SE2XB3 OptimizeU V1.0
Design Specification

Final Project for SFWRENG 2XB3:Software Engineering Practice and Experience: Binding Theory to Practice

Group 8
Members:

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Created and Edited on: April 1, 2018

Contents

1 Revisions

1.1 Revision History

Revision History

```
commit a748c1a6482f27b152745485942452f59440b7ca
Author: Michael Le <lem12@mcmaster.ca>
Date:   Mon Feb 26 20:15:07 2018 -0500

    Initial commit

commit 6c1e97dce4b6d9a60fc9c23689a20e5489e8aa63
Author: Necried <duttonl@mcmaster.ca>
Date:   Mon Feb 26 20:28:02 2018 -0500

    added docs directory

commit 3aa5cffc3768973d9323bdd126545688337c1cdf
Author: Necried <duttonl@mcmaster.ca>
Date:   Mon Feb 26 20:34:06 2018 -0500

    Added helpful readme

commit 7f77082b2d7264cc647b66ce156781e04ccfdb28
Author: Necried <duttonl@mcmaster.ca>
Date:   Tue Feb 27 10:58:30 2018 -0500

    added src folder

commit 8daffe3cf9594f231d7401aca8b03571293476ba
Author: Necried <duttonl@mcmaster.ca>
Date:   Tue Feb 27 11:01:20 2018 -0500

    Testing java commits

commit c677fd1122b34fb2330142c28d5084e5801970a6
Author: Necried <duttonl@mcmaster.ca>
Date:   Tue Feb 27 12:14:13 2018 -0500

    Added meeting minutes folder

commit 33b301c33bf84e9fc01ff55bede6f0e7a42e65bb
Author: Necried <duttonl@mcmaster.ca>
Date:   Tue Feb 27 12:15:05 2018 -0500

    populated readme

commit 90af85614d8b0a86dacb52609f3e867a478a608c
Author: Necried <duttonl@mcmaster.ca>
Date:   Tue Feb 27 12:18:17 2018 -0500
```

```
    added Milestone1

commit 32a141ccf282cf8a5ffd5725ef7ca511883d80d5
Author: Necried <duttonl@mcmaster.ca>
Date:   Sat Mar 3 17:30:26 2018 -0500

    Initial k-means and coordinates ADT

commit 3fec7d578a60192edbfd238bae3d08b989c6432b
Author: Necried <duttonl@mcmaster.ca>
Date:   Sat Mar 3 17:54:15 2018 -0500

    Fully added comments and unit testing in main method

commit adb0a2fadb494e1a88eec340224fb9149f96eea8
Author: Necried <duttonl@mcmaster.ca>
Date:   Sat Mar 3 18:01:19 2018 -0500

    removed test class file

commit fce89457f20fed11d591fba127f6d0035cb7c5b6
Author: Necried <duttonl@mcmaster.ca>
Date:   Mon Mar 5 21:01:33 2018 -0500

    Added hidden dependencies

commit 00e0473b79db337291f0aedf32d47966337b9116
Author: le-michael <lem12@mcmaster.ca>
Date:   Tue Mar 6 00:20:35 2018 -0500

    Cord and Cluster ADT  Basic Display

commit 7d928e70f10d4d908ac61a12ff6d6411f62218ed
Author: Omar Elemary <elemaryo@mcmaster.ca>
Date:   Tue Mar 6 07:32:24 2018 -0500

    Unfunctional Kruskal

commit 4b0a72bce189e4ad8bd75e9dfcaf4343369c1553
Author: le-michael <lem12@mcmaster.ca>
Date:   Tue Mar 6 14:49:04 2018 -0500

    Animation

commit 99990facd2d0f5ec84d86fce5da324dfcbb7cfac
Author: Necried <duttonl@mcmaster.ca>
Date:   Tue Mar 6 11:16:20 2018 -0500

    Updated to ADTs
```

```
commit 8803c1eb1a7aa6ed5fc08ce16b4c7afe4c4bce2c
Author: Necried <duttonl@mcmaster.ca>
Date:   Tue Mar 6 11:22:23 2018 -0500

    im so bad

commit 22251014dc653cf258be560af0fe94ab6ccd2370
Author: Necried <duttonl@mcmaster.ca>
Date:   Tue Mar 6 11:24:10 2018 -0500

    Emptied main method

commit a06041a5d3101e6d0287d311d82c755cabebc6b4
Author: Saad <thesaadfather@gmail.com>
Date:   Tue Mar 6 11:43:39 2018 -0500

    Dijkstra

commit 5cbde859eccedc18a0e20231f8084556309ae178
Author: Saad <thesaadfather@gmail.com>
