Past, Present and Future of Ambient Intelligence and Smart Environments

by Juan Carlos Augusto

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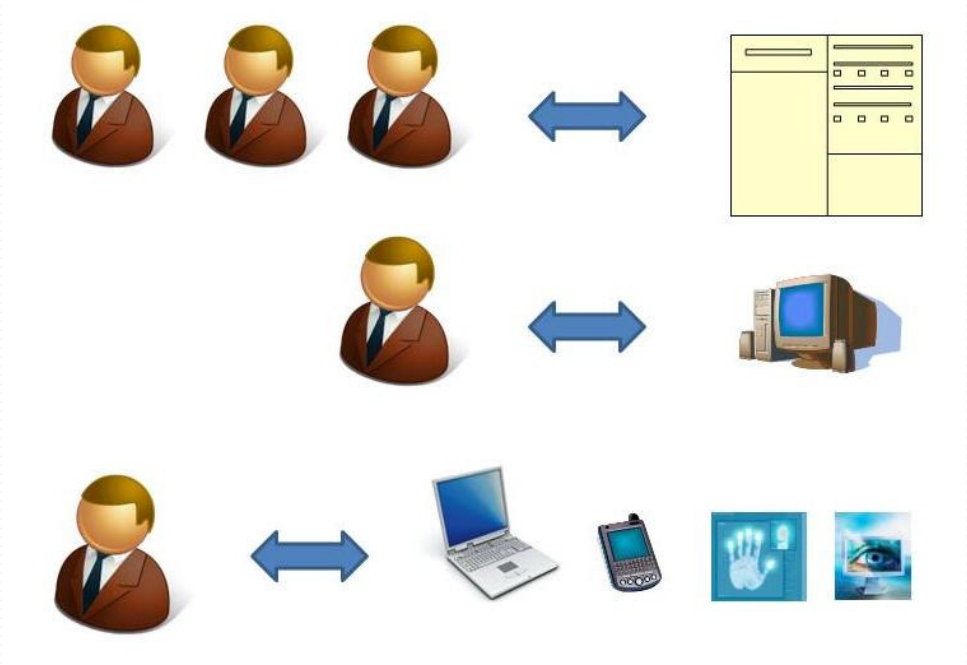
Route Map

- **Past**
  - **Evolution**
  - **Some basic concepts**

AAL, part of a historical trend…



Many users to
one (big) computer

One user to One PC

One user to
many computing devices!

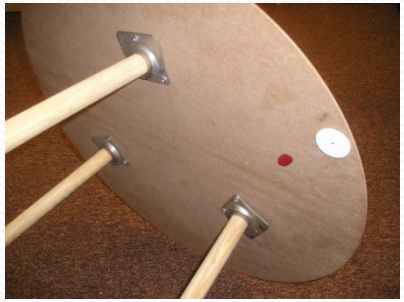
Moore's Law

"...*The complexity for minimum component costs has increased at a rate of roughly a factor of two per year ... Certainly over the short term this rate can be expected to continue, if not to increase.* ..."

[Moore 1965]

Computing **is** everywhere …

at a different scale!!



Transformation of CS and its immersion in society...

"The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it."

The "disappearing computer" (Weiser)

AmI and SmE

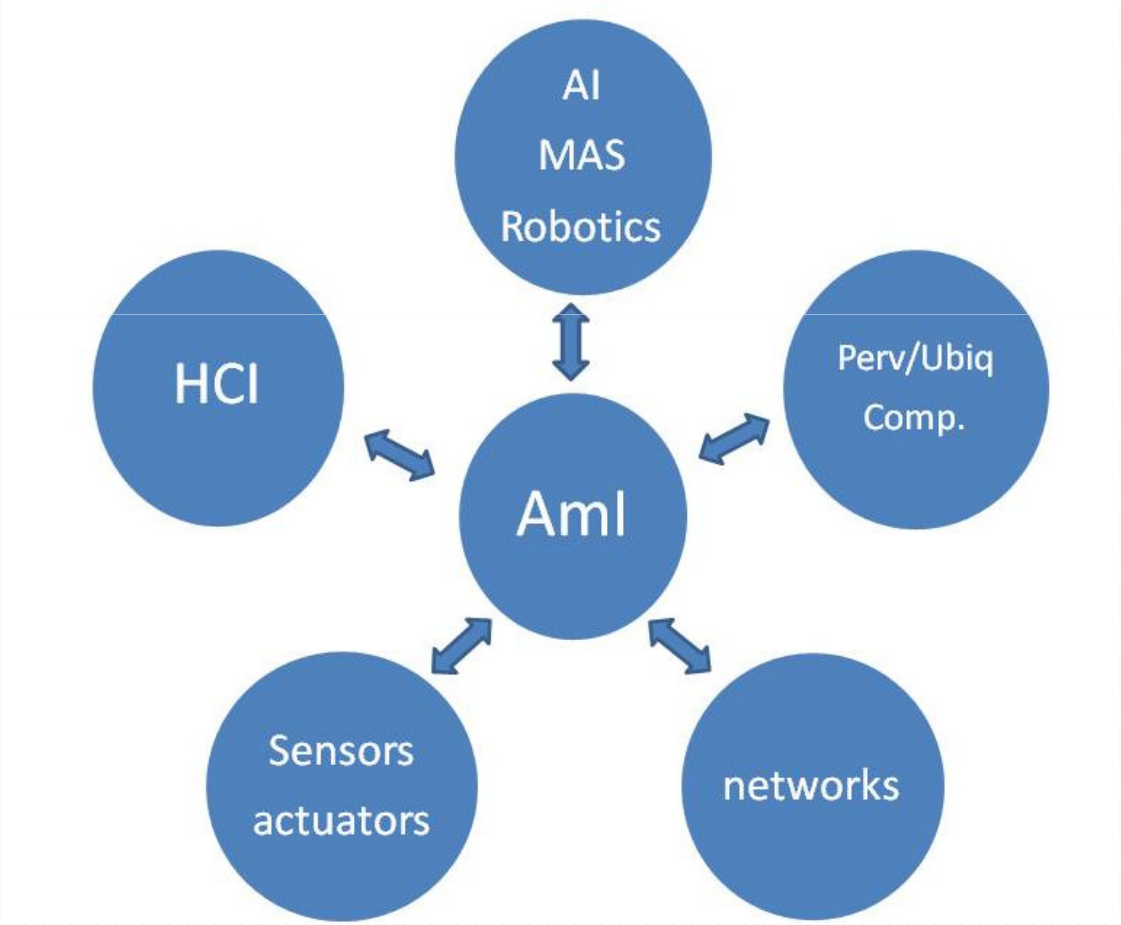
Ambient Intelligence: *"A digital environment that proactively, but sensibly, assists people in their daily lives".*

Note: 'Sensible' here includes both accurate diagnosis and timely intervention with emphasis on the users' needs and preferences.

