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Outpatient clinics: The viability of walk-in based policies

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Outpatient clinics: The viability of walk-in based policies

- Traditionally organized by appointments systems (Bailey 1952)

- Walk-in:
  - Eliminate access times
  - One stop shop
  - Less delay in care pathway
  - Patient centered: visit at moment of their choice
  - Less involved planning process

- Problems:
  - Not applicable for all patients
  - Uncertainty

Research question

- **Implications walk-in:**
  - **Peaks in congestion?**
  - **Idleness?**
  - **Combination?**

- **What is the viability of a walk-in based policies**

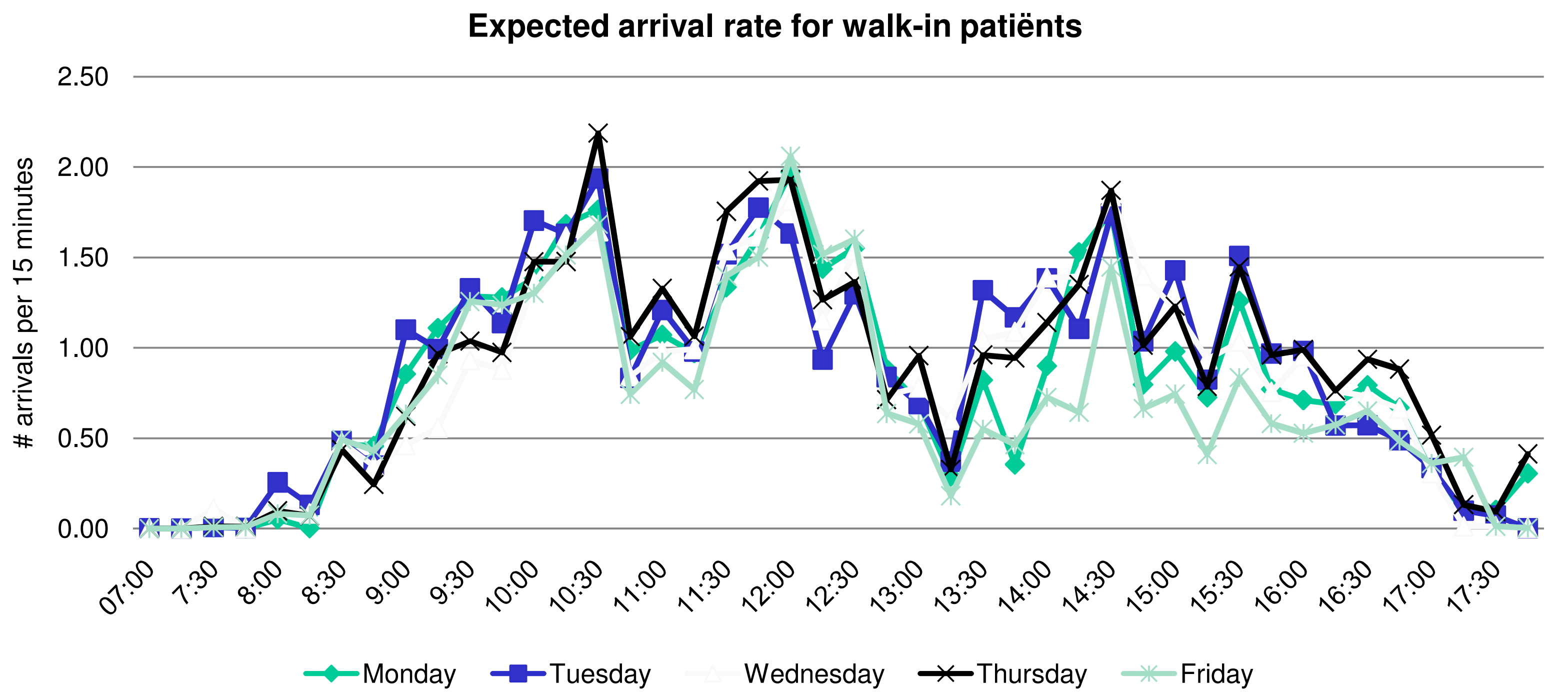
  ⇒ **What is the optimal ratio between walk-in and appointment?**

