Business Rules for E-Commerce:

Interoperability and Conflict Handling

Dr. Benjamin Grosof
IBM T.J. Watson Research Center
Hawthorne, NY, USA
grosof@us.ibm.com http://www.research.ibm.com/people/g/grosof

Overview

- Intro & Background
  - Overall mission, technical approach, industry trends
  - EECOMS project (NIST ATP) on inter-enterprise supply chain integration
- Core Technology: CommonRules prototype based on logic program KR
  - Innovative conflict handling, procedural attachments; sample engine
  - XML Interlingua between heterogeneous rule systems; standards play
- Applications: represent business processes/workflow, policies, products
  - Contracts/agreements, negotiation esp. B2B, security authorization
  - EECOMS supply chain scenarios, Net.Commerce-type B2C scenario
- Directions
  - External alpha release in about 7/99 of core technology
  - Explore more applications

Vision overall

- Vision: Rules as an important aspect of coming world of Internet e-business: rule-based business processes for both B2B and B2C.
  - represent buyer's requests, interests, bids
  - represent seller's offerings of products & services, capabilities, bids; map offerings from multiple suppliers to common catalog.
  - represent business processes, e.g., sales help, customer help, procurement, authorization, brokering, workflow.
  - automatic execution; matchmaking of buyers with sellers
  - high level of conceptual abstraction, easier understanding and specification by non-programmers

Rules: Fundamental Technical Approach

- Aim to enable: <u>exchange & update business rules</u>, dynamically.
- Context: key application logic is represented via rules, in many systems. E.g.,
  - rules about terms & conditions associated with a product or service in Internet purchasing.
  - exchange among multiple supply chain players:
    - price vs. quantity vs. delivery date
    - when and how to order or return items, that impact planning.

Rules: Fundamental Technical Approach (continued)

- Declarative approach: provide semantics that is clean and deep.
- Facilitate specification of a given rule set:
  - by multiple authors, cross-enterprise, cross-application
  - by non-technical authors
  - dynamically
  - with abstraction level more easily human-understandable
- Enable conflict handling in multiple rule systems.
- Interoperate between multiple rule systems via common-core interlingua: inter-agent standards in XML.

Applications of Rules our work to-date: Overview

- Can view generally in terms of business processes, including workflow.
  - rules are good to capture if-then conditionality esp. involving chaining.
- Storefront/catalog-based services: initially, B2C personalization/promotions.
- *Contracts/agreements.
  - represent products or services, or service terms & conditions of product.
  - <u>executable</u> specification
  - partially-specified / template, during process of negotiation.
- *Negotiation, esp. B2B:
  - represent contents of proposals, counter-proposals, RFQ’s, RFP’s.
  - configure auction mechanisms based on contract templates.
- *Security authorization policies: including delegation, certificates.
  - often, are really a part of overall business policy, at application-level.
- * = in EECOMS inter-enterprise supply chain scenarios. EECOMS is a $29Million 3-year NIST ATP consortium effort led by IBM.

Applications of Rules: earlier work on Agent Building Environment

- Can view generally in terms of business processes, including workflow.
  - rules are good to capture if-then conditionality esp. involving chaining.
- Embeddable technology for building rule-based intelligent agent capabilities into applications.
- Class of applications: filtering and routing of info items
  - mail, news, Lotus Notes documents
  - customer service / help desk
  - workflow in manufacturing: design changes, plant floor alerts

EECOMS Example of Conflicting Rules

- Vendor's rules that prescribe how buyer must place or modify an order:
- A) 14 days ahead if the buyer is a qualified customer.
- B) 30 days ahead if the ordered item is a minor part.
- C) 2 days ahead if the ordered item's item-type is backlogged at the vendor, the order is a modification to reduce the quantity of the item, and the buyer is a qualified customer.

- Suppose more than one of the above applies to the current order? **Conflict!**

- Helpful Approach: **precedence** between the rules. Often only *partial* order of precedence is justified. E.g., $C \succ A$.

