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| **Project Title:** | **StormWare** |
| **Lab Section Number:** | **02** |
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By virtue of submitting this document I electronically sign and date that the work being submitted is my own individual work.

**Abstract**

Natural disasters- though widely impactful in many different aspects- rarely stay in mind for longer than the weekly news cycle. Thousands of disasters happen each year leading to many casualties, injuries, and structural damage. Efficient analysis of the vast deposits of storm data could provide benefits for future homeowners, city planners, insurance companies, and many others, leading to safer and more mindful communities. StormWare uses the data from hundreds of thousands of individual natural disasters from the past 70 years to locate and display regions with high levels of concern, so that we can be better prepared for future disasters.

**1. Objective**

StormWare is an interactive map software for visualizing natural disaster trends by location, magnitude, and frequency. It also displays comprehensive visual guides such as graphs and charts to further analyze historical records of natural disasters.

**2. Motivation**

With the increase of global warming causing more frequent occurrences of natural disasters all over the world, tools are needed to better identify trends in the environment to prepare people for future disasters. Disaster researchers would be able to use StormWare as a tool to organize and view hundreds of thousands of historical records of natural disasters in a well-structured interactive map, that would allow them to study location and temporal-based trends of natural disasters in an efficient and effective way, leading to a better understanding of what type of disasters to prepare for.

**3. Prior Work**

The National Oceanic and Atmospheric Administration’s (NOAA) Natural Hazards Viewer is an interactive map webpage software that displays historical earthquake, tsunami, and volcano eruption events as points on a map of the world, as well as other points such as volcano locations and plate boundaries. Each of these features can be toggled on and off with the user interface. The major difference between NOAA’s Natural Hazards Viewer and StormWare is that StormWare displays the level of concern for disasters at any location on the map, as well as the individual disaster points. This extrapolation of the data allows for a more concrete estimate of trends anywhere on the map. Furthermore, the interface for StormWare will be designed to be simple for any user to understand and use. The Natural Hazards Viewer’s interface could be improved, but it does well for the purpose it serves.

**4. Input/output and proposed solutions**

The National Oceanic and Atmospheric Administration’s (NOAA) Natural Weather Service Storm Events Database: <ftp://ftp.ncdc.noaa.gov/pub/data/swdi/stormevents/csvfiles/>

This database is a collection of natural disaster records from 1950 to 2017 including events such as tropical storms, blizzards, droughts, and more. Each entry has information about where and when the event occurred, as well as the number of casualties and injuries caused directly and indirectly by the event, and the structural damage costs in the areas affected.

The data from the NOAA dataset will be used to calculate areas on the map that could be perceived as dangerous, based on nearby historical natural disaster events. The goal is to display these areas as a heat map overlaid on top of the desired region. The NOAA dataset has data for the United States, so that is that map that will be used. Alternatively, a single location can be provided, and StormWare will calculate the level concern for each type of natural disaster at that location, based on events that have happened in the past, as well as the frequency of their occurrences.

To calculate the level of concern of a specific natural disaster type (blizzard, drought, tropical storm, etc.) at a single location point on the map, a gaussian average is used to approximate the value at the point by using a subset of points , which are all within a radius from , and are of the common natural disaster type which is being used. The function approximates the level on concern at a point with the following formula:

Where is the known level of concern at a point in , given by the normalized magnitude of the event occurring at that location in the dataset. is the number of points in and is the gaussian distribution function for 2-dimensional space:

where and are the and components of the point , and , because any point further from would have little impact in the value of . The function takes a weighted average of all points in , by summing the point’s level of concern multiplied by its gaussian weight given by , and then dividing by . This means that points further away from have a lower weight and a smaller influence on the output of , and points closer to have a higher weight, and therefore a greater influence.

**5. Algorithmic challenges:**

When is calculated for a given natural disaster type, the subset must be computed from the set of all data . To do this, the dataset needs to be searched for all elements whose type is the same as the given one, and whose proximity to is less than or equal to , which can be set by the user. To perform this operation in an efficient manner, the dataset will be separated into smaller subsets of records, separated by each type of natural disaster. That way, each search only has to look through the dataset of the desired type and does not have to waste valuable time searching through elements which aren’t even the desired type.

Sorting the datasets by location and then use a search algorithm with complexity would not be efficient because the dataset would have to be sorted every time is computed at a new location. Instead, the dataset will simply be searched by a linear search algorithm with complexity .

**6. Project plan**

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| **Milestone** | **Description** | **Week** |
| Design plan | Decide on programming languages, platforms, version control, etc. | 1 |
| Pseudocode and algorithms | Design the algorithms and structure of the program and write pseudocode for them. Specifically, the parsing algorithms for reading and sorting the datasets. | 2 |
| Basic implementation | Implement the designed algorithms in the chosen language and display a map of the United States with data points on it. | 4 |
| Heat map | Design and implement the level of concern function and use it to display gradients on the map. | 6 |
| Charts and graphs | Design and implement chart and graph popups to display information about the information over time | 8 |
| Final product | Polish program interface and finish documentation | 9 |

**References**

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