EEG daydreaming, a machine learning approach to detect daydreaming activities

Ruyang Wang (Brandeis University), Xiaodong Qu (Swarthmore College)

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Outline

Introduction

Data

Method

Result

Discussion & Future Work

Conclusion

Introduction

Challenge: Low signal-to-noise ratio

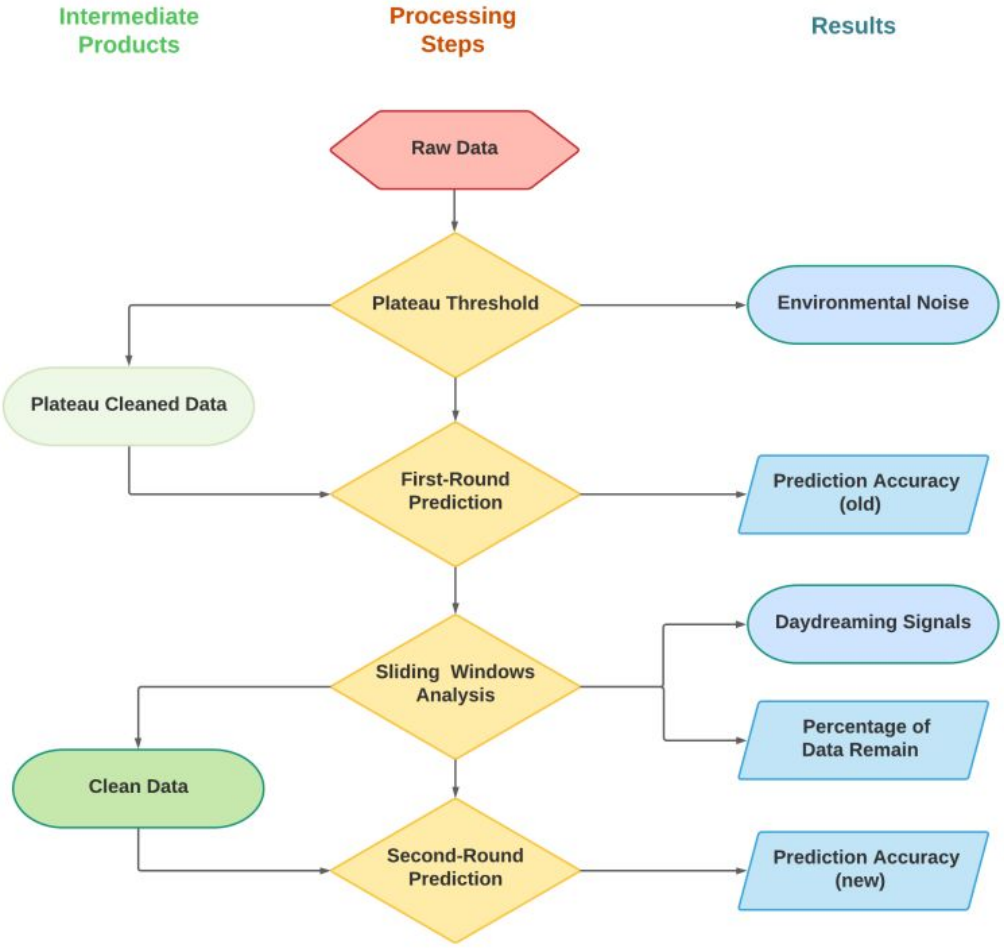
- Noise from the outside: environmental noise
- Noise from the human body
  - Physical activity: blinking and breathing
  - Mental activity: distracting thoughts — **Daydreaming signals**

Data

- Thinking1 BCI experiments dataset
- 16 subjects, 6 sessions (each lasting for five minutes),
- 5 tasks (Think [T], Count [C], Recall [R], Breathe [B], Draw [D], each task one minute)