Smart Environments: *refers more to the infrastructure (sensors, etc) which sometimes have some local and limited reasoning capability.*

Note: this can be seen as the old mind-brain dichotomy

A Multi-disciplinary Area



Smart Home by far the most explored case study!

Route Map

- Past
  - Some basic concepts
- **Present**
  - **The emergence of AmI and SmE…**

Technology is everywhere...Just look at home and in public spaces...

Even our children play with sensor equipped mechanisms!!

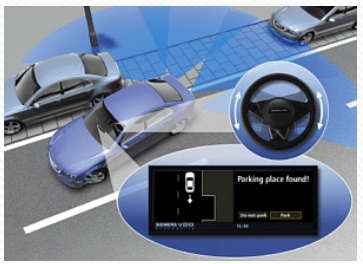
Smart Environments

Smart Homes

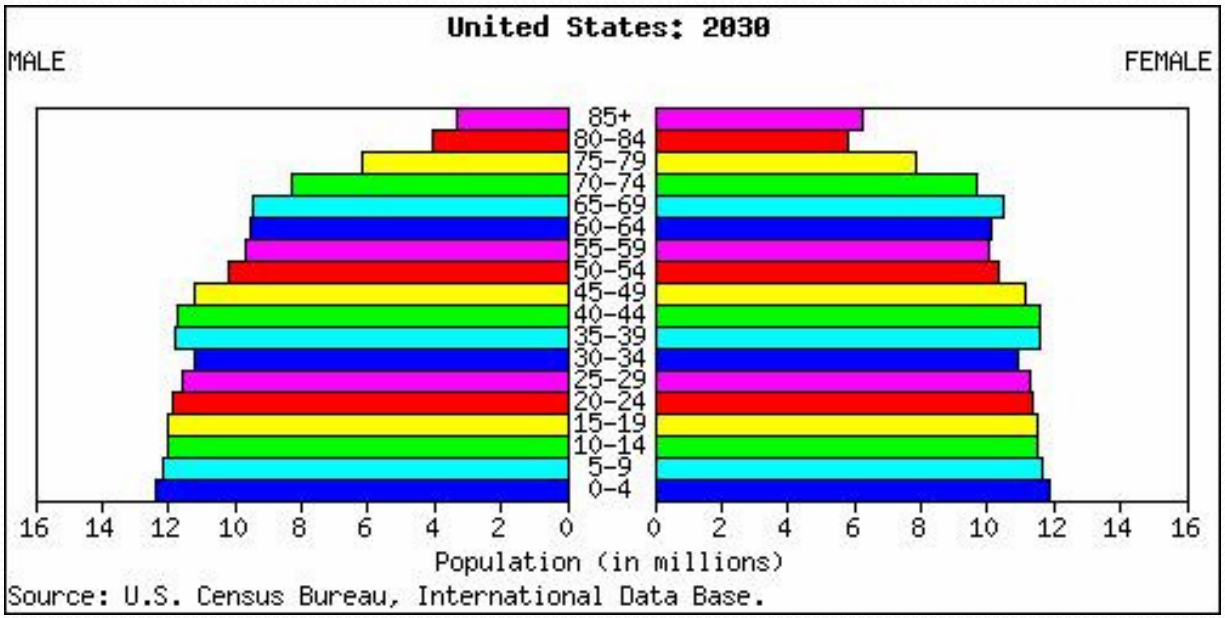
Smart Classrooms

Smart Offices

Smart Cars

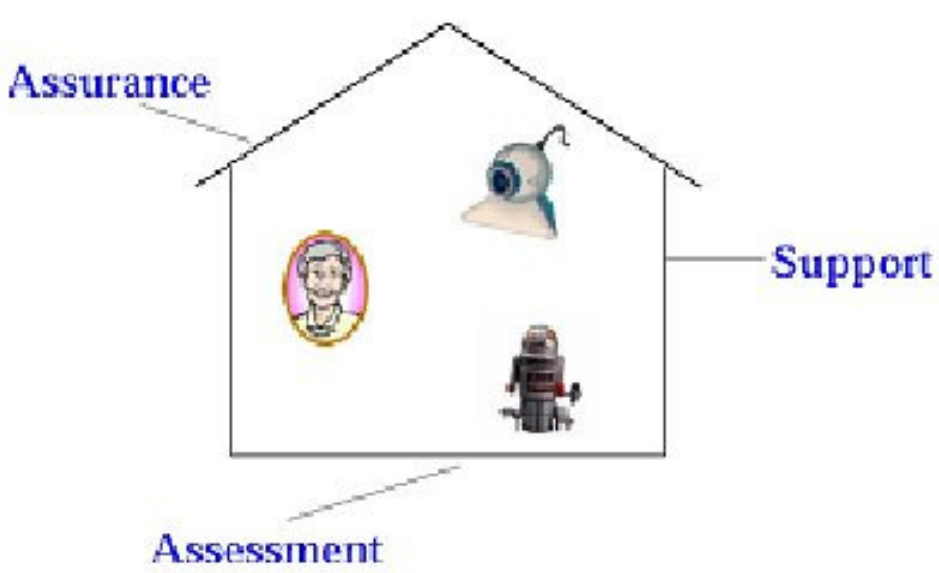


Smart Homes for Health Monitoring



- Older adults want to remain at home even when home cannot sustain safety
- As medical care improves and population ages, problems of aging and disability converge
- Nursing home costs ~30 K€/year, and sacrificing family members provide Ms € worth in free care

Categories of Assistive Technology



From [Pollack, 2005]

