Scheduling Emergency Room Doctors

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IEOR E4450: Production Scheduling

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Outline

- The Problem
  - Dataset
- Our Approach
  - Setup & Approach
  - Code
  - Simulation & Scheduling
- Results & Analysis
- Closing Remarks

1

The Problem

What is the optimal dispatch rule for scheduling doctors in the emergency room given different objectives.

Dataset

Emergency Department Attendances, Admissions, and Admissions by Triage for 1 June 2013 - 30 June 2014

- **The ED (emergency department)**: a hospital or primary health care service that provides initial treatment to patients with a broad spectrum of illnesses and injuries, some of which may be life-threatening and require immediate attention. EDs provide rapid assessment and management of critical illnesses.
- **After initial assessment and treatment**, patients are either admitted to the hospital, stabilised and transferred to another hospital for various reasons, or discharged (Australasian College of Emergency Medicine).
- **Upon arrival in the ED**, people usually undergo a brief triage, or interview, to help determine the nature and severity of their illness. Individuals with serious illnesses are then seen by a physician more rapidly than those with less severe symptoms or injuries.
- **The data includes** patient attendances, admissions and admissions by Triage for 1 June 2013 to 30 June 2014.
- **367 days, 547,668 patients**

Dataset

Royal Perth Hospital

Date	Attendance	Admissions	Tri_1	Tri_2	Tri_3	Tri_4	Tri_5
1-Jul-13	235	99	8	33	89	85	20
2-Jul-13	209	97	N/A	41	73	80	14
3-Jul-13	204	84	7	40	72	79	6
4-Jul-13	199	106	3	37	73	70	15

Attendances - the number of patients recorded as arriving at a public emergency department.

Admissions - the number of patients who are subsequently admitted to the hospital for care and/or treatment.

Triage categories are allocated to each patient based on an assessment of their presenting conditions, generally by the triage nurse, with triage 1 being the most urgent and triage 5 being the least urgent. (Triage 1: Resuscitation- immediate, within seconds; Triage 2: Emergency- within 10 minutes; Triage 3: Urgent- within 30 minutes; Triage 4: Semi-urgent- within 60 minutes; Triage 5: Non-urgent - within 120 minutes). N/A - Values is less than 3 and has been suppressed.

2

Our Approach

How we went about solving the problem.

Problem Setup and Approach

- **Create a scheduling problem from the dataset by simulating patient arrivals, processing times, and due dates**
- **Terms:**
  - Machine = emergency room doctor for that hospital
  - rj = patient arrival times to the emergency department
  - pj = (.6 – triage number)
  - dj = rj + pj + triage type
- **Objective:**
  - Minimizing number of late jobs
  - Minimizing average late jobs
- **Scheduling Algorithms Used:**
  - Earliest due date (EDD)
  - Shortest processing time (SPT)
- **Assumptions:**
  - Doctors are unable to preempt patients
  - 10 doctors working at each hospital

Patient	Triage type	pj	rj	dj
1	THREE	0.3	0.1	0.9
2	THREE	0.3	0.2	1
3	THREE	0.3	0.3	1.1
4	FOUR	0.2	0.3	1.5

The Code

Simulation.java

- Runs simulation
- Determines schedules
- Provides schedule analysis and relevant metrics

Patient.java

- Initial data store:
  - Name
  - Type
  - Arrival Time
  - Due Date
  - Processing Time

CompletedPatient.java

- Represents a processed patient:
  - Completion Time
  - Doctor Number
  - All Patient fields

Simulation + Scheduling

Reading Hospital Data

- Standard File input/output protocols
- Provides the foundation for the arrival rate calculation

