Agreement Computing

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Talk plan

- Concept and Motivation
- Some methods and applications:
  - Negotiation in TSP
  - Organisations and Argumentation in ACE
  - Organisations in PRAISE
  - Trust and CBIT
- Conclusions

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Motivation

Human relationships have dramaticaly changed in the last decade because they are largely mediated by information and communication technologies. E.g. Email, Virtual Worlds, Games.

Research has focused on:

- New Human-Computer interfaces.
- Network management
- Task delegation
- Intelligence and autonomy
- Cyber Physical systems. Embedded systems.

Motivation

Large innitiatives:

- Global compouting.
- Semantic Web.
- Autonomic computing.
- Distributed computing: P2P, Grid.
- Smart cities.

Motivation

Although human relationships cannot be understood without the notion of agreement, software rarely incorporates this concept in its operational semantics. I think that **agreements must become explicit** in software engineering so that:

- Software ‘understands’ human interactions.
- Humans generate expectations on software behaviour
- Interoperability and co-ordination gets simplified.

Motivation

These agreements are of many sort: on meaning of the exchanged parameters, on norms to respect, on the particular protocol to follow, etc.

There are challenges in the area of **Semantics**, **Norms**, **Organisations**, **Negotiation** and **Trust** and on these areas relationships.

ESSENCE is a good place to achieve these challenges.

In the remainder a few SOA approaches.

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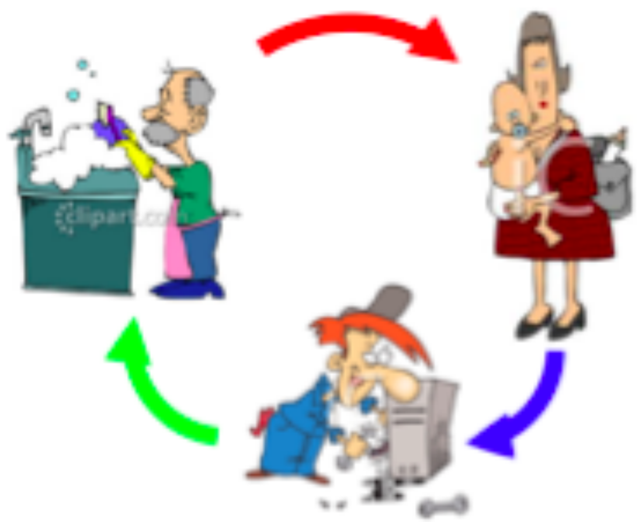
Negotiating agreements

- An agreement between agents:
  - Each agent agrees to execute its part of a joint plan.
  - A plan is a subset of the set of all possible actions.
- The agreement space:
  - set of all possible plans.
  - the power set of the set of all possible actions.

Negotiating agreements

- Example: Alice, Bob and Charly reach an agreement.
  - Action 1: Alice babysits for Bob.
  - Action 2: Bob repairs Charly's computer.
  - Action 3: Charly does the dishes for Alice.



Application area 1: Time tabling

- e.g. schools teachers and their schedule
- Negotiation on exchanging slots
- Private goals and preferences
- Bilateral or multilateral negotiations
- Current solutions are centralised without negotiation

Application area 2: Logistics

- Package delivery
- Multi-track scheduling
- Dynamic package generation
- Private goals and preferences
- Limited amount of time
- Current solutions are centralised and not reactive

Application 3: Diplomacy

Problem characteristics

- Resource Negotiation Problem (RNP)
- Competitive MAS with repeated interactions
- Multi bilateral or multilateral
- Agents control several resources
- Agents act on their resources
- Agents negotiate about those actions
- Interacting involves acting and negotiating
- Time matters

Problem characteristics

- Utility is highly **non-linear**, **hard** to calculate and functions are in many cases **one-way**.
- Solutions may involve a large number of agents, possibly including humans.
- The space of solutions is huge, i.e. there is no possibility to exhaustively explore the set of solutions.
- The environment changes during the negotiations due to actions of others.
- Other agents in the system are unknown and cannot be blindly trusted.
- Decisions have to be made within a limited time frame.

Requirements for a solution

- There is competition from other agents
- We need to make deals before competitors do
- There's a dilemma/trade-off:
  - Search long enough to find the best possible deal.
  - Don't search too long, because deals might become impossible.
- Example: buying a house.
  - Don't buy too soon: I might find a better one.
  - Don't wait too long: somebody else might buy it.

We cannot wait until we have found the optimal solution and then propose it.

