USD

Odense
11 August 2010

MAS Course 6

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SCHEDULE OF THE COURSE + EXAMINATION

MAS 01	04 Aug.	Introduction, Methodology, Agents
MAS 02	05 Aug.	Agents, Environments, Interactions
MAS 03	06 Aug.	Dynamics, Organisations, Example
MAS 04	09 Aug.	Development, Deployment, Example
MAS 05	10 Aug.	Stand alone MAS, Interaction with Users
MAS 06	11 Aug.	User-Centered MAS, Service to the User

attendance ; handouts ; individual work
[Ferber 95] [HERMES 01] [OFTA 04]

MAS Ex. 13 Aug. Written Control and Oral Delivery

User-Centered Multi-Agent Systems

ALAVs

M@trice Active Project (with U. Paris 1 - Lavaud)

VOWELS approach

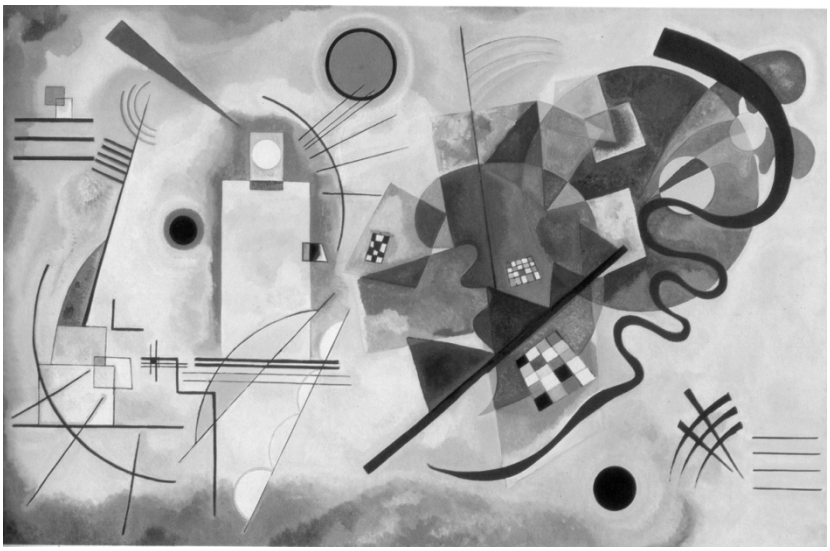
- Extension of PACO to a 3D world environment
- Elements as A, evolving in a 3D Environment
- I and O wrt Kandinsky's rules of painting

Applications

- Pedagogical : to explain and to explore Kandinsky
- Artistic : to support Kandinsky's like painting
- Creative : multi-user collaborative framework

Y. Gufflet & Y. Demazeau, "Applying the PACO paradigm to a 3-D artistic creation", 5th International Workshop on Agent-Based Simulation, ABS'04, pp. 121-126, SCS, Lisbon, Portugal, May 2004.

M@trice Active : the Kandinsky example



ZKM

CLIC

LEARNING

Motivations to Learning

Knowledge Acquisition
- to acquire new knowledge (from interactions)
- to acquire, synthesize, refine experiences

Knowledge Processing
- to update knowlegde and acquire new one
- to create new concepts from lower level ones

Local Performance
- to minimize interactions among agents
- to remember experiments for reuse

Global Performance
- to improve the system performance
- to get global centralization and homogeneity

Multi [Agent Learning]

A Learning to perceive and represent other agents

- Discovering skills, and possible roles through a dedicated introduction protocol [Demazeau 92]
- Learning by linear anticipation, to predict future states and guide low-level behaviour [Davidsson 97]
- Learning algorithms are actions which should be evaluated like other actions [Schmidhuber 97]
- ...

E Learning to re-act, to co-act in shared environments

- A multi-legged robot learning to walk using reinforcement learning [Demazeau 90]
- Using reinforcement learning to program a team of robots with a shared mission [Versino 97]
- Evolutionary mutation and selection mechanisms to find stable coordination strategies [Bazzan 97]
- ...

[Multi-Agent] Learning

I Learning to communicate, to inter-act

- Learning to converse by coconstructing the meaning of an exchanged messages [Pesty 97]
- Using common ontology for possible information exchange and learning framework [Friedrich 97]
- Learning to reduce communications amount by avoiding broadcasting when possible [Ohko 97]
- ...

