Defining and Demarcating Desert From Geographic Data

Tania Singh

MSc Cognitive Systems
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Sc07ts@comp.leeds.ac.uk

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Dedication

ACKNOWLEDGEMENT

I am thankful to the GOD almighty for helping me to come to this stage in life and education. I would like to acknowledge the support of all those people who supported me at the various stages to accomplish this dissertation. I would like to thank my grandparents, mother, my sister and friends. I, also, take this as an opportunity to thank my supervisor, Dr. Brandon Bennett, without his guidance and support; this project work would have not been possible.

My sincere thanks go to Dr. Andrew Bulpitt (Director of Taught Admissions).

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ABSTRACT

Geographic concepts and features on the planet Earth are highly vague in many respects. The problem of vagueness is an issue of concern for many geographers. Dealing and handling vagueness in this field is a very challenging task. A lot of background study has been carried out to get the clear picture of the problem area. Also, previous work carried out dealing with similar issues has been studied thoroughly.

This project describes vagueness in the ‘desert’ feature. The aim is to define and demarcate deserts on the world map and make it as vagueness free as possible. Computing techniques have been adopted to handle vagueness in geography. Supervaluation semantics technique is adopted to demarcate boundaries of desert regions. The project, also, focuses on standpoint approach, allowing users to explore various definitions of ‘desert’ feature by choosing parameters and their values. The result is, thus, software that gives a clear demarcation of deserts according to the parameter that help defining it. Also, the software produced enables users to make their own choices for the parametric values and the threshold. A prototype implementation of the proposed is presented.

Methods of evaluation of the work have been proposed and hence carried out. The project, hence, deals basically with the problem of vagueness in geography and to illustrate it, the project focuses only on ‘desert’ feature. Techniques have been adopted to handle vagueness and remove it as much as possible. Future direction on the similar work and concepts is stated at the end.

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CHAPTER 1
INTRODUCTION

The first chapter of the report will give a brief introduction to the problem area. Following it is the aim of the project, minimum requirements and objectives of the project. Methodology and key steps involved explaining how the progress of the project is carried out. At the end, a report structure has been given that gives an overview of how the report explains the project work carried out.

1.1 MOTIVATION

Computer science applications have been providing solutions to problems in all the areas and fields of the world now. In [24] vagueness is explained as, “Vagueness is a pervasive phenomenon of human thought and language, and plainly, the world of geography is not exempted from its grasp.” The field of geography faces the problem of vagueness in many ways. Experts in this field chose to adopt computing techniques to overcome the problem of vagueness.

Interest was built up a lot after going through the previous work under the guidance of Dr. Brandon Bennett, which was commendable as it dealt with the issues of vagueness in different geographic concepts. It is not possible to remove vagueness completely from the geographic features because of various issues like climatic changes, mind dependency etc. But there are techniques like supervaluation that can prove helpful in dealing with vagueness as much as possible. For example, supervaluation deals with the demarcating of boundary of a region. The outcome helps users to experiment with the parametric values and hence defining the geographic concept.

Also, the project demands knowledge of subjects that have been studied in the course, which mainly includes Knowledge representation and reasoning. It is very interesting to see practical implications of what has been learned during the entire course.

1.2 OVERVIEW

Planet Earth is extraordinarily varied in different aspects of geography. For the same reason, geography has been a subject of keen interest since ages. The field of geography faces many problems, one of which is vagueness. It is a field that is very highly vague when defining any of the geographic concepts or features.

The project proposal was to add functionality to an existing project or use similar concepts handling some geographic features. Previous work carried out at the University of Leeds, under the supervision of Dr. Brandon Bennett, has focused on identifying water-features, such as lakes and rivers, given a geometric representation of the whole water system. The future work on this existing system, expectedly, was to add capabilities for handling other type of geographic features, such as forests, hills, valleys, town etc.

The feature, desert was chosen as it is one the very prominent geographic features of the planet Earth. Deserts cover approximately one-third of the Earth's land surface [23]. The word 'desert' brings quite a many parameters and different definitions, which then contrast with each other at times. The target of the project is, thus, to define deserts as far as possible and visualize it on the world map according to given parametric values to define it. It also includes a functionality to deal with the concept of vagueness as much as possible by including user-defined parametric definitions and their various combinations. To carry out the above, a tool or an application has to be developed.

1.2.1 Aim of the project

To ensure the decided aspects to be delivered, a number of objectives and aim were laid out. The overall aim of the project is as:

"To create an application that enables demarcation and visualization of desert regions, identified in terms of user configurable definitions applied to a variety of geographic datasets."

1.2.2 Objective of the project

The key objectives of the project to achieve its aim are as:-

1. Gather and analyze geographic data that is relevant to the classification of deserts.
2. Devise a representation for specifying multiple parameterized definitions for identifying desert from geographical data.
3. Build a prototype software system that will enable visualization of desert regions as identified according to a variety of different definitions, which may be specified by the user.
4. Evaluate the usefulness of the proposed definitions and practicality of the applied method to define and demarcate to visualize desert all over the world.

1.2.3 Minimum Requirement

With regard to the overall aim and objectives of the project, the minimum requirements were outlined as:-

1. An analysis of the concept of 'desert' identifying the significant physical parameters relevant to classify desert regions.
2. Implemented functionality for specifying definitions and parameters appropriate for desert classification.

3. Implemented functionality for applying specified definitions to geographic data in order to identify boundaries of desert regions.
4. A tool, which enables visualization of desert regions by applying user, defined definitions to a variety of geographic datasets.

1.3 KEY APPROACHES

To get the understanding of the key issues to achieve the aim and objectives of the project, quite a large emphasis is laid upon the research and the design aspects. The study about deserts helped gaining knowledge and listing all the important parameters that not only will define a desert but also should help effectively demarcate to visualize desert accordingly.

The next important thing was to gather geographic dataset of the world with parameters that should proof useful for the application. The data was taken from the Climatic Research Unit (CRU), which is widely recognized as one of the world's leading institutions concerned with the study of natural and anthropogenic climate change [7]. Since, the project aims to define and demarcate deserts of the world, it was important to use data of the world. Demarcation was also expected to carry out on a world map for the same reasons as above. World map has been plotted using data of the world countries (latitude/longitudes values) provided by the supervisor, Dr. Brandon Bennett, which originally can be made available from [16].

The project was designed using the standpoint approach [18], since besides vagueness it is also very important how a particular feature or concept is seen from different standpoints or observations of the user. Thus, the project enables users to choose their own parameterized values to define the concept ('desert', in this case). Different approaches to handle both vagueness and standpoint (or human dependency) [18, 22] have been studied. Supervaluation semantics approach is used to handle the issues of vagueness of desert feature. A prototype using some data of the parameter defining desert is presented and methods are proposed to carry out evaluation. Future works that can be carried out in handling similar issues have also been proposed, which might prove helpful later.

1.4 METHODOLOGY

Software has its own lifecycle which involves the process, rather a step by step process of its creation. There are many software development cycles, most common of which is waterfall model. This model is a sequential model which shows flow of phases – analysis, design, implementation and testing. This model fits for the software that has a defined set of requirements including no future changes in the requirements or up gradations. Waterfall model is linear in its flow from one phase to another.

Waterfall model doesn’t fit to suit this project as this project needs a more flexile model that allows coming back to any phase at any time of the project. Since the project deals with the issues in the field of geography, so it surely seems to have up gradations in the future like for data, or design etc. Also, more functions can be added to the project than the existing, or more requirements can be added. For these reasons, waterfall model does not suit this project.

Evolutionary Software Prototyping Methodology is used to carry out this project. This methodology has advantages over the traditional waterfall model, like it is more flexible in moving from one phase to another and coming back to any phase whenever needed [21]. This methodology, also, enables adding functionality that may be required at any time in the future or during the project. Hence, Evolutionary software prototyping methodology is used. This methodology allows producing many prototypes to be produced after an initial one is produced. All these various prototypes can go through all the modifications that are required to be made, until a final product is achieved. The figure below 1.1 illustrates the stages of this model.

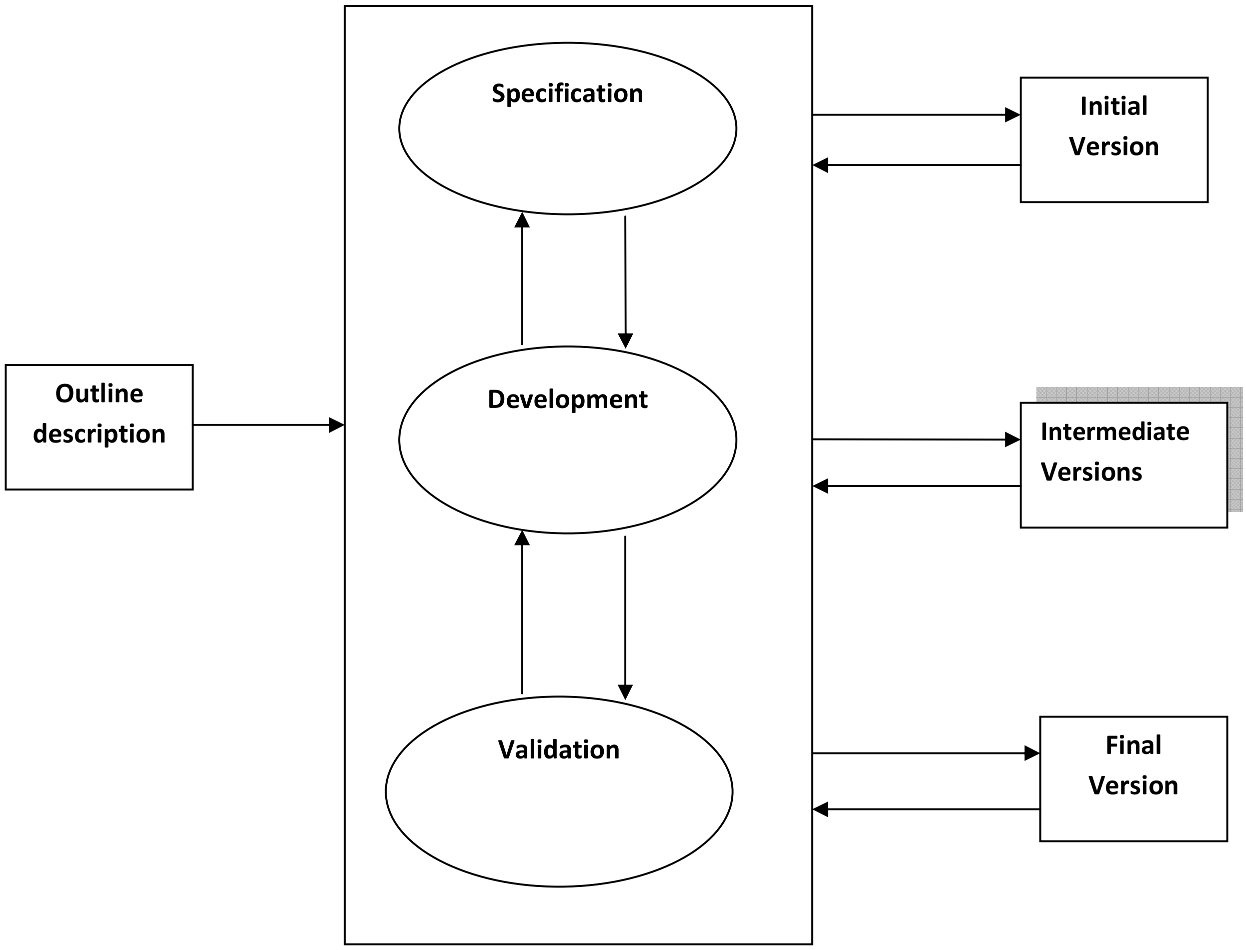

Fig 1.1 EVOLUTIONARY PROTOTYPE SOFTWARE MODEL, SOURCE [21]

1.5 SCOPE

The report focuses on making the reader firstly familiar with the issue of vagueness and how it exists in the field of geography. Also, approaches to handle vagueness in geography are studied. The aim is to define the concept of desert and demarcate it on the world map making it free from vagueness as much as possible. The project shows the deserts of the world according to the given parameterized values. To deal with all the parameters defining a desert and study the concept of vagueness is beyond the scope of this project as it is not easy to get the geographic data of the world according to the given parameter.

The data made available does not include the data of Antarctica, so it does not demarcate deserts which are present on this continent [7]. Deserts present in Antarctica proof to ensure that vagueness prevails in the concept of 'deserts'. This is because when deserts are usually considered to be hot in temperature, the deserts in Antarctica are frozen. Because the data of the Antarctica continent was not available, it is not possible to demarcate the deserts of Antarctica. Also, the data doesn't include many of the important parametric values, which might proof helpful in defining the desert feature. Certain parameters can be added to the available data, which can help in a better demarcation of the desert feature.

Boundaries play a very important role in making a concept vague [24]. Overlapping of certain boundaries or things, like, whether boundary points are counted as the part of the region or not, etc add to the concept of vagueness existing in desert feature. There are many approaches proposed in the past to deal with vagueness. Method of supervaluation semantics have been proposed to find boundaries of desert. It helps a lot in demarcating deserts in a sophisticated manner.

