Quakeworx science gateway: A custom instance of OneSciencePlace

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Earthquake rupture forecasts (ERFs) are critical seismic hazard research results that provide probabilities of future earthquake times, locations, and magnitudes for a given region. Several generations of ERFs have been developed for California jointly by the USGS and the Statewide California Earthquake Center (SCEC) and are used in broad impact seismic hazard maps. However, advanced physics-based models that account for fault system evolution and are well validated by observations are not yet used. Moreover, current models reside in the hands of a few highly skilled researchers, which reduces research pace and applications for societal benefits.

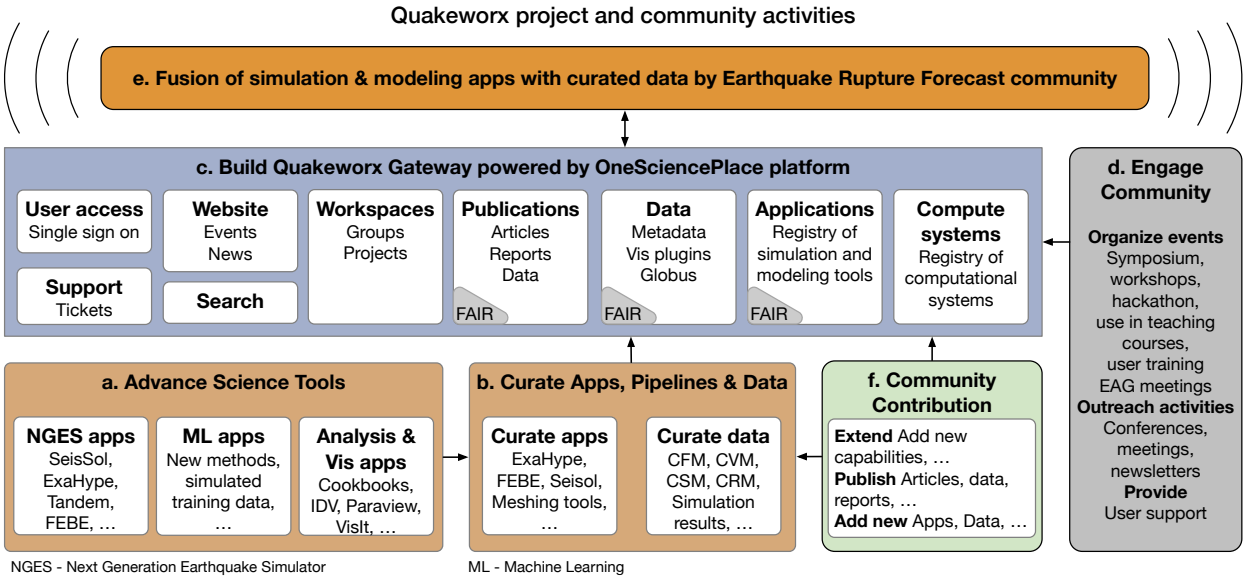

Figure 1: Illustration of Quakeworx activities: a) Project contributed apps to advance science tools; b) Curation of apps with input parameters and reference outputs to be deployed on gateway with user interface; c) Gateway that provides access to apps and data along with comprehensive set of collaboration, curation and execution capabilities; various research products can be published that follow FAIR data principles are highlighted with gray annotation; d) Engage community via multiple channels; e) Ability for the community to use the gateway for research, education and training; and f) Ability for the community to extend capabilities and publish research products including apps, data, and others.

The overarching goal of this project is to enable a wide community to access state-of-the-art models of rupture forecasts, further improve existing tools, validate model results, and use them for research and education. We have developed Quakeworx as a science gateway framework to significantly reduce barriers to execute/access simulation tools/data and facilitate rapid availability of emerging tools and results. Figure 1 illustrates different elements of the project. The Quakeworx gateway will accelerate innovation in earthquake science by enabling generation of diverse outputs (seismicity, ground motion, fault network configuration, strain rates, topography) that can be used to validate model results, improve ERFs, and discover new patterns.

