

Finding Tents and Other Emergency Housing Through Exploitation of Satellite Imagery

Damage from January, 2020 Earthquakes, Puerto Rico



<https://www.nytimes.com/2020/01/07/us/why-puerto-rico-earthquake.html>

Damage from January, 2020 Earthquakes, Puerto Rico



<https://www.npr.org/2020/01/07/794176844/deadly-6-4-magnitude-quake-rocks-residents-awake-in-puerto-rico>

Damage from January, 2020 Earthquakes, Puerto Rico



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Damage from January, 2020 Earthquakes, Puerto Rico



<https://www.forbes.com/sites/ericmack/2020/01/06/magnitude-58-puerto-rico-earthquake-destroys-famous-landmark/#2acc26ad48e1>

An estimated 2,000 people were displaced

Informal shelters after Jan. 2020 Earthquakes in Puerto Rico



<https://www.centralillinoisproud.com/news/world/puerto-ricans-settle-in-quake-shelters-refuse-to-go-home/>

<https://www.directrelief.org/2020/01/puerto-rico-reels-from-latest-earthquake-medical-care-reaches-evacuees/>

Informal shelters after Jan. 2020 Earthquakes in Puerto Rico



<https://www.directrelief.org/2020/02/as-quakes-rocked-puerto-rico-ipromptu-communities-formed/>

Informal shelters after Jan. 2020 Earthquakes in Puerto Rico



By maryamarce - Own work, CC BY-SA 4.0, <https://commons.wikimedia.org/w/index.php?curid=86476972>

Can an app be created using satellite imagery with computer vision solve this problem?



Google Earth Satellite Imagery - Location of recent earthquakes $18^{\circ} 0'39.55"N, 66^{\circ}38'26.54"W$

Proposed Solution

Gather satellite imagery

Find areas with damage
(MODEL)

Gather satellite imagery

Detect shelters
(MODEL)

Gather satellite images of the disaster area.

Find areas which have damaged structures using the satellite images.

Gather high res satellite images of “before and after disaster” for the areas surrounding the damage.

Images which have new structures/tents after the disaster, which weren’t present before the disaster should be marked as encampments.

