Class Activation Map (CAM)

Prof. Seungchul Lee

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CNN with Image

- A class of deep artificial neural networks
- Most commonly applied to classifying visual images

- LeNet-5
  - The original Convolutional Neural Network model goes back to 1989 (LeCun)

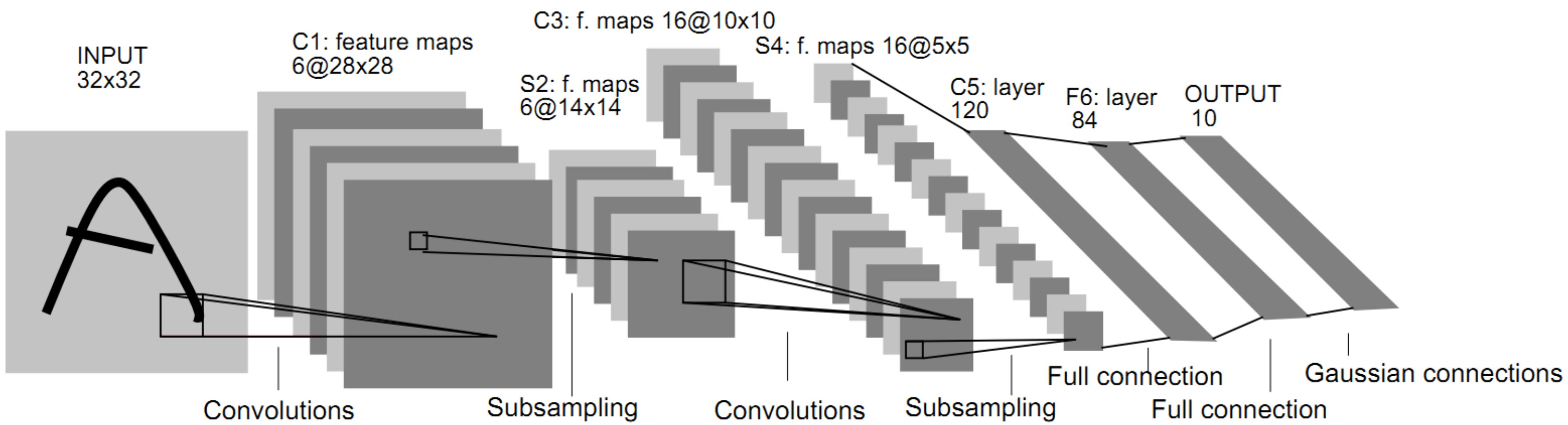
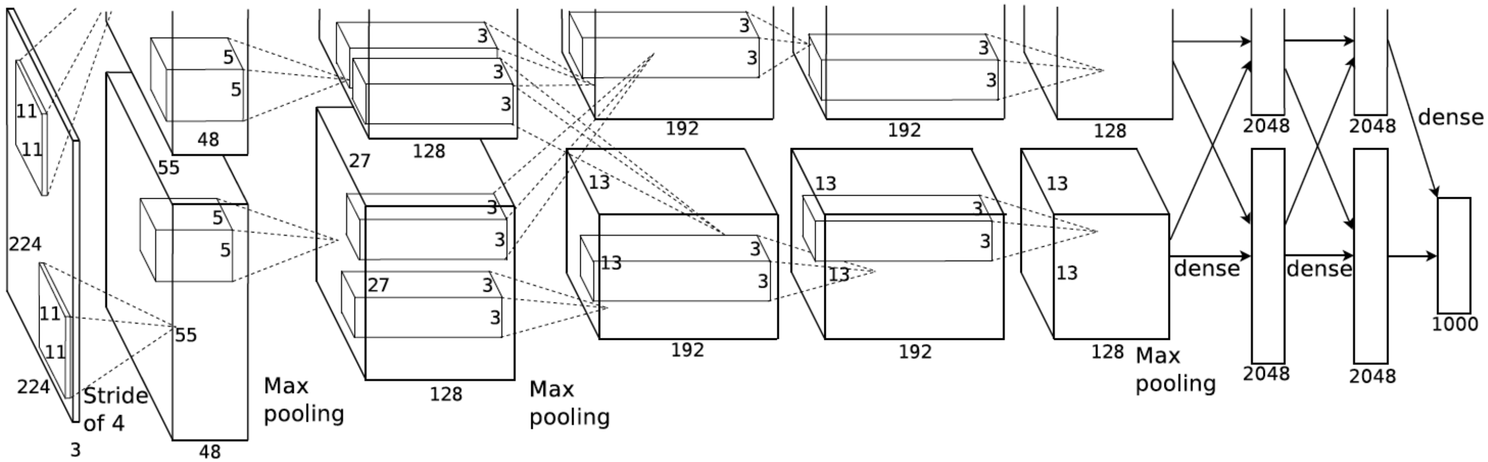


