Pervasive technology for healthcare: Supporting an aging population

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The Rising Tide

- Canada's healthcare system is currently faced with the challenge of caring for an increasing number of older adults.

- A large proportion of these individuals are living with diseases and impairments that are beyond those related to the normal aging process.
  - E.g., neurodegenerative diseases (dementia, Parkinson's disease), cardiovascular disease, cancer.

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But...!

- Most older adults want to live in their own homes for as long as possible.
- Family would like them there, too.
- People want to be “in-control” of their health and environments.

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Aging in Place

- “The ability to live in one's own home and community safely, independently, and comfortably, regardless of age, income, or ability level.“ (**CDC, 2015**).

- Why consider aging in place?
  - More positive health outcomes compared to long-term care;
  - Lower cost of care compared to institutional care;
  - People can make more of their own care decisions; and
  - Quality of life can be improved.

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Aging in Place and Technology

- Technology can help support aging in place!
- But what is “Technology”?

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Pervasive Computing

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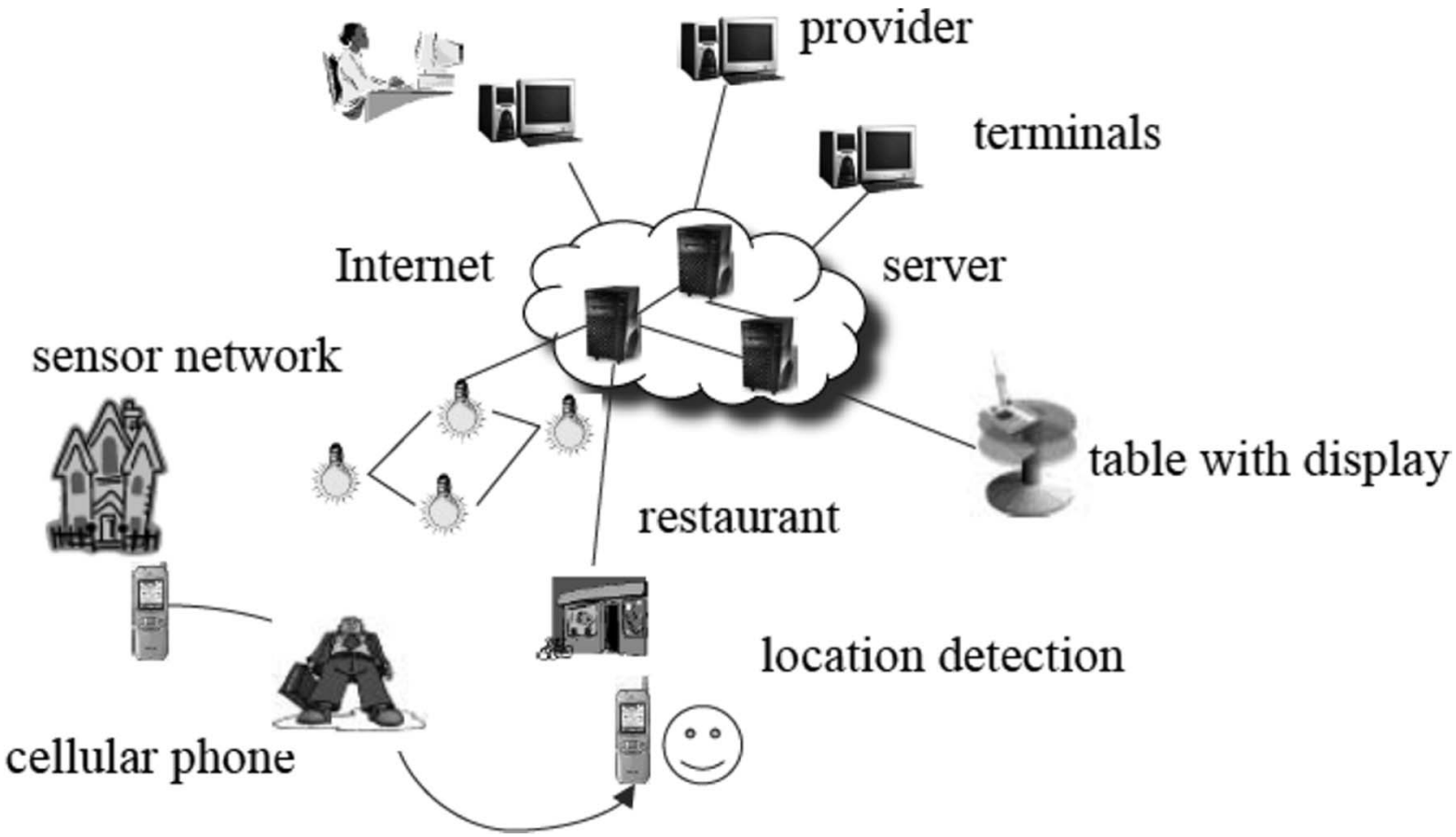
Pervasive Computing



What is Pervasive Computing?

