Machine Learning applied to Planetary Sciences

PTYS 595B/495B

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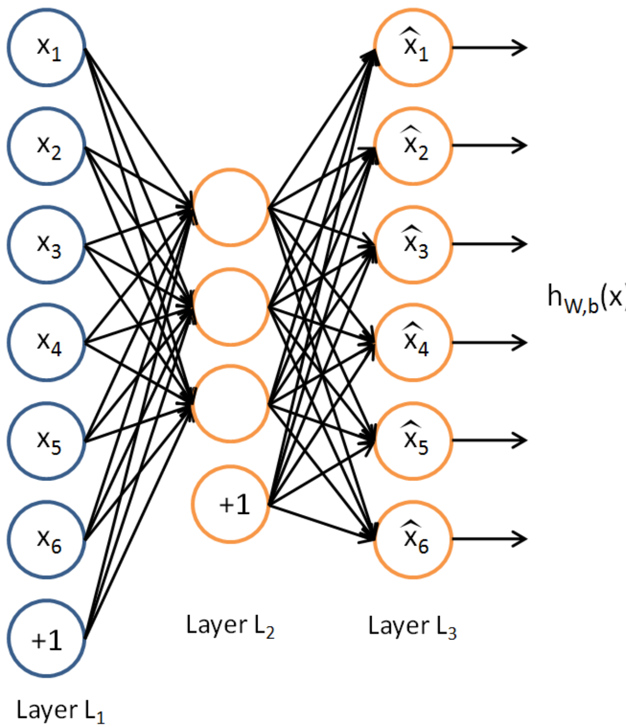
https://leonpalafox.github.io/MLClass/

