

Looking at kinematic data from a different perspective: inter-joint coordination and cyclograms

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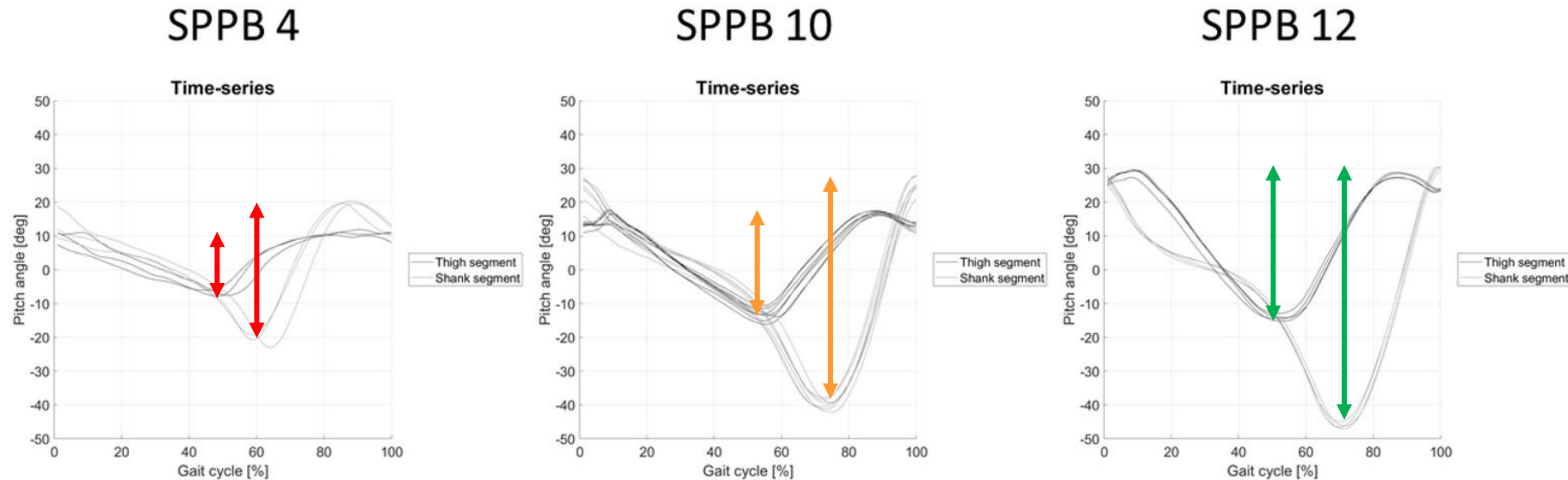
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Background

- Altered walking kinematics in elderly and people with neurodegenerative diseases → falling

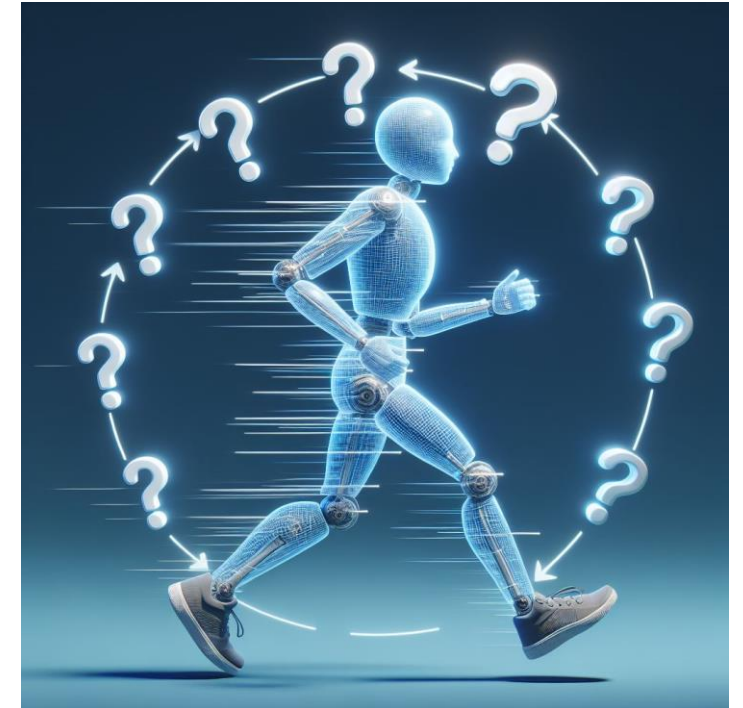


- People with Parkinson's disease suffer from gait abnormalities, which have daily consequences
- Medication can partially improve those abnormalities
- Adequate inter-joint coordination is crucial for proper execution of the daily life activities

Aim

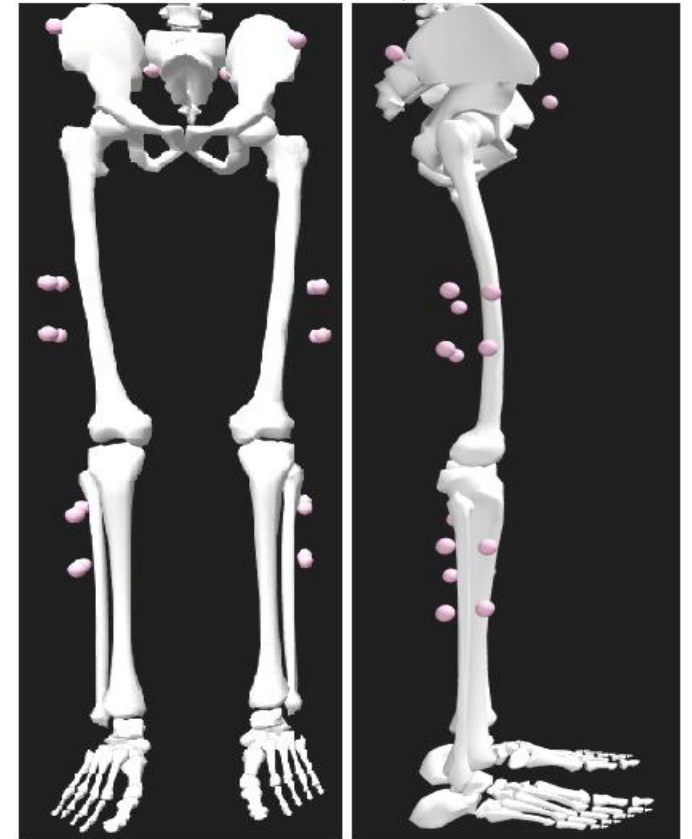
In PD, how do inter-joint coordination changes associate with diagnosis and treatment?

- How do different walking speeds affect:
 - The hip-knee coordination?
 - Hip and knee movement throughout the gait cycle?
- In which phases of the gait cycle could changes be detected?



