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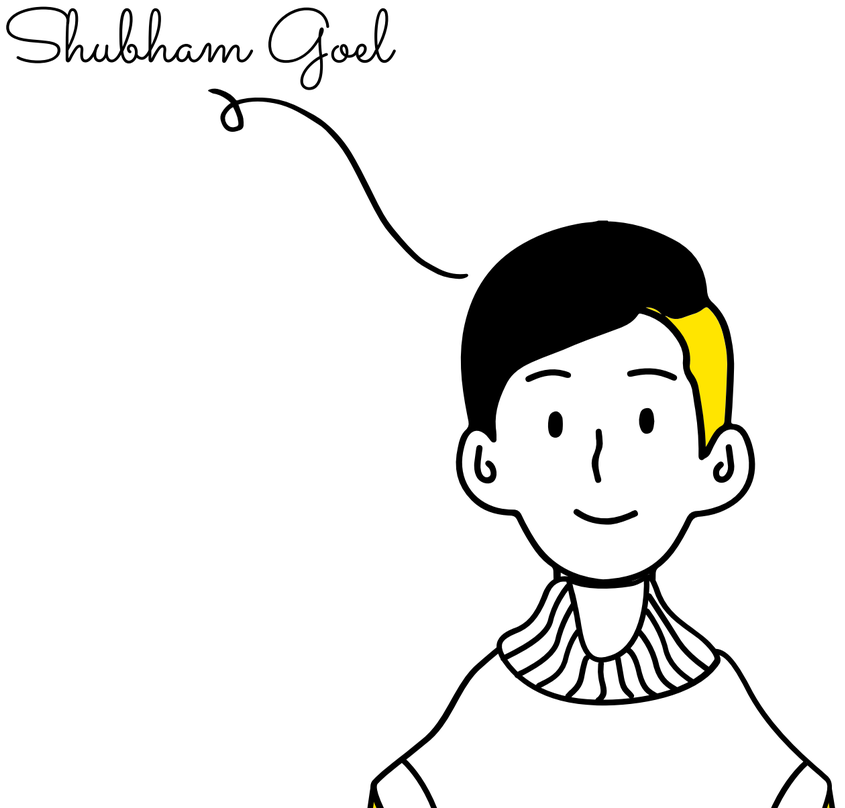
Hurricane Damage Estimation using Siamese Networks

Shubham Goel



Today's Agenda

1. Introduction
2. Siamese Networks
3. Inference Data Acquisition
4. Post-processing

Speaker Intro

Shubham Goel

Final year graduate student at The University of Illinois at Urbana-Champaign.
Spent 3 years building computer vision products in the remote-sensing domain.
Likes technology, startups, football, music.

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Change Detection

Hurricanes cause a lot of damage to human lives, property houses and the surroundings.

Detecting this change in an automated and a scalable manner helps assist those who have suffered the most.

The technique used to detect change needs to have some desirable qualities -

- Detect relevant changes/ignore others
- Be robust to account for different lighting conditions/angles
- Be modular

Simonton, Texas in November 2016 before and after Hurricane Harvey (Digital Globe)

Training Data

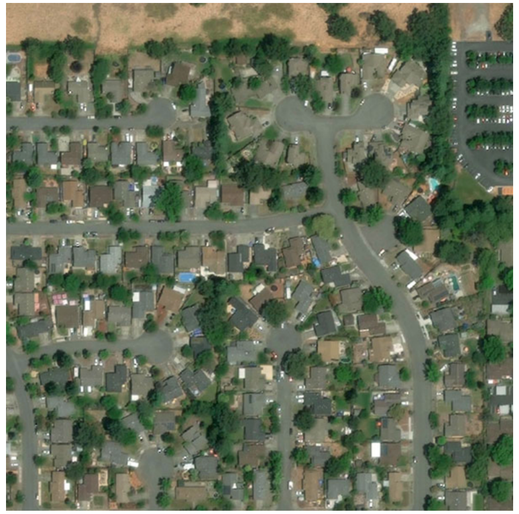
XView2 dataset (850,000 building polygons) used for training.

Manually annotated localized polygons as well as damage scores for individual buildings are provided.

Covers 6 disasters including hurricanes, forest fires, tsunamis and floods, spanning 15 countries.