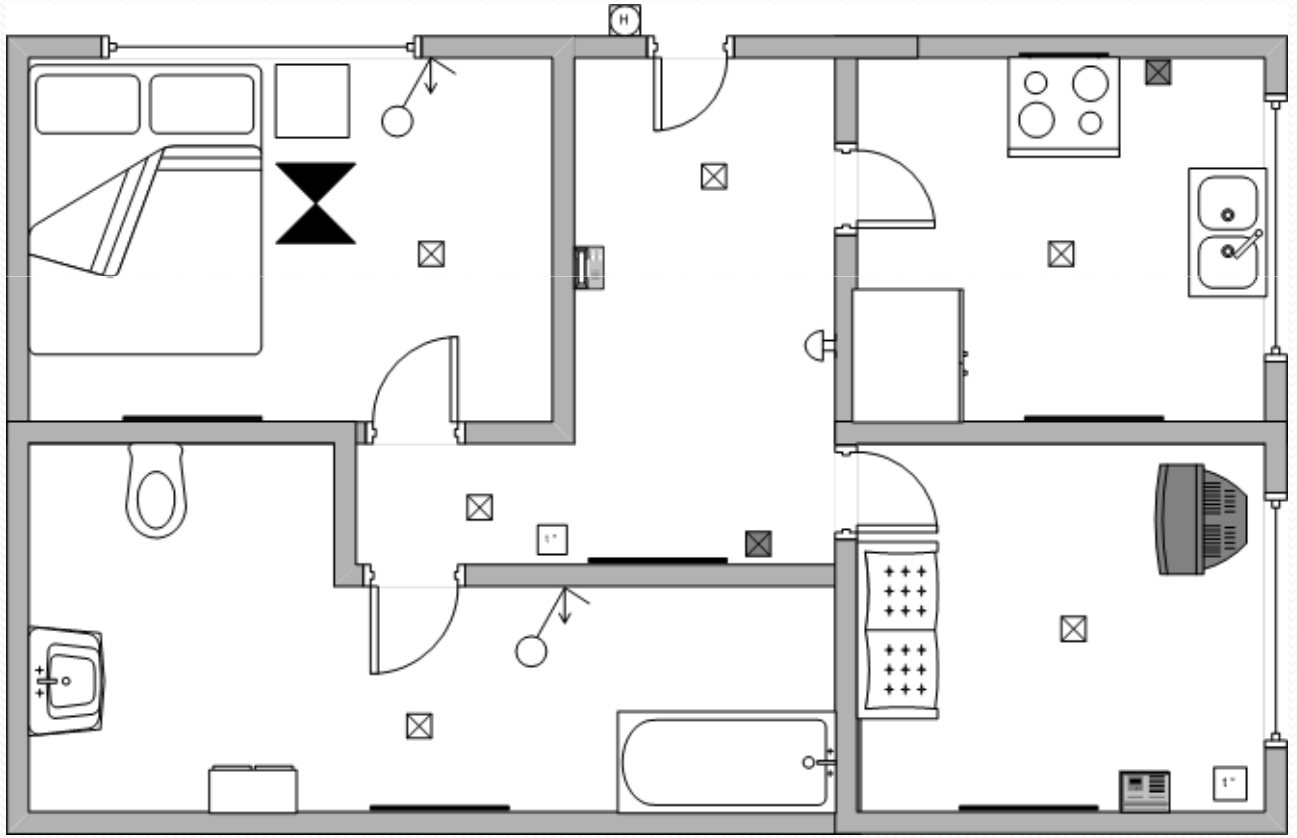
(AI Magazine – V26 N2)

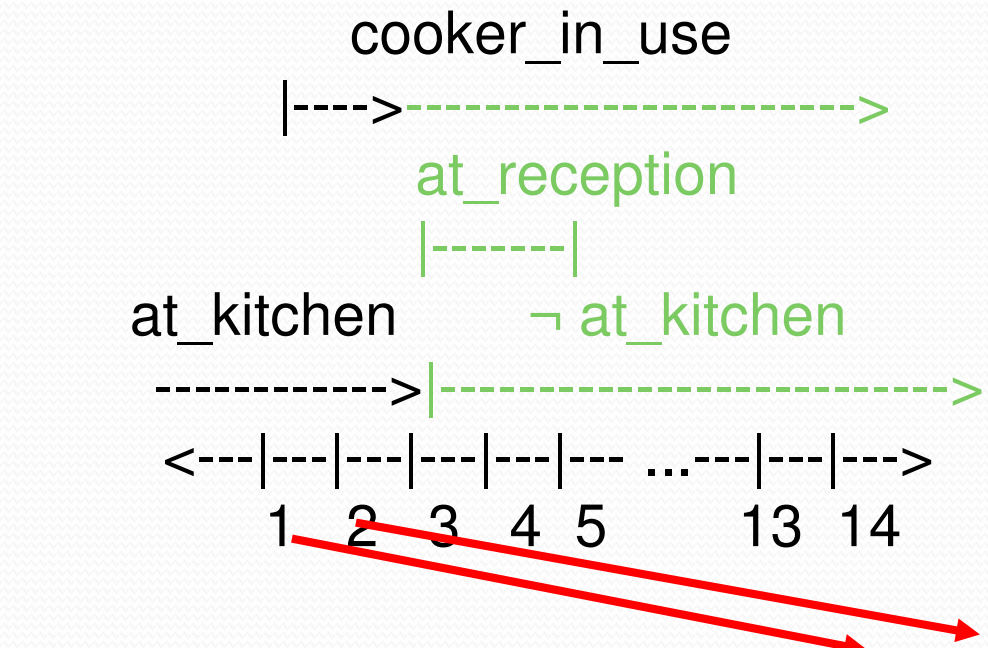
Assurance: making sure the individual is safe and performing routine activities

Support: helping individuals compensate for impairment

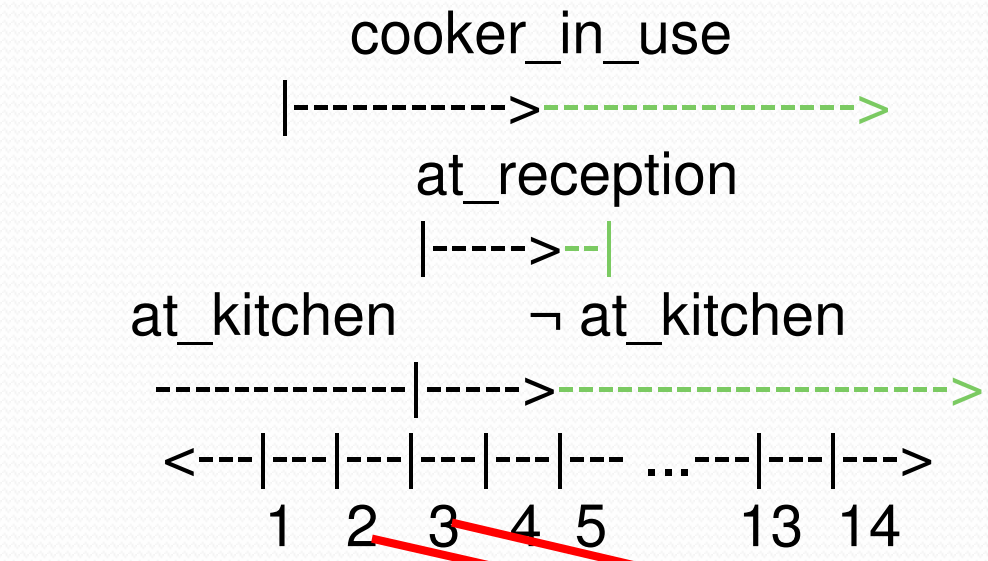
Assessment: determining physical or cognitive status