Courteous LP's: Example

- <leadTimeRule1> orderModificationNotice(?Order,14days)
- ← preferredCustomerOf(?Buyer,?Seller) ∧
- purchaseOrder(?Order,?Buyer,?Seller) .
- <leadTimeRule2> orderModificationNotice(?Order,30days)
- ← minorPart(?Buyer,?Seller,?Order) ∧
- purchaseOrder(?Order,?Buyer,?Seller) .
- <leadTimeRule3> orderModificationNotice(?Order,2days)
- ← preferredCustomerOf(?Buyer,?Seller) ∧
- orderModificationType(?Order,reduce) ∧
- orderItemIsInBacklog(?Order) ∧
- purchaseOrder(?Order,?Buyer,?Seller) .
- overrides(leadTimeRule3 , leadTimeRule1) .
- ⊥ ← orderModificationNotice(?Order,?X) ∧
- orderModificationNotice(?Order,?Y); GIVEN ?X ≠ ?Y.

XML Interlingua for Example

```
<clp>
  <erule rulelabel="leadTimeRule1">
    <head>
      <cliteral predicate="orderModificationNotice">
        <variable name="?Order"/>
        <function name="days14"/>
      </cliteral>
    </head>
    <body>
      <and>
        <fcliteral predicate="preferredCustomerOf">
          <variable name="?Buyer"/>
          <variable name="?Seller"/>
        </fcliteral>
        <fcliteral predicate="purchaseOrder">
          <variable name="?Order"/>
          <variable name="?Buyer"/>
          <variable name="?Seller"/>
        </fcliteral>
      </and>
    </body>
  </erule>
...
</clp>
```


CommonRules Example: bookstore Web storefront

- B2C personalized promotions:
  - discounting
  - showing targeted ads with incentives
- Rules & facts from:
  - marketing managers: with updates & merges
    - priorities from recency, authority, specificity
  - data mining
  - DB
  - dynamic Web session data

INSERT Bookstore Web E-Storefront App Example SLIDES

- Running example in CommonRules: includes about 60 rules and facts.
- See IBM Research Report RC 21473 “DIPLOMAT...Demonstration”
- Alternatively, see file bookstoreExampleUnified10-30-98.txt .