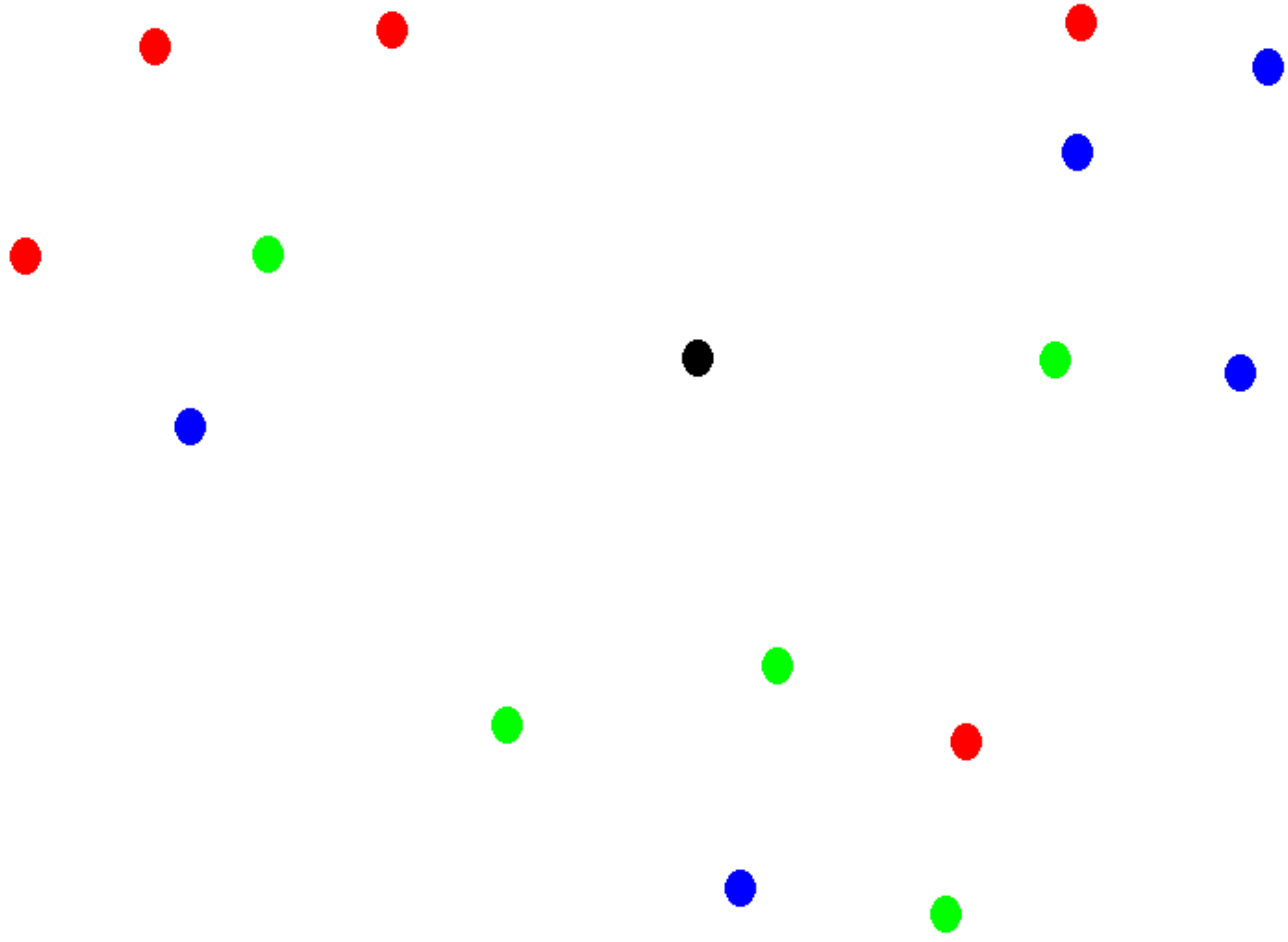
Requirements for a solution

- We need/want an algorithm that:
  - searches for near-optimal solutions,
  - has reasonable solutions/deals available at any time,
  - combines the search for (partial) plans with their negotiation.
- Solution proposal: **Negotiation Branch & Bound,** NB^3. It performs two concurrent tasks:
  - Applies a Branch & Bound algorithm to search for plans.
  - Negotiates partial plans.
- First algorithm where negotiation and search are intermingled.

Testcase: Negotiating Salesmen Problem

- A set of salesmen.
- A set of cities.
- Each city has to be visited by one salesman.
- Each salesman wants to minimize the length of its own path.
- The salesmen can negotiate which city will be visited by whom.

Testcase: Negotiating Salesmen Problem



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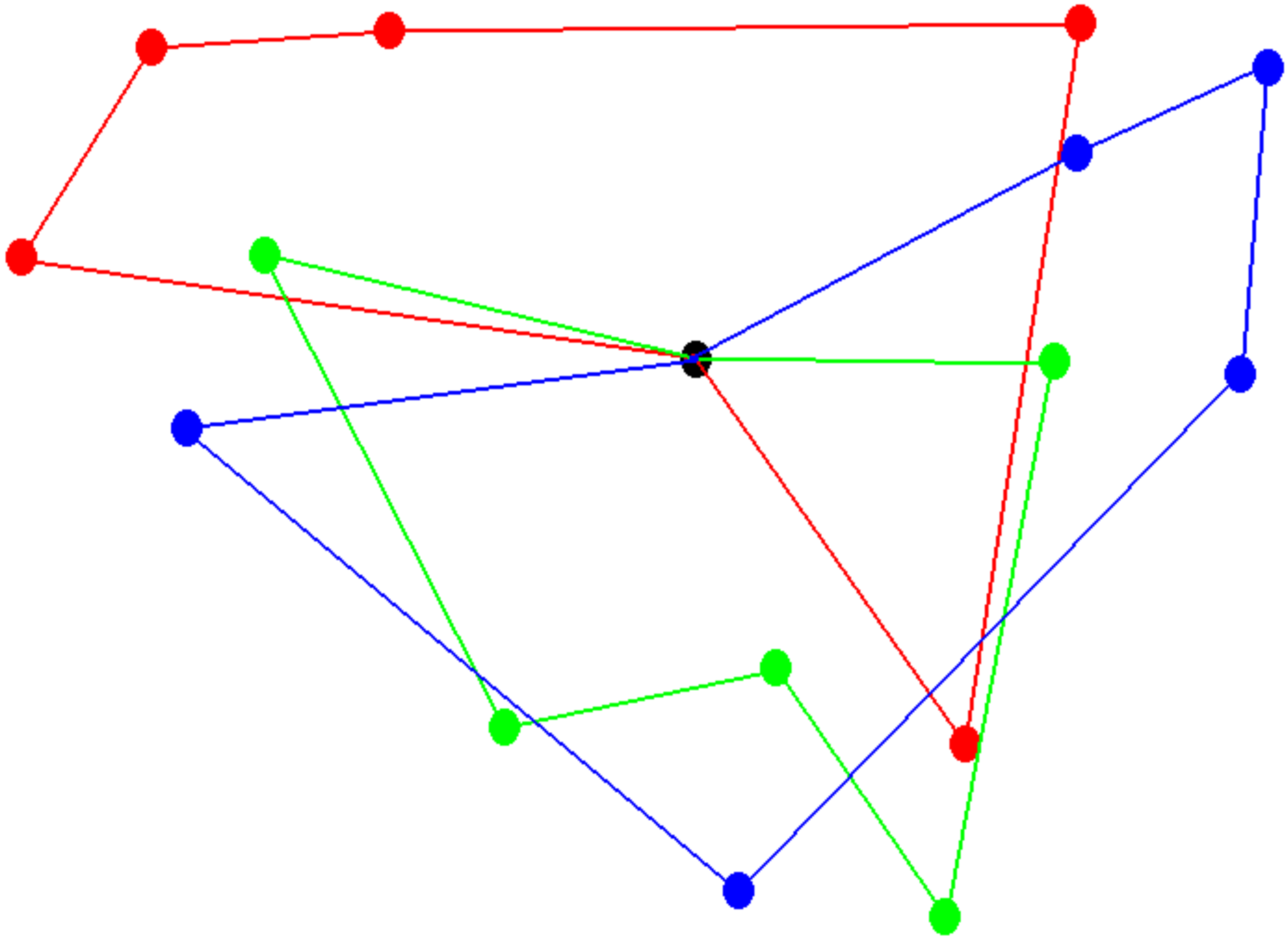

