What’s My Deal?  
Contract Communications in  
XML Agent Marketplaces

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Outline

• **Aiming to be provocative**

• 1. Intro: XML, Semantic Web
  – example: e-signatures: deeper issues & opportunities

• 2. What’s Doable Now in rule-based agent contracting
  – functionality: communicate, execute, modify
  – what kind of stuff represented by rules

• 3. Example of Agent Contract Communication:
  – Approach: Inter-operable, modular XML Rules represent parts of Contract Content

• 4. Applications:
  – Current
  – Vision

• **5. Discussion: Directions for the Glorious Future**

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**SweetDeal system**
Deeper Issues of E-Signatures

• WHAT’S THE DEAL ? ... !!
• SIGN AS WHAT ?? ... !!

• Vision/Approach: A net of documents combined by links, on the Web
Looks Simple To Start... 
then Gets Interestingly Precise

A Vision/Approach of what Web & Agents enable

SALES RECEIPT

Web info/knowledge “behind the curtain”

ComfieCo.com
5way Chair Blue

Operating Rules

of MIT Sloan

$140.
VISA Europe

Signed,

Benjamin

Receive ID 
# K46239...

Web links

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The Web is becoming XML → the Semantic Web

- XML (vs. HTML) offers much greater capabilities for structured detailed descriptions that can be processed automatically.
  - Eases application development effort for assimilation of data in inter-enterprise interchange
  - A suite of open standards both current and emerging
  - … including for knowledge-level SEMANTICS
- Soon, Agents will Talk according to these standards…
  - .. potential to revolutionize interactivity in Web marketplaces
  - B2B, …
What’s Doable Today in rule-based agent contracting, based on our approach to rule representation (“SweetDeal”)  

- Communicate: with deep shared semantics  
  - XML, inter-operable with same sanctioned inferences  
  - ↔ heterogeneous rule systems / rule-based agents  

- Execute contract provisions:  
  - infer; ebiz actions; authorize; ...  

- Modify easily: contingent provisions  
  - default rules; modularity; exceptions, overriding  

- Reason about the contract/proposal  
  - hypotheticals, test, evaluate; tractably  
  - (also need “solo” decision making/support by each agent)
Approach:

**Rule-based Contracts for E-commerce**

- Rules as way to specify (part of) business processes, policies, products: as (part of) contract terms.
- Complete or partial contract.
  - As default rules. Update, e.g., in negotiation.
- Rules provide high level of conceptual abstraction.
  - easier for non-programmers to understand, specify, dynamically modify & merge. E.g.,
  - by multiple authors, cross-enterprise, cross-application.
- Executable. Integrate with other rule-based business processes.
our SweetDeal System

• **SWEET** = Semantic WEb Enabling Technology
  - software components, theory, approach
  - pilot application scenarios, incl. contracting (SweetDeal)
• Uses/contributes *emerging standards* for XML and knowledge representation:
  - RuleML (co-founder)
  - WebOnt ontologies (W3C)
• Uses *repositories* of business processes and contracts
  - MIT Process Handbook (Sloan IT)
  - legal/regulatory sources: law firms, ABA, CommonAccord, … *Suggestions welcome!!*
Contract Rules across Applications / Enterprises

Contracting parties integrate e-businesses via shared rules.

Application 1, e.g., seller e-storefront
- Business Logic
  - Rules
    - e.g., OPS5

“E-Business”

Application 2, e.g., buyer shopbot agent
- Business Logic
  - Rules
    - e.g., Prolog

“E-Commerce”

Contract Rules Interchange

“E-Business”

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Examples of Contract Provisions
Well-Represented by Rules
in Agent Deal Making

• Product descriptions
  – Product catalogs: properties, conditional on other properties.

• Pricing dependent upon: delivery-date, quantity, group memberships, umbrella contract provisions

• Terms & conditions: refund/cancellation timelines/deposits, lateness/quality penalties, ordering lead time, shipping, creditworthiness, biz-partner qualification, service provisions

• Trust
  – Creditworthiness, authorization, required signatures

• Buyer Requirements (RFQ, RFP) wrt the above

• Seller Capabilities (Sourcing, Qualification) wrt the above
Contract Rules during Negotiation

Contracting parties NEGOTIATE via shared rules.
Exchange of *Rules Content* during Negotiation: example

**Buyer, e.g., manufacturer**

- Request For Quote
- Quote
- Purchase Order
- Ack. Deal

**Seller, e.g., supplier of parts**
Exchange of Rules Content during Negotiation: example

- Request for Proposal
- Proposal
- Counter-Proposal
- Final Offer
- Purchase Order
- Acknowledgment of Deal
Negotiation Example XML Document: Proposal from supplierCo to manufCo

- `<negotiation_message>`
  - `<message_header>`
  - `<proposal/>
  - `<from> supplierCo </from>
  - `<to> ManufCo </to>
  - `<message_header>`
  - `<rules_content>`
  - `…[see next slide]`
  - `<rules_content>`
  - `…`
  - `<negotiation_message>`

