
EXPRESSION OF INTEREST

Network of Excellence:

Enhancing the governance of sustainable institutions and resources: agent-based models and simulation

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Enhancing the governance of sustainable institutions and resources: agent-based models and simulation

1. Objectives

The aims of the proposed Network are

1. to secure and reinforce the position of Europe as the international scientific leader in agent-based simulation, and
2. to develop and apply Europe's expertise in social simulation and modelling to significant policy issues

in order to profit from the potential of agent-based simulation tools to contribute to the understanding and resolution of problems stemming from the management and governance of complex social and economic institutions in Europe.

The Network will mobilise the already existing, but fragmented community of experts in agent-based simulation from different application areas, educate the wider policy and business communities about the potential of agent-based simulation for the understanding of complex social problems, and apply their expertise to areas recognised as priorities in FP6, including:

- 'research in the area of the **environment** [which] will focus on knowledge-based systems for natural resource management and for risk prevention and crisis management' (1.1.2.i)
- '**Complex problem solving in science, engineering, businesses and for society**: Research will ... include novel collaborative tools and programming methods and ... new generations of simulation, visualisation and data mining tools.' (1.2.1)
- '**Sustainable energy and transport systems**. The goal is to bring innovative and cost competitive technological solutions to market...which address not only technical but also organisational, institutional, financial and social issues' (1.6.1.1.i and 1.6.2)
- '**Water cycle, including soil-related aspects**. ...management strategies and their impacts; scenarios of water demand and availability' (1.6.3)
- '**Strategies for sustainable land management**, including coastal zones, agglomerations, agricultural land and forests. Development of the necessary tools for integrated management of coastal zones' (1.6.3)
- **Citizens and governance in a Knowledge-Based Society** to enhance social and corporate responsibility; to foster trust in social, economic and legal institutions and favour their emergence and efficacy; and to contribute to the development of community identity and reputation (1.7)

Agent-based simulation involves the construction of computer models of social, political and economic institutions in which the main actors are represented within the model as 'agents'. The field originated in the early 1990s and has since grown very rapidly as the value of such models has come to be more clearly realised. Agent-based models are able to represent processes of evolution, social learning and innovation; heterogeneous actors, with different capabilities, knowledge-bases and goals; and non-linear dynamics. These features make them much better suited for the modelling of complex social institutions and for exploring and experimenting alternative ways for enhancing their adaptation and efficacy than conventional econometric or statistical models.

The Network will contribute to the development of the European Research Area through its work in structuring and integrating the existing research base, which is widespread through Europe (see e.g. the list of proposed partners), provide a centre of gravity to balance the expanding investment in agent-based social simulation currently underway in the United States, and allow the formation of critical mass sufficient to undertake projects within the network that will make real contributions to policy problems, as well as acting as powerful demonstrations of the value of agent-based modelling (see *Thematic Priority Areas* 1.1.2v).

2. Rationale

As the Lisbon European Council recognised, recent developments are posing increasingly difficult problems for the effective governance of European resources. It is imperative that new tools for decision-making are developed that respect this complexity, including co-ordinated decision-making at the European, national and regional levels.

A new technology, agent-based social simulation, has been developed during the last ten years. This technology has the potential to provide decision-makers with a new generation of modelling tools that will deal directly with the complexity of modern governance. It has also the potential of enhancing the participation of stakeholders in the decision making process. While the potential of these tools has been demonstrated in a few current Framework 5 projects, the expertise and experience within Europe now needs to be brought together and consolidated in order that the opportunities for the practical use of agent-based simulation can be exploited to the full.

Examples of current European work (much of it supported by FP5) using agent-based simulation that hint at the opportunities becoming available include:

Water resource management. The Water Framework Directive establishes policies that require the integration and coordination of policies at local and regional levels for the management of water resources. Agent-based models are being developed for stakeholders to use to help them develop appropriate management structures.

Spatial development of agglomerations. The agglomerations in Europe continue to grow and spread in space, a situation that generates major problems in terms of land-use, pollution, mobility patterns and access. Agent-based models are used to represent the development of cities in time and space.

Enhancing innovation. It is increasingly recognised that effective innovation depends on the establishment of appropriate networks or clusters of innovative firms, together with a sustaining economic and political context that can be provided by regional, national and European government. The factors that encourage the formation of innovation networks are being modelled using agent-based simulation.

