IBM ITALY RESEARCH CENTER on ACTIVE INTELLIGENCE

Bologna

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IBM INNOVATION
+ OPEN BUSINESS INNOVATION

Bring **INNOVATION** to Italian market to tackle complex real-world industrial problems in the areas of human **well being**

Act as a catalyzer to capture **OPEN INNOVATION & NETWORK**: fostering partnerships and joint collaborations with the University & Research Ecosystem in Italy and innovative companies in key strategic world areas: US, Switzerland China, Israel and Japan

R&d

Autonomous behaviors for machines will be a frequent asked option.
Active Intelligence
Individualized options or offerings on a universal scale becomes feasible. AI, big data and IoT enable content and experiences to be proactively tailored to the user with an unprecedented level of relevance along the whole industrial chains
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Big Data

Decision Lakes

Sense & Organize Data & Information

- Internet
- Web/Mobile
- Data
- Cloud / IoT

Propose decisions for us and our businesses

- Analytics
- Artificial Intelligence /Machine Learning
- Natural Interfaces
- Multimodal Reasoning

Product & Services that *Proactively* mediate users

- Behavior analysis to support Healthy decisions and Well being
- Augment Problem Solving and learning
- Active Cyber-Physical Systems (Homes, Bikes, etc.)
- Resilient Work Environments & Manufacturing

Active support for aging and fragile population segment

New ways for learning and problem solving

Ambient and Human Interaction Automation

& R&D - Discovery

Dementia in Italy

1.2 million in Italy

Today there are 47.5 million people in the world suffering from dementia and 8.2 million in Europe

37.7 Billion Euro expenditure (about 2% GDP)

Annual social cost in Italy (2015 data)

57%

Expected reduced ratio of the number pf AD patients by a hypothetical intervention that delays the onset of AD by 5 years

45%

Diagnosis coverage in high income countries

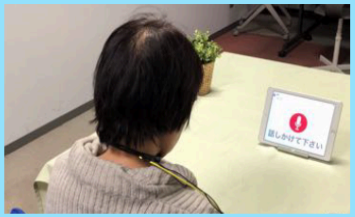
Aiming to build a dataset and develop AI-powered analytics enabling to extract meaningful behavioral features from sensor data and infer changes in physical, cognitive, and mental functioning.

