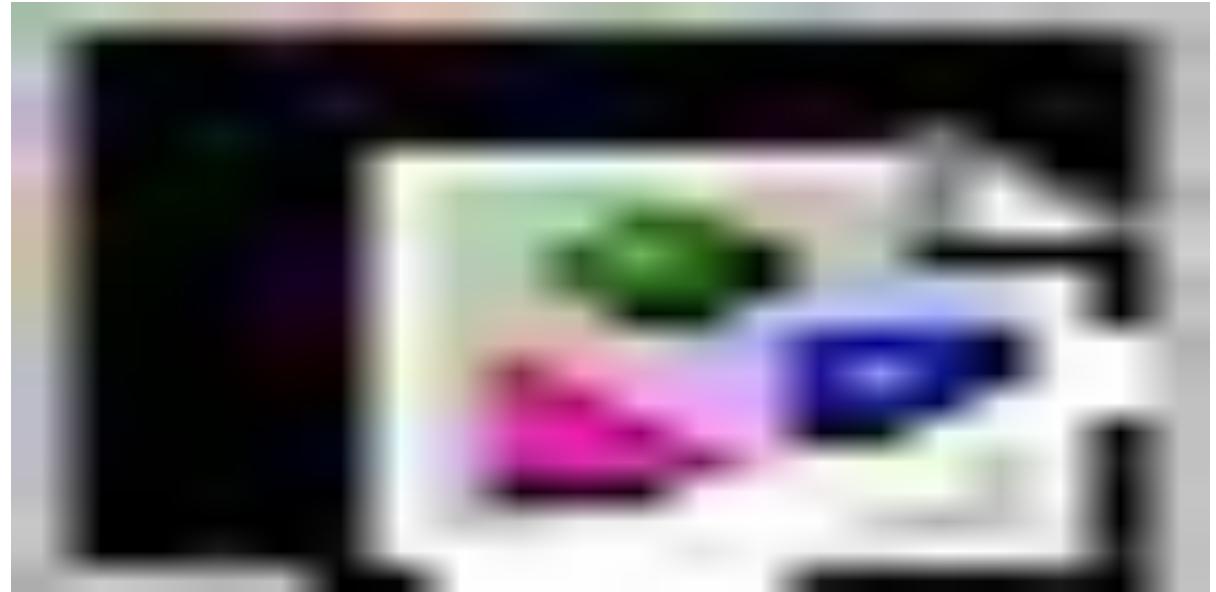
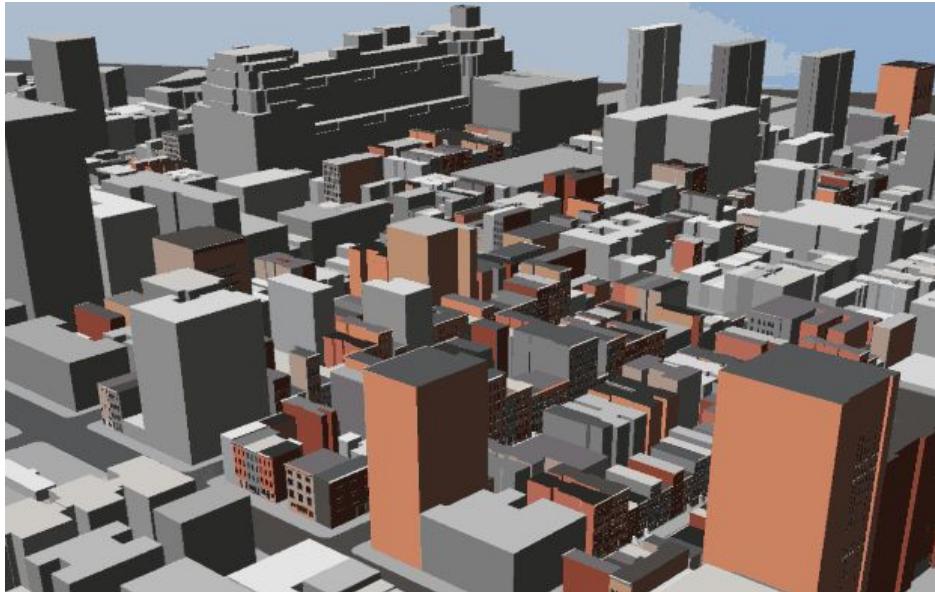




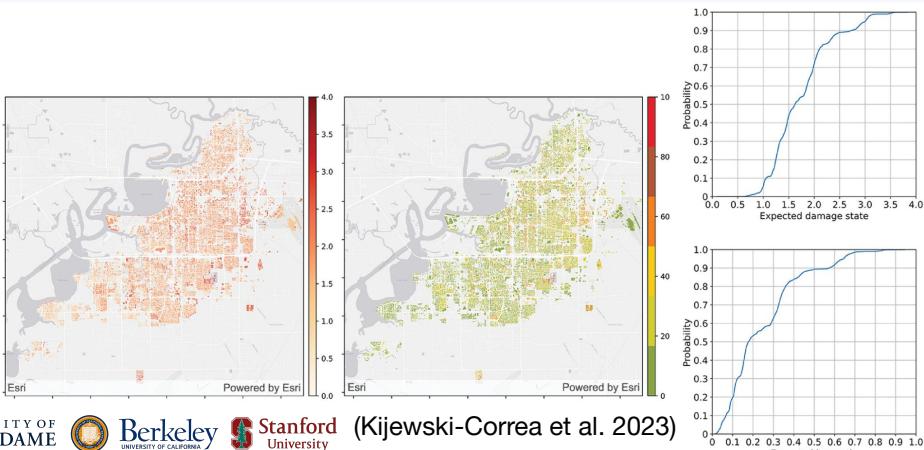
BRAILS



This material is based upon work supported by the National Science Foundation under Grant No. (1612843 & 2131111). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Use Cases

