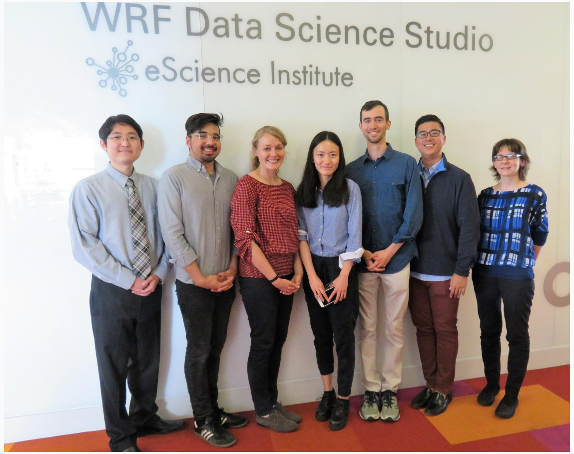
From Open Satellite Data To Emergency Response

Valentina Staneva, eScience Institute, UW



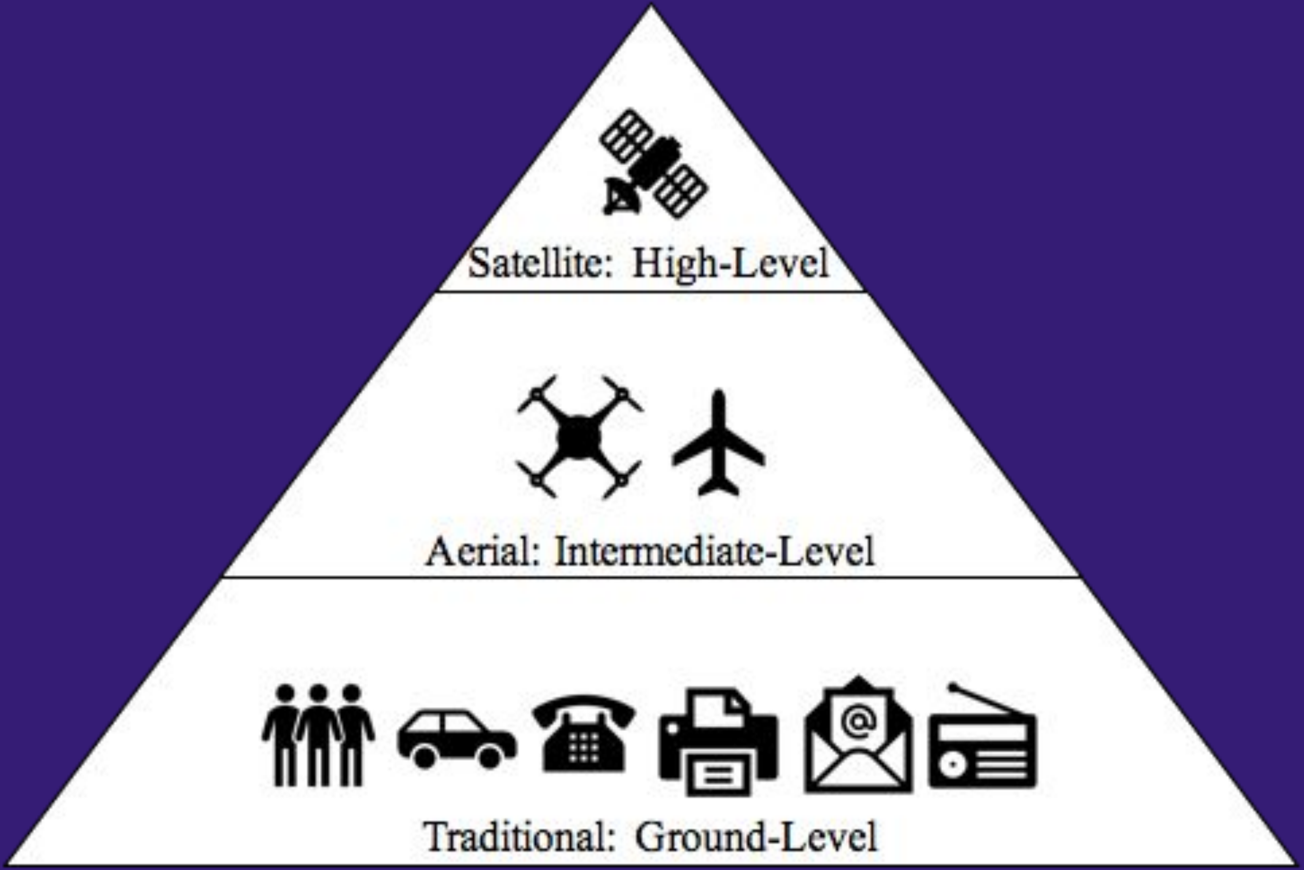
Building Damage Detection in Post-Hurricane Images
(summer Data Science for Social Good project 2018)

Sean Chen, New York University
Andrew Escay, University of the Philippines
Christopher Haberland, University of Washington
Tessa Schneider, Hertie School of Governance
An Yan, University of Washington
Youngjun Choe, University of Washington

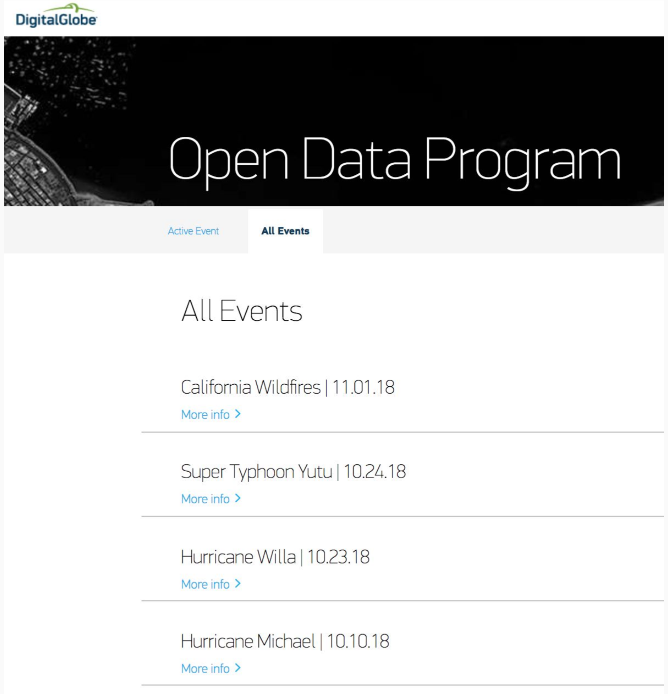
The Problem

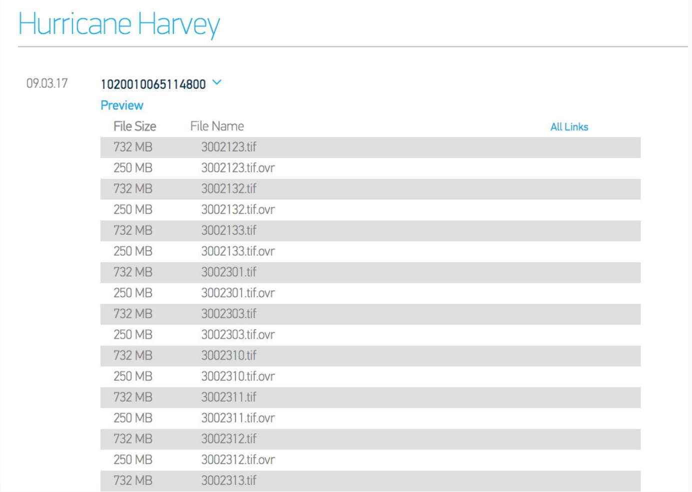
http://blog.digitalglobe.com/news/team-rubicon-uses-digitalglobe-technology-to-aid-houston-residents-after-hurricane-harvey/

