# Satellite Identification Imaging for Small Satellites using NVIDIA
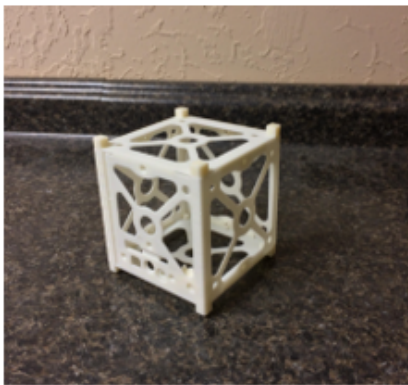
SmallSat Conference 2017
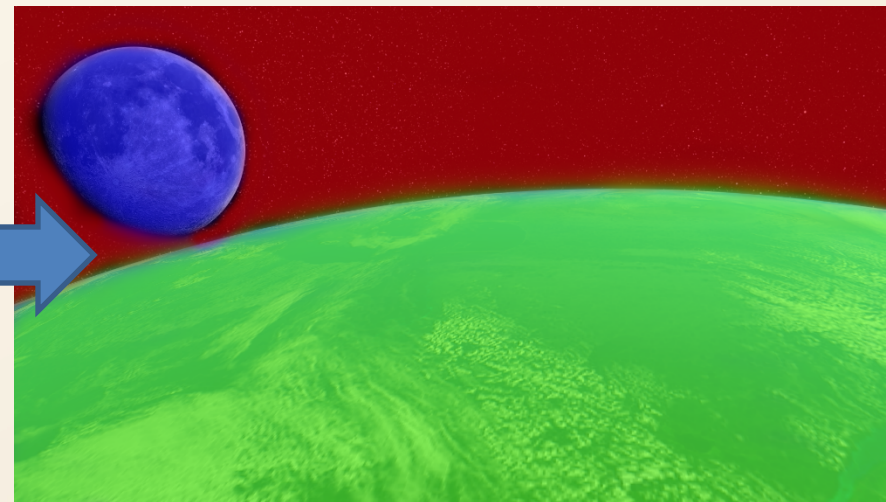
Brian Zufelt
Craig Kief
Nick Buonaiuto

# How to Get Started and Why do we care

- New capability brings new payloads

- Hardware and become cheap and easily accessible

- Software tools are free and easily available

# Machine Learning 101

- The "process flow"
  - Training of models
  - Validation of trained model
  - Deployment of model

- Types of models (popular types of open source models)
  - Classification
  - Regression

- Types of learning
  - Supervised
  - Unsupervised
  - Reinforcement learning



Predictions

| | |
|---|---|
| 1U CubeSat | 98.95% |
| fox | 0.99% |
| fish | 0.05% |

**Image Recognition**
Classification
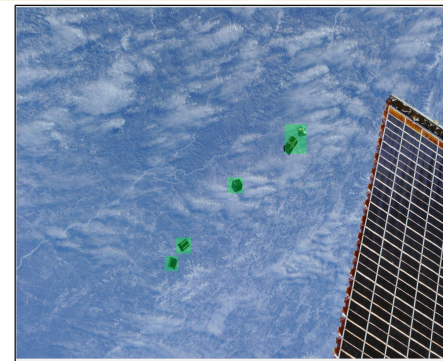
**Object Detection**
Localization
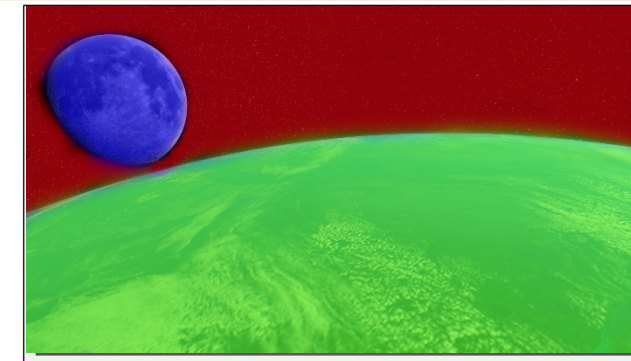
**Segmentation**
Free Space

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# Models, Datasets, Frameworks

- Datasets
  - Largely "grunt" work
  - Probably one of the hardest parts of ML is getting good DS
  - Open Source DS are available but not for CubeSats

- Models
  - Open Source pretrained models available (VGG-16, GoogleNet, etc.)