Sustainable energy systems. Current attempts by the EU to implement sustainable energy systems in Europe require changes in consumer behaviour and in the configuration of energy producers. The interaction of prices, availability, risk, and the entry and exit of organisations in the market has been modelled using agent-based simulation, which allows the implications of alternative scenarios to be examined.

The digital content market in Europe. Digital content (on-line music, video, news etc.) is predicted to be an increasingly important sector within Europe. However, there are threats to Europe's position from new technologies that could dissolve the market completely. Agent-based modelling is being used to study the effects of new products and services and the consequences of alternative policy regimes.

Improving risk management, regulation and supervision processes in the European financial markets. The financial services industry has been undergoing major transformations in the past decades, during which it has become increasingly important to understand and manage financial, operational, and counter party risks in the context of global markets and cross-border investment flows. Agent-based modelling could, for the first time, allow policy makers and decision takers to explore the effect their actions have on local, national, and global markets and help them in the process of regulating, supervising, and managing risk.

Natural habitats management. The conservation of many European natural habitats involves the preservation or enhancement of a set of specific agricultural activities. The interactions between agricultural, forestry and nature conservation activities have been modelled using agent-based simulations coupled with role-games in order to compare different management scenarios and alternative policy regimes.

Emergence and informal governance of cooperative relationships within organizations. Modern work organization increasingly face the challenge that voluntary cooperation between employees (organizational citizenship behaviour) is required to sustain complex, self-managed production processes. Agent-based modelling is ideally suited to study how cooperative relationships between organization members can self organize.

Crisis and disaster management. During a crisis or disaster several key agencies need to coordinate and cooperate to achieve joint plans and goals. However, the unpredictable nature of such events and expense in performing productive "dry runs" means that the development of robust plans is hard to achieve. Agent-based simulation offers the potential to test plans in the computer and to bring together distant stakeholders and agencies over networks to participate in role-playing simulations.

These examples illustrate the very wide opportunities for enhancing the governance of European resources that could exist if there was a more coherent and better developed pool of expertise within Europe on agent-based modelling.

3. Expected outcome

The Network of Excellence would:

- Establish pan-European co-operation in agent-based simulation and modelling
- Ensure that European research in agent-based modelling is the equal or better than that elsewhere
- Create a number of demonstration applications of the technology applied to issues of European governance
- Create a pool of social and policy scientists who are trained in the use of agent-based models and can apply them

4. Activities required to achieve the objectives

4.1 Integration Activities

Integration activities will be needed to integrate the diverse range of skills needed to build and deploy agent-based models. These skills include: Computer science and information technology, Economics, Political science, Sociology, Cognitive science, Environmental science (for models that involve the management of natural resources) and Business and management.

The integration activities can be summarised as follows:

Training activities

The number of suitably skilled personnel within Europe is still very low. The skills needed are a combination of competence in information technology (programming, information systems and methodologies, human-computer interaction etc.) and social science (e.g. economics, business, sociology knowledge and research methods). Expertise that straddles these two areas is rare. The proposed network would therefore take the following actions:

1. Develop a training course in agent-based modelling for the partners within the Network, and mount the course as many times as necessary. This will not only enhance the expertise of those within the Network, but also enable the course to be refined from experience.
2. Run the course for interested parties outside the Network.
3. Set up a system of exchanges of doctoral students among the partners, so that the students can learn from the various specialisms of the partners.
4. Encourage the development of graduate level courses in social simulation, in University departments of informatics and social science. This will be done by publishing syllabi and by supporting the development of a cross-institution and cross-nation Masters course in Agent-Based Simulation (this is likely to attract students from all over the world, as there is no course of this nature anywhere as yet, although UCLA are proposing to start one).

Dissemination activities

1. Publish a series of guides that recommend methods for building agent-based models, review existing tools, and describe examples of best practice
2. Set up or enhance existing communications to encourage interchange between European experts.
3. Maintain a web-site with links to relevant work.
4. Publish elementary descriptions and guides for those who may be interested but are not aware of the potential of agent-based modelling.
5. Publish a regular review of relevant work being done in Europe.

