PERVASIVE ADAPTATION: CHALLENGING CASE STUDIES

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with the cooperation of all tutorialists

MOTIVATIONS (OF THIS TALK AND OF THE SUMMER SCHOOL IN GENERAL)

- Trying to teach you something useful, i.e.,
  - About the existence of interesting technology/science for pervasive adaptation
  - How to apply such technologies
  - Seeing far in the future of pervasive adaptation
- Trying to have you discuss with each other and exchange experience and knowledge
  - Social events
  - Group work

THE GROUP PROJECTS: OVERVIEW

- Now (with this talk):
  - Identify a few interesting/visionary/challenging future application scenarios
  - In which "pervasive adaptation" research/technology can be effectively applied
- After this talk
  - Group students in teams of 4-5 and assign a case study to each
- Following (during the summer school)
  - Adopt the identified case studies as the themes of group projects (one for each group)
  - To be expanded/developed by exploiting the lessons learnt at the school, and by applying models/technologies presented by speakers
  - To be presented during the last day
  - And to be possibly worked out into survey/vision papers

THE METHODOLOGY FOR GROUP PROJECTS (1)

- I will only "sketch" the general vision behind the case study scenarios
  - Do not go into technical details or into the details of the envisioned functioning of applications within
  - Can at most suggest some solutions, without prescribing any
- You will have to detail the scenario with your own visions of usage, functionalities, and technological solutions
  - Possibly revising (or even totally scrambling) the scenario if you think so
  - Going as far as possible in terms of "conceptual design"
  - Trying to identify open challenging issues too
- There are specific time slots devoted to group project
  - However, since we are all here, we can work on projects at any time and at any place (even on the beach!)
  - Inter-group interactions are encouraged

THE METHODOLOGY FOR GROUP PROJECTS (2)

- The tutorialists, during the week
  - Will be around to discuss with you nearly at any time
  - Will try to refer to case studies in their talk
  - In some cases, they will actively participate with you in building your group projects (visionary mind exercises are fun for seniors too!)
- On the last day
  - You will finalize the project and its presentation
  - You will present it to the others (best project award!)
- Past the school
  - You can continue refining the project, turning it into a research proposal or into a visionary paper
  - The PANORAMA coordination action will organize a journal special issue in 2009, and this could become (if the projects are good enough) a "Vision of Pervasive Adaptation" special issue

WHAT CHARACTERIZES THE CASE STUDIES?

- Medium/long-term social/technological scenarios in which:
  - Pervasive computing technologies (sensors, tags, PDAs, wireless communications, etc.) have become massively pervasive (houses, streets, offices, etc.)
  - And can be put to the service of people (whoever)
- Yet, for them to be very useful
  - They require capability of dynamically self-organize and self-adapt their computational/communication activities
  - i.e., they require "Pervasive Adaptation"

THE SELECTED CASE STUDIES

- Different scenarios and different goals
  - The Ecosystem of Displays
  - Adaptive Traffic Swarms
  - The Alive Kindergarten
  - The All-About Diary
- Yes many common points
  - Intensive exploitation usage of pervasive computing technologies
  - Compulsory need for adaptation
- Also (possibly, you will tell us)
  - Many technical solutions that can be shared by more than a single scenario
  - Many “sub-parts” than can be useful to several scenarios

SCENARIO 1: THE ECOSYSTEM OF DISPLAYS

(DEFINED IN COOPERATION WITH ALOIS FERSCHA)

- Digital screens are increasingly populating our everyday environments
  - Streets, buildings, offices, shops, houses, etc.
  - To display generic information, shows, advertisements
  - Without adapting at all at who is actually watching them
  - Pervasive computing technologies can change things
- Displays can start "sensing" what's happening around (environmental information) and who's around (users, with their PDAs and phone, bring information about them)
  - Whatever information/clip may can be dynamically found on the Web
  - Parties interested in displaying something (e.g., advertisment companies) can do it in an informed way, and get more revenues
  - Users, in the end, will be able to gather more effective/pleasant information from the displays
- It is a sort of open "ecosystem", i.e., an open environment in which components of different species live and interact each for satisfying its own goals

THE ECOSYSTEM OF DISPLAYS: ACTORS

- Normal users of various types
  - Tourists, security people, working people, young vs. elderly people, etc.
  - With various profiles and needs
- Advertising/Media companies
  - They want to "display" things
  - Having possibly to pay, they want to get the best possible audience
- Display owners
  - Shop owners, municipalities, private users
  - Do not forget to account for personal (e.g., PDA) displays too
- Service companies
  - They may wish to exploit the display infrastructure to offer digital/Web services
- Sensors, of any type, in the environment

