SimCenter NHERI

Center for Computational Modeling and Simulation

2021 AI Bootcamp

Introduction to SimCenter

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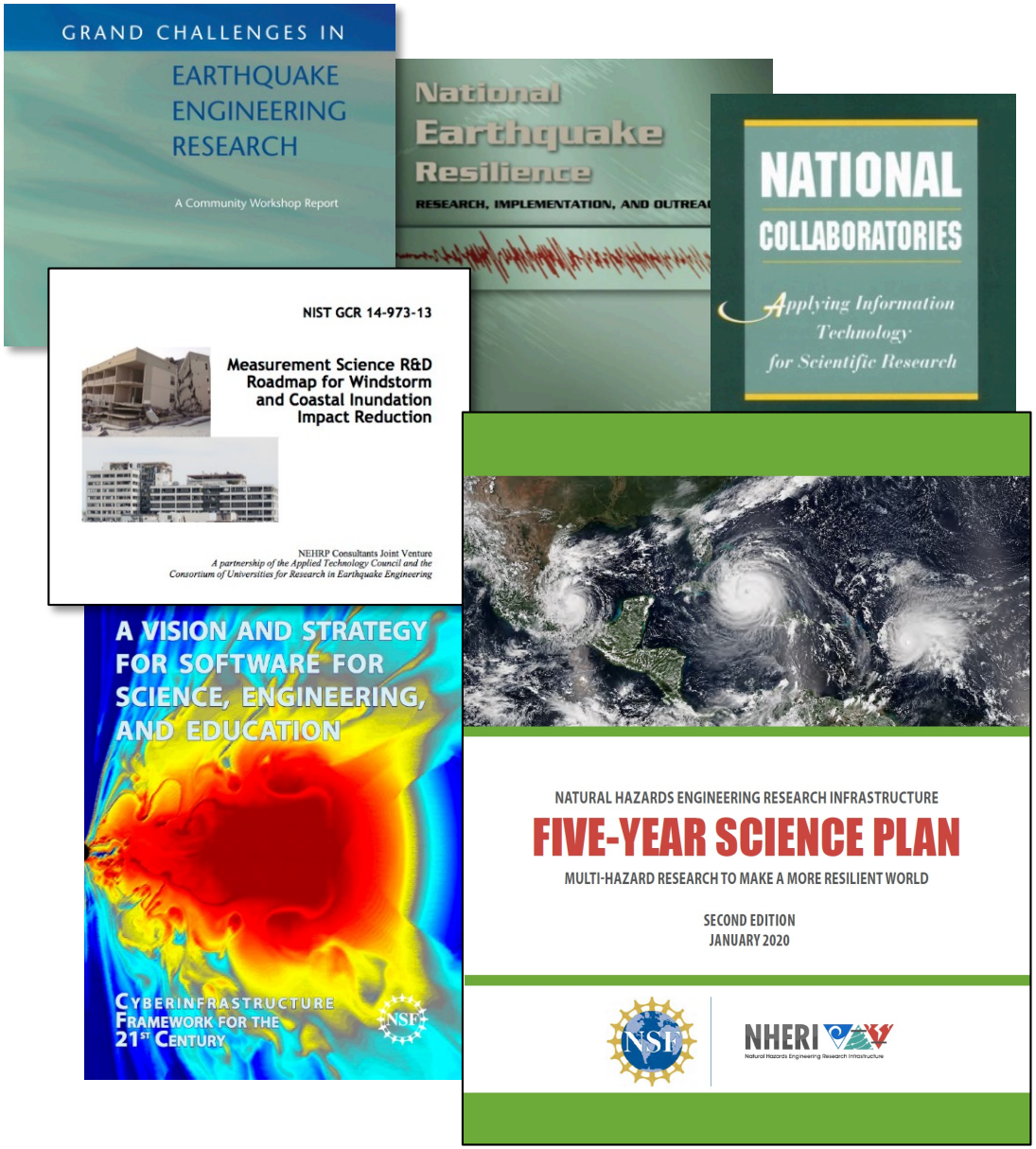
University of California, Berkeley

NSF award: CMMI 1612843

NHERI Natural Hazards Engineering Research Infrastructure

NSF's Facilities/Programs

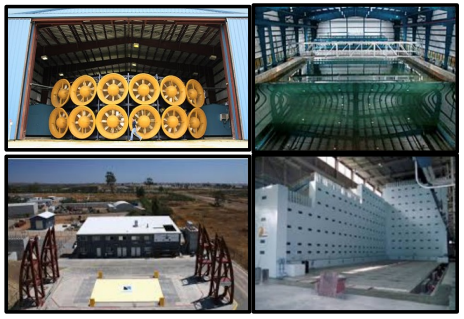
NSF NHERI Science Plan



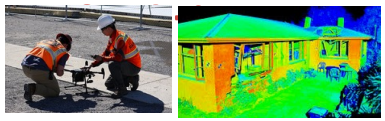
Grand Challenges:

1. Quantify the damaging characteristics of earthquakes, windstorms, and associated hazards—tsunamis, storm surge, and waves
2. Assess the physical vulnerability of civil infrastructure and the social vulnerability of communities
3. Develop technologies and engineering tools to design, construct, retrofit, and operate resilient and sustainable infrastructure

