MID ONE:

Q1:

a. Model: An abstraction of reality, representing physical or non-physical systems, phenomena, or processes

b. Environment: A virtual created setting that mimics real world systems or processes for simulation

c. System: A representation in simulations, encompassing selected elements and boundaries to depict a simplified version of reality.

e. Computer Simulation: The use of computer-based mathematical models to emulate the behavior or outcomes of real-world systems.

f. Continuous Model: A simulation approach using continuously changing variables, typically governed by differential equations.

g. Discrete Event Model: A simulation technique that models system changes as a sequence of distinct, individual

events.

h. Model Accuracy: The extent to which a simulation model accurately reflects the real world scenario it is designed to represent.

i. Model Performance: The efficiency and effectiveness with which a simulation model operates and produces results.

j. Quality of a Random Number: An assessment of how well a random number generation process simulates truerandomness in simulations.

Q2:

a. Determine the mean and variance of X.

The mean (expected value) of a random variable is given by:

E(X)=∑ixi·P(X=xi)

And the variance is given by:

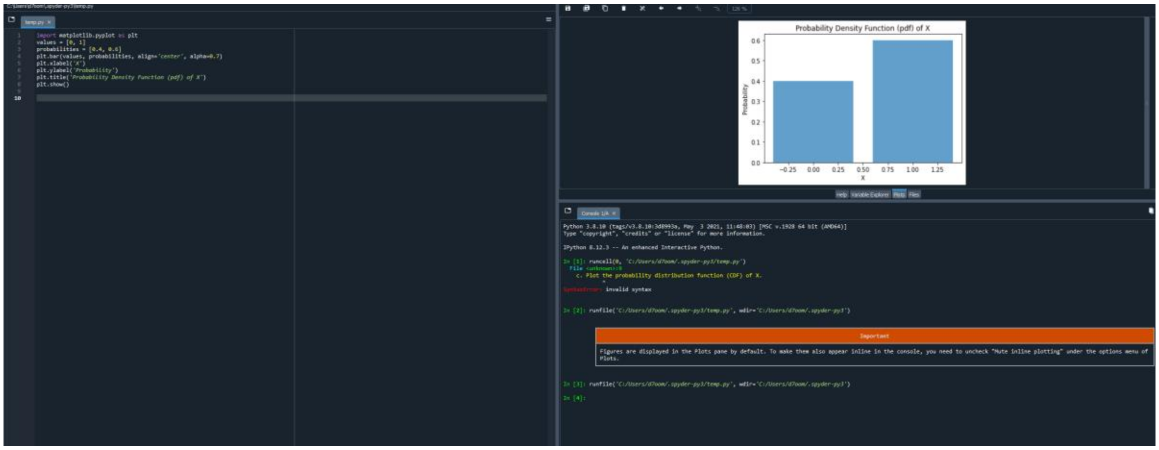
2]Var(X)=E[(X−μ)2]

where μ is the mean.

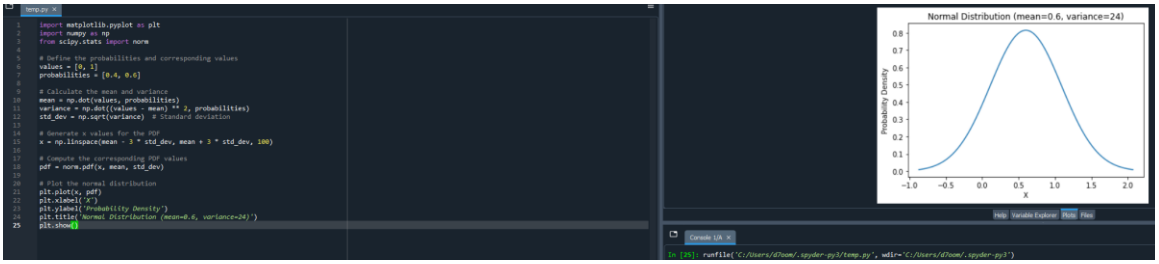
For the given random variable 0·0.4+1·0.6=0.6E(X)=0·0.4+1·0.6=0.6

0−0.6)2·0.4+(1−0.6)2·0.6=0.24Var(X)=(0−0.6)2·0.4+(1−0.6)2·0.6=0.24

b. Plot the probability density function (pdf).



c. Plot the probability distribution function (CDF) of X.



Q3:

1. Start:

• Begin the simulation.

2. Initialization:

• Set initial conditions, parameters, and variables.

• Initialize simulation clock.

3. Event List:

• Create an event list to manage the order of events.

4. Generate Initial Events:

• Generate initial events to kickstart the simulation.

5. Simulation Loop:

• While there are events in the event list:

• Get the next event from the list.

• Update the simulation clock to the time of the event.

6. Event Handling:

• Determine the type of event (arrival, departure, etc.).

• Execute the corresponding event procedure.

• This may involve updating state variables, scheduling new events, or performing other actions.

7. Data Collection:

• Collect relevant data for analysis.

• This may include system performance metrics, statistics, or other output.

8. Termination Criteria:

• Check if termination conditions are met.

• This could be a specific simulation time, a number of events, or reaching a desired state.

9. End:

• Finish the simulation.

10. Analysis and Reporting:

• Analyze the collected data.

• Generate reports or visualizations.

11. End of Flowchart:

• End the flowchart.

