



UNIVERSITÀ DEGLI STUDI DI NAPOLI  
**FEDERICO II**

**itee**<sup>PhD</sup>  
information technology  
electrical engineering



**DIE**  
**TI**

**UNI**  
**NA**

# MICHELA RUSSO

‘Artificial Intelligence & Gait Analysis for Neurological Diseases’

Tutor: Maria Romano

Cycle XXXVII

Year: Second

# My background

## Education

M.Sc in Biomedical Engineering (University of Naples, Federico II)

**“Implementation of machine learning algorithms for the recognition of gait-pattern in Parkinson’s disease patients with mild cognitive impairment”**

## Ph.D in Information Technology and Electrical Engineering

1 November 2021

## Partner company



Azienda Ospedaliero Universitaria  
San Giovanni di Dio Ruggi d'Aragona  
Scuola Medica Salernitana

# Summary of study activities

## Ad hoc courses:

- Muscle-based Human
- On the challenges and impact of Artificial Intelligence in the insure domain
- Using deep learning properly

## Workshop:

- Statistics for clinical studies and biomedical engineering (at Karlsruhe Institute of Technology, Germany)

**Period abroad:**   
Karlsruher Institut für Technologie

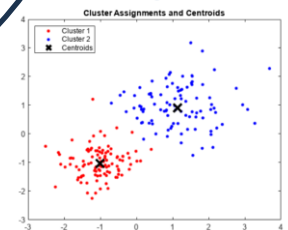
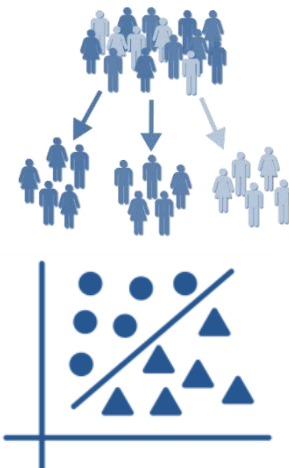
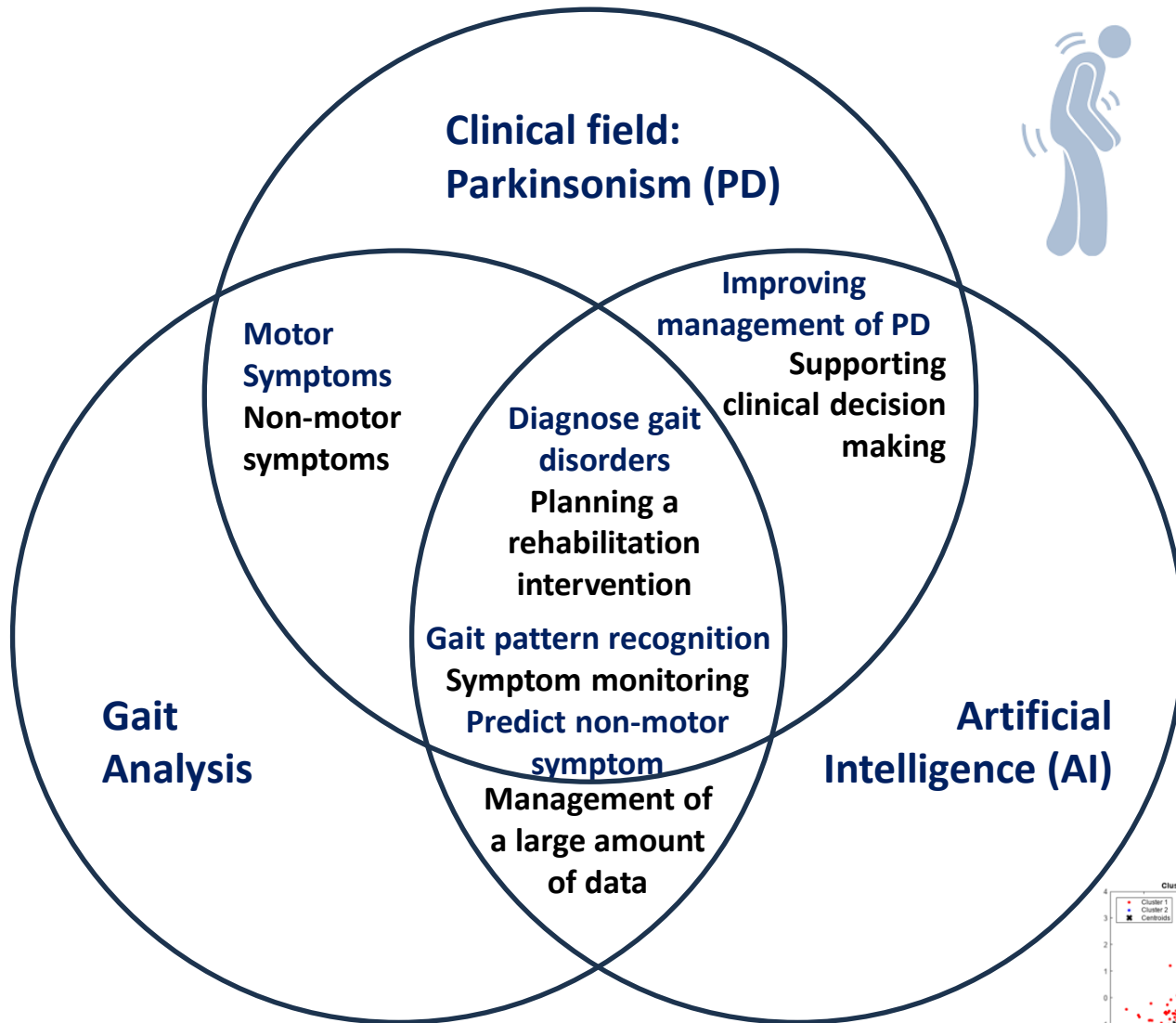
Visiting student at Institute of Biomedical Engineering at Karlsruhe Institute of Technology (Germany) – from 8° September to 16° December 2023

