

Resource Pooling and Staffing in Call Centers with Skill-Based Routing

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Joint work with:

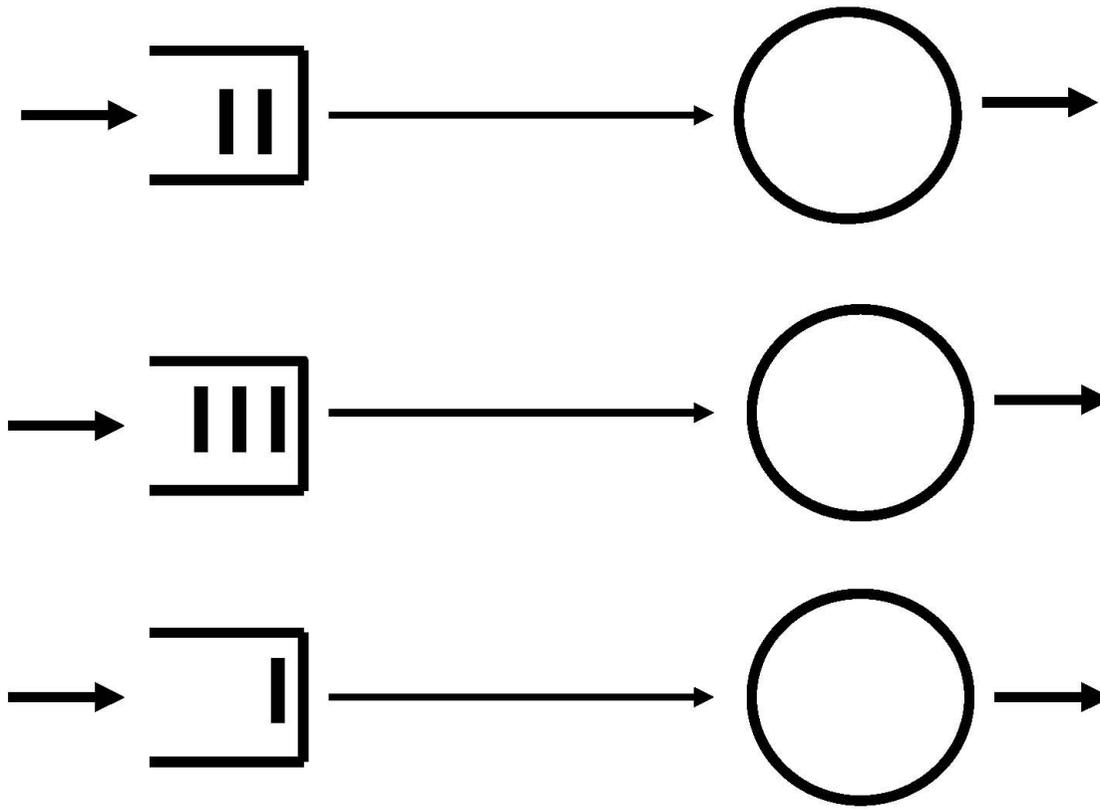
Rodney B. Wallace

IBM and George Washington University

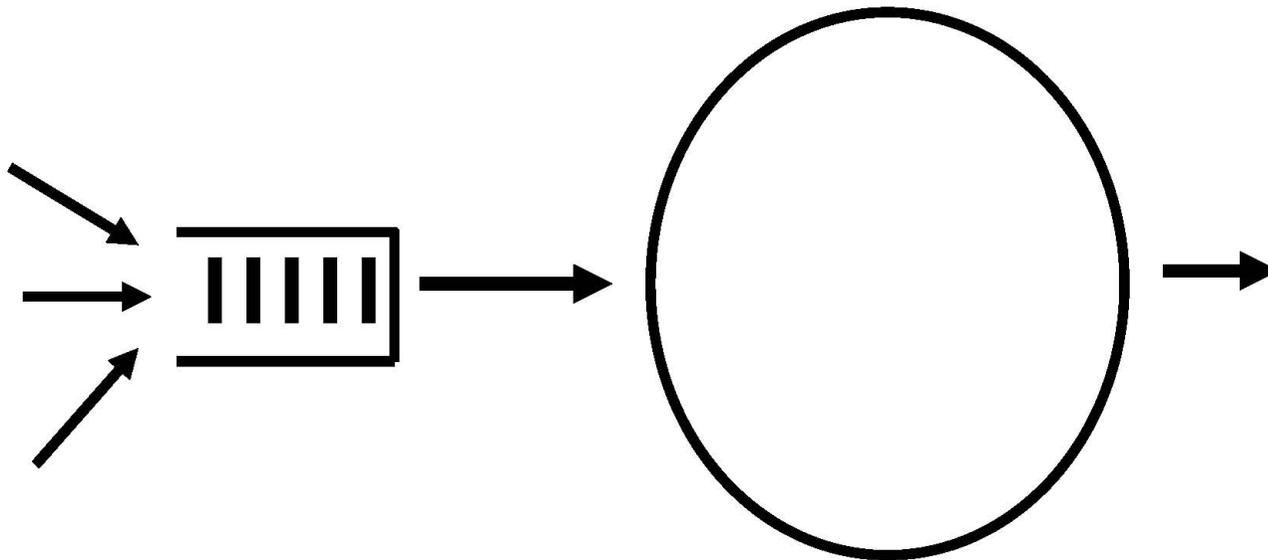
Thesis: Performance Modelling and Design
of Call Centers with Skill-Based Routing