  ⇒ **What is the best agenda?**

- **Goal:**

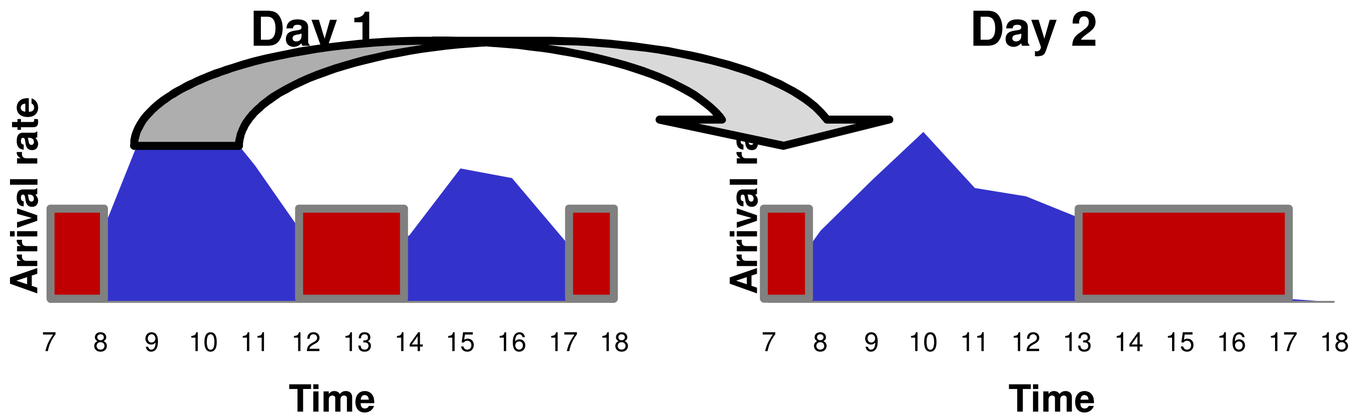
  To develop a general methodology, applicable to various outpatient clinics

Case study: CT AMC Amsterdam



Walk-in based policies

- Walk-in: non-stationary behavior at day and week level



- 1. Appointments: balance fluctuation by avoiding peaks
- 2. Walk-ins: offer an appointment when system congested

Result: cyclic policy

	Monday	Tuesday	Wednesday	Thursday	Friday
8.00					
8.15					
8.30					
8.45					
9.00					
9.15					
9.30					
9.45					
10.00					
10.15					
10.30					
10.45					
11.00					
Totaal	5	7	3	3	9

Cycle

Overview

- **Principles**
- **Goal**
- **Methodology**
- **Numerical example**

Principles

- Patients walk-in if medically possible
- If congested, patients are offered an appointment
- Earliest appointment possibility is tomorrow
- Different arrival distributions for different days

- Balance access time & waiting time by:
  - Set access time norm for appointment patients (e.g. E[*access time*] < *Y days*)
  - Given this constraint, maximize fraction of walk-ins seen directly

Goal

- **Design a methodology by which a specific outpatient clinic can decide upon its access policy, consisting of**

  1. **Percentage of walk-in patients to divert to appointment slots:** L

  2. **(a) Optimal distribution of appointment slots over period *D* (e.g. a week):**