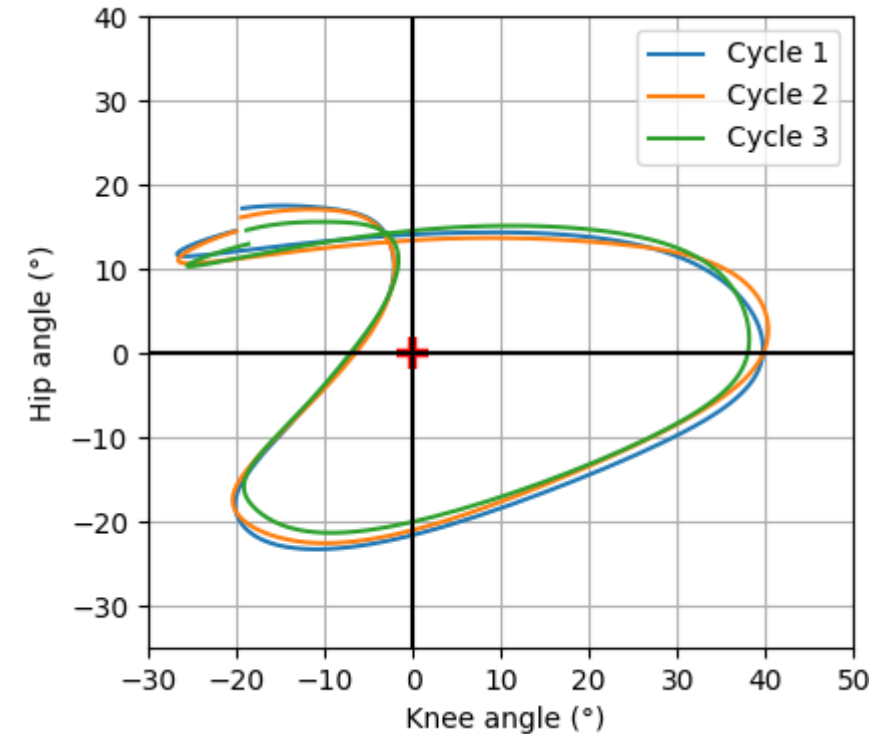
Experimental set-up

- 58 participants:
 - 29 people with PD (mean age 67 years, 11 females), on medication
 - 8 people (mean age 63) with PD measured off medication
 - 29 healthy controls (mean age 67 years, 14 females)
- 12-camera optical motion capture system:
 - 20 markers placed on pelvis and lower limbs
- 5 m walk in ***slow***, ***preferred*** and ***fast*** walking speed



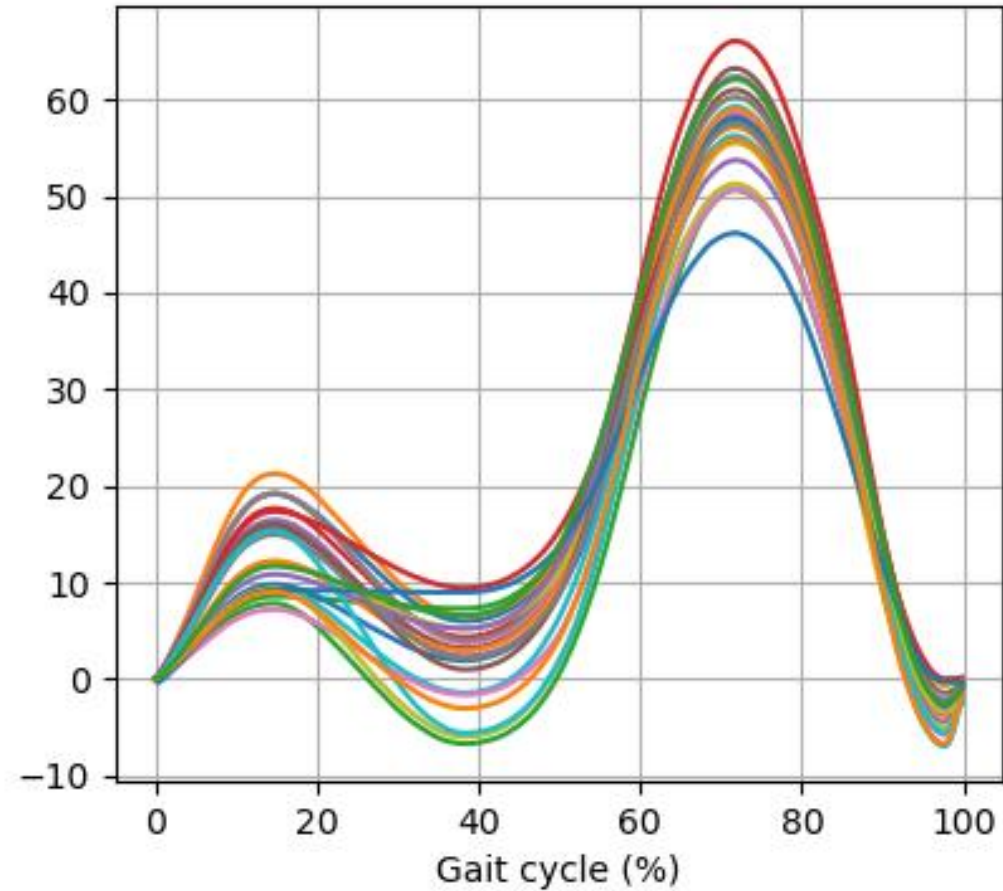
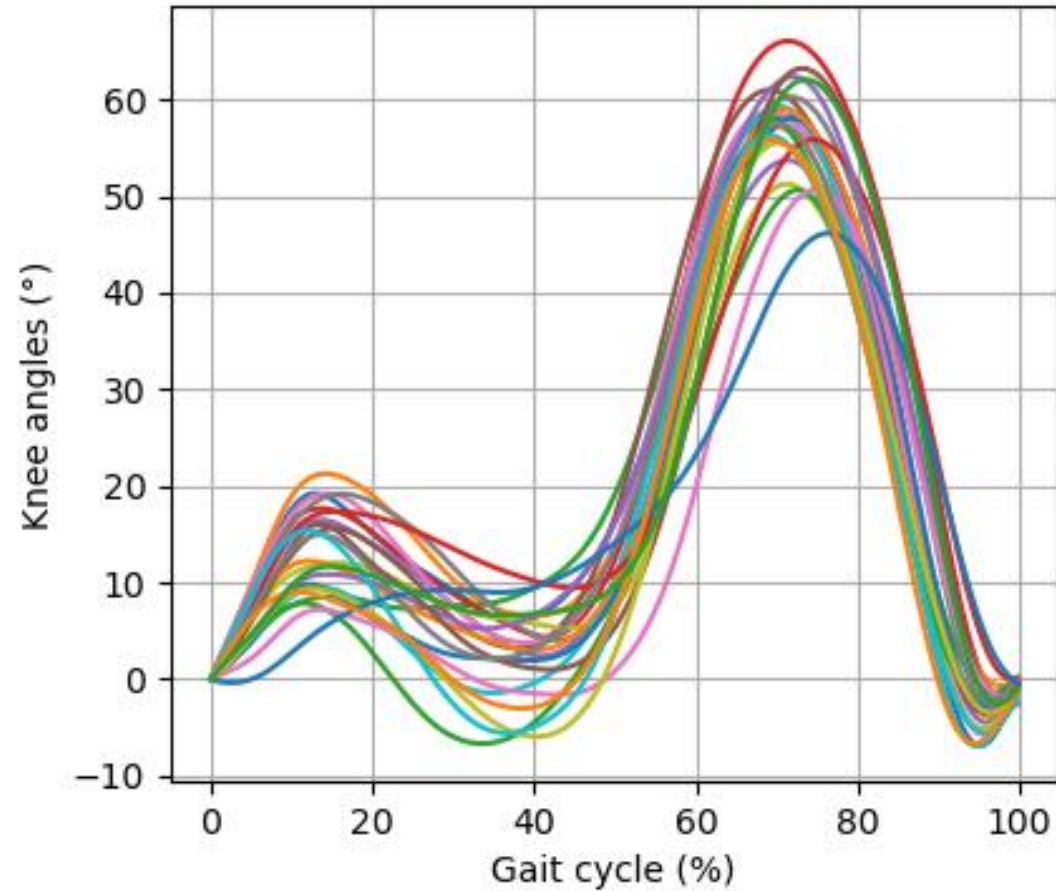
Data processing