Flooding on the outskirts of Houston, Texas, August 31, 2017 (Photo credit: South Carolina National Guard)
https://www.planet.com/insights/anatomy-of-a-catastrophe/


Satellite: High-Level
Aerial: Intermediate-Level
Traditional: Ground-Level

Digital Globe Open Data




Hurricane Harvey

09.03.17 1020010065114800

Preview

File Size	File Name
732 MB	3002123.tif
250 MB	3002123.tif.ovr
732 MB	3002132.tif
250 MB	3002132.tif.ovr
732 MB	3002133.tif
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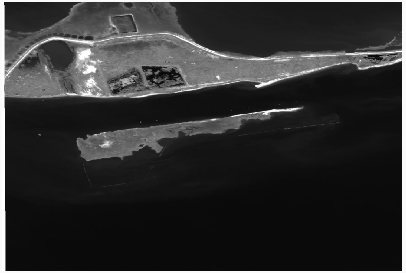
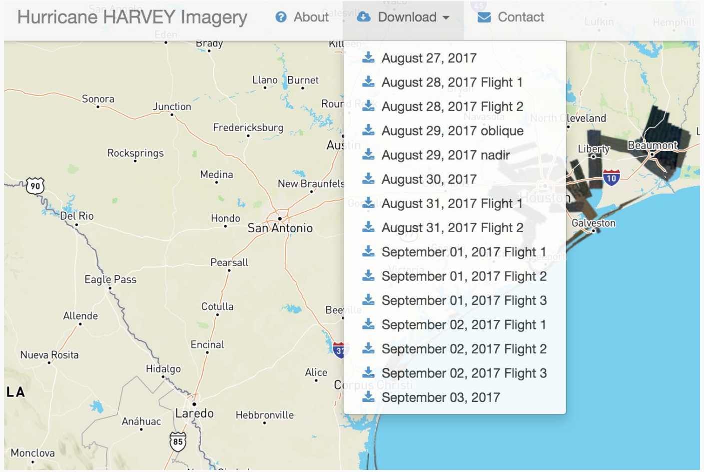
732 MB	3002301.tif
250 MB	3002301.tif.ovr
732 MB	3002303.tif
250 MB	3002303.tif.ovr
732 MB	3002310.tif
250 MB	3002310.tif.ovr
732 MB	3002311.tif
250 MB	3002311.tif.ovr
732 MB	3002312.tif
250 MB	3002312.tif.ovr
732 MB	3002313.tif

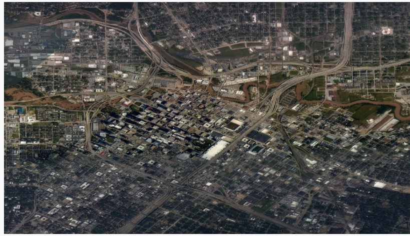
All Links



- 3 TB of image data
- Missing data, missing bands
- Clouds
- Crowdsourced manual annotations in JSON (Tomnod)