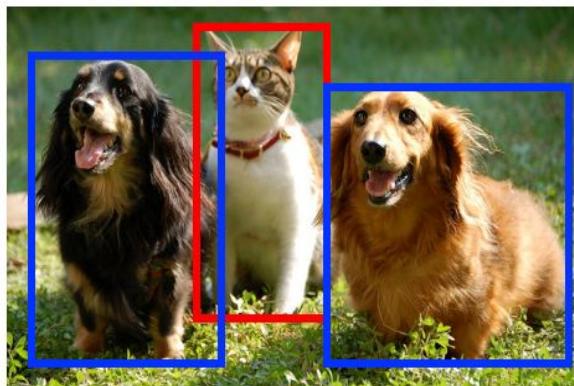
Types of image recognition

Classification



CAT

Object Detection



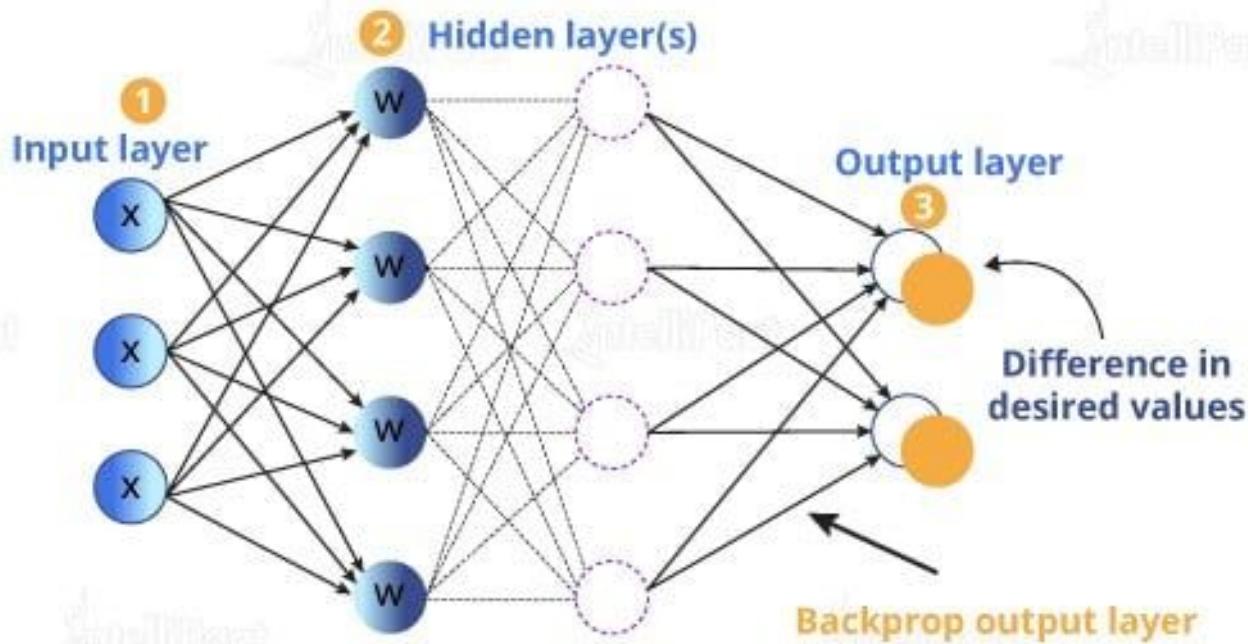
CAT, DOG

Instance Segmentation



CAT, DOG

NEURAL NETWORK



CONVOLUTIONAL NEURAL NETWORKS

- CNNs have proven very effective in image recognition.
- Hidden Layers in CNN:
 - First layers: Basic feature detection filters: edges, corners.
 - Middle layers: Detect parts of objects. For faces, they might learn eyes, noses, etc
 - Last layers: Learn to recognize full objects, in different shapes and positions.

Classification: Satellite Imagery of Hurricane Harvey

- Divided into two classes: ‘**DAMAGE**’ and ‘**NO DAMAGE**’
- Training data: 5000 images of each class
- Validation data: 1000 images of each class
- Testing data : 1000 images of each class

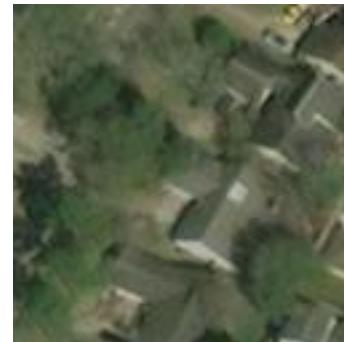
Classification of Images(CNN)



