

Simulating a container terminal using SimPy

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!pip install simpy
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Collecting simpy
  Downloading simpy-4.1.1-py3-none-any.whl (27 kB)
Installing collected packages: simpy
Successfully installed simpy-4.1.1

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import simpy
import random
import csv
from datetime import datetime

# Constants
AVG_ARRIVAL_TIME = 5
NUM_CONTAINERS = 150
CRANE_TIME_PER_CONTAINER = 3
TRUCK_CYCLE_TIME = 6
NUM_BERTHS = 2
NUM_CRANES = 2
NUM_TRUCKS = 3

class ContainerTerminal:
    def __init__(self, env):
        self.env = env
        self.berths = simpy.Resource(env, capacity=NUM_BERTHS)
        self.quay_cranes = simpy.Resource(env, capacity=NUM_CRANES)
        self.trucks = simpy.Resource(env, capacity=NUM_TRUCKS)

class Logger:
    def __init__(self, filename):
        self.filename = filename
        with open(self.filename, 'w', newline='') as file:
            writer = csv.writer(file)
            writer.writerow(["Timestamp", "Simulation Time", "Event"])

    def log_event(self, env, message):
        with open(self.filename, 'a', newline='') as file:
            writer = csv.writer(file)
            writer.writerow([datetime.now(), f"{env.now:.2f}", message])
        print(f"{env.now:.2f}: {message}")

def vessel_process(env, terminal, logger, vessel_id):
    containers = NUM_CONTAINERS
    logger.log_event(env, f"Vessel {vessel_id} arrived with {containers} containers")

    with terminal.berths.request() as berth:
        yield berth
        logger.log_event(env, f"Vessel {vessel_id} berthed")

    with terminal.quay_cranes.request() as crane:
        yield crane
        logger.log_event(env, f"Quay crane assigned to Vessel {vessel_id}")

    while containers > 0:

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        with terminal.trucks.request() as truck:
            yield truck
            yield env.timeout(CRANE_TIME_PER_CONTAINER) # Time to move container to truck
            containers -= 1
            logger.log_event(env, f"Quay crane moved a container from Vessel {vessel_id} to truck.

            yield env.timeout(TRUCK_CYCLE_TIME) # Truck's round trip to yard
            logger.log_event(env, f"After Dropping Truck returned from yard for Vessel {vessel_id}

        logger.log_event(env, f"Quay crane released for Vessel {vessel_id}")

    logger.log_event(env, f"Vessel {vessel_id} unloaded and departed. Berth is now free.")

def vessel_generator(env, terminal, logger):
    vessel_id = 1
    while True:
        yield env.timeout(random.expovariate(1 / (AVG_ARRIVAL_TIME * 60))) # Average 5 hours (300 minutes)
        env.process(vessel_process(env, terminal, logger, vessel_id))
        vessel_id += 1

def run_simulation(env, simulation_time, logger):
    terminal = ContainerTerminal(env)
    env.process(vessel_generator(env, terminal, logger))
    logger.log_event(env, f"Starting simulation for {simulation_time} minutes")
    env.run(until=simulation_time)
    logger.log_event(env, "Simulation completed")

if __name__ == "__main__":
    try:
        SIMULATION_TIME = int(input("Enter simulation time in minutes: "))
        if SIMULATION_TIME <= 0:
            raise ValueError("Simulation time must be a positive integer.")
    except ValueError as e:
        print(f"Invalid input: {e}")
    else:
        env = simpy.Environment()
        logger = Logger("container_terminal_simulation.csv")
        run_simulation(env, SIMULATION_TIME, logger)

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Enter simulation time in minutes: 3000
0.00: Starting simulation for 3000 minutes
29.11: Vessel 1 arrived with 150 containers
29.11: Vessel 1 berthed
29.11: Quay crane assigned to Vessel 1
32.11: Quay crane moved a container from Vessel 1 to truck. Remaining: 149
38.11: After Dropping Truck returned from yard for Vessel 1
41.11: Quay crane moved a container from Vessel 1 to truck. Remaining: 148
47.11: After Dropping Truck returned from yard for Vessel 1
50.11: Quay crane moved a container from Vessel 1 to truck. Remaining: 147
56.11: After Dropping Truck returned from yard for Vessel 1
59.11: Quay crane moved a container from Vessel 1 to truck. Remaining: 146
65.11: After Dropping Truck returned from yard for Vessel 1
68.11: Quay crane moved a container from Vessel 1 to truck. Remaining: 145
74.11: After Dropping Truck returned from yard for Vessel 1
77.11: Quay crane moved a container from Vessel 1 to truck. Remaining: 144
83.11: After Dropping Truck returned from yard for Vessel 1

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86.11: Quay crane moved a container from Vessel 1 to truck. Remaining: 143
92.11: After Dropping Truck returned from yard for Vessel 1
95.11: Quay crane moved a container from Vessel 1 to truck. Remaining: 142
101.11: After Dropping Truck returned from yard for Vessel 1
104.11: Quay crane moved a container from Vessel 1 to truck. Remaining: 141
110.11: After Dropping Truck returned from yard for Vessel 1
113.11: Quay crane moved a container from Vessel 1 to truck. Remaining: 140
119.11: After Dropping Truck returned from yard for Vessel 1
122.11: Quay crane moved a container from Vessel 1 to truck. Remaining: 139
128.11: After Dropping Truck returned from yard for Vessel 1
131.11: Quay crane moved a container from Vessel 1 to truck. Remaining: 138
137.11: After Dropping Truck returned from yard for Vessel 1
140.11: Quay crane moved a container from Vessel 1 to truck. Remaining: 137
146.11: After Dropping Truck returned from yard for Vessel 1
149.11: Quay crane moved a container from Vessel 1 to truck. Remaining: 136
155.11: After Dropping Truck returned from yard for Vessel 1
158.11: Quay crane moved a container from Vessel 1 to truck. Remaining: 135
164.11: After Dropping Truck returned from yard for Vessel 1
167.11: Quay crane moved a container from Vessel 1 to truck. Remaining: 134
173.11: After Dropping Truck returned from yard for Vessel 1
176.11: Quay crane moved a container from Vessel 1 to truck. Remaining: 133
182.11: After Dropping Truck returned from yard for Vessel 1
185.11: Quay crane moved a container from Vessel 1 to truck. Remaining: 132
191.11: After Dropping Truck returned from yard for Vessel 1
194.11: Quay crane moved a container from Vessel 1 to truck. Remaining: 131
200.11: After Dropping Truck returned from yard for Vessel 1
203.11: Quay crane moved a container from Vessel 1 to truck. Remaining: 130
209.11: After Dropping Truck returned from yard for Vessel 1
212.11: Quay crane moved a container from Vessel 1 to truck. Remaining: 129
218.11: After Dropping Truck returned from yard for Vessel 1
221.11: Quay crane moved a container from Vessel 1 to truck. Remaining: 128
227.11: After Dropping Truck returned from yard for Vessel 1
230.11: Quay crane moved a container from Vessel 1 to truck. Remaining: 127
236.11: After Dropping Truck returned from yard for Vessel 1
239.11: Quay crane moved a container from Vessel 1 to truck. Remaining: 126
245.11: After Dropping Truck returned from yard for Vessel 1
248.11: Quay crane moved a container from Vessel 1 to truck. Remaining: 125
254.11: After Dropping Truck returned from yard for Vessel 1
257.11: Quay crane moved a container from Vessel 1 to truck. Remaining: 124
263.11: After Dropping Truck returned from yard for Vessel 1