Quakeworx gateway is built on OneSciencePlace, a content centric and composable online platform to transform delivery of FAIR content and computing in a single and easy to use environment.

The Quakeworx gateway framework will provide a range of capabilities that includes:

1. An app registry with a set of state-of-the-art-computational earthquake modeling codes such as SeisSol, Tandem, FeBE, RSQSim and others that are readily usable on computation resources. Both interactive (such as Jupyter) and command line apps are supported.
2. Curated data such as input configurations and output results for selected earthquake scenario simulations using various curated apps.
3. Online, web-based, workspaces for collaboration, training, and teaching. Apps, data and other content can be restricted to projects or shared with everyone.
4. Publishing capability that enables users to publish ancillary information such as reports, data and other content.
5. Users can easily use available apps, data, and publications or contribute new ones via a web browser. For instance, a new app can be contributed by uploading Docker or Singularity containers with necessary configurations and pairing them with the appropriate available computational resources.
6. A website that provides the above capabilities to all registered users via single sign-on from various institutions.

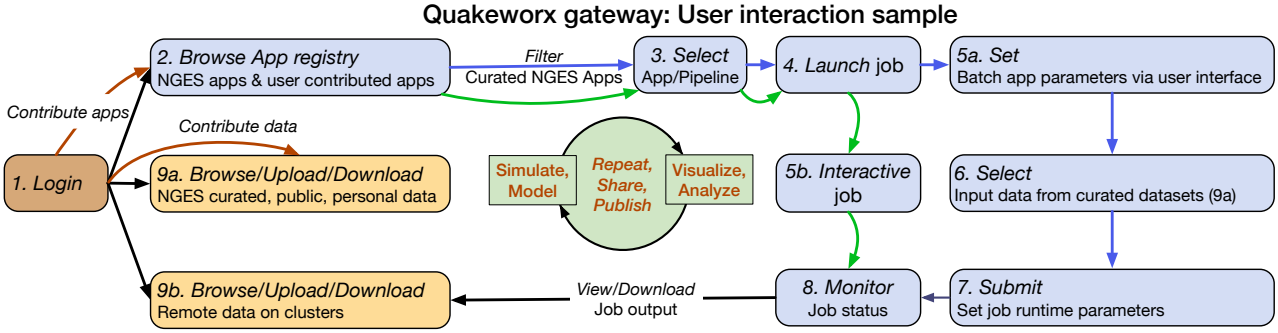

Figure 2: Illustration of sample user interaction paths on the gateway. Blue boxes depict a series of steps to perform simulation, modeling, visualization, or analysis. Steps 1–4, 5b, 8 & 9 with green arrows show an interactive session for an app. Steps 1-4, 5b, 6-9 with blue arrows show a batch job for an NGES app. Steps 1 & 9 show ability for users to contribute datasets for curation; apps may be contributed for curation with step 1 & 2 and both app and data can be published with FAIR principals. Yellow boxes indicate users ability to view and download curated NGES datasets, public or personal datasets (steps 1 & 9). The user interaction also allows cloning and repetition of simulation and analysis, and their output results may be shared or published at the gateway.

In this demonstration, we will provide an overview of the Quakeworx gateway. We will discuss apps, systems and data, single-sign-on capabilities and will also showcase some of the user interaction paths that are illustrated in figure 2. To ensure that it is accessible and easy to use for a large and diverse user community, the platform includes low-code and no-code options, as well as comprehensive training materials and tutorials. Our project's goal is to advance the science of rupture forecasts, to obtain new insights on earthquake physics, to improve seismic hazard estimates, and to create new opportunities for STEM education and engagement by providing a cyberinfrastructure platform for the broad community to easily use and reuse computational tools and data.

Quakeworx gateway: https://quakeworx.org
OneSciencePlace platform: https://onescienceplace.org