Pervasive computing (also called ubiquitous computing or “everyware”) is…

> “…machines that fit the human environment instead of forcing humans to enter theirs.”
>
> - J. York, P.C. Pendharkar, *Int. J. Human-Computer Studies, 60* (2004) 771–797

> “…computing [that] is made to appear everywhere and anywhere”
>
> - Wikipedia (2015)

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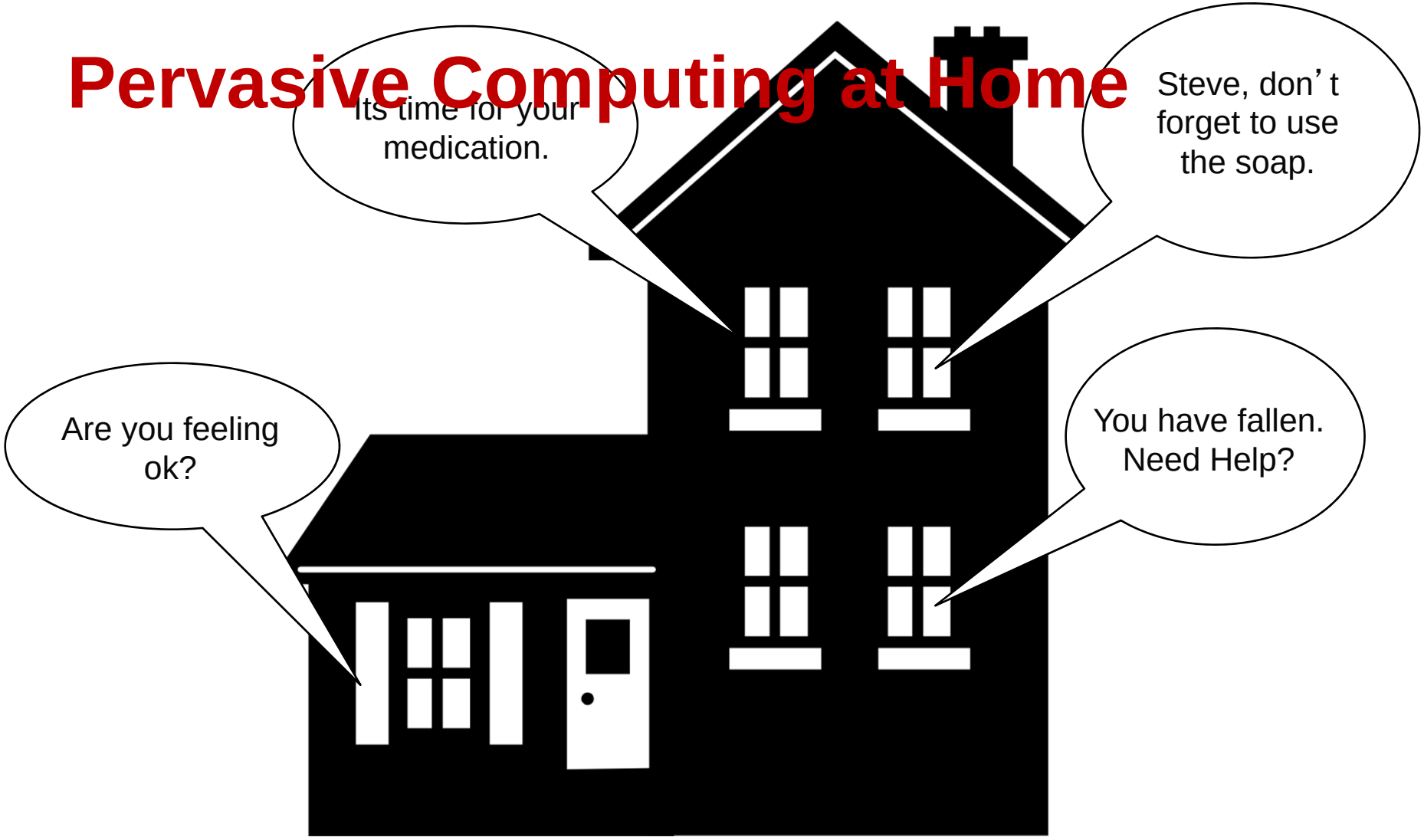
Pervasive Computing at Home



