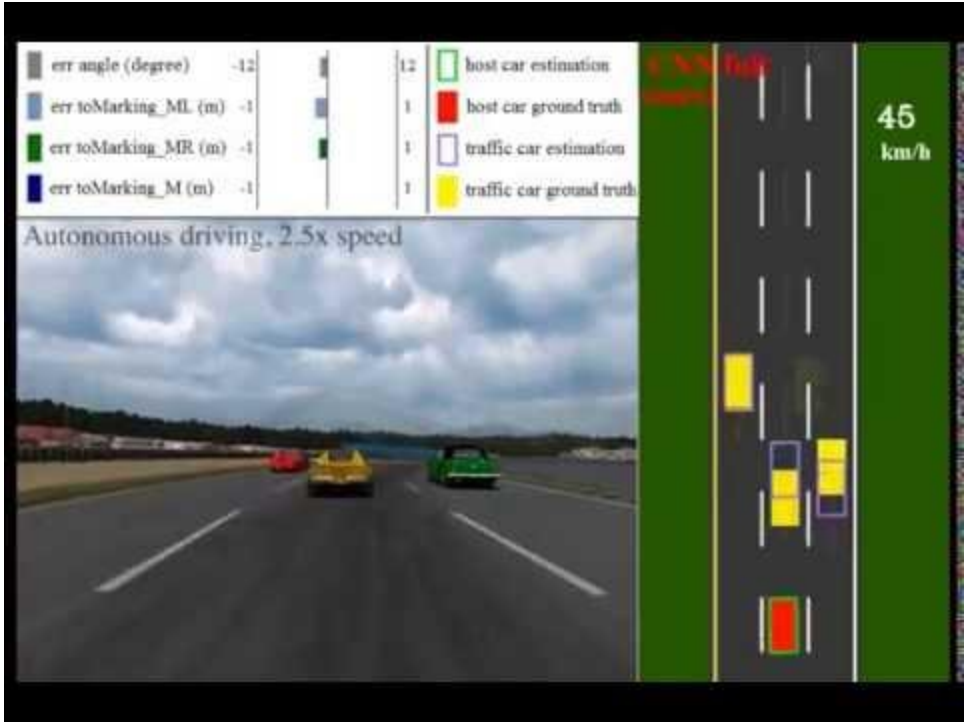
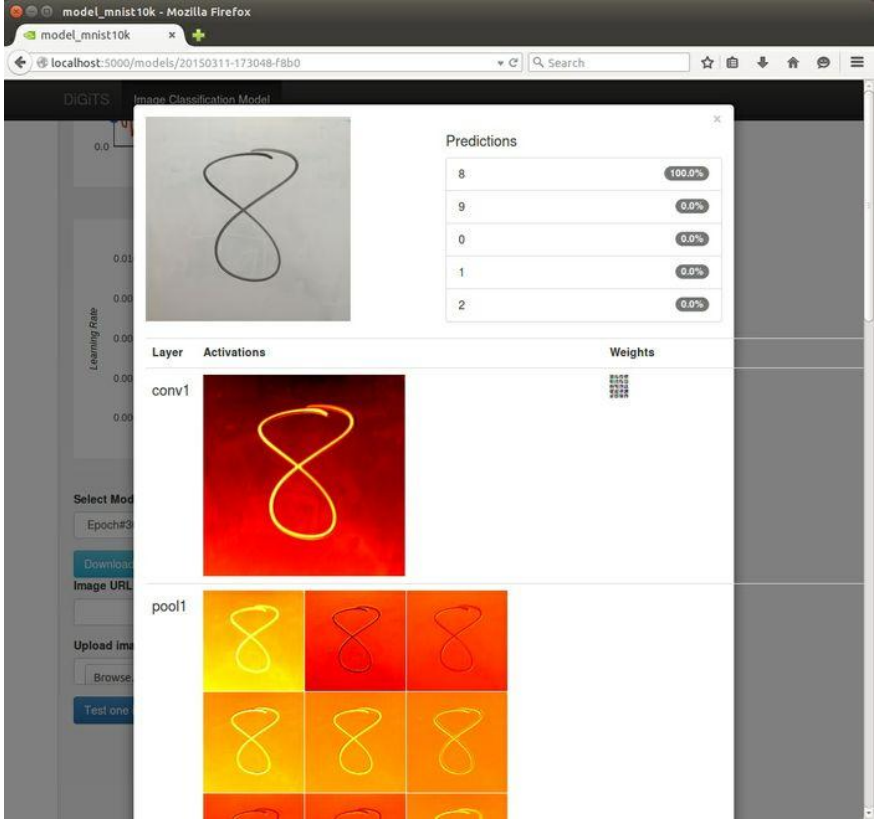
Machine Learning

