

EMMA

**Emergency Monitoring for Medical Assistance
by Daternauts**



The problem

Falls are the second leading cause of unintentional injury deaths worldwide¹

**684 000 fatal
falls each
year¹**

**37.3 million
severe falls
each year¹**

2

A “Long Lie” has biological and psychological consequences²

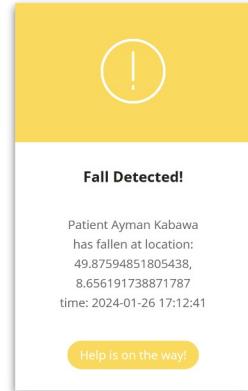
- **Biological Consequences:** hypothermia, infections, wounds, bruises, head injury, bone fracture, death.
- **Psychological and Social Impact:** an increased fear of falling, which can lead to reduced activity levels and increased reliance on ambulance services or long-term care facilities.

¹ WHO, 2021

² Kubitza et al., 2023



Our solution: EMMA



3



Team Introduction



Hazim
Software



Helena
Software



Ardra
Software



Denis
Hardware



Son
Hardware



Erich
Interface



Ayman
Hardware



Market Analysis



In Germany: 18.7 million people over 65 years³
→ ~ 6 million people live alone⁴



23% of all internet users in Germany are using smart watches⁵
→ only 8% of people over 65 years⁵



German smartwatch sales +76% since 2018⁶
→ 7.2 million in 2022⁶



Purchase can be supported by **health insurance**

³ destatis, 2023

⁴ destatis, 2021

⁵ destatis, 2020

⁶ Statista, 2024

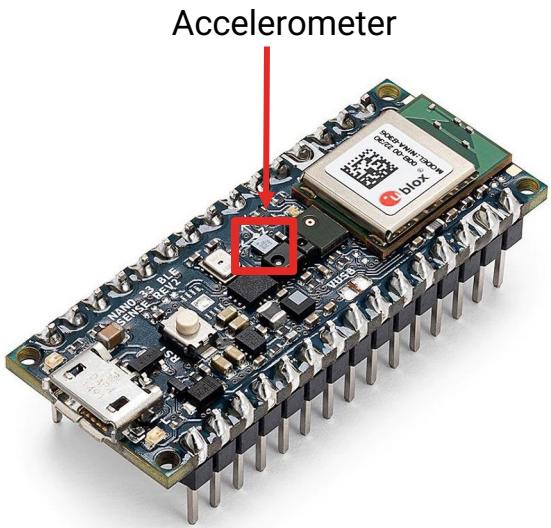


Advantages of EMMA compared to similar products

EMMA	Smart Watches
Compact and user-friendly design	Complex UI for elderly
Long battery life	Charge every day
Low cost: 40€	100 to 600€
Wear on waist	Wear on arm