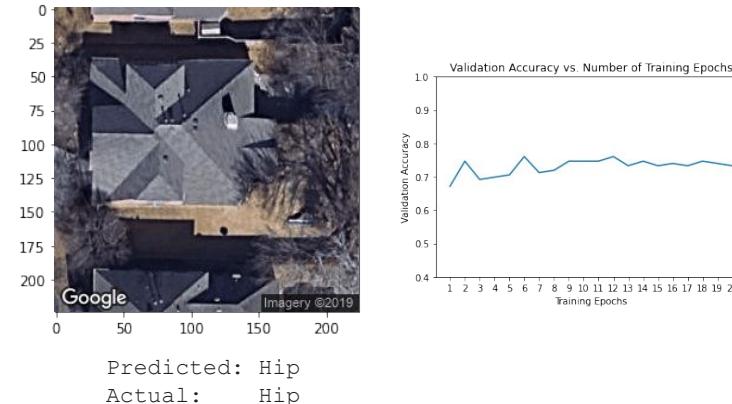
Building Inventory Generation for Regional Studies



UNIVERSITY OF NOTRE DAME Berkeley UNIVERSITY OF CALIFORNIA Stanford University

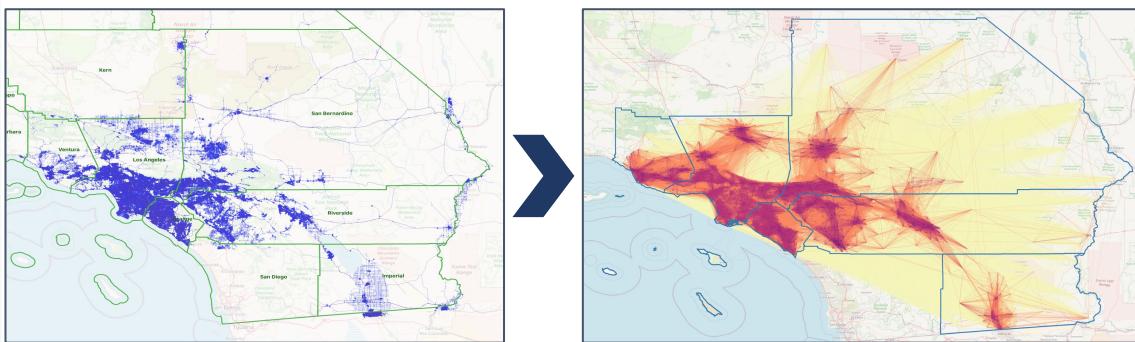
(Kijewski-Correa et al. 2023)

Custom Computer Vision Model Training



Berkeley UNIVERSITY OF CALIFORNIA

Transportation Network Extraction for Regional Studies



Berkeley UNIVERSITY OF CALIFORNIA UCLA

(Virtucio et al. 2024)

Automated Disaster Reconnaissance



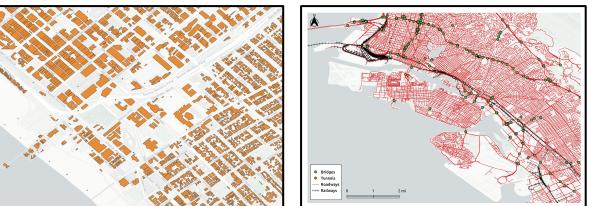
NSF RAPID NHERI
Natural Hazards Reconnaissance

Inventory Generation Using BRAILS

BRAILS: Automated Inventory Generation Using AI



BRAILS Framework



Building footprints or transportation infrastructure geometries



Building/transportation infrastructure imagery



AI-based automated feature extraction



User Input

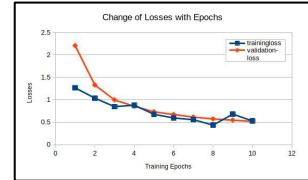
- i) Location name(s) or bounding box
- ii) User-defined inventory
- iii) NHERI RAPID Imagery



Baseline inventories from public databases



High-fidelity inventories from AI models



(Optional)
model
retraining or
fine-tuning

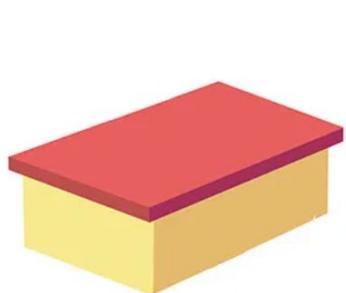
AI-Based Building Attribute Prediction Capabilities

Approach	Attribute	Output	Model Version
Image Classification	Roof Type	Flat, Gable, Hip	1.1.0
	Roof Cover	Shingles, Tiles, Metal, BUR, SPM	1.0.0
	Occupancy	Residential/Other	1.1.0
	Construction Type	Wood, Concrete, Steel, Masonry, Manufactured	1.0.0
Object Detection + Post-processing	Number of Floors	Integer	1.1.0
	Garage	Yes/No	1.0.0
	Chimney	Yes/No	1.0.0
Image Segmentation + Image Rectification + Post-processing	Building Height	Float	1.1.0
	Roof Pitch	Float	1.1.0
	Roof Height	Float	1.1.0
	First Floor Height	Float	1.1.0
	Window Ratio	Total Window Area/Facade Area	1.1.0