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Mazzuchi (GW) and Ward Whitt (Columbia)

In the beginning ...



Resource Pooling for Efficiency



How to Understand?

Infinite-Server Models ($M/G/\infty$)

Offered-Load Models

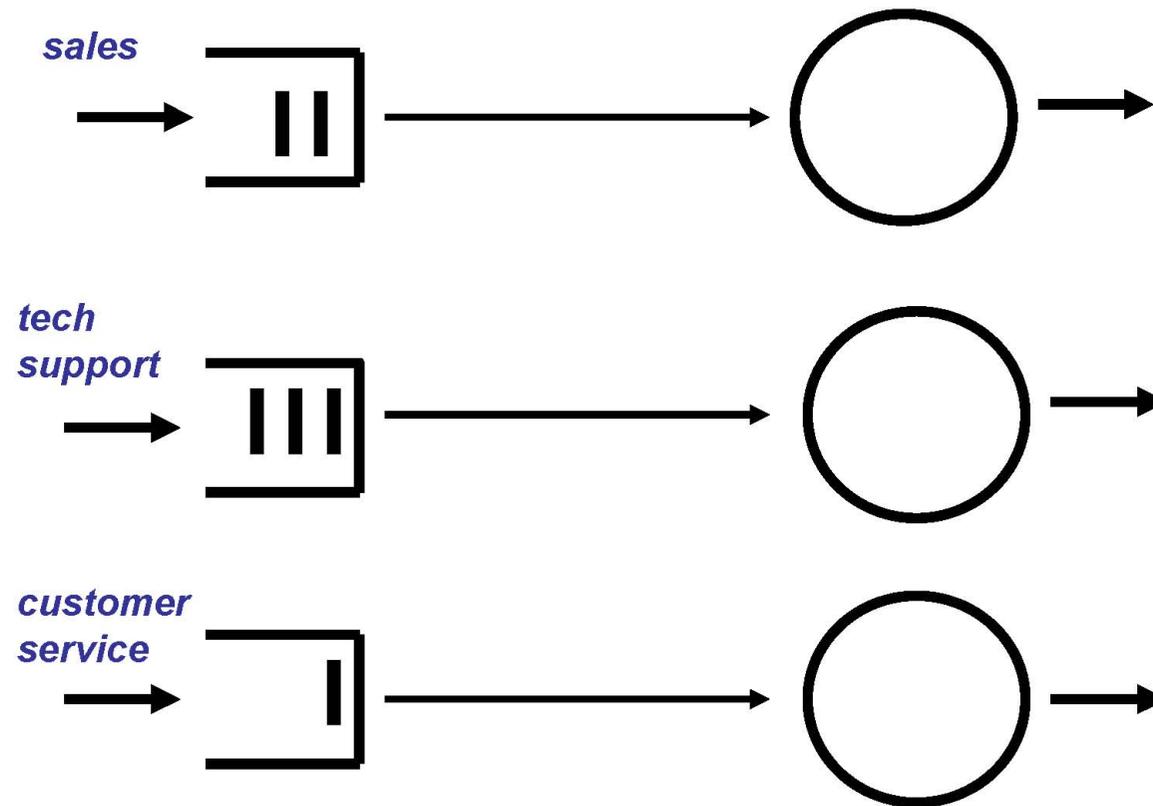
Poisson

Normal & Mean = Variance

Square-Root-Staffing Rule

Service Differentiation

Multiple Call types: Different Skills



From Load-Based Routing

Handle Calls PROMPTLY