## Conferences/ Events attended:



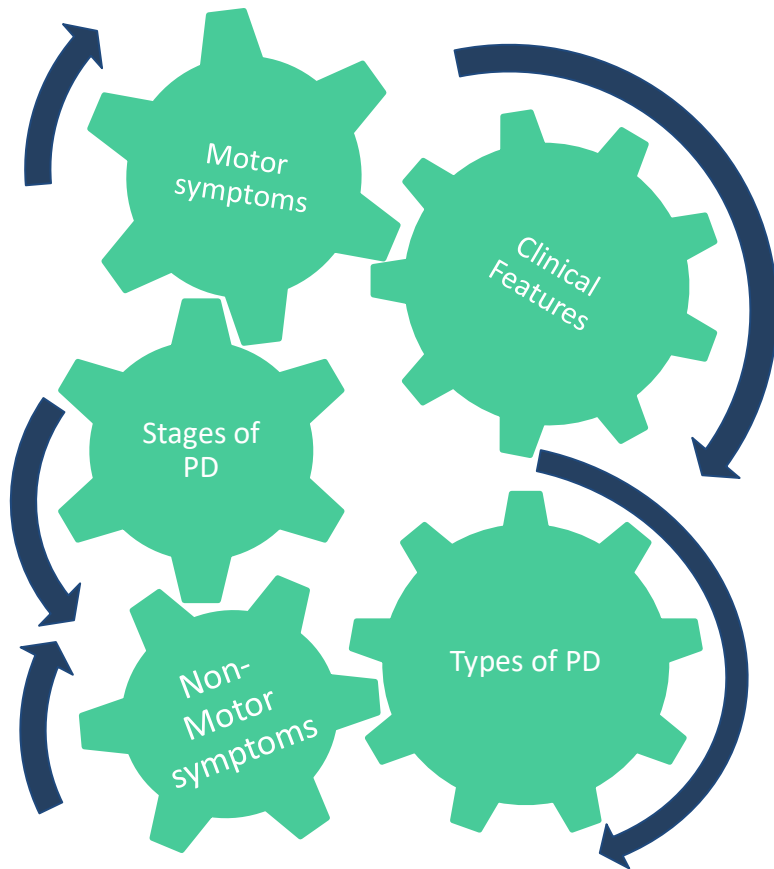
IEEE International conference on Metrology for eXtended Reality, Artificial Intelligence and Neural Engineering (2023IEEEMetroXRAINE); 24-27 October 2023, Milan.

