# Gait Analysis Algorithms using Wearable Sensors to Inform Monitoring and Decision-Making in Amputee Rehabilitation

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Background

- Amputation and lower-limb disability lead to significant changes in gait patterns

- Efficient, informed gait training → enable better outcomes
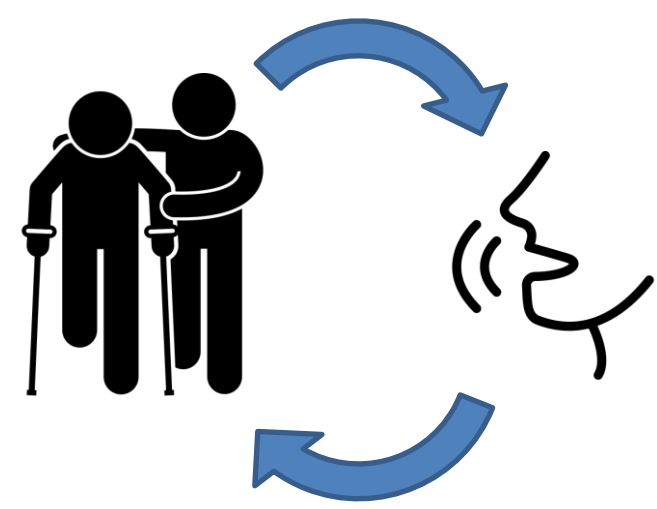
- Research has identified a variety of different parameters (spatiotemporal, kinematic, kinetic, etc.) that can describe features of gait

- No consensus as to which parameter(s) is/are the most important for good quality walking

Research Question

Can we develop a clinically relevant wearable system for remote gait monitoring applications?
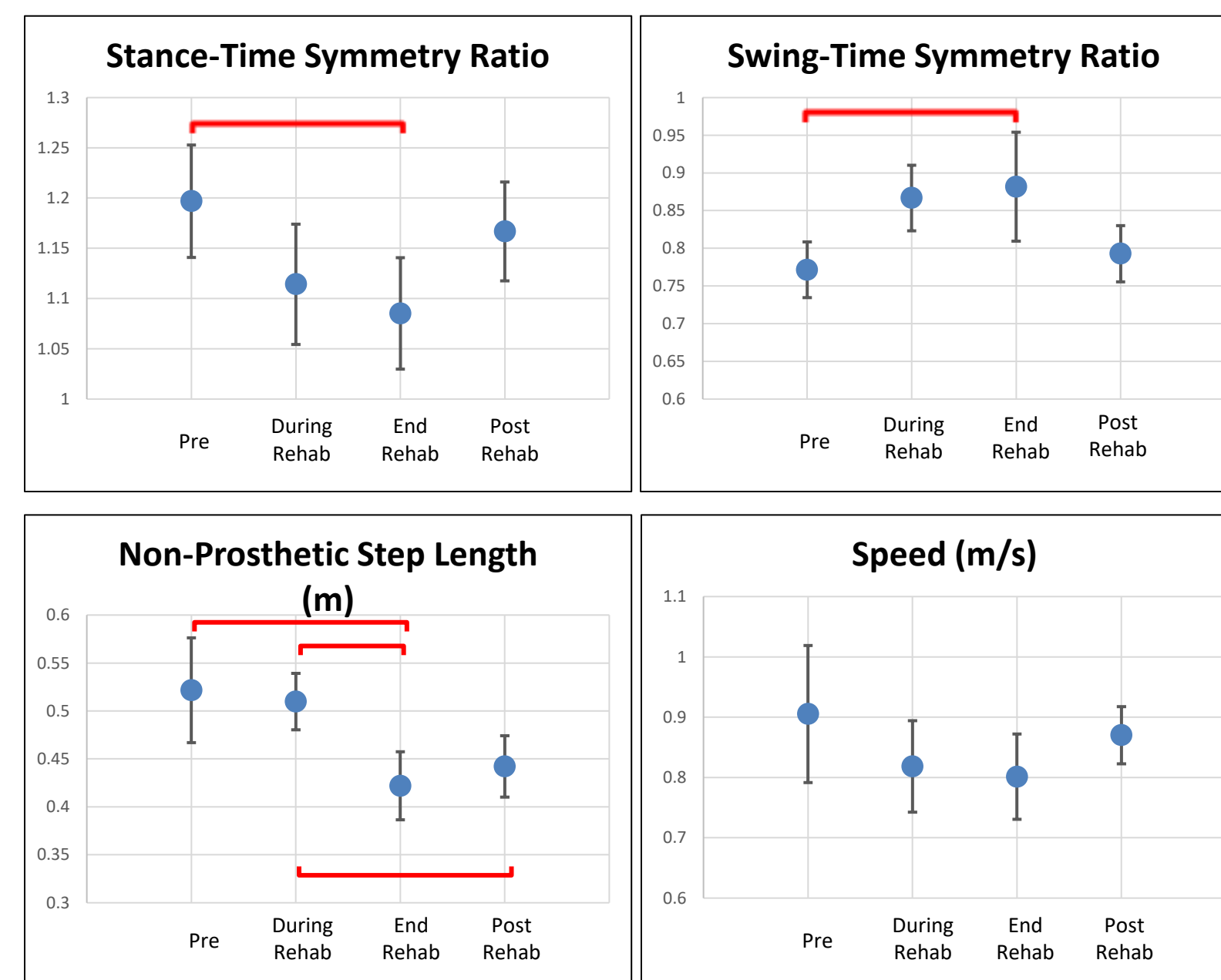
Methodology

