

Performance Improvement of a Two-Stage Classification Algorithm in a Cloud-Based MCI Screening System

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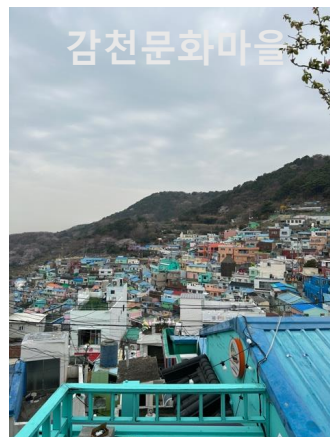
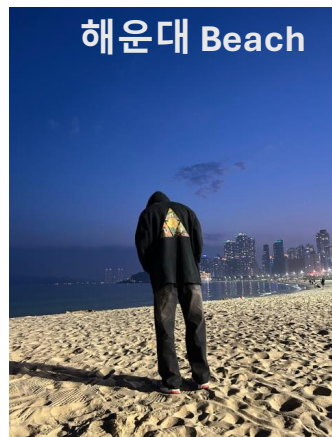
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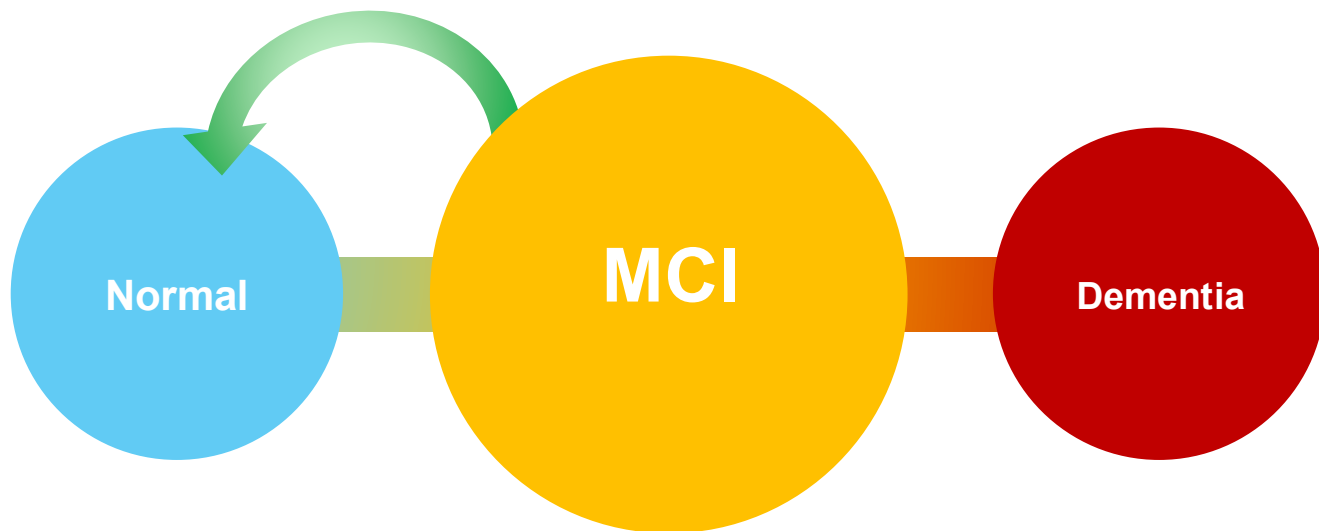
📍 서울



📍 부산



1. Backgrounds



Mild Cognitive Impairment (MCI)