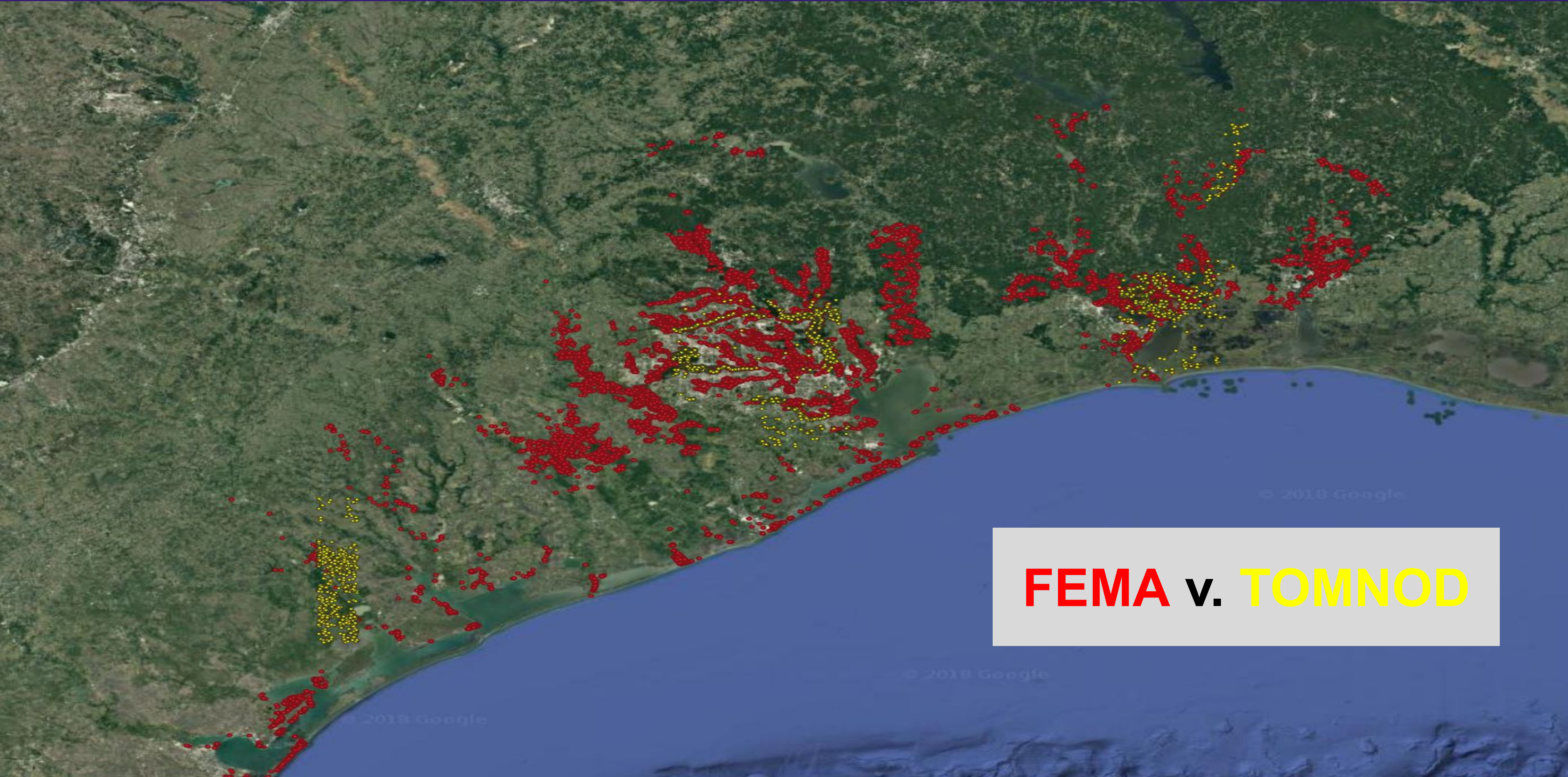
NOAA Public Data



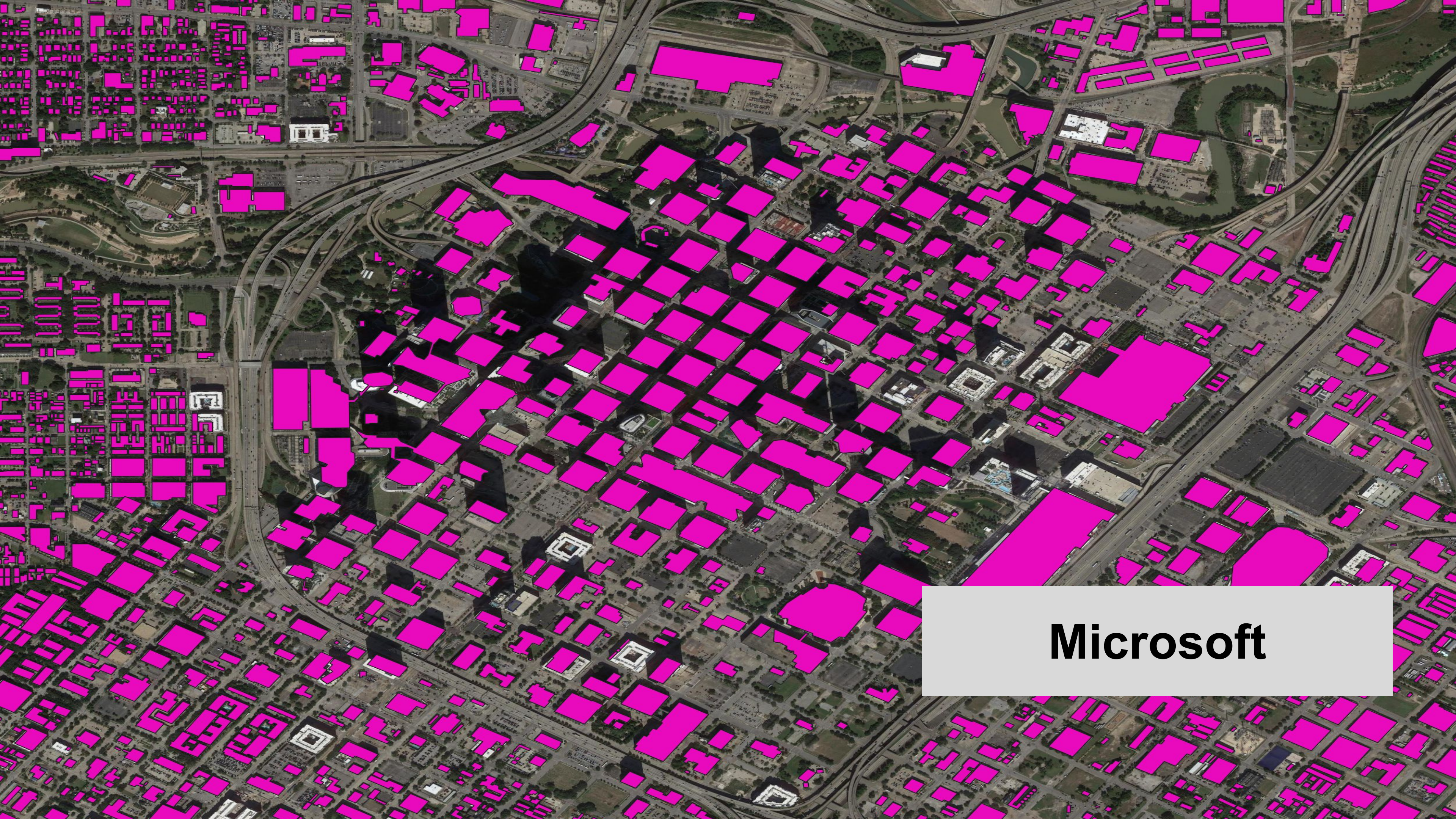


- ➢ 400GB of image data
- ➢ No clouds

Damage Annotations



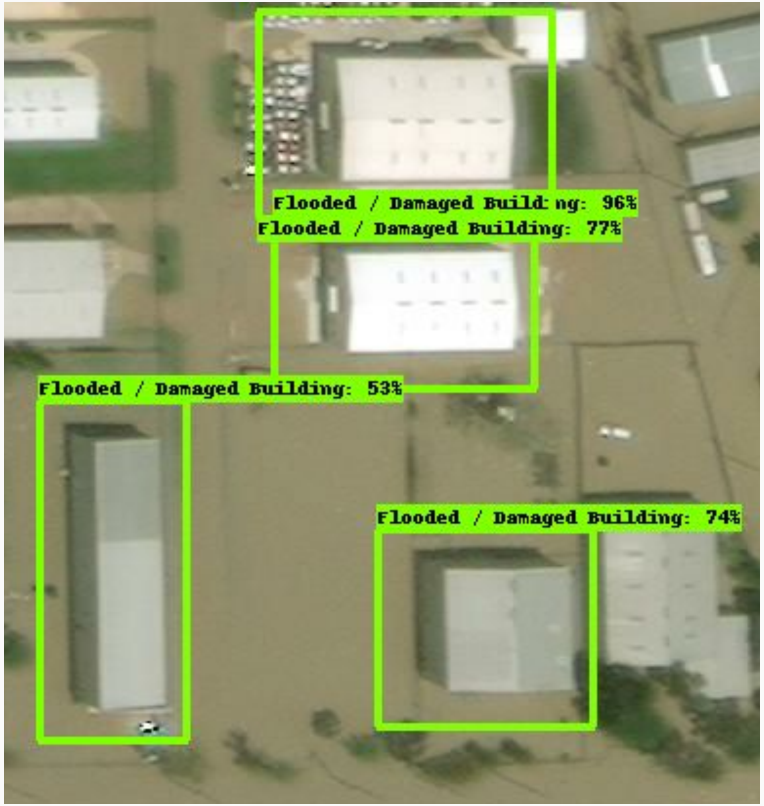