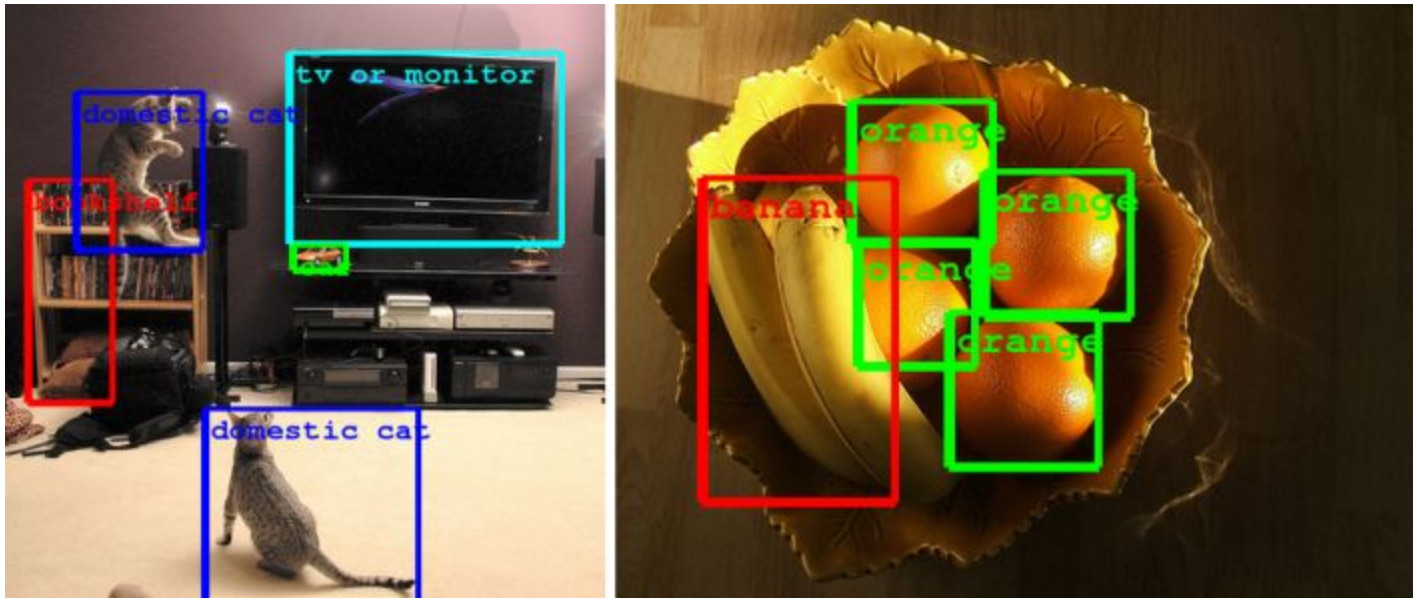
Your robot can understand what it sees


err angle (degree)
-12
12
err toMarking_ML (m)
-1
1
err toMarking_MR (m)
-1
1
err toMarking_M (m)
-1
1
host car estimation
host car ground truth
traffic car estimation
traffic car ground truth
Autonomous driving, 2.5x speed
45
km/h

Too hot: Pixel segmentation (too much for FRC, for now)



