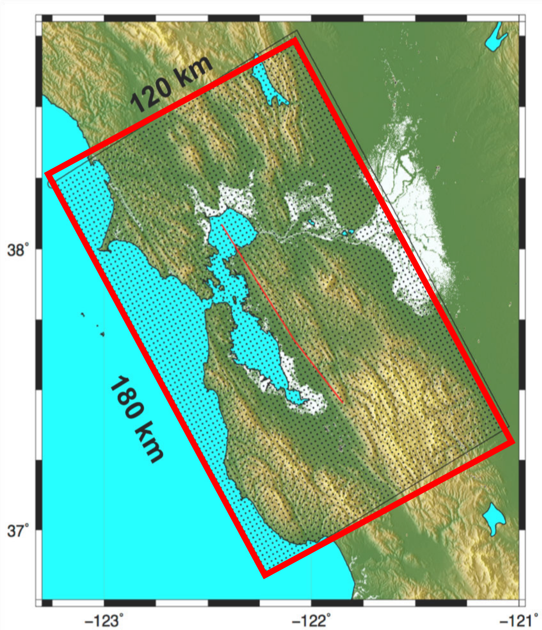
Development of a neural network with simulated ground motion data for seismic hazard and risk assessment in the Bay Area



PRINCIPAL INVESTIGATOR

Mamun Miah

New or Continuing: **NEW**

BUDGET REQUEST: **Salary and computing resources for two years**

EXASCALE COMPUTING PROJECT

EARTH & ENVIRONMENTAL SCIENCES

BERKELEY LAB

Coupling geophysics with structural engineering

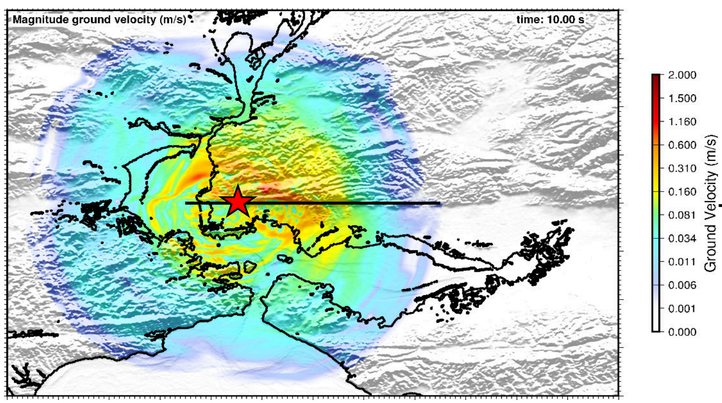
Aligns with which EESA Strategic Initiative: Critical Infrastructure (aligns with current ECP)

Relevance of the project to EESA's strategic plan and directions: Accelerate (from years to hours) informed decision using scalable solutions (from supercomputers to laptops) for a future sustainable society

Earthquake hazard

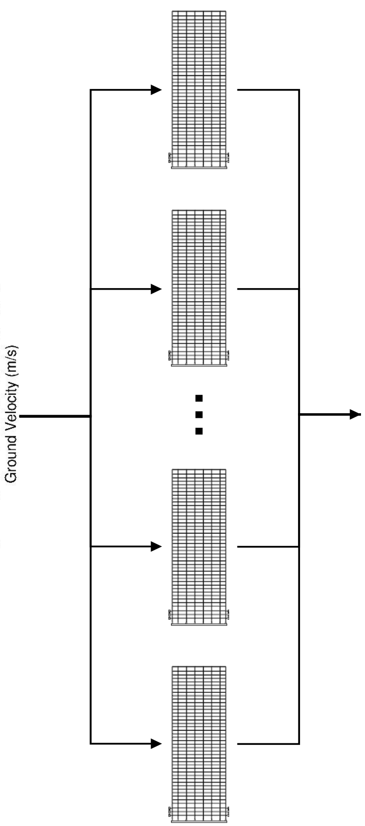
557,056 cores for one event simulation

Surface motions from regional geophysics simulation



Rupture hypocenter

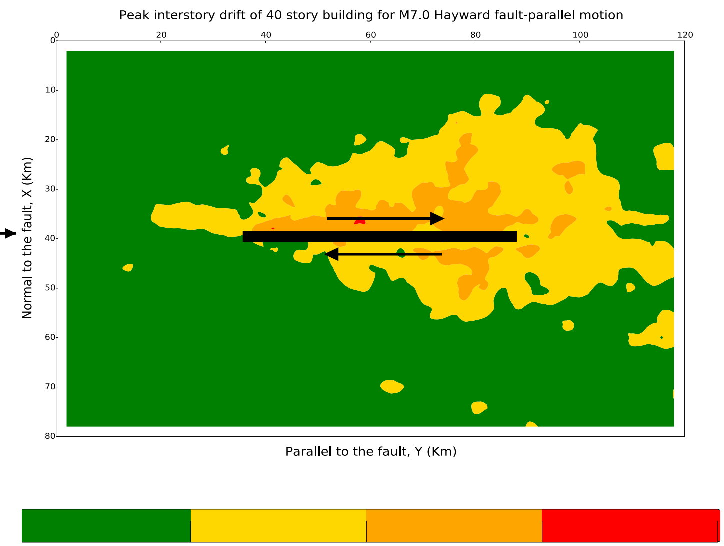
~ 2000 nonlinear building response history simulations



