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Engineering Method

Problem description:

OSIM Holdings is a Colombian company that wants to buy assets from all over the world. However, since they are wary of losing money from bad investments, they have decided to research earthquakes in order to know which countries are likely to suffer economic hardship due to a particularly devastating earthquake. This is why they have asked JohannioSoft, our company, to create a solution that can help them solve their problem. They say that they want us to obtain the data of earthquakes around the world (including latitude, longitude, magnitude, magnitude and depth) and display all this data conveniently on a map for them to analyze and decide their future investments.

Identifying the problem:

We must obtain and visualize all the data regarding where the earthquakes occurred in order to better understand these natural phenomenons.

*We must keep in mind that they have specifically asked for the data to show latitude, longitude, magnitude, magnitude type and depth.

Research:

Earthquakes

Earthquakes are “the release of energy from the earth's tectonic plates” (Structural Engineers Association of Northern California, 2020). The movement of tectonic plates (which account for the Earth’s surface) generate a build up of tension, and when this tension is released an

earthquake occurs (Structural Engineers Association of Northern California, 2020). There are many ways of measuring an earthquake. One way is measuring the intensity (measure of damage to the ground surface) using the Modified Mercalli Scale; the other way is measuring magnitude (which depends on the wave amplitude and distance) using the Richter Scale (Structural Engineers Association of Northern California, 2020).

United States Geological Survey

The US Geological Survey is a "science bureau within the United States Department of Interior [that] provides science about the natural hazards that threaten lives and livelihoods; the [...] natural resources we rely on [...] and the impacts of climate and land-use change." (United States Geological Survey). This site contains many maps, data and publications, as well as news and educational tools. It is also important to note that this website contains data about the entire planet Earth, not just the United States.

Kaggle

Kaggle is "a crowd-sourced platform to attract, nurture, train and challenge data scientists from all around the world to solve data science, machine learning and predictive analytics problems" (Usmani, 2017). The platform has hundreds of thousands of active members from all over the world and receives more than 100 thousand submissions per month (Usmani, 2017). It contains courses, contests, and a huge collection of datasets (some of which include data concerning earthquakes).

Google Maps

Google Maps is a service provided by Google that displays various information about maps all around the world. To do this, Google collects a massive amount of geospatial data from many credible organizations such as the United States Geological Survey, Forest Service and local governments; in addition, it collects location data from users' mobile devices and uses various vehicles to take pictures of streets and buildings (Stark, 2017). The app is relatively easy to use and contains a lot of useful features.

.NET Framework

The .NET Framework is a "software development framework for building and running applications on Windows" (Microsoft Corporation, 2020). There are two major components in the

.NET Framework. One component is the Common Language Runtime (CLR), which is an execution engine used to run the applications with features such as garbage collections, threading and exception handling; the other component is the Class Library, which contains various APIs and types to perform actions such as reading and writing files and drawing objects on the screen (Microsoft Corporation, 2020).

Windows Forms

Windows Form is a UI Framework that is part of the .NET Framework. It can be used to create desktop applications and various features to process and visualize data; furthermore, it has a visual designer integrated in Visual Studio (Microsoft Corporation, 2020). One Windows Forms component that can be used to display maps to the user is GMaps.NET.

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Creative solutions:

Brainstorming:

Alternative A:
Go to the library and ask the librarian for any available records of earthquakes, then underline all the important data and give it to the client.

Alternative B:
Obtain all the earthquake data from an online database and then draw the map with all the data manually using paint, colored pencils or any other art tool.

Alternative C
Obtain all the earthquake data from an online database and then draw the map using a drawing software in the computer or a tablet.

Alternative D:
Obtain all the earthquake from the United States Geological Survey website and use Photoshop or a similar computer program to edit a photo of the earth to display all of the data we obtained regarding earthquakes

Alternative E:
Obtain all the data from the data science website Kaggle in a .csv file and create a program using the .NET Framework in C# that displays the data using GMaps.

Alternative F:
Obtain all the data from the data science website Kaggle in a .csv file and create a program using the Java programming language and a library such as Java FX.

Alternative G:

Obtain all the data from the data science website Kaggle in a .csv file and use Excel or a similar software to organize and display all the data and charts we want to analyze.

Alternative H:
Create a program from scratch to analyze data and create maps without using the .NET Framework or any third-party APIs or libraries such as the Windows Forms Library.

Transformation to preliminary designs:

Alternative A:
This alternative might take too much time and the client will most likely not be entirely satisfied with just having the data underlined without any maps or graphical representations of the data. Therefore we must discard this alternative and find a better one.

Alternative B:
This could be a good alternative, however, we do not have any experience with cartography so this alternative might be too difficult and time consuming for us, and, even if we completed the map on time, I am not sure that the client will like a map made by amateurs. For this reason we must discard this alternative and find a better one.

Alternative C:
This could also be a good alternative, since drawing on a tablet is not difficult and, if a big and high quality tablet is available, might be even better than drawing on paper in some cases. However, we also lack experience drawing on a tablet, so we might end up taking too much time and creating an inferior product. Therefore, we must discard this alternative and find a better one.