- Flexion angles for knee and hip joints extracted from optical motion capture data (Python, GitHub)
- Gait cycles → initial contact to initial contact of the same side
- Cycles normalized with linear interpolation
- Hip and knee angles plotted against each other



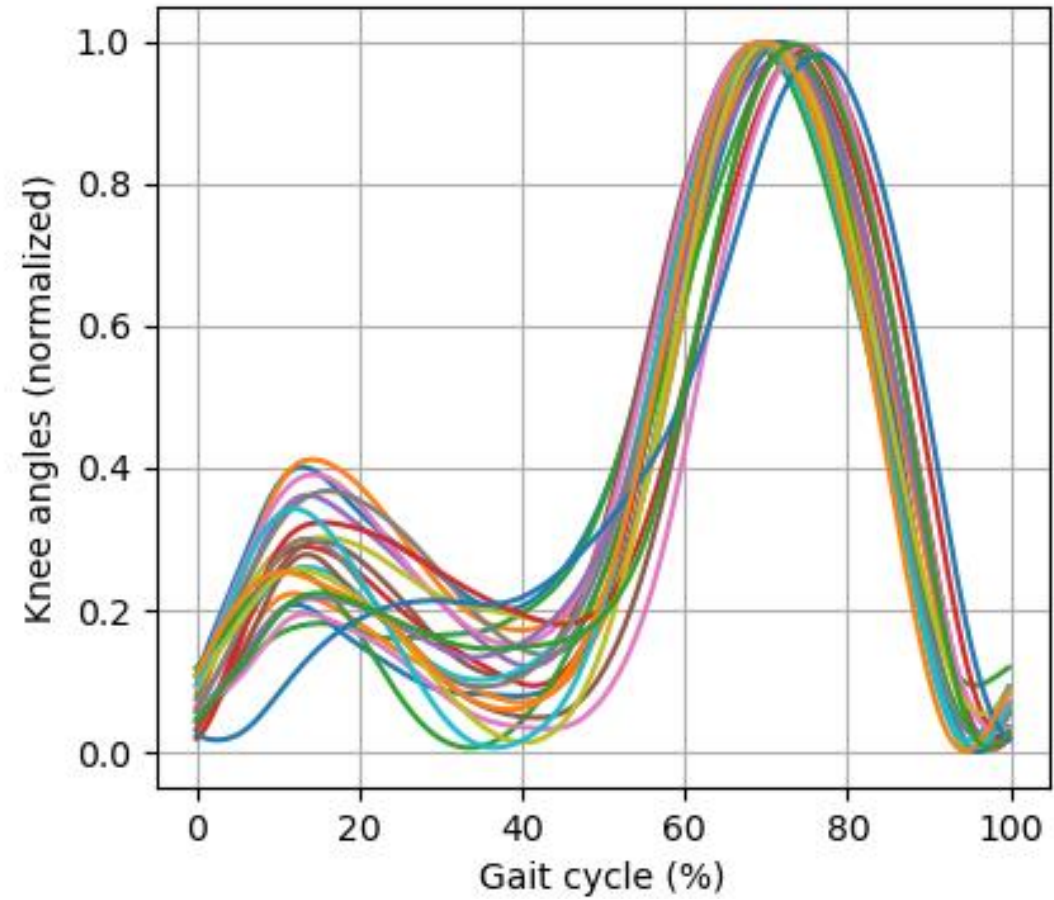
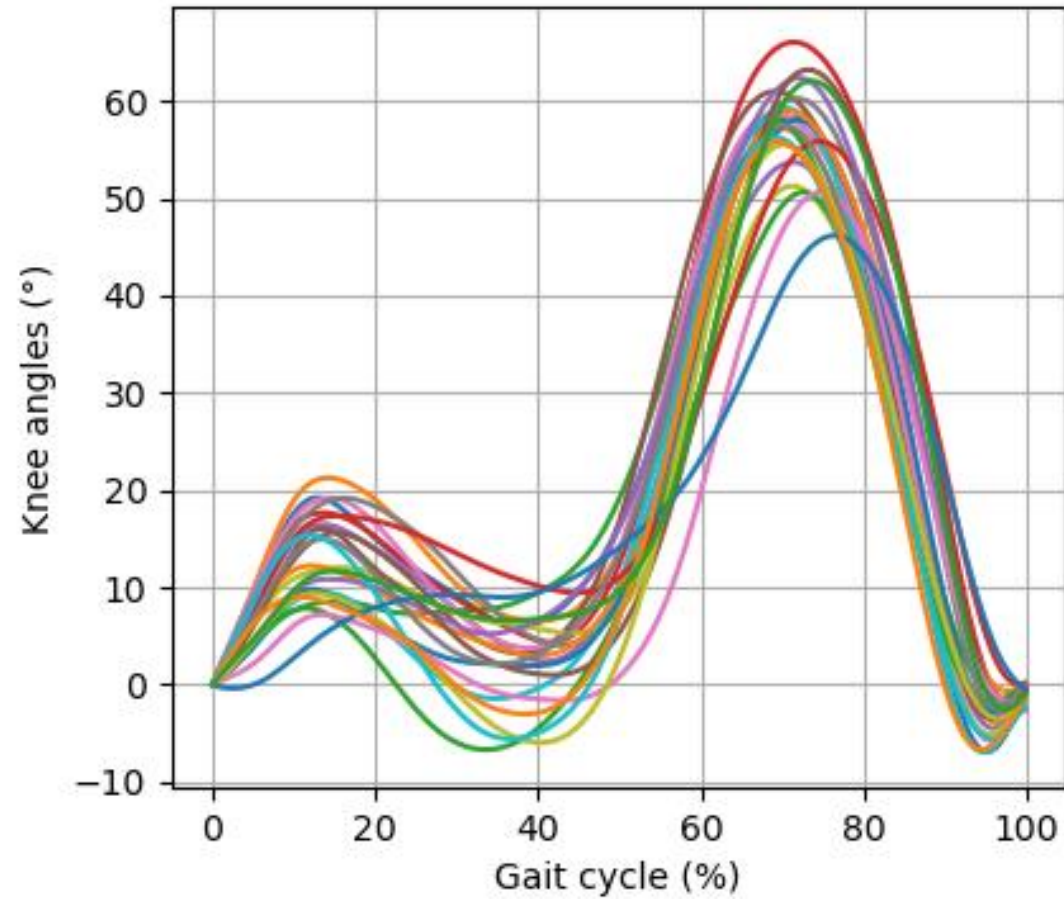
Data processing (Statistical Parameter Mapping)

