Towards a foundational model of pathological gait kinemaitcs

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Project page
videos of input and reconstructions

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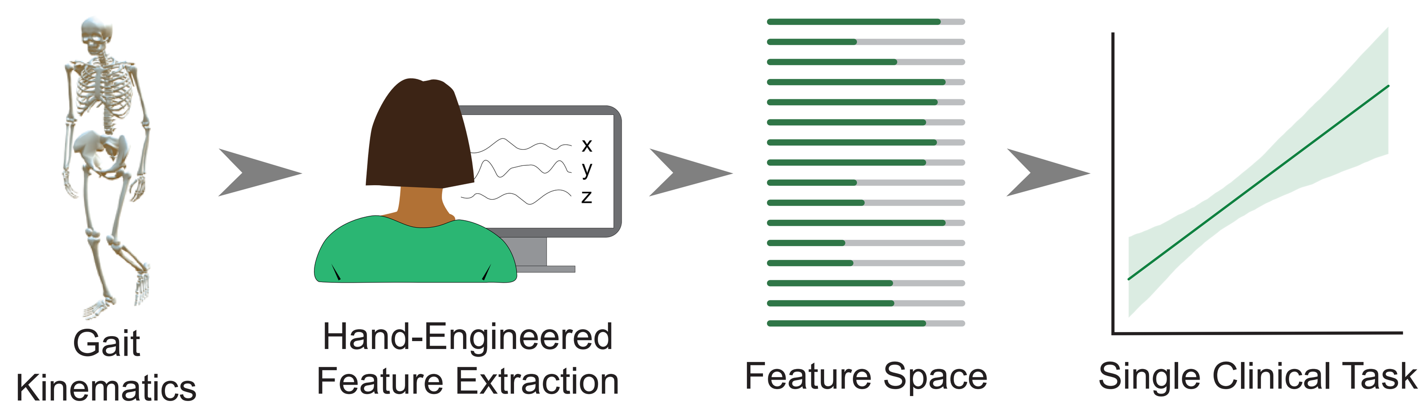
Introduction