SimCenter Within NHERI



Experimental



Rapid facility

DESIGNSAFE-CI
A NATURAL HAZARDS ENGINEERING COMMUNITY

Data Storage

HPC

Agave Platform

TACC web API

SimCenter NHERI
Center for Computational Modeling and Simulation

Cloud-enabled research applications
Scalable to run on HPC with emphasis on UQ

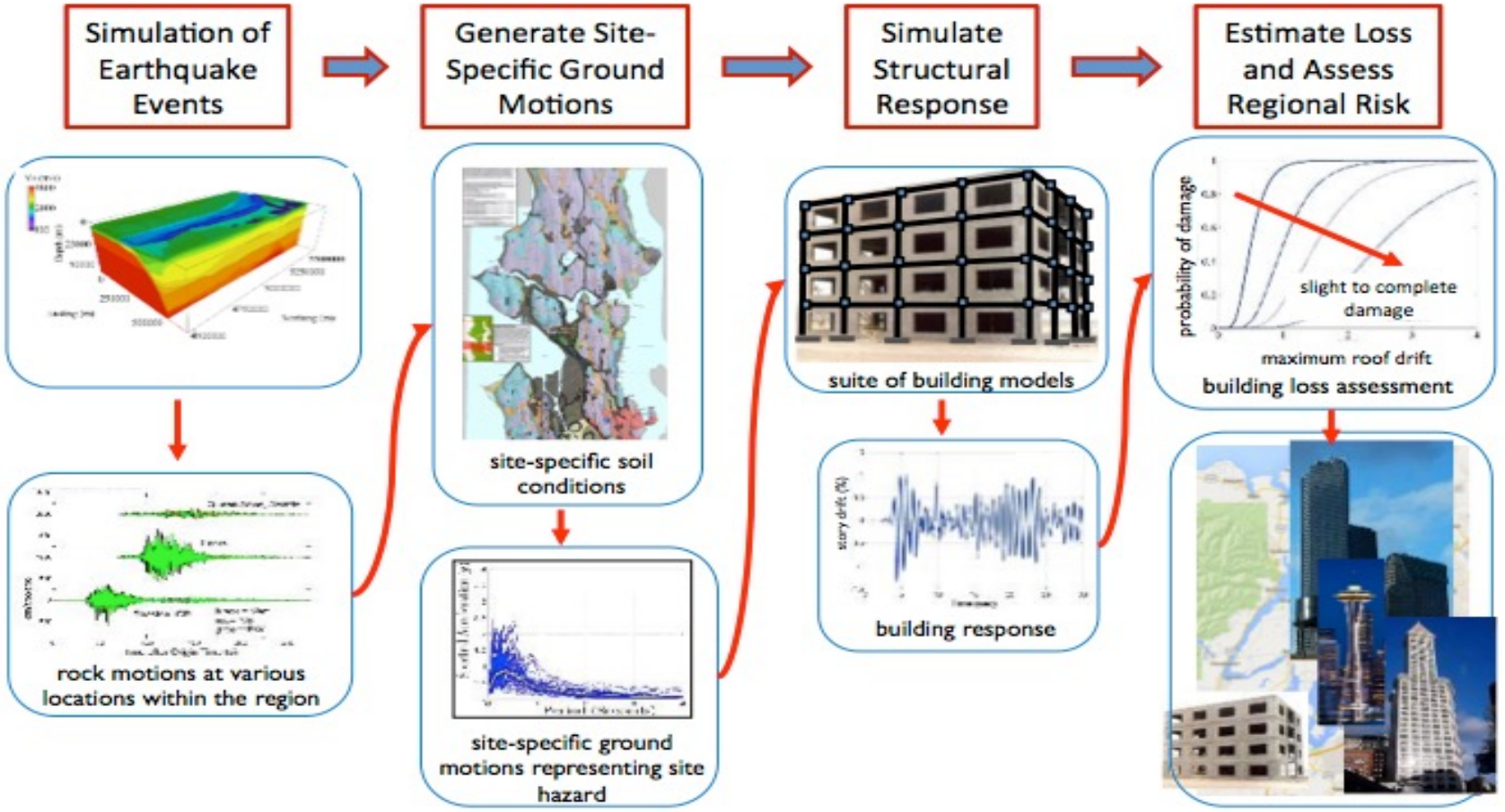
Front-end

SimCenter Research Applications

UQ FEM | PBE | EE-UQ | CWE-UQ

We are a Virtual EF

Workflow for Performance-Based Engineering



Scientific Workflow Systems

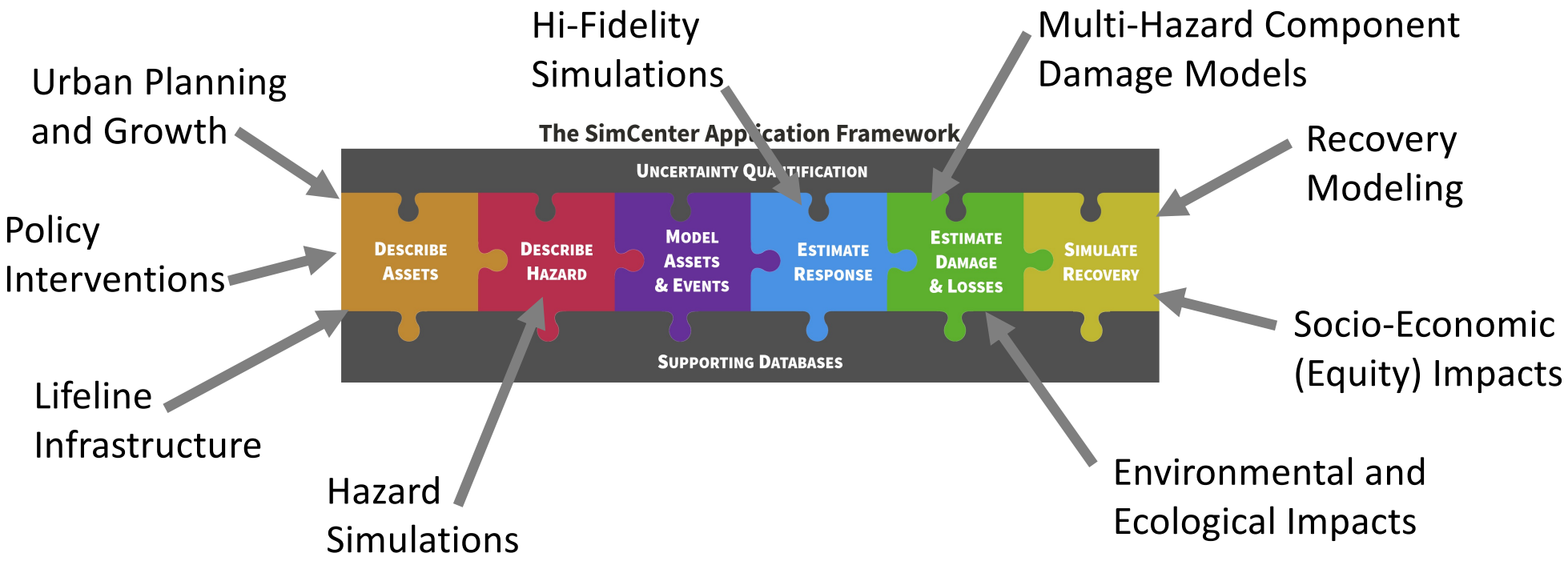
An application or application to aid a user in set-up, schedule, run and monitor the in-silico running of a workflow in which software launches the different applications processing outputs from one application into inputs needed by the next application.

Computational Framework

- Develop an **open-source computational framework for building scientific workflow applications** to support decision-making to enhance community resilience to natural hazards **in the face of uncertainty**;
- **Design a framework** that is sufficiently **flexible, extensible, and scalable** so that any component of it can be enhanced to improve the analysis and thereby better meet the needs of the community;
- **Seed the framework** with enough **data** and **interfaces to existing simulation applications** so that it can be employed in the near-term;
- **Release scientific workflow systems built using this framework** that meets the computational needs of researchers in natural hazards engineering;
- **Provide an ecosystem** that fosters collaboration between scientists, engineers, urban planners, public officials, and others who seek to improve community resilience to natural hazards.