Learning to share organizations, to organize

- Clustering techniques through interactions to form coalitions [Sichman 95]
- Supervised learning to discover social rules and conventions [Huhns 97]
- Better knowing skills, improving organisational knowledge, to optimize interactions [Terabe 97]
- ...

Impact of Multi Agent Learning

Learning in Multi-Agent Systems

- is either A-, E-, I-, or O- centered
- mainly deals with A-E, A-A, A-I, A-O, and... I-O
- permits global and local feedback
- ensures global and local goals

Multi [Agent Learning]

- privilegiates individual skills
- assumes homogeneous agents

[Multi Agent] Learning

- not always minimizes A-A interchanges
- does not protect individual skills

TRUST

Trust in MAS

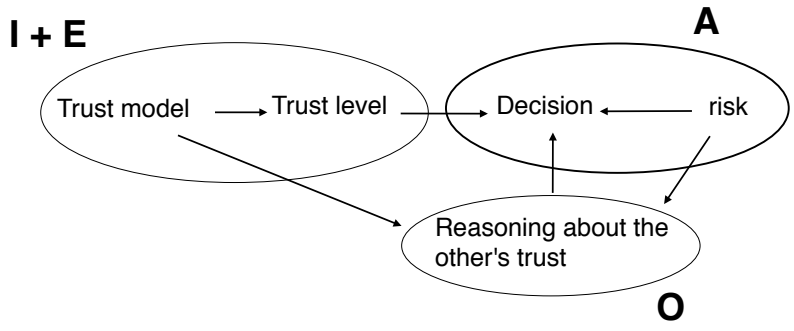
Expansion of the distributed systems such as electronic trade, services for citizens, or BtoB applications

- Act in an open, unpredictable, dynamic environment
- Need for guaranteeing security
- Need for providing the best services for other services and users

Trust: mechanism of social integration and mechanism of coordination

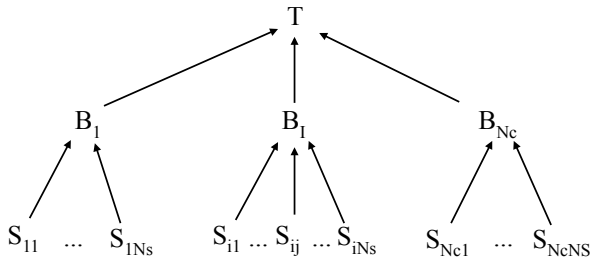
Trust model based on Falcone's approach

Trust is regarded as a mental state and consists of beliefs in the behaviour of the other, in connection with something in a precise field or context.



Bayesian trust network : first approach

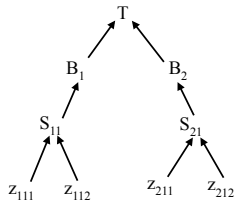
- Beliefs: ability, willingness, danger, opportunity…
- Each component is associated with a probability of satisfaction. The subjective certainty of the beliefs is derived from the credibility of their sources



- Computation by Bayesian inference: influences between the components are supported by conditional probabilities
- Dynamics using Kalman filtering

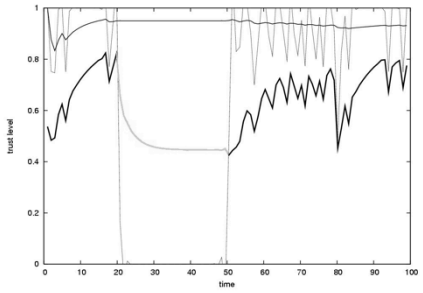
Dynamic trust model : first experiments

Simple instantiation of our model



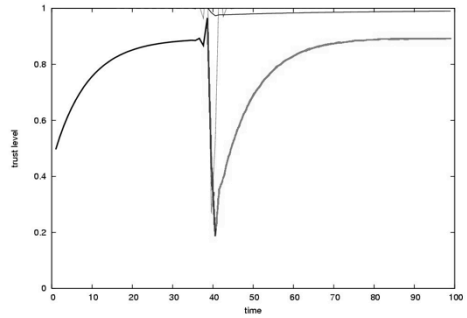
- Two beliefs and only one source
- Bernoulli distribution
- A priori distribution: uniform
- Common sense inertia: the decrease is faster than the increase
- No belief is privileged