Example of similar message document format:

- FIPA Agent Communication Markup Language (draft industry standard).
Negotiation Ex. Doc. Rules:
Proposal from supplierCo to manufCo

- ...  
  \(<\text{usualPrice}>\ \text{price}(\text{per\_unit}, \ ?\text{PO}, \$60) \leftarrow\) 
- \ \text{purchaseOrder}(\ ?\text{PO}, \ \text{supplierCo}, \ ?\text{AnyBuyer}) \land 
- \ \text{quantity\_ordered}(\ ?\text{PO}, \ ?\text{Q}) \land (?\text{Q} \geq 5) \land (?\text{Q} \leq 1000) \land 
- \ \text{shipping\_date}(\ ?\text{PO}, \ ?\text{D}) \land (?\text{D} \geq 24\text{Apr}00) \land (?\text{D} \leq 12\text{May}00). 
- \ \langle\text{volumeDiscount}\rangle\ \text{price}(\text{per\_unit}, \ ?\text{PO}, \$51) \leftarrow 
- \ \text{purchaseOrder}(\ ?\text{PO}, \ \text{supplierCo}, \ ?\text{AnyBuyer}) \land 
- \ \text{quantity\_ordered}(\ ?\text{PO}, \ ?\text{Q}) \land (?\text{Q} \geq 100) \land (?\text{Q} \leq 1000) \land 
- \ \text{shipping\_date}(\ ?\text{PO}, \ ?\text{D}) \land (?\text{D} \geq 28\text{Apr}00) \land (?\text{D} \leq 12\text{May}00). \overright(\text{volumeDiscount} \ , \ \text{usualPrice}). 
- \ \bot \leftarrow \text{price}(\text{per\_unit}, \ ?\text{PO}, \ ?\text{X}) \land \text{price}(\text{per\_unit}, \ ?\text{PO}, \ ?\text{Y}) \ \text{GIVEN} \ (?\text{X} \neq \ ?\text{Y}). 
- \ ...
Negotiation Ex. Doc. Rules:

Counter-Proposal from manufCo to supplierCo

- ...  
  <usualPrice> price(per_unit, ?PO, $60) ← ... 
- <volumeDiscount> price(per_unit, ?PO, $51) ← 
  purchaseOrder(?PO, supplierCo, ?AnyBuyer) ∧ 
  quantity_ordered( ?PO, ?Q) ∧ (?Q ≥ 5) ∧ (?Q ≤ 1000) ∧ 
  shipping_date(?PO, ?D) ∧ (?D ≥ 28Apr00) ∧ (?D ≤ 12May00) . 
  overrides(volumeDiscount, usualPrice) .
- ⊥ ← price(per_unit, ?PO, ?X) ∧ price(per_unit, ?PO, ?Y) GIVEN (?X ≠ ?Y).
- <aSpecialDeal> price(per_unit, ?PO, $48) ← 
  purchaseOrder(?PO, supplierCo, manufCo) ∧ 
  quantity_ordered( ?PO, ?Q) ∧ (?Q ≥ 400) ∧ (?Q ≤ 1000) ∧ 
  shipping_date(?PO, ?D) ∧ (?D ≥ 02May00) ∧ (?D ≤ 12May00) . 
  overrides(aSpecialDeal, volumeDiscount) .
- overrides(aSpecialDeal, usualPrice) .
- ...

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Negotiation Example ---

XML Encoding of Rules in RuleML

• <rulebase>
• <imp>
• <_rlab>usualPrice</_rlab>
• <_head>
  • <clit>
  • <_opr><rel>price</rel></_opr>
  • <ind>per_unit</ind>
  • <var>PO</var>
  • <ind>$60</ind>
  • </clit>
• </_head>
• </_body> ... (see next page) </_body>
• </imp>
• ...
• </rulebase>
Negotiation Example --

XML Encoding of Rules in RuleML, Continued

- <body>
- <andb>
- <fclit>
  - <opr><rel>purchaseOrder</rel></opr>
  - <var>PO</var>
  - <ind>supplierCo</ind>
  - <var>AnyBuyer</var>
- </fclit>
- <fclit>
  ...
- </fclit>
- ...
- </andb>
- </body>

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Commercial Implementation & Piloting

• **IBM CommonRules**: AlphaWorks Java library
  – implements rule-based capabilities:
    • XML inter-operability; prioritized conflict handling

• **Rule Markup Language**: nascent industry standards effort
  – XML Knowledge Representation (KR) → make the Web be “Semantic”
  – KR: *Situated Courteous Logic Programs in XML*

• EECOMS industry consortium including Boeing, Baan, TRW, Vitria, IBM, universities, small companies
  – $29Million 1998-2000; 50% funded by NIST ATP
  – application piloted
    • contracting & negotiation; authorization & trust
Flavors of Rules Commercially Most Important today in E-Business

- E.g., in OO app’s, DB’s, workflows.