# Research field of interest

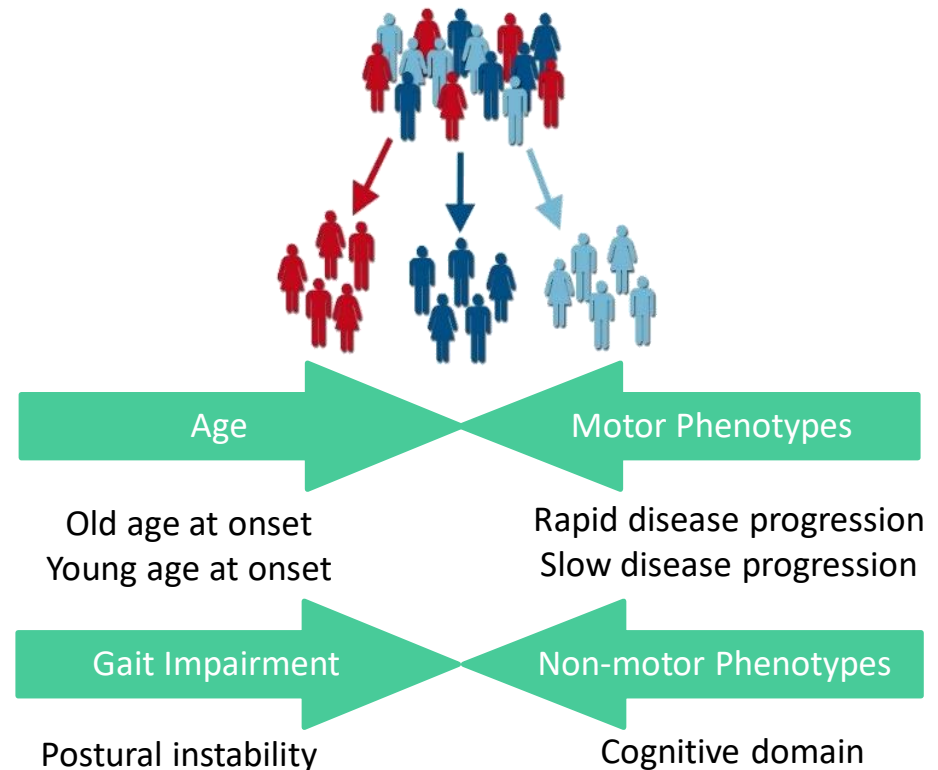


# Heterogeneity of PD (Problem)

PD clearly manifests a heterogeneous clinical syndrome for the large quantity of aspects that the disease involves. This variability in the clinical phenotype suggests the existence of several subtypes of the disease.



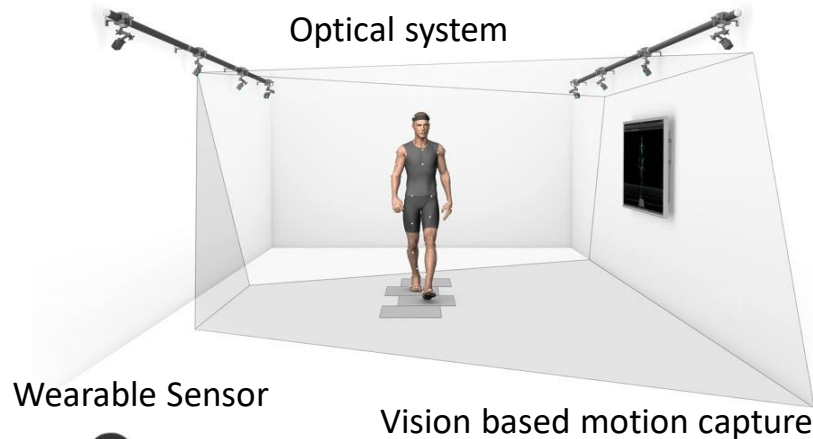
Recognition of different subgroups of patients may be relevant for understanding of disease progression, prognosis and treatment strategies.



# Research activity (Methodology)

Gait analysis has become a quantitative tool for analysing different walking disorders and gait abnormalities caused by musculoskeletal and neurological degradation.

