MAYO CLINIC

CHOIR

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CENTER FOR THE
SCIENCE of
HEALTH CARE
DELIVERY

Scheduling interval planning with time-dependent no-shows and cancellations

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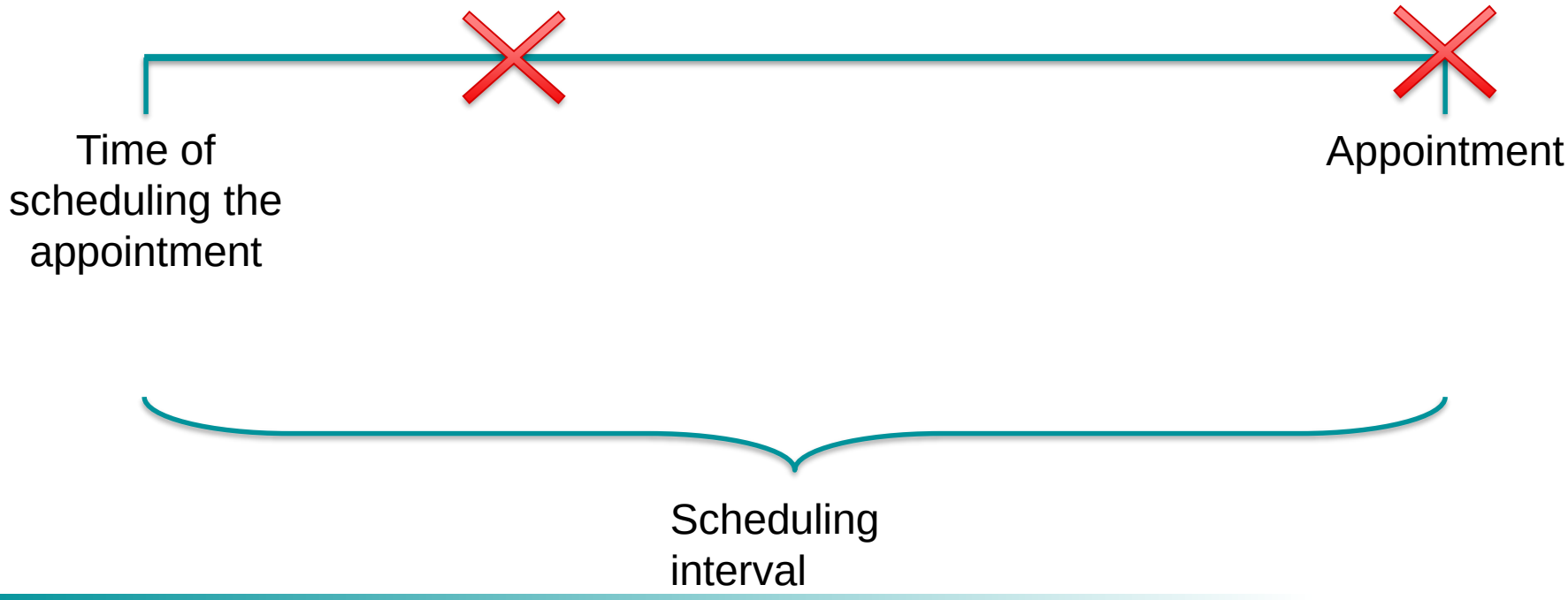
Background

- Healthcare clinics face reduced quality of care and inefficient operations due to patient no-shows and cancellations
- Strategies:
  - Influencing patient behavior, e.g., by reminders
  - Overbooking
  - Open access scheduling
  - Panel sizing
  - Limiting the scheduling interval

Data-analysis (1)

- No-show and cancellation rate depend on scheduling interval



Data-analysis (2)