Experiment : erosion of trust



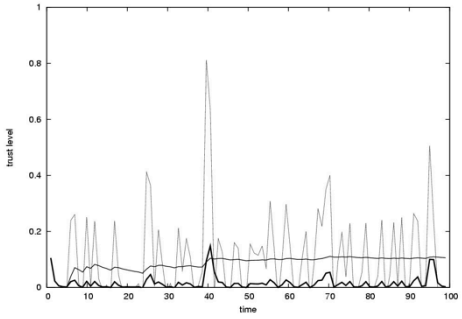
Erosion: in the absence of information, trust drifts towards a default value corresponding to an increase of the uncertainty

Experiment : impact of a negative observation



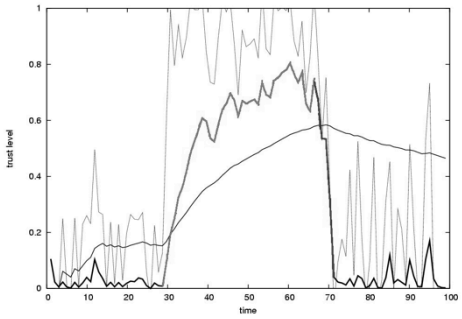
Only one negative observation corresponds to a contradiction perceived in regard to the previous positive observations

Experiment : impact of a positive observation



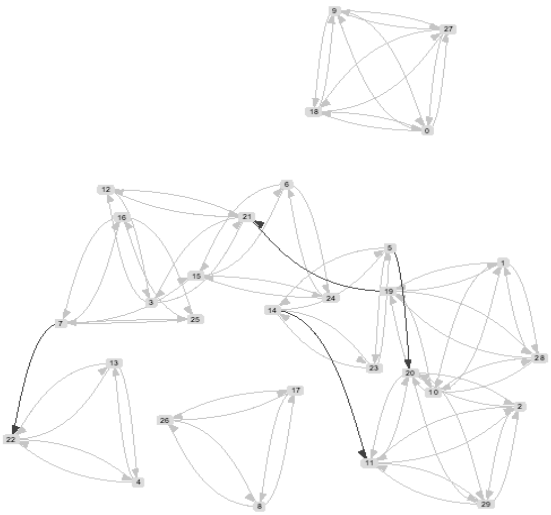
Only one positive observation has a weak impact on trust

Experiment : versatile behaviour

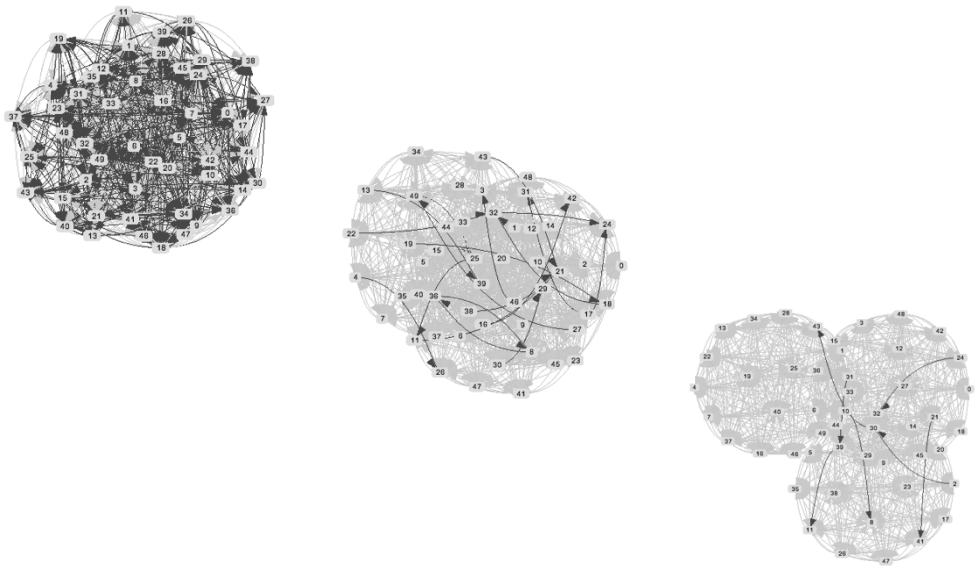


Inertia of trust and distrust: speed to swing to one to the other

The statics of trust networks



The dynamics of trust networks



CONCLUSION

How MAS Methodology is specific ?

