Data analysis and validation of call center models

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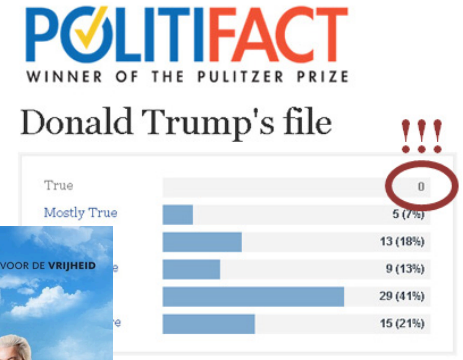
based on joint work with Sihan Ding, Siqiao Li, Rob van der Mei, and Raik Stolletz

Workshop on
Data Driven Operations Management
Eurandom, Eindhoven, 25 Oct 2016

What is data-driven OM?

- Politics is becoming fact-free...
- in the US...



- and in Holland

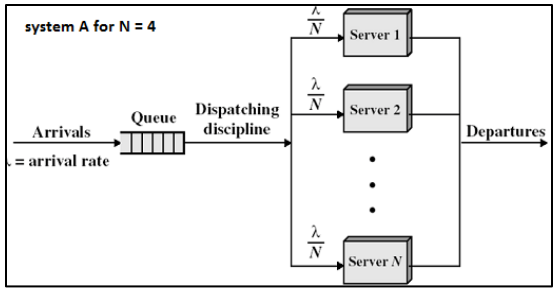
"tsunami of refugees"

data:

but also scientists lie with data!

- maths is to some extend fact-free...
- but applied science has always used facts = data
- what's new? availability of data? *big* data?
- *integration* of statistics in decision making

Why use models in call centers?



model: SL predictions

realized SL

X – 4w: planning

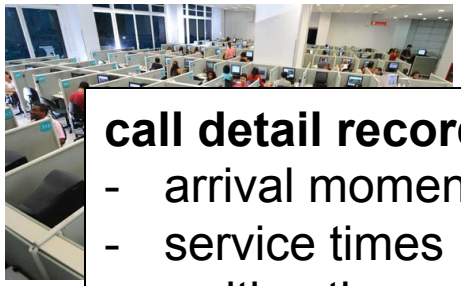
time →

eXecution

- 10M's of agents are scheduled based on SL predictions
- Question: is prediction close to realization?
- No, because parameters change (especially FC)
  - Therefore: flexibility in WF + real-time rescheduling
  - Also: validation of model is impossible
- Consequence: nobody knows if model is "correct"

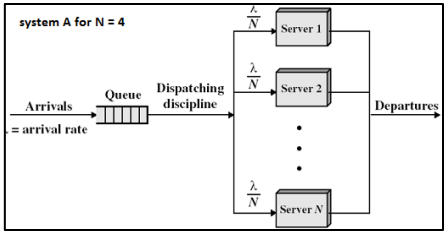
Research question

- Is prediction biased?
  - is it correct given parameter values?
- Method = compare afterwards



call detail records
- arrival moments
- service times
- waiting times

compute parameters

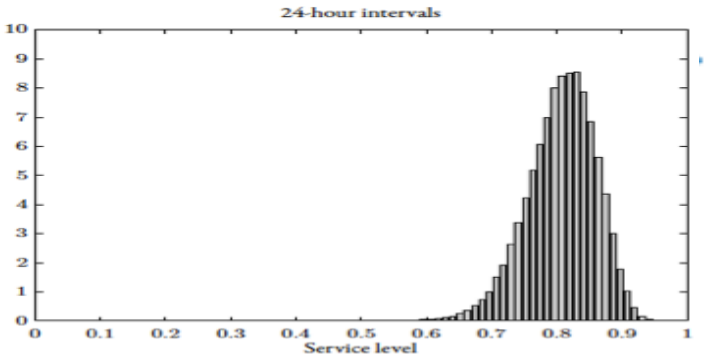


→ model-based SL

→ realized SL

- Data = 1 yr in multi-skill cc (VANAD/city of R'dam)
- Solution method = simulation

