

Red-Net: Investigating The Generalizability of Color Features

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Background and Question

- Can convolutional neural networks learn to generalize features across an image space?
- Does size of a feature matter?
- Can a CNN trained to recognize red objects in the foreground of an image also recognize red objects in the background?

Why red?

- CNNs have been shown to exhibit hierarchical color processing that makes them prefer red (Hickey and Zhang 2020)

1A: No Red



1B: Foreground Red



1C: Background Red



1D: Excluded Image



Dataset

- 850 images pulled from CIFAR-100 dataset
- Hand-labelled into 3 categories
- 61 with red in foreground
- 39 with red in background
- 34 excluded images for 816
- Images are 32x32 pixels
- Split into “train” and “test” sets

Figure 1

Building the Model

- Used keras library
- Wanted to keep the structure simple to avoid learning unnecessary complex features
- In order to validate accuracy metrics, ran the same experiment using a varied number of convolutional filters

| Model: "sequential_72" | | |
|-------------------------------------|-------------------|---------|
| Layer (type) | Output Shape | Param # |
| conv2d_71 (Conv2D) | (None, 25, 25, 4) | 772 |
| max_pooling2d_69 (MaxPooling2D) | (None, 12, 12, 4) | 0 |
| flatten_69 (Flatten) | (None, 576) | 0 |
| dense_68 (Dense) | (None, 2) | 1154 |
| re_lu_65 (ReLU) | (None, 2) | 0 |
| softmax_68 (Softmax) | (None, 2) | 0 |
| Total params: 1926 (7.52 KB) | | |
| Trainable params: 1926 (7.52 KB) | | |
| Non-trainable params: 0 (0.00 Byte) | | |

Figure 2: Sample Model Schema for 4 convolutional filters

Figure 3

- Trained with foreground red objects as target (blue line)
- Tested on background red objects (orange line)
- Averaged accuracy across epochs
- Seems to confirm generalizability