Building Footprints


Microsoft

Object Detection (A Deep Learning Approach)

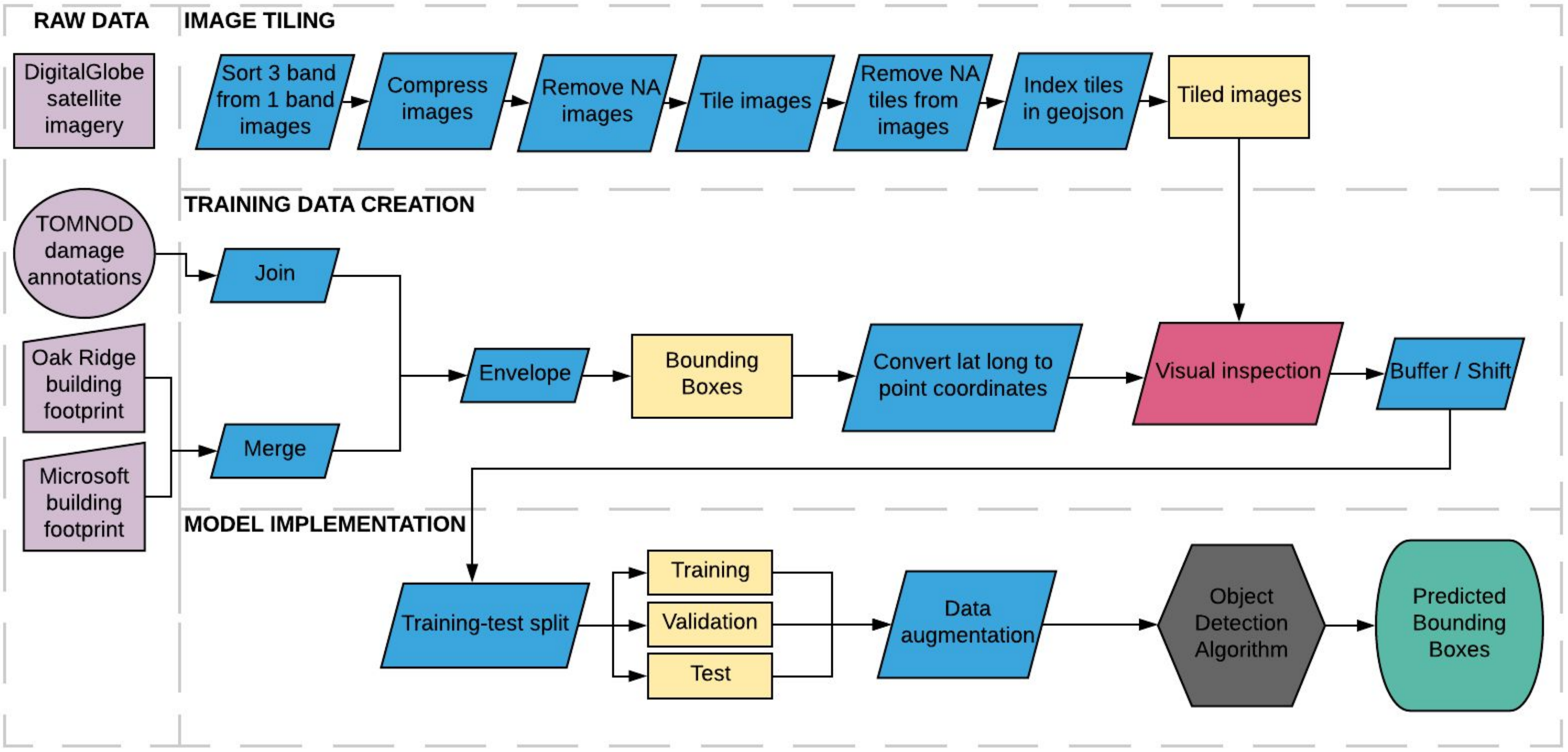
- Faster R-CNN (Ren et al., 2015)
- Single Shot MultiBox Detector (SSD) (Liu et al., 2016)