- No-show and cancellation rate depend on scheduling interval

USA data

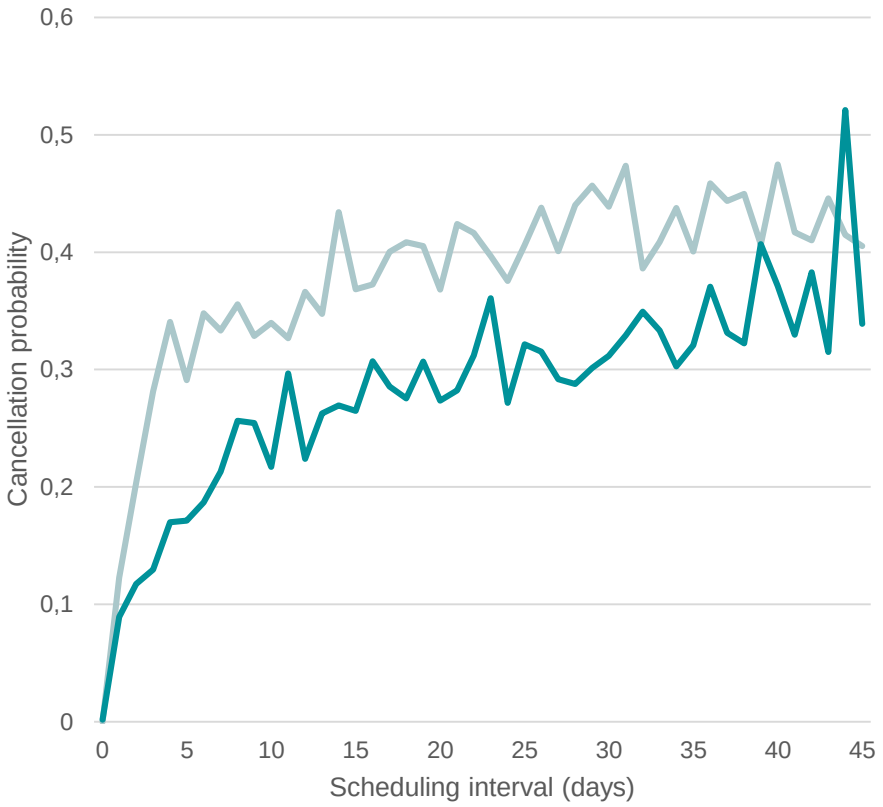
- No-show: weak positive monotonic correlation (ρ=0,344, n=61, p=0.007)
- Cancellation: strong positive monotonic correlation (ρ=0,741, n=61, p<0.001)

EU data

- No-show: weak positive monotonic correlation (ρ=0,230, n=61, p=0.230)
- Cancellation: strong positive monotonic correlation (ρ=0,877, n=61, p<0.001)

Data-analysis (3)

- Cancellation probability given the length of the scheduling interval for both institutions
- Data shows similar trend as described in the literature:

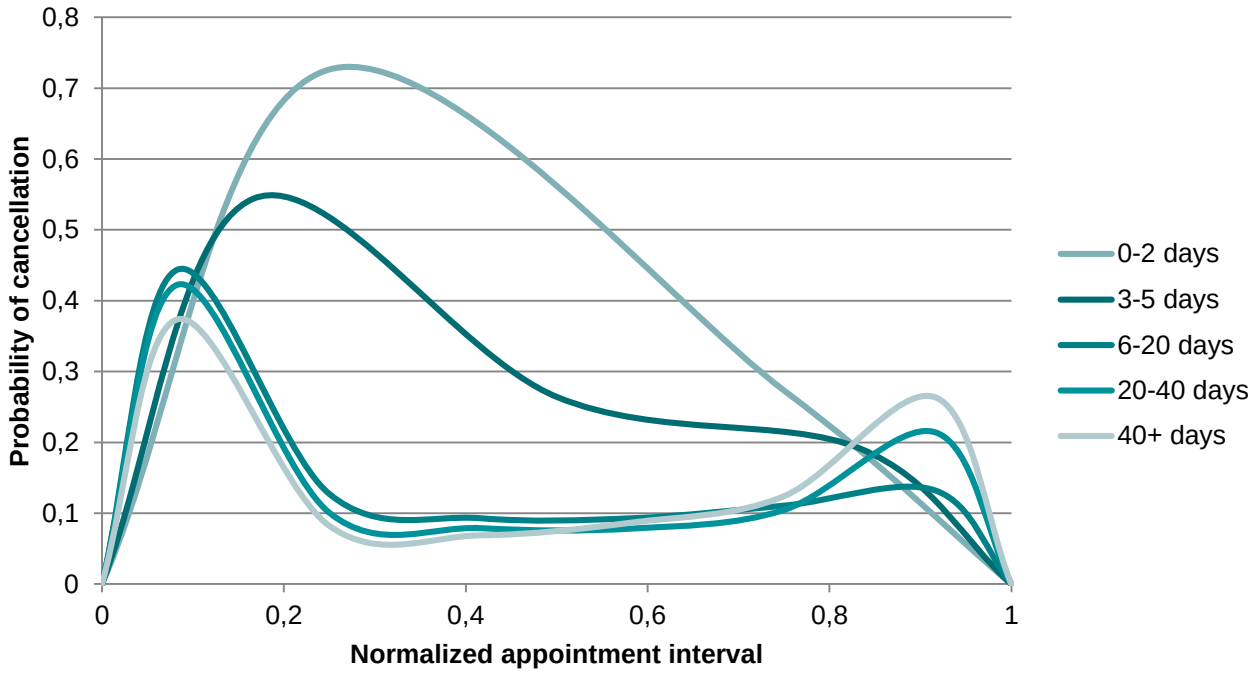


$$\chi_j = \chi_{max} - (\chi_{max} - \chi_0)e^{\lfloor -j/\mu \rfloor / C}$$

As derived from Green and Savin (2008)

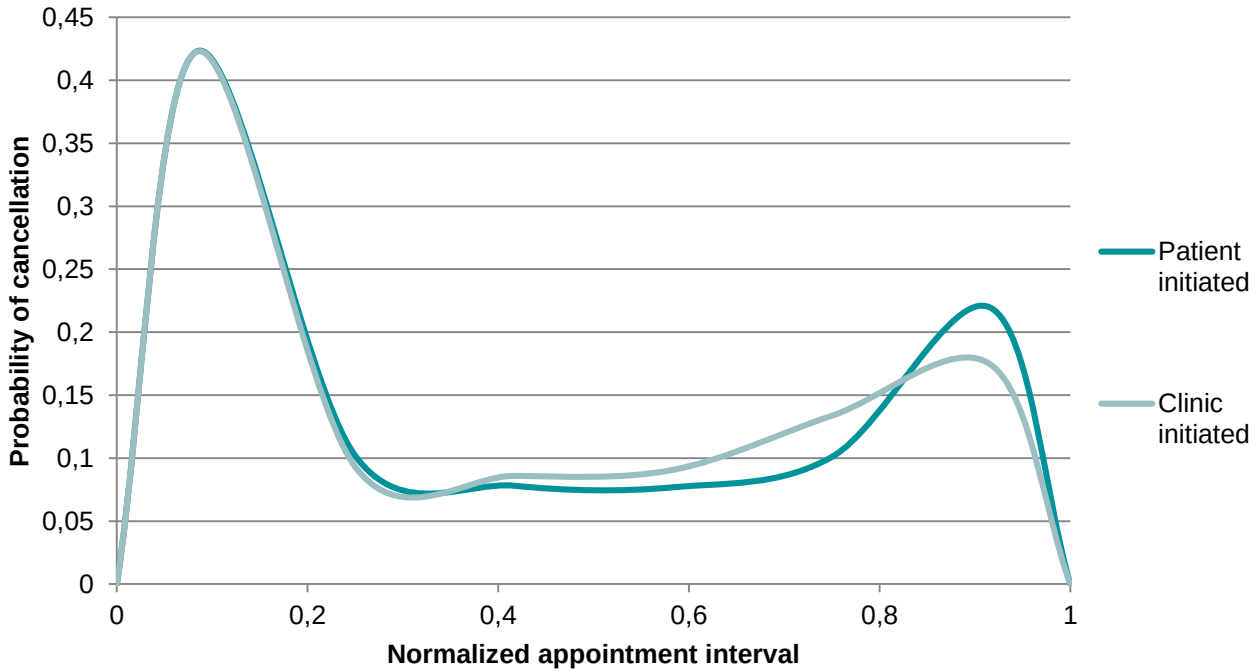
Data-analysis (4)

- The timing of cancellations within the scheduling interval is bimodal distributed



Data-analysis (5)

- Similar behavior in timing for patient and clinic initiated cancellations



Length of scheduling interval?