The problem of vagueness is a big concern to the geographers mainly. All the concepts or features in the geographical world are vague in many aspects. So, a product like this which can reduce vagueness in the geographical features can be help to the geographers. Also, the project deals with the standpoint approach i.e. it deals with the issue of how a particular interpretation might change from one to another according to different standpoints of an observer or user [18]. Thus, the project allows users to experience different definitions of deserts by changing the parametric values according to themselves.

Dealing with vagueness is geography or any other field is a very difficult and challenging task. It is not possible to remove vagueness from geography completely. But the project here deals with reducing it as much as possible. Definitely, there can be many future enhancements to this work that can prove helpful in dealing with vagueness in a better way. A deeper study is required to understand vagueness and figure out methods to remove vagueness completely from the world of geography. There are many constraints in each geographic feature like water, forest, mountains, desert etc. These complex constraints lead to different vagueness types and issues. Also, global climatic changes that lead to complex processed like desertification, variations in amount of rainfall, temperature changes etc. have to be handled with care. A regular update is will be needed to the system because of the changing environment. Up to date data should be made available.

For reasons like above, it is not possible to deal with the concept of vagueness very effectively by eliminating it completely from the field of geography.

1.6 PROJECT SCHEDULE

Planning is a very important aspect to show how a project was carried out in a given time span.

Meetings with supervisor after every few days have been a great support of guidance at each milestone. The progress meeting scheduled with the accessor, Dr. Andrew Bulpitt and the supervisor, Dr. Brandon

Bennett helped a lot in achieving the aim and minimum requirements. The project schedule and the Gantt chart are made available in the appendix C. The Gantt chart, shows the duration (in days) taken to accomplish each task. There are 5 tasks, excluding the interim report and the progress meeting. Also the tasks show duration mentioning he start and the end date.

1.7 REPORT STRUCTURE

The rest of the project report is organized as follows:-

Chapter 2 - Background study

This chapter includes the detailed problem description and the previous work carried out in the same field with its limitations. It includes the literature review and detailed background study. It also includes detailed explanation of vagueness and the possible approaches to deal with it. The concept of vagueness is explained using the 'desert' feature. Background reading of the desert region is done to understand the problem of vagueness that exists in it. Not only vagueness but human dependency and standpoint approach has been explained as well.

Chapter 3 – Design and Methodology

This chapter explains the designing aspects of the software. It includes the explanation of the dataset used and its source. Also, the chapter explains the methodology involved, which is the supervaluation of the 'desert' feature. It also explains the milestones or the phases involved in the progress of the project briefly.

Chapter 4 – Implementation

Implementing what was designed is an important phase of the project. This chapter explains how the product works with some screenshots showing its functionality and the outcome. This chapter mainly includes the screenshots needed to show the results obtained.

Chapter 5 – Evaluation

The outcome obtained needs evaluation. Many ways have been proposed to carry out the evaluation of the software produced. The project, hence, is evaluated and is explained accordingly in this chapter.

Chapter 6 – Conclusion

The last chapter gives the conclusion of what has been achieved in the entire process of work. Also, it gives the future directions to the same and limitations are stated.

Appendix A – Personal Reflection

A small reflection has been given about the project experience and details of how it was carried briefly.

Appendix B – Interim

This includes the comments given by the assessor, Dr. Andrew Bulpitt and the supervisor, Dr. Brandon Bennett. Also, the interim report has been attached to the hard copy of the report.

Appendix C – Gantt chart and Project Management

Project schedule according to the tasks and duration have been shown in form of a Gantt chart in this appendix.

CHAPTER 2
BACKGROUND STUDY

This chapter includes an in-depth research study about the problem area – Vagueness in geography (‘deserts’ specifically). The aim of this chapter is to make the reader familiar with the concepts and ideas used in the project to deal with the problem. Supervaluation approach has been discussed, as it is used to handle vagueness in this project. Also, mind-dependency and standpoint concepts have been discussed as well in this chapter.

2.1 BRIEF INTODUCTION TO PROBLEM AREA

Geographical features are planet components that can be referred to as locations, areas, sites, or regions. These can also be called as geographical formations. Geographical features can be classified into natural geographical features, artificial geographical features and abstract geographical features. Natural geographical features include bodies of water, landforms, biomes etc. Artificial geographic features includes human settlement, construction engineered features (highways, bridges, airports etc). Abstract geographic features are those that don’t exist physically in the world, still they have a location by definition and can be located on maps. This includes countries subdivisions, latitude lines and longitude lines, poles of the earth etc[23].

Human beings tend to use a variety of common terms when referring to geographic features – like forests, rivers, deserts, mountains etc. It is supposed that terms as above are clearly understood by humans but when referring in terms of physical geography their meanings are not well understood. There exist many geographic features that can be seen as an aggregation of other small features or objects. To explain this, for example, forest is a collection of tress, shrubs etc. Other important factors such as geometric properties of regions of a particular type are also present. For example, rivers are linearly extended regions of water. Also, profile of the surface of the earth like hills and mountains is an important feature.

Geographic concepts are affected by vagueness in many ways. Geographic researchers deal with the concept of vagueness using the techniques of computer science. They take techniques like fuzzy logic, multi-valued logic etc [15]. The project deals with the concept of vagueness that prevails in the world of geography. To do so, it was best to deal with only one geographic feature which has not been dealt before. So, geographic feature, desert was chosen. An in-depth research was carried out to gather knowledge about the problem of vagueness and ways to deal with it. Also, how mind-dependency affects a certain concept was studied [22].

The target of the project is to define deserts of the world as far as possible and visualize it on the world map according to given parametric values to define it. To deal with vagueness and mind-dependency issues, it also includes user definitions according to the same parameters and their various combinations. The deal is to demarcate deserts according to the given values of the defined parameters.

2.2 CONCEPT OF VAGUENESS

In natural language terminology, often a term ‘ambiguity’ is used, which states the unclear meaning of a particular word, sentence etc. The term ‘Vagueness’ roughly relates to the term ‘Ambiguity’ with respect to having unclear notions of an entity. Vagueness is different from ambiguity though. [2] regards vagueness as, “A lack of clearly defined criteria for the applicability of a certain concept.” Vagueness describes what human beings think and the language they use when referring to some entity.

Vagueness deals with natural language terminology being different when expressing any concept. It can be said that vagueness is a property of language.

2.2.1 Vagueness in Geography

The field of geography is also influenced with the problem of vagueness. The language used to describe geographical concepts is extensively vague. The concept of vagueness is highly seen when it comes to defining any of the geographic features. For example, while talking about mountains, it is very difficult to say what the lowest mountain peak is. Also, for cities, it sounds impossible to say what city is the smallest of all. When defining a river as a stream of water body; this definition doesn’t classify it from other water bodies like lake, ocean, sea etc. Hence, it can be said that definitions of many of the geographical features remain vague in many respects.

The figure 2.1 below shows a picture of the Himalayas, featuring the Mount Lhotse and Mount Everest. The boundary between the mountains and its valley is not clear and remains vague. It does not seem to be clear whether the areas near the foothill belong to the mountain or the Everest. Hence, this explains in a way how vagueness can influence boundaries and thereafter regions.

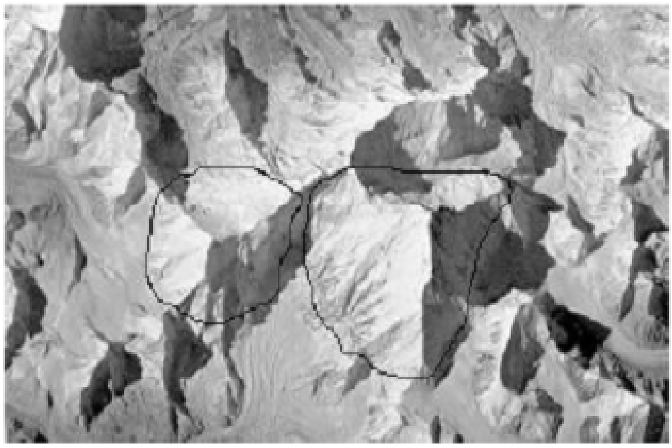

Fig 2.1 Picture of Himalayas taken from space. Left mountain is Mount Lhotse and the right one is Mount Everest, Source [26, 1]

2.2.2 Types of Vagueness

Conceptual vagueness and Sorites vagueness are the two kinds having different logical descriptions [2]. Both of these are not mutually exclusive. Perhaps, there exists many concepts or terms that are influenced by both these vagueness types. These are explained individually below:-

While trying to precisely define a concept, when there is not even a single definition that proves beneficial in describing the concept, then conceptual vagueness arises. Many definitions can be stated for a single concept, but later they might coincide with each other at some other situation. . For example, it is believed generally that desert is a hot and barren place without any surface water. It is also considered as a dry region covered with sand. But there are deserts in Antarctica and Greenland icecaps which are never hot [4]. The Atacama Desert in Chile is one of the most arid places and borders on the ocean[4]. Similarly, there can be many other definitions to desert; certain combinations of whose might make sense but individually they will not represent any recognized mark. As stated in [2], a general concept can be achieved if the disjunction of plausible definitions can be taken. Perhaps, an unsatisfactory result will be obtained if intersection of such definitions of a concept is taken.

If a concept is seen as a cluster of many definitions that fully or partially overlap with each other, and still it is not clear that what definitions gives the cluster some sense of precise (or close) definition to it. The above will correspond to Conceptual vagueness to any term or concept.

Sorites vagueness deals with the phenomenon of making a boundary to define a concepts like; ‘a tall mountain’, ‘a small city’ or ‘a long river’ etc [2]. This kind of vagueness determines what affects the threshold value used to define the above possibilities. It has nothing to do with the vague concept; rather it deals with the boundary of applicability. For example, Peirce stated of the problem of demarcating a line and what color will it be, between a black spot and a white background. Concepts like these face the problem of Sorites vagueness [24].

2.2.3 General method proposed to handle Vagueness

[2], explains clearly the ways by which vague terms can be clarified to get a precise definition of a concept. There are two ways modes of analysis to be carried out. They are as:-

1. Firstly, conceptual vagueness must be handled. To do this, all the definitions individually should be taken into consideration and then the points that raise collision amongst the definitions of the concept should be recognized.
2. If needed, artificial definitions to the concept should be added to support in defining the concept more precisely.

If an in-dept analysis as stated above is carried out, the concept is then supposed to have a clear sense of what it originally is, and should be then free from conceptual vagueness completely.

A limitation to the above method is that the artificial definitions added may face the problem of sorites vagueness. To overcome this limitation, sorites vagueness should be removed by adding a threshold which shall constraint the boundary when defining a certain concept.

2.2.4 Spatial Vagueness

Vagueness usually deals with the borderline cases. "Most modern geographic information systems model the spatial extensions of geographic objects as sharp regions that have a unique boundary."[15] Spatial concepts in terms of vagueness, its reasoning and solutions have become a wide area of research and importance to the field of Artificial Intelligence [8]. In demarcation of a geographic concept, borders play a very important role to get a clear demarcated picture of a certain geographic concept or feature. The importance of a well-marked boundary is that it enables a clear idea of which points that lie within that particular region or area.

All the geographic features are vague in various aspects. As explained in [15], geographic features and concepts usually have gradual boundaries. By gradual boundaries it means that the boundary points are not clear, in context whether they belong to the particular geographical area or region. For an example, in case of desert, there can be a gradual boundary between two vague regions – desert and a prairie.

Fig 2.2 The Big Prairie desert in Michigan, Source [12]

The picture above, Fig 2.2, shows a prairie region in the area of Michigan. This got transformed into a desert. Geographic changes like these on the surface of Earth, lead to vagueness. This makes it difficult to identify a particular feature, and then define and demarcate geographic features. For, changes like these; it becomes tough to even evaluate a system over time.

In [8], spatial vagueness concept divides itself into two categories as shown below;

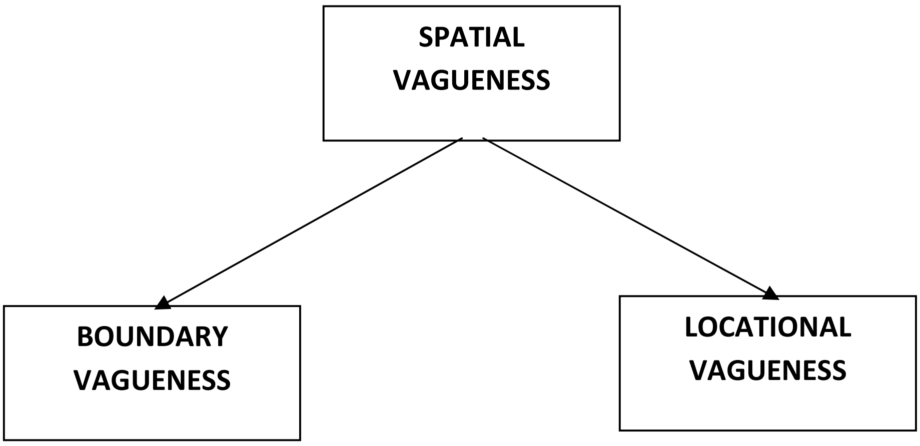

FIG 2.3 CLASSIFICATION OF SPATIAL VAGUENESS, SOURCE [8]

Boundary vagueness clearly is caused due to vagueness of boundary points of a particular region, whereas locational vagueness is due to vagueness in location (spatial).