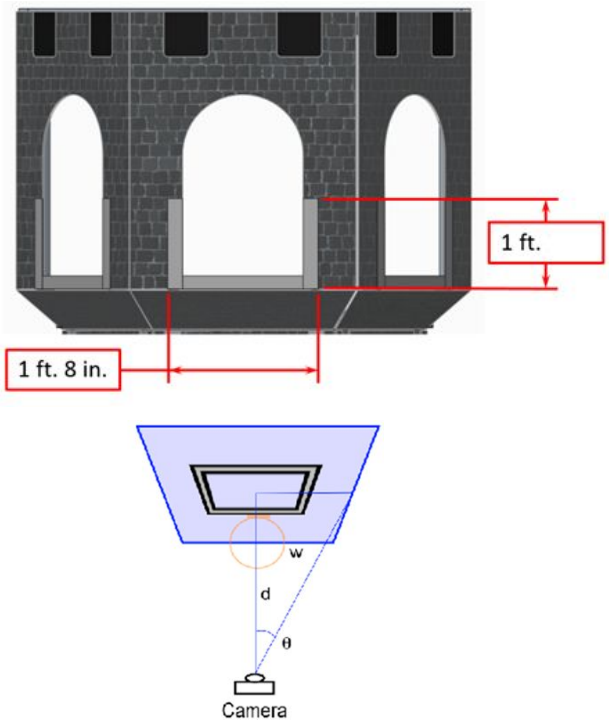
Too cold: identifying which category of object is in image



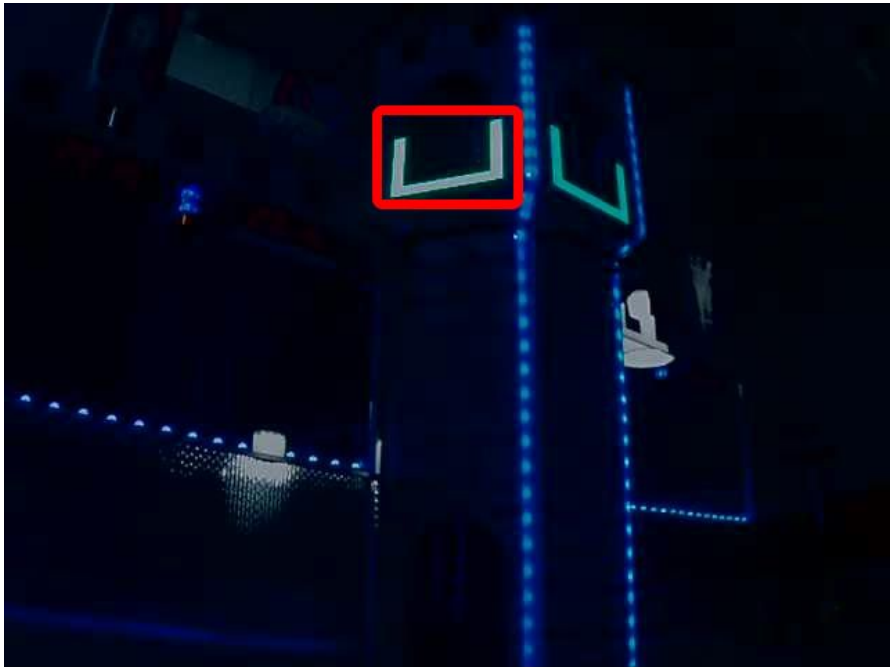
Just right: determine where in an image an object is

Machines can learn?

How would you mathematically define this U shape?



Geometry matters -- and why vision is tough to program, so why not let the machine solve the problem?

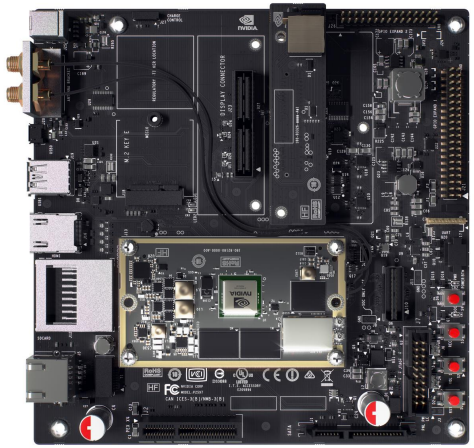


The Left U is very different than the right U.
You and I can tell both are targets. Can the machine?

Software tools

- NVIDIA CUDA / CUDNN
  Library for efficient math computation on GPUs
- NVIDIA DIGITS
  Webpage tool to train and test a neural network
- Caffe (NVIDIA fork)
  Neural network software that uses CUDA/CUDNN, and DIGITS runs for us with the correct settings
- NVIDIA TensorRT
  Software to run the neural network efficiently on the Jetson TX1
  Gets higher frame per second performance with other processor shortcuts

Hardware diagram



USB camera to either device, pro/cons with each.
Two cameras?