Q4:

```
import simpy
import random
class SingleServerQueue:
 def __init__(self, env, arrival_rate, service_rate):
 self.env = env
 self.server = simpy.Resource(env, capacity=1)
 self.arrival_rate, self.service_rate = arrival_rate, service_rate
 def arrival_process(self):
```

```
customer_id = 1
while True:
yield self.env.timeout(random.expovariate(self.arrival_rate))
self.env.process(self.service_process(customer_id))
customer_id += 1
def service_process(self, customer_id):
with self.server.request() as request:
yield request
service_time = random.expovariate(self.service_rate)
yield self.env.timeout(service_time)
print(f"Customer {customer_id} served in {service_time:.2f} units at {self.env.now:.2f} units.")
def run_simulation(arrival_rate, service_rate, simulation_time):
env = simpy.Environment()
queue = SingleServerQueue(env, arrival_rate, service_rate)
env.process(queue.arrival_process())
env.run(until=simulation_time)
if __name__ == "__main__":
    run_simulation(arrival_rate=0.5, service_rate=0.7, simulation_time=10)
```

Q5:

1. Define the Road Network:

• Identify the main roads and intersections around KSU.

• Collect data on road lengths, lanes, speed limits, and road connectivity.

2. Traffic Flow Model:

• Choose an appropriate traffic flow model (e.g., microsimulation or mesosimulation).

• Consider traffic demand patterns, such as peak hours and weekdays vs. weekends.

3. Driver Behavior:

• Model driver behavior, including acceleration, deceleration, lane changing, and reaction to traffic

signals.

• Incorporate factors like driver aggressiveness, patience, and adherence to traffic rules.

4. Traffic Signals and Controls:

• Implement traffic signal timings and controls at intersections.

• Consider adaptive signal control systems that can adjust timings based on real-time traffic conditions.

5. Data Collection:

• Gather real-world data on traffic patterns, including vehicle counts, speeds, and congestion levels.

• Use GIS data for accurate road geometry and topology.

6. Simulation Software:

• Choose a suitable simulation tool, such as VISSIM, AIMSUN, or any other traffic simulation software.

• Input the road network, traffic flow model, and driver behavior parameters into the simulation tool.

7. Validation and Calibration:

• Validate the simulation model against real-world data.

• Calibrate the model to ensure that it accurately represents observed traffic conditions.

8. Performance Metrics:

• Define performance metrics such as travel time, congestion levels, and queue lengths.

• Evaluate the impact of different scenarios, such as road closures or changes in traffic signal timings.

9. Accuracy Concerns:

• The accuracy of the simulation depends on the quality of input data and the realism of the chosen

models.

• Calibration is crucial to ensure that the simulation results align with observed traffic conditions.

• The accuracy of driver behavior models can significantly impact the overall simulation accuracy.

10. Scenario Analysis:

• Conduct scenario analyses to assess the impact of different interventions (e.g., road expansions, signal changes).

• Consider future scenarios, such as increased traffic due to urban development.

11. Sensitivity Analysis:

• Perform sensitivity analysis to understand how changes in model parameters affect simulation

outcomes.

• Identify critical parameters that significantly influence results.

12. Continuous Improvement:

• Update the simulation model regularly based on new data and changes in the road network or traffic

patterns.

• Continuously refine and improve the model to enhance accuracy.

13. Engage Stakeholders:

• Involve local authorities, traffic management agencies, and other stakeholders in the simulation

process.

• Seek feedback and validation from experts in traffic engineering and urban planning.

Q6:

Customer	Arrival time (AT)	ST	TS START	TS ENDS	TIME CUSTOMER WAITS	time spent on system	time of system idle
1	1	3	1	3	0	2	1
2	4	5	4	9	0	5	-
3	8	15	9	24	1	16	-
4	17	2	24	26	7	9	-

Metric   Value

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System Throughput (X)   0.2

Total Busy Time (B)   24

Mean Service Time (Ts)   6

Utilization (U)   0.923

Mean Time in Queue   2

Mean System Time (W) 8

Mean Number in the System (L) ≈ 1.232

Q7:

1. Collect Data:

• Gather historical population data for Riyadh over the past 5 years.

2. Calculate Birth and Death Rates:

• Use the collected data to estimate annual birth and death rates.

3. Estimate Immigration and Emigration Rates:

• If available, collect data on immigration and emigration rates for Riyadh.

4. Initialize Model:

• Set the initial population (P0) using the most recent population data.

5. Apply Population Growth Equation:

• Use the population growth equation to model population changes over the next 5 years.

6. Compare with Real Data:

• Compare the model's predictions with the actual population data for the corresponding years.

Comparison and Error Calculation:

Compare the model's predicted population with the actual population for each year.

Calculate the error as the absolute difference between the predicted and actual populations.

Error=∣Actual Population−Predicted Population∣

Q8:

• Initial Population (P0): 7 million (based on the latest available data)

• Birth Rate (B): 2%

• Death Rate (D): 0.5%

• Immigration Rate (I): 1%

• Emigration Rate (E): 0.8%

Q9:

1. Discretize the Pipe:

• Divide the pipe into a grid of nodes along the axial and radial directions.

2. Define Governing Equations:

• Use the Navier-Stokes equations for incompressible flow (assuming steady-state, no-slip conditions).

• These equations include terms for velocity, pressure, and viscosity.

3. Apply Finite Difference Approximations:

• Discretize the spatial derivatives in the governing equations using finite difference approximations.

• Common schemes include central differences for second-order derivatives.

4. Boundary Conditions:

• Apply boundary conditions, considering the given inlet pressure and flow rate.

• Implement no-slip conditions at the pipe walls.

5. Iterative Solution:

• Set up an iterative solver to solve the system of discretized equations.

• Common solvers include the Gauss-Seidel method or the Conjugate Gradient method.

6. Convergence Criteria:

• Define a convergence criterion to determine when the solution has reached a steady-state.

7. Post-Processing:

• Extract relevant information such as velocity profiles, pressure distribution, and flow patterns.