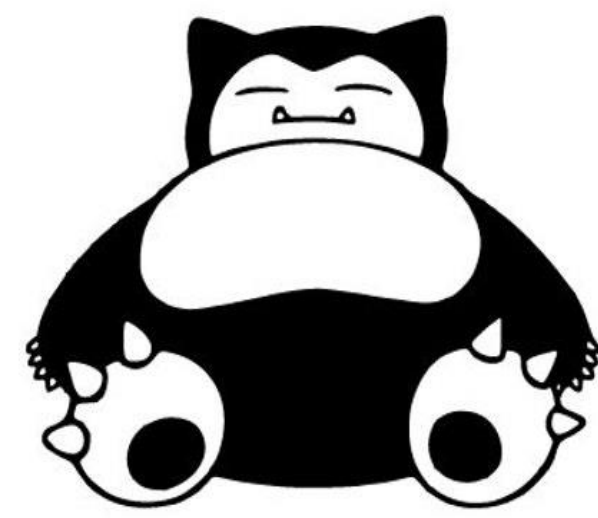


MOTIVATION

- Sleep: a crucial role in overall health and quality of life
- Wrist-worn actigraphy: a cost-effective and unobtrusive method
- There has not yet been a comprehensive comparison of published sleep algorithms



ALGORITHMS TESTED

Algorithm	Method	Features used	Output	Open source
Cole-Kripke (CK)	Linear model	Scaled activity count in 7-minute window	Sleep label of each epoch	R package actigraph.sleep
Sadeh (S)	Linear model	Statistics of activity count from an 11-epoch window	Sleep label of each epoch	R package actigraph.sleep
Tracy (T)	Decision Tree	Activity counts over time	Sleep label of each epoch	R package PhysActBedRes
She-Zhai (SZ)	Hidden Markov model, Fisher's linear discriminate	Median and s.d from epochs	Sleep label of each epoch	https://gitlab.eecs.umich.edu/yayazhai/shezai_bme2020
Tudor-Locke (TL)	Automation	Sleep label of each epoch	sleep quality metrics	R package actigraph.sleep