The stage where mild cognitive impairment is recognized

Appropriate interventions can revert MCI to Normal

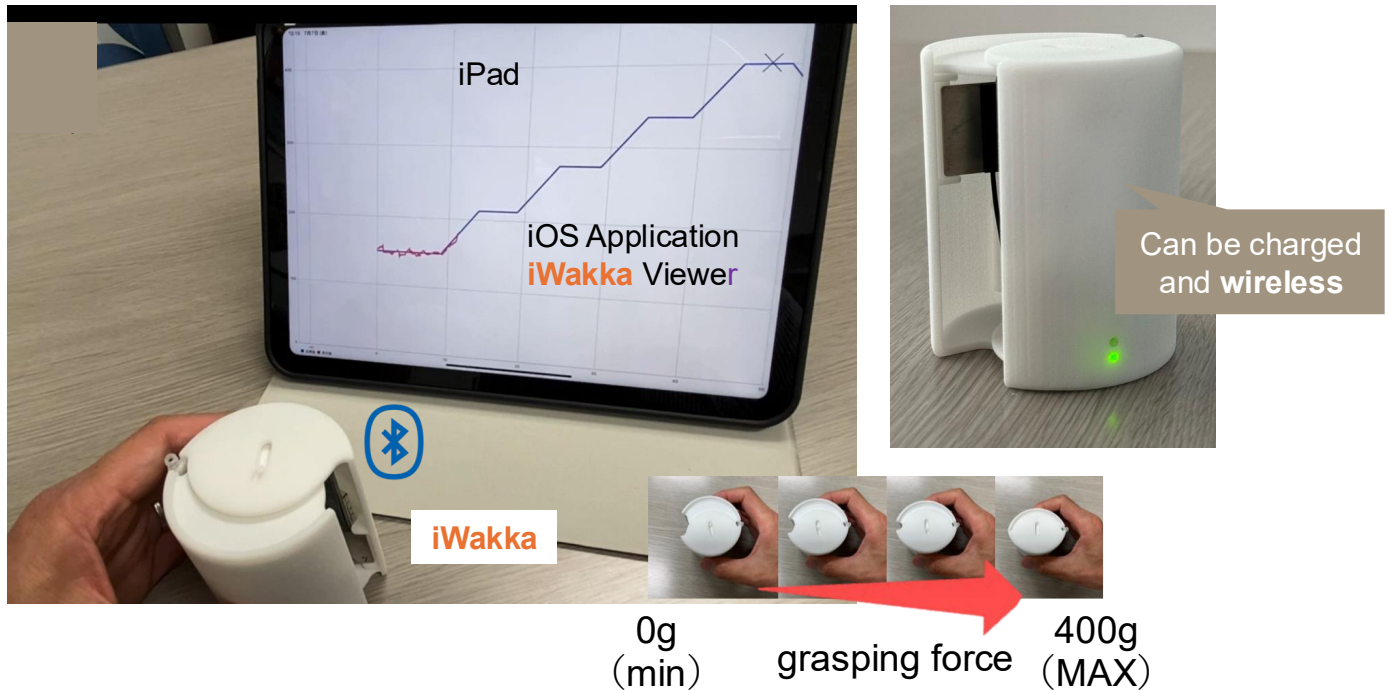
Detecting MCI by Using iWakka

What is iWakka?

A device for measuring the grasping force of the user when grasping a **soft material**



Tohu (豆腐)



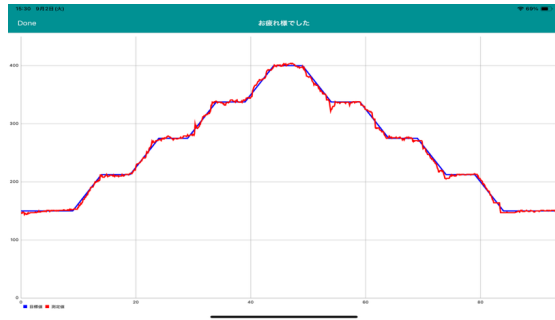
1. Backgrounds

How to Use

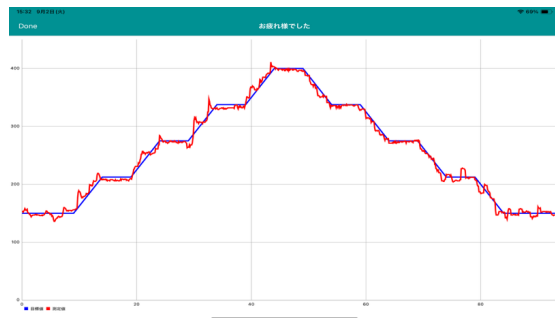


- Red point moves vertically according to the user's grasping force
- Users try to adjust their grasping force to keep the red point along the blue line

How to Evaluate



AGFscore is low
(Superior grasping control ability)



AGFscore is high
(Inferior grasping control ability)

- **AGF** : Adjustability for Grasping Force
 ↳ The ability to modulate grasping force through muscle contraction control
- Learning Rate (*LR*)

$$AGFscore [g] = \frac{1}{N} \sum_{k=1}^N |f(k) - f_d(k)|$$

$f(k)$: Measured Force[g]

$f_d(k)$: Target Force[g]

N : Number of samples in the evaluation period

$$LR^j = \frac{\overline{AGF}^1 - \overline{AGF}^j}{\overline{AGF}^j}$$

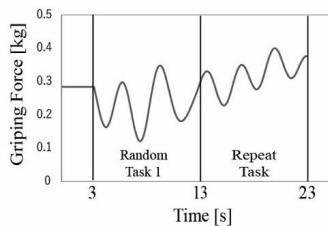
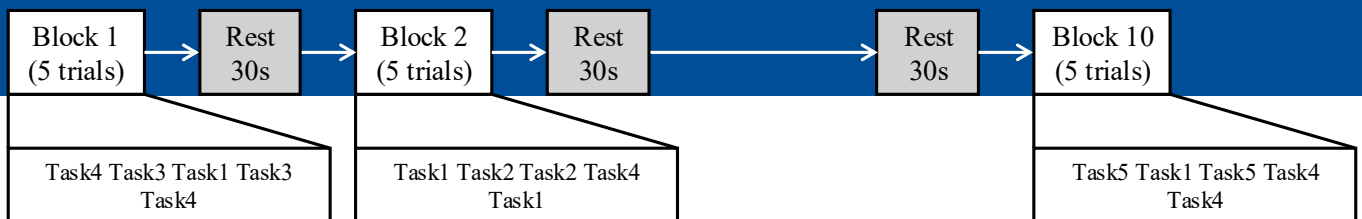
\overline{AGF}^j : AGF in Block j

