Optimal traffic management

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Call center workshop

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What is traffic management?

- Operational call center mgmt with as goal to obtain set objective (SL, …)
  - availability of human resources
  - deployment of human resources
- Related: adherence = extent to which agent schedule is met
- Terminology
  - Traffic management is more than managing traffic
  - Adherence is not a goal by itself
  - Better: resource “replanning”?
- Part of workforce management

Call center Workforce Management

- Workload forecasting
- Staffing
- Shift scheduling
- Traffic management

optimal WFM

- WFM steps often executed separately
  $\Rightarrow$ suboptimization
- integration staffing & scheduling
  depends on wfm tool
  sometimes excel work-around
- lack integration traffic mgmt & other steps

Outline

- Fluctuations
- Traffic management as separate activity
  - resource deployment
  - capacity decisions
- Integration in WFM

Forms of variability

Demand variability, from short to long-term:

- Poisson arrivals & random handling times
- Intra-day pattern
- Random daily volume (random arrival rate)
  - forecasting “error”
- Seasonal patterns (in week & year) & trend

Supply variability

- Shrinkage
  - many different factors
  - unpredictable

Short-term fluctuations

- Staffing for 15 or 30-minute interval: Erlang formula or simulation
- However: gives long-run average
- Here: finite intervals
- Thus: SL random
- Is this effect of importance?

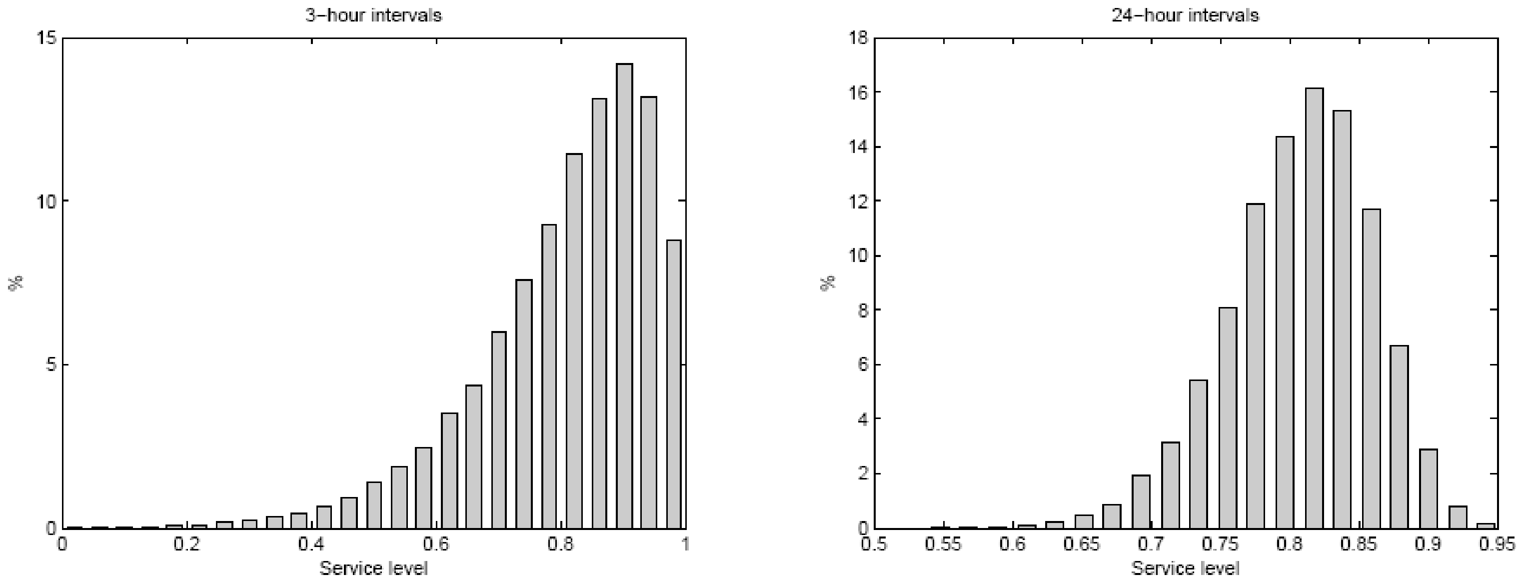
Simulation Erlang A

FC=2/min
AHT=5
patience=3
s=12
TTA=20s
empty at 0
200 runs

Length	Expected SL	10% SL quantile	90% SL quantile
1 h	83±2%	68%	97%
4 h	80±1%	71%	87%
12 h	80±1%	75%	85%
∞ (theory)	80%	80%	80%