THE ECOSYSTEM OF DISPLAYS: REQUIREMENTS

- Openness and Integration
  - Anyone should take advantage of the ecosystem infrastructure and exploit (in a safe way) its resources
  - Wireless sensors, PDAs, displays, can communicate and interact with each other, and new components can be added ad any time
- Effectiveness & Fairness
  - The resources should be exploited at the best (computational, communication, and displaying resources)
  - There should not be second-class actors
- Adaptation
  - Short-term: adapt to contingencies and changes and re-organize and re-configure activities
  - Medium-term: adapt overall behaviours to common patterns of usage
  - Long-term: evolve accordingly to identified evolutions of patterns of usage

THE ECOSYSTEM OF DISPLAYS: YOUR TASKS

- Within the project work (*the same considerations apply to all other scenarios*) you are expected to:
- Refine the scenario, or scramble as you wish it
  - Define functionalities, expected way of using it, involved actors
- Refine requirements
  - Beside the ones I have roughly indicated
- Identify a sort of "conceptual design" for a working system, which include
  - The overall system architecture
  - Technological/algorithmic solutions to be integrated within
  - Patterns of adaptation and solutions to deal with them
- Go further and try to
  - Identify open issues and grand challenges

THE ECOSYSTEM OF DISPLAYS: EXPLOITING WHAT YOU WILL LEARN

- It is expected (*and again the same consideration applies to all other scenarios*) that the various lectures of the week will give you useful insights for pushing your project work ahead, e.g.:
- What methodology to build the scenario and its architecture?
  - Course on "Engineering Self-organizing Applications"
- Does the topology of the network of displays impact on the systems functioning? And the structure of the users' network?
  - Course on "Complex Networks and Social Networks"
- How can each display get a global view of the overall system?
  - Course on "P2P and Gossip-based Algorithms"
- How can displays adapt to changing environmental conditions?
  - Course on "Distributed programming in sensor networks"
- How can the various actors involved self-organize their activities in the presence of competing needs?
  - Course on "Organized Adaptation"
- How can the overall system self-evolve over time?
  - Course on "Evolutionary Computing"
- Etc. etc.

SCENARIO 2: ADAPTIVE TRAFFIC SWARMS

- Consider again a city with:
  - Sensors (there included cameras capable of artificial vision) densely embedded in streets, crossings, parkings, etc.
  - "intelligent" actuators (traffic lights, road signs, etc.) capable of interacting via wireless with whatever around
  - Cars and trucks that have computers and sensors aboard, that are wireless enabled and can communicate everything about them around
- Then it is possible to conceive the overall system as a sort of adaptive ecology, in which
  - The environment can dynamically adapt to the traffic around
  - Viceversa, cars (by interacting with the environment and with each other) move in a sort of adaptive self-organizing swarm, where the goals of the individuals orchestrate with the overall goals of the traffic ecosystem

ADAPTIVE TRAFFIC SWARMS: ACTORS

- Vehicles
  - Have a goal (get to X with shortest path on with shorter time)
  - Have inherent characteristics (speed, size, etc.)
  - Cannot influence actuators
- Police and security/safety vehicles
  - Have a goal
  - Can influence actuators
- The city
  - Interest in satisfying vehicles
  - Must minimize traffic hot spot and pollution
- Actuators (traffic lights, road signs, etc.)
  - Can influence vehicles and their behaviour
  - But do not have full control over them
- And of course a lot of sensors around

ADAPTIVE TRAFFIC SWARMS: REQUIREMENTS

- Safety and efficiency
  - Of the traffic situations of the infrastructure itself
  - Of drivers
- Differentiation
  - To distinguish between different classes of vehicles with different needs
- Adaptation
  - Short-term, related to the behaviour of the various components (e.g., traffic lights) to different patterns of traffic, and to react to contingencies (e.g., crashes)
  - Medium-term, to "predict" situations and adapt accordingly (accounting for history and Web info)
  - Long-term, to tolerate changes in the structure of the streets' grid and its computational infrastructure

SCENARIO 3: THE ALIVE KINDERGARTEN

- The kindergarten becomes a very smart (seemingly "alive") environment to actively support safety and gaming/social activities of children
- We can think of having:
  - Some "activity recognition" sensors and tags worn by children
  - Sensors every where in the kindergarten rooms, as well as specific furniture and walls capable of actuating actions
  - Desktop computers and PDAs for teachers to monitor and control the whole kindergarten
- In this context, we can provide the following functionalities
  - Continuous monitoring for safety, capability of recognizing and learning danger conditions
  - Capability of playing with children and of enabling children play all together and together with the kindergarten
  - "Alive" walls and games, capable of interacting with children, of changing their configuration (e.g. colour and shape), the kindergarten is a sort of liquid environment…(in the end this could also be an attraction at disneyland)
  - Intelligent social games (with sensors and actuators)