Spatial and Temporal Reasoning for Context-Awareness





ON (occurs(ingr(cooker_in_use), I1a][I1b) ^
occurs(trans(at_kitchen, at_reception), I2a][I2b))
IF (earlier(I1b, I2b) ^
¬ holds(at_kitchen, [I2b,Now]) ^
moreThanNUnitsElapsed(I2b, Now, 10 mins))
THEN (ApplyPossibleHazardProcedure)



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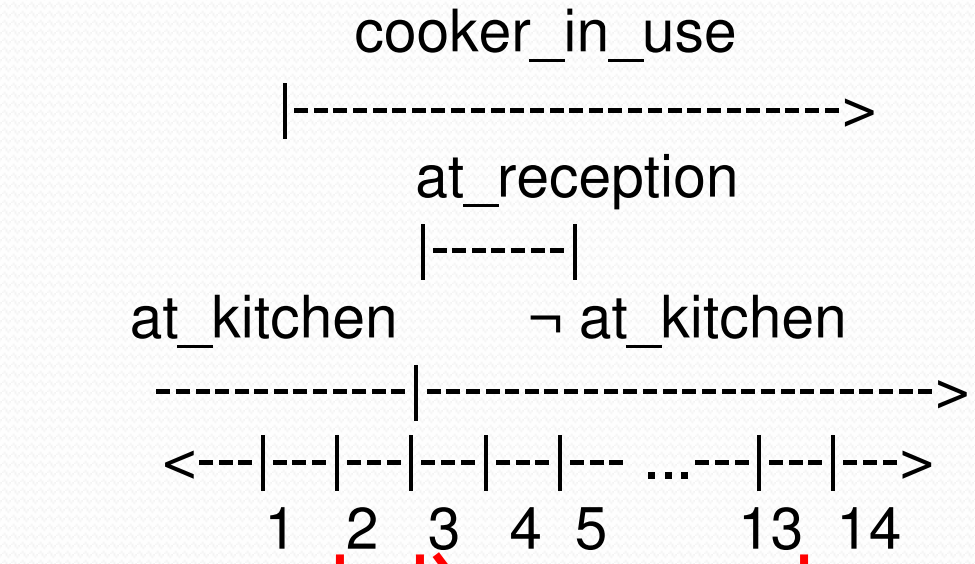

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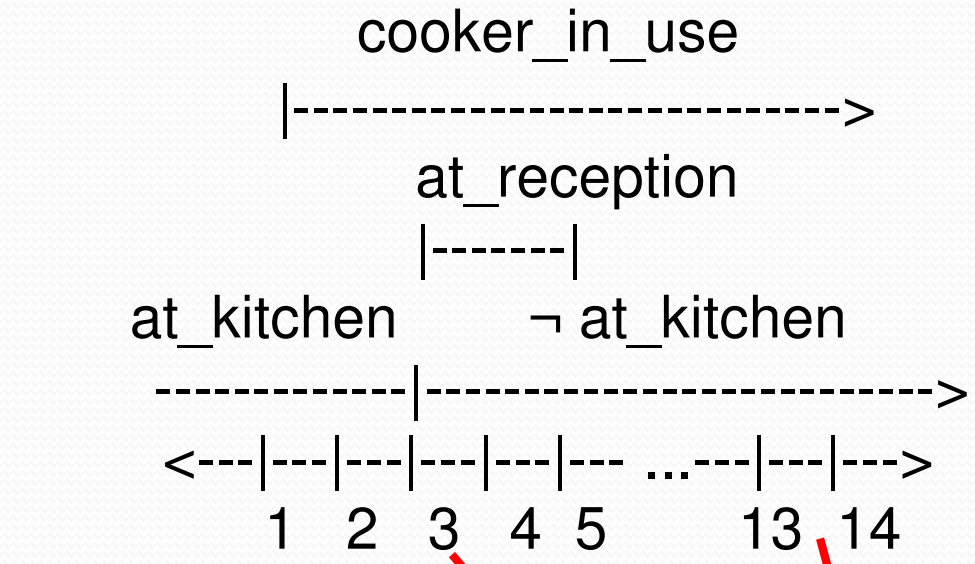

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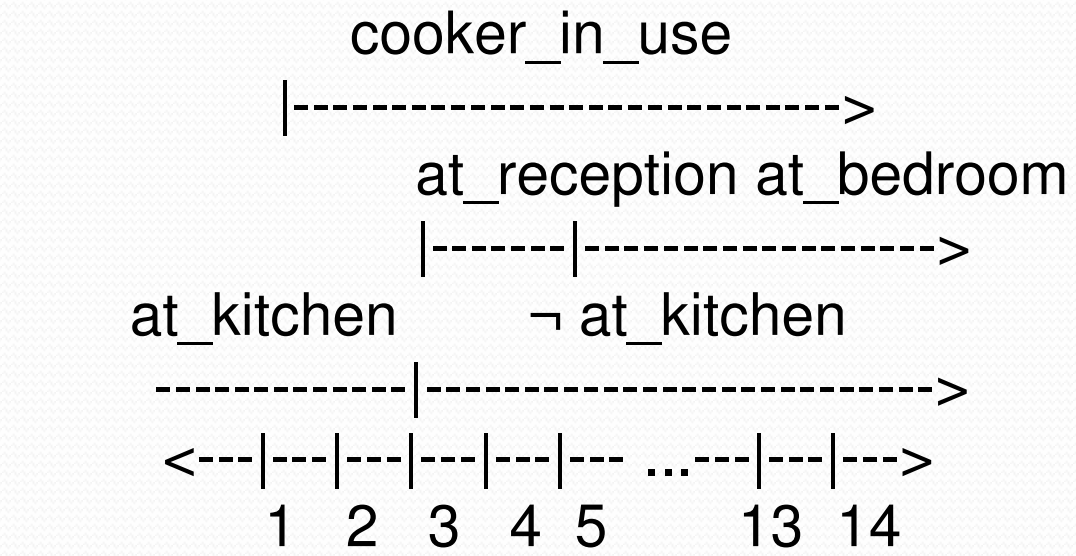