TOMNOD damage predictions with SSD

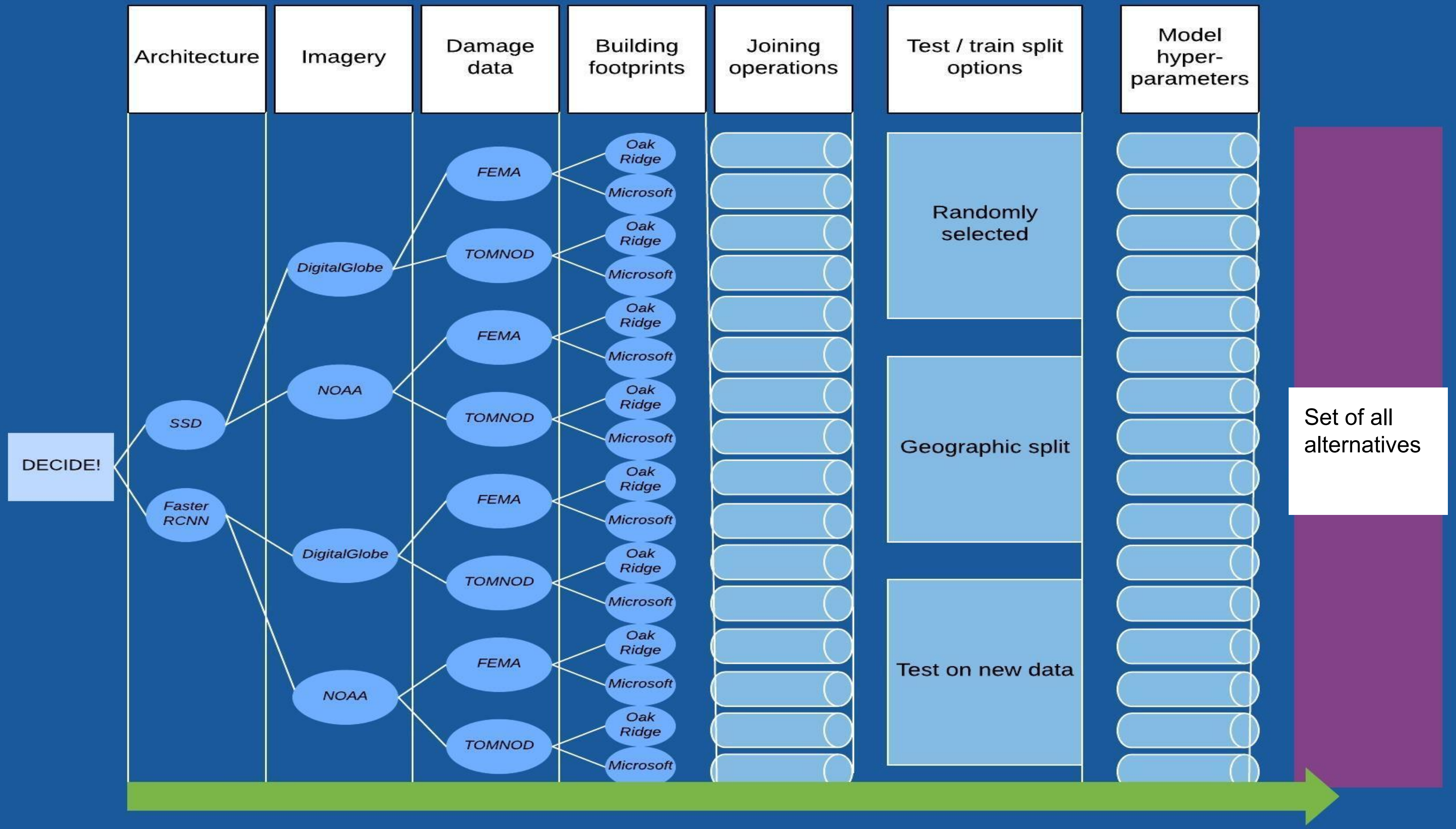


NOAA damage predictions with SSD

Data Processing Pipeline



Alternatives



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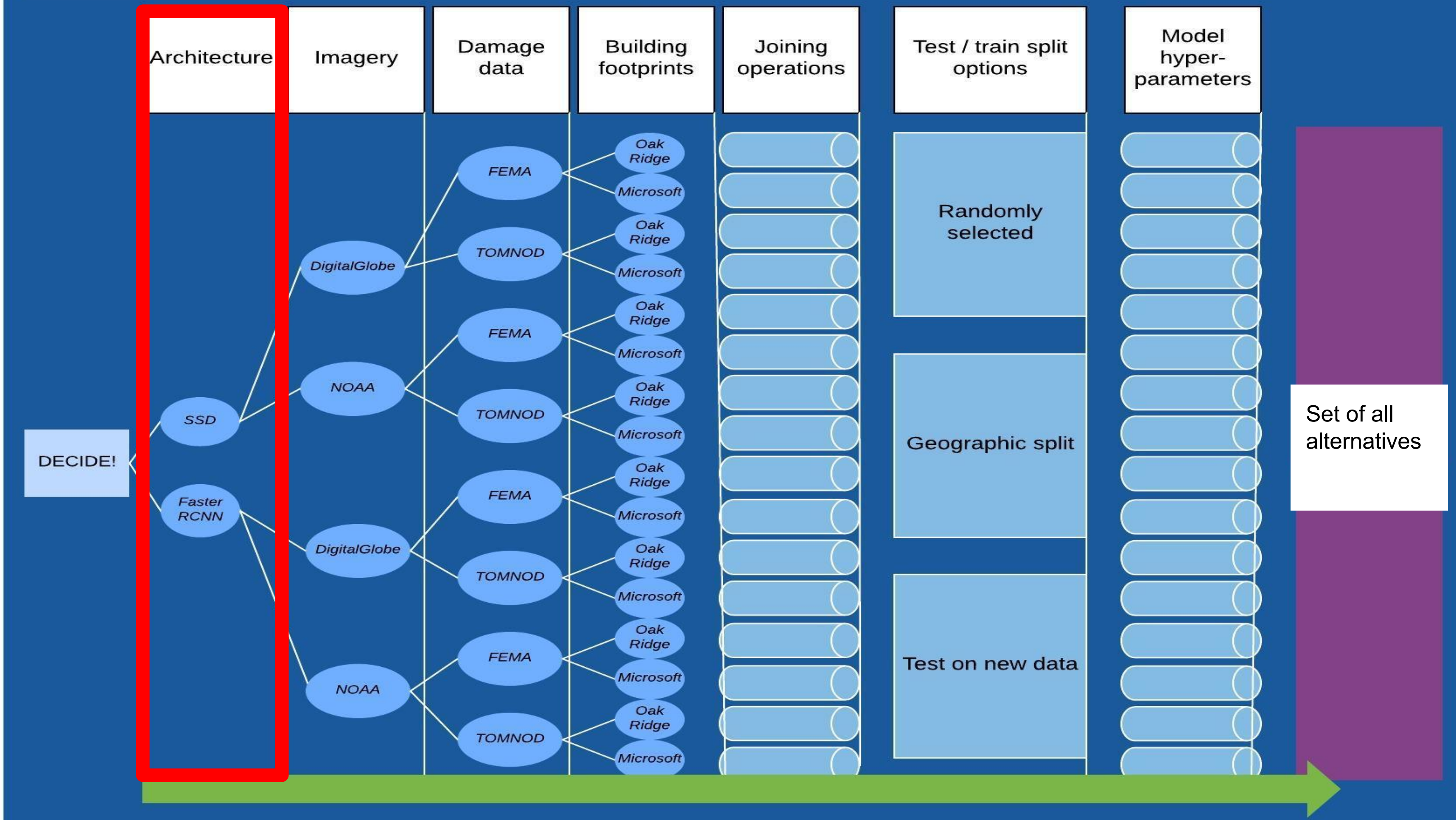

