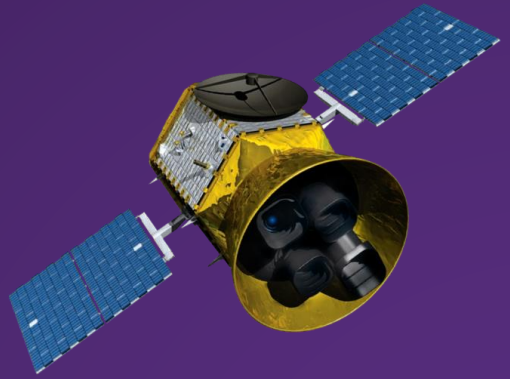
SAR Segmentation

Lens Desrouleaux



The Problem

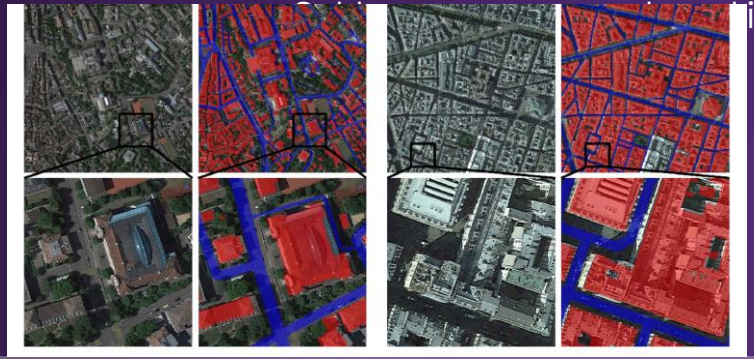
- Synthetic Aperture Radar satellites allow the military to perform surveillance
- Incoming images are hard for people to interpret
- Labeling images takes a long time and a lot of training
- For hard examples an expert needs to be ringed in to make sense of an image

The Company

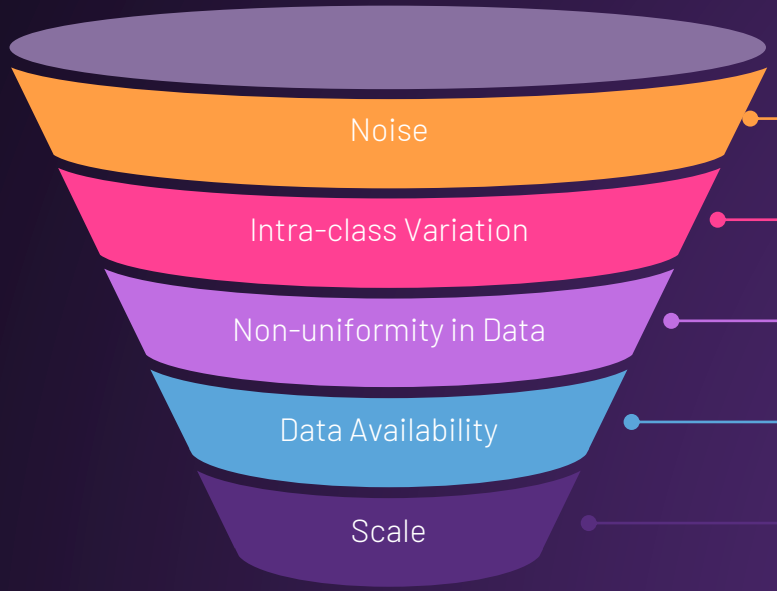
- A growing defense startup focused on developing military software and AI
- Main missions are in Cybersecurity and AI
- About ~200 employees

The Solution

- Create automatic SAR labelling software
- Robust and accurate models
- Minimal misclassifications
- Would need to be lightweight
- [illegible] internally



Obstacles to Overcome



- The nature of radar introduces a lot of extraneous information
- High variance between within target classes
- Every SAR vendor processes data in their own unique way
- There are limited datasets available
- Satellite imagery is large in scale scores of terabytes

