"Natural Disaster damage assessment using Image Segmentation by Deep Learning"

Background

- Work done in this field so far
  - Mapping of built environment. Buildings, roads, and critical infrastructure are done with traditional image processing algorithms in the past. But these lack accuracy at pixel level.
- Possible Shortcomings/Challenges
  - Deep learning based semantic Image Segmentation algorithms improves the accuracy at pixel level. This requires large amount of training datasets and high computing power.

Problem statement

- As urban populations grow, more people are exposed to the benefits and hazards of city life.
- One challenge for cities is managing the risk of disasters in a constantly changing built environment.
- Buildings, roads, and critical infrastructure need to be mapped frequently, accurately, and in enough detail to represent assets important to every community.
- Knowing where and how assets are vulnerable to damage or disruption by natural hazards is key to disaster risk management

Dataset and features

- Dataset and size - Aerial Image Segmentation Dataset(80 images) Open Cities AI Challenge Dataset(80GB Testing+Training) Inria Aerial Image Labeling(810 sq km land area)
- The images are stored as large Cloud Optimized GeoTiffs (COG). Spatial resolution varies from region to region. All images include 4 bands: red, green, blue and alpha. The alpha band can be used to mask out NoData values.

Project requirements

- The technologies - Deep learning
- Platforms - Tensorflow
- Languages - Python
- Software Engineering methodologies - U-Net Semantic Image Segmentation
- Data requirements - SpatioTemporal Asset Catalog (STAC)

Design approach

Using the base U-net architecture model we have tweaked it to obtain better accuracy in image segmentation.

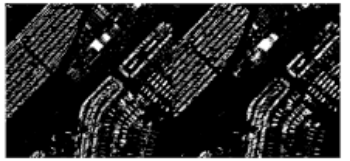
- CLAHE (Contrast Limited Adaptive Histogram Equalization to obtain the enhanced image for better pixel-level segmentation)
- ELU activation
- he_normal kernel initializer for initial weights which suited best for elu activation
- sigmoid activation for in final convolution
- adam optimizer and binary cross entroy for loss was used
- 2 convolutions was performed at each height
- The model performed best after 12 epochs

Results

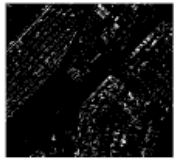
- The images before and after the disaster was segmented accurately and the percentage of damage was shown.
- One example is given below:
  on the left is before disater and on the right is after disaster

Input image

Enhanced image



Segmented image



Damaged region
Difference of segmented images before and after disaster

Conclusion

We presented a Siam-U-Net-Attn model with self-attention for building segmentation and damage scale classification in satellite imagery.

The proposed technique compares pairs of images captured before and after disasters to produce segmentation masks that indicate damage scale classifications and building locations. Results show that the proposed model accomplishes both damage classification and building segmentation more accurately than other approaches with the xView2 dataset. We use the self-attention module to enhance damage scale classification by considering information from the entire image.

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