Knowledge Representation Tools for Electronic Commerce

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P2P EC —what this talk is about?

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- Marketplace: mostly, Web Site with human interaction
- Renowned example: eBay
  `http://www.ebay.com`

Some figures

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. . . how did you choose?

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. . . *which reasoning* did you employed?

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- usually, the seller owns the Web Site
- the seller publishes offers
- the client browses...

- P2P: *Peer*-to-*Peer*
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- both parties can publish on the Web Site
- *Both* parties may take initiative (and browse...)

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Semantic Annotation is making Electronic Commerce an arena for Knowledge-based applications

Knowledge Representation tools can be used in *Logic-based Electronic Commerce* applications.

Outline of the talk —how I will try to argue?

1. √ P2P Electronic Commerce
2. *Enabling technologies*
3. General assumptions
4. Reasoning for Matchmaking
5. Reasoning for Negotiation
6. Languages and expressivity
7. What next?

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  — *OWL* - Web Ontology Language Overview
- *DAML* - DARPA Agent Markup Language
- Web Services can be described through languages like *DAML-S, OWL-S*,...

An Example in OWL — more precisely, OWL-Lite

“On-sale PCs are . . .

home PCs with at most one OS, of type WinX”

```
<owl:Class rdf:ID="onSalePC"/>
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    <owl:intersectionOf rdf:parseType="Collection">
      <owl:Class rdf:ID="homePC"/>
      <owl:Restriction>
        <owl:onProperty rdf:resource= "hasOS" />
        <owl: maxCardinality
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          1
        </owl:maxCardinality>
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  - formula consistent with $\mathcal{T} \cup \{O, R\}$

Most of the talk —the past is the prologue

1. √ P2P Electronic Commerce
2. √ Enabling technologies
3. √ General assumptions
4. *Reasoning for Matchmaking*
5. Reasoning for Negotiation
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What's Matchmaking?

First phase in a Bilateral Commercial Transaction:

1. *Matchmaking* (find counterpart)
2. Negotiation (agree/tradeoff details)
3. Exchange (goods, services, money)

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Do they match?

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How well they match? (compared to other offers/requests)

Aim: less browsing in P2P EC

Solution: move the reasoning methods from persons browsing ads into a *facilitator* system

—But: which reasoning?

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- *Revise* conflicting issues

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conflicting info: *430* vs. *360* (different models)

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in R, not in O: *Coupe/Spider, urgently required*

Evaluating the match

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- Offer: 2000/V FERRARI 360 Modena F1 *Argento Nurburgring with Bordeaux Leather* *22,700* £65,000 NE England

in O, not in R: color *Argento, Bordeaux Leather* seats, *22,700* miles, . . .

Abduction (history)

- C. S. Peirce (1839–1914)
  From $A \Rightarrow B$ and B, *abduce* A
- Abduction was the first step of scientific reasoning, the other two being
  - Deduction
  - Induction
- since Pople [1973] has been used to formalize Diagnosis in AI

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  - $\mathcal{T} \models H \wedge O \Rightarrow R$

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- vice versa for O, with a different H' such that $\mathcal{T} \models R \wedge H' \Rightarrow O$

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  - *e.g.*, expected utility from H's
- construct an *explanation* for match suggestions
  - *e.g.*, a facilitator that suggests “Offer 213 seems to be the best, supposing your requests *color:blue* and *Credit Card Payment* are satisfied”

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Different criteria:

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  - *e.g.*, minimal conjunctions if $\vee, \neg \notin \mathcal{L}$

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- *bundleOffer* is a *shortest* H
- neither solution is in the other set.

Intermezzo

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- what about conflicting information?

Belief Revision (history)

- Gärdenfors [1988], among many others:
  Revise Knowledge $\mathcal{K}$ with new info A by:
  1. *contracting* $\mathcal{K}$ into $\mathcal{K}^{-}_{\neg A}$ such that $\mathcal{K}^{-}_{\neg A} \not\models \neg A$
  2. *adding* A to $\mathcal{K}^{-}_{\neg A}$
- Intuition: contract the least

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- $\langle G, K \rangle$ is a *contraction* of R w.r.t. O

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- $\mathcal{T} = \left\{ \begin{array}{rcl} \mathit{firstFloor} \wedge \mathit{lastFloor} & \equiv & \mathit{house} \\ \mathit{flat} & \equiv & \neg \mathit{house} \end{array} \right\}$

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Alternatives to Belief Revision

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- formula α is preferred to formula β in the context ϕ with weight $x \in \mathbb{N}$

Negotiation

Second phase in a Bilateral Commercial Transaction:

1. $\surd$ Matchmaking (find counterpart)
2. *Negotiation* (agree/tradeoff details)
3. Exchange (goods, services, money)

Logic-based negotiation

- each agent puts utilities on formulas

e.g.,
$$\begin{cases} U_R(\textit{price2000}) &= 2 \\ U_R(\textit{1YearGuarantee}) &= 15 \end{cases}$$

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- additive utilities

  e.g.,

  $U_R(\mathit{price2000} \wedge \mathit{1YearGuarantee}) = 2 + 15$

Example: buyer

Utilities for R:

formula	$U_R(\cdot)$
FiatPanda	strict
fogLamps $\wedge$ *radio*	strict
price2000	2
price1000	5
1YearGuarantee	15

Example: seller

Utilities for O:

formula	$U_O(\cdot)$
FiatPanda	strict
1YearGuarantee $\Rightarrow$ *price2000*	strict
price2000	10
price1000	2

Agreements as models

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  - max-product: $\max_m\{U_O(m) \cdot U_R(m)\}$

Example, cntd.: agreement

satisfied formulas	R	O
FiatPanda	$\surd$	$\surd$
fogLamps $\wedge$ *radio*	$\surd$	
1YearGuarantee	15	
price2000	2	10
1YearGuarantee $\Rightarrow$ *price2000*		$\surd$
total utilities	17	10

Preliminary results — see next ECAI-06

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- Integer Linear Programming can be used, also for max-product
- any other methods provably better?
- No: finding an optimal agreement is NPO-complete
  - tailored approximation algorithms unlikely to exist, unless APX = NPO

Rest of the talk —do you need a coffee?

1. √ P2P Electronic Commerce
2. √ Enabling technologies
3. √ General assumptions
4. √ Reasoning for Matchmaking
5. √ Reasoning for Negotiation
6. *Languages and expressivity*
7. What next?

Which language for P2P EC?

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- why not Logic Programming?

Example, revisited —just an idea

- $R = \mathit{FiatPanda}, \mathit{radio}, \mathit{fogLamps}$
- $O = \mathit{FiatPanda}, \mathit{year2000}$
- $\mathcal{T} = \left\{ \begin{array}{rcl} \mathit{radio} & \textbf{:–} & \mathit{bundleOffer}. \\ \mathit{fogLamps} & \textbf{:–} & \mathit{bundleOffer}. \\ \mathit{alarm} & \textbf{:–} & \mathit{bundleOffer}. \end{array} \right\}$
- **:–**R can be derived from $\mathcal{T} \cup \{O\}$ if *bundleOffer* is *abducible*

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  - $-$ limited expressivity

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- Tommaso Di Noia
- Simona Colucci
- Azzurra Ragone
- ... among many others

An invitation — among many other conferences

- next *ACM Symposium on Applied Computing* (SAC-2007)
- track on Semantic-based Resource Discovery, Retrieval & Composition (SDRC)
- papers welcome!