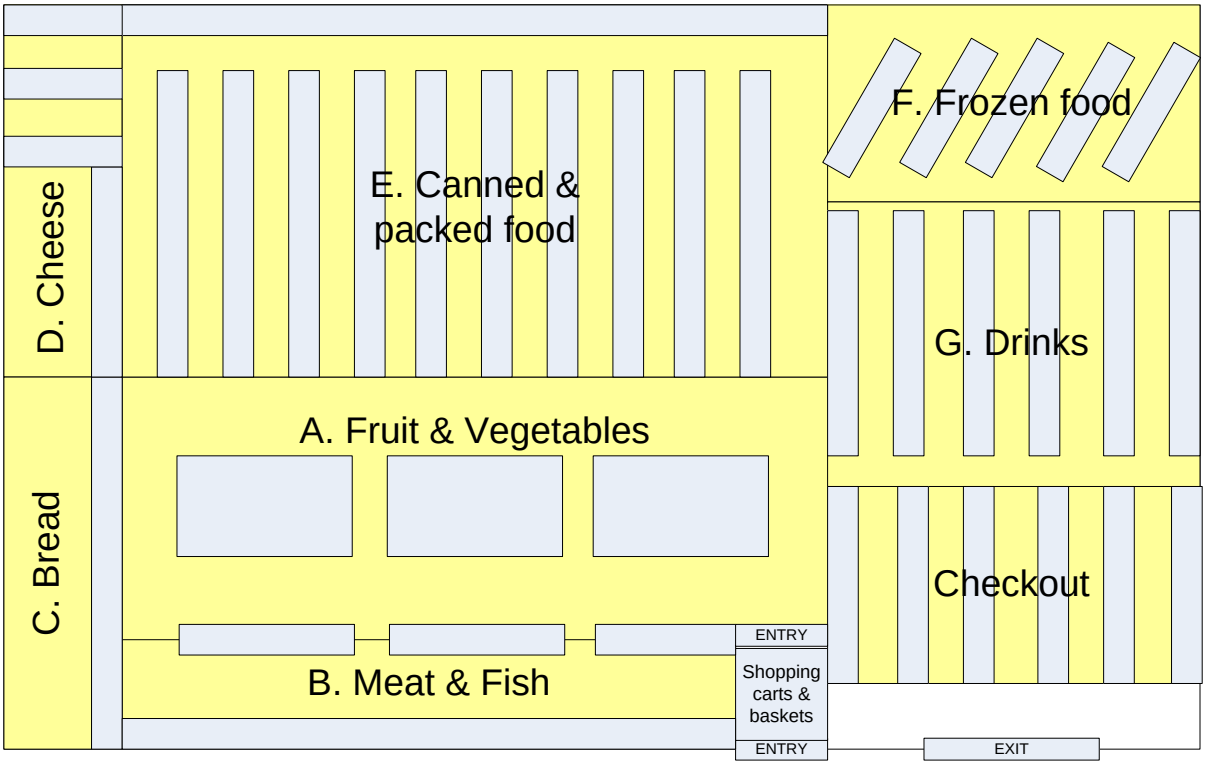
SEN9110 Simulation Package: Assignment 1

Assignment to be carried out in your simulation package

The manager of a medium-size supermarket has asked you for help to analyze the efficiency of the supermarket using a simulation study. Especially on Saturday, there are complaints from customers that there are not enough carts, and that waiting times at the bread department and the checkout counters is too long. There are also complaints from customers who have to wait a long time to get a shopping cart. During the past three months, the supermarket has gathered data for the simulation study.

The floorplan of the supermarket is given below. 40% of the customers follow route A-B-C-D-E-F-G, but 60% follow route B-C-D-E-A-F-G. 80% of the customers take a shopping cart, 20% a shopping basket. There are 45 shopping carts available, the number of baskets is several hundreds.



On Saturday, the supermarket is open from 08:00 till 20:00. The number of customers arriving each hour is not constant; the table below gives an indication of the average number of arriving customers per hour:

08:00-09:00	30
09:00-10:00	80
10:00-11:00	110
11:00-12:00	90
12:00-13:00	80
13:00-14:00	70

14:00-15:00	80
15:00-16:00	90
16:00-17:00	100
17:00-18:00	120
18:00-19:00	90
19:00-20:00	40

There are 7 major departments in the supermarket. The table below indicates how many items customers buy on average at each department:

Department	Minimum items	Mode items	Maximum items
A. Fruit & Vegetables	4	10	22
B. Meat & Fish	0	4	9
C. Bread	1	4	10
D. Cheese & Dairy	1	3	11
E. Canned & packed food	6	17	35
F. Frozen foods	2	8	19
G. Drinks	1	9	20

Selecting and taking an item and putting it in the shopping cart or basket takes between 20 and 30 seconds, including walking time to the next place where an item will be taken from the shelves. This has been measured for departments A, B, E, F, and G.

The bread department (C) and the cheese department (D) have a counter where customers are served. In the bread department, 4 employees serve the customers. On average, the process to order and get the 1 to 6 items takes two minutes. At the cheese department, there are three employees. Here, the process takes on average 1 minute.

After shopping, the customers go to the checkout department to pay. Shoppers always choose the shortest queue. Scanning the items takes 1.1 second per item on average. Payment takes between 40 and 60 seconds. There are three checkout lanes in use right now on Saturday. After payment, those shoppers that used a cart return it. The supermarket stays open till the last customer leaves.

Model the basic working of this system for a full Saturday, without warmup time. Run 10 replications, and gather the throughput time of the customers (average + 95% confidence interval), and the waiting times and average queue lengths for all departments, but especially at the entrance (shopping carts), at the bread department, and at checkout. Provide the utilization data of the shopping carts and checkout, based on the 10 replications.

Animation is not yet necessary. Just create the basic model. When something is too difficult, simplify and implement what can be done. Make assumptions for missing information. Take note of what is easy and what is hard in the simulation language.

Deadline and requirements

Hand in a small slide pack (5-10 slides) describing how you built the model, and how you created the experiment. Provide the results of the simulation experiment as well. Describe what was easy and what was difficult, compared to simulation package(s) that you know. Hand in the model as well. Make sure the teacher can run the model -- provide model and input files, and instructions if needed to run the model (e.g., requirements.txt for Python-based models).

The slides and model have to be uploaded Friday 20 September (end of week 3) latest at 17:00 as an assignment in Brightspace.