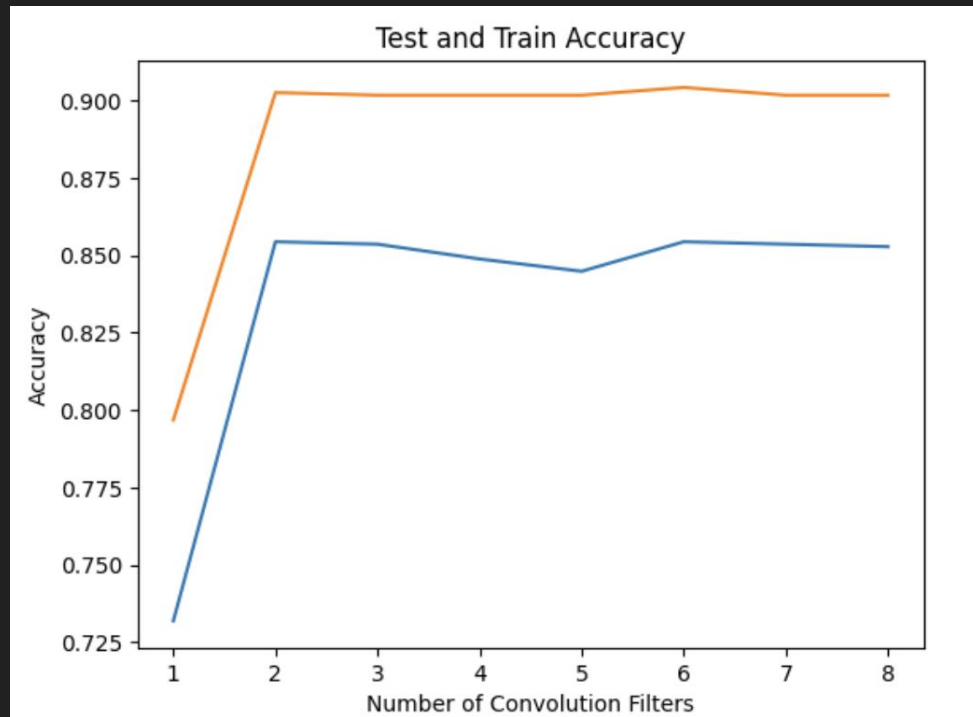
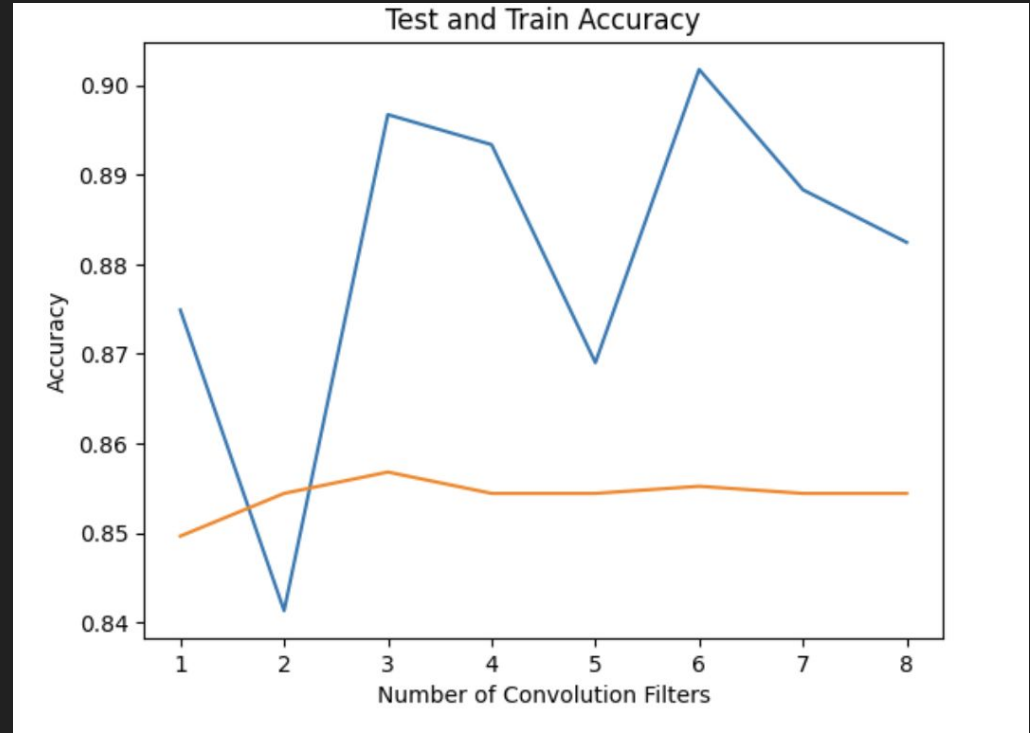
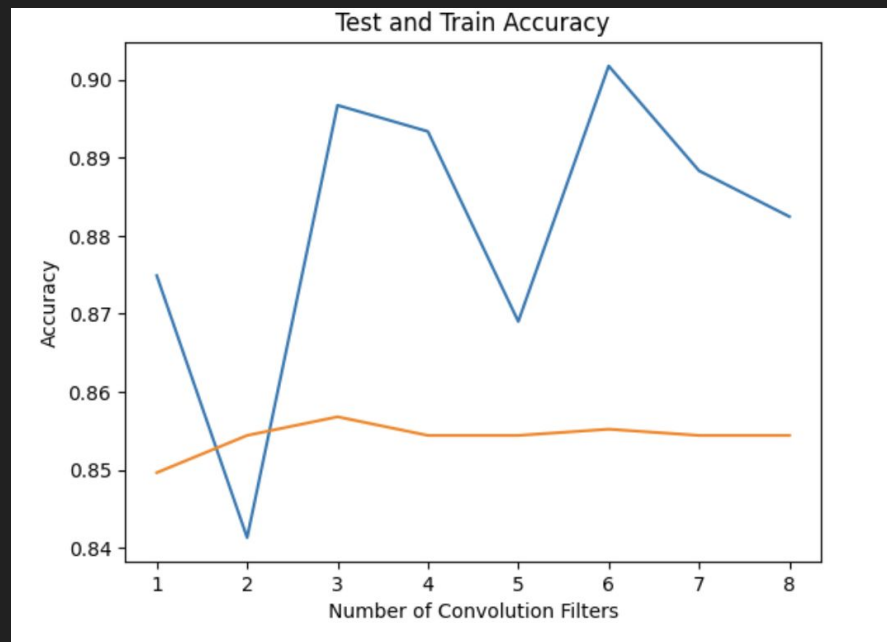
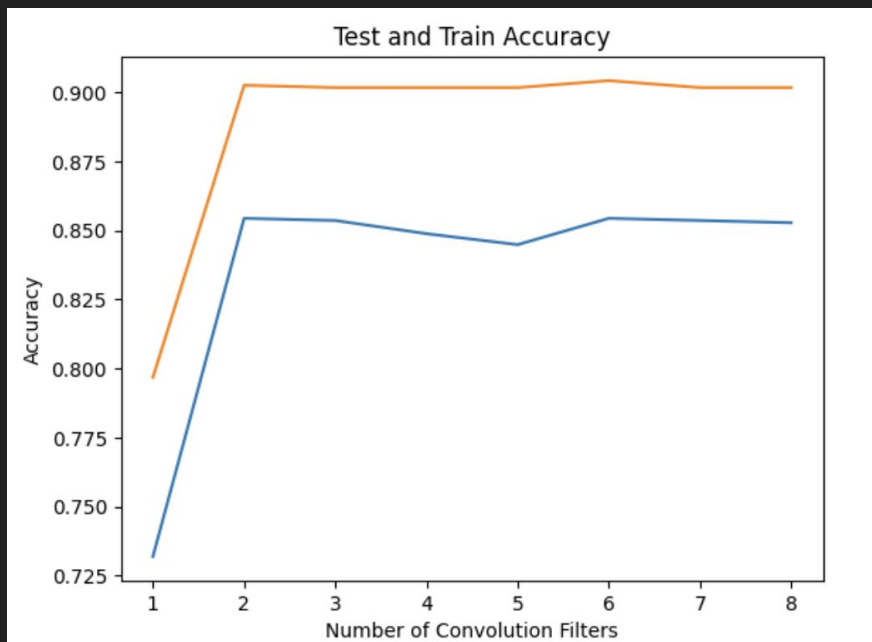


Figure 4

- Reversed training and test sets
- Trained on background red objects (blue line)
- Tested on foreground (orange line)
- More inconsistent, but still showed better performance for background objects



Figures 3 and 4



Hypothesis confirmed?

Results seem to indicate that the task is generalizable

Potential Confounding Factors and Next Steps

- Coarse images only require a few red pixels to inhabit the foreground
- Convolutions are close in size to image
- Small dataset with subjective labelling
- Did not pad images before applying convolutional filter
- Examine convolutional filter activations
- Train on grayscale images where only color is red
 - Test on full color images to detect red objects

Questions?

<https://github.com/ak-johnston/Vision-Final/>