- Relational databases, SQL: Views, queries, facts are all rules.
- Production rules (OPS5 heritage): e.g.,
  - Blaze, ILOG, Haley: rule-based Java/C++ objects.
- Event-Condition-Action rules (loose family), cf.:
  - business process automation / workflow tools.
  - active databases; publish-subscribe.
- Prolog. “logic programs” as a full programming language.
- (Lesser: other knowledge-based systems.)
Criteria for Contract Rule Representation

1. High-level: Agents reach common understanding; contract is easily modifiable, communicatable, executable.
2. Inter-operate: heterogeneous commercially important rule systems.
3. Expressive power, convenience, natural-ness.
   ... but: computational tractability.
4. Modularity and locality in revision.
5. Declarative semantics.
   – essential feature in commercially important rule systems.
7. Prioritized conflict handling.
8. Ease of parsing.
9. Integration into Web-world software engineering.

OPC

OLP

Courteous

XML

Situated

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Also Currently Being Developed in the world today

- Delegations between agents
- XML Ontologies (Vocabularies)
  - knowledge representation: infer with definitional knowledge
  - specific domain/industry vocabularies
- DARPA Agent Markup Language: ontologies, rules
- Industry Standards:
  - Web, incl. Web services
  - Agents, Business Processes, Workflow
  - E-Commerce: ebXML, ...
  - Industry-Specific
  - Legal XML
- Law: Electronic Signatures, ...
- Reusable Contract doc’s on Web: CommonAccord, our work, ...

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Our Current Research Directions

• **SweetRules**: prototyping of SCLP RuleML inferencing, translation, knowledge integration
  – ontologies; justifications; queries; using Web protocols to invoke procedural actions; Jess.

• In **SweetDeal**, using **SweetRules**: deals about Web services, using MIT Process Handbook; integrating shallowly automated legal text; reputations; exception handling and management of risk contingencies; financial services; P3P privacy policies; and distributed trust management incl. for security authorization.

• *I.e.*, **Business Intelligence on the Semantic Web**
Thanks!

Questions?

Comments?  Pointers?

For More Info:
  – http://www.mit.edu/~bgrosof/
  • links to http://www.research.ibm.com/rules/
Speaker Bio

• Benjamin Grosof is Douglas Drane Assistant Professor in Information Technology at MIT Sloan School of Management. His research is to create and study knowledge-based information technology for e-commerce applications, including high-level business/agent communication, information integration, contracts/negotiation, trust, product descriptions, business rules/policies, Web services, and e-marketplaces. The pioneer of inter-operable XML business rules and of their application to contracting, he co-leads the RuleML emerging industry standards effort on inter-operable XML/RDF rules. He is PI currently for a project in the DARPA Agent Markup Language (DAML) initiative, to create Semantic Web technology and explore its business applications.

• Previously, he was a senior research scientist at IBM T.J. Watson Research Center (12 years there), where most recently he conceived and led IBM CommonRules (V3.0 currently on IBM alphaWorks) and co-led its application piloting for rule-based XML agent contracting in EECOMS, a $29 Million NIST industry consortium project on manufacturing supply chain management. His notable technical contributions also include fundamental advances in rule-based security authorization, conflict handling for rules, rule-based intelligent agents, and integration of rules with machine learning. He is author of over 30 refereed publications, two major software releases, and a patent. His recent service includes co-chairing the AAAI (National Conference on Artificial Intelligence) Workshops on AI in E-Commerce (1999) and Knowledge-Based E-Markets (2000). His background includes 2 years in software startups, PhD in Computer Science (specialty AI) from Stanford University, and BA in Applied Mathematics from Harvard University.
Intelligent Agents in Web E-Commerce

• Today: especially in the discovery phase of shopping
  – sales agents: recommend products, target ads
  – buyer agents: find vendors; compare offers on price, delivery, and availability

• Coming soon to a world near you:…
  – billions/trillions of agents
  – ...with smarts: knowledge gathering, reasoning, economic optimization
  – ...doing our bidding
    • but with some autonomy
Automating Contracting

- “Contract” in broad sense: = offering or agreement.
- “Automate” in deep sense: =
  - 1. Communicatable automatically.
  - 2. Executable within appropriate context of contracting parties’ business processes.
  - 3. Evaluable automatically by contracting parties.
    - “reason about it”.
  - 4. Modifiable automatically by contracting parties.
    - negotiation, auctions.
Contracting 1-2-3

1. Find Contracting Opportunity
2. Negotiate Contract
3. Execute Contract Terms

- DISCOVER
- NEGOTIATE
- EXECUTE

- Applies to any contracting, electronic or not.
- May iterate or interleave these steps.
- Boundaries not necessarily sharp.

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