The Device



Arduino BLE Sense Rev2



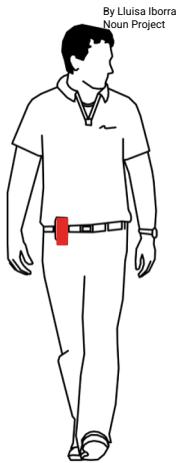
Secure
Cover



Battery



Device at work

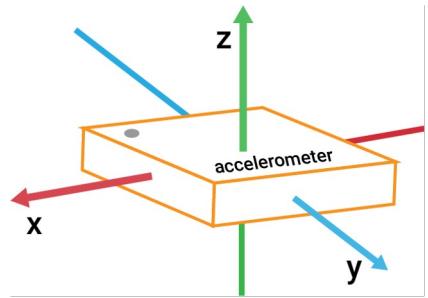


Position

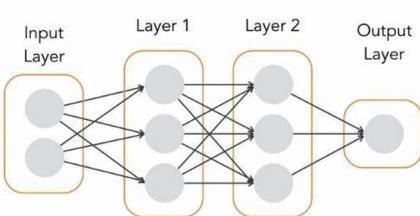




How EMMA works



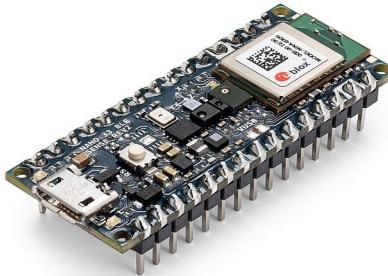
convert accelerations to .csv file



send prediction and
real-time data to server



send trained model as .h file to device

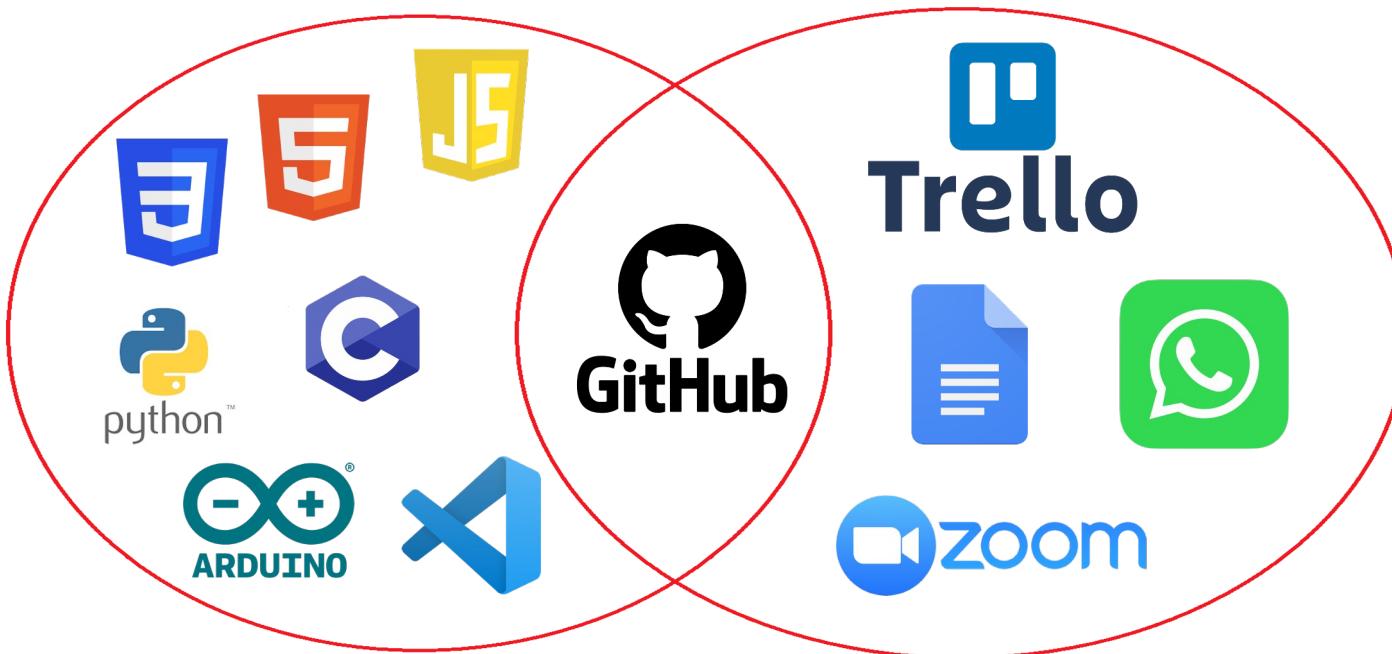




Technology Stack

Software Development

Project Management