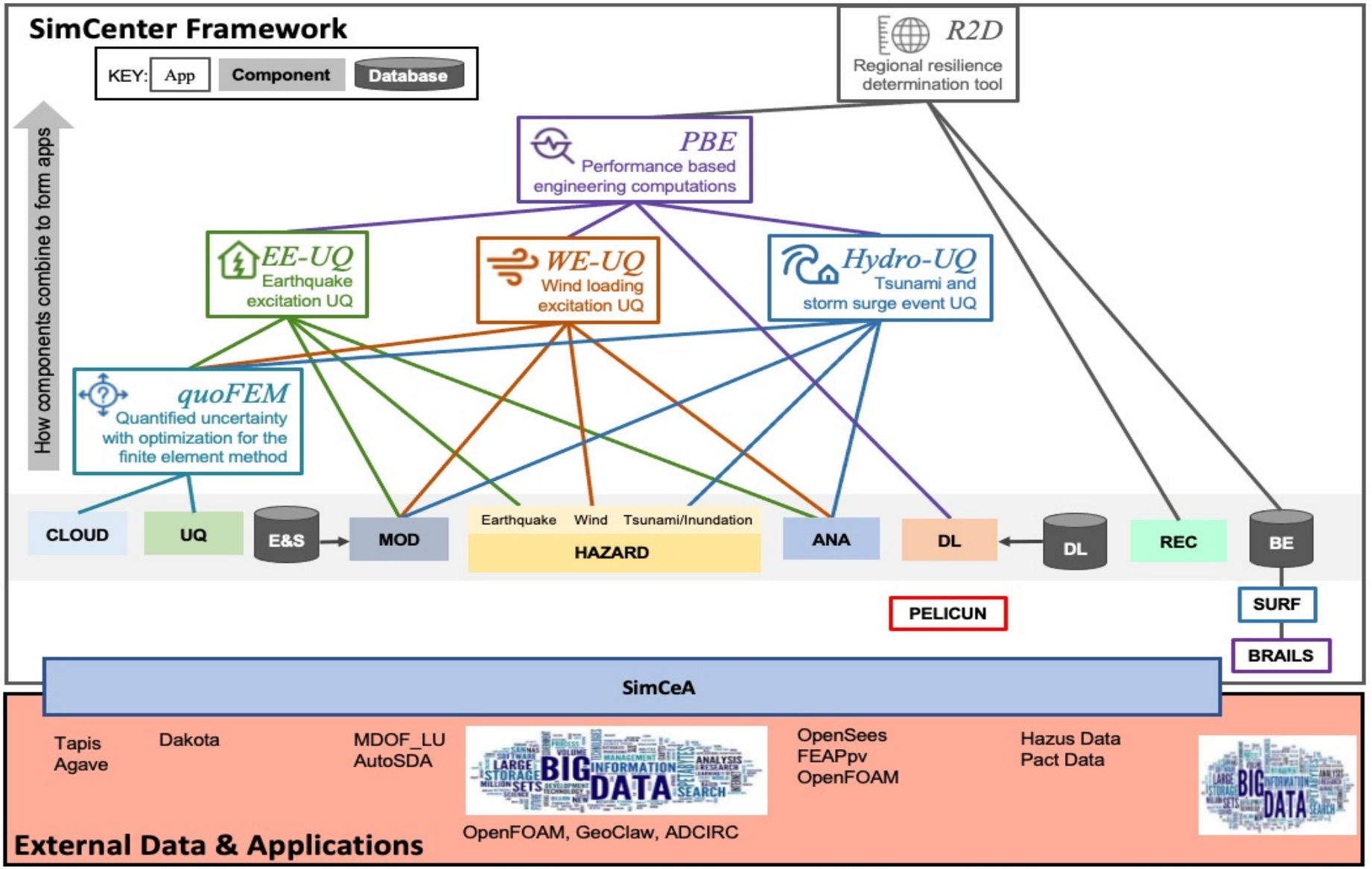
Computational Framework

Develop an Extensible computational workflow to develop and share models and data to simulate natural hazard effects and design communities to be more resilient



Learn more at: https://simcenter.designsafe-ci.org/

Computational Framework



Scientific Workflow Applications

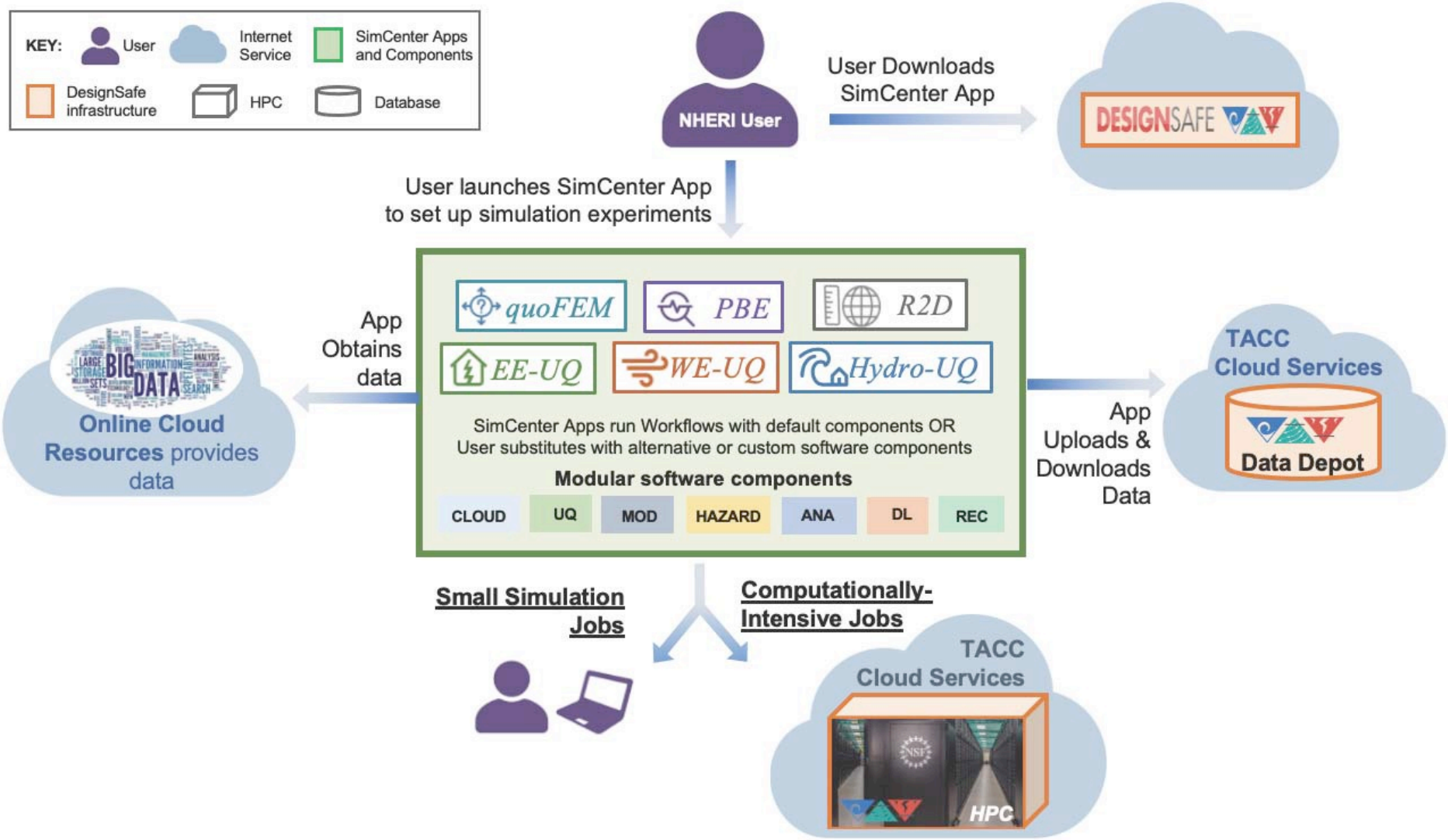
Coupling: Quantification of Uncertainties & Optimization with FEM