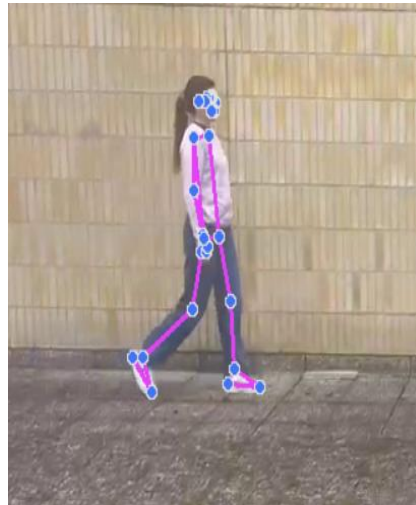
## In which way?



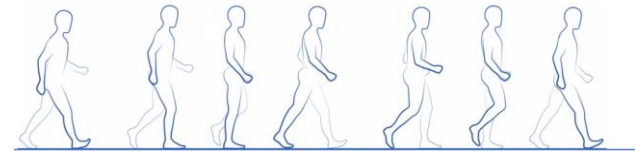
Wearable Sensor



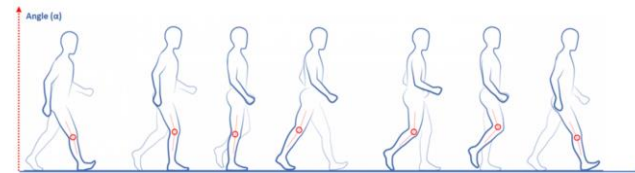
Vision based motion capture



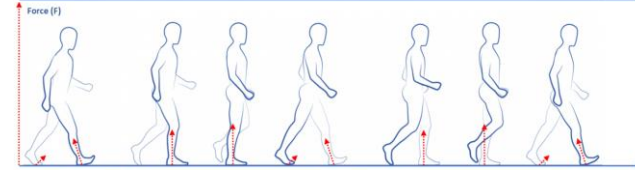
## What parameters?



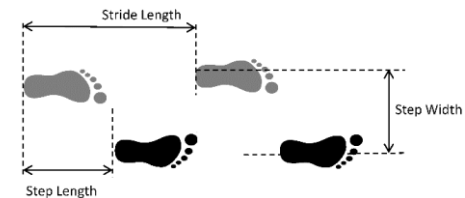
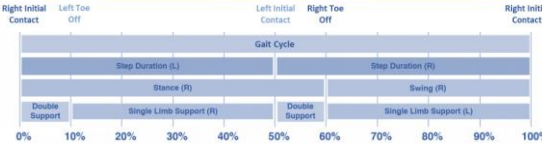
Spatial-temporal parameters



Kinematics parameters

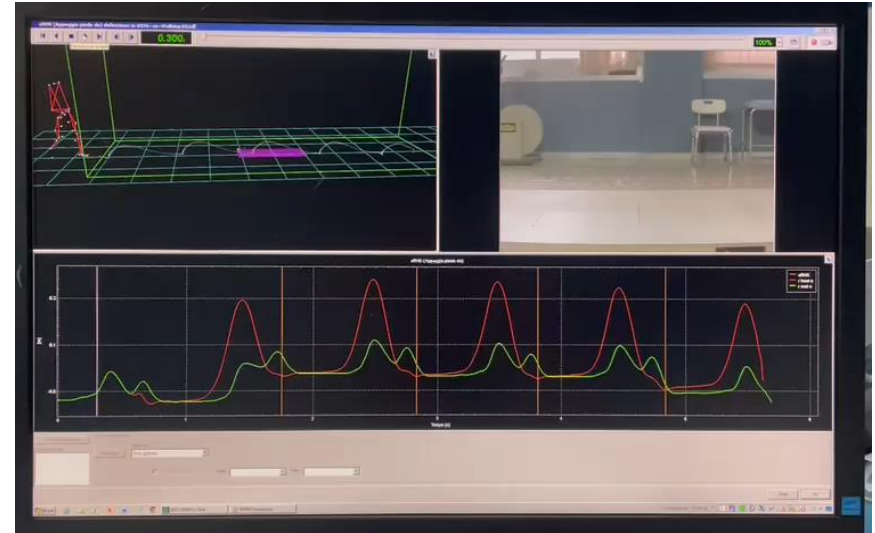


Kinetics parameters



# Research activity (Methodology)

## ❑ Marker motion capture system



**Optoelectronic system** is the Gold standard for the motion capture:

- Provides robust and precise acquisition of physical movements
- Allow to have detailed information of the subjects