1. Backgrounds

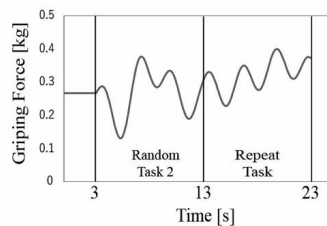
Subjects : 126 elderly individuals

Tasks : 5 kinds of waveforms combined from two sine waves (23seconds × 5trials × 10blocks)

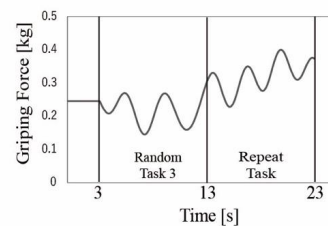
Protocol



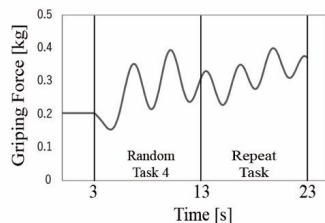
(a) Task 1



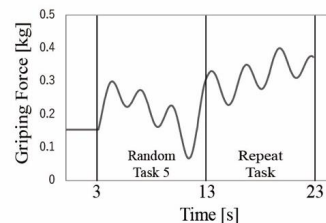
(b) Task 2



(c) Task 3

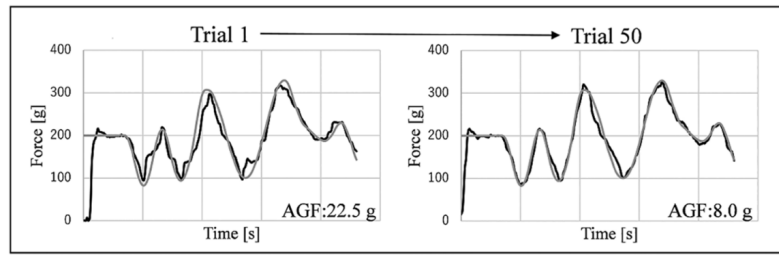
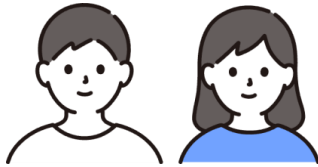


(d) Task 4



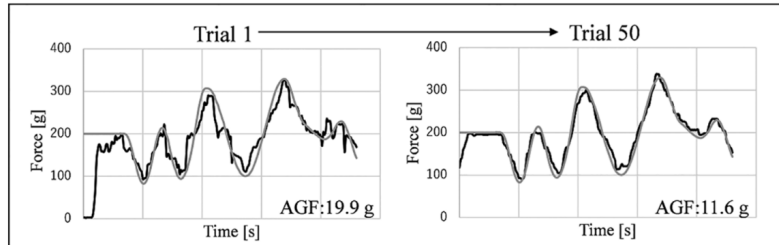
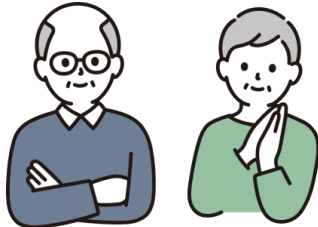
(e) Task 5

Young Adults (YA)



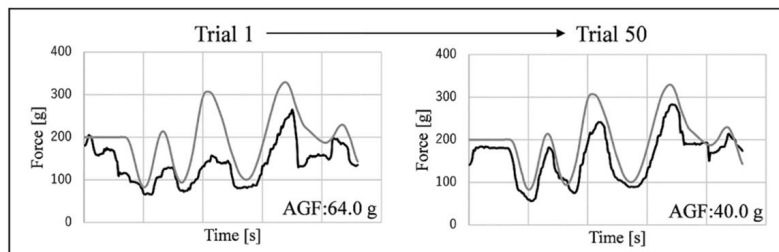
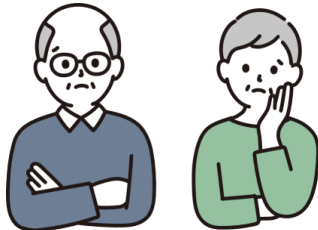
(A) Subject in the YA group

Older Adults (OA)