DAMAGE

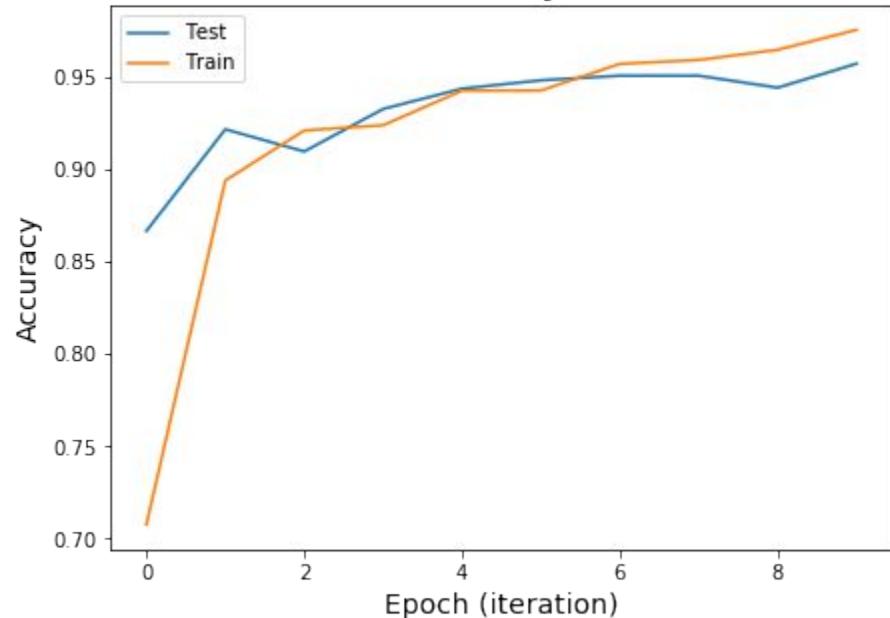


NO DAMAGE

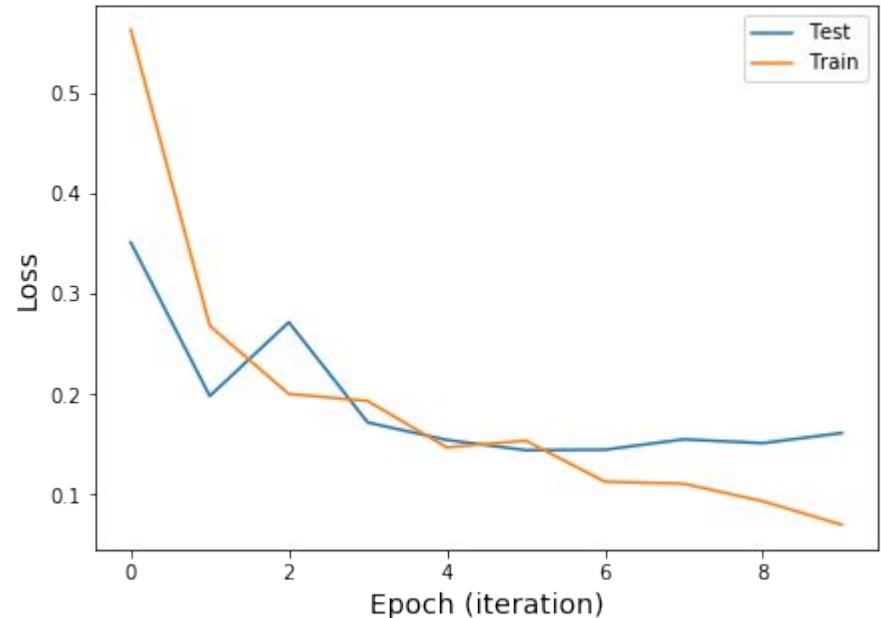


CNN Model

CNN Accuracy Results

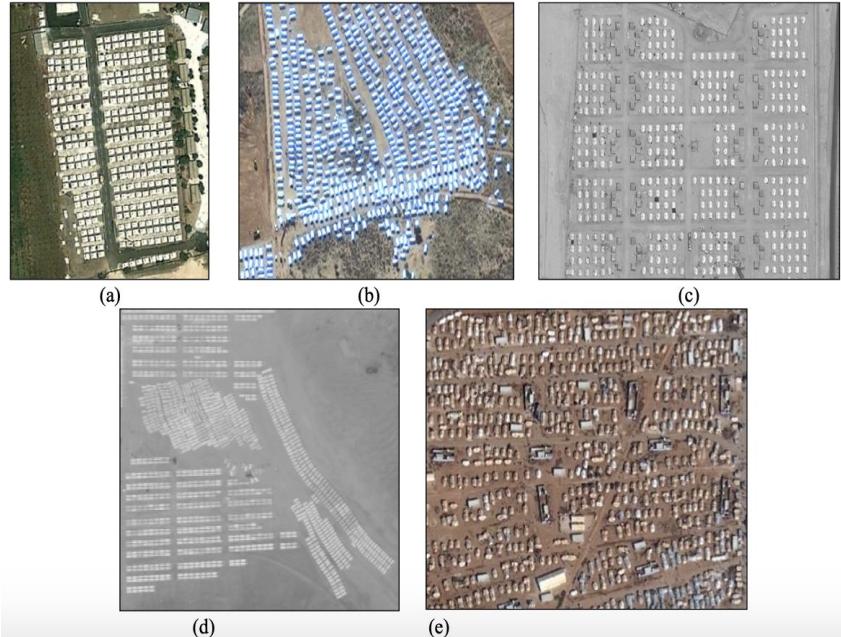


CNN Loss Results



Next steps: Locating Encampments

- CNN detection model to locate new shelters.
- Also output total tent area, so growth can be detected.
- Segmentation can be used to account for size, and changing nature of encampments
- Pre-train models for various regions, which can be used immediately after a disaster.