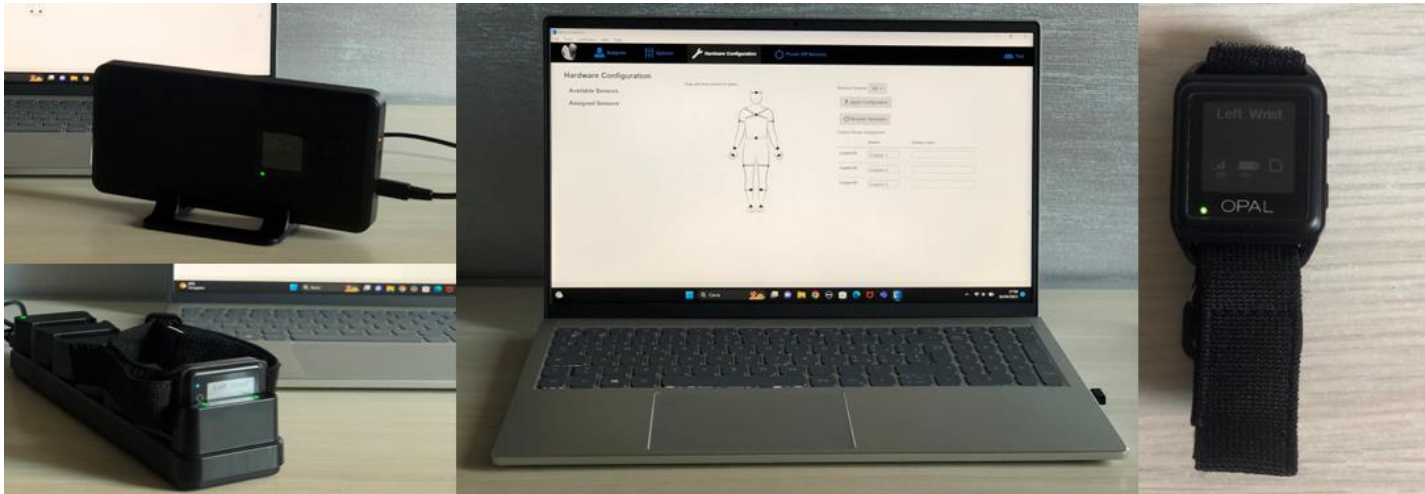
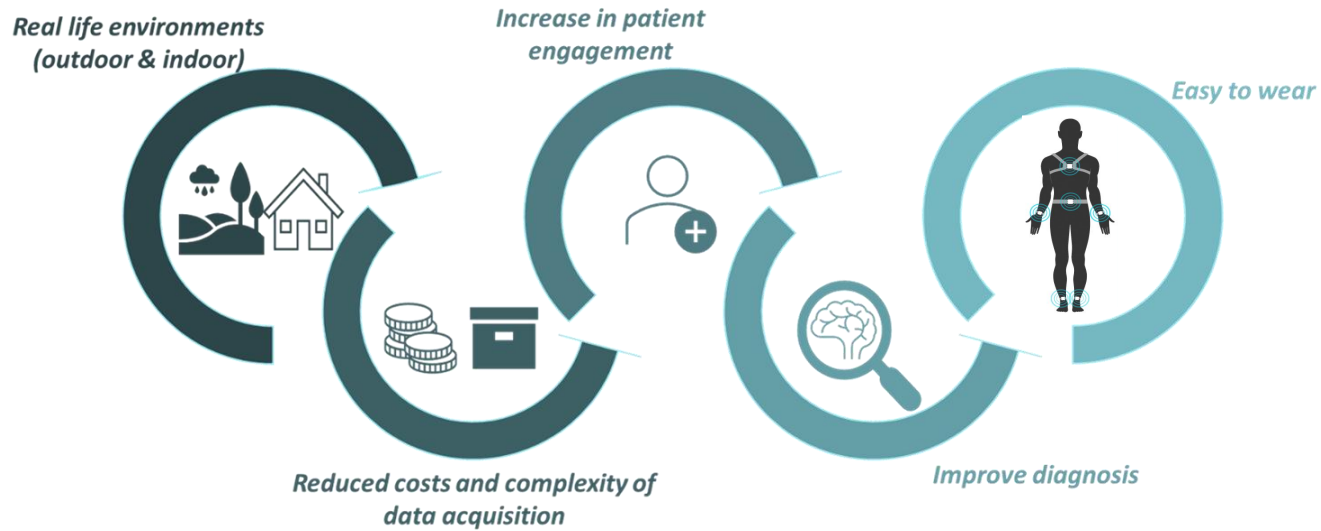
**Disadvantages** : High cost of instrumentation