To Skill-Based Routing

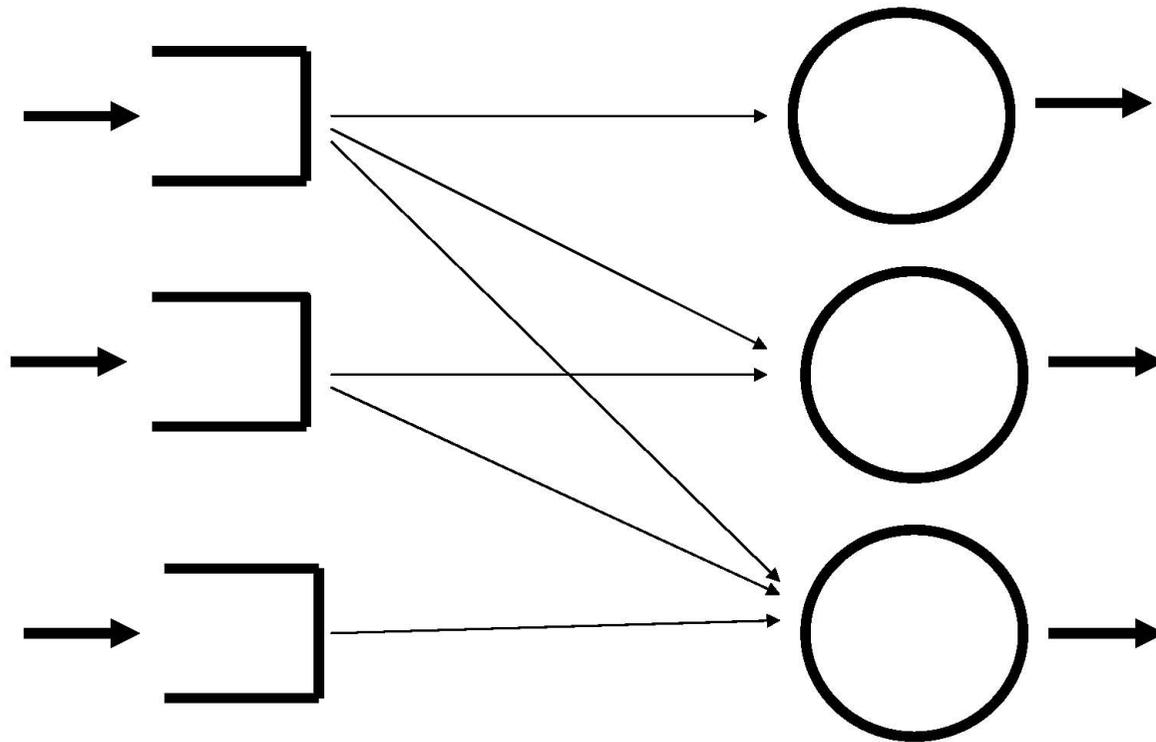
Handle Calls PROPERLY

But keep looking for efficiency

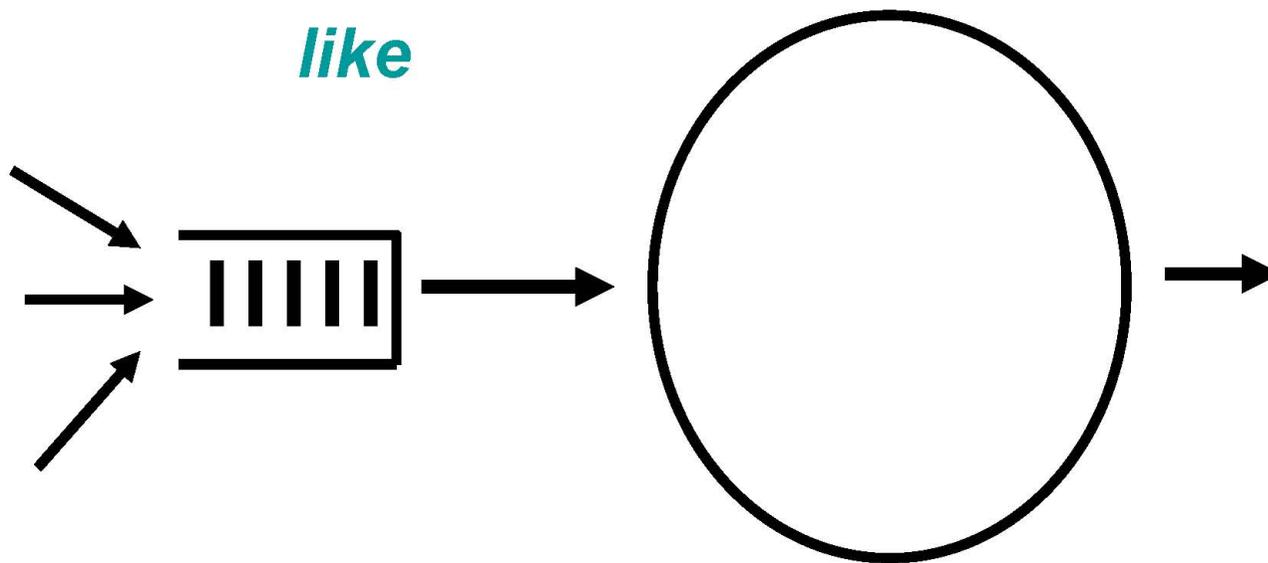
cross training

call types

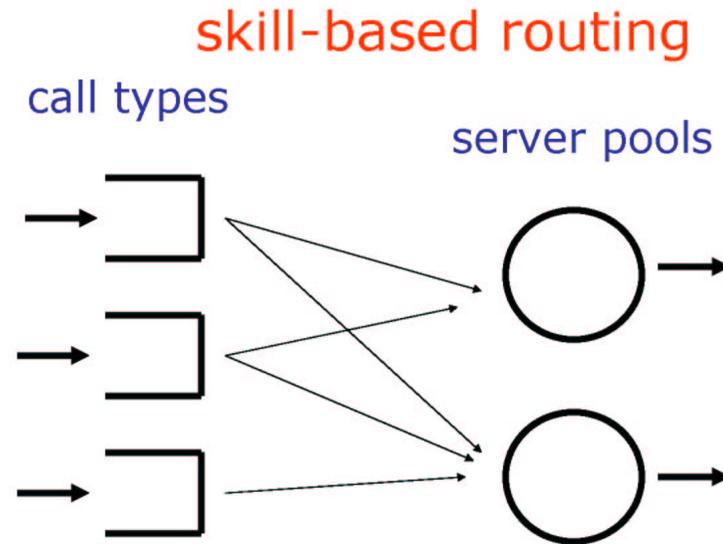
server pools



May get Resource Pooling again!!



Multiple Types of Calls and Agents



Common case: The service-time distribution does not depend on the call type or the agent.

First Contribution:

Demonstrate Resource-Pooling Phenomenon

A small amount of cross training (multiple skills) produces almost the same performance as if all agents had all skills (as in the single-type case).

Simulation Experiments

Precedents

” A little bit of flexibility goes a long way.”

Joining One of Many Queues

- Azar, Broder, Karlin and Upfal (1994)
- Vvedenskaya, Dobrushin and Karpelovich (1996)
- Turner (1996, 1998)
- Mitzenmacher (1996) and
- Mitzenmacher and Vöcking (1999)

