Technical Analysis of a Research Paper

A Paradigm Shift in Appointment Scheduling: Introducing a decentralized integrated online booking system

Authors: Pardis Seyedi, Kourosh Eshghi & Michael W. Carter

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Key Problem

- **Key Problem:** Many health systems struggle with long wait times, coordination challenges, and integration gaps, which complicate effective waitlist management and delay patient care. The conventional approach, where each center manages scheduling independently, limits the ability to respond collectively to changes in demand [1].

Evidence:

- *At least **11,581 patients** across Canada died in 2020–21 while waiting for surgeries, diagnostic scans, and appointments with specialists [2].*
- *Nearly **one-third (30 %)** of patients in Canada **must wait more than 2 months** for a specialist appointment, and the average wait time for an MRI scan is 10.2 weeks [3].*
- *England's health system has **missed its key 62-day cancer waiting time target** for over five years owing to delays in diagnosis [4].*

Literature Review & Methodology

- **Literature Review**
- Current approaches to reduce wait times:
  - Controlled overbooking strategies or pre-charging strategy.
  - Telemedicine interventions, such as e-consultations, referral protocols.
  - Patient reminders via phone calls, emails, or text messages - aim to utilize resources more efficiently.
  - Healthcare organizations are increasingly turning to **data science** technologies.
  - Leverage **advanced algorithms** which are **complex**.
  - They look at **optimization-based technology.**

- **Methodology**
- Case study approach
- Discusses the solution design

- **Presents the framework of the Integrated Online Booking System** focused on primary care and specialty care.
- Adopts the current procedure of the appointment system for **MRI service in Ontario**.
- A decomposable algorithm based on the **Alternating Direction Method of Multipliers (ADMM)** is used for this system.

Proposed Solution

An **Integrated Online Booking system** (IOB) for **outpatient services** is designed in this study, presenting the first **central intake-based appointment system** integrated with an optimization approach and a novel **decentralized and distributed appointment system**.

This system considers the **independence of centers** while better **responding to demand** and **improving overall system performance.**

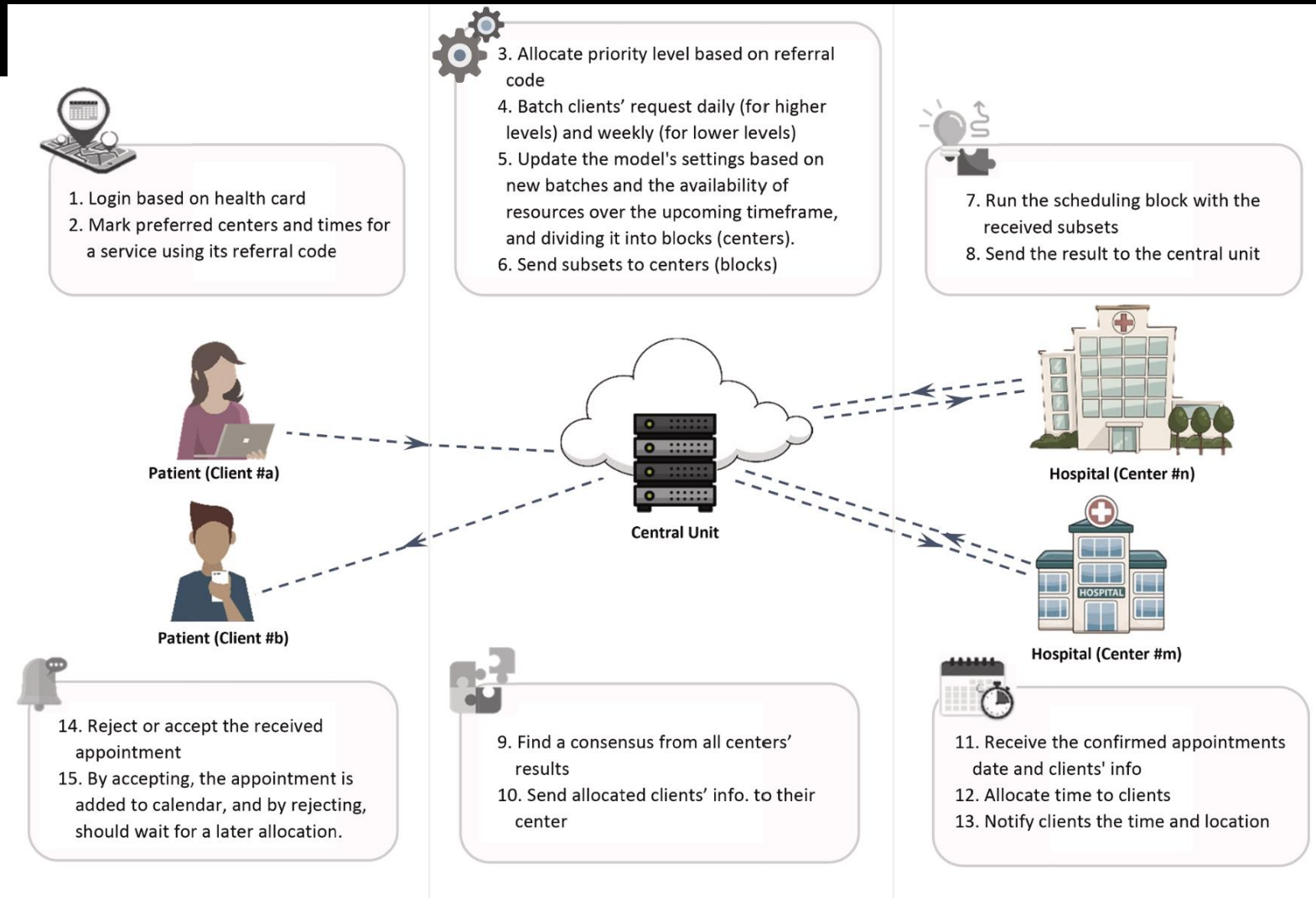

Fig. 1. The sketch of integrated online booking (IOB) system.

