Inventory Classifier using Convolutional Neural Net

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Background

In the world of manufacturing and distribution, optimizing warehouse capacity and utilization can result in savings of overhead costs and better organizational efficiency.

When an operations manager has good insights into space utilization, she can improve efficiency and cost through space consolidation allowing for a reduction in space or re-purposing of space to accommodate growth and other organizational needs.

Objectives

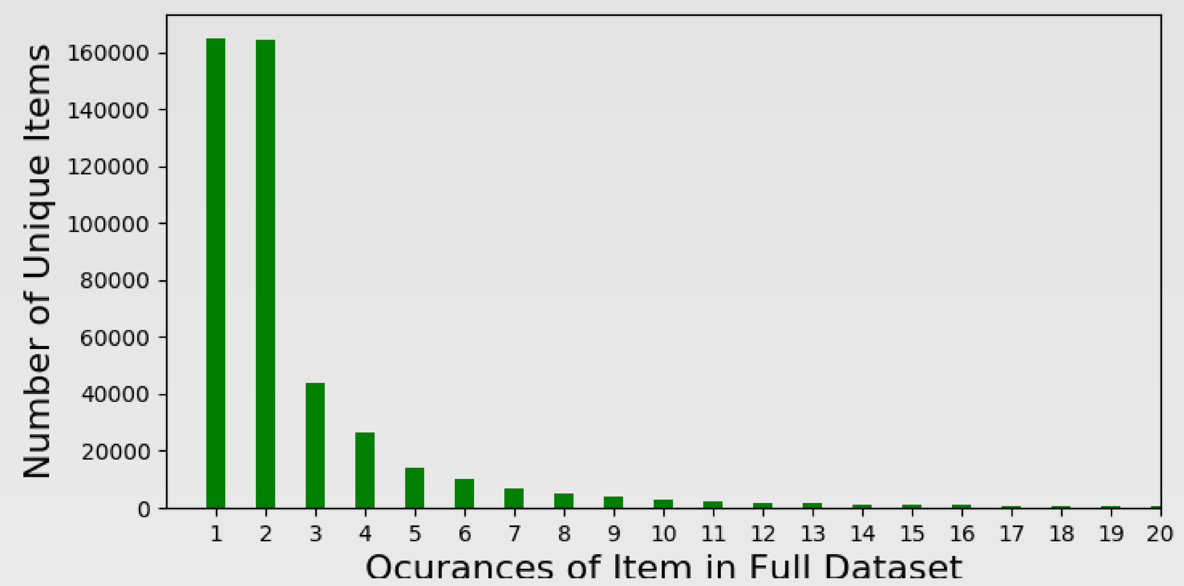
- *Analyze image to determine if a storage location is empty*
- *Analyze image to determine if a storage location is under utilized by counting the number of items stored*

Data

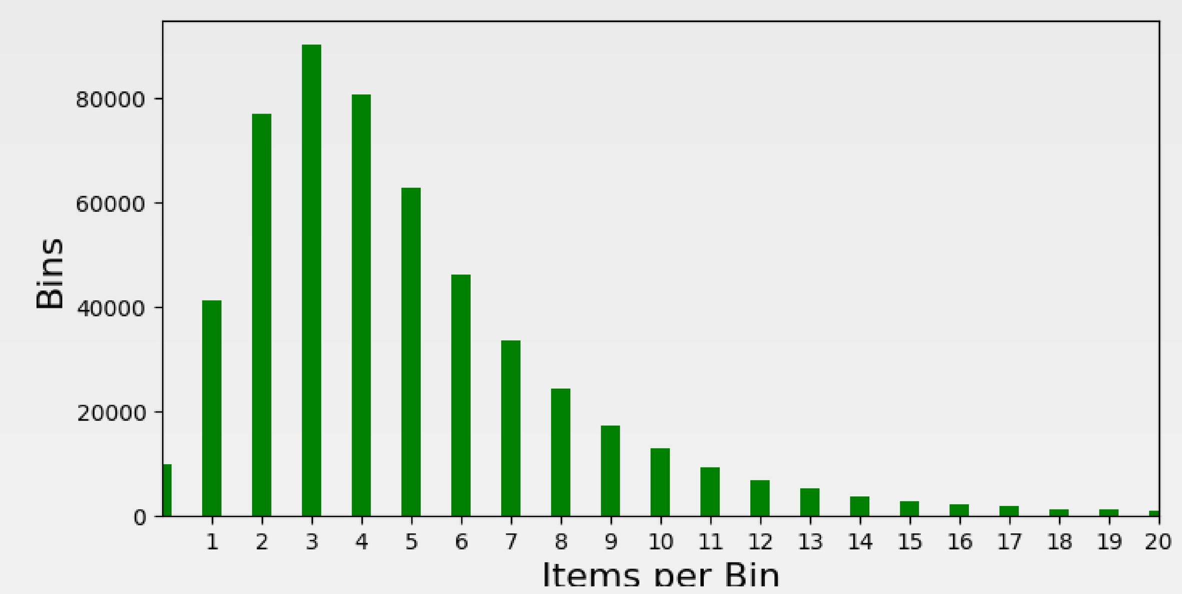
- *Amazon Bin-Image Dataset*
- *~536k storage bin images*
- *~460k unique items depicted*

