



T.C.

MARMARA UNIVERSITY

FACULTY of ENGINEERING

COMPUTER ENGINEERING DEPARTMENT

CSE4197 Engineering Project I

Project Specification Document

*GENETIC ALGORITHM LECTURES: “İSPİNOZ”*

Group Members

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## 1. Problem Statement

Genetic Algorithms have been applied to many different problems, usually with valuable results [1]. Since the Genetic Algorithm is often applied to large optimization problems and genetic knowledge is required for the Genetic Algorithm, it can be difficult to understand by students. Nowadays, students mostly prefer the Internet to access information. However, there is no sufficient number of Turkish-English web sources to learn the Genetic Algorithm. In this project, we will implement an interactive web-based application which name is İspinoz to make Genetic Algorithm more understandable for the students.

## 2. Problem Description and Motivation

There are different types of computational approaches like deterministic, random and evolutionary. Evolutionary techniques are also known as nature-inspired techniques. Genetic Algorithm is one of the most commonly used evolutionary techniques and it is adaptive heuristic search algorithm based on genetics and the evolutionary ideas of natural selection. The famous quote by Charles Darwin is “*It is not the strongest of the species that survives, nor the most intelligent, but the one most responsive to change*” and Genetic Algorithm is laid on this "survival of the fittest" [2]. As in nature, there is a competition among individuals for limited resources and it results in the fittest individuals dominating over the weaker ones.



Figure 1: An example of natural selection [3]

Past research shows that Genetic Algorithm has been effectively used to solve the different problems from the domain of computer science such as software cost estimation, task scheduling, clustering, natural language processing, image processing etc. [4]. There are many applications of Genetic Algorithm besides computer science. It has been also applied to many branches of medicine [5], environmental science [6], often with good results.

Genetic Algorithm which is an advanced topic is used to solve different NP-hard computational problems and it is generally taught as one of the subjects in Artificial Intelligence course. Unlike older AI systems, in searching a large state-space, multi-modal state-space, or n-dimensional surface, a Genetic Algorithm may offer significant benefits over the more typical search of optimization techniques like linear programming, heuristic, depth-first, breadth-first [2]. Nevertheless, the Genetic Algorithm is a biology-related algorithm that requires knowledge of genetic terms as well as fundamentals of programming. The requirement of the knowledge on the Genetic Algorithm which are, for example, gene, chromosome, population etc. may make the algorithm difficult and complicated for the students. We propose an interactive web-based application which makes the genetic algorithm more understandable with providing fundamental knowledge, quizzes and solution of problems based on genetic algorithm.

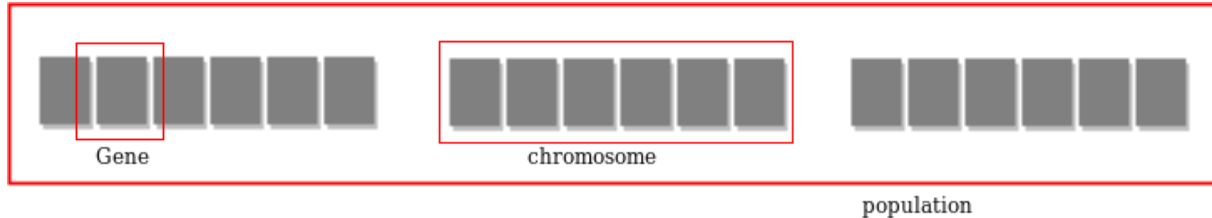


Figure 2: Gene, chromosome and population in Genetic Algorithm [2]

### 3. Aims of the Project

- Providing genetic-related knowledge required for Genetic Algorithm to the students, for example, the terms gene, chromosome, population and etc.
- Providing quizzes to measure whether the students learn the Genetic Algorithm or not
- Providing many problems and their solutions with Genetic Algorithm such as Traveling Salesman Problem, Knapsack Problem etc.
- Providing an interactive web site for the students to have more knowledge about Genetic Algorithm
- Providing a website where students can view their learning histories and results of quizzes