Fig. 2. Architecture of LeNet-5, a Convolutional Neural Network, here for digits recognition. Each plane is a feature map, i.e. a set of units whose weights are constrained to be identical.

CNN with Image

- A class of deep artificial neural networks
- Most commonly applied to classifying visual images

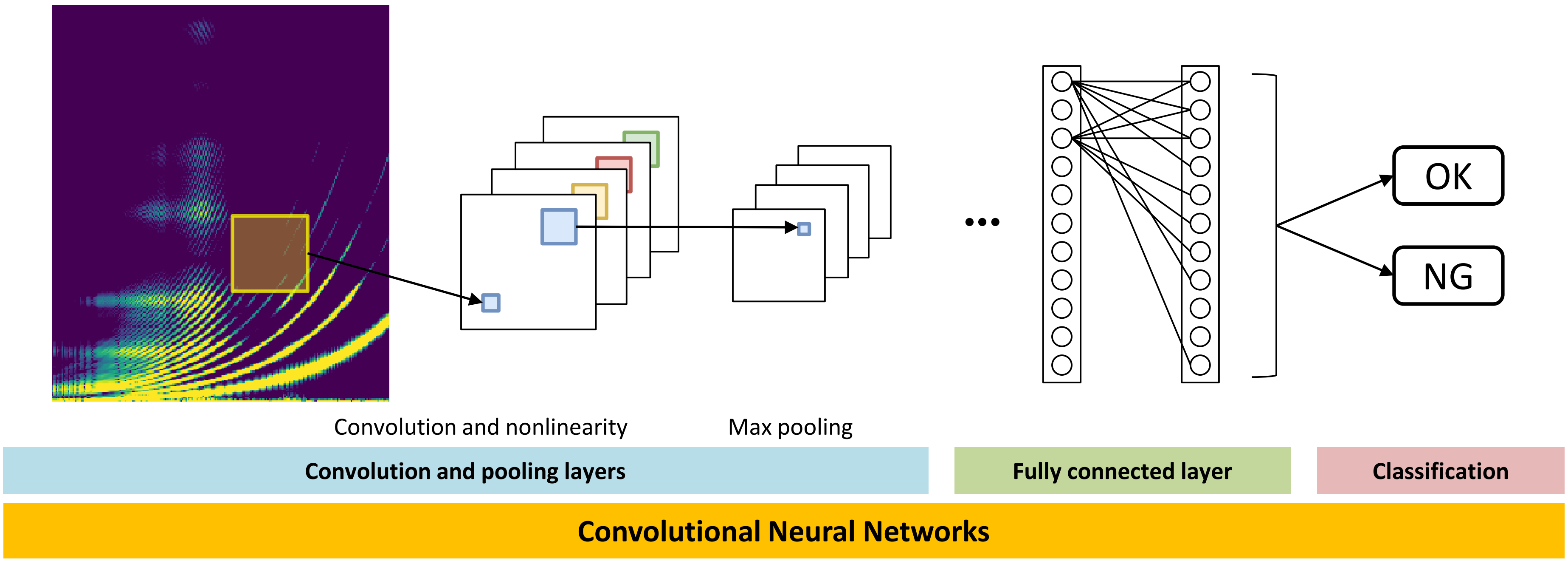
- AlexNet (Krizhevsky, Sutskever, Hinton 2012)
  - ImageNet 2012 15.4% error rate



CNN with Vibration Signals

- A class of deep artificial neural networks
- Most commonly applied to classifying visual images

- A spectrogram is a visual representation of the spectrum of frequencies of signal as they vary with time



