Utilizing AI to Optimize EMS Response to Acute Mental Illness and Resulting ER Resource Allocation

Poster Showcase
#IAEM24

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Problem

- Work as a licensed EMR highlighted growing numbers of mental health and substance abuse calls
- Little training to properly assist which resulted in "passing the buck" to emergency departments
- Patients wait hours, if not days, for treatment, sometimes only to be transferred to a mental health facility
- Police presence can escalate situation, sometimes resulting in injury or death to the mental health patient

Is there a better way to allocate EMS resources and provide care for patients with mental health concerns?

Overview

Today, modern EMS crews respond to an increasing number of calls from people experiencing mental health issues, who are termed emotionally disturbed persons (EDP), and calls related to substance abuse/addiction.

- Communities nationwide are grappling with this issue
- Some are piloting a new approach: treating this as a public health issue, not a public safety one by pairing EMS with social workers to respond to mental health calls
- The key question is WHEN to send these teams

Project Goal: Develop an Artificial Intelligence (AI) algorithm that can accurately predict the need for a mental health or addiction response to an incoming 911 call.

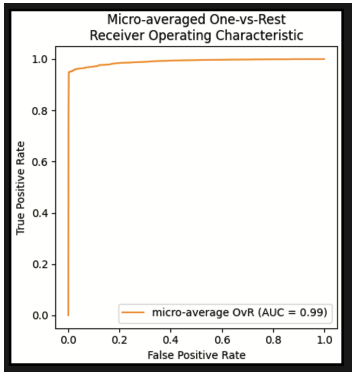
To the best of my knowledge, this study is the first to predict the appropriate type of EMS response to a 911 call using an AI algorithm.

Methodology

- The algorithm utilizes the NYC EMS Incident Dispatch Data of 24 million 911 calls made to NYC's EMS from 2005-2022
- Given file size of 5.6 GB, workflow was established through Google Colaboratory, then accessed with a Python Jupyter Notebook
- Python libraries—Pandas, NumPy and Sklearn—were used to clean the dataset, then split the dataset into train and test datasets
- Six of the database's 31 variables were used due to their influence on the outcome of the call type
- Several data elements needed to be manipulated:
  - combining call types,
  - transforming time conventions,
  - combining similar call types to balance classes and reduce bias towards larger data classes, and
  - transform the text into a numerical format
- Began project by developing neural networks but shifted toward using ensemble learning strategies, specifically gradient-boosting methods which have been proven to outperform neural networks when a large tabular dataset such as this one is used
  - Algorithms used included XGBoost, LightGBM, and CatBoost. Use of these frameworks improved predictive capabilities and was better at handling the scale of this dataset

Results

Results of Training Date using the CatBoost Model

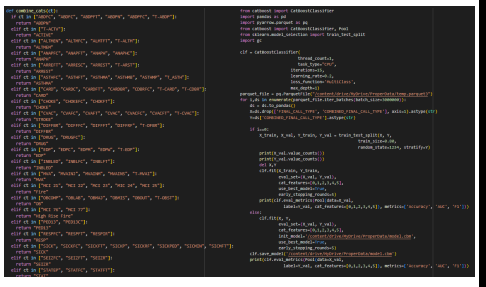


The more closely the orange line approaches the 90-degree angle, the more accurate the model is. The curve here represents a 94.5% accuracy rate.
Chart by Pierce Wright

For a 911 call, the algorithm can accurately predict the call type, allowing for the appropriate dispatching of EMS resources, including social workers for mental health emergencies.

- Using the CatBoost model, the algorithm achieved a 94.5% predictability rate
- Human 911 operators correctly designated calls at a rate of 92.3%
- This makes the model *more* accurate than a human

Sample of Code



Code at top imports specific variables from the data set; code at bottom converts data from 12-hour time to 24-hour time. Code at near right combines similar call types; code at far right utilizes the CatBoost strategy. CatBoost is beneficial because it is efficient, especially for large data sets, able to create a model quickly (unlike models such as XGBoost), and compatible with a variety of Python libraries such as SkLearn and NumPy. *All images/code by Pierce Wright*

Conclusion

This AI algorithm can accurately predict appropriate EMS response, including when a trained mental health specialist should accompany an EMS crew.

- The **U.S. spends $5.6 billion each year** on mental and substance use disorder visits to ERs
- **Savings of over $123 million** could be possible by better allocating public resources
- The **algorithm could impact 198,000 mental health cases** each year in New York City alone

This algorithm has some limitations:

- Potential bias that reflects systemic racial and economic disparities
  - In urban centers, EMS calls for routine medical care and mental health care are likely higher in lower-income and minority neighborhoods with limited primary medical care access
- Possibility of mislabeled data
  - If initial data input is flawed, the predictive nature of the algorithm's deep learning could be affected

Areas for future study:

- Additional data for regional municipalities could enhance the model
- Conduct testing to mitigate potential racial and socioeconomic biases within the AI model

The public health crisis related to acute mental health disorders and substance abuse is enormous, and this—or any—algorithm alone is not enough to solve the problem.

To help address this crisis, this study's AI model would allow municipalities to predict when to send crews with mental health specialists and to better allocate ER resources, all while significantly reducing costs.

Acknowledgements & Citations

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