EARTHQUAKE INSURANCE PORTFOLIO RISK MODELING

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Introduction

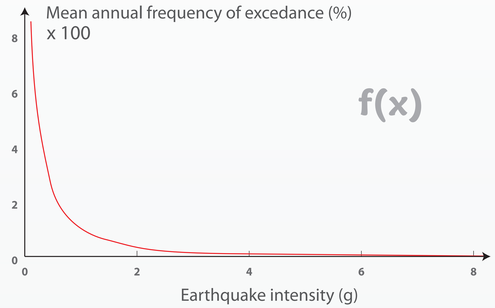
Earthquake risk modeling is the process of gathering and analyzing data on earthquake frequency and intensity, **correlating these variables with potential economic damage** to assets, and determining the **financial exposure** to assets stakeholders. Similar to present modeling of hurricane induced property asset risk, such models are of great usefulness to property insurers and owners for providing critical insights into the risk of their portfolios that allow them to properly **quantify and control their risk** through better pricing, coinsurance, and geographic diversification.

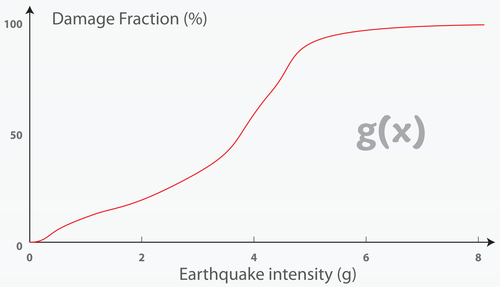
Objectives and Hypothesis

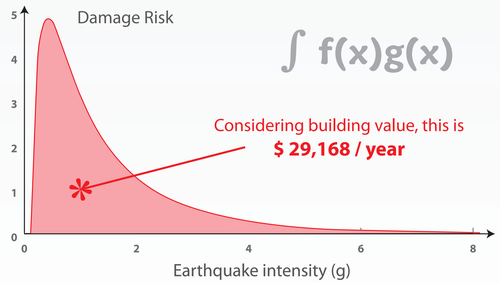
The project goal is to produce a simplified earthquake analogue to present hurricane risk models. Our model **estimates the damage risk** associated with a certain building types using various attributes (e.g. height, cost, framing system, building materials, contents, location). Individual buildings are **aggregated** into a theoretical insurance portfolio to determine insurer risk for the total portfolio and its individual parts. This tool reveals which properties carry disproportional risk compared to the overall portfolio as well as geographic areas of higher overall risk.

Data provided by the USGS, collaboration with Dr. Henri P. Gavin, and Code-Oriented Damage Assessment for Buildings were the primary project resources. The 34 building classifications based on ATC-13 data and the CODA model were used for simplification of structural responses to acceleration. The model calculates a **monetary average loss per year for any given building** within the ATC-13 class codes **at any given location in the United States** using two discrete curves, **spectral ground acceleration vs. probability or hazard** (USGS) and spectral acceleration vs. damage fraction (CODA).

Analysis and Methods







Hazard Curve

The USGS database has ground acceleration vs. probability (hazard) data for multiple frequencies throughout the USA. Our model builds **discrete acceleration vs. hazard curves** for any point using a bilinear interpolation of the four closest points. Only accelerations which may cause damage are considered. The model uses this process twice at frequencies above and below the structural natural frequency to interpolate a customized hazard curve for the building and location.

Damage Curve

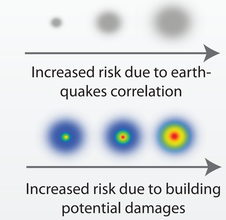
The damage fraction model was developed by W.P. Graf and Y. Lee in Code Oriented Damage Assessment for Buildings or CODA. In their work, the ATC-13 analysis is remapped to include engineering parameters for 34 generalized building types. Damage fractions for these buildings are plotted against Demand to Capacity Ratios. From this, our product calculates **damage fractions for the same accelerations** used in the hazard curve for the building types with one exception. The highest accelerations used for the hazard curve do not apply to the CODA model and are thus extrapolated. This contributes little error because probability of these accelerations is essentially zero.

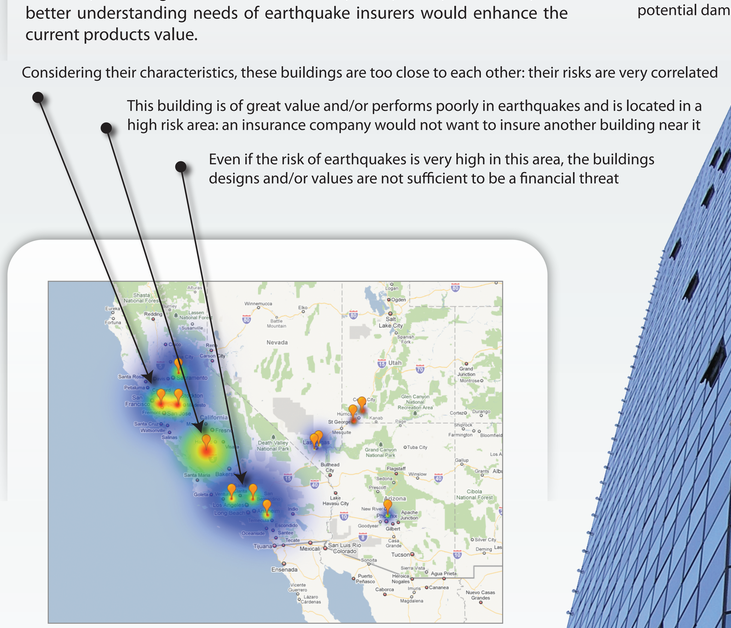
Calculating Damage per Year

The damage fraction curve is multiplied with the hazard curve to produce the discrete **spectral acceleration vs damage risk** curve. The **area** under this curve represents average yearly risk (% / yr) and is calculated using the trapezoidal method of integration. The product of the yearly risk and building value is the yearly monetary risk of the structure.

Results and Conclusion

The current prototype sufficiently calculates an **average damage cost** to a building owner for a generalized building anywhere in the United States and plots an **insightful heat map** for earthquake risk for building portfolios. **Oriented object framework** was used to develop the model such that additions and improvements could easily be added. Finding more specific building/geographical data, modeling damage curves to building contents, including insurance instruments (co-ins, re-ins, deductible) and better understanding needs of earthquake insurers would enhance the current products value.





Simulation on a small portfolio in the California area

References :

- 2008 United States National Seismic Hazard Maps (usgs.gov)
- Graf, William and Lee, Yajie. Code Oriented Damage Assessment for Buildings. 2009