Inventory Generation: Roof Classification



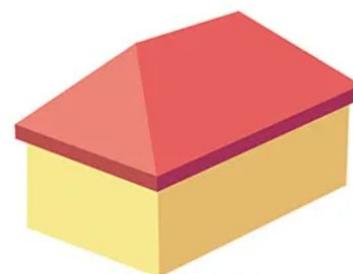
- **Roof Type:** Multi-class transformer (**BRAILS**)
- **Source Data:** Google aerial imagery
- Trained on labeled dataset of 22,800 images (85% training, 10% validation, 5% testing)
- **Output:** gable, hip or flat (HAZUS classes)
- **Performance:** 88% detection accuracy for hip and gable roofs in Lake Charles, LA (StEER)



FLAT



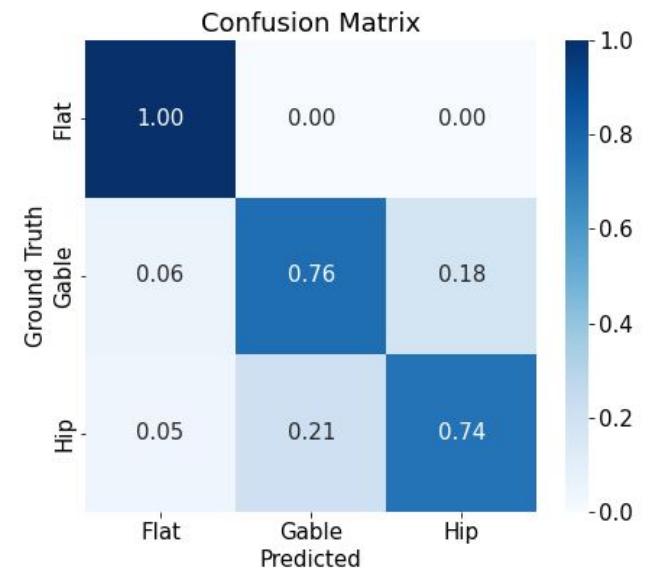
GABLE



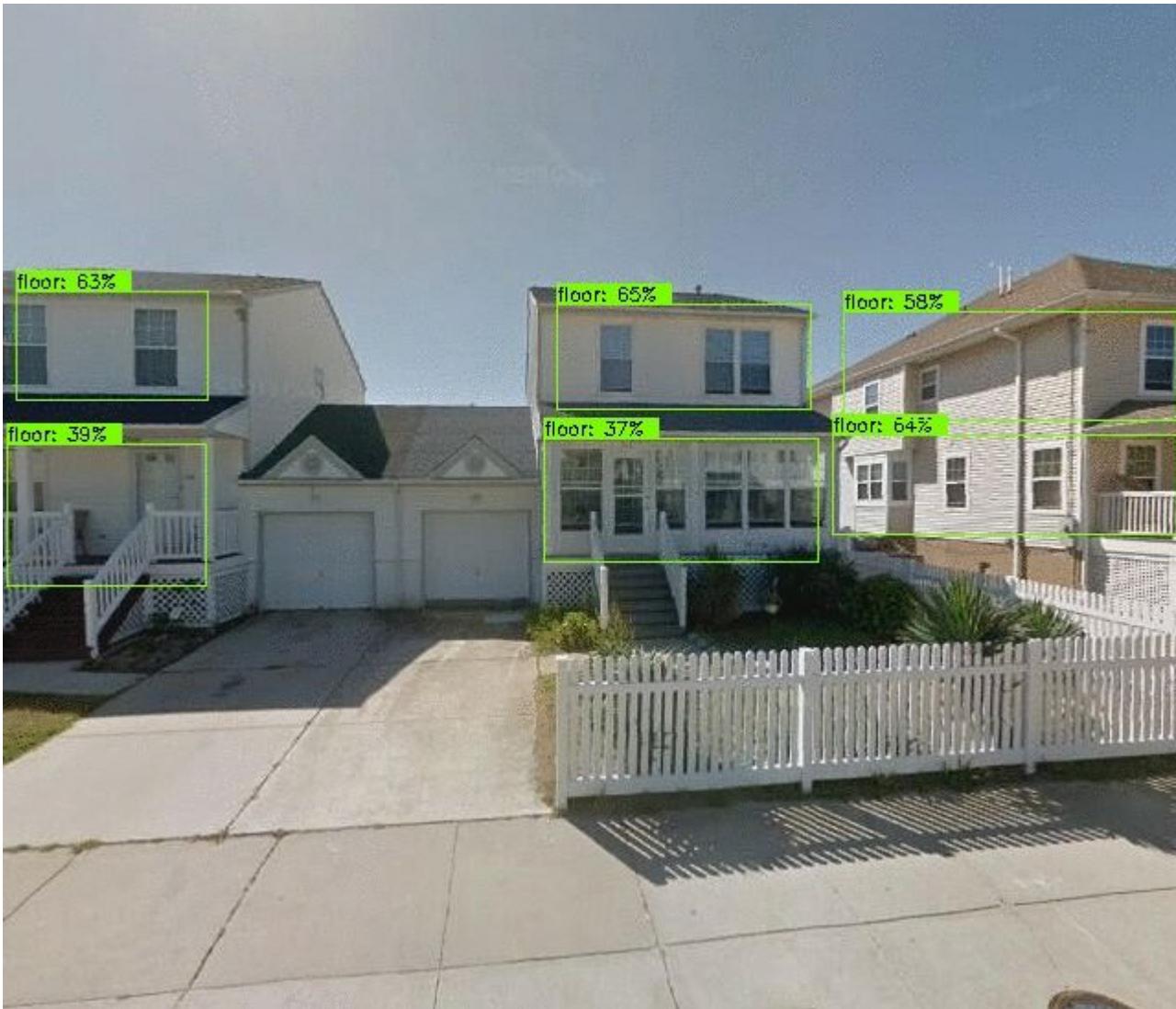
HIP



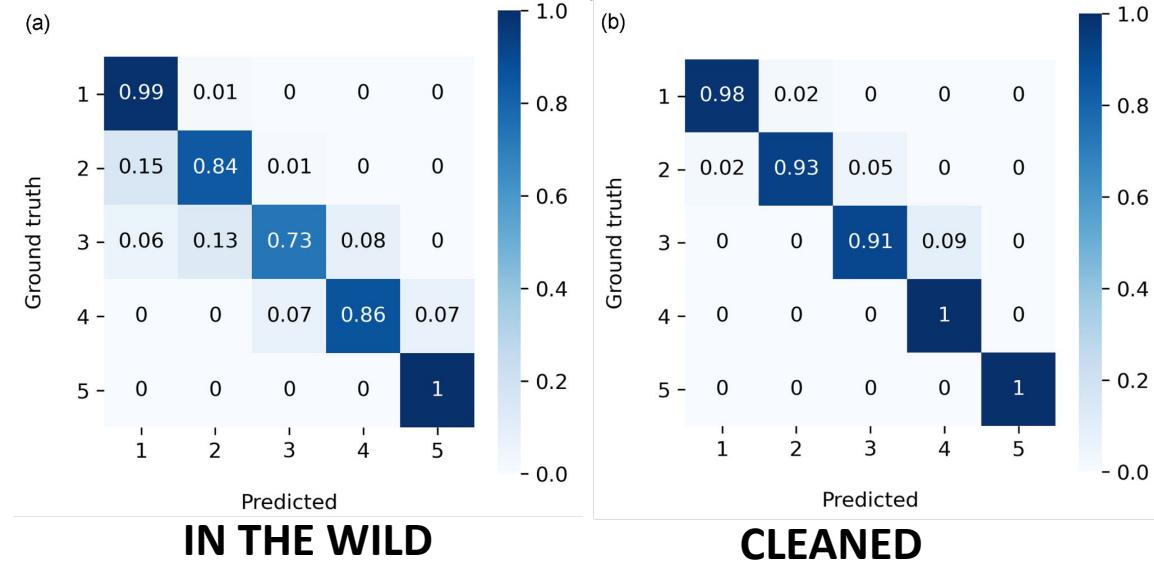
StEER
STRUCTURAL
EXTREME EVENTS
RECONNAISSANCE



Inventory Generation: Number of Floor Detection



- **Object detection model** automatically detect rows of building windows (**BRAILS**)
- Trained on dataset of 60,000 images (80% training, 15% validation, 5% testing)
- **Output:** bounding box with confidence level
- Number of stacked bounding boxes indicates number of stories
- **Performance:** Identified accuracy on 3,000 Google Street View images in Atlantic County, NJ of 86% (wild) and 95% (clean)



Inventory Generation: Elevations & Window Area



- Semantic segmentation model automatically detects the pixels that can be used for the predictions (**BRAILS**)
- Once coupled with an image rectifier and a scale determination algorithm (**BRAILS**) all metric quantities can be extracted
- Trained on dataset of 5,000 images (80% training, 15% validation, 5% testing)
- **Output:** First floor elevation, building height, roof eave height, roof pitch, and window area
- Distance from ground to bottom of door gives the foundation height.
- Distance between the ground level to the bottom or top of the roof gives the roof eave height or the building height
- Ratio between the facade and window pixels give the window area
- Roof height divided by the roof run yields the roof pitch

Public Datasets Integrated Into BRAILS

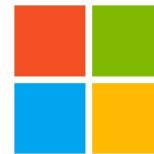
Building Footprints & Attributes

OpenStreetMap
Microsoft Global Footprints
FEMA USA Structures



GOOD TO KNOW!

You can also ingest
user-specified building
footprints and inventory data
into BRAILS!

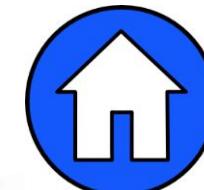


FEMA



Transportation Inventories

US Census TIGER/Lines
National Bridge Inventory
National Tunnel Inventory
OpenStreetMap



