A Machine Learning approach to predict future falls for older care home residents across Japan: a collaborative study with a care company

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Introduction

- Aging and population decline -> major socio-economic problems in Japan [1]
- Increasing falls -> big challenge for elderly people [2]
- Many elderly live in care homes in Japan [3]
- Falls and related injuries are on the rise in care homes [4]
- Goals -> collaborative project to predict future resident fallers (& non-fallers)
  - Possible ergonomic changes in care homes and updating caregivers' training programs

Conclusion

- ✓ Random Forests (RF) are better than Decision trees and most other algorithms
- ✓ **4** models are made – full model and models with reduced (topmost) predictors
- ✓ **37 predictors, 36 predictors, top 30 and top 20 predictors models**
- ✓ Early & successful tool to do fall-related screening for incoming care home residents
- ✓ SHAPley (**SHAP**) plots [5] explain the model predictions in an intuitive way for caregivers

Methods

- **N=10,648** residents in SOMPO Care database
- Average age -> **88 years** old
- 2301 males and 8347 females (**22%** ♂ and **78%** ♀)
- Dataset timeline –>
  - April 2019 - March 2020 (aka Pre-COVID zone)
  - August 2021 - July 2022 (last 1 full year of available data)
  - 6949 common residents
- Completely anonymized and delivered to AIST
- Non-fallers (0) & multiple fallers (1) -> binary classification problem
- Modeling algorithms considered -> Decision trees, **Random forests**, kNN, Naïve Bayes, Boosting, Light GBM
- 60% used for training, 20% for validation & 20% for pure testing
- Predictors used ->
  - mostly **Activities of Daily Living (ADLs)** of residents, especially if they can really do the activities or not
  - Nursing care status, **subjective risk of falling**, history of falling, facility type of residents, age-groups, among others
  - Predominantly categorical, also a few ordinal and numeric
  - One-hot encoding was done, as needed

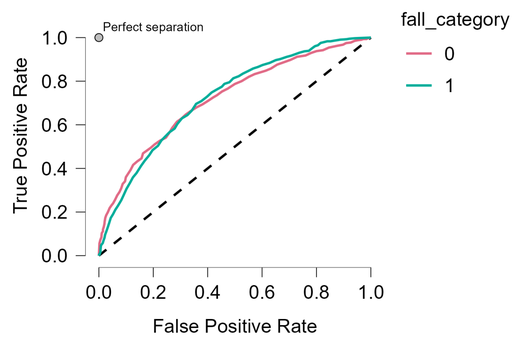
Predominantly from ADLs., we can identify future fallers (& non-fallers) with ~70% accuracy

Results

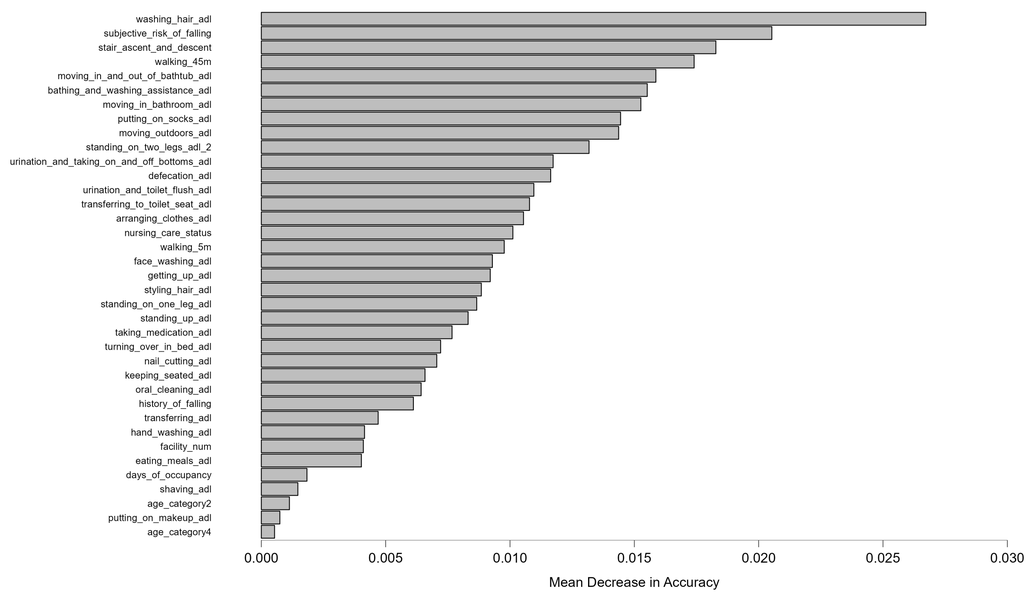
*Better model metrics than [6] -> **66%** specificity, **67%** accuracy, precision, recall, F1 score, NPV and **73%** AUC (averaged over both classes) -> test set, unseen during model training*

Confusion Matrix ▼

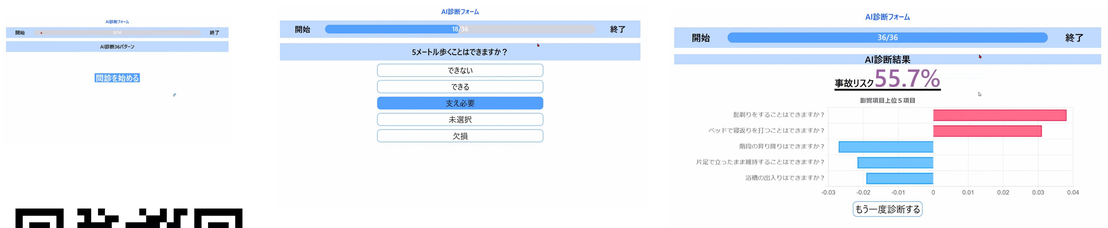
		Predicted	
		0	1
Observed	0	891	301
	1	400	537



- ✓ From Pre-COVID to final dataset changes
  - ✓ **3993** residents remained non-fallers
  - ✓ **1830** residents remained multiple fallers
  - ✓ **1126 residents became multiple fallers**



Discussion and Future Work



Models with reduced predictors -> similar model metrics as the full model

Goal -> to generalize the tool for community-dwelling elderly and partner with city halls & rehab centers

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Create the Future, Collaborate Together

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