# Journal 4

### How Convolutional Neural Networks Work

* Can idealize layers into features of an image for recognition
* CNNs can play videogames based on patterns on a screen & learn to make the next move
* Xs and Os example:
  + Issues arise when X’s and O’s are shifted in a minute way in the pixels
  + Can use features of the image to match them
  + Filtering takes the feature compared to the image by multiplying them, summing all results, and dividing by the number of pixels (1 being perfect match)
  + Repeat the process with different features
  + Convolution layer: one image becomes a stack of filtered images
  + Pooling: shrinking the image stack
    - Take a stride (usually 2) and take the maximum value of the two cells
    - Makes a similar pattern but smaller
  + Normalization: keeps the math from breaking by tweaking the values
    - Change every negative value to 0
  + Stack the Convolution, ReLU and Pooling layers
  + Alternatively, we can perform deep stacking by stacking multiple convolution, ReLU and pooling layers
  + Last layer: fully-connected layer
    - Every value gets a vote on what the answer is
    - Last two neurons are a vote for X, or a vote for O
  + The last fully-connected layer can also be stacked with more layers
* Backpropagation updates the feature weights and the fully-connected weights
* Hyperparameters:
  + Convolution Layers
    - Number of features
    - Size of features
  + Pooling
    - Window size
    - Window stride
  + Fully Connected
    - Number of Neurons
* There are common-practices for picking hyperparameters but still there is no “rules”
* The designer also has to choose how many layers, what type of layer, and in which order?
* This can also be applied to sound and text
* In text: you can made a 2D array where one axis is the one-hot encoded word and the other axis is the position in the sentence
* ConvNets only capture local spatial patterns – if the data can’t be manipulated to look like an image then these layers are less useful
  + For example they used customer retail data to show that the patterns in this data aren’t the spatial kind – which is why people don’t use CNNs for this type of classification
* **Rule of thumb: If your data is just as useful after swapping any of your columns with each other then you can’t use CNNs**