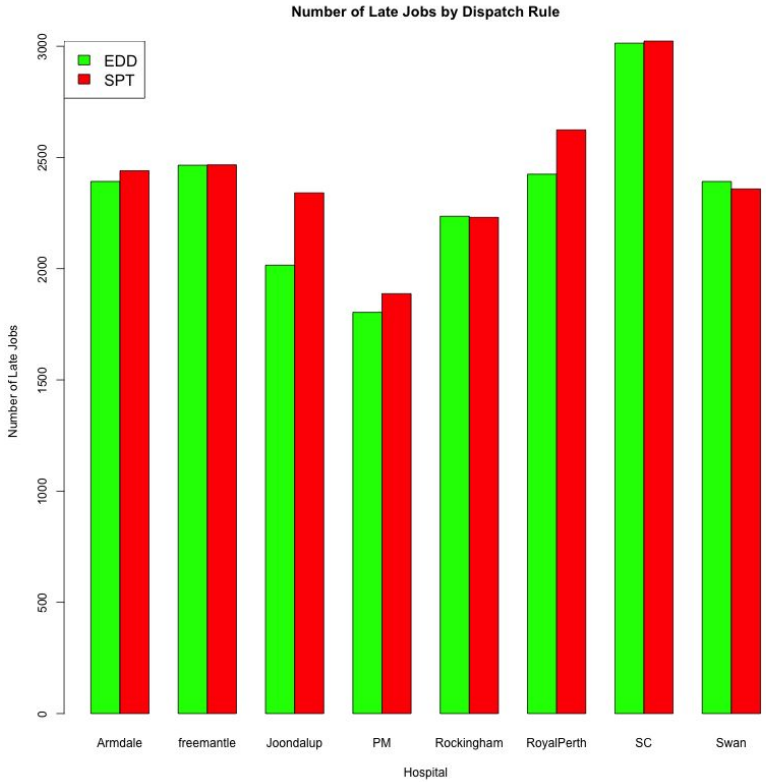
Simulation

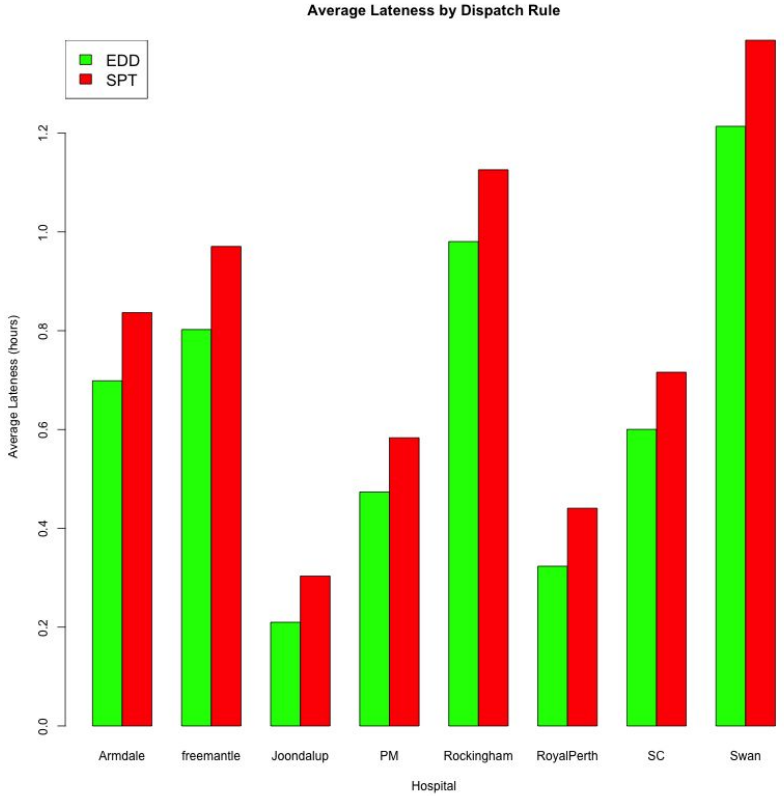
- Poisson arrivals with dynamic arrival rate
- Generates a new patient with relevant attributes

Scheduling

- EDD, SPT
- Discretized time to 0.1 intervals
- Customized PriorityQueue
- Tracks a (Doctor, Patient) pairing as time continues

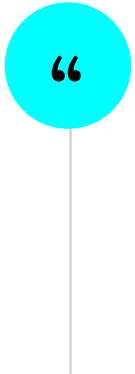
3 Our Results





EDD minimizes both the number of late jobs and the average lateness for all hospitals.

EDD is a better dispatch rule than is SPT for minimizing both the number of late jobs and average lateness.



4 Closing Remarks

? Going forward

- Apply EDD and SPT with preemption
- Experiment with different numbers of doctors and processing times
- Test different dispatch rules and algorithms such as simulated annealing

Thank You!

Any questions?

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