A Method for Staffing Large Call Centers Based on Stochastic Fluid Models

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This summary presentation is based on: Harrison, J. Michael, and Assaf Zeevi. "A Method for Staffing Large Call Centers Based on Stochastic Fluid Models." Stanford University, 2003.

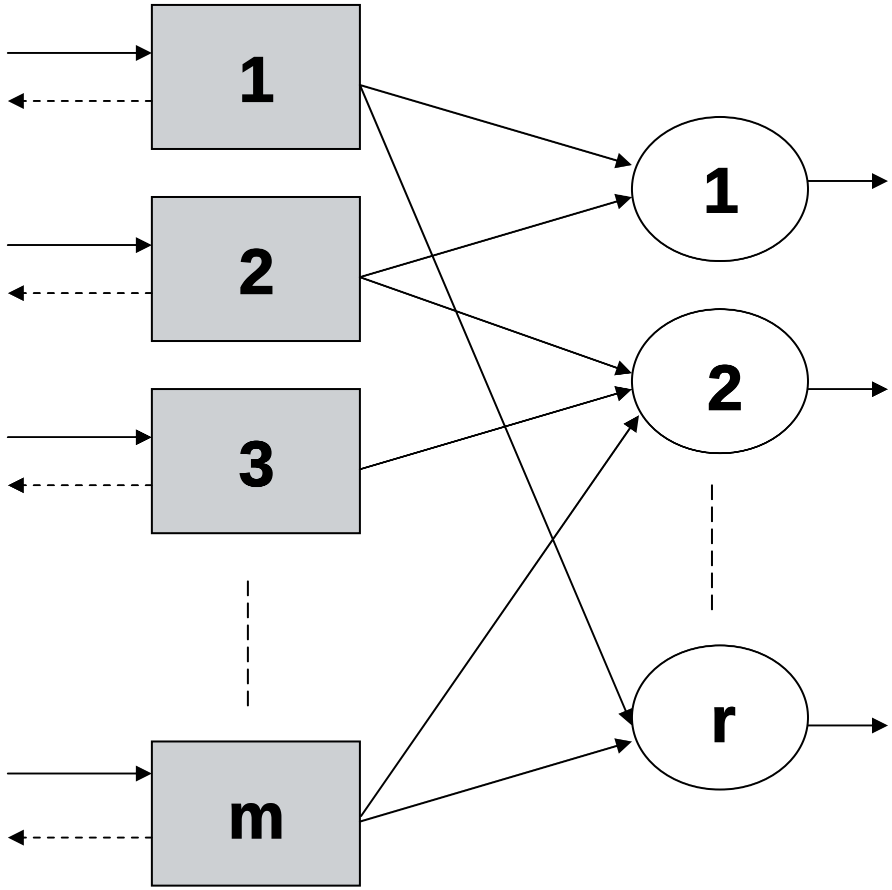
Outline

- Motivation and Problem
- Proposed Model
- Supporting Logic
- Numerical Examples
- Comments and Discussion

Motivation

- Large-Scale Call Centers
- Example: AT&T, Verizon
- Local Phone, DSL, Cell Phone, etc.
- Billing, Technical Support, Termination, etc.
- Different Agents/Servers for different types of calls
- Other examples: Banks, Insurance Companies, Dell, IBM and many others

Model



- m customer classes
- r agent pools
- b_i agents in pool i
- Service time depends on customer class and service pool

Tasks

1. Staff Scheduling/ Capacity Planning*
   - Number and types of agent pools
   - # of agents in each pools
2. Dynamic Routing
   - Customer arrival -> serve/buffer
   - Service Completion -> server idle/another customer

Assumptions

- Scale is large enough to treat variables as continuous variables
- The capacity is determined in advance and cannot be revised
- Demand is doubly stochastic Poisson
- All other uncertainty and variability are negligible compared to demand, i.e., assume everything else constant

Doubly Stochastic Poisson Model

$$\Lambda(t) = (\Lambda_1(t),\ldots,\Lambda_m(t)), 0 \le t \le T$$

Given $\Lambda(t) = (\lambda_1,\ldots,\lambda_m)$

conditional distribution of arrivals in different classes immediately after t are independent Poisson processes

Objective

- Cost c_k per agent in pool k
- Penalty p_i per abandonment call per customer for class I
- Want to select bk to minimize

$$\sum_{k=1}^{m} c_k b_k + \sum_{i=1}^{r} p_i q_i$$

Problem:

Difficult to find q_i the total expected abandonment call per class

Notations

(Please see the Harrison and Zeevi paper for notation explanations.)

Proposed Method

Given $\lambda \in \mathbb{R}_+^m$ $\quad b \in \mathbb{R}_+^r$

$$\pi^*(\lambda, b) = \text{minimize } \pi = p \cdot (\lambda - Rx)$$

$$\text{subject to: } Rx \le \lambda,\ Ax \le b,\ x \ge 0$$

Objective: minimize $c \cdot b + \mathrm{E}\left\{\int_0^T \pi^*(\Lambda(t), b)\,dt\right\}$

Let $F(\lambda) := \frac{1}{T}\int_0^T \mathrm{P}\{\Lambda(t) \le \lambda\}\,dt$ for $\lambda \in \mathbb{R}_+^m$

minimize $c \cdot b + T \int_{R_+^m} \pi^*(\lambda, b)\,dF(\lambda) =: \phi(b)$

Proposed Method

Proposition

$\phi(b)$ is a convex function on $\mathbf{R}^r_+$

- Convex Optimization problem
- Gradient-descent method combined with Monte Carlo simulation to find the numerical solution

Supporting Logic

(See section 3 on page 9 of the Harrison and Zeevi paper)

Numerical Examples

Homogenous System

(See Figure 3, Figure 4, and Table 1 on pages 15-17 of the Harrison and Zeevi paper)

Numerical Examples

Stylized Demand

(See Figures 5-6, and Tables 2-6 on pages 18-23 of the Harrison and Zeevi paper)

Comments and Critiques

- Well written paper with interesting under-research topic
- Proposed a model for skill-based routing
- Major Criticism:
  - Assume no variability in service time
  - Neglect the dependence between optimal policy and routing method -> most routing methods may only get a cost far above optimal given the theoretical policy
  - Would be more interesting if they provide some interesting results using their methods