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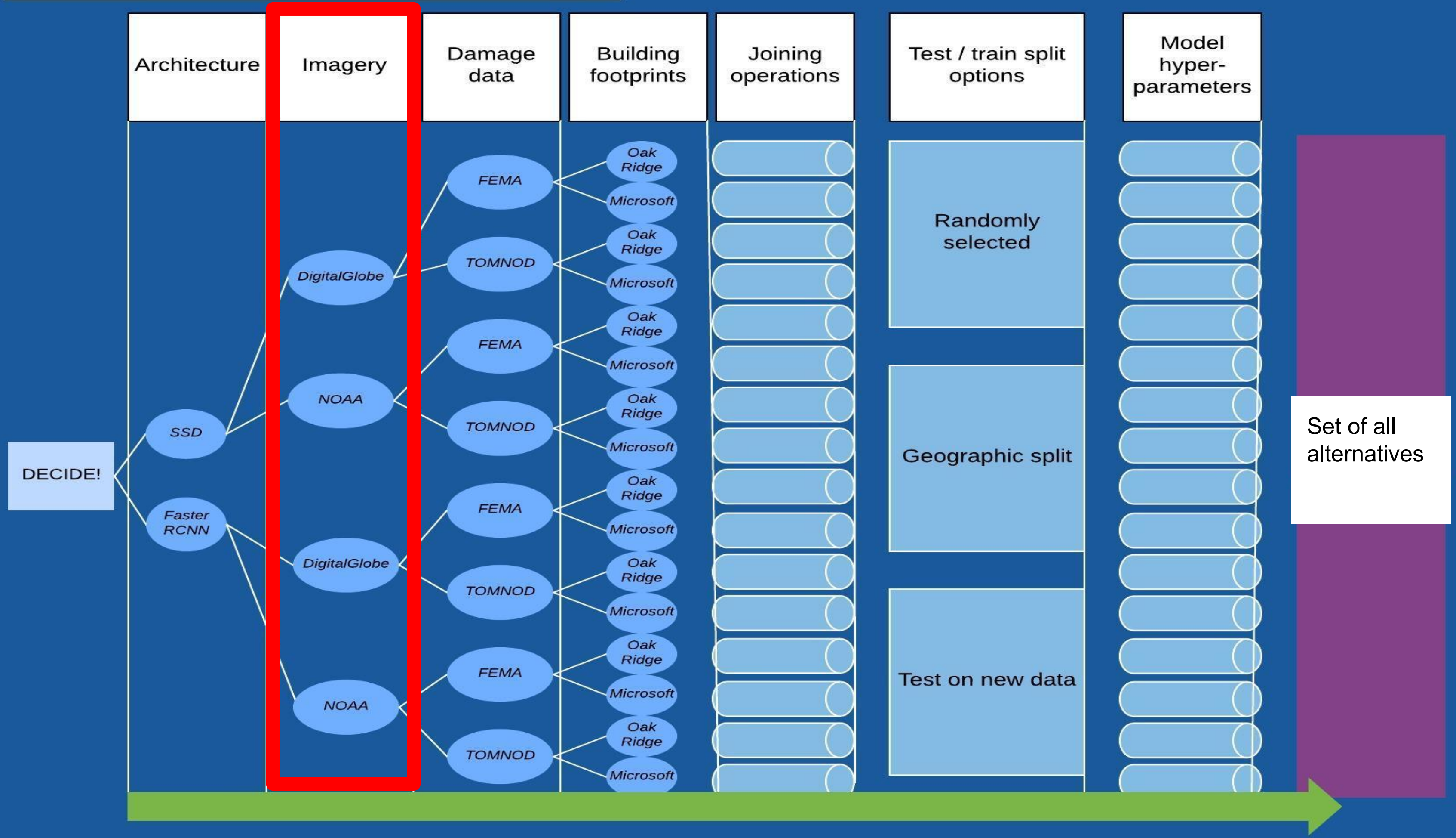
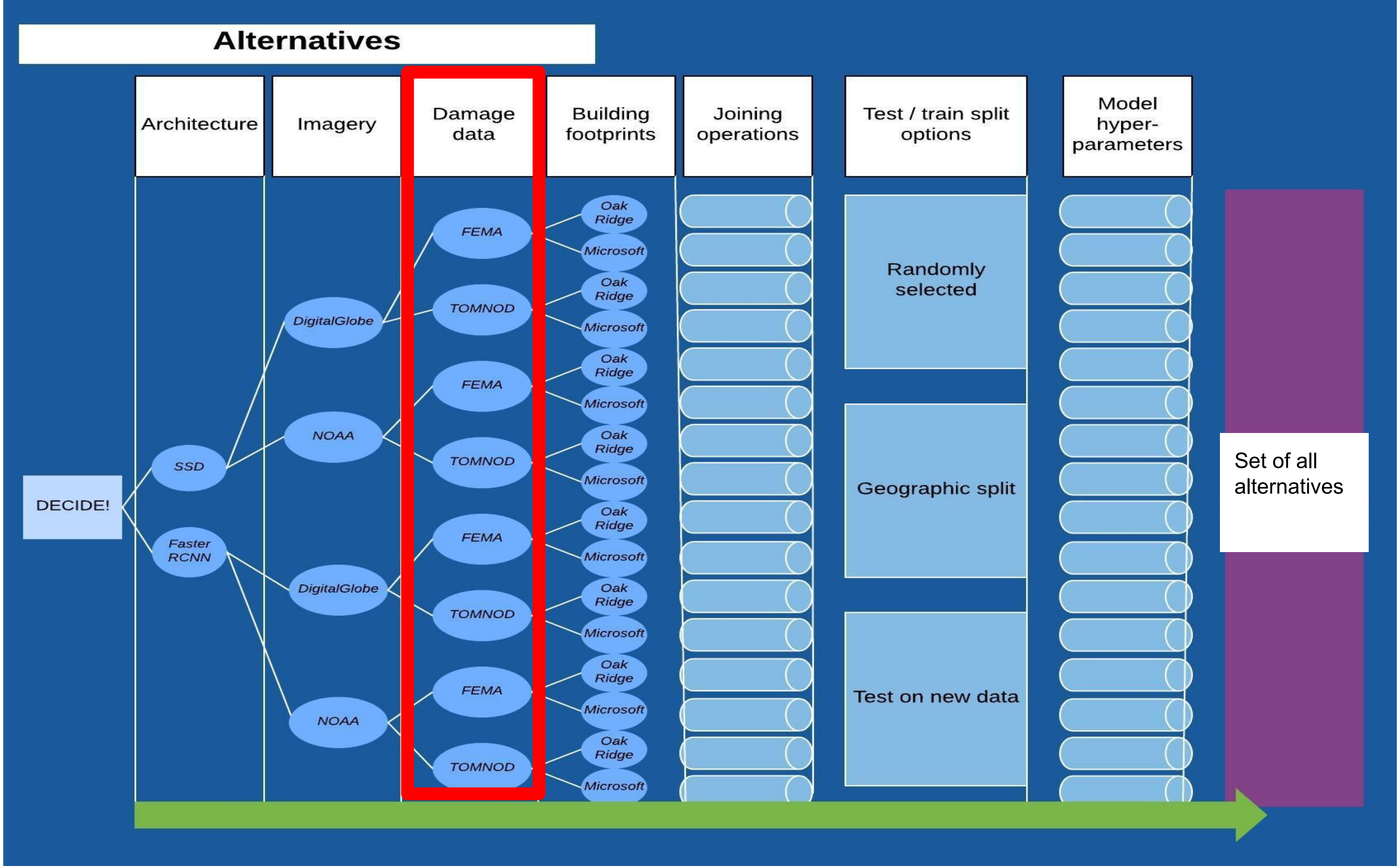
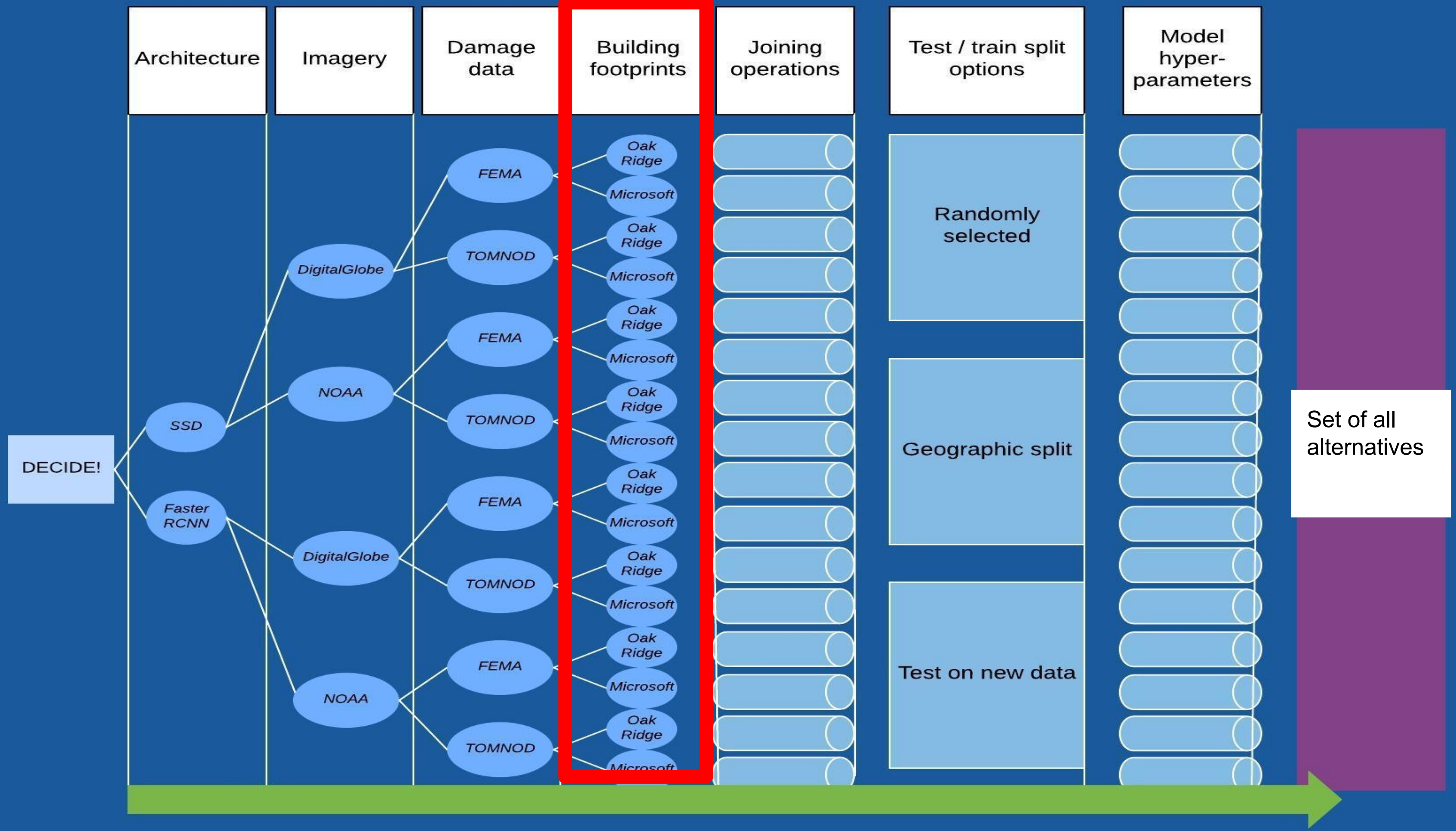



