

Using Data Mining to Predict Hospital Admissions from the Emergency Department

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Abstract

- ▶ Crowding within Emergency Departments (EDs) can have significant negative consequences for patients. EDs therefore need to explore the use of innovative methods to improve patient flow and prevent overcrowding. One potential method is the use of data mining using machine learning techniques to predict ED admissions.
- ▶ This study uses routinely collected administrative data (120,600 records) from two major acute hospitals in Northern Ireland to compare contrasting machine learning algorithms in predicting the risk of admission from the ED.
- ▶ We use three algorithms to build the predictive models: (1) logistic regression, (2) decision trees, and (3) gradient boosted machines (GBM).
- ▶ The GBM performed better (accuracy=80.31%, AUC-ROC=0.859) than the decision tree (accuracy=80.06%, AUC-ROC=0.824) and the logistic regression model (accuracy=79.94%, AUC-ROC=0.849).
- ▶ Drawing on logistic regression, we identify several factors related to hospital admissions including hospital site, age, arrival mode, triage category, care group, previous admission in the past month, and previous admission in the past year.
- ▶ This study highlights the potential utility of three common machine learning algorithms in predicting patient admissions. Practical implementation of the models developed in this study in decision support tools would provide a snapshot of predicted admissions from the emergency department at a given time, allowing for advance resource planning and the avoidance of bottlenecks in patient flow, as well as comparison of predicted and actual admission rates.

When interpretability is a key consideration, EDs should consider adopting logistic regression models, although GBM's will be useful where accuracy is paramount.

Existing

- ▶ Emergency department (ED) crowding can have serious negative consequences for patients and staff, such as increased wait time, ambulance diversion, reduced staff morale, adverse patient outcomes such as increased mortality, and cancellation of elective procedures.
- ▶ Previous research has shown ED crowding to be a significant international problem, making it crucial that innovative steps are taken to address the problem.
- ▶ There are a range of possible causes of ED crowding depending on the context, with some of the main reasons including increased ED attendances, inappropriate attendances, a lack of alternative treatment options, a lack of inpatient beds, ED staffing shortages, and closure of other local ED departments.
- ▶ The most significant of these causes is the inability to transfer patients to an inpatient bed, making it critical for hospitals to manage patient flow and understand capacity and demand for inpatient beds.

Disadvantage

- ▶ EDs therefore need to explore the use of innovative methods to improve patient flow and prevent overcrowding Previous research has shown ED
- ▶ crowding to be a significant international problem
- ▶ making it crucial that innovative steps are taken to address the problem

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Proposed

- ▶ focuses on the use of machine learning algorithms to develop models to predict hospital admissions from the emergency department, and the comparison of the performance of different approaches to model development.
- ▶ We trained and tested the models using data from the administrative systems of two acute hospitals in Northern Ireland.
- ▶ This study draws on this data to achieve two objectives. The first is to create a model that accurately predicts admission to hospital from the ED department, and the second is to evaluate the performance of common machine learning algorithms in predicting hospital admissions.
- ▶ We also suggest use cases for the implementation of the model as a decision support and performance management tool

Advantage

- ▶ Implementation of the models as a decision support tool could help hospital decision makers to more effectively plan and manage resources based on the expected patient inflow from the ED.
- ▶ This could help to improve patient flow and reduce ED crowding, therefore reducing the adverse effects of ED crowding and improving patient satisfaction.
- ▶ The models also have potential application in performance monitoring and audit by comparing predicted admissions against actual admissions

HARDWARE REQUIREMENTS

- ▶ Processor – Pentium -III
- ▶ Speed – 1.1 Ghz
- ▶ RAM – 256 MB(min)
- ▶ Hard Disk – 20 GB
- ▶ Floppy Drive – 1.44 MB
- ▶ Key Board – Standard Windows Keyboard
- ▶ Mouse – Two or Three Button Mouse
- ▶ Monitor – SVGA

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SOFTWARE REQUIREMENTS

- ▶ Operating System : Windows 8
- ▶ Front End : Java /DOTNET
- ▶ Database : Mysql/HEIDISQL

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Conclusion

- ▶ This study involved the development and comparison of three machine learning models aimed at predicting hospital admissions from the ED.
- ▶ Each model was trained using routinely collected ED data using three different data mining algorithms, namely logistic regression, decision trees and gradient boosted machines.
- ▶ Overall, the GBM performed the best when compared to logistic regression and decision trees, but the decision tree and logistic regression also performed well.
- ▶ The three models presented in this study yield comparable, and in some cases improved performance compared to models presented in other studies.
- ▶ Implementation of the models as a decision support tool could help hospital decision makers to more effectively plan and manage resources based on the expected patient inflow from the ED.
- ▶ This could help to improve patient flow and reduce ED crowding, therefore reducing the adverse effects of ED crowding and improving patient satisfaction.
- ▶ The models also have potential application in performance monitoring and audit by comparing predicted admissions against actual admissions.

However, whilst the model could be used to support planning and decision making, individual level admission decisions still require clinical judgement.

Reference

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