CONFLICT OF INTEREST DISCLOSURE

I have no potential conflict of interest to report
City4Age: Unobtrusive Detection of Mild Cognitive Impairment and Frailty by Harnessing Sensor Technology and Big Data Sets in Smart-Cities

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The paradigm: data-driven preventive actions

Behavior

Visit (diagnosis, interventions)

«Big» Unobtrusive Datasets

City4Age Risk detection subsystem

Monitoring and Assessment Dashboards

Health indicators
Rantz et al., Using Sensor Networks to Detect Urinary Tract Infections in Older Adults, 2011

- Usage of **infrared motion detectors** to detect increased nightly visit to **bathroom** to test patients (in residential care facility) for Urinary Tract Infection
- Alert caregiver when activity is 4 standard deviations beyond the mean of the previous 14 days
- 2 out of 3 cases led to early UTI detection (the other was a FP)
Related work / 2

Akl et al., Autonomous Unobtrusive Detection of Mild Cognitive Impairment in Older Adults, 2015

- Usage of **infrared motion detectors** to measure walking speed and detect MCI
  - Based on Buracchio et al., *The trajectory of gait speed preceding MCI*, 2010
- Machine Learning approach (Support Vector Machines, Random Forests)
  - 6 measures related to walking speed
  - Features: 24-week trajectories
- Classifier with $\text{AUC}_{\text{ROC}} = 0.97$ and $\text{AUC}_{\text{precision-recall}} = 0.93$
What can be done with «big data»?

Collect multiple datasets ➔ investigate multiple determinants

- Survey of instruments, used in current practice
  - Fried Frailty Index
  - Edmonton Frail Scale
  - Lawton IADL Scale
  - Direct Assessment of Functional Status
  - …

- Comparison with available, unobtrusive datasets that can measure behavior
  - (Athens, Birmingham, Lecce, Madrid, Montpellier, Singapore)
The City4Age computational model

Identification of 10 Geriatric factors (GEF) and 43 sub-factors (GESs)

- **Behavioral GEFs**
  - Mobility
  - Physical Activity
  - Basic ADLs
  - Instrumental ADLs
  - Socialization
  - Cultural engagement

- **Context and status GEFs**
  - Dependence
  - Environment
  - Health – Physical
  - Health – Cognitive

Example of decomposition in sub-factors:

- **Mobility**
  - Walking
  - Climbing stairs
  - Still/moving
  - Moving across rooms
  - Gait balance

Each factor is associated to specific measures collected from unobtrusive technologies
The resulting framework in Pilot Cities

Madrid Pilot (6 GEFs, 9 GESs, 31 unobtrusive measures)

- Motility
  - Walking
  - Still/moving

- Physical Activity

- Basic ADLs
  - Going Out

- Instrumental ADLs
  - Shopping
  - Transportation

- Socialization
  - Visits
  - Attending Senior Centers
  - Attending other social places

- Cultural engagement
  - Visit entertainment/culture places

<table>
<thead>
<tr>
<th>Motility</th>
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WALK_DISTANCE
WALK_STEPS
WALK_SPEED_OUTDOOR
WALK_TIME_OUTDOOR
LONG_WALKS_NUM
STILL_TIME
PHYSICAL_ACTIVITY_CALORIES
HOME_TIME
OUTDOOR_NUM
OUTDOOR_TIME
GOING_OUT_NUM
GOING_OUT_LENGTH
SUPERMARKET_TIME
SUPERMARKET_VISITS
PUBLIC_TRANSPORT_RIDES_MONTH
PUBLIC_TRANSPORT_DISTANCE_MONTH
PUBLIC_TRANSPORT_TIME
TRANSPORT_TIME
VISITS_PAYED
SENIORCENTER_TIME
SENIORCENTER_TIME_OUT_PERC
SENIORCENTER_VISITS
SENIORCENTER_VISITS_MONTH
OTHERSOCIAL_TIME_OUT_PERC
OTHERSOCIAL_VISITS
OTHERSOCIAL_TIME
PUBLICPARK_TIME
PUBLICPARK_VISITS_MONTH
PUBLICPARK_VISITS
CULTUREPOI_VISITS_MONTH
CULTUREPOI_VISITS_TIME_PERC_MONTH
Data interpretation

Behavioural & Contextual Geriatric group factors


Behavioural Geriatric factors


Mobility  Physical Activity  Basic Activities of Daily Living  Instrumental Activities of Daily Living  Socialization  Cultural Engagement
Future plans

Data analytics and machine learning: a proposal

- **Computational model → Bayes Network**
  - ~ 160 nodes

- **Apply Machine Learning techniques**
  - To clarify the actual structure of the model and improve it
  - To build a classifier (predictor)
    - Support Vector Machines
    - Random Forest
    - ...
Thank you!

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