**BTS Bioengineering**

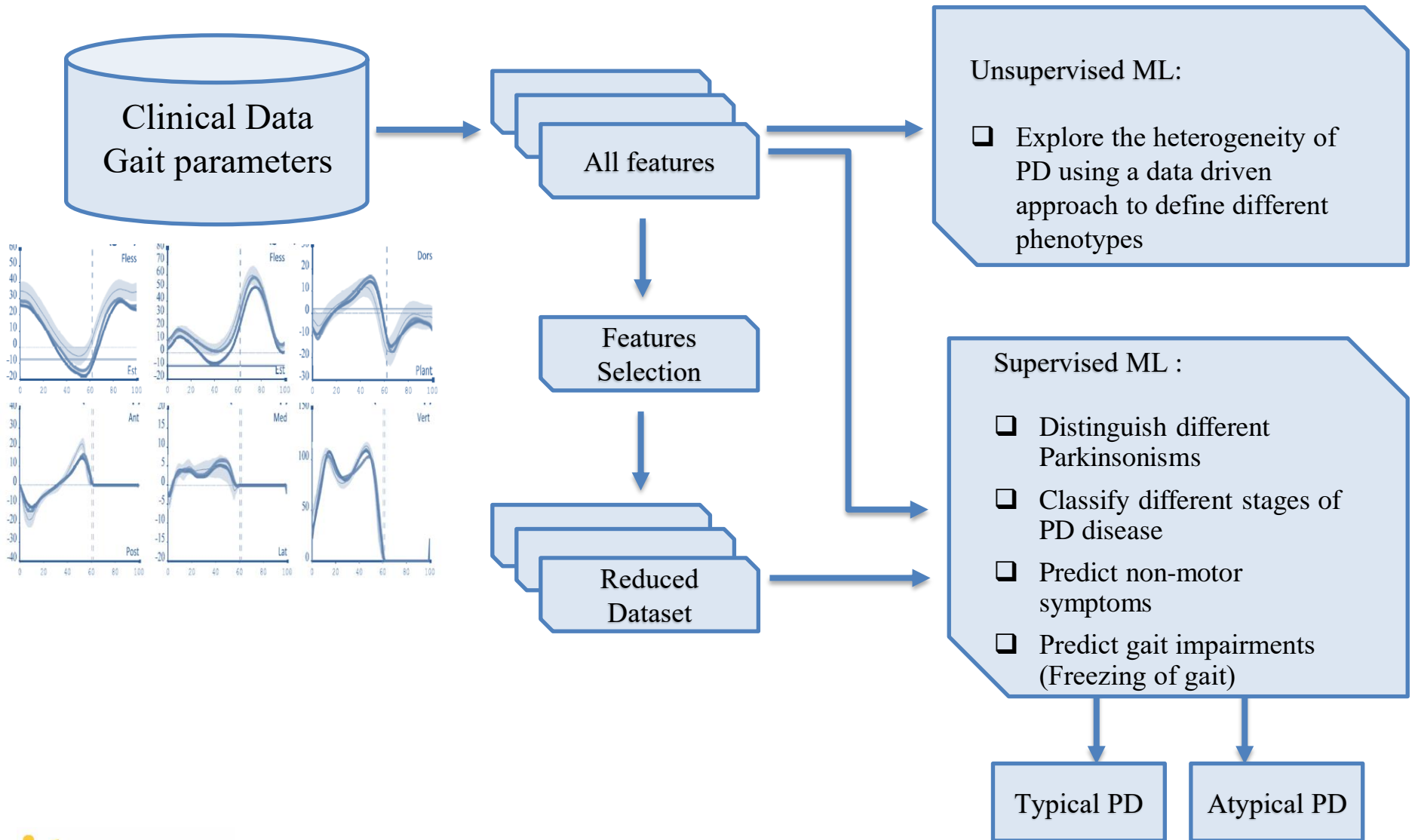
# Research activity (Methodology)