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Pervasive Computing & Healthcare

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Limitations of Pervasive Computing

- While conceptually interesting, there have been barriers to development and use:
  - It is easy to ***be*** everywhere but difficulty to ***know*** everything.
  - Often these technologies are not able to accommodate the changing needs of a user.
  - Many result in an increase in burden for nurses, caregivers, and family members.
- What is missing?
  - Inadequate representation of ***context***!

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Context

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What is Context?

- Context is any information that is relevant to the application, including:
  - Time.
  - Location.
  - User's preferences.
  - State of people, groups and objects.
  - Actions / behaviours.
  - Patterns of living.

- Context encompasses everything about a person and a person's environment **including the person**.

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Smart Versus Intelligent Technologies

- **Smart:** Performing actions based on direct input of information or data.

- **Intelligent:** Performing actions based on input, common sense, experience, and the ability to adapt.
  - Understanding context!

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Artificial Intelligence

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Artificial Intelligence (AI)

- An umbrella term that encompasses many different types of techniques and processes.
- We must collect the necessary data and observations (**intelligent sensing**).
- A system that **makes rational decisions,** like a human.
- Techniques for representing and reasoning (learning) about knowledge (**planning and predicting**).

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Artificial Intelligence

Vision and Sensing

Machine Learning

Speech Recognition

Decision Making

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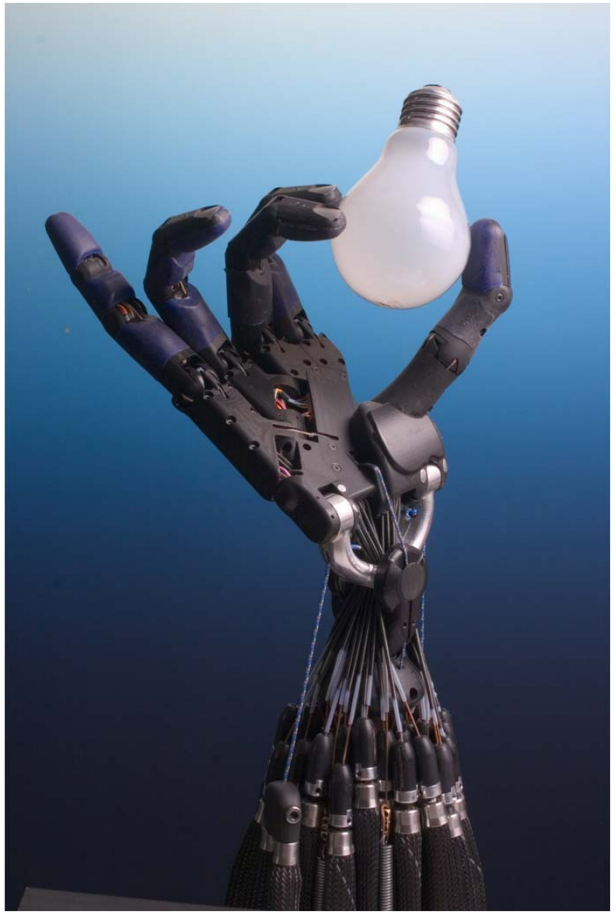
What this can do for us

- Embed systems into the user's life.
- Learn and adapt to user's context.
- Provide timely and appropriate help.
- Make data available.



Shadow Robot Hand (www.shadowrobot.com)

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Some Examples of Pervasive Technologies

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1. Automated Task Support (COACH)

The COACH

Cognitive Orthosis for Assisting Activities in the Home

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Key System Features

- Can autonomously monitor an older adult (e.g., with dementia) during a self-care activity.
- Provides prompts ***as needed*** and adapts them over time.
- Provides feedback to a caregiver when necessary.
- Is a passive (zero-effort) system.