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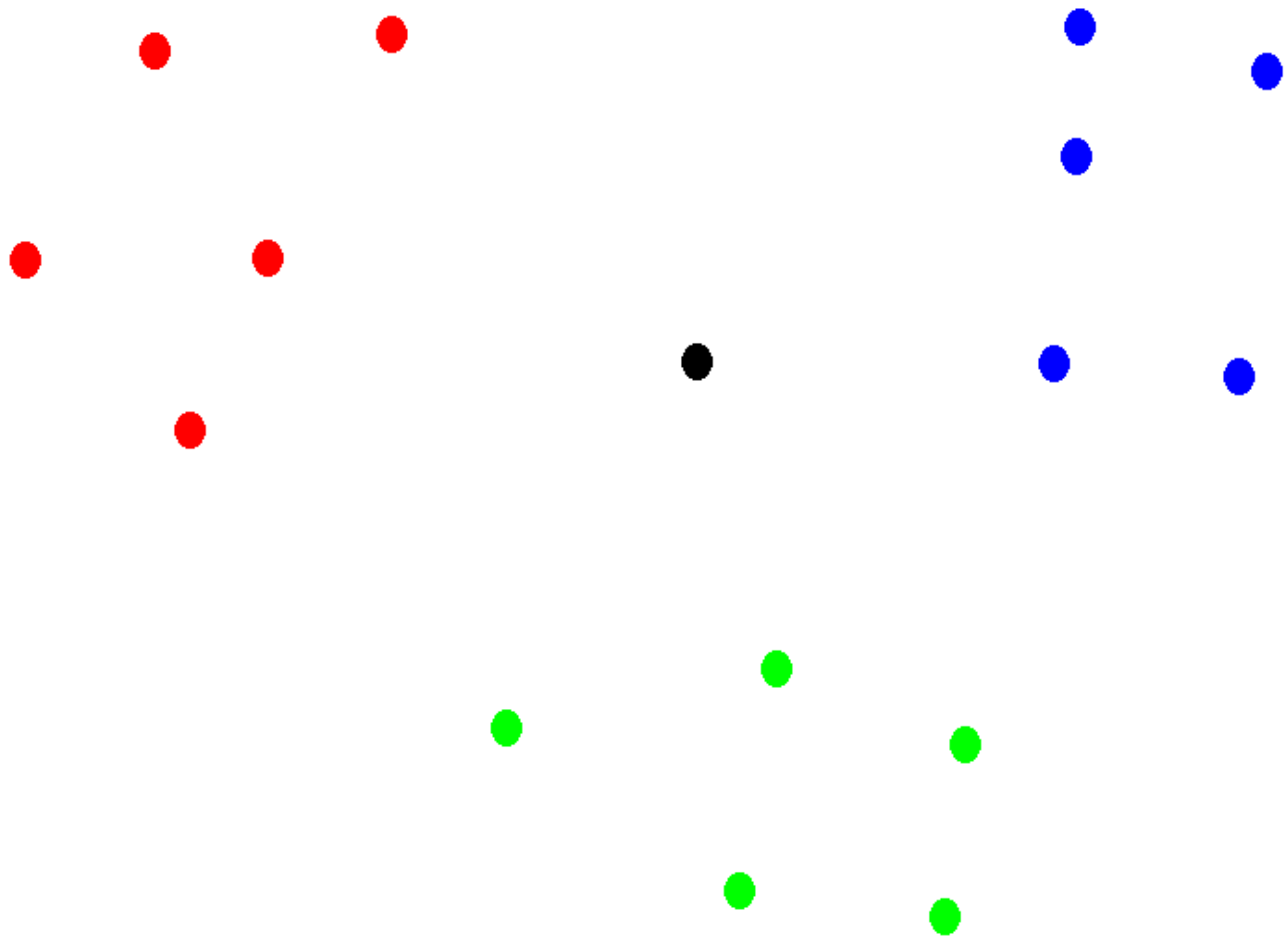

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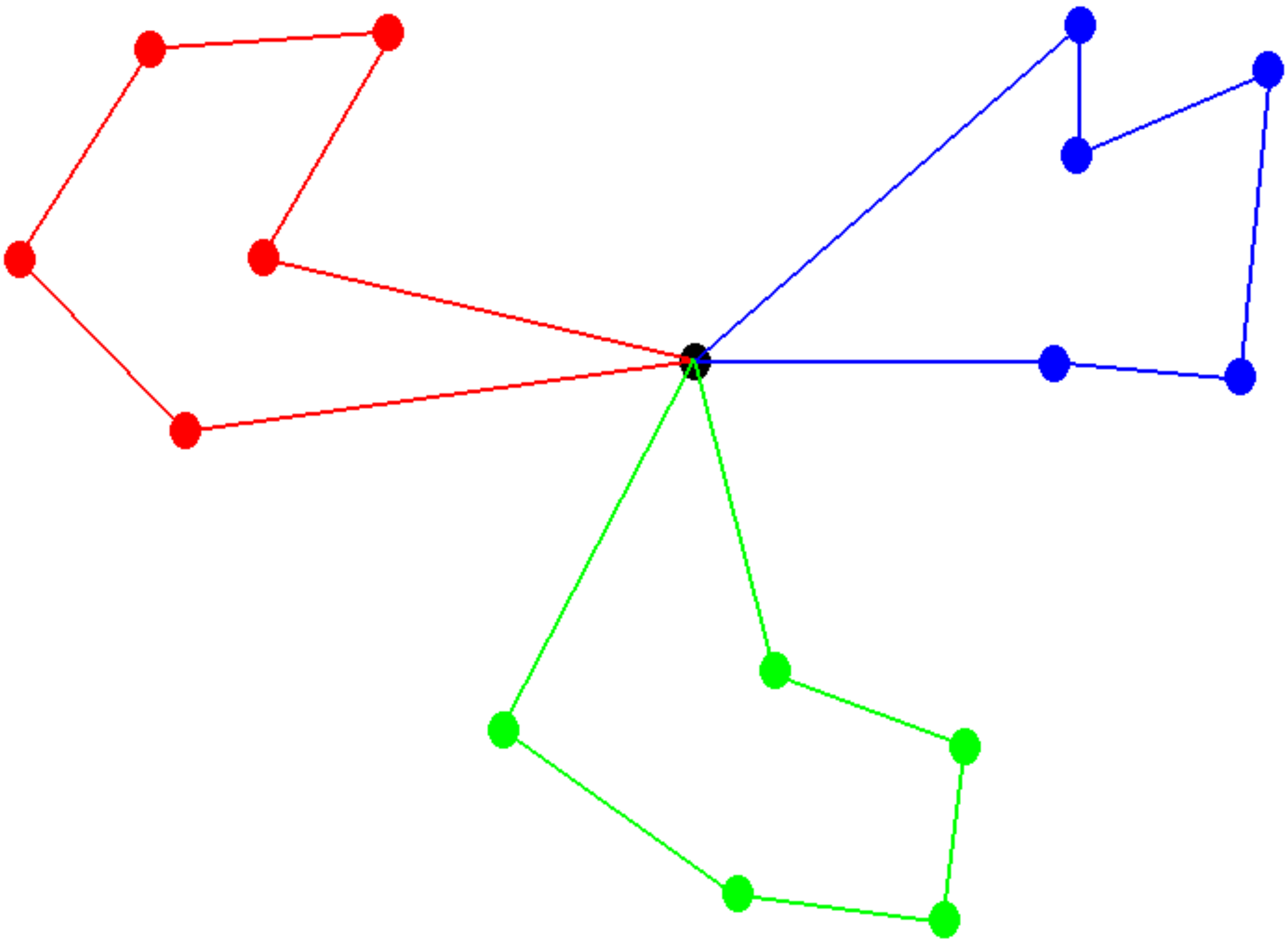
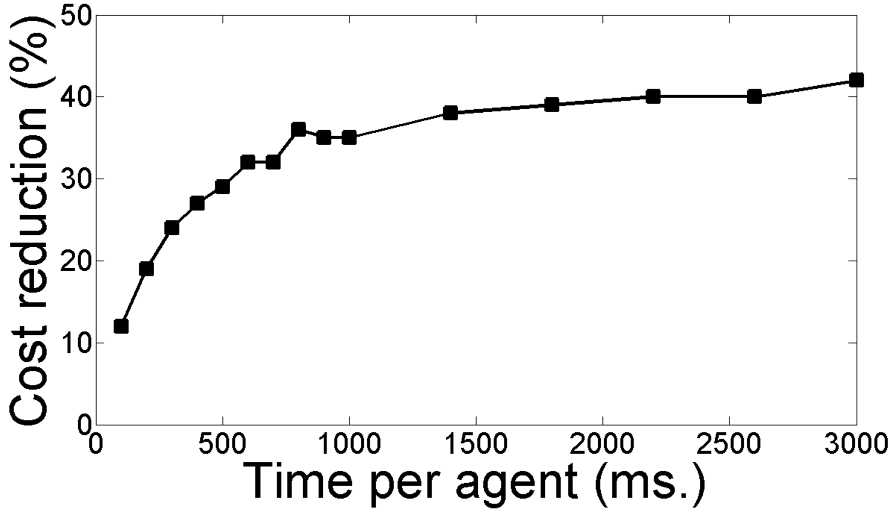