= Approach + Model + Tools + Problem + Domain
= Analysis + Design + Development + Deployment

It provides a new analysis and design approach

It is supported by existing formalisms,

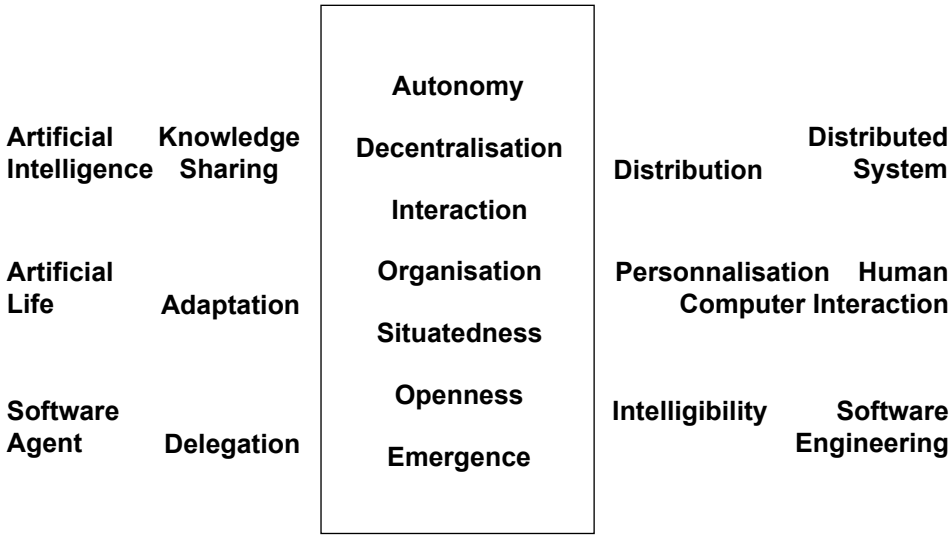
It integrates existing programming paradigms,

It is striving towards industrial quality,

It caters for distributed intelligence applications,

It will always imply difficulties in provability.

MAS Characteristics [OFTA 04]



Issues driving to the use of MAS

Availability of supporting technologies
- network Capacity 78%
- processor performance 48%
- software Language and Tool Power 11%

Inherent distribution
- physical
- organizational

System openess
- changing system structure
- uncertain environment

Competitive collaboration
- multiple knowledge domains
- multiple solution methods

Natural or social systems modelling

...

Issues refraining to the use of MAS

Social acceptability of MAS applications
- degree of delegation (trust by users)
- degree of autonomy (responsability of owners)

Important properties cannot be guaranteed
- deadlock avoidance
- convergent negotiation

Impossibility to prove system behaviour
- prediction of system behaviour
- validation of system behaviour

Transfer from research to industry
- first to market has greater impact than best technology
- theoretical / formal MAS research have little impact

...

The MAS Working Space

The AgentLink Network of Excellence

The European series of conferences
- 10 issues of the MAAMAW workshops from 89 until 01
- 6th CEEMAS in XXX in XXX 10
- 7th EUMAS workshop in Ayia Napa in December 09

The IFAAMAS Foundation & the FIPA IEEE Chapter

The International series of conferences
- ICMAS series of conferences (merged into AAMAS)
- 11th IAT in Toronto in September 10
- 8th PAAMS in Salamanca in April 10
- 9th AAMAS in Toronto in May 10

The AAMAS Journal and the MASA Collection

MAS Series of Events

- **IWDAI - International / American W. DAI (USA)**
- **MAAMAW - Western European W. MAS (Europe)**
- **MACC - MA and Concurrent Computing W. (Japan)**
- **JFSMA - DAIMAS W. (French Speaking Countries)**
- **ICMAS - Int. Conference on MAS (World)**
- **DIMAS - Decentralized Intelligent MAS W. (Poland)**
- **ADAIMAS - Australian DAIMAS W. (Australia)**
- **PDAI - Parrallel and DAI Conference (India)**
- **IAWDAIMAS - IberoAmerican W. (C. & S. America)**
- **DAIMAS - International / Russian W. (Russia)**
- **IWMAS - International / American W. (North-America)**
- **CEEMAS - Central & Eastern Europe MAS W (Europe)**
- **AAMAS - Int. Conference on AA&MAS (World)**
- **IAT - Int. Conference on Agent Technology (World)**
- **EUMAS - European Workshop on MAS (Europe)**
- **PAAMS - Practical Applications of Agents and MAS (World)**
- **PRIMA - Principles of Practice in MAS (World)**