Behavioral Data of IoT Sensors

Gait

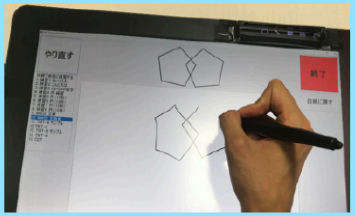
Eye Movement

Phone Call



Voice Interaction

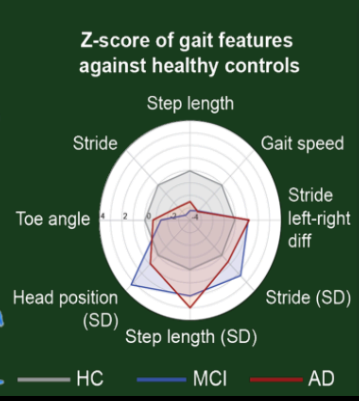
Preparing Meal

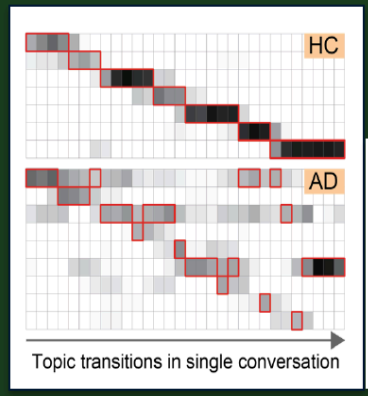


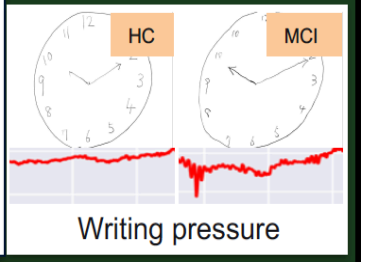
Drawing

Behavioral Features

Extract changes in behavioral patterns as interpretable features



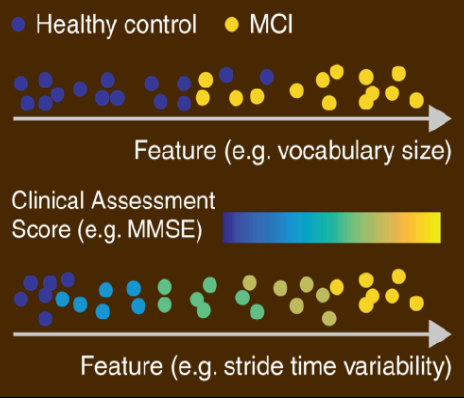




Infer Clinical Outcomes

Bridge between behavioral changes and clinical outcomes

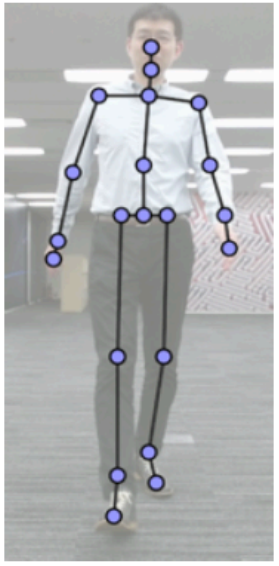
- ✓ Diagnosis (e.g. MCI, AD)
- ✓ Motor, Cognitive, and mental health functioning measured by clinical tests



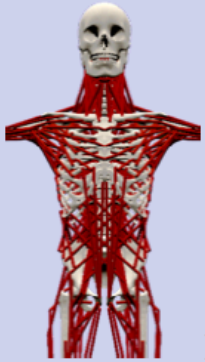
Gait Analysis

Estimate the whole body muscle and joint coordination from nonintrusive sensors which we can embed in our daily living environment, and enable accurate and early estimation of age related risks.

Motion Sensor



E.g.: mounted on a wall at a care facility

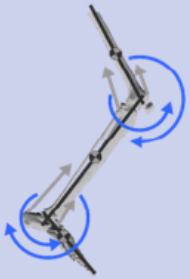


Anatomical data

Musculoskeletal model based on MRI/CT data

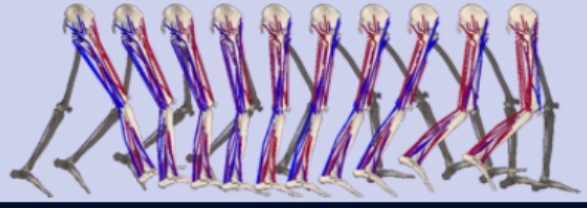
Robotics

Estimate joint torques with inverse dynamics



Machine Learning

Estimate muscle activities with optimization



Gait Features

Kinematic features

- Joint coordination, Jerk

Torque

- Joint load, Effectiveness

Muscles

- Tension, Synergies, Coordination

Target Risks
(future goal)