The Team and My Role

- One GIS data engineer to process and analyze data
- One ML Engineer

Model Evaluation

- Evaluated a model architectures

Pipeline Development

- Make changes to data pipeline to make data easier to use

Model Improvement

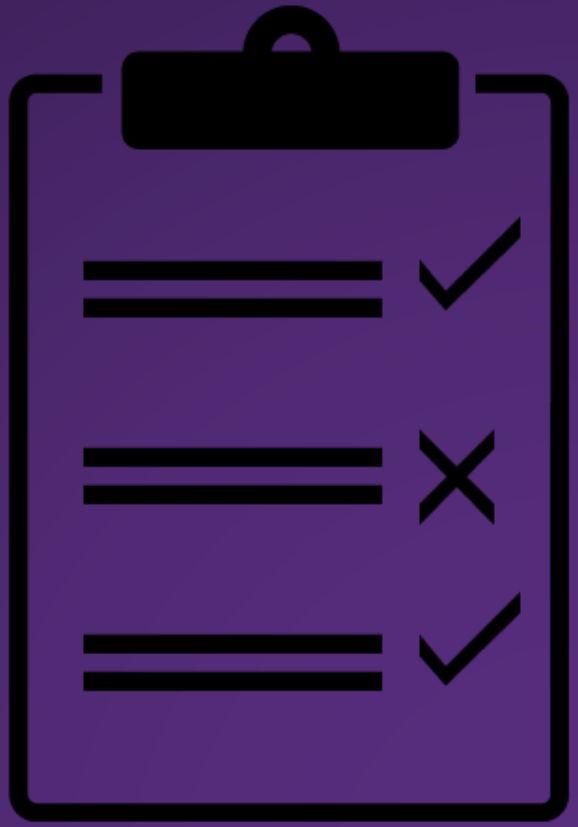
- Research and implement deep learning techniques to improve model performance

Toolset

- Python
  - NumPy
  - Tensorflow
  - Albumentations
  - Gdal
  - networkx,Igraph,Cugraph
  - Tifffile
- Docker
- Terraform

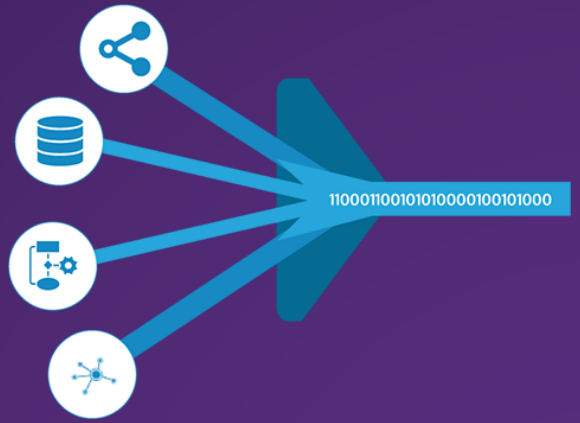
Model Evaluation

- Creating a data split for training, testing
- Deciding upon an evaluation criteria
- Testing architectures
- Selecting best performers to be used in later experiments



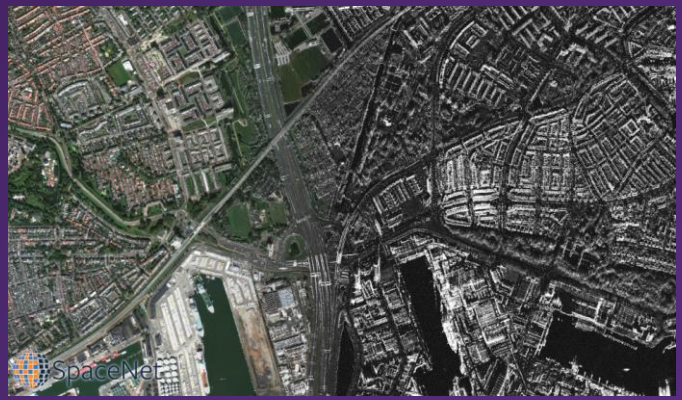
Pipeline Development

- Utilizing Albumentations library to augment data
- Selecting which augmentations would be useful
- Reduced overfitting and improved performance on test dataset



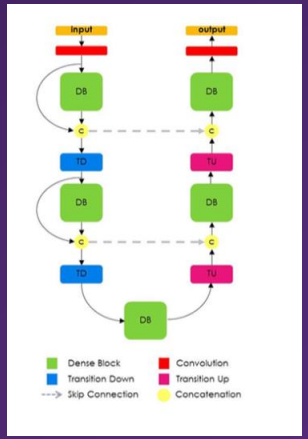
Transfer Learning

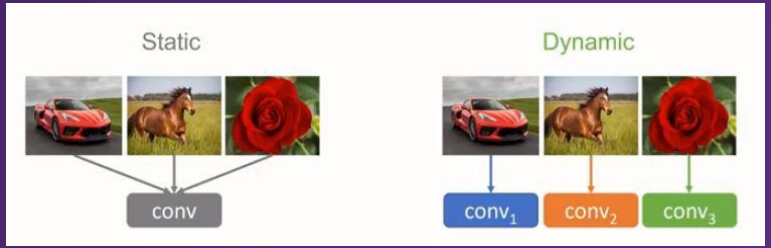
- Researched publicly available aerial datasets
- Selected a Kaggle competition dataset
- Molded the data to fit with our parameters
- Noticeable improvement on convergence times



