Transfer learning – Next big thing

PRESENTED BY -
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Education -

- MS in Business Analytics, Carlson School of Management, University of Minnesota, 2017
- B.Tech in Electrical Engineering, Malaviya National Institute of Technology, India, 2013

Experience –

- >4 years in Data science, Currently working as Data scientist for Land O’ Lakes, Inc.
- Moderator and rank 3rd at https://www.analyticsvidhya.com/
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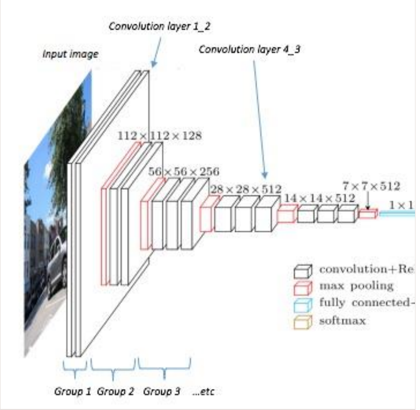
Agenda

Introduction to CNN's



What/WHY

Transfer learning?

How to do

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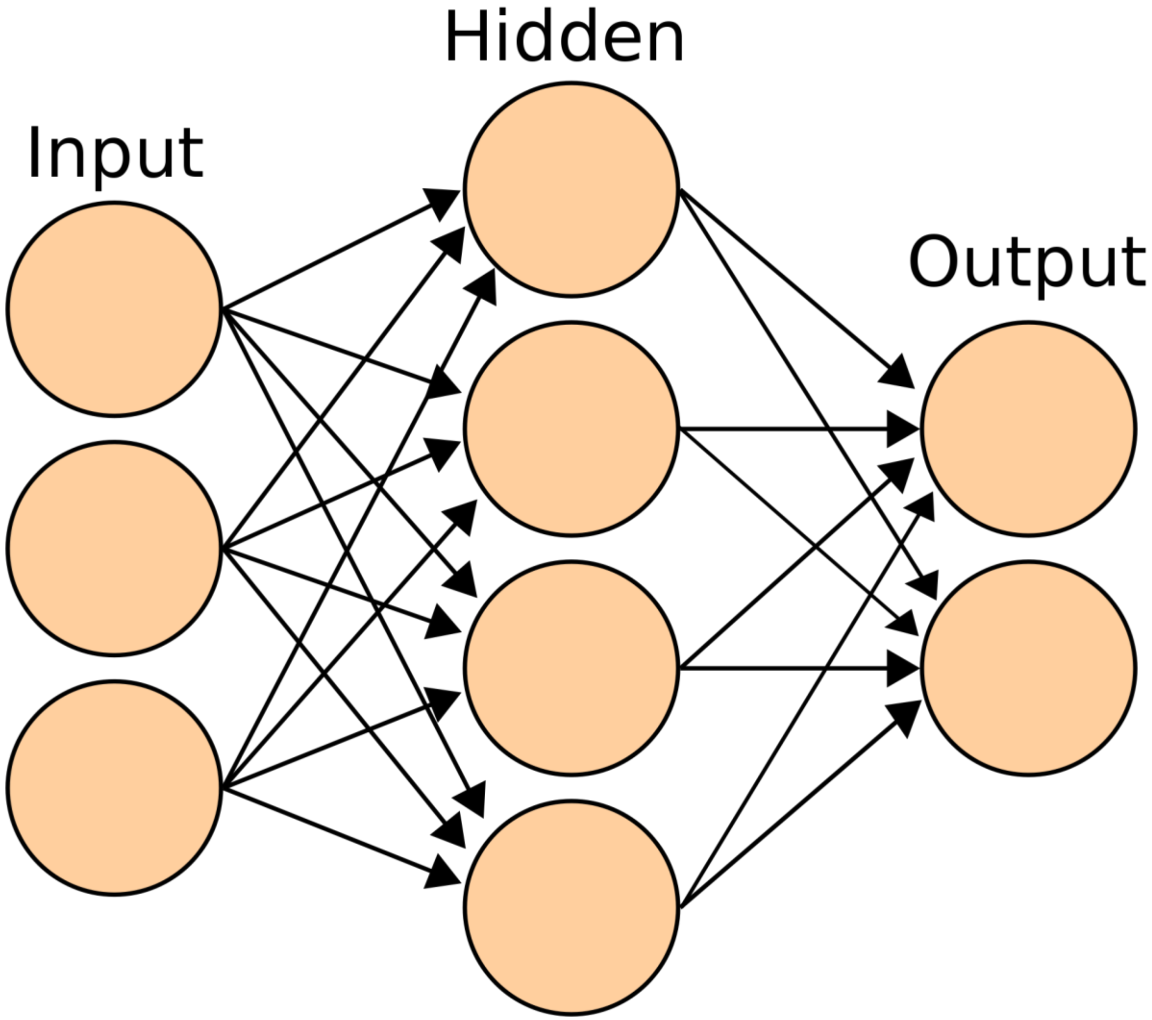
Examples

