Electronic Institution: an introduction

Seminários de Sistemas Inteligentes, Interacção e Multimédia
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Agenda

• Institution: concept
• Electronic Commerce
  – B2C & B2B
  – Agents and Electronic Commerce
• Electronic Institution
  – Electronic Institution in B2B
  – Related work
• ANTE: Agreement Negotiation in Normative and Trust-enabled Environments
  – Negotiation
  – Normative Environment
  – Trust
Institutions

- Multiple situations of interaction between individuals involve:
  - Commitment, delegation, repetition, responsibility, risk, …

- These situations involve individuals that are:
  - autonomous, heterogeneous, independent, not benevolent

- Such situations are common in several environments: markets, medical services, army, …
  environments where individuals live in society

Institutions

- It is usual to use a trusted entity whose purpose is to effect the interactions between individuals by setting and enforcing rules that:
  - define standard interactions
  - establish obligations and sanctions
  - guarantee the fulfillment of certain actions and prevent unwanted situations

  the basis for the specification of many traditional institutions

- They are even more necessary when interactions take place in the electronic world
Institutions

- Real institutions (human) are successfully for a long time
- Institutions are:
  - created to achieve certain goals by following a set of pre-defined procedures
  - responsible for defining the rules of the game, enforcing the participants to respect those rules and imposing penalties in case of violation
- Exemples: auction houses, stock markets, ...

Interest in the Electronic Commerce scenario, especially B2B

Electronic Commerce

- Market Transaction
  - finite set of processes of interaction between participants with different goals (eg. buyer/seller)
  - establishment of an agreement among participants to exchange products or services (goods)

- Electronic Commerce (EC)
  - occurs in an electronic market (no physical)
    - B2C
      - transaction between individual buyers and sellers
      - subject of the transaction is a final good
    - B2B
      - transaction between enterprises
      - subject of the transaction is an asset to be used in production processes (not a final good)
Electronic Market

- Network of interactions where an exchange of information, products, services and payments occurs
  - supports all necessary transactions
  - place where buyers and sellers meet electronically
  - buyers and sellers negotiate, submit bids, establish an agreement

- Prices are set dynamically
  - by mapping between demand and supply in real time

B2C & B2B
### B2C

**Life Cycle**

- **Information**
  - Product search (Jango, PersonaLogic, Firefly)
  - Suppliers search (Bargainfinder, Jango)
- **Negotiation**
  - Agreement on the terms of the transaction
- **Resolution**
  - Payment vs. Delivery
  - After-sales service

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### Information search (recommender systems)

- **Content based filtering**
  - Search multiple sources; extract information from content
    - search based on keywords
    - extraction of semantic information

- **Collaborative filtering**
  - Use comments and ratings from different consumers with similar profiles

- **Constraint based filtering**
  - Problem and state space formulated in terms of variables, domains and constraints
  - Assign values to variables satisfying all constraints (strong and weak)
Negotiation

- **Commerce implies interaction:**
  - Between buyers and sellers (B2C), between business partners (B2B)

- **Negotiation is the key of interaction in EC:**
  - "key" because the individuals / agents are autonomous, need to be convinced, to be influenced
  - The process through which groups of entities communicate with each other trying to reach an agreement acceptable to all
  - Several kinds: auction, contract net, argumentation, …

- **Negotiations carried out by formulating proposals, adding various business options, offering concessions, …**

Negotiation

- **Several markets allow simple negotiation**
  - [www.miau.pt](http://www.miau.pt): simple auction
  - [www.ebay.com](http://www.ebay.com): simple auction, possibility of automatic bidding with predetermined increments
  - Amazon: simple auction
  - …

- **Research work:**
  - Kasbah (1999): multi-agent system for trading goods, built on negotiation tactics
  - FishMarket: Dutch auction
  - …
Agents and Electronic Commerce

Are agents a right paradigm for EC?

- Autonomy
  - Agents act pro-actively, reactively, without human intervention (can wait for good deals or opportunities)
  - Personalization
  - Agent profile reflects the human preferences

- Sociability
  - Ability of communication between agents used to discuss the terms of the deal

- Intelligence
  - Agents can learn from past experiences in order to achieve better deals in the future

Eletronic Institution

- Eletronic Institution, is an electronic place where agents interact.
  