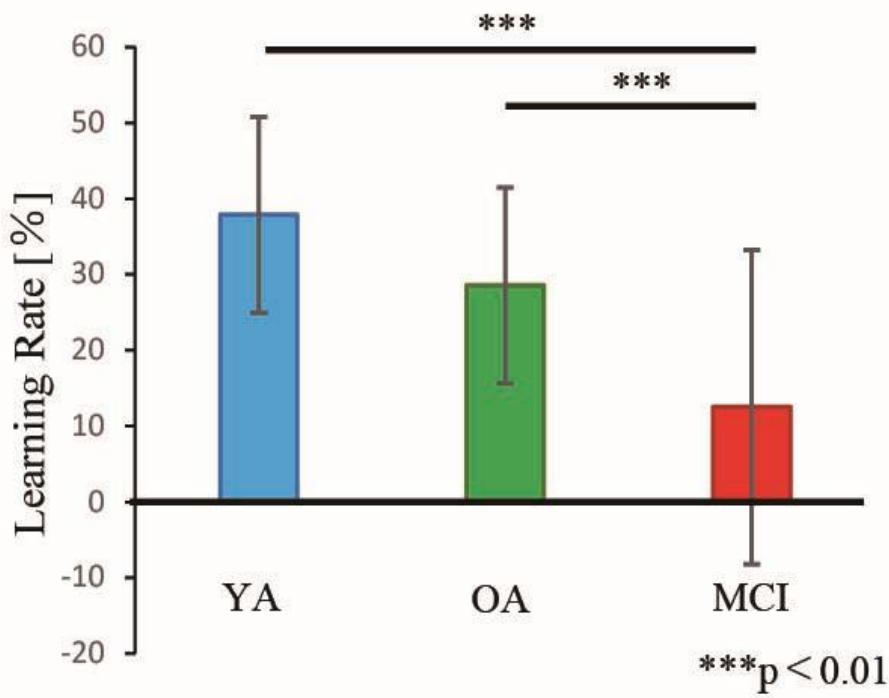


(B) Subject in the OA group

MCI



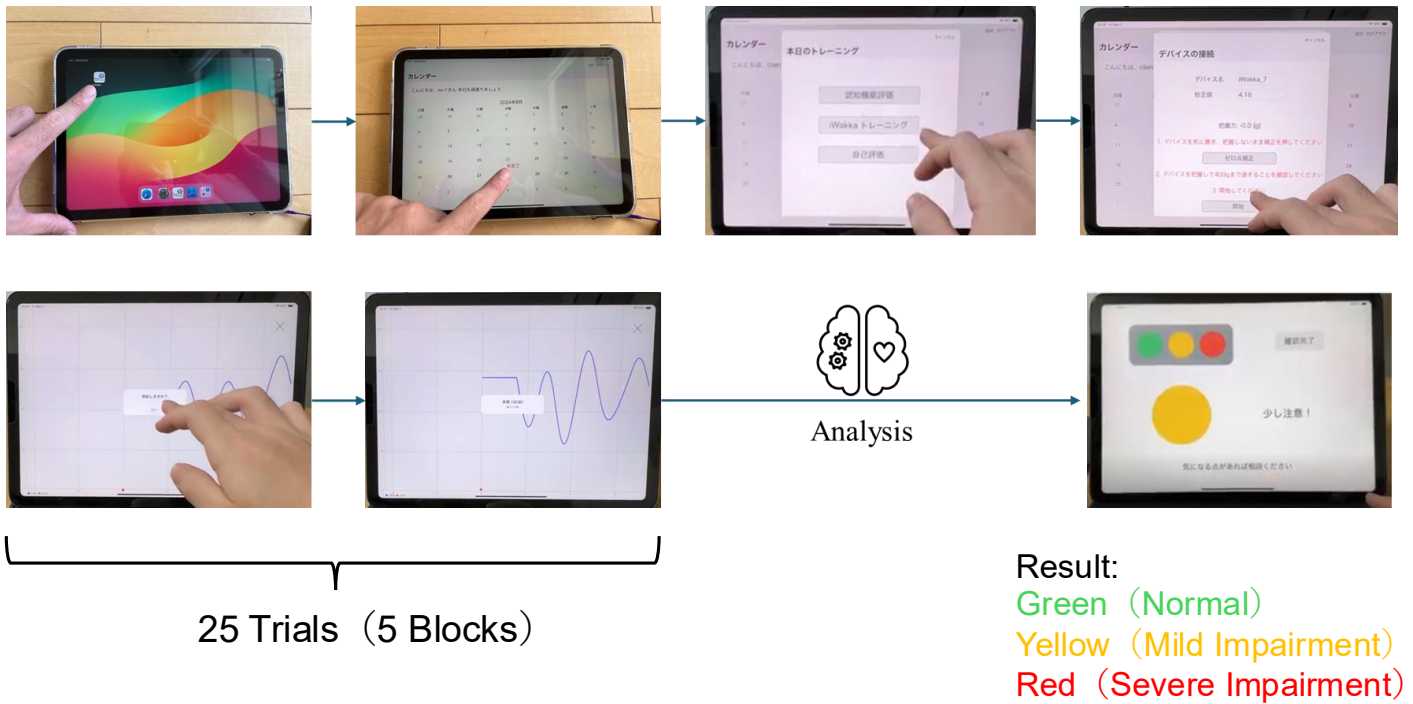
(C) Subject in the MCI group



Detect significant differences between YA and MCI, OA and MCI

→ Learning Rate is an **effective variance** to classify users to Normal or MCI

