Inteligencia Artificial en el Ámbito de la E-salud.

U. Cortés

2010
¡Gracias por invitarme!

No soy MÉDICO

Soy un profesor universitario que coordina proyectos europeos en el área de las TIC aplicadas a la medicina

Puedo estar equivocado
ICT & Ageing: A social necessity an economic opportunity

80+ population: doubles until 2050
60+ population: from 20% in 1995 to 25% in 2020
50+ population: 21% has severe vision/ hearing/ dexterity problems
Today 4 working for 1 retired, in 2050 only 2 working for 1 retired
Cost of pensions/health/long-term care: up by 4-8 % of GDP (2025)
Shortfall of care staff
ICT & Ageing: A social necessity an economic opportunity

Wealth and revenues in Europe of persons over 65 is over 3000 B€

Smart homes market will triple between 2005 and 2020

Early patient discharge by tele-health: reduced cost of 1,5 B€ p.a. (DE)

Tele-care technology at home: Empowerment of elderly and efficiency gains of 25% (UK)
ICT and AI in support (elder) citizens

At work
Staying active and productive for longer
Better quality of work and work-life balance

At Home
Overcoming isolation & loneliness
Keeping up social networks
Accessing public services

In Community
Better quality of life for longer
Independence, autonomy and dignity
AI Tools (after Pollack’s seminal ideas)

**Assurance tools**
To provide continuous information about user’s environment and his/her status/localization

**Compensation tools**
Navigational Support
Schedule Management
Activity guidance

**Assessment Systems**
To provide continual, naturalistic assessment of their cognitive status
Cognitive Aids
INTELIGENCIA ARTIFICIAL: ¿CIENCIA, TECNOLOGÍA, FICCIÓN O MARKETING?
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User Profiles
Scenarios
Mobility platforms
Services
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Objectives

To develop next generation assistive systems that empower persons with (in particular cognitive) disabilities and aging citizens to play a full role in society, to increase their autonomy and to realize their potential.
To Whom

• Individuals with disabilities
• Post - Stroke patients
• Demented patients (Alzheimer disease)

BUT not only
User profile

- Hemiparesis
- Neglect
- Aphasia
- Apraxia
- Agnosia
- Memory deficits

Physical: Mild, Moderate, Severe
Cognitive: Mixed

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Patient sample

- 21 patients:
  - 5 cognitive with Alzheimer Disease
    - 4 mild impaired
    - 1 moderate impaired
  - 16 mixed post-stroke
    - 8 mild impaired
      - 1 neglect
      - 2 aphasia
    - 8 moderate impaired
      - 5 neglect
      - 1 aphasia
Scenarios
Scenarios allow to model mission-critical applications inside home.
Environment: Casa Agevole
Casa Agevole
Alberto uses an i-Walker: he has not a real deficit of the gait, but – as many cognitively impaired patients – he feels much more confident if he can rely on a walking aid. He usually wakes up at 9 a.m. After having had his breakfast, Alberto has to take some pills, as part of his drug therapy but – since he suffers from memory impairment – he cannot always remember that. The same situation repeats three times: after breakfast, in the middle of the afternoon, and at dinner. Early, in the morning, before leaving home Alberto’s daughter subdivides the proper amount of the different drugs that have to be taken during the day in three boxes – one for each medication episode – different for colour and shape. This requires minimum effort from the caregiver and the support of the system will allow Alberto to manage his therapy alone. At 10:00 a.m. the screen mounted on the i-Walker shows the system reminder; it consists of both a visual suggestion and a sound alarm, inviting Alberto to take his pills. The system asks then Alberto to confirm to have taken his drugs. If the system does not receive it, it will send an alarm message (via SMS) to the caregiver. The same procedure will be repeated every time Alberto has to take his therapy...
Mobility Platforms
Intelligent mobility platforms

- Enhancing user’s autonomy
- Different ways of interaction
  - Voice
  - Touch-pad
  - Traditional controllers
  - Pre-programmed
- Adaptable to the user
- Adaptable to the environment
- Reactive
- Proactive
- Safe
A mobility platform as sensor
# Mobility platform data mining sources