Actes JFSMA

1. IRIT, Toulouse, 1993
2. LIFIA et TIMC, Grenoble, 1994
3. LIA, Chambéry, 1995
4. LIRMM, Montpellier, 1996
5. LI2S, Nice, 1997
6. LORIA, Nancy, 1998
7. IREMIA, St Gilles, 1999
8. EMSE, St Etienne, 2000
9. CRIM, Montréal, 2001
10. LIFL, Lille, 2002
11. ENSI, Hammamet, 2003
12. LIP6, Paris, 2004
13. LIL, Université du Littoral, Calais, 2005
14. LISTIC, Annecy, 2006
15. IRIT, Carcassonne, 2007
16. LISYC, Brest, 2008
17. LIESP, Lyon, 2009

MAAMAW Proceedings

1. Decentralized A.I.
   - ✓ Y. Demazeau, J.-P. Müller (eds), Elsevier N.-H., 1990
2. Decentralized A.I. 2
   - ✓ Y. Demazeau, J.-P. Müller (eds), Elsevier N.-H., 1991
3. Decentralized A.I. 3
   - ✓ E. Werner, Y. Demazeau (eds), Elsevier N.-H., 1992
4. Artificial Social Agents
   - ✓ C. Castelfranchi, E. Werner (eds), Springer V. LNAI 830, 1994
5. From Reaction to Cognition
   - ✓ J.-P. Müller, C. Castelfranchi (eds), Springer V. LNAI 957, 1995
6. Distributed Software Agents and Applications
   - ✓ J. Perram, J.-P. Müller (eds), Springer V. LNAI 1069, 1996
7. Agents Breaking Away
   - ✓ W. Van de Velde, J. Perram (eds), Springer V. LNAI 1038, 1996
8. Multi-Agent Rationality
   - ✓ M. Boman, W. van de Velde (eds), Springer V. LNAI 1237, 1997
9. Multi-Agent System Engineering
   - ✓ F. Garijo, M. Boman (eds), Springer V. LNAI 1647, 1999
10. Multi-Agent Organisations
    - ✓ Y. Demazeau, F. Garijo (eds), e-publication, CD-ROM, 2001

ICMAS and AAMAS Proceedings

1. ICMAS 95, San Francisco, USA
2. ICMAS 96, Kyoto, Japan
3. ICMAS 98, Paris, France
4. ICMAS 00 Boston, USA

5. AAMAS 02 Bologna, Italy
6. AAMAS 03 Melbourne, Australia
7. AAMAS 04 New York, USA
8. AAMAS 05 Utrecht, the Netherlands
9. AAMAS 06 Hakodate, Japan
10. AAMAS 07 Hawai, USA
11. AAMAS 08 Estoril, Portugal
12. AAMAS 09 Budapest, Hungary
13. AAMAS 10 Toronto, Canada

IAT & PAAMS Proceedings

1. IAT 99 Hong-Kong, China
2. IAT 01 Maebashi, Japan
3. IAT 03 Halifax, Canada
4. IAT 04 Beijing, China
5. IAT 05 Compiègne, France
6. IAT 06 Hong-Kong, China
7. IAT 07 Silicon Valley, California
8. IAT 08 Sydney, Australia
9. IAT 09 Milano, Italy
10. IAT 10 Toronto, Canada

11. PAAMS'09 Salamanca, Spain
12. PAAMS'10 Salamanca, Spain

Monographies and Compilations (1)

- Distributed Artificial Intelligence
  M. Huhns (ed), Pitman, 1987
- Readings in Distributed Artificial Intelligence
  Alan H. Bond & L. Gasser (eds), Morgan Kaufman, 1988
- Distributed Artificial Intelligence (Volume II)
  L. Gasser & M. Huhns (eds), Pitman, 1989
- Distributed Artificial Intelligence: Theory and Practice
  N. Avouris, L. Gasser (eds), Kluwer Academic Publishers, 1992
- Multiagent Systems
  M. Singh, Springer V, 1994
- Les systèmes multi-agents *(in french)*
  J. Ferber, InterEditions, 1995