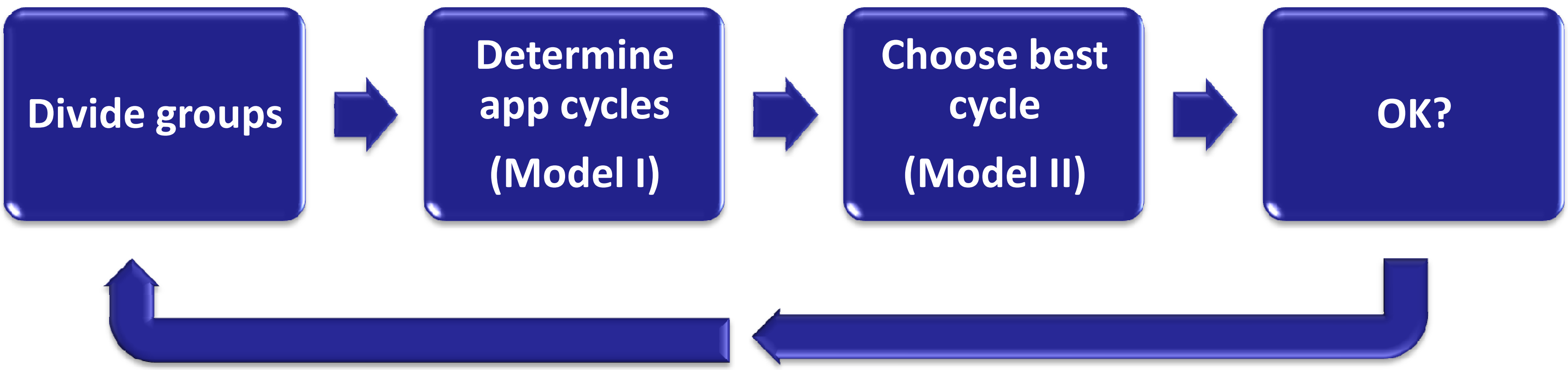
     $k_1, \ldots, k_D$

     (b) Given (a), optimal appointment day schedule

  which satisfies access time norm for appointment patients and minimizes L

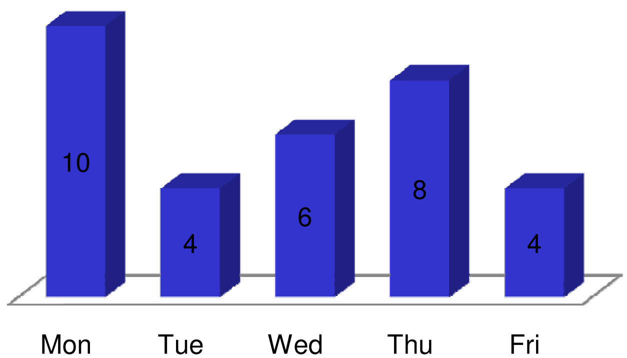
Methodology

- **Model I** Access process to outpatient clinic
- **Model II** Day process at outpatient clinic
- **Algorithm** Optimization combination walk-in / appointment



Model I: Access Process

- **Cycle Length** D
- **Daily capacity**



- **Daily demand (Poisson)** $\lambda_1, \ldots, \lambda_D$
- **Consult duration** **1 slot**

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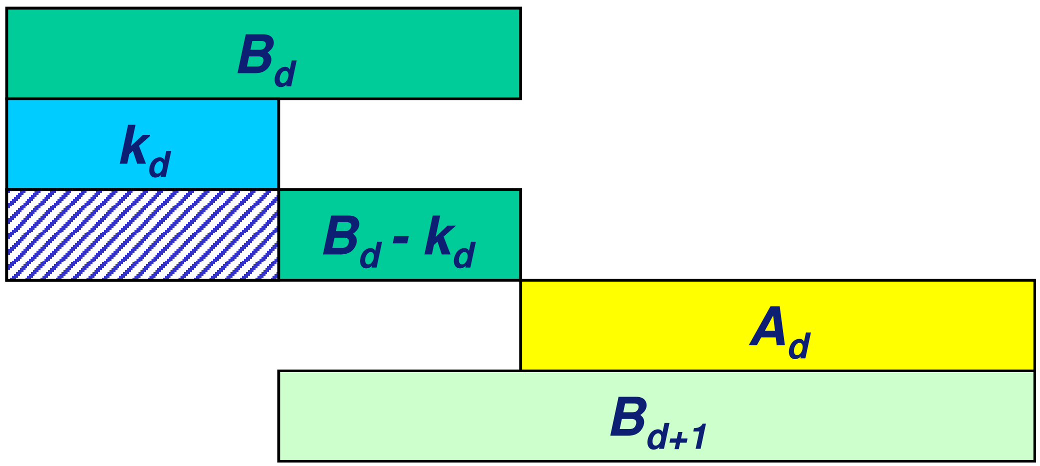
Model I: Access Process