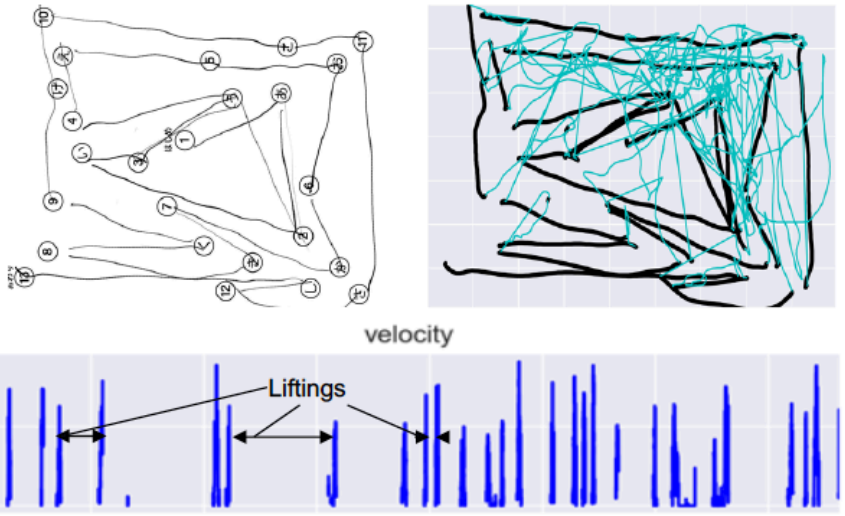
- Motor function
  - Fall risks
  - Frailty
- Cognitive decline
  - Episodic memory
  - Executive function
- Diseases
  - Parkinson disease
  - MCI
  - Alzheimer's disease

Examples of Behavioral Features Related to Drawing

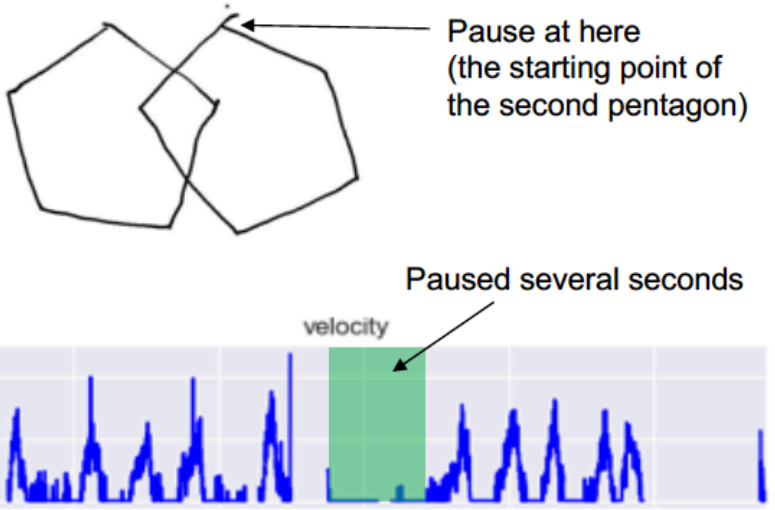
- Extracted features during tests and free text writing, and found significant difference among subjects' groups (HC/MCI/AD)
  - Features related to motor function: smoothness, writing pressure and its change
  - Features related to cognitive function: pause, order, and contents

[Garre-Olmo *et al*, *Curr Alzheimer Res*, 2017]
[Gulde *et al*, *Front Neurol*, 2018, Kahindo *et al*, *IEEE*, 2018]