Joint Damage Scale (JDS) scale used -

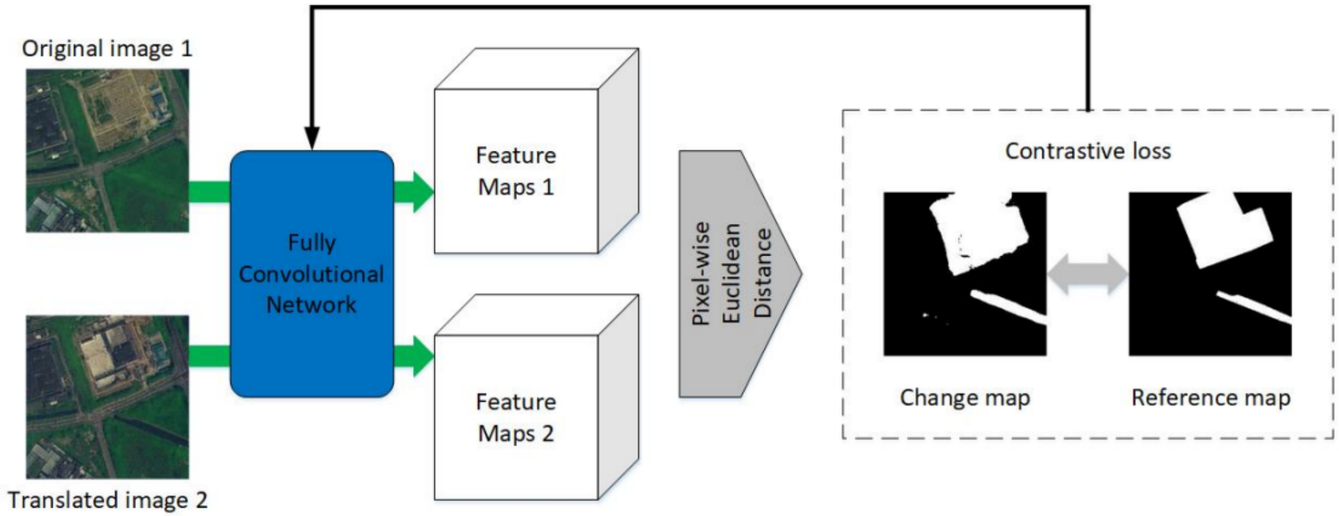
- 1 - Undamaged
- 2 - Minor Damage
- 3- Major Damage
- 4 - Completely destroyed



Pre-disaster image

Post-disaster image

Siamese Networks



Siamese Network Overview

Training

The training is done in 2 stages -

Stage 1: Localization network

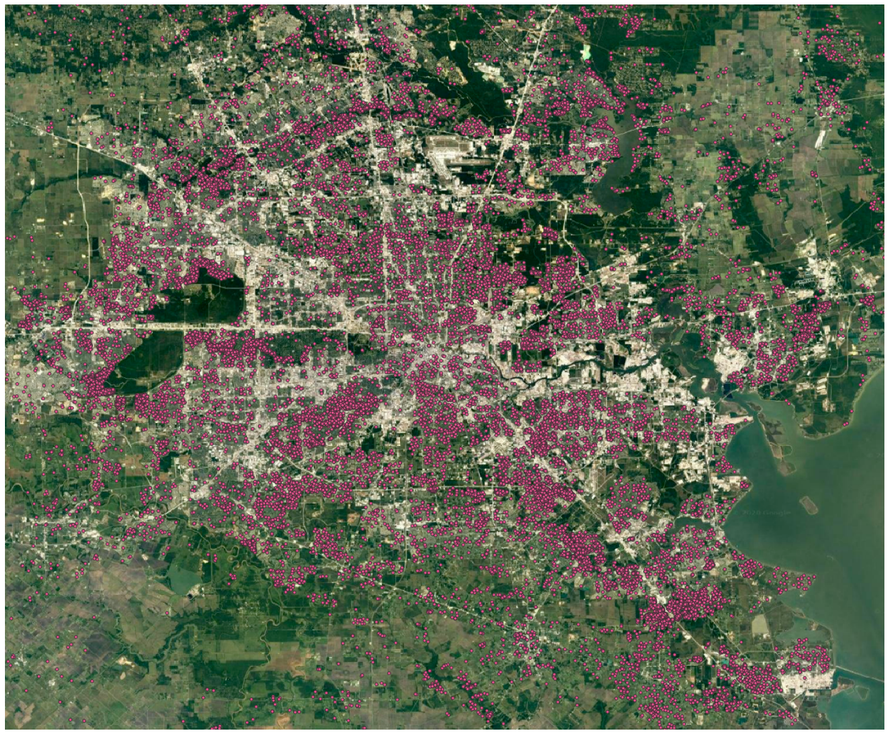
- A U-Net like Encoder-decoder architecture trained only on the "pre" images to detect buildings.
- "Post" disaster images where the buildings are destroyed and the surroundings are flooded are neglected on purpose.
- Loss function: Combination of **Dice** loss and **Focal** loss