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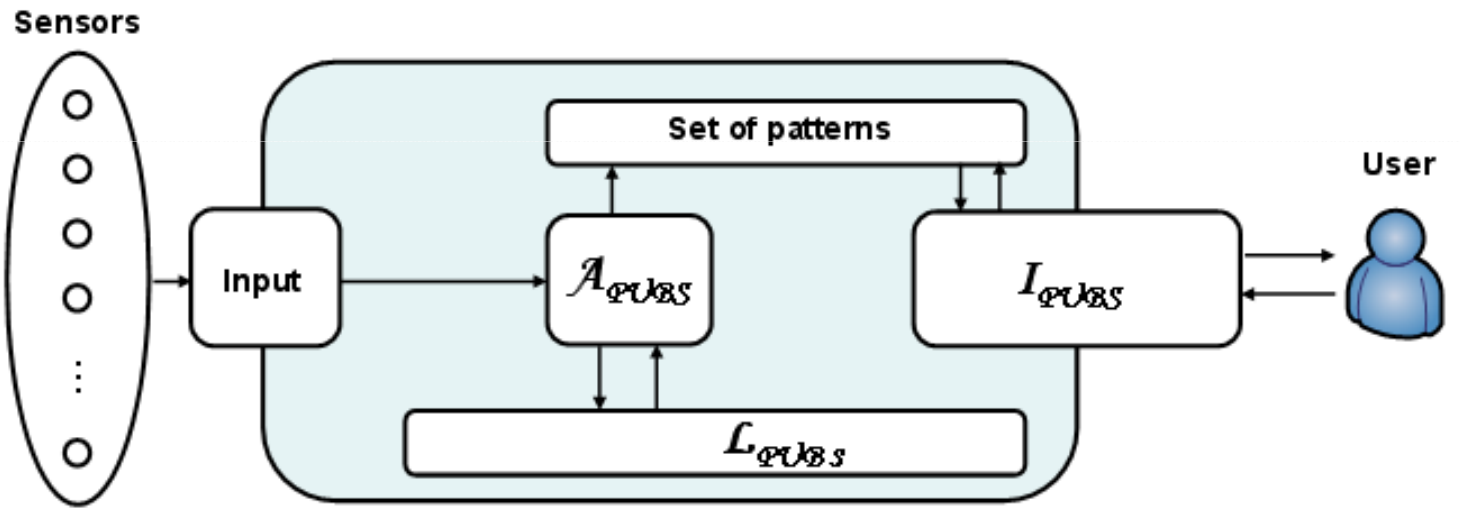
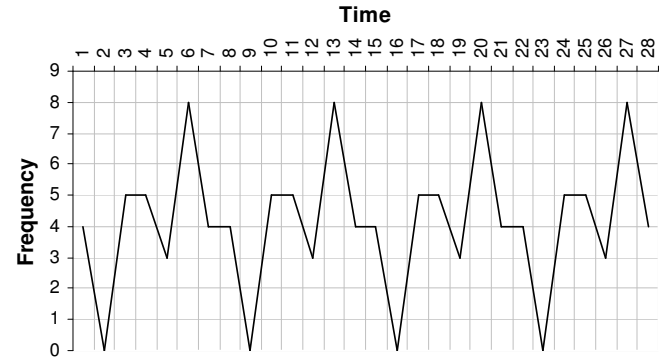
Patterns of User Behaviour System (PUBS)



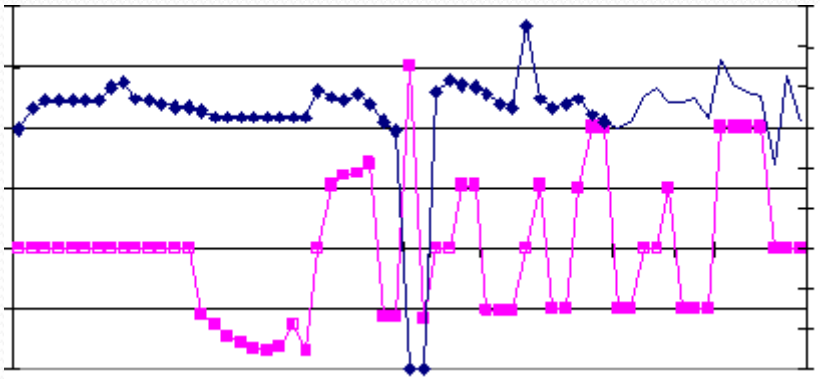
Main researcher:
Asier Aztiria from U. of Mondragon, (Vasque Country - Spain)

Identify Trends

- Collect, predict, and store changes to detect concept drifts



- Contrast with expected behaviour and detect anomalies



Why it is important?

Lets take falls in elderly people, it should not be underestimated… For example, in North Down and Ards, Northern Ireland, 1 in 3 people aged over 65 will fall at least once per year.

Serious injuries associated, e.g., hip fracture carries a six months mortality rate of 20%. 50% of survivors are unable to return to Independent living.

Estimated cost in UK: £981million annually!

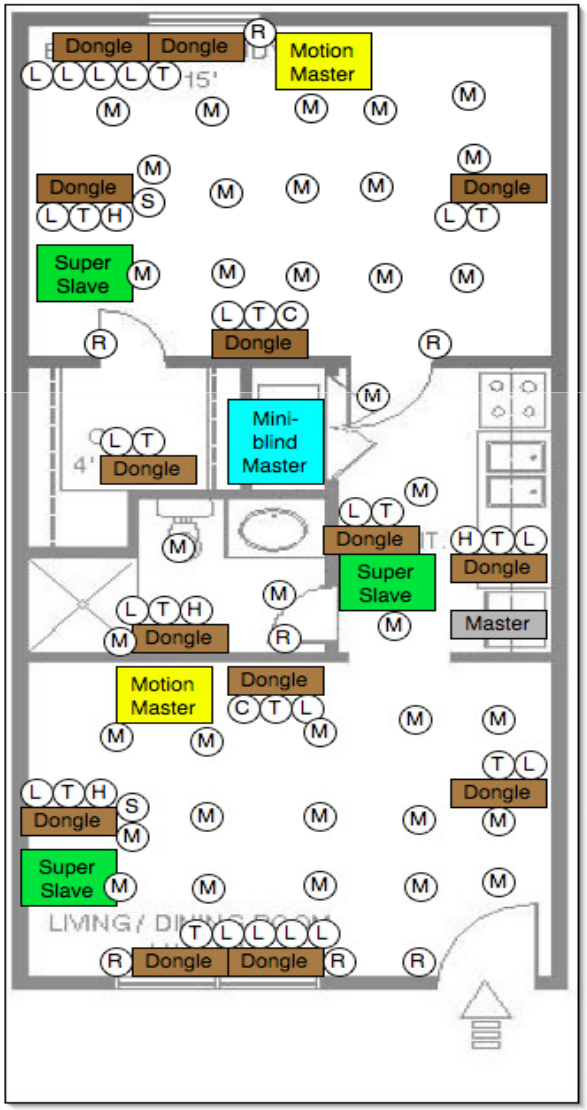
A Few of the Many Many Current AAL Projects

- MavHome
- Aware Home
- Domus Lab
- Adaptive House
- Duke Smart House
- iDorm
- Fraunhofer
- Ikerlan
- Philips
- Siemens
- Microsoft
- Intel
- West Lothian and Pathfinder (UK)
- BT, France Telecom, Telefonica, …

So many in Asia, esp. Japan, Korea, Singapore, that is difficult to enumerate all them!