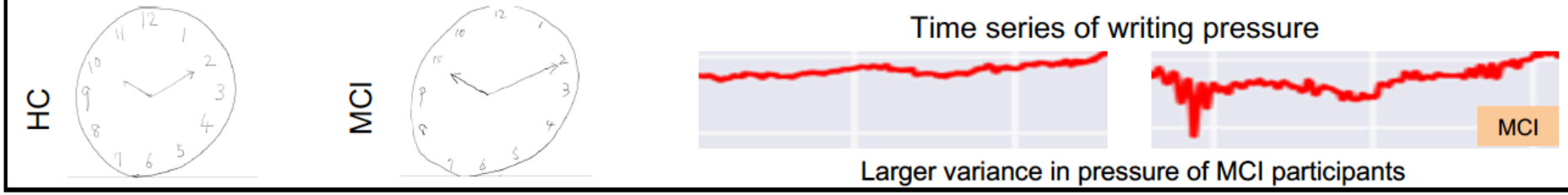
Irregular liftings in trail making



Long intermediate pause



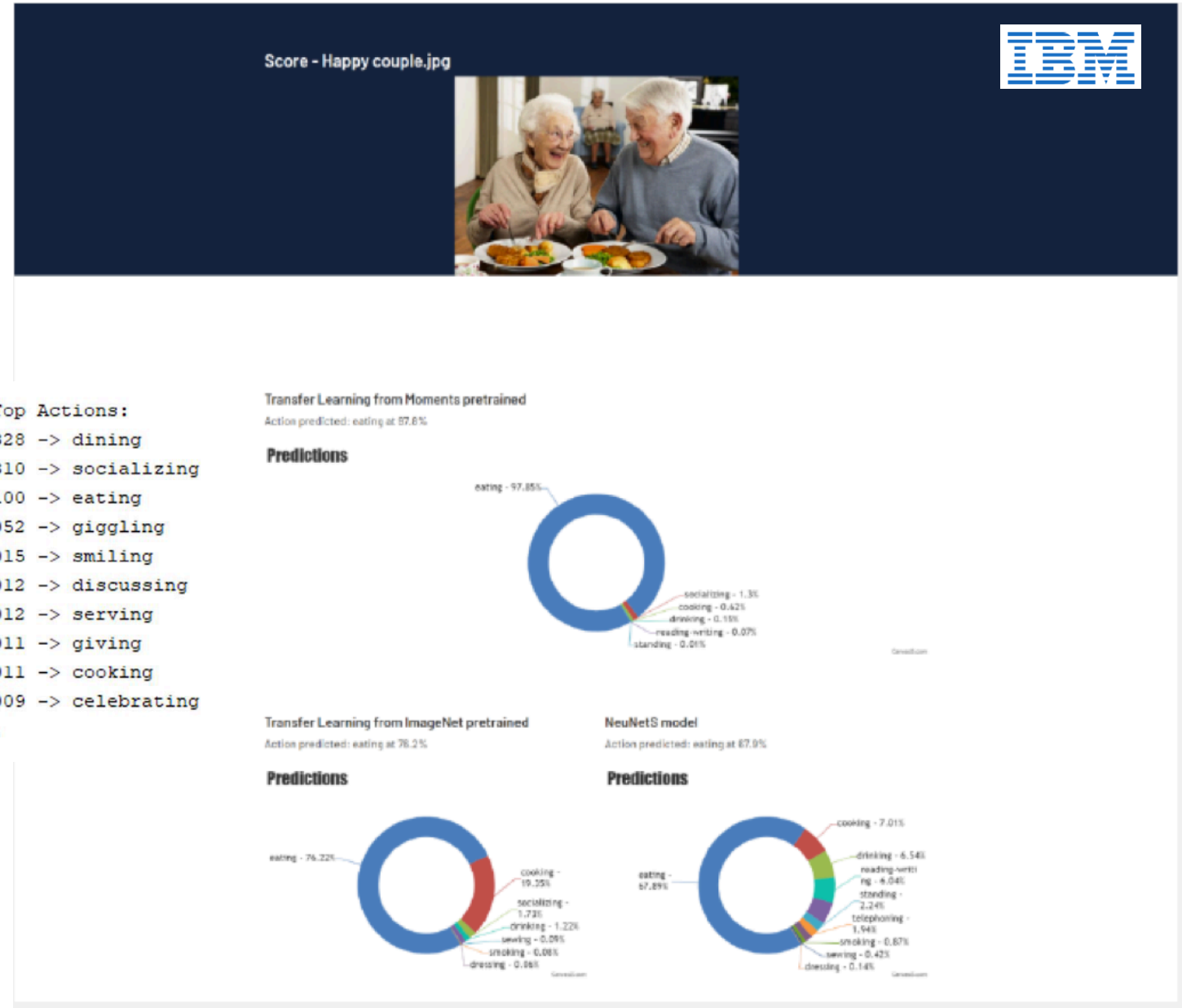
Unstable pressure during circle drawing



[Ishikawa *et al*, *MedInfo*, 2019]

