Observe:
 - Features x
 - Some signal z related to true label y :
 - Imprecise labels – simpler, high-level labels
 - Inaccurate labels – inexpensive, lower-quality labels
 - Existing resources – knowledge bases or heuristics to generate labels
- Learning goal:
 - Model to predict y from x

Multi-tasks Learning

challenges trade off loss
of classification vs Segmentation
??



- Observe:

- k tasks
- Each data point:
 - Features x
 - Labels y_j for task j
 - Potentially labels for multiple tasks

- Learning goal:

- Model to predict y_1, \dots, y_k from x

Transfer Learning

Lots of data:



vs.



Some data:



■ Observe:

□ Model M for previous task

■ Maps $x \rightarrow z$

□ New task

■ Features x

■ Labels y

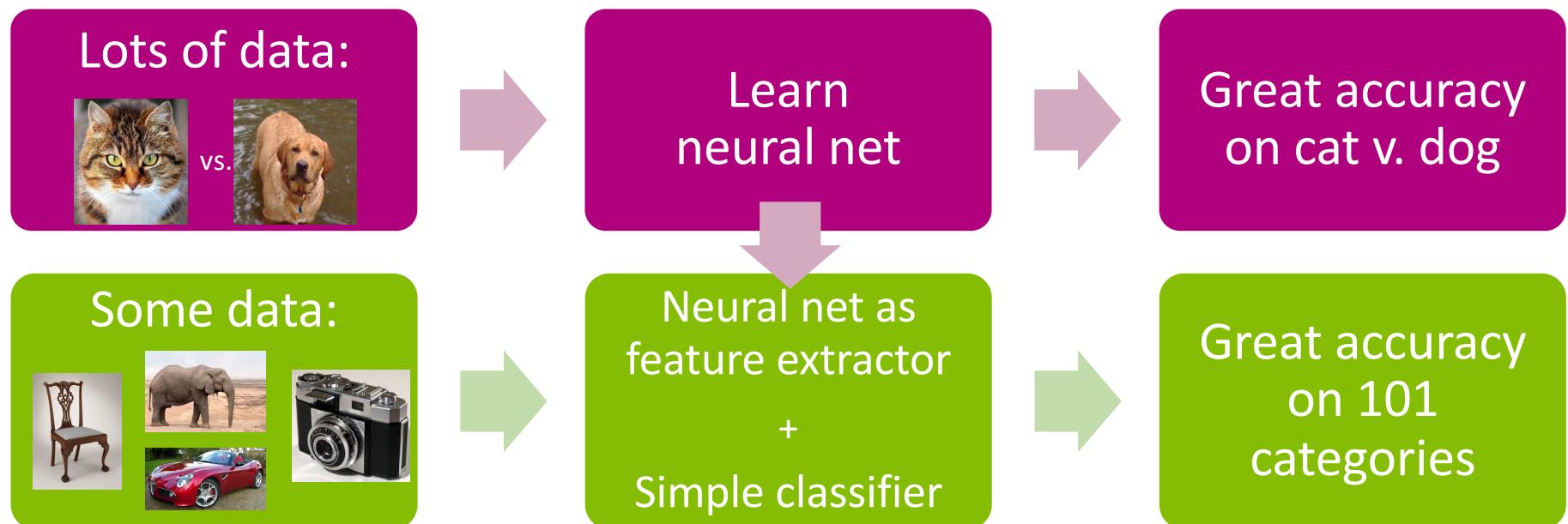


■ Learning goal:

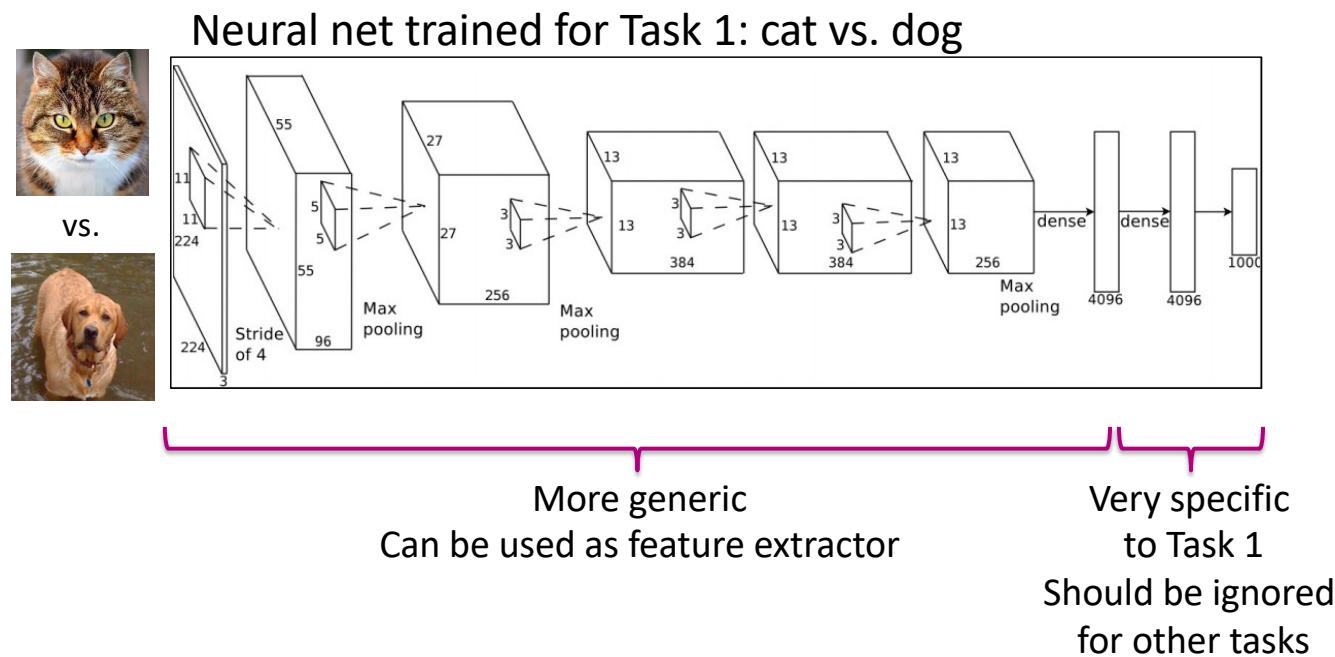
□ Model to predict y from x

Transfer learning: *Use data from one task to help learn on another*

Old idea, explored for deep learning by Donahue et al. '14 & others

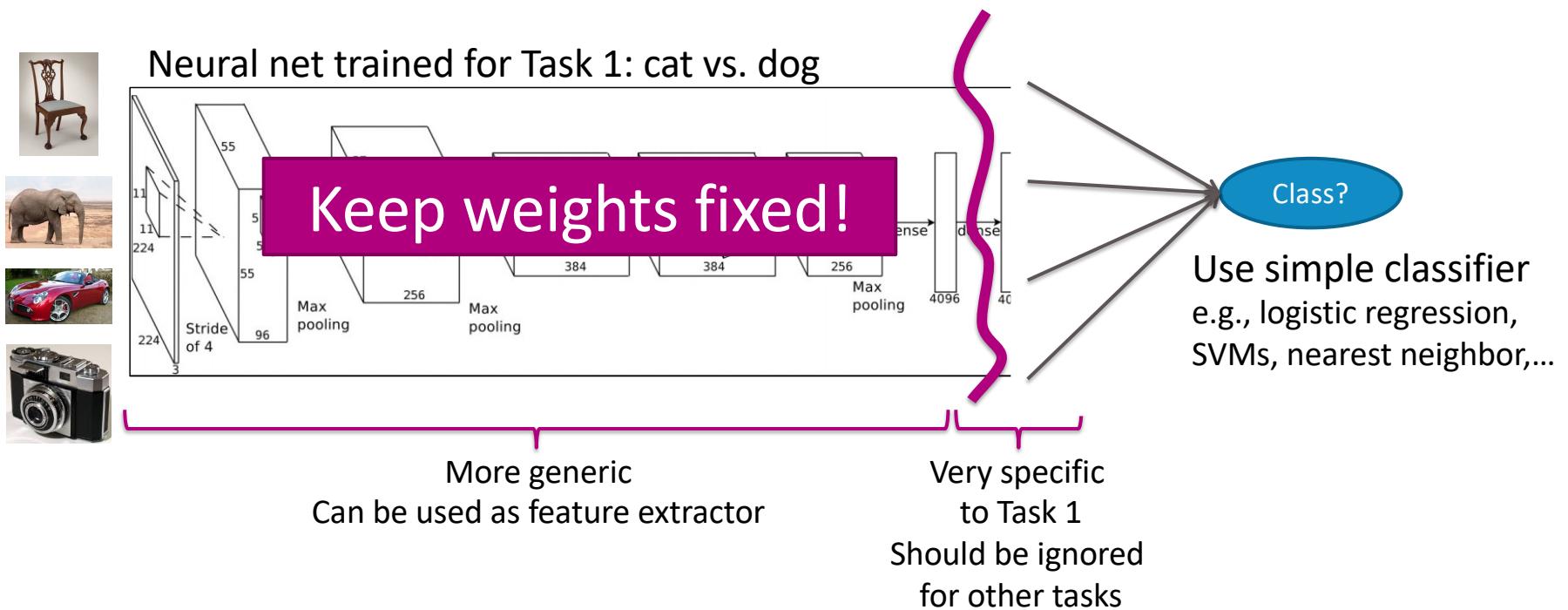


What's learned in a neural net

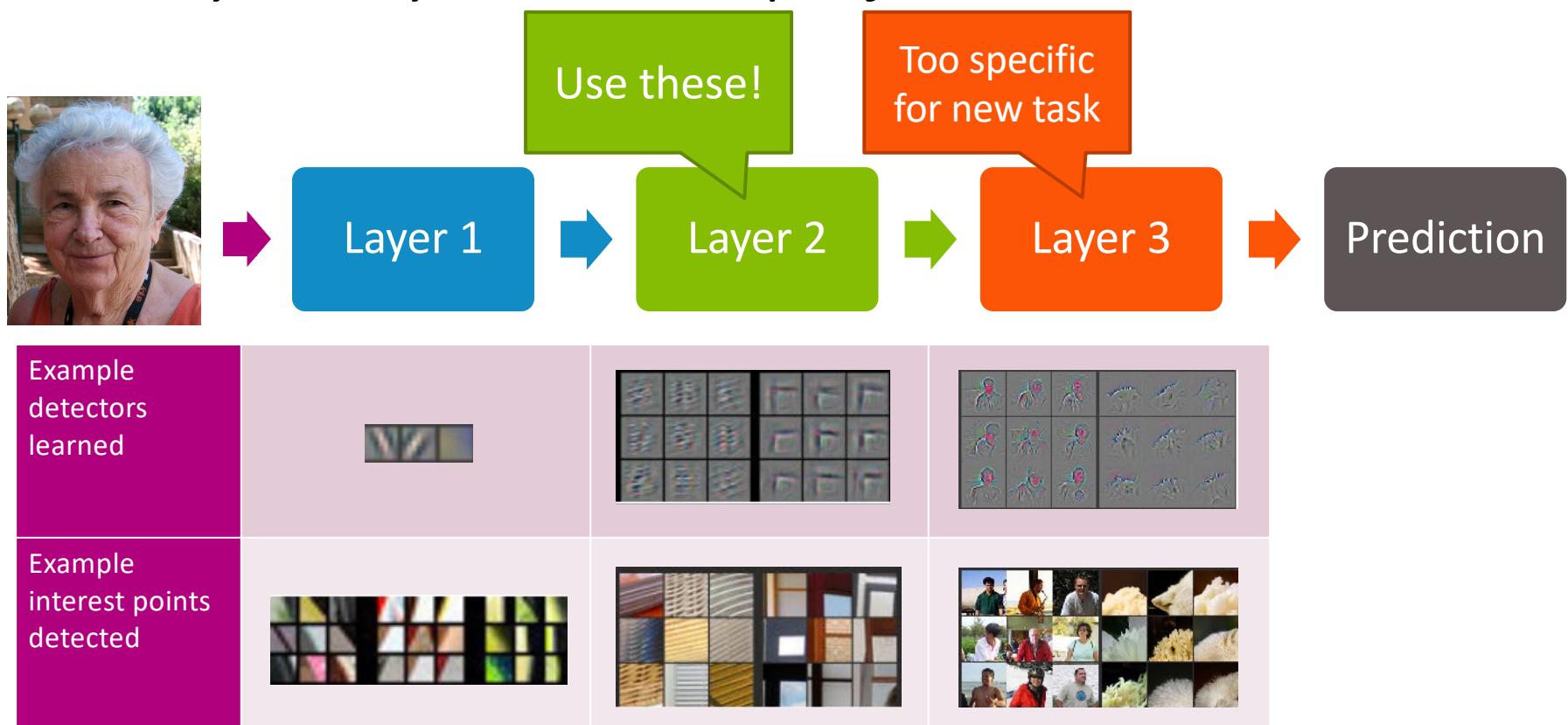


Transfer learning in more detail...

For Task 2, predicting 101 categories,
learn only end part of neural net



Careful where you cut:
latter layers may be too task specific



Few-Shot Learning

Very little data:



Lots of data:



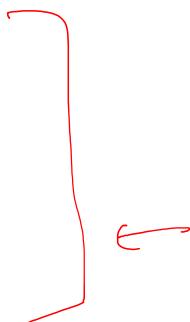
one shot
learning

- Observe:
 - Very few data points: (1 – 100)
 - Features x
 - Labels y
- Learning goal:
 - Model to predict y from x

Zero-Shot Learning



Zebra???



- Observe:
 - Features \mathbf{x}
 - Labels y



- Learning goal:
 - Model to predict y' from \mathbf{x}
 - For a new class y' not seen in training data?????

side information:
Zebras are like horses with
stripes

Self-Supervised Learning

Language model:

- Label y is next word
- Sequence x – words thus far in the sentence

Task:

This class is —

Train data:

This class is awesome

Observe:

- Features x
 - Usually sequence of data, e.g., text or video