Data Acquisition

Online

MobiFall⁷

4 types of falls
12 types of ADLs
66 subjects
630 measurements

SisFall⁸

15 types of falls
9 types of ADLs
37 subjects
4465 measurements

Collection

Daternauts

4 types of falls
6 types of ADLs
4 subjects
225 measurements

⁷ Vavoulas et al., 2014

⁸ Sucerquia et al., 2017



Data Acquisition



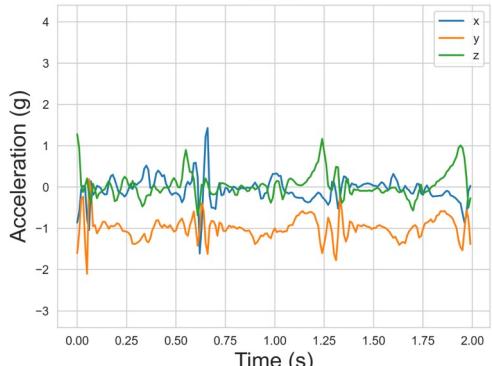
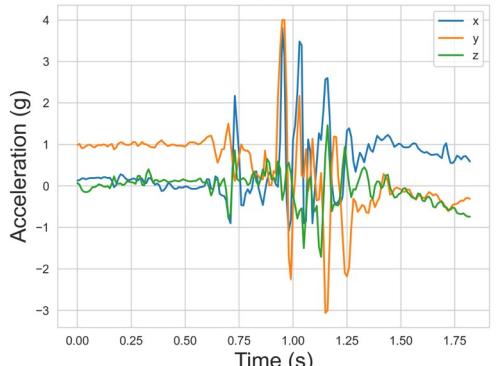
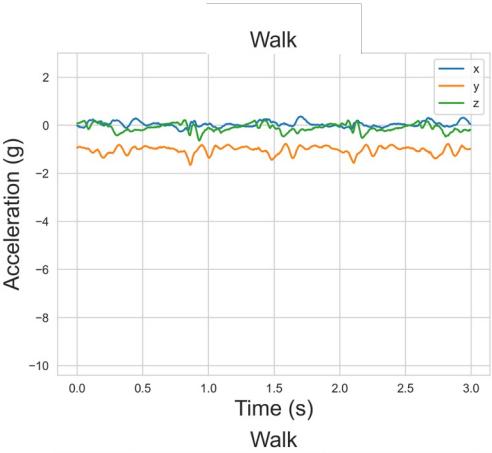
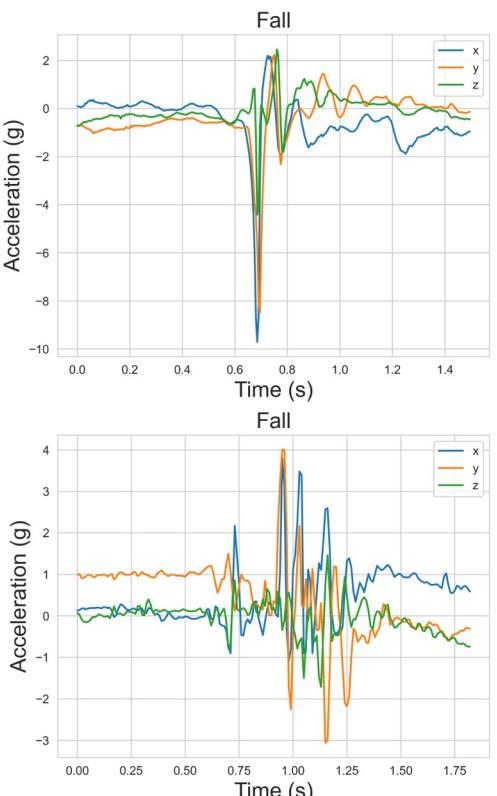
12