- **Backlog at start of day *d+1***



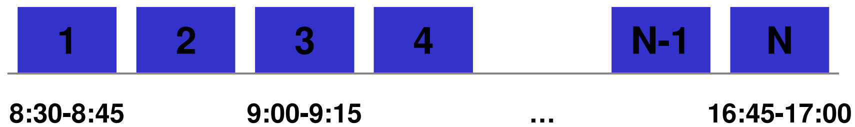
Model I: Access Process

- **Lindley-type equation** $$B_{d+1} = (B_d - k_d)^+ + A_d$$
- **Ger**
- **Equ**
- **Per**

$$P_{B_d}(z) = P_{A_{d+D-1}}(z) \times G^{-1} \times \left[\sum_{i=1}^{D} \sum_{q=0}^{k_{d+D-i}-1} (1 - z^{q-k_{d+D-i}}) \pi_{d+D-i}(q) \left(\prod_{r=1}^{i-1} z^{-k_{d+D-r}} \prod_{j=1}^{i-1} P_{A_{d+D-j-1}}(z) \right) \right]$$

Model II: Day Process

- **Time slots**



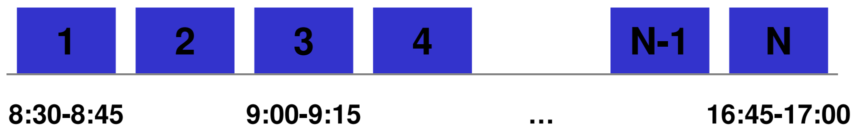
- **2 types of patients** *Appointment / Walk-in*
- **Consult duration** **1 time slot**
- **Number of facilities** *F*
- **Arrivals** *Appointment according to schedule*

$$Z = (z_1, \ldots, z_{N-1})$$

Walk-in according to Poisson process with rates

$$\Gamma = (\gamma_1, \ldots, \gamma_{N-1})$$

Model II: Day Process



- Walk-in patients are willing to wait *X* time slots, otherwise *"LEAVE"*
- Appointments get priority over walk-in patients
- Calculate performance by evaluating Markov Process
- Main performance indicator