The problem of spatial vagueness regions and their spatial relations are explained using 'Egg-Yolk theory' [2,8].

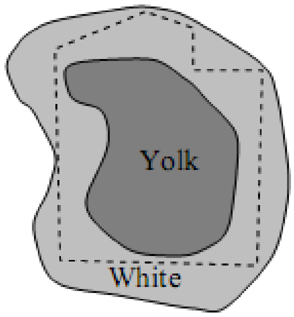

FIG 2.4 EGG-YOLK MODEL, SOURCE [2,]

[8]Both egg and yolk are regarded as rigid regions where yolk has a flexibility to locate itself within the egg region. Thus, yolk is considered as the 'minimal' possible extension whereas the egg itself is considered as the 'maximal' possible extension of the region. 'Crisp' region is considered to be when both the egg and the yolk are both equal sized regions. [2,8] The egg-yolk theory is considered useful in dealing with rather simple cases of relationships between the maximal and minimal extended regions. It cannot handle complex constraints when establishing various spatial relations between the minimal and maximal regions. [8] Spatial vagueness can also be caused due to temporal variation i.e. changes that can occur during the span of time. In case of deserts, such can be seen as an example of process of desertification that occurs over time. Also, the scene of global climate changes come into consideration, it becomes obvious to see changes growing in geographic concept like deserts. Such temporal variation seems problematic by leading to vagueness in geography.

2.2.5 Approaches to formalize the Vagueness logic

Vagueness is a prime issue of concern to the geographers. Modeling a formal categorization of vague concepts plays a very important role [15]. For this reason, people in the field of geography, opt for computer methods to model vagueness. There have been many approaches proposed to deal with the concept of vagueness in geography.

[15], gives the following approaches used to deal with vagueness:-

1. Fuzzy approaches
2. Accounts based on rough set theory
3. Qualitative characterization

4. Supervaluation semantics

Spatial vagueness have been modeled very often in the past using fuzzy method approach. Vagueness is described by fuzzy methods by using the concept of degrees of membership [15]. Fuzzy logic uses multi-valued logic by using membership values between 0 and 1. This depends on the truthfulness of a statement about a certain geographic concept or feature. Another approach proposed to deal with vagueness is accounts based on rough set theory. Instead of using the concept of membership as used in fuzzy logic, this approach uses mathematical concepts to identify boundary region of a geographical concept. There is an upper and lower approximation in the rough set; thus it gives indication whether points belong to a particular set definitely or may belong to that set. The approach of qualitative approach was considered over approaches like fuzzy set theory. The reason behind this is that spatial reasoning demands only qualitative knowledge. This involved topological relations and geometric knowledge for geographic concepts [15].

Two other approaches to deal with vagueness were proposed by the supervisor, Dr. Brandon Bennett (on20 June, 2008):-

- Field contour map
- Satellite image land cover classification

Lot of work in past handling vagueness has used fuzzy approach. But when formalizing logic for vagueness, [2] suggests fuzzy logic not be a suitable method for carrying method for carrying logical reasoning. Supervaluation semantics approach has been proposed to deal with vagueness. Also, this approach was considered useful to deal with vagueness by the supervisor.

2.2.6 Supervaluation Approach

The approach of supervaluation semantics have been used in this project to deal with vagueness. As explained in section 2.2.4, the egg-yolk theory to illustrate the problem of spatial vagueness in terms if spatial regions and the relations, the limitation of this theory is that it can not deal with complex cases constraints on the possible relations between regions of extension – maxima and minima [2]. Supervaluation semantics can deal with cases of spatially vague regions like shown in fig 2.3(a), where there are arbitrary constraints applicable on the regions and their relations. Also, supervaluation approach is capable of handle sorites vagueness; here threshold value is experimented to check how boundaries are demarcated differently each time [1,2,8].

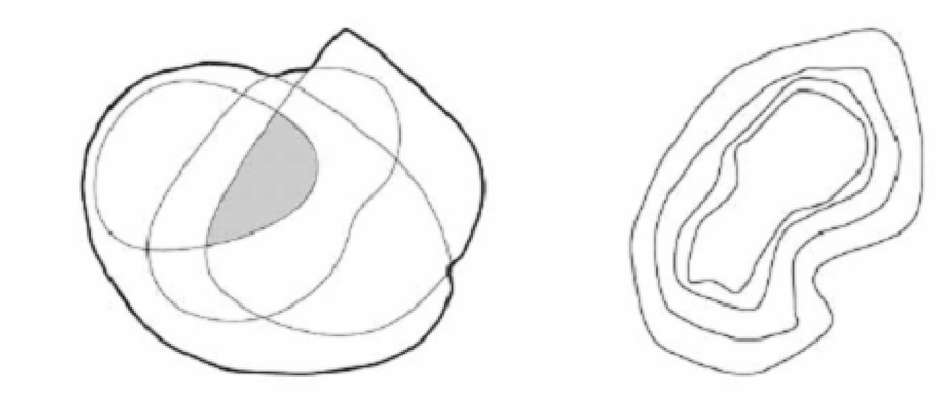

Fig 2.5 (a) **(b), SOURCE [2]**

[15] very well explains the terminology used when describing the supervaluation semantic approach to deal with vagueness, by considering vagueness as a 'semantic indecision'. The following terminology can be illustrated from [15] as:

- Positive Extension - entities to which the vague predicate is clearly and surely applicable.
- Negative Extension – entities to which the vague predicate is not applicable at all.
- Penumbra of the predicate – entities to which the applicability of the predicate is indefinite.

"An interpretation assigning a meaning to a predicate like' forest' is called *admissible* if it makes the predicate true in the positive extensions, false in the negative extension, and either true or false in the penumbra." [15]Every admissible interpretation is called a *precisification.* [18] Thus, in the theory of supervaluation, a vague concept or feature is a set of different precise versions of itself, giving its own definitions according to various attributes. Each of these distinct versions are called precisification, p. each p is identifiable from a decision made from an interpretation I_p of the concept or the feature been discussed. Hence, a supervaluation model is a set of distinct precisifications.

Supervaluation semantics is effective in modeling vagueness in terms of threshold values or parameters, which is in way sorites vagueness. Supervaluation semantics not only handle vagueness in this way, but it also is used to handle standpoint observatory changes. By standpoint it is meant, an interpretation of a concept might change from the standpoint observation of a user from another; this is also called user's judgment [18]. It is also mentioned in [18] that supervaluation approach is useful in drawing inferences of a particular concept being studied. [18] Thus, prefer supervaluation semantics over the fuzzy logic approach, mainly because of the reason of supervaluation approach been affective in achieving inferences about the particular vague concept. This proves to be the main advantage of supervaluation semantic approach over fuzzy logic approach to deal with vagueness.

By using threshold values on different attributes of a concept or feature, it proves effective in producing distinct definitions of the concept or feature. Thus, it gives definitions as required and these definitions are considered not to be vague. The number of resultant definitions is assumed to be achieved from different standpoints of the observer or user. [18] says, “We assume the supervaluation semantics to provide a framework for standpoints on feature definition”.

2.3 PREVIOUS AND EXISTING WORK

2.3.1 Geographic Information Systems (GIS)

A geographic information system (GIS) integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information [6]. In another definition, "GIS is a system or tool or computer based methodology to collect, store, manipulate, retrieve and analyze spatially (georeferenced) data." An going research project under Dr. Brandon Bennett, at the University of Leeds; involves development of Geographic Information System (abbreviated as GIS) that can interpret geographic data in terms of high-level-natural-language like concepts. The meaning of such concepts is what humans use in day-to-day life while talking about any of the geographic features, which clearly is not stated as a good definition in comparison to what it geographers will define. The key problem of developing Geographic Information System is to identify geographic features and then defining them in terms of their respective physical properties (in natural language terminology).

2.3.2 Previous work

One of the previous years project by a student at the University of Leeds, deals with forests. The project was carried out by setting a number of trees, distance between them and a threshold value. It hence, shows if the defined attribute values define a forest. This project dealt with sortis vagueness as well as conceptual vagueness. Previous work carried out at the University of Leeds, under the supervision of Dr. Brandon Bennett, has focused on identifying water features (example – lakes, rivers etc.), given a geometric representation of the whole water-system. The future work on the existing system was expected to handling other type of geographical features.

2.3.3 Limitations of the previous work

Previous work carried out on water feature and forests at the University of Leeds, had limitations. Both these work were not carried out in a way to show real features of the planet Earth.

To overcome the limitation of the above, the project deals with real world data. Also, demarcation is carried out on a world map. It, hence, shows real world deserts demarcated on the world map. This helps overcoming the limitations of the previous work.

2.4 PROBLEM AREA

2.4.1 Key steps involved

As described above, previous projects have been dealing with geographical concepts like forests and rivers. The future work on it was expected to be handling other type of geographical features of our planet. The project would involve the following tasks:

1. Decide upon a type of geographic feature that should be investigated.
2. Analyze relevant geometric and other characteristics that may be used to identify the feature.
3. Devise a definition (or multiple definition) and various parameters that shall describe the feature concept.
4. Refine the definition by experiments testing how well it characterizes the feature using geographic data.
5. Evaluate the usefulness of the definition and practicality of the project.

The first task of the project was to choose a type of geographic feature. The feature 'Desert' was chosen as it is one of the very prominent and important geographic features of our plant. Also, it does cover quite a recognized part of the surface of Earth (approximately, one-third) [23]. There are many parameters, combinations of which, define deserts in various ways. There are many definitions of deserts according to different parameters, which are agreed upon by the geographers around the world. These parametric definitions, contradict with some example of deserts on the surface of Earth, hence, leading to the concept of vagueness that very highly exist in the field of geography.

2.5 DESERTS

To explain the above, many examples of deserts around the world can be quoted along with their proposed definitions. It is believed generally that desert is a hot and barren place without any surface water. It is also considered as a dry region covered with sand. But there are deserts in Antarctica and Greenland icecaps which are never hot. The Atacama Desert in Chile is one of the most arid places and borders on the ocean. Deserts like Sahara desert in Africa have sand dunes cover on it. But it is a fact, that only one-fourth of all desert surfaces are made of sand, the rest are clay, rock or some mixture of organic and inorganic materials [23, 4]. Although deserts generally have little precipitation but many have at least one rainy season each year. All these parameters and their values to define a desert are not consistent to define all the deserts of the world as the same. Thus, many parameters and their different values actually will demarcate different desert areas of the world.

Desert can be defined and classified in many number of ways. It is almost equivalent to the number of deserts all around the world. Many of the desert classifications reply in combinations of factors like annual rainfall, number of days of rainfall, temperature, humidity etc. Deserts have been classified into sub-tropical desert, cold winter and the cool coastal desert [23]. Deserts are form of landscapes (natural geographical feature) or regions that receive very little precipitation with an average annual precipitation of less than 250mm (or 10 inches). Based on the total amount of precipitation in a year, desert maps subdivide world deserts into semiarid, arid, extremely and rainless deserts. The daytime temperature is as high as 45 C (or 113 F) and the nights are as cold as 0 C (or 32 F) and since the desert air is dry it hold very little moisture [23].

The Köppen climate classification is one of the most widely used climate classification systems. According to this climate classification system, a desert is a place where more water is lost through evaporation than is gained from precipitation. This concept is called 'Evapotranspiration'. Matt Rosenberg, an award winning professional geographer, technically describes evapotranspiration as evaporation from soil and plants plus transpiration from plants. Hence, he describes deserts, as regions that receive amount of precipitation lesser that their potential evapotranspiration [17].

[2], talks about the problem of identification and classification of 'deserts' in his paper. He also proposes the problem of monitoring and measuring the progress of desertification on Earth. An award-winning professional geographer, Matt Rosenberg [17] discusses the issue of threat of desertification on a quarter of Earth's land. Desertification is a process in which a land which once was suitable for agriculture transforms into desert. There can be multiple causes of desertification like global climatic changes or bad land practices by humans like deforestation, overgrazing etc [23]. The Sahel strip that stretches along the southern fringe of the Sahara Desert (in Africa), in the 1970s, turned into desert from a land which was earlier used for grazing. This region turned into a desert because of the complex process of desertification [17].

