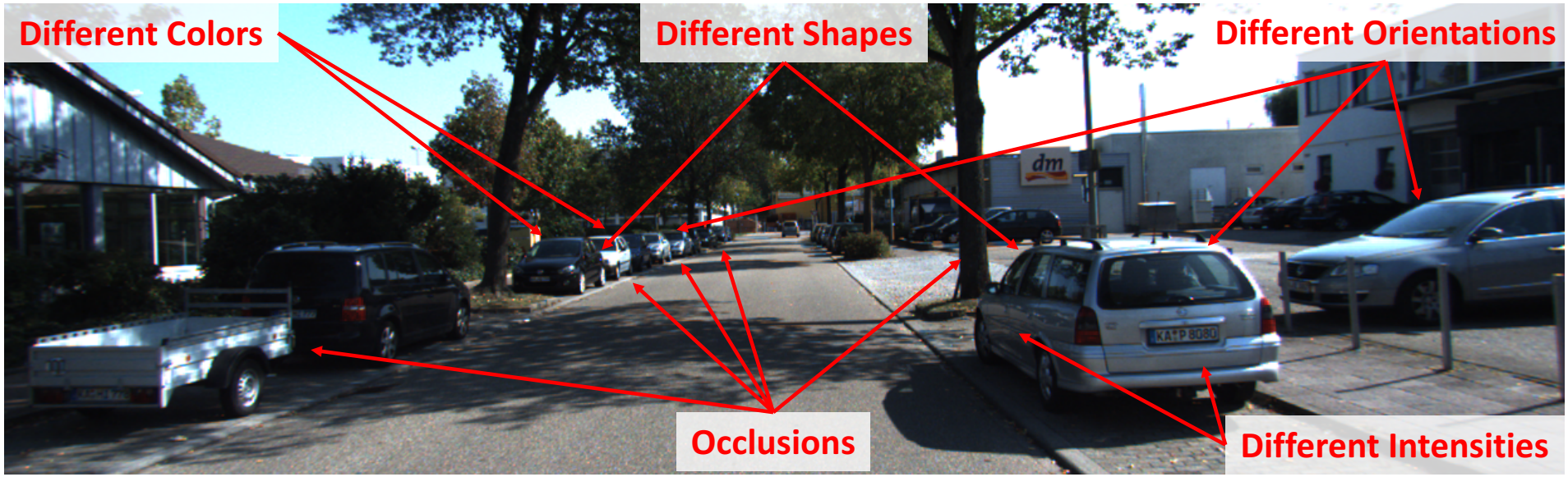
Day3-B
Training computers to recognize objects: Supervised Deep Learning

Pennsylvania State University

Enormous visual conditions in real world

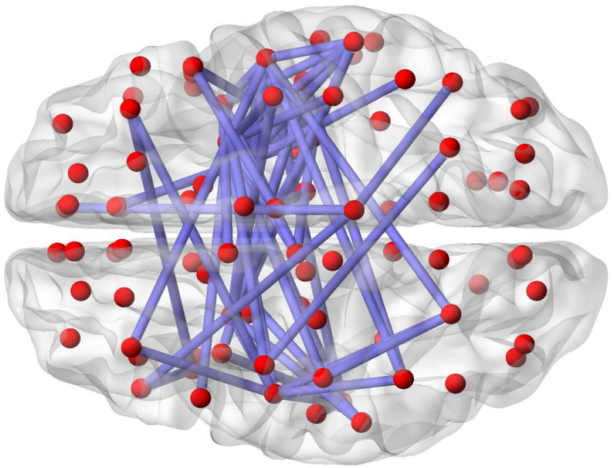


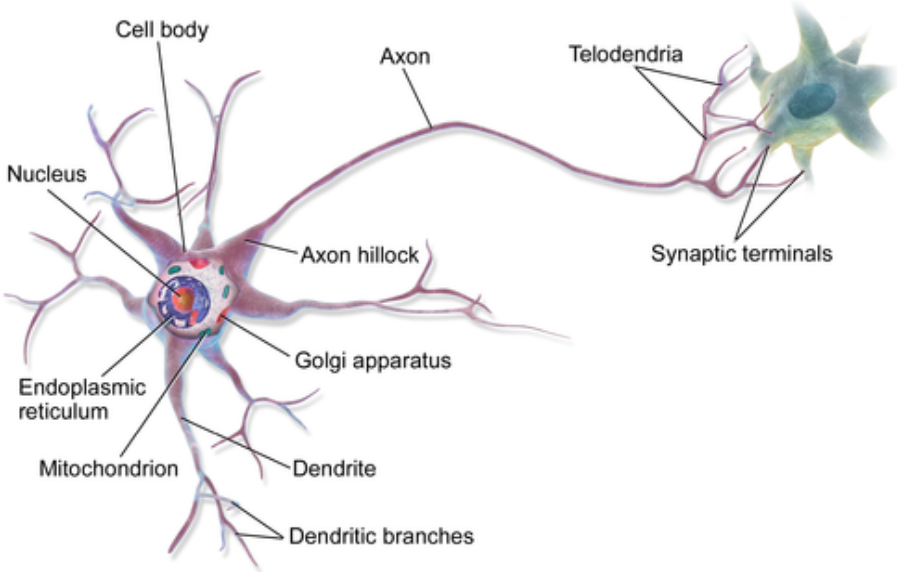
How can you visually recognize cars?

Similar visual feature from objects

Can computers also detect cars in a road as you do?