Action recognition to estimate Activities of Daily Living (ADL) of elderly people with standard RGB cameras

```
--Top Actions:
0.328 -> dining
0.310 -> socializing
0.100 -> eating
0.052 -> giggling
0.015 -> smiling
0.012 -> discussing
0.012 -> serving
0.011 -> giving
0.011 -> cooking
0.009 -> celebrating
...
```

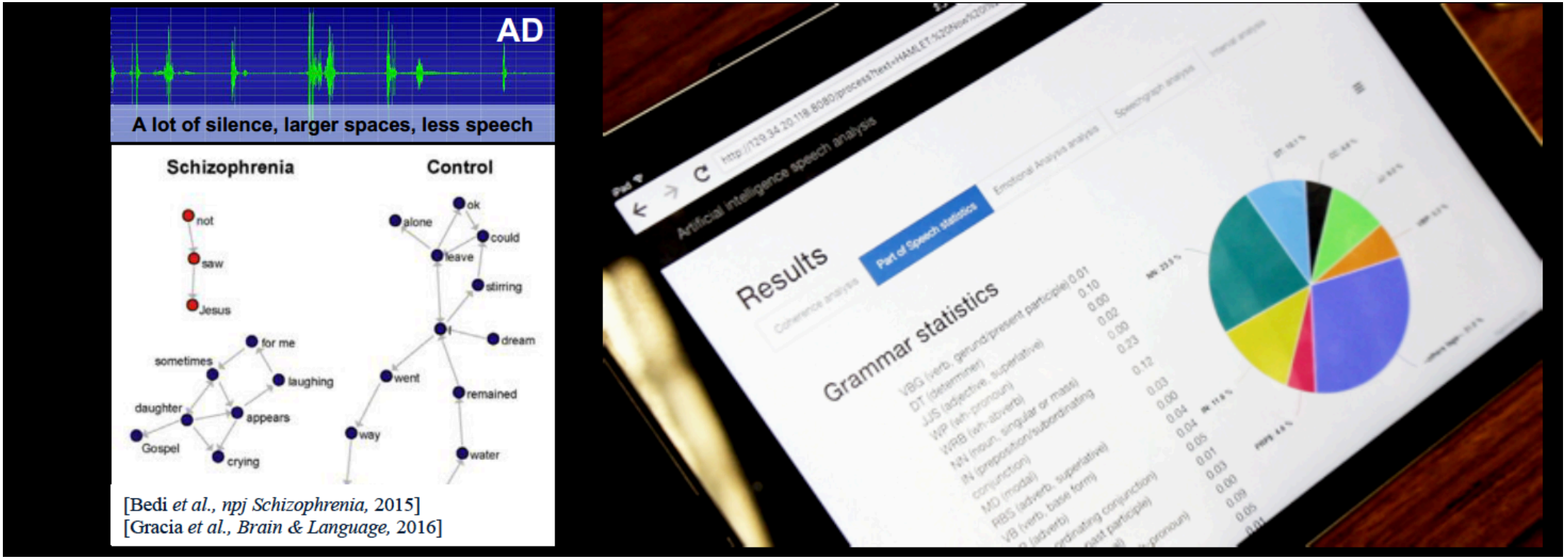


Gabrielli, at all . “Action recognition to estimate Activities of Daily Living (ADL) of elderly people ”- FAAL 2019

Speech Analysis Engine for Inferring Health States

Based on our efforts about the relationship between speech and mental health, we're developing a realtime engine to help clinical decision making including timely diagnosis and intervention.

Depression, Bipolar disorder, Parkinson's disease, Schizophrenia, Dementia, Mild cognitive impairment, Emotion, Mood, Daily physical condition, etc.



