Participation MAPS 2 Conference
Teaching of/with Agent-Based Models in the Social Sciences
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As a sequel to the MAPS 1 Conference in 2009, a collective of the UMR organized a follow-up MAPS 2 meeting to evaluate a couple of Ph.D. student projects started during the MAPS 1 meeting and to assess the state of the art about Agent-Based modeling (ABM) tools and standards. The meeting was held at the the Ecole Normale Supérieure d'ULM (ENS-ULM). The MAPS 1 meeting was an initiative of some young scientists in France, who wanted to promote ABMs and chose NetLogo as platform.

Thursday 8/4. The first morning: the MAPS Experience, four teams of PhD students presented the process and the outcome of constructing simple ABMs using the NetLogo software developed by Uri Wilensky at Northwestern University USA. NetLogo, which can be downloaded from the site XXX, is at the moment the most widely applied platform for making ABMs; other platforms are RePast and CORMAS (www.cormas.fr). The students had 10 months to work on it, were more or less intensely guided by trainers (such as Michelle Etienne of INRA Montpellier), had to make a presentation during the MAPS 2 and used as principle that organizers and trainees of the projects and meetings are the same persons. The approach was to first conceptualize the problem (static – dynamic), then formulate in UML and then in NetLogo. The over-all evaluation was positive in terms of skill development and NetLogo [community], but there was specialization (programmers vs. thematic interest). Three groups reported.

Presentation 1 TOXICITY
An ABM was constructed about an industrial accident in an urban area. The motivation was: you have to understand and target those people who do not know about dangers and risks. In a 2D city agents are people with four different action profiles: C1 look around for shelter in buildings; C2 runaway; C3 not-knowledgeable, therefore follow nearest neighbour; and C4 fixed at a random destination. The question asked: what determines the fraction of C3-agents being rescued? The students considered it a concrete, complete, do-it-by-yourself interdisciplinary experience.

Presentation 2 IRIUS
This model was an attempt to understand dynamics of Land Use land Cover Change (LUCC), in particular the influences of social networks at various levels (local, socio-economic, and for-all-agent-equal global) on the development of the landscape.

Presentation 3 BUSH TAXI
In this model, it was investigated how an unregulated taxi system could work in a rural (African) setting. Villagers can walk but also take a taxi at one of the stops on their way to the market. Taxi drivers cruise around and may pick up clients and unload them at a market place. Various network patterns evolve in the territory. The explanation of the model was not good enough to understand what was going on.

The afternoon lecture ***NetLogo: A Multi-Agent platform for research and education*** was given by Uri Wilensky, Professor at the Northwestern Institute of Complex Systems (NICO) in Chicago (ccl.northwestern.edu). He is the creator of the presently most widely used ABM platform: NetLogo. This year a textbook will appear about how to work with NetLogo and with demo-models. Wilensky advocates the view, not surprisingly, that existing ways of modeling have to be disrupted and replaced by agent-based modeling – at a young age of the students. It will be a slow and painful process – he makes the comparison with the replacement of the Roman numerals by the Arabic-Hindu numerals which took several centuries.

It is a novel way of making sense of dynamic processes and of structuration. It is a break with the existing, Leibniz-based calculus. Yet, it is also a continuation: inferring rules for agents is like differentiation, inferring consequences of rules is the equivalent of integration. But essential differences are ABM-aspects such as:

- order is seen to come from below, not as a result of a deterministic process as the Deterministic/Centralized (D?C) mindsets thinks; cf. a flock of geese
- it democratizes ideas of random events and of rules guiding behavioiur;
- it is a way of restructuring traditional content in existing models.

Wilensky gave a brief genealogy, in which NetLogo, as a derivative of Logo and StarLogo, comes from Von Neumann/Ulam replicating machines, via Logo by Papert, Game of Life by Conway, CA by Wolfram, Holland a.o. and SIMD by Hillis to ABM as practiced by people like Resnick, Wilensky and Langton.

NetLogo is designed for both teaching and research and can avoid the miscommunication often occurring between programmer and scientist. It aims at 'model literacy', advocates that the modeler 'should think like an agent' and is already widely used on US (high) schools. There are over 100 demo models on ccl.northwestern.edu/netlogo/models. He illustrates the different approaches with the two key equations describing a fire in a forest – and the ABM way of describing such an event/process. Discrete object-oriented modeling is better than continuous modeling in many cases as it is more intuitive. He also gives an interesting overview of 'restructured content' i.e. a list of existing issues which are modelled in NetLogo, such as:

- Beagle on evolution (Rand)
- EconLab (Maroulis, Berland…)
- Cities (Watson)
- Management science (Maroulis…)
- Cognition psychology (Blikstein…).