Date:   Tue Mar 6 12:06:27 2018 -0500

    Dijkstra

commit 6e63dc33d44062f4b5f26e189c3290743e3c384e
Author: le-michael <lem12@mcmaster.ca>
Date:   Tue Mar 6 16:52:11 2018 -0500

    Display K-Means

commit 328f125652a31dd2503641b99c6ff87b3efc6f57
Merge: 6e63dc3 a06041a
Author: le-michael <lem12@mcmaster.ca>
Date:   Tue Mar 6 16:52:44 2018 -0500

    Merge branch 'master' of https://github.com/le-michael/2xb3-optimizeu

commit 6d568fbafebd5f10d557d828710293c8363b143d
Author: le-michael <lem12@mcmaster.ca>
Date:   Tue Mar 6 17:01:54 2018 -0500

    Background colour

commit 33801f1ef00d377107486db96e7fc582070ec152
Author: Necried <duttonl@mcmaster.ca>
Date:   Tue Mar 6 13:17:30 2018 -0500

    Fixed Kruskals

commit 736305b42c9dbd65b0753f0d92c20e2f1e014d6b
Merge: 33801f1 5cbde85
```

```
Author: Necried <duttonl@mcmaster.ca>
Date:   Tue Mar 6 13:18:28 2018 -0500

    Merge branch 'master' of https://github.com/le-michael/2xb3-optimizeu

commit cc8d367a1af48cb22df2d3c153a98fc26315ddbd
Author: Necried <duttonl@mcmaster.ca>
Date:   Thu Mar 8 16:06:35 2018 -0500

    Updated readme

commit 0ba7b8cea753138d1dbf80efe996bc500ee8e2d9
Author: Necried <duttonl@mcmaster.ca>
Date:   Fri Mar 9 11:19:48 2018 -0500

    updated docs

commit f91ad01a1f674e282d9d9e9118fa7354494d6319
Author: Necried <duttonl@mcmaster.ca>
Date:   Tue Mar 13 22:20:22 2018 -0400

    Updated to linked list Cords

commit 51300a97e47ea1405b1c9333929e57da4127400e
Author: le-michael <lem12@mcmaster.ca>
Date:   Tue Mar 13 22:24:33 2018 -0400

    Class for loading data set

commit 5e07ae2f42057d79c28d753e975fae3d04b76c0c
Author: Necried <duttonl@mcmaster.ca>
Date:   Wed Mar 14 00:03:23 2018 -0400

    Minor changes

commit 67854df60afc24029479fbaa4f9ca17c733dbc60
Author: le-michael <lem12@mcmaster.ca>
Date:   Wed Mar 14 00:19:27 2018 -0400

    Fixed kmeans

commit 56dfb224b1e149bd0564b6e7a15eae0cbca52680
Author: Necried <duttonl@mcmaster.ca>
Date:   Wed Mar 14 20:48:07 2018 -0400

    initial normalize added

commit b115a172c68d12c50315d19d51814b6dfc33fddc
Author: Necried <duttonl@mcmaster.ca>
Date:   Wed Mar 14 20:50:31 2018 -0400
```

```
    normalized to 500

commit 06d1ccb6447265c84e98b083aa38e69dc4e43ed4
Author: Omar Elemary <elemaryo@mcmaster.ca>
Date:   Wed Mar 14 20:54:49 2018 -0400

    Meeting6

commit 765a08b341739f8a817d81107981dcfbc0566358
Author: Necried <duttonl@mcmaster.ca>
Date:   Wed Mar 14 21:49:22 2018 -0400

    Load fix

commit 0249c0463c62c42756c0ba1823ab068c996fa203
Merge: 765a08b 06d1ccb
Author: Necried <duttonl@mcmaster.ca>
Date:   Wed Mar 14 21:49:44 2018 -0400

    Merge branch 'master' of https://github.com/le-michael/2xb3-optimizeu

commit 3a5b1bedd3e61042a6d9c352f8089356f282bc86
Author: Omar Elemary <elemaryo@mcmaster.ca>
Date:   Wed Mar 14 23:10:21 2018 -0400

    cord commented

commit 204b8af524060732303f8d2128dc0498d31ac594
Author: Necried <duttonl@mcmaster.ca>
Date:   Thu Mar 15 11:36:42 2018 -0400

    Added Kruskals with custom ADTs

commit 63777bace85dcdcbc74eb8d16be1b73032387ee8
Merge: 204b8af 3a5b1be
Author: Necried <duttonl@mcmaster.ca>
Date:   Thu Mar 15 11:39:24 2018 -0400

    Merge branch 'master' of https://github.com/le-michael/2xb3-optimizeu

commit 5952707dc9c9506376c190a8f16164f6c00f056a
Author: le-michael <lem12@mcmaster.ca>
Date:   Fri Mar 16 09:18:56 2018 -0400

    Project Proposal