Earthquake risk

6,800 cores

Distribution of building peak interstory drift



0.5% 1.0% 2.5%

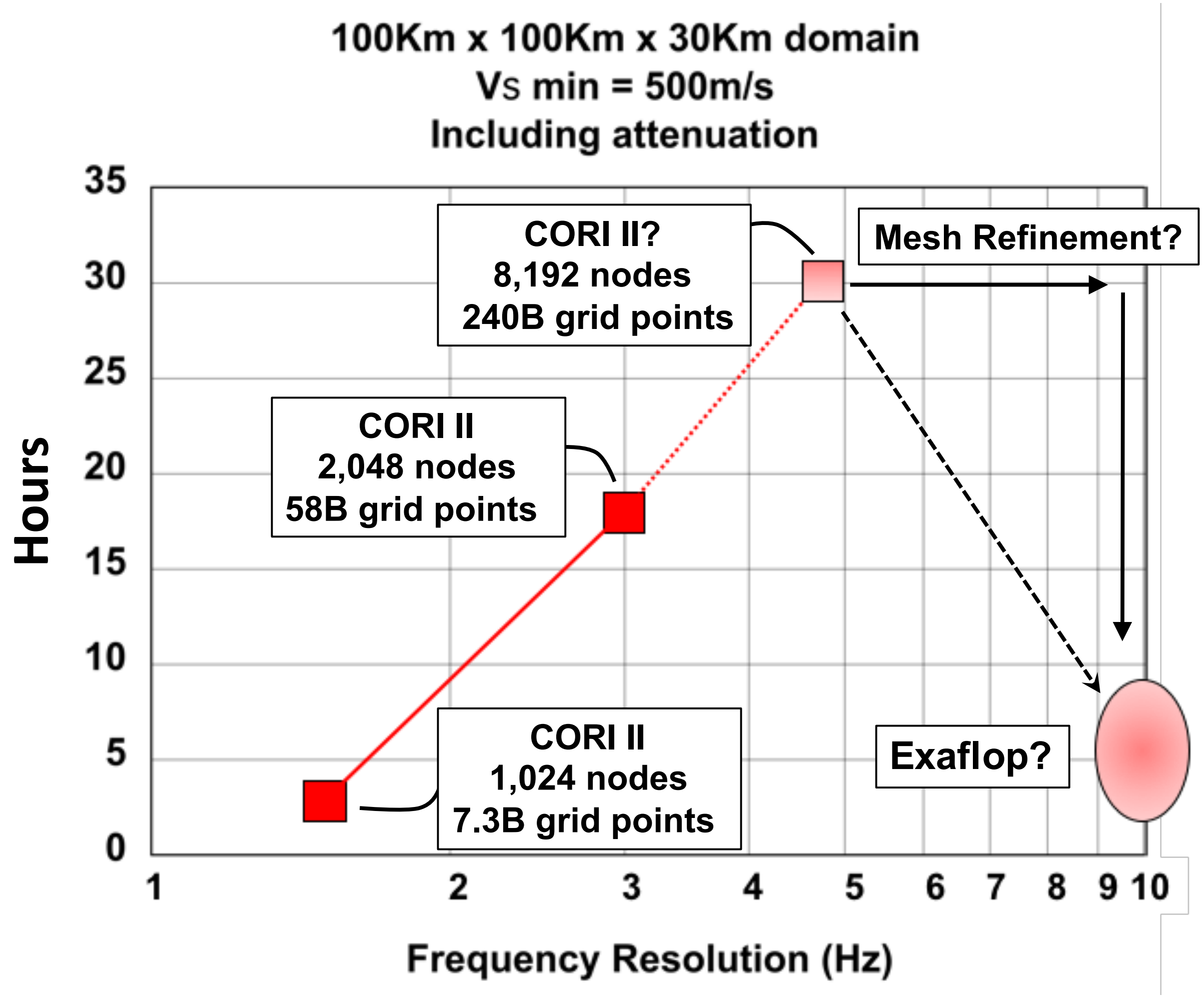
Elastic Behavior | Limited Permanent Distortion | Moderate Permanent Distortion | Large Permanent Distortion

MOTIVATION

- to predict ground motion intensity on a regional scale without running **astronomically expensive** (both time and cost) physics-based full wave propagation code