## **4. Related Work**

Similar to our project, there are many educational web sites on computer science. Two of the educational websites are W3Schools, VisuAlgo and Vitamin described below:

W3Schools [7] is an interactive website which provides tutorials and references on web development languages such as HTML, CSS, JavaScript, PHP, Python and etc. The tutorials W3Schools start from the basic level and become increasingly difficult. W3Schools uses simple code explanations with simple illustrations which makes the learning easy and straight-forward. Similar to W3Schools, our project will provide quizzes and exercises that the students can practice. Unlike W3Schools, in our website İspinoz students have accounts and when they log in the website they can see the progress of their learning and results of quizzes. In the development of W3Schools, HTML, CSS, ASP.Net were used as web technologies.

VisuAlgo [8] is a website to help students better understand data structures and algorithms such as Binary Search Tree, graphs, sorting algorithms and etc. For example, you can visualize the solution of Traveling Salesman Problem, website VisuAlgo shows iterations of code and its outputs step by step which makes VisuAlgo more interactive for students to understand. Similar to VisuAlgo, our website will provide quizzes and visualizations of problems and the students have accounts like VisuAlgo. The difference between VisuAlgo and İspinoz is that İspinoz will focus only on Genetic Algorithm and it will provide the solution of problems by using Genetic Algorithm. VisuAlgo was developed by using HTML, CSS, JavaScript and PHP.

Vitamin [9] is an interactive Turkish website which provides lectures for the students in primary school and high schools. Vitamin mainly consists of video lectures, 3-dimensional representation and experiments on subjects. Differently from İspinoz, Vitamin is not a free website, the students who want to use Vitamin must pay price monthly. Unlike İspinoz, Vitamin has also video lectures for teaching. In the development of Vitamin, HTML, CSS and JavaScript were used.

## **5. Scope of the Project**

Our project is developing a web-based application on teaching Genetic Algorithm, which is a web site called İspinoz and its development mainly consists of three phases which are software design, problem selection for Genetic Algorithm and software implementation. Firstly, we design our website and database for the data required for the website. In this phase, we will

create a logo and find a slogan for our website İspinoz. This phase includes preparing system diagrams, UML diagrams, ER diagrams and deciding on view of the website and its colors. Our website will be a website with a login of the students and information of the students.

After the software design phase finished, problem selection phase will start. This phase can be divided into two. One of two is preparing questions and their solution for quizzes. These will be stored in the database. The number of questions will be sufficient to measure whether a student understand the algorithm or not. Another one is preparing problems and their solutions based on Genetic Algorithm. The more problems İspinoz provides, the more understandable the Genetic Algorithm is for the students. Therefore, our web site will provide many questions which are simple mathematical equality problems, Travelling Salesman Problem (TSP), Knapsack Problem (KP), N-Queen Problem and so on. These problems will be on a small scale and steps of problem solutions and outputs will be visualized so that Genetic Algorithm will be easy to understand because visuality is at the forefront in our web site. In the implementation phase, we will develop our web site with new web technologies according to our software design phase.

When the students who want to learn Genetic Algorithm sign up the web site, they will start to learn genetic-related terms of Genetic Algorithm which are declared below.

- |             |              |              |
|-------------|--------------|--------------|
| • Gene      | • Chromosome | • Population |
| • Crossover | • Mutation   | • Generation |
| • Selection | • Fitness    | • Allele     |
| • Genotype  | • Phenotype  | • Offspring  |

After the students obtain knowledge about Genetic Algorithm's terms and definition, they will continue practicing Genetic Algorithm by solving quizzes and problems. Our project will only provide Genetic Algorithm and problem solutions based on it. Any other algorithm is not in the scope of this project. We will develop our web site is only for the students who want to learn the Genetic Algorithm and practice on it.

There is no sufficient number of Turkish-English web site on Genetic Algorithm and our web site will support two languages Turkish and English so that Turkish people and any people who know English can use the web site to learn the algorithm.

The percentage of developers who have self-reported as being blind is about 1% in the 2017 survey of Stack Overflow which is an accessible web site [10]. Now, neither having visual impairment nor being blind is not an obstacle for the people who want to code. Therefore, our web site İspinoz will be accessible and blind people by using a screen reader can use the web site to learn and practice the Genetic Algorithm.