    - Formal specification of institutional rules, should define:
      - Interaction type: register, search, buy, payment, …
      - Interaction protocol
      - Behaviour rules

    - Execution, mediates agents’ interactions while enforcing the institutional rules

- Market should be fair for all participants
Agents and Institutions

- Electronic institutions support the use of agents in electronic transactions

- Agents must know possible transactions, norms, rules and protocols of the institution
  - Transactions occur within the institution (indirect)
  - Transactions occur between agents (direct). Agents should be able to find the capabilities of the others and establish a protocol for interaction

Less control of the electronic institution implies Greater complexity in communication between agents.

Agents and Institutions

- Institutions define/impose interaction
  - Agents can be developed independently.
  - Agents interact according to what was specified by the institution

- Two types of interaction:
  - Interaction with the institution (use of institution’s services)
    - register as buyer/seller, payment, …
  - Interaction with other agents (within the institution)
**EIDE** (Electronic Institutions Development Environment)

- Supports all phases of the EI, since the specification of institutional rules to its execution and monitoring

![Diagram of EIDE](http://e-institutions.iii.csic.es)

- **Formal specification of institutional rules -- ISLANDER**
  - Definition of roles and relations
  - Definition of a common ontology
  - Interaction protocols and its relation to roles
  - Normative rules that define the consequences of an action

- **Verification (dynamic) -- SIMDEI**
  - Done by simulation
  - Multiple simulations with different populations of agents
  - Simulation analysis (graphic tool) made by designers who decide to modify or not the institutional rules
EIDE (Electronic Institutions Development Environment)

- **Agent development -- aBUILDER**
  - Agents are heterogeneous
  - It is not mandatory to use aBUILDER
  - Graphical specification of agent’s behaviours
  - Automatically builds an agent’s skeleton

- **Execution and analysis -- AMELI**
  - Provides information about the current execution (to agents)
  - Obliges agents to follow institutional rules (validates the actions of the agents)
3D Electronic Institution

- 3D Electronic Institution combines the concepts of Electronic Institution and 3D Virtual World

- Features:
  - Friendly interface
  - Facilitates the use of the EI by human users
  - Allows to study the relationship between humans and software agents in a 3D virtual space
HarmonIA


- **Abstract Level**
  - **Statutes**: abstract specification of the **objective** of the organization, the **values** that direct the fulfilling of this objective and the **context** where the organization will have to perform its activities.

  Ex: statutes of ONT (National Organization for Transplants)

  The principal objective of the ONT is the promotion of donation and the consequent increase of organs available for transplantation, from which all its other functions result. The ONT acts as a service agency for the National Health System, works for the continuing increase in the availability of organs and tissues for transplantation and guarantees the most appropriate and correct distribution, in accordance with the degree of technical knowledge and ethical principles of equity which should prevail in the transplant activity.
HarmonIA

- **Concrete Level**
  - Abstract norms are translated to actions and concepts
  - Concrete norms: actions described in terms of the ontology of the organization

- **Rule Level**
  - Translating norms into rules (in a language suitable to express actions and time constraints)

- **Procedure Level**
  - Two approaches:
    - Create a rule interpreter that any agent will incorporate
    - Translate the rules into procedures easily followed by the agents

EIDE vs HarmonIA

- **ISLANDER**
  - External agents follow (blindly) the protocols: efficient
  - But agents only possess autonomy to accept/reject the protocol

- **HARMONIA**
  - External agents interpret the operational rules
  - Two approaches:
    - Low level protocols that agents should strictly follow
    - Associated rules
Electronic Institution Platform for B2B Contracting

Agent-based Automated Negotiation
Agent-based Automated Negotiation

- **Negotiation protocols**
  - Mechanism design: the rules of the negotiation game
  - What can agents do
  - Auctions vs. Negotiation
    - **Negotiation**: two or more parties jointly determine outcomes of mutual interest
    - **Auction**: market mechanism with an explicit set of rules determining resource allocation and prices based on bids from market participants

- **Negotiation strategies**
  - How each agent plays the game

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Virtual Enterprise (VE)

- “a *cooperation of legally independent enterprises*, institutions or individuals which (...) contribute their core competences (...) the cooperation is managed by using feasible *information and communication technologies*”
  

- “a *temporary consortium* of autonomous, diverse and possibly geographically dispersed organizations that pool their resources to meet *short-term objectives* and exploit *fast-changing market trends*”
  

- “a *temporary alliance* of enterprises that come together to share skills or core competences and resources in order to better respond to business opportunities, and whose cooperation is supported by *computer networks*”
  
