Robust time series classification in Remote Health Monitoring

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The topic

- **Physical activity** and **rehabilitation exercise execution** are important **information sources** for **decision making** in **rehabilitation medicine** (e.g. people recovering from sports injuries, stroke incidents, the elderly)

- Time (of patients and doctors) and costs (of patients) can be reduced if **assessment** of the *quantity* (and/or quality) of the activity / rehabilitation exercise sessions can be **remotely monitored** through use of **wearable sensors** (e.g. accelerometer bracelets, smartwatches)

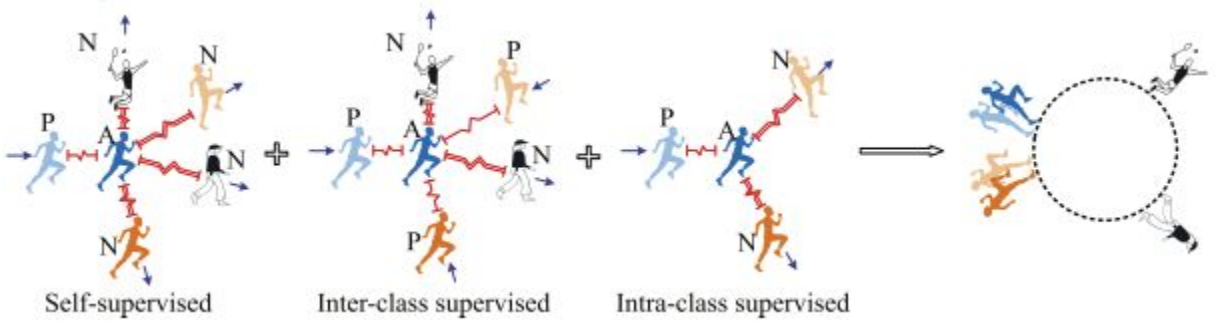
The topic and its **challenges**

- Activity monitoring (e.g. in physical rehabilitation therapy, in sports activities) exhibits **high variability** of activity / exercise execution from person to person
  - ⇒ Challenge in **robust detection / classification** of an activity **for new individuals**

- **Labeled datasets** often have low patient support (in the order of tens), with unquantified intra- and inter-patient variability

The proposed solution

- Leverage recent methods on **unsupervised pre-training** for time series **representation learning** using large unlabeled, free-living collected data (e.g. Capture-24, UK Biobank, Fenland
  - Main candidate: **contrastive learning**



Hao et al., MICOS: Mixed **supervised contrastive learning** for multivariate time series classification, Knowledge-Based Systems, 2023

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- Leverage:
  - Proper **data augmentation** techniques
  - Metrics for activity time series **similarity measurement** to inform training

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- Analyse:
  - Robustness to **misplacing sensors**
  - Robustness to intra-patient variability for a type of activity; Use of **learned representation space** to quantify intra-patient and inter-patient variability
  - **Adaptation ability**: number of samples required from a **new patient** to ***fit*** a general model to patient-specific execution

The multi-agent potential

- “Bootstrapping” of **best-for-patient** model
  - Use the large pre-trained model to quantify *similarity* to an existing patient (e.g. all patients registered to the same rehabilitation therapy center)
  - Agents ***adapt*** the models to their users

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- How to other agents respond to a request?
  - Send **their models** (not the data) to be evaluated by the requester
  - Requester retains best model