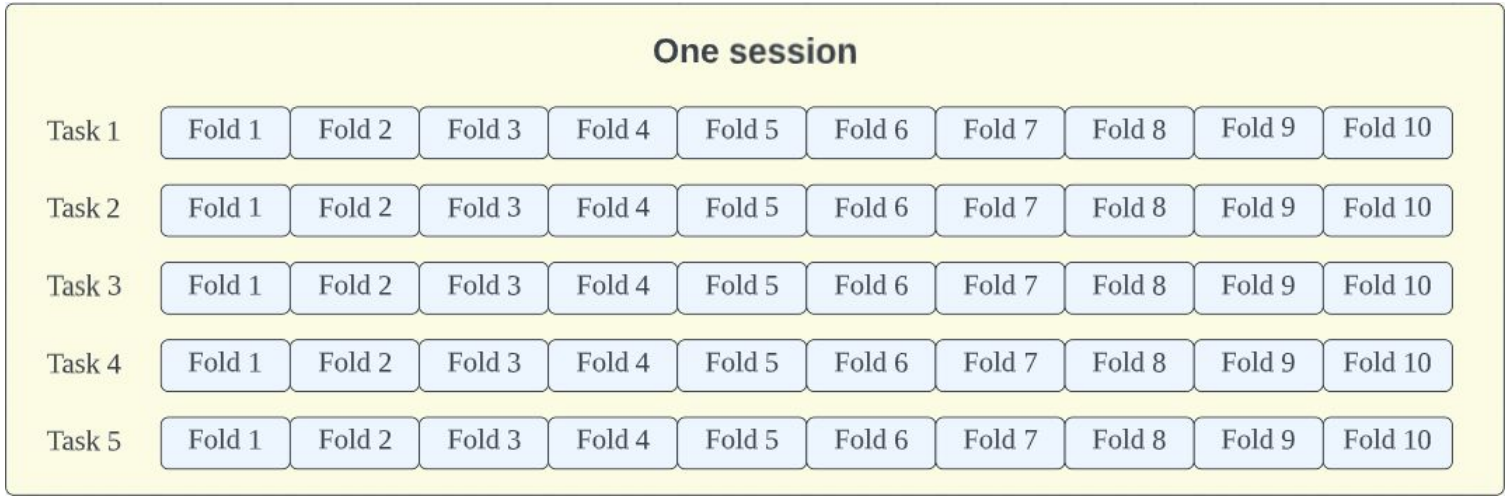
S/T	1	2	3	4	5
1	T	C	R	B	D
2	B	T	C	R	D
3	T	B	R	D	C
4	T	C	R	B	D
5	C	T	R	D	B
6	T	C	B	R	D