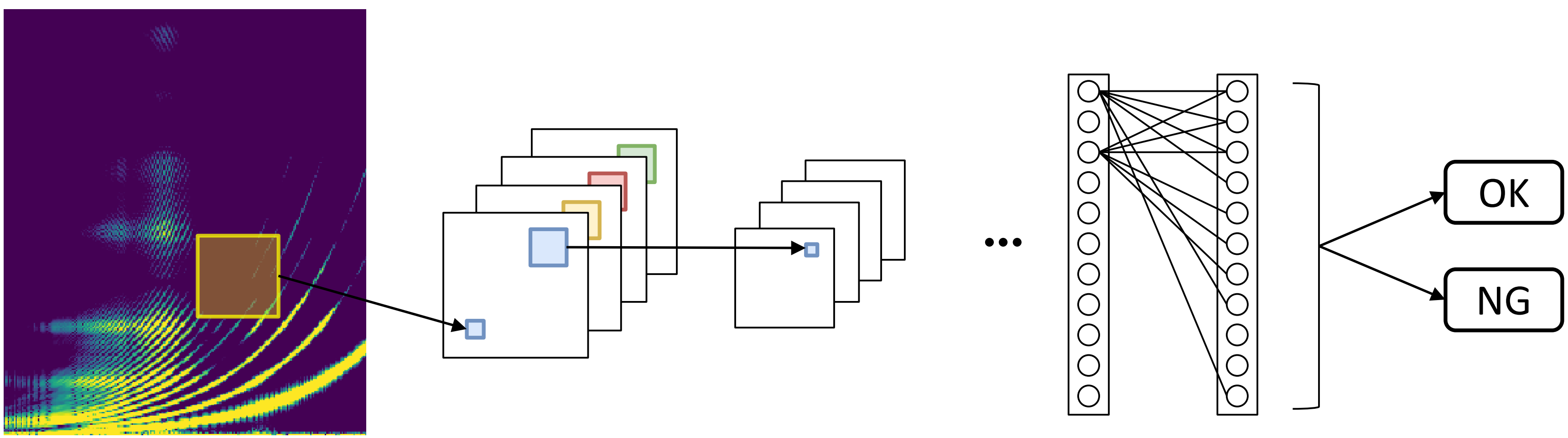
Issues on CNN (or Deep Learning)

- Deep learning performs well comparing with any other existing algorithms
- But works as a black box
  - A classification result is simply returned without knowing how the classification results are derived → little interpretability

- When we visually identify images, we do not look at the whole image
- Instead, we intuitively focus on the most important parts of the image
- When CNN weights are optimized, the more important parts are given higher weights

- Class activation map (CAM)
  - We can determine which parts of the image the model is focusing on, based on the learned weights
  - Highlighting the importance of the image region to the prediction