Online

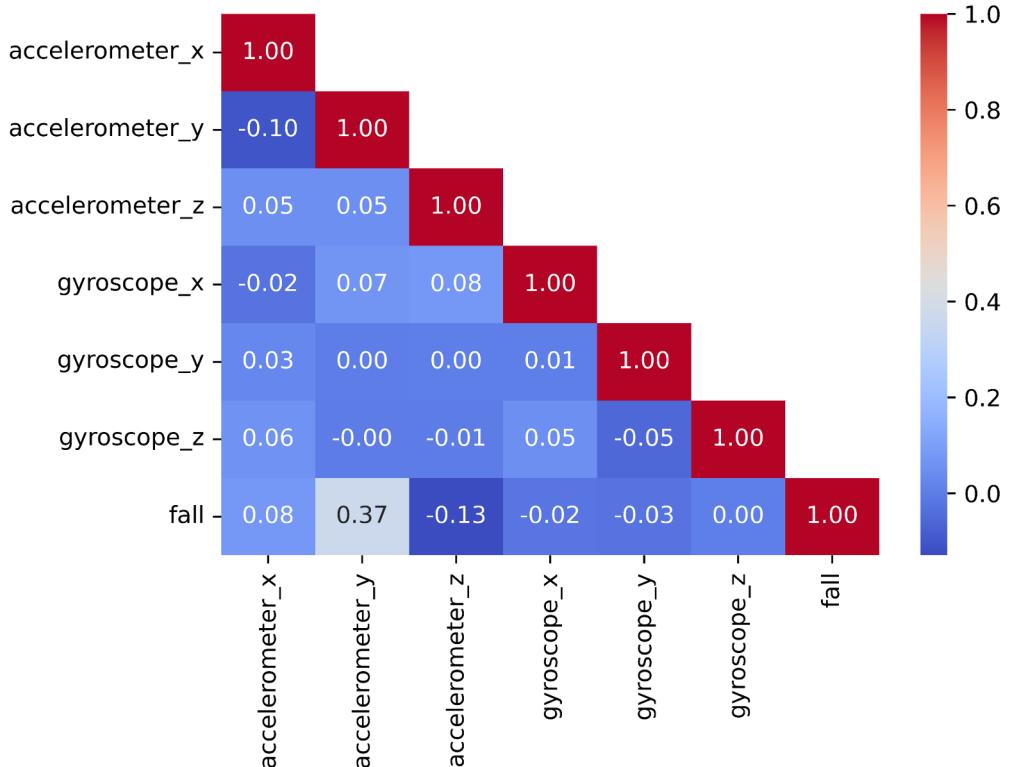
Collection

Data Acquisition





Feature Selection



14



Data Preprocessing

Normalizing

Adjusting Units

- MobiFall: $\pm 20\text{m/s}^2$
- SisFall: $\pm 16\text{g}$
- Self-Collected: $\pm 4\text{g}$