commit b77cdda1ec1ae7064d8d9555d4815e5430d96a3b
Author: Necried <duttonl@mcmaster.ca>
Date:   Fri Mar 16 09:41:38 2018 -0400

    Added meetings
```

```
commit 065793face845b0689bdaa4fbc0f75324754abc1
Author: le-michael <lem12@mcmaster.ca>
Date:   Sun Mar 18 20:23:29 2018 -0400

    Proper coordinate normalization + Data visualization

commit 469a795a3195ab28ec7880dc17128658cae00227
Author: Omar <oelemary@gmail.com>
Date:   Fri Mar 23 10:03:35 2018 -0400

    Meeting8

commit 0fa22584311fe312eab0744fd6762c85ea790cdc
Author: Necried <duttonl@mcmaster.ca>
Date:   Wed Mar 28 17:00:10 2018 -0400

    Updated README

commit d333ae60082742033a6b2c7b89dcd26daaefd95e
Author: Necried <duttonl@mcmaster.ca>
Date:   Wed Mar 28 20:24:48 2018 -0400

    Unit testing added to TODO

commit 55333e51d3d2b61057f63929061d91ff3765f6b1
Author: le-michael <lem12@mcmaster.ca>
Date:   Wed Mar 28 21:10:03 2018 -0400

    readme

commit 1d119826e40b0b745c3906d1e83145bbdc7c1291
Merge: 55333e5 d333ae6
Author: le-michael <lem12@mcmaster.ca>
Date:   Wed Mar 28 21:10:54 2018 -0400

    Merge branch 'master' of https://github.com/le-michael/2xb3-optimizeu

commit 6e50f8d337821d37d99c74a975744fc130575ad5
Author: le-michael <lem12@mcmaster.ca>
Date:   Wed Mar 28 21:13:03 2018 -0400

    readme

commit 5ca76ec84b6dffbc3ea574cc689f610d2df9bb20
Author: Necried <duttonl@mcmaster.ca>
Date:   Wed Mar 28 21:37:03 2018 -0400

    added presentation draft in docs dir

commit 4cb6f90f02bcf7a55a698b46ad3e4f6ff2492e76
```

```
Author: Necried <duttonl@mcmaster.ca>
Date:   Thu Mar 29 19:30:27 2018 -0400

    Updated draft

commit 835b70d28217c4747851d2cce6d2fb09f179e13f
Author: Omar <oelemary@gmail.com>
Date:   Thu Mar 29 20:18:22 2018 -0400

    Meeting9

commit 8ae247773b5d387aca51fc12aff56463aba92463
Author: le-michael <lem12@mcmaster.ca>
Date:   Fri Mar 30 22:50:22 2018 -0400

    Clean slate

commit 81d9cf5a170ad3135f3baba2fba007df7499b6d0
Author: le-michael <lem12@mcmaster.ca>
Date:   Fri Mar 30 23:03:08 2018 -0400

    New cluster and new cord

commit 2c697258561c6c2ebcf3d9867e00bc7621b4b094
Author: Necried <duttonl@mcmaster.ca>
Date:   Fri Mar 30 23:40:30 2018 -0400

    KMeans with ArrayList updated

commit b86d309f9c3749eb242e804085462dd842cf9dc2
Author: Necried <duttonl@mcmaster.ca>
Date:   Fri Mar 30 23:58:53 2018 -0400

    Updated Kruskal and dependencies to ArrayList

commit 11e3a41d66abe191d4a4f08b690a003427515247
Author: le-michael <lem12@mcmaster.ca>
Date:   Sat Mar 31 01:11:29 2018 -0400

    Load and Display conversion

commit 1c0247c32ed68620c708253ae81e00fde4fe6b84
Author: Saad <thesaadfather@gmail.com>
Date:   Sat Mar 31 01:47:31 2018 -0400

    Pushing Slides

commit a532f88a49a11c6d588268abbc0c3466e2e4fa00
Author: le-michael <lem12@mcmaster.ca>
Date:   Sat Mar 31 20:08:53 2018 -0400
```

```
    gui update

commit f27d3ba59e003d402893ac9d73a886d4e8785cf1
Merge: a532f88 1c0247c
Author: le-michael <lem12@mcmaster.ca>
Date:   Sat Mar 31 20:09:20 2018 -0400

    Merge branch 'master' of https://github.com/le-michael/2xb3-optimizeu

commit 7beb0a8650e2b8ce99e831fc330b0d1580b9440c
Author: le-michael <lem12@mcmaster.ca>
Date:   Sat Mar 31 22:13:36 2018 -0400

    Fully finished gui

commit 4f7e746c67c373edcd56e8a5cb49c70d049c8ed4
Author: le-michael <lem12@mcmaster.ca>
Date:   Sat Mar 31 22:19:24 2018 -0400

    Clean up
```

1.2 Team Details

Name	Student Number	Roles
Michael Le	400070369	Group Leader, Graphics Implementation
Lucas Dutton	400052930	Log Admin, Algorithms Implementation
Saad Khan	400085498	Documentation Designer, Server Researcher
Omar Elemary	400100169	Algorithms Researcher, Log Assistant

1.3 Attestation and Consent

By virtue of submitting this document we electronically sign and date that the work being submitted by all the individuals in the group is their exclusive work as a group and we consent to make available the application developed through SE2XB3 project, the reports, presentations and assignments (not including my name or student number) for future teaching purposes.

2 Contributions

Note: Member roles are outlines in **Revisions: Team Details**

Name	Contributions	Comments
Lucas Dutton	Implemented Kruskals, K-Means and Associated ADT (Abstract Data Type)	Responsible for implementing and updating algorithms with any project changes
	Project Log and Meeting Minutes admin	Responsible for monitoring and updating Project Logs
	Documentation editor	Responsible for creating and sharing documents such as Requirements and Design Specifications
Michael Le	Implemented graphical representation of outputs	Responsible for presenting data in a graphical environment in Java
	Implemented graphical ADTs	Cluster and Cord ADTs made for interaction between algorithms and graphics
Saad Khan	Presentation Facilitator	Responsible for organizing presentation slides
	Graphics creator for documents	Responsible for creating diagrams for documents, e.g. UML
Omar Elemary	Meeting Minutes upkeep	Responsible for creating and updating project logs
	Algorithms research	Responsible for researching algorithms in the project proposal

3 Executive Summary

OptimizeU is intended to be a portable app that addresses the problem of finding an Uber pickup on busy nights, as well as optimizing driving routes of Uber drivers. The project leverages a dataset of twenty million Uber pick ups in New York City to help drivers locate the busiest hotspots in the city, routing more cars to denser locations which allows more users to find access to an Uber vehicle in a faster time. The application uses various algorithms related to machine learning and graphing, as well as pre-processing the dataset with searching and sorting algorithms to generate a pick-up density map of the city. The map will contain heat clusters related to density and distances between each cluster to inform the driver of optimal routes that can be taken. In short, the aim of OptimizeU is decrease wait times of passengers and maximize profits of Uber drivers.

4 Design Description

4.1 Module Description and Decomposition

4.1.1 Module Overview

The table below shows a top-level view of each class in the application. Classes are grouped by their functionality and dependency on one another.

Function	Class Name	Description
Basic Representation	Cord	2-Dimensional representation of coordinates
Clustering	Cluster	Representation of a cluster produced by K-Means
	KMeans	Clustering algorithm API
Minimum Spanning Tree	KruskalMST	Driver class to calculate Minimum Spanning Tree
	Edge	ADT representation of weighted edges
	Graph	Module to instantiate a graph with directed edges
	UF	Helper module for connecting vertices in a graph
	Heap	Heapsort on edges for Kruskals
Input/Output	Load	Reads dataset, sorts them according to time, and puts each coordinate in a Hash Table
	drawSurface	Graphics implementation of clusters and MST
	demoFrame	Main driver of application

4.1.2 Module Decomposition Semantics

Following the table in the previous section, the following items below provide a more detailed description of the rationale behind the modular decomposition of the design.

- **Basic Representation:** Since the application makes use of coordinates on a two-dimensional plane, the Cord API makes available a convenient coordinate ADT that is used whenever a point in the plane needs to be represented or stored.
- **Clustering:** KMeans and its associated ADT, Clusters, are used to compute clusters from a random number of points. Clusters are stored in the ADT as a point representing the mean of the cluster, called the centroid. All points associated to the centroid are stored in the ADT as well
- **Minimum Spanning Tree:** Kruskal's algorithm is used to generate the minimum spanning tree of the clusters' centroids. All the associated modules are helpers to the algorithm, such as union-find, sorting, and graph/edge representations.
- **Input and Output:** This can be divided by itself into two parts: input and output. Load is the input routine of the application: It leverages countsort to sort input data according to the pickup time which is partitioned by th 24-hour system. The other two modules are used to collect output from the algorithms and display it on a graphic canvas.

4.1.3 Uses Relation

An overlay of the application can be viewed in the Uses relationship below:

4.1.4 UML Class Diagram

An overlay of the application can be viewed in the UML class diagram below:

4.2 Module Interface Specification

This section will cover:

- A description of the interface of each public entity, as well as its syntax and semantics
- A description of the implementation of private entities of each module, state variables and how the methods maintain these state variables
- Requirements trace back for each module

4.3 UML State Machine Diagrams

The diagrams below are UML State Machine Diagrams for KMeans and KruskalMST

5 Internal Review and Evaluation

The internal review is as follows: