Emergency Medical Triage:

A Machine Learning Approach for Patient Severity Prediction

C-951 Task 3

Robert J. Robinson

Student ID: #01168728

## A. Organizational Need:

The proposed project aims to address the organizational need of improving patient triage and severity prediction for Emergency Medical Technicians (EMTs) in the field. Currently, EMTs rely on manual assessment, which can be subjective and sometimes time-consuming. By leveraging machine learning, the goal is to provide EMTs with a more efficient and accurate method to prioritize treatment and transportation based on the signs and symptoms and the severity of a patient's condition. Using these machine learning tools will allow for faster triage and transport decisions to have better outcomes for patients.

## B. Context and Background:

The current manual triage process may lead to delays in critical cases, potentially affecting patient outcomes. EMTs currently use a series of mnemonics and flow charts to classify and triage patients. By implementing an ML-based triage system, EMTs can make data-driven decisions, leading to quicker interventions for patients in urgent need.

## C. Review of Outside Works:

Three outside works will be reviewed to explore existing machine learning solutions in the prehospital healthcare domain. These works include research papers on ML-based triage systems, interviews with medical professionals regarding the effectiveness of such systems, and whitepapers on the impact of ML in emergency medicine.

### A Validation of Machine Learning-Based Risk Scores in the Prehospital Setting (Spangler, Hermansson, Smekal, Blomberg, 2019)

This study examines a machine learning-based risk assessment approach for prehospital care, utilizing routinely collected data. The researchers developed gradient boosting models to predict hospital admission, critical care, and two-day mortality, resulting in risk scores that outperformed traditional rule-based triage methods and human prioritization decisions. Notably, the machine learning-based risk scores demonstrated consistent and strong performance in both retrospective and prospective datasets. These findings highlight the potential of such tools to enhance patient triage in prehospital settings, leading to improved decision-making and better patient outcomes.

### On Scene Injury Severity Prediction (OSISP) Machine Learning Algorithms for Motor Vehicle Crash Occupants in the US (Candefjord, Muhammad, Bangalore, Buendia, 2021)

This study investigates the potential of machine learning-based algorithms to enhance triage accuracy in prehospital care for motor vehicle crash occupants. Utilizing data from the "National Automotive Sampling System - Crashworthiness Data System," the research evaluates OSISP algorithms' accuracy in predicting severe injuries. The best-performing algorithm, Logistic Regression, achieved an area under the receiver operator characteristic curve (AUC) of 0.86. The study emphasizes the importance of accurate triage in improving patient outcomes in motor vehicle crash scenarios.

### Using Machine-Learning Risk Prediction Models to Triage the Acuity of Undifferentiated Patients Entering the Emergency Care System: A Systematic Review (Miles, Turner, Jacques, Williams, & Mason, 2020)

This review evaluates the accuracy of machine learning methods in triaging the acuity of patients presenting in the Emergency Medical System (EMS). Results show that machine-learning methods, including neural networks, tree-based methods, and logistic regression, appear accurate in triaging undifferentiated patients.

D. Summary of Machine Learning Solution:

The proposed machine learning solution involves developing a K-Nearest Neighbors (KNN) algorithm to classify patients based on their vital signs and symptoms. By identifying the K-nearest patients with similar conditions, EMTs can determine the severity level of the new patient and prioritize care accordingly.

E. Benefits of Proposed Machine Learning:

The benefits of the proposed machine learning solution include:

- Improved Triage: EMTs can quickly and accurately assess the severity of a patient's condition, leading to faster interventions for critical cases.

- Resource Optimization: By efficiently allocating resources, the healthcare system can better handle emergencies and ensure appropriate use of medical facilities.

- Enhanced Patient Outcomes: Timely and appropriate treatment can significantly impact patient outcomes, reducing morbidity and mortality rates.

# Machine Learning Project Design

## A. Scope:

The scope of the project includes the development of a prototype machine learning system for patient triage, which will be tested on historical emergency call data and real-time patient scenarios.

