qFlow
Project Plan Document

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VERSION HISTORY

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<td>Internal meetings between Team Borealis</td>
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1. **INTRODUCTION**

The problem this project seeks to address is the problem of optimizing stochastic flow charts. Many systems can be modeled as networks of interconnected queues, from emergency rooms to communication in computer networks. It is, however, nontrivial to find optimal configurations for these systems, given factors such as cost and throughput. This project seeks to solve this optimization problem in a way that can be applied to many different fields.

The goal of this document is to establish a detailed description of the plan to be followed during the development of qFlow. It includes a statement of work detailing the scope of the project, work requirements for each phase, acceptance criteria and a rough schedule.

2. **STATEMENT OF WORK**

The scope of this project includes creating a model to simulate stochastic flow systems with an easy to use and intuitive interface which can easily show how the systems behave over a long period of time. The scope also includes a genetic algorithm to optimize these flow systems.

The models to be simulated will consist of a set of nodes, connections, and resource pools. Each node contains a set of queues and represents a state in the system. One of the nodes will act as an entry node, where clients will enter the system at a specified rate. Each client will randomly be assigned a priority. Each edge contains a vector of weights, each with a probability. The elements of these vectors correspond to transition probabilities for clients of each probability.

3. **WORK REQUIREMENTS**

**Kickoff:**
- Setup development environment for each team member.
- Each developer will require development tools such as Visual Studio.
- Prepare documentation, such as this one.

**Design Phase:**
- Work out object oriented class structure for the simulation.
- Model chromosome for the genetic algorithm.

**Implementation Phase:**
- Build the stochastic flow model simulation, front-end and back-end.
  - Build back-end
    - Ability to create graphs representing stochastic flow charts
    - Ability to simulate these stochastic flow charts
    - Ability to create one time connections between nodes
    - Ability to create resource pools
    - Ability to calculate outputs
  - Build front-end
    - User interface
      - Edit node properties
      - Edit edge properties
        - One time or normal connections
        - Probabilities for client transitions
    - Result display window
  - Connect front-end and back-end
- Apply genetic algorithms to the models for optimization.
- Fix bugs.

**Training Phase:**
- Documentation.
  - Demooing the project.

**Handoff/Closure:**
- Final packaging/Submission.
4. **Schedule/Milestones**

![Timeline](image)

**Important Deadlines:**

- **February 23rd, 2018:** Ability to Represent Stochastic Flow Charts in Frontend
- **March 2nd, 2018:** Ability to Send Stochastic Flow Chart Structure from Frontend to Backend
- **March 9th, 2018:** Flow Model/Simulation
- **March 16th, 2018:** Genetic Algorithm Optimization
- **March 23rd, 2018:** Presentable Demo

5. **Acceptance Criteria**

The criteria for this program to be accepted are as follows:

- The user should be able to model complex stochastic flow systems easily using a simple drag and drop interface, with the ability to drag and drop nodes representing the states of the system, and create connections between them. The stochastic flow system should have a parameter, arrival rate, to determine how often clients enter the system.

- The user should be able to set parameters on these nodes, including number of servers, cost per server, the processing rate of the servers, and whether the node uses priority queues, or regular queues.

- The simulated clients in the system should have a randomly assigned priority between 1 and 5. This priority determines which probability numbers it uses when transitioning from one state to another, and determines the order of service in states that use priority queues.

- The user should be able to set parameters on the connections between the nodes, including probabilities for clients to take the connections based on the client’s priority. The connections should also be able to be set as one-time connections, which can only be taken once per client.

- The stochastic flow systems should be able to be simulated to calculate values such as cost, average waiting time per client, and total waiting time for all clients. These calculations should be reasonably close to real world data.

- The stochastic flow systems should be able to be optimized by genetic algorithms, choosing an optimal number of servers for each node given weighted priority to cost and client waiting time.

- The design should be clean and object oriented, though still reasonably efficient.
6. **RESOURCE REQUIREMENTS**

Each member of the group will require a working development environment, including a working computer with Visual Studio. The only other real requirement would be data to verify correctness of the simulations and optimizations.

7. **RISKS**

The largest risk of this project is being unable to get the project to a workable state before the deadline. We will attempt to mitigate this risk through planning, as in this document.

8. **ROLES AND RESPONSIBILITIES**

Although no section of the project will be exclusive to any one member, each member will assume the following major roles:

Nicholas Lasswell: Simulation of the stochastic flow charts
Nicholas Pennington: Front-end
Michael Smith: Genetic Algorithm
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