Traditional NN don't scale well to full images

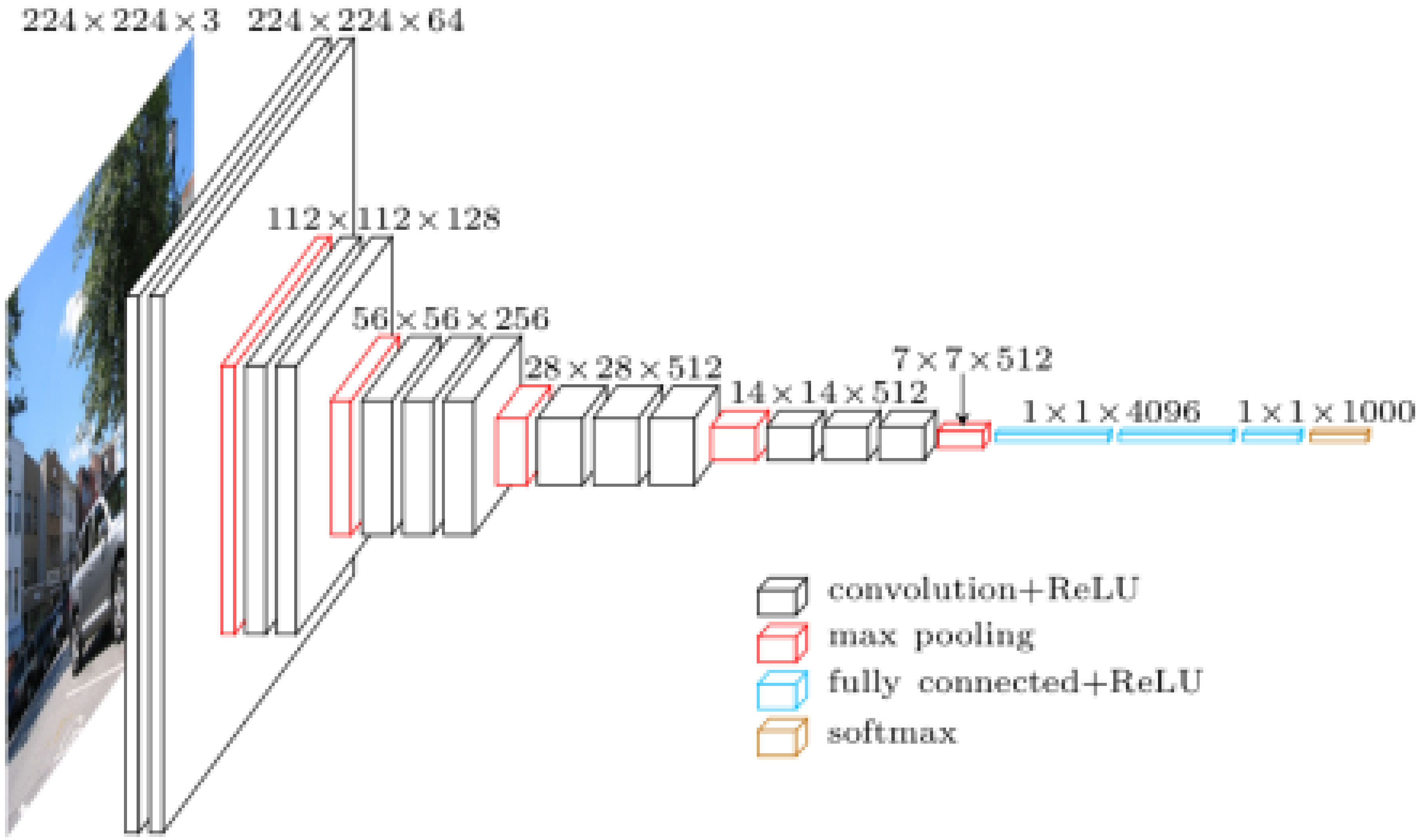


- Consider an image of size 32*32*3 (CIFAR-10 images), each neuron have 32*32*3 = 3072 weights
- A low resolution image these days are around 200*200*3 while leads to 120,000 weights
- Also we need more than one neuron obviously
- We also need more than one layer