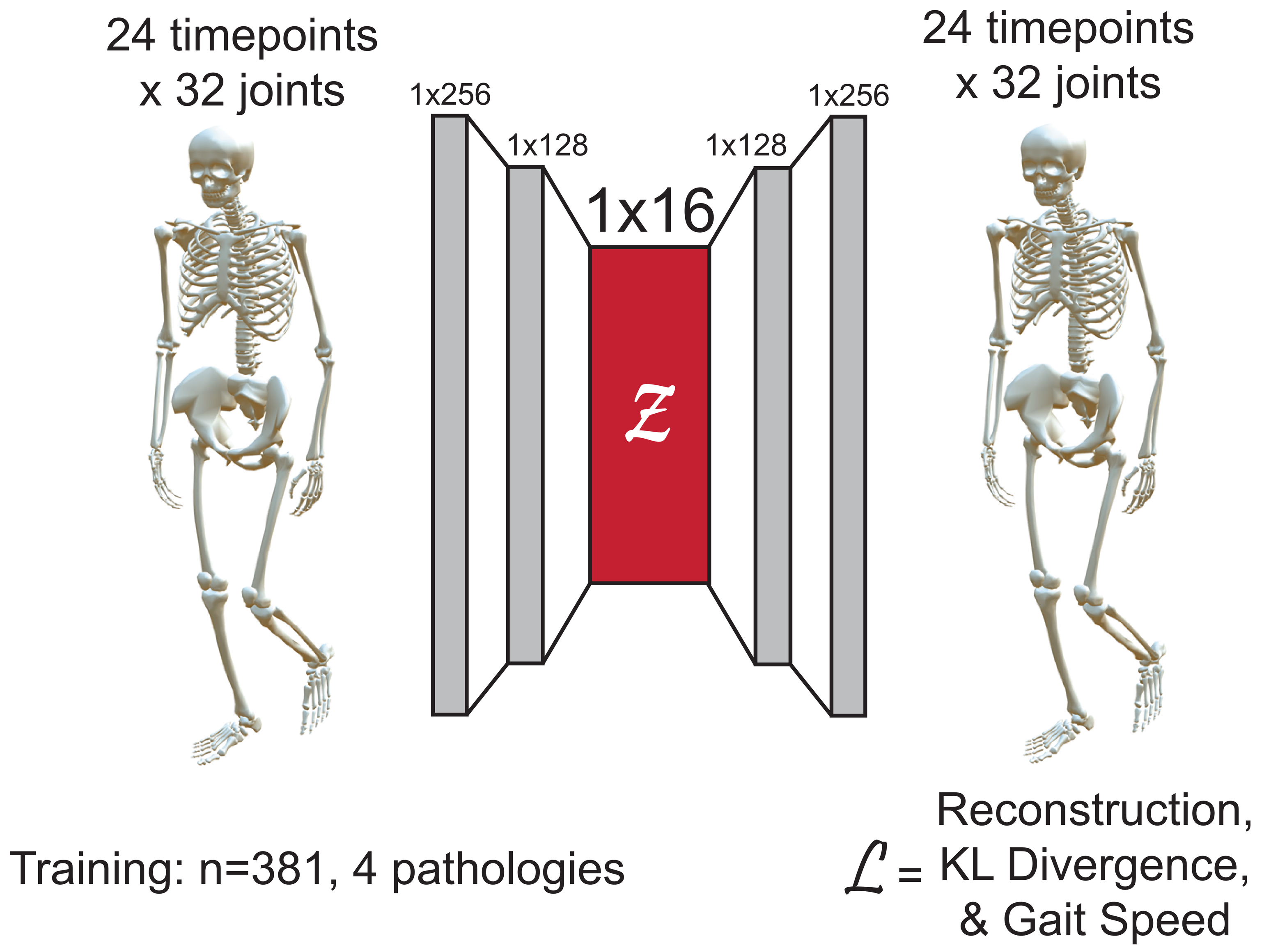


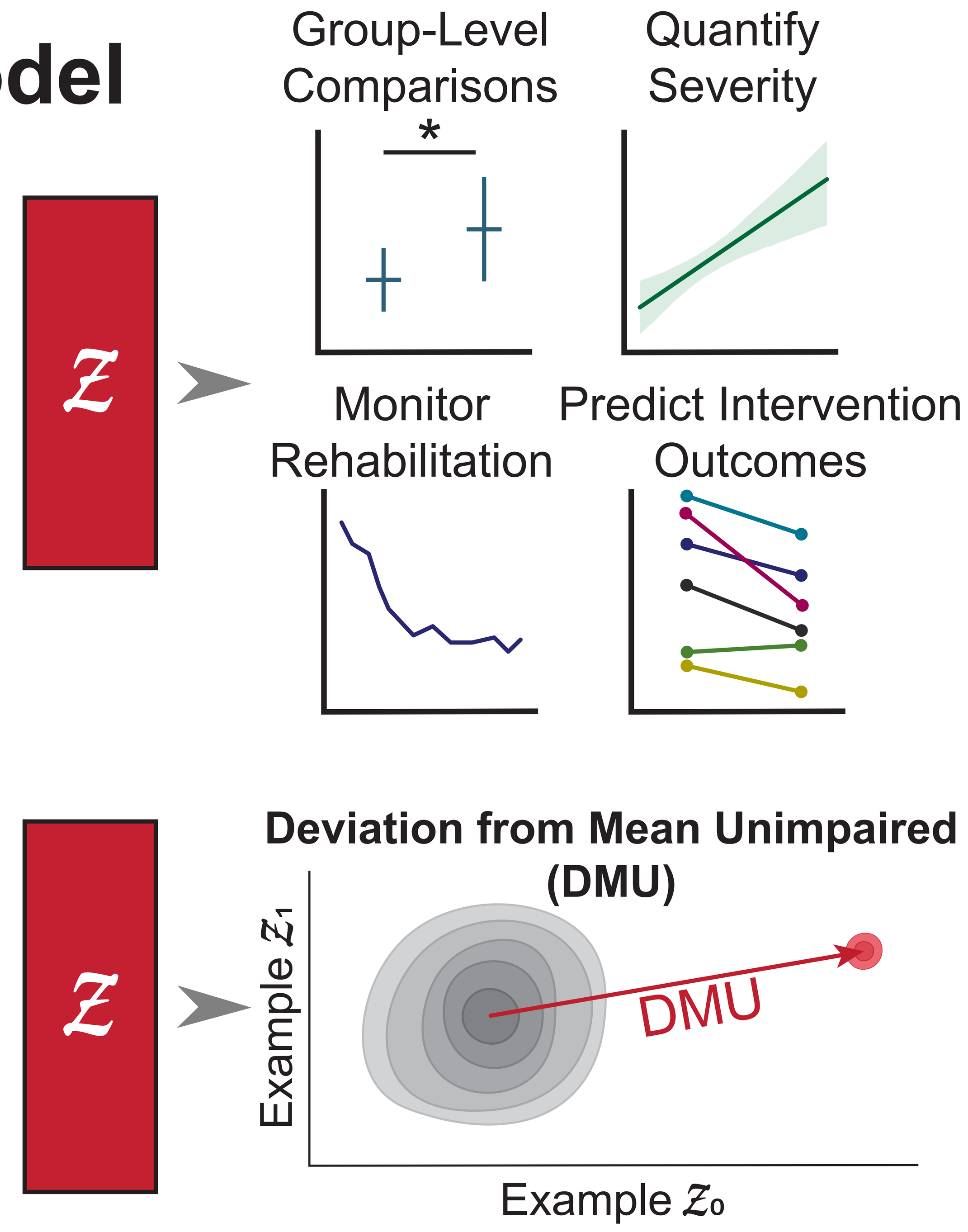
Traditional task-specific modeling

- Recent advancements in markerless motion capture have enabled accurate biomechanics in clinics [1].