Clipping to $\pm 2\text{g}$

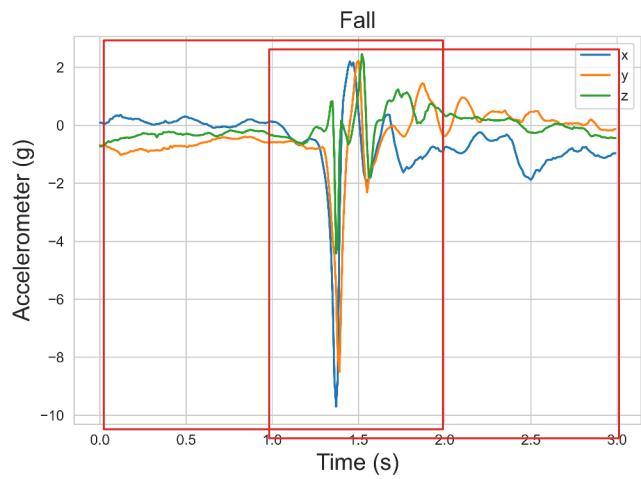
Normalizing to $[0, 1]$

Class Imbalance

- \oplus Class Weights
- \oplus Sliding Window
- \ominus Over-/Undersampling

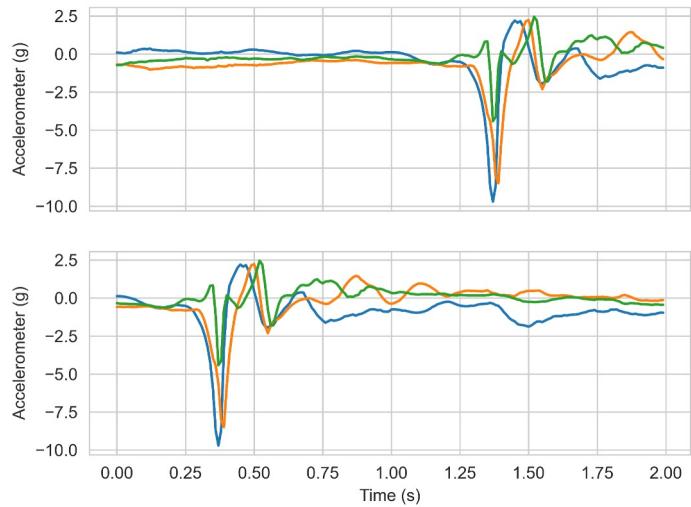


Data Preprocessing



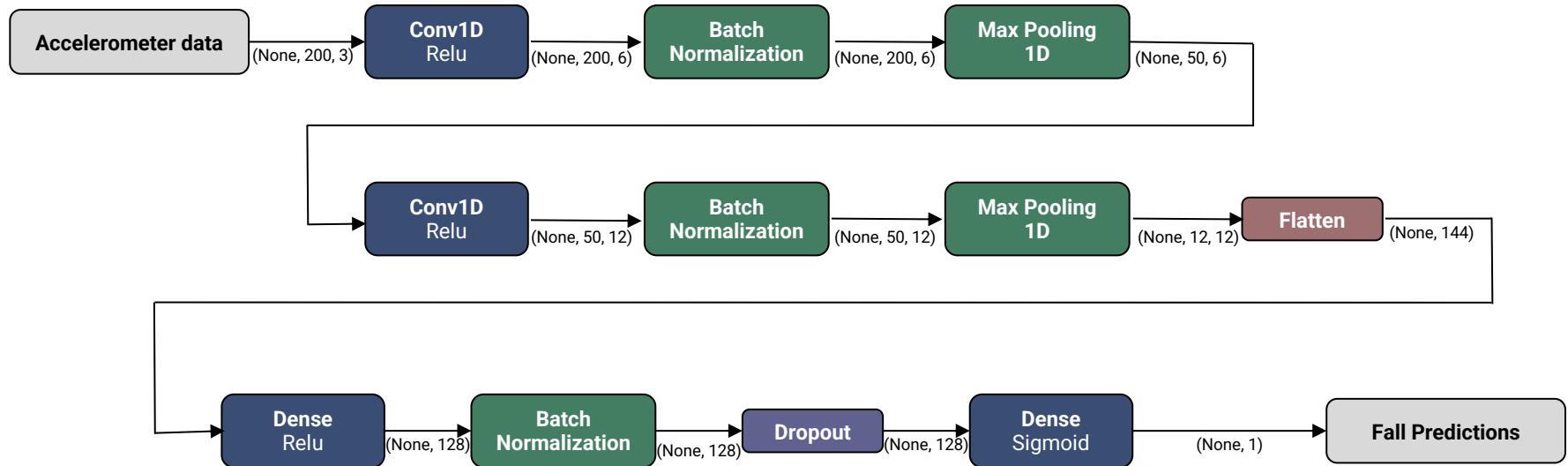