Challenges

- Poor image quality
- Overlapping items or occluded items
- No definitive object class to train on



- Class imbalance



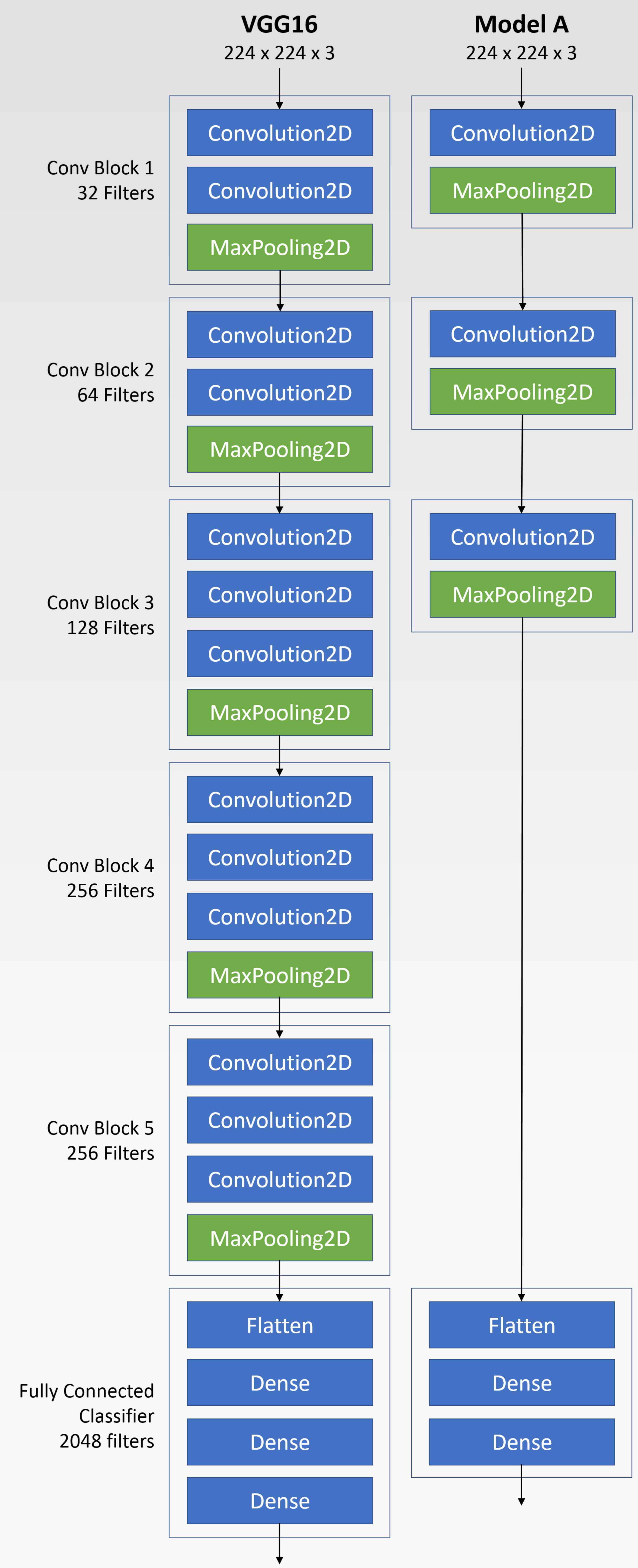
Methods

The inputs to my CNN models are 224 x 224 RGB images. The only pre-processing consists of resizing and rescaling. To avoid class imbalance, all empty bin images are selected, then an equal number of images are randomly selected from the remaining classes. The holdout images are used for demonstration.

Images are passed through a stack of Conv layers with filters using a small receptive field(3x3) and stride of 1. Each Conv layer is followed by a RELU activation layer and each block is followed by a 2x2 pooling layer. A dropout is applied to each layer to avoid over-fitting.

Model A is designed for the empty bin use case. A VGG16 variant is developed for counting items in a bin.

Model



Results

Empty Bin Detection

Model	Optimizer	Epochs	Loss	Accuracy
A	Adam	10	0.116	0.979
	RMSProp	10	0.206	0.940
	SGD	10	0.123	0.962

Counting 0 to 5 Objects

Model	Optimizer	Epochs	Loss	Accuracy
A	Adam	20	1.792	0.168
	RMSProp	20	1.612	0.280
	SGD	20	1.232	0.455
VGG16	RMSProp	20	1.807	0.164
	SGD	80	3.073	0.418

- P(0) = 0.027
- P(1) = 0.110
- P(2) = 0.205
- P(3) = 0.260
- P(4) = 0.219
- P(5) = 0.172

Future Goals

- *Extend counting to 10 objects and explore larger number of filters*
- *NLP to develop small set of item classes and categorize items in bins according to these classes*

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References

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Zou, W., Wang, X ., Sun, M., Lin, Y. Generic Object Detection with Dense Neural Patterns and Regionlets. Stanford, 2014