



Impact Assessment of Public Holidays on Emergency Department Attendance using Seasonal Auto-Regressive Integrated Moving Average with eXogenous Factors (SARIMAX) Framework

Francis Ngoc Hoang Long Nguyen¹; Nur Diana Binte Abdul Rashid²; Tay Wen Jun²; Low Seng Kee²; Goh Ze Wei²; Yogeswary D/O Pasupathi²; Shao Wei Sean Lam¹
¹SingHealth; ²Singapore General Hospital

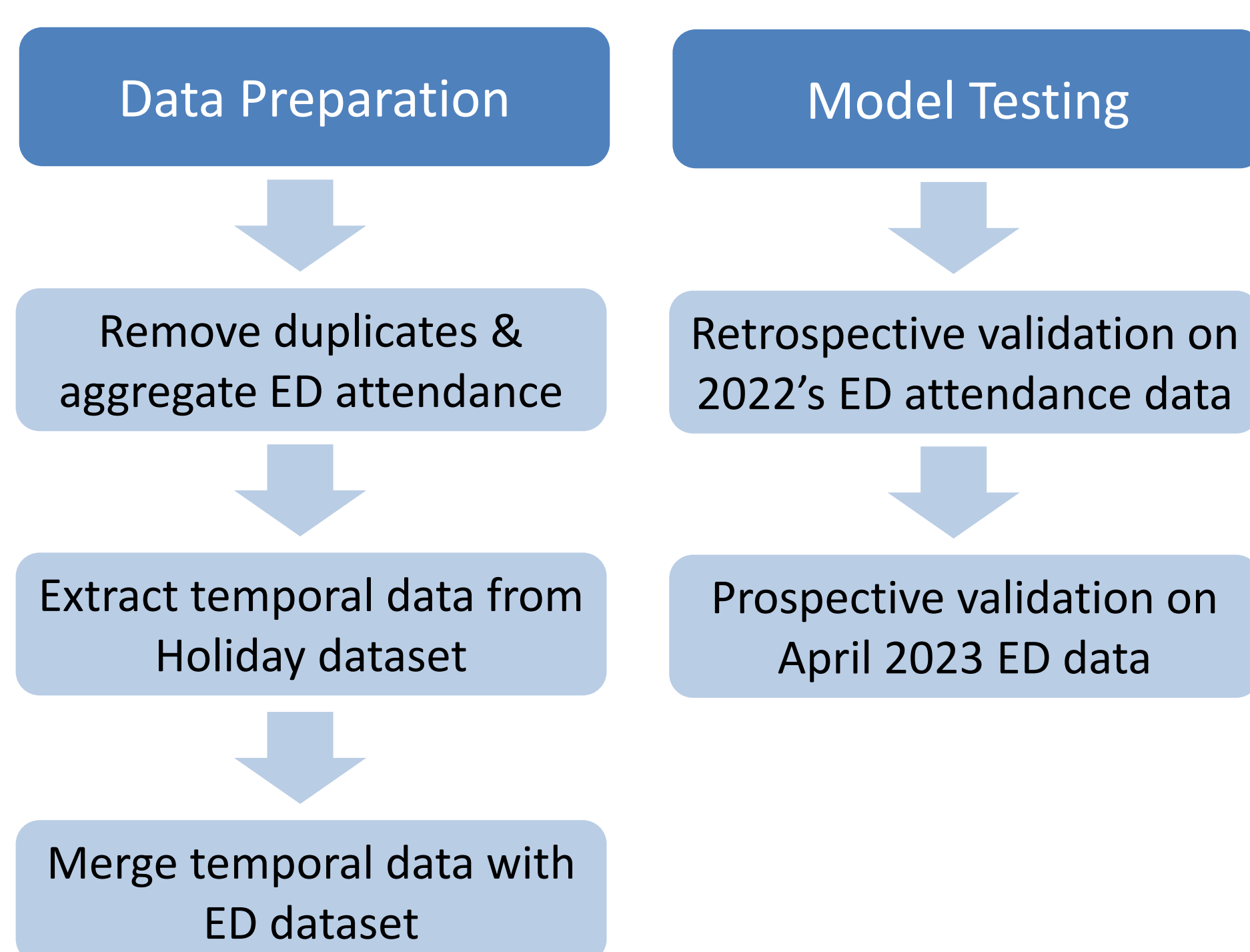
Background & Introduction

Amidst the Covid-19 pandemic, the number of patients arriving at the Emergency Department (ED) underwent significant and erratic changes, creating difficulties for the hospital to deliver timely treatment and to allocate resources efficiently. A precise model that can forecast daily ED attendance is crucial for assisting manpower rostering and hospital operations planning.

Aim

The goal of this study is to investigate the effectiveness of the SARIMAX framework in predicting daily Emergency Department (ED) attendances at Singapore General Hospital (SGH) by analyzing patterns, trends, and the impact of public holidays.

Workflow



Methodology

- Step 1:** Remove duplicates from ED data based on admission time, patient ID and session ID to aggregate daily ED attendance
- Step 2:** Incorporate the day of the week, public holidays, holiday eves, and first working days after holidays
- Step 3:** Select the main parameters of the SARIMAX models (p, d, q, P, D, Q, and m) by minimizing the Akaike Information Criterion to determine a parsimonious model
- Step 4:** Perform retrospective model validation on 2022 ED attendances data
- Step 5:** Perform prospective model validation was conducted with the Bed Management Unit team over 3 weeks (3rd - 23rd April 2023)

Results

The SARIMAX model was used to conduct multivariate analysis, providing valuable insights into the significance, strength, and direction of each indicator variable in predicting ED attendance. In this analysis, the reference category for the SARIMAX(0,1,1)(0,0,0,7) model is considered to be 'Sunday'. It is observed that on working days following a public holiday (post-holidays), the average ED attendance tends to increase. Conversely, on days preceding a public holiday (holiday eves), the attendance decreases. Additionally, Mondays exhibit higher ED volume compared to other days. The elevated attendance levels following weekends or holidays can be attributed to the "Day-off Effect," where patients tend to postpone seeking emergent medical attention during their time off. The model has a Mean Absolute Error (MAE) of 16.34 and 13.25 and Mean Absolute Percentage Error (MAPE) of 5.30% and 4.17% for 2022 (retrospective validation) and April 2023 (prospective validation) respectively.

Public Holiday	Holiday Eve	Holiday	Post-Holiday
Chinese New Year	-48.56*	10.21*	50.13*
Christmas Day	-23.50*	-5.87	28.13*
Deepavali	-8.12	-9.45	39.36*
Good Friday	12.08	-4.15	-0.50
Hari Raya Haji	6.64	-3.52	32.64*
Hari Raya Puasa	-16.79*	3.06	45.03*
Labour Day	2.82	-2.09	15.29*
National Day	-11.81	-8.60	40.55*
New Year's Day	-24.08*	9.49	27.38*
Vesak Day	4.19	8.95	31.65*

Day	Coefficient
Working Day	33.52*
Friday	-7.61
Monday	48.47*
Saturday	12.37*
Thursday	-3.87
Tuesday	4.82
Wednesday	-4.79

Time Period	MAE	MAPE
2022	16.34	5.30%
April 2023	13.25	4.17%

*Coefficient values in red are statistically significant (p-value < 0.05)

Conclusion

We have demonstrated that ED attendances are significantly impacted by pre- and post-public holidays and that the SARIMAX model is an effective decision support tool for hospital administrators in anticipating and managing potential fluctuations in ED demand.