Temporal alignment



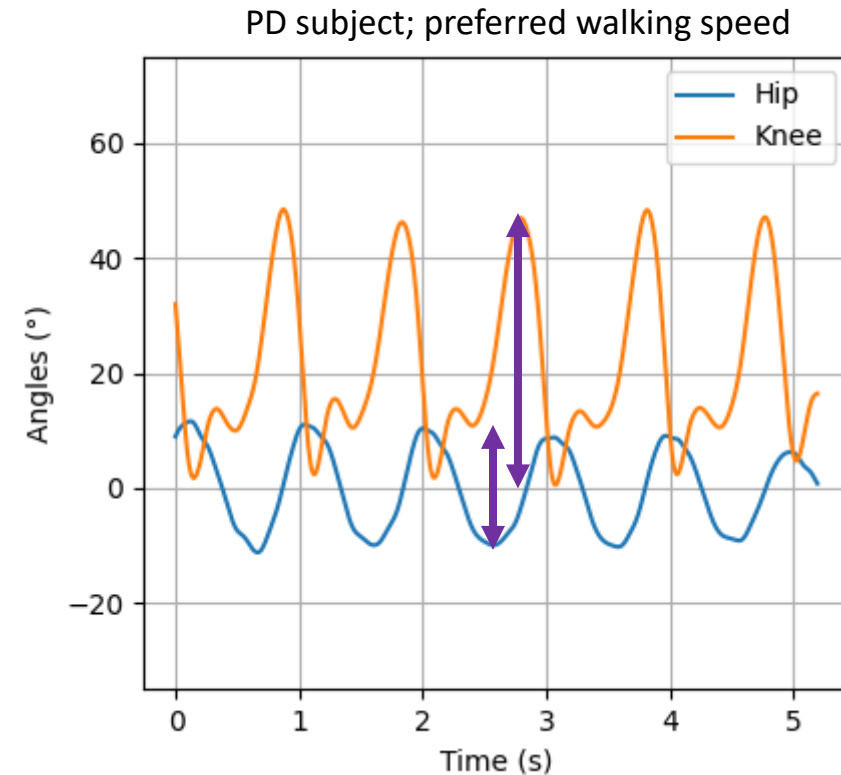
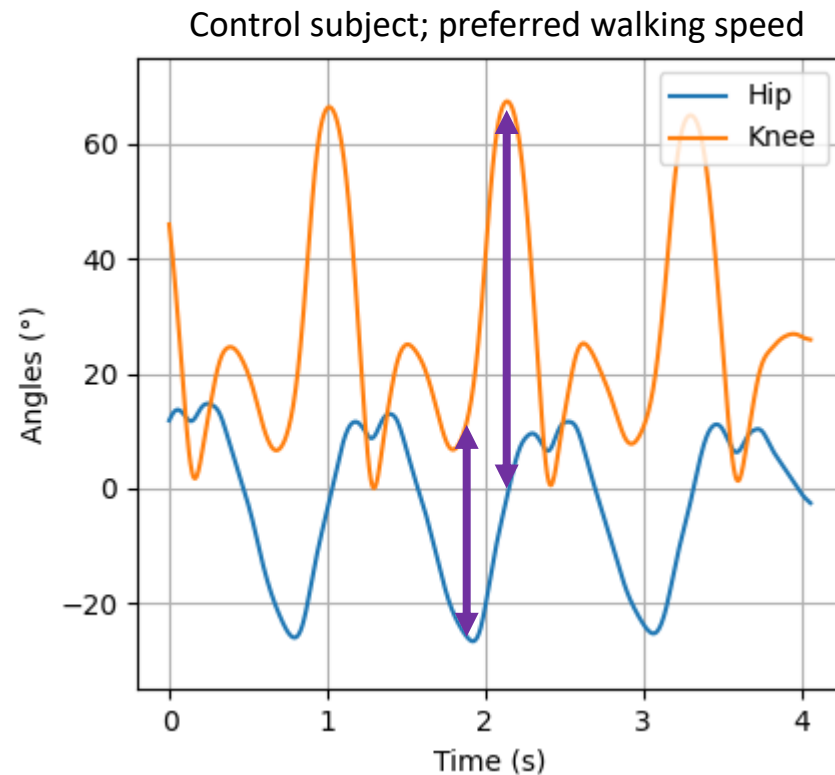
Data processing (Statistical Parameter Mapping)

Spatial alignment

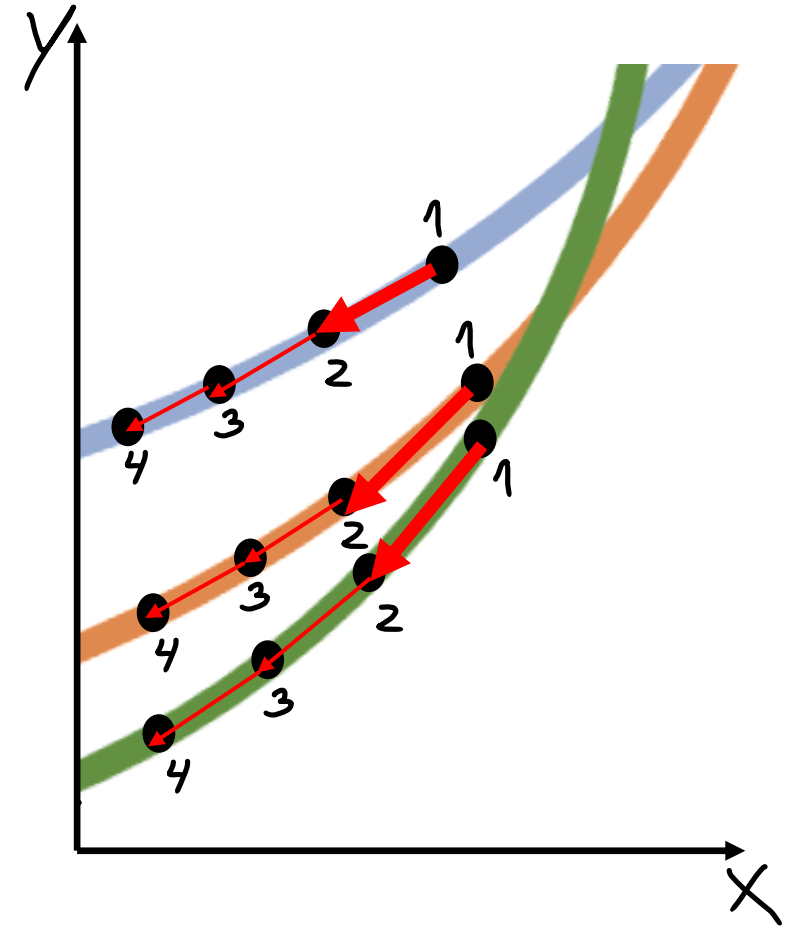
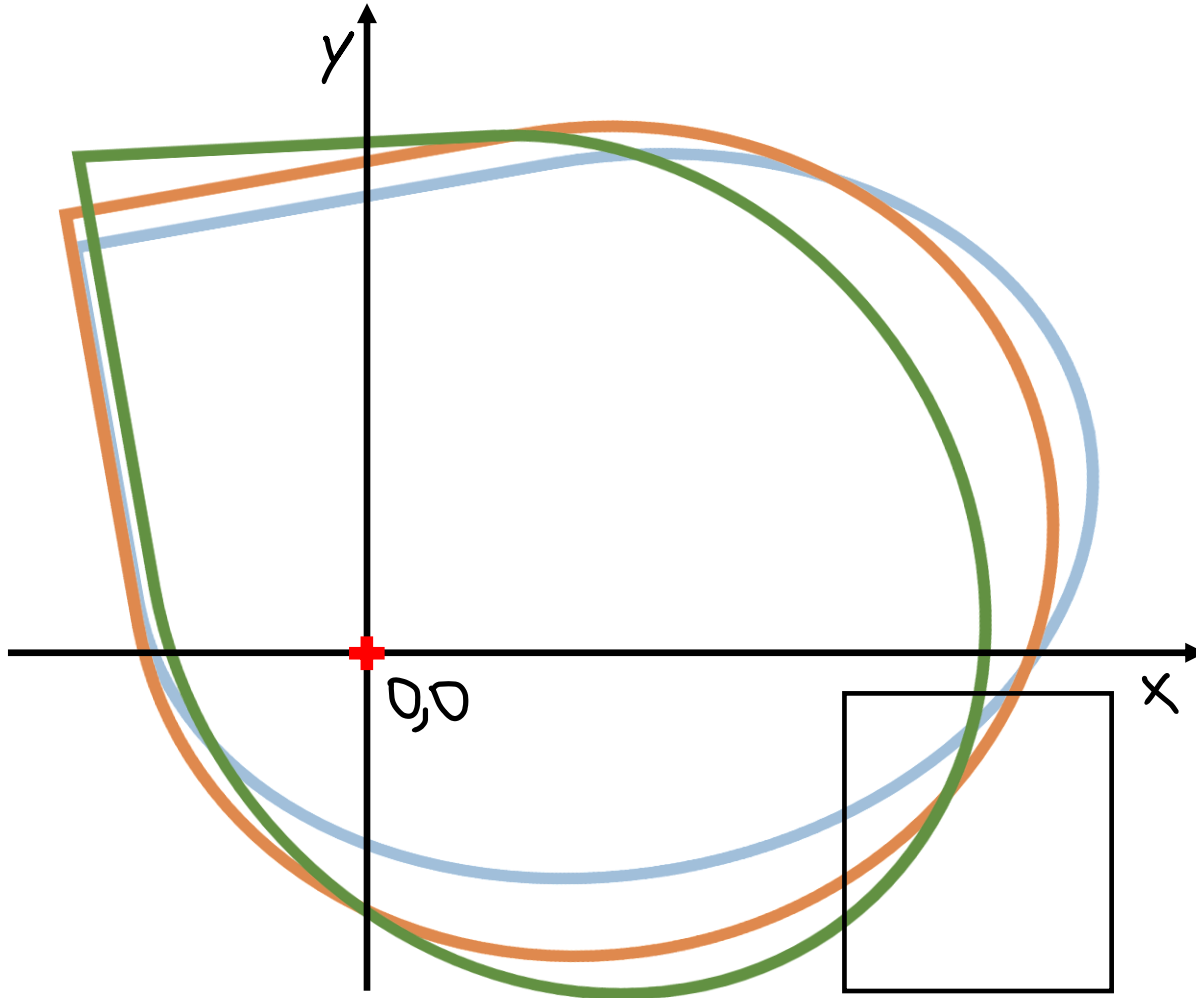