Stage 2: Siamese network

- The trained localization network, with trained weights is converted to a Siamese Network
- Used as a feature extractor for both "pre" and "post" images (using the last Decoder layer)
- Damage level for every building pixel is learnt.
- Loss function: Dice loss, Focal loss and **CrossEntropyLoss** (with a higher weight for 2-4 damage classes) combined.

Small Business Administration (SBA) Data

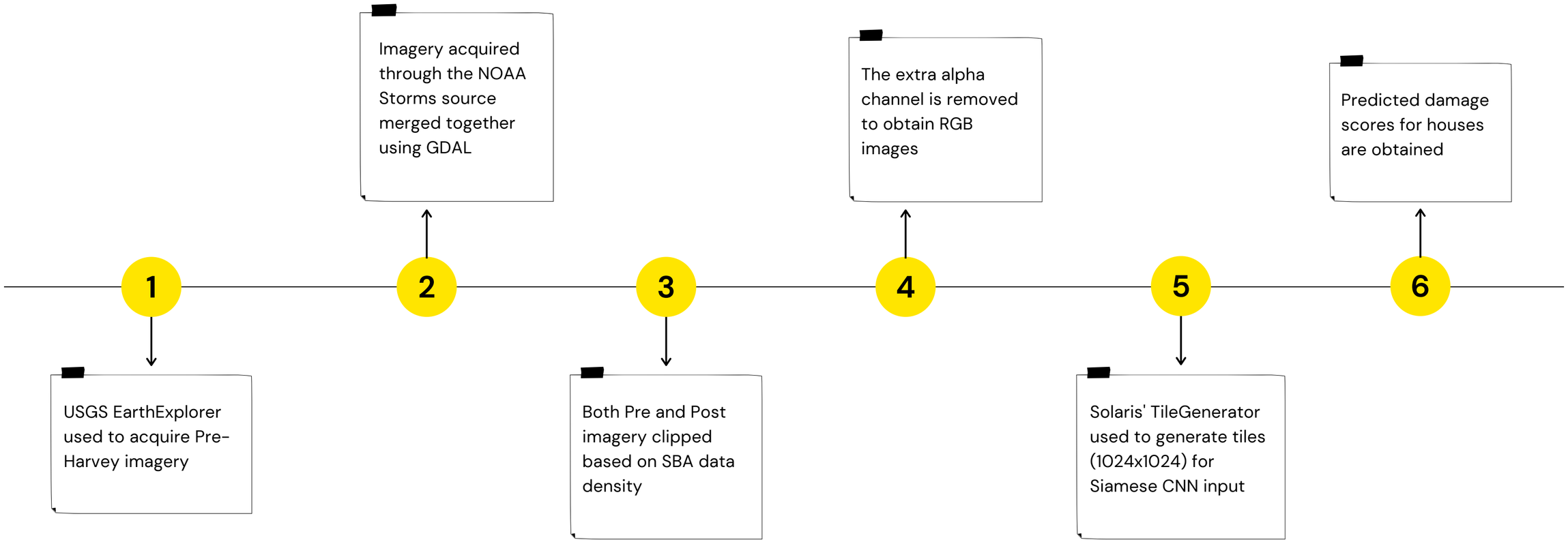
- Dataset about the insurance claims filed by people after Hurricane Harvey (Houston, Texas). Contains -
  - Homeowners
  - Addresses (geocoded by geocod.io
  - Insurance claims (in $$$)
- Combine Siamese CNN output with
  - SBA dollar value amounts, and
  - Houston TaxRolls Data (2016)
- Roughly 53K rows



