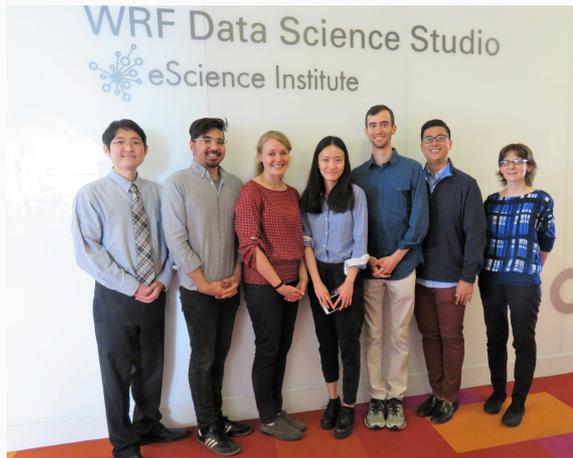


From Open Satellite Data To Emergency Response

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

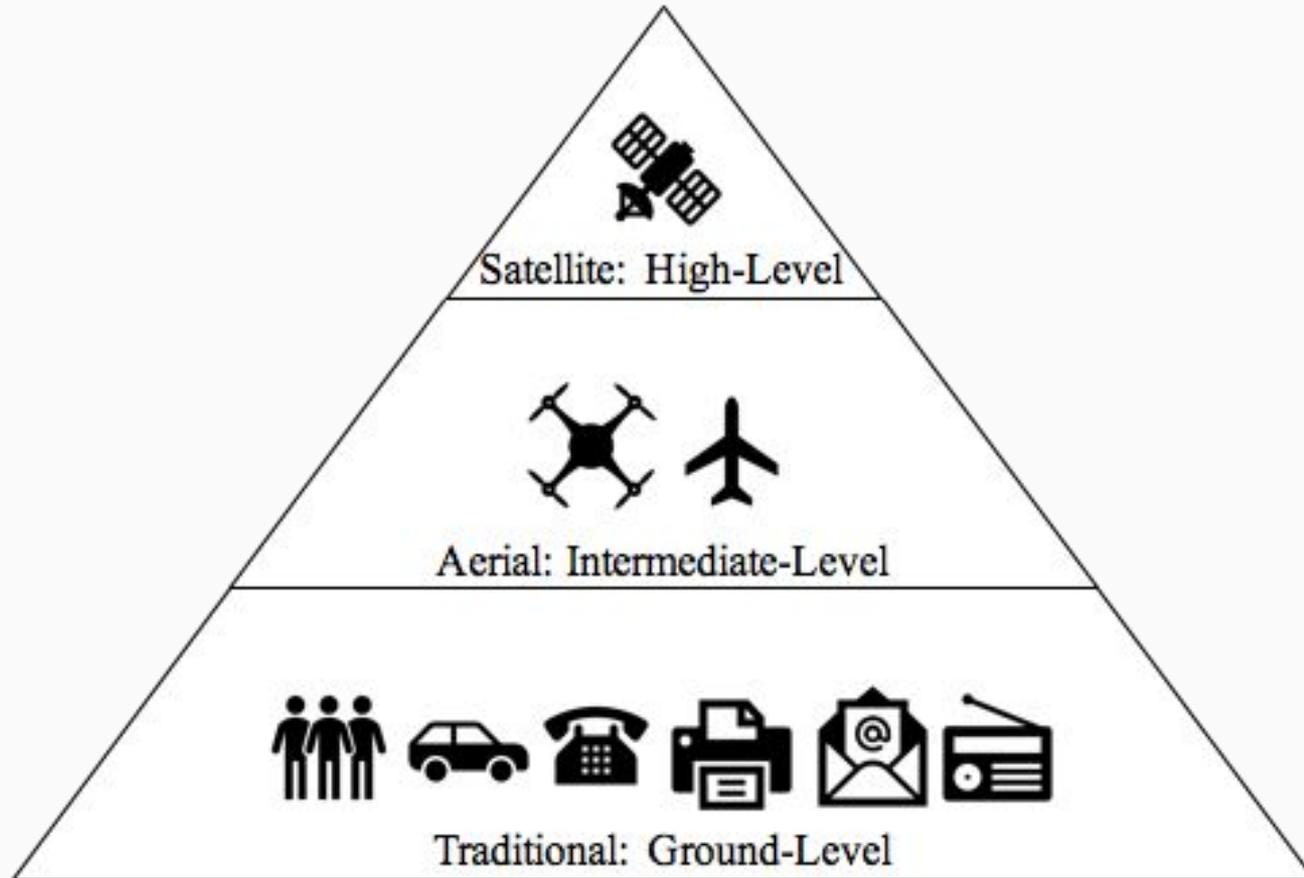


<http://blog.digitalglobe.com/news/team-rubicon-uses-digitalglobe-technology-to-aid-houston-residents-after-hurricane-harvey/>



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/>

Multiview Approach



DigitalGlobe Open Satellite Data



Open Data Program

Active Event | **All Events**

All Events

California Wildfires | 11.01.18
[More info >](#)

Super Typhoon Yutu | 10.24.18
[More info >](#)

Hurricane Willa | 10.23.18
[More info >](#)

Hurricane Michael | 10.10.18
[More info >](#)

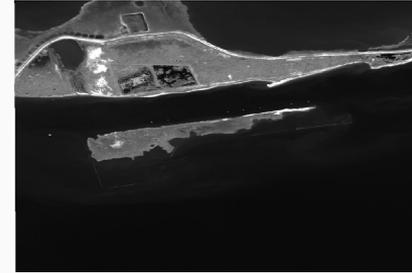
Hurricane Harvey

09.03.17

1020010065114800 ▾

Preview

File Size	File Name	All Links
732 MB	3002123.tif	
250 MB	3002123.tif.ovr	
732 MB	3002132.tif	
250 MB	3002132.tif.ovr	
732 MB	3002133.tif	
250 MB	3002133.tif.ovr	
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	



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

NOAA Public Aerial Data



 **Emergency Response Imagery**
National Geodetic Survey

NGS Home | About NGS | Data & Imagery | Tools | Surveys | Science & Education | Search

The imagery posted on this site was acquired by the **NOAA Remote Sensing Division** to support NOAA homeland security and emergency response requirements. In addition, it will be used for ongoing research efforts for testing and developing standards for airborne digital imagery.

Tips for navigating the Emergency Response Imagery Viewer.