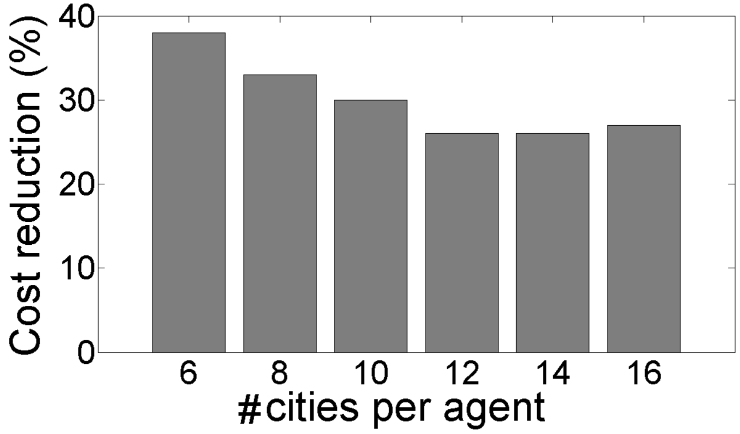
Experiment: Increasing time length

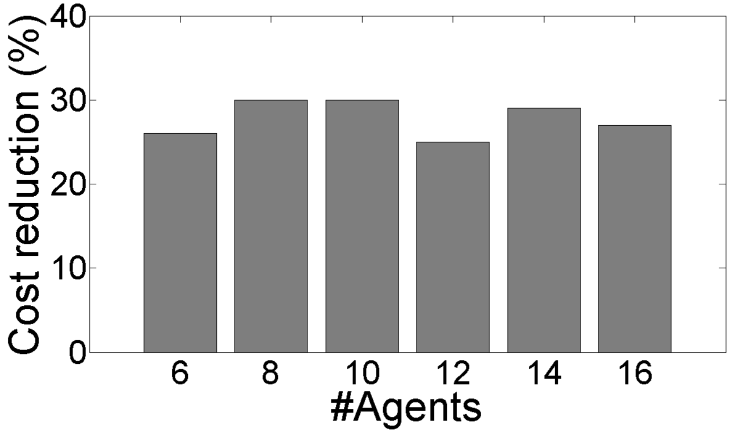
- 15 tests:
  - Varying negotiation length
  - 10 agents, 10 cities per agent
- Each agent runs NB^3



Experiment: Increasing problem size

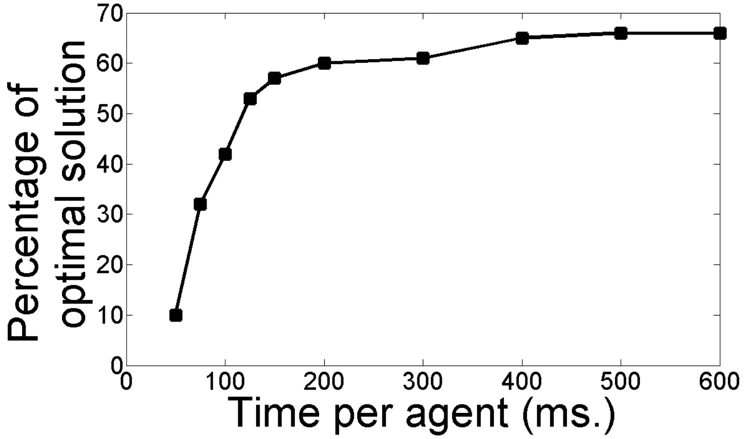
- Two tests:
- 500ms per agent
  - 10 agents, X cities per agent.
  - X agents, 10 cities per agent.
- Each agent runs NB^3





Experiment: Comparing with social optimum

- a agents
- a cities far from one another
- $m - 1$ cities around each of those cities
- A cluster associated to each agent ('optimal assignment')
- a random swaps



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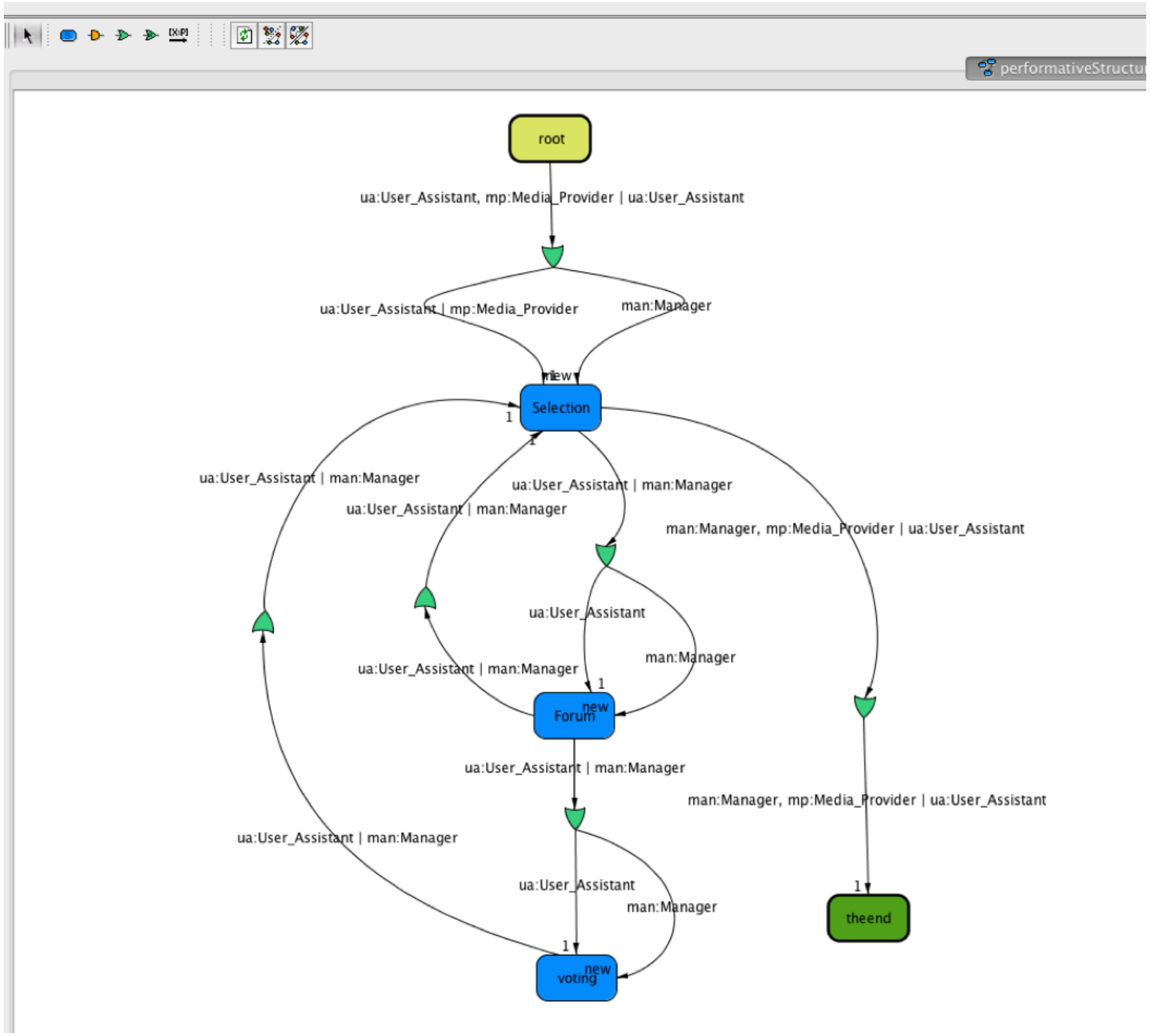
Organisations and argumenation in ACE