Strengthening scientific excellence

1. Set up a learned society to promote research and development on agent-based systems, to match the one currently being established in the United States. Eventually, set up joint arrangements with the US society.
2. Establish a mobility scheme allowing established researchers to visit other European researchers for short periods.
3. Support the development of the existing European academic journal for social simulation.
4. Sponsor an annual international conference on agent-based modelling

4.2 Research Activities

The main research activities required are:

1. Review the state of the art and identify gaps, weaknesses and research opportunities.
2. Encourage, through a research competition, appropriately qualified partners to engage in research to fill the identified gaps and opportunities.

3. Identify a small number of exemplar topics where agent-based models might make a substantial contribution to problems of the governance of complex social and economic institutions. These testbeds will be chosen in conjunction with the Governing Council (see section 7). Candidates for these exemplars are:
 - a. Policy options for enhancing innovation networks in e.g. biotechnology
 - b. Managing technological development in mobile e-commerce
 - c. Modelling the conditions for and consequences of transitions in energy systems targeted at sustainable development
 - d. The impacts of ICT use on mobility and spatial development
 - e. Cooperation, institutions and network development in science-industry relations
 - f. Design of (self-)regulatory and supervision processes that provide the European financial system with improved response mechanisms to global market shocks
 - g. The factors and conditions for enhancing corporate image and reputation
 - h. The consequences of diverting agricultural subsidies towards environmental management rather than agricultural production.
 - i. Conflicts between key stakeholder groups in river catchment and/or coastal zone management.
 - j. The dynamics of social networks in socio-economically deprived areas, urban and rural.
 - k. Market mechanisms, especially for emerging markets and mixed private/public markets
 - l. Modelling the conditions and mechanisms by which agents in complex work organizations and informal communities can learn to form voluntary cooperative and sharing relationships.
4. Bring together groups of partners to develop prototype agent-based models for these selected exemplar issues.

5. Expertise needed to achieve the objectives

Europe was and remains at the forefront in developing agent-based simulation. However, its lead is being rapidly eroded by the United States, where the number of researchers in the area is increasing rapidly, and is likely to do so even more rapidly as new courses are brought on stream.

The Network would expect to involve all the major European players, and the list of partners (see next section) includes all the best established and most prominent European researchers in the area. The network would ensure that these partners work together so that Europe maintains its status as world leader.

5.1 Proposed Consortium

The table below lists the 'core group' who will jointly manage the Network. Underneath are those 'associated' with the Network, who will participate in its activities. In addition, there will be those, not listed here, who will participate through responding to Calls for Participation once the Network has been set up (this ensures that the Network is open to new partners and new developments).

Core Group

Organisation	Country	Principal	Area of Excellence	Role in Project
University of Surrey	UK	Nigel Gilbert	Social simulation	Training courses; participatory simulation
University of Hamburg	D	Petra Ahrweiler	Innovation studies; conflict resolution	Science and technology policy research topics
ARC Seibersdorf	A	Matthias Weber	STI policy research, science-industry relations	Participatory simulation, STI policy research issues
CIMNE	E	Gilbert Pepper	Financial management	Relationships with SMEs
CIRAD	F	Christophe Le Page	Simulation of land use change, simulation of interactions between societies and natural resources	Training courses, participatory simulations
Cemagref		Olivier Barreteau		Development of computer simulation tools
Institute of Cog. Science and Tech., CNR	I	Rosaria Conte	Multi Agent Systems and agent-based simulation	Theory of agent modelling and simulation

Macaulay Land Use Research Institute	UK	Nicholas Gotts	Agent-based social simulation, spatially explicit modelling	Simulation of land-use change
Manchester Metropolitan U.	UK	Bruce Edmonds	Agent-based social simulation	Methodology
University of Groningen	NL	Andreas Flache, Henk de Vos, Wander Jager	Simulation of social networks	Organisational modelling
University of Koblenz Landau	D	Klaus G. Troitzsch	Multi-level modelling	Training courses
Ecole Normale Supérieure	F	Gerard Weisbuch	Complex systems dynamics	Exemplar cases
University of Torino	I	Ugo Merlone	Modelling for Business and Management	Training courses
University of Twente	NL	Anne van der Veen	Spatial information modelling	Socio-economic topics
University of Oxford	UK	Edmund Chattoe	Innovation diffusion, Evolutionary simulation	Exemplar cases
University of Zurich	CH	Hans-Joachim Mosler	Intervention studies for social systems	Psychological simulation

In addition to the above core members, this expression of interest is supported by the following 48 organisations (in alphabetical order):