Objective



- Data gives daily SL x_t^{act}
  - No i.i.d. replications
- Model outcome = estimated daily SL = r.v. X_t^{sim}
- Goal: Estimate "model error" $w\sum_t | EX_t^{sim} - EX_t^{act} |$

$$w\sum_t | EX_t^{sim} - EX_t^{act} | \leq$$

$$w\sum_t | EX_t^{sim} - x_t^{act} | + w\sum_t | EX_t^{act} - x_t^{act} |$$

simulation

$$w\sum_t | EX_t^{act} - x_t^{act} | \approx w\sum_t | EX_t^{sim} - x_t^{sim} |$$

simulation

Models

- More than 1 model
- Options concern:
  - model for arrivals
  - handling time distribution
  - handling times agent-dependent
  - shrinkage = breaks
  - solution method (Erlang/SIPP/intra-day-sim)
  - ...

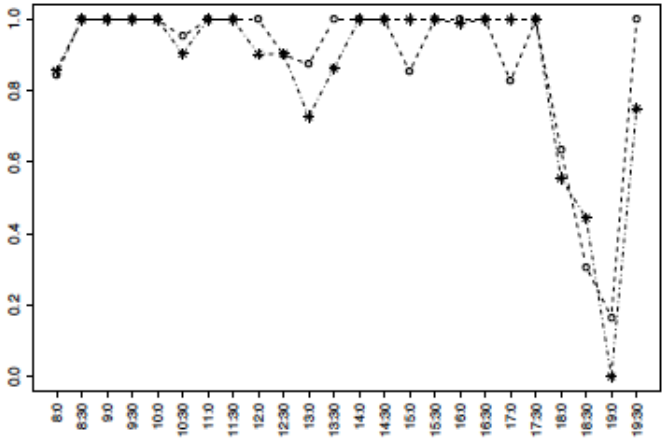
Arrival process

Options:

- Use real rate – unknown
- Use forecast – bad, not enough data
- Use actuals – cheating

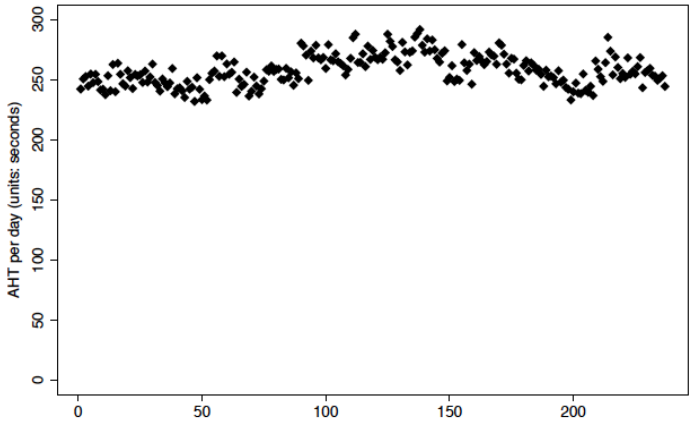
Solution:

- Use actuals and estimate impact of cheating
- By a simulation experiment with the (bad) FC

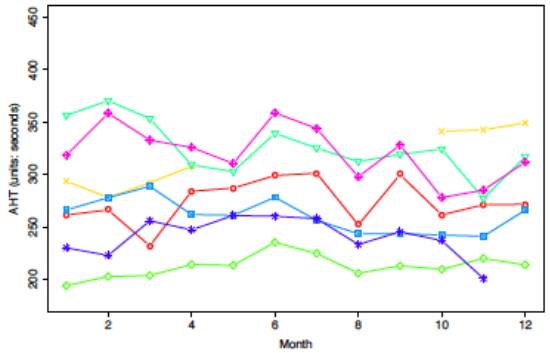


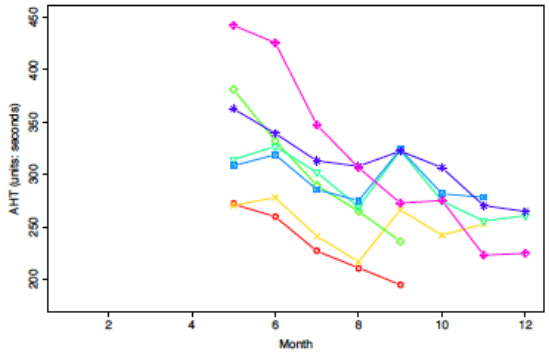
15-min SL with IPP based on rates and actuals

Results: AHT



Overall AHT fluctuates....