SL distribution

- Converges to normal distribution



joint work with Alex Roubos and Raik Stolletz

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Consequence SL variability

- Always SL variability
- Consequence: traffic mgmt always necessary
  - even under perfect forecast
  - forecast = parameter Poisson process

Forecasting error

- Error in rate prediction
- Hard to differentiate from Poisson error
- FC should include uncertainty
- Uncertainty reduces over time
- Galbraith: uncertainty is info that is needed but not yet available
  - temporal aspect
- High uncertainty at scheduling moment

  $\Rightarrow$ traffic management

Variability in shrinkage

- Shrinkage includes absence (illness)
- Influences adherence
- Dealt with by traffic management

Managing resource deployment

Requires one of the following:

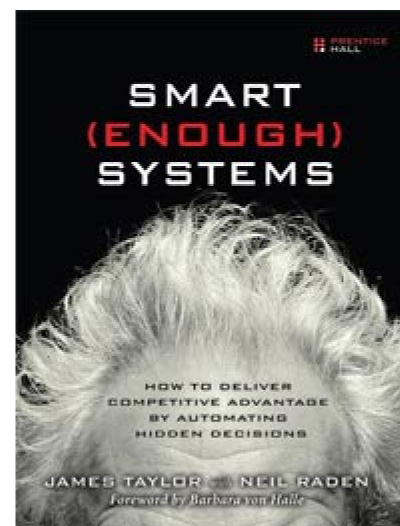
- Different channels (inbound, email, …)
- Multiple skills
- Integration front and backoffice

Smart integration channels/skills/tasks handles short and medium-term fluctuations

Integration channels/skills/tasks

- Integration channels/tasks: blending
- “Integration” skills: skill-based routing

- Requires smart systems or manual traffic mgmt
  – much to be gained by making systems smarter



Capacity decisions

- Possibility overtime
- Flexible contracts
  - when to call flexible agents?
  - humans tend to react too quickly
  - requires good rules or smart systems