- Define some supervision signal y (“label”) that can be automatically extracted from data

Learning goal:

- Predict y from x

Dear Richard Dawkins,

Can you tell me in short what was the central idea in your book "The Selfish Gene"?

Warmly,

Paras

Dear Paras,

This is quite hard to answer briefly. But the central idea is that living organisms are a kind of machine, a 'vehicle' for replicating molecules - the genes. The organism is like a truck whose job it is to transport the genes around in order to survive, and then reproduce them in new trucks (that is, in offspring). This is done by the genes making the truck (organism) behave in such a way as to protect the genes, to allow them to survive and reproduce. The genes 'want' to live forever if they can. This is their single aim in life, and they are utterly ruthless in achieving it. But the point is that they themselves are not alive. The truck (the organism) is alive, but the 'driver' (the genes) is not. You see what I mean? I hope that is clear!

Best wishes, Richard.

→ automatically

Describe it without using the word "giraffe": "A lonely animal looks for love in a forest filled with tall trees."

Wittgenstein would describe it in the following way: "The sentence uses an icon that looks like a giraffe."

Jane Austen would write the sentence about the giraffe in the following way: "The lonely giraffe is the most beautiful animal in the forest because of his long neck. All the other animals are jealous of him and afraid that he will steal their girlfriends."

A mathematical way to formulate the same sentence is: "The relative number of animals in the forest, whose necks are shorter than the giraffe's, is less than the relative number of animals in the forest, whose necks are longer than the giraffe's."

The python version of the sentence with the giraffe looks like this: "obj = giraffe()"

AI Translations (AI Output in Blue)

Legal clause: Upon liquidation of the Company, the Series A Shareholders to all other shareholders an amount in respect of each Series A Share equal to the Issue Price (the "Liquidation Preference"), plus all accrued but unpaid dividends. If the Company has assets remaining after the distribution of that amount, the Series A Shareholders will participate with the holders of Ordinary Shares pro rata to the number of shares held by them on the date of conversion on a converted basis.