Data-derived variables (time-series)

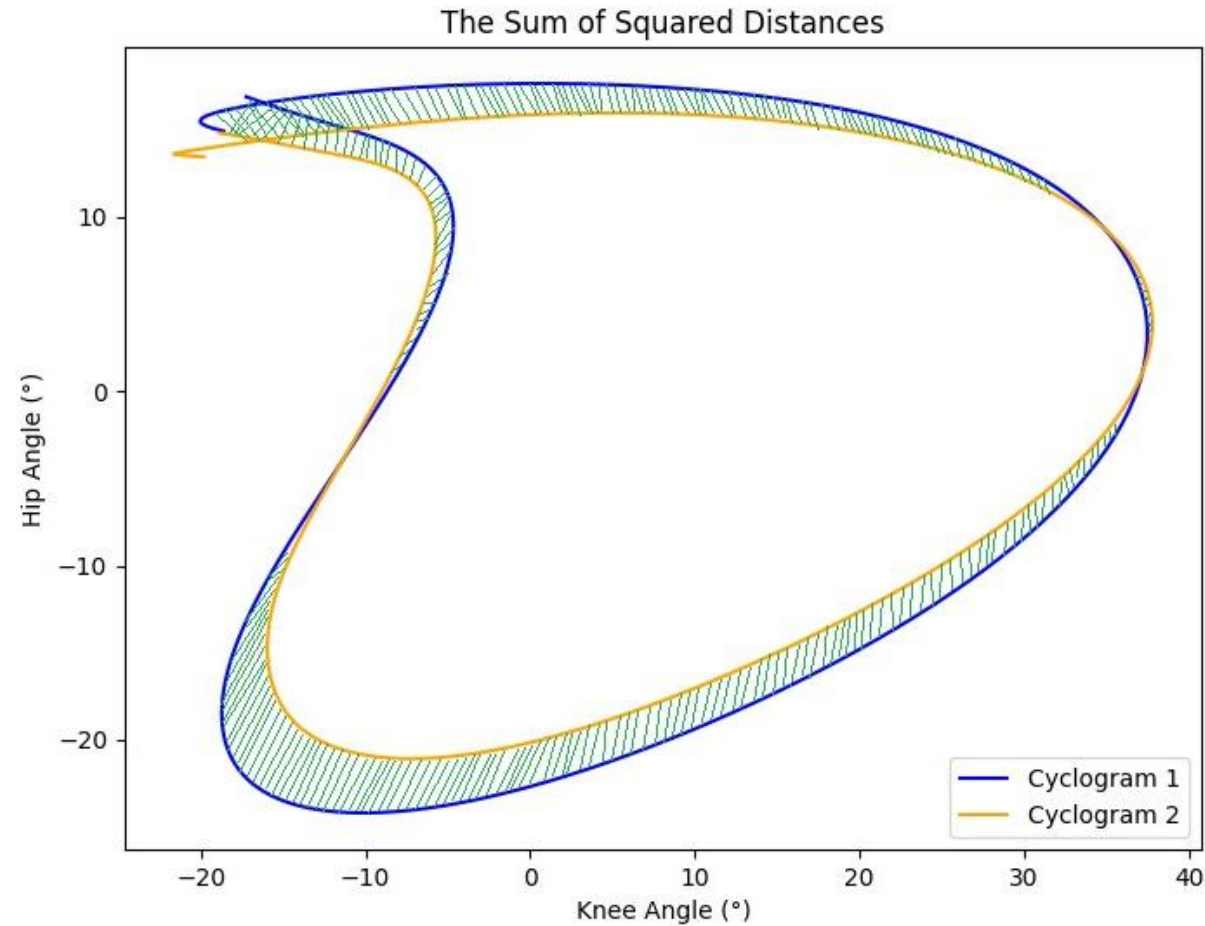
- Range of motion (ROM) for the hip and knee joints



ACC (0 – maximal inconsistency; 1 – maximal consistency)