MAS for VE Formation

- Modeling a VE as a Multi-Agent System (MAS)
  - Distributed and autonomous entities
  - Temporary coalition

- Negotiation methodology for VE formation
  - Multi-attribute and adaptive
  - Distributed dependencies resolution
  - Information privacy

Q-Negotiation
Q-Negotiation

• Call
  – Issued by a Market Agent
  – Specifies the Good, as a set of components
  – Specifies each Component as a set of attributes with admissible value ranges (without specifying an utility function)

• Making an initial proposal
  – Issued by those Enterprise Agents that are competent to satisfy the announced component(s)
  – The proposal includes those values that are preferable to the Enterprise Agent (while satisfying the admissible ranges)

Q-Negotiation

• Proposal evaluation
  – Quantifies the deviation of the values in the proposal as compared to the optimal values

\[
Ev = -\frac{1}{Deviation} \\
Deviation = \frac{1}{\sum_{i=1}^{k} \sum_{j=1}^{n} (k-j+1) \cdot \text{diff}(PrefV_i, V_j)}
\]

• Making a qualitative comment
  – A qualitative value (sufficient, bad, mediocre) is attributed to each of the attributes in the proposal
  – Describes the distance between the values of the current proposal and those of the best proposal received so far

– to say that there is a better proposal in the market
– is more convincing than
– to say that the current proposal is not optimal
**Q-Negotiation**

- **Remaking a proposal**
  - Uses an algorithm based on Q-learning
    \[
    Q(e,a) = Q(e,a) + \alpha [r + \gamma \max_b Q(e',b) - Q(e,a)]
    \]
  - Actions included in the exploration space are deduced according to the received comment
    - state: \( s = <cl_1, cl_2, ..., cl_k> \), \( cl_i \): qualitative comment relative to attribute \( i \)
    - action: \( a = <a_1, a_2, ..., a_k> \), \( a_i \in \{ \text{increment}, \text{decrement}, \text{maintain} \} \)

- **Reward** value is calculated according to the qualitative comment received (immediate reward)
  \[
  r = \begin{cases} 
  k, & \text{if winning} \\
  k/2 - \sum \text{penalty}, & \text{if not winning} \quad (0 \leq \text{penalty} \leq 1)
  \end{cases}
  \]

**Electronic Institution Platform for B2B Contracting**

Ontology-Mapping
What is Ontology?

- “An ontology defines the basic terms and relations comprising the vocabulary of a topic area as well as the rules for combining terms and relations to define extensions to the vocabulary.”

- “An ontology is an explicit specification of a conceptualization.”

- “An ontology is a formal specification of a shared conceptualization.”

- “An ONTOLOGY may take a variety of forms, but necessarily it will include a vocabulary of terms, and some specification of their meaning. This includes definitions and an indication of how concepts are inter-related which collectively impose a structure on the DOMAIN and constrain the possible interpretations of terms.”

Ontology Building

- Definition of:
  - Classes organized in a taxonomy (subclass-superclass)
  - Properties (attributes)
  - Relations
  - Instances (elements)
  - Axioms
  - Functions

- Representation languages:
  - Frames, RDF(S), OWL, XML Schema, Class hierarchies (e.g. Java)
Ontology-Mapping: Motivation

- Automating business interactions is not a trivial task
  - Simplifications are typically made regarding the ability of agents to understand each other

- Underlying assumptions regarding agents’ interoperability:
  - common language and interaction protocols
  - common understanding on domain-independent business vocabulary
    - proposal, deal, price
    - delivery, payment
  - common domain ontologies

The Heterogeneity Problem

- Interoperability between different agents
  - hindered by the use of different ontologies
    - with different representation formats
    - with different terminologies for the same concepts
    - with similar terminologies for distinct concepts

- Critical impediment to efficient business information exchange and to the automation of B2B processes

- Avoid heterogeneity problem?
  - common or shared ontology
  - unfeasible in open environments
  - conversion of own ontologies to common one is too troublesome

- Approach
  - an **Ontology Service Agent** for MAS(FIPA proposal)
  - ontology mapping
Agent-Based Automated Contracting

Ontology-Mapping Service

- **Principle:**
  - two different ontologies for the same domain will probably have concepts with a similar syntax and that share similar attributes
- **Assumption:**
  - domain ontologies describable in terms of classes and attributes

```
X
ax1 : T1
ax2 : T2

Y
ay1 : T1
ay2 : T2
```