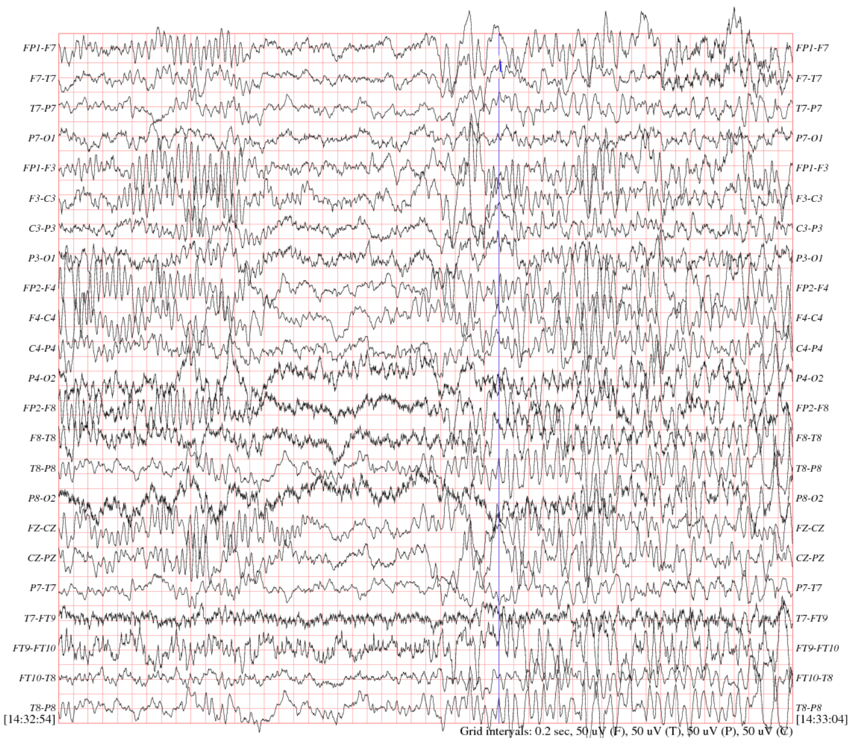
Autoencoders

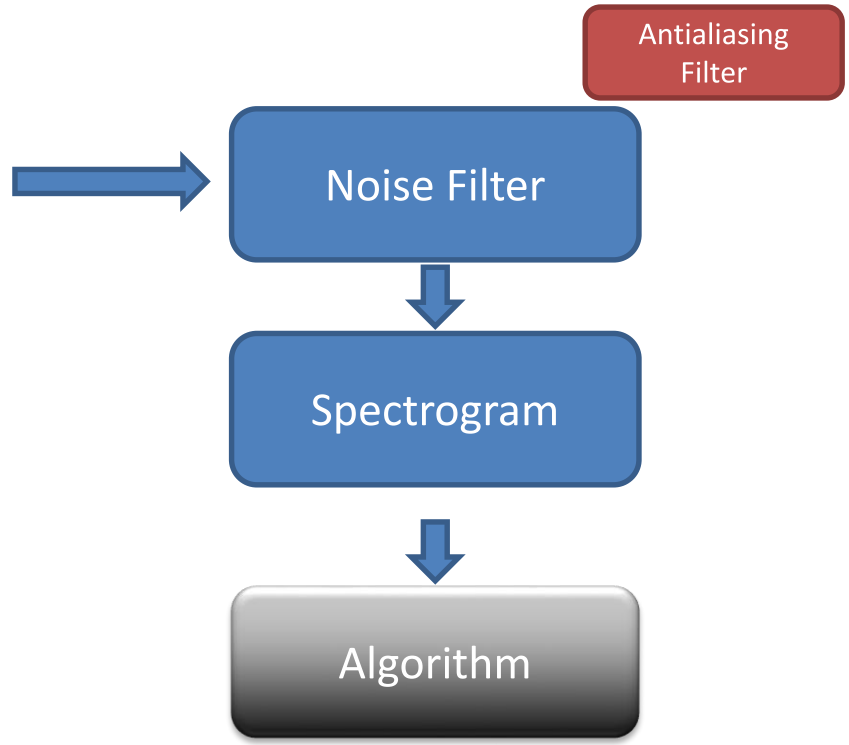
- An autoencoder is a NN where the output and the input are the same.



Preprocessing Data

- It’s a pain, but is needed





Convolutional Neural Nets

Image Transformations

- How do we deal with these transformations without CNNs
  - Transform the examples ahead and get an artificially large dataset.
  - MNIST: 60,000 x 4 (rotation) x 4 (Translation) x 2 (scaling)
    - 1,920,000
    - This is an approach that many algorithms do end up using.
  - I only assumed 4 degrees of freedom, they could be more. (stretching, shearing)
  - What if we had voxels (3D pixels)
- **Use an architecture that "learns" the transformations.**

Stationarity

- Stationary datasets
  - Images, traditional classification datasets.
  - You can scramble them around and the classification should not be affected.
  - *The probability does not change with a shift on time*
- Non-stationary sets
  - Time series, terrain profiles

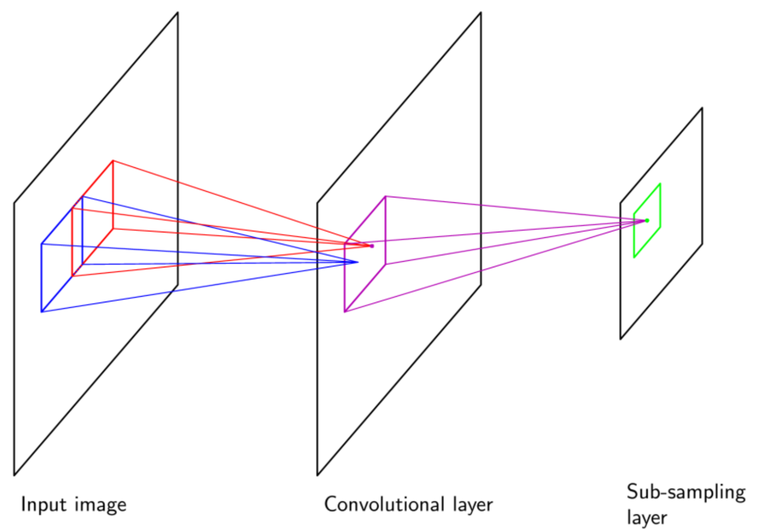
Stock Market

You are hired to create a classifier that will sell or buy.