Convolution NN takes advantage that input consists images

- Typically a ConvNets will consist of three layers
  - Convolutional Layers
  - Pooling layer
  - Fully – Connected layer
- Basic architecture - **[INPUT - CONV - RELU - POOL - FC]**
- **Convolution** layer will compute the output of neurons that are connected to local regions in the input, each computing a dot product between their weights and a small region they are connected to in the input volume (https://distill.pub/2016/deconv-checkerboard/)
- **Relu** layer will apply an elementwise activation function, such as the max(0,x) thresholding at zero.
- **Pool** layer will perform a downsampling operation along the spatial dimensions (width, height)
- **Fully connected** layer will compute the classes. Each neuron in this layer is connected to all the inputs

A basic VGG16 architecture



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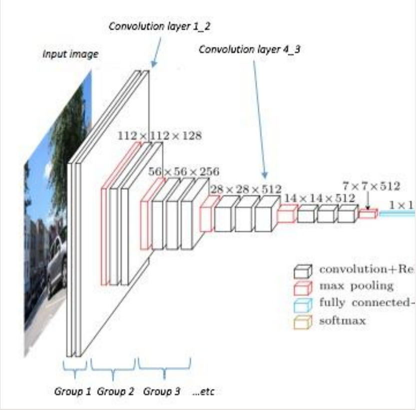