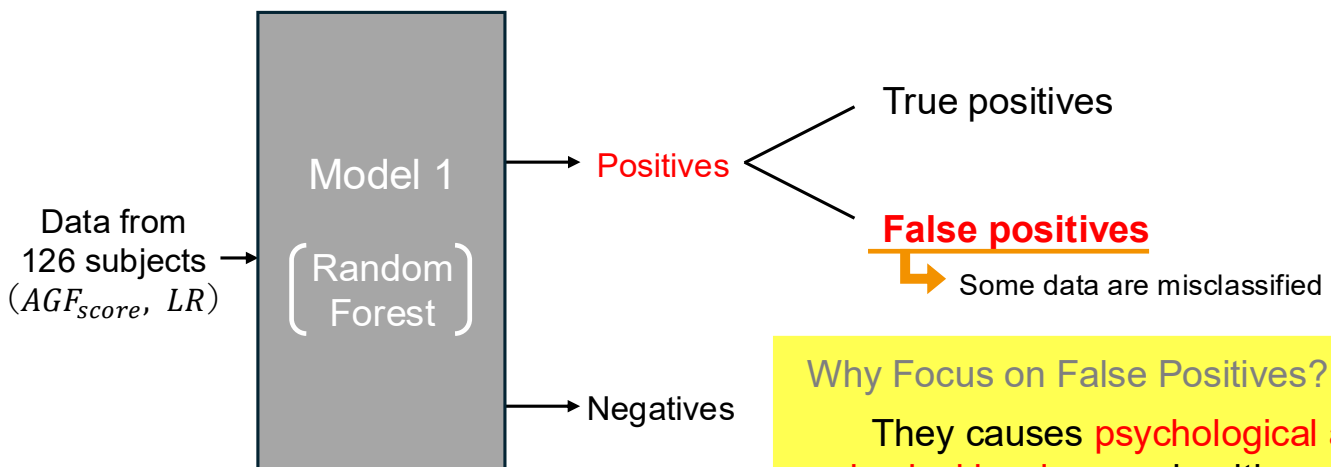
iWakka Health Care System



Evaluate user's cognitive skills in 15 minutes

2. Experimental Methods

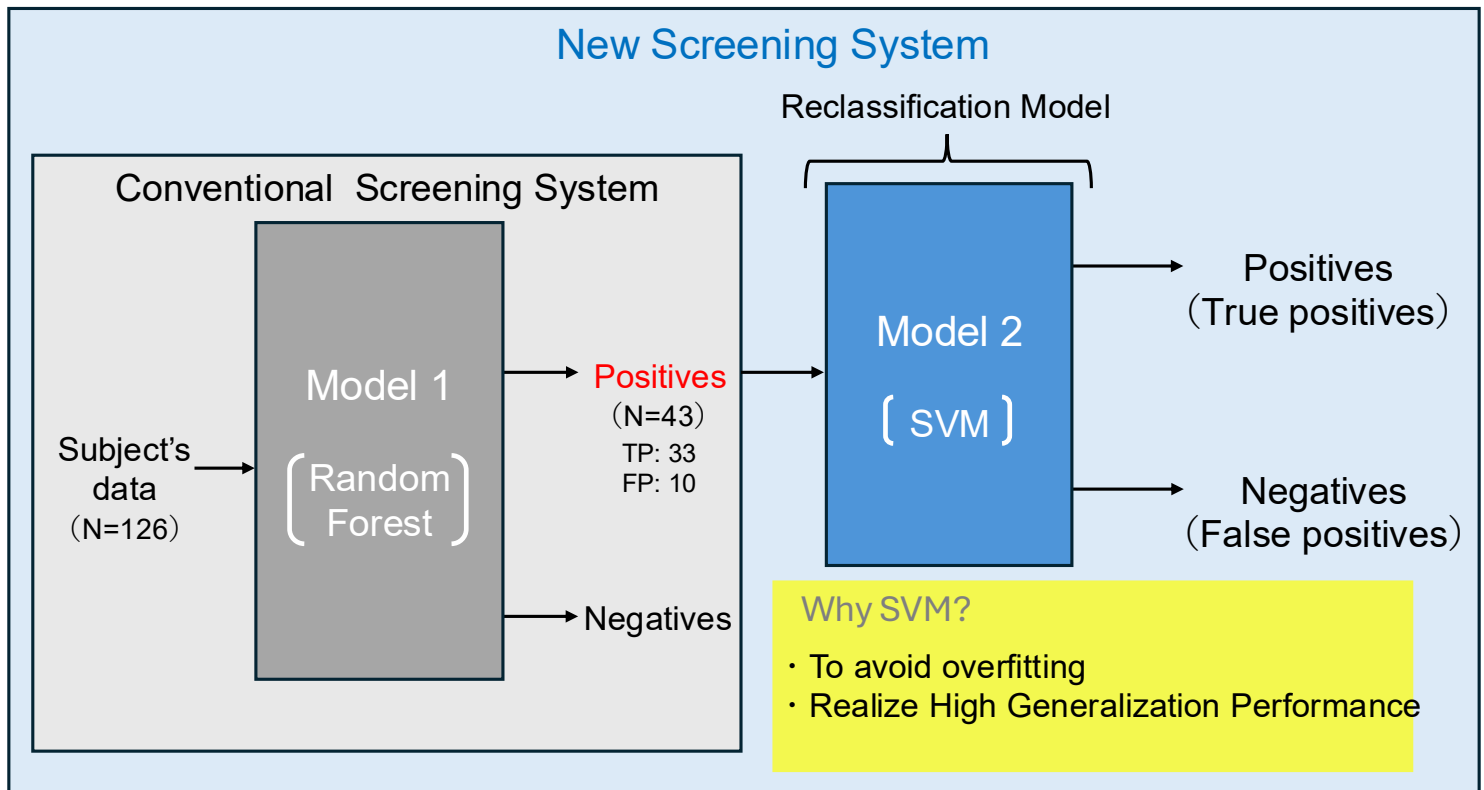
Toshima (2025) : Created MCI screening model
 Area Under the Curve (AUC) : 0.81