- Despite this accessiblity, deriving actionable insights from gait data remains a challenge [2].
- Machine learning models show promise, but require large pathology specific datasets [3], which limits generalizability to unseen pathologies.

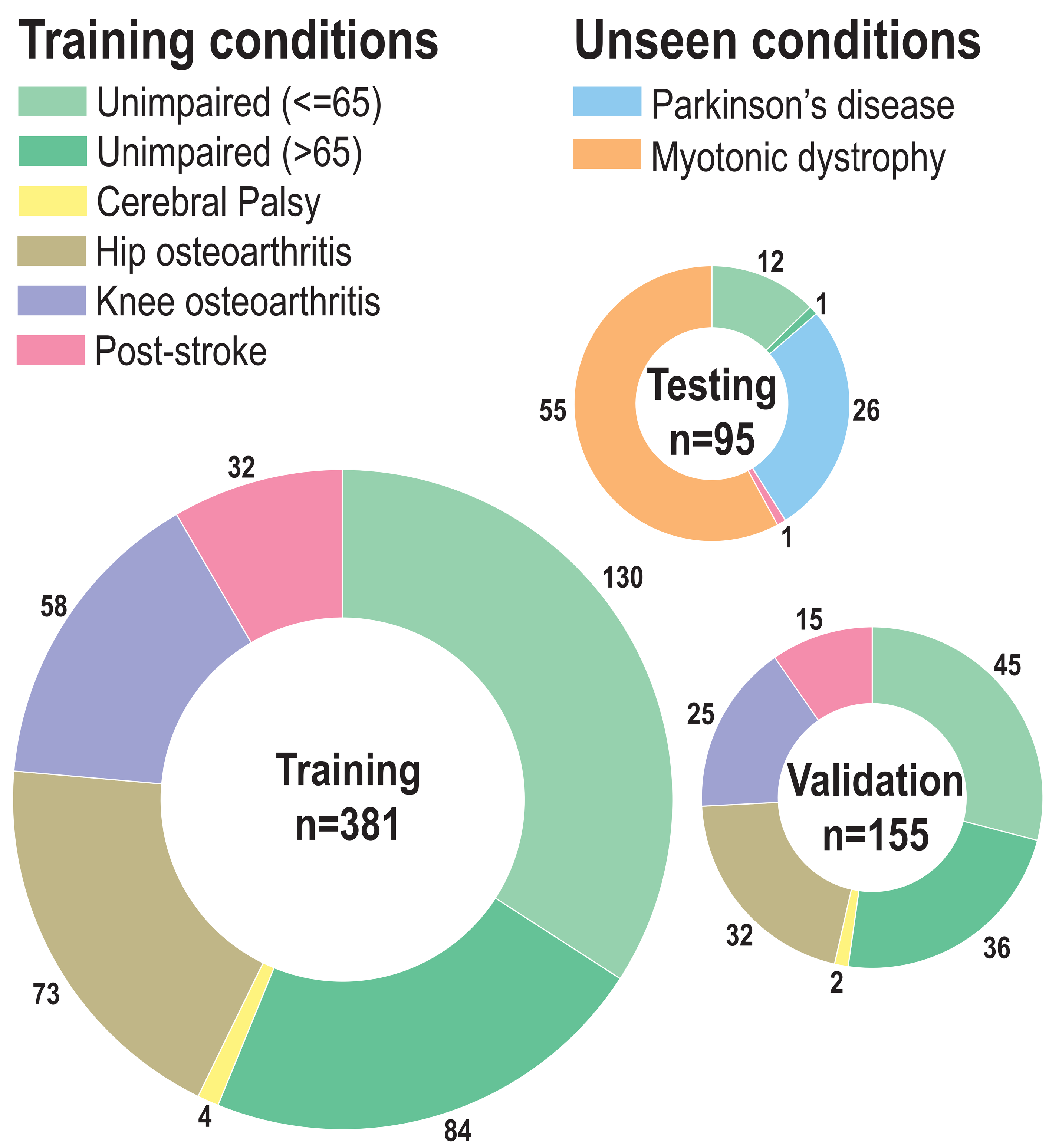
We aim to enable automated gait analysis that generalizes across diverse pathologies and supports a range of clincially relevant tasks.

