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## AI For Business – MIS716

## Assignment 1

## Trimester 1 2022

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# Executive Summary

Medical appointment no show is a consistent issue across most hospitals and medical providers that has financial and non-financial missed opportunities associated with this problem. In a study run by the Western Australian government in 2019, it is estimated that in a 12-month period, more than 160,000 outpatient appointments have been missed in private and public medical clinics and hospital across the state. This equates to an estimated of $26 million lost in underutilised resourcing.

This does not only have a financial cost associated, but also a non-financial cost. For example, this can extend out wait times on waiting lists, as a missed appointment spot could have been utilised by another patient waiting for an appointment.

There is also plenty of research that specifies that there are certain patient characteristics that put them into a higher risk of treatment discontinuation once a patient has missed an appointment, thus it is imperative to identify these patients and have systems in place to reduce the no show rate with these higher risk group of patients to ensure continued medical treatment (Kurasawa, et al., 2016).

The proposed solution will be an integrated solution with the existing data and database infrastructure to support the following:

* Identify appointments dates/days where there is a high percentage of patients who is most likely to skip an appointment. This will prompt for a percentage of overbooking to mitigate empty slots.
* Identify patients who are at substantial risk of skipping an appointment and then continuing to discontinue their treatment. Using AI, these groups of patients will then receive a follow up call to confirm and remind them of the upcoming appointment.

# Literature Review

From our research on the use of artificial intelligence used in managing health appointments, one of the clear observations and similarities is that the use of supervised machine learning is prevalent in the sector. Before we discuss the similarities and differences, we must first understand what artificial intelligence is and the different types of artificial intelligence.

Artificial intelligence (AI) can be defined as leveraging of the use of computer systems to perform tasks that usually require human intelligence. It is the combined use of computer systems, and robust data sets to problem solve. Presently all AI solutions are considered weak AI, instead of strong AI. Weak AI is used to automate regular and time-consuming tasks, and it simulates human cognition. Strong AI refers to AI that can exhibit human behaviour which is presently unavailable. Within the field of weak AI, it can be broken down further into the following groups of AI – Assisted Intelligence, Augmented Intelligence and Autonomous Intelligence.

Augmented intelligence primary role is to support human decision making with the use of machine learning, natural language processing, image recognition and neural networks. This type of AI learns from past data and through human feedback on output (Padma, 2020). Assisted intelligence is the most basic form of AI and is used to automate regular tasks and processes that usually require human input, this AI leverages of the use of big data, cloud platforms and data science and is not used for decision making and used to improve processes efficiency. Autonomous intelligence is AI systems that can adapt to different situation without any human intervention, examples of these include self-driving cars, and military drones.

From our research, the main types of AI used in healthcare to manage missed appointments are mainly under the umbrellas of Assisted and Augmented Intelligence, the most popular being the use of appointment reminder SMS’s which is a form of assisted intelligence. There are mixed opinions on the efficiency of SMS in reducing the missed appointment rates, and recent studies show that a more targeted approach in SMS may be useful (Bellucci, et al., 2017). In a study based on data collected across a span of 46 months, it was found that the nonattendance rate was much lower prior to the implementation of SMS reminders, this same study also found that there various other factors that is impacting nonattendance such as if the appointment was going to be done by a trainee doctor, number of consecutive appointments where the study found that patients are more likely to miss an appointment as the number of their appointment increases (Bellucci, et al., 2017).

There has been plenty of research in building predictor models to predict the likelihood of a patient missing an appointment, and some of the key findings from my research was that the following factors contribute to an increased likelihood of nonattendance.

* Previous nonattendance at appointments (Elvira, et al., 2017)
* Government health subsidies – patients with subsidies are more likely to miss an appointment (Karpagam, et al., 2017)
* Appointment day and time – Sundays and morning appointments tend to see highest rates of nonattendance (Karpagam, et al., 2017), (Salazar, et al., 2021)
* Appointment Lead Time - Longer lead time increases the likelihood of nonattendance (Mohammadi, et al., 2018)
* Lower income and higher unemployment leads to higher nonattendance (Mohammadi, et al., 2018)
* Cooler weather and rainy days tend to see higher nonattendance (Salazar, et al., 2021)
* Number of hospital attendance – the nonattendance rate is lower for patients who needed to be admitted into hospital frequently (Almuhaideb, et al., 2019)

The tables below summarises few key research that has utilised machine learning to manage nonattendance rates at appointments.