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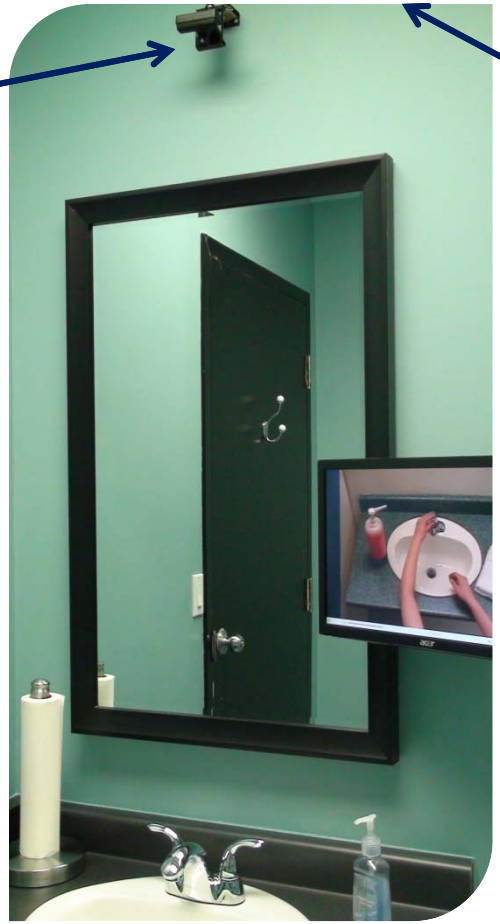
A Typical COACH Installation

Overhead camera to track users

Speakers (in ceiling) to provide audio prompts



Display to provide visual prompts

Computer located in adjacent room

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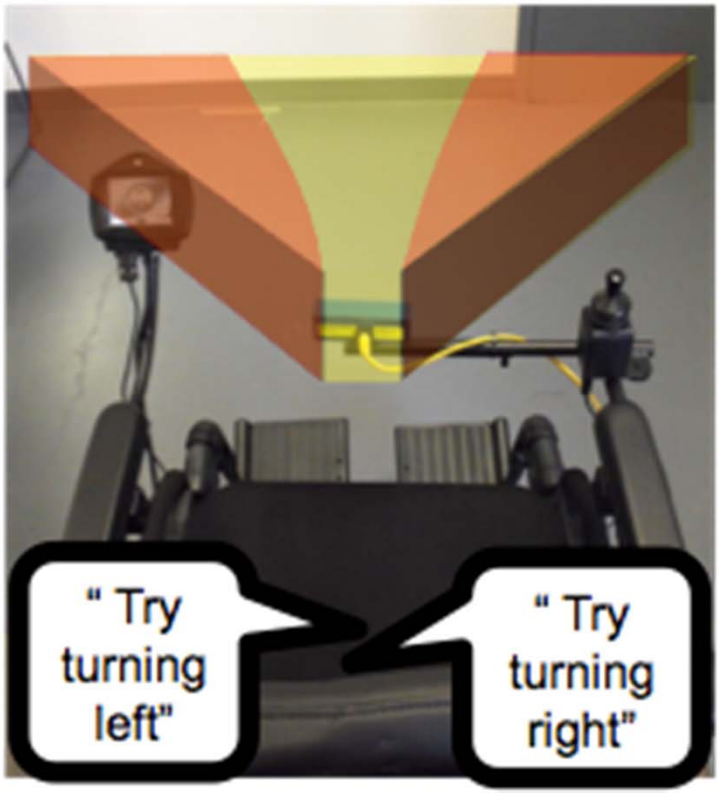
2. Intelligent Wheelchair



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Key System Features

- Automatically detects objects and other potential hazards.
- Stops the wheelchair before collision.
- Prompts the user on the best way to avoid the hazard.
- Can be installed on a standard powered wheelchair.