Alternatives
Architecture
Imagery
Damage data
Building footprints
Joining operations
Test / train split options
Model hyper-parameters
DECIDE!
SSD
Faster RCNN
DigitalGlobe
NOAA
DigitalGlobe
NOAA
FEMA
TOMNOD
FEMA
TOMNOD
FEMA
TOMNOD
FEMA
TOMNOD
Oak Ridge
Microsoft
Randomly selected
Geographic split
Test on new data
Set of all alternatives

Alternatives



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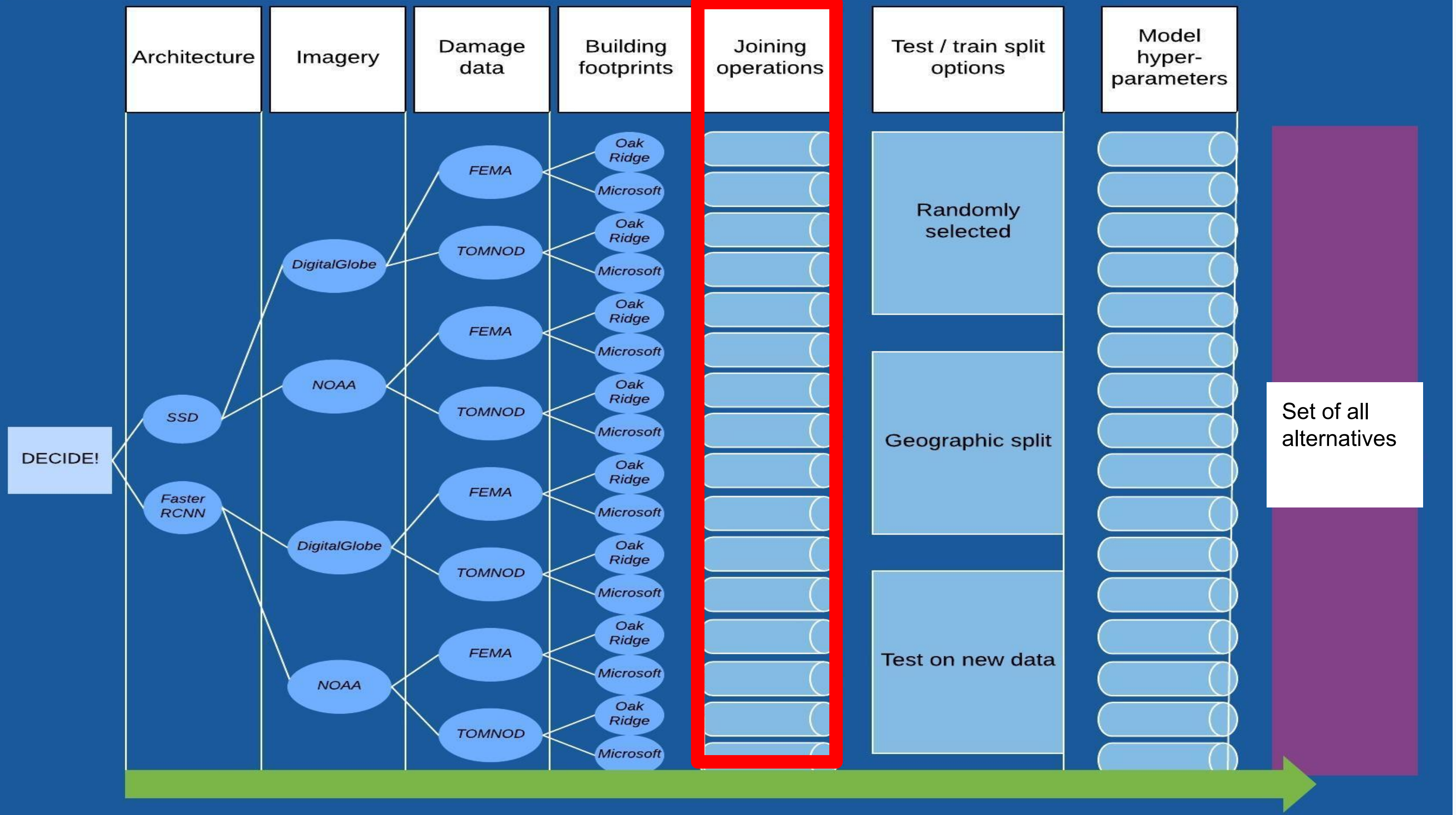

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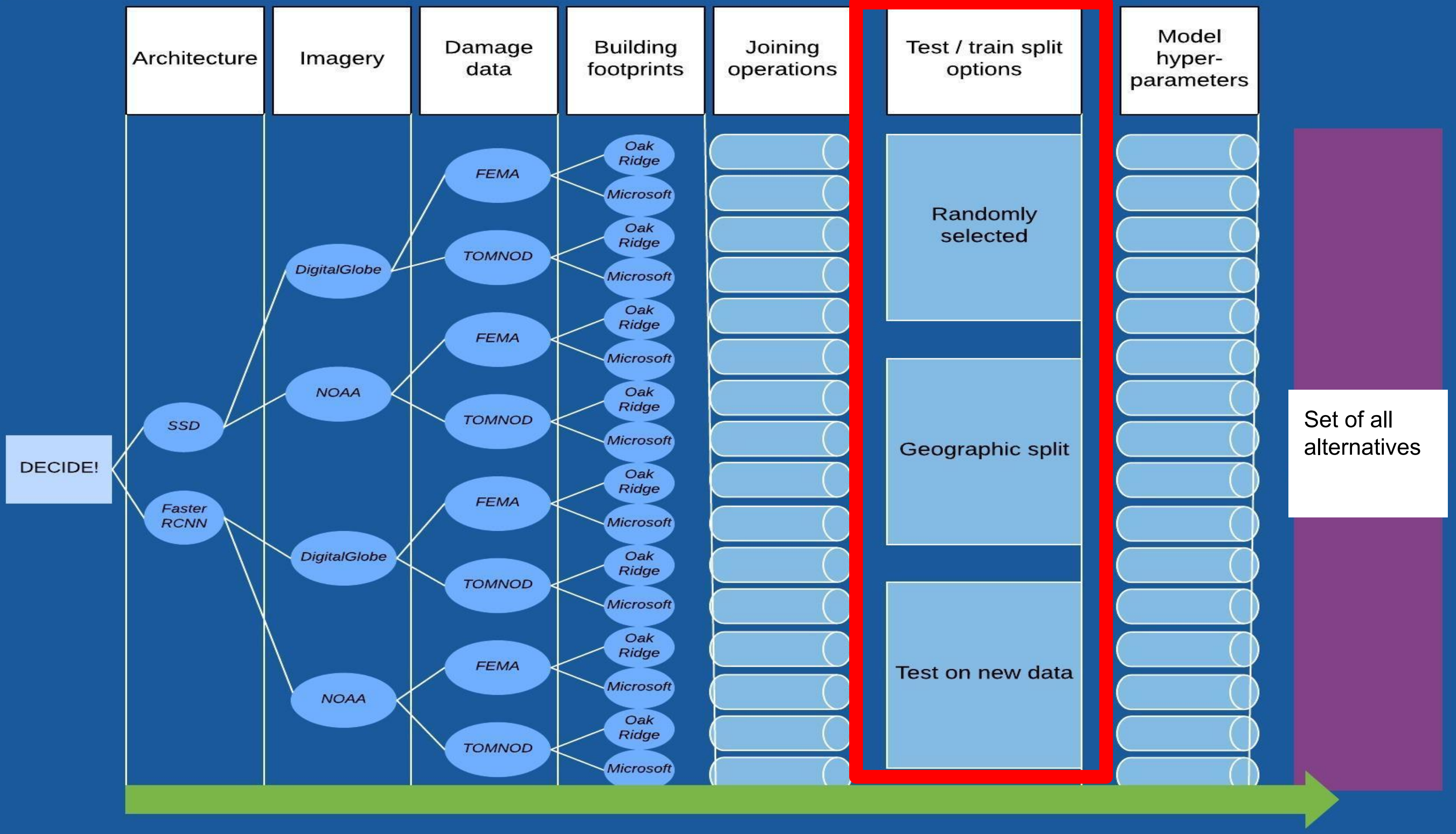