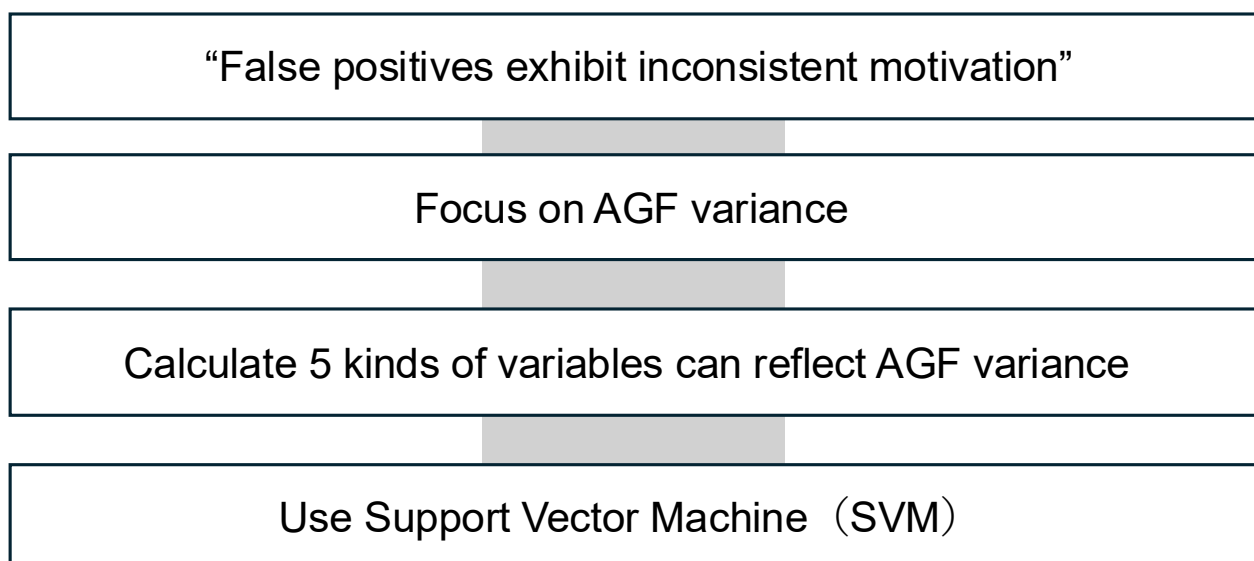
Why Focus on False Positives?
 They causes **psychological and physical burdens** on healthy patients
 → Hinders the optimal allocation of medical resources

→Address this problem by **re-classifying** positives into True Positives or False Positives

Reducing false positives by applying two-stage model and improve the performance of the MCI screening system