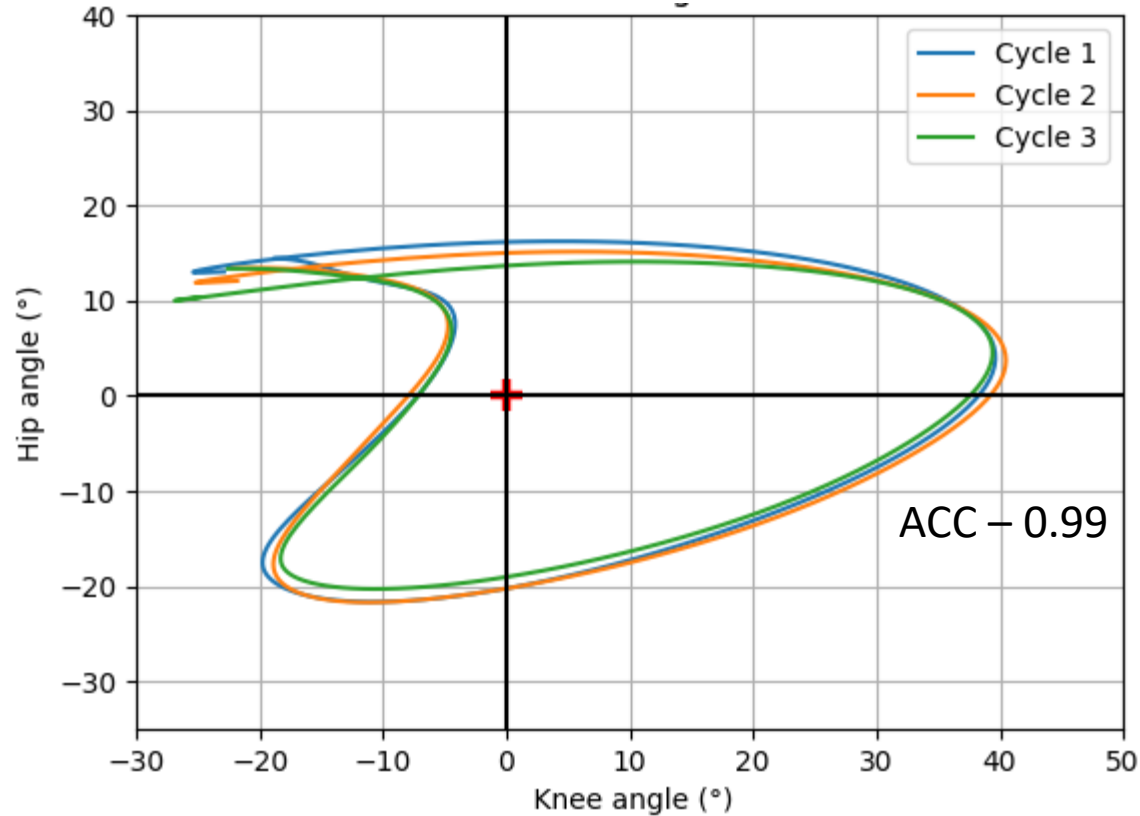


SSD (differences in cyclogram areas)