Objectives:

- Develop a P2P Electronic Institution infrastructure
- Embed the P2P autonomic electronic institution infrastructure in mobile devices
- Make the software available as open source
- Argumentation-based agent architecture
- BDI mental model
- Argumentation-based agreements

Organisation for ACE



Argumentation for agreements in ACE

- Problem: a group collection of images
- Interfacing users to the system
- Storing the likes and dislikes as preferences
- Merging users' tags (Group preference defined)
- Selecting subsequent images
- Arguments are supports for an overall image opinion as pairs $\langle tag, value \rangle$
- Arguments change dynamically, sometimes via private negotiations

Prototype


Like
Dislike
discard
keep
wood
beards
scary faces
Vote
discard
keep
Textile
Beads
Wood
Textile
Beads
Textile
Beads
Wood
Wood
Vote
Add this image to the collection?
Yes
No
Abstain
Time Remaining 49 Sec

Video

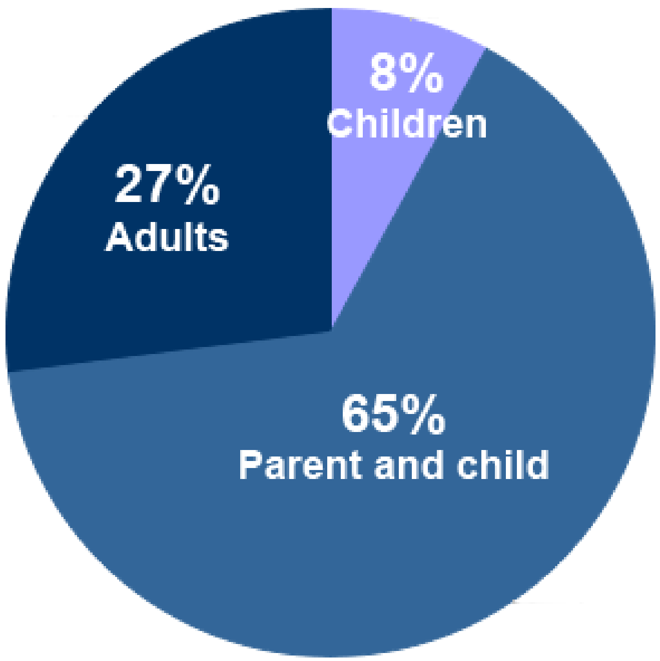
Validation and evaluation of the prototype

WeCurate was installed as a multiuser museum interactive, and was used by visitors in groups of up to four people. Multiple sources of qualitative and quantitative data were collected:

- An automatic log of all participants actions (92 sessions)
- Observations based on field notes (37 sessions)
- Questionnaires (48 collected)

The analysis of the data concentrated on the distinct interactive behaviours of different social groups.

Validation and evaluation of the prototype



High variation of engagement:

- Time: mean 5mins 38secs
- Images viewed: mean 4.4

Social groups: 83% familiar with the group (46% family) reflecting the public's everyday habits in cultural institutions. Key findings showed evidence of collective decision making and negotiation:

- Parent and child: scaffolded experience
- Adult groups: playful engagement and interdependent behaviours

Validation and evaluation of the prototype

Strong evidence for the social group's influence over individual's decision making, made available via the WeCurate system:

- Participants felt they were able to communicate their preferences and had an awareness of the group's intentions and opinions - 87% of participant were aware of others' action via the synchronised view.
- The social group had an influence on individual's decision making, as 42% reported changing their decision as a consequence of seeing (a representation of) other's actions.
- Effectiveness of the agents - 75% of participants voted on the images they prefered.

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Organisations in PRAISE

- More people engaged with creating and sharing music
- More students having a stronger engagement in practicing music
- More students able to learn to music together
- Enrich and encourage praise and feedback in music learning communities

Praise and Feedback

- Crucial way to get better
- Evidences how we have got better
- Learning to give good feedback is important
- Learning how to take feedback is important

Communities provide the context for giving and receiving feedback

Communities in PRAISE

- How do we coordinate and regulate large numbers of learners?
  - How to structure group lesson plans
  - How to define and manage the norms of behaviour
  - How to manage trust and reputation
- How do we do so on a large scale?
- How do we make coordination and regulation technologies accessible to users?

Current results in PRAISE

- We have a scalable p2p electronic institution infrastructure for regulating communities

- We have an automatic GUI generator for our community regulation system

- We have a trust and reputation model suitable for mass online learning

Video

PRAISE creates technologies that will support a wide range of users in collaborative music learning. The fundamental concept is to use technologies and communities to help students discover the joy of learning music.

The explosion of social media sites is an unprecedent opportunity to build new learning environments augmented with learning agents that can foster collaborative learning.

PRAISE goes beyond what is currently available by building learning agents to act as guardians and tutors in a community of music practice that provide ongoing personalized praise and feedback.

The combination of reflexive pedagogy techniques and advanced AI technologies can boost creativity and trigger learning behaviours that would otherwise be very difficult to achieve.

Breakthroughs at a pedagogical level by finding new principles that can work in these novel environments such as personalized reflexive feedback.

Breakthroughs at a technological level by advances in real-time content, gesture and linguistic analysis, communitiy infrastructure, student modelling and educational interaction designs.

