Call Center Simulation – Queueing Analysis

📞 Call Center Simulation using Queueing Theory

Internship Project – Data Analysis

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Project Objective

🎯 Objective: To simulate and analyze a real-world call center using the M/M/s queue model

Goals:

- Minimize customer wait times
- Determine optimal staffing levels
- Reduce abandonment and cost

Queueing Model Overview

📘 What is M/M/s Queue?

- M = Memoryless arrivals (Poisson)
- M = Memoryless service (Exponential)
- s = Number of agents (servers)

Used to model call center where:

- Customers arrive randomly
- Service time is random
- Limited number of agents are available

Simulation Approach

🧪 Steps Taken:

1. Simulated customer arrival & service times

2. Calculated wait time and system size

3. Compared results to theoretical M/M/1 model

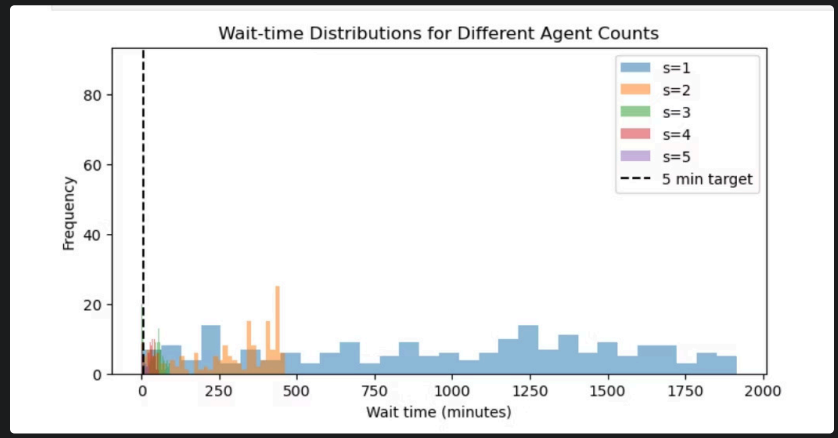
4. Tested different agent counts (1 to 5)

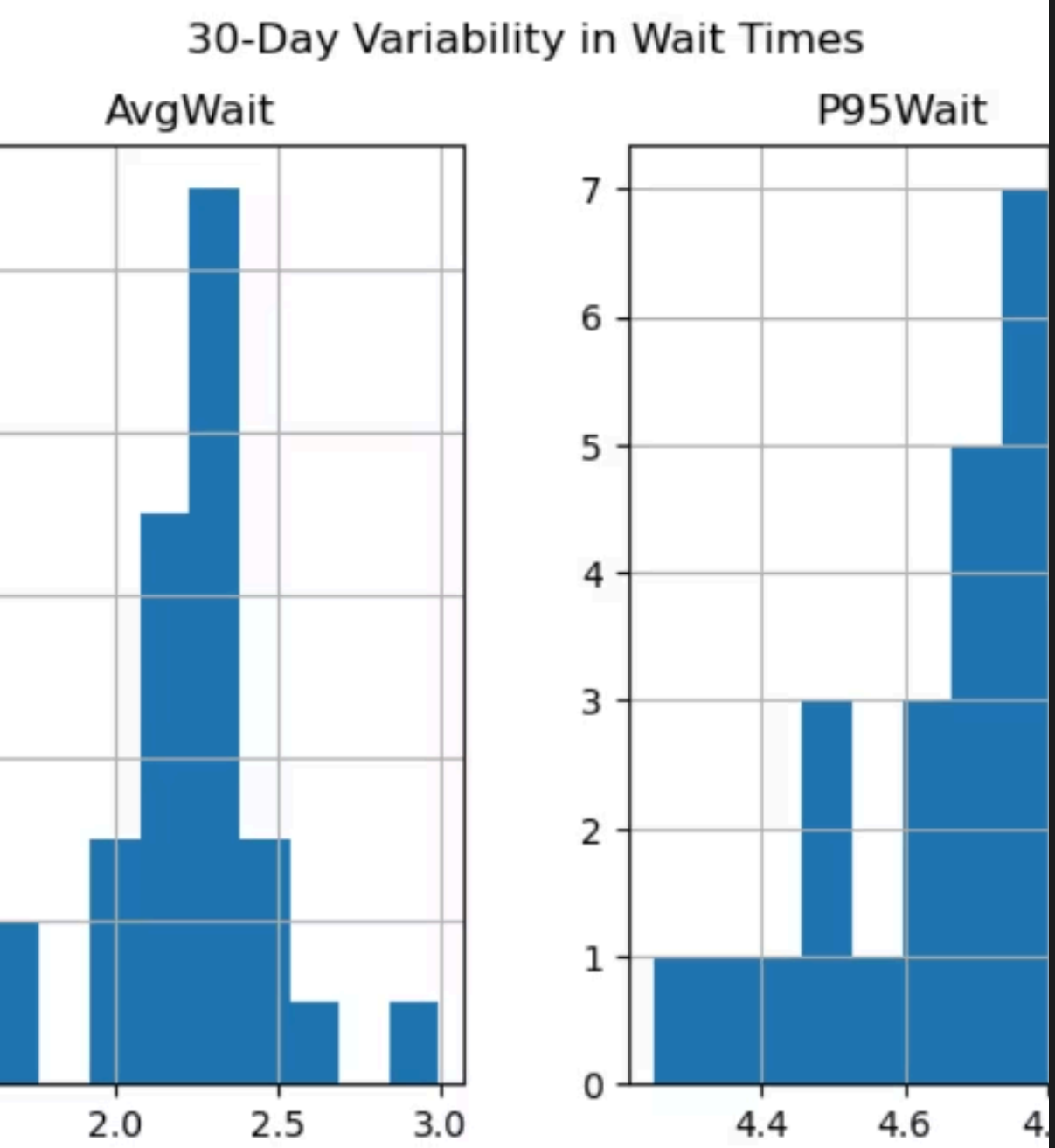
Wait Time Optimization

📊 Wait Time Results:

- Tested s = 1 to 5
- Goal: 95% of calls served within 5 minutes

✅ Found optimal number of agents to meet service level





Visualizing Wait Distributions

📈 Distribution of Wait Times:

- Compared histograms for each agent count
- Dashed line shows 5-minute threshold

Conclusion: More agents = lower wait time

Time-Varying Traffic Simulation

⏰ Realistic Traffic:

- Arrival rates change throughout the shift
- Peak hours: 30–40 calls/hour

Impact:

- Increased wait time during peak
- Need for dynamic staffing

Modeling Abandonment

🚫 Customer Abandonment:

- Customers leave if waiting more than 5 minutes
- We modeled abandonment rate & adjusted wait costs

Result:

- More agents = fewer abandonments
- Better customer satisfaction

Cost Optimization

💸 Cost Analysis:

- Agent Cost: $20/hr
- Wait Cost: $0.50/min

✅ Optimal s = [X] agents

- Balances staff cost with wait time cost
- Saves money while keeping customers happy

Daily Performance Simulation:

- Simulated 30 days using optimal staffing
- Tracked avg wait and 95th percentile each day

✅ Shows system reliability and performance risk

Final Conclusion

✅ Key Learnings:

- Queueing theory helps with realistic business simulations
- Staffing decisions must balance service and cost
- Even simple simulations reveal critical insights

This project showed how data analysis can improve real-life operations!

🛠️ Tools & Libraries:

- Python
- NumPy
- Pandas
- Matplotlib
- Seaborn (optional)