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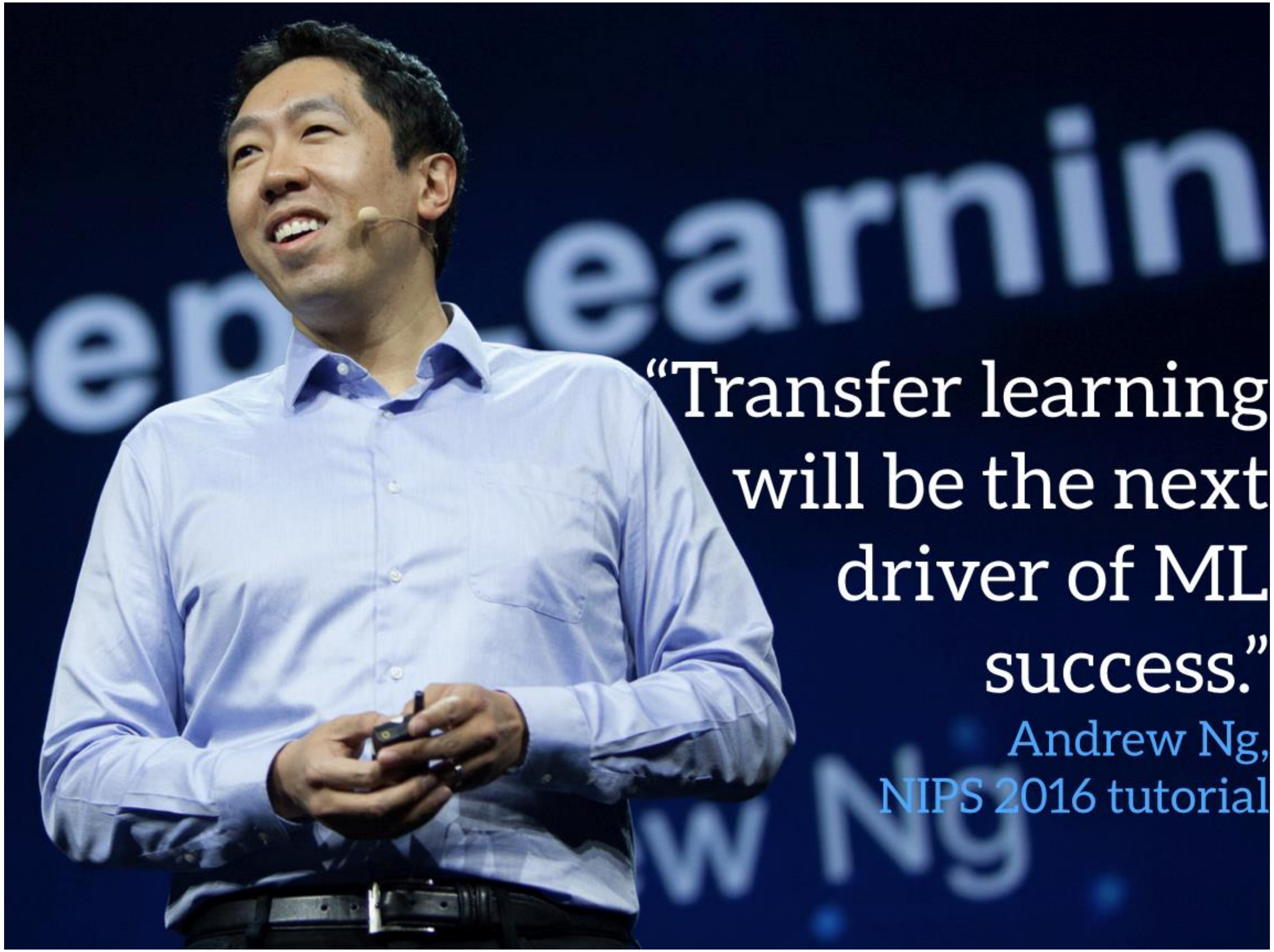
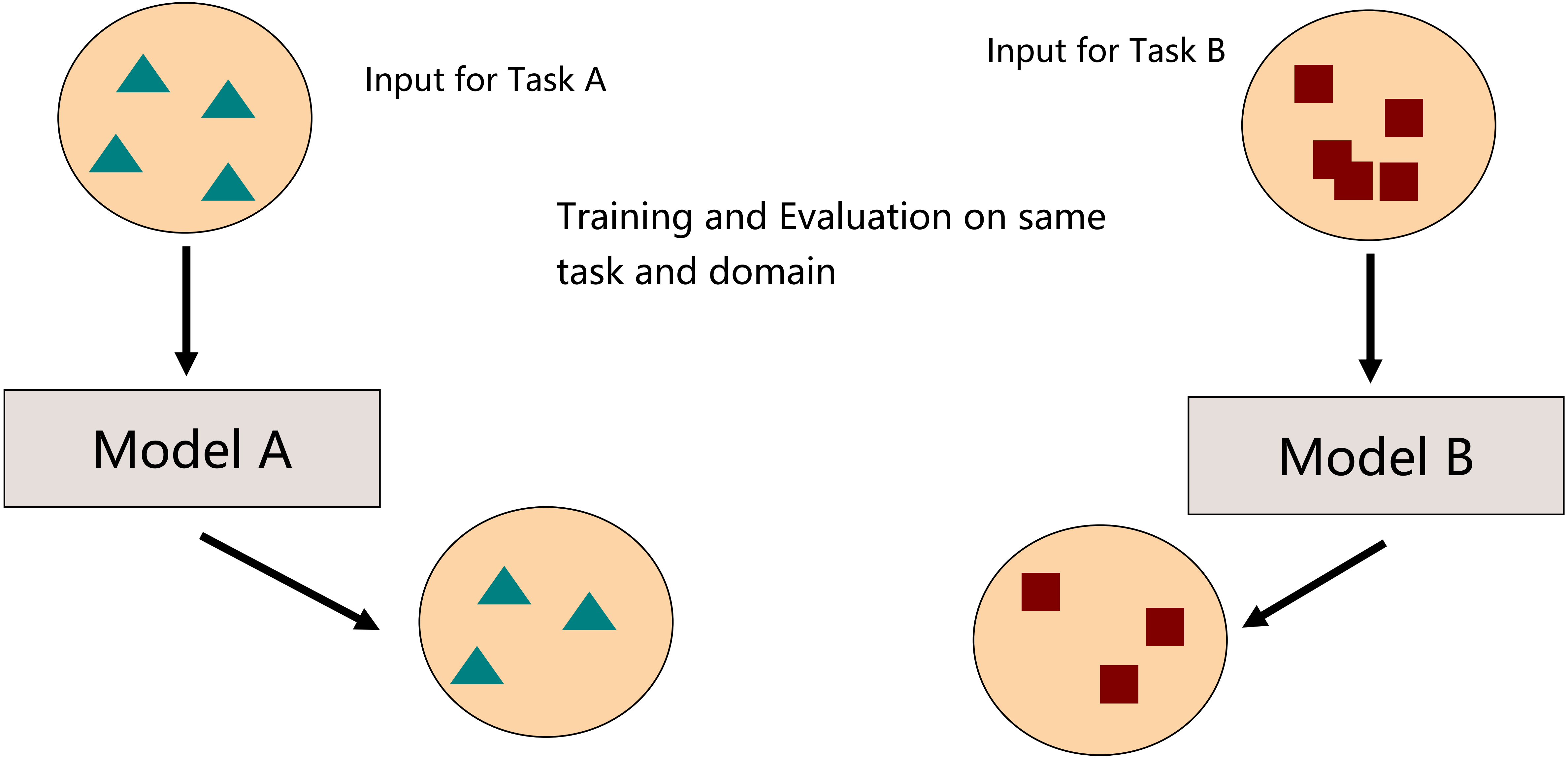
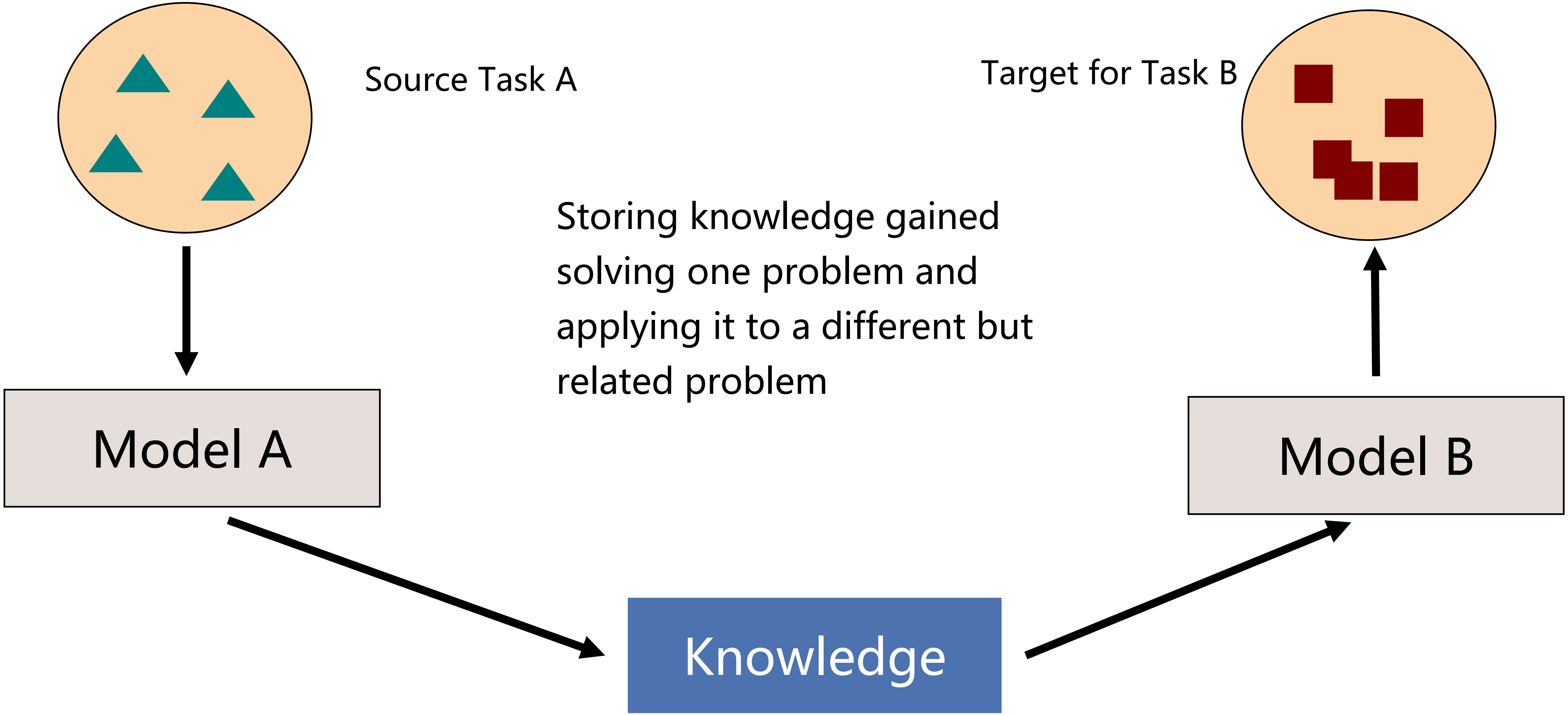
Because Andrew NG said so ….