Monographies and Compilations (2)

- Readings in Agents
  M. Huhns & M. Singh (eds), Morgan Kaufman, 1997
- Multi Agent Systems
  G. Weiss, MIT Press, 1999
- Principes et Architecture des SMA *(in french)*
  J.-P. Briot & Y. Demazeau, Hermès, 2001
- Systèmes Multi-Agents *(in french)*
  Y. Demazeau, OFTA n°29, Lavoisier, 2004
- Knowledge Engineering and Agent Technology
  J. Cuena, Y. Demazeau, A. Garcia, J. Treur, IOS, 2004
- Multiagent Systems
  Y. Shoham & K. Leyton-Brown, Cambridge, 2008

Journals

Artificial Intelligence	**Elsevier**
Artificial Intelligence in Medecine	**Elsevier**
Artificial Intelligence Research	**www**
Autonomous and Adaptive Systems	**ACM**
Autonomous Agents and Multi-Agent Systems	**Springer Verlag**
Autonomous Robots	**Springer Verlag**
Information Interaction Intelligence	**Cepadues**
Intelligence Artificielle	**Hermes**
Intelligent Systems and Applications	**IEEE**
Internet Computing	**IEEE**
Multiagent and Grid Systems	**IOS**
Pattern Recognition	**Elsevier**
Robotics and Autonomous Systems	**Elsevier**
Systems, Man, and Cybernetics	**IEEE**
Web Intelligence	**Springer Verlag**
...	

PROSPECTIVE

Evolution of Agents and Multi-Agent Systems

Robotics Agents	Artificial Intelligence
Mobile Agents	Telecommunications
Software Agents	Software Engineering
Interface Agents	HC Interfaces
Service Agents	Internet Computing
User Agents	Creative Computing
…	...

MAS assuming Closed Environments
MAS integrating Open Environments
MAS including Human Agents (CSCW, ITS)
MAS for the benefit of Human Agents
…

A VISION OF THE FUTURE (1st 98 – 2nd 01 – 3rd 04)

Fusion of Virtual Reality and Real Virtuality
Mutual acceptance and Social space
Interaction interfaces between Agents
Management of the Social space
From Productivity tools to Creativity tools
Towards real-time interactive Applications

Fusion of Virtual Reality and Real Virtuality

The physical world and the virtual world will merge

- Virtual agents will be increasingly present in the physical world... Animal-like and human-like robots, connected to the network, will interact with humans (and each other) in a physical way… Already toys exist that are based on this philosophy. Some work on humanoid robots also fits in quite well…
- Agentcities services will interact with the user, even if through some kind of "user agents" attached to the user…
- Interactive Game characters will interact with the User, should they represent the player or directly interact with…

Social rules have to be identified for such a world !

Mutual acceptance and Social space

Human and artificial agents will accept or at least tolerate each other

- Human agents will adapt quickly to artificial agents that play a peripheral, assisting role. If artificial agents obey certain rules, they might be taken for granted... Artificial agents have hard time understanding our world. The artificial agents will socially organise themselves…
- Agentcities services will support interests and preferences of the user, respecting privacy, generating trust…
- Interactive Game characters will better care about the User capabilities, respecting his/her skills, actively helping him/her to learn and progress, installing trust…

One might not care to deal with a real or an artificial agent (reversing the Turing test !)

Interaction interfaces between Agents

Which kind of interaction language, of representation will arise between such agents ?

- Representing other agents in terms of competences is the usual way… DAML-S, AUML, WSDL represent services… Between human and artificial agents, HCI try to reach the level of NL… Between artificial agents, Interactions are based on Speech Acts (ACL) … Using ontologies that share the same representation (DAML+OIL) …
- Agentcities services representation and languages will evolve in order to better interact wit the User…
- The interactions between the Interactive Games Characters and the User will be grounded on emotions...

Semantics and pragmatics should be worked out to satisfy both artificial and human agents !