Fully Connected Layer



Convolution and nonlinearity

Max pooling

Convolution and pooling layers

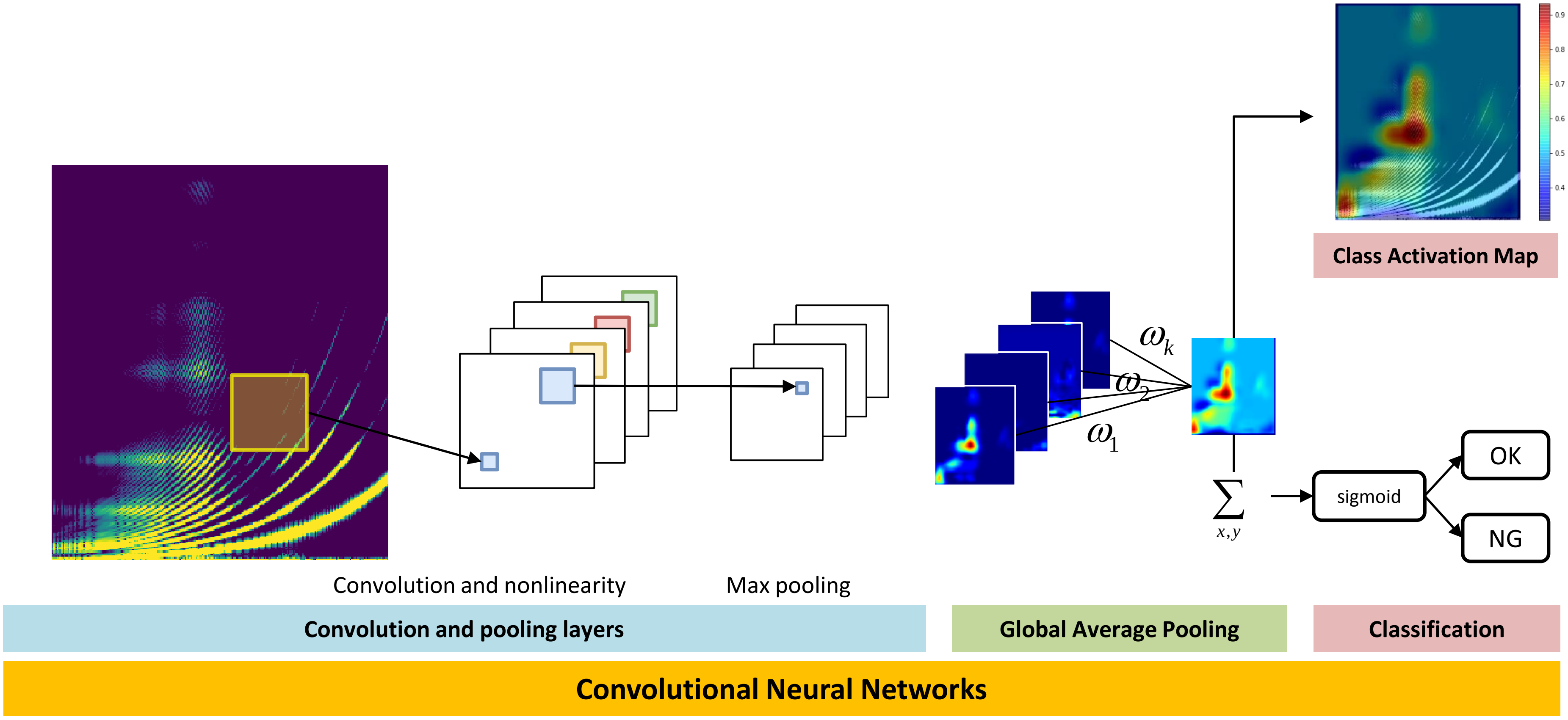
Fully connected layer

Classification

Convolutional Neural Networks

Global Average Pooling

- Class Activation Map (or Attention)



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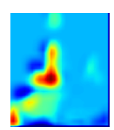
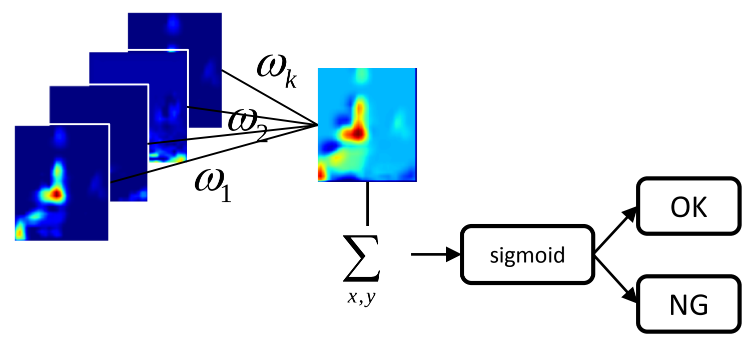
Global Average Pooling Implementation

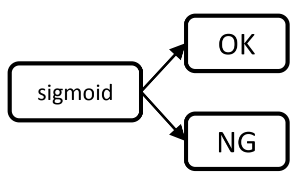
```
## global average pooling
SUM = tf.zeros([1,7,7,1])
for i in range(int(weights['w'].shape[0])):
    SUM = tf.add(weights['w'][i]*tf.reshape(maxp2[:,:,:,i],(-1,7,7,1)), SUM)

attention = tf.reduce_sum(SUM, axis = (3))
output = tf.reduce_sum(attention, axis = (1,2))
output = tf.nn.sigmoid(output)
output = tf.stack(((1-output), output),1)
```

$$S_c = \sum_k \omega_k^c \sum_{x,y} f_k(x,y) = \sum_{x,y} \sum_k \omega_k^c \, f_k(x,y)$$