Wilensky considers the next step to be participatory simulations via the internet: HubNet, with a mix of human and simulated agents. The NetLogo has many new features. It is being used in many disciplines – only economists have serious problems / resistance using it. Validation of model is a tricky issue.

During the discussion a number of suggestions and doubts are expressed. One danger is that people may not criticize the models they make but instead overestimate them. I think this is a danger indeed, especially wich children who increasingly live in virtual worlds and may think they really made a model which reflects scince – but it does not, it reflects what they personally see and experience which is not neceassily the same as 'objective' and widely shared science. The link with [social] science should be carefully examined and using ABM brings in an additional responsibility for the teacher. Wilensky agrees but emphasizes that students, whatever the model, do learn modeling…

Friday 9/4. The morning lecture was by Volcker Grimm (Helmholtz Institute, Germany) who gave a presentation ***Protocols and methods to communicate with and about models*.** He gave an overview of theory and practice of a ODD protocol for the construction of ABMs, which will soon be published as a book (www.openabm.org and www.railsback-grimm-abm-book.com) . The idea is to develop a standard for the design principles of ABMs to structure the existing ad-hoc situation – "ODD is meant to be a soft weak magnetic field which orients (ABM-)modlling". Grimm proposes and hopes that the combination of NetLogo + ODD becomes the Lingua Franca of ABM. He also showed a list of models which are or can be framed in an aent-based platform, most of these fom ecology (he refers a.o. to models of flock dynamics of birds by Hemelrijk RUG). Some references for the models are Grimm and Railsback 2005, Jackson et al. 2008 and Weiner et al. 2001. His lingua franca idea would imply:

- A coherent and efficient scientific method
- Unifying perceptions
- Facilitating communication.

In the discussion is was suggested (Dawn Parker) to introduce something in-between ODD as a set of design principles and the actual (NetLogo) coding, e.g. basic neighbourhood methods, learning mechanisms. I fully agree that such a 'library of elementary mechanisms' would be useful. There was also some doubt whether ODD would work to design models – but it may work in communicating your model. The relation between ODD and IML was another issue – as most of the practitioners of the French CORMAS group work with UML.

One of the key persons in the French ABM CORMAS group (INRA – Montpellier, Avignon), Christophe LePage, gave a presentation ***Teaching agent-based simulation for renewable resource management*** on the CORMAS platform (www.cormals.fr and www.cormas.cirad.fr/indexing.htm). The literature survey LePage did also shows that an increasing number of publications (35%) mentions the platform on which the research nis based. It is now having only a small 'market share' if based on citations in the literature, behind the US platforms NetLogo, RePast and SWARM. The strength of CORMAS is its use with stakeholders in what is being called *companion modeling* (see further on). Its weakness is that its use of the language Smalltalk and Visualworks means that a user has to learn object-oriented programming (Smalltalk) – which in turn has the advantage that the actual code is very readable for non-programmers.

LePage distinguishes three ways in which CORMAS (and other platforms) are / can be used:

- Abstract models (see e.g. Pepper and Smuts in Kohler and Gumermann 2000);
- Applied models (see e.g. Etienne et al. and further on)
- Action research (see e.g. d'Aquino 2003, Gurung 2006).

The CORMAS-team is especially interest in participant-participant interaction and uses three approaches:

- Role playing games;
- Companioin modeling: ComMod
- ABM model construction with CORMAS (workshops in montpellier in may and june 2010).

An important scheme for their work is the one connecting model development, stakeholder inputs (giving the model 'trust' and 'ownership' feeling) and the (generic) model.

The afternoon lecture was given by Michel Etienne, another key person in the CORMAS-team: ***Companion modeling (ComMod): a participatory modeling approach***. Etienne's talk was about the pioneering work the CORMAS group did over the past 10-15 years in developing and applying ABMs in combination with participatory methods, leading to their own brand of Companion Modelling **ComMod**. The basic principles are:
Collaboratively tackling a question
Co-construct a shared representation
Implement it in a computer model
Visualize dynamics and collaborative design scenarios
Website: www.cormas.fr. Booklet: Daré, Ducrot, Botta and Etienne (2009) Repères méthdologiques pour la mise en oeuvre d'une demarche de modélisation d'accompagnement). English book to be published. :
What do people learn during this process? Experiential learning – does it work? Five key learning:

1. Better understand system at stake: the dynamics and complexity of the socio-ecosystem
2. Learning knowledge and techniques: technical options to reach desired state
3. Learning about others: understand that people don't see the same things
4. Communicational learning: social learning in order to share knowledge etc. and for group decisionmaking, learn to defend interests
5. Organizational learning.