Example of project for refugee tent detection

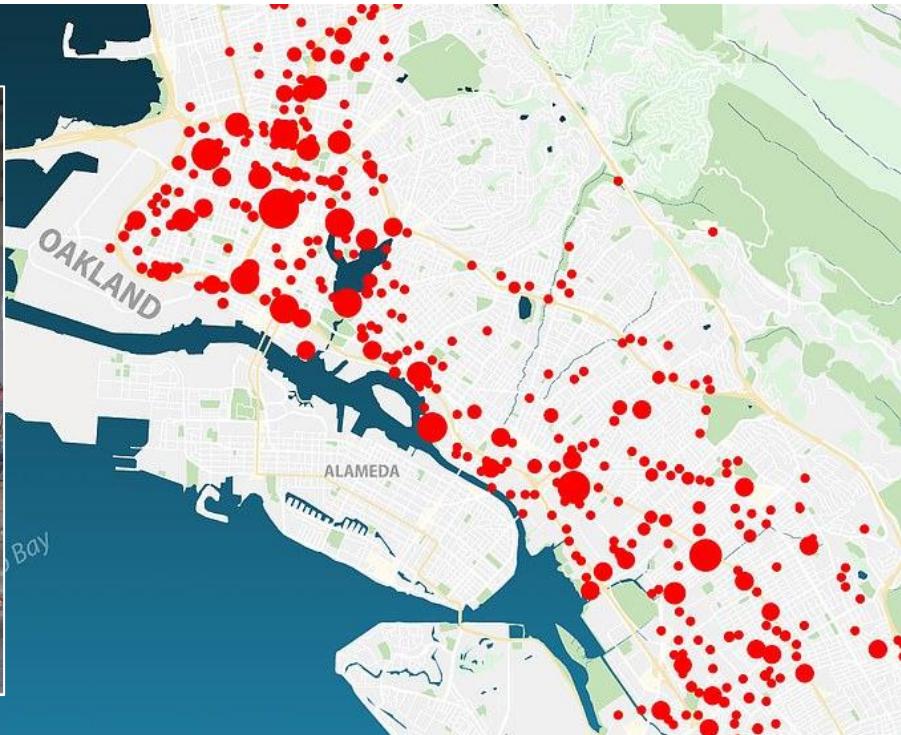
Next steps

Get or produce a dataset of geo-locations labelled as either containing informal shelters or not.

Homeless Encampments as an Analogous Data Source



SOURCE: ArcGIS World Geocoding Service



<https://www.eastbayexpress.com/SevenDays/archives/2015/12/30/berkeley-researchers-oaklands-homeless-camp-policies-are-contradictory-harmful>

Other Analogous Data

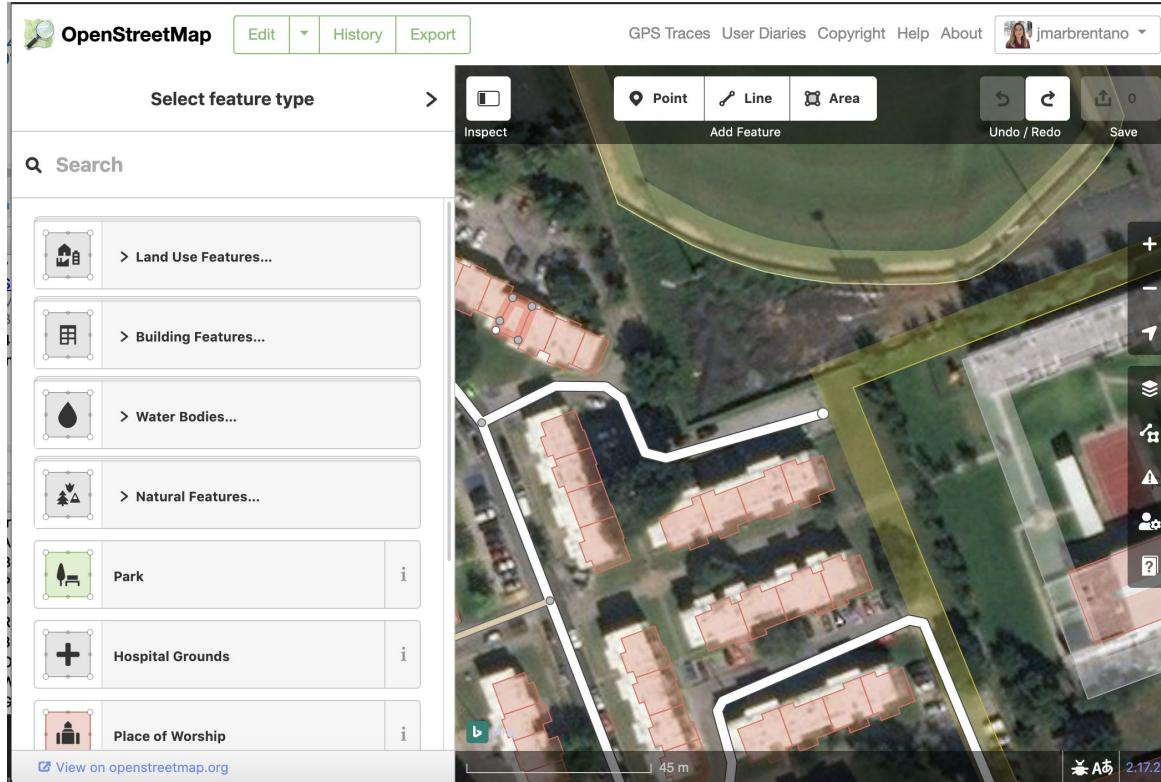
Burning Man



Refugee encampments



Label the data



OpenStreetMap's MapSwipe hosts humanitarian mapping projects - datasets are labelled by users via their app.

Next steps

Use Google Earth Engine to access satellite images and train a model in the same interface.

Google Earth Engine

Google Earth Engine

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A planetary-scale platform
for Earth science data &
analysis

Powered by Google's cloud infrastructure

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Google Earth Engine

- Huge amount of available data
- Development platform for making models, exploring data imagery
- Ties in with Google cloud services and Google App Engine