2.5.1 Spatial Vagueness and Desert

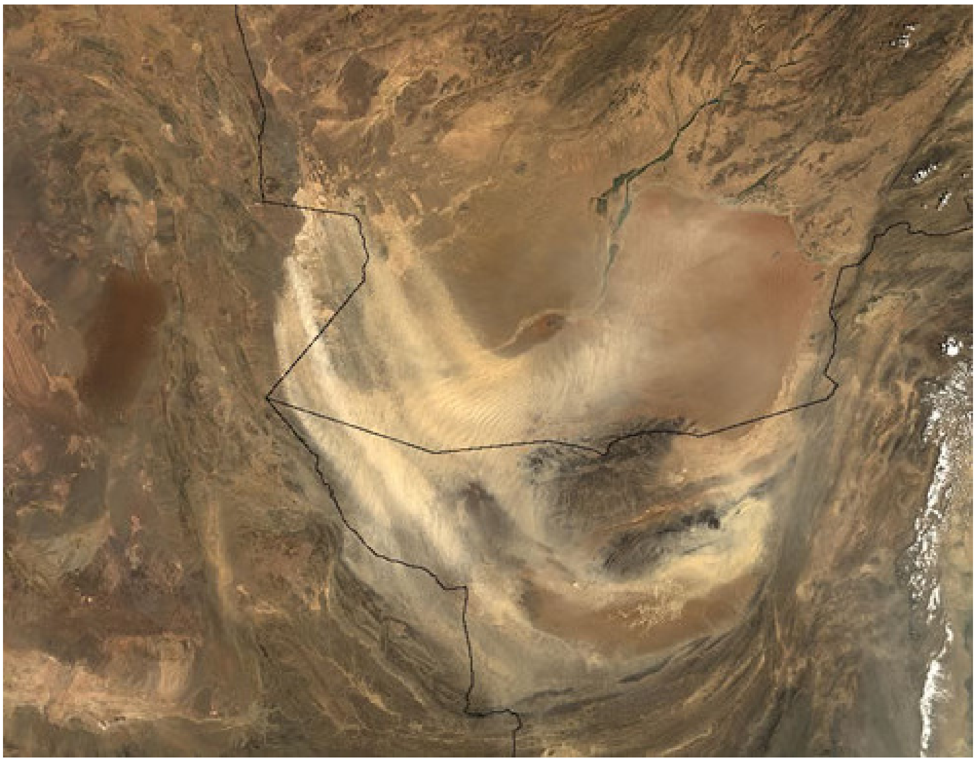

Fig 2.6 Dramatic photograph from space of deserts of Pakistan and Afghanistan, Source [13]

The geographic feature, 'desert' surely is not away from the concept of vagueness. As discussed, deserts surely go through many such issues which lead to vagueness. For an example, fig 2.6 is a picture taken from space of the deserts in Pakistan and Afghanistan. Desert landforms can be seen but not sand dunes. A dune is a small hill made up of sand, but it is not shown in the pictures. Although dunes form a part of deserts but they are not demarcated and thus, vagueness arises.

All the geographic features on the planet Earth are assumed to have vague boundaries. This gives rise to situations where it can be said that two vague regions can have a common and gradual boundary like transition from hill and valley etc. In case of deserts, such transition can be seen in desert and prairie. Here, desert is a vague feature classifier and it doesn't have an exact and precise definition. Definition of desert feature remains vague in many ways. A desert can be defined according o various parameters but they always not turn out to give a generalized definition because it clashes with some examples of deserts present in the world.

A list of questions regarding the geographical feature, desert is produced. All the questions produced give the picture of the problem of vagueness that is associated with 'desert' feature. There seems to be no direct to answer to any of the below [2].

1. What are the different types of parameters that can be useful in defining a desert?
2. How large area should be occupied to be called as a desert?
3. How should seasonal and other variations (e.g. desertification, change in global climatic conditions etc) be handled?
4. Should any small village or a road passing through a desert be considered as a part of desert?
5. Could it share a boundary or border with another region of a desert or shall it be a maximal?
6. Can there be any constraints on the shape of the desert regions?
7. Does a desert need to be self connected, or can it consist of many several disjoint parts?
8. How a desert can be defined which doesn't match with the generalized defined parameters?

A feature or concept that can be defined according to points is said to have spatial properties. In case of deserts it cannot be just described as a set of points which receive a particular amount of annual precipitation; instead it has to be a connected region of the set of maximal set of points covered as a desert region. According to [2], "Maximal connectedness is one of the most important factors that enable us to individuate geographical features from the attributed point data". This property of maximal connectedness of geographical set of points exist in only very few basic features and concepts. An extended part of a particular concept or feature described by a set of spatial set of points depends on complex constraints, which don't seem to be easily and practically possible.

To identify a geographical feature, its boundary is a very important factor. Vagueness is very much identified in concepts when defining their boundary. Also, when in context of spatial concepts, a question raises of whether to include boundary points as a part of the region to be demarcated or not.

2.5.2 Mind dependency and Desert

The concept of Mind-dependence can be said to what human beings might think of a particular geographic feature. Mind-dependence rises from the various ways of human beliefs and sometimes even the customs. According to Thomasson [22], "This mind-dependence raise certain crucial problems from epistemology and ontology of geography, leading some to doubt whether geography can really be considered a science involved in making discoveries about the world, and whether or not the purported facts studied by geographers should really be considered as existing at all." For this reason the project aims at user choices of selection when demarcating a desert according to stated parameters.

But Lakoff [22] argued with statement as, "No true fact can depend upon people's believing it, on their knowledge of it, on their conceptualization of it, or on any other aspect of cognition. Existence cannot depend on human cognition". Somehow, human-dependency leads to vagueness.

There are many cases seen in the world of geography that are dependent on the collective beliefs and customs of group of people. Incase of desert, many people believe it to be just as a land covered with sand, but it is a fact that only one-fourth of all desert surfaces are made of sand; the rest are clay, rock or some mixture of organic and inorganic materials. Most of the people believe deserts to be a place with very high temperature; not aware of deserts present in Antarctica which is covered with snow. Absence of water in deserts is something that is believed by a majority of people, but some rivers rise within a desert region itself. Flow of such rivers occurs only after rainfall period, otherwise they are intermittent. Rivers like the Nile and the Indus, rise outside the desert but they flow across it. [4].

The foundations of geographical concepts like deserts vary from mere mental constructs and beliefs or human imaginations. Thus, sorting or grouping of different senses in which diverse geographical features like deserts are mind-dependent, should be done. The steps taken to fulfill the above is to –

(a) Make user choices applicable on the world map demarcating desert,

(b) Making desert definitions according to the decided parameters like precipitation, temperature etc.

Also, human dependency is closely related to standpoints. Supervaluation semantics [18], also called standpoint approach, not only deals with the vagueness issue but also provides methodology to handle changes that come in front because of 'standpoint'.

[18]By standpoint, it is meant the changes that occur because of different decisions or interpretations that can be made according to different standpoints or views of users. This, thus, is related to human dependency.

2.6 EXPECTED OUTCOME

The main aim of the project is to deal with vagueness in geography. As it is beyond the scope of the project to deal with all the geographic features, so only deserts have been taken for the illustration of the problem and its possible solution. The project not only deals with the vagueness problem in deserts but it also deals with the human dependency or standpoint judgments. Hence, the outcome is expected to be dealing with the problems that make a feature vague and also the human dependency.

Firstly, to deal with vagueness like boundary problems, supervaluation semantics have been used. This approach helps in producing better results as it plots the boundaries well according to the parametric values. Also, the human dependency makes a feature vague. This project enables user to make their own definition by setting parametric values according to their choice and hence visualizing a desert accordingly.

This chapter gives a detailed description of all the background study carried out about vagueness and desert feature. Approaches to handle vagueness have also been proposed in this chapter. Thus, this chapter explains the problem area in detail and possible solutions for it.

CHAPTER 3
DESIGN AND METHODOLOGY

This chapter gives an overview of the geographic data used and its semantics. It also discusses the various phases and milestones needed to design a solution to the problem. This chapter, explains briefly how theoretically, a 'desert' feature can overcome vagueness (may not completely but effectively) using the supervaluation approach.

3.1 DATA ANALYSIS

One of the very important key objectives of the project is to gather and analyze geographic data that is relevant to the classification of deserts. The data should be according to the parameters like precipitation, temperature etc, which are helpful in defining and demarcating deserts of the world. It is very important to be thorough with the dataset been used because there lies uncertainty in data. Also, it is very crucial to understand the underlying meaning and properties of the data

Maps are used to visualize the geographic features and concepts according to the given geographic data. They are used as visualizing tool, and have been used since ages in the field of geography. Maps make understanding the concepts and see results in an easier way. To overcome the limitations of the previous work carried out in the same field, it was decided to carry out the project work using the real data of the world. Also, demarcation of desert was decided to be shown on a world map, which as a result should give real picture of the deserts of the world.

3.1.1 World Countries Data

To picture the real world deserts, it was decided to carry out demarcation of deserts on a world map. World map was decided to plot using data of the world countries, instead of just uploading a map. The data of the world countries was provided by the supervisor, Dr. Brandon Bennett. The major source of geographic data is [16].

The data includes the latitude and longitude values according to which the world map is plotted. The dataset is a GML file. GML is Geography Markup Language Encoding Standard [16]. [16] explains, the Geography Markup Language (GML), is an XML grammar that is used for expressing the geographic features of the world. GML is also regarded as a modeling language in [16], and this GML is used for geographic systems widely and also, users and developers dealing with the geographic datasets of the world, use GML as a modeling language.

3.1.2 Climatic data for demarcating deserts

A very important key issue was to gather a geographic dataset of the world with parameters that should prove useful for the application. This was a very difficult task to collect data of the world, which should be relevant to the desert parameters, when defining it. After a lot of search, data was taken from Climatic Research Unit (CRU). It is one the recognized, world's leading institution concerned with the study of climate change. [7]

The climatic data of the world taken from the Climatic Research Unit (CRU) is a high resolution dataset. An earlier record of climatic data of the world was 30-minute latitude/longitude dataset; the data used for this project is a 10-minute latitude/longitude. Thus, the one used now is a high resolution dataset [7].This dataset includes data of all the countries of the world, except Antarctica.

This climatic data includes 8 data elements:

- precipitation,
- wet-day frequency,
- temperature,
- diurnal temperature range,
- relative humidity,
- sunshine duration,
- ground frost frequency,
- wind speed.

The data is given as average figures for each calendar month and is an interpolated data set of station means for the period from 1961 to 1990.

Nomenclature and Units

1.	pre	precipitation	mm/month
a.		cv of precipitation	percent
2.	rd0	wet-days	no days with >0.1mm rain per month
3.	tmp	mean temperature	Deg C
4.	dtr	mean diurnal temp- i. erature range	Deg C (note tmx=tmp+0.5*dtr tmn=tmp-0.5*dtr)
5.	reh	relative humidity	percent
6.	sunp	sunshine	percent of maximum possible (percent of daylength)
7.	frs	ground-frost	no days with groudn-frost per month
8.	wnd	10m windspeed	m/s
9.	elv	elevation	km

Table 3.1 – Units explaining the dataset used, source [7]

Data format

1. All grid files except elevation (elv) and precipitation (pre)
latitutde, longitude, 12 monthly values (Jan to December)
lat and lon are in degrees decimal

format='(2f9.3,12f7.1)'

Example (first line of tmp file):

```
 -59.083  -26.583    0.2    0.3    0.2   -1.9   -6.0   -9.8  -13.6   -9.2   -8.1   -5.3   -2.3   -1.1
```

2. Precipitation
latitude, longitude, 12 monthly means of precip, 12 monthly CVs of precip

format='(2f9.3,24f7.1)'

Example (first line of pre file):

```
 -59.083  -26.583  105.4  121.3  141.3  146.7  159.6  162.4  141.5  151.1  141.6  124.9
110.0   93.9   35.2   38.7   38.4
  27.5   49.5   40.8   50.8   33.5   42.2   56.6   35.5   43.4
```

3. Elevation
latitude, longitude, elevation

format='(3f9.3)'

Example (first line of elv file):

```
 -59.083  -26.583    0.193
```

Table 3.2 - Format of dataset used, source [7]

More attributes to the available dataset can be added, to add to the functionality of defining and demarcating desert feature. In the precipitation data, where it gives data of the world giving mean monthly precipitation of all the twelve months; annual precipitation is computed to define deserts. Deserts receive an annual precipitation of less than 25 cm. Adding annual precipitation makes computing the desert area according to the precipitation (annual) easier.

[2], suggests that not only identifying and defining deserts is a complicated and tough task but also classification of deserts is not easy. This is mainly because of the varying attributes and parametric values of deserts all over the world. [28], uses aridity index to define and classify deserts. For the same reason,

aridity index value can be added to the available data. Aridity defines the degree of dryness in climate and is computed as:-

$$I_a = \frac{P}{T + 10}$$

Where, I_a - aridity index,

P – Mean annual precipitation,

T – Mean annual temperature

The classification and definition according to the aridity index is shown below;

Rainfall/mm yr^{-1}	Aridity index	Aridity	Examples
< 25	< 5	Hyper-arid	Namib; Arabian
25–200	5–20	Arid	Mojave
200–500	20–50	Semi-arid	Parts of Sonoran

Table 3.1 DEFINITION OF DESERT ACCORDING TO THE ARIDITY INDEX VALUE, SOURCE [28]

But average precipitation can be an uncertain value because different desert regions receive different amount of precipitation. Similar is the case with annual mean temperature of deserts which can vary from place to place. Where deserts are considered to be hot with really high temperature, there are deserts present in Antarctica, which are cold and don’t have high temperature. Such uncertain parametric values of the attributes used to define deserts become the cause of vagueness and difficulty in defining and classifying deserts of the planet Earth.