Examples:

a) integrated or shared water management (aGUaLOCA: Brazil). People start thinking in qualitative terms, call in experts etc.
b) water availability, migration and (shortage of) farm labour (Lam Dome Yaï, Laos). People effectively changed their behaviour regarding water use, crops etc.
c) participation in how to manage and develop multiple use regions e.g. wetlands (Vendres, France). Goal is to elicit stakeholder strategies, ask relevant questions and confront different point of view (Mathevet et al. 2008)
d) learning about negotiation mechanisms (TerAguas, Brazil) (Ducrot and Barban 2008). How to interact with stakeholders, better organize and articulate expectations, change way of interacting with people (more listening)
e) discussion of 4 groups of stakeholders about land management (Causse Méjan, France) (Etienne 2009). It was about better understanding SES, construct scenarios, setting a concerted management plan in groupsd of farmers, forest owners, National Park agents and conservationists.

Learning dynamics along the process: time is important in learning so many projects are followed through time e.g. Mae Salaep (Thailand). Getting aware of collective issues (learning by doing) step 1; identifying collaborative solutions (learning by negotationg) step 2; exploring scenarios (learning by visioning) step 3.

C-learning between scientists and stakeholders (Njoobaari, Senegal). You make model and use it in a process of sharing with stakeholders, in a social situation where the complexity of the reality can be discussed -> co-learning. How the scientists are in the process (arrogant, provocative etc.) is also important.

Confronting types of knowledge (Pays de Caux, France). Investigation of social network (scientific, technical and lay knowledge input) weaved during the ComMod process, in this region of intensive agriculture (Souchère et al. 2009).

Co-constructing a collaborative representation of a highly complex situation (Camargue, France) (Mathevet et al. submitted). Issue: from individual to collective mental models? One of the items is the knowledge gap between members and non-members of Water Board Commission.

Learning for action and social change: involve local academics, co-facilitate process, involve progressively the technical services of policy makers into the process. All worked out in projects, in Doi Tiew (Laos), Mae Salaep (Thailand) and Gard (France).

Do people change behaviour once back in reality? See William Dare (2001). Learning in reality mainly occurs in unpredictable situations that have to be discussed in the debriefing. Literature: Daré et al. 2008 (Laudun, French). Are people replacing one heuristic for a (more correct) other one?

Active learning: learning with students, not stakeholders. New service to train people at Agricultural Schools. Items:

- formalize a joint representation of a complex system
- immerse students in situated actions so that they can experience this complexity
- use the modeling of this complexity to imagine alternative management (scenarios).

There is extensive evaluation of what students have learned (Gril et Goutay 2010; Etienne et al. 2008). Are there already generic lessons/theories which can be put into [agro-economic] textbooks? Le Page's answer: hardly general theories but useful experiments in which one can evaluate the role of the context in the observed beliefs, behaviours etc.

There were also some morning presentations with specific applications of ABM. F Rebaudo presented *Teaching pest management through agent-based models in tropical socio-ecological systems: insights from the potato tuber moth in Ecuador.* The essence: teach the farmers the mechanisms and consequences of human-related long-distance dispersal (of disease) events. Why using ABM? One practical reason: it was found that young farmers become interested if you use computers and models (and copperate sometimes because the computer is goven: 'development brokers'). Another reason: introduce the heterogeneity among farmers.

Nicoals Brax presented *When predictive modeling meet participatory simulation: a feedback on potential and issues of a combined approach.* This research was done with Electricité de France and concerned the study of water management in the Midi-Pyrenées in France. It was meant to help resolve various interests among EdF (hydropower) and farmers (irrigation). They used the consumat approach (Jager et al 2000) and tried to combine modeling on the one hand (anticipatory, decision support) and participatory simulation on the other (perception, stakes, negotiation).

I missed a presentation on teaching complex systems in primary schools. Mathias Rouan and colleagues did a very interesting project: *Role-playing game and learning for young people about sustainable development stakes: an experiment in transferring and adapting interdisciplinary scientific knowledge*. This research project was meant to use role-playing games and CORMAS-based companion modeling to improve the understanding and management of the resources of an island before the coast of Bretagne (Groumelon et al. 2010). They made models, 3D-representations and other ways to engage stakeholders, and designed and applied a role-playing game together with local teachers and managers. The game takes one day, including a guided tour,

and supposedly fitted into school curricula. It uses a CORMAS interface and wireless connectkions, with a newly designed gameboard. Requirements for the game: robust, intuitive, simple. There have been 13 sessions with 230 students in march-april 2010. See www.menir.univ-brest.fr/projects.MEDIA for more info and download. It has not been investigated if the players actually show different behaviour afterwards.