Method

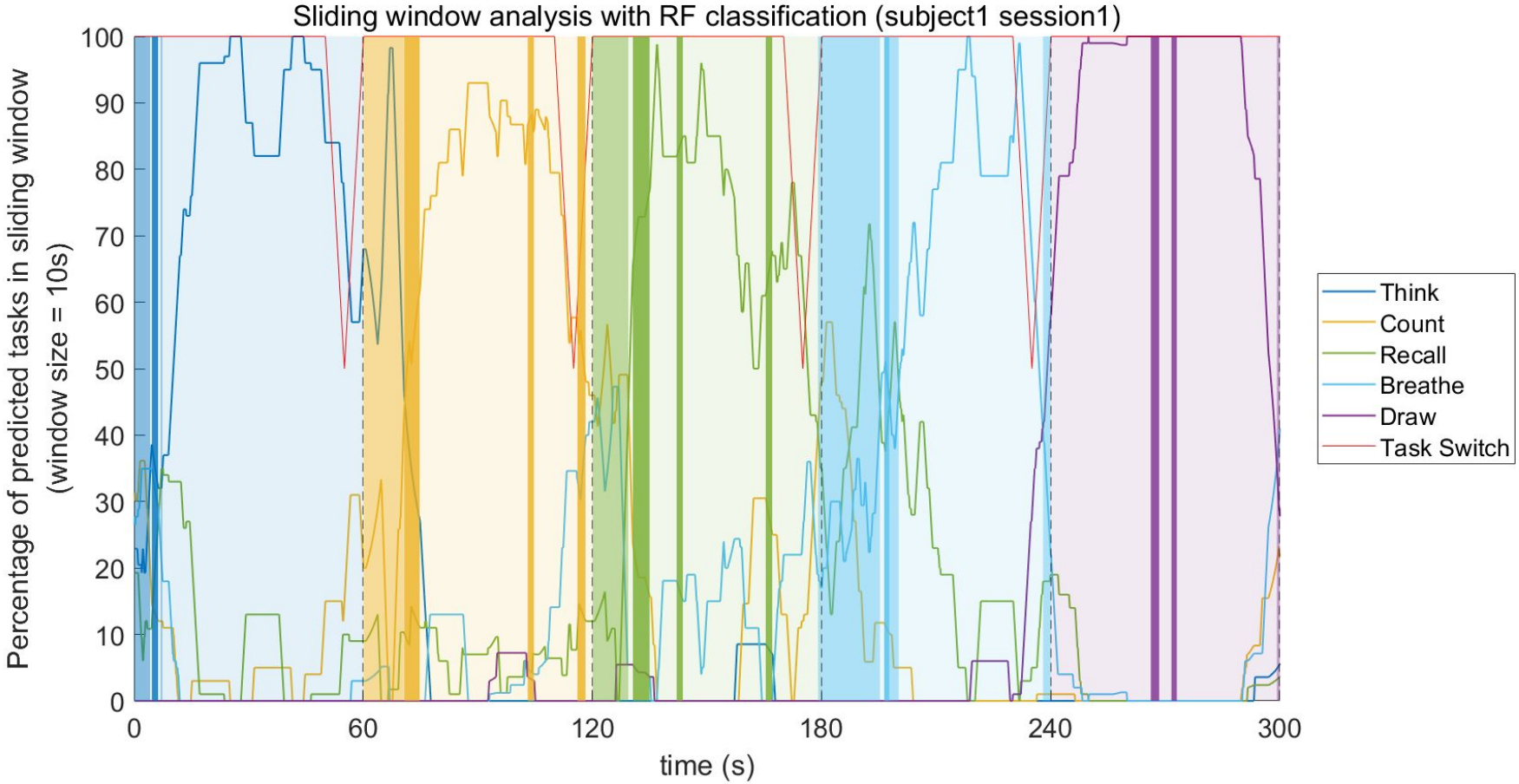

Intermediate Products
Processing Steps
Results
Raw Data
Plateau Threshold
Environmental Noise
Plateau Cleaned Data
First-Round Prediction
Prediction Accuracy (old)
Daydreaming Signals
Sliding Windows Analysis
Percentage of Data Remain
Clean Data
Second-Round Prediction
Prediction Accuracy (new)

Method—first-round prediction

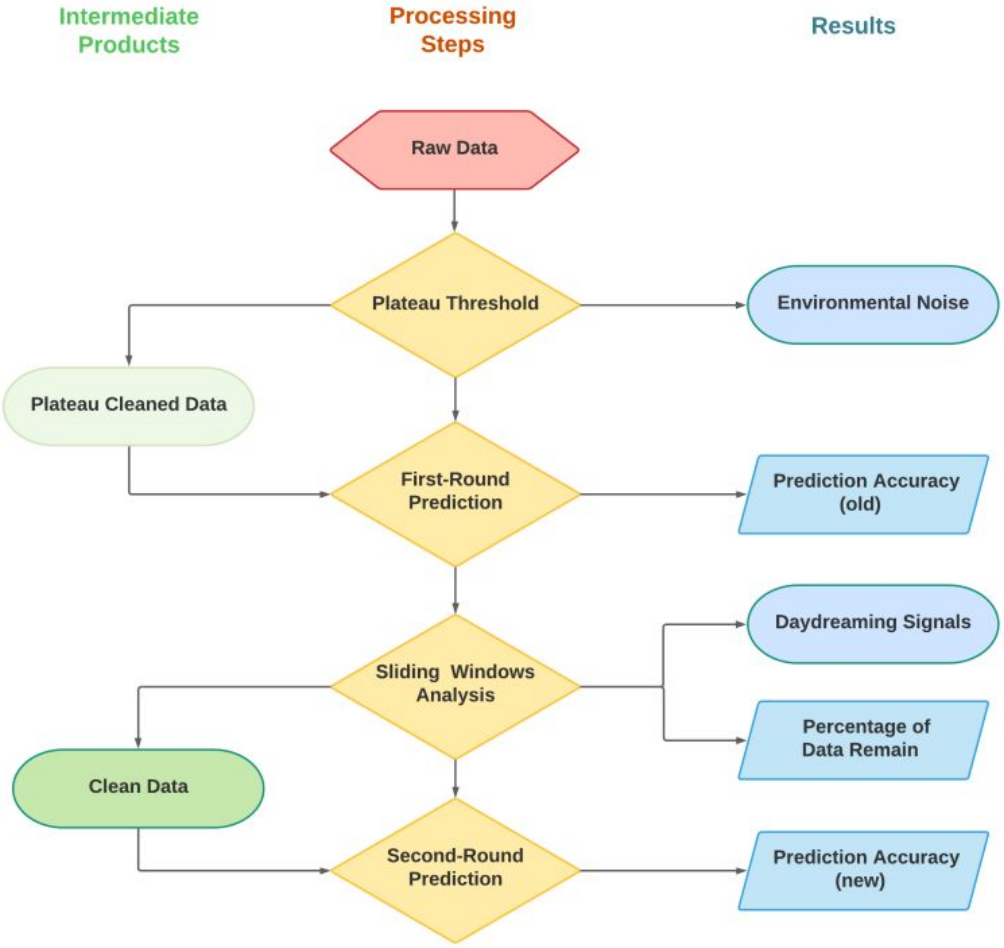
- 10-fold cross validation
- Baseline method: Random Forest (RF), Support Vector Machines (SVM), or Long Short-Term Memory (LSTM) (LSTM)
- Record classification results