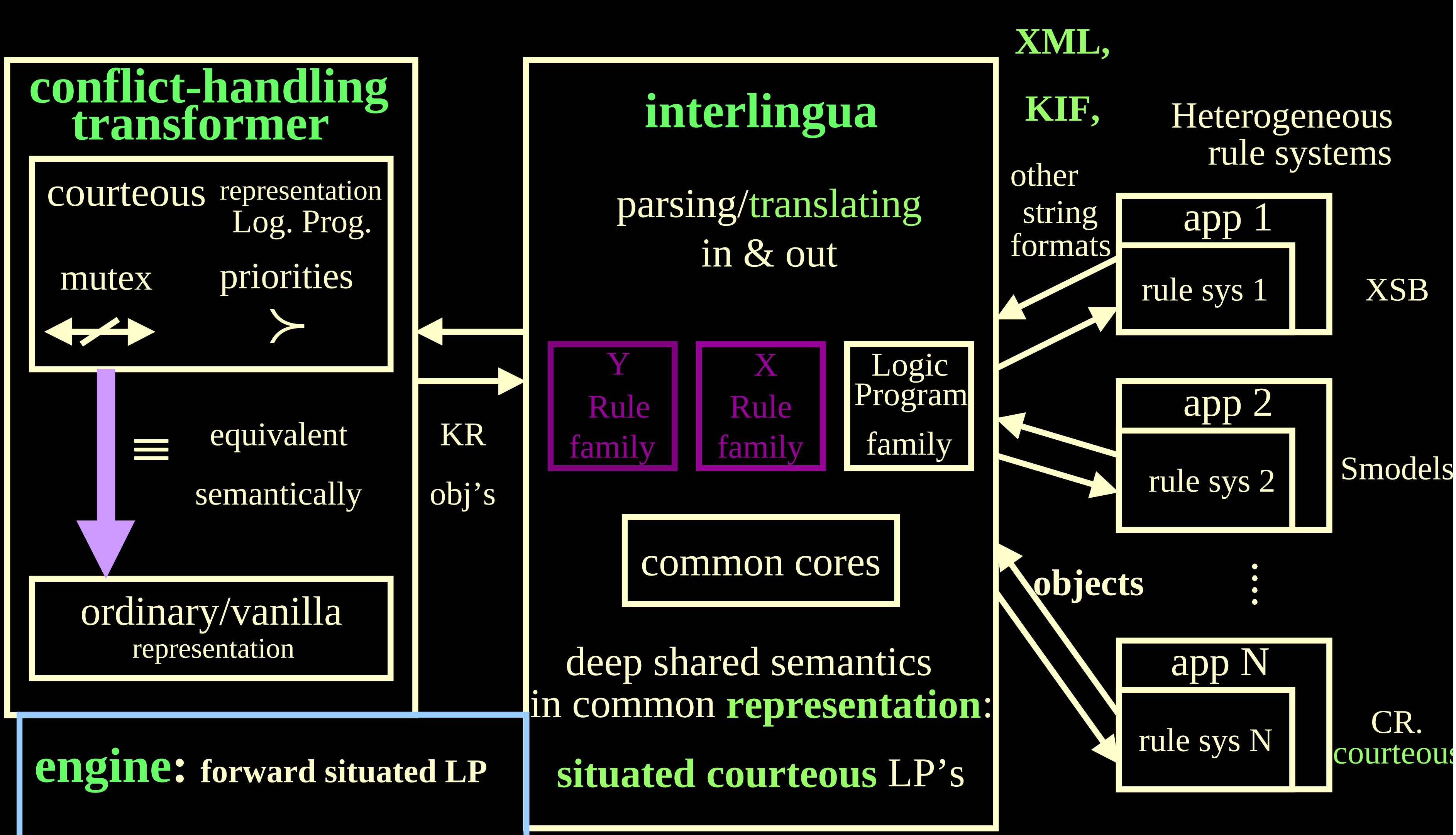
CommonRules technology overview

- Java library, V1 prototype running.
  - plan external alpha release 7/30/99 on AlphaWorks http://alphaworks.ibm.com
  - piloting in EECOMS $29Million NIST ATP project (IBM, Baan, Boeing, universities, other co.'s)
- Basic rule representation: <u>Logic programs</u> (LP's).
  - LP's in declarative sense, not Prolog. E.g., forward or backward chaining.
  - representation = syntax + deep semantics.
    - semantics of rule set = its set of valid conclusions.

CommonRules technology overview (continued)

- Extends rule representation to:
  - Courteous LP's:
    - prioritized handling of **conflicts**, e.g., in updating/merging.
  - Situated (Courteous) LP's:
    - **procedural attachments** to invoke non-reasoning actions or queries, via methods external to inferencing engine.
- Courteous Compiler from courteous LP's to ordinary LP's.
- XML Interlingua and sample translators.
  - interlingua = common rule representation for translation between heterogeneous rule systems. Suitable to become industry standard.
- Sample Inferencing/Execution Engine:
  - forward-chaining situated courteous LP's.

Current-version CommonRules



Flavors of Rules Commercially Most Important in E-Business

- E.g., in OO app's, DB's, workflows.

- Logic Programs (in pure knowledge-representation sense): e.g.,
  - Relational databases, SQL.
  - Prolog; Knowledge-based systems.
- Production rules (OPS5 heritage): e.g.,
  - Neuron Data rule-based Java objects.
  - IBM VisualBanker using (Haley).
- Event-Condition-Action rules (loose family), cf.:
  - business process automation / workflow tools.
  - active databases; publish-subscribe.

Overview (repeated)