Semi-supervised gait kinematics model





Methods



Training the model

- Aggregated a gait kinematics [4, 5] datasets of varied pathologies
- Includes both markered and markerless datasets
- Variational autoencoder (VAE) [6] for semi-supervised learning
- Auxillary task: predicting gait speed to promote interpretability

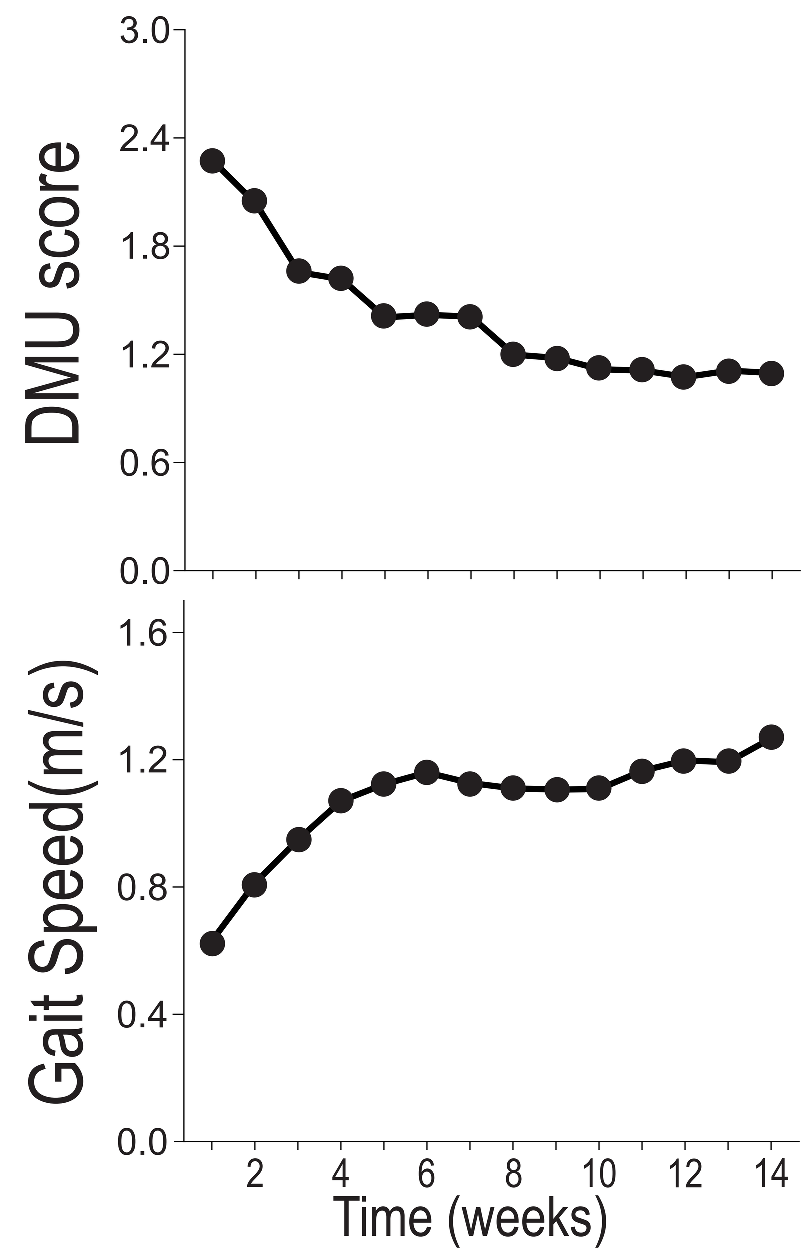
Calculating DMU (Deviation from Mean Unimpaired)