Definition and classification of deserts are determined by the value of annual mean temperature as shown below;

Climate	% of deserts	Examples	Mean T_a coldest month/° C	Mean T_a warmest month/° C
Hot	43	Central Sahara; central Australian	10–30	> 30
Mild	18	Kalahari-Karoo, Chihuahuan	10–20	10–30
Cool	15	Mojave, Namib	0–10	10–30
Cold	24	Gobi	< 0	10–30

Table 3.3 DEFINITION OF DESERT ACCORDING TO THE MEAN ANNUAL TEMPERATURE, SOURCE [28]

From the above it becomes, clear that the most important parameters that become the vital source of defining and classifying deserts are annual mean precipitation and annual mean temperature.

3.2 ANALYSIS OF REQUIRED FUNCTIONALITY

The project mainly deals with the problem of vagueness in the field of geography. To illustrate the problem of vagueness in geography, desert feature has been used. How vagueness could affect even definition of a geographic concept (desert, in this case) has been shown. The problem area and possible solution to it is shown in context with the geographic feature desert. To deal with the problem of vagueness, the following two main ways were proposed in the past are as: - [2, 15]

1. Fuzzy Logic
2. Supervaluation Semantics

Because of the limitations of fuzzy logic as discussed in Chapter 2, the approach of supervaluation is used. The platform chosen to carry out the project work is Java.

3.3 PROJECT METHODOLOGY

The methodology in the project process involves the following phases;

PHASE 0: LEARNING AND BACKGROUND RESEARCH

In the very initial meetings with the supervisor, Dr. Brandon Bennett, previous work on water and forest feature was studied. Both the work carried out at the University of Leeds, under the supervision of Dr. Brandon Bennett, were handling similar issues in the field of geography and computing. Thus, it was very important to study them and get an idea of the problem area. After considering many geographic features, with the acceptance of the supervisor, desert feature was decided. The desert feature was finalized to illustrate the problem area and possible solution to it. The project mainly deals with the problem of vagueness that prevails in geography.

A lot of background research had to be carried out to study the problem area and to understand it first. After reading many articles, papers, etc; the issue of vagueness in geography became clearer. Also, the various approaches to reach to the solution were studied. After deciding upon the desert feature, the parameters which define it were listed. Also, affect of vagueness and mind-dependency on the desert. After getting a clear picture of the problem area, possible approaches to solve the problem of vagueness as much as possible were studied. Looking into all the advantages and limitations of the approaches, super valuation approach was decided to take to reach the solution.

A lot of time was devoted to search data relevant to the geographic aspect of the world, which shall prove useful when defining desert according to the decided parameters. To plot the world map, dataset of the world countries containing latitude and longitude values was provided by the supervisor, Dr. Brandon Bennett. It was tough to search for the world climatic data, which specifically should be according to the parameters to define the desert feature like precipitation, temperature etc. The data was, then, taken from the Climatic Research Unit (CRU) [7].

PHASE 1: CHOICE OF PLATFORM

To carry out the process of producing a solution to the problem area, the platform chosen was Java. Java is a platform independent programming language and so it is widely used." Its rapid ascension and wide acceptance can be traced to its design and programming features, particularly in its promise that you can write a program once, and run it anywhere."[27] There are many other features in Java, which proves to be a reason for selection of it as a platform. The dynamic nature of Java, helps adding classes anytime. A number of applets, classes prove advantageous.

It was decided to use C#.NET earlier to use as a platform, but it was changed to Java with the approval of the supervisor, Dr. Brandon Bennett. This is because of the carious advantages of Java as described above.

PHASE 3: DESIGN AND FORMULATION OF SOLUTION

While formalizing a solution for the problem, it is important to consider all the possible approaches. In case of the problem of solution, the two main approaches are fuzzy logic approach and supervaluation approach. After considering them both, supervaluation semantics was chosen to formalize a solution. This is because supervaluation semantics not only handles vagueness but also standpoints and mind-dependency. Therefore, supervaluation approach is also called standpoint approach sometimes. A brief theoretical formulation of desert according to supervaluation semantics is given.

To design a solution, it was decided to put in user choices, which is one of the features of supervaluation approach to deal with vagueness. To start up, it is important to gather data that can be relevant to the parameters that define the deserts. Firstly, to plot the world map a GML file that includes the latitude/longitude values of the countries of the world was used to plot a world map. And then, a climatic dataset including parameters to define deserts is used to demarcate regions according to the values was taken. The design of the solution includes map of the world and parameters with the value bars to adjust numeric values of the parameters. Demarcation of regions according to the parametric numeric values is, thus, carried out.

PHASE 4: IMPLEMENTATION

The design formulation is implemented effectively using many prototype versions.

Prototype 1

The first task was to make a world map using the GML file containing the latitude and longitude values of the countries of the world. Also, color schemes and drawing polygons were tried in this prototype. Initially the program took quite some time display the map. Then editing the map, and making different classes, improved the performance. The world map was compared to test whether it displayed the right things. Later scroll bars were added to the map image to make the image scalable.

Prototype 2

The second task was to use the precipitation data, and use it on the world map produced. After studying deserts data was divided into some values to make regions accordingly. The regions were demarcated according to colors and parametric values, and were displayed on the map.

Prototype 3

The next prototype implementation was to add user function to enable them to choose their data. In this prototype, parametric value bars are added, so that by scrolling them user can choose the values and hence see the result.

Prototype 4

The last built prototype was put on the school webpage of the supervisor, Dr, Brandon Bennett by him.

All the way, during the implementation, the supervisor, Dr. Brandon Bennett was a great support and help. Without him, the implementation wouldn't have been possible.

PHASE 5: EVALUATION

After the implementation, evaluating the software is very important to check the quality of software. The results obtained from the software are compared with other maps, to see if the demarcated regions that are produced are correct or not. Also, other software evaluation like usefulness of the software and its flexibility are done to carry out the evaluation. Lastly, all the minimum requirements are revised to check whether the expected has been achieved or not.

This chapter explains has thus, explained the designing aspects of the project. Also, the methodology has been explained in terms of different phases.

CHAPTER 4
IMPLEMENTATION

Implemetation of the software is one the most important parts of the software development or a project. There have been many prototype implementations during the designing and implementation of the project. The following were the prototypes designed and implemented ;

4.1 PROTOTYPE 1

This project deals with vagueness and a lot of work have been carried out in the past in the same field. To overcome their limitations as mentioned in chapter 2, it was decided to demarcate the regions and use the dataset on a world map. This will enable the users to see the real demarcated regions of the deserts which exists in the world. To make this working, world map was meant to be used. Instead of just uploading a world map image, the world map was plotted using a data file. The dataset was a GML file that was meant to be used. The file included the latitude and the longitude values, and was planned accordingly in Java. Earlier it was tried to make a color coding and polygon, to check for various shapes. Later the scroll bars were added to make the visibility clearer and flexible.

The prototype of the above is shown below, with all the countries of the world and also the scroll bars.

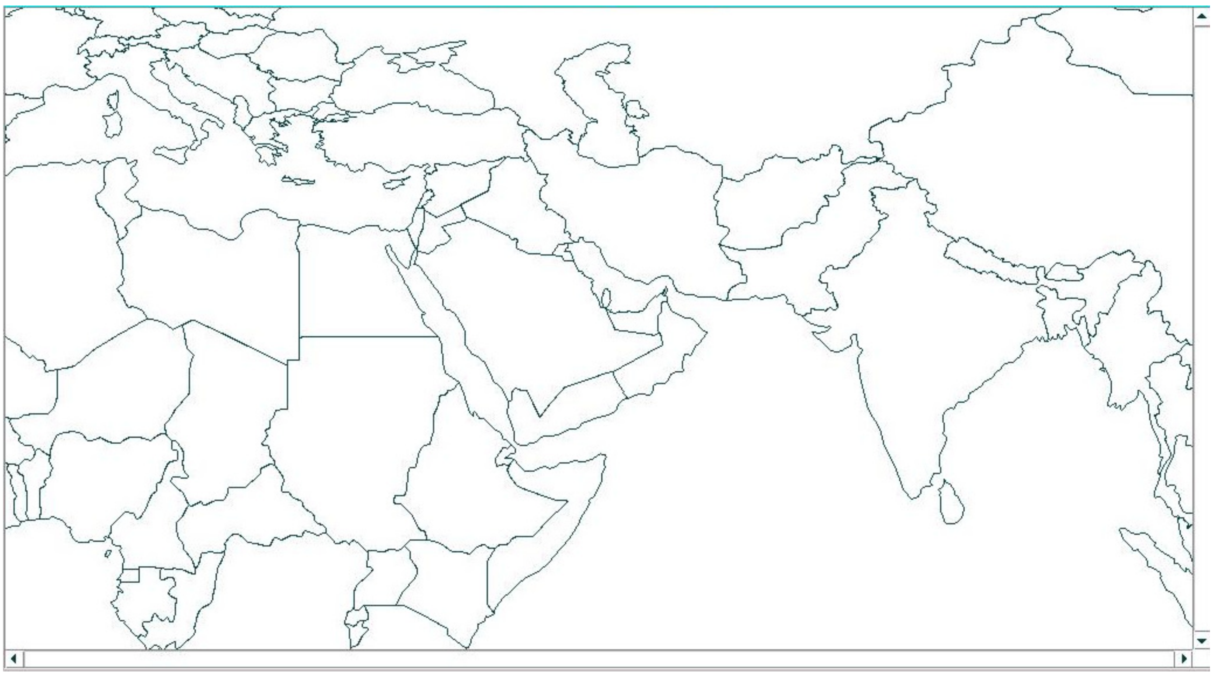

Fig 4.1 World Map

As an evaluation, the world map was seemed to be appearing slow in displaying. With a few changes in the coding, the time taken to draw map became fast. Also, the map was compared to the other world maps to just check whether right demarcation of countries has been produced or not.

4.2 PROTOYPE 2

The next implementation was to use the precipitation data file and demarcate it on the world map according to the constraints on values. Since, the supervaluation approach has been used to deal with vagueness, threshold values have been used. The table below shows, different threshold values, color scheme accordingly and what inference can be carried out about the area. The data file had mean monthly precipitation, so while programming it is computed to be mean annual temperature.

PRECIPTATION THRESHOLD VALUES	COLOR	INFERENCE
5	RED	DESERT
20	ORANGE	ARID/SEMI-ARID
40	YELLOW	SEMI-ARID/TEMPERATE
100	GREEN	TEMPERATE/WET
NONE OF THE ABOVE	DARK GREEN	VERY WET

Table 4.1 Precipitation data and thresholds

The map obtained according to the following thresholds is shown below in fig 4.2.

Since, the project deals with demarcating deserts only, so different iterations can be observed by just changing the threshold value for precipitation value for desert. Deserts are colored as red, and variations in desert region can be clearly seen with different threshold values.

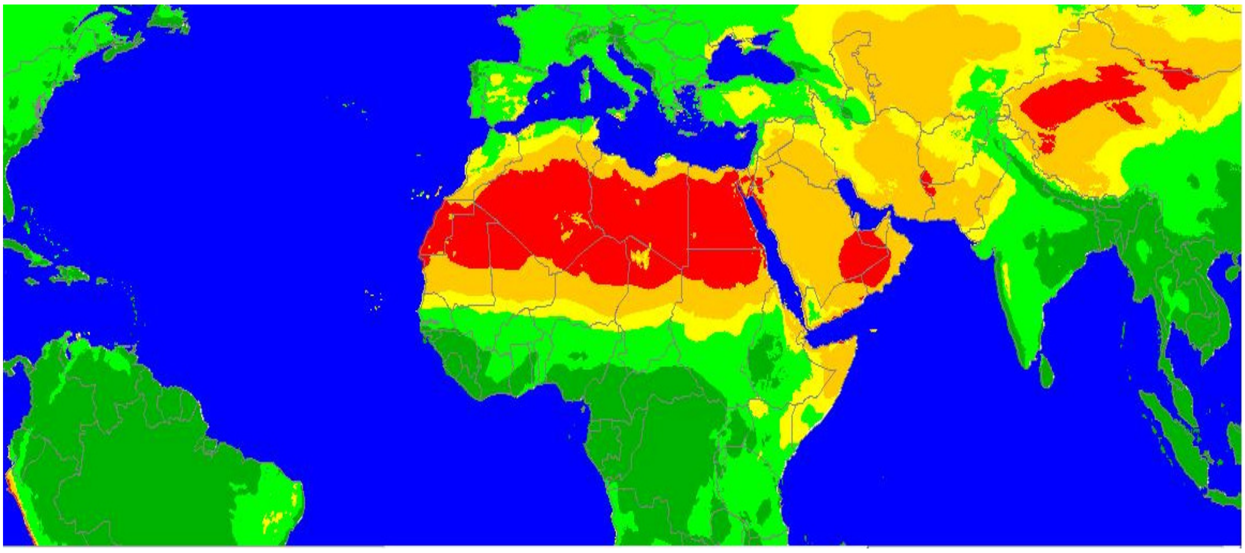

Fig 4.2 World Map demarcating deserts according to the precipitation threshold as five