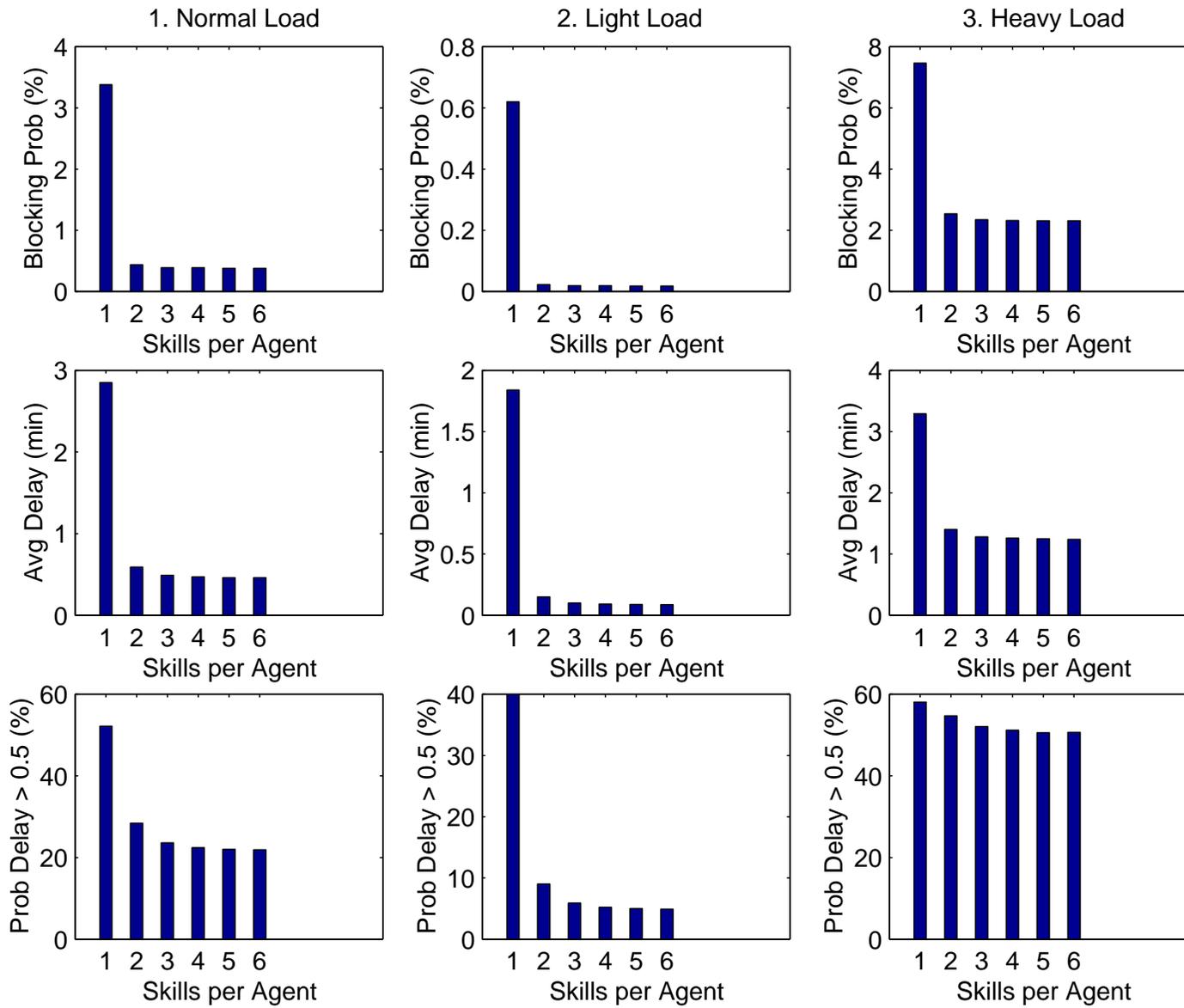
Flexible Manufacturing: Chaining

- Jordan and Graves (1995)
- Aksin and Karaesman (2002)
- Hopp and Van Oyen (2003)
- Jordan, Inman and Blumenfeld (2003)
- Gurumurthi and Benjaafar (2004)

An Experiment

Agents are given k skills, $1 \leq k \leq 6$

Three Loads: Normal (84), Light (77.4), Heavy (90)



Second Contribution:

Routing and Provisioning Algorithm

Minimize the Required Staff and Telephone Lines
While Meeting the Service level Agreement (SLA)

$$P(\text{Delay} \leq 30 \text{ seconds}) \geq 0.80$$

$$P(\text{Blocking}) \leq 0.005$$

(service level may depend on call type)

Give each agent TWO Skills

Use Static Priorities

Determining Primary Skills

$$C_k = \alpha_k + x\sqrt{\alpha_k}$$

$$x = \frac{(C - \alpha)}{\sum_{i=1}^n \sqrt{\alpha_i}}$$

and round

Determining Secondary Skills

$$C_{i,k} = \frac{C_i C_k}{C - C_i}$$

and round

Perform Local Search

Using Simulation

Performance?

Remarkable!

STOP