MavHome

"Managing an Adaptive Versatile Home"



iDorm

- Intelligent Dormitory (iDorm) at the University of Essex
- Student bedroom built inside Computer Science Department

Domus Lab

- University of Sherbrooke
- Cognitive assistance for people suffering from dementia
- Perform plan recognition
- React to prevent hazardous situations

Gator Tech Smart House

- Assistive environment to support independent living
- Remote monitoring of residents

- Gator Tech Demo

Philips Homelab

- Research facility at Philips in The Netherlands
- Test home technology prototypes with volunteer temporary residents

Microsoft

- Cameras throughout environment
- Visually track individuals, devices respond to presence
- More recently, focusing on supporting technologies and devices

//research.microsoft.com/easyliving/Videos/2001%2002%20Video%20300k.wmv

Smart Offices

AIRE project

- Intelligent workspaces, conference rooms, and kiosks use gaze-aware interfaces and multi-modal sketching
- Integrate captured speech and writing on whiteboard

Monica project

- identifies gestures and activities in order to retrieve and project information

Interactive Room (iRoom) project

- Easy retrieval and display of information
- Display URLs on a selected surface by dragging it onto PDA icon

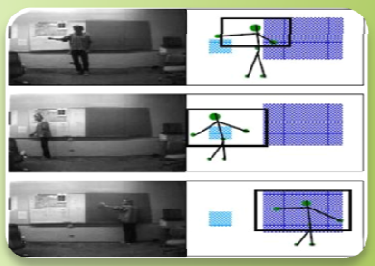
Smart Classrooms

eClass (Classroom 2000)

- Interactive whiteboard stores content in a database.

Shi's Smart classroom

- Lecturers write notes on board with a digital pen
- Video and microphones recognize gestures, motions, speech



Intelligent classroom at Northwestern University

- Uses the captured information to infer speaker intent
- Room controls light settings, plays videos, and displays slides

Smart cars

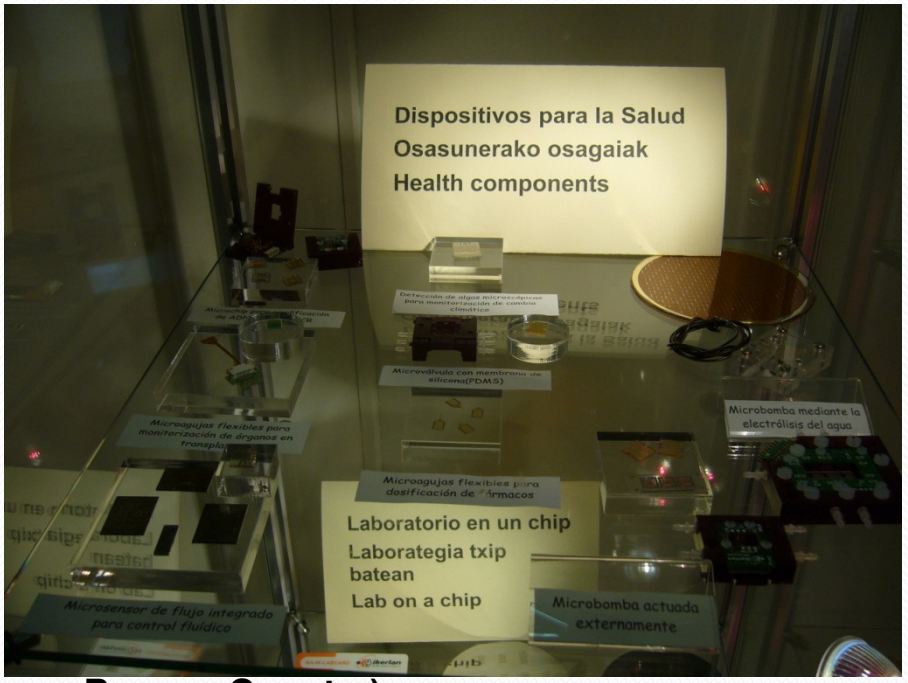
- Pentland collaborated with Nissan US to make the car aware of the driver's alertness and react consequently.

- Siemens–Parkmate is software on the car that enables the driver to find parking spaces and automatically park cars in those spaces.

Route Map

- Past
  - Some basic concepts
- Present
  - The emergence of AmI and SmE…
- **Future**
  - **Deploying technology and software not enough anymore!**

No shortage of new technology coming…



Taken at Ikerlan (Mondragon, Basque Country)

But…How far are we from the ideal?

A prediction made reality…

"… computers are complex machines that are hard to use. Today we serve them, instead of them serving us. If we are suffering under 1 ton of complexity and inadequacy today, and our machines become 100 times more pervasive in the future we should naturally expect that the complexity and inadequacy of computers will soar 100-fold!…"

[M. Dertouzos, 2001] Human-centered Systems, in The Invisible Future, pp. 181.

“To Hear this options again mark 9”
…“sorry, wrong answer”

Today technology is in control (!)

People used to be “waken up” in the following way…

A modern “Intelligent” Environment…

Some Current systems ask people:

- with Alzheimer's to remember how to use a PDA (or even where it is) to be dependent on using an accelerometer.
- not to carry things when walking over a smart floor so that the floor still know who they are
- to rest assured that the video taken in the bathroom will be stored under strict confidentiality in the server

The result...

A Modern Smart Environment

Privacy

[Aghajan at Stanford's WSNL]

Very useful resource but some users will not accept it !!

Security

- If our phone numbers are being used for unsolicited marketing offers …

imagine

what can happen if the files with our habits and complete daily life routine falls in the wrong hands!!