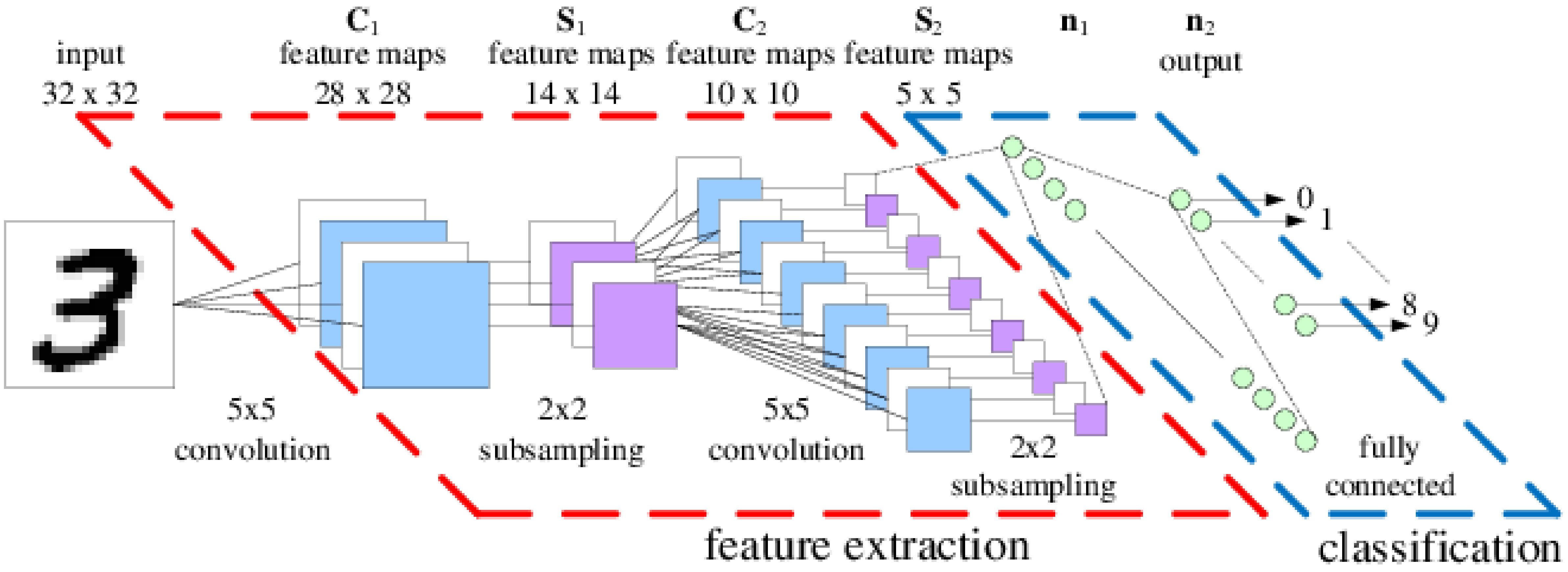
Classic machine learning requires retraining from start