- Collect inertial sensor data using Xsens system during and around gait training sessions with a physiotherapist at HB

- Analyze changes in gait parameters and signal profiles

- Use changes to inform design of wearable gait analysis system

Wearable data can inform amputee rehabilitation and be incorporated into a **mobility training system for amputees** to use **outside the clinic**

PDF of full proposal →
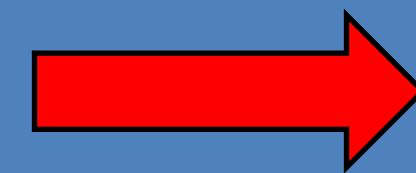
Classification based on Raw Inertial Sensor Signals

P1 Shank Sensors (R/L Legs)

P2 Shank Sensors (R/L Legs)

Legend: Pre-, During Rehab, End of Rehab
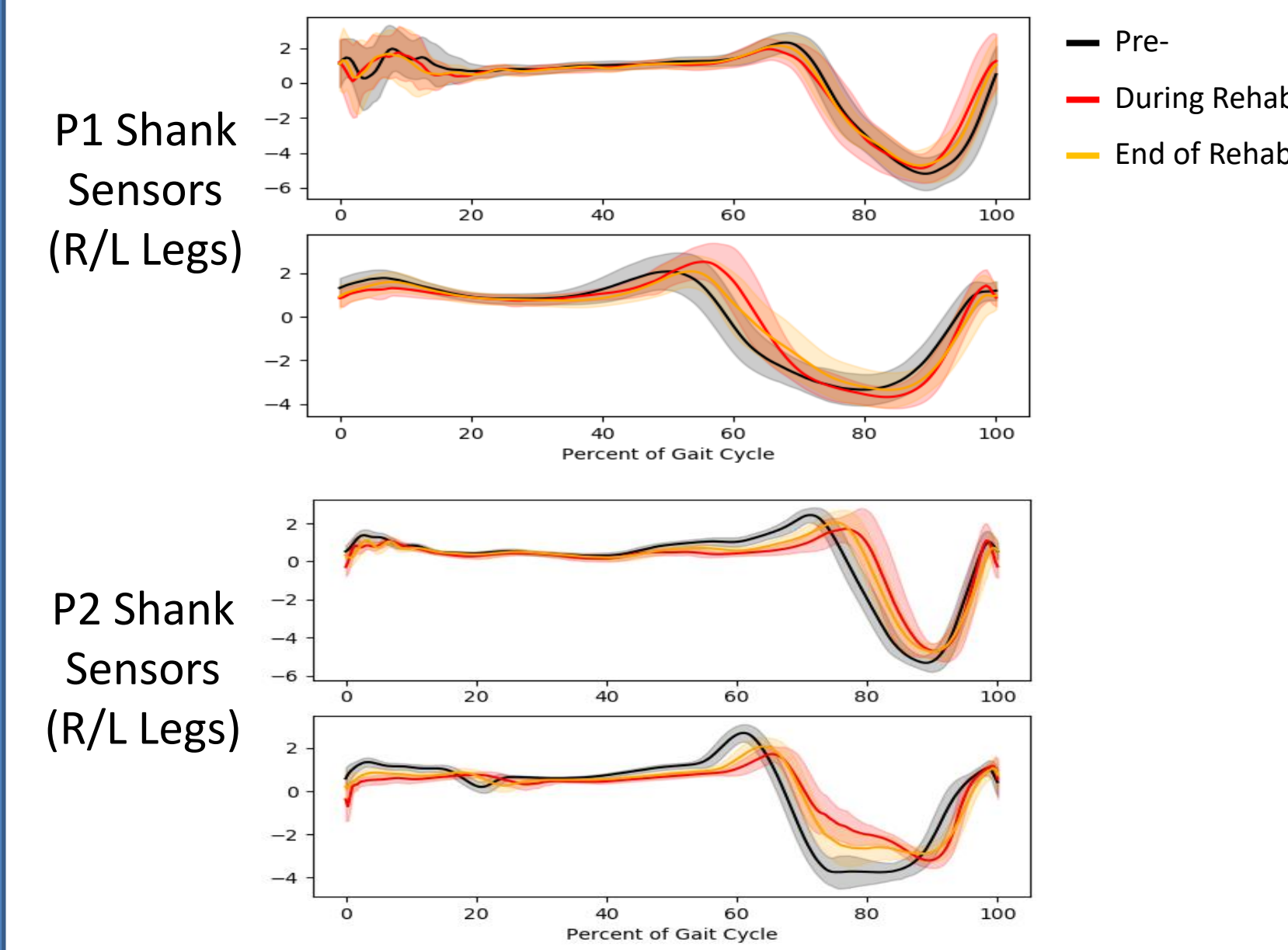
Test Group	Euclidean Distance Classification		Dynamic Time Warping (DTW) Classification	
	Pre-Rehab	End-Rehab	Pre-Rehab	End-Rehab
End of Rehab	0	13	3	10
During Rehab	0	39	7	32
After Rehab	22	10	13	19

Test Group	Pre-Rehab	End-Rehab	Pre-Rehab	End-Rehab
End of Rehab	0	23	0	23
During Rehab	1	61	1	61
After Rehab	0	53	0	53

Discussion

- Significant changes seen within both spatiotemporal parameters and kinematic profiles for 2 of the 3 participants

- For 1 participant, gait profile changed in alignment with PT goals. For the other, gait parameters and signal profile worsened

- Euclidean and DTW classifiers performed generally well and followed similar trends to the gait parameters

Conclusions/Next Steps

- Preliminary data suggest PT can induce measurable, significant changes in gait profiles

- Validation of signal-based analysis indicates models perform in line with gait profile trends measured by wearable system

- Next steps are to incorporate into portable system and test with performance feedback to see whether gait re-improves

Physiotherapy Effects on Gait Parameters

Participant 1 Gait Parameters

Stance-Time Symmetry Ratio

Swing-Time Symmetry Ratio

Non-Prosthetic Step Length (m)

Speed (m/s)

Participant 2 Gait Parameters

Swing-Time Symmetry Ratio

Double-Support Stance Phase (% of Gait Cycle)

Non-Prosthetic Step Length (m)

Speed (m/s)