Constructing procedure of reclassification model

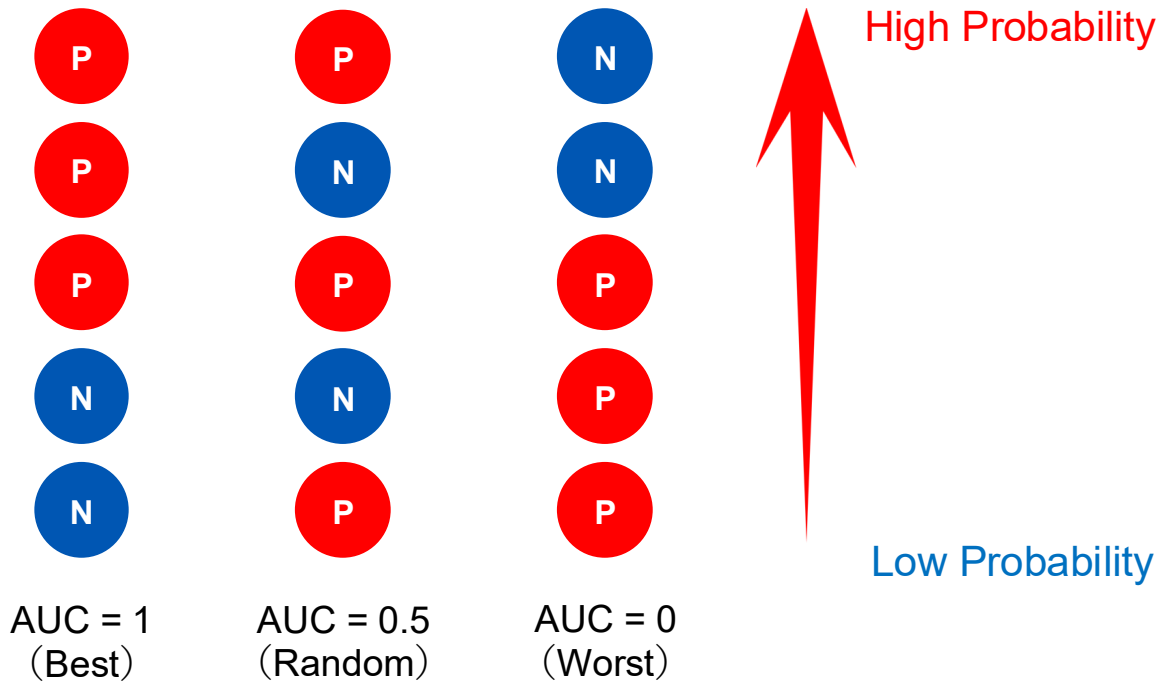


Model performance was evaluated by calculating the **AUC** using 5-fold stratified cross-validation.

AUC

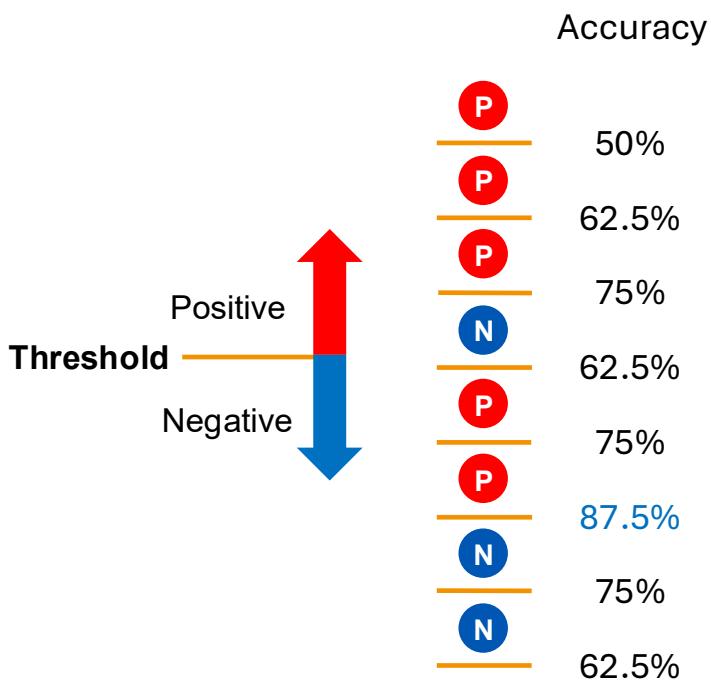
→The ability to rank subjects by their probability of being positive (MCI)

Example) 5 Subjects (3 Positives, 2 Negatives)

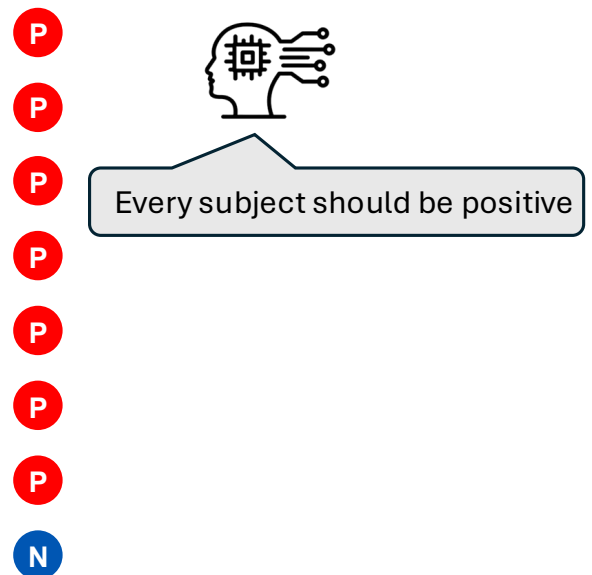


Why not Accuracy?