INITIAL DATA & RESULTS

DATA



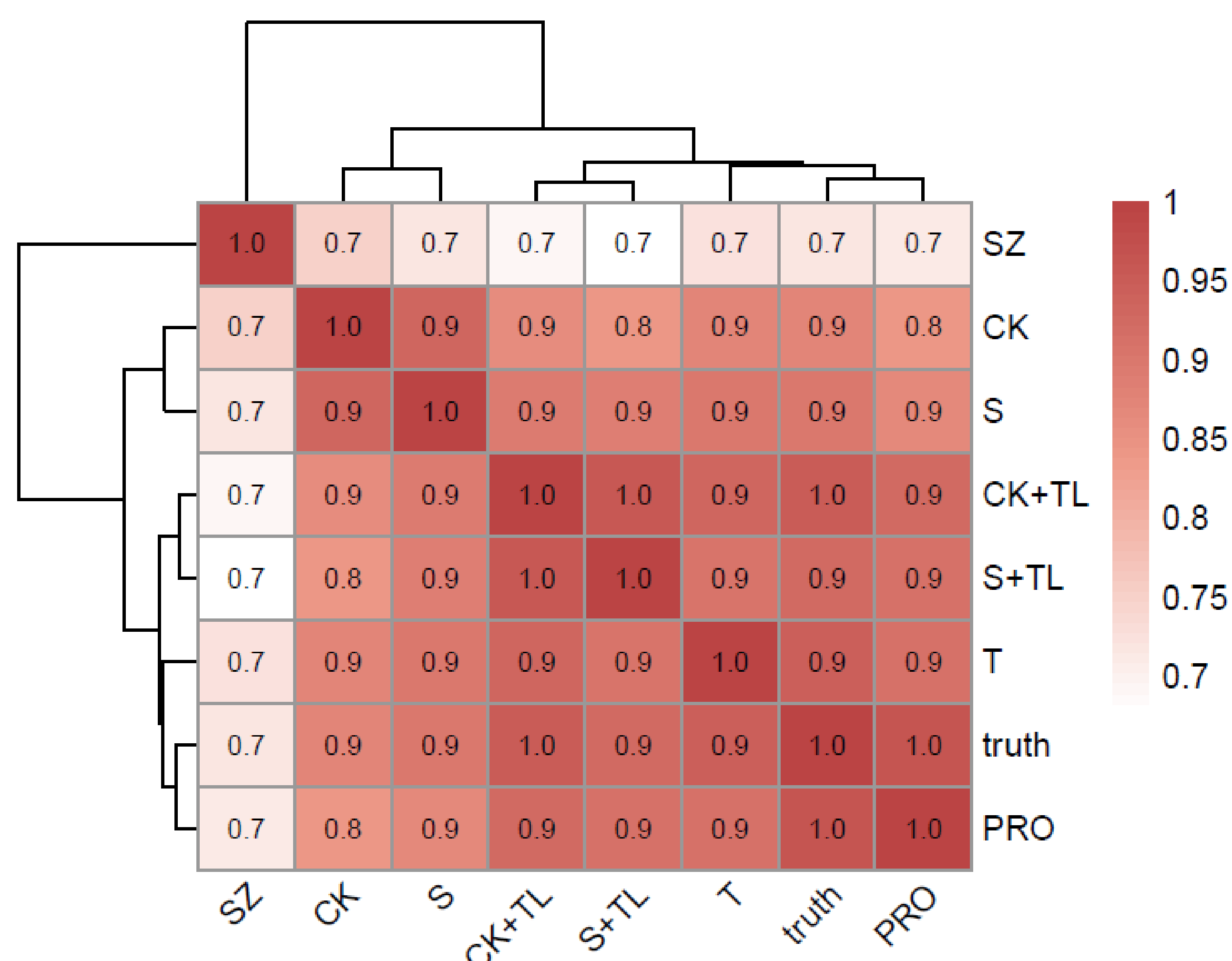
RESULTS

Table 1. Performance of sleep detection algorithms versus expert-curated reference sleep annotations.

	PRO	CK	S	CK+TL	S+TL	T	SZ
Accuracy	0.96	0.87	0.90	0.95	0.93	0.95	0.72
Sensitivity	0.80	0.83	0.80	0.82	0.75	0.88	0.79
Specificity	0.85	0.82	0.88	0.94	0.95	0.90	0.59
F1 Score	0.95	0.83	0.86	0.92	0.88	0.92	0.68
Sleep onset ^a	1 ± 121	188 ± 136	189 ± 137	39 ± 80	62 ± 94	36 ± 69	-22 ± 191
Sleep duration ^a	-12 ± 123	-373 ± 110	-401 ± 99	-75 ± 105	-119 ± 119	-60 ± 96	40 ± 250
Sleep offset ^a	-11 ± 33	-184 ± 125	-212 ± 123	-36 ± 70	-57 ± 87	-21 ± 64	18 ± 186