Virtual Trainer for cognitive impaired patients

ViTA Advisor: it is a conversational multi-modal agent to support older as well as a tool to collect meaningful data about the context of an individual

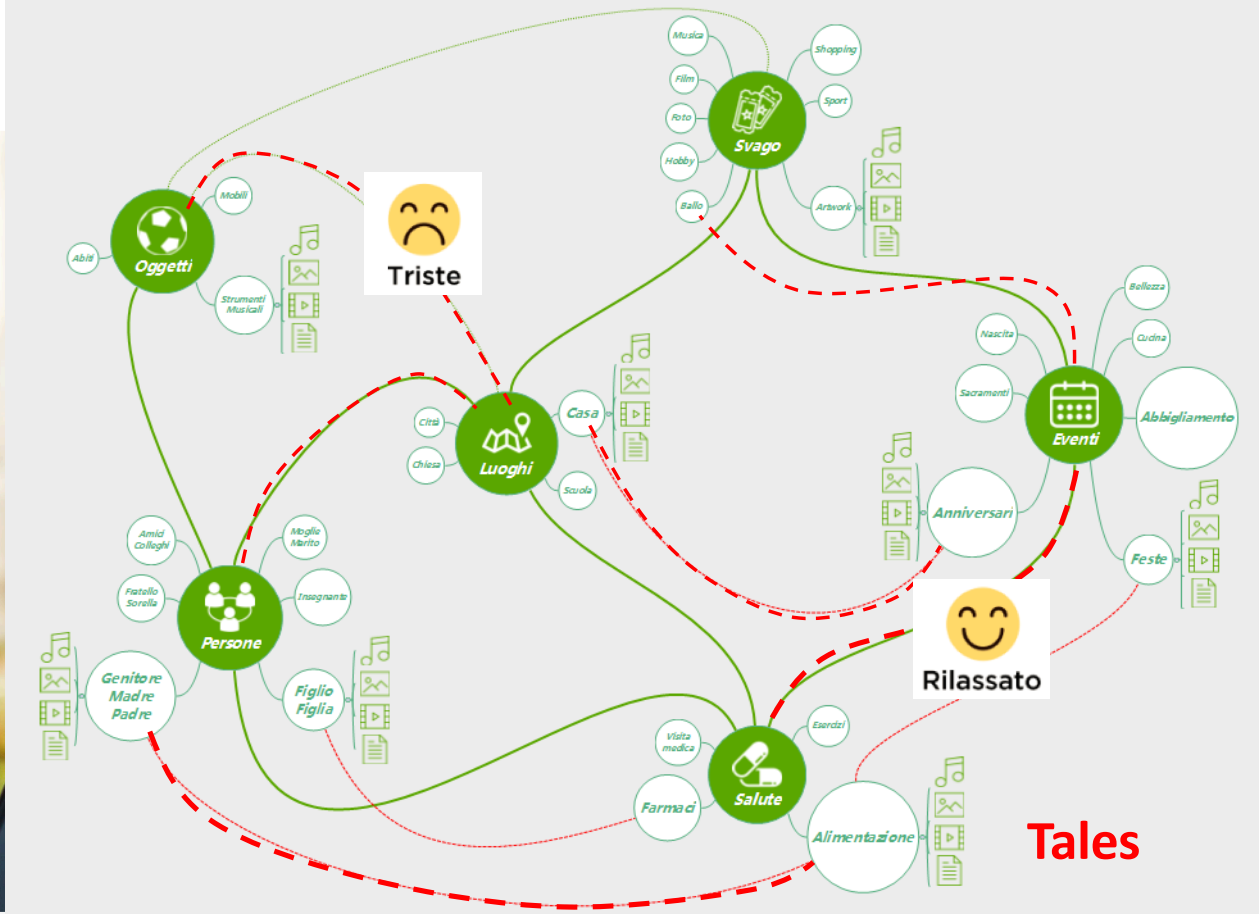
Vita Memory Coach: a system that supports caregivers to collect meaningful facts and memories of an individual and his context

Leo, at all , “ViTA: Virtual Trainer for Aging”- FAAL 2017

FONDAZIONE IBM ITALIA

FONDAZIONE CASA SOLLIEVO DELLA SOFFERENZA OPERA DI SAN PIO DA PIETRELCINA SAN GIOVANNI ROTONDO

Coaching our memory and triggering affective states



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