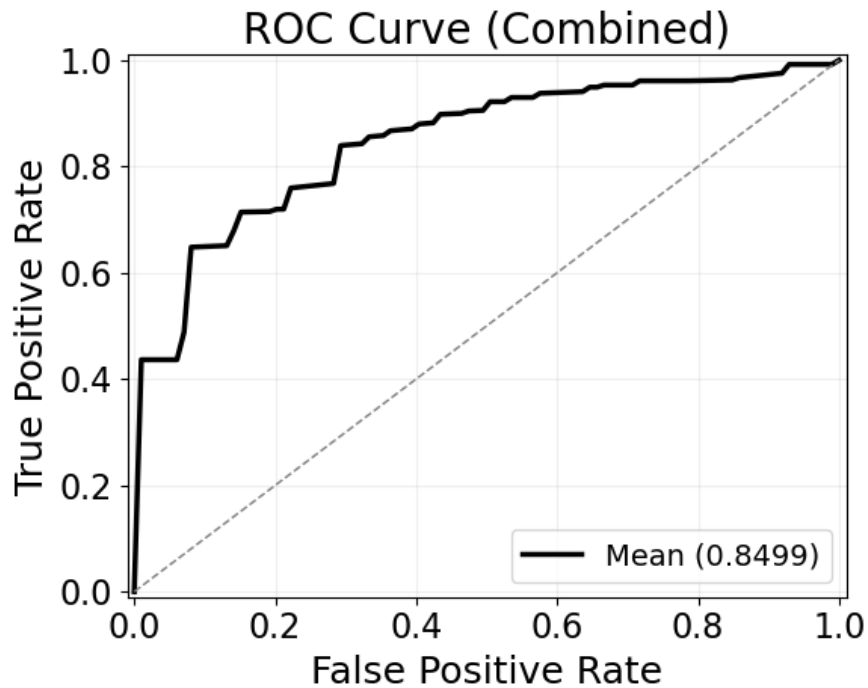
① Threshold Dependency



② Imbalance Sensitivity



Combined Model AUC



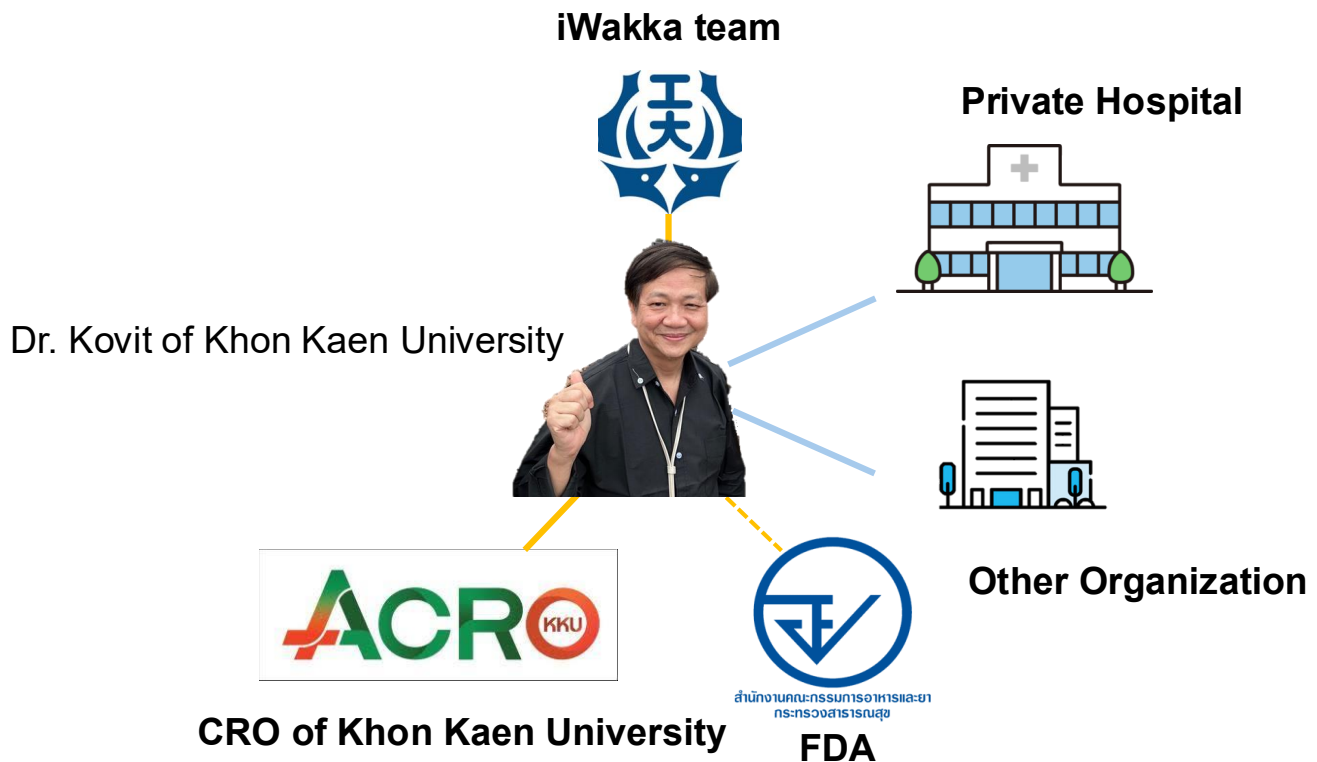
Combined Model AUC : **0.85** (Conventional Method : 0.81)

→Contribute to Reducing False Positives

4. Collaborative Research with Thailand



Collaborative Research is in the Works



5. Conclusion

Objective

Reducing false positives by applying two-stage model and improve the performance of the MCI screening system

Results

Improved AUC to 0.85

→ Enabled more precise classification of the borderline between positive and negative cases than conventional methods

Future Works

- Redefining features
- Incorporating ongoing data in Tobishima city

Thank you for your attention

 *My hometown, Kyoto City from Mt. Daimonji*

