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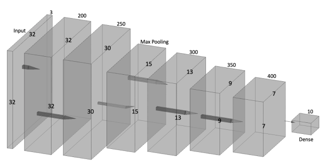
1. CNNs for Classification

The effects of influential parameters of CNNs were be observed in their ability to classify images - these include; kernel size, number of kernels, number of layers, pooling and activation functions.



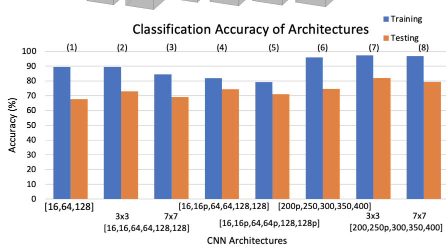


Figure 1. (Top)Optimal Architecture - 81.1% accuracy
Figure 2. (Bottom)Architecture accuracy in predicting animals. Numbers above bars are referred to. Model 5 - VGG model [1].

Generally, simpler CNNs (Appendix3.1a) were more responsive to parameter changes, affecting both training and test accuracy more as compared to complex (Ap.3.1b) CNNs. Increasing the layers causes an increase in test accuracy up to roughly 6 layers (see 1&4) before falling, while overfitting consistently increases(Ap.3.3). Increasing kernel size reduces test accuracy, particularly past 7x7, with 3x3 typically optimal (see pairs 2&3,7&8) . However, in simple networks 5x5 filter sizes performed better and with less overfitting(Ap.3.4). Max pooling reduced overfitting for simple CNNs (see 2&5), but caused performance degradation when overused. In complex networks max pooling did not have a large affect on overfitting, only improving testing performance (see 6&7). Early placement of pooling caused worse performance(Ap 3.2). ReLU had the highest accuracy and least overfitting (Ap.3.5), with softmax in the final layer. Combining the observations gave model 7 with the highest test accuracy. Made up of 5 conv. layers with a large number of purely 3x3 filters, a single pooling layer after the second layer and a single fully connected layer.

2. CNNs for Regression

The effects of influential parameters of CNNs and epoches during training were be observed in predicting real valued outputs, these included; number of layers, number of filters, the number of dense layers and pooling.

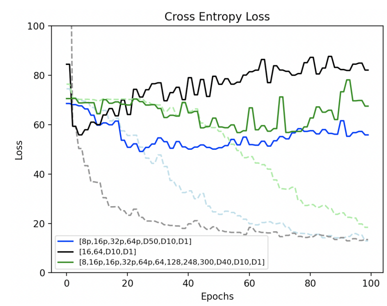


Figure 3. Cross Entropy Loss of House Price prediction for varying architectures. Dotted lines-training error, solid lines-validation error. All filter sizes were 3x3, apart from green with two 7x7 sizes. A low pass filter was applied for better overall trend observation.

As in classification, increasing the number of layers increased test accuracy up to a point (black-blue) when it decreased again (blue-green). Additionally, deeper networks(green) showed overfitting at roughly 50 epochs, compared to the 5th epoch in the shallow network(black), showing more layers increases epoches-until-overfitting. Pooling reduced validation error, occurring at every layer in the best model (blue). Larger kernels reduced overfitting in complex networks (green), but in turn increased the validation error. Fully connected layers affected the validation error greatly, with two layers of 50 and 10 nodes (blue) before the output prediction giving the lowest validation error.

Input Image Type	Accuracy (%)
Frontal	53.01
Bedroom	71.86
Kitchen	69.24
Bathroom	79.13

Table 1. Varying input types to most successful architecture.

The results in Table 1 indicates either the model does not generalise well to other types of input image, or that certain areas of the house are more indicative of house price.

References

[1] K. Simonyan and A. Zisserman. Very deep convolutional networks for large-scale image recognition. Technical report, University of Oxford, 2015.

3. Appendix

3.1 Definitions CNN sizes

a Simple CNN - 100,000 to 1.5 million parameters.

b Complex CNN - 1.5 million - 6 million parameters.

3.2 Max Pooling Detailed observation of the effects of Max Pooling on simple and complex CNNs.

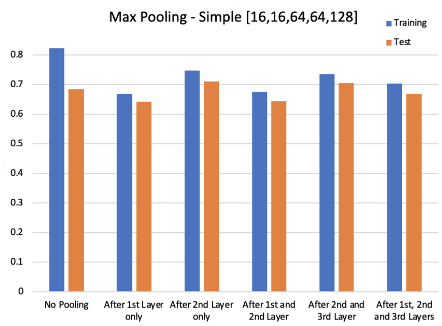


Figure 4. **a** Max pooling after different layers in a simple CNN. Large drop in accuracy when used too early. Optimal use after second layer.

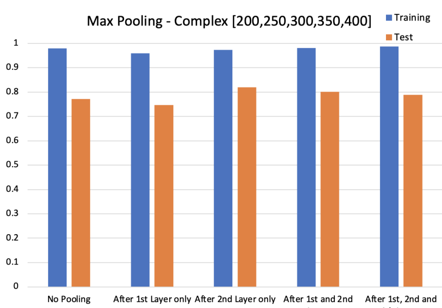


Figure 5. **b** Max pooling after different layers in a complex CNN. Max pooling does not reduce overfitting. Optimal placement after second layer.

3.3 Layers - Detailed observation of the effects of varying the number of layers in CNNs.

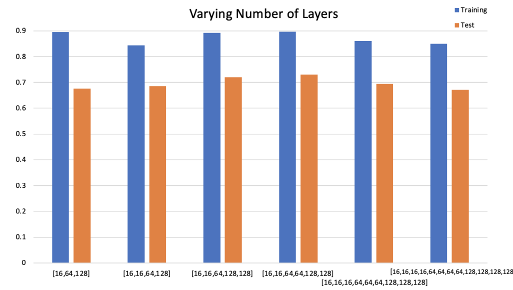


Figure 6. Changing the number of layers in a CNN. Highest test accuracy at 6 layers.

3.4 Kernel Size - Detailed observation of the effects of varying the kernel size in CNNs.

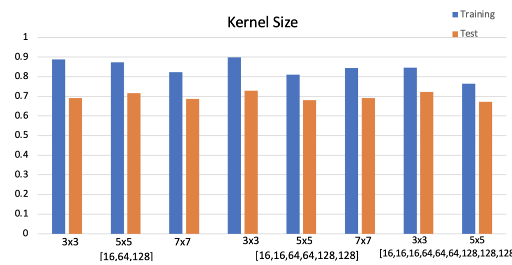


Figure 7. Changing the filter sizes in CNNs. 3x3 optimal for deeper architectures, 5x5 optimal for 3 layered CNN.

3.5 Activation Functions - Detailed observation of the effects changing activation functions.

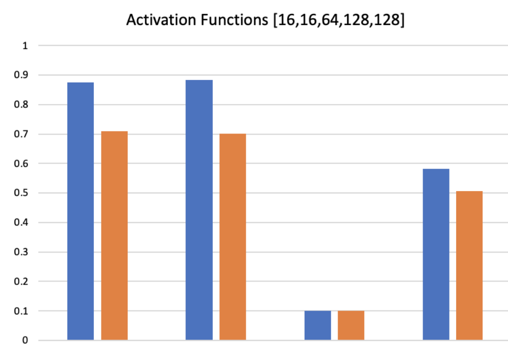


Figure 8. Changing the activation functions for a set network with no additional parameters. ReLU marginally better than LeakyReLU.