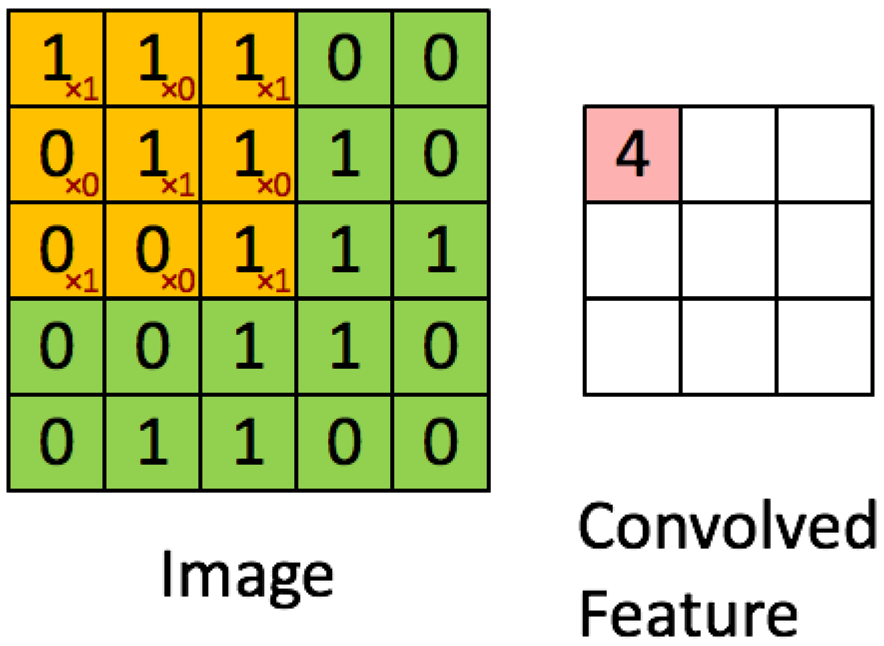
Images

Convolutional Neural Nets

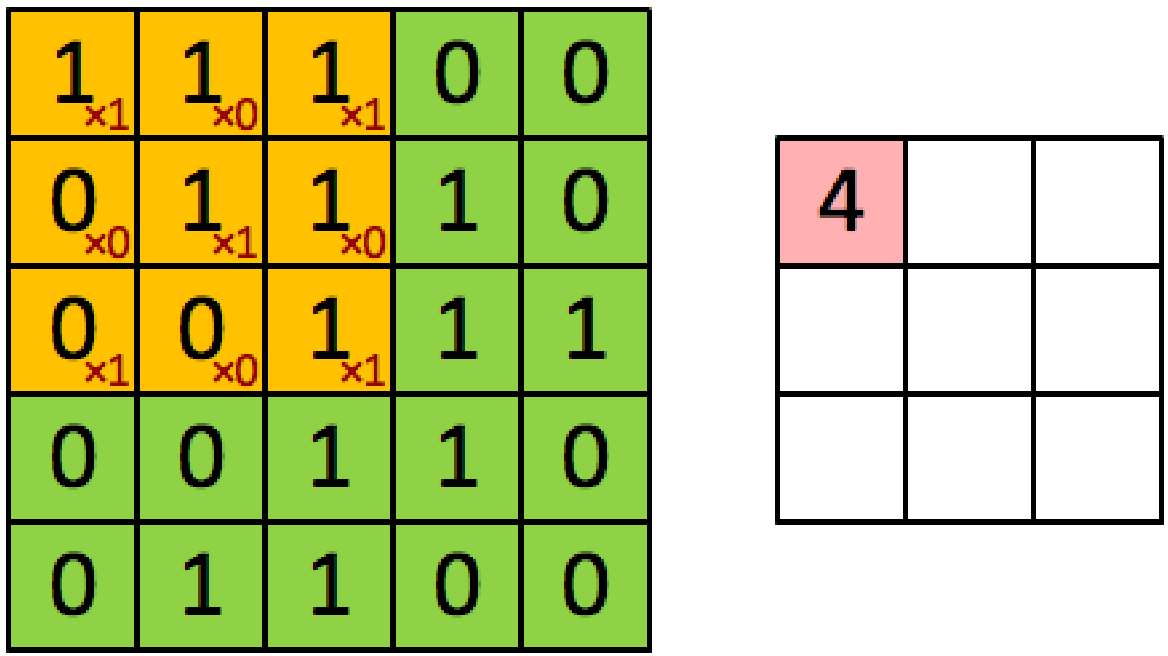
- The logic is that the training will take advantage of the invariances in the network.
- The network will learn invariant features, instead of general ones.