<table>
<thead>
<tr>
<th>Source</th>
<th>Data Acquisition Rate</th>
<th>Action Update Rate</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GPS</strong></td>
<td>1 second</td>
<td></td>
<td>Acquires absolute position of the chair</td>
</tr>
<tr>
<td><strong>Compass</strong></td>
<td>1 second</td>
<td></td>
<td>Acquires absolute heading of the chair</td>
</tr>
<tr>
<td><strong>Gyroscope</strong></td>
<td>5.85 milliseconds/sec</td>
<td>171 times/second</td>
<td>Senses the variation of the heading angle of the chair</td>
</tr>
<tr>
<td><strong>Encoders</strong></td>
<td>5.85 milliseconds/sec</td>
<td>171 times/second</td>
<td>Acquires the current velocity of each wheel</td>
</tr>
<tr>
<td><strong>Joystick</strong></td>
<td>5.85 milliseconds/sec</td>
<td>171 times/second</td>
<td>Interfaces the user. His/her commands are registered</td>
</tr>
<tr>
<td><strong>Motors</strong></td>
<td>5.85 milliseconds/sec</td>
<td>171 times/second</td>
<td>Provides boost to each wheel. Differences in each wheel's speed allows the chair to turn and rotate</td>
</tr>
<tr>
<td><strong>Warning lights</strong></td>
<td>5.85 milliseconds/sec</td>
<td>171 times/second</td>
<td>Visually warns the user if he/she is heading out the predefined path</td>
</tr>
<tr>
<td><strong>Auditive warning</strong></td>
<td>5.85 milliseconds/sec</td>
<td>171 times/second</td>
<td>Audio warning if the user is heading out the predefined path</td>
</tr>
</tbody>
</table>
Data mining results
Rolland III
Spherik Kinematics

Longitudinal  Transversal  Turn
CARMEN
i-Walker
Computer-controlled brake actions

The i-Walker can guide the user when his/her orders are wrong.
Setting Definition & Objectives

Measurements of the forces.
Setting Definition & Objectives

Measurement of the forces.
Setting Definition & Objectives

Measurement of the forces.

Force sensors

F1y

F2y
Setting Definition & Objectives

Measurement of the forces.
Setting Definition & Objectives

Measurement of the forces.
Without motor torques

Left hand longitudinal force

With constant braking torques

Left hand longitudinal force

The force, and work, done by the user varies along the path.
Almost constant hand force strategy

A small fraction of the required force is left to the user

Partial compensation done by motor torques

Force required to get over a constant braquing torque

The small fluctuations are associated to user intent detection and feeling.

The work done by the user is almost proportional to the path.
Areas/domains supported by SHARE-it services

- Security Assistant
- Driving Assistant
- Route Assistant
- Multimodal driving Assistant
- Multiobjective navigation
- Shared control
Cognitive Aids
Areas/domains supported by SHARE-it services

- Mobility
- Transfer
- Take a medication
- Preparation of meals
- Shopping
- Dressing
- Reminders
- Safety (Alarm)
- Exchange of information
Servicios

- Remainders
- ADL
- Help request
- Tutorials
Shared control (some ideas)

- **Autonomy**, in an agent, can be defined as the ability of performing a activity
- *Sharing own autonomy* implies the will to give someone some permissions to perform in our behalf

- Why to share?
- When to share?
- With whom?
Shared control (maybe an answer)

- **Autonomy**, in an agent, can be defined as the ability of performing a (desired) activity

- **Sharing own autonomy** implies the will (compromise) to give someone *some* permissions to perform in our behalf

- Why to share? I know that I have problem and/or comfort

- When to share? [Never, When need, only at some point]

- With whom? I trust you
**SHARE-it MAS**

Patient Agent provides all the available and permitted services to each user (security, mobility, help, monitoring).