How does our brain work? Neural Network





**Source: An example of a neural network in a human brain and Anatomy of a multipolar Neuron,*
https://en.wikipedia.org/wiki/Biological_neural_network

Revisit - Linear Filters

filter result

0	0	0
0	1	0
0	0	0

Take a center pixel among neighbors

Identity

Revisit - Linear Filters

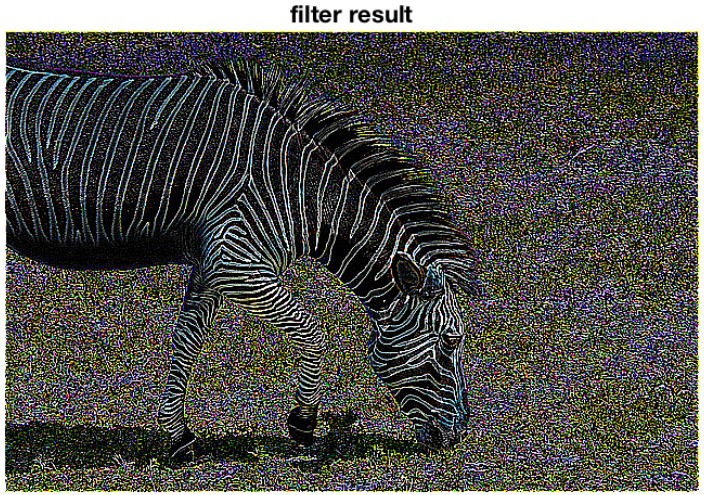
filter result

$$\frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

Take an average of neighbor pixels

Blur

Revisit - Linear Filters

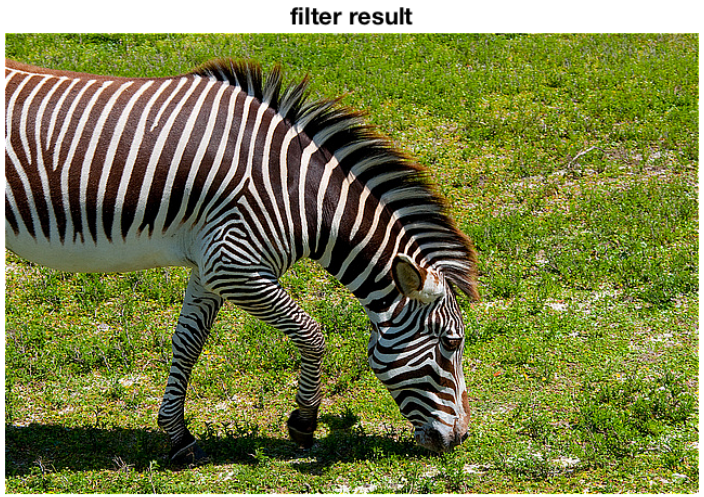


$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix} - \frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

Remove the impact of neighbor pixels

Outline

Revisit - Linear Filters

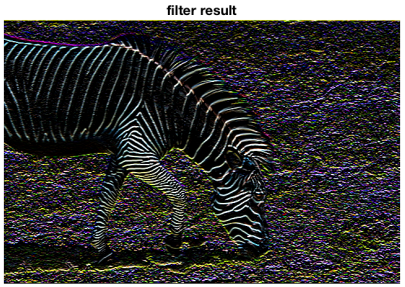


$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix} + \begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix} - \frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

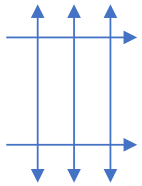
Fortify outline in an image

Sharpen

Revisit - Linear Filters

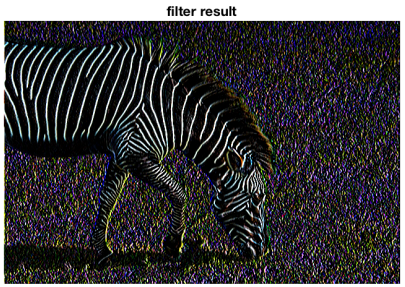


-1	-1	-1
0	0	0
1	1	1

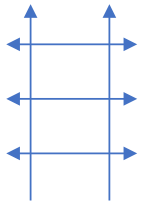


Find horizontal differences and averaging them equally

Horizontal Edges



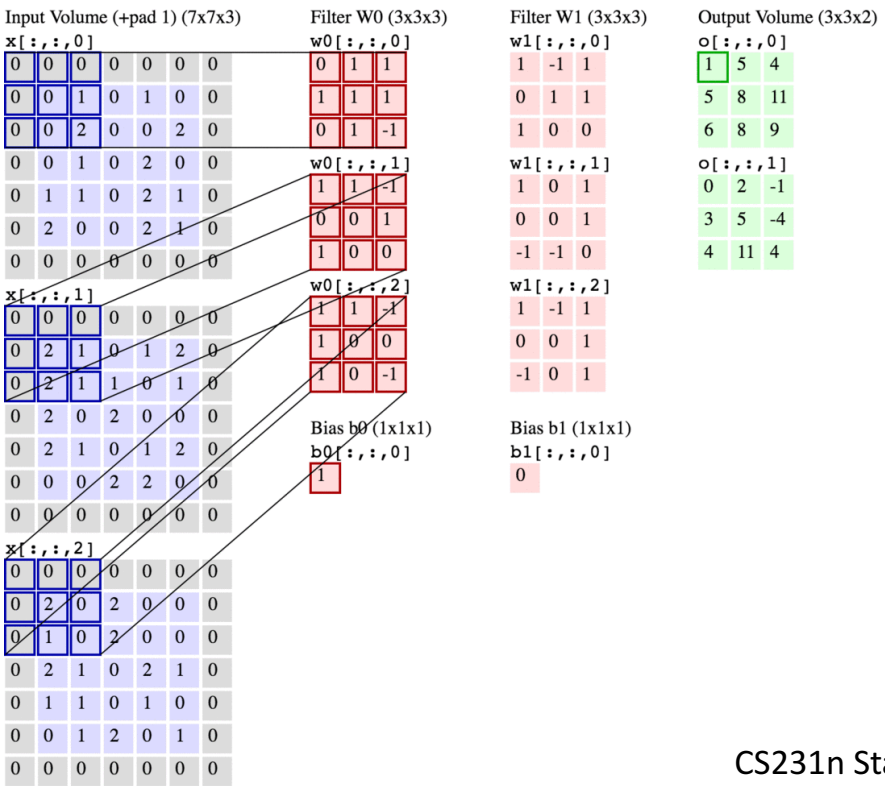
-1	0	1
-1	0	1
-1	0	1



Find vertical differences and averaging them equally

Vertical Edges

Mapping Convolution to Neurons



- We call operation of linear filters ***Convolution***

- What does it happen if we make a network of convolutions like our brain?