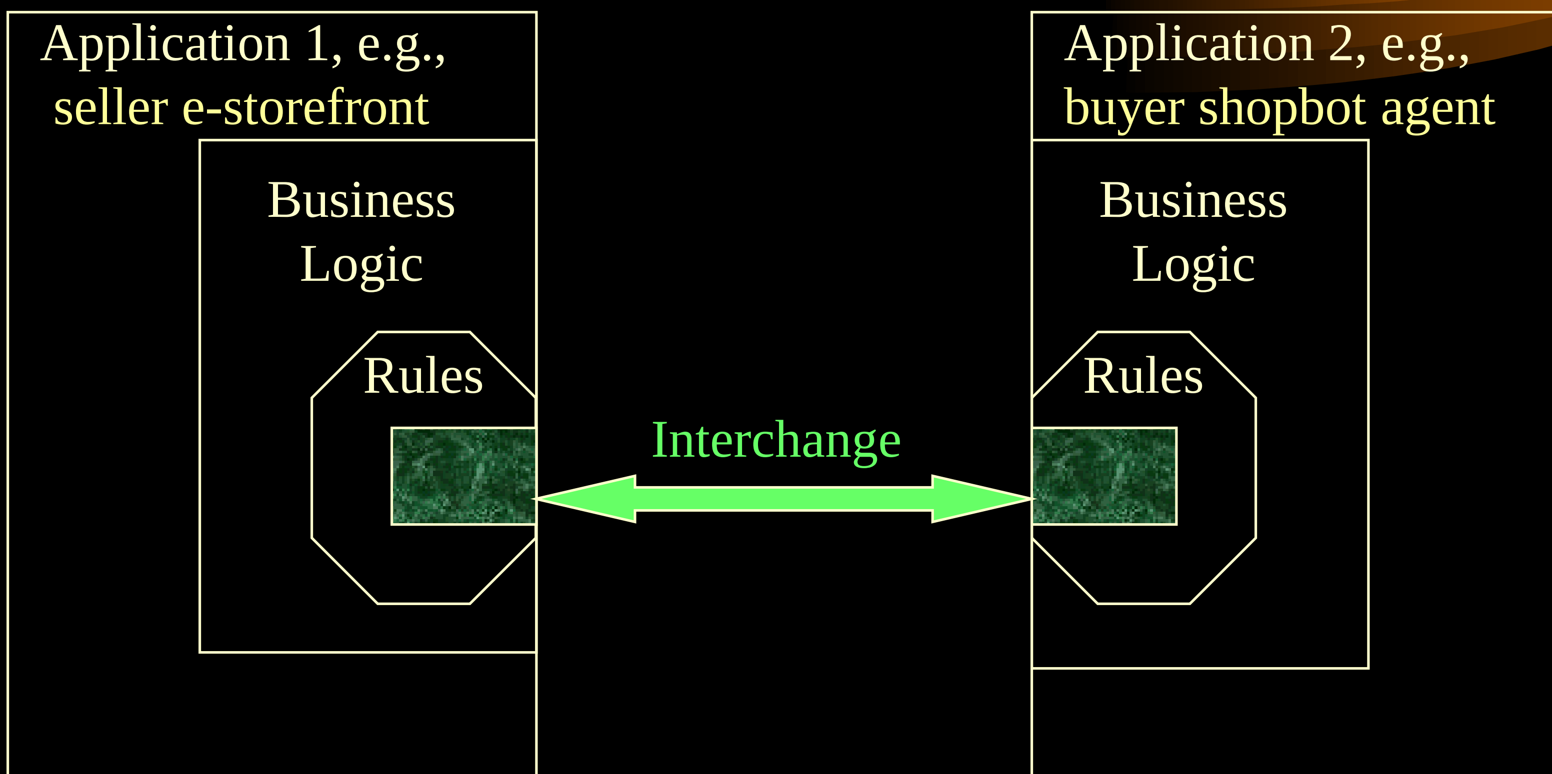
- Intro & Background
  - Overall mission, technical approach, industry trends
  - EECOMS project (NIST ATP) on inter-enterprise supply chain integration
- Core Technology: CommonRules prototype based on logic program KR
  - Innovative conflict handling, procedural attachments; sample engine
  - XML Interlingua between heterogeneous rule systems; standards play
- Applications: represent business processes/workflow, policies, products
  - Contracts/agreements, negotiation esp. B2B, security authorization
  - EECOMS supply chain scenarios, Net.Commerce-type B2C scenario
- Directions
  - External alpha release in 7/99 of core technology
  - Explore more applications

OUTLINE OF OPTIONALS SLIDES

- Part 1: for Introductory section of talk
- Part 2: about EECOMS
- Part 3: more Technical Details, including logic programs, courteous, situated, applications, etc..