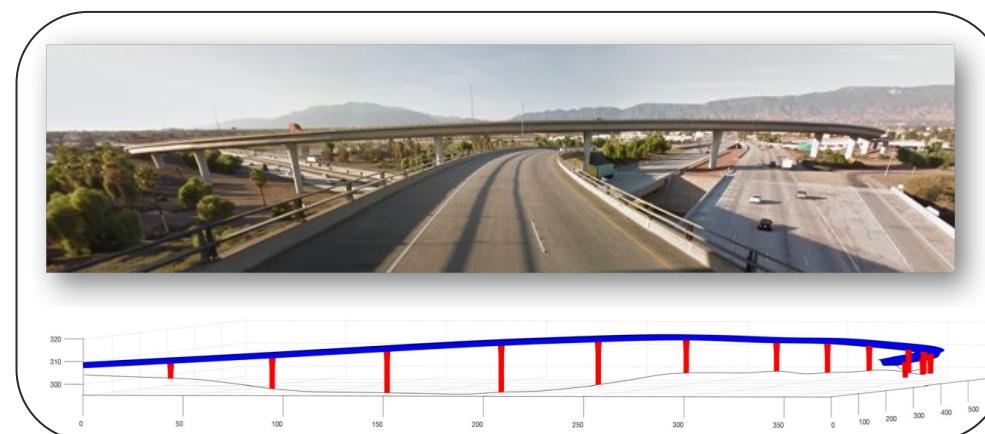
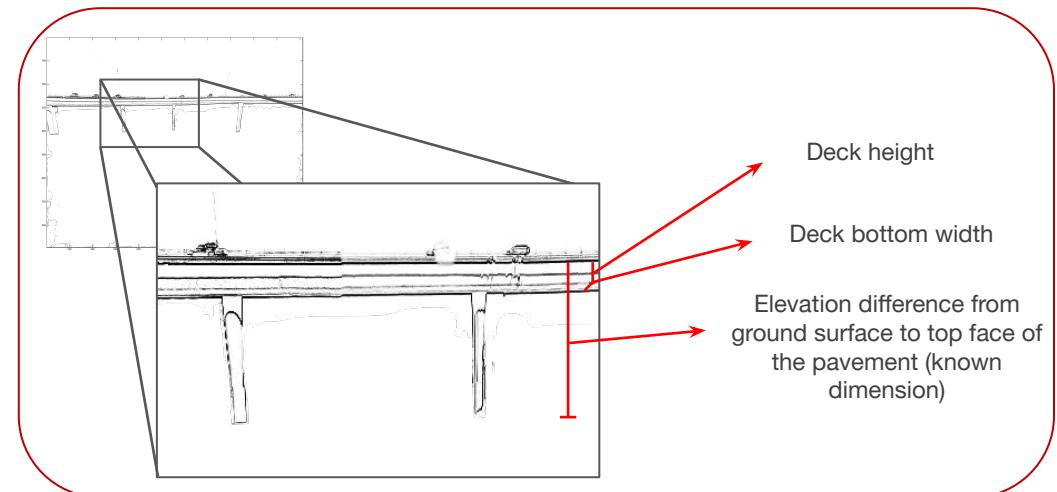
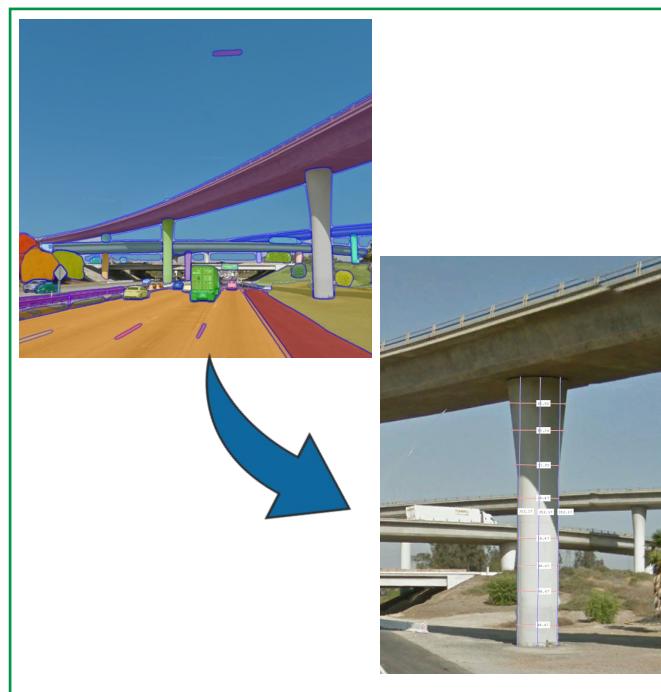
Building Databases

National Structure Inventory

Upcoming: AI-Based Bridge Inventory Generation

Bridge Geometry Extraction

3D bridge models obtained by coupling dimensions obtained from Google Street View images, bridge centerline derived from satellite images/OSM, ground elevation data