**Source: "The neurons from Neural Network"*
CS231n Stanford University, http://cs231n.github.io/convolutional-networks/

Introduction to Convolutional Neural Network

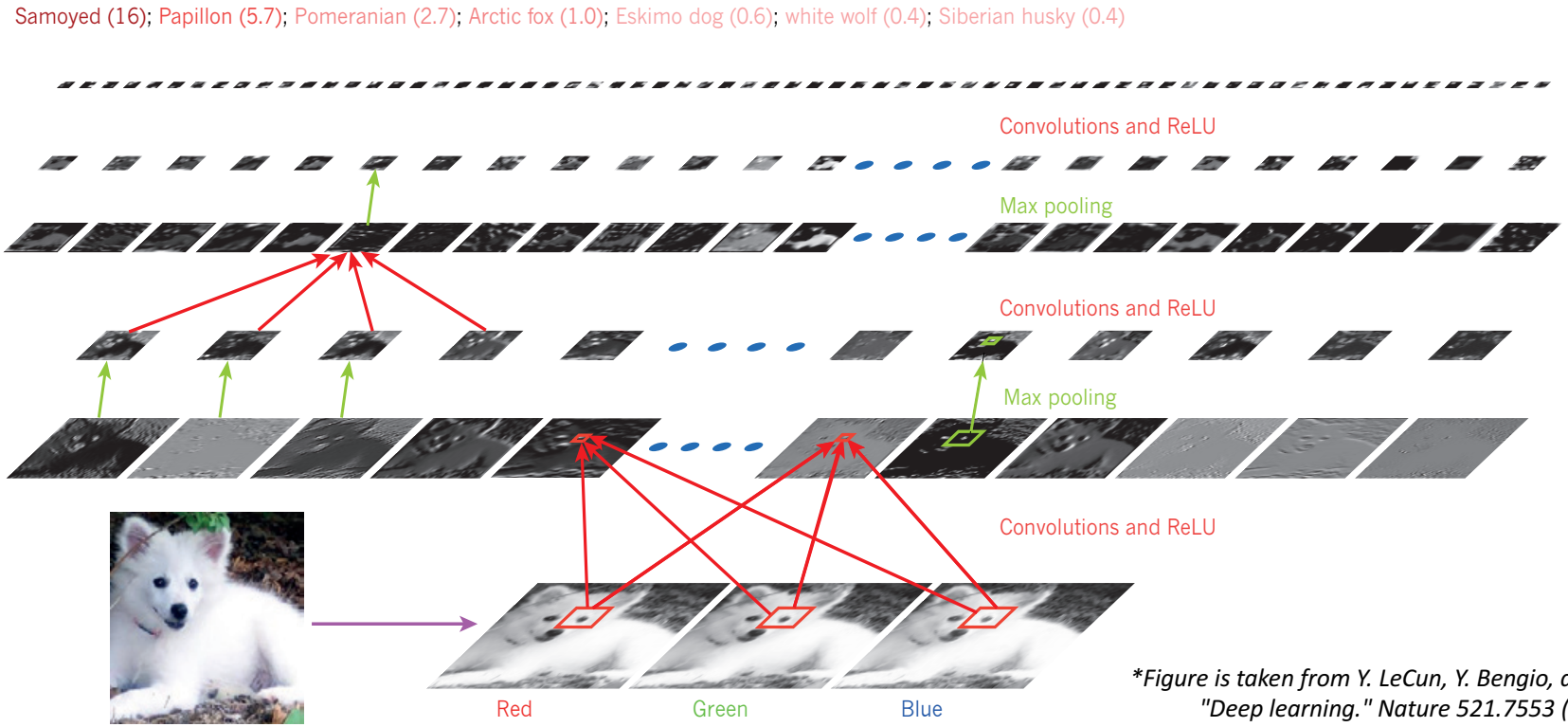


**Figure is taken from Y. LeCun, Y. Bengio, and G. E. Hinton. "Deep learning." Nature 521.7553 (2015): 436-444.*

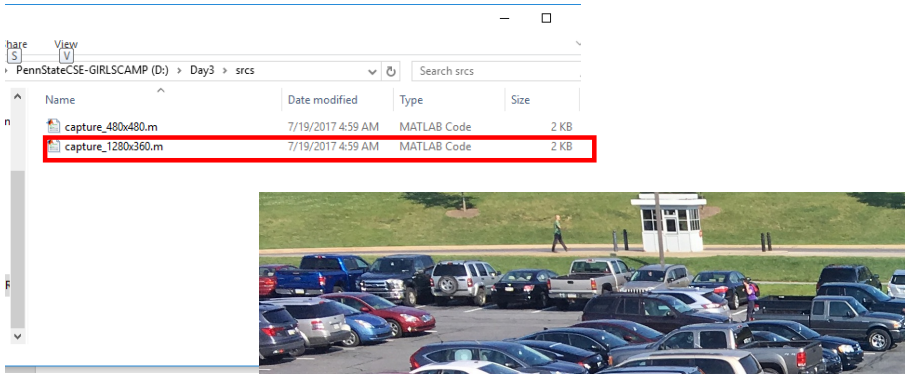
Activity – Testing Convolutional Neural Networks