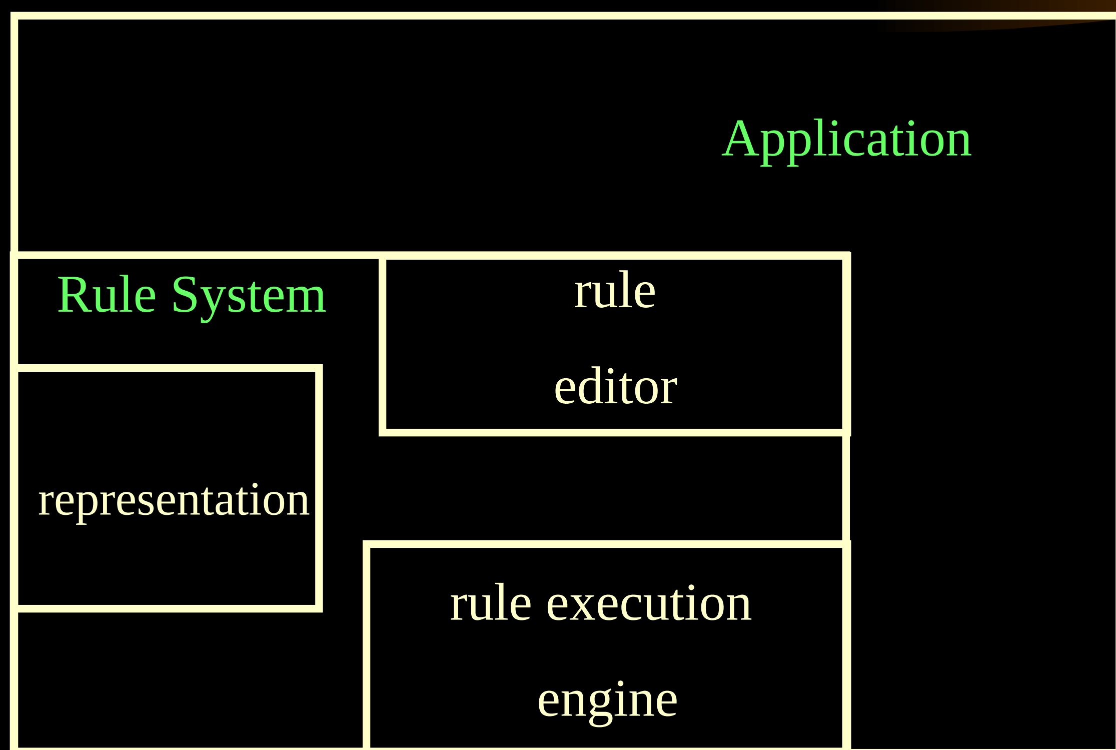
PART-1 OPTIONALS FOLLOW: from INTRODUCTORY-section

Rules across Applications



 by Benjamin Grosof IBM

Application Using Rules



Roles for Rules

- 1st step: Rules as rigorous specification without execution.

- 2nd step (our main focus): Rules as executable specification.
  - Coarse-grain integration with rest of code. E.g.:
    - rules engine in wrapper, agent, workflow, database, extended transaction monitor, ….

- 3rd step: Fine-grain integration with rest of code. E.g.:
  - Object-oriented application development tool's rules feature.

Rules Authoring Approaches

- Graphical.
- Natural Language (limited).
- Pre-defined templates and vocabulary.
  - domain/industry specific.
  - application/suite specific.

PART-2 OPTIONALS FOLLOW: about EECOMS

EECOMS Supply Chain Project: Overview

- EECOMS = Extended Enterprise Consortium for Integrated Collaborative Manufacturing Systems.
- IBM-led consortium, 50%-funded by US government's NIST Advanced Technology Program. $29M over 3 years, ends 2001.
- Advanced supply chain management. Consortium includes manufacturing software vendors, rules and tool vendors, manufacturer customers.
- Business Focus: improve **"agility"** of manufacturing. Respond to common but unpredictable events such as late delivery, plant line breakdown, larger than expected order. React quickly, including modify plans, schedules. Integrate: typically multi-application, very often multi-enterprise.
- Technical Focus: **rules and conflict handling**; virtual situation room for human collaborative workflow; attendant tools, agents, and security issues.
- Is follow-on to CIIMPLEX (IBM-led NIST ATP $22M) & challenges it identified. Shares: consortium, scenarios, agent-based approach.

EECOMS Supply Chain Project: ***Our Role***

- **Rules** primarily:
  - application Scenarios with customers.
  - **interlingua**.
  - **conflict handling**.
  - for **security authorization** policies (trust management).

- Multiple, heterogeneous rule systems within consortium: from vendors, universities.

EECOMS: Participants

- IBM is leader of consortium, via its Manufacturing ISU. Runs EECOMS Project Office, EECOMS Integration Center and Tools Dev..
- IBM org.'s involved: T.J. Watson Research, Supply Chain Optimization Prod. Dev., Supply Chain Manuf. Sol'ns, Synchronous Collaboration Tools and AD (Austin).
- Boeing military aircraft. A major manufacturer. Acts as customer.
- Berclain, part of Baan: major manufacturing / ERP software vendor.
- Universities as IBM sub-contractors: U. NC Charlotte, U. MD Baltimore, U. Florida. Contribute research-ily to all technical foci.
- Vitria, EnvisionIt, IndX, Scandura: (small) tools/specification vendors.
- TRW supply-chain consulting practice. Acts as customer(s).

