

For office use only	Team Control Number	For office use only
T1_____	<b>88902</b>	F1_____
T2_____		F2_____
T3_____	Problem Chosen	F3_____
T4_____	<b>E</b>	F4_____

2018 MCM/ICM Summary Sheet

A Probabilistic Model of the Relationships between Countries and Climate Change

Summary

**Background** Under the effects of climate change, a series of economic, environmental and social problem have emerged from region to region, especially in fragile states. It becomes more and more imperative to develop a sophisticated but easy-to-understand model of the relationships between a country's fragility and the impact of climate change over it as a guide for the decision and policy makers.

**Objective** The objective of this paper is to propose a probability and machine learning based model called **2THN(2-Time-slice Hybrid Network)**, as well as two new metrics to measure the fragility(**WFSI(Weighted Fragile State Index)**) and climate change's impact of the country(**CCIC(Climate Change Index by Country)**). The whole paper can be divided into five main parts: data collection and pre-process; model representation; parameter estimation; model analysis; case study and problem solution.

Firstly, we identify all the data we would like to use in an ideal situation. But since we cannot get access to some subset of the ideal data, we have to construct our model using a different dataset other than the expected one. Incomplete as it is, it's sufficient for the purpose of illustrating the main points of our model. Data augmentation, classification, and several normalization methods are also introduced in this part.

Secondly, trying to make the paper easy to read and understand, we then concentrate only on the representations and semantics of our models, leaving out the esoteric mathematical details. We first define our first metric - Climate Change Index(**CCI**), which is a global metric to quantize the degree of climate change. Later on, Climate change vulnerability(**CCV**) is introduced, which is a state-level metric. We then define the Climate Change Index by Country(**CCIC**) using CCI and CCV as our second metric. Then Weighted Fragile State Index(**WFSI**), a revised version of FSI utilizing Analytical Hierarchy Process(**AHP**) and Entropy Method(**EM**) is defined, after which we introduce the novel 2-Time-slice Hybrid Network(**2THN**) to connect the two dots(**CCIC** and **WFSI**) and establish an easy-to-understand relationship, where the rationales of our choice of a probabilistic model, as well as other concerns are thoroughly discussed.

Thirdly, the details of how the parameters are derived are introduced, including the details of Entropy Method(**EM**) and the learning and inference of 2THN. Meanwhile, the reasons for our choice to learn both the structure and parameters are discussed.

Fourthly, we analyze the properties and characteristics of our model using **Mean Value Analysis**, correlation analysis, information-theoretical analysis and other analysis to better understand the trained model, where we make our hypothesis of the dynamics of the Climate-Fragility system and justify them by reasoning through the evidence. Furthermore, the notion of Warning Zone(**WZ**) is introduced, indicating that the latent effects of climate change are invisible to people outside a specific range.

Eventually, we come back to the 5 tasks assigned to us in the first place and tackle our model one by one. We use **K-Means** to define the standard line of one country's fragility status and Greece



as examples to apply our model in practice, after which we identify some possible strategies taking Sudan's example again. Finally, we scale our model to the level of continents and discuss the feasibility of scaling it to even cities.

**Conclusion** In general, the models of **WFSI-CCIC** and **2THN** fit well to reality and therefore pragmatic. The fact that the parameters are calculated by analyzing the data instead of fixed gives our model enormous flexibility, making it easy to be applied widely. But meanwhile, its strong dependence on data makes it useless when facing extreme situations such as countries in large scale wars.

公众号·科研交流