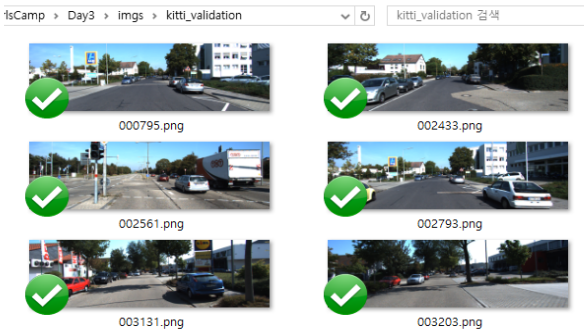
Activity – Testing Convolutional Neural Networks

1. Copy Day3 folder
2. Double-Click on the **Day3/srcs/capture_1280x360.m**
3. Run Matlab Program
4. Take a picture of cars at parking lot (an image file would be located at **Day3/srcs/img_1280x360.jpg**)

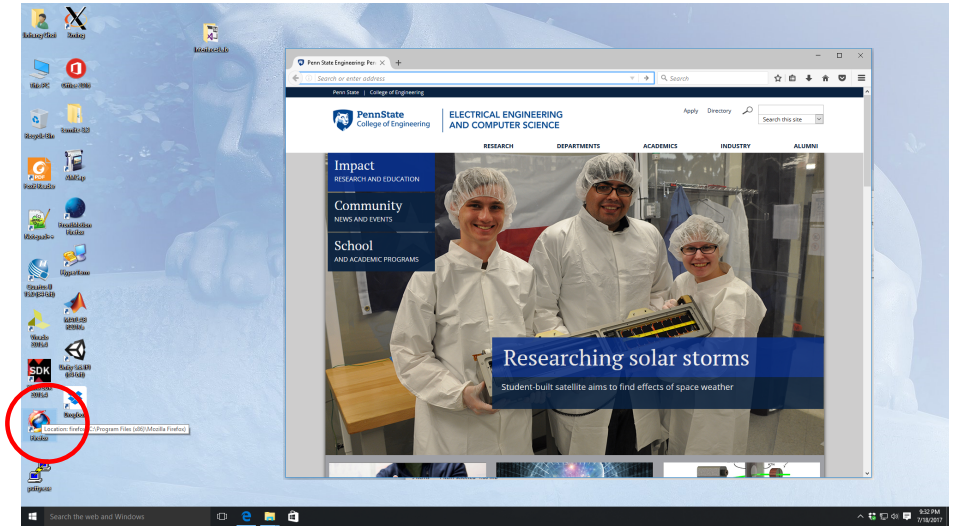
Or,

1. If it is not easy to take a picture, then you can use images in **Day3/imgs/kitti_validtation** folder

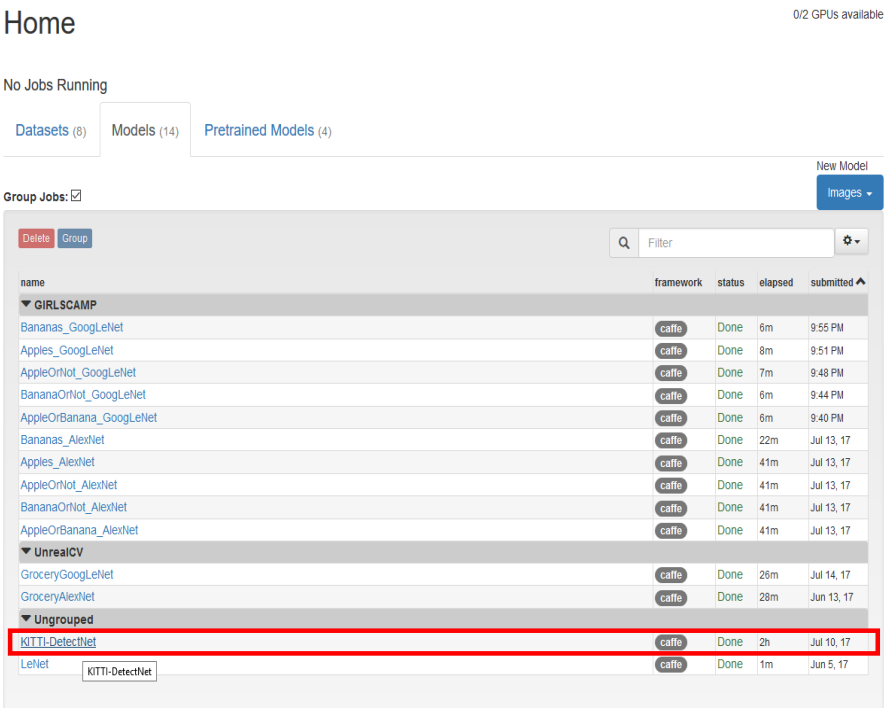




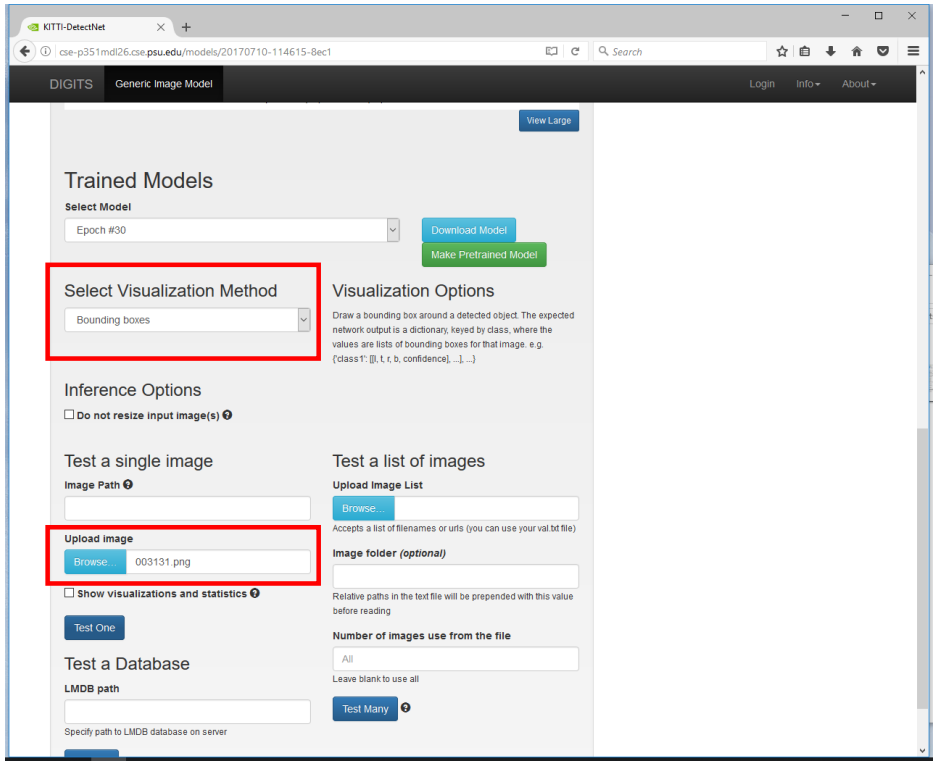
Activity – Testing Convolutional Neural Networks