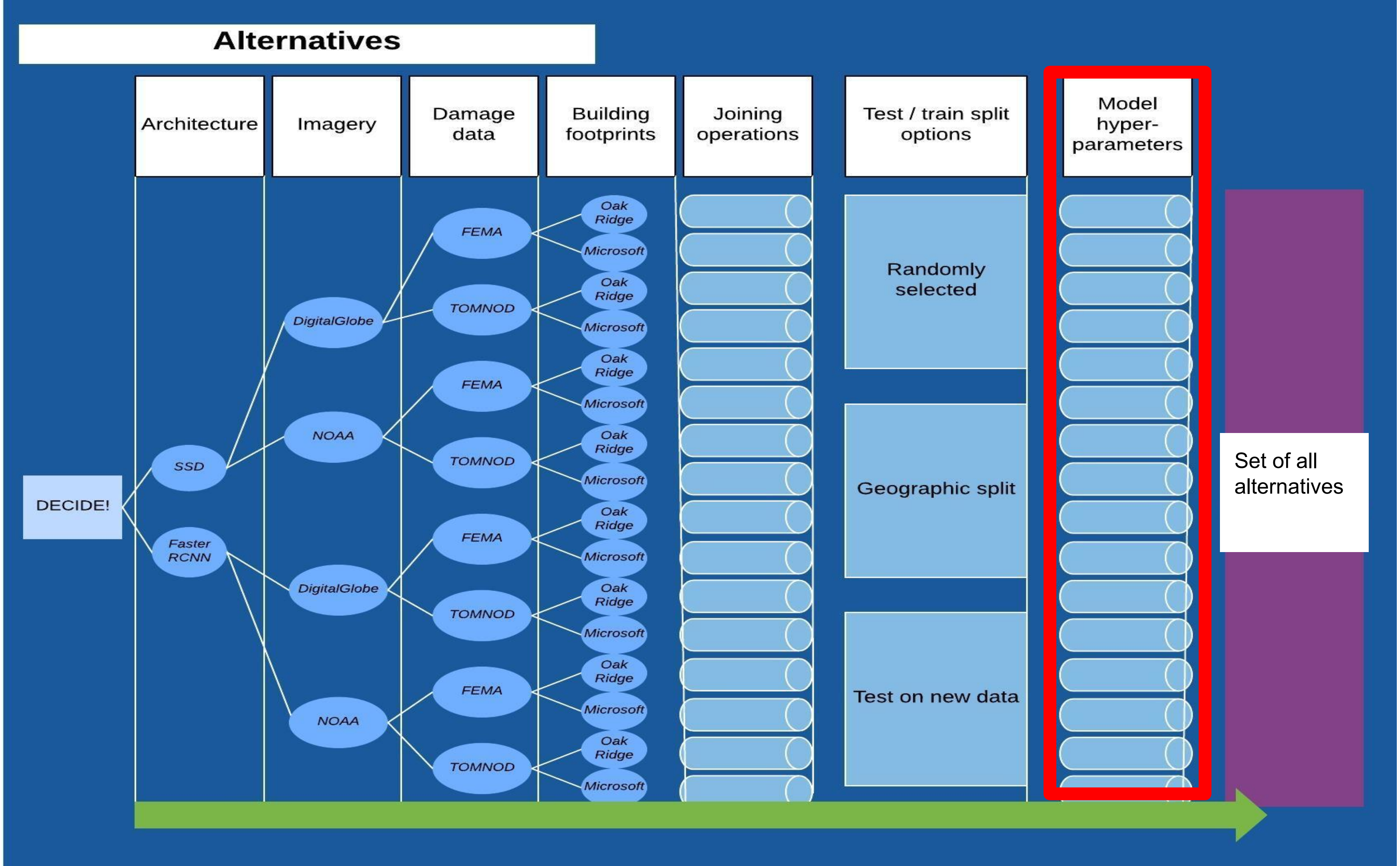
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Results (Average Precision)

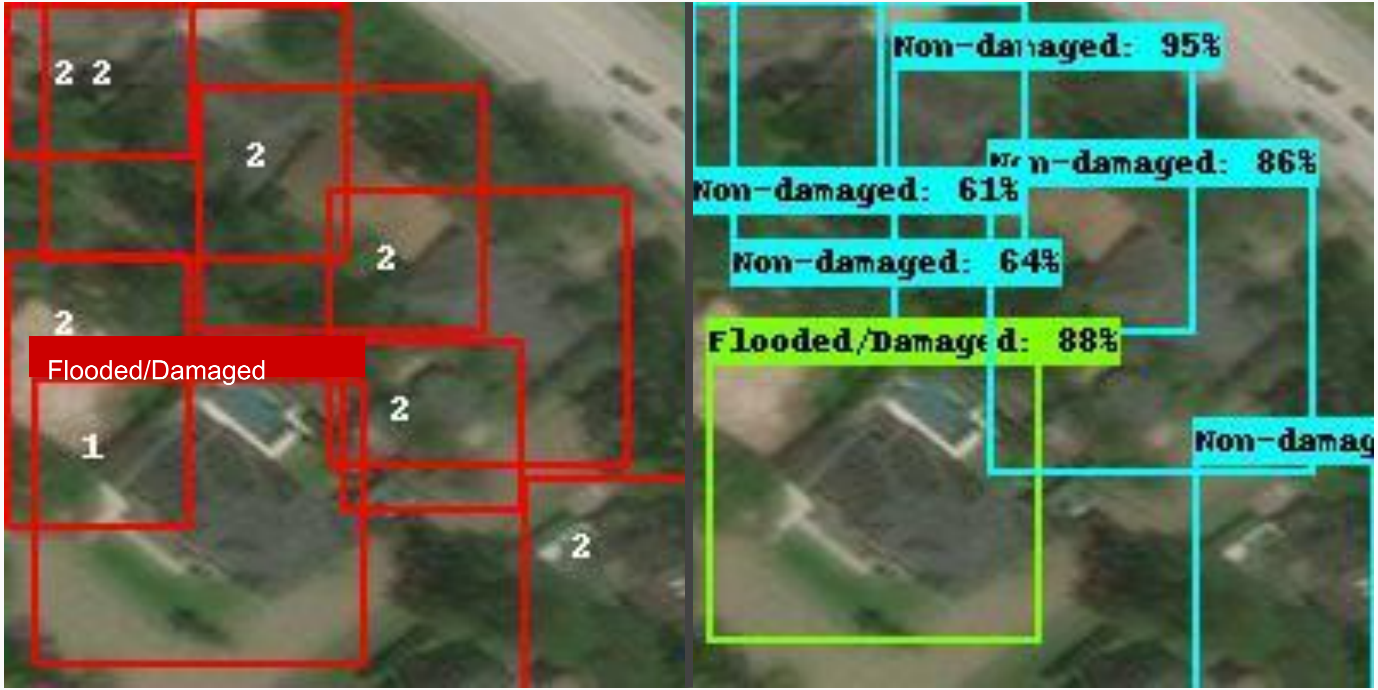
Alternative	**Flooded/Damaged**	Non-damaged	Evaluation Score (mAP)
SSD on Satellite Imagery	**0.47**	0.62	0.55
SSD on Aerial Imagery	**0.32**	0.65	0.48
Faster R-CNN Satellite Imagery	**0.31**	0.61	0.46

How can we represent the uncertainty to emergency responders?

Evaluation

Human-labeled data

Predicted output



Identify Flooded Buildings

Evaluation

Human-labeled data

Predicted output

Identify Damaged Buildings (Blue Tarp)

Evaluation

Human-labeled data

Predicted output

Identify Damaged Buildings

Computational Infrastructure

Hyak University Cluster: Downloading, Compressing and Tiling

Pros:	**Cons:**
• easy to experiment as not charged for every action	• no root access: ◦ best to install Python packages through conda ◦ Some geospatial libraries conda distributions don't have full functionality ◦ no docker support

Amazon Web Services: Deep Learning

Pros:	**Cons:**
• can use pre-built images: great for deep learning • can save snapshots of all the work • can use GPUs without dealing with hardware and drivers • can use managed databases	• everybody needs to learn about security management • uploading data is free, but exporting and GPU computations are expensive

Local QGIS server: Joins and Manual Inspection

Pros:	**Cons:**
• easy to see	• not reproducible

Sharing Data

Datasets:
- Compressed and tiled dataset
- Training Dataset
- PostGIS SQL database with geospatial data
- Pickled trained models

Cloud Backup:
- AWS S3 bucket
- Snapshots for instances + database

Code on GitHub:
https://github.com/DDS-Lab/

Website:
https://dds-lab.github.io/disaster-damage-detection/

Satellite Image Analysis

Special Interest Group at UW eScience Institute

Objectives:

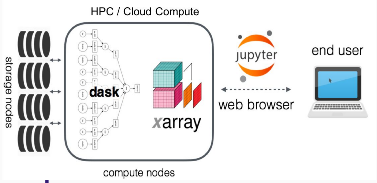
- Build an interdisciplinary community of users of satellite/aerial imagery
- Apply state-of-the-art approaches for large scale data processing and computer vision
- Develop software tools and advance the methodology in the remote sensing field

Activities:

- Computational Workflow Demos, Tutorials, Hackatons, Networking

Join us remote_sensing@uw.edu!

https://uwescience.github.io/sat-image-analysis/



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