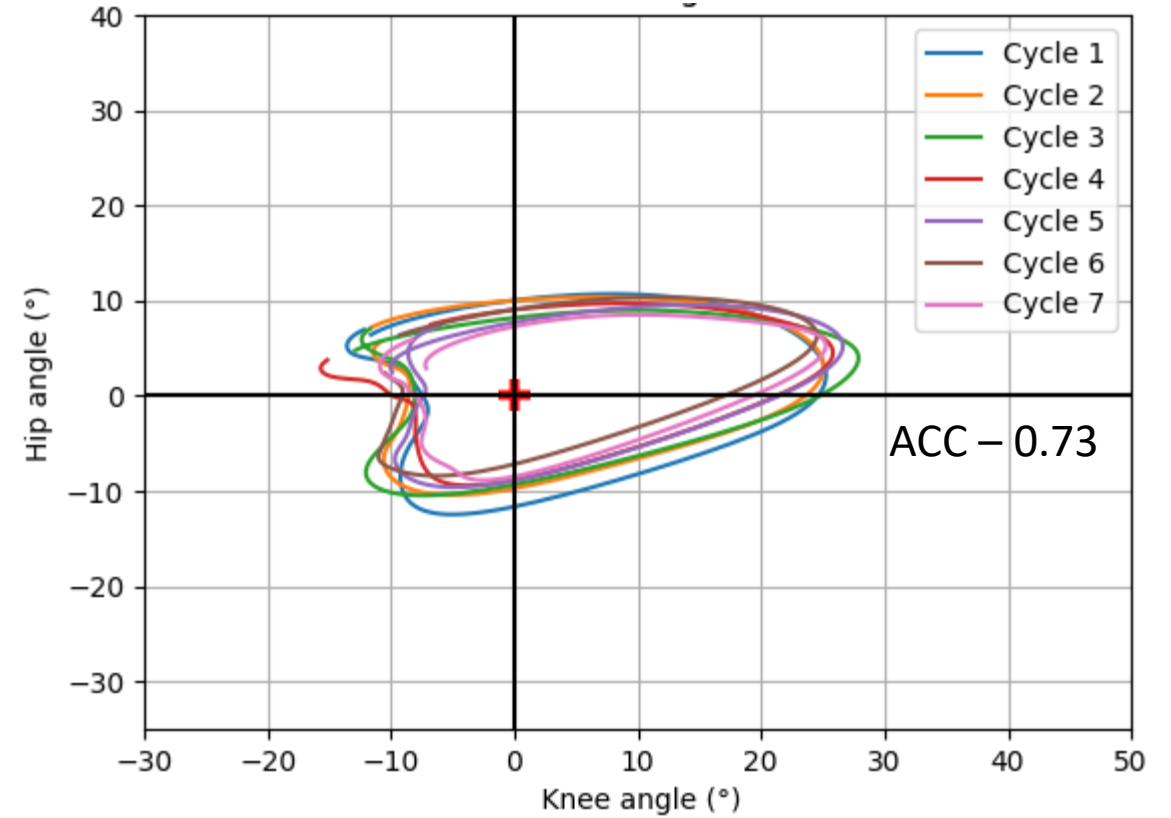


Results

Control subject; preferred walking speed

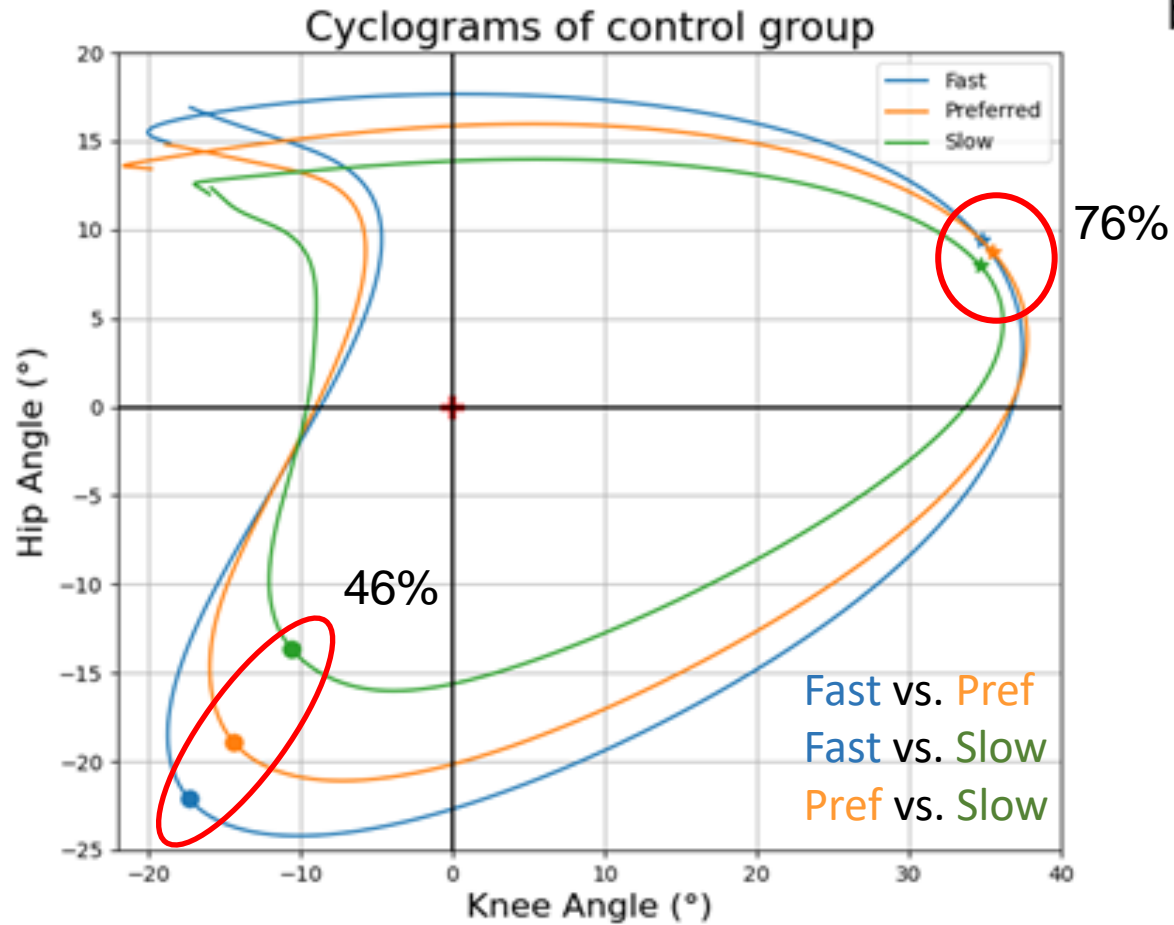


PD subject; preferred walking speed

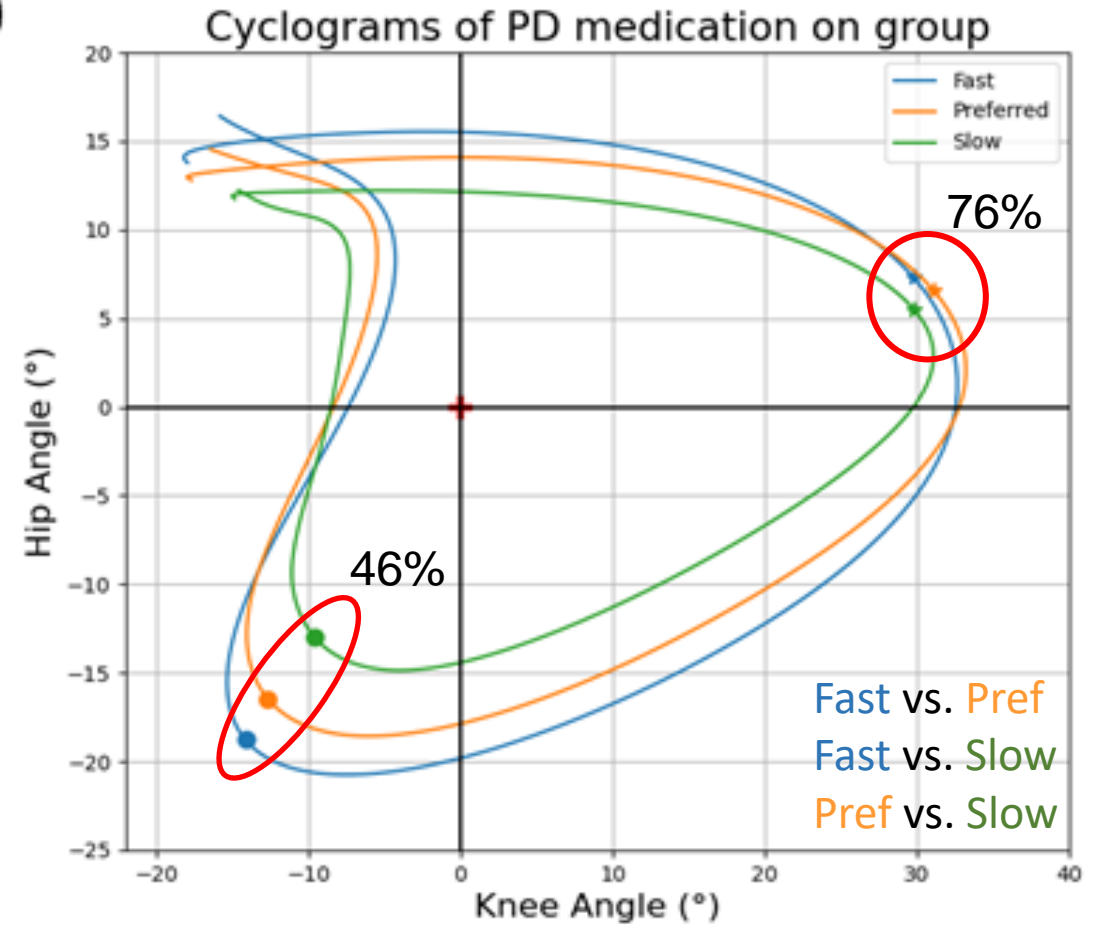


Results

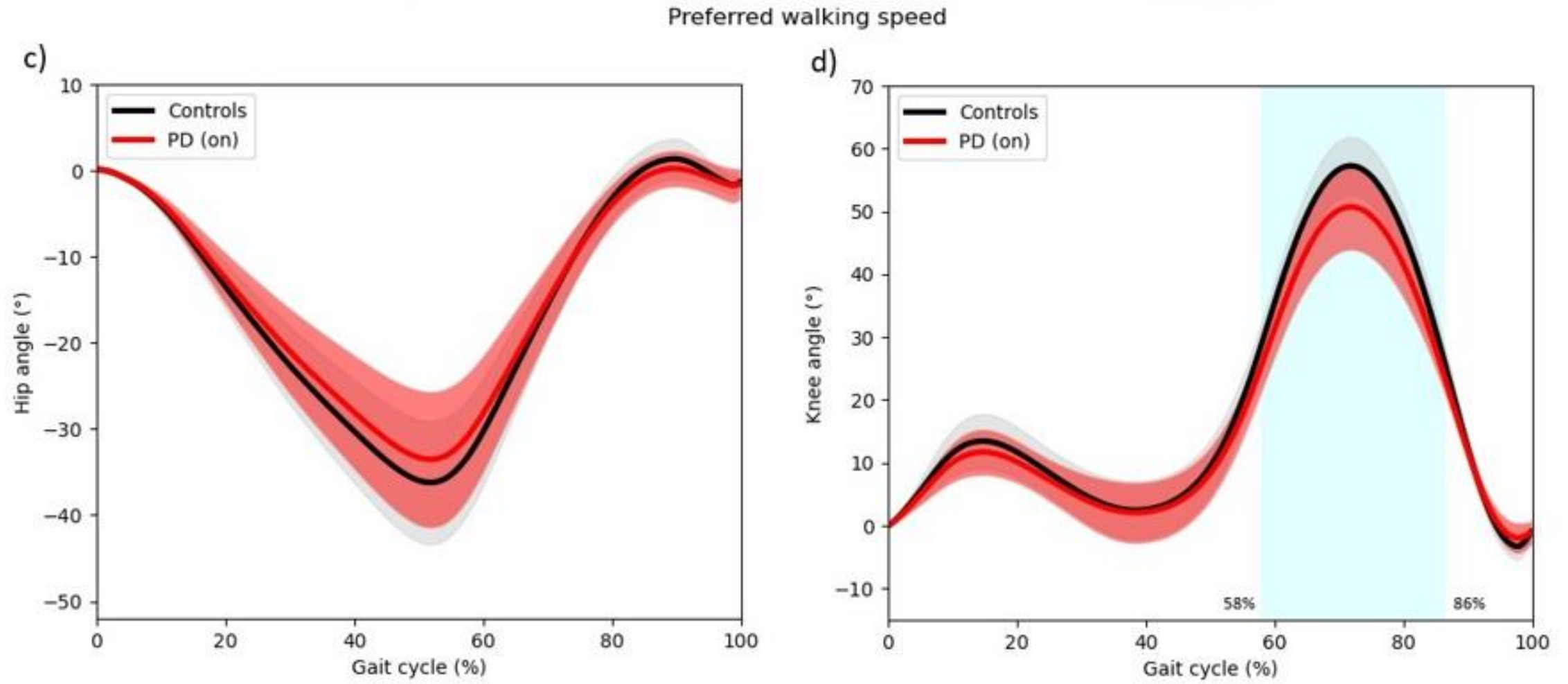
a)