Method—remove daydreaming signal with sliding windows



Method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Method—second-round prediction

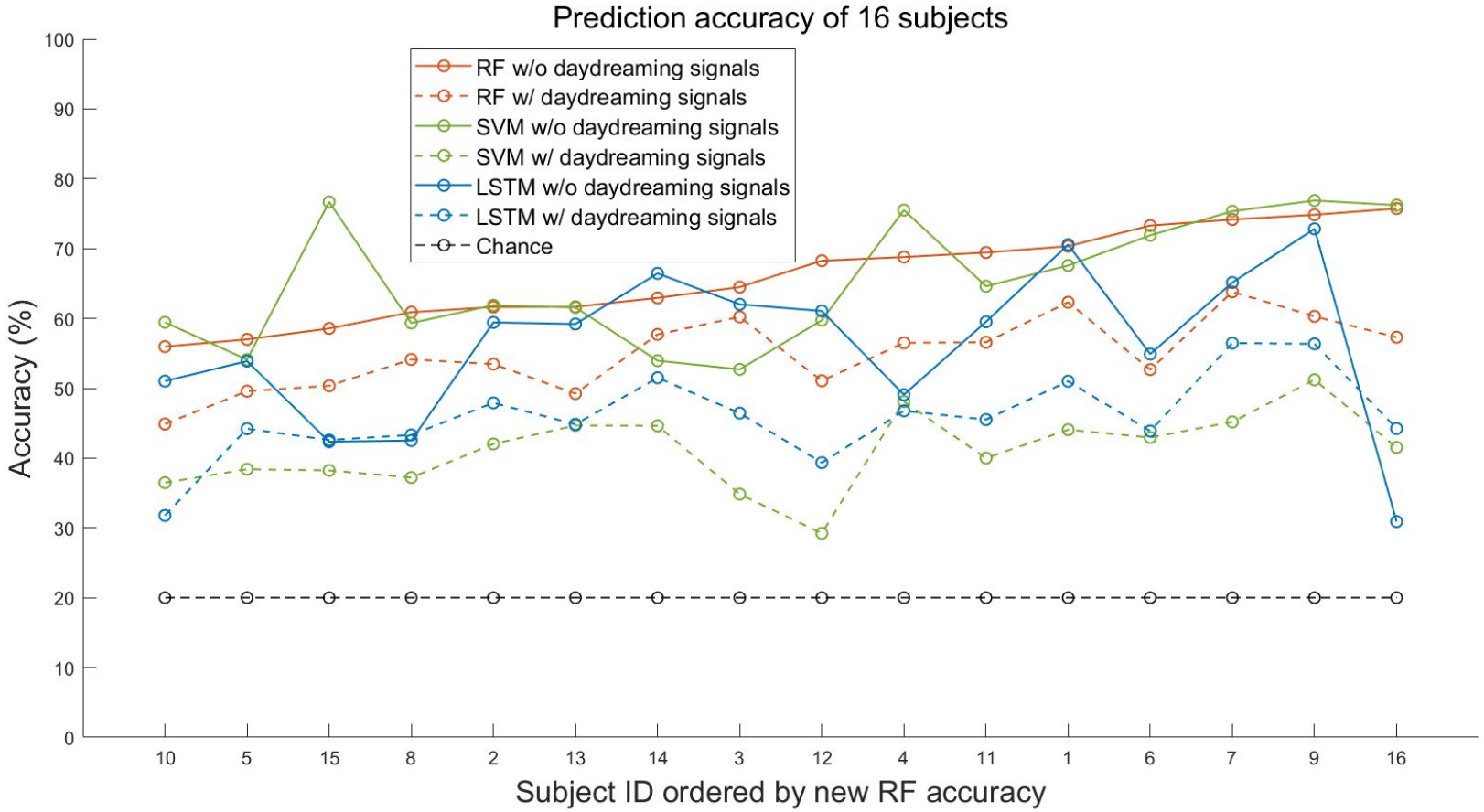
- Same as first-round:
  - 10-fold cross validation
  - Same baseline method: Random Forest (RF), Support Vector Machines (SVM), or Long Short-Term Memory (LSTM) (LSTM)
- Record classification results
- Calculate data remaining percentage and prediction accuracy