Convolution



Convolution



Image

Convolved Feature

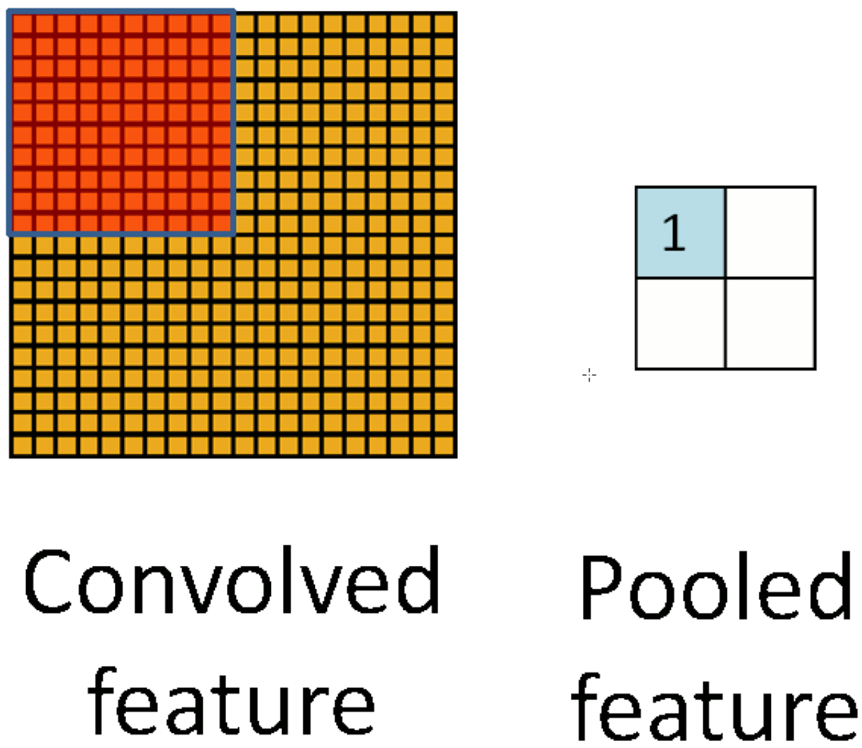
Connection to NN

- Given a large r x c image
  - Train an autoencoder on small a x b patches from the image.
  - This will learn k features (convolutions).
  - Now, using that autoencoder, we run a feedfoward evaluation to obtain all the features of the image.
  - k x (r-a+1) x (c-b+1) features
  - If k is 400, in 96 x 96 images, we would have around 3 million features.

Pooling

- Once we have learned the convolved features, we need to take advantage of the locality.
- We choose adjacent features, and can either take the max or the mean .
- The size of the pooling is defined by the user.
- This way we reduce the number of features and at the same time we take advantage of locality.

Pooling



Analysis

- By the end of the training a CNN training scheme is similar to training with an artificially large dataset.
  - Similar results
- Pooling actually decreases the number of weights in the actual network (The autoencoder did most of the heavy lifting)
- Sharing weights is the reason the CNN takes into account local features instead of global ones.

Disadvantages

- This approach is ad-hoc for images (or look alike).
- Trying to use it in time-series or other 1D data is not necessarily a good idea.
  - Long training times
- Unless you use Theano/TensorFlow/MatConvNet/Torch is hard to do real work.

Frameworks

- Theano:
  - Facebook's platform
  - Python
  - Windows, Linux, Mac OSX
- TensorFlow:
  - Google's platform
  - Python/C++
  - Linux, Mac OSX
- Lua/Torch
  - More academic oriented (a bot of Google though)
  - Lua (different language)
  - Linux

Applications

- We can train the CNN with random patches of many images.
- Then we can make prediction over images datasets.
- Applications?
  - Occluded Images were there is suddenly an obstacle.
  - Video is a set of time dependent pictures, the fact that there is an extra dimension does not eliminate the fact that the image is stationary.

https://www.youtube.com/watch?v=qrzQ_AB1DZk

TensorFlow

- Installing TensorFlow

- CNN Tutorial