$$P_c = \frac{\exp(S_c)}{\sum_c \exp(S_c)}$$



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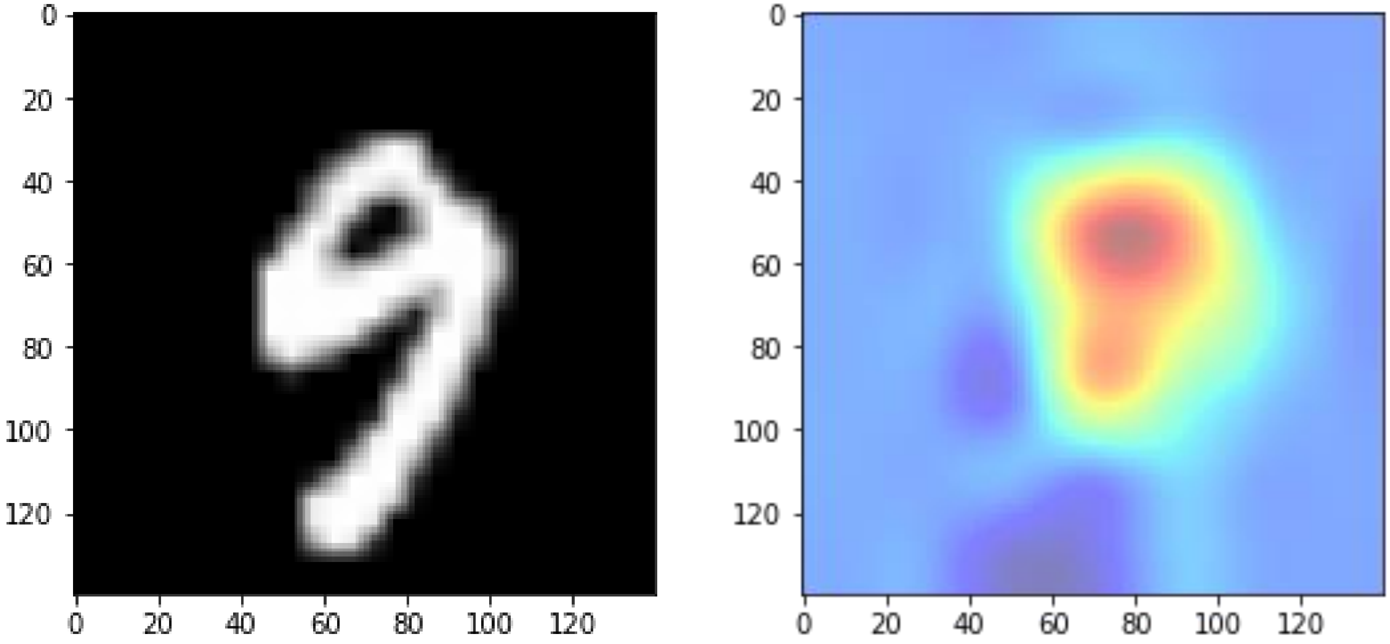