In this project, we assume that the students have a programming and algorithm knowledge from the past. The students who want to use the web site must internet connection and there are not any constraints to use website İspinoz.

## **6. Success Factors and Benefits**

### **6.1 Measurability/Measuring Success**

In this project, when we provide knowledge on Genetic Algorithm and provide the quizzes, problems and their solution with Genetic Algorithm, the most important way to measure the success of our project is results of quizzes that the students solve. While studying Genetic Algorithm, the students will continuously solve quizzes and exercises. In quizzes, obtaining an overall average score 80 out of 100 is a successful outcome for a student. Registered users will be able to give points to our site. 7 points out of 10 is a success for us. The feedback from students and the teachers is also a success factor for this project.

### **6.2 Benefits/Implications**

When the project is completed with a success, the students will have learned the genetic-related terms required for Genetic Algorithm and they will have practiced the algorithm with many quizzes and problems. As a result, the students who used the website İspinoz can easily apply the Genetic Algorithm to different problems. Our website can also be used in Artificial Intelligence classes while Genetic Algorithm part.

## **7. Methodology and Technical Approach**

In this project, we will develop our website from scratch by coding, not use any template or content management systems like WordPress. Flowchart of our website development is shown below:

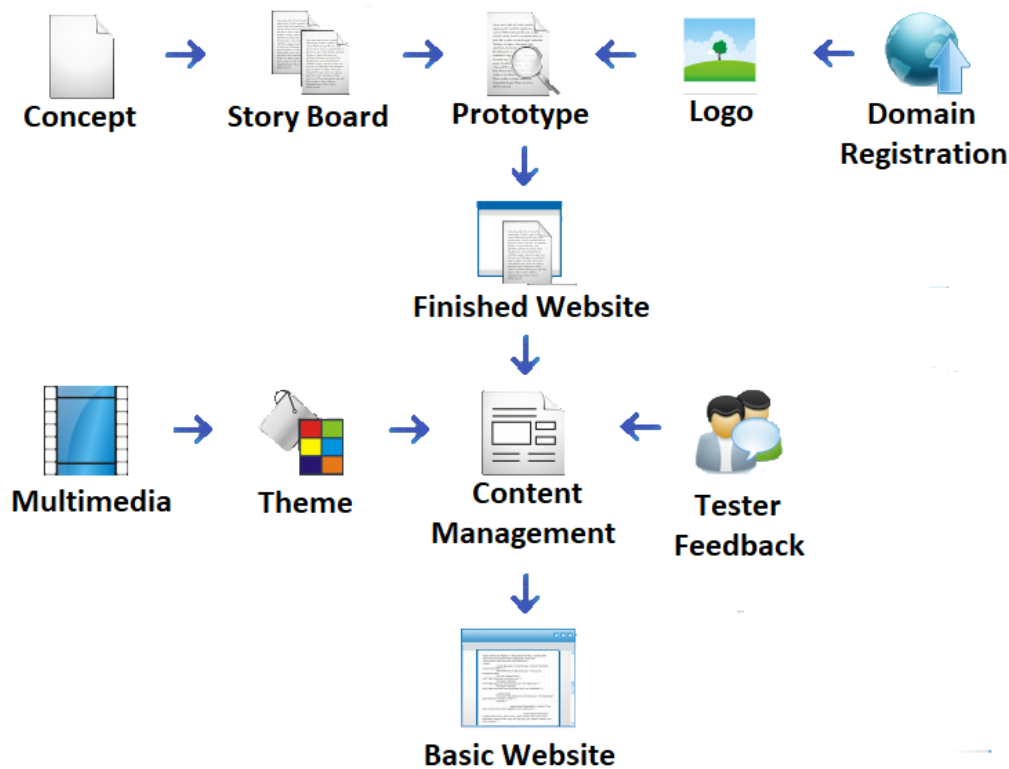


Figure 3: Flowchart of our website development

What languages, libraries and interfaces we will use in this project are:

- **HTML and CSS**

Hypertext Markup Language (HTML), a standardized system for tagging text files to achieve graphic, color, font, and hyperlink effects on World Wide Web pages. It is used in web pages as markup language. It allows text, video or visual elements to be placed inside the page and positioned as desired. These prepared codes are understood by web browsers and converted into visual web pages in this way. We could not say for HTML that it is a programming language.