1. Open Firefox browser
2. Go to PennState MDL Nvidia DIGITS server
3. Click on **KITTI-DetectNet**

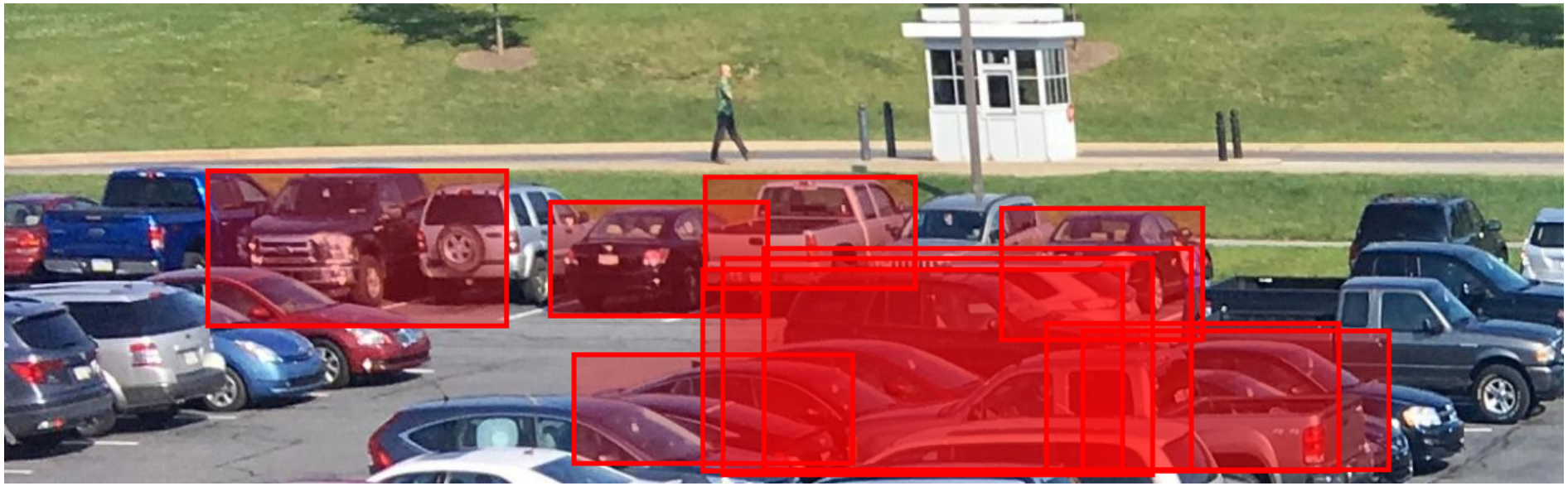


Activity – Testing Convolutional Neural Networks



1. Change Visualization Method to **Bounding boxes**
2. Click on **Browse** for selecting your image to be uploaded
3. Click on **Test One (it takes time)**

Activity – Testing Convolutional Neural Networks



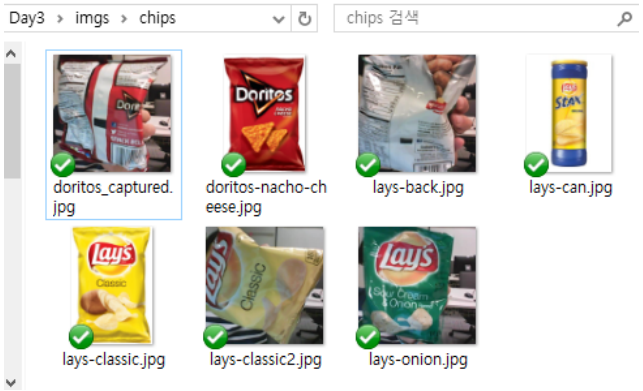
Does it work? Let’s test another example

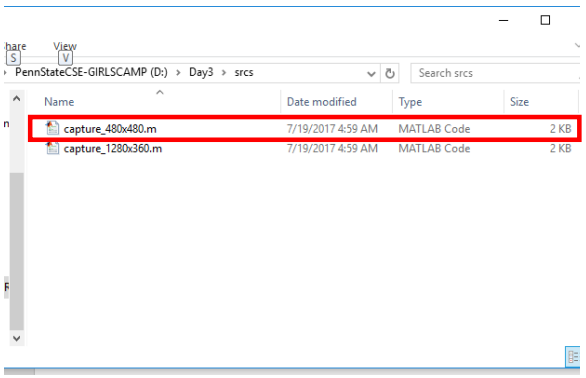
Activity – Testing Convolutional Neural Networks