Transfer learning allows to transfer knowledge from one task to another



A large part of ConvNet is transferable



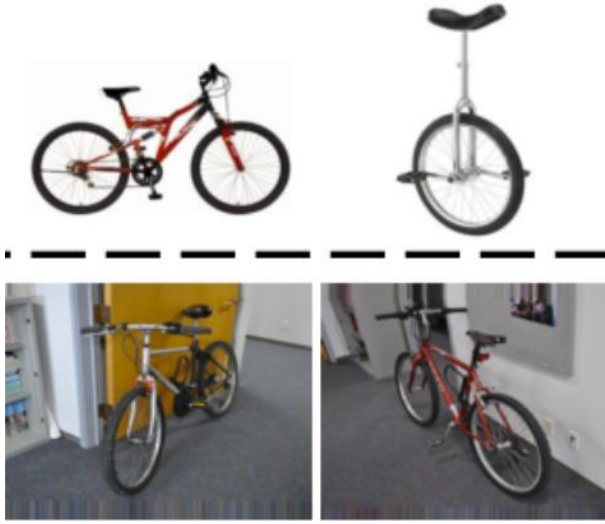
Generic and can be transferred

Task specific

Transfer learning allows model to adapt for unseen scenarios

- We don’t need extensive amount of data for a specific real scenario to train a deep learning model