THE ALIVE KINDERGARTEN: ACTORS

- Children
  - Cannot be easily controlled, have unpredictable behaviours
  - Can have sensors to worn
  - Their safety is vital
- Teachers
  - They have to take care of children
  - Solicit and participate to games, social activities, etc.
  - They have control over the computational infrastructure
- The Kindergarten (and its components)
  - Are living actors in the everyday activities of the kindergarten
- And of course sensors, computational devices, etc.

THE ALIVE KINDERGARTEN: REQUIREMENTS

- Safety
  - Of Children, is the primary and necessary goal of the whole application
  - Preventing from problems, and avoid generating safety problems in itself
- Control
  - There must be way to control and influence the system in a simple way (by not necessarily expert teachers)
- Adaptation
  - Children get bored soon, and the alive kindergarten should adapt to invent new situations
  - Patterns of behaviour may be unpredictable, and the overall activities should adapt to whatever pattern
  - New tools/objects should be integrated in the overall activities of the kindergarten

SCENARIO 4: THE ALL-ABOUT DIARY
(DEFINED IN COOPERATION WITH MARCO MAMEI)

- To start, imagine to have a iPhone with GPS
- Starting from a set of simple GPS reading (as a sort of personally, unexpressive, "whereabouts diary")
- We can
  - Mine the Web for inverse geo-coding, by accessing white and yellow pages
  - Mine the past history of our GPS traces (or of those of other users)
  - Apply probabilistic analysis…
- And eventually obtain
- A high-level, expressive, diary of our activities

Who	What	Where	When
Franco	Speed: 1Km/h	@11°16'43.17", 48° 5'11.75"N	March 5, 2008, 8:17.23am
Franco	Speed: 9 Km/h	@11°16'43.21", 48° 5'11.77"N	Sept. 20, 2007, 8:17.33am
…	…	…	…

Who	What	Where	When
Franco	Break fast	Hotel Corrallo	March 5, 2008, 00:27am – 8.25am
Franco	Run	Rimini Beach	March 5, 2008, 8.26am– 8.42am
Franco	Work	PERADA School	March 5, 2008, 8:43am-16:47pm
…	…	…	…

THE ALL-ABOUT DIARY: WHERE CAN WE GO?

- Let's push the example forward, and imagine:
  - the possibility to account for environmental sensors, to make the diary even more expressive
  - to have each and every user in a city run its own "whereabouts diary"
  - that diaries can be shared and merged across group of users, for social reasons and also to improve inference power
  - that objects too can have their own diaries (cfr. the Internet of things)
  - that the diaries' computational engines have the capability of adapt their behaviour and learn over time
- The result can be a global and globally distributed computational system that can understand, represent, store, and make available, the (past and present) individual and social activities of everything
- It's a diary about ALL, that can be used per se or can become a support to context-aware applications

THE ALL-ABOUT DIARY: ACTORS

- Common people
  - Moving around with their phones+GPS
  - Typically organized in groups/classes
- Objects
  - Computationally enriched (or simply with tags attached
  - And of course sensors of any type in anywhere (such that each and every region in the environment is computationally enriched
- The Web 2.0 + Semantic Web
  - Can provide information about things and facts in the world
  - We can assume the existence of ontologies
- Users and services
  - Wishing to exploit the information of the all-about diary

THE ALL-ABOUT DIARY: REQUIREMENTS

- Semantically-enriched and multilevel information
  - Different users/services may need to access different kinds of information with different details
- Security and privacy
  - There must be ways to organize information and to provide it in differentiated way to different users
  - There must be way to “open” information to groups
- Effectiveness
  - How can we retrieve, store, ink together, huge amounts of information pervasively produced at distributed sites
- Adaptation
  - The system should adapt the way to analyse/represent information depending on how it is requested and used
  - Common-sense computing can be used to learn new fact and to adaptively improve the information representation

CONCLUSIONS

- There is a lot of fantasy and technique to be put at work in the selected case studies
- There is a lot the courses of this week can provide to the case studies

- In any case:
  - Do you have alternate case studies to suggest?
  - Do you already have in mind extensions/modification to suggest to the case studies?

- Then, let start working on it!