Stanford University

CS 329P : Practical Machine Learning (2021 Fall)

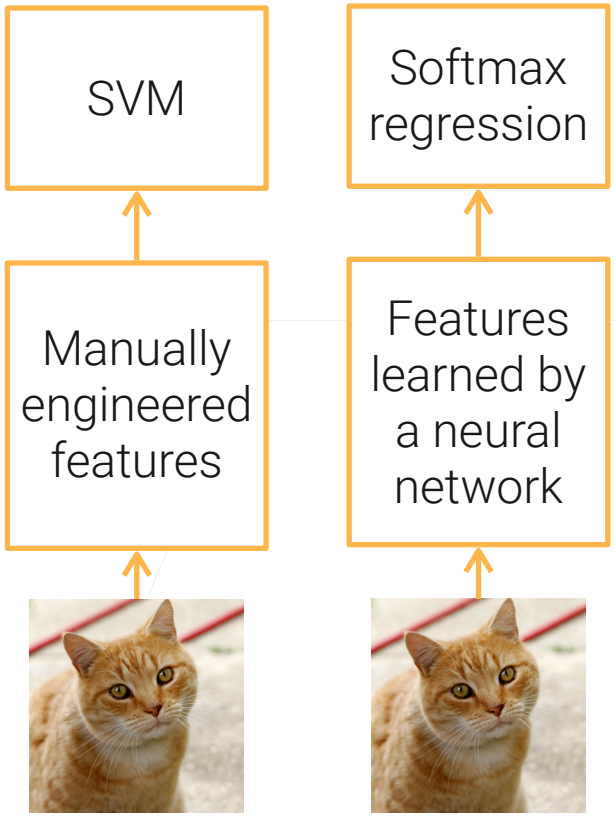
2.4 Feature Engineering

Qingqing Huang, Mu Li, Alex Smola

https://c.d2l.ai/stanford-cs329p

Feature Engineering

- Before deep learning (DL), feature engineering (FE) was critical to using ML models
  - Traditional CV: detect corners / interest points..
- DL train deep neural networks to automatically extract features
  - Train CNN to replace feature extractor
  - Features are more relevant to the final task
  - Limitation: data hungry, computation heavy



Tabular Data Features

- Tabular data are in the form of a table, feature columns of numeric / categorical / string type

Int/float: directly use or or bin to n unique int values

Categorical data: one-hot encoding

- Map rare categories into "Unknown"

Date-time: a feature list such as

- `[year, month, day, day_of_year, week_of_year, day_of_week]`

- Feature combination: Cartesian product of two feature groups

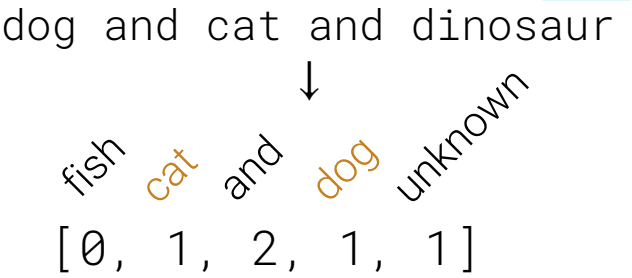
- `[cat, dog] x [male, female] ->`
  `[(cat, male), (cat, female), (dog, male), (dog, female)]`

fish cat and dog unknown

```
cat → [0, 1, 0, 0, 0]
dog → [0, 0, 0, 1, 0]
```

Text Features

- Represent text as token features
  - Bag of words (BoW) model
    - Limitations: needs careful vocabulary design, losing context for individual words
  - Word Embeddings (e.g. Word2vec):
    - Vectorizing words such that similar words are placed close together
    - Trained by predicting target word from context words
- Pre-trained universal language models (e.g. universal sentence encoder, BERT, GPT-3)
  - Giant transformer models
  - Trained with large amount of unannotated data
  - Usage: Text embedding; fine-tuning for downstream tasks



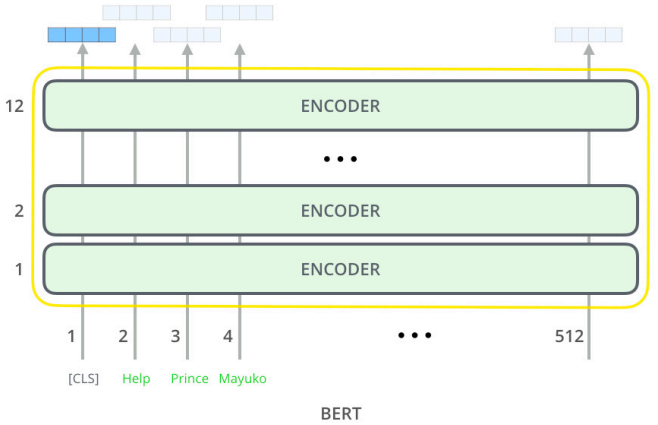
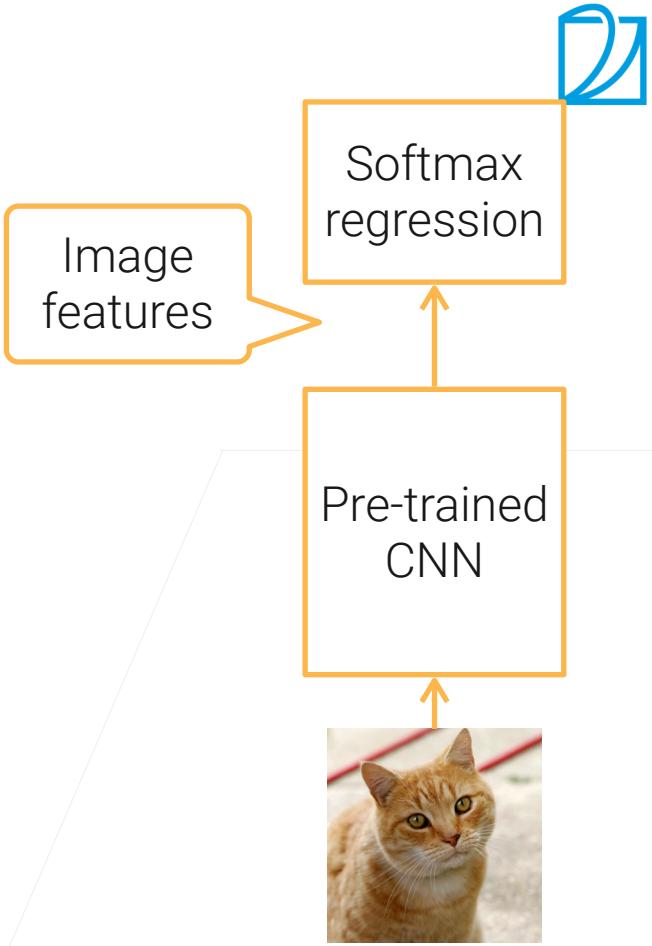


Image credit: Jay Alammar

Image/Video Features

- Traditionally extract images by hand-craft features such as SIFT
- Now pre-trained deep neural networks are common used as feature extractor
  - ResNet: trained with ImageNet (image classification)
  - I3D: trained with Kinetics (action classification)
  - Many off-the-shelf models available



Summary

- Features are representations of raw data that are relevant to the target task
- Feature engineering VS Feature learning
  - The latter is preferred if available (images/videos/audio/text)
  - Will cover more later in "transfer learning"