Response of structure to natural hazard effects: ground shaking, wind effects, and surge/tsunami flows

Performance-based computations of individual facilities to natural hazards

Regional assessment of facilities and systems to natural hazards to support resilience decision making

Computational Framework



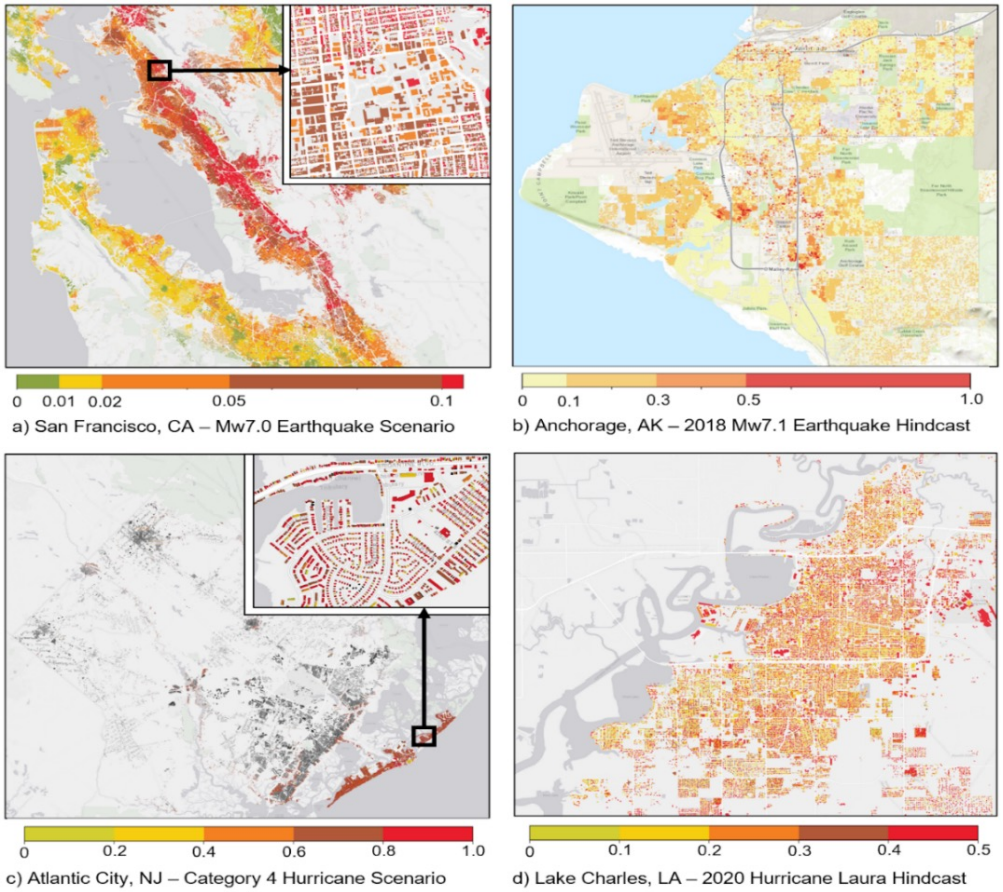
Regional Testbed Applications

https://simcenter.designsafe-ci.org/testbeds/

Motivation & Objectives

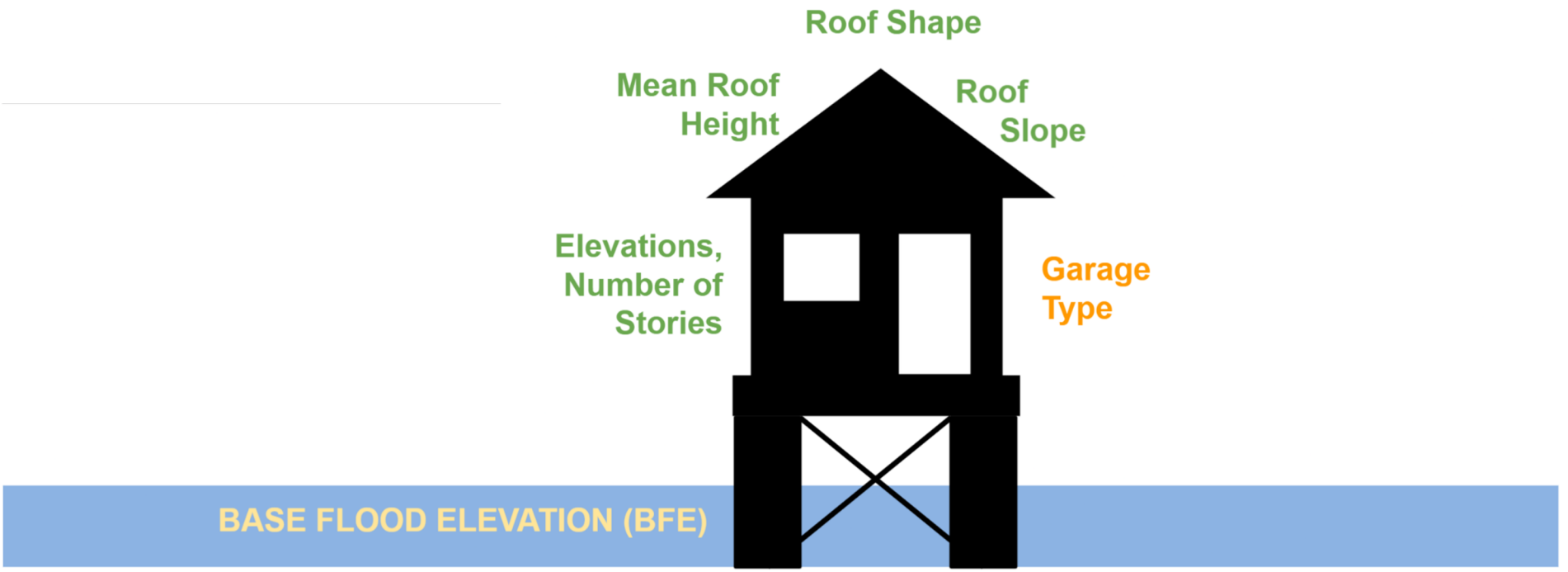
- proof of concept
- test and verify workflows
- engage research developers and users
- identify research opportunities, e.g.,validation through post-event simulations