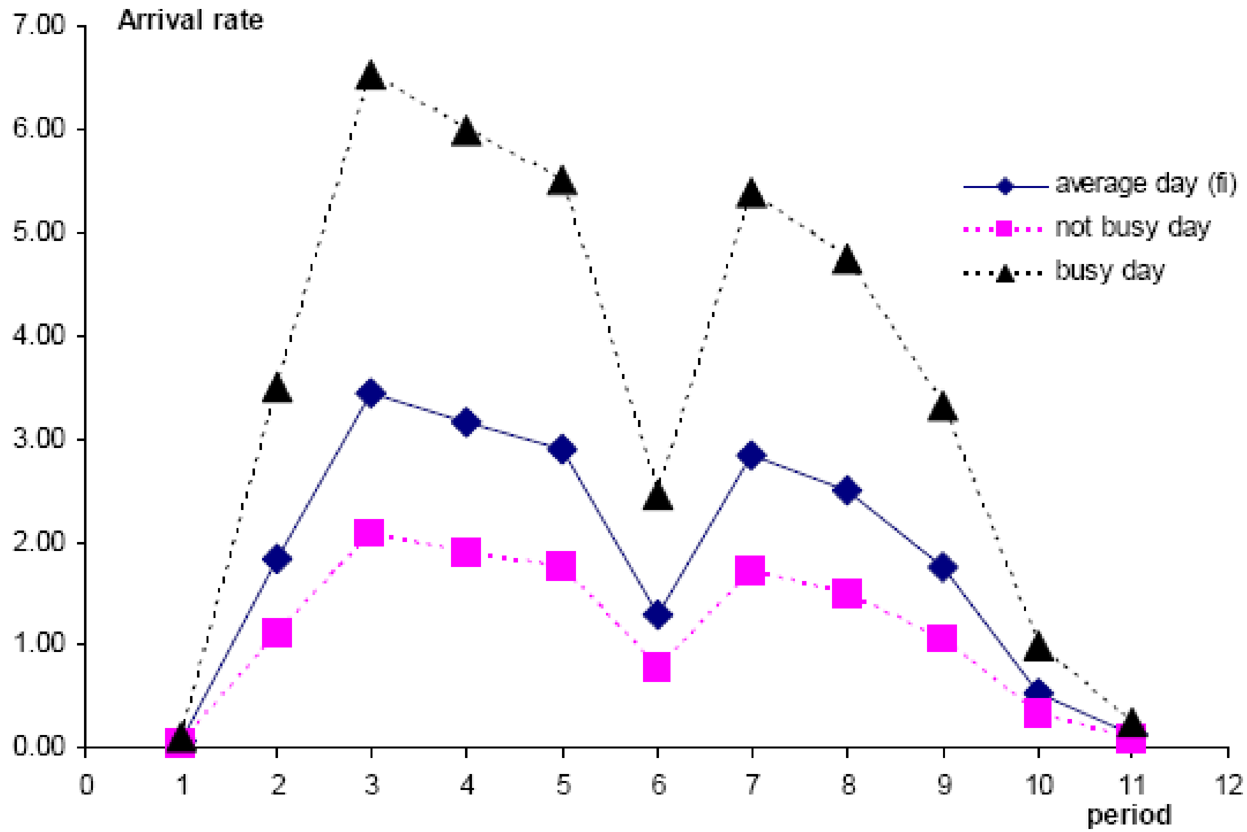
Traffic mgmt integrated

- Effective traffic mgmt only possible if sufficient flexibility was scheduled
- Shift scheduling should take variability into account
  - schedules exactly right amount of flexibility
- Current practice: no relation shift scheduling & traffic mgmt
- Remainder talk: simple model where shift scheduling takes variability into account
- Joint work with Shuangqing Liao, Christian van Delft & Oualid Jouini

Situation

- Single shift (office hours)
- Inbound & email (W hours)
- Interval i: V_i agents required for inbound
- Note: W and V_i are random
  - and highly fluctuating!
- Possibilities of email in overtime (or extra cost)

Arrival process



- Data from Dutch hospital
- High correlation within a day: doubly stochastic Poisson process

- Decision variable y = # agents
- Works on inbound until V_i
- Remaining emails done in overtime
- Costs for staffing (c /interval), understaffing (u) and overtime (r)
- Total expected costs for staffing level y:

$$C(y) = n\,c\,y + u\,E[\sum_{i=1}^{n}(V_i(\Lambda_i) - y)^+] + r\,E[W - E[\sum_{i=1}^{n}(y - V_i(\Lambda_i))^+]\,]^+$$

staffing costs

costs for understaffing (bad SL)

costs for treating email in overtime

Solution

- Theorem: C(y) is convex in y
- Simple search suffices
- Related to newsboy problem
- Lowest expected costs, but high variability
- Solutions:
  - stochastic programming with CVaR
  - robust programming