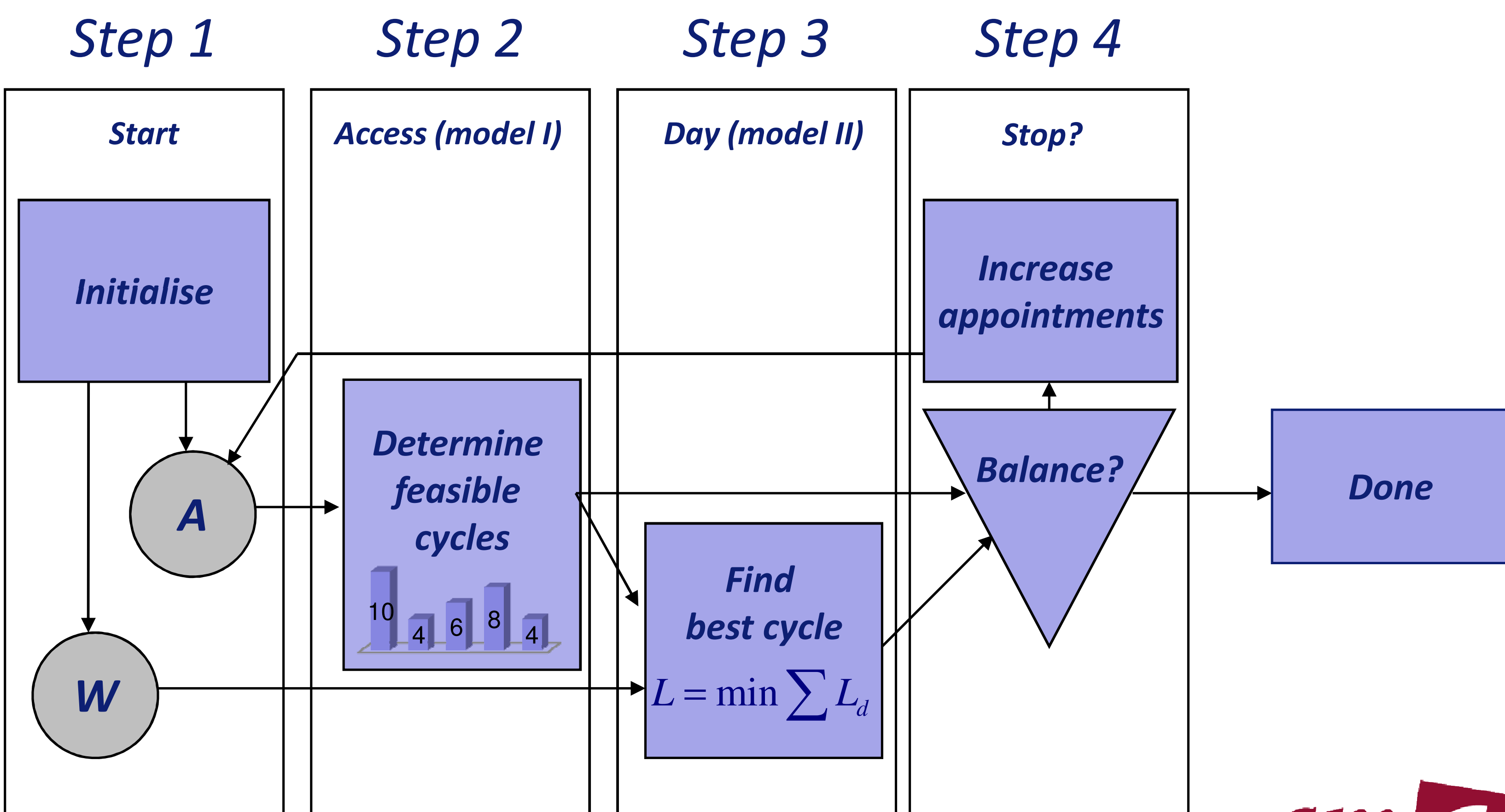
$$L = E[\text{number of walk-in patients to not seen/treated}]$$

Algorithm (prelude)

- Connect model I and II
- Possibility not all appointment slots are used
  - From model I we know the probabilities of using appointment slots: $\pi_d(0),\ldots,\pi_d(k_d)$
  - Evaluate day process for all realizations => $L_d^{\,j}$
- Result: expected number of patients leaving at day *d*

$$L_d = \sum \pi_d(j) \cdot L_d^{\,j}$$

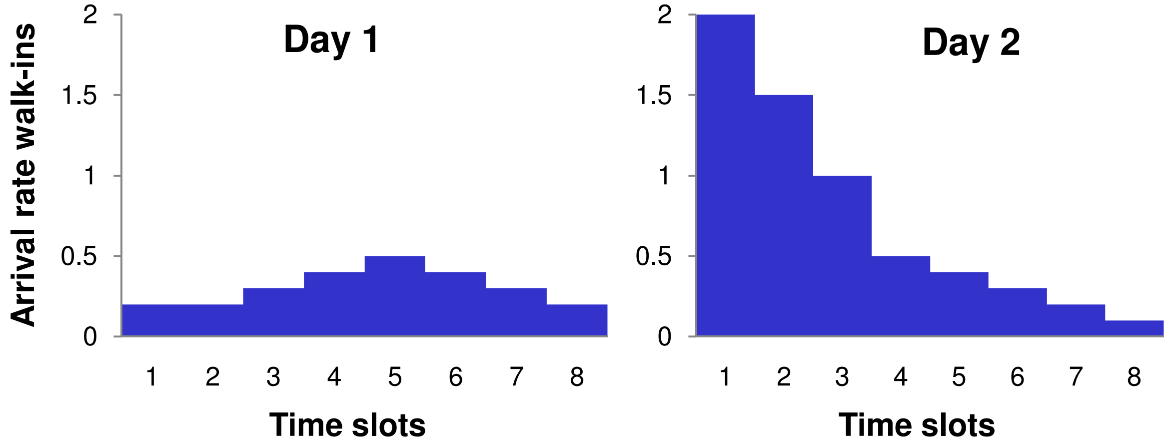
Algorithm


Step 1
Step 2
Step 3
Step 4
Start
Access (model I)
Day (model II)
Stop?
Initialise
Increase appointments
A
Determine feasible cycles
10
4
6
8
4
Balance?
Done
Find best cycle
$L = \min \sum L_d$
W