Sliding Window

Window size = 2 s
Overlap = 1 s
Sample rate 100 Hz





Final Model

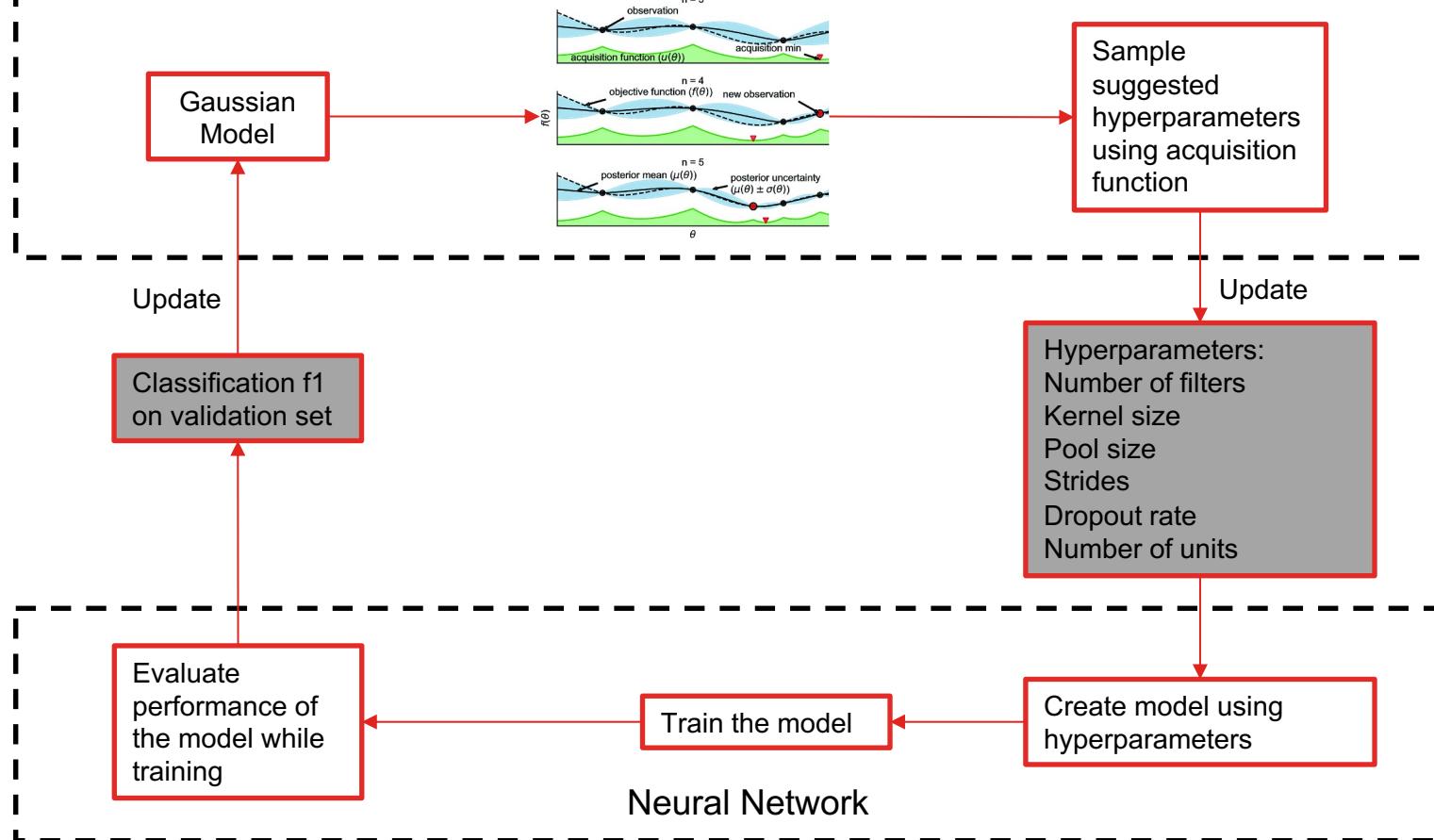


17

Based on Liu, Pengda, et al., 2021
Datanauts

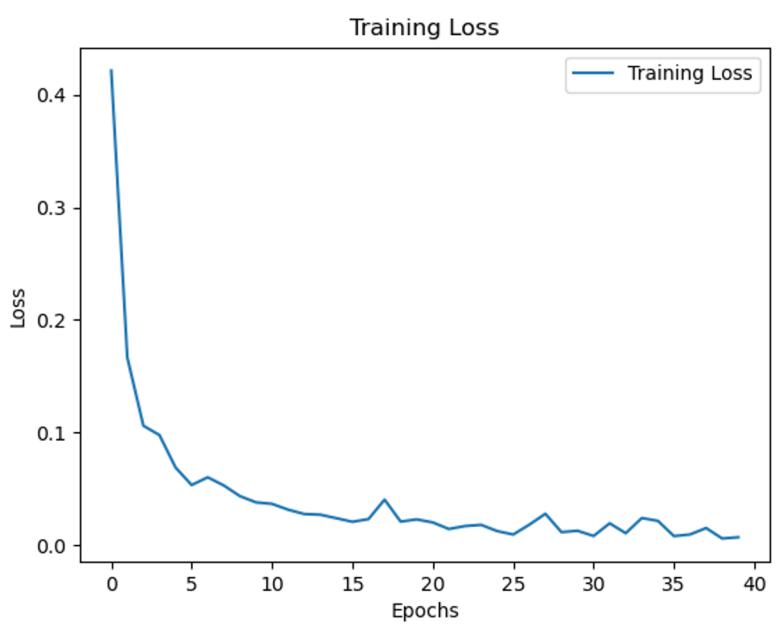
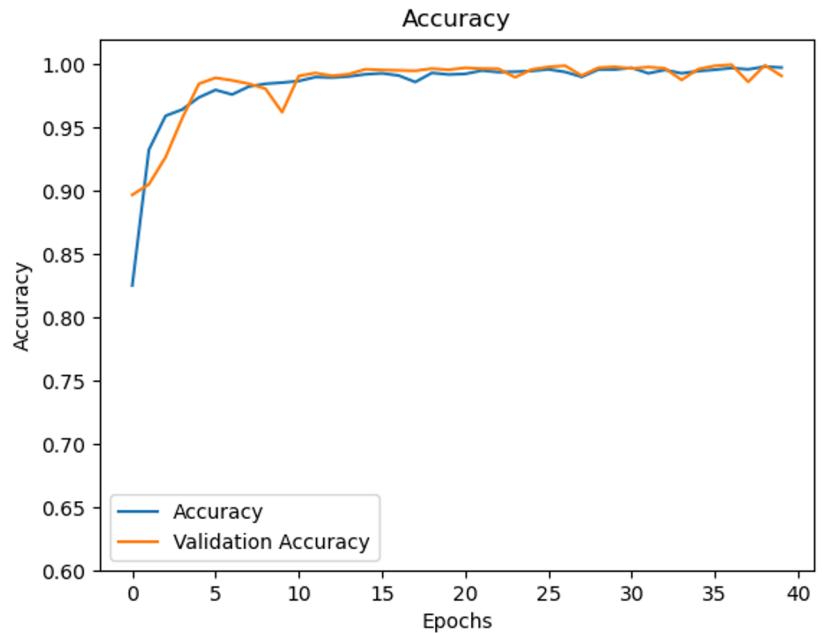