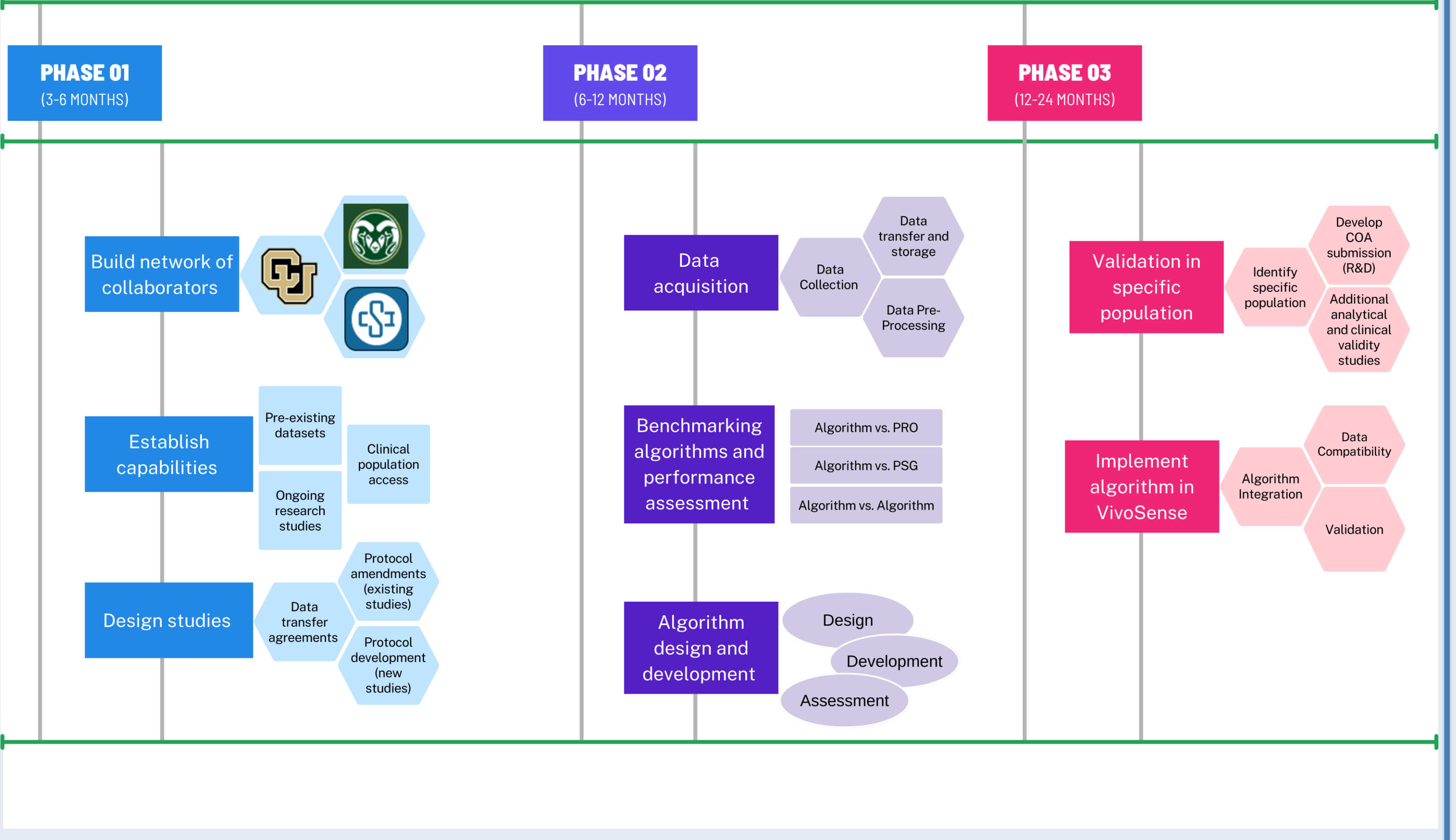
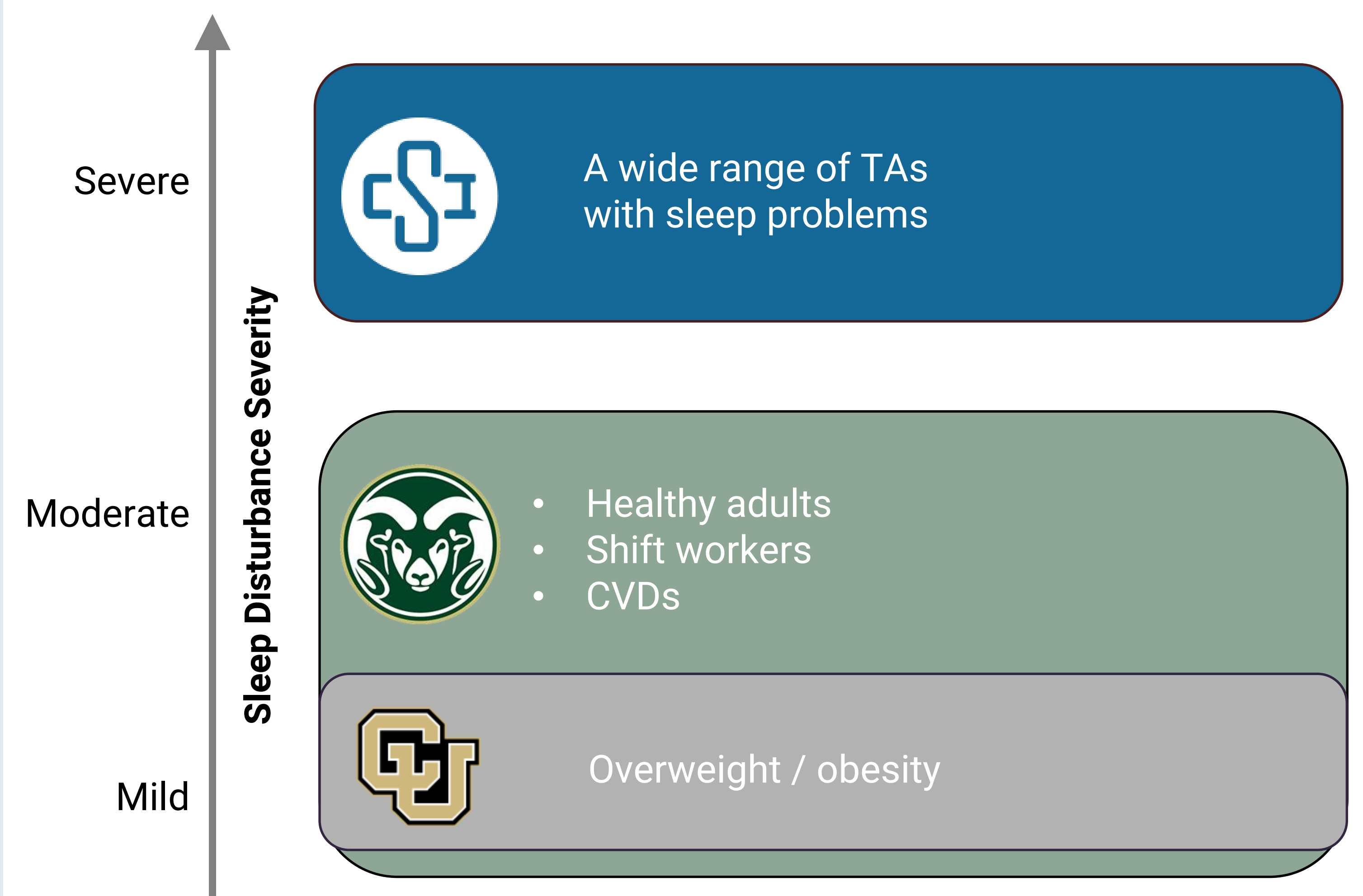
^a. Mean ± s.d. (unit of minutes) of the difference between predicted and ground truth.

Figure 1. Agreement rate between algorithm predictions, participant reported sleep and truth.



FUTURE WORK & PLANS

DEVELOPING AND VALIDATING FUTURE SLEEP ALGORITHMS COLLABORATIVELY



CONCLUSION

- Cole-Kripke + Tudor Locke and Tracy sleep algorithms **EXCEL** at the epoch level.
- **NONE** of the algorithms provide a perfect estimate of sleep period.
- We're dedicated to enhancing these algorithms and generating more evidence to enhance the quality and reliability of data derived from meaningful patient-centered measures.

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