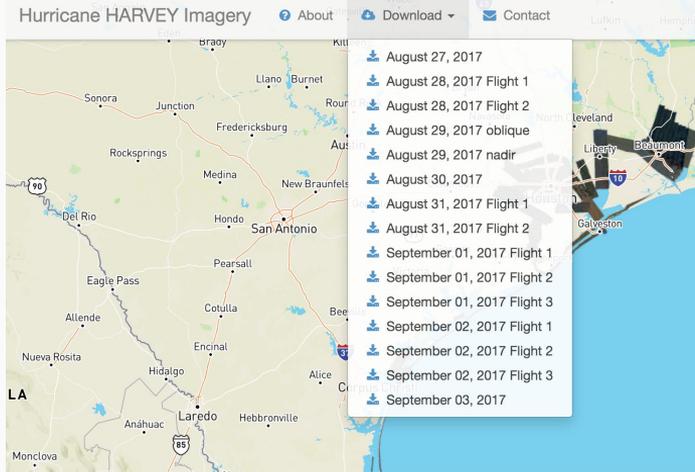
Emergency Response Imagery:

- Hurricane Barry (2019)
- Hurricane Michael (2018)
- Hurricane Florence (2018)
- Tropical Storm Gordon (2018)
- Hurricane Nate (2017)
- Hurricane Maria (2017)
- Hurricane Irma (2017)
- Hurricane Harvey (2017)
- Hurricane Matthew (2016)
- Louisiana Flooding (2016)
- Midwest U.S. Flooding (2015)
- Illinois Tornadoes (2015)
- Hurricane Arthur (2014)
- Hurricane Sandy (2012)
- Hurricane Isaac (2012)
- Hurricane Irene (2011)
- Joplin, MO Tornado (2011)
- Tuscaloosa, AL Tornado (2011)
- North Dakota Flooding (2011)

Navigation
National Geodetic Survey
Pre-Event Imagery

Contact Us
Content and Technical Issues
Comments and Policy Issues

Hurricane HARVEY Imagery | About | Download | Contact

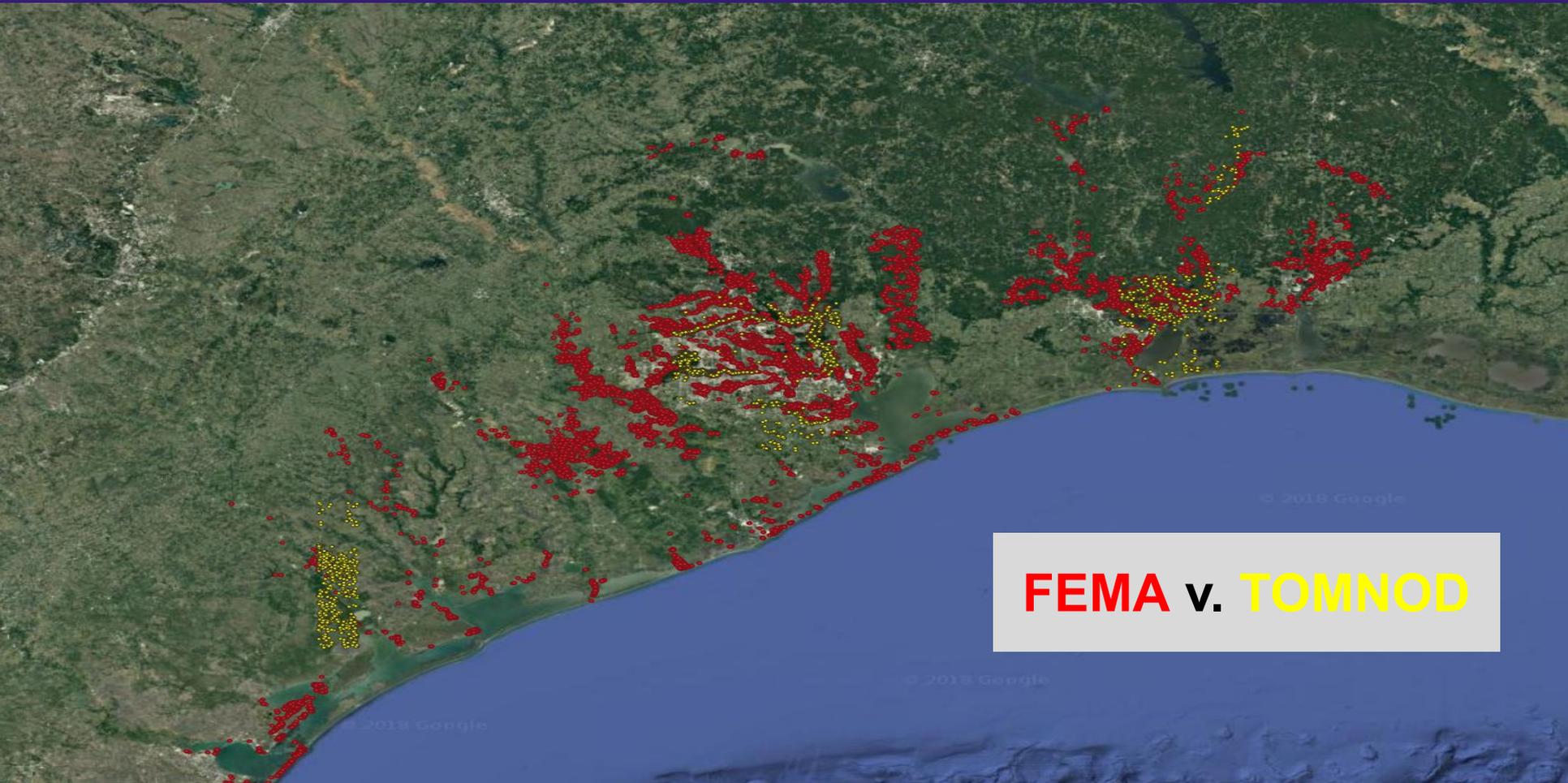


- August 27, 2017
- August 28, 2017 Flight 1
- August 28, 2017 Flight 2
- August 29, 2017 oblique
- August 29, 2017 nadir
- August 30, 2017
- August 31, 2017 Flight 1
- August 31, 2017 Flight 2
- September 01, 2017 Flight 1
- September 01, 2017 Flight 2
- September 01, 2017 Flight 3
- September 02, 2017 Flight 1
- September 02, 2017 Flight 2
- September 02, 2017 Flight 3
- September 03, 2017