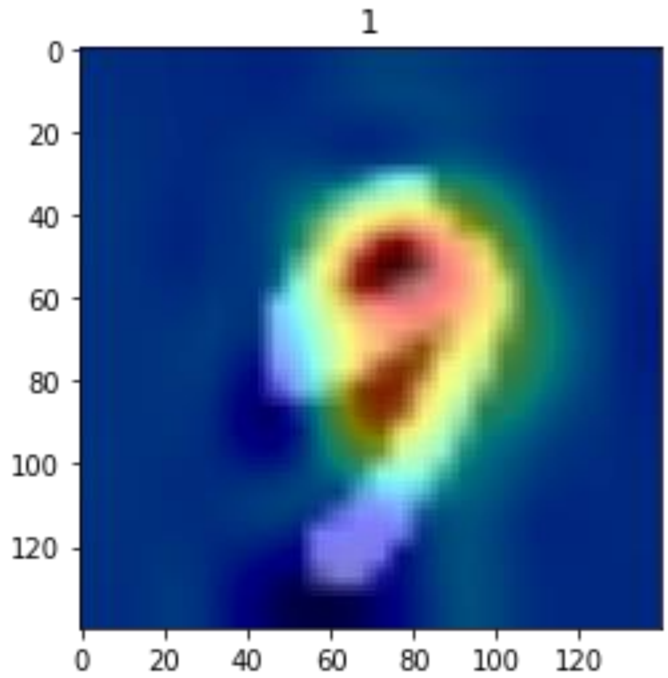
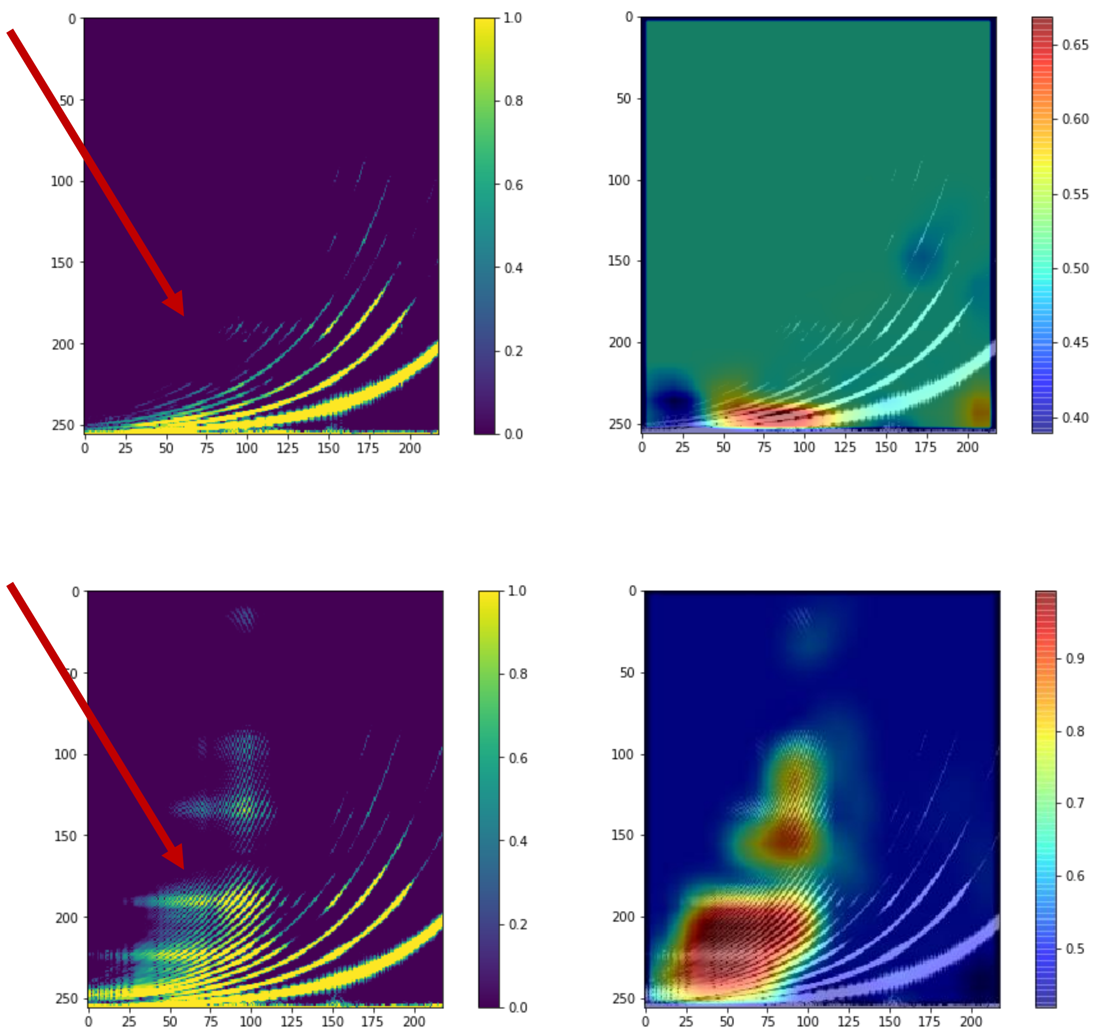
Example: MNIST



Example: MNIST



Example: Frequency Sweep



Example: Real-time Human Detection