The three block level tags that each HTML file should contain are `<html>`, `<head>`, and `<body>` tags.

- The `<html>` `</html>` tag is the highest-level element that closes each HTML page.
- The `<head>` `</head>` tag contains meta information, such as the page title and the character limit.
- Finally, the `<body>` `</body>` tag integrates all the content that appears on the page.

CSS is used as style templates. It helps to obtain global templates for pages prepared over the Internet. It allows us to change the properties such as color, size and font for a single letter. Thanks to its flexibility, it provides ease of use and helps to make this process more convenient. With the help of CSS, the operations performed in one time are defined and the other pages are valid in the same way. In this way, it is valid in other prepared web pages in the same way. These codes are used by writing into the HTML code. Depending on the type, these codes are placed in the body or head sections. In addition to this process, CSS files can be created in some cases and can be called from within the HTML document.

We will structure our website skeleton with HTML and style with CSS. The picture below shows HTML and CSS relationship:

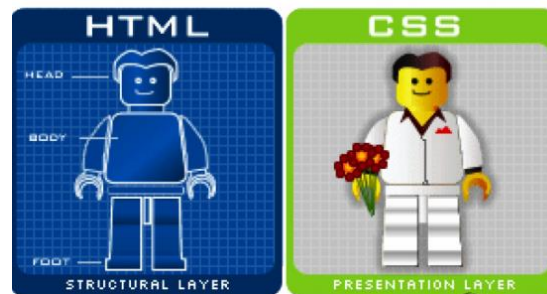


Figure 4: HTML and CSS relationship [11]

- **JavaScript**

It is an object-oriented computer programming language. We will use it to create interactive effects within our web site. We can also write front-end and back-end codes with using JavaScript frameworks like NodeJS and ReactJS.

- **NodeJS**

NodeJS is a platform that works on Google Chrome's v8 JavaScript Engine, which allows us to develop server-side, runtime environment applications, and code development with JavaScript. Almost all kinds of web applications can be developed with NodeJS. It uses a scalable, event-driven, asynchronous, non-blocking I/O operating model. This makes it work with high performance.



We will use it to write back-end side of the web site. We can use different languages for back-end development but using JavaScript for different works will provides us fast and easy development of the web site.

- **npm**

NPM (Node Package Manager or Node Packaged Modules) is a package manager that automatically downloads, updates, and deletes a set of scripts. It works via command line. The explanation on his site is as follows:

*“npm makes it easy for JavaScript developers to share and reuse code, and it makes it easy to update the code that you’re sharing” —npmjs.org*

- **ReactJS**

It is a JavaScript library for building user interfaces. It makes it painless to create interactive UIs. It provides us to design simple views for each state in our web site, and it will efficiently update and render just the right components when our data changes. It is the most important aspect of the React for us to use it. We do not want to refresh whole page when just one component updated. In order to provide ease of use of the web site, we need to update and render just the right component when teaching the genetic algorithm.

- **MongoDB**

We need animations, pictures, text to teach GA (Genetic Algorithm) to users in order to make the learning easy. Thus, we need to store our teaching data in server-side of the website. We solve the storing problem with using MongoDB.

MongoDB is NoSQL document database system with scalability and flexibility. It provides us to do what we want with querying and indexing. It stores data in flexible, JSON-like documents. It means that we can store our data as a document and it can be changed over time.

- **Genetic Algorithm (GA)**

In this project, while we teach the Genetic Algorithm to the students, we will also give illustrated solutions of NP-Hard Problem such as Traveling Salesman Problem, Knapsack Problem in small scale with the Genetic Algorithm.