Model Improvement

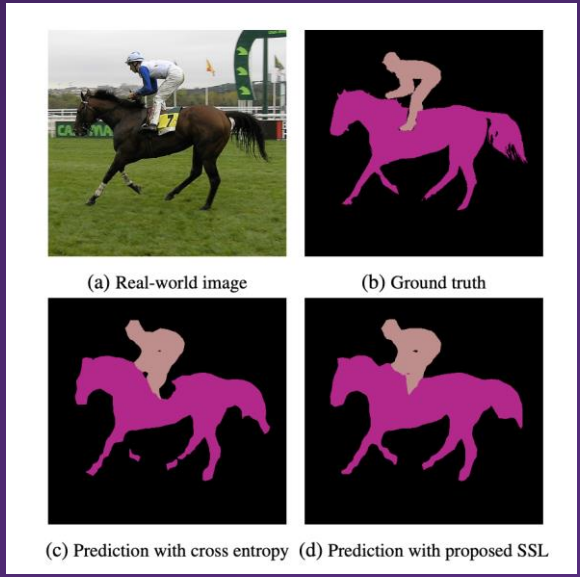
- Architectures
  - Researched and implemented several unique state of the art architectures
  - Tiramisu
  - Dynamic Convolution





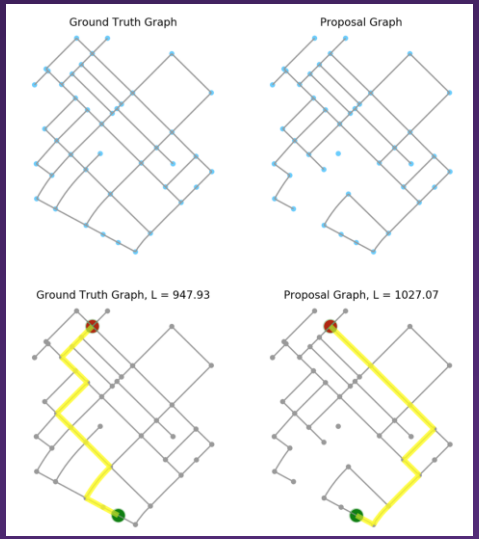
Model Improvement

- Structural Similarity Loss
  - Implemented this unique loss function to improve road segmentation
  - Ultimately used to improve segmentation of buildings



Model Improvement

- Graph Derived Losses
  - Created several loss functions based on graph connectivity
  - Yielded no positive results

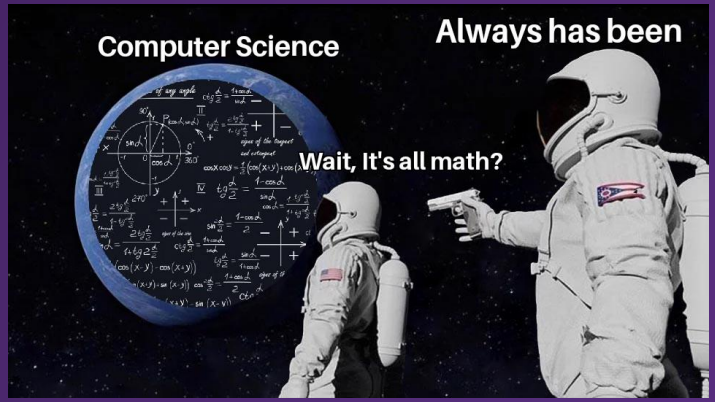


What I Learned

- How to read, understand, and implement research papers
- Data Augmentation
- Data pipeline modification
- Tensorflow
- Terraform

How Salisbury Helped

- Development and presentations in Software Engineering
- Machine learning project in COSC 320
- Machine learning project in COSC 370
- Linear Algebra
- Dr. Anderson



Sources and Questions

- Segmentation Image
- Opening Satellite
- Aerial SAR transition
- Data Pipeline Image
- Graph derived loss images
- Structural Similarity Loss for Semantic Segmentation
- Satellite Gif
- Its all math meme
- Nvidia Tiramisu , Tiramisu Paper