## ❑ Wearable Sensors



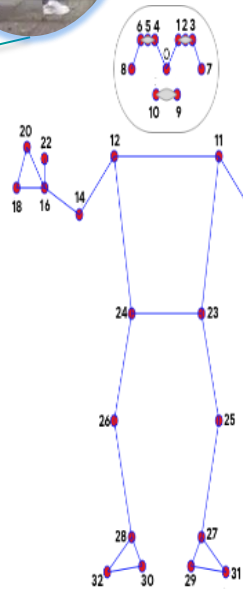
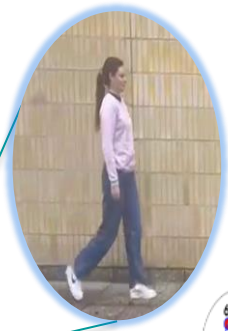


# Research activity (Solution)



# Visiting Student at KIT

- ❑ Markerless motion capture system



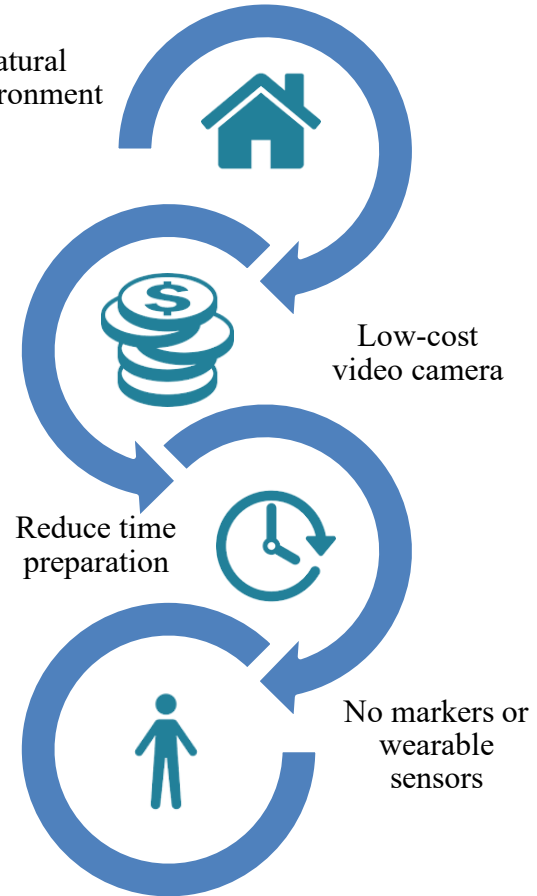
## AI Pose Estimation Technique

### Landmarks

- |                    |                      |
|--------------------|----------------------|
| 0. Nose            | 17. Left_pinky       |
| 1. Left_eye_inner  | 18. Right_pinky      |
| 2. Left_eye        | 19. Left_index       |
| 3. Left_eye_outer  | 20. Right_index      |
| 4. Right_eye_inner | 21. Left_thumb       |
| 5. Right_eye       | 22. Right_thumb      |
| 6. Right_eye_outer | 23. Left_hip         |
| 7. Left_ear        | 24. Right_hip        |
| 8. Right_ear       | 25. Left_knee        |
| 9. Left_mouth      | 26. Right_knee       |
| 10. Right_mouth    | 27. Left_ankle       |
| 11. Left_shoulder  | 28. Right_ankle      |
| 12. Right_shoulder | 29. Left_heel        |
| 13. Left_elbow     | 30. Right_heel       |
| 14. Right_elbow    | 31. Left_foot_index  |
| 15. Left_wrist     | 32. Right_foot_index |
| 16. Right_wrist    |                      |