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SONY Computer Science Lab, France

Duration: October 2012 - September 2015

www.iiia.csic.es/praise

SEVENTH FRAMEWORK PROGRAMME

EUROPEAN COMMISSION

Collaborative project funded by the European Commission under programme FP7-ICT-2011-8

PRAISE

Practice and peRformance Analysis Inspiring Social Education

PRAISE

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TrustFlow

uHelp

Help!
My Request:
Action: Pick up my child
Child: Mark
Location: School
Date: 02/05/2013 16:30
Find Help!
Pick up my child
Name: Mark
Location: Home
Date: 2013-05-02 13:15:00
Status: Looking for a volunteer
Pick up my child
Name: Anna
Location: School
Date: 2013-04-29 18:15:00
Status: Looking for a volunteer
Settings
Appearances
My Profile
My Community
The Charter
FAQ
About uHelp
My Community
Add from contacts
Add from facebook
jmadrenas 0.59
davdela 0.20
clopez 0.64

TrustFlow and CBIT

Every time a requested activity with a child takes place, the adult responsible of the child generates an evaluation. The evaluation is a tuple with the form

$$eval(Volunteer, ActivityType, ChildType, Evaluation)$$

Examples:

- $eval(John, Entertaining, Toddler, 0.7)$
- $eval(Mary, SingingSongs, Preschooler, 0.8)$

Trust calculation in TrustFlow

We evaluate trust as an aggregation of the trust that a person associates to the type of activity and the object of the activity.

$$\begin{aligned} Trust(R, V, T, Ch, t) =& \alpha * Trust_{object}(R, V, Ch, t) + \\ & (1 - \alpha) * Trust_{activity}(R, V, T, t) \end{aligned}$$

where R is the requester, V the volunteer, T the activity, Ch the type of child, t the time and α an interpolation parameter.

Trust calculation in TrustFlow ($Trust_{object}(R, V, Ch, t)$)

First, we use a similarity threshold to filter out the evaluations associated to objects too distant from the target in the Children's taxonomy. The similarity value for the Children's taxonomy is calculated using the following formula:

$$simVal(R, Ch_i, Ch_j) = \begin{cases} semSim(Ch_i, Ch_j) & \mathit{if}\, simTh \leq semSim(Ch_i, Ch_j) \\ 0 & otherwise \end{cases}$$

where $semSim(Ch_i, Ch_j) \in [0, 1]$ is the semantic similarity between types of children Ch_i and Ch_j and $simTh \in [0, 1]$ is the similarity threshold **defined by the community**.

Trust calculation in TrustFlow ($Trust_{object}(R, V, Ch, t)$)

The trust that requester R gives to volunteer V associated to a particular object Ch is calculated using the formula:

$$Trust_{object}(R, V, Ch) = \frac{\sum_{E_i \in E} simVal(R, Ch, Ch(E_i)) \cdot Eval(E_i)}{\sum_{E_i \in E} simVal(R, Ch, Ch(E_i))}$$

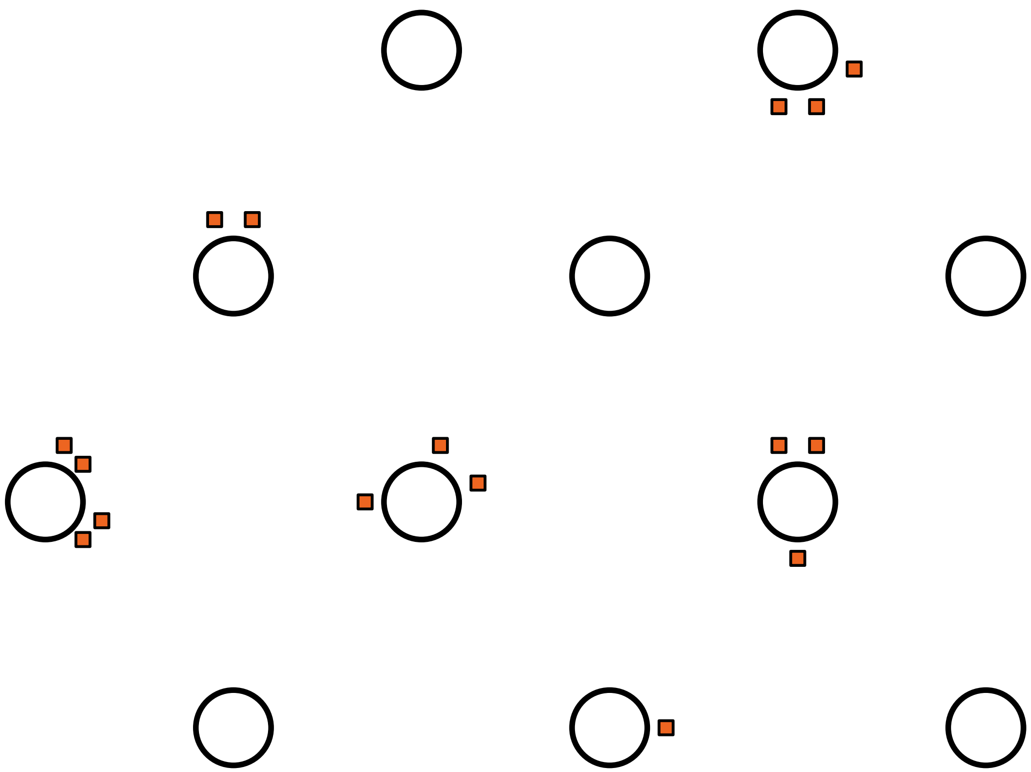
where E is the set of evaluations, $Ch(\cdot)$ is the childtype in an experience and $Val(\cdot)$ the evaluation of an experience.

Trust calculation in TrustFlow ($Trust_{activity}(R, V, T, t)$)

We use the OpinioNet system.

OpinioNet

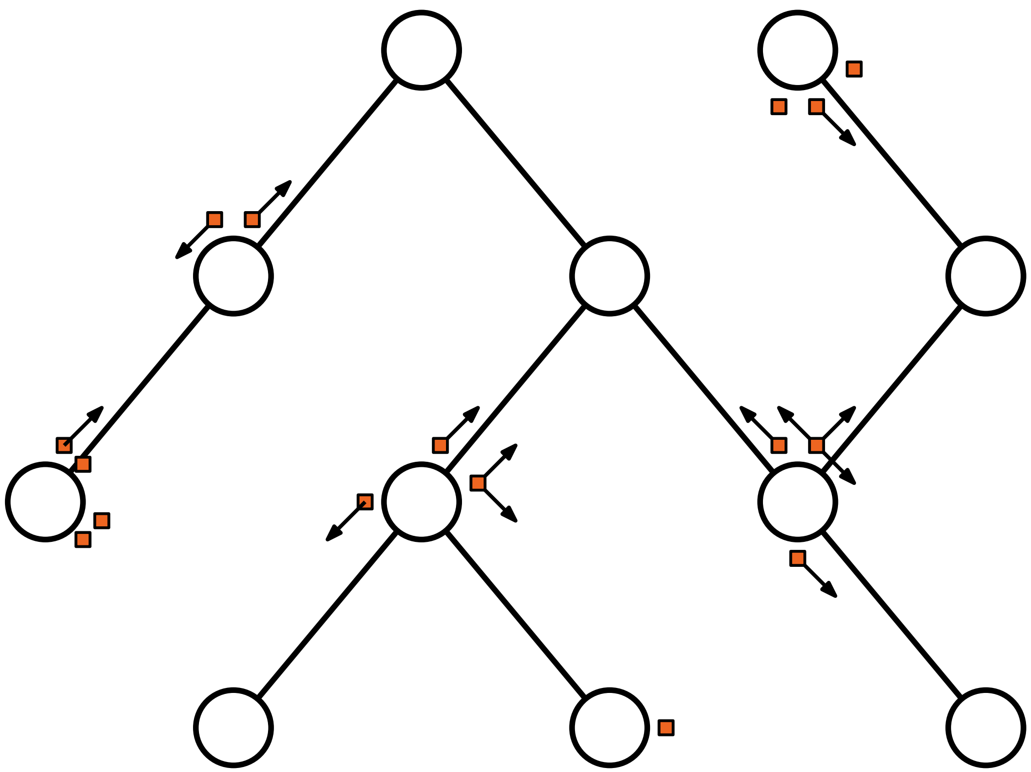
Objectives



Problem definition: What can we say about new entities that we have not formed any opinions about them yet?

OpinioNet

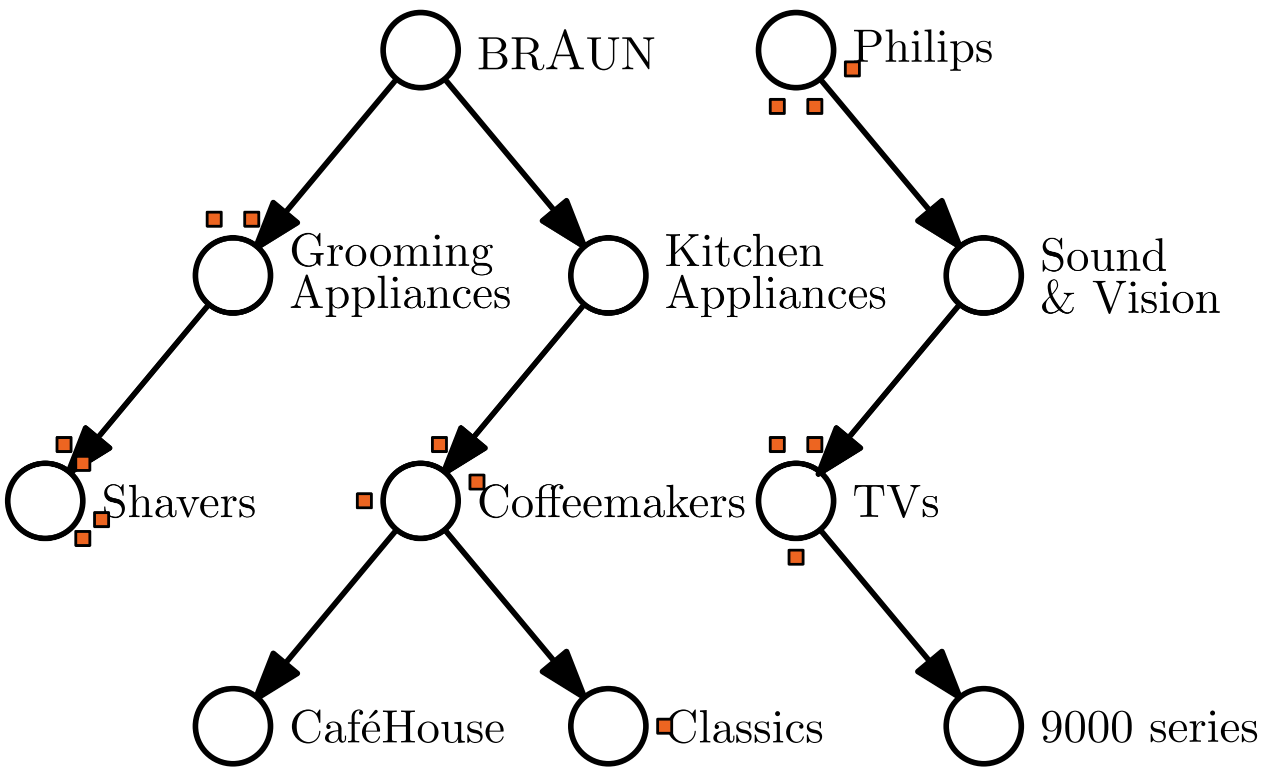
Objectives



Proposal: When structural relations exist, existing opinions may propagate from one entity to another, allowing us to infer opinions about new entities.

OpinioNet

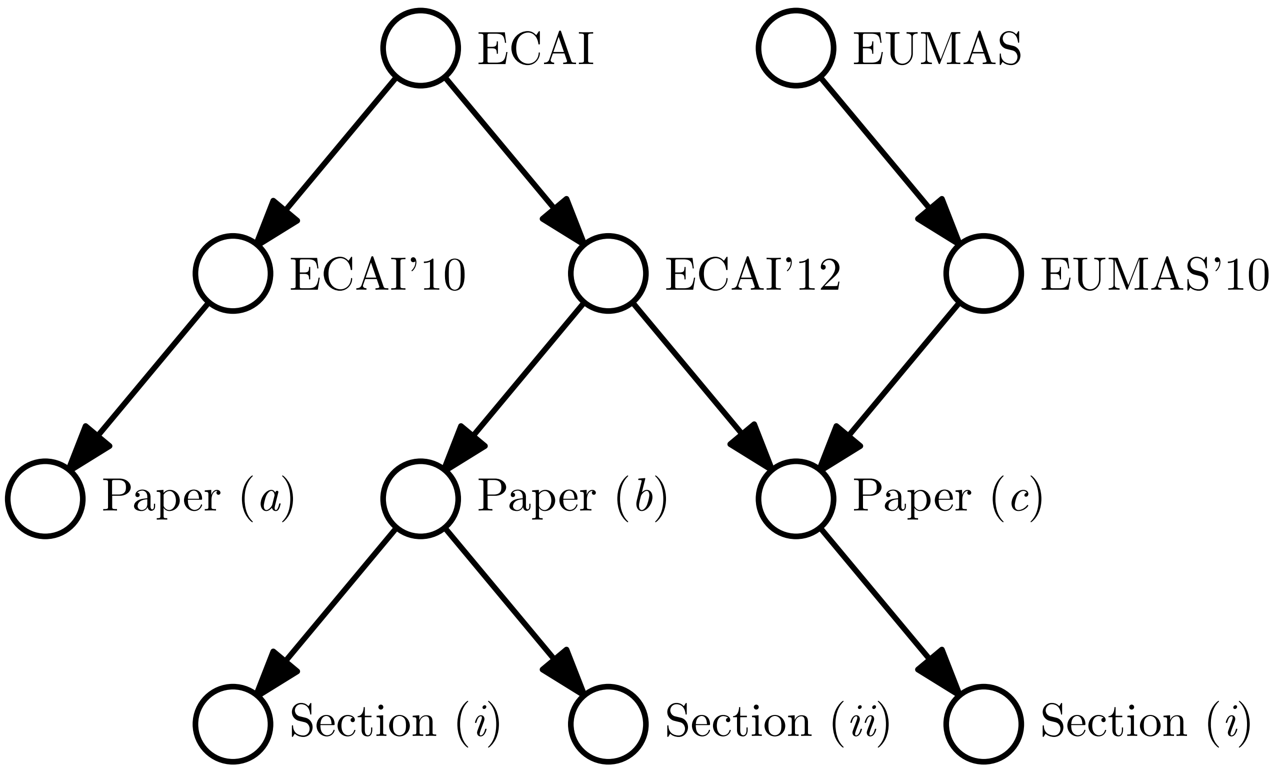
Objectives



Examples of structural graphs

OpinioNet

Objectives



Examples of structural graphs

OpinioNet

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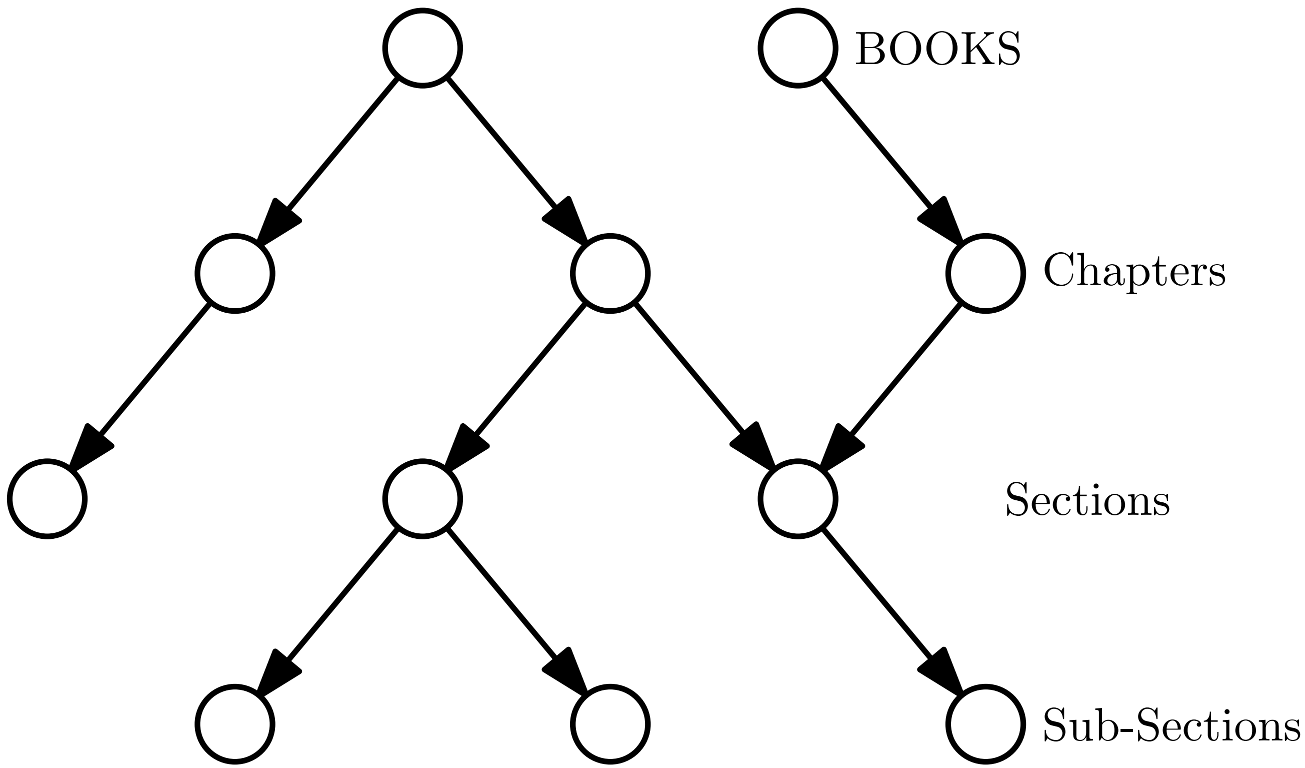
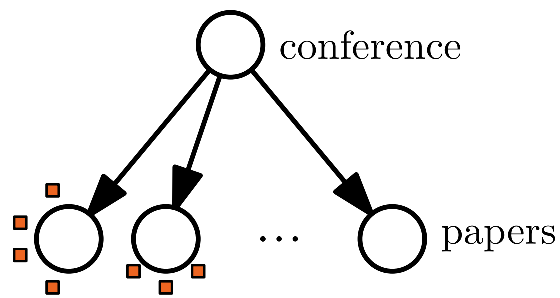


Examples of structural graphs

OpinioNet

Basis of Opinion Propagation

Analogical Reasoning: *If a is similar to b, then the opinion about a is* **probably** *similar to the opinion about b.*



OpinioNet

Opinion Propagation

IMPACT of a node	DIRECTION of propagation	DECAY of information value

OpinioNet

Opinion Propagation

IMPACT of a node	DIRECTION of propagation	DECAY of information value

$$\pi_n^t = \begin{cases} 1 & \exists\, t' \leq t \cdot direct(\mathbb{P}_n^{t'}) \\ 0 & \forall\, t' \leq t \cdot \neg direct(\mathbb{P}_n^{t'}) \\ & \wedge\ \not\exists\, c \cdot (c, n) \in \mathcal{E} \\ \displaystyle\sum_{(c,n)\in\mathcal{E}} \frac{\pi_c^t}{|\{c' \mid (c', n) \in \mathcal{E}\}|} & \text{otherwise} \end{cases} \tag{1}$$

where

- π_n^t is the impact of node n at time t
- $N = \{c, c', n, n', \ldots\}$ is the set of nodes of the structural graph
- $\mathcal{E} \subseteq N \times N$ defines the edges of the graph ($(nn') \in \mathcal{E}$ represents n as being part of n')
- $direct(\mathbb{P}_n^{t'})$ states that node n has received a direct opinion at time t'

OpinioNet

Opinion Propagation

IMPACT	DIRECTION	DECAY
of a node	of propagation	of information value

$$\mathbb{P}_n^t = \frac{1}{\sum_{(c,n)\in\mathcal{E}} \pi_c^t} \cdot \sum_{(c,n)\in\mathcal{E}} \pi_c^t \cdot \mathbb{O}_c^t \tag{2}$$

$$\mathbb{D}_n^t = \frac{1}{\sum_{(n,p)\in\mathcal{E}} \pi_p^t} \cdot \sum_{(n,p)\in\mathcal{E}} \pi_p^t \cdot \mathbb{O}_p^t \tag{3}$$

where

- $\mathbb{O}_n^t = \begin{cases} \mathbb{P}_n^t & \text{, if } \mathcal{H}(\mathbb{P}_n^t) < \mathcal{H}(\mathbb{D}_n^t) \\ \mathbb{D}_n^t & \text{, otherwise} \end{cases}$

  and $\mathcal{H}(\mathbb{P})$ is the entropy of a distribution $\mathbb{P}$ describing the distribution's uncertainty

OpinioNet

Opinion Propagation

IMPACT of a node | **DIRECTION** of propagation | **DECAY** of information value

$$\mathbb{P}_n^t = \Lambda_i(\mathbb{D}_n^{t_n}, \mathbb{P}_n^{t_n}) \tag{4}$$

$$\mathbb{D}_n^t = \Lambda_e(\mathbb{F}, \mathbb{D}_n^{t_n}) \tag{5}$$

where

- Λ is a decay function
- $\mathbb{F}$ is the uniform distribution describing ignorance

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Conclusions

- Agreements will become increasingly central in software engineering
- Agreements on semantics are key for interoperability
- Negotiation and organisations are key to build mixed societies
- Trust models go beyond agreement computing
- High industrial interest: ODR, CRM, Social networks, ...

THANKS!