1. You can use images in **Day3/imgs/chips** folder

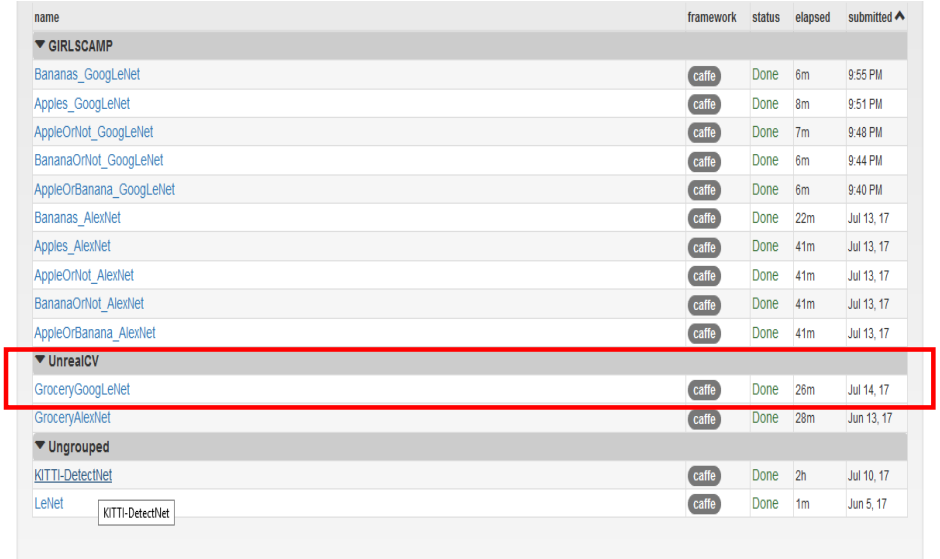
Or

1. Double-Click on the **Day3/srcs/capture_480x480.m**
2. Run Matlab Program
3. Take a picture of chips (an image file would be located at **Day3/srcs**)





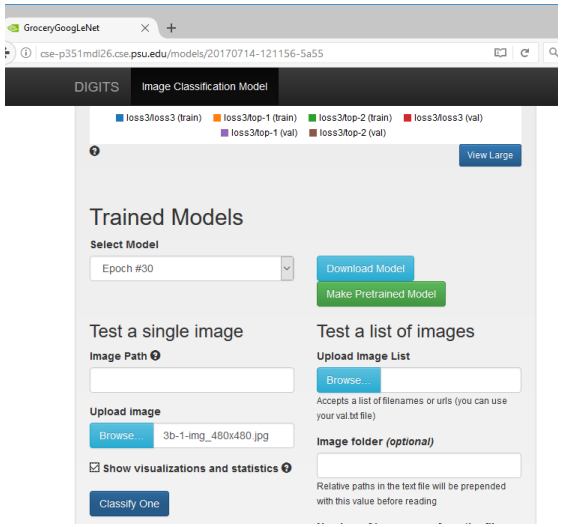
Activity – Testing Convolutional Neural Networks



name	framework	status	elapsed	submitted
▼ GIRLSCAMP				
Bananas_GoogLeNet	caffe	Done	6m	9:55 PM
Apples_GoogLeNet	caffe	Done	8m	9:51 PM
AppleOrNot_GoogLeNet	caffe	Done	7m	9:48 PM
BananaOrNot_GoogLeNet	caffe	Done	6m	9:44 PM
AppleOrBanana_GoogLeNet	caffe	Done	6m	9:40 PM
Bananas_AlexNet	caffe	Done	22m	Jul 13, 17
Apples_AlexNet	caffe	Done	41m	Jul 13, 17
AppleOrNot_AlexNet	caffe	Done	41m	Jul 13, 17
BananaOrNot_AlexNet	caffe	Done	41m	Jul 13, 17
AppleOrBanana_AlexNet	caffe	Done	41m	Jul 13, 17
▼ UnrealCV				
GroceryGoogLeNet	caffe	Done	26m	Jul 14, 17
GroceryAlexNet	caffe	Done	28m	Jun 13, 17
▼ Ungrouped				
KITTI-DetectNet	caffe	Done	2h	Jul 10, 17
LeNet	caffe	Done	1m	Jun 5, 17