Aarhus University (DK) Brian Mayoh; **Aston University** (UK) Sudhir Jain; **Blekinge Institute of Technology** (S) Paul Davidsson; **Cagliari University** (I) Michele Marchesi; **CALT, INSEAD** (F) Thierry Nabeth; **Collegium Budapest** (HU) Karoly Takacs; **Cranfield University** (UK) Peter M. Allen; **ENST de Bretagne** (F) Denis Phan; **Fraunhofer Institute for Autonomous Intelligent Systems** (D) Michael Paetau; **GREQAM-CNRS** (F) Juliette Rouchier; **Humboldt University Berlin** (D) Hans-Dieter Burkhard; **Hungarian Academy of Sciences** (HU) Laszlo Gulyas; **IMEDEA, CSIC and the University of Balearic Islands (UIB)** (E) Maxi San Miguel; **Industrieanlagen-Betriebsgesellschaft mbH** (D) Alexander v. Baeyer; **INRA** (F) Michel Etienne; **International Institute for Applied Systems Analysis** (A) Michael Obersteiner; **ISCTE** (P) José Caldas; **ISOCO, S.A.** (E) Juan A Rodriguez-Aguilar; **London School of Economics** (UK) Eve Mitleton-Kelly; **NIWI-KNAW** (NL) Paul Wouters; **Politecnico di Torino** (I) Luca Caneparo; **SATE Srl** (I) Michele Capobianco; **Steinbeis Transfer Centre Applied System Analysis (STASA)** (D) Guenter Haag; **Stockholm University/Royal Institute of Technology** (S) Harko Verhagen; **Swedish Institute for Computer Science (SICS)** Magnus Boman; **Technical University of Hamburg-Harburg (TUHH)** (D) Thomas Malsch; **The Netherlands Institute for Scientific Information Services** (NL) Andrea Scharnhorst; **University of Fribourg** (CH) Georg Mueller; **Universidad Autonoma de Madrid** (E) Manuel Alfonso; **Universidade de Lisboa** (PT) Helder Coelho; **Università della Svizzera Italiana** (CH) Giorgio Tonella; **Universität Augsburg** (D) Andreas Pyka; **Universitat Politècnica de Valencia** (E) Juan Carlos Micó; **Université Paul Sabatier** (F) Julie Dugdale; **University College London** (UK) Michael Batty; **University of Amsterdam** (NL) Loet Leydesdorff; **University of Genoa** (I) Silvano Cincotti; **Universidad de Granada** (E) J J Merelo; **University of Osnabrück** (D) Claudia Pahl-Wostl; **University of Patras** (GR) Moses A. Boudourides; **University of Portsmouth** (UK) Thomas Addis; **University of Torino** (I) Pietro Terna; **University of Valencia** (E) Antonio Caselles; **University of Valladolid** (E) Adolfo L. Paredes; **University of Wageningen** (NL) Stanislas Boissau; **University Pierre et Marie Curie (Paris 6)** (F) Alexis Drogoul; **Utrecht University** (NL) Frank Dignum; **Volterra Consulting Ltd** (UK) Paul Ormerod; and by the current FP5-supported networks: **EXYSTENCE** and **COSI**.

6. Promotion of results outside of the Network

A prime objective of the Network will be to promote agent-based modelling as a tool that can assist policy-making to those who might benefit from it. The Network will therefore see most of its activities as ‘outward-facing’, involving users at every stage. As well as the web-site and other activities mentioned above (section 4), the Network will:

- mount a series of seminars to involve relevant user groups and government and industry associations at the European level;
- publish a regular newsletter for interested users;
- run training courses for potential users; and
- invite the stakeholders for the selected exemplars to a tailored sequence of events in order to involve them closely in the model building.

Particular attention will be paid to involving SMEs, with the aim that some SMEs will be able to take up and commercialise the technology. ‘Spin-off’ companies already associated with the proposed partners (e.g. KSR Net GmbH, E-Consult GmbH, iSOCO S.A., EuroBios, COMSORT, Twynstra Gudde, SATE Srl, Volterra Ltd) will be included in the main Network activities.

7. How the project will be managed

The Network will be managed through a Management Committee with a representative from each partner in the Core Group. This Committee will be advised on strategic issues by a larger Governing Council, composed of the main scientific figures in the field, including some from the US and Japan, and senior representatives of European organisations that are already using agent-based models.