Open access

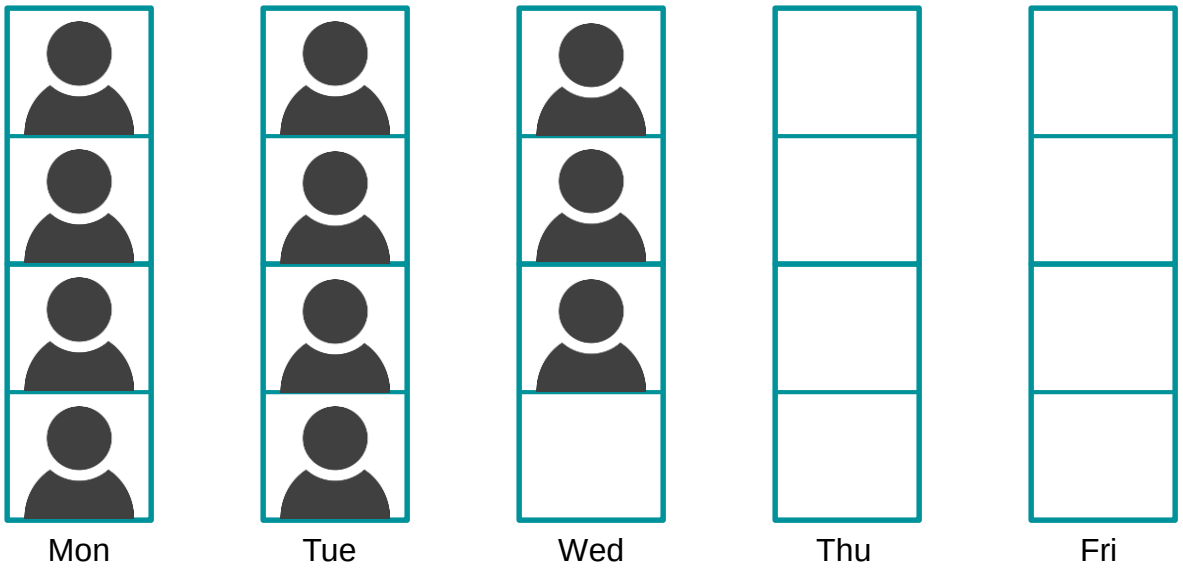
- Few no-shows and cancellations
- Increase of rejections, overtime, or need to maintain a waiting list

Unlimited

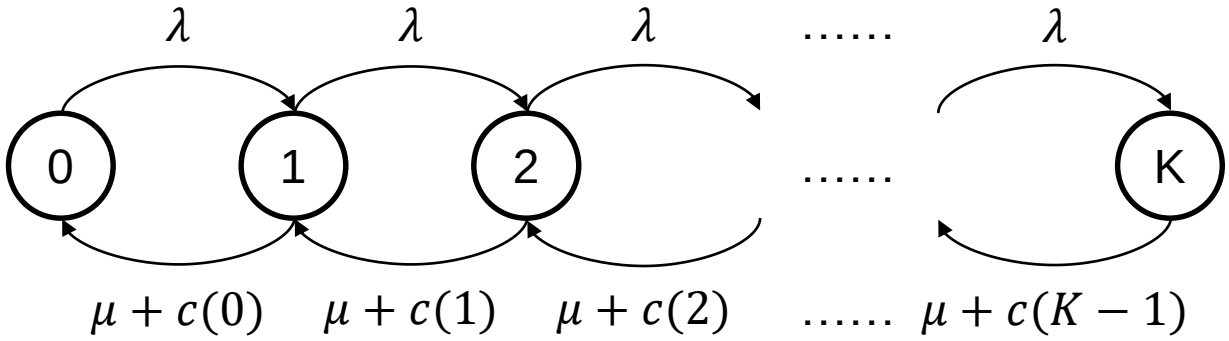
- Many no-shows and cancellations
- No rejections (but long lead times that may interrupt continuity of care)

Scheduling interval optimization model (1)

- Single-server queueing system with no-shows, regening in the queue, and balking: M/M/1/K
  - FCFS service strategy
  - Example: K = 20



Scheduling interval optimization model (2)