- Major applications of transfer learning
  - **Learning from simulations**
    - Self driving cars can learn from data collected from driving car in GTA5
    - Robotics simulation can ease the data collection process from a real robot
  - **Adapting to new domains**
    - General image classification can be used to train on new domains
    - Speech models like Glove, Word2vec can be used to adapt to new domain specific text
    - Voice recognition system built adapting to kids voice



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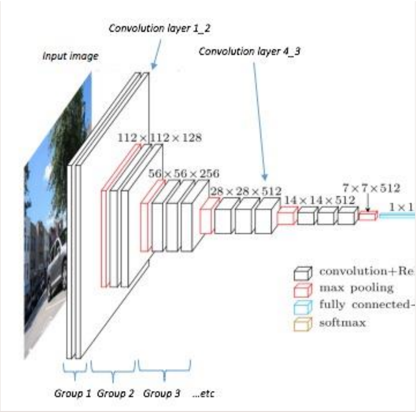

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Transfer learning in ConvNet

Three major transfer learning scenarios look as follows:

- **ConvNet as feature extractor**
  - Take a ConvNet pretrained on dataset like ImageNet
  - Remove the last fully connected layer
  - Treat the last as a feature extractor for the new dataset
  - Run a linear/tree based classifier on new features

- **Fine Tuning the ConvNet**
  - Replace the classifier of a Convnet saved on Imagenet
  - Fine tune model weights of all the layers present in the model using new dataset
    - Tuning the last few layers give maximum increase in accuracy

- **Using a pretrained model**
  - This involves using pretrained weights of someone else to finetune the existing model

When and how to finetune?

Scenario 1: *New dataset is small and similar to original dataset*
Recommendation: Use a Convnet as feature extractor and train a linear model on top of it, because of overfitting issues

Scenario 2: *New dataset is large and similar to the original dataset*
Recommendation: Fine tuning the ConvNet by adding new fully connected layer would be best as we can prevent the overfitting issues because of large data size.

Scenario 3: *New dataset is small but very different from the original dataset.*
Recommendation: Don't use a pretrained model and go for linear models only

Scenario 4: *New dataset is large and very different from the original dataset*
Recommendation: Train a Convnet from scratch. It is very often still beneficial to initialize with weights from a pretrained model. Fine tuning the entire network is best case scenario.

Practical advice/drawback using pretrained models

- *Constraints from pretrained models*
  - *Restricted by the architecture used for training pretrained model*
  - *You can't arbitrarily take out Convolutional layers from the model*

- *Learning Rates*
  - *Always start with a small learning rate for ConvNet weights that are being fine tuned*
  - *We expect ConvNet weights to be good enough to be used, so we don't wish to distort them too quickly and too much*

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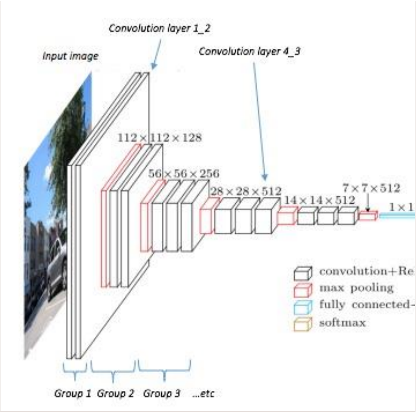

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Deep learning path Suggestion

Data science path - https://www.analyticsvidhya.com/blog/2017/01/the-most-comprehensive-data-science-learning-plan-for-2017/

My Deep learning track –

1) Machine learning by Andre NG(his first course and the most popular course in MOOC history) -> https://www.coursera.org/learn/machine-learning (Low difficulty)

2) Deep learning by Google on udacity - https://www.udacity.com/course/deep-learning--ud730 (Hard)

3) Practical deep learning for Coders by Jeremy Howard (Former Kaggle #1) - http://course.fast.ai/ (Medium/Hard)

4) A book on deep learning (Goodfellow) - http://www.deeplearningbook.org/ (If you need to understand deep math)

5) Andrew NGs deep learning track - https://www.coursera.org/specializations/deep-learning (easy/medium)

6) Just some collection of good blogs - http://colah.github.io/

References for transfer learning used in presentation

- http://ruder.io/transfer-learning/
- http://cs231n.github.io/transfer-learning/
- http://course.fast.ai/
- https://github.com/fastai/courses

Thank You!