- 400GB of image data
- No clouds

Damage Annotations



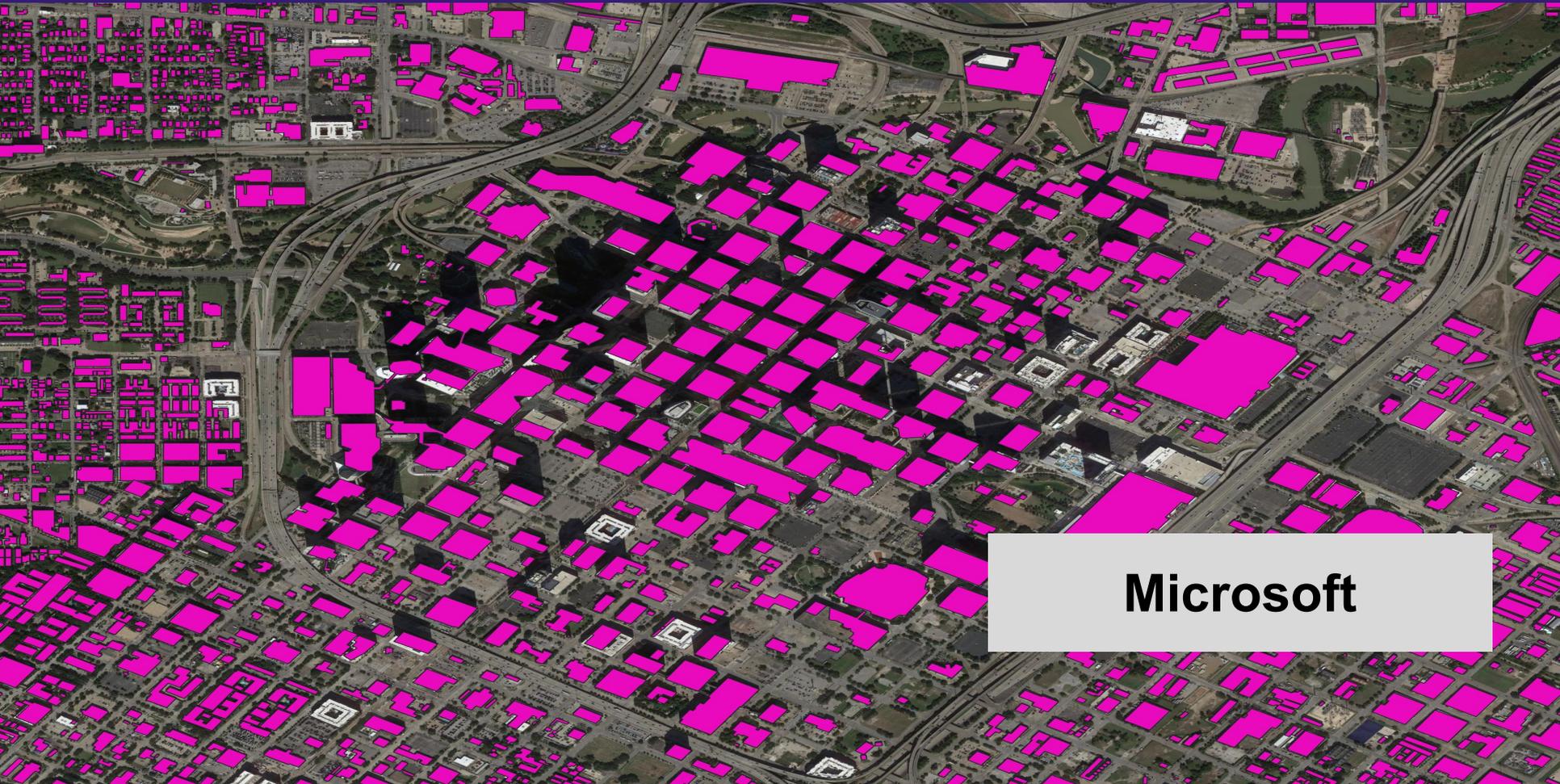
FEMA v. **TOMNOD**

Building Footprints



Oak Ridge National Labs

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)

