

# Project Plan

Visualization and evaluation of nature inspired optimization metaheuristics

S224758 - Silas Thule Mackrill

## Introduction

In this project I am creating a framework in React and C# Dotnet. The framework aims to analyze and visualize nature inspired metaheuristics when applied to solving combinatorial optimization problems. This will mainly revolve around 2 search spaces: bit strings and permutations (permutations: referring to the Traveling Salesman Problem). The algorithms I will explore are: (1+1) Evolutionary Algorithm, Simulated Annealing Algorithm and Ant Colony Optimization (MIN/MAX Ant System). I will then compose different experiments to compare these solutions to the specified search spaces and analyze the results and how they fit with related theory.

## Goals

With this project I have chosen to create a web application in React and C# Dotnet, because one of my goals is to become familiar with industry standard technologies. This project is a good opportunity to work on a bigger project using a larger combination of the concepts I have learned throughout my time at DTU.

## Learning Objectives

The BSc graduate from DTU

1. Can work independently and is able to structure a major project, including meeting deadlines and organizing and planning the project work

Here I am using multiple project management tools to keep organized and focused on the project; Trello for managing subgoals and time, Miro for brainstorming, quick sketching and diagrams and Git for version control. These tools are essential for being organized for a project of this duration.

2. Can summarize and interpret technical information and is fully familiar with technical problem solving through project work

For this project I will describe the specific problem of the travelling salesman. Here I will analyze and explain the difficulties with solving it and evaluate and visualize different solution approaches to the same problem.

3. Is able to work with all project phases, including the preparation of proposals, solutions, and documentation

This document is part of the first phase, to plan and prepare my approach to understanding and then solving the technical problem. I will use the specified tools to create detailed proposals outlining how I will work on and complete the project, such as UML-diagrams to design the application architecture. I will write code documentation to maintain to ensure that another party could use the project even once it is completed.

4. Is able to independently acquire new knowledge and adopt a critical approach to the acquired knowledge and carry out relevant and critical information searches, and on this basis find the right methods to shed light on the problem in question

I will utilize various resources such as academic journals, online courses, and technical forums to acquire new knowledge relevant to the project. Based on the acquired knowledge, I will experiment with different nature-inspired metaheuristics to determine the most efficient approach for different scenarios. I will run these experiments and log them, then compare the results to the literature allowing me to draw a conclusion.

5. Is able to communicate technical information, theory, and results in written, visual/graphic, and oral form

I will show this through my report, that will describe the theory behind the chosen problem, my problem analysis, solution and implementation. Then I will show the results of the project and compare them to the theory described. Through my implementation I will be able to create graphs and plots to analyze the data collected. These results will then be presented and discussed in my oral defense. Additionally, I will use the oral defense to further explain some of the design and implementation decisions to provide clarity of my work.

## Work Process

The work process for this project involves several key phases. Initially, I will conduct thorough research and planning, including a literature review on nature-inspired metaheuristics and their applications in combinatorial optimization. This phase will also involve defining the project's scope and objectives, and creating detailed project plans and timelines using tools like Trello and Miro. Following this, I will set up the development environment for React and C# Dotnet, and establish version control with Git. The backend development phase will focus on implementing functionalities for bit-string search spaces and algorithms for the Traveling Salesman Problem (TSP). Concurrently, the frontend development will aim to design and develop user-friendly interfaces to visualize and analyze experiments. The experimentation and analysis phase will involve running various configurations on the defined search spaces, logging results, and comparing them with theoretical expectations. Comprehensive documentation and testing will be conducted throughout the project to ensure code quality and maintainability.

## Challenges

The main difficulty and therefore the focus of the project will be to keep the codebase modular, flexible yet still maintainable. The implementation aims to be expandable later, which requires great foresight and meticulous planning of every component and how they mutually interact. Among other tools, I will use UML-diagrams to reach a well thought out application architecture.

Additionally, there will be an added challenge of deployment, hosting and maintainability for this project, because of the nature of the application being an online hosted web service. Ensuring that the application is robust and can handle various user interactions without downtime based on an expected number of concurrent users. Therefore, it could be useful to implement monitoring to be able to identify issues once the application is deployed.

## Time Plan

Throughout the duration of this project, I will be writing parts of the report, as many sections of the project will be easier to communicate while working on them, rather than waiting 2 months. This will hopefully provide deeper explanations in the final report.

Week	Objective
9	Planning project architecture and sketching diagrams (UML and application flow). Information gathering of the technical problem and potential solutions.
10	Setting up development framework and writing project plan.
11	Information gathering on the bit-string search space and different nature-inspired metaheuristics. Developing the backend capabilities for bit-string search space.
12	Developing the frontend to visualize and enable analysis of experiments in bit-string search space.
13	Initial development of backend functionality to handle the traveling salesman problem.
14	Initial development of frontend to handle the execution of experiments in the permutation search space.
15	Refactoring, providing documentation and writing unit tests.
16	Continued backend development: implementing multiple different algorithms and different running modes such as step-by-step, algorithm-compare-mode and maybe more.
17	Implementation. Specific area is determined closer to date, dependent on what challenges have presented themselves.
18	Implementation. Specific area is determined closer to date, dependent on what challenges have presented themselves.
19	Experimentation and logging. Analyzing data and comparing to theory.
20	Finishing touches for implementation
21	Buffer time for implementation
22	Full focus on writing the report
23	Full focus on writing the report
24	Final touches before hand-in
25	Prepare for oral form
26	Prepare for oral form

## Self-Evaluation

The project has been successful in terms of planning and execution. I have designed an application that works as a tool to visualize and evaluate nature-inspired metaheuristics for different optimization problems. It delivers on the functionality required by the problem description. Additionally, it has been designed with extensibility in mind, where future expansion of problems or algorithms is simple. It is very user friendly and doesn't require much of the user. With that said, there were plenty of unforeseen difficulties when implementing the designed software. This meant that parts of the time plan got delayed and moved around. This was made less problematic by having several weeks of buffer-time.

I have been able to follow the learning objectives and working on this project alone has proved to me that I am able manage a whole project in all its phases, acquiring knowledge for it and document this process.

Having 2 jobs outside of university has made the project more difficult; not being able to attend many group meetings and constantly having to split my focus and time has impacted some aspects of the project and report. I have still given a lot of energy to this project, and I am very proud of the finished result.