Management of the Social space

Social space has to be organised and this is actually too much usually done in an ad hoc fashion

- Buildings not only provide shelter, but also organise physical space… To interact with somebody, one had to be physically close… Transportation technology serves to overcome the constraints of physical space... Until the Internet, people did not change their social space through technology… Using chat rooms, people can now make friends without physically meeting…
- Producers will have organize and dynamically combine Agentcities services to offer more complex services…
- Complex Interactive Game scenarios will be dynamically composed in a more User-driven way…

Most of the social space between artificial agents should be organized in a dynamic way !

From Productivity tool to Creativity tools

The new world has to move from a space of productivity tools to a space of creativity tools

- As barriers disappear,, the need for middlemen will gradually disappear… Using networks, the product (not the producer !) will easily find its way to the consumer…As production becomes smoother, the importance of creativity will increase… Creation of original content will be a main activity… Agents will want tools to assist in this process…
- Agentcities services will find their way to users… Users will build quick prototypes, using virtual agents…
- Games will find their way to the User, and will adapt to his/her wishes, offering tools to assist…

High-Level License Free Users-driven Products will help to move from productivity to creativity !

Towards real-time interactive Applications

There will be a new focus on highly interactive real-time applications

- Static information becomes no value… People want the information to be interactive, to follow them... Information will not only have to be original, it will have to be live and to adapt real time… Producers will have to return to the live production of their material... Virtual agents and Human agents will join in production / creation teams...
- Agentcities products product will adapt to the needs of the user in a real-time and interactive way…
- Interactive Game evolution will imply the active cooperation of the characters as well as the contribution of the User...

The support of an interactive real-time agent-like technology will enable new kind of applications !

User Centered Emergent Creativity [Demazeau 03]

Grand challenge

- User centred adaptive ICT systems, or
- From production tools to creation tools
- Emergent real-time ICT usage

Working hypothesis

- Users are either human or virtual agents

Research themes

- The process and the economy of creation
- Real-time user-centred exploitation of data
- User modelling, personalization, and trust
- Interaction, collaboration, organisation
- Emergence, composition of functionality
- The creator becoming the real designer
- A way to evaluate properly such systems

Industrial recommendations

MAS generates more and more revenue !

- New applications become viable
- MAS reduces risk of building the applications
- MAS encourages reusability

Widespread adoption of MAS requires

- MAS and not only Agents
- Methodology
- Industrial strength toolkits
- Standards and Norms

Deployment of lead applications requires

- The use of simple, well understood techniques
- The focus on application value, not technology
- An industrial partnership

Scientific recommendations

The problem lays in the relations between mental issues and coordination theories, between micro and macro issues.

- Mutual representations, including trust issues
- Coordination models, including full decentralization
- Organisations, including dynamic emergent ones
- Methodologies, including user-centered ones

Multi-agent systems will be in the near future what object oriented systems are today: a set of well defined techniques

- Multi-Agent Oriented Programming, not only Agents
- Testbeds and Benchmarks, not only Moke-ups
- Standards, not only delocalized efforts
- Available industrial platforms to be universally used

Research agenda : Service to the person

Both the purpose of the user and the one of the domain have to be taken in parallel…

Protecting personal data, managing multiple identity, towards cognitive trust (delegation) …

Reasoning under incertain and incomplete models such as partial BDI models… (social reasoning)

Static (personnalisation) and dynamic adaptation (real time) of service composition

Evaluating MAS systems from a CS point of view and from a usage point of view (evaluation)

Purposive MAS will also have to be able to deal with real-time and real-size issues…

MAGMA

MAGMA : Project 11-14 : Service to the person

MULTI AGENT SYSTEMS TO SERVE THE PERSON

Theme 1 : Affective Conversational Agents

Theme 2 : Coordinated Planning Agents

Theme 3 : Engineering Multi-Agent Systems

Theme 4 : Agent-Based Modelling and Simulation

ACA : Affective Conversational Agents

Speech acts as the central view

- From A-A interaction to A-U conversation
- Dialogism, 32 speech acts, Dynamics, Conversation
- Damasio theory linking decision making and emotion
- Investigating the language in parallel to the appearance

Works

- Pedagogical, rational, & affective, interactive agent PRAIA Project Application to pedagogical games and e-commerce (with LIMSI Sansonnet) (with UFRGS Jaques) (Pesty)
- Project ANR CECIL sur les Agents Conversationnels Animés. Language expressivity in an Emotional Conversational Agent (with IRIT Longin) (with INRIA Pelachaud) (Rivière)

CPA : Coordinated Planning Agents

Composition as the central view

- Composition is not coordination, the goal is not to coordinate existing individuals plans but to build a collaborative plan.
- The user as an additional constraint to be taken into account in order to help to solve the problem.
- Real-time constraints.