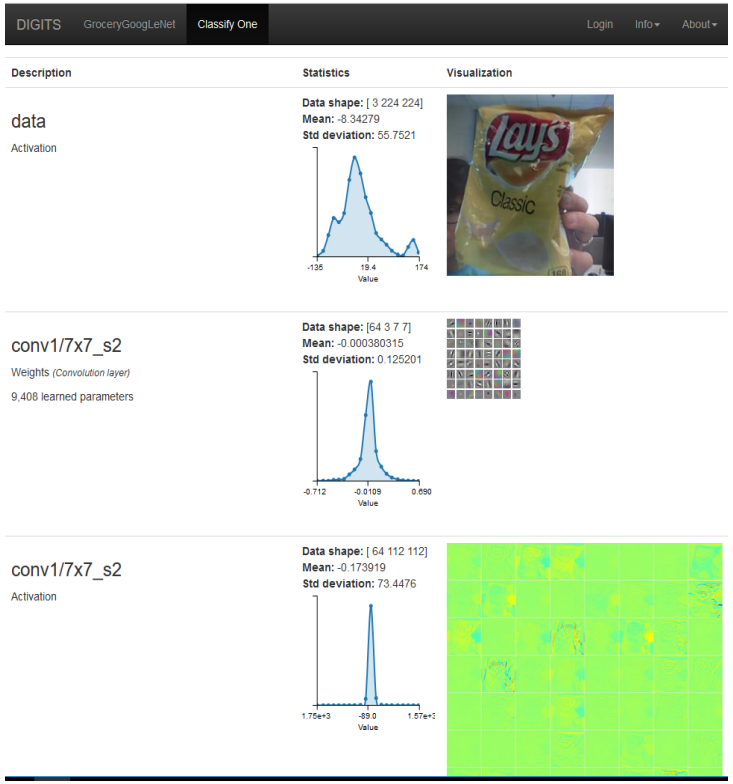
KITTI-DetectNet

1. Open Firefox browser
2. Go to PennState MDL Nvidia DIGITS server
3. Click on **GroceryGoogLeNet**



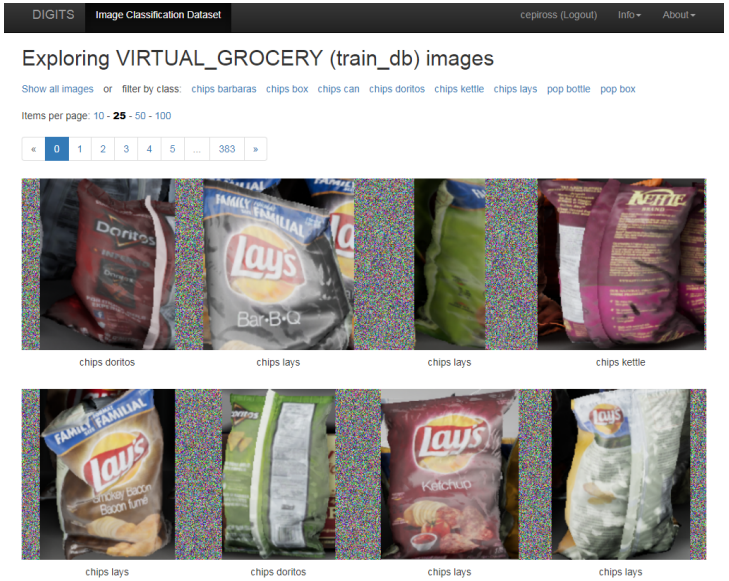
4. Click on **Browse** for selecting your image to be uploaded
5. Check Show visualization and statistics
6. Click on **Classify One (it takes time)**

Testing Convolutional Neural Networks - Recap



- Is it accurate?
- How long does it take to get a result?
- How many parameters do you need?
- Would you like to use this model for helping visually impaired person? If not, what are problems?

- How to create a CNN model?

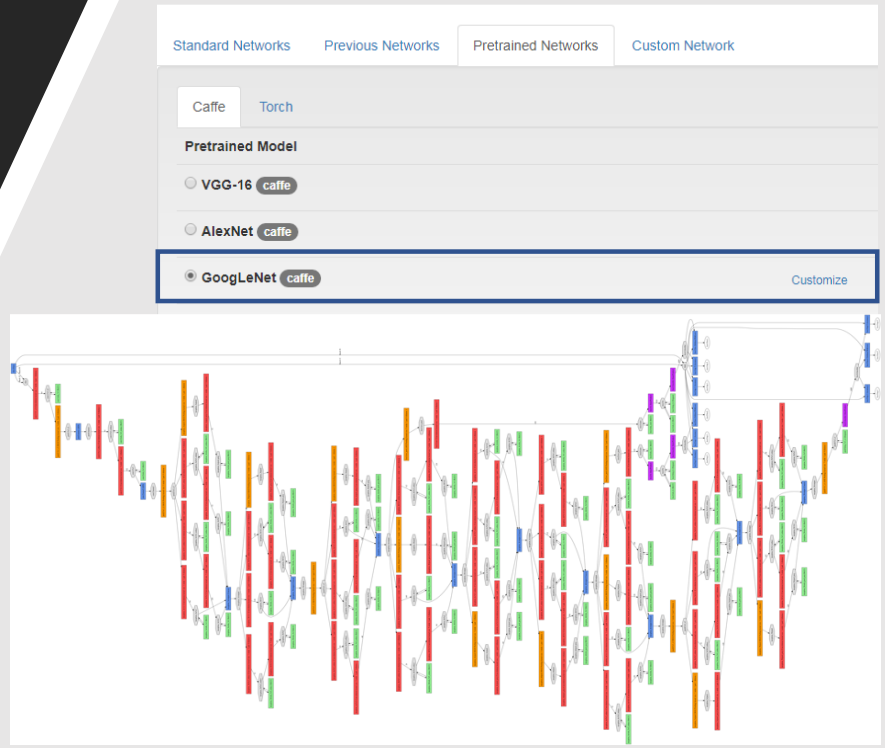


Supervised Deep Learning Step 1: Data preparation

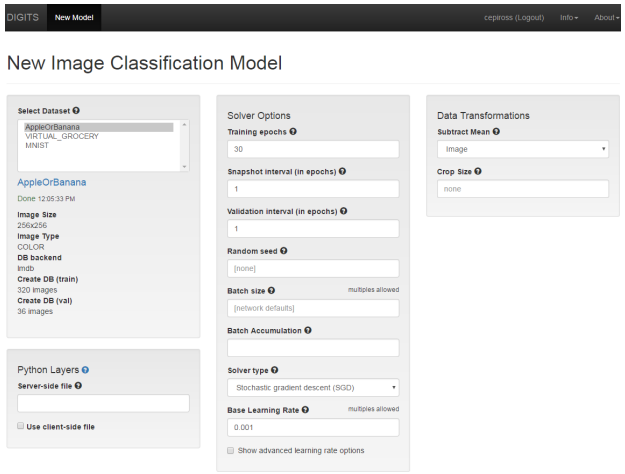
Prepare for enough images with their corresponding labels (annotation)

