Cascading Natural Disasters Modeling and Prediction

Research Questions

Which model can be applied to analyze cascading natural disasters?
How to find the probability of a certain kind of disaster to happen?
How to define and quantify the relationships between disasters?
How to generate the prediction of disaster which is going to happen?

Research Objective

Serious natural disasters happen all the time. This project is to find the relationships between disasters by applying statistical theory and data analysis method. The potential secondary disasters can be predicted in this way to protect people from lives and property loss.

Solution Procedure

1. The time and places that disasters happen are unknown. It is considered as a system that contains random factors or even a time series. It is a Markov Chain Model. Stochastic process is applied to describe the events that happen randomly.

Implement Markov chain to model disaster series

$$P(X_{m+n}=a_j \mid X_{t_1}=a_{i_1}, X_{t_2}=a_{i_2}, \ldots, X_m=a_i) = P(X_{m+n}=a_j \mid X_m=a_i)$$

Finds out the transition probabilities to define the relationships between disasters by analyzing historical data

$$P_{ij}(n) = P_{ij}(m, m+n) = P\{X_{m+n}=a_j \mid X_m=a_i\}$$

Use the transition matrices to predict the probabilities of secondary disasters to happen. This stands for the relationships between disasters. The matrix contains all the information about the relationships between secondary disasters. If this Markov process is positive recurrent, aperiodic and inreducable, then there exists a limiting matrix.

$$P(1)=\begin{bmatrix} p_{11} & p_{12} & \cdots & p_{1j} & \cdots \\ p_{21} & p_{22} & \cdots & p_{2j} & \cdots \\ \vdots & \vdots & \ddots & \vdots & \cdots \\ p_{i1} & p_{i2} & \cdots & p_{ij} & \cdots \\ \vdots & \vdots & \cdots & \vdots & \ddots \end{bmatrix}$$

Expected Outcomes

This model is designed to predict the next secondary natural disaster so that people can take actions to minimum their loss. Thus, the probability for each disasters to happen next is the prospected outcome. The limit probability is also an outcome which shows the overall actions preference.

Historical data

⇨ Statistical modeling

⇨ Prediction generated

⇨ Action prepared

Future Plans

CIA-ISM can be applied to model cascading natural disasters ideally. It can evaluate the grade of damage loss, forecast the consequent secondary disasters and help people to avoid the threats effectively and comprehensively.