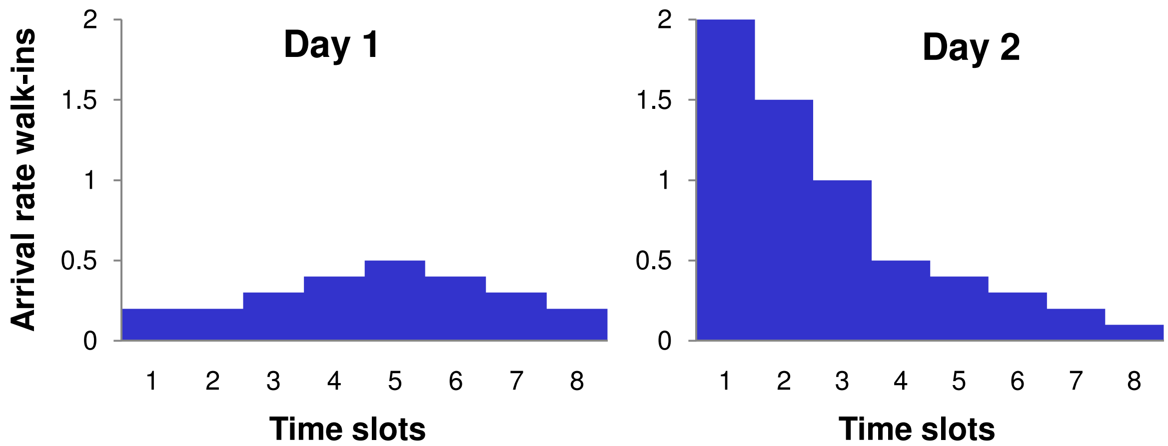
Example

- Cycle Length — 2 days
- Time slots per day — 8
- Facility capacity — 1
- Demand for appointments — $\lambda_1 = \lambda_2 = 2$
- Patience of walk-ins — 2 time slots
- Access time norm — average <3 days

Example

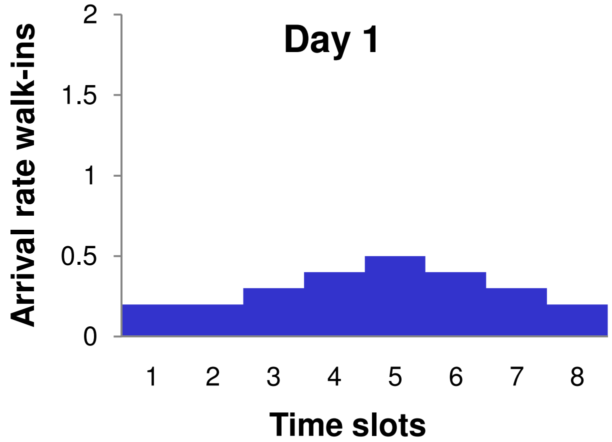

Arrival rate walk-ins
Day 1
Day 2
0
0.5
1
1.5
2
1 2 3 4 5 6 7 8
Time slots
Time slots

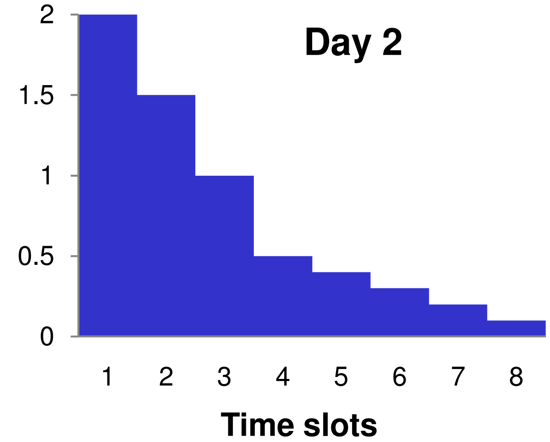
Example



Iteration	Planned	Shifted	BestCycle	Leaving	Total	Schedule day 1								Schedule day 2							
1	(2, 2)	(0, 0)	(4, 1)	(0.24, 0.88)	1.12	1	0	1	0	0	1	0	1	0	0	0	0	0	0	1	0