Robot Software flow

Show: Python, Camera, TensorRT, Python to networktables

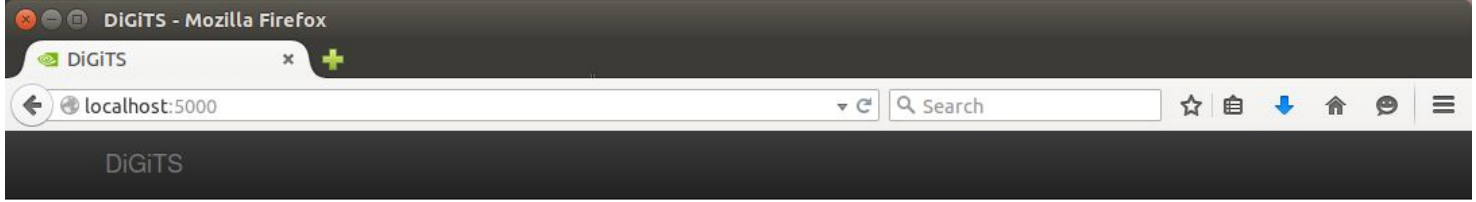
Gap

Then: C++ program on robot reads networktables values and moves robot

Building a neural network

You can train a neural network anywhere (go to your fastest computer). You can do this on your laptop with DIGITS and Caffe.

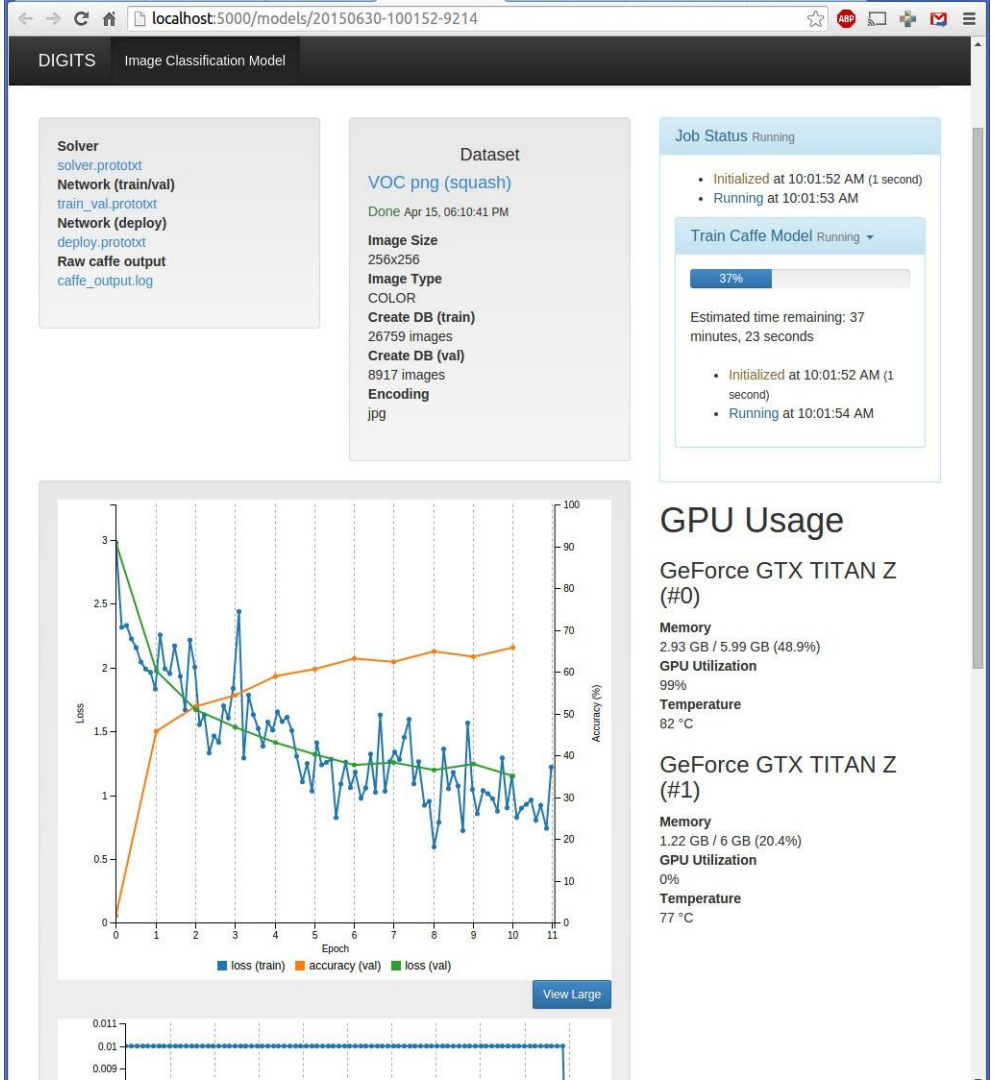
After you have a trained neural network, we then copy the file to the Jetson to run with TensorRT.