Natural Environment



KIT  
Karlsruher Institut für Technologie

Michela Russo



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# Products

[P1]	<p><b>Title:</b> Identification of a Gait Pattern for Detecting Mild Cognitive Impairment in Parkinson’s Disease  <b>Authors:</b> Russo, M.; Amboni, M.; Barone, P.; Pellecchia, M.T.; Romano, M.; Ricciardi, C.; Amato, F..  <b>Journal:</b> Sensors  <b>Year:</b> 2023  <b>Current Status:</b> Published (<a href="https://www.mdpi.com/1424-8220/23/4/1985">https://www.mdpi.com/1424-8220/23/4/1985</a>)</p>
[P2]	<p><b>Title:</b> Wearable sensors for assessing disease severity and progression in Progressive Supranuclear Palsy  <b>Authors:</b> Abate, F; Russo, M; Ricciardi, C; Tepedino M.R.; Romano, M; Erro, R; Pellecchia, MT; Amboni M; Barone,P; Picillo, M.  <b>Journal:</b> Parkinsonism and Related Disorders  <b>Year:</b> 2023  <b>Current status:</b> Published (<a href="https://doi.org/10.1016/j.parkreldis.2023.105345">https://doi.org/10.1016/j.parkreldis.2023.105345.</a>)</p>
[C1]	<p><b>Title:</b> A cluster analysis for Parkinson’s Disease phenotyping with gait parameters  <b>Authors:</b> Russo, M.; Ricciardi C.; Amboni, M.; Volzone A.; Barone, P.; Romano, M.; Amato, F.  <b>Journal:</b> 2023 IEEE International Conference on Metrology for Extended Reality, Artificial Intelligence and Neural Engineering (MetroXRAINE)  <b>Year:</b> 2023  <b>Current Status:</b> Accepted</p>
[RP1]	<p><b>Title:</b> Biomechanics parameters of gait analysis to characterize Parkinson’s disease: a systematic review  <b>Authors:</b> Russo, M.; Amboni, M.; Pisani, N.; Calderone D.; Barone, P.; Amato, F.; Ricciardi, C.; Romano, M.  <b>Journal:</b> Biocybernetics and Biomedical Engineering  <b>Year:</b> 2023  <b>Current Status:</b> Submitted</p>

P = Journal Paper; C = Conference Paper; RP = Review Paper

# Activities

## Tutorship

- ❖ Co-supervisor of two master theses in Biomedical Engineering on supervised and unsupervised approaches for predict cognitive impairment in PD patients.
- ❖ Practical lectures/seminars during courses of Health Facilities Management (Master Degree in Clinical Engineering)
- ❖ Assistant during courses of Elaboration of Biomedical Signal and Data (Bachelor Degree in Biomedical Engineering)

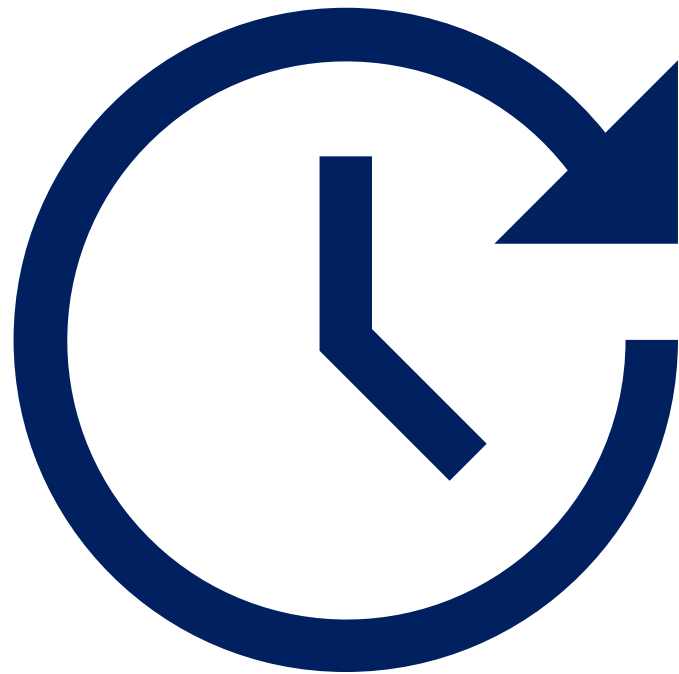
## 13 Seminars

## 3 Ad-Hoc courses

## 1 Workshop

# Next Year

- Extended analysis on the kinematic and kinetic gait parameters
- Agreement study between Optoelectronic System and Wearable Sensors
- Results validation of the markerless capture system on PD patients with gold standard system
- Research period abroad at Institute of Biomedical Engineering, Karlsruhe (Germany)



# THANK YOU FOR ATTENTION!

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