Alternative D:
This might be an alternative suitable for us because all of us have experience with photo editing software, and Photoshop (as well as its alternatives) has a lot of tools that can help us create a good product. We must consider this alternative.

Alternative E:

This is a great alternative, since we already have created a program using C# and Windows Forms. In addition, the data in Kaggle is very well organized and we already know how to read the data into the program using C#. Thus, we must consider this alternative.

Alternative F:

This is also a great alternative, since we have spent over a year creating programs using Java. As I said before, the data in Kaggle is very well organized and we know how to read the data into the program using Java. Thus, we must also consider this alternative.

Alternative G:

Excel is very good at analyzing software and creating graphical representations of data, and we have a lot of experience with this software. We must consider this alternative.

Alternative H:

This alternative could be good because creating our own software from scratch can give us more control over the final product. However, we would be “reinventing the wheel” and it could take too much time. Therefore, we must discard this alternative.

The final candidates are alternative D, alternative E, alternative F and alternative G.

Evaluation and selection of the best solution

We will evaluate the final candidates (alternative D, alternative E, alternative F and alternative G) using the following criterions:

Criterion A: Time consumption

[3] The solution takes a team of three people five days or less to implement

[2] The solution takes a team of three people one week or less to implement

[1] The solution takes a team of three people more than one week to implement

Criterion B: Modeling of the problem

[3] - The problem can be modeled with the solution very well

[2] - The problem can be modeled with the solution

[1] - The solution does not model the problem very well

Criterion C: Versatility

[3] - The solution is very versatile and works in many situations

[2] - The solution is moderately versatile and works in certain situations

[1] - The solution is not versatile at all

Criterion D: Difficulty of implementing

[3] - The solution is not difficult to implement well

[2] - The solution is moderately difficult to implement well

[1] - The solution is extremely difficult to implement well

Alternative	Criterion A (Time consumption)	Criterion B (Modeling of the problem)	Criterion C (Versatility)	Criterion D (Difficulty)	Total
D (Photoshop solution)	1	2	1	1	5
E (C# solution)	2	3	3	2	10
F (Java solution)	2	3	3	2	10
G (Excel solution)	2	2	2	2	8

Justification:

Alternative D (Photoshop solution): Even though this was a solid option, there is an immense amount of data concerning earthquakes. So putting all this data in using photoshop will take too

much time, might prove to be extremely difficult, will be hard to edit later and it may not even model the problem very well. This alternative gets a low score of 5 (out of a maximum of 12 points).

Alternative E (C# Solution): This solution gets a very high score (10 out of a maximum of 12 points) because using the .NET Framework we can read the data and create a map in a relatively short time and without much difficulty. It is also easy to edit later because every change is stored in GitHub and a well-done program can model the situation very well.

Alternative F (Java Solution): This solution gets the same high score as the C# solution (10 out of a maximum of 12 points) because the Java programming has many similarities to C#. If we use the Java libraries and utilities, then we can also read the data and create a map in a relatively short time and without much difficulty. A well-done Java program can also model the situation very well and can be hosted in GitHub if we need to change it later.

Alternative G (Excel Solution): Using excel as our main solution is not bad at all, nevertheless it has some major problems. The creation of all charts and cell functions in Excel needs almost the same amount of time as using other solutions as Java or C#, but the Microsoft Excel application does not have the option of showing a map, so it can not solve the entire problem easily. As a matter of fact, Excel does not have the versatility of a well-done computer program in C# or Java and does not have some options that other programs could have.

Although there is a tie between the C# solution and the Java solution, we ultimately decided to create the solution using C# because we have been programming in Java for over a year and we must learn new programming languages in order to become better systems engineers.

The C# solution wins.

Functional requirements

Name	FR1: Load data
Summary	The system allows loading a dataset from a file
Input	The file **path**
Output	The data was loaded successfully

Name	FR2: Generate a table
Summary	The system allows generating a table with the data set
Input	-
Output	A table with the dataset

Name	FR3: Filter the table
Summary	The system allows filtering the table by all fields. If the field is a string the table must be filtered with the elements that are exactly the same or a substring of the searched word, nevertheless if the field is numeric the table must be filtered with all the elements that are between a specified range, however if the field is a category, the table must be filtered with all the elements that are exactly the same that the category specified.
Input	A field and a **value** (also could be a **range**)
Output	A table filtered by a specified field and value

Name	FR4: Generate charts
Summary	The system allows generating three different charts based on the dataset
Input	-
Output	Three different charts

Non-functional requirements

- The program has to use a data set from an open database and have georeferenced elements (with longitude and latitude coordinates).

- The application need to be coded with C# and use the Framework GMaps.

- The program needs to be able to display a GMaps map with the option of marking and filtering points in the map, a table with the dataset and by last three different types of charts (pie chart, bar chart, dispersion chart, etc).

- The table should be able to be filtered by all the fields, there have to be a comboBox with all the fields, if the field is a string, there have to appear a textBox where the user could write the value, otherwise if the field is numeric, there have to appear two textBox where the user could specified the range of search, introducing the min and max number. Finally if the field is a category, there have to appear other comboBox with the possible values where the user could select the one he wants to filter.

Diagrams: