Automating Contracting among XML Agents

Invited Presentation for
American Bar Association (ABA) Business Law Section Spring Meeting 2002: Cyberlaw Committee, E-Commerce Subcommittee, E-Contracting Practices Workgroup
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PREFACE: This talk is an updated/expanded version of a talk from last year’s ABA Mtg:

“Rule-based Technology for Automating Contracting by Agents”

Invited Presentation for
ABABusiness Law Spring Meeting 2001:
Cyberlaw Committee, Internet Law Subcommittee & Electronic Agents Task Force;
March 24, 2001 at Philadelphia Convention Center
Outline

• Aiming to be provocative

• 1. What is Law in the Small
  – 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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What is “Law in the Small”

- “Hum-drum”: agreements, “rules & regulations”
- contracts; e-signatures; authorizations
- regulations; bureaucratic forms, processes
- routine, but lots of details to be worked out & dealt with
  - what we deal with every day
  - not intrinsically controversial, usually doesn’t → court
  - no TV channels or shows, lacks glamour
- goal: minimize run-time human lawyer/client labor
- represent business policies and processes, many of which have legal aspects or legal weight
Law in the Small (continued)

• Dream: Automate it
  – specify
    • modify
  – infer
    • act, decide
  – communicate
    • find relevant
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
The Web is becoming XML

• 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

• 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)

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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!!*

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Contract Rules
across Applications / Enterprises

Contracting parties integrate e-businesses via shared rules.

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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.

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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

- Buyer, e.g., manufacturer
- Seller, e.g., supplier of parts

1. Req. For Proposal
2. Proposal
3. Counter-Proposal
4. Final Offer
5. Purchase Order
6. Ack. Deal

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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).

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Negotiation Ex. Doc. Rules: Proposal from supplierCo to manufCo

• ...
  <usualPrice> price(per_unit, ?PO, $60) ←
• purchaseOrder(?PO, supplierCo, ?AnyBuyer) ∧
• quantity_ordered( ?PO, ?Q) ∧ (?Q ≥ 5) ∧ (?Q ≤ 1000) ∧
• shipping_date(?PO, ?D) ∧ (?D ≥ 24Apr00) ∧ (?D ≤ 12May00).
• <volumeDiscount> price(per_unit, ?PO, $51) ←
• purchaseOrder(?PO, supplierCo, ?AnyBuyer) ∧
• quantity_ordered( ?PO, ?Q) ∧ (?Q ≥ 100) ∧ (?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).
• ...

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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) .
- ...

Simply added rules!
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) …
  • </imp>
  • …
• </rulebase>

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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
  - $29 Million 1998-2000; 50% funded by NIST ATP
  - application piloted
    - contracting & negotiation; authorization & trust

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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

- **High-level**: Agents reach common understanding; contract is easily modifiable, communicatable, executable.
- Inter-operate: heterogeneous commercially important rule systems.
- Expressive power, convenience, natural-ness.
- ... but: computational tractability.
- Modularity and locality in revision.
- Declarative semantics.
- Logical non-monotonicity: default rules, negation-as-failure.
  - essential feature in commercially important rule systems.
- Prioritized conflict handling.
- Ease of parsing.
- Integration into Web-world software engineering.
- Procedural attachments.
Extension of Approach: Combining Textual and Rule/deeply-Automated fragments of Contracts

- Exploit XML
  - *text* documents in XML
  - *rule* documents in XML
  - … in XML
  - “swap ‘em and glue ‘em, over and over”
  - *reusable* contract fragments, e.g., 1st steps:
    - SweetDeal repository
    - CommonAccord.com: textual
- Support *incremental* evolution of automation & adoption
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
  - Agents, Business Processes, Workflow
  - E-Commerce
  - Industry-Specific
  - Legal XML
- Law: Electronic Signatures, …
- Reusable Contract doc’s on Web: CommonAccord, our work, …

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Applications: Current and Visions

- product and contract/deal descriptions
- negotiation
- authorization
- automating legal reasoning and processes
- evidence
- regulations
- Alternative Dispute Resolution
- adjudication, legal decision-making
- … ?pointers?
• 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 $29Million 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.
Launch Vector:  My Background  
E-Commerce Agents, Rules:  Techno + Biz

- Harvard BA math econ & mgm sci
- startups
- Stanford CS (Computer Science) PhD in AI
- IBM Watson Research: IA for EC
  - Led Intelligent Agents, Business Rules for E-Commerce
- MIT Sloan:  Information Technology group
- Technology end of B-school IT world
  - how/where the technology is useful, important
  - business value; implications for processes & strategies
  - market evolutions; innovation paths; organizational changes
Background in Law-related Research

• Overall: formally represent policies and info as rules
• Evidential Reasoning: probabilistic, fuzzy, ...
• Bureaucratic Processes as domain
  – pioneer within AI knowledge representation community
• Argumentation with rule-based beliefs:
  – efficient algorithms
  – theory
  – bridge to commercially practical rule-based/database systems
• Contracting & Negotiation, Authorization & Trust

• Invited Speaker at 2001 International Conference on AI & Law:
  – “Automating Law in the Small: Contracts, Regulations, and Prioritized Argumentation”
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”.
    • negotiation, auctions.
Contracting 1-2-3

DISCOVER

Find Contracting Opportunity

NEGOTIATE

Negotiate Contract

EXECUTE

Execute Contract Terms

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