- identify gaps in research & development

Regional earthquake and hurricane scenarios, each with a unique focus



SimCenter Uses AI/ML for Developing Building Inventories

Developing building inventories



Developing building inventories

Augmented Parcel Approach: Fusion data from multiple sources

- State, Parish, or Municipal DB
- MS Footprint DB
- OpenStreetMaps

- Tax Assessor Data
- Building Permit Data
- Open GIS Data
- ATC Hazards by Location
- Land Use/Land Cover DB
- US Census, ACS, AHS
- Real Estate DB (e.g., Zillow ZTRAX)

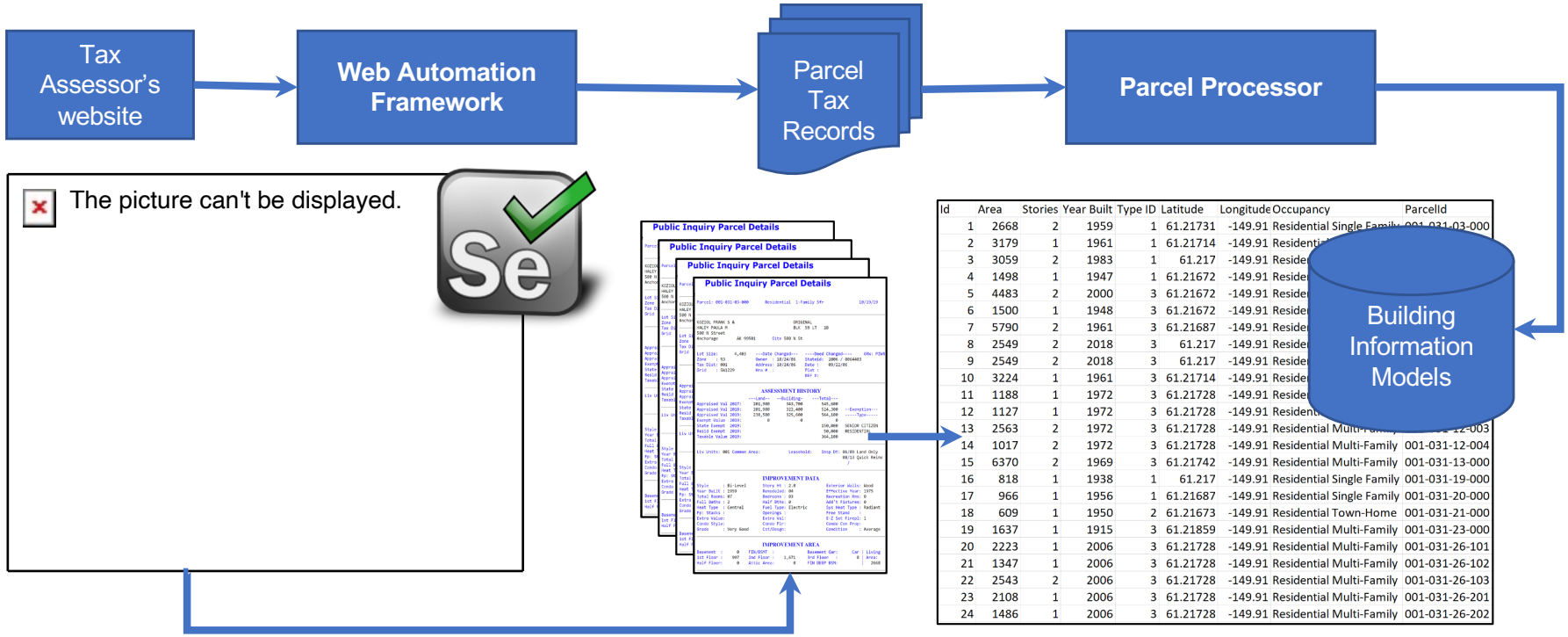
- Foundation Features
- First Floor and Roof Elevations
- Roof Geometry and Dimensions
- Openings

