Use Convolution Neural Nets to Address Classification

Iphone 5s  
Iphone X  
Nexus 7  
Galaxy 6

Nx classification
Use Convolution Neural Nets to Address

• **Input:** Images that have isolated or non-isolated products
• **Training:** Labeling data, pre-process data, optimize parameters (hit a button),
• **Exhaustive vs. non-exhaustive** set of images for training
• **Output:** Classified category
Ground truth: we need the labeled images

• Lots of labels
  • hire people on Amazon turk (www.Mturk.com),
  • scour the internet (require pre-processing)
  • Use people in recycling plants looking at images as they come in
    • More costly and time consuming
    • Better quality images for training because more realistic

• Few labels
  • One-shot learning – don’t need as much data, just need a few images of each
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Obtaining the training data could be a challenge and time consuming
Classify smartphones by model/brand

- **Input:** Images have only a single phone in them
- **Training:** Each training image contains a label saying what make and model
- **Exhaustive set** of images for training
- **Output:** make and model

![Image of smartphones with classification diagram]
Key words:
1. Convolution
2. Nonlinearlity
3. Max pooling
4. Fully connected layers
5. Classification
Convolution

- A kernel matrix (filter), moves across the image in a stride and takes dot product with the numbers on the image.
- When training the network we end up finding the numbers that make up the kernel matrix.
- Each image may be convolved by a number of kernels.
Nonlinearity

- Activation functions are used to increase the nonlinearity of the network.
- ReLU is typically preferred as it results in faster training.
- Other types of activation include:
  - Leaky ReLU
  - Tanh
  - Exponential linear units
  - Softmax
Pooling

- Down-samples input image allowing for assumptions to be made about features contained in the sub-regions.
- Helps prevent over-fitting by providing an abstracted form of the representation.
- Reduces computational cost by reducing the number of parameters to learn.
- Provides basic translation invariance to the internal representation.
Fully connected layers

- Every element from the pooling layer would be connected to every element of the output layer.
- These output elements may be some type of activation function (i.e. a softmax function) and will return a probability representing how likely a particular object with the features described in the kernels is in the image.
- In our example, output could be probability that the image is of a particular phone model/make.
Classification

- A loss function is defined: Difference between the output of the fully connected layer and the ground truth
  - L1,
  - L2,
  - Cross entropy (preferred for image classification)
- Loss function is minimized over all the weights/parameters from previous layers (kernels of convolutions layers, weights of fully connected layers etc.)
- Minimization carried out using
  - Stochastic gradient descent (SGD)
  - Adaptive gradient descent (Adagrad)
  - Adaptive moment estimation (Adam)