Motion identification and classification of mentally ill patients

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Project Goal:

Provide a wearable able to detect typical states of minds of mentally ill patients

Previous research

Psychomotorics: correlation between motion and state of mind

Applications

Assisting treatment & increasing patient recovery speed

Classification of gestures and motion on sliding window data

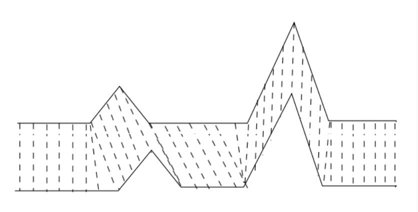
- Dynamic Time Warping
- Motor primitive decomposition:

$$\min_{a_{ru}} \left(y_r(t) - \sum_{u=1}^{U} a_{ru} \cdot f_u(t - \tau_{ru}) \right)$$

- moving window statistical moment decomposition:

$$\mu : \mathbb{R}^{m \times \omega N_t} \to \mathbb{R}^{mN}$$

$$\mu_n = \int_{-\inf}^{\inf} (x - c)^n f(x) \mathrm{d}x$$



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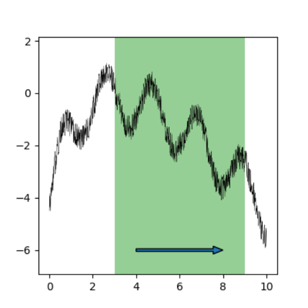
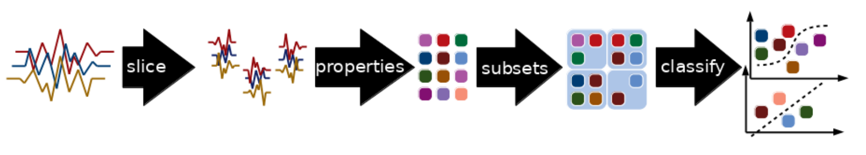


Motion Detection Evaluation Pipeline

Question: Which properties allow us to detect predefined motions in a stream of sensor data?

- >7h of sensor data ($\ddot{\vec{x}}$, $\vec{\omega}$), sliced into 3-30s windows
- up to 304 properties computed per window
- 12 Classifiers



Infeasable on commodity hardware $\rightarrow$highly parallelized computation necessary.

Plan: field study, factor 100 times that amount of data

Model based reconstruction

Sensors

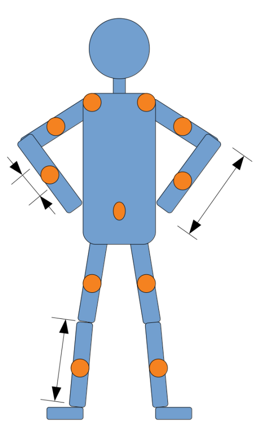
Kinematic fit:

$$\min\left(\sum_{i=1}^{N}(\ddot{x}_i - \ddot{x}_{i,m})^2 + \sum_{i=1}^{N}(\omega_i - \omega_{i,m})^2\right)$$

Sources of uncertainty:

- model dimensions
- sensor positions

Model



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Reconstruction accuracy: sensor placement and number

$p :=$ set of sensor positions

$R :=$ number of reference points

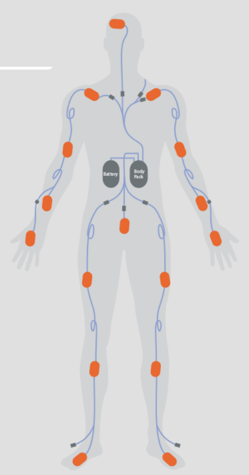
$\omega :=$ data acquisition frequency

$$\min_{p} \left(\sum_{i=0}^{R} \left(x_{ref,i} - x_{reconst,i}(p, \#p, \omega) \right)^2 \right)$$

$x \in trajectories, accellerations, torques, \ldots$

Current approach:

- $x_{ref,i}$ obtained by full forward simulation
- $x_{reconst,i}$ obtained by reconstructing tracer-subset of full forward simulation



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