EECOMS: Main Collaborators

- Prof.'s Tim Finin and Yannis Labrou of U. Maryland (Baltimore):
  - negotiation protocols between agents; FIPA standards for these
  - XML versions of FIPA and KIF draft standards
  - security authorization policies, delegation
- Prof.'s Bill Chu and Bob Wilhelm of U. N. Carolina (Charlotte)
  - constraint satisfaction and optimization in private negotiation decisions
  - integrating rule-based authorization policies into security services
- Prof.'s Stanley Su and Joachim Hammer of U. Florida (Gainesville)
  - negotiation architecture
  - Event-Condition-Action rule system
- Lynne Thieme of Vitria Technologies
  - business process automation and publish-subscribe
  - Event-Condition-Action rule system

EECOMS: Virtual Situation Room

- **Human** business process and workflow: for timely, agile response.
- **Distributed, inter-enterprise.**
- Leads:
  - Concept: Bill Tolone of UNC Charlotte (IBM sub-contractor)

PART-3 OPTIONALS FOLLOW: about more Technical Details

 by Benjamin Grosof IBM

Logic Programs as basic representation: Definition

- A LP is a set of (premise) rules; semantically, it specifies a set of conclusions.
- Example rule:
- sendPage(?msg,Joe) $\leftarrow$ from(?msg,?s) $\wedge$ urgent(?msg) $\wedge$ caresAbout(Joe,?s).
- where the "?" prefix indicates a logical variable.
- Generally, a rule has the form of Head IF Body :
- $H \leftarrow B_1 \wedge \ldots \wedge B_j \wedge \sim B_{j+1} \wedge \ldots \wedge \sim B_m$.
- where $m \geq 0$; $\wedge$ stands for logical "AND"; $\leftarrow$ stands for logical "IF"; and H, $B_1, \ldots, B_m$ are each an <u>atom</u> with form: Predicate($Term_1, \ldots, Term_k$).
- A predicate = a relation. An atom semantically denotes a boolean.
- ~ stands for <u>negation-as-failure</u> (a.k.a. weak negation, default negation).
  - The negation-as-failure construct is logically non-monotonic.
  - Intuitively, ~p means p's truth value is either *false* OR *unknown*.

Logic Programs: Definition (continued)

- Each argument $Term\_1$, ..., $Term\_k$ is a term.
- A term is either a logical constant (e.g., “Joe”) OR a logical variable (e.g., “?msg”) OR a functional expression of the form:
- LogicalFunction($Term\_1$, ..., $Term\_k$)
- A functional expression semantically essentially denotes a logical constant.
- A term, atom, or rule is called “ground” when it has no logical variables.
- A fact is a ground rule with empty body.
- A primitive conclusion has the form of a ground atom (compound conclusions are built up from these via logical operators such as AND etc.).
- Semantically, a rule or LP stands for the set of all its ground instances.
- (Observe that a rule body can represent an expression in relational algebra cf. relational DB’s (e.g., SQL).)

Logic Programs as basic representation: Advantages

- <u>Declarative</u>: semantics is independent of inferencing procedure implementation, e.g., forward vs. backward chaining, sequencing of executing rules or conditions within rules.
- <u>Expressive</u>: relational expressions cf. SQL, large fragment of first-order logic, <u>chaining</u>, basic logical <u>non-monotonicity</u> (unlike first-order logic).
- <u>Efficient</u>: computationally tractable given two reasonable restrictions:
  - 1. Datalog = no logical functions of non-zero arity.
  - 2. Bounded number v of logical variables per rule.
  - $m = O(n^{(v+1)})$, where $n = ||LP||$, $m = ||\text{ground-instantiated } LP||$.
  - Inferencing time is $O(m)$ for broad (acyclic) case, $O(m^2)$ generally (for well-founded semantics).
  - By contrast, first-order-logic inferencing is NP-hard.

Logic Programs: Advantages (continued)

- Widely deployed and familiar:
  - relational DB's, SQL
  - Prolog
  - intelligent agents and knowledge-based systems
    - e.g., IBM's Agent Building Environment
- Common core shared semantically by many rule systems: e.g., production rules, Event-Condition-Action rules, first-order-logic each overlap strongly with LP's.