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# Proposed Solution

Based on the findings of the research and the existing use of SMS by MWHealth, we will not propose the use of further SMS technologies to manage nonattendance as it is found to not effectively reduce these rates and may cost the business copious amounts of expenses in the long run.

The solution that I am proposing is an integrated and hybrid approach solution that utilises a mix of supervised learning and unsupervised learning techniques.

Using the current data infrastructure, data from both the MWHealth patient HER and Appointment Scheduler system will be extracted into a data lake for real time analysis. From here, the first stage is to utilise an ensemble supervised learning model that is made up of a stack of models (Logistic Regression, Decision Tree, Support Vector Machine) to predict and identify patients with a high likelihood of not showing up for an appointment, these tags are then dynamically integrated back and tagged against each patient record in the EHR and scheduler system daily. Reason for opting with an ensemble model here is due to each of the individual models having their own strengths and diverse ways of working with live data, thus ensuring the predictions are more robust and accurate.

Once the model predicts patient that are likely to miss an appointment, these patients are then integrated into an unsupervised learning clustering model using Kmeans to then identify high risk patients that are likely to discontinue their treatment following from a missed appointment, as research shows that there are certain demographic and social indicators that can be used to predict instances of treatment discontinuation (Kurasawa, et al., 2016). Once the high-risk cluster is identified, this information is then integrated back to the EHR system and recorded as elevated risk for treatment discontinuation against the patients record.

From here, using those 2 tags, we can use the data for a few purposes such as below:

* Scheduling system to flag appointment dates with high number of patients who may not attend, and use this as a basis to overbook, or prepare short notice waiting list for other patients.
* Scheduling system to use data to avoid booking in patients who have been flagged as potential no show on days and times where there is higher no shows (Sundays, morning appointments) to reduce likelihood of patient not showing up
* Use of Vozy which is an AI system to make follow up phone calls to patients flagged as elevated risk of discontinuing treatment.

The tables below demonstrates the infrastructure, vendors and data required to build the proposed solution above. The proposed data flow and solution integration can be viewed in image 1 below.

By integrating the following recommendations, MWHealth will be equipped to identify days with high probabilities of no show, and proactively overbook or create a short notice waiting list to fill the appointments to reduce wasted resources and missed appointment costs. This solution will also identify patients that require further intervention to ensure treatment discontinuation, I am confident that a phone call will work better than an SMS, as a conversation could be had using the AI bot, and using natural language processing, the AI both will be able to ask prompting questions to reinforce the importance of not missing the appointment.

# Diagram of proposed solution (Image 1) A picture containing diagram Description automatically generated

# Self-Evaluation

There are areas of AI that I am quite familiar with and other areas of AI that I’ve come to learn through this unit. I am quite comfortable with Augmented intelligence and the use of machine learning in AI. I have the right technical skills to build predictive or clustering models and can build good models when I work with marketing, fundraising or customer data. I struggle applying these concepts to datasets that I am not familiar with such as health and environmental data, thus this is something I will need to keep working on. I plan on filling these gaps by practicing using datasets found on Kaggle or Github.

I am also quite comfortable with the use of AI in terms of automation, as I work on automated platforms (Campaign Monitor, Shopify) regularly, so can understand how to integrate automation into business processes for efficiency. As I am process and systems oriented, I would say in the entire field of AI, this will be my key strength.

Prior to starting this unit, I had extremely limited knowledge on assisted and autonomous intelligence, this is one of my weakness and knowledge gaps. I lack the proper understanding of these fields, thus find it hard to conceptualise what they are and how to apply them within a business. In order to address these gaps, I will need to do more research into this area and find professionals working in this area to connect with to understand the inner workings of these areas of AI, and how does it go from concept to final product. I would also like to look for any volunteering opportunities in these areas to gain some practical experience.

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# Appendix

# There are a few assumptions made with regards to the proposed solutions that needs further investigating, and they are:

* MWHealths’s patient electronic health records (HER) system and the scheduler is integrated.
* Both the EHR system and scheduler has API capabilities enable plugins or other tools to be connected on top of both these systems
* MWHealth has an analytics data lake that is integrated with a cloud-based analytics and machine learning tool such as Azure.