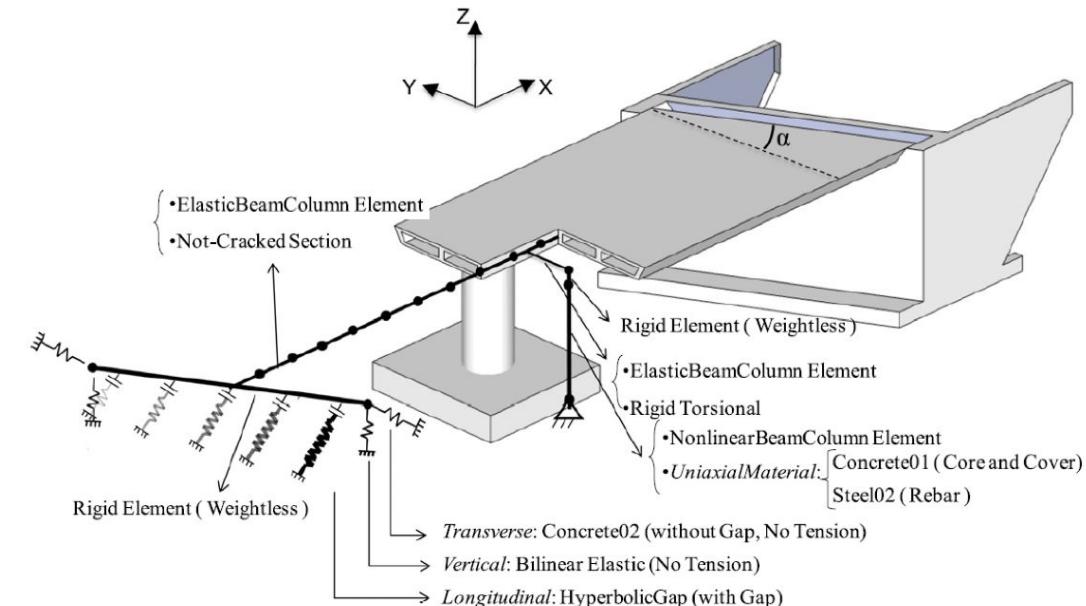
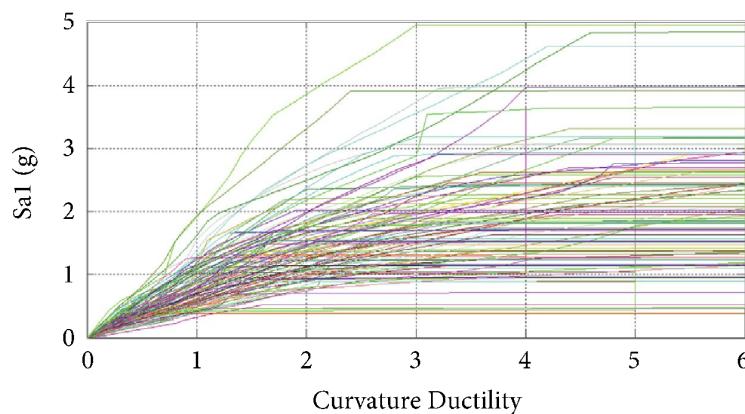
Granular Bridge Models for Natural Hazards Studies

Bridge Geometry Extraction

3D bridge models obtained by coupling dimensions obtained from Google Street View images, bridge centerline derived from satellite images/OSM, ground elevation data

Bridge Model Generation

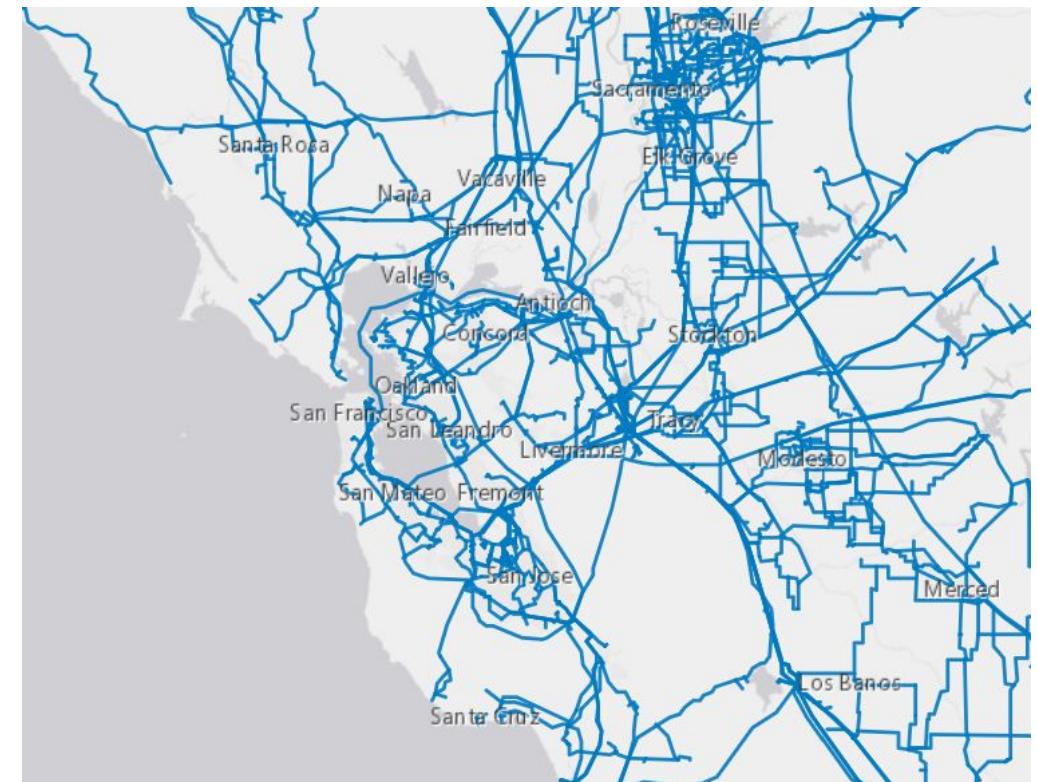
Model multiple realizations of the extracted bridge geometry using statistical distributions of structural properties, simulate their response to the determined loads



Transverse steel reinforcement ratio

Design Era	Distribution				
	Type	Mean	Standard Deviation	Lower Bound	Upper Bound
Pre-1971	#4 @ 12 in. irrespective of the cross-section				
Post-1971	Uniform	0.85	0.07	0.4	1.3