- Year of Construction
- Structural Design Details e.g., roof cover type, sec. water resistance, shutters, garage type

Third-party Datasets

Ideal case: Data publicly available in a repository or through an API

Web Automation: Facilitates data collection from public websites



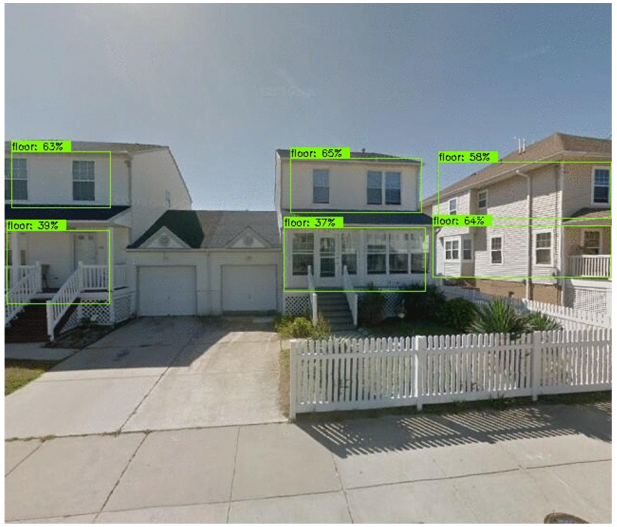
Id	Area	Stories	Year Built	Type ID	Latitude	Longitude	Occupancy	ParcelId
1	2668	2	1959	1	61.21731	-149.91	Residential Single Family	001-031-03-000
2	3179	1	1961	1	61.21714	-149.91	Residenti	
3	3059	2	1983	1	61.217	-149.91	Reside	
4	1498	1	1947	1	61.21672	-149.91	Reside	
5	4483	2	2000	3	61.21672	-149.91	Reside	
6	1500	1	1948	3	61.21672	-149.91	Reside	
7	5790	2	1961	3	61.21687	-149.91	Reside	
8	2549	2	2018	3	61.217	-149.91	Reside	
9	2549	2	2018	3	61.217	-149.91	Reside	
10	3224	1	1961	3	61.21714	-149.91	Reside	
11	1188	1	1972	3	61.21728	-149.91	Reside	
12	1127	1	1972	3	61.21728	-149.91	Residenti	
13	2563	2	1972	3	61.21728	-149.91	Residential Multi-Family	001-031-12-003
14	1017	2	1972	3	61.21728	-149.91	Residential Multi-Family	001-031-12-004
15	6370	2	1969	3	61.21742	-149.91	Residential Multi-Family	001-031-13-000
16	818	1	1938	1	61.217	-149.91	Residential Single Family	001-031-19-000
17	966	1	1956	1	61.21687	-149.91	Residential Single Family	001-031-20-000
18	609	1	1950	2	61.21673	-149.91	Residential Town-Home	001-031-21-000
19	1637	1	1915	3	61.21859	-149.91	Residential Multi-Family	001-031-23-000
20	2223	1	2006	3	61.21728	-149.91	Residential Multi-Family	001-031-26-101
21	1347	1	2006	3	61.21728	-149.91	Residential Multi-Family	001-031-26-102
22	2543	2	2006	3	61.21728	-149.91	Residential Multi-Family	001-031-26-103
23	2108	1	2006	3	61.21728	-149.91	Residential Multi-Family	001-031-26-201
24	1486	1	2006	3	61.21728	-149.91	Residential Multi-Family	001-031-26-202

Machine Learning

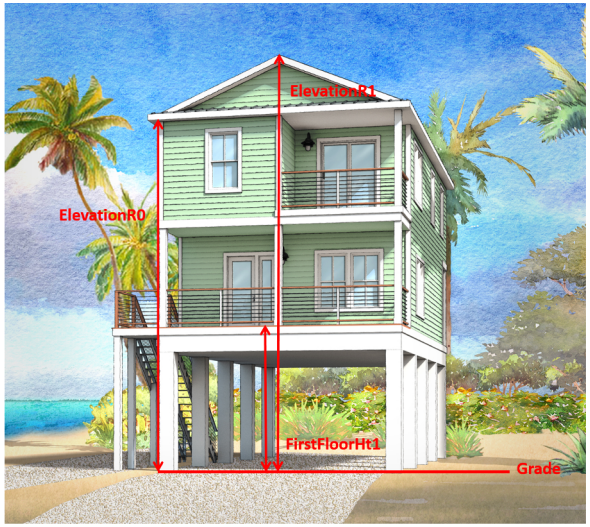
BRAILS: Collection of calibrated machine learning models

- Supports both direct use and location-specific training on additional data
- Good experience with crowdsourced image labeling through Zooniverse