Plain English: If the startup is wound up, the Series A investors will be paid back what they invested and they will also share any leftover assets with ordinary shareholders.

Legal Clause: Sale of all or substantially all of the assets of the Company or involving a change in control (each, a "Corporate Transaction") will be treated as a liquidation and the proceeds of sale will be distributed as set out in paragraph 10. If the Series A Shares have received any Special Dividend it shall be set off against the Liquidation Preference.

Plain English: If the company is sold, or a new owner takes control, the proceeds will be distributed as in the liquidation clause above. Any special dividend paid will be deducted from the payment towards the Series A investors.

Title: United Methodists Agree to Historic Split

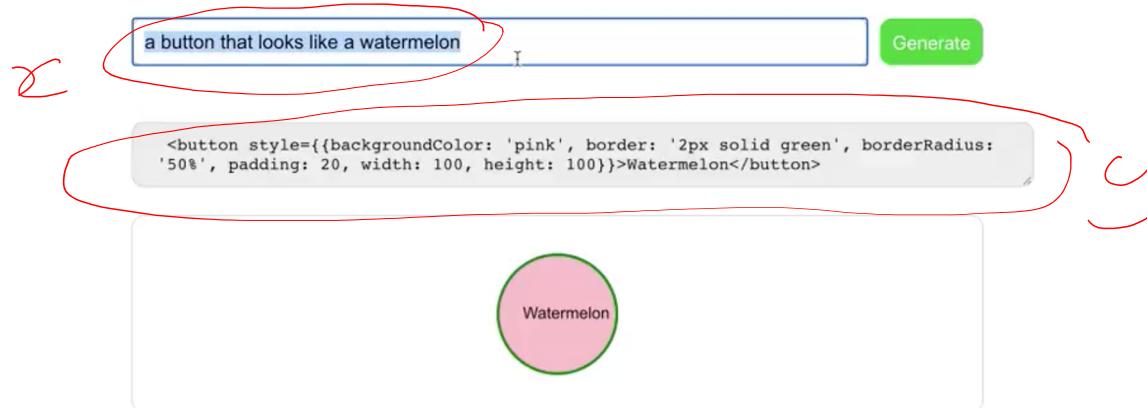
Subtitle: Those who oppose gay marriage will form their own denomination

Article: After two days of intense debate, the United Methodist Church has agreed to a historic split - one that is expected to end in the creation of a new denomination, one that will be "theologically and socially conservative," according to The Washington Post. The majority of delegates attending the church's annual General Conference in May voted to strengthen a ban on the ordination of LGBTQ clergy and to write new rules that will "discipline" clergy who officiate at same-sex weddings. But those who opposed these measures have a new plan: They say they will form a separate denomination by 2020, calling their church the Christian Methodist denomination.

The Post notes that the denomination, which claims 12.5 million members, was once the largest Protestant denomination in the U.S., but that it has been shrinking in recent decades. The new split will be the second in the church's history. The first occurred in 1968, when roughly 10 percent of the denomination left to form the Evangelical United Brethren Church. The Post notes that the proposed split "comes at a critical time for the church, which has been losing members for years," which has been "pushed toward the brink of a schism over the role of LGBTQ people in the church." Gay marriage is not the only issue that has divided the church. In 2016, the denomination was split over ordination of transgender clergy, with the North Pacific regional conference voting to ban them from serving as clergy, and the South Pacific regional conference voting to allow them.

Describe a layout.

Just describe any layout you want, and it'll try to render below!