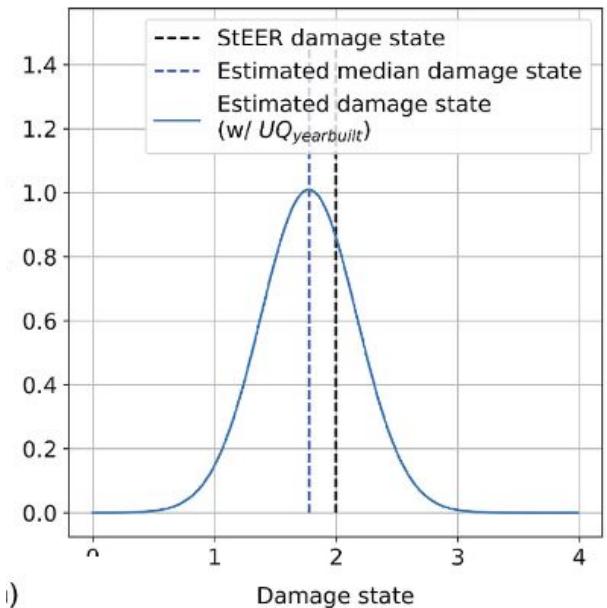
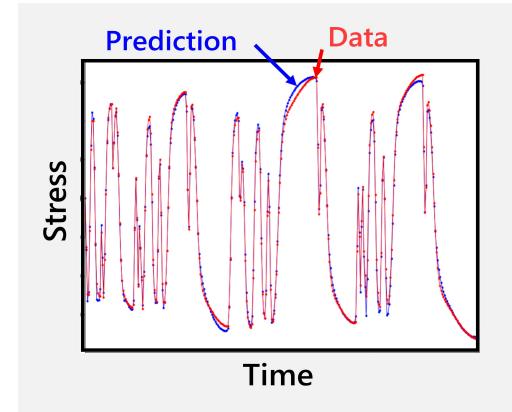
Upcoming: Support for Power Systems



Tools for NHERI RAPID Data

Model Validation/Calibration

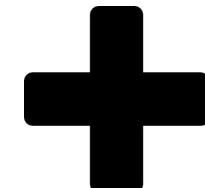
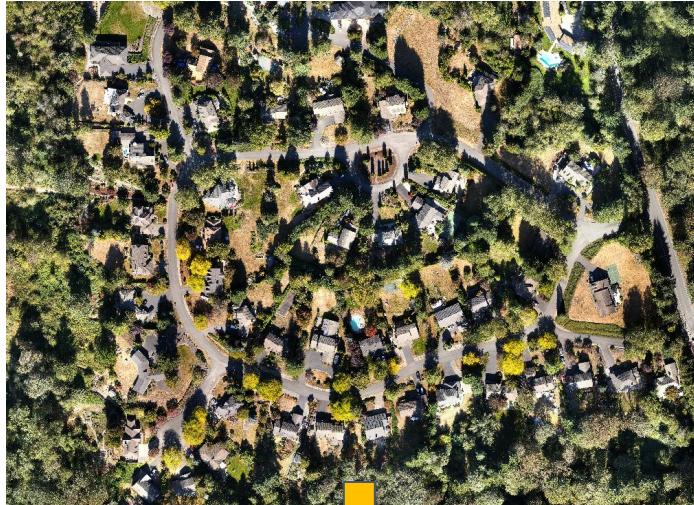
- RAPID data provides ground truth for validation and calibration of engineering models
- Using SimCenter tools and RAPID data, various models for natural hazards engineering can be validated/calibrated with state-of-the-art methods



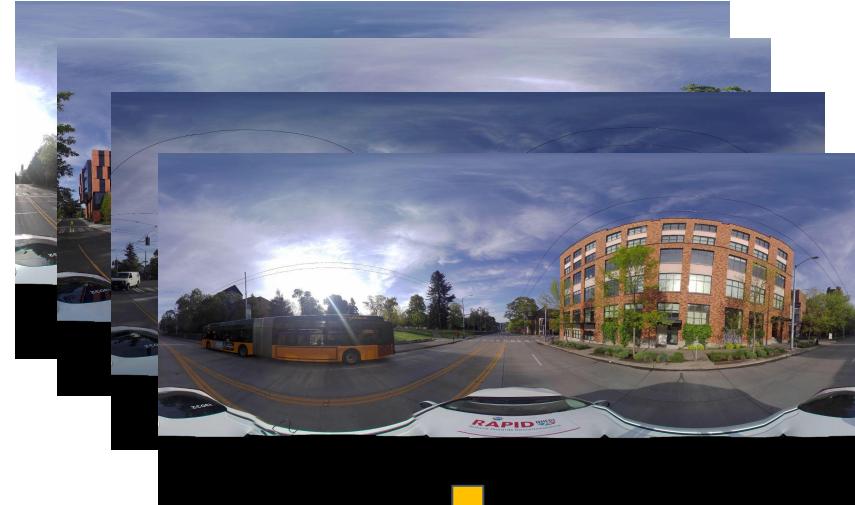
Using NHERI RAPID Data with BRAILS

Automated building-specific aerial and street-level imagery extraction from RAPID data