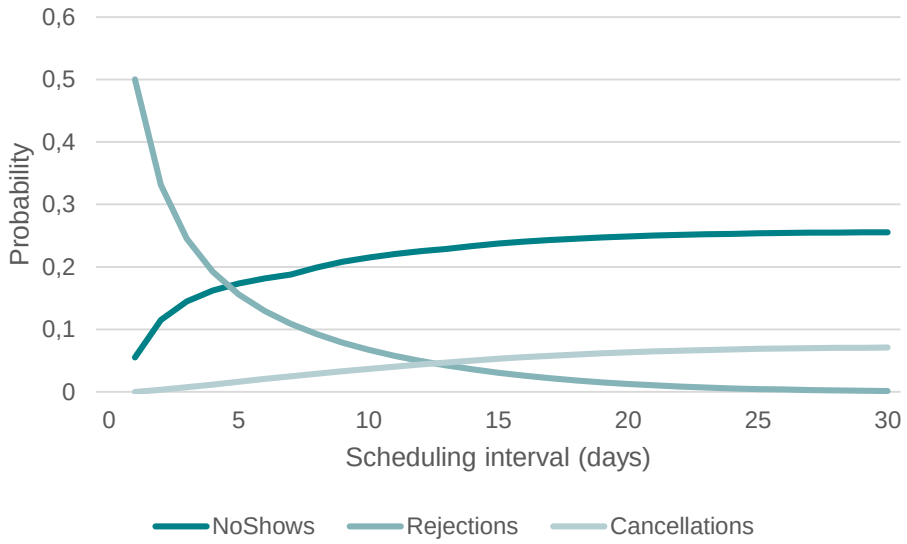


- Objective: find scheduling interval with maximal system revenue
  - Access (rejection cost)
  - Efficiency (service revenue)

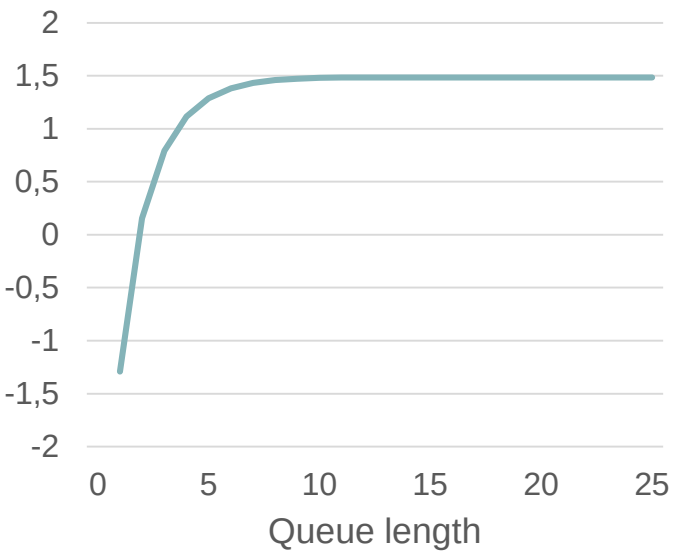
$$\mathrm{R(K)} = \lambda P_{\mathrm{s}}(\mathrm{K}) + \mu P_N(K)\theta_N - \lambda P_B(K)\theta_B - \lambda P_C(K)\theta_C$$

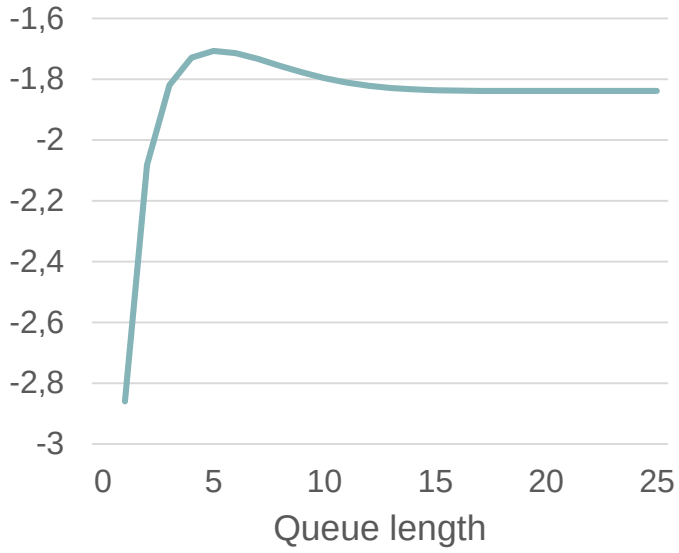
Experiments and results (1)

- Simulation model to assess assumption of time-dependent cancellation behavior and FCFS service strategy
- Experiments to assess impact of parameter variations
  - λ
  - No-show rate
  - Cancellation rate
  - Objective weights



Experiments and results (2)





- Low demand & low cancellation
- Long scheduling interval
- High demand & high cancellation
- Short scheduling interval

Conclusions

- No-show and cancellation rates are time-dependent
- Timing of cancellations is bimodal distributed
- No-show rate converges faster than cancellation rate
- Analytical model to determine scheduling interval, which is applied to EU and USA institutions

- Low demand & low cancellation?
- Long scheduling interval

- High demand & high cancellation?
- Short scheduling interval

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Thank you!