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Earthquake and failure forecasting in real-time: A Forecasting Model Testing Centre

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Across Europe there are a large number of rock deformation laboratories, each of which runs many experiments. Similarly there are a large number of theoretical rock physicists who develop constitutive and computational models both for rock deformation and changes in geophysical properties. Here we consider how to open up opportunities for sharing experimental data in a way that is integrated with multiple hypothesis testing. We present a prototype for a new forecasting model testing centre based on e-infrastructures for capturing and sharing data and models to accelerate the Rock Physicist (RP) research.

This proposal is triggered by our work on data assimilation in the NERC EFFORT (Earthquake and Failure Forecasting in Real Time) project, using data provided by the NERC CREEP 2 experimental project as a test case. EFFORT is a multi-disciplinary collaboration between Geoscientists, Rock Physicists and Computer Scientist. Brittle failure of the crust is likely to play a key role in controlling the timing of a range of geophysical hazards, such as volcanic eruptions, yet the predictability of brittle failure is unknown. Our aim is to provide a facility for developing and testing models to forecast brittle failure in experimental and natural data. Model testing is performed in real-time, verifiably prospective mode, in order to avoid selection biases that are possible in retrospective analyses.

The project will ultimately quantify the predictability of brittle failure, and how this predictability scales from simple, controlled laboratory conditions to the complex, uncontrolled real world. Experimental data are collected from controlled laboratory experiments which includes data from the UCL Laboratory and from Creep2 project which will undertake experiments in a deep-sea laboratory. We illustrate the properties of the prototype testing centre by streaming and analysing realistically noisy synthetic data, as an aid to generating and improving testing methodologies in imperfect conditions. The forecasting model testing centre uses a **repository** to hold all the data and models and a **catalogue** to hold all the corresponding metadata. It allows to:

1. `Data transfer`:
    - `Upload experimental data`: We have developed *FAST* (Flexible Automated Streaming Transfer) tool to upload data from RP laboratories to the repository. *FAST* sets up data transfer requirements and selects automatically the transfer protocol. Metadata are automatically created and stored.
2. `Web data access`:
    - `Create synthetic data`: Users can choose a generator and supply parameters. Synthetic data are automatically stored with corresponding metadata.
    - `Select data and models`: Search the metadata using criteria design for RP. The metadata of each data (synthetic or from laboratory) and models are well-described through their respective catalogues accessible by the web portal.
    - `Upload models`: Upload and store a model with associated metadata. This provide an opportunity to share models. The web portal solicits and creates metadata describing each model.
    - `Run model and visualise results`: Selected data and a model to be submitted to a High Performance Computational resource hiding technical details. Results are displayed in accelerated time and stored allowing retrieval, inspection and aggregation.

The forecasting model testing centre proposed could be integrated into EPOS. Its expected benefits are:

- Improved the understanding of brittle failure prediction and its scalability to natural phenomena.
- Accelerated and extensive testing and rapid sharing of insights.
- Increased impact and visibility of RP and GeoScience research.
- Resources for education and training.

A key challenge is to agree the framework for sharing RP data and models. Our work is provocative first step.