Thomas Louail presented the AccesSim model: *Simulation of accessibility in urban setting and an experiment in teaching applications: the AccesSim model*. This is a teaching tool to communicate geographical core notions, such as accessibility, network relations, centrality and territorial inequalities. Louail give an interesting list of pros and cons of ABM:

PROs	CONs
Focus on entities and behaviour	More realistic → harder to control
Expressive, heuristic, anthropomorphic	GUIs simplicity hides internal complexity
More structure, less abstraction	Computation may dominate reasoning

AccesSim uses NetLogo to simulate pedestrians who wish services on a city transport network with shopkeepers and people as agents. People (=children) have one action: buy pain au chocolat (!). They can post their experience at a bakery on a blackboard, which serves as the neighbourhood memory spot. The taste of the pain au chocolat is not included.

In second instance the model has been developed into a game, with two roles: Mayor (positions bakeries and has access to indicators) and Baker (aspire to be most popular, compare with other bakers). A nice GUI has been made in NetLogo, with nice use of icons. Player strategies are either Blind red fish or Math's professor's son. Transmitted notions:

- spatial inequalities based on accessibility
- individual vs. collective interests
- choices, compromises, multi-criteria DSS
- role models: good identification of child-players with the two roles.

It is a simple model from a behavioural point of view but teaches some interesting notions. To be inspected at www.spatial-modelling.info/-education-module- .

Christope Sibertin-blnac gave the view of a professor in sociology at the institute for … (IRIT) in Toulouse: *The validity of simulation results in social sciences*. In the context of the sociology of organized action, Sibertin-blanc discussed the ways in which the object of interest is processed into model outcomes and implementations and discussed how validation might look like. He suggested that the theory of systems is the referential domain, with the object domain (re)constructed in an analytical way with 1. active entities 2. passive entities 3. transitions (from one to other state probability) 4. relationships (between active, passive events and relationships). He emphasized that a model is a simplification intended to produce some knowledge – it is not reality; and that in socisla sciences the interpretation of the results in terms of the social reality is essential.

Alex Smajgl (CSIRO Australia) presented set-up and experiences of an interesting project in Indonesia: *Agent-based learning process for decision makers in Indonesia*. This presentation was about an interesting project asked for by the Indonesian government about the *problem*: the government spends 25% on fuel subsidies, so these have to be reduced. The *question* was: how are the impacts of such a subsidy reduction on poverty [thresholds]? The team made two ABMs, one for East

Kalimantan and one for Java, trying to assess changes in livelihood. The constructed the model across three tiers of governance, in search of optimal combinations of policies. It was found that the beliefs about the relation fuel subsidy – poverty differed across the governance levels and was inconsistent:

Central gov't	Local gov't
Fuel subsidies benefit mainly the middle class, not the poor (source of belief: consultants)	Fuel subsidies help the poor (source of belief: local situation, less analytic and context specific)
Fuel price increases increase poverty	Idem
Fuel price reductions benefit the poor	Idem

One explanations is the urban context vs. the rural reality. The model outcomes gave sometimes contradictory results which could only be understood by deeper analysis e.g. fuel price ↓ use of local fish/forest ↑ poverty ↑. See cms.csiro.au/resources/Indonesian-Pathways-Resources.html .

An interesting aspect of this project is the explicit investigation of beliefs at different government levels and among agents. They show up somewhere along the line Vision – [sectoral] Goals – Actions/Strategies, with the last two connected by causal relations. The causality however is a perceived causality, in other words: a belief, or better: different and multiple beliefs. Question is: how to reveal beliefs? 3500 household interviews were organized, which led to 19 household typologies. Five 2-3 day workshops were organized to elicit beliefs, about how the system does/would respond to interventions. Most beliefs were very general. It is interesting to examine the relations with values/worldviews.

The models were made in RePast, with the local people using the principles 1. first train then conduct and 2. teach the teachers. The central gov't was interested in process and tool; the district heads wanted the tools but missed the skills. ABM was chosen – partly because in another (Danish-funded) project a system dynamics approach was used.

Finally, some key notions from the panel discussion:

- interaction between: teaching of students ↔ participation of stakeholders, with learning=engaging
- role of ABM in science: theory – experiments interactions
- further developments: online teaching and materials; creation of archive / library of models; grid-comuting…
- how to keep models up-to-date?