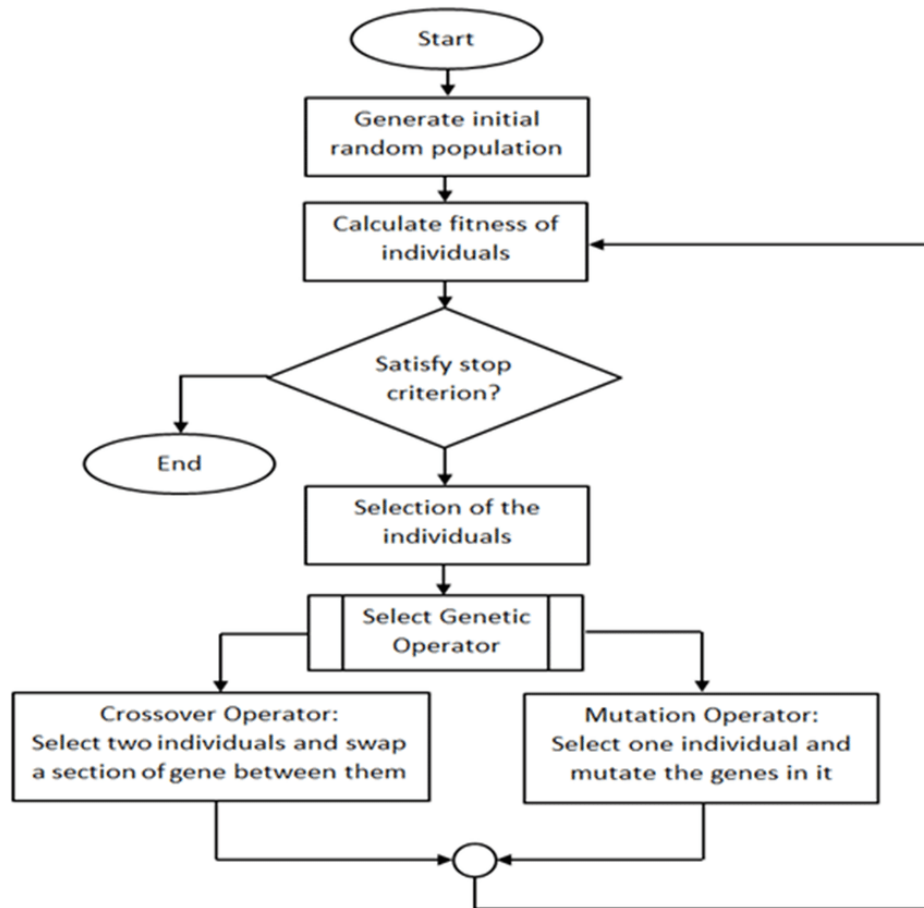


Figure 5: The flowchart which we use for Genetic Algorithm in this project [12]

## 8. Professional Considerations

### 8.1 Methodological considerations/engineering standards:

We will use HTML, CSS, JavaScript and React which is JavaScript library to implement our website. We will use Source Code Control via Git to see and manage version control and all versions of our project development will be saved on Git. We use a GANNT chart to show our management plan and prevent problems related to the project plan. UML diagrams and ER diagrams will be used to design our software plan and database.

### 8.2 Societal/ethical considerations

- **Economical:** Our website will be free for students. The students can learn and practice the Genetic Algorithm without paying any price.
- **Ethical:** Definitions and information about Genetic Algorithm which our website contains must be correct and the references must be shown on the website.

- **Sustainability:** New subjects can be added to our website in the future, for example, any other Artificial Intelligence or Machine Learning techniques.

### **8.3 Legal considerations**

We need a logo for our website and we design our logo in free online applications. UML and ER diagrams will draw in free online websites. While implementation, we will use only open source programming languages and libraries. There is no any other permission for our project.

## **9. Management Plan**

Our project is divided into 7 phases described below. The time plan of our project for first and second semester is given in Table 1.

Phase 1: Literature survey on Genetic Algorithm

Phase 2: Web application design

Phase 3: Database design

Phase 4: Web application implementation

Phase 5: Database implementation

Phase 6: Problem selection

Phase 7: Solving problems with Genetic Algorithm (GA)

Phase 8: Implementation of visualizing inputs and outputs for problems on the web application.