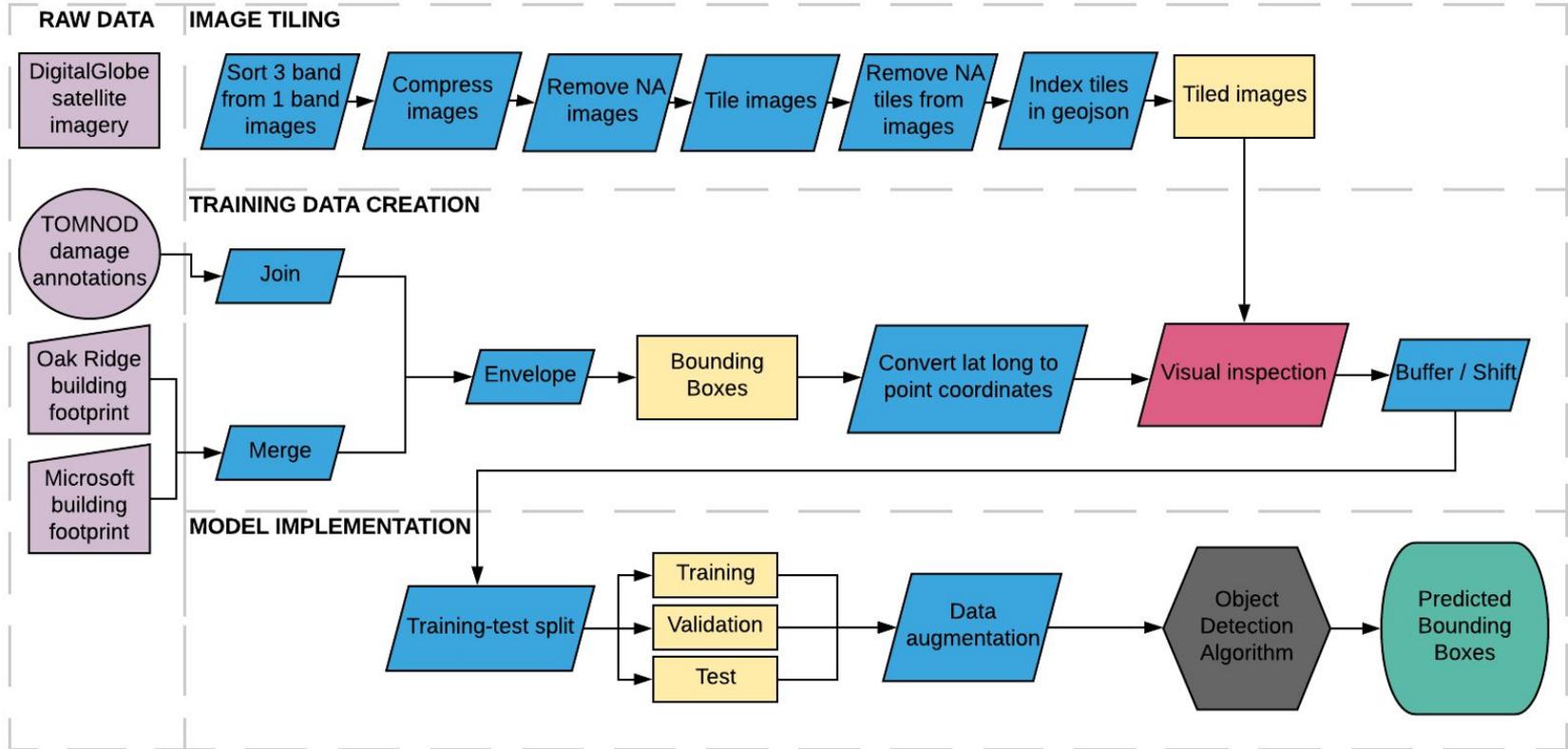


TOMNOD damage predictions with SSD

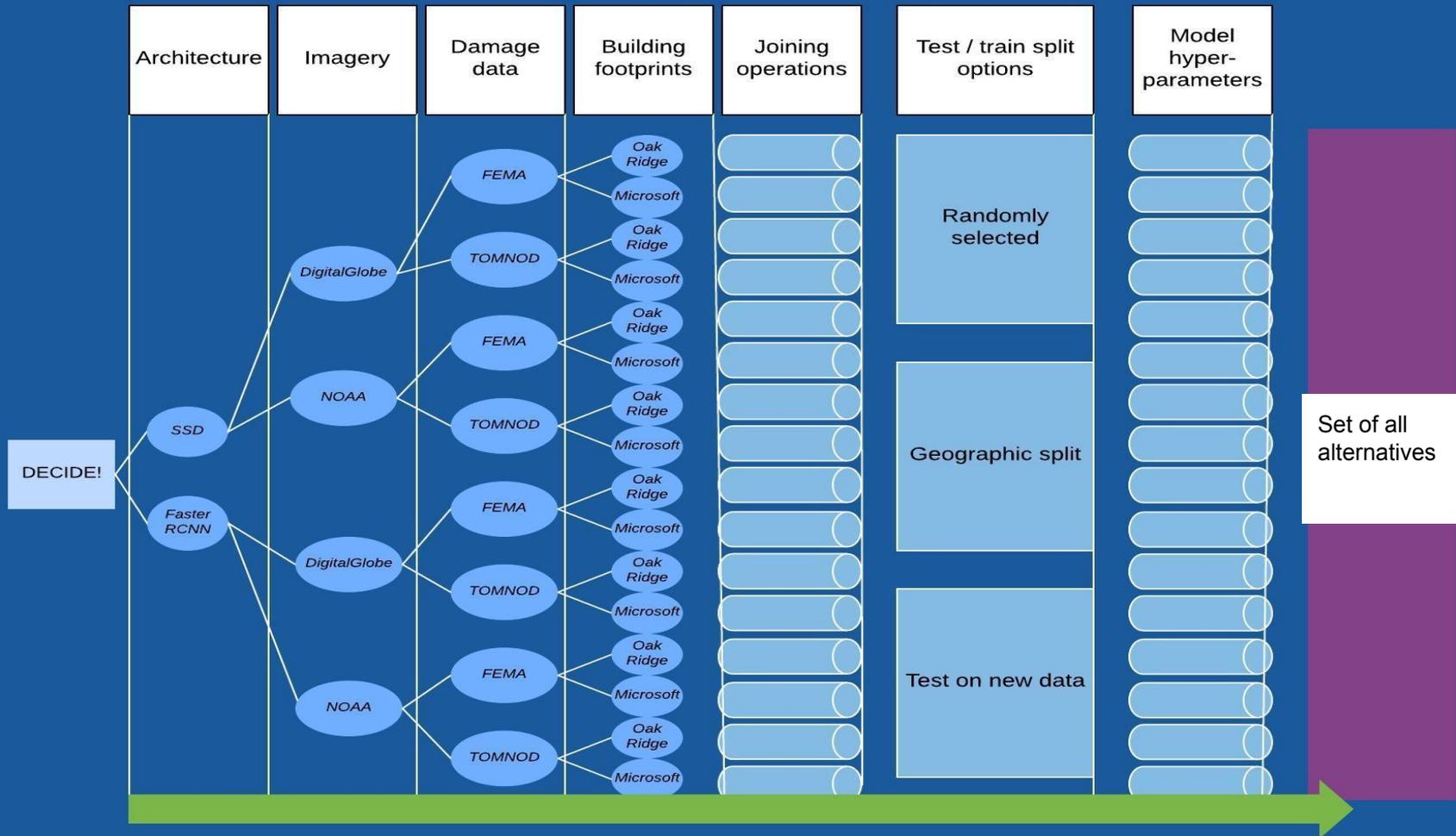


NOAA damage predictions with SSD

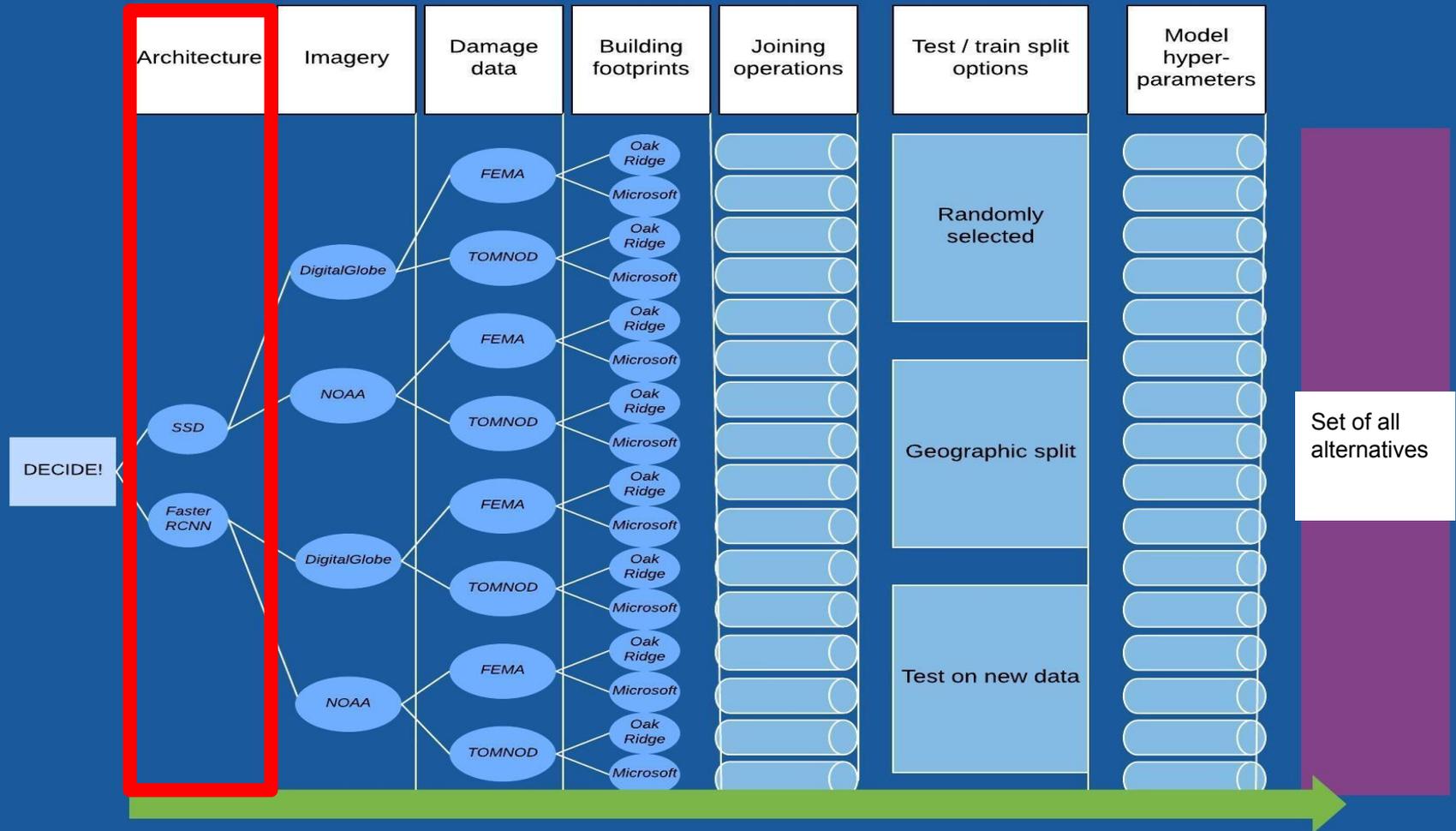
Data Processing Pipeline



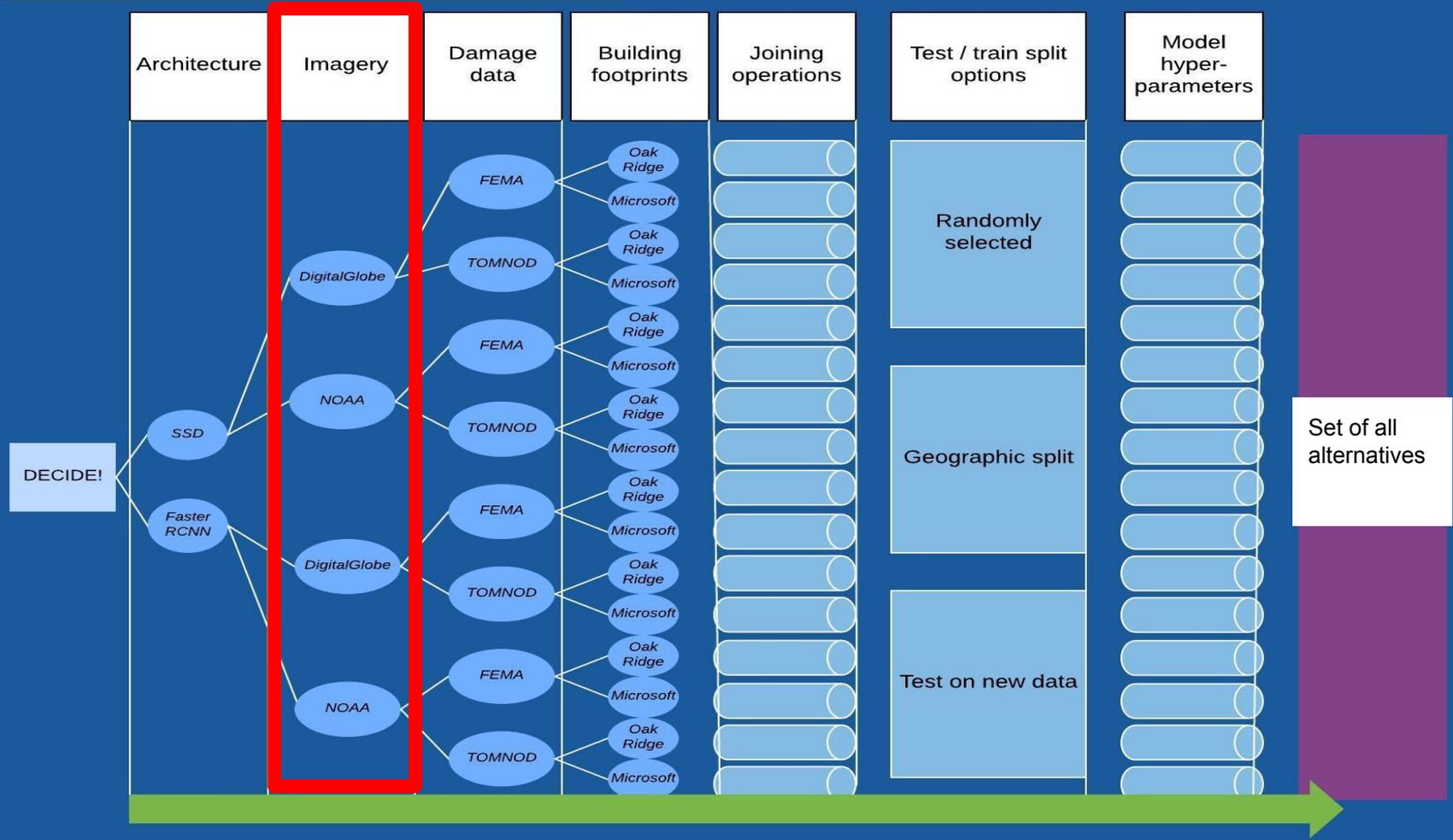
Alternatives



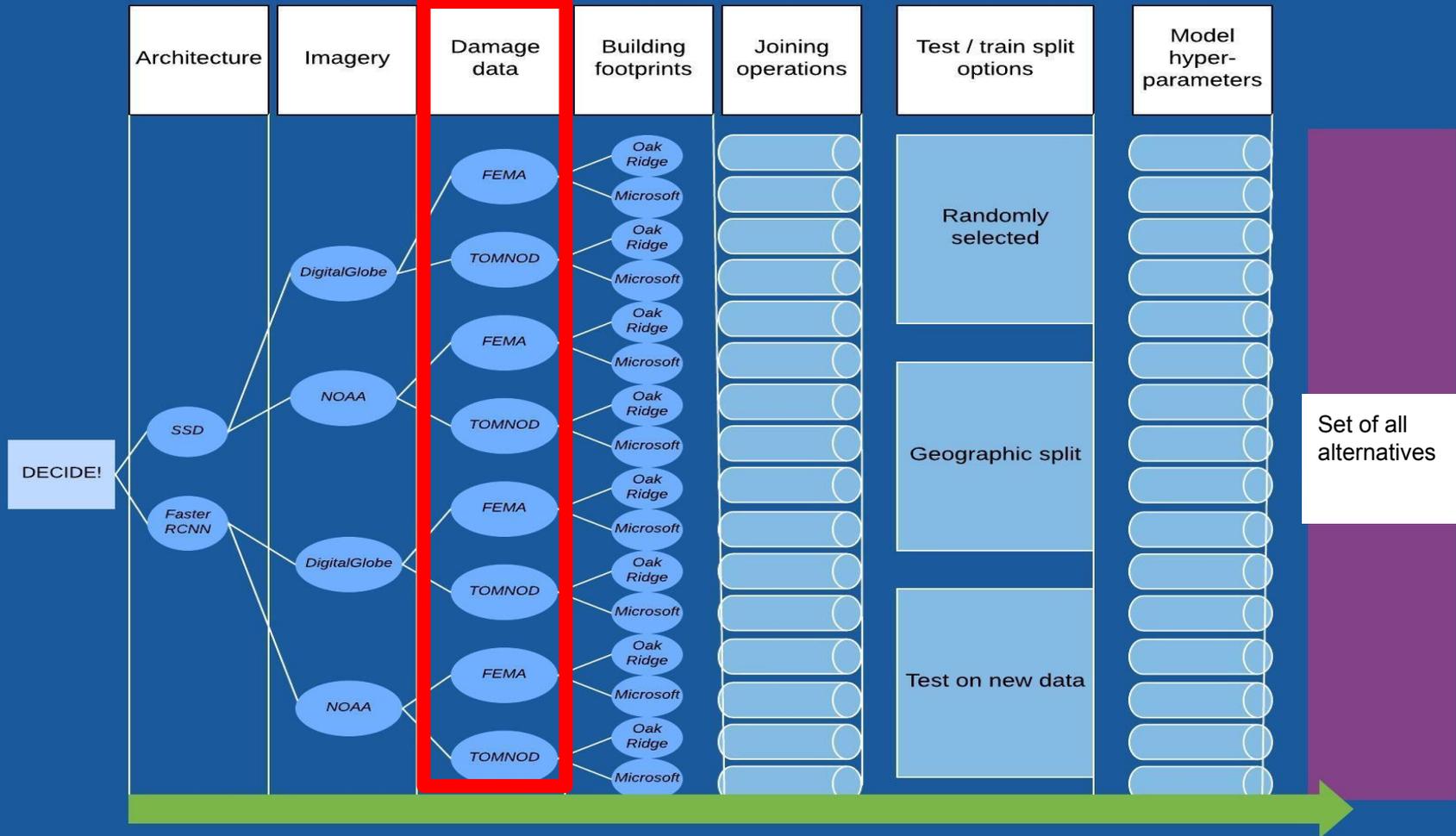
Alternatives



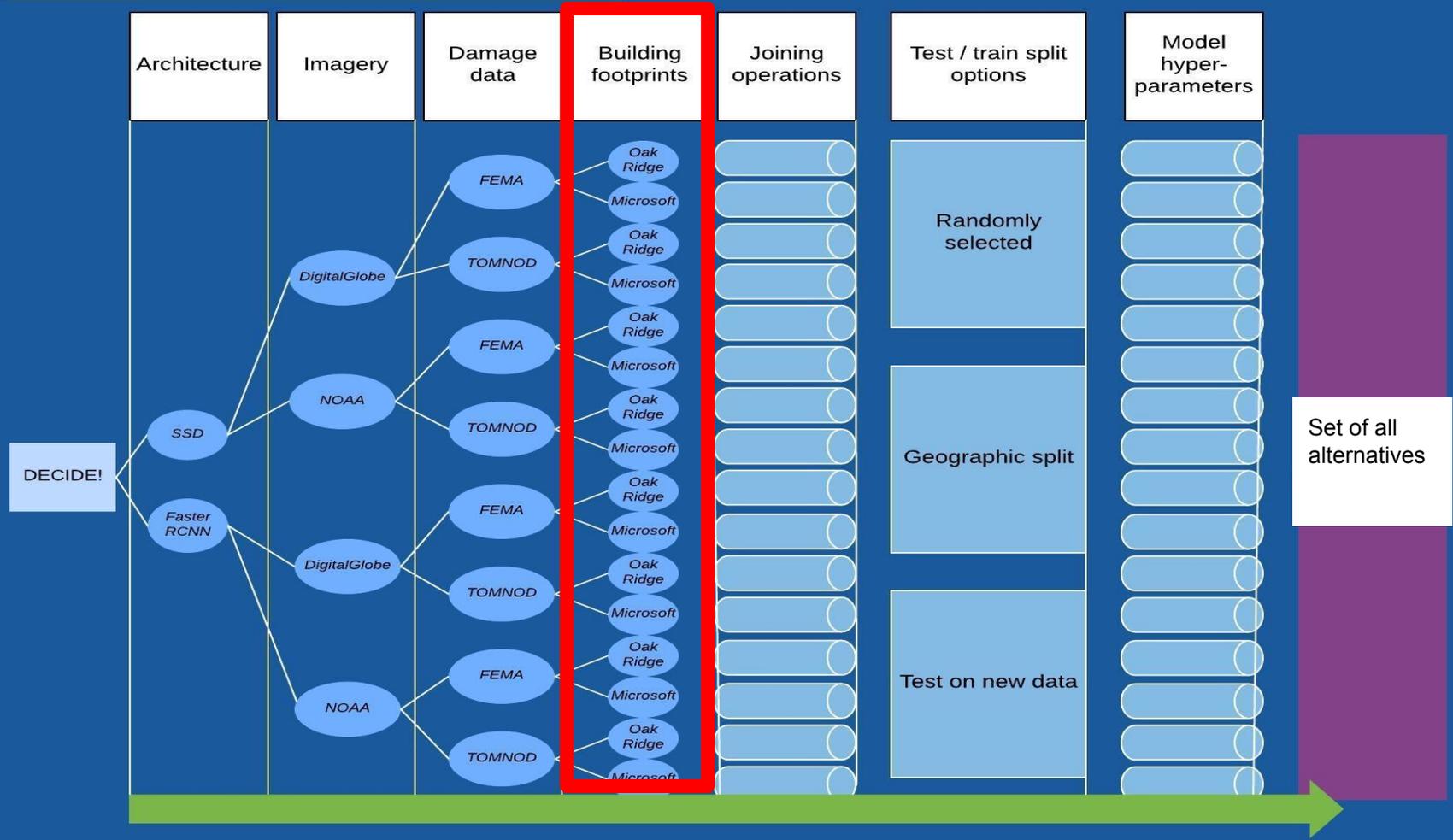
Alternatives



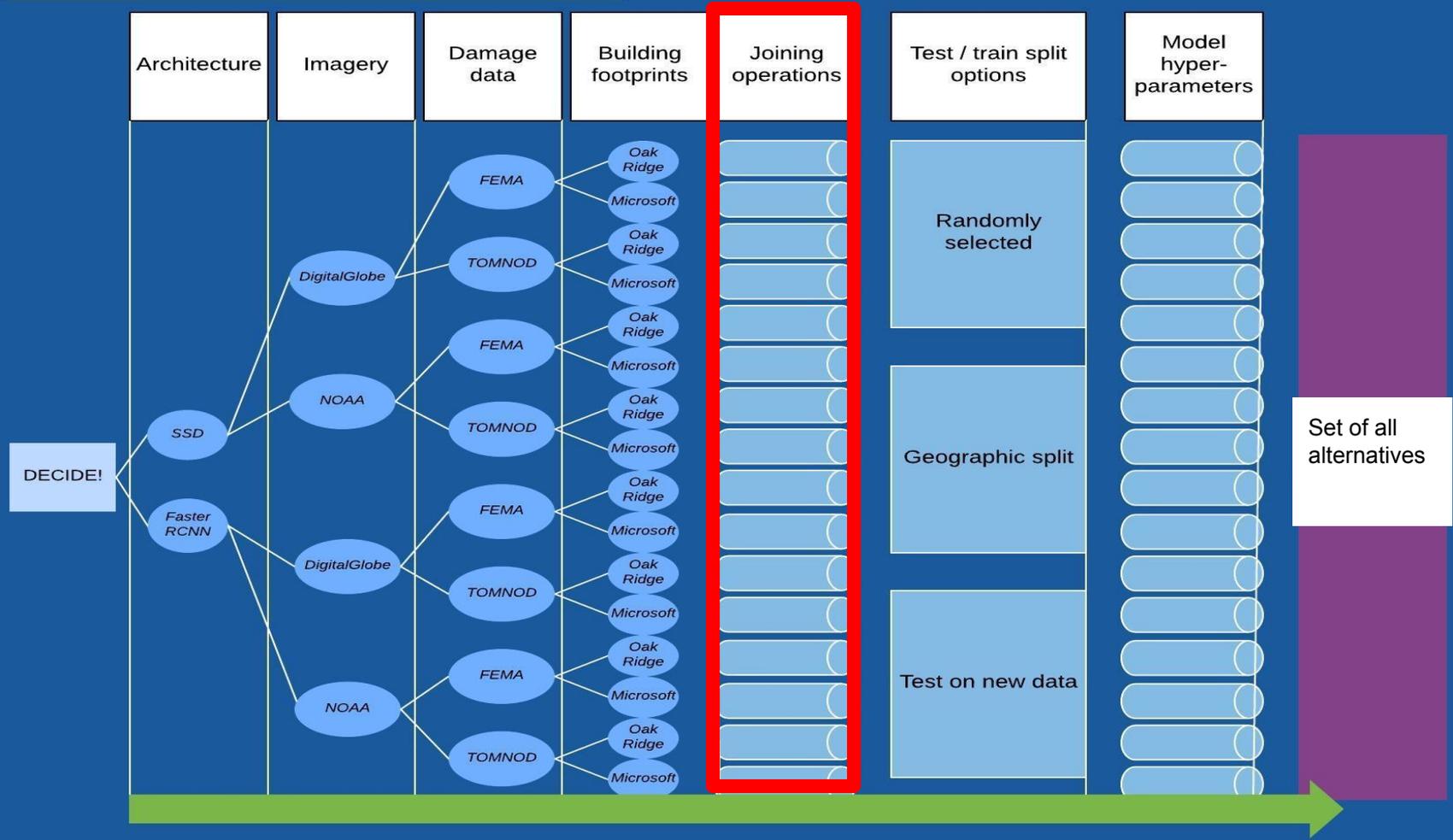
Alternatives