Courteous LP's: the What

- Updating/merging of rules sets: is crucial, often generates conflict.
- Courteous LP's feature prioritized handling of conflicts.
- Specify scope of conflict via a set of mutual exclusion constraints.
  - E.g., $\bot \leftarrow$ discount(?product,5%) $\wedge$ discount(?product,10%) .
  - E.g., $\bot \leftarrow$ loyalCustomer(?c,?s) $\wedge$ premiereCustomer(?c,?s) .
  - Permit classical-negation of atoms: $\neg$p means p has truth value *false*
    - implicitly, $\bot \leftarrow p \wedge \neg p$ for every atom p.
- **Priorities** between rules: partially-ordered.
  - Represent priorities via reserved predicate that compares rule labels:
    - overrides(rule1,rule2) means rule1 is higher-priority than rule2.
    - Each rule optionally has a rule label whose form is a logical constant.
    - overrides can be reasoned about, just like any other predicate.

Courteous LP's: Example (repeated)

- <leadTimeRule1> orderModificationNotice(?Order,14days)
- ← preferredCustomerOf(?Buyer,?Seller) ∧
- purchaseOrder(?Order,?Buyer,?Seller) .
- <leadTimeRule2> orderModificationNotice(?Order,30days)
- ← minorPart(?Buyer,?Seller,?Order) ∧
- purchaseOrder(?Order,?Buyer,?Seller) .
- <leadTimeRule3> orderModificationNotice(?Order,2days)
- ← preferredCustomerOf(?Buyer,?Seller) ∧
- orderModificationType(?Order,reduce) ∧
- orderItemIsInBacklog(?Order) ∧
- purchaseOrder(?Order,?Buyer,?Seller) .
- overrides(leadTimeRule3 , leadTimeRule1) .
- ⊥ ← orderModificationNotice(?Order,?X) ∧
- orderModificationNotice(?Order,?Y); GIVEN ?X ≠ ?Y.

Priorities are available and useful

- Priority information is naturally available and useful. E.g.,
  - recency: higher priority for more recent updates.
  - specificity: higher priority for more specific cases (e.g., exceptional cases, sub-cases, inheritance).
  - authority: higher priority for more authoritative sources (e.g., legal regulations, organizational imperatives).
  - reliability: higher priority for more reliable sources (e.g., security certificates obtained by delegation, assumptions, observational data).
  - closed world: lowest priority for catch-cases.
- Many practical rule systems employ priorities of some kind, often implicit, e.g.,
  - rule sequencing in Prolog and production rules.

Courteous LP's: Advantages

- Facilitate updating and merging.
- Expressive: classical negation, mutual exclusions, partially-ordered prioritization, reasoning to infer prioritization.
- Guarantee consistent, unique set of conclusions.
  - **Mutual exclusion is enforced**. E.g., never conclude both p & ¬p.
- Efficient: low computational overhead beyond ordinary LP's.
  - Tractable given reasonable restrictions (Datalog, bound v on #var's/rule):
    - extra cost is equivalent to increasing v to (v+2) in ordinary LP's.
  - By contrast, more expressive prioritized rule representations (e.g., Prioritized Default Logic) add NP-hard overhead.

Situated LP's: Overview

- Point of departure: LP's are pure-belief representation, but most practical rule systems want to invoke external procedures.
- Situated LP 's feature a semantically-**clean** kind of **procedural attachments**. I.e., they hook beliefs to drive procedural API's outside the rule engine.
- Procedural attachments for **sensing** (queries) when testing an antecedent condition or for **effecting** (actions) upon concluding a consequent condition. Attached procedure is invoked when testing or concluding in inferencing.
- Sensor or effector **link** statement specifies an association from a predicate to a procedural call pattern, e.g., a method. A link is specified as part of the representation. I.e., a SLP is a conduct set that includes links as well as rules.

Situated LP's: Overview (continued)

- phoneNumberOfPredicate ::s:: BoeingBluePagesClass.getPhoneMethod .
  ex. sensor link
- shouldSendPagePredicate ::e:: ATTPagerClass.goPageMethod .
  ex. effector link
- Sensor procedure may require some arguments to be ground, i.e., bound; in general it has a specified binding-signature.
- Enable dynamic loading and remote loading of the attached procedures (exploit Java goodness).
- Overall: cleanly separate out the procedural semantics as a declarative extension of the pure-belief declarative semantics. Easily separate chaining from action.