Spread of SBA data across Houston

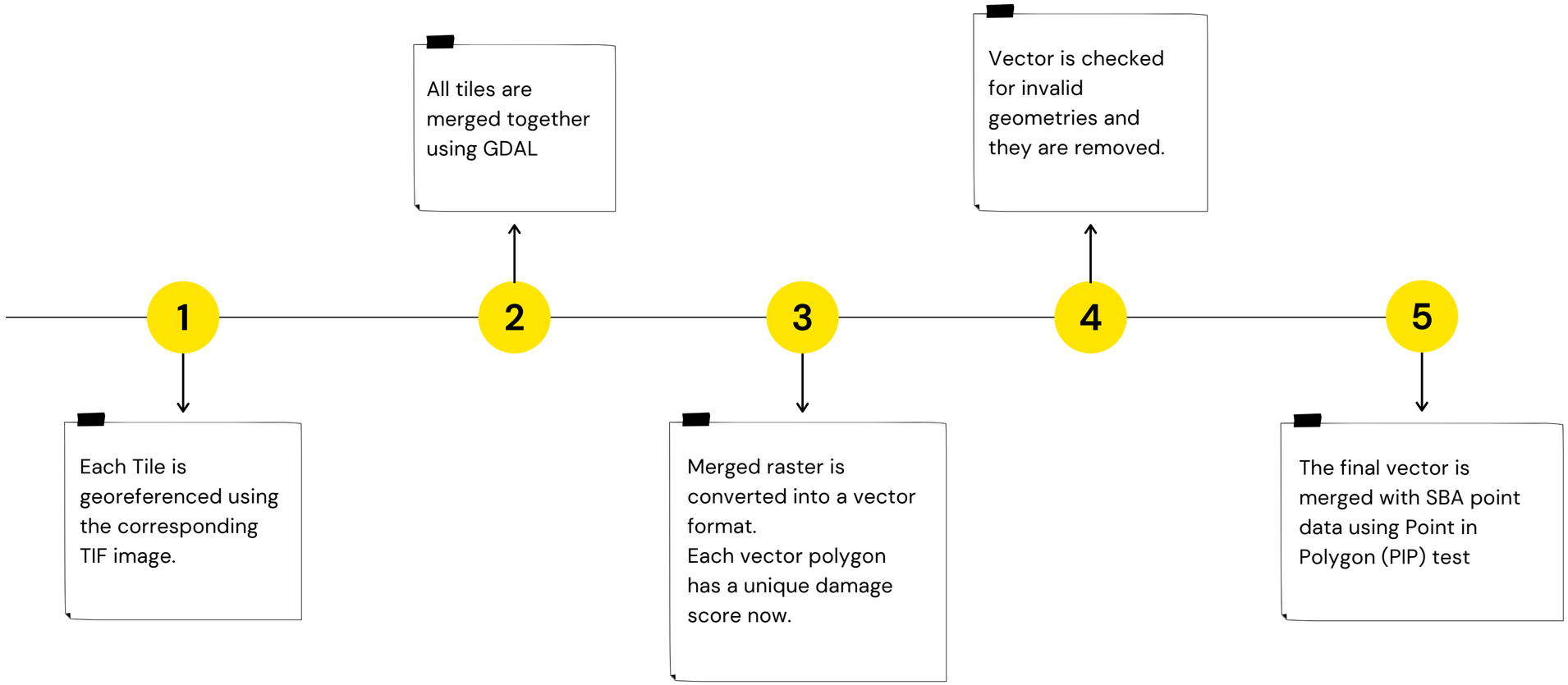
Inference data Acquisition

Pipeline built to acquire Pre and Post imagery for Houston region of Texas



Post-Processing

Once predictions for all tiles are obtained, the following steps are applied



Results

Siamese Network Result

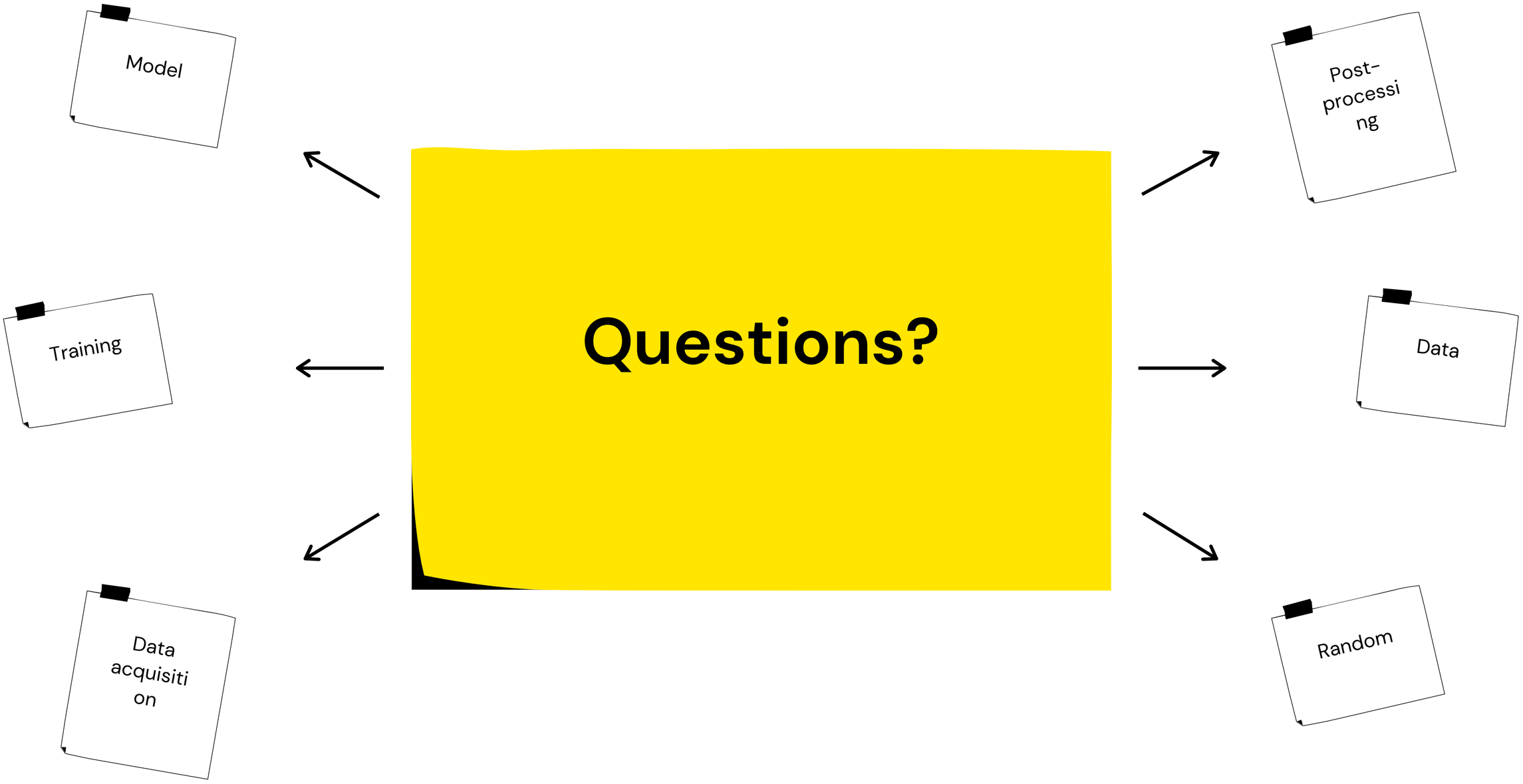
Localization F1 score - 0.88
Damage F1 score - 0.79

Overall F1 score (30:70 ratio of localization and Damage F1 score) - 0.82

SBA Data Result (Coming soon)

Current Challenges

- Automate partially manual portions of the Image Acquisition and the Post-Processing pipeline
- Evaluate results over a bigger region of Houston and check for correlation.
- Merge SBA data with Tax Rolls data and compute a damage ratio
    - Compare this with Siamese network's output


Model
Post-
processi
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Questions?
Training
Data
Data
acquisiti
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References

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- Fully Convolutional Siamese Networks for Change Detection: https://arxiv.org/abs/1810.08462
- A Recipe for Training Neural Networks: http://karpathy.github.io/2019/04/25/recipe/

Thank you!

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