- Training and Validation
  - Test model (high end desktop with Nvidia GPU)
  - Train model (Amazon Web Services/AWS)

- Frameworks – Caffe, TensorFlow, Torch, etc.

IMAGENET

Caffe  torch  K

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# Deployment

- Once a model is trained, can be deployed on orbit

- Not deploying entire dataset

- Can be used to filter collected data to optimize download

- Hardware

  – Processing requirements reduced for running a trained model vs training the model

  – Nvidia TX1/TX2, Raspberry Pi, Android, Snapdragon, etc.

  – Optimized runtime environments via TensorRT and TensorFlow Lite
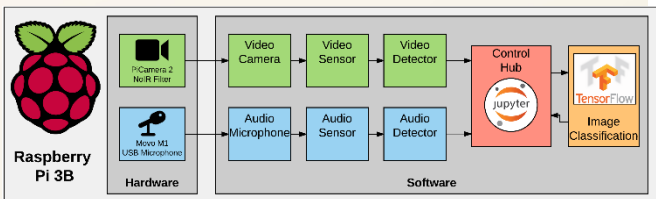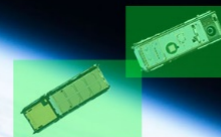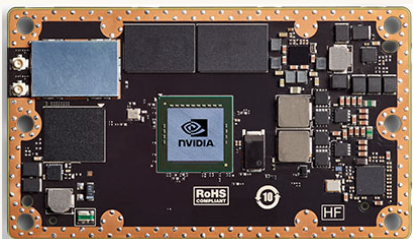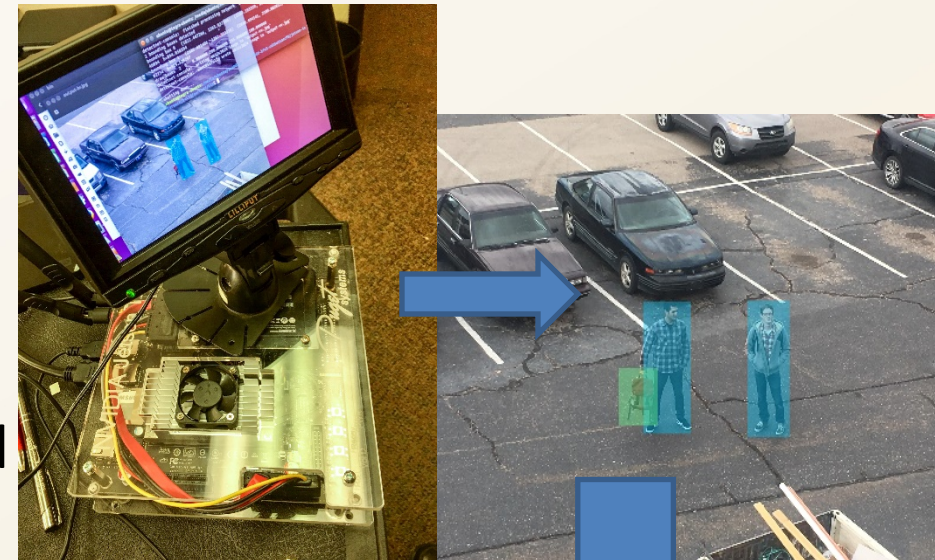
# Work to be done

- How do I quickly identify that it is a satellite and what it is doing

- Need great library of images that are properly formatted for training – Amazon Mechanical Turk

- Radiation testing of hardware for survivability and understanding of SEE on models and NNs

- Community involvement

- All we need is time, and money, all other problems can be solved