Designing autonomous advisor systems

Koneautonomian mahdollisuudet ja rajoitteet

MATINE-seminaari

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Advisor systems 1/2

- Systems that give advice to human users and monitor the system of systems and the users
  - Anticipation of problems, not postponing the actions until the crisis
  - Proposing actions and interpretations
- Understanding and analyzing the (computational) rationale behind decisions
- **Human operator has the ultimate responsibility**

Advisor systems 2/2

- Traditionally: proposing changes to CAD design to lower manufacturing cost of a machine part
- Interpretation of credit rating e.g. for mortgage

Autonomity in advisor systems

- Most of the tasks are carried out in background
  - User is alerted only when necessary, e.g. for making a decision
- Amount of data processing can be huge
  - Need to share between systems and systems of systems
- Users can concentrate on the tasks, advisor system does not make final decisions
- An autonomous advisor system learns from the actions of expert users
  - Compensating the differences in skill levels?

Autonomous data processing

- Most of the data is not intelligible for humans
  - Multidimensional, small variations
  - Low semantic level, the data has meaning only when interpreted (e.g. GPS coordinates vs. map position)
- Processing methods are complex and require considerable amount of knowledge
  - Neural networks, clustering algorithms
  - Artificial immune systems, swarm optimization, genetic algorithms
- Autonomous machine – a monolithic entity or a society of data processing units, i.e., a system of systems?
  - Autonomity as a property of a system or as a relationship of systems (of systems)?

Understanding processed information

- Meaning of results from information processing is hard to understand
  - Certainty/uncertainty, plausibility
  - Limitations and shortcomings of processing methods
- Advisor systems provide interpretations and understanding to allow for making **informed decisions**
- Complex processing in systems of systems -> need for clear and intelligible advice

Challenges for data

- Erroneous data is far more dangerous than bad decisions
  - How to cope with the problems?
- Data is often incomplete, unreachable, outdated
  - Volatile networks, isolation
  - Questionable sources, faulty equipment
- Representing courses of action as uncertain suggestions, not irrefutable truths
  - Alternative actions and certainty of suggestions

RISUS project proposal

- Combining sensor data with societal and occupational safety knowledge
- Detects imminent violent and emergency situations on train stations and in public places
- For security personnel - pointing out possible problem zones
  - No alarms, but advice for pre-emptive measures
  - Computing system can learn from human professionals
- Using a minimal set of sensors and simplest effective machine learning
  - Microphones, cameras, touch, infrared ...
- Abstraction of human body and voice to avoid identification or discrimination
- Anti-"big brother watching"

Designing autonomous advisor systems of systems (AASoS)

What is designed?

- Understanding and modeling the problem is the hardest part
  - Technologies are not enough
- Defining the experimentations for validation
- Designing the semantics and context in a systems of systems
- Implementation is the simplest task
- Designing the degree of autonomity and user intervention

Modeling and experimentation 1/2

- Designing targetting the problem/objective, not the implementation/solution
  - Explicating objective of the autonomous and advisor systems allows auditing
  - Modelling how system appears in physical world, how it works in systems of systems, and considering involved organizations
- Difficult errors are those that are about failing to take into account something or making implicit wrong assumptions
  - Therefore, experimentations on future systems and solutions are needed before they exist
  - Not about testing against specification, but experimentation on the intended design to discover unexpected and hidden

Modeling and experimentation 2/2

- Modelling and experimentation allow experts of different viewpoints to brokered
  - Inter-disciplinary designing
  - Justification and proof, validity and reliability
- Anticipating dynamic development paths
  - Pre-product development

Designing autonomous information processing

- Choosing the technologies is not enough
  - Organizations, participants, stakeholders
  - Roles of users and their interface to an advisor system
  - Validation of complex systems with scientific experimentations
  - Modeling to preserve knowledge and understanding the problem
- Context, information sources, networking, participants, organizations etc. change dynamically
- Methodology for designing systems of systems: innovation prototyping methodology
  - Modeling, experimentations and balanced brokering
- Anticipating future technologies and experimenting with them before availability

Multipath designing for interaction

- Obvious source of losing control or unintended consequences/ happenings are problems in interaction
- User groups, information sources, communication networks, device context
- Dynamically choosing the suitable combinations in every context
- Design space - information systems can configure themselves but according to the limitations of design space
  - Explicitly defining every possible combination is not feasible
- Bringing new constituents of context to system is straightforward
- Designing dual uses

Ubiquitous computing and autonomous systems

- Autonomous advisor systems (of systems), not a single product
- Ubiquitous computing – future paradigm
  - Forget everything you've heard of ubi-"thisandthat"
  - Instantiation of a computing systems of systems dynamically"
  - Advisory and unobtrusive system - the antithesis of experience and gaming industry
- Innovation prototyping methodology
  - Inter-disciplinary models for design space
  - Balanced brokering - finding new combinations and noticing risks and consequences
  - Valid scientific experimentations to allow for validation before investments and even availability of technologies

Conclusions

- Autonomity does not always refer to unattended operation and decision making
  - Advisor systems -> autonomity and human control can be balanced
- Advisor systems work autonomously, but interact with users when necessarily
  - Responsibility for actions is left to the human operator
- Designing autonomous systems requires
  - Solid methodology
  - Validation of critical features with scientific experimentations
- **Autonomity does not mean turning on a car and jumping out when it starts moving**
  - **Or letting a child run free on a motorway**
- **No agile, ad-hoc, undesigned and unplanned trial-and-error approaches**
  - **Really, what's a "proof of concept demonstration", considering weapon systems? Someone's gonna die...**

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