Hyperparameter tuning using Bayesian optimization





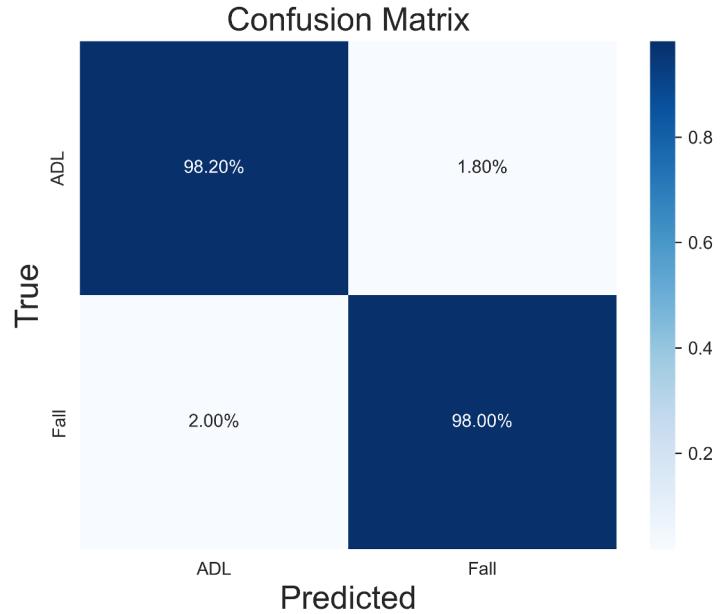
Performance vs Epochs



19



Performance on Test Set



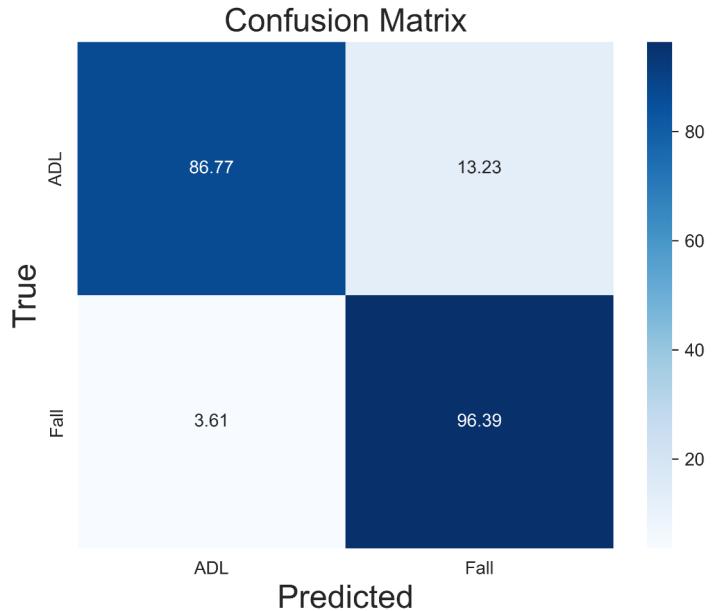
Metric	Score
AUC-ROC	98.1%
Balanced Accuracy	98.1%
Error Rate	1.9%
F1-Score	91.6%
Precision	86%
Recall	98%