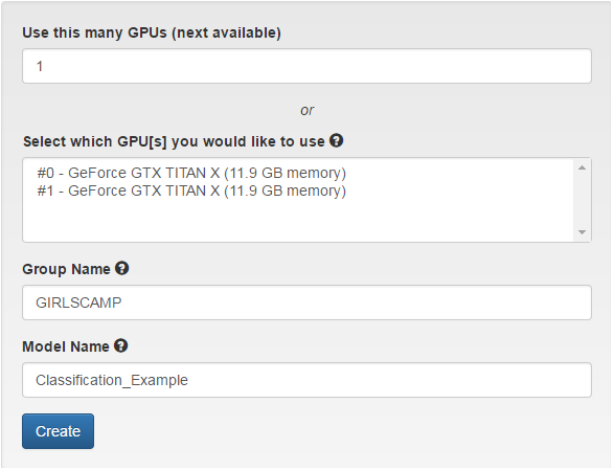
Supervised Deep Learning Step 2: Architectural Selection

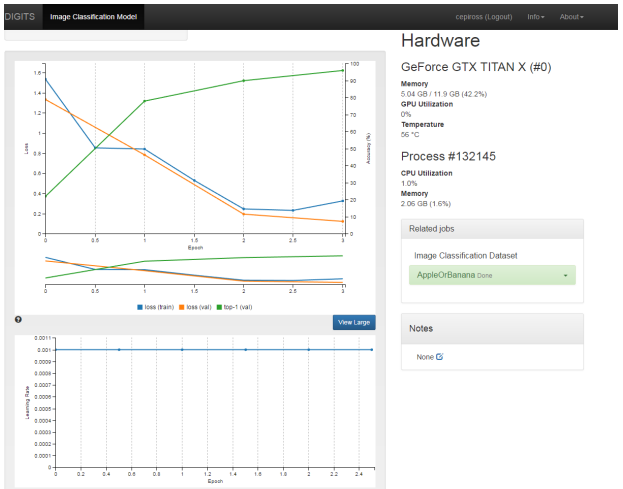
- We can borrow the existing CNN architecture's functionality
- In this example, *GoogLeNet* is customized for recognizing selected grocery items



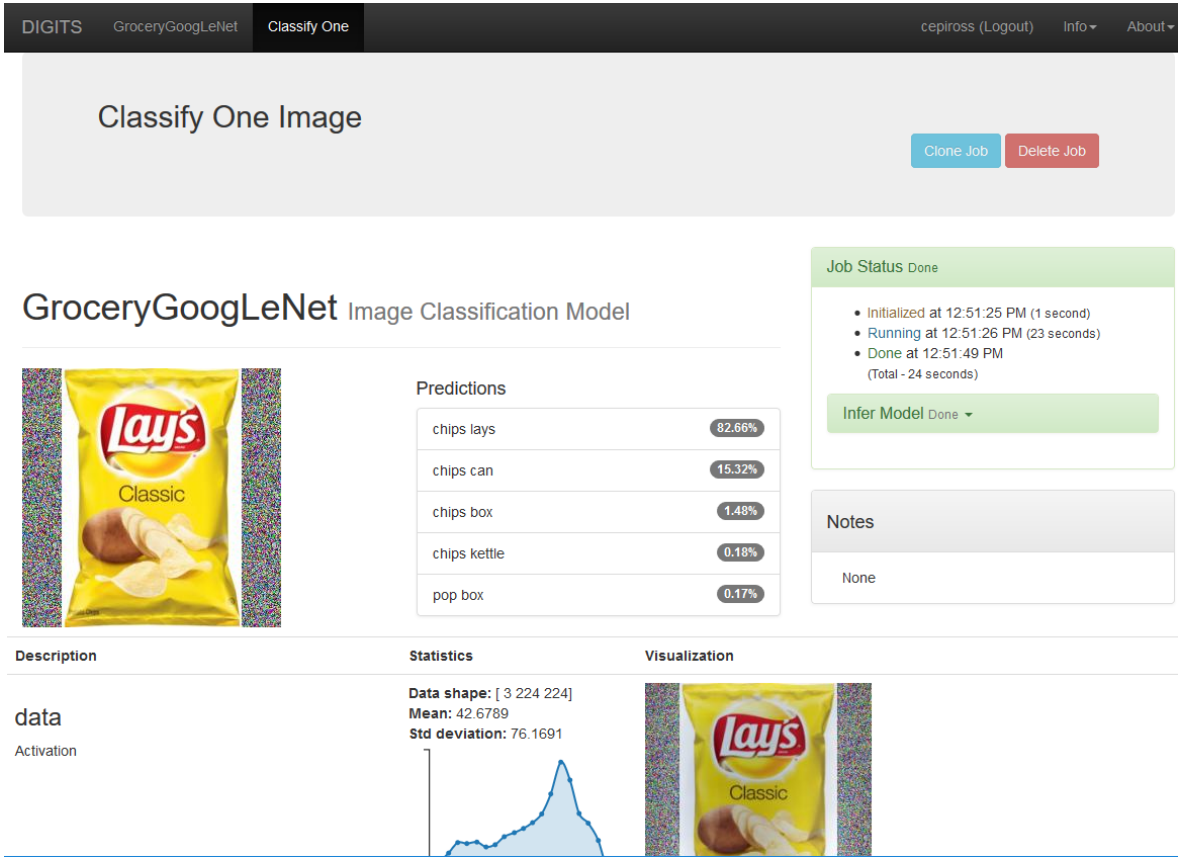
C. Szegedy, W. Liu, Y. Jian, *et al*. "Going Deeper with Convolutions," pp. 1–9. Proceedings of the 2015 IEEE Conference on Computer Vision and Pattern Recognition (CVPR)







Supervised Deep Learning Step 3: Training a Convolutional Neural Network

Supervised Deep Learning Step 4: Object Recognition Inference

Now you can test a trained model!