Home Agent has the objective of monitoring the users and managing their profiles.

Environment Agent processes information from all available sensors and distributes it to all the agents interested.

Vehicle Agent is intended to manage route requests, plan making, contribute to shared control.

Caregiver Agent permits the caregiver to monitor some user’s data.

-INTELIGENCIA ARTIFICIAL: ¿CIENCIA, TECNOLOGÍA, FICCIÓN O MARKETING?
# Environment agent

<table>
<thead>
<tr>
<th>Beliefs</th>
<th>Goals</th>
<th>Plans</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Sensing environmental set</td>
<td>• Sensor connection</td>
<td>• Sensor server</td>
</tr>
<tr>
<td>• Acting environmental set</td>
<td>• Check readings</td>
<td>• Sensor connection</td>
</tr>
<tr>
<td>• Date</td>
<td>• Add capability</td>
<td>• Check sensor readings</td>
</tr>
<tr>
<td></td>
<td>• Remove capability</td>
<td>• Add capability</td>
</tr>
<tr>
<td></td>
<td>• Add sensor</td>
<td>• Remove capability</td>
</tr>
<tr>
<td></td>
<td>• Remove sensor</td>
<td>• Add sensor</td>
</tr>
<tr>
<td></td>
<td>• Add capability interaction</td>
<td>• Remove sensor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Add capability interaction</td>
</tr>
</tbody>
</table>
## Vehicle Agent

<table>
<thead>
<tr>
<th>Beliefs</th>
<th>Goals</th>
<th>Plans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status monitor set</td>
<td>Monitor status</td>
<td>Check status</td>
</tr>
<tr>
<td>Fall detection</td>
<td>Detect fall</td>
<td>Stop vehicle</td>
</tr>
<tr>
<td>Battery monitor</td>
<td>Handle fall</td>
<td>Caregiver inform</td>
</tr>
<tr>
<td>Self-diagnoser set</td>
<td>Low battery inform</td>
<td>Hardware failure inform</td>
</tr>
<tr>
<td>Case set</td>
<td>Change battery</td>
<td>CBR navigation</td>
</tr>
<tr>
<td>Profile</td>
<td>Monitor resources</td>
<td></td>
</tr>
<tr>
<td>Efficiency</td>
<td>Hardware failure management</td>
<td></td>
</tr>
<tr>
<td>Spatial situation</td>
<td>CBR navigation management</td>
<td></td>
</tr>
<tr>
<td>Disagreement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Navigation control</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Patient Agent

<table>
<thead>
<tr>
<th><strong>Beliefs</strong></th>
<th><strong>Goals</strong></th>
<th><strong>Plans</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Current ADL</td>
<td>Show Tutorials</td>
<td>Get Tutorials</td>
</tr>
<tr>
<td>Current time</td>
<td>Counter</td>
<td>Reminder</td>
</tr>
<tr>
<td>Location</td>
<td>Reminder</td>
<td>Counter</td>
</tr>
<tr>
<td>Duration</td>
<td>Review ADLs</td>
<td>Register ADL</td>
</tr>
<tr>
<td>Activity</td>
<td>Help Request</td>
<td>Review ADLs</td>
</tr>
<tr>
<td>Tutorial</td>
<td>Learn</td>
<td>Help Request</td>
</tr>
<tr>
<td>Learning</td>
<td></td>
<td>Learn</td>
</tr>
<tr>
<td>CBR</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Tutorial: Put on your shoes: Left foot

1. Sit down on a chair
2. Take left shoe
3. Put tip of left foot inside
4. Take shoehorn
5. Put it at heel of left foot
6. Slip into the shoe
Tutorials

› Dressing (different code depending on the season)
› Cook Pasta (cook with me)
› Making coffee
› Toilet (washing hands/head… combing)
› Cleaning house (washing/ironing, vacuuming, etc)
Tutorials

- Different resources:
  - Text
  - Sound
  - Images
  - Video
Tutorials

- Tailored to the user:
  - Different number of steps
  - Different *media*
  - Confirmation step
  - Built *on-demand* user’s profile may change over time
- Context dependent
Interface touch-screen