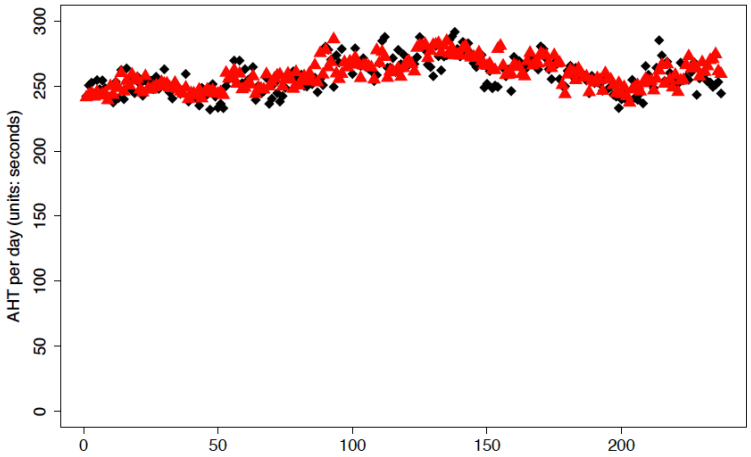




also per agent

$$\mathrm{EAHT}_{j,m_i} = \alpha_j e^{\omega_j m_i}$$

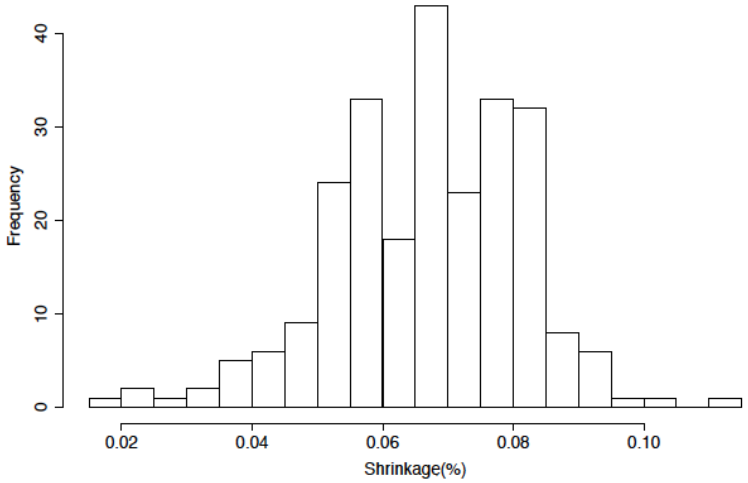
model per agent and function of time



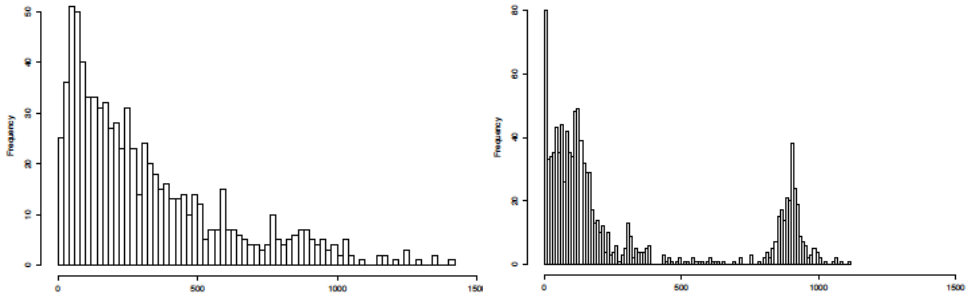
new AHT prediction (R^2 = 50%)

WAE reduction of 2.6%

Results: breaks



loss in availability due to breaks:
substantial + varies between agents



durations are also considerable and vary between agents

WAE
reduction of
5.4%

other issues looked into:

- patience
- wrap-up time
- handling time distribution

Conclusions (so far)

- Agent variability in handling times matter
- Breaks should be modeled