20



21

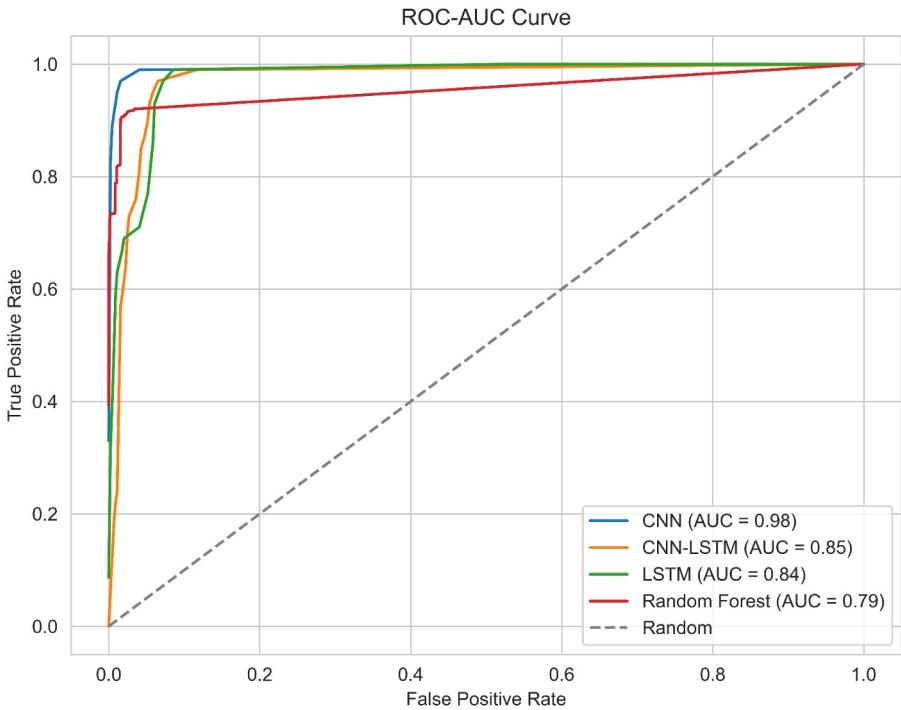
Performance on Collected Data



Metric	Score
AUC-ROC	91.6%
Balanced Accuracy	90.8%
Error Rate	8.4%
F1-Score	89.7%
Precision	83.9%
Recall	96.4%



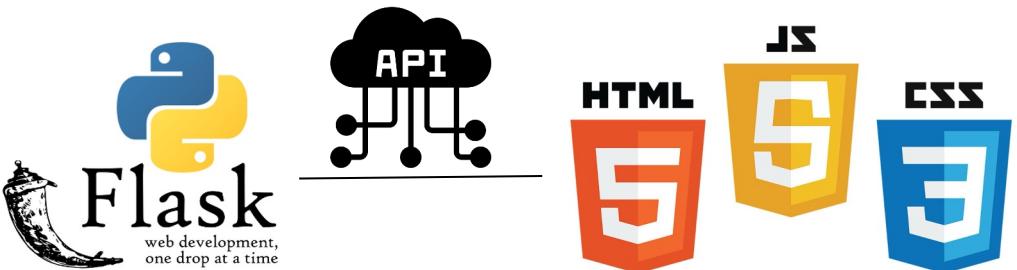
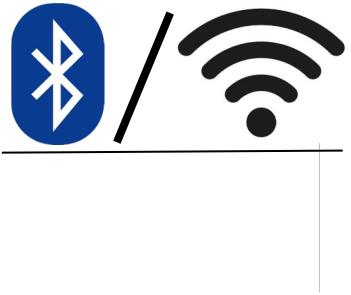
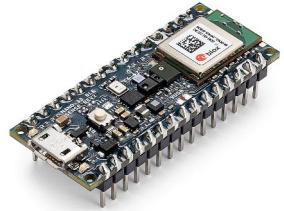
Comparison to other models



CNN-LSTM based on ⁹Jun Xu et al., 2019
LSTM based on ¹⁰Torti et al., 2019

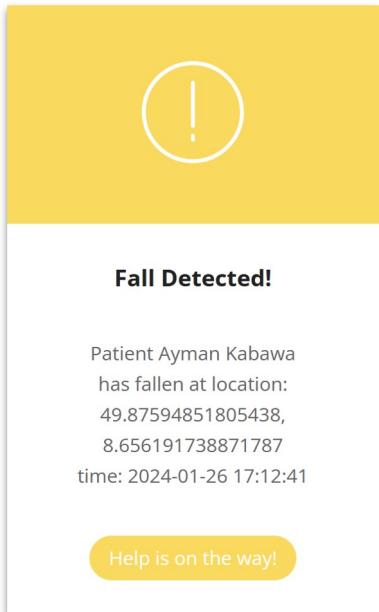
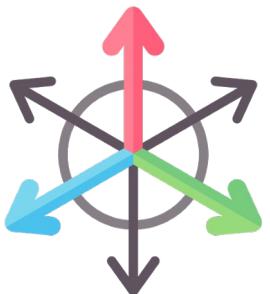
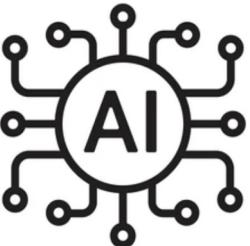


Interface





Interface





Success Criteria



F1-Score > 80 %



Real-world testing



FNR < 5 %



Latency < 5 s



Wi-Fi support



Now: Live Demo



Future work



Multi-Modal Integration



- User Interaction for Confirmation



- Fall Severity Assessment



User-Specific Fall Risk Assessment



- Biometric Authentication and privacy



- Wearable Emergency SOS Beacon



- Community based assistance

27





Thank you!

References

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