Results

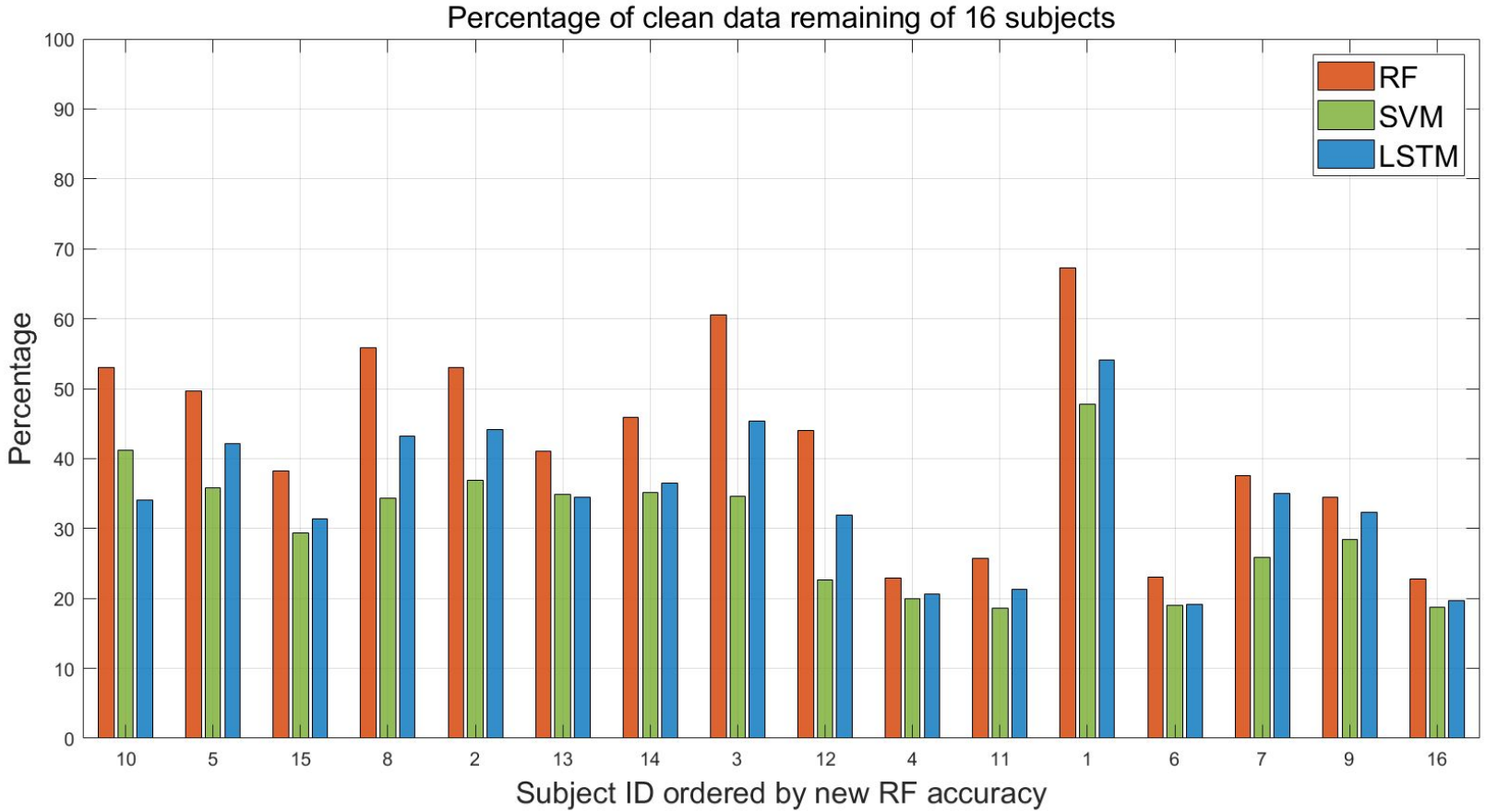
Average Prediction Accuracy for Baseline Methods

	RM	SVM	LSTM
Prediction Accuracy (old)	55.0	41.2	46.0
Prediction Accuracy (new)	**66.1**	**65.5**	**56.3**