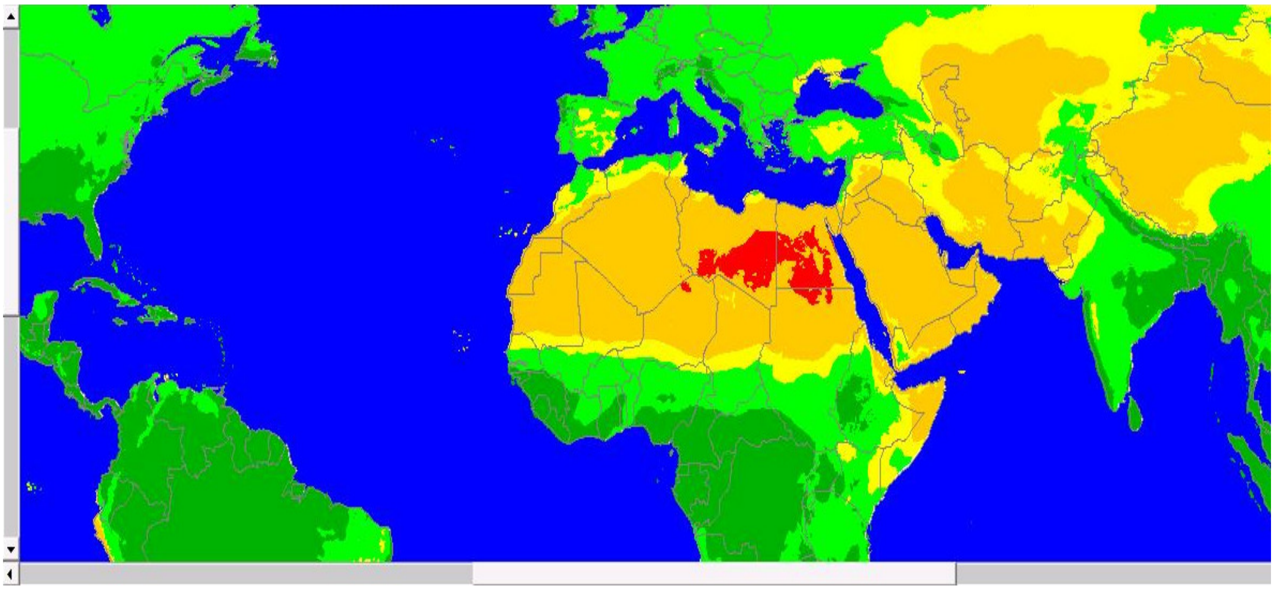

Fig 4.2 World Map demarcating deserts according to the precipitation threshold as one

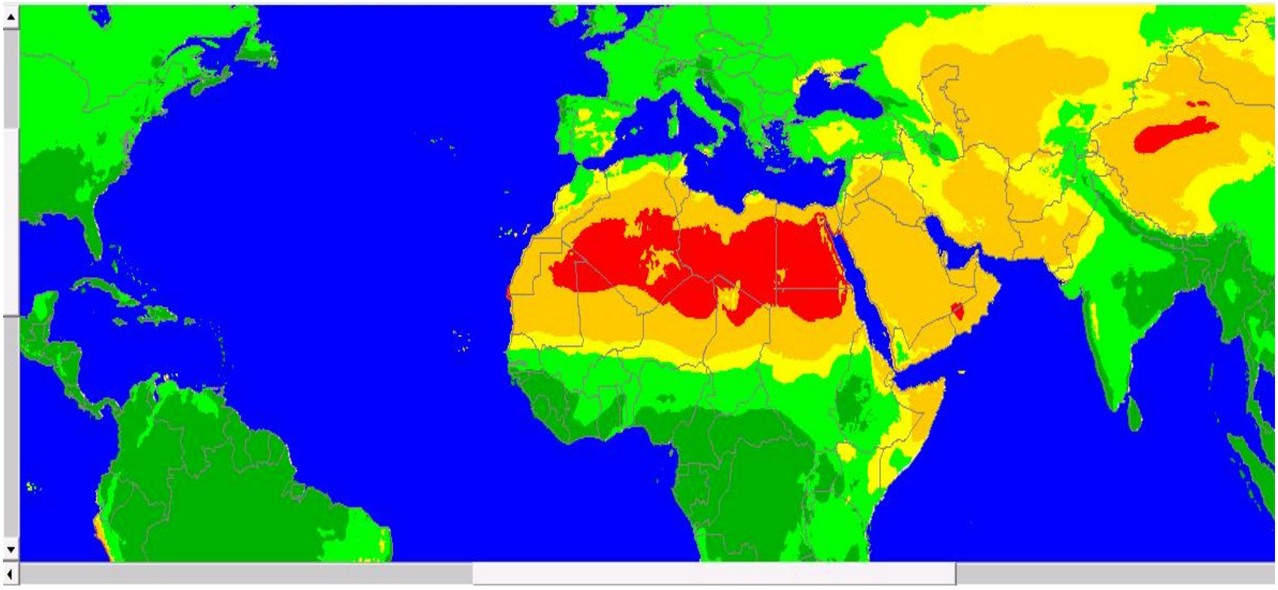

Fig 4.3 World Map demarcating deserts according to the precipitation threshold as three

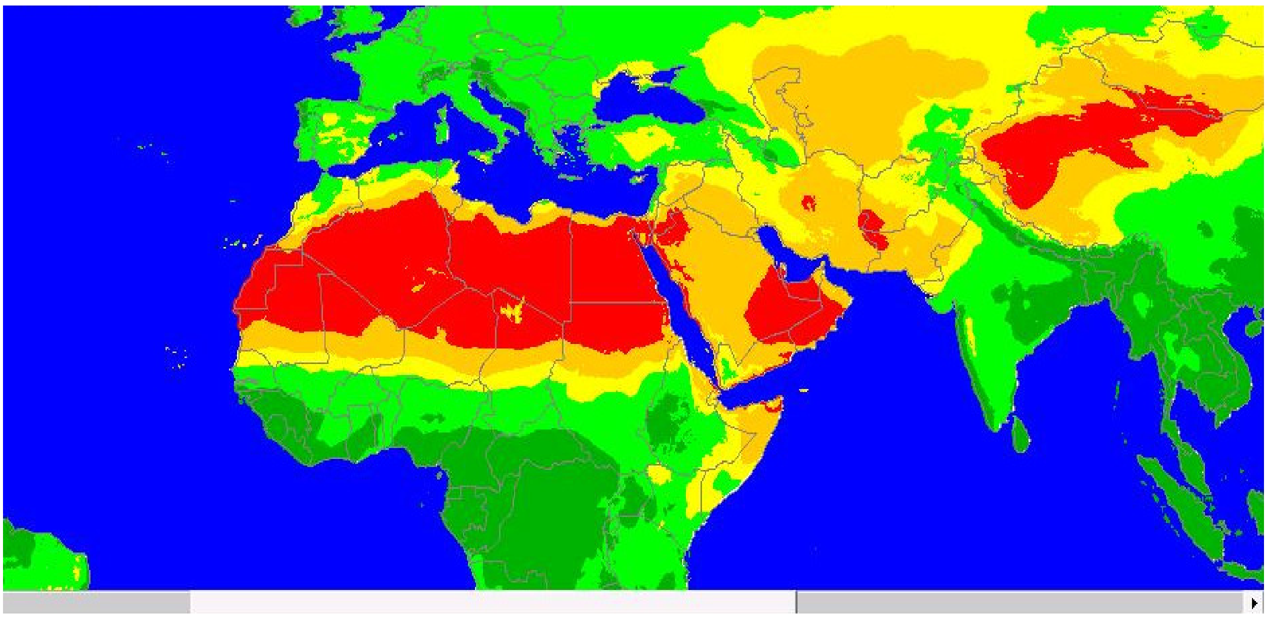

Fig 4.4 World Map demarcating deserts according to the precipitation threshold as seven

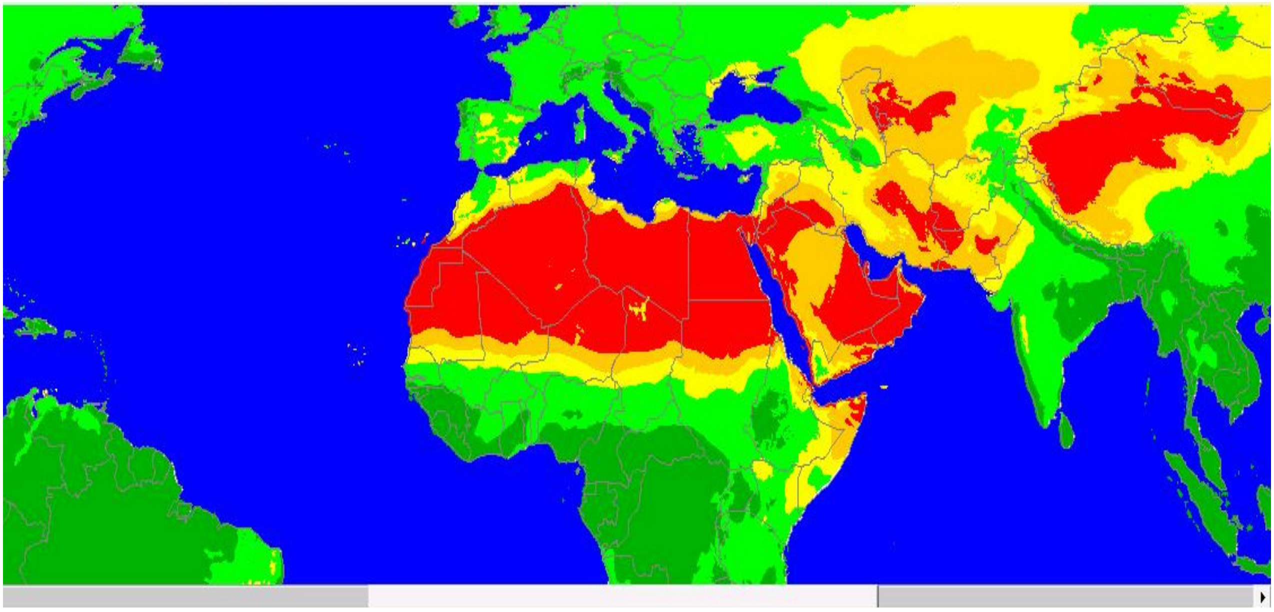

Fig 4.5 World Map demarcating deserts according to the precipitation threshold as ten

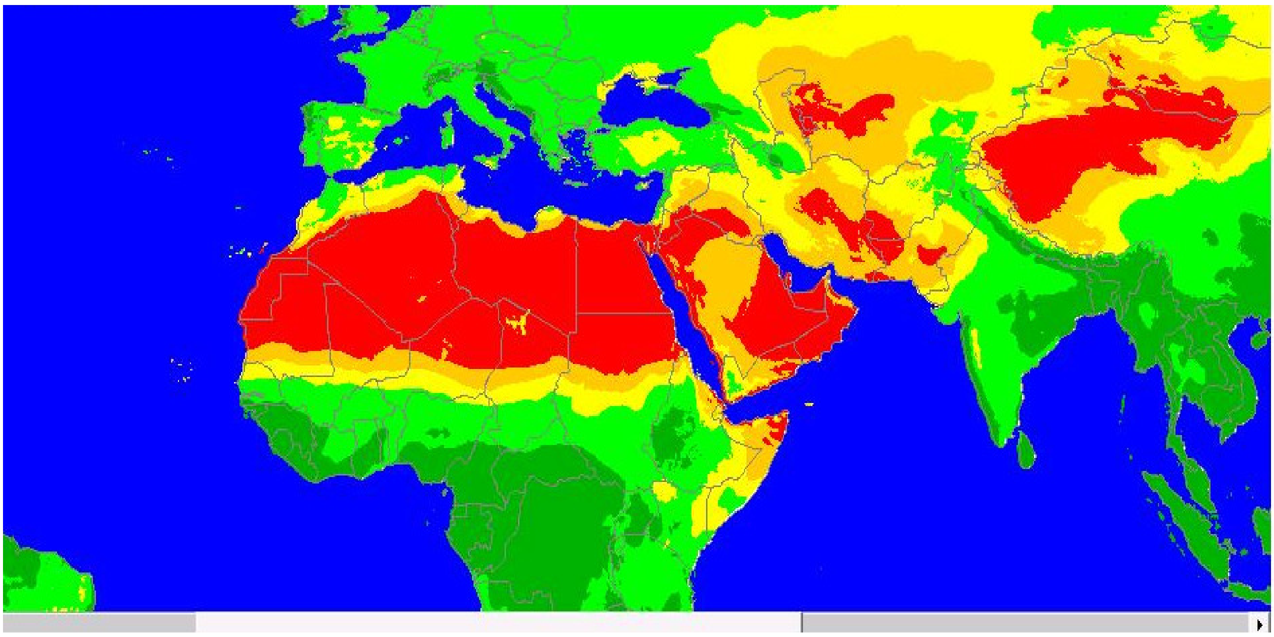

Fig 4.6 World Map demarcating deserts according to the precipitation threshold as fifteen

