An Object-Oriented Approach in R for the Visualization of Functional Actigraphy Data

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**Background (1)**

- **Actigraphy**: emerging technology for measuring a patient’s activity level continuously over time

- **Actigraph**: watch-like device (attached to the wrist or a leg) that uses an accelerometer to measures (human) movements (every minute or more often)
Analysis of Human Actigraphy Data:
Useful for detecting sleep, for assessing insomnia and restless leg syndrome, for tracking recovery after heart attacks, and as an assessment tool for overall status of HIV patients

Actigraphy Data can be best described as functional data
Visualization of Functional Data

- Very limited! A rare example is:

- Figure from http://www.smith.umd.edu/faculty/wjank/DIV-Berlin2006.pdf (page 30).
Current Visualization of Actigraphy Data
New Visualization of Actigraphy Data

- **Plots:**
  - Raw data
  - Smoothed data
  - Averages etc.
  - Velocity (First Derivative)
  - Acceleration (Second Derivative)
  - Cumulative Sums
  - Sorted Cumulative Sums

- **Interaction:**
  - Linking & Brushing
  - Zooming & Focusing
Object-Oriented Approach

“Object-oriented programming (OOP) is a [programming paradigm](http://en.wikipedia.org/wiki/Object-oriented_programming) that uses "objects" – [data structures](http://en.wikipedia.org/wiki/Object-oriented_programming) consisting of [datafields](http://en.wikipedia.org/wiki/Object-oriented_programming) and [methods](http://en.wikipedia.org/wiki/Object-oriented_programming) together with their interactions – to design applications and computer programs. […]

An object is a discrete bundle of functions and procedures, often relating to a particular real-world concept such as a bank account holder or hockey player. Other pieces of software can access the object only by calling its functions and procedures that have been allowed to be called by outsiders. […]"

Object-Oriented Programming in R

- **S3 System (via UseMethod function):**
  - Available for a long time
  - Many restrictions
  - Widely used

- **S4 System (via R package methods):**
  - More sophisticated
  - Less computationally efficient
  - Less widely used

- **Directly via R package R.oo:**
  - Extends S3
  - Developed since 2002
  - Easy to use, more user friendly
  - Reference variables
  - Widely used
OOP for AVAD Software (Use Case Diagram)
OOP for AVAD Software (Class Diagram)
User Interfaces for AVAD Software

- Main users in the medical field
- Easy-to-use interfaces needed (users unlikely to learn R)
- Approaches via
  - Web interface (everyone knows how to operate a Web browser)
  - Rmcdrr interface from within Excel (data collected with Excel)
Live Demos (1)

- AVAD Software (Web Interface to R)
  - Based on R package Rpad
  - Operational up to R 2.9.2
- Example: 1 Subject
  - Orange: 5 Days at Baseline
  - Purple: 5 Days after 6 Months
Live Demos (2)

- Rcmdr Interface to R (through Excel)
  - Utilizing Rcmdr GUI and package
  - Functional on all recent R versions
Conclusions

Visualization of Actigraphy Data provides

- Potential for application in various medical fields
- Additional insights into actigraphy data
- Ease to compare baseline and past-treatment data
  - of a single patient
  - of multiple patients
  - to identify outliers
  - to compare averages
Questions ???