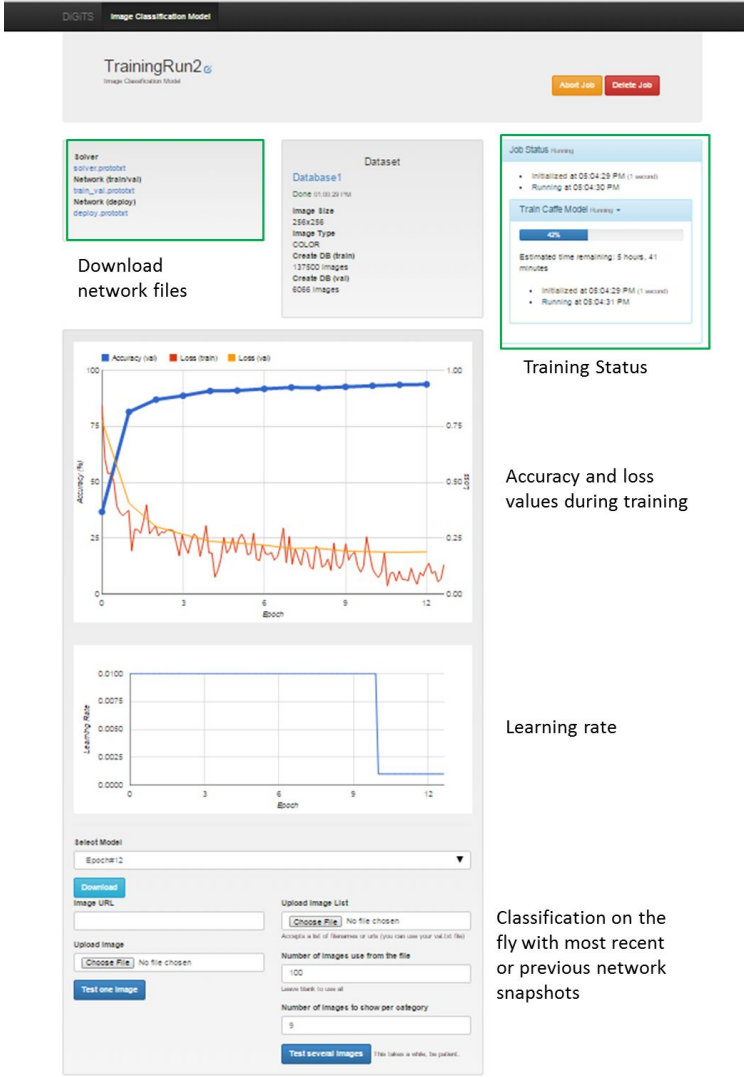


Datasets: large collection of example pictures of the target U shape.

Models: A neural network layout trained for a specific task in your dataset (find the U)

Accuracy close to 70% and only 37% finished training.





Download network files

Training Status

Accuracy and loss values during training

Learning rate

Classification on the fly with most recent or previous network snapshots

After training, this lower area lets you try out your NN with a new picture

How does one write in this “Python”?

Before we start...

- No main method/function (executes from the top down)
- No semicolons to end lines
- Use of classes is not necessary (as in Java)
- Variables do not require a type
- No use of brackets, imposes strict indentation requirements instead

A sample

```
def count_numbers(amount):
    num = 0
    while num <= amount:
        print('Number is ' + str(num))
        num += 1
    return True


if count_numbers(20):
    print('Number counting was successful')
```

Food for thought

- The names of the functions have underscores instead of camelCase
- Bools are capitalized
- There’s no increment by one (++) operator
- Variables do not have a type specifier