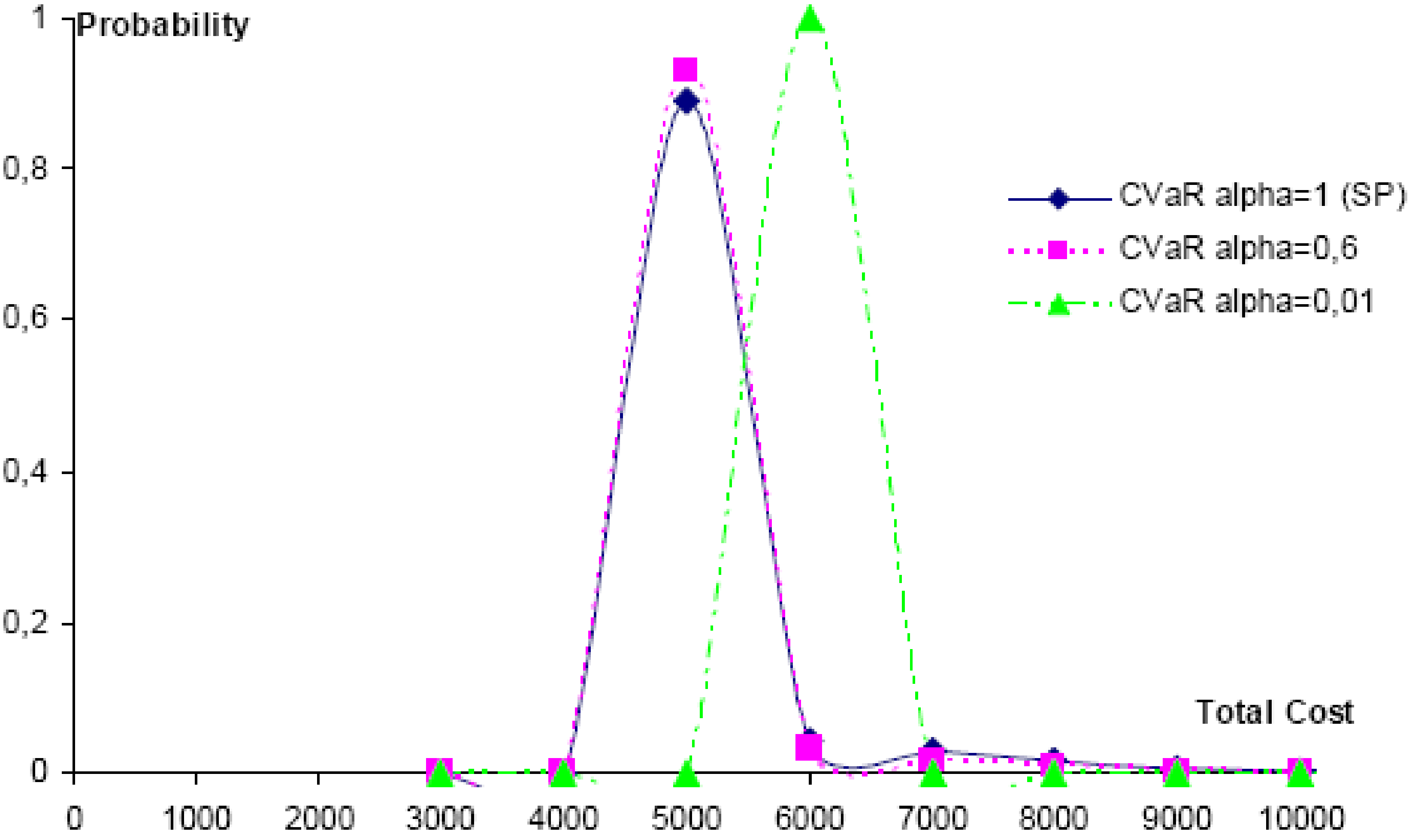
SP with CVaR

- CVaR = Conditional value at risk
  = expected value of tail with prob. α
- Disadvantage (SP with/without CVaR): computationally hard

Robust programming

- Determine uncertainty set U (subset of outcomes)
- Optimize for worst case in U
- Here: costs are increasing in inbound & email workload
  - worst case easily identified

Numerical results



Results

- PI = perfect info
- DA = det. approx.
- More agents protects against high costs

	Optimal staff y^*	Total Cost Average	Total Cost Stand. dev.
PI	—	3925.34	410.22
DA	23	4134.55	452.37
SP	23	4134.55	452.37
Cvar			
$\alpha = 1.$	23	4134.55	452.37
$\alpha = 0.8$	24	4165.50	353.26
$\alpha = 0.6$	24	4165.50	353.26
$\alpha = 0.4$	25	4238.96	258.14
$\alpha = 0.2$	26	4347.25	176.34
RP			
$k = 0.1$	24	4165.50	353.26
$k = 0.5$	25	4238.96	258.14
$k = 1.$	27	4480.67	113.23
$k = 2.$	30	4951.72	25.70
$k = 3.$	33	5445.14	4.39

Conclusions & future work

- Traffic management
  - lacks research
- Integration forecasting, scheduling & traffic management
  - improves staffing decisions
  - many possible extensions

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