CS5233 2016/17 Semester 2: Assignment 2 (Deadline noon, 20th March

February 21, 2017

1 Application Scenario

Public bicycle sharing/rental systems have been gaining popularity in the past few years. As of December 2016, public bikesharing systems are available in more than 1000 cities spread over 50 countries. In such systems, users can rent bikes from a bike station and travel to other destinations. These destinations also have bike stations to allow them to return their bikes, i.e. users do not have to return their bikes from where they rented the bikes from. When leaving the destination, they can again rent bikes from the station. Although successful implementations of the bicycle sharing systems continue to emerge across the globe, two problems continue to frustrate the users of such systems:

- the difficulty of acquiring a bicycle from a station when a user wants to start their journey, because all the bicycles are already taken out.

- the difficulty of returning a bicycle to a station when a user arrives at their destination, because all the docking stations are already full.

2 Problem Description

You are on a team analyzing the bicycle sharing system of a Singapore Theme Park, which is described below. Your task is to see if the current system is feasible and if not, propose improvements.

2.1 The Bicycle Rental System

- The Singapore Theme Park has four attractions, each of which has a bicycle station (the attractions and the corresponding stations are represented as A, B, C and D respectively, as shown in the figure).

- Each station has a collection of bicycles and bicycle docks. The number of bicycles at each station is 80. Initially, the number of docks is the same as the number of bicycles.

- Tourists can rent bicycles only if there are bicycles available at the station, and can return bicycles only if there are empty docks at the station. When there are no bicycles at the station, tourists who want to rent bicycles need to wait for the bicycles, on a first-come-first-serve basis. A tourist can only rent one bicycle at any one time. When there are no empty docks at the station, tourists who want to return bicycles need to wait for the docks to be empty. They also follow a first-come-first-serve rule. A tourist can only return one bicycle at one time.
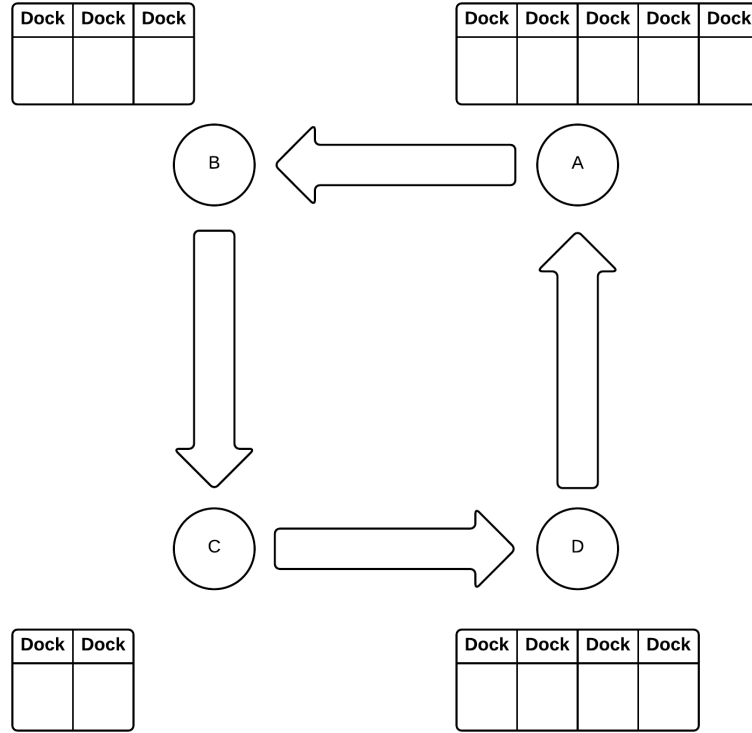
- Tourists can start their journey at any attraction, i.e. they arrive at random at any of the four attractions, and we assume they will visit all four attractions before leaving. It is 3 kilometres between A and B, 3.5 kilometres between B and C, 4 kilometres between C and D, and 2 kilometres between D and A. As shown in the figure, the road is one-way and is wide enough for tourists to travel. Tourists have to ride bicycles to get from one attraction to another.

- After arriving at one attraction, a tourist will spend some time visiting the attraction. They need to return their bikes to the station at that attraction prior to visiting it. If they want to go to the next attraction, they will need to queue to rent bicycles again.

- Each tourist rides the bicycle with a constant speed throughout the theme park. Different tourists have different speeds.

- We assume the park operates 24 hours per day.

2.2 Data Files

Data have been collected over a 24-hour period and are provided in the following three files. speeds.xlsx timespent.xlsx arrivals.xlsx

- *speeds.xlsx*: each entry is the speed (in km/h) of a tourist riding a bicycle. A tourist will travel at the same speed between the attractions, and throughout his journey in the park.

- *timespent.xlsx*: each entry is the time (in minutes) a tourist spends at an attraction. This time excludes the waiting time for bicycles or docks.

- *arrivals.xlsx*: each entry is the time of arrival (in minutes) of a tourist at the Singapore Theme Park at the denoted station.

2.3 Your Assignment Tasks

- Your team is asked to create a model of the Bike rental system and simulate it.

- You are to calculate the average waiting time for renting or returning a bicycle at each station. If tourists should not wait more than two hours in total (both for renting bikes and returning them), is the current system satisfactory?

- Tourists feel happy if their average waiting time for renting/returning the bike is less than 5 minutes. For example, if a tourist spends 4 minutes waiting to rent a bicycle at Station A, 6 minutes waiting to return bicycle at Station B, 2 minutes waiting to rent a bicycle at Station B, 7 minutes waiting to return bicycle at Station C, 4 minutes waiting to rent a bicycle at Station C, 1 minute waiting to return a bicycle at Station D, then his/her average waiting time is $(4+6+2+7+4+1)/6 = 4$ minutes. The management hopes that at least 80% tourists feel happy, and at the same time, they want to minimize their cost of building docks and buying the bicycles at the stations. How many docks and bicylces should there be for each station? For simplicity, we assume the numbers of docks and bicycles at each station are the same. For example, if there are n docks and m bicycles in Station A, then all other stations have n docks and m bicycles.

You may choose any platform to implement your model. If you choose Arena, instructions on how to use the full Academic version of Arena will be provided later.

2.4 Deliverables

Each group must:

- submit a written report (guidelines provided below)

- make a presentation of their work, findings, etc.

- peer review another group's work and report using the report review form (provided below)

Guidelines for writing the report
Review Report Form
Details about the presentation and review will be provided later.