PROTOTYPE 3

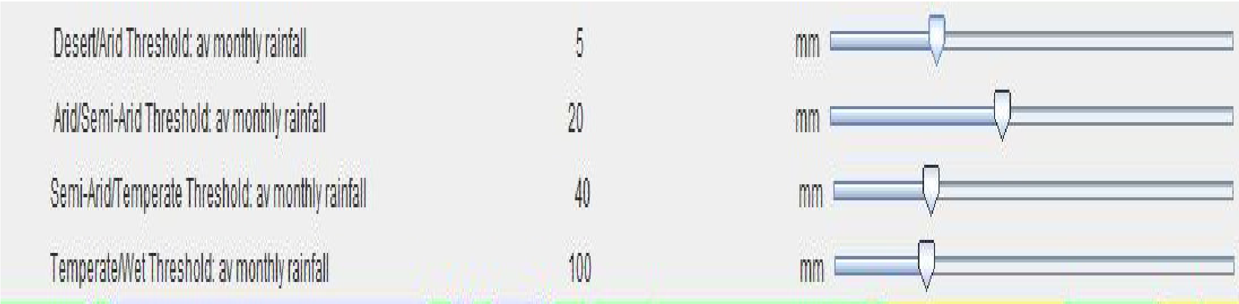

Fig 4.7 Threshold sliders

To enable user definitions, threshold sliders have been made. This helps user to change the value of all the four climate types mentioned and then they can view the demarcations clearly. They are identifiable because of the colors as mentioned in table 4.1

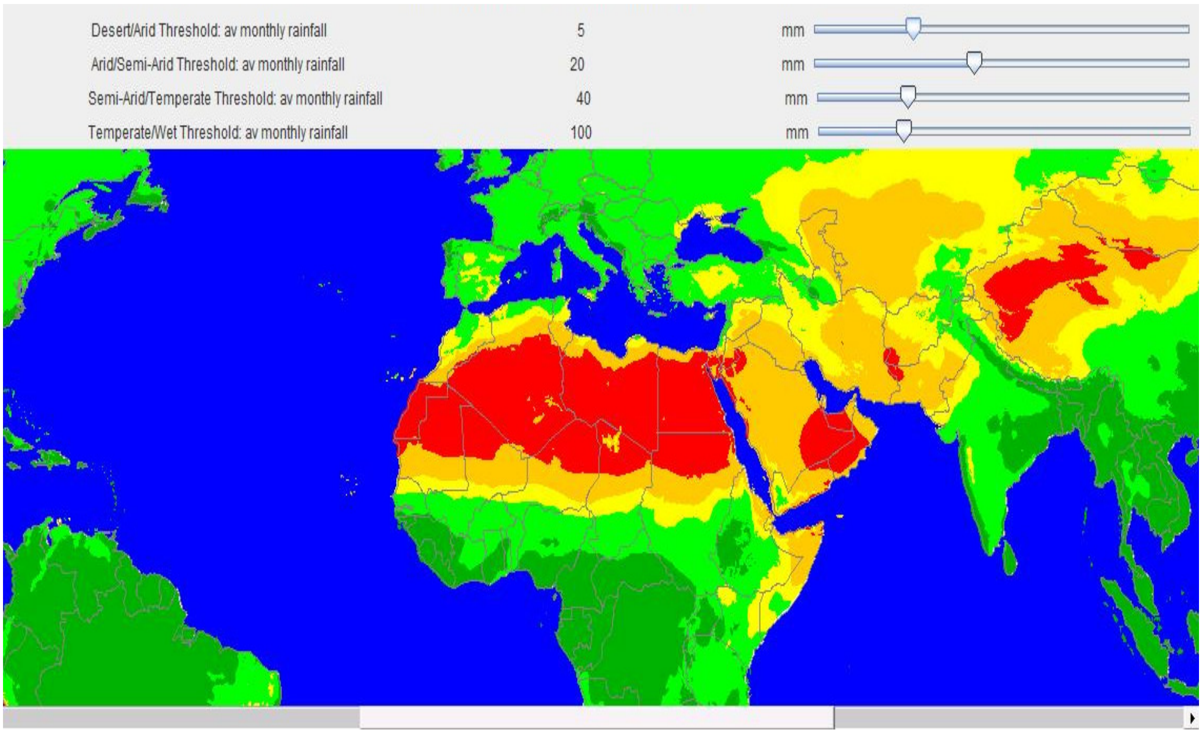

Fig 4.8 World Map demarcating deserts with user choices on choosing threshold values

Fig 4.8, shows the demarcation of regions according to the user-defined thresholds, redrawing of maps is fast i.e. computational time is very less. When coding these, the colors were plotted first and then the boundaries of the countries, so that the boundaries are visible over the colors, which on the contrary would have not been displayed if the boundaries were marked early.

PROTOTYPE 4

Lastly, the supervisor, Dr. Brandon Bennett, had put the piece of software on his webpage, which can be accessed at –

http://www.comp.leeds.ac.uk/brandon/climateview/

The working seems good, with not taking much time to load and draw maps even after varying thresholds. The maps are reproduced flexibly and show the real demarcated deserts of the world with clear boundaries.

This chapter discusses the implementation; the working of the project is illustrated by putting up screenshots at various compilations. The implementation was done under the strong guidance of the supervisor, Dr. Brandon Bennett, without whom the results could not be achieved this way.

CHAPTER 5
EVALUATION

Evaluation plays an important part of the complete working of the project work. Evaluation describes the quality of the software developed. Each prototype devised, was evaluated to check for the success.

- Firstly, the usefulness of the product is evaluated, whether the software proves any use to the geographers and the people who might use it. The fig below shows the, demarcation of desert on the world map according to the annual mean precipitation. The figure below is a world map picked up from the World Wide Web, showing demarcation of regions according to the precipitation as well. They can be easily compared according to the demarcation of regions, and what can be seen is that the resultant demarcation achieved reproduces map in a flexible way. The map produced with deserts shown and regions marked according to the precipitation, are much effective and produce an excellent result.

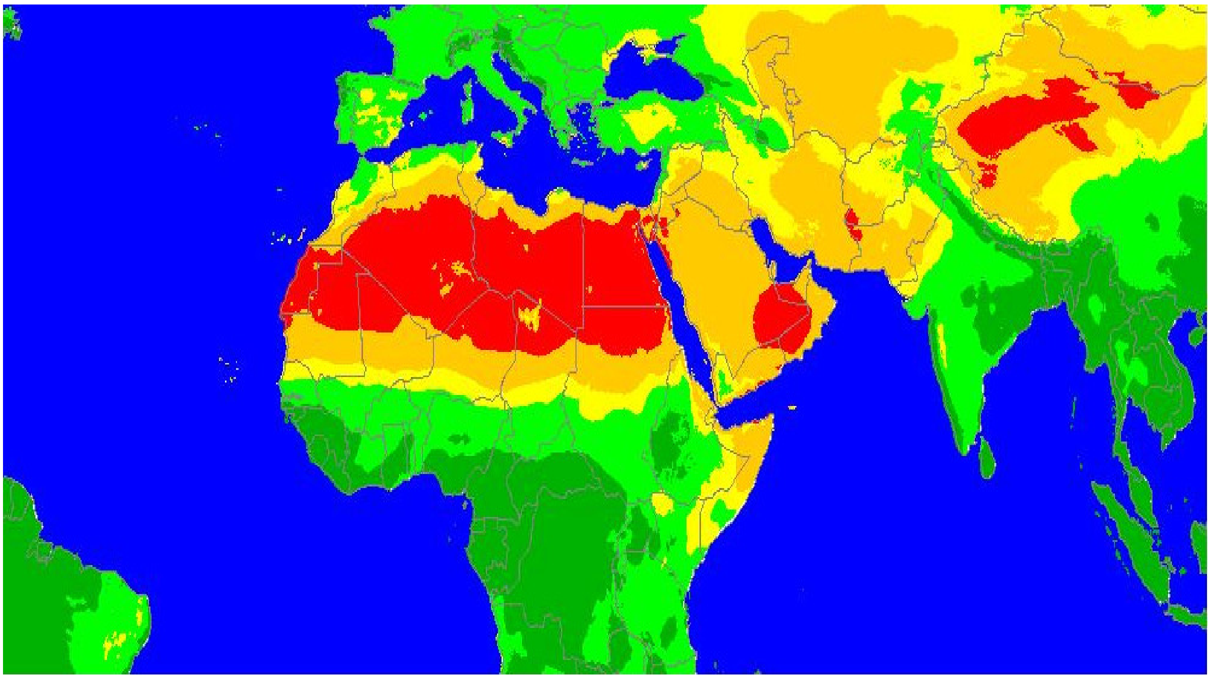

Fig 5.1 Map produced by making threshold of precipitation in desert region as five

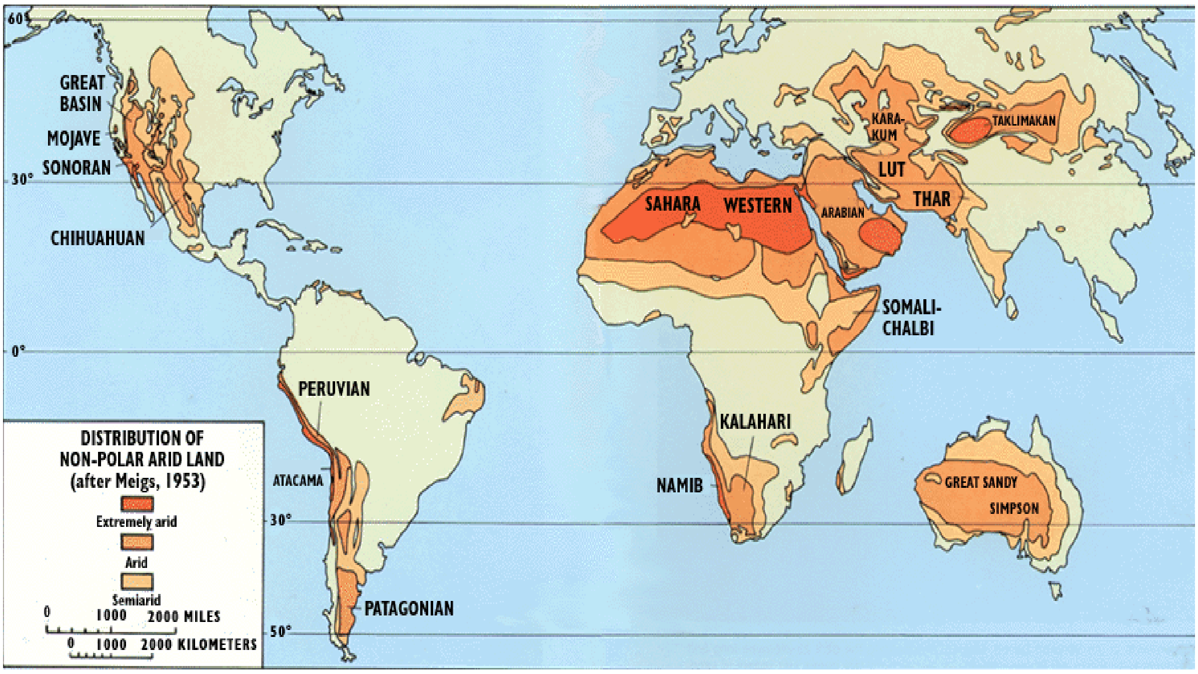

Fig 5.2 World Map according to the precipitation distribution, source [26]

- Flexibility of the software tool is another aspect of evaluation that should be carried out. The software is designed on the JAVA, which is platform independent. So, this makes it easy to be used. But the dataset used, is very large this makes the compilation a little slow. The project includes only the climatic dataset of annual mean precipitation but when much data will be included, that might make the time taken to draw the map increase. The size of the precipitation data file is 101 MB, but after compressing it to Java, the size becomes 3.69 MB. But, the data takes time to load in.

  The time taken to draw the map has been noted. After changing the threshold values, the time taken to redraw the map is taken. There are 10 such compilations done, they are as:-
  1622 ms, 1289 ms, 1354 ms, 1027 ms, 1298 ms, 1326 ms, 1170 ms, 1365 ms, 1348 ms.
  The average time, thus, that takes to produce a map is 1281.7 ms.

- There are man y approaches that have been proposed to handle vagueness in geography as described in Chapter 2. But the supervaluation semantics approach has been used as it not only handles vagueness but also handle standpoint concept. The product obtained can enable users to choose their own parameterized values and the results obtained according to those values. Hence, the project is not only enabled to deal with vagueness in an effective way but it also deals with standpoint observations by enabling user choices.

- A table below shows all the stated minimum requirements and their justified completions.

Requirements	***Justification of Completion***
5. An analysis of the concept of 'desert' identifying the significant physical parameters relevant to classify desert regions.	*Chapter 2 discusses in detail the concepts required to understand the concept of vagueness in deserts. About deserts and all the possible parametric definitions are given, showing the vagueness in 'desert' feature.*
6. Implemented functionality for specifying definitions and parameters appropriate for desert classification.	*All the possible approaches to deal with the problem area have been studied and supervaluation semantics have been chosen. Desert classification is stated according to the aridity index, precipitation and temperature in Chapter 3.*
7. Implemented functionality for applying specified definitions to geographic data in order to identify boundaries of desert regions.	*The solution is designed and implemented on Java platform. Geographic climatic data has been used to implement the solution. To identify boundaries, supervaluation approach is used.*

8. *A tool, which enables visualization of desert regions by applying user, defined definitions to a variety of geographic datasets.*	*Supervaluation approach that has been used enables not only effective dealing of vagueness but also, standpoint observations. The result achieved, enables user choices of parametrized values and sees the demarcated results on the world map according to the chosen parametric values.*

Table 3.1 - A table giving a comparison of minimum requirements and the results achieved

The chapter explains the evaluation of the product produced. The evaluation is given with many ways produced. Also, lastly, a justification is given to compare the minimum requirements and the result is achieved.

CHAPTER 6
CONCLUSION

This last chapter details with the limitations of the work carried in this project. Followed by this, the future direction to the work is proposed and lastly, summary of the project is given.

6.1 LIMITATIONS

The concept of vagueness exists highly in geography because all the geographic features or concepts are vague in many aspects. This project aims at handling vagueness in the field of geography. To deal with vagueness is considered to a tough task, because it is very difficult rather impossible to remove vagueness completely from the world of geography. But, with an in-depth study of vagueness and getting an understanding of the problem, it can become easy to formalize a solution. There have been lot of work been carried out in the past and also at the University of Leeds, under the supervision of Dr. Brandon Bennett, to deal with vagueness. Many approaches have been considered to handle vagueness in geography, and a lot of research work has been carried out in the same field. There can be many ways considered, to deal with vagueness as effectively as possible.

There are some limitations in the work carried out -

- A global climatic change is a serious issue. An up-to-date data is a primary demand of the project to deal with vagueness in the future. Because there is a lot of uncertainty involved in the data, it becomes very difficult to make an appropriate data available. Also, because of the varying climatic conditions even in context of a particular geographic feature like 'desert' only, it becomes very difficult to demarcate the regions accurately. For example, Matt Rosenberg [17], explains this by, the amount of precipitation and rainfall in deserts vary from year to year. To say, a desert might have an annual average precipitation off five inches in one year, the next year and the same desert region receive fifteen inches of precipitation, and then may be zero precipitation in a certain year as well. To conclude not much can be said about the actual amount of rainfall from the annual average precipitation in even arid environment. Although, the dataset made available is an interpolated data of the mean if the parametric values of the time period of 1961 to 1990 [7]. So, the main limitation of this project is data.

- Size of the data files is also a limitation. Because the data is in accordance to the latitude and longitude values of the countries of the world, the size of all the data files are big and this can make the compilation slow.

- Evaluating the software by comparing the resulted demarcated desert with the real deserts of the world. For example, fig 6.1 shows the satellite view of a small portion of the desert region in Dubai. It is known that Dubai constitutes deserts over a large area of its land surface. The country is has been carrying out artificial irrigation methods to make the land usable for agriculture, cultivation or even setting up a town there. As it can be seen in the desert, a small area has been shown, where desert can be seen and patches of vegetation and greenery can be seen. Now in future when evaluation of such software dealing with the climatic data is carried out by comparing it with such satellite views, can lead to failure in what was expected. And, hence, such an evaluation would not only lead to failure but also increase the vagueness.

Fig 6.1 Satellite view of the desert region in Dubai, source [26]

6.2 FUTURE ENHANCEMENTS

The product is a tool that will help to define and visualize desert regions according to the defined parameters. As known that deserts can be defined and classified in a number of ways according to a number of parameters and attributes. The result obtained is demarcated deserts only according to the definition in accordance to the annual mean precipitation. So, many more parametric values can be added which may prove useful in defining and demarcating deserts. These can also be used to be defined by the user, which would then give the user a useful visual perspective according to the parameters defined by them. Other parameters that can be added to the dataset can be vegetation cover, color (using satellite maps), land cover (sand dunes, rocky etc.), ground water etc.

Also, data of higher resolution is available from the same source where the present is taken. This data gives 5 minute latitude/longitude range, which is 10 minutes in the presently used dataset [7]. Such a data can give a higher resolution but it holds a limitation of a much more increased size of the data file, almost four times bigger.

The outcomes or the resultant demarcation of deserts, in case when the user chooses their own parameters and their values, can be verified in a way by comparing the desert demarcations derived from the system, from a variety of definitions, with cartographic data that shows desert regions. By comparing with other desert demarcated maps, the user will gain confidence when making their own choices of attributes and parametric values.

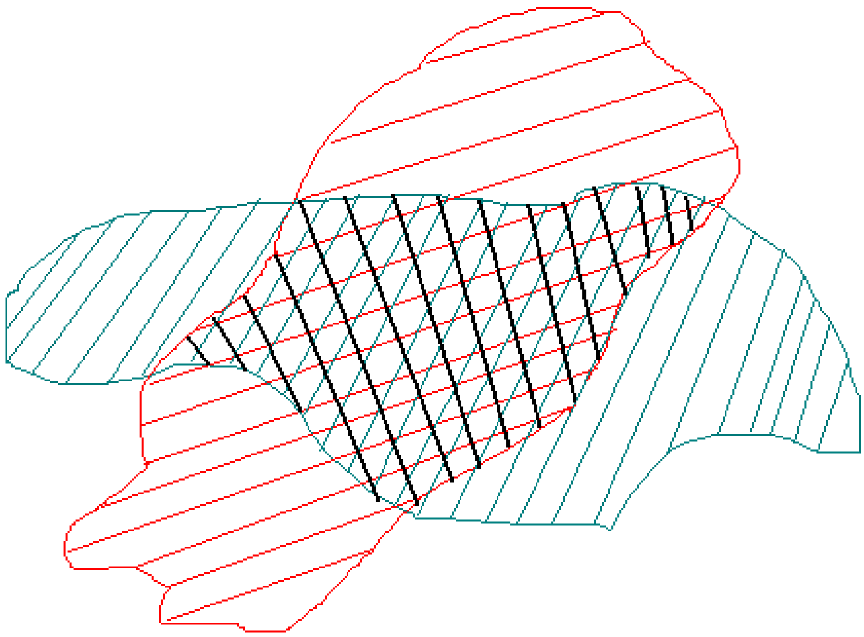

Fig 6.2 Overlapping of the two demarcated regions

The field of geography deals with a geometric style of representation. It deals with entities that may overlap or fail to overlap or have only parts to overlap. Overlapping happens according to the geographic attribute of each entity. To say, it depends on the parameters that have been looked at for describing a particular geographic feature. For example, fig 6.2 explains overlapping. Consider the blue region is the area demarcated as desert according to the precipitation dataset and region is the one demarcated according to the defined temperature range for deserts. Now, the overlapped region can be shown as the black lines, this overlapped region shows the best definition of the desert region. This concept of overlapping can give an effective result and can be implemented in the future. To implement the above as a clear demarcation, XOR color scheme can be used in JAVA [25]. The XOR color scheme is shown as below in fig 6.3.

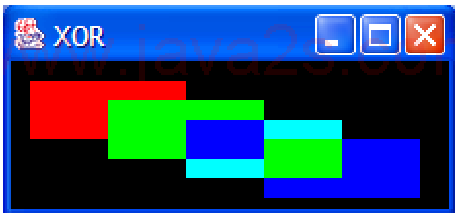

Fig 6.3 XOR Color

Also, another important future direction in dealing with vagueness can be, instead of just having hardwired concepts, formal definitions can be given. Ontological aspects can be included because vagueness surely affects the ontological area as well.

These are, hence, some of the directions that can be taken in the future when working on handling vagueness in geographical features or concepts.

6.3 SUMMARY

The aim of this work was to handle the concept of vagueness in geographic world. To give an illustration of explanation and solution of spatial vagueness, 'desert' feature has been used. A lot of background study has been carried out to understand the problem area. Previous work and literature reviews gave a clear picture of the problem area of vagueness in geography.

To design a solution, a lot of approaches were considered and then supervaluation semantics approach was opted to deal with vagueness in desert. Gathering useful data for the project work was a challenge, which was made available from Climatic Research Unit (CRU). A tool was developed, that could demarcate deserts on the world map as accurately as possible according to the parameters of annual mean precipitation and annual mean temperature. Since, the demarcation was done on a world map, so it was possible to check it with the maps available showing desert regions. Boundaries were demarcated quite reasonably well.

Evaluation of the project work carried out was proposed. Also, future directions have been given to the present work to enhance it and enable the system to deal with vagueness in deserts much more effectively.

This chapter, thus, concludes the project effectively by giving a summary of the work, and some future directions as well. The project write-up gives a well planned description of all the results achieved and the milestones achieved in working of the project. It is not possible to include all the small details of the project, but an attempt is done to cover all the important aspects involved.

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APPENDIX A
PERSONAL REFLECTION

A project plays a very important part in gaining what has been learnt during the degree by implementing it in practical aspects. An MSc project demands a huge amount of research and background study, and also, an in-depth of knowledge of what has been learnt during the degree course. This project demands basically an in-depth knowledge in the module of Knowledge Representation and Reasoning.

The project deals with the concept of vagueness, which is very highly present in the field of geography. Thus, the project involved a lot of literature reading as the problem area it deals with, is in itself very huge and complex. Also, to illustrate the explanation and solution of vagueness in geography, 'desert' feature was used. Therefore, an in-depth study of the deserts of the world was carried out and then the vague terms and concepts involved with it were identified. Thus, background reading is a very important task or milestone in the MSc project and seems endless. A lot of work had to be carried out on collecting relevant data that can be used when implementing the solution. Design and methodology played another important aspect. Designing a solution that could deal with vagueness as effectively as possible was a tough task. It involved lots of approaches and methods that were proposed and considered in the past to deal with the concept of vagueness.

Implementation of the project seemed to be the toughest when dealing with data. Certain attributes could be added, and also fiddling with data was not an easy go. But with the support of the supervisor who has tremendous knowledge in the same field, things became a little easier. Scheduling the project and driving the tasks according to time, is a key factor to the success of the project. Careful scheduling should be planned and followed to achieve what has been proposed.

It is very important to word the project at the best, explaining each and every aspect and milestone involved effectively. Write-up for the project is usually considered by most of the students to be taken during the last few weeks. In this project, the write-up was left up for the last few weeks as well. This is not a much appreciated task, as writing up what was proposed and achieved, dealing with all the minute details involved carefully, is sure to be tough. Much time should be devoted in the write-up and this should be a simultaneous job while carrying out other tasks involved in the project.

Surely, it is almost impossible to remove vagueness from the field of geography completely. But, there can be many ways to carry it out effectively, by doing an extensive research. This, thus, can involve a lot of future work relevant to this field. Future directions have been stated in the report that can be helpful for the future interest takers in this field.

APPENDIX B
INTERIM REPORT

This includes just a picture of the comments given by the assessor, Mr. Andrew Bulpitt and the supervisor, DR. Brandon Bennett; on the interim report.

School of Computing, University of Leeds

MSc Interim Project Report

All MSc students must submit an interim report on their project to the CSO ***by 9 am Friday 13th June.*** Note that it may require two or three iterations to agree a suitable report with your supervisor, so you should let him/her have an initial draft well in advance of the deadline. The report should be a maximum of 10 pages long and be attached to this header sheet. It should include:

- the overall aim of the project
- the objectives of the project
- the minimum requirements of the project and further enhancements
- a list of deliverables
- resources required
- project schedule and progress report
- proposed research methods
- a draft chapter on the literature review and/or an evaluation of tools/techniques

The report will be commented upon both by the supervisor and the assessor in order to provide you with feedback on your approach and progress so far.

Student:	TANIA SINGH
Programme of Study:	MSC COGNITIVE SYSTEMS
Title of project:	DEFINING AND DEMARCATING DESERT FROM GEOGRAPHIC DATA
Supervisor:	BRANDON BENNETT
External Company (if appropriate):	

Tania

Signature of student:

Date: 13 JUNE, 2008

Supervisor's and Assessor's comments overleaf

Comments on the MSc Project Interim Report of Tania Singh

The report gives a good account of the nature of the problem that will be tackled but is rather vague about the details of how it will be solved.

The explanation of the choice of Java as a platform is very brief and the stated motivation ("to learn Java more") is not appropriate to a serious software development project. You need to explain why the platform chosen is suitable to achieve the goals of the project. Java is certainly a reasonable choice; but you must give good reasons why.

A good description is given of the problems of identifying and demarcating deserts, and some interesting examples are mentioned. However, more specific details would have been useful. For instance an explanation of the various "aridity indices" used by climatologists would give a good example of the kinds of defined measures that could be used to identify deserts.

Some illustrations would have been useful in aiding the explanation.

Rather little information is given about what the system will look like to the user. A fuller explanation of the intended functionality would have been useful.

Although the report is generally readable, there are quite a large number of grammatical errors. The final report will need to be thoroughly checked to ensure correct grammar and spelling.

Relatively few references are given and these are not specified in the correct way. You should give the details of where the articles were published --- ie the name of the journal or conference, not the address of the author.

Brandon Bennett

Assessor's comments on the Interim Report

As noted by Brandon, the report lacks detail on the methods that will be used or the methodology. There is little in the report that links the work to KRR at present.

It would also be useful to generate a gantt chart for the project indicating milestones so that you can monitor progress & reflect on this in your final report.

The background reading provides details on the nature of the problem but does not cite references to previous work beyond what Brandon has done in the past. In the final report I would expect to see a much longer reference list (of journal publications rather than web links). Previous work needs to be critically analysed. Evaluation requires further thought.

APPENDIX C
GANTT CHART AND PROJECT SCHEDULE