- Orientation
  - spatial (navigation)
  - temporal

- Memory
  - Agenda
  - Reminder

- Tutorial

- Help
Interface touch-screen

✓ Orientation
  spatial
  temporal

✓ Memory
  Reminder
  Agenda

✓ Tutorial

✓ Help
Interface touch-screen

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- Tutorial

- Help
Scenario 7: Alberto takes his drugs

- **Alberto** uses an **i-Walker**: he has *not a real deficit of the gait*, but – as many cognitively impaired patients – he feels much more confident if he can rely on a walking aid. He usually wakes up at 9 a.m. After having had his breakfast, Alberto has to take some pills, as part of his drug therapy but – **since he suffers from memory impairment** – he cannot always remember that. The same situation repeats three times: after breakfast, in the middle of the afternoon, and at dinner. Early, in the morning, before leaving home Alberto’s daughter subdivides the proper amount of the different drugs that have to be taken during the day in three boxes – one for each medication episode – different for colour and shape. This requires minimum effort from the caregiver and the support of the system will allow Alberto to manage his therapy alone. At 10:00 a.m. the screen mounted on **the i-Walker shows the system reminder; it consists of both a visual suggestion and a sound alarm**, inviting Alberto to take his pills. **The system asks then Alberto to confirm to have taken his drugs. If the system does not receive it, it will send an alarm message (via SMS) to the caregiver.** The same procedure will be repeated every time Alberto has to take his therapy...
Scenario 7: Alberto takes his drugs

- Assistive device: i-Walker/CARMEN
- Disability profile: Cognitive
- Severity cluster: Mild
Scenario 7: Alberto takes his drugs
Two years ago, Pietro suffered from a stroke. He recovered well and at moment he needs only a light support to walk, because he has left a mild decrease of strength in his left leg. Sometimes he is not confident enough in the sequence of actions needed to reach a goal. Today is Sunday and his caregiver has his day off. At eleven in the morning Pietro gets a reminder from the GUI that – if he wants to go to church – it is time to get ready. He is also reminded to put on his shoes, the overcoat, to turn off the lights, and to lock the door. He gets to the church, and while trying to open the church’s door, he gets hampered and falls on the pavement. The i-Walker detects the fall. It is also detected that Pietro is lying motionless. At the same time, the BCM detects stress. Pietro’s caregiver is informed via SMS of the alert. The SMS message includes Pietro’s position information.
Scenario 3: Pietro goes to the church with the i-Walker

- Assistive device: i-Walker
- Disability profile: Mixed (physical + cognitive)
- Severity cluster: Mild
- Limitative symptoms: Aphasia
Scenario 3: Pietro goes to the church with the i-Walker
Real Scenarios
Medical Analysis

- Wheels are ideal for internal and external walks
- The height of the iWalker with respect to the user is correct.
- The angle of the user’s arms is correct (slightly flexed)
- The user’s feet position is correct
- The user’s body position (his back) during the parade is correct
Medical Analysis (2)

- iWalker breaks so the user has not to retain the weight with his own effort.
- User’s arms remain in the same normal position. It is clear that he is making not an extra effort.
- User’s feet keep in the same normal position.
- User’s body remains in a correct position. He is not bouncing to the front.
Conclusions

- Disability is a condition in which an individual is unable to perform a necessary activity

- SHARE-it can compensate or expand the activity of a disabled subject through new forms of human-computer interaction

- SHARE-it improve users’ autonomy

- SHARE-it improve professionals/users interaction
Conclusions

- *SHARE-it* may contribute to
  - to improve home care (medical and social aspects)
  - to enhance the quality of life of disabled, senior citizens and their families
  - to lengthen the time spent at their preferred environment and to postpone the need for institutionalization
  - to reduce institutional and social costs
“The best way to predict the future is to invent it.”

Alan Kay

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http://www.ist-shareit.eu