Verb Noun Analysis

Analysis of specification requirements:

Verb:

Noun:

The task is to develop a simulation of a self-service petrol station with a certain number of pumps and a shop. Different types of vehicles may come to the station to top up, (optionally) pick up some food and necessities and then pay for everything at one of the tills. The purpose of the simulation is to study what level of demand can be handled with a certain number of pumps and tills, keeping customers happy and net income high. All value ranges mentioned are uniformly randomly distributed.

You will have various types of vehicles:

- Small cars have 7–9 gallon tanks, and take up 1 unit of space in the queue.
- Motorbikes take up 0.75 units of space in the queue, and their gas tanks are smaller (5 gallons).
- Family sedans take up 1.5 units of space in the queue, and their gas tanks are larger (12–18 gallons).

Your simulation should model the petrol station with a time resolution of 10 seconds (1 “tick”). The system has the following configuration:

1. There is a configurable number of pumps. Each pump has a queue that can fit up to 3 units of space (e.g. 2 sedans, 3 small cars or 4 motorbikes). Pumps provide 1 gallon per tick of fuel.
2. There is a configurable number of tills in the shop. Paying at the till takes 2–3 minutes.
3. Small cars and motorbikes arrive with a probability of p per tick.
4. Family sedans arrive with a probability of q per tick.
5. Customers always go to one of the least occupied queues first (both for pumps and for tills).
6. If a vehicle arrives and does not fit into any of the queues, the vehicle will simply leave.
7. Vehicles always fully top up their tanks. By default, one gallon is £1.20 for the simulation.
8. Vehicles stay in the queue for the pump while the driver goes to the shop to pay at the till.
9. The vehicle starts topping up on the next tick after it gets to the front of the queue for the pump, and the driver goes to the till on the next tick after it tops up.
10. You must track how much money was earned, and how much money was lost because of vehicles being unable to enter the station.
11. You must write test classes in JUnit 4 for at least five of your classes.

There is a second set of requirements that you will need to complete for full marks:
1. A graphical user interface should be provided and allow the user to set values such as p and q, the price of the gallon, and the period of time that the simulation should run for.
2. You must also simulate a shopping area in the gas station. Happy customers that refill quickly will spend some time looking around (away from the tills), before queueing up at a till on the next tick and paying some additional money:
- For small cars, if the refill is done in less than 5 minutes since arriving, there is a probability of 0.3 that the driver will shop for 2–4 minutes to spend an extra £5–£10.
- For family sedans, if the refill is done in less than 10 minutes since arriving, there is a probability of 0.4 the driver will shop for 2–5 minutes to spend another £8–£16.
- Motorbike drivers in the area are thrifty and will never go to the shopping area.

You will need to track the money lost from missed sales as well. It may be interesting to track it separately from the money gained from selling fuel.

3. Trucks may also arrive at the station. They take up 2 units of space. After refilling their 30–40 gallon tank, a truck driver that refilled in 8 minutes or less will always do a purchase of £15-£20 after browsing for 4–6 minutes.
An unhappy truck driver will let the other truck drivers know about the bad service. This will make it less likely that they come. Trucks arrive with a probability of t, which is initially t0 = 0.02. An unhappy truck driver will reduce t by 20% of its current value: t′ = 0.8t. A happy truck driver will increase it by 5% of its current value, up to the original value of t: t′ = min{1.05t, t0}.
The aim of running the simulation is to decide for each station configuration (number of pumps and tills) which level of activity it is best suited for: that is, which are the values of p and q that report the highest net income (raw income minus missed sales).
To do this, the simulation should be run for four hours (1440 ticks) for all independent combinations of the values below, and the results should be averaged over 10 different seeds for the random number generator:

• p: 0.01, 0.02, 0.03, 0.04, and 0.05. • q: same options as p.
• Pumps: 1, 2 and 4.
• Tills: 1, 2 and 4.
• With and without trucks (if implemented).

Breakdown of analysis: Identifying classes and their behaviours:

Classes	Behaviour
Vehicle	Drive into the petrol station, receive fuel, leave the petrol station
Small Car	Drive into the petrol station, receive fuel, leave the petrol station
Family Sedan	Drive into the petrol station, receive fuel, leave the petrol station
Motorbike	Drive into the petrol station, receive fuel, leave the petrol station
Truck	Drive into the petrol station, receive fuel, leave the petrol station
Till	Receive cash
Pump	Deliver petrol to the vehicle
Pump Queue	Hold a user specified amount of pumps
Till Queue	Hold a user specified amount of tills
Customer	Leave Car, Enter Shop, Shop, Leave Shop, Re-enter car
Petrol Station	Have a pump queue and a till queue, have a shop, allow customers to pay, calculate earnings
Shopping Area	Hold a customer while shopping

Input Options for the user:

Input Options for probability of vehicle/Input Options for probability of vehicle appearing

Vehicles	0.01	0.02	0.03	0.04	0.05
Small Car	Yes	Yes	Yes	Yes	Yes
Motorcycle	Yes	Yes	Yes	Yes	Yes
Motorbike	Yes	Yes	Yes	Yes	Yes
Truck	Preset to 0.02	Preset to 0.02	Preset to 0.02	Preset to 0.02	Preset to 0.02

CRC Cards: Link to the repository of CRC cards

https://echeung.me/crcmaker/?share=W3sibmFtZSI6IlZlaGljbGUgIiwic3VwZXJjbGFzc2VzIjoiIiwic3ViY2xhc3NlcyI6IlNtYWxsIENhci
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