- **Two approaches:**
  - *N-Grams*: lexical similarity
    - given two strings, compute the number of common sub-strings
  - *WordNet*: semantic similarity
    - a lexical database with semantic relations between words
Mapping Process

- Target class → set of candidate classes
  - choose best matching class

- Matching score between target (TC) and candidate class (CC)

1. Compute class name similarity score ns
2. Compute attribute list similarity score as
   - map every attribute in TC with attributes in CC
3. Return average of ns and as

- Similarity score

1. Compute N-Grams similarity score ngs
2. If ngs is satisfactory then return ngs
3. Compute WordNet similarity score wns
4. Return max(ngs, wns)

Example
Results

<table>
<thead>
<tr>
<th>Ontology A</th>
<th>Ontology B</th>
<th>Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photographic Equipment</td>
<td>Camera</td>
<td>0.81 (WordNet)</td>
</tr>
<tr>
<td>Price</td>
<td>price</td>
<td>1.00 (N-Grams)</td>
</tr>
<tr>
<td>Wireless</td>
<td>has_wiress</td>
<td>0.64 (N-Grams)</td>
</tr>
<tr>
<td>Lens Dimension</td>
<td>lens_size</td>
<td>0.85 (WordNet)</td>
</tr>
<tr>
<td>Sight Angle</td>
<td>vision_angle</td>
<td>0.73 (WordNet)</td>
</tr>
</tbody>
</table>

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<tr>
<td>Control</td>
<td>Command</td>
<td>0.97</td>
</tr>
<tr>
<td>Siren</td>
<td>Switch</td>
<td>0.82</td>
</tr>
<tr>
<td>Alarm</td>
<td>Alarm</td>
<td>0.90</td>
</tr>
<tr>
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Electronic Institution Platform for B2B Contracting

Normative Environment
Norms in Multi-Agent Systems

- Imposed, compile time, rigid
  - "rules of the game, interaction conventions
  - restriction on behavior, regimentation
  - norm violation, reactive enforcement

- Emergent, run-time, loose
  - normative support, default norms
  - contract negotiation
  - norm adoption
  - norm negotiation

Social norm emergence, patterns of behavior

Norms

- Definition 1
  - Informal guideline about what is considered normal (what is correct or incorrect) social behavior in a particular group or social unit. Norms form the basis of collective expectations that members of a community have from each other, and play a key part in social control and social order by exerting a pressure on the individual to conform. In short, "The way we do things around here."

- Definition 2
  - Formal rule or standard laid down by legal, religious, or social authority against which appropriateness (what is right or wrong) of an individual's behavior is judged.

Source: http://www.businessdictionary.com/
Institutional Normative Environment

Normative Environment $NE = (REA, BF, CR, NS, IR, N)$

Hierarchical Normative Framework

- Normative background that assists contract establishment
- “Default rules” (contract law)
Rule-based Automated Monitoring

Electronic Institution Platform for B2B Contracting

Computational Trust and Reputation
Computational Trust Systems

- They estimate the trustworthiness of agents in order to assist some specific trusting decision

- A computational handling of trust is critical to enable automating business processes between companies

- There are three main research challenges:
  1. How to build trust
  2. Which information sources must be considered
  3. How to formalize the process of trust building into a model

Which Information Sources to Use

- Direct experience
- Contractual evidences
- Shared images / opinions
- Reputation (as a social evaluation)
- Certificates / recommendations
- Roles in an institution
- Rules defined in the community
- Group trust
- Social networks (twitter, facebook, linkedin) / Internet
Our Computational Trust Model

- **Motivation:**
  1. The model must perform well when the number of evidences on the target agent is small
  2. The model should be situational-aware
  3. The model should incorporate known properties of the dynamics of trust
     - Additionally, contractual evidences should be used whenever available

The Sinalpha Aggregation Engine

- **Desired Characteristics:**
  - Asymmetry
  - Maturity
  - Distinguishable past
  - Embedded personality of trusting agents

\[ y(\alpha) = \delta \cdot \sin \alpha + \beta \]
\[ \alpha_{\text{min}} = \frac{3\pi}{2}, \alpha_{\text{max}} = \frac{5\pi}{2} \]
\[ \alpha = \alpha + \lambda \omega \]
Problems

- Traditional approaches fail to correctly model trust:
  - Trust is a socio-cognitive concept.
  - Trustworthiness is not single dimensional.
  - Trust is more than trustworthiness.
  - Approaches are evaluated using extremely simple agent behaviour models.

The SOLUM Framework
ANTE demo

- demo