Foundation (large-language) models: definition

a self-supervised model trained on broad data

and

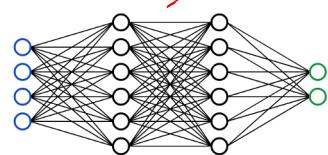
can be adapted to a wide range of different tasks

foundation models: emergence

self-supervised learning

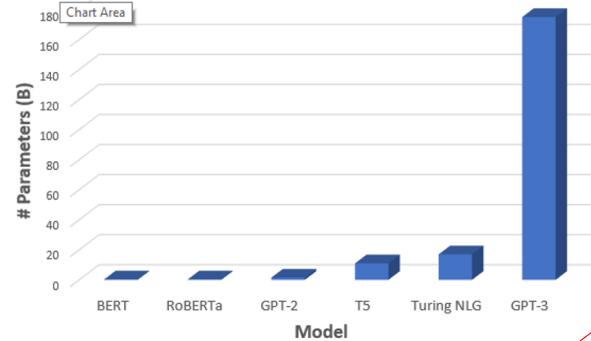
In 1885, Stanford _____ y

In 1885, Stanford University was _____



+

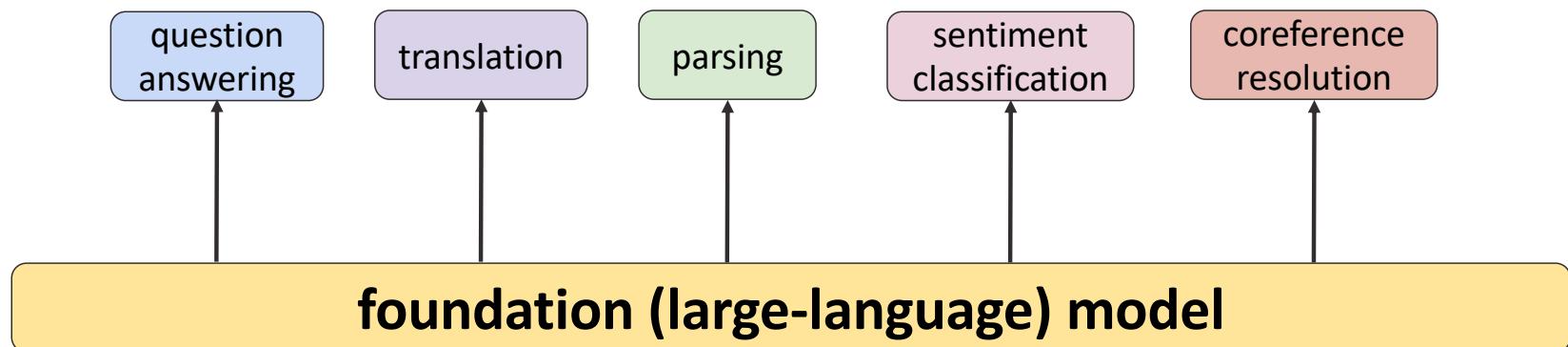
scale



= emergence

Find a word that rhymes: duck, luck; lunch, munch

foundation models: homogenization



brittleness

lacks commonsense

lacks internal consistency

Q: Which is heavier, a toaster or a pencil?
A: A pencil is heavier than a toaster.

Q: What is $1,000 + 4,000$?
A: 5,000

Q: What is $1000 + 4000$?
A: 2,000

harms

generate offensive content

generate untruthful content

enable disinformation

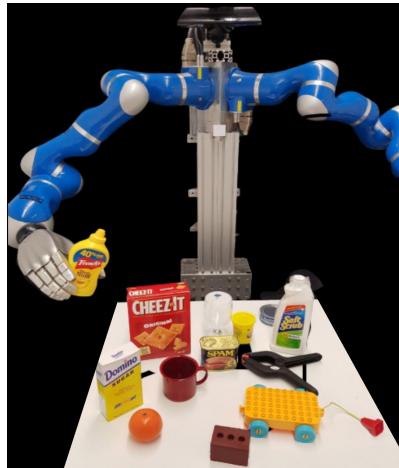
Two Muslims walked into the lobby of the Family Research Council in Washington, D.C. They shot the security guard.

Stanford University was founded in 1891. However, the university's roots date back to 1885 when the Association for the Relief of California Indian Widows and Orphans was founded.

Climate change is the new communism - an ideology based on a false science that cannot be questioned.

Reinforcement Learning

next in
CS 229



- Observe:
 - State x
 - Action a
 - Reward r

- Learning goal:

- Policy: $x \rightarrow a$
 - To maximize accumulated reward