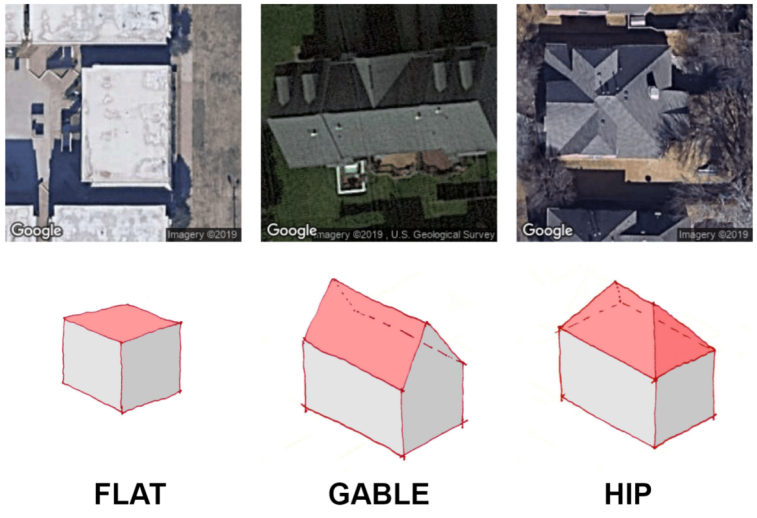
Number of Stories



Elevation & Geometry



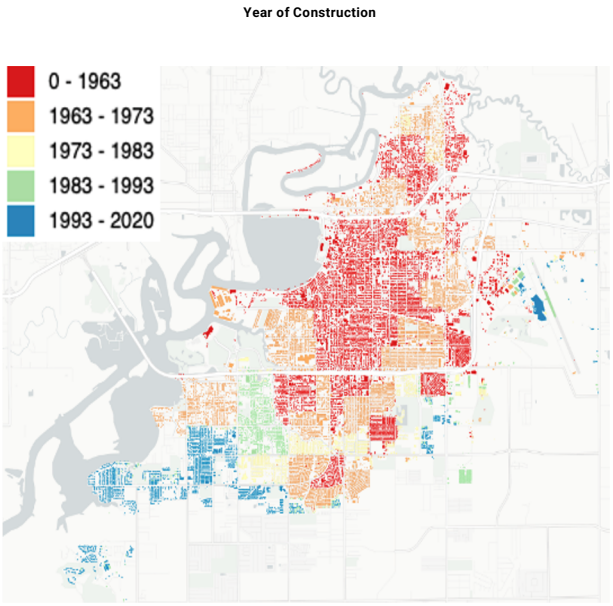
Roof Classification



Statistical Inference

SURF: Infers building attributes based on known data nearby -> fills the gaps

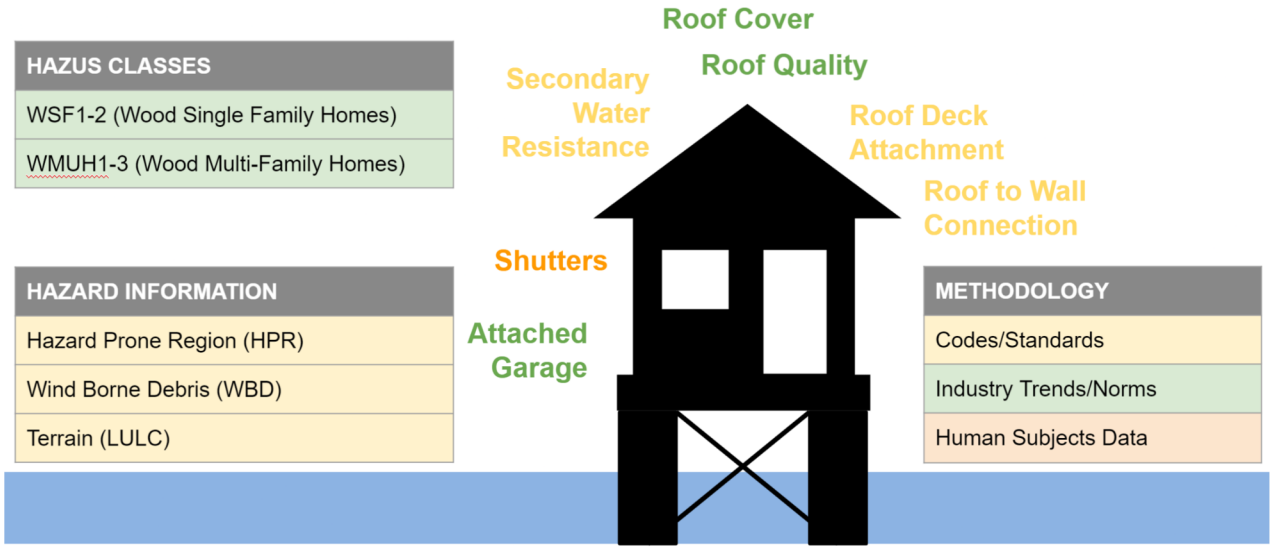
Rulesets: Time-evolving logic to infer building attributes
based on codes and industry norms at each design era & behavioral data



Design Details Inferred using Rulesets

HAZUS CLASSES
WSF1-2 (Wood Single Family Homes)
WMUH1-3 (Wood Multi-Family Homes)

HAZARD INFORMATION
Hazard Prone Region (HPR)
Wind Borne Debris (WBD)
Terrain (LULC)



METHODOLOGY
Codes/Standards
Industry Trends/Norms
Human Subjects Data