: [1]

Case Study & Results

- **Case Study:** The algorithm was applied to **MRI data comprising over 172,000 outpatient records** from **76 hospitals** in **Ontario**.
- **The data** was sourced from the **Wait Time Information System (WTIS),** developed and implemented by Ontario Health. The data is provided by Cancer Care Ontario (CCO). Dataset is from 2015.
- **Existing data insights:** Under the current practice, about **50 % of priority 3** patients and **70 % of priority 4 patients** exceed their targeted wait time. Priority 3 patients who went past the target date had to wait another **25.04 days** on average (+initial 10 days) to receive the procedure. Priority 4 patients had to wait an average of **40 days longer** than the targeted 28 days.

Case Study & Results

- **Criteria:** The IOB-based appointment scheduling considered patients' **flexibility** and the **timing of scheduling**.
- **Results:** The percentage of patients who waited over the WTT **decreased from 25.2 % to 10.8 %,** and the average wait times for both priority levels decreased from above the WTT to within the WTT. The impact was **more noticeable** for **semi-urgent patients at P3**.
- **Outcome:** The IOB system can **outperform common appointment scheduling approaches** in terms of **reducing** patient wait times, **balancing** utilization rates, **improving** referral patterns, and **enhancing** system efficiency.

Key Benefits

- **Improved Experience:** A **central appointment scheduling system** for outpatients addressing **variability** and **long wait times**.
- **Speed:** This **speeds up diagnosis** and **treatment processes** while improving the **efficiency** of healthcare systems.
- **Better Response:** to demand fluctuations, **alleviating excessive patient wait times**, and **improving healthcare** providers' **profits.**

Citation: [1]

Importance & Uniqueness

- **Importance:**
- This study provides insights for **decision-makers**, **highlighting the importance of effective scheduling** in **managing client waitlists** during treatment in the **healthcare sector**, such as elective surgery, home healthcare, physical and mental therapies, and other service industries like government and education.

- **Uniqueness:**
- **Simpler:** The solution takes a **simpler, optimized approach** whereas existing solutions are more **complex & inefficient**.
- **Integration:** This solution adopts an **embedding optimization approach** into existing IT tools, that can be applied in **real situations** and bring added value to healthcare market.
- **Foundational Engine:** The IOB system **serves as a foundational engine** and **decision support tool** within **larger healthcare initiatives**.
- **First of its kind:** It was the first study to **expand the appointment scheduling-sequencing model** to include **multiple sites**, while also incorporating **wait time targets.**

Citation: [1]

Limitations in the research

- **No evidence of an empirical study** to gather actual requirements from stakeholders.
- Solution is **limited to imaging appointment scheduling** only.

- The case study is based on a **past dataset from 2015**, whereas the paper was published in 2024.
- Although the solution has claimed to be **extensible to other countries and regions**, it has **not been tested**.

- There is **no strategic approach** in the system to **predict demand** for appointments that can **aid decision-making** using advanced technologies like AI.

Citation: [1]

Improvements suggested to the Research

- **For the Research:**
- **Methodology/ Empirical Study:** Conduct an empirical study to validate the findings from the literature survey, and further understand the current needs and requirements from all stakeholders.
- **Case Study Sample:** Instead of MRI imaging scheduling it is recommended to take a more common scenario such as booking specialist doctor's appointments which is more widespread in the real-world.
- **Data Aspects:** Test with real-time data for more accurate OAS features, and appointment scheduling should be obtained faster and efficiently to reduce wait times.

Improvements suggested to the Solution

- **Artificial Intelligence (AI)** and Machine Learning (ML) for Demand Forecasting and Predictive Analytics:

Forecast patient demand across healthcare centers by analyzing historical appointment data, seasonal trends, and population health statistics faster. These insights can **optimize resource allocation** and **reduce wait times** by anticipating demand fluctuations. **AI-driven recommendations** can assist in dynamically adjusting appointment availability based on real-time data.

- **Internet of Things (IoT)** for Real-Time Resource Monitoring

IoT devices (e.g., sensors in MRI machines) could provide real-time status updates on equipment usage, room availability, and patient flow. This data can be fed into the IOB system to refine appointment times and improve resource utilization, ultimately reducing idle time and improving coordination.

References

Main paper:

[1] P. Seyedi, K. Eshghi, and M. W. Carter, "A paradigm shift in appointment Scheduling: Introducing a decentralized integrated Online booking system," *Expert Systems with Applications*, vol. 257, 2024, doi: 10.1016/j.eswa.2024.124836.

Other references:

[2] C. Craig, "Waiting List Deaths Surge in 2020-21," SecondStreet.org. Accessed: Nov. 06, 2024. [Online]. Available: https://secondstreet.org/2021/12/09/waiting-list-deaths-surge-in-2020-21/

[3] B. Barua and M. Moir, "Waiting Your Turn: Wait Times for Health Care in Canada, 2020 Report," Fraser Institute, Dec. 2020. Accessed: Nov. 06, 2024. [Online]. Available: https://bit.ly/3hXaMcr

[4] N. England, "National Cancer Waiting Times Monitoring Dataset," *National Cancer Waiting Times Monitoring Dataset Guidance*, vol. 11, 2020.

Thank you

Lakshika J. Paiva

300323918

lpaiv023@uottawa.ca