References:

Feature Pyramid[1]

- This paper explains the use of feature pyramid networks (FPNs) for object detection. A well-known problem for object detection in images is the scale of objects, especially when the object is small due to distance or nature of the object. To resolve this, a feature pyramid scales objects to to be more recognizable by a convolutional neural network. FPNs have become a standard for both one and two stage object detection networks. This is especially important for our problem because we are going to be identifying hundreds to thousands of *small* synapses.

Focal Loss[2]

- This paper discusses a one-stage object detector RetinaNet that surpasses the accuracy of two-stage detectors and matches the speed of previous one-stage detectors due to the novel focal loss function. RetinaNet is one of our potential detectors since it can identify multiples of the same object type (synapses).

Mask R-CNN[3]

- This is an example of a two-stage implementation. The way this model works, and why it excels, is by decoupling the mask and the classifier allowing them to run in parallel. This seems like a very powerful framework for object classification, but might be overkill for the scope of our project since all we want to do is locate and detect Neurons within an image.

Single Shot Multibox Detector[4]

- SSD, which is a similar implementation to RetinaNet, utilizes a single deep neural network. This framework utilizes multiple feature layers as well as convolutional layers to break down the problem into something more manageable. One of the main benefits is that this model is really fast, but only when given low resolution images which is why this model uses their layering system to reduce the image down. This implementation is very common for real-time detection.

YOLOv3[5]

- YOLO is presented as an extremely fast predictor and trainer. It mitigates the problem with large training times and slow real-time prediction. It achieved the same accuracy as SSD, but was 3X faster. This model takes bits and pieces from many other models like darknet, faster-r-cnn, and in order to be good at general object detection.

1. Lin, T.-Y. *et al.* Feature Pyramid Networks for Object Detection. *ArXiv161203144 Cs* (2016).

2. Lin, T.-Y., Goyal, P., Girshick, R., He, K. & Dollár, P. Focal Loss for Dense Object Detection. *ArXiv170802002 Cs* (2017).

3. He, K., Gkioxari, G., Dollár, P. & Girshick, R. Mask R-CNN. *ArXiv170306870 Cs* (2017).

4. Liu, W. *et al.* SSD: Single Shot MultiBox Detector. in *Computer Vision – ECCV 2016* (eds. Leibe, B., Matas, J., Sebe, N. & Welling, M.) 21–37 (Springer International Publishing, 2016).
5. Redmon, J. & Farhadi, A. YOLOv3: An Incremental Improvement. *ArXiv180402767 Cs* (2018).