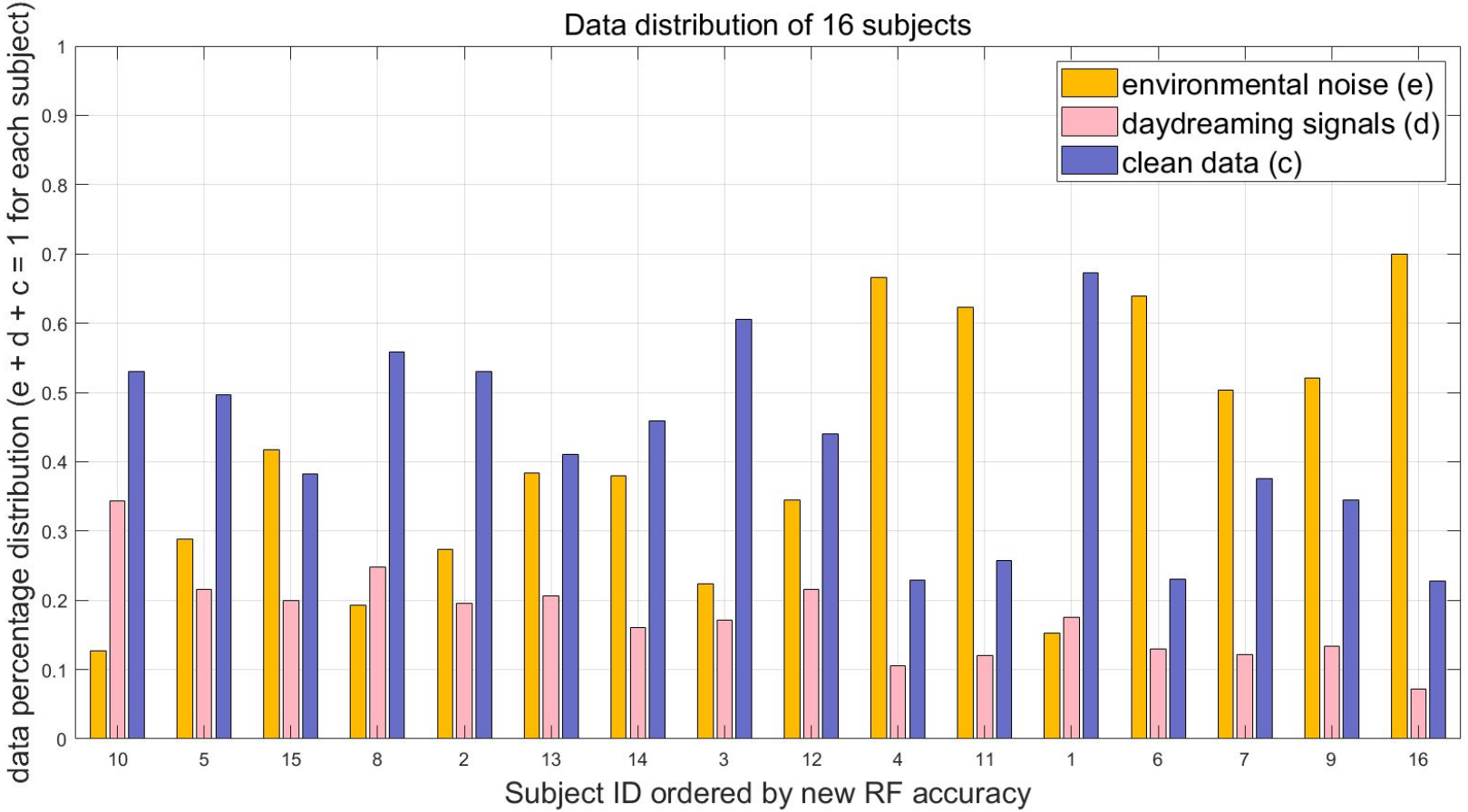
Result: Prediction accuracy



Result: Data remaining



Result: Data distribution



Discussion & Future direction

- Baseline methods: RF, SVM, LSTM
  - Accuracy
  - Other Algorithms
- Sliding windows: size & overlap
- Daydreaming signal distribution pattern
- Larger dataset

Conclusion

- Sliding windows -> Daydreaming signals
- Increased accuracy
- Designing and adjusting experimental setups
- Personalizing uses

	RM	SVM	LSTM
Prediction Accuracy (old)	55.0	41.2	46.0
Prediction Accuracy (new)	**66.1**	**65.5**	**56.3**

Questions?

Thank you for listening!