A Definition…(again)

***Ambient Intelligence**: "A digital environment that proactively, but sensibly, assists people in their daily lives"*

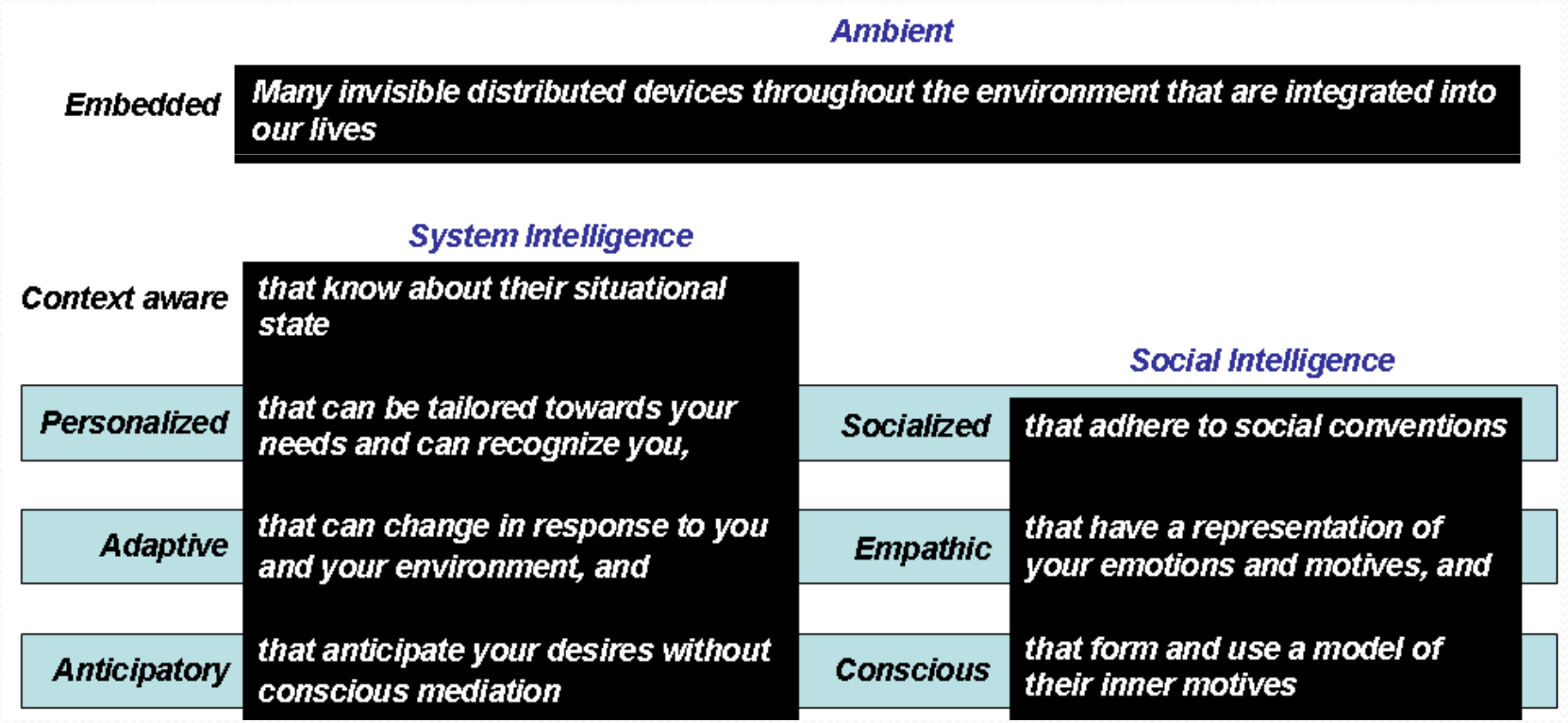
Note: 'Sensible' here includes both accurate diagnosis and timely intervention with emphasis on the users' needs and preferences.

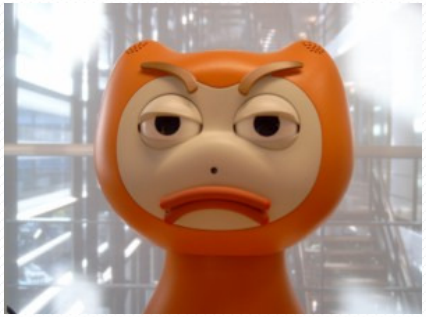
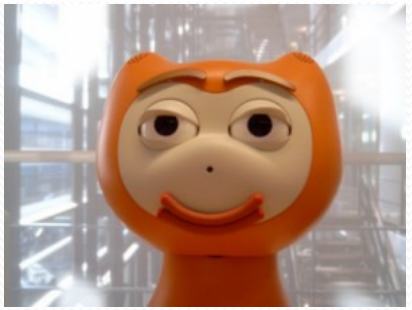
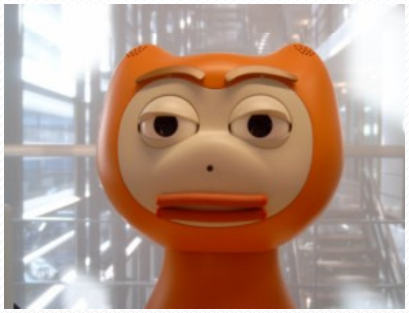
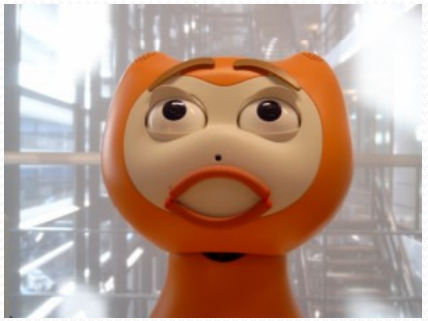
Current Challenge

- **Satisfy the user!**
- We already have all sort of smart environments exhibiting some degree of intelligence but SmE/AmI will not be adopted until the user can use the systems comfortably.

Philips

[B. de Ruyter and E. Aarts, 2006] Proceedings AITAmI'06, pp. 3-4:



The iCat Home Dialogue System

Streitz et al.

[Streitz et al., 2007] Ch. 1 of "The Disappearing Computer", Streitz et al. (Eds.).

Emphasizes the distinction in between:

- System-Oriented, **Importunate** Smartness
  - System takes/imposes decisions (e.g., "smart" fridge orders food, sometimes non sensibly)
- People-Oriented, **Empowering** Smartness
  - System makes suggestions (e.g., fridge advises on feasible meals according to fridge content)

MIT (n_house)

[Intille, 2007] "Smart People, Not Smart Homes", Proceedings of ICOST 2006, pp. 3-5.

