

# CS1515

## Foundations of Computing Science 2

### Group Programming Exercise

#### Practicals 6-8

#### SuperSim



A major supermarket chain (SuperSim) is planning changes to the way it provides services for its customers. Before putting these into effect, it wishes to have an accurate model (in the form of a computer simulation) of what happens at present within a typical store. Your team has been selected along with others to bid for the contract to build such a model. The bid must be based on a preliminary model which you will construct. To decide who gets the contract, SuperSim will evaluate the models according to the Computer Assisted Supermarket (or CAS) scale.

### To be awarded up to CAS 11:

You should simulate the queues which build up at the checkout. You can assume that the probability of a **customer** arriving at the checkouts during any given minute is constant. The **supermarket** opens a new **checkout** when the average of the queue lengths gets above a given threshold. The time taken to process a given customer is uniformly distributed between two limits; customers chose the queue with the fewest number of people in it.

You should collect and output statistics for: the total number of customers served during your simulation period, the average queue size, the average waiting time per customer.

*[Hint: Look at the PacketSwitch and JavAirPlus problems. You should provide your own values for the arrival rate, queue threshold and the upper and lower limits for the processing time. Consider the words in bold above as possible classes.]*

### To be awarded up to CAS 14

Rather than customers arriving directly at the checkouts, you are to simulate their arrival at the store and the time they spend selecting items. The probability of arrival at the store during any given minute is constant and has the same value as that used above. Once in the store, a customer spends time selecting items to put in his/her trolley, so the total time spent in the shelves is given by the number of items selected multiplied by a constant time per item. The number of items they select is distributed normally. The supermarket now operates an 'express' checkout for customers with fewer than 10 items; customers in this category will go to this checkout, otherwise they chose the shortest queue as above. On all checkouts, the time taken to process a customer is a constant times the number of items they have selected.

In addition to the above statistics for all tills you should collect and output statistics for the express checkout.

*[Hint: You will need to create customers as they enter the store and keep them in a special collection until the time comes for them to arrive at the checkouts. This time depends on the number of items they select which will clearly be discrete. Strictly speaking you can only generate continuous random variables from a normal distribution, but there is nothing to stop you rounding to the nearest integer to get a discrete random variable. You should provide your own values for the mean and standard deviation of this normal distribution and for the two constant times per item – to select and to process at the checkout.]*

### To be awarded up to CAS 17

Rather than the **items** being anonymous, they should be selected from a known list of items. The names of items stocked and their prices should be made available in a text file. The store operates a loyalty card system which enables it to keep track of what items are purchased by individual customers and the total amount they spend. It does this by capturing this information as the customer goes through the checkout and writing it to a file. To simulate this, just allocate a unique number to each customer as they enter the store.

The output will consist of the text file of customer purchases.

*[Hint: There are similarities with the StockControl system. We will look at text file reading and writing in week 6. You will need to create a suitable text file of supermarket items.]*

### To be awarded up to CAS 20

Surprise me! Make the simulation more realistic.

- Allow the simulation to run for an extended period of time and vary the customer arrival rate depending on the time of day.
- Allow checkouts to be closed when the average queue size falls below a threshold (but remember that customers in the queue have to be served before it closes).

- When choosing which queue to join, allow customers to take into account the number of items in other people's trolleys so that they chose the queue with the fewest number of items in the queue.
- Allow that every so often a customer has an item which is missing a bar code, so that the checkout assistant has to call for help – this introduces a significant delay.

You might also generate some graphics to show the sizes of the queues etc. as the simulation proceeds.

## Deliverables

You must submit your bid before **noon on Friday 25th March 2010** using the [BlueJ submission system](#). Bids submitted late will attract the following penalties:

- Bids submitted up to **one day late** attract a **penalty of 10%**
- Bids submitted up to **one week late** attract a **penalty of 25%**
- Bids handed in **more than one week late** will be marked and returned but will receive **CAS 0**

The bid is a group bid and is submitted by the group as a whole. **All of the following files should be stored in the project directory:**

- A report of no more than 2000 words as a Word document which should contain the following sections:
  1. *Front cover*: This should contain the name of the project, the name of the group, and the names of the individual members of the group. It should contain the following declaration: "We acknowledge that this exercise is part of the formal assessment of the course, and declare that the work done is our own. Any contribution made by anyone outside the group is acknowledged as indicated in the section on Cheating & Plagiarism in the student handbook."
  2. *User manual*: How do I run your program and what output should I expect?
  3. *Maintenance manual*: What are the classes and main methods for each class?
  4. *Simulation*: What assumptions have been made? What values have been chosen for the simulation constants? How were these values arrived at? If you have carried out any analysis of the outputs, your conclusions should be reported here.
  5. *Group activities*: Describe how the group operated. Were individuals assigned specific roles? Set out the work undertaken by each individual member of the group.
- The code for the simulation as a set of BlueJ files.
- JavaDoc for the program.
- Any input and output text files.

In addition, **each individual member of the group** must email me ([w.w.vasconcelos@abdn.ac.uk](mailto:w.w.vasconcelos@abdn.ac.uk)) with a paragraph stating, in more detail than in the main report, your own individual contribution to the project. If you fail to do this, you will receive CAS 0. The subject of the email should be 'SuperSim'; you should make sure that the email contains your name. If you feel that any member of the group has not contributed to the work of the group, you should tell me here. This information is given in confidence.

## Notes on how the group should operate

1. Problem analysis, coding, program testing and analysis of output, observation of actual supermarkets to establish simulation constants, report writing etc. are all meaningful activities in preparing the bid and should be taken into account in ensuring that all members of the group contribute equally to this.
2. It is expected that all group members will contribute significantly to the preparation of the bid. All members must undertake some programming, but it is up to the group how the programming tasks are allocated between members of the group.

3. Normally all members of the group will receive the same mark. However if it is established that any member or members of the group have not contributed significantly then their mark(s) will be reduced accordingly (possibly down to 0).
4. The practical sessions during weeks 6, 7 and 8 should be devoted to this activity; attendance at practicals is compulsory and any non-attendance will be taken as evidence of a lack of contribution to the bid.
5. In the same way, I consider the contribution of your mentors to be so important to this activity that attendance at mentoring sessions is compulsory for weeks 6 to 8.
6. If any group becomes non-viable because not enough members are participating, the other members should contact me immediately.