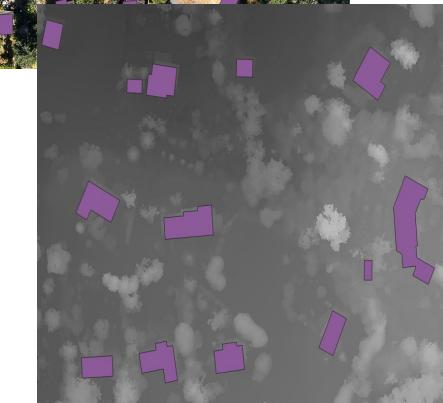
RAPID Geotiff Data



RAPID High-res Panos

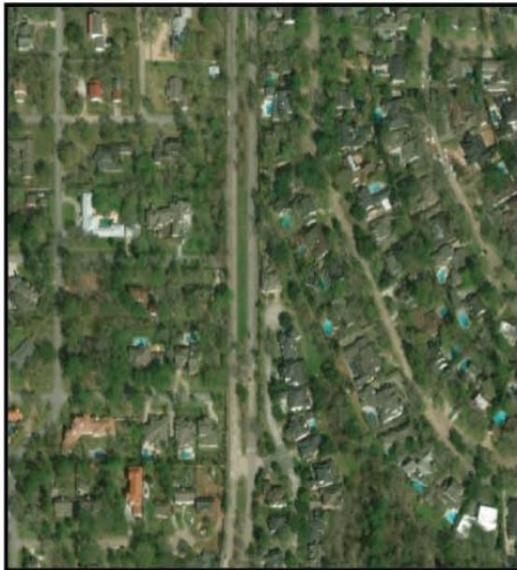


High-fidelity building inventories



Automated Disaster Damage Detection from Aerial & Street-Level Imagery

Pre-disaster



Post-disaster



Labeled imagery
(ground truth)

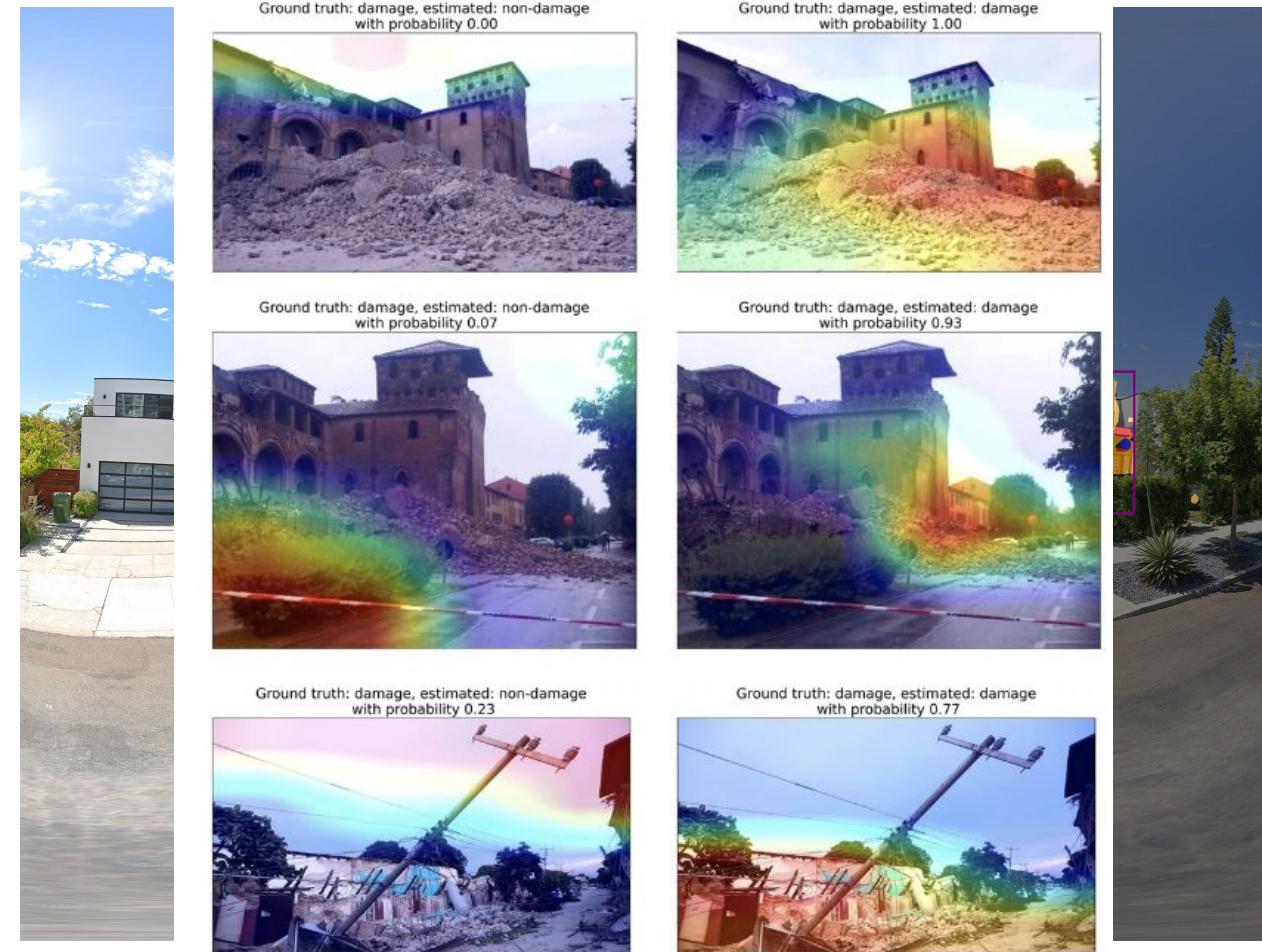


Damage assessment
from xView 2 model



Upcoming Functionalities for RAPID Data

- Damage detection from fusion of aerial and street-level imagery
- Computing metric features from imagery



Questions?



Feedback & Suggestions?