	1 <sup>st</sup> Semester					2 <sup>nd</sup> Semester					
	Feb	March		Apr	May	Sep	Oct	Nov	Dec	Jan	
Phase 1			Project Specification Document		Presentation						Poster Presentation
Phase 2											
Phase 3											
Phase 4											
Phase 5											
Phase 6											
Phase 7											
Phase 8											
											Project Report

Table 1: GANNT Chart for time plan of our project

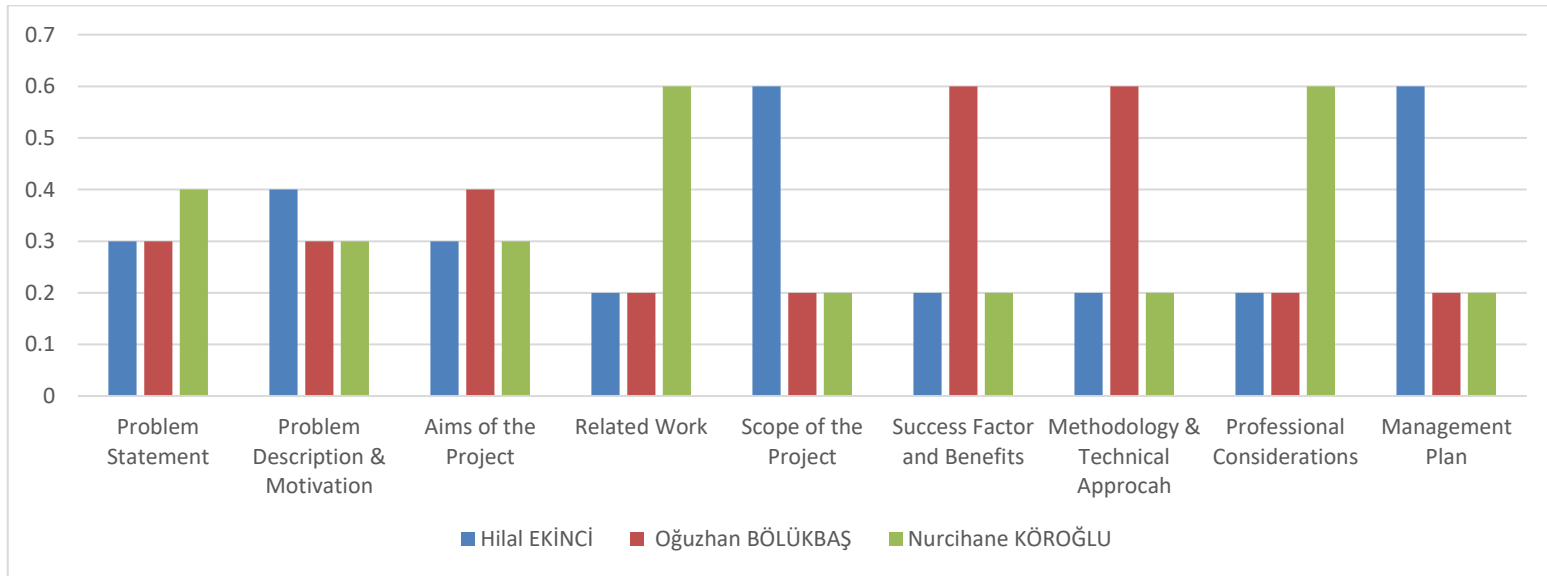


Table 2: Work Sharing Chart for preparing our Project Specification Document



## 9.1 Risk Management

There is no risk not to be able to complete the website throughout the development of the project. However, we may face some risks that affect the maintainability of the website after the project is completed. For example, we do not know how many people will use our website. We will buy hosting for our website according to our budget. If too many people use our website at the same time, it can affect the availability of our website. In this situation, we can increase the capacity of hosting for our website by providing an extra budget. In addition, potential vulnerabilities may cause serious problems so while we implement our website, we will consider security issues, for example, SQL injection, Cross Site Scripting (XSS) and etc.

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