Motivate (not control!) behaviour change by:

1. Present simple, easy to understand, message
2. At an appropriate time
3. At an appropriate place
4. Using non-irritating, engaging, and tailored strategy
5. Repeatedly and consistently

Group Decision Making (Polytechnic of Porto)

- A MAS system such that:
  - System is supported by Argumentation System.
  - The system takes into account past and current emotions of participants perceived at the meeting.
- Each agent having a perception of other agent's mood and having a role in the algorithm for the negotiation strategy adopted.

The Darmstadt Challenge

[Presented yesterday in Session 4]

- Aims at measuring how comparable in intelligence the artificial intelligence of an Intelligent Environment (e.g., a Smart Home) is with regards to the natural intelligence of a human being that performs similar tasks (e.g., a buttler).

- Related but different to the Turing Test

Route Map

- Past
  - Some basic concepts
- Present
  - The emergence of AmI and SmE
- **Future**
  - Deploying technology and software not enough anymore!
  - **What else can be done?**

Sure…

- Work hard**er** on core technical issues:
  - Improve Context-Awareness (e.g., spatio-temporal reasoning)
  - Improve Learning
  - Improve Reasoning

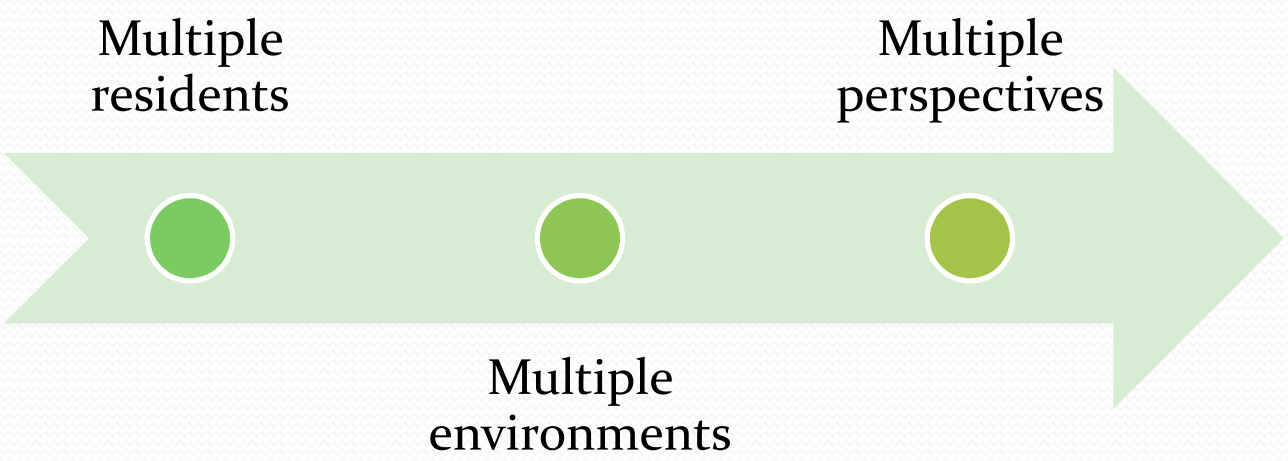
Some open problems

- Create tools (e.g., MAS architectures) which can provide **emotional** and social **awareness**

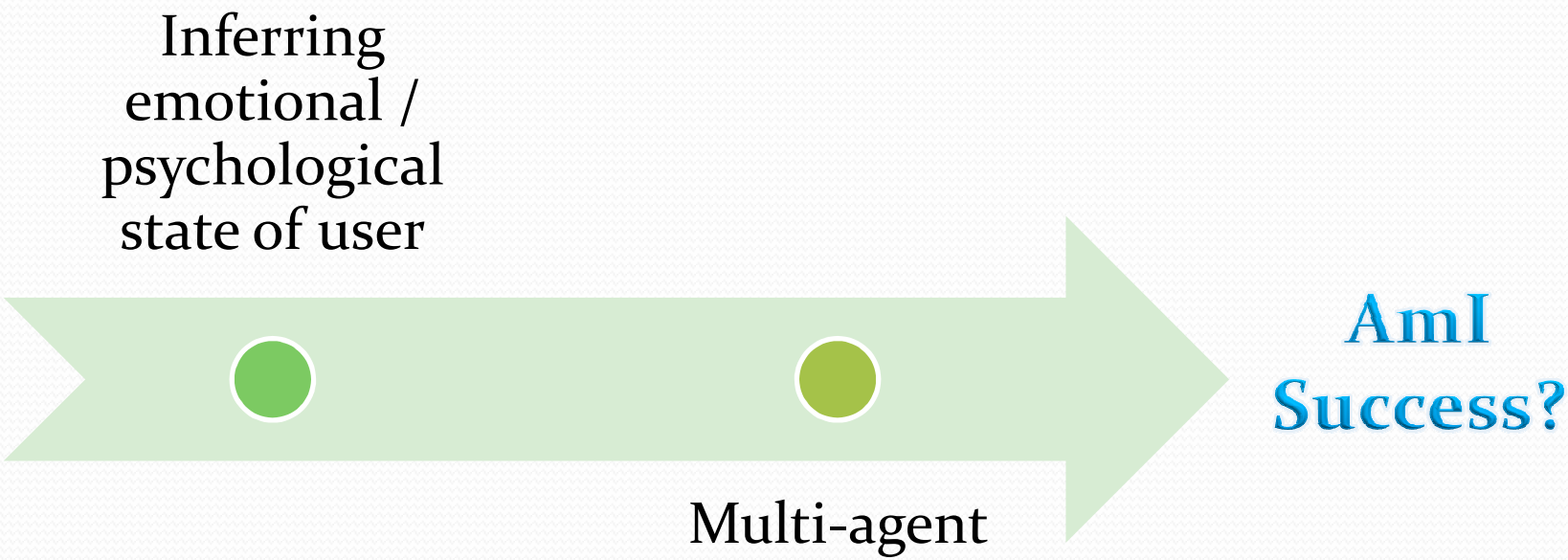
Some open problems

- Create tools (e.g., MAS architectures) which can provide **emotional** and social **awareness**
- Balancing needs and preferences
- Mediating conflicting preferences in a group

What's Next?


Multiple residents
Multiple perspectives
Multiple environments

What's Next?


Inferring emotional / psychological state of user
Multi-agent negotiation for resources
AmI Success?

Conclusions

- Lots of work have been done in:

  Pervcomp/Ubicomp/AmI/SmE/IE

- There are advances on making proactive systems …

  …(but not necessarily accurately proactive)

- Sensible/Sensitive ==> pending

- Trustable ==> pending

Questions?