Courteous Compiler

- Transformer compiles a courteous LP into an ordinary LP.
- A radically innovative approach in rules representation.
- "Compiles away" conflict, as modular add-on to rule system X's
  - inferencing
  - specification
- Enables courteous features to be added to, or implemented in, a variety of rule systems.

Interlingua Concept

- Challenge: heterogeneity of rule systems (within applications) to be integrated.
  - Each has own rule representation. N of them.
  - Representation = syntax + **semantics**.
- Approach: translate via interlingua rep'n.
  - rep'n A ↔ interlingua ↔ rep'n B.
  - Advantage: O(N) translators instead of O(N^2).
- *Focus: commercially important rep'n families:
  - LP's, production (OPS5), Event-Condition-Action.
  - E.g., in OO app's, DB's, workflows.

Interlingua: Deep Shared Semantics at Core

- Desire: deep semantics (model-theoretic) to
  - understand and execute **imported** rules.
- Possible only for shared expressive subsets: “cores”.
  - Rest translated with superficial semantics.
- Desideratum: declarativeness of core / rep’n (in sense of knowledge representation theory).
  - Maximize overall advantages of rules:
    - Non-programmers understand & modify.
    - Dynamically (run-time) modify.

Interlingua: Going Beyond KIF

- Point of departure is KIF: Knowledge Interchange Format
  - Intent: general-knowledge interlingua.
  - Emerging standard, in ANSI commmittee.
  - Main focus: classical logic, esp. first-order.
  - Has major limitations remedied by our Interlingua:
    - logically monotonic; no conflict handling or priorities.
    - pure-belief: no procedural attachments.
- Our Interlingua uses situated courteous LP's rep'n.
  - Complements KIF.   Overlaps on:
    - pure-belief rules without negation-as-failure.

Interlingua: current version

- XML format ↔ Java objects ↔ text syntax for rule system X
- Sample translators to/fro KIF and 3 rule systems in LP family, initially with pure-belief semantics as courteous LP rep'n.
  - backward-direction: XSB (Stonybrook, commercializing).
  - forward-direction: Smodels (Helsinki, academic).
  - CommonRules courteous LP text syntax:
    - courteous expressiveness: mutex's, priorities.

Interlingua: early standards engagements

- FIPA = Foundation for Intelligent Physical Agents
  - Standards body: main industry locus of action since '96 for intelligent agents knowledge-interchange standards work, e.g., for Internet e-commerce negotiation between agents.
  - Current draft standard uses ANSI KIF to represent rules.
  - In collaboration with U. Maryland, we are driving XML version of KIF, in synch with our IBM rules interlingua and EECOMS.
  - In early discussions about going beyond KIF.
- ANSI KIF
  - We have long-running role in committee: non-monotonicity and conflict handling.

Sample Rule Engine: current version

- Sample Inferencing/Execution Engine:
  - forward-chaining situated courteous LP's.
- Composes *courteous compiler* with engine for situated *ordinary* LP's.
- Intent is proof-of-concept for Interlingua, courteous compiler, situated techniques.
  - Not performance-tuned.
  - Lacks various features found in best-of-breed commercial rule systems.
    - Restricted to acyclic case (no predicate depends thru rules on itself).
- IBM is not in the rule-engine business, we will partner with commercial rule-system vendors to license their technology
  - ... which CommonRules complements and extends.

Contracts/Agreements

- Use Interlingua to represent products or services, or service terms & conditions of product, e.g., in catalog or during negotation.
  - E.g., business process to return an item for repair, or to deliver an order.
- Executable specification; situated / procedural attachments is esp. useful.
- Partially-specified / template, esp. during process of negotiation.
- Complement XML ontologies already evolving for various domains.
  - Ontology = formally-represented vocabulary / definitions
- Configure automated auction mechanisms, based on contract templates.
  - which goods, which attributes (e.g., price, delivery-date) are at issue.
- In collaboration with: EECOMS and
  - Prof. Mike Wellman and PhD student Dan Reeves of U. Michigan (Ann Arbor), as IBM-funded University Partnership project started 1/99.
    - Mike leads AuctionBot, a major existing