Call Center with Limited Agents

**Problem Domain**

A call center has a fixed set of agents who handle incoming customer calls. Because the arrival of calls is statistically unpredictable and staff is limited, customers often wait a long time to speak to an agent at peak call times. Agents may also be overloaded or underloaded, resulting in performance inefficiencies. A major challenge is being able to analyze how the number of agents, arrival rate, and service rate affect overall system performance. The goal is to identify bottlenecks in the system, allocate agents more efficiently, and achieve a good balance between service level and operational cost.

The system has enough complexity to model performance bottlenecks, throughput, resource utilization, latency, and scalability through simulations of various configurations and workloads.

**Data Set**

The data set is generated from a discrete-event simulation of a call center with limited agents, recording key performance metrics such as call arrival rate, service times, wait times, queue length, and agent utilization.

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| --- | --- | --- | --- | --- | --- | --- |
| **Number of Agents** | **Arrival Rate** | **Service Rate** | **Total Calls Handled (Throughput)** | **Average Wait Time (min)** | **Average Queue Length** | **Agent Utilization (%)** |
| 2 | 0.5 | 0.333333333 | 52 | 0.710282464 | 0.425 | 65 |
| 3 | 0.5 | 0.333333333 | 65 | 0.394319621 | 0.2 | 54.16666667 |
| 6 | 0.5 | 0.333333333 | 55 | 0 | 0 | 22.91666667 |
| 3 | 0.5 | 0.333333333 | 58 | 0.40682605 | 0.2 | 48.33333333 |
| 3 | 0.75 | 0.333333333 | 98 | 0.914562922 | 0.75 | 81.66666667 |
| 3 | 1 | 0.333333333 | 119 | 6.590192524 | 7.083333333 | 99.16666667 |
| 3 | 0.5 | 0.333333333 | 63 | 1.467345912 | 0.775 | 52.5 |
| 3 | 0.5 | 0.5 | 53 | 0.200115216 | 0.1 | 29.44444444 |
| 3 | 0.5 | 1 | 59 | 0.01042193 | 0.008333333 | 16.38888889 |

**Performance Objectives**

* **Minimize Response Time:** Reduce how long customers wait before their call is answered.
* **Maximize Throughput:** Increase the number of customer calls resolved per time unit.
* **Identify Bottlenecks:** Understand when and why customer calls are queued and delay service.
* **Optimize Resource Allocation:** Determine the optimal number of agents to balance cost and performance.
* **Improve Scalability:** Evaluate how the system behaves or performs as the number of agents or customer calling volume changes.