## B. Goals, Objectives, and Deliverables:

The goals are to create a functional ML model for triage, evaluate its performance on a diverse dataset, and integrate the system into the existing EMT workflow. The main deliverable is a robust ML-based triage system.

C. Standard Methodology:   
  
The CRISP-DM methodology will be applied to the project, including data understanding, data preparation, modeling, evaluation, and deployment phases.

D. \*\*Projected Timeline\*\*: The project is expected to take six months, with tasks including data collection (Month 1), model development (Months 2-4), testing and validation (Months 4-5), and system integration (Month 6).

E. \*\*Resources and Costs\*\*: The project will require a team of data scientists, medical experts, and software developers. Hardware, software, and third-party services will be needed, with estimated costs outlined in the project budget.

F. \*\*Success Criteria\*\*: The success of the project will be evaluated based on the accuracy and efficiency of the ML triage system in real-life emergency scenarios compared to the manual triage process.

# Machine Learning Solution Design

A. \*\*Hypothesis\*\*: The proposed project hypothesizes that an ML-based triage system will outperform manual triage in accurately predicting patient severity levels.

B. \*\*ML Algorithm\*\*: The chosen ML algorithm for the proposed solution is K-Nearest Neighbors (KNN). Its simplicity, interpretability, and effectiveness for classification tasks make it suitable for patient triage.

\*\*Justification\*\*: KNN can effectively capture local patterns and relationships in the data, allowing EMTs to make informed decisions based on similar patient cases. However, one limitation of KNN is its sensitivity to outliers, which may impact predictions.

C. \*\*Tools and Environments\*\*: Python with libraries such as scikit-learn and NumPy will be used to develop the ML solution. The system will be deployed on a cloud-based platform for scalability.

D. \*\*Performance Measurement\*\*: The performance of the ML solution will be measured using metrics such as accuracy, precision, recall, and F1-score. Cross-validation and holdout testing will be performed to assess model generalization.

\*\*Description of Data Set(s)\*\*

A. \*\*Data Source\*\*: The data will be collected from historical emergency call records, electronic health records, and patient vital sign monitors.

B. \*\*Data Collection Method\*\*: The data will be obtained from hospitals, emergency response agencies, and medical databases, ensuring patient privacy and informed consent.

\*\*Advantages\*\*: Collecting data from multiple sources allows for a diverse dataset that represents various patient conditions and emergency scenarios.

\*\*Limitations\*\*: Data collection might be subject to missing values, inconsistent formats, and possible selection bias.

C. \*\*Data Preparation\*\*: The data will be preprocessed to handle missing values, outliers, and noise. Feature engineering will be performed to extract relevant information from raw data.

D. \*\*Sensitive Data Handling\*\*: The project team will adhere to HIPAA guidelines and implement secure data storage and access protocols to ensure patient data privacy and confidentiality.

# References:

1. Article Title: "A Validation of Machine Learning-Based Risk Scores in the Prehospital Setting"

Authors: Douglas Spangler, Thomas Hermansson, David Smekal, Hans Blomberg

Publication Date: December 13, 2019

Journal: PLOS ONE

DOI: https://doi.org/10.1371/journal.pone.0226518

2. Article Title: "On Scene Injury Severity Prediction (OSISP) Machine Learning Algorithms for Motor Vehicle Crash Occupants in the US"

Authors: Stefan Candefjord, Azam Sheikh Muhammad, Pramod Bangalore, Ruben Buendia

Publication Date: September 2021

Journal: Journal of Transport & Health

Volume: 22

DOI: https://doi.org/10.1016/j.jth.2021.101124

3. Article Title: "Using Machine-Learning Risk Prediction Models to Triage the Acuity of Undifferentiated Patients Entering the Emergency Care System: A Systematic Review"

Authors: Jamie Miles, Janette Turner, Richard Jacques, Julia Williams, Suzanne Mason

Publication Date: October 2, 2020

Journal: Diagnostic and Prognostic Research

Volume: 4

Article Number: 16

DOI: https://doi.org/10.1186/s41512-020-00082-4

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