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Example of Use

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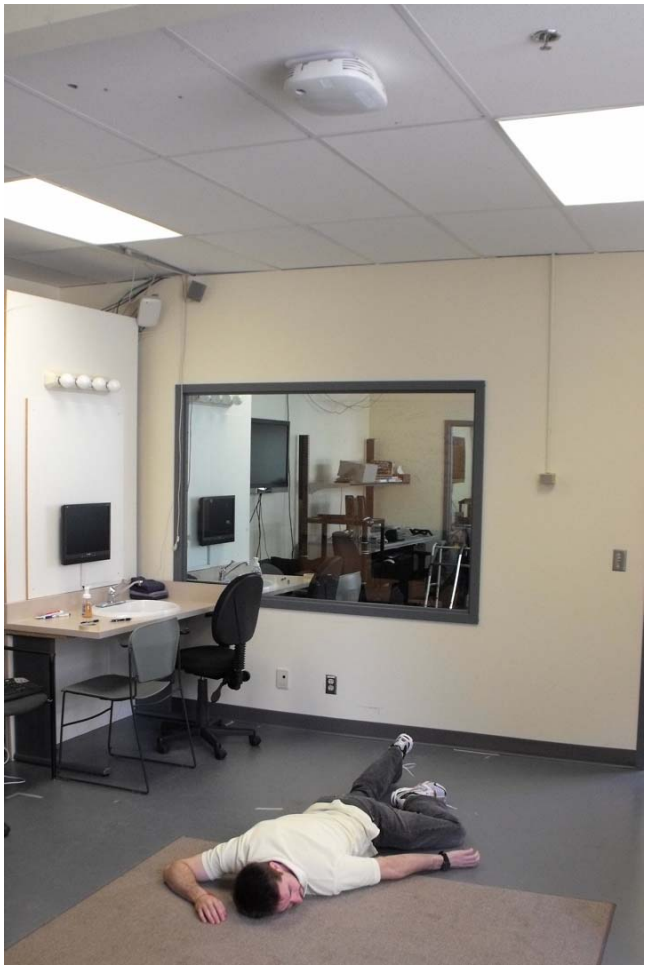
3. Fall Detection (The HELPER)



An intelligent hands-free personal emergency response system

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Key System Features

- No push-button or manual intervention.
- Intelligently talks with the user using speech recognition and AI.
- Not stigmatizing
  - Respects the privacy and autonomy of the user.
- Can “plug in” to existing infrastructures.

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Ceiling Mounted Unit

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Example of Use

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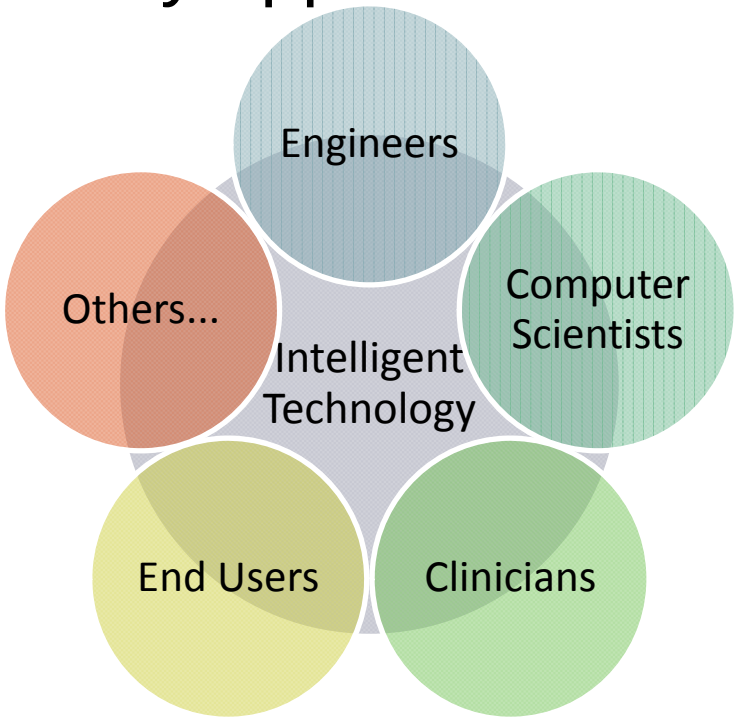
Why am I Here Today?

- This type of technology requires an interdisciplinary approach!



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What Do I Do?

- Biomedical Engineering:
  - Computer Vision and Sensing;
  - Machine Learning;
  - Automated Decision Making.

- Clinical Development and Evaluation:
  - What do the users need?
  - Does it ***actually*** work?

- Two Main areas:
  - Ambient Assisted Living.
  - Automated assessment.

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Technology Design Philosophy

- Develop for real-world using real-life problems and motivations.
- Involve the user from the start to the finish of the design process.
- Test new technologies as often as possible throughout the design process.

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Thanks!

Questions?

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