Works

- Interleaving assumption-based planning and goal-space planning (Fiorino)
- Interfaces plasticity. From functional kernels to human-computer interfaces (with IIHM Calvary) (Martin)
- Interfaces plasticity. From human-computer interfaces to functional kernels (with IIHM Calvary) (Gabillon)
- User constraints. Application to web services, in relation semantic web (with USavoie Huget) (Fiorino)

EMA : Engineering Multi-Agent Systems

VOWELS as the central view

- Evaluation as the cornerstone of UCMAS methodology…
- The user as a consumer, as a partner, as a creator…
- Engineering by dynamic composition of the vowels…

Works

- The VOWELS Framework. Adding the User (U). VOWELS Dynamics through AMAS (with IRIT Camps) (Demazeau)
- Personalisation and dynamics of agent networks (with IRIT Camps) (Lacomme)
- MAS characteristics modelling towards evaluation of performance. Application to the transporter-explorer application (with MESCAL Vincent) (Joumaa)
- CLIC : Support to artistic creation (with COIN-COIN Houot) (Lacomme)
- Citizen Agents Project (with EMSE, IRIT, LIFL) : personal assistants to assist the daylife of the citizen (Demazeau)
- Intellicare Project : Ambient Assisted Living (with MMMI Hallenborg) (Demazeau)

ABS : Agent-Based Modelling and Simulation

Cognition as the central view

- Focus on both modelling and simulation on social aspects
- The cognitive level, the work group level, the societal level
- Creativity support, intelligent house, crisis management

Works

- Crisis Management (with IRD Drogoul) (Dugdale)
- MAS support to individual human creativity (Dugdale)
- Intelligent houses (with G-SCOP Ploix) energy regulation (Pesty)
- Crisis management (with ENSI Tunis) (Dugdale)
- Modelling expectations (with U Pelotas) (Dugdale)
- Middle Age social networks (with IRIT Camps) (with IMT Jouve) (Lacomme)
- Personalized follow-up of a soldier (with TIMC Baconnier) (Amate)

MAGMA People in 09-10

Staff	**08**	**Y. Demazeau**	**CNRS**	**EMA, ABS**
	05	**J. Dugdale**	**UPMF**	**ABS**
	05	**H. Fiorino**	**UJF**	**CPA**
	02	**C. Garbay**	**CNRS**	**ABS, AMA**
	04	**S. Pesty**	**UPMF**	**ACA, ABS**
Post Doctoral	**06**	**L. Amate**	**UJF**	**ABS, AMA**
Collaborators	**01**	**S. Abras**	**G-Scop**	**ABS**
	01	**V. Camps**	**IRIT**	**EMA**
	01	**L. Crépin**	**LIRMM**	**EMA**
	01	**M.-P. Huget**	**LISTIC**	**EMA**
PhD students	**01**	**L. Crépin – 4**	**UJM**	**EMA**
	07	**H. Joumaa – 4**	**UJF**	**EMA, MESCAL**
	03	**Y. Gabillon – 3**	**INPG**	**IIHM, CPA**
	10	**L. Lacomme – 2**	**INPG**	**EMA**
	07	**C. Martin – 2**	**UJF**	**CPA, IIHM**
	10	**J. Riviere – 1**	**UPMF**	**ACA**
MSc students	**04**	**A. Kashif**	**UJF**	**ABS**
	04	**R. Lamarche**	**UJF**	**MESCAL, EMA**
	04	**B. Vettier**	**UJF**	**CPA**
	01	**M. Vezain**	**UPMF**	**ABS**

MMMI

MAS at MMMI

ON GOING

B. Norregard	**Negociation, explanation** **Plant growing**
K.Hallenborg	**Platform, Planning, Personalisation** **Intellicare**

PERSPECTIVES

U. Will	**Human modelling, Social networks** **Counter-terrorism**
U. Schultz	**Dynamics, Programming language** **Reconfigurable robotics**