- to predict building damage and corresponding risk without resorting to **nonlinear building response simulations** for each of hundreds or more possible hazard scenarios

- As time and funding permits we would be able to incorporate **infrastructure and utility risk** on top of building damage risk



CORI Phase II – 9,304 Intel Xeon Phi Nodes, 68 cores per node

Objective and approach

To develop a novel machine learning framework for earthquake hazard and risk estimation in the HF zone

APPROACH:

With out ongoing **ECP project we are generating** an unprecedented amount of ground motion synthetics using full physics-based code SW4. Next we are utilizing this synthetics in building response simulations using another finite element code. The proposed approach will **leverage** this huge mass of data and be used in training a neural net in order to model both earthquake hazard and risk. Because there are lots of **uncertainties** in the geophysics model such as hypocenter location, fault rupture distribution, local geology, Vsmin or site amplification, we need many simulations of a single magnitude event to constrain the hazard problem. But once the neural net is fully trained with hundreds of simulated events, we will no longer need to run the astronomically expensive both geophysics and structural analysis codes.

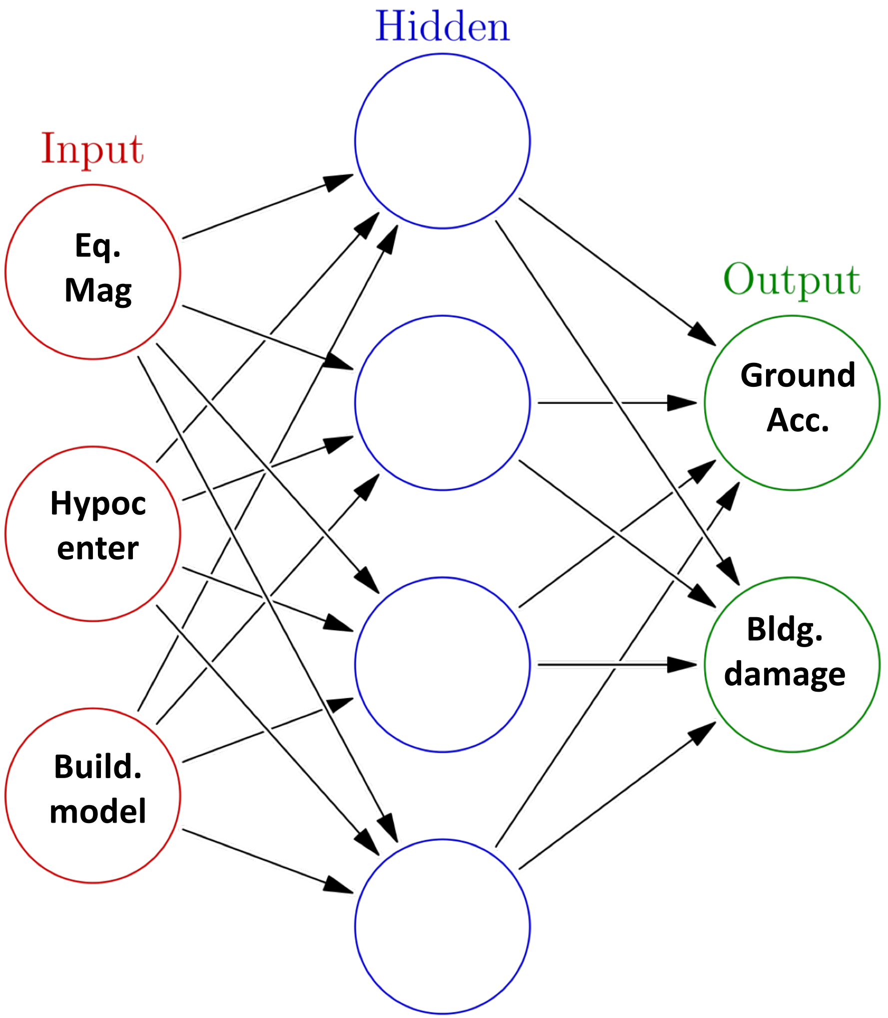
BENEFITS: (Both time and cost)

What would take **years on a supercomputer** with the existing technology could be accomplished within **hours on a laptop** with the proposed neural network.

TENTATIVE WORKFLOW

KEY PROPOSED FY20 TASKS:

- **More earthquake event simulation and structural risk evaluation**
- **At the same time developing the proposed neural net with available open-source code such as Scikit-learn or TensorFlow**
- **There needs not be time lag between data generation and training the model – the proposed model could be developed and trained in parallel with the training data generation**



LDRD SUCCESS COULD LEAD TO:

Development of a novel computational framework in earthquake science and engineering without relying on **supercomputers** and waiting for **years**. The same outcome could be accomplished on a **laptop** within **hours** once the proposed model is fully trained.

Thank you for your consideration of my proposal!