- Distance from the distribution of healthy gait features [7]

Diverse clinical applications and pathologies

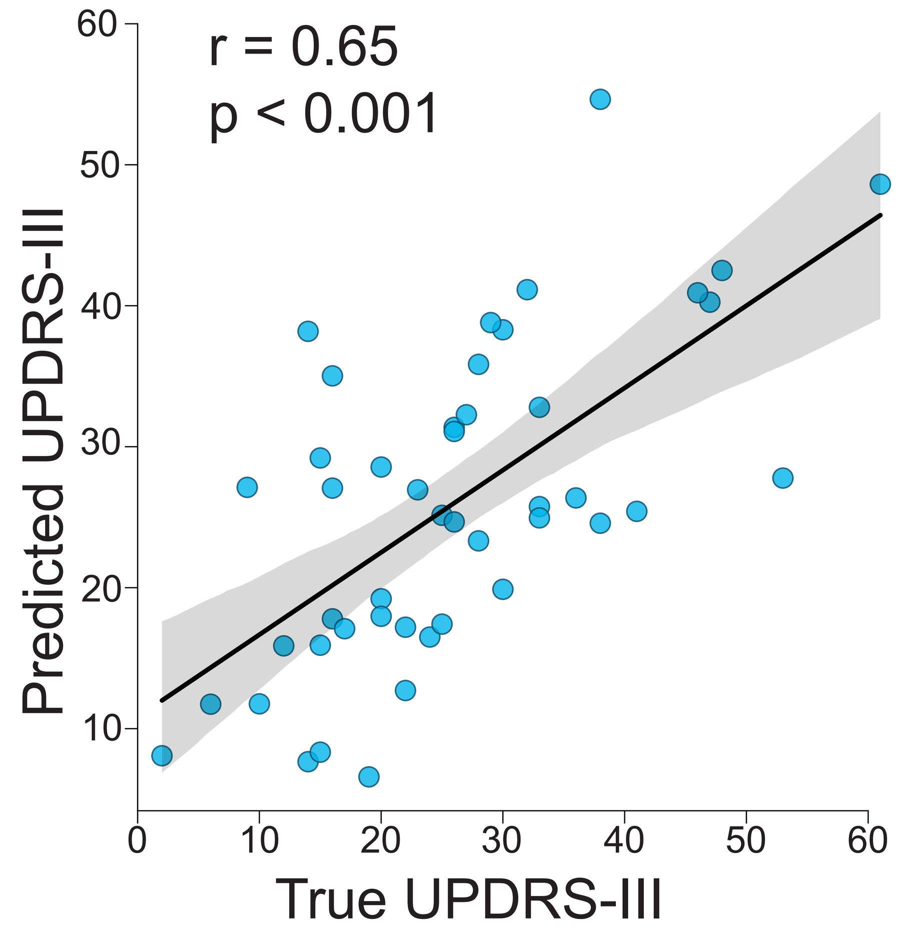
Tracking recovery post-stroke

DMU responds to recovery during post-stroke rehabilitation



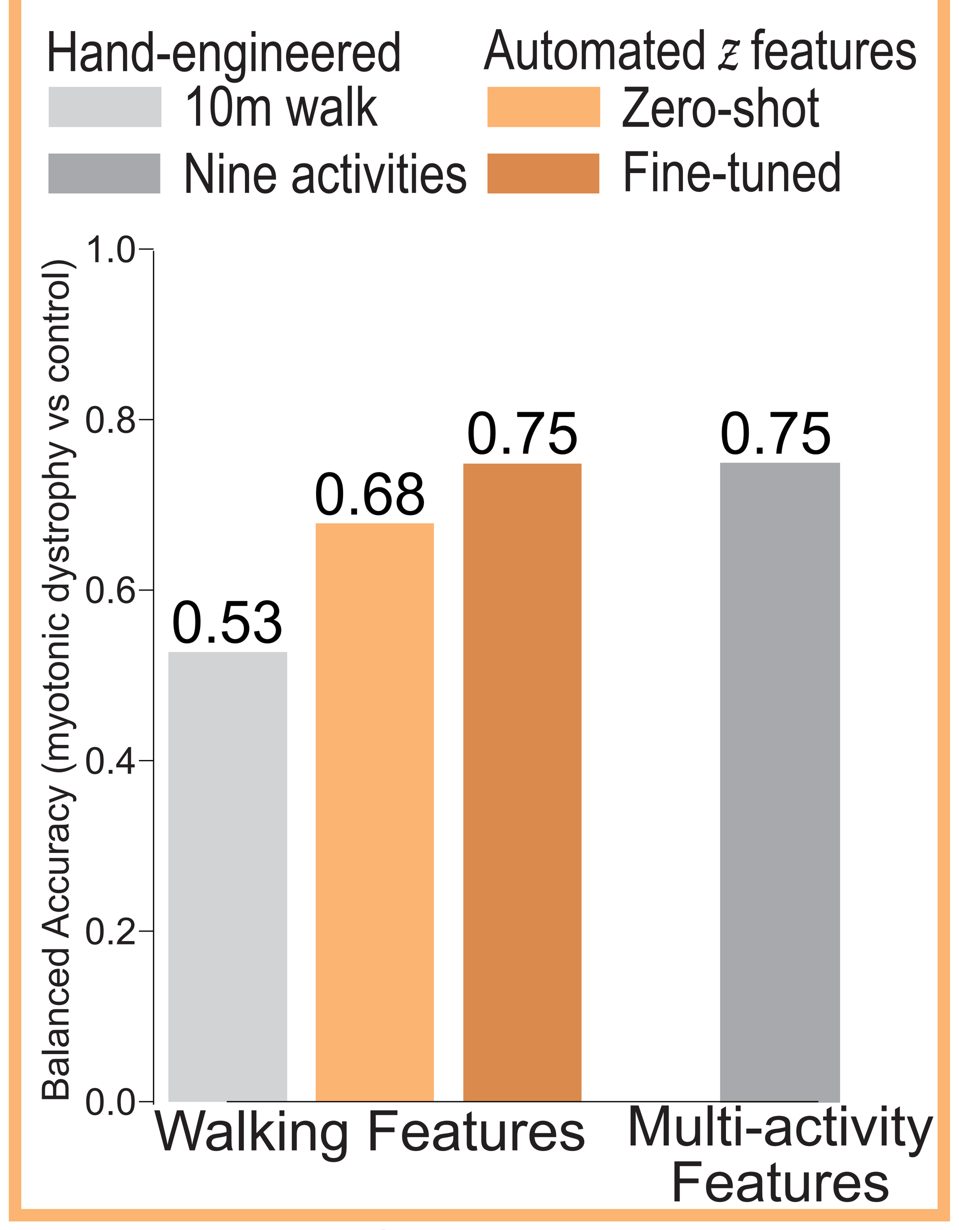
Quantifying severity in Parkinson's disease

$\mathcal{Z}$ predicts clinican and self-reported scores of PD



Identification of myotonic dystrophy

$\mathcal{Z}$ outperforms hand-engineered features of walking



Impact

- Estimates impairment, automates feature selection, and can be improved by fine-tuning with small datasets
- Generalizes to unseen pathologies
- Open source and automatically computed during OpenCap gait analysis

References

[1] Uhlrich & Falisse et al., 2023. *PLoS Comp.* 19(10)
[2] Simon, 2004. *J. Biomech.* 37(12): 1869-1880
[3] Jeon et al., 2022. *JBHI.* 26: 696-703
[4] Werling et al., 2023. *PLoS ONE.* 18(11)
[5] Rajagopal et al., 2016. *TBME.* 63(10): 2068-2079
[6] Kingma & Welling, 2013. *arXiv.*
[7] Schwartz & Rozumalski, 2008. *Gait Posture.* 28(3): 351-357