Ph.D. THESIS DEFENSE ANNOUNCEMENT

Soft Computing Based Spatial Analysis of Earthquake Triggered Coherent Landslides

By
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Abstract:

Earthquake triggered landslides cause loss of life, destroy structures, roads, powerlines, and pipelines and therefore they have a direct impact on the social and economic life of the hazard region. The damage and fatalities directly related to strong ground shaking and fault rapture are sometimes exceeded by the damage and fatalities caused by earthquake triggered landslides. Even though future earthquakes can hardly be predicted, the identification of areas that are highly susceptible to landslide hazards is possible. For geographical information systems (GIS) based deterministic slope stability and earthquake-induced landslide analysis, the grid-cell approach has been commonly used in conjunction with the relatively simple infinite slope model. The infinite slope model together with Newmark's displacement analysis has been widely used to create seismic landslide susceptibility maps. The infinite slope model gives reliable results in the case of surficial landslides with depth-length ratios smaller than 0.1. On the other hand, the infinite slope model cannot satisfactorily analyze deep-seated coherent landslides. In reality, coherent landslides are common and these types of landslides are a major cause of property damage and fatalities. In the case of coherent landslides, two- or three-dimensional models are required to accurately analyze both static and dynamic performance of slopes. These models are rarely used in GIS-based landslide hazard zonation because they are numerically expensive compared to one dimensional infinite slope models. Building metamodels based on data obtained from computer experiments and using computationally inexpensive predictions based on these metamodels has been widely used in several engineering applications. With these soft computing methods, design variables are carefully chosen using a design of experiments (DOE) methodology to cover a predetermined range of values and computer experiments are performed at these chosen points. The design variables and the responses from the computer simulations are then combined to construct functional relationships (metamodels) between the inputs and the outputs. In this study, Support Vector Machines (SVM) and Artificial Neural Networks (ANN) are used to predict the static and seismic responses of slopes. In order to integrate the soft computing methods with GIS for coherent landslide hazard analysis, an automatic slope profile delineation method from Digital Elevation Models is developed. The integrated framework is evaluated using a case study of the 1989 Loma Prieta, CA earthquake ($M_w = 6.9$). A seismic landslide hazard analysis is also performed for the same region for a future scenario earthquake ($M_w = 7.1$) on the San Andreas Fault.