ENSAO / MAS COURSE

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MAS Course 04

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DECENTRALIZED CALENDARS

DECENTRALIZED CALENDARS [Demazeau 06]

An internal project, to support every day's life of every citizen.

VOWELS approach

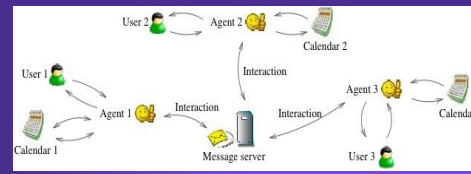
- One personal assistant per life domain, being the A
- Environment E : Temporal environment mainly
- Interactions I : Sharing, Trusting, Negotiating
- Groups O : Family, Team, Consortium
- User U: Importance and urgency are subjective

Y. Demazeau, D. Melaye, M.-H. Verrons, "A Decentralized Calendar System Featuring Sharing, Trusting and Negotiating ", 19th IEA/AIE'06, Annecy, 2006.

DECENTRALIZED CALENDARS

Decentralized Calendars

- Negotiating meetings and sharing events
- Importance and urgency as subjective features
- Local storage of the calendars and partial mutual knowledge



Approach

- Individual interactions : Sharing, Trusting, Negotiating
  - Full sharing: CSP-like solution
  - Partial sharing: introduction of trust
  - No sharing: negotiation is necessary!
- Broadcasting to groups : Family, Team, Consortium

Sharing Timetables

When timetables are shared, the meetings can be scheduled by well-known CSP techniques...

Groups

- Social organization of the agents
- Groups are structured in a hierarchy with subsumption relation

Sharing and groups

- An event can be public or private or...
- ...shared by several agents, but not all of them
- Sharing information or not according to the groups the agent belongs to
- If an agent belongs to several groups, its sharing capability is the logical combination of the sharing capability of its groups

Importance and Urgency

Addition of an event

- Importance and urgency: two common dimensions of time handling, used by all agents,
- Each agent has a subjective vision of the combined priorities. Usually:

	High urgency	Low urgency
High importance	I	II
Low importance	III	IV

Checking consistency

- A higher priority task cannot be scheduled after a less priority one
- This is the responsibility of the user! The system only checks the constraint

Trust in Agents

Why trust?

- Trust is a central mechanism of coordination in situation of ignorance
- Trust can compensate the absence of information due to absence of sharing
- Individual trust supports dynamics

Sharing with trust

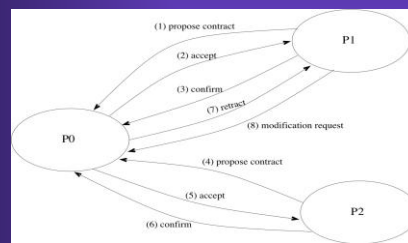
- A trust model calculates a trust capability in an agent permitting the sharing with this agent
- The trust model is based on several sources of trust (reputation, experiences, categorization, etc.)
- Which sources of trust to choose? It depends to the context, all sources are not necessarily at disposal

Negotiating a meeting (1)

In absence of sharing, negotiation is necessary

Negotiation level

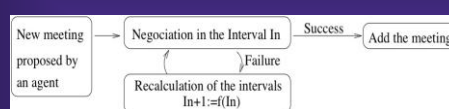
- Several rounds of negotiation
- Proposition, counter-proposition, confirmation and retraction of meetings



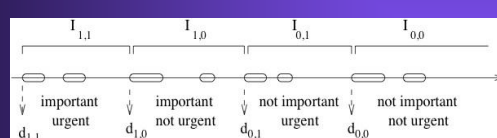
Negotiating a meeting (2)

Strategic level

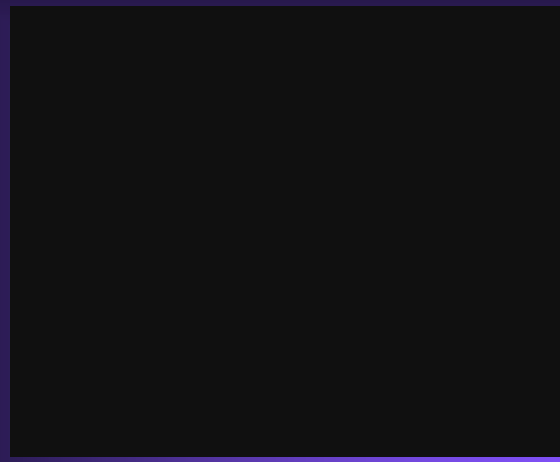
- Negotiation a meeting inside a time interval of possible solutions



- These intervals are built from the tasks and according to the different importance/urgency priorities



DECENTRALIZED CALENDARS



CITIZEN AGENTS

CITIZEN AGENTS

To support every day's life of every citizen

VOWELS approach

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- Environment E : Temporal environment mainly
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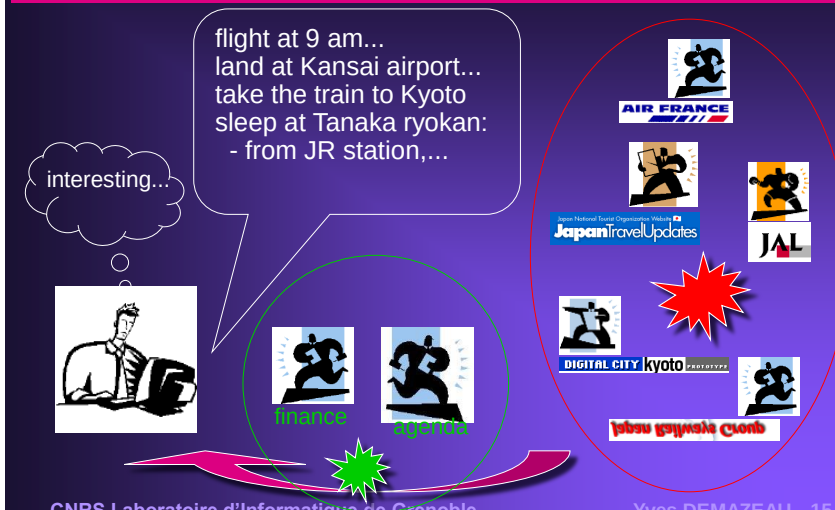
Applications

- Leisure : citizen as a consumer
- Finance : citizen as a partner
- Administration : citizen as a provider

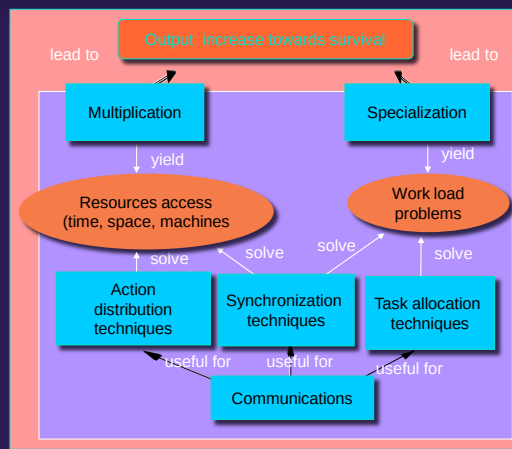
CITIZEN AGENTS Towards Complex Requests

CITIZEN AGENTS Towards Global Answers



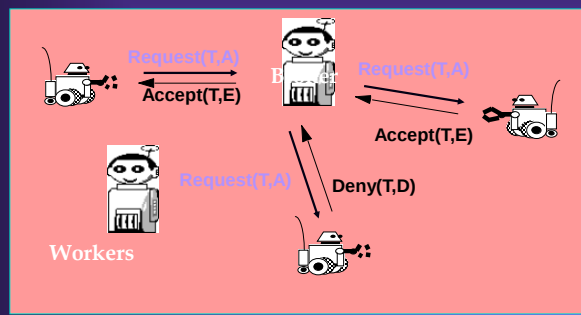
COGNITIVE COORDINATION

Systems of coordination

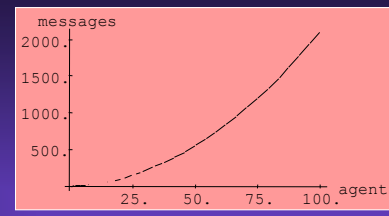


TA Centralized allocation

Use of a broker to centralize requests and offers



TA Centralized allocation



Advantages

- Simple to realize
- System coherence
  (the broker knows every agent)
- More or less easy to add or suppress agents (check in, check out protocol)

Drawbacks

- Sensitive to broker failure
- Bottleneck for messages (in $O(N^2)$)
- Useless for very large networks (use many brokers)

TA Acquaintance networks

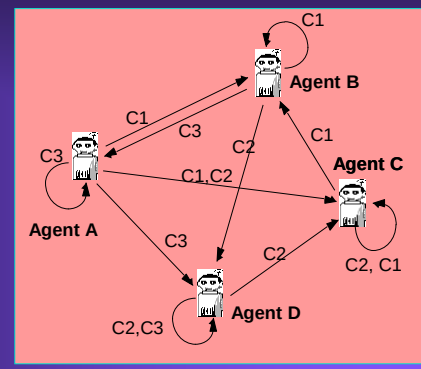
Each agent "knows" the skills of a set of agents

Direct allocation

- An agent request a service to agents it directly knows

Indirect allocation

- Speech acts are propagated through the network
- Uses algorithms adapted from distributed operating systems classics



TA Acquaintance networks

Advantages

- Not sensitive to failures or shut down of agents
- Good performances due to parallelism
- Can introduce learning methods to increase performances

Drawbacks

- Problem of reorganization of acquaintance network when an agent is suppressed (see the problem of management of URL links in the WWW)
- More difficult to implement (due to parallelism)
- Subject to incoherencies

TA Contract Net [Smith 80]

The most widely known algorithm in DAI

Uses the protocol of state markets and two types of agents (two roles)

- Managers and Bidders

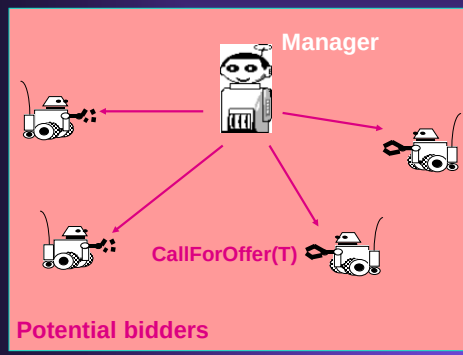
It is realized in 4 steps : Call for offer, Offers (bids), Awarding contract, Contracting and work

Problems with the Contract Net

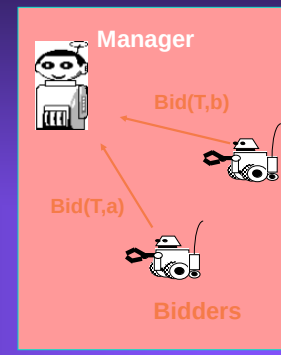
- Subcontractors and commitment
- Deadlines
- Multiple managers and optimality

TA Contract Net : Call for Offer & Offers

Call for offer

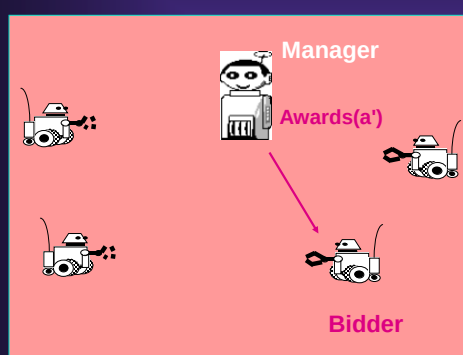


Offers (bids)

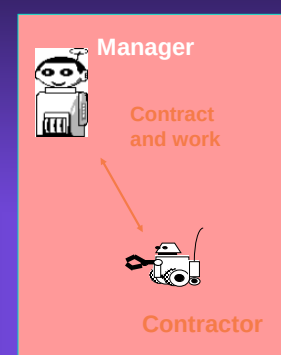


TA Contract Net : Awarding contract & Contract

Awarding contract

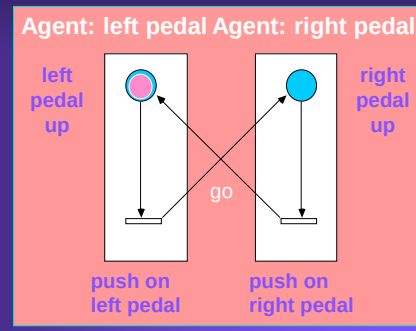


Contracting and work



SYNCHRONIZATION The Cyclist example

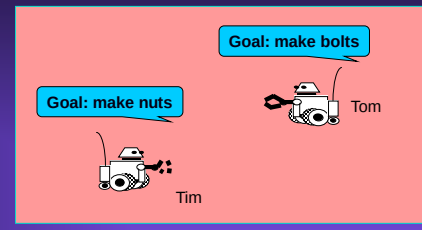
The cyclist example



SYNCHRONIZATION The resource access example

behavior Tim
- go to the machine
- places metal in machine
- makes a nut
- carry nut to stock

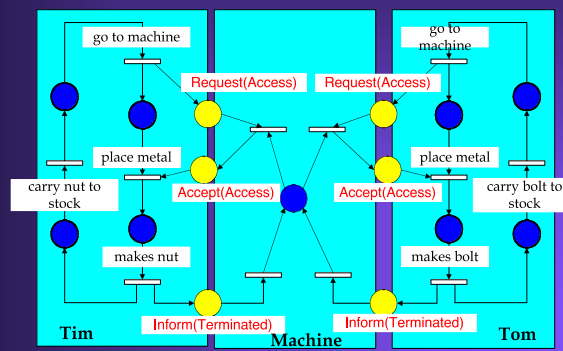
behavior Tom
- go to the machine
- places metal in machine
- makes a bolt
- carry bolt to stock



Pb: conflict between Tim and Tom to access the machine

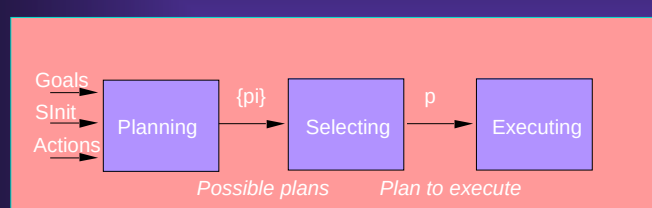
SYNCHRONIZATION The resource access example

Consider the machine as an agent (at least as a process) which gives access to one agent at one time



AD Multi-Agent Planning [Grosz 96]

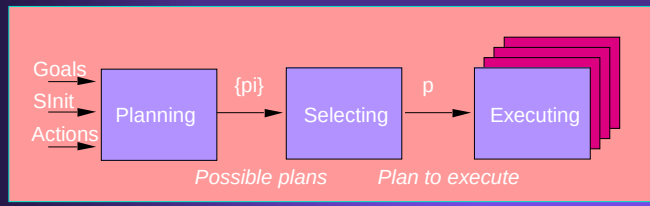
Find a sequence of operators Oi such that Sfin = On(... O2(O1(Sinit)) ...). Each operator is seen as a transition in a state space. The solution is obtained by finding a path from initial state to final state.



Centralized planning for multiple agents
Centralized coordination for partial plans
Distributed coordination for partial plans

AD Centralized planning

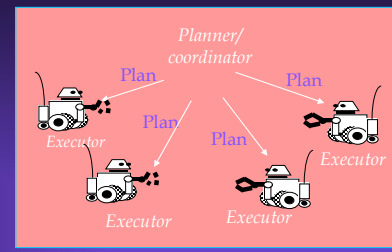
A central system which both plans and distribute plans among agents. Agents are just executors.

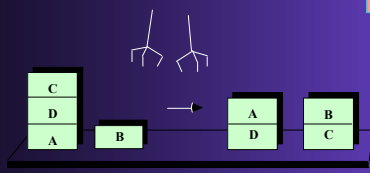


Coordination

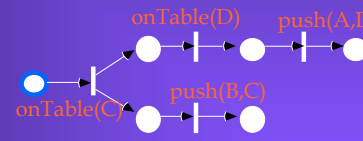
AD Centralized planning

Planning for multiple agents
=
planning
+
coordination





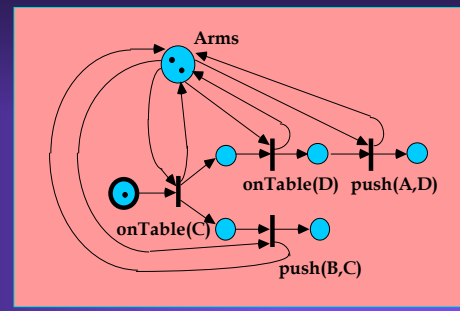
The problem



The plan

AD Centralized planning

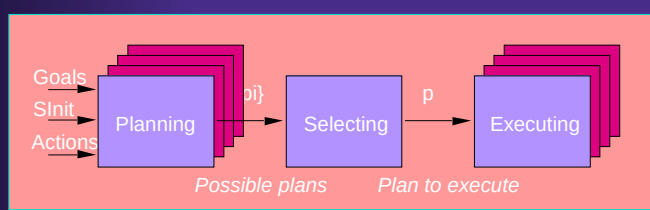
Coordination
=
resource allocation
+
synchronization



Each arm is considered as a resource and is represented as a token in the Petri net

AD Centralized coordination

The planning process is distributed but coordination of partial plan is centralized. The preferred approach.

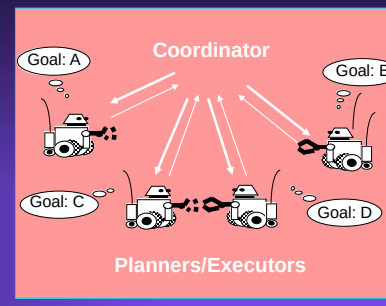


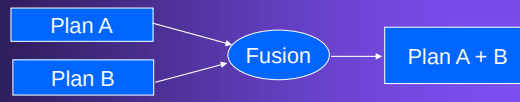
AD Centralized coordination

Fusion of partial plans

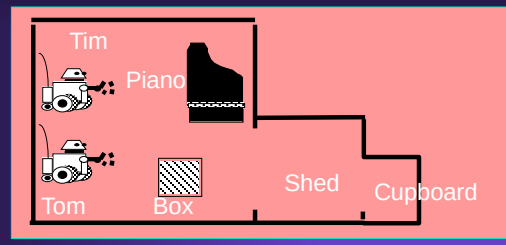
Partial plan

Coordinated plan





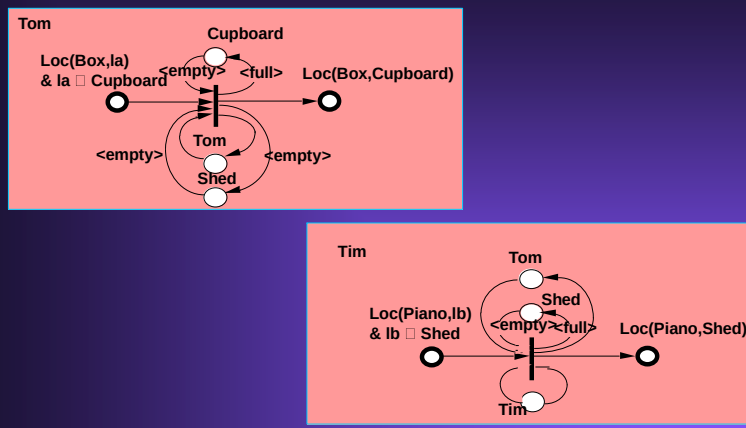
AD Centralized Coordination



Operator: movePiano
nbAgents: 2
pre: Loc(Piano, la), Empty(Shed)
del: Loc(Piano, la), Empty(Shed)
add: Loc(Piano, Shed), Full(Shed)

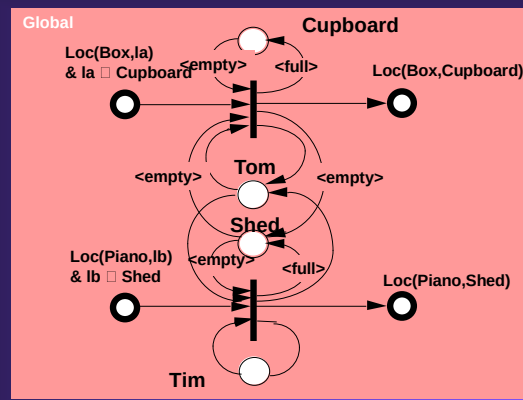
Operator: moveBox
nbAgents: 1
pre: Loc(Box, lb), Empty(Shed), Empty(Cupboard)
del: Loc(Box, lb), Empty(Cupboard)
add: Loc(Box, Cupboard), Full(Cupboard)

AD Centralized Coordination



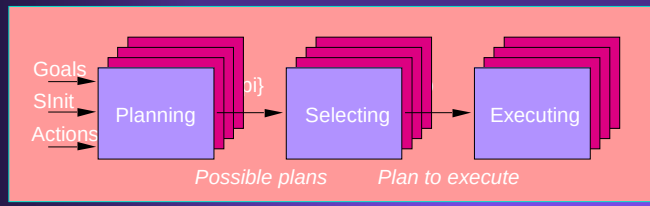
Principle: stick plans together by unifiying places

AD Centralized Coordination



AD Distributed Coordination

The planning process is distributed but coordination of partial plan is centralized. The most difficult.



Partial Global Planning as the main result so far. Assumption-based planning algorithms since then.

AD Distributed coordination [Durfee 91]

Each agent produces a partial plan. Existence of possible conflicts between the different plans (more difficult situation, non exhaustively solved by now)

Possible solutions

- **One agent receives all the partial plans** (centralizing, merging, synchronizing partial plans)
- **Every agent sends its partial plans to everybody** (each agent analyses the potential conflicts and identifies the conflicts with its own plans)
- **The partial plans are executed. As soon as some conflict occurs during the execution, it is identified and handled** (which means that dynamic re-planning and execution is possible) (example PGP : Partial Global Planning)

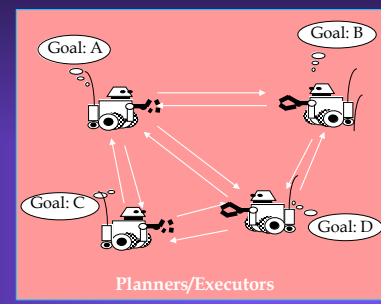
AD Distributed coordination

Two questions:

- Find the other agents with whom one should coordinate its plan
- When does it have to be coordinated

Problems

- Detect conflict and synergies
- Convergence of plans
  See for instance: PGP (Lesser, Durfee, Decker,..)



AD Assumption-Based Planning

Agents interact collaboratively in the dialog in order to co-construct a plan without assumption

Agents have a dialogue based on speech acts

Agents can refine, refute, repair a conjecture. The plan is produced and revised through conjecture / refutation cycles

As in argumentation, the current plan is acceptable when the conjecture / refutation cycles end and no more objection remains

AD Assumption-Based Planning [Pellier 05]

Ideas

- Planning expressed as a problem where agents exchange proposals and counter-proposals
- Agents are able to formulate plan steps on hypothetical states of the world (conjectures)

Advantages

- The approach merges the three steps : collaborative plan generation, composition, coordination
- The uncertainty as taken into account in the agents reasoning allows the agents to make conjectures and to compose their heterogeneous competences

An agent can

- Elaborate plans under partial knowledge
- Produce plans that partially contradicts its knowledge

NEGOTIATION [Davis 83]

Conflict Resolution

Agents pursuing similar or different goals will have to face conflicts : • resource accessibility • alternative solutions • conflicting interests or goals

Example of conflict resolution techniques :

- **A priori solution** using strength, authority, ...

Conflict Resolution

Agents pursuing similar or different goals will have to face conflicts : • resource accessibility • alternative solutions • conflicting interests or goals

Example of conflict resolution techniques :

- **A priori solution** using strength, authority, ...
- **Mediation** by a third agent which knows about the different points of view, and tries to solve the conflict

Example of mediation on the net [Koning 95]

J.-L. Koning, M. Occello, N. Ferrand, Y. Demazeau, F. Van Aeken & Ch. Baeijs, "A Multi-Agent Approach for Mediation Support on the Net", 1st Int. Workshop on Decentralized Intelligent and MAS, DIMAS'95, pp. 251-258, Krakow, 1995.

Conflict Resolution

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Example of conflict resolution techniques :

- **A priori solution** using strength, authority, ...
- **Mediation** by a third agent which knows about the different points of view, and tries to solve the conflict
- **Negotiation** agents in conflict enter a transactional phase (exchanges, compromises, persuasive arguments, disagreement with the compromise or argument, requests for additional information, reasons for disagreement, utilities / preferences for the disagreed-upon issues) in order to reach an agreement, i.e. an equilibrium state

Negotiation Structure

Negotiation structure

- **step 1 :** A propose a solution
- **step 2 :** B evaluates the solution, determines its satisfaction
- **step 3 :** If B is satisfied, ok, otherwise B propose another solution with regards to its own goals and constraints
- **step 4 :** goto step 1 exchanging A and B roles

Negotiation control

Negotiation structure

- **step 1 :** A propose a solution
- **step 2 :** B evaluates the solution, determines its satisfaction
- **step 3 :** If B is satisfied, ok, otherwise B propose another solution with regards to its own goals and constraints
- **step 4 :** goto step 1 exchanging A and B roles

Negotiation control

- **Consensus** (zero cost as summary) **:** the solution is found without additional cost for either of one or the other agent
- **Compromise :** (negative utility as summary) each party relaxes its weakest constraints. The solution is found as soon as every constraint is satisfied
- **Integration :** (positive utility as summary) each part tries to induce the deep goals of the others and then tries to find a solution which will satisfy these deep goals, even not the fully surface solutions

Conflict resolution

Agents pursuing similar or different goals will have to face conflicts : • resource accessibility • alternative solutions • conflicting interests or goals

Example of conflict resolution techniques :

- **A priori solution** using strength, authority, ...
- **Mediation** by a third agent which knows about the different points of view, and tries to solve the conflict
- **Negotiation** agents enter a transactional phase in order to reach an agreement, i.e. an equilibrium state
- **Flip a coin**

Conflict resolution

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- **Flip a coin**

TRUST

Trust in MAS

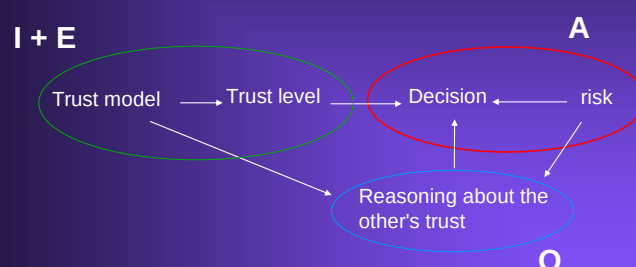
Expansion of the distributed systems such as electronic trade, services for citizens, or BtoB applications

- 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

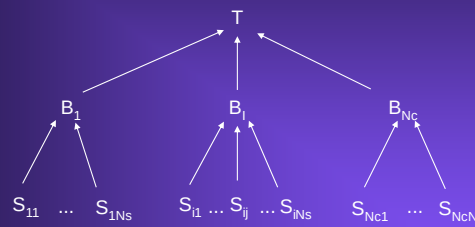
Trust model based [Melaye 05]

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

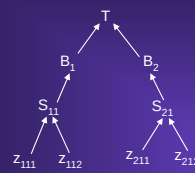
- Beliefs: ability, willingness, danger, opportunity…
- Each component is associated with a probability of satisfaction. The subjective certainty of the beliefs is derived from the credibility of their sources



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

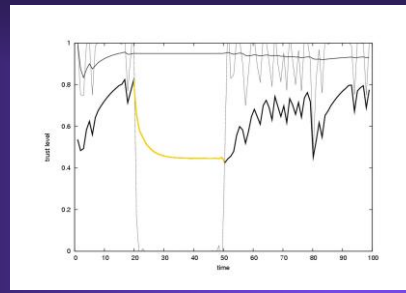
Dynamic trust model : first experiments

Simple instantiation of our model



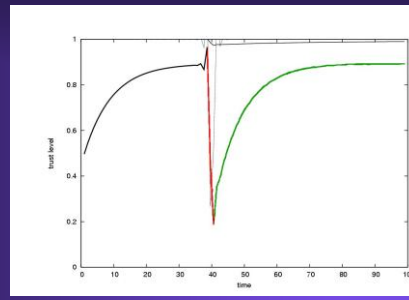
- Two beliefs and only one source
- Bernoulli distribution
- A priori distribution: uniform
- Common sense inertia: the decrease is faster than the increase
- No belief is privileged

Experiment : erosion of trust



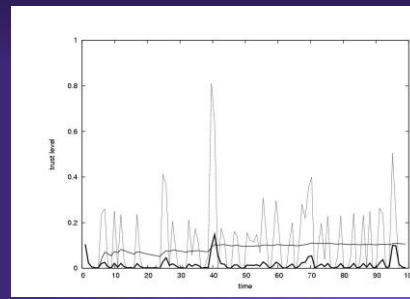
Erosion: in the absence of information, trust drifts towards a default value corresponding to an increase of the uncertainty

Experiment : impact of a negative observation



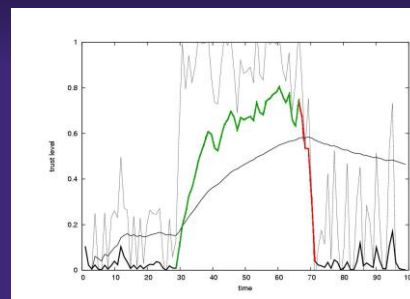
Only one negative observation corresponds to a contradiction perceived in regard to the previous positive observations

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

ORGANISATIONS

History (1)

-> 1992 : Introducing the concept

- 77 : Distributed Interpretation - Hearsay-II [Lesser 80]
- 80 : Contract Net [Smith 80]
- 83 : Organizational Self-Design - DVMT [Corkill 83]
- 87 : Organizational Structures [Pattison 87]
- 89 : Organization Knowledge - MACE [Gasser 89]
- 90 : Roles and Social Structure [Werner 89]

1990 -> 2000 : Settling the concept

- 92 : Organizations and Coordination [Bouron 92]
- 92 : Social Laws [Shoham 92]
- 93 : ASIC [Boissier 93][Ricordel 99]
- 93 : Conventions [Jennings 93]
- 94 : Dependence Networks [Sichman 94]
- 95 : AEIO [Demazeau 95]

History (2)

1990 -> 2000 : Setting the concept

- 96 : PopOrgs [Demazeau 96][Costa 96]
- 96 : Norms [Dignum 96] [Conte 99]
- 96 : Learning [Prasad 96] [Camps 98]
- 98 : Agents, Groups, Roles [Gutknecht 98]
- 98 : Roles [Kendall 98] [Stone 98]
- 99 : Dynamics [Baeijs 98] [Van Aeken 99] [Kozlak 00]

1998 -> : Exploiting the concept

- 98 : Organization Oriented Programming [Lemaitre 98]
- 98 : MADKIT platform (AGR) [Gutknecht 98]
- 99 : Institutions [Sergot 99] [Esteva 01]
- 01 : VOLCANO platform (AEIO) [Ricordel 01]
- 01 : MESSAGE methodology [Garijo 01]
- 01 : VOWELS [Demazeau 01]

Definitions (1)

An arrangement of relationships between components, which results into an entity, a system, that has unknown skills at the level of the individuals [Morin 77] : emergence

An organization is characterized by : a division of tasks, a distribution of roles, authority systems, communication systems, contribution-retribution systems [Bernoux 85] : norms

A decision and communication schema which is applied to a set of actors that together fulfil a set of tasks in order to satisfy goals while guarantying a global coherent state [Malone 87] : design

Definitions (2)

Tools to solve complex problems in order to overcome the individual limitations (cognitive, physical, temporal, institutional, …) [Gasser 01] : problem solving

Models and tools to define a social order and to guarantee a social control [Castefranchi 01] : socio psychology

Organizations (O) as a ground brick of MAS just like the Agents (A), the Environment (E), and the Interactions (I), Organizations (O) as elements for structuring sets of entities within the MAS [Demazeau 95 97 02] : computer engineering

Types and Classes [Baeijs 96]

Types

- **Teams** : shared environment in which agents interact
- **Communities of practice** : formation of groups independently of predefined schemas
- **SIGs** : gathering of agents sharing some interest
- **Markets** : common value sharing
- **Groups** : goal sharing, heterarchical decision
- **Hierarchies** : system sharing, hierarchical decision

Types and Classes [Baeijs 96]

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Classes

- **Centralized** : simple hierarchies, multi-level hierarchies, recursive structures, …
- **Decentralized** : multiple hierarchies, Markets, Markets, …
- **Unstructured** : groups, teams, SIGs, communities of practice, …

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Inspiration sources (1) [Demazeau 02]

Mathematics

- [Corkill 83], [Bouron 92], [Boissier 93], [Ricordel 99]
- Orders, to improve convergence issues.
- O as predefined authorities or shared social laws, that translate the controller-controlled relationships between possible pairs of agents.
- O are implemented as explicit rules, usually external.

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Economics

- [Carley 99], [Kozlak 00]
- Markets, to educate users and to preserve resources.
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Inspiration sources (2) [Demazeau 02]

Mechanics

- [Baeijs 98]
- Forces, to extract solutions of unsolved problems.
- O as global structures to emerge from local interactions between agents of different classes, locally organized as groups sharing common features of interest.
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- [Sichman 94], [Hannoun 99]
- Graphs, to compute the Human and Social Sciences models
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Inspiration sources (3) [Demazeau 02]

Sociology

- [Costa 96], [Demazeau 96]
- Relationships, to maintain functional integrity of systems.
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Thermodynamics

- [Van Aeken 99]
- MAS in WWW, to dynamically structure it, to optimize its social organization.
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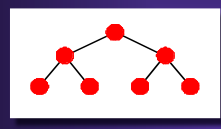
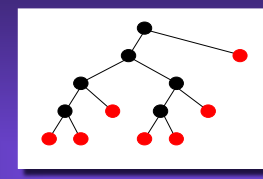
Minimal Multi-Agent Systems (1) [Van Aeken 98]

Atomic agents and more complex agents

$\Lambda = \{ S \mid S = \Delta \text{ or } S = (G\ D) = (D\ G) \text{ with } G, D \in \Lambda \}$





Agents behavior

- « qui se ressemble, s'assemble »

MAS behavior

- Size of a closed SMAM is constant over time
- Equilibrium of a closed SMAM is maximizing over time
- Entropy of a closed SMAM is maximizing over time

Minimal Multi-Agent Systems (2) [Van Aeken 98]

Measuring SMAMs : Size, EQuilibrium, Entropy

$$EQ(S) = \frac{E(S)}{\log_2(TR(S))}$$

$$EQ(\mathrm{D}) = 1$$

$$E(S) = \sum \frac{N(A)}{2^{N(A)}}$$

Francis Van Aeken & Yves Demazeau, "Minimal Multi-Agent Systems" (poster), 3rd International Conference on Multi-Agent Systems, ICMAS'98, IEEE, pp. 471-472, Paris, July 1998.

FRIENDS (industrial project)

A joint project between INPG and France Telecom

Vowels Approach

- Agents and Organizations as basic design bricks
- Dynamics principle : « qui se ressemble, s'assemble »
- Size of a closed SMAM is constant over time
- Equilibrium of a closed SMAM is maximizing over time
- Entropy of a closed SMAM is maximizing over time

Applications

- Augmented SMAMs vs. pure SMAMs
  - introduction of symbols
  - Adding attributes
- Friends
  - Off-Line (users and keywords)
  - On-Line (communityware, testing at ICMAS 98)
  - Numbercruncher (clustering, France Telecom QuiQuoiOù)

FRIENDS (industrial project) / Numbercruncher

QuiQuoiOù Data (France Telecom)

- 4997 services
- 146674 keywords, 16384 being different
- 70337 seconds (19.5 hours)
- 128 identified groups at level 7, and 18 at level 6

Identified Groups at level 6

RELIGION	LINGUISTIQUE	SPORT	POLITIQUE
ALIMENTATION	ZOOLOGIE	LITTERATURE	MUSIQUE
COMMERCE	MEDIA	DROIT	MEDECINE
ART	TRANSPORTS	EDUCATION	TELECOM
INFORMATIQUE	GEOGRAPHIE		

Example of the GEOGRAPHIE subgroups

CANADA	FRANCE	BELGIQUE	AGRICULTURE
TRANSPORTS	...		

Self-organisation

Firstly mentioned in the domain of physics

Definition : Changes to the internal order or organisation of a system without guidance or management from an outside source

Examples : Natural section (characteristics that support survival become more common in the species), evolutionary computation, brain plasticity, neural networks, flocking behaviour

Often confused with emergence, but…

- there are instances of self-organisation without emergence
- there are instances of emergence without self-organisation

PopOrgs (1) : Populations [Demazeau 96]

The Population structure is the set of agents, the set of possible behaviors of the agents, and the set of all interaction processes between agents

Pop = (Ag, Bh, Ip; bc, ic)

- Ag set of **Agents**
- Bh set of **Behaviors** agents are able to perform
- Ip set of interaction processes
- bc Ag ---> P(Bh), **behavioral capability**
  bc(a), set of behaviors a is able to perform
- ic Ag x Ag ---> P(Ip), **interaction capability**
  ic(a1,a2), set of interaction processes agents a1 and a2 may perform together

PopOrgs (2) : Organisations

The Organization structure is composed of organizational roles and organizational links

Org = (Ro; Li)

Ro is defined in a relational way

- e.g. Ro $\subseteq$ Lp x Gp : global processes (Gp) and local processes (Lp), the role is the part of agent's behavior that is integrated in the global process.
- e.g. Ro $\subseteq$ Fo x Lv : foci of interest (Fo), representation levels (Lv), the role is the agent's behavior for a given focus at a given level.

Li $\subseteq$ Ro x Ro

PopOrgs (3) : Pop $\Re$ Org

The suitable relation between the Pop and the Org is the system's organization implementation

It is any relation imp = Pop $\Re$ Org, on (Ro x Ag) $\cup$ (Li x Ip), Pop = (Ag, Bh, Ip; bc, ic), Org = (Ro; Li).

- if (r,a) $\in$ imp, r is said to implemented by a
- if (l,p) $\in$ imp, l is said to implemented by p

imp is said "proper" iff $\Re$ is an homomorphism.

- $\forall$ r $\in$ Ro, $\exists$ a $\in$ Ag / (r,a) $\in$ imp, and r is properly implemented by some behavior b $\in$ bc(a)
- $\forall$ l = (l1,l2) $\in$ Li, $\exists$ ip $\in$ Ip / { (l,ip) $\in$ imp $\wedge$ $\exists$ (a1,a2) $\in$ Ag x Ag / ip $\in$ ic(a1,a2), (r1,a1) $\in$ imp, (r2,a2) $\in$ imp, and r1, r2 are properly implemented by the behaviors of a1 and a2, respectively }

PopOrgs (4) : Pop $\Re$ Org [Demazeau 96]

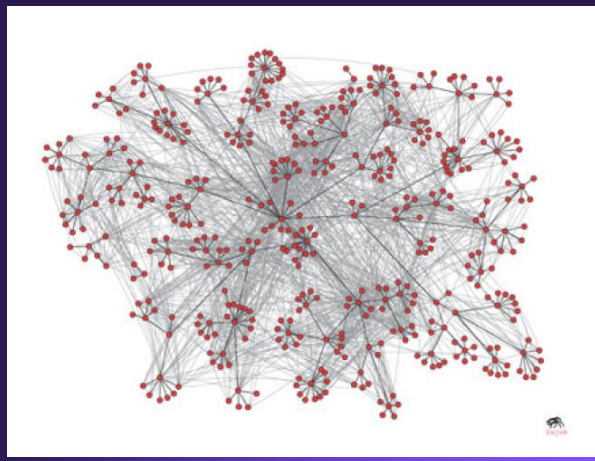
The Interior (= Population + Organization) of a time-invariant multi-agent system is captured by a population-organization structure PopOrg = (Pop, Org; imp), where

- Pop = (Ag, Bh, Ip; bc, ic) is a population structure
- Org = (Ro; Li) is a organization structure
- imp $\subseteq$ (Ro x Ag) $\cup$ (Li x Ip) is an organization implementation relation as defined previously

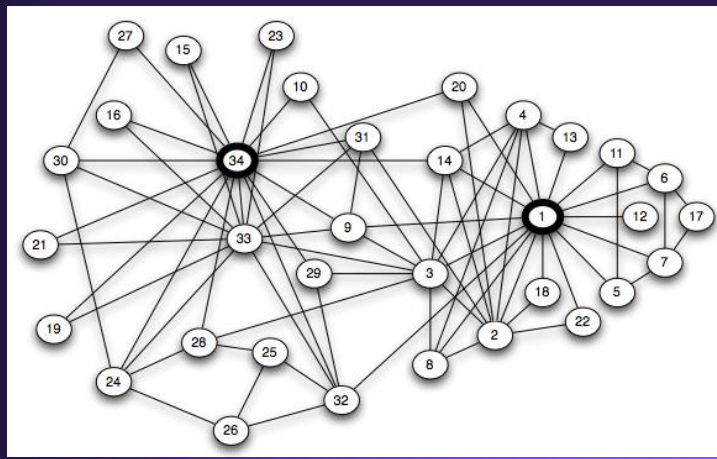
Y. Demazeau & A. Rocha Costa, "Populations and Organizations in Open MAS", 1st Nat. Symposium on Parallel and Distributed AI, PDAI'96, Hyderabad, 1996.

NETWORKS

Employees Network at HP Labs [Easley 09]



Friendship Network at the Karate Club [Easley 09]



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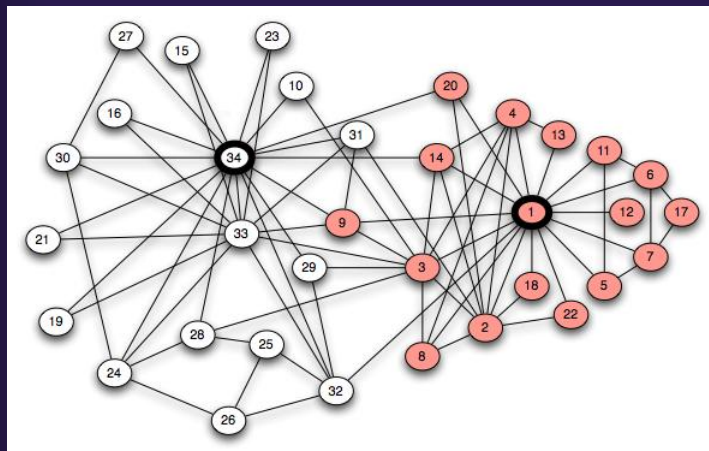
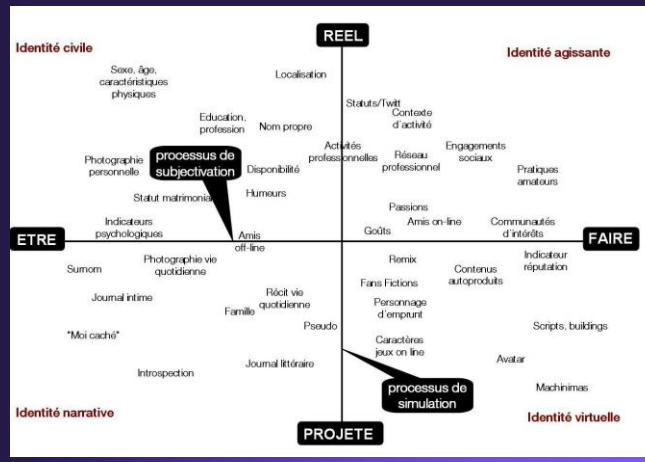
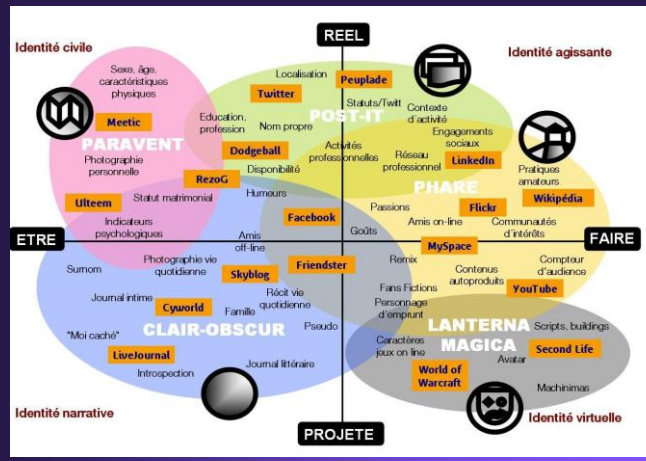


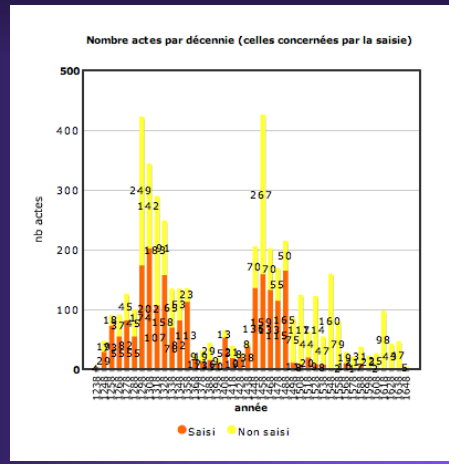
Social networks (1) [Cardon 09]



Social networks (2) [Cardon 09]



Middle-Age Social Networks [Jouve 10]



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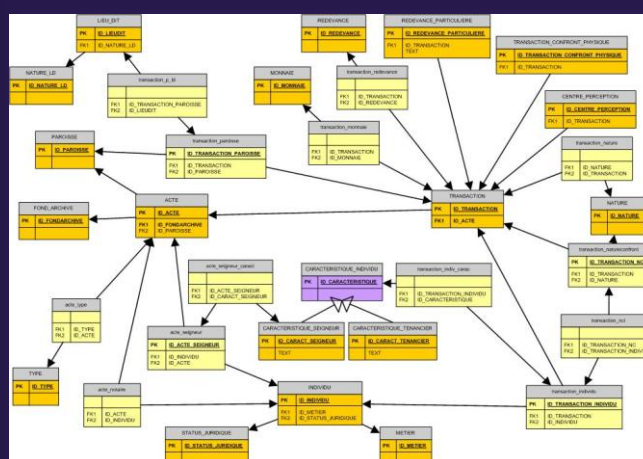
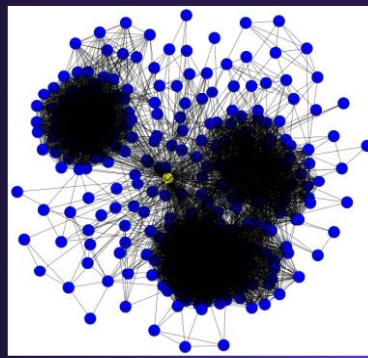
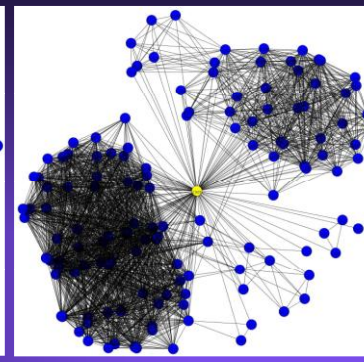


Middle-Age Social Networks [Lacomme 11]



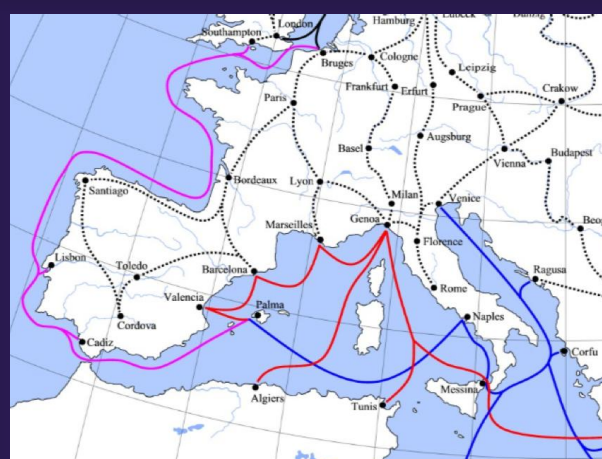


n° 1714 Pierre de Prestis

n° 2905 Guillaume de Maurs

L. Lacomme, V. Camps, Y. Demazeau, Fl. Hautefeuille & B. Jouve, "Middle Age Social Networks: a dynamic organizational study". PAAMS'11, pp. 211-216, Salamanca, 2011.

Middle Age Transport Networks [Easley 09]



Dependency Networks [Sichman 94]

Each agent evaluates its social (goals or resource) dependencies from the external description of other agents, in terms of goals, actions, and resources

social-autonomy (g) = action-autonomy (a,g) and resource-autonomy (r,g)

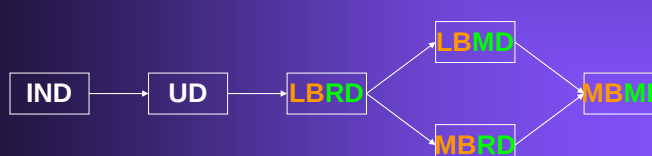
social-dependency (g) = action-dependency (a,g) or resource-dependency (r,g)

J. Sichman, R. Conte, Y. Demazeau & C. Castelfranchi, "A Social Reasoning Mechanism based on Dependence Networks", 12th Eur. Conference on AI, ECAI'94, pp. 188-192, 1994.

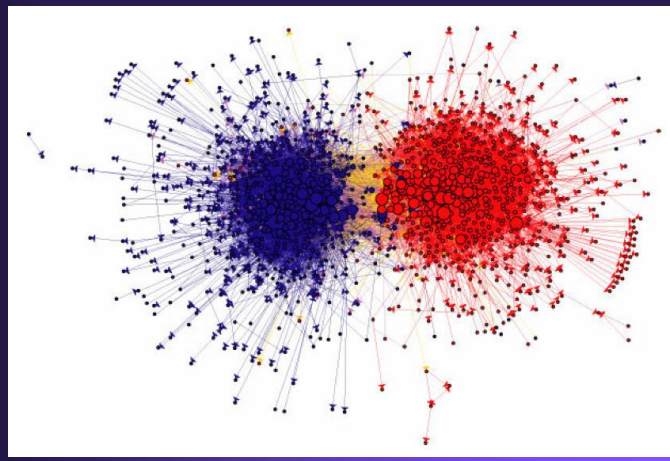
Dependency Networks [Sichman 94]

Dependency Relationships between two agents

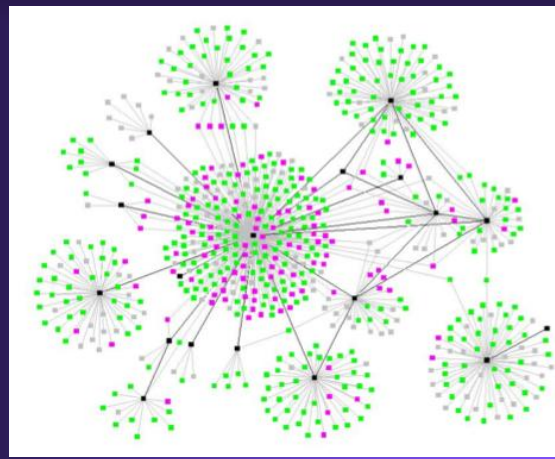
- Independency (IND)
- Unilateral dependency (UD)
- Mutual dependency (**MD**)
  - For the same goal
- Reciprocal dependency (**RD**)
  - For different goals
- Locally believed dependency (**LB**)
  - A1 cannot infer the dependency from A2's description
- Mutually believed dependency (**MB**)
  - A1 can infer the dependency from A2's description



Web page Network at 2004 US Election [Easley 09]

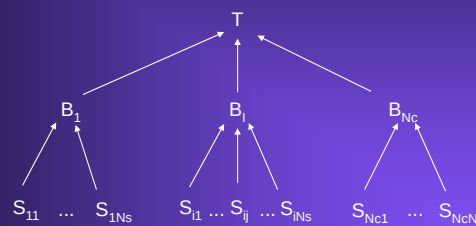


Epidemic Network [Easley 09]



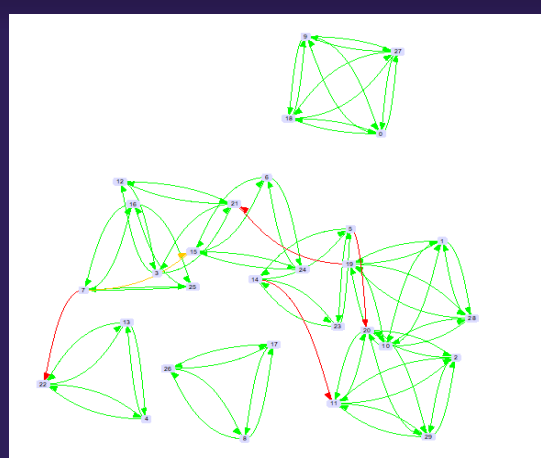
Trust Networks [Melaye 05]

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

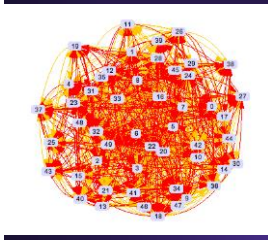


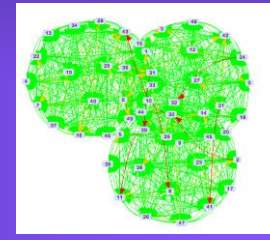
D. Melaye, Y. Demazeau & Th. Bouron, "Which Adequate Trust Model for Trust Networks?", 3rd IFIP Conference on Artificial Intelligence Applications and Innovations, AIAI'2006, IFIP, Athens, June 2006.

Trust Networks / Statics [Melaye 05]



Trust Networks / Dynamics [Melaye 05]





AGENTCITIES

AGENTCITIES Europe

AGENTCITIES World

AGENTCITIES Project [Willmott 03]

100+ organizations involved worldwide

- Including Industry giants : HP, Fujitsu, Motorola, …
- Participating in an open test environment
- Long term deployment, evolution and integration of technologies

Key technology issues

- Service interaction / semantics
- Service composition
- Automating service components

Concrete terms most groups work on:

- Particular technology trials
- Particular application focus

AGENTCITIES Network

160 nodes registered

- 70 or so active
- 30-50 "up" at any moment

Each service platform is connected live to the internet

- FIPA Agent standard implementation
- DAML-OIL/OWL processing
- Local directories and services
- HTTP / XML communication

Now moving towards use by some major projects

- Each working on different applications

AGENTCITIES Demo [Jul. 03]

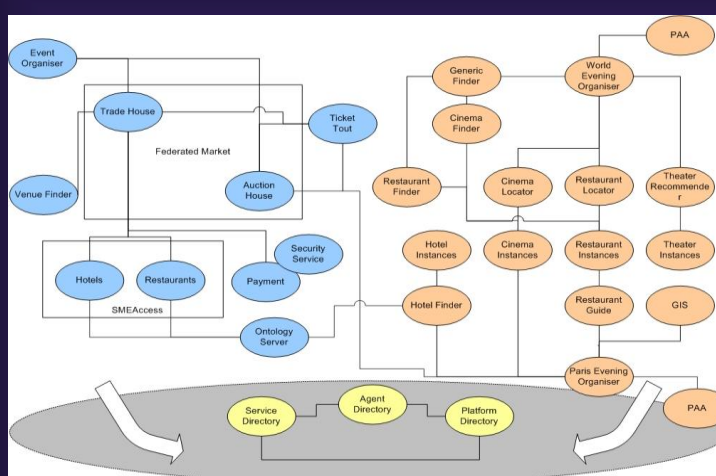
Agent Based Service Components

- From simple representatives to personal agents to complex federated markets, hosting and infrastructure
- More than 25 service types, nearly 200 agents

Business as Usual?

- Hosted by 14 companies and Universities
- Deployment on at least 5 different platform (JADE, FIPA-OS, AAP, ATOMIK Agent Shell, ZEUS) Dynamic application creation
- Fully specified communication interfaces
- Coherent frameworks for all aspects of the environment
- Automated process in many areas

AGENTCITIES Demo [Jul. 03]



COMPLEMENTARY REFERENCES

Complementary references

Traditional description of negotiation mechanisms

R. Davis & R. Smith, "Negotiation as a metaphor for distributed problem solving". Artificial Intelligence, 20, 63-109, 1983

The high-performing PGP, nothing better since !

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Traditional approaches to collaborative planning

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