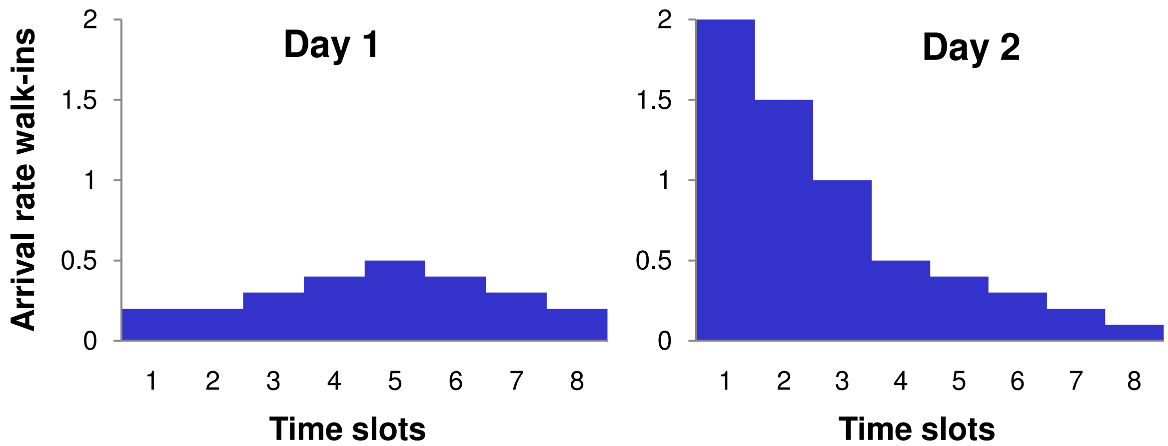
Example





Iteration	Planned	Shifted	BestCycle	Leaving	Total	Schedule day 1								Schedule day 2							
1	(2, 2)	(0, 0)	(4, 1)	(0.24, 0.88)	1.12	1	0	1	0	0	1	0	1	0	0	0	0	0	0	1	0
2	(2.24, 2.87)	(0.24, 0.87)	(4, 2)	(0.28, 0.98)	1.26	1	0	1	0	0	1	0	1	0	0	0	0	0	1	1	0

Example



Iteration	Planned	Shifted	BestCycle	Leaving	Total	Schedule day 1								Schedule day 2							
1	(2, 2)	(0, 0)	(4, 1)	(0.24, 0.88)	1.12	1	0	1	0	0	1	0	1	0	0	0	0	0	0	1	0
2	(2.24, 2.87)	(0.24, 0.87)	(4, 2)	(0.28, 0.98)	1.26	1	0	1	0	0	1	0	1	0	0	0	0	0	1	1	0
3	(2.28, 2.98)	(0.28, 0.98)	(4, 2)	(0.28, 0.98)	1.26	1	0	1	0	0	1	0	1	0	0	0	0	0	1	1	0

To conclude

- Cyclic schedule that maximizes walk-ins seen same day
- Exponential service time, emergencies, no-shows and planned absence of server can be incorporated
- Tool by which management can evaluate trade-off
- Practice:
  - Estimate expected walk-in pattern
  - Constantly monitoring walk-in pattern
  - Monitoring patience of walk-in patients

	Maandag	Dinsdag	Woensdag	Donderdag	Vrijdag
8.00					
8.15					
8.30					
8.45					
9.00					
9.15					
9.30					
9.45					
10.00					
10.15					
10.30					
10.45					
11.00					
Totaal	5	7	3	3	9

Questions?

- **CHOIR:** *Center for Healthcare Operations Improvement & Research*

  http://www.choir.utwente.nl

- **Online Bibliography OR & Health Care “ORchestra”:**

  http://www.choir.utwente.nl/en/orchestra

- **E-mail:**

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