Science of complex systems for socially intelligent ICT

Overview of background document
Objective IST-2007.8.4
FET proactive

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Dresden, CRP @ ECCS'07
06/10/07

Formulation

- Result of wide consultation
  - O. Babaoglu, C. Barret, P. Bourgine, Ch. Diot, A.E. Eiben, D. Floreano, D. Hales, D. Helbing, A. Hoekstra, J.H. Johnson, S. Kirkpatrik, M. Morvan, C. Nikolau, N. Packard, M. Schoenauer, P. Sloot, L. Steels, A. Vespignani... ***and many others***
- Apologies if a name is not listed...

Basic Idea

- Application of Complex Systems approach for designing, understanding and modelling...
- Socially Intelligent ICT

Socially Intelligent ICT?

- ICT composed of many interacting parts
- Semi-autonomous, possibly diverging goals
- Include humans in-the-loop
- Required to coordinate and cooperate socially to achieve collective goals
- Socially Intelligent ICT facilitate this through mechanisms of social coordination

Why Now?

- Emergence of global scale distributed ICT as major application domain
  - Massive (10m's)
  - Distributed (lack of central control)
  - Open (unknown new behaviours)
- Increasing use of ICT to mediate, create and enable communities (techo-social communities)

Why Now?

- Recent example applications:
  - Social networking
  - Wiki-based content creation
  - Social tagging
  - Peer-to-Peer systems
- Compare: Social software (Web 2.0)

Why Complexity Science?

- Maturing body of work providing:
  - Scientific results: empirical & analytic
  - Tools: models, formalisms, measures
  - Methodology: simulation, analysis
- For modelling, predicting and designing complex adaptive systems
- Can help where traditional engineering approaches struggle

Why Complexity Science?

- Many relevant domains – e.g:
  - emergent network structures
  - trust and cooperation
  - formation of sustainable communities
  - evolutionary economics
  - computational sociology
  - econophysics

Why Complexity Science?

- Provide alternatives to “rational action”:
  - Realistic models of user behaviour
  - Localised and noisy information
  - Bounded computation
  - Bounded rational models
  - Evolutionary models of behaviour
  - Psychology and experimental economics

Vision and Challenges

- Produce effective models of techno-social systems
- Avoiding commons tragedies without central control
- Controlling malicious behaviour & noise
- Efficient reputation systems preserving privacy

Three broad challenge areas

- Theoretical and algorithmic foundations
- Data-driven simulation
- Prediction and predictability

Theoretical and algorithmic foundations

- techno-social systems are complex
- required multi-level modelling
- micro, macro and meso scales
- previous models often focus only on:
  - micro or macro levels
  - micro to macro level relationships
- need feedback from macro to micro
- realistic diversity of behaviours and social and spatial structures

Data-driven simulation

- Social and economic models often ignore empirical data (abstract / theoretical)
- Derive models of techno-social systems empirically - need tools and methods for:
  - collection and processing of huge noisy datasets to derive multi-level dynamic models
  - probing technologies in date rich environments
  - design of protocols and experiments (humans)
  - scalable and distributed knowledge extraction
- Validation methods (not just curve fitting)

Prediction and predictability

- Complex systems and human systems are difficult to predict
- But statistical signatures, patterns, can be found. For given systems:
  - what is the appropriate predictive level?
  - what are the limits to predictability?
  - what are the relationships between predictive, descriptive and theoretical / abstract models?
- Understanding the limits of predictability valuable for engineering and design

Vision and Challenges

- Potential application domains:
  - massive ICT mediated service economies
  - ICT mediated communities
  - Peer-to-Peer systems
  - emergency and disaster relief systems

Source Documents

Background document:
http://cordis.europa.eu/fp7/ict/fet-proactive/home_en.html

Complexity Research Living Roadmap:
http://complexsystems.lri.fr/Portal/tiki-index.php?page=Living+Roadmap

Complex Systems Research in FP7 document:
ftp://ftp.cordis.europa.eu/pub/ist/docs/fet/co-16.pdf

See FET FP7 closed consultations at:
http://cordis.europa.eu/ist/fet/id-fp6.htm