Back to the Future-Proofing:
Machine Learning Predicts the Safety of Mobility Scooter Drivers

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Problem

- Mobility scooters are **vital assistive technology** that enable the social participation of people with mobility challenges or disabilities.
- With this technology, it is crucial to recognize the **possibility of accidents** and **consequences of serious injury** if some drivers' behaviors are not regularly monitored.

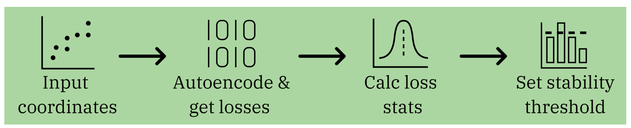
Proposed Solution

- Develop a **mobile application** to perform **stability analysis** of disabled and/or senior citizen scooter drivers based on **driving behaviors**, especially **posture.**
- For use in clinical and home settings for **rehabilitation** and **telemedicine purposes.**
- When deployed, this application will help **address health inequities** and **enhance the healthcare** of an underserved community.

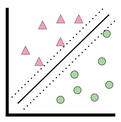
Methodology

- Design the **user interface** with **accessibility features** to accommodate **vision** and **neurological disabilities.**
- **Record** research participants' driving, process these videos with a previously-made **pose estimation system**, and gather riders' **upper-body keypoint coordinates** as data for **machine learning (ML) models.**

- Build 2 supervised **ML models** to classify drivers' postures as "stable" or "unstable."
- #1) **Deep stability model (statistics-based):** Pass coordinates to preexisting autoencoder, which calculates the **losses** of each video frame (measure of deviation from baseline of stable driving postures). Then, set a **stability threshold** *n* standard deviations (SD) above mean loss. New losses: "stable" ≤ threshold < "unstable"



- #2) **Support vector machine (SVM):** Pass same coordinates to SVM, a machine that tries to separate and distinguish between "stable" and "unstable" coordinates.
- Send the **performance result** back to the app for **display to the user.**
- Compare the 2 models in terms of **accuracy** and **efficiency** (execution time).

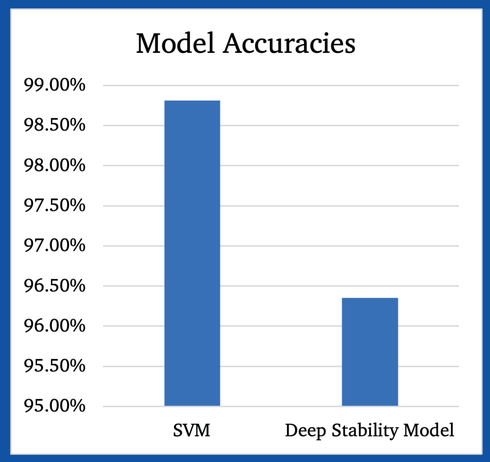


Ex: 2D SVM

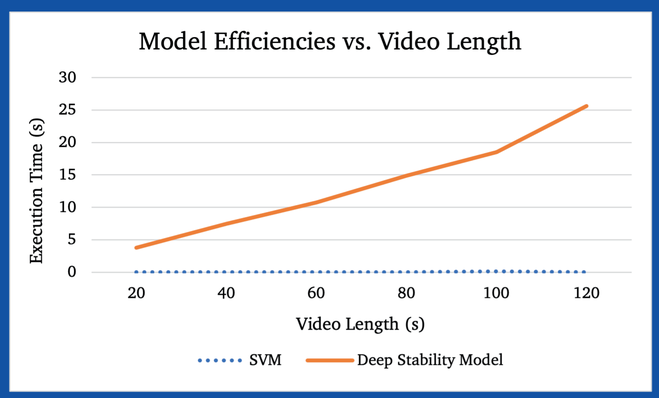
Results

- **Longer videos** => **increase** processing time for **deep stability model** => **about equal** processing time for **SVM**
- Deep stability model = 96.35% accurate vs. **SVM = 98.81% accurate.**
- For the deep stability model, more SD (which determine and therefore raise the stability threshold) *minimally* increase accuracy.

Support vector machines (SVM) are **more accurate** and **efficient** than statistics in **predicting the stability** of mobility scooter drivers.

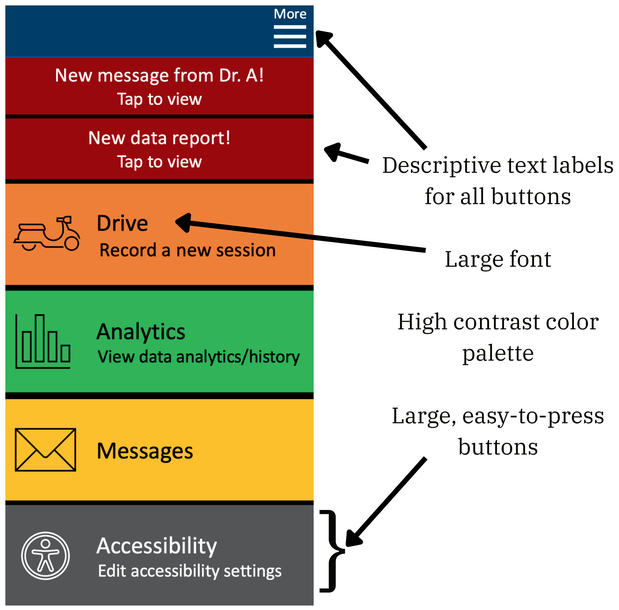


SVM is **2.46% more accurate** than statistics-based stability model.

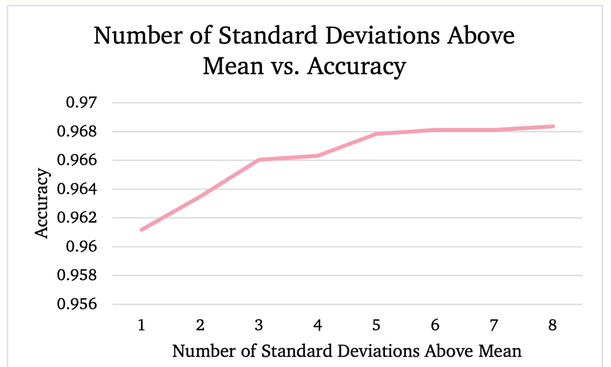


SVM efficiency does **NOT change** with more data vs. stability model processing time **linearly increases** with more data.

Mobile App Home Page



Number of SD vs. Accuracy



For the deep stability model, the number of standard deviations (SD) above the mean loss determines the stability threshold. More SD (and therefore a higher threshold) slightly increase model accuracy.

Stability Model Confusion Matrix

		Predicted Classes: Stable	**Predicted Classes: Unstable**
Actual Classes	**Stable**	3737 ●	117 ■
	Unstable	25 ■	9 ●

● = correctly classified data pts
■ = incorrectly classified

Acknowledgements

This project is part of a larger team with students who worked on other parts of the backend and frontend of the mobile application. Namely, thanks to Chenrui Zhang, who implemented my frontend design and collected data on the efficiency of my ML models.