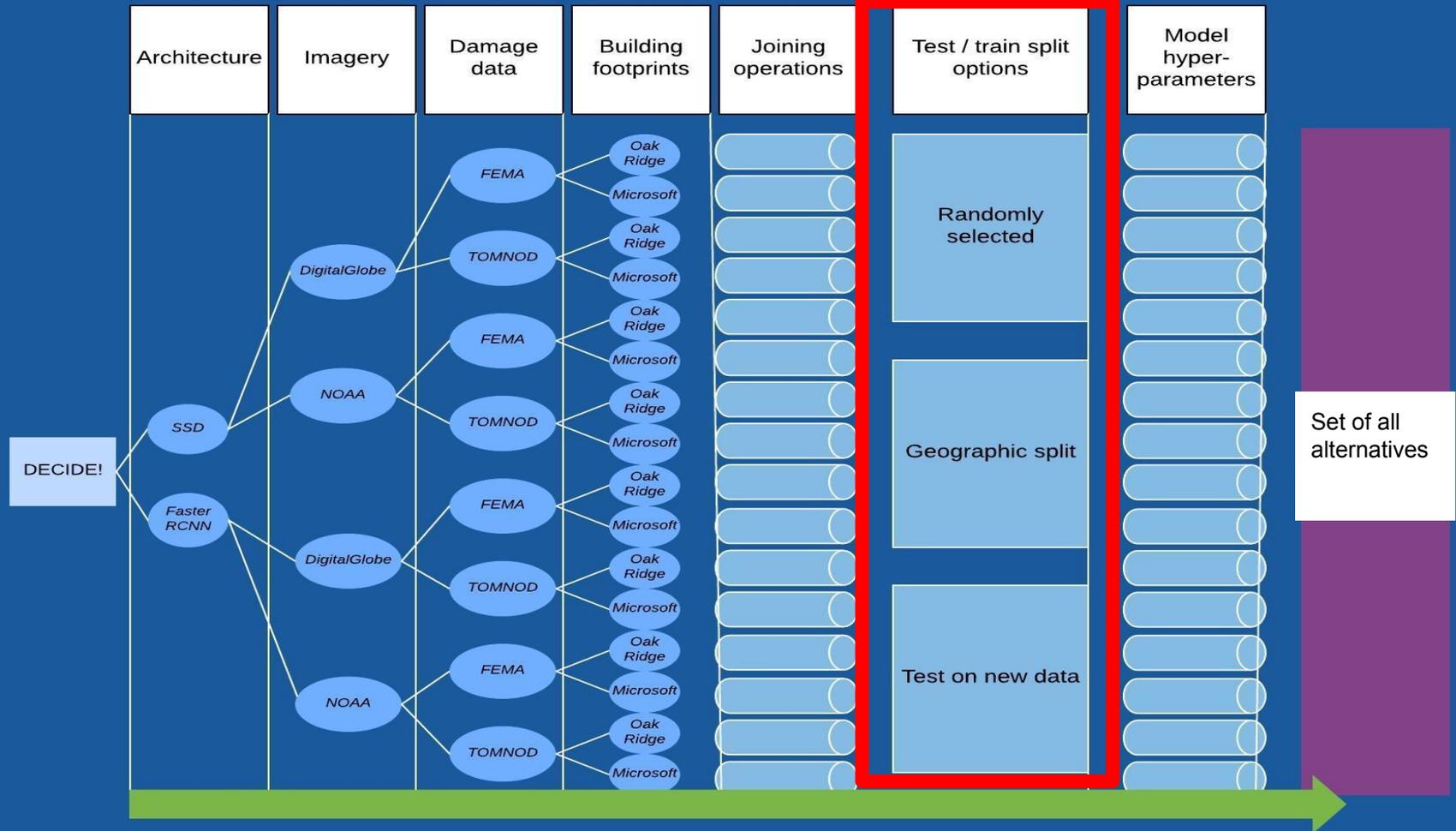
Alternatives



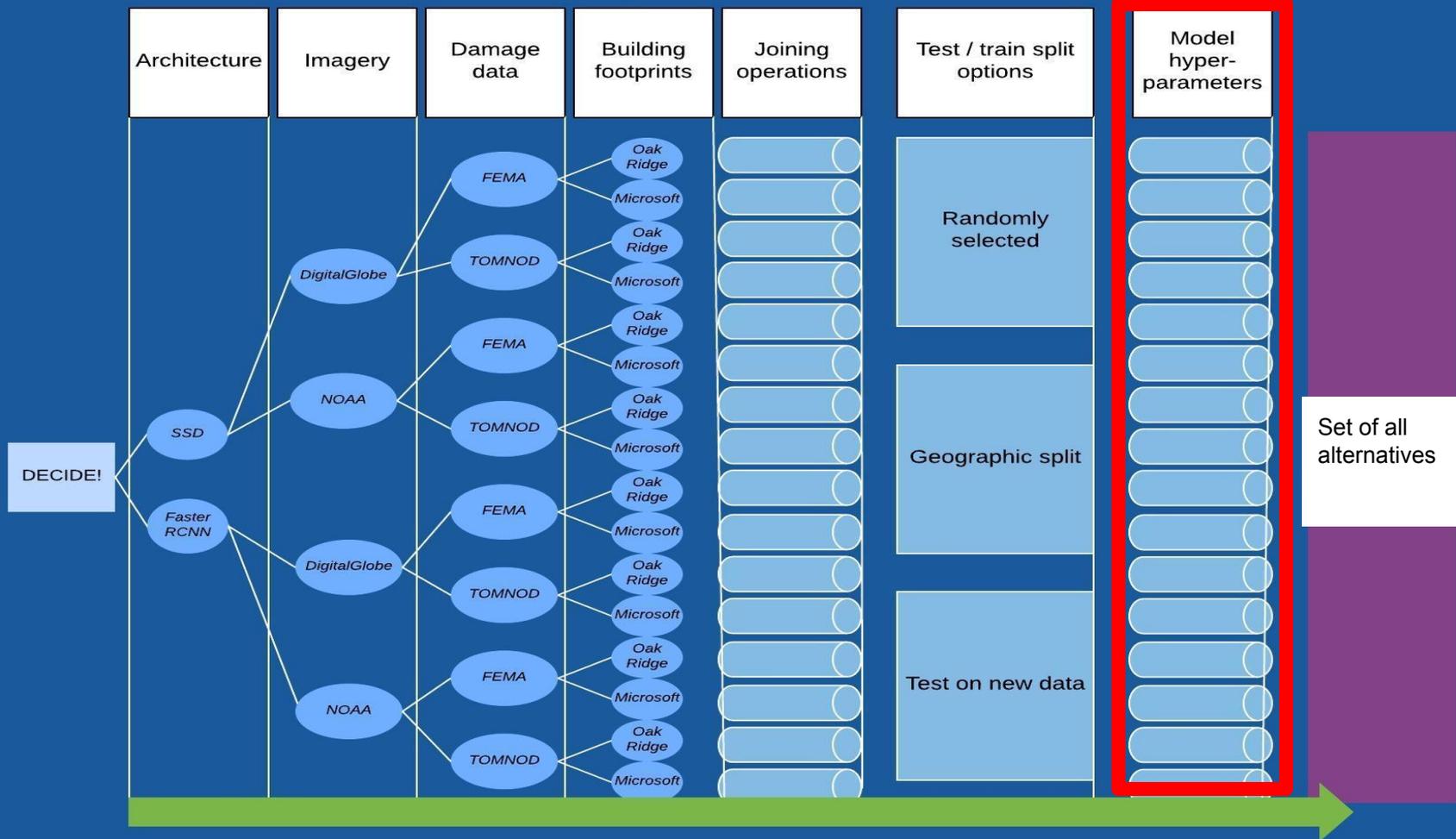
Alternatives



Alternatives



Alternatives



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

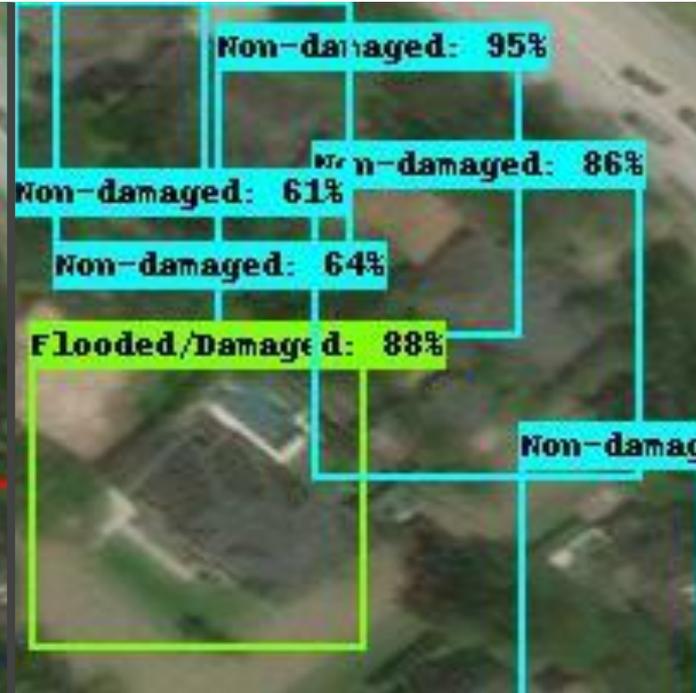
How can we represent the uncertainty to emergency responders?

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:

- easy to experiment as not charged for every action

Cons:

- 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:

- 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

Cons:

- 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:

- easy to see

Cons:

- not reproducible

Sharing is Caring

Datasets:

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

Cloud Backup:

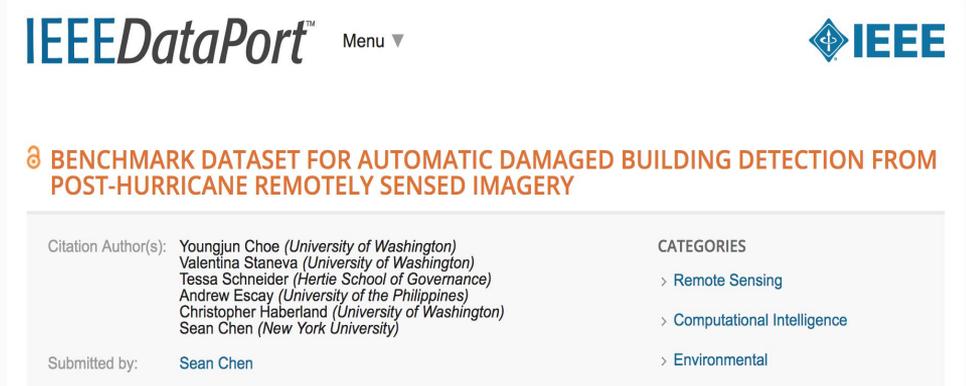
- AWS S3 bucket
- Snapshots for instances + database

Code on GitHub:

<https://github.com/DDS-Lab/>

Website:

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



The screenshot shows the IEEE DataPort website. At the top left is the "IEEE DataPort" logo with a "Menu" dropdown arrow. At the top right is the IEEE logo. The main heading is "BENCHMARK DATASET FOR AUTOMATIC DAMAGED BUILDING DETECTION FROM POST-HURRICANE REMOTELY SENSED IMAGERY". Below this, the "Citation Author(s)" section lists: Youngjun Choe (University of Washington), Valentina Staneva (University of Washington), Tessa Schneider (Hertie School of Governance), Andrew Escay (University of the Philippines), Christopher Haberland (University of Washington), and Sean Chen (New York University). The "Submitted by:" section lists Sean Chen. On the right, the "CATEGORIES" section lists: Remote Sensing, Computational Intelligence, and Environmental.

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/>

Valentina Staneva: vms16@uw.edu and Amanda Tan: amandach@uw.edu