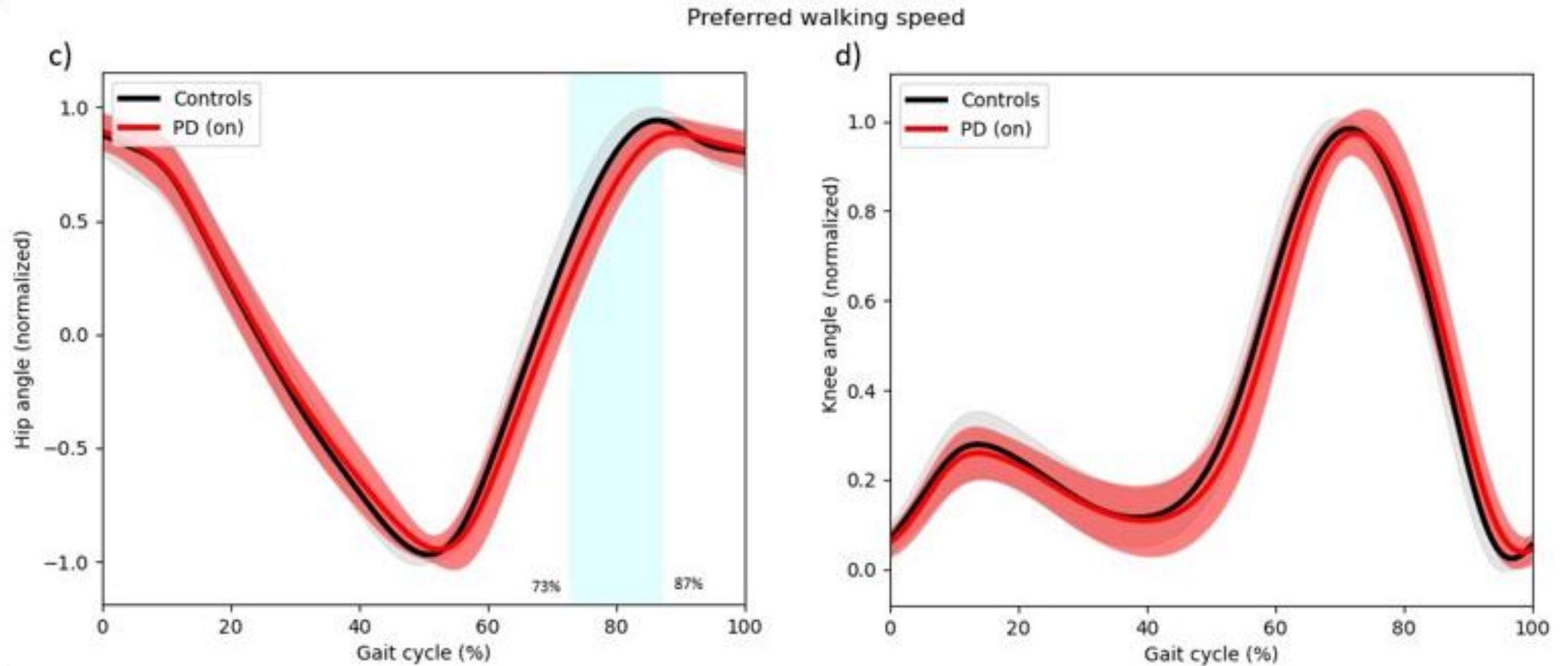
b)



Secondary results



Secondary results



Discussion

- Cyclograms may serve as promising intermediate clinical endpoints
- People with PD exhibit altered adaptation strategies of hip and knee movements to different walking speeds
- Controls demonstrate a more dynamic preparation for subsequent steps
- Interventions targeting the timing of the hip flexion in people with PD may enhance gait speed

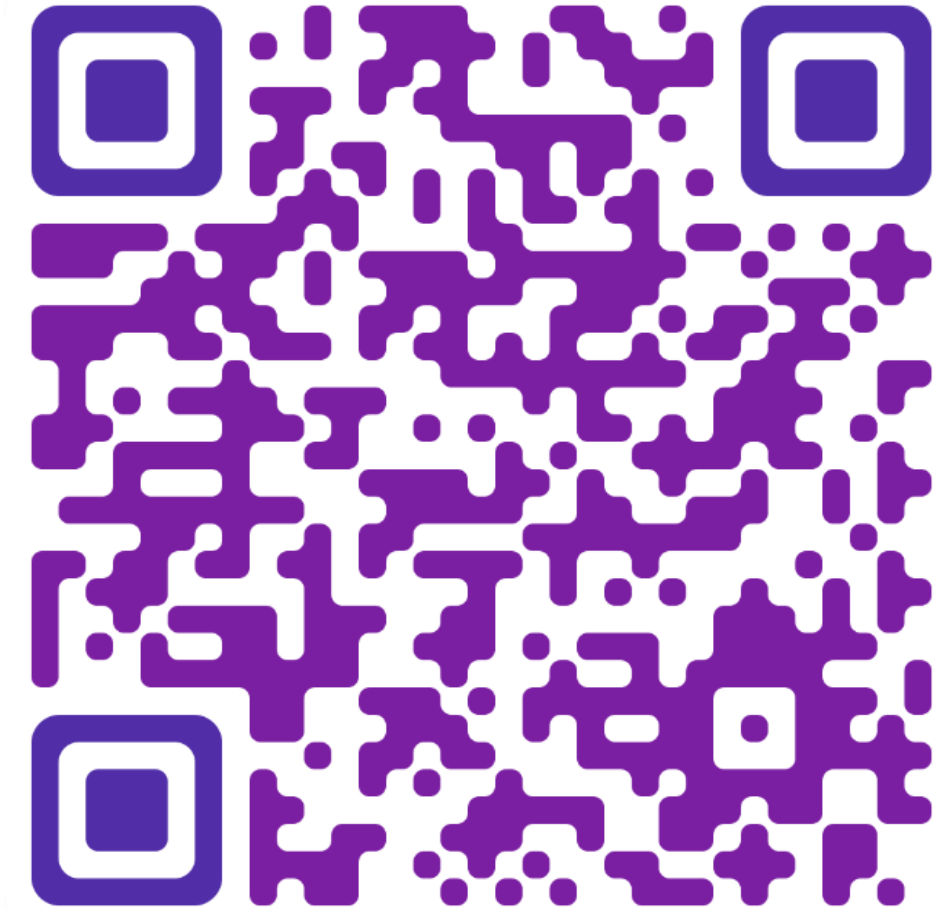


The outlook and conclusions

- The proposed methods can be used to analyse:
 - the relationship of other than hip and knee joints
 - analysing movement in other than sagittal plane
 - using cohorts from other mobility limiting diseases
- Surrogate Marker: ratio of minimum points to ratio of maximum points
- Significance: indicates adaptive strategies to changing walking speed
- Advantages: quick, inexpensive and directly applicable in clinical practise



Thank you for your attention



Python code for hip and knee angle extraction from motion capture data