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# Prediction Technology for El-Niño and La-Niña using Bayesian Network

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## El Niño and La Niña

 El Niño - A band of anomalously warm ocean water currents that generally develops on the western coast of South America and can cause climatic changes across the Pacific Ocean mainly affecting continents of North America, South America, Asia and Australia

 La Niña – The positive counterpart of El Niño which generally follows the El Niño phenomenon and is traditionally considered to have a balancing counter effect

### Causes of El Niño

- The actual and accurate causes of the beginning of the phenomenon are still a matter of debate in the scientific community
- Caused by the coupled effects of changes in the wind patterns and the ocean waters
- Chain of events that is considered to be the major cause -
  - Diminishing of Equatorial easterly winds unnatural reduction in the westward ocean currents.
  - > Unnatural warming of the western pacific waters

#### Impacts of El Niño

- Extensive droughts in Australia and Indonesia
- Forest fires in the western Pacific coastal regions
- Excessive rain in tropical regions of North America
- Drier than normal North American monsoons, especially for Mexico, Arizona and New Mexico
- Reduction in the monsoon rains in India
- Reduction in hurricanes in south eastern regions of North America



Effects of El Niño on different regions across the globe

# **Current Technology for Prediction**

- Altimeter Satellites are used for measuring sea surface temperature
- Weather Satellites are used to measure heat in the form of infrared radiation
- Scatterometers are special radars that measure wind speed, and the directions of trade-winds
- Towering buoys deployed under the Tropical Atmospheric Ocean Project (TAO), are used to hold instruments to measure various parameters

- The prediction models used currently can be divided into two categories:
  - > Ocean-Atmosphere Coupled Model
  - Statistical and Numerical Models

The most efficient models have been limited to a prediction time of 6 months in advance

# Limitations of Current Systems

- Inability to integrate the advancements in technology into the existing satellites
- Many satellites with vital instruments have been discontinued or have lost contact in recent years
- Also, the input of data from the moored buoys has seen a steep fall in the recent years



#### The Proposed Solution

- A constellation of Small satellites, monitoring specific factors related to El-Niño at grass root level
- A Bayesian Network, developed and trained using the archived data from sources like satellites and buoys
- Increase in prediction time up to 1 Year in advance by feeding the data from the aforementioned satellites into the Bayesian network as parameters



#### Data acquisition

- Data sets from the past decades, of factors being monitored would be required for the training of the Bayesian Network
- Agencies such as NOAA, GHRSST and other meteorological departments will act as suitable candidates for data acquisition
- A portion of the acquired data would be utilized for the testing of the Bayesian network

#### **Bayesian Network**

- Prediction of disasters is difficult due to the uncertainties and complexity of disaster related factors
- Bayesian Network One such probability based model
- It is being extensively used for predictive modeling in complex domains such as ecosystem and environment management

Factor	Area of measurements	Sensors used
Sea Surface Temperature	Peruvian region of eastern Pacific Ocean	Radiometer
Surface Wind Velocity	Equatorial Central Pacific Ocean	Scatterometer
Cloud Formation	Along Equatorial Pacific Ocean	Infrared Imaging Spectrometer
Air temperature	Eastern and Central Pacific Costal areas	Microwave Radiometer
Surface Pressure	Western Pacific Ocean	Microwave Radar Pressure Sensor

Required Parameters and Sensor Technology



Data flow and plan of implementation for the Bayesian Model

# Why Bayesian?

- Consistent, theoretically solid mechanism for processing uncertain information
- It is a theoretical framework for handling missing data
- Can Handle different variable types
- It has smoothness properties
- Requires less computing power with respect to other models

#### Advantages of our model

- The array of small satellites will act as a host for various MEMS based sensors to monitor various atmospheric variables
- The system will be small sized, expandable, modular with low development cost
- It will be a system dedicated to prediction of El-Niño
- Will allow integration of future technology owing to its modular structure

# ThankYou !