CSI4124/SYS5110
Final Exam 2012 – Annex
Gas Station Modelling and Simulation Project

1 Problem Description

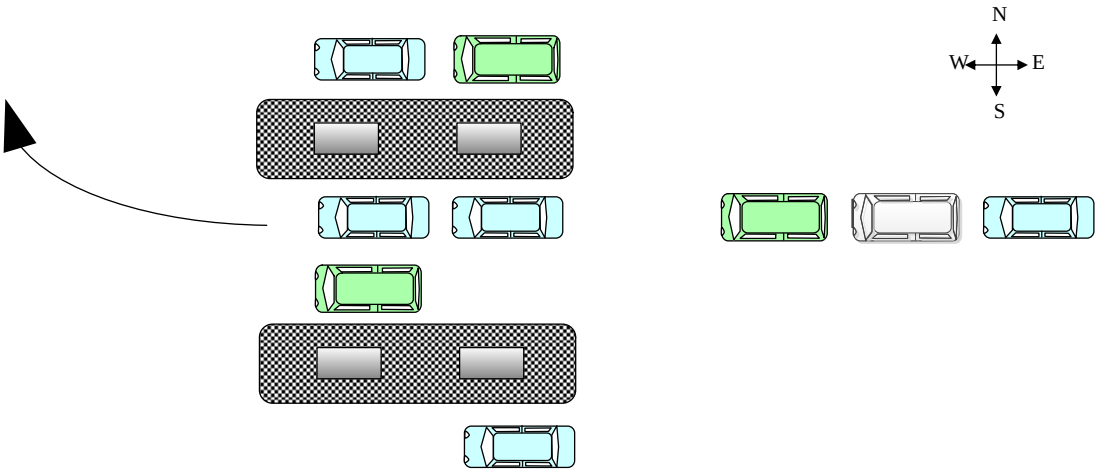
1.1 Problem Statement

A gas station owner noticed that some cars do not enter when the station is too busy and is thinking of hiring additional attendants to help increase profits. Thus the station's owner has an interested in using modeling and simulation to determine how many attendants he should have to maximize the station's daily profit.

1.2 SUI Details

Garage

The garage contains two islands each with 2 gas pumps. Each gas pump has 2 hoses such that 2 cars can be serviced on both sides of each pump which means that up to 2 X 2 X 2 = 8 cars can be serviced at the same time. An attendant stays with the car until it has been completed serviced (that is an attendant cannot take care of more than one car at a time). Cars line up in a single line and move to the island when an attendant signals the car to approach. The diagram shows the case where 6 attendants (all attendants) are servicing 6 cars while three cars are waiting for servicing.



Hours of Operation

The gas station is open from 7 a.m. until 7 p.m. The lights are turned out at 7 p.m., meaning that cars arriving later than that are not accepted for service. Any cars already waiting in line at 7 p.m. are served, however, before the attendants leave for the night.

Customers

A car stops only if the driver perceives that not more than one car per attendant is already waiting to be served. This means that a car will go to another gas station if the number of cars already waiting for service is greater than the number of cars currently being served.

Profit and Costs

The profit per car varies according the amount of gas sold and does not include attendants' salaries and other fixed costs. Attendants earn $15.50 per hour and are only paid for working a 12-hour day, even if they stay beyond 7 p.m. to finish service on previously waiting cars. The other fixed costs amount to $300 per day.

2 ABCmod Conceptual Model

2.1 Project Goal

Find the number of attendants that provides the best daily profit to the gas station. In addition determine the amount of lost daily profit due to cars turning away from the station.

2.1.1 Parameters

numAttendants – the number of attendants servicing cars.

2.1.2 Experimentation

Cases: A case for each of the following values of ***numAttendants***: 3, 4, 5, 6, 7, 8.

2.1.3 Output

dailyProfit: The average daily profit.
revenuLost: The average revenu lost due to cars turning away.

Note: The daily profit is calculated as DailyRevenu - FixCosts – AttendantSalairies, where the DailyRevenu is computed from the profit of sales to each of the cars, FixCosts is $300, and AttendantSalaries is calculated as numAttendants * 12 * 15.50.

2.2 High Level ABCmod Conceptual Model

2.2.1 Simplifications and Assumptions

Complete this section in the exam.

2.2.2 Structural View

Complete this section in the exam.

2.2.3 Behavioural View

Complete this section in the exam.

2.2.4 Input

Exogenous Input (Entity Stream)			
Variable Name	**Description**	**Domain Sequence Procedure**	**Range Sequence Procedure.**
uCarArr(t)	The input variable uCarrArr is the input entity stream variable that defines points in time that cars arrive at the station.	RVP.DuCarArr()	N/A, 1 customer arrives at each arrival.

Endogenous Input (Independent: implicit time dependence)		
Variable Name	**Description**	**Value**
uServiceCarTime(t)	Defines the time that it takes to service a car.	RVP.UServiceCarTime()
uProfit(t)	Profit from the sale of gas to a customer.	RVP.UProfit()

2.3 Detailed Conceptual Model

2.3.1 Structural Components

Constants		
Name	**Description**	**Value**
MEAN_ARRIVAL	Mean interarrival times for the cars.	5.8 minutes
MEAN_SRVTIME	Mean service time for servicing the cars.	7.5 minutes
STD_DEV_SRVTIME	Standard deviation for servicing the cars.	3.333 minutes
MIN_PROFIT	Minimum profit from the sale of gas to a car.	$5.00
MAX_PROFIT	Maximum profit from the sale of gas to a car.	$15.00
HOURS	Number of hours that attendants work during the day.	12.0
HOURLY_PAY	The hourly wages an attendant receives for working at the gas station.	15.50
FIXED_COSTS	The daily fixed costs to open the station.	300.0
Parameters		
Name	**Description**	**Value**
numAttendants	Number of attendants hired to service cars at the gas station.	2, 3, 4, 5, 6, 7, 8

Complete this section in the exam.

2.3.2 Behavioural Components

Complete this section in the exam.

2.3.2.1 Output

Complete this section in the exam.

2.3.2.2 User Defined Procedures

None required

2.3.2.3 Input Constructs

Random Variate Procedures		
Name	**Description**	**Data Model**
DuCarArr()	Provides the arrival time of the next vehicle. The data model provides the interarrival times. The time of the first arrival t0 is determined by the exponential random variate generator(). No arrivals occur after the 12 hour day (i.e. 12*60 = 720 minutes)	Exponential(MEAN_ARRIVAL).
UServiceCarTime()	Detemines the time to service a car.	Normal(MEAN_SRVTIME, STD_DEV_SRVTIME)
UProfit()	Profit from the sale of gas to a single car.	Uniform(MIN_PROFIT, MAX_PROFIT)

Complete this section in the exam.

2.3.2.4 Behavioural Constructs

Complete this section in the exam.