Neural Networks:
Transfer Learning

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Objectives

- Illuminating quotes
- Define transfer learning
- Transfer learning for you - how you might apply it
  - Provide a few examples
- Describe two approaches
  - Feature extraction
  - Fine-tuning
- Look at code example

Illuminating Quotes

Transfer learning definition: *Situation where what has been learned in one setting is exploited to improve generalization in another setting.* Ian Goodfellow et. al. (book)

After supervised learning — Transfer Learning will be the next driver of ML commercial success Andrew Ng

the key motivation … is the fact that most models which solve complex problems need a whole lot of data, and getting vast amounts of labeled data for supervised models can be really difficult, considering the time and effort it takes to label data points. Dipanjan Sarkar (blog)

Transfer learning definition

Transfer learning is a research problem in machine learning that focuses on storing knowledge gained while solving one problem and applying it to a different but related problem.

For example, knowledge gained while learning to recognize cars could apply when trying to recognize trucks.

-- Wikipedia

How you might apply transfer learning

You don’t have the data that you want, or you don’t have enough of it, so find something similar to train on, and then transfer that knowledge to your application.

In the case of neural networks, that usually means one of two things:

- Train your architecture and weights on one thing (that you have a lot of) then transfer those weights and architecture to your specific problem. (N. Rao capstone example)
- Use a pre-made architecture described in the literature (e.g. Xception) that has been trained on a massive dataset (e.g. ImageNet) to extract features then
  - Use those feature in another ML model training on your data, or
  - Little-by-little let the weights change for your specific data

Example 1: Accent classification capstone

- Non-native English speakers were 30% less likely to be understood by both Amazon's Alexa and Google Home.
- Goal: Be able to build a model that can classify the accent of the speaker using a raw audio file.
- Dataset that she wanted to train and predict on: Mozilla Voice Dataset
  - Problem - speakers are saying so many things, so the dataset doesn't focus on accent specifically
  - Tried to make an accent classifier on it - didn't work well.
- Dataset that she used to pre-train her network: Speech Accent Archive
  - Only 2500 recordings, but from speakers from over 100 countries **all reading the exact same passage**.
  - After "learning" accents on this dataset, was able to train successfully on Voice Dataset.

https://github.com/nkrao220/accent-classification

Example 2: Determining dog breed

- Scraped 50,000 images of 188 dog breeds (equally)
- Made his own CNN - test accuracy 2.4%
- Used Xception architecture, but trained his own weights - 64%
- Used Xception architecture with pre-trained ImageNet weights, fine-tuned weights with very low learning rate on training data - 87% accuracy

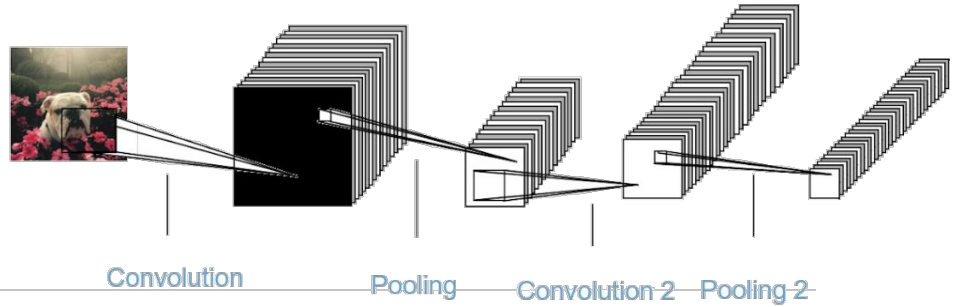
https://github.com/michaellouisdyer/doggo.name

Two approaches

- Feature extraction
  - Using intermediate levels of a neural network as features to train another machine learning model on

- Fine-tuning
  - Replace final output layer of neural network with output layer corresponding to new data
  - Gently update the network to predict on new data

Feature Extraction



CNN trained on bears

Random Forest Classifier

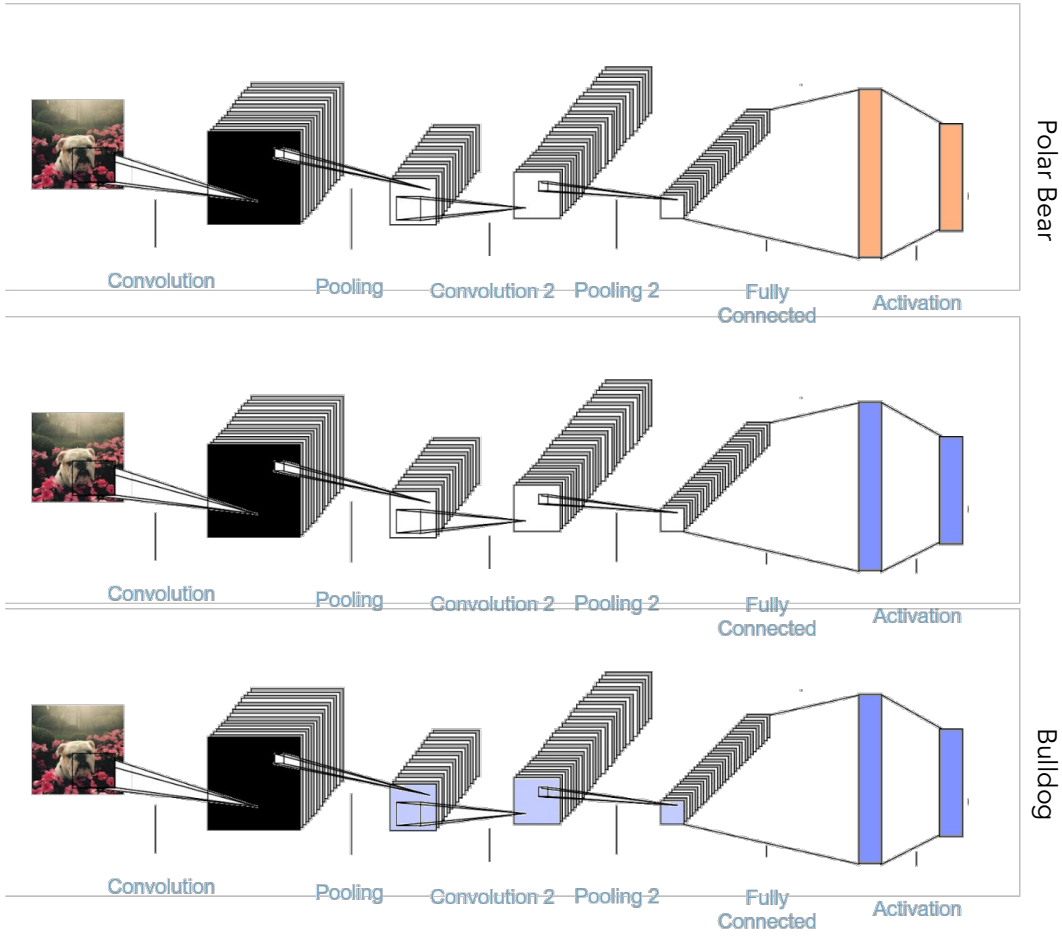
“Bulldog”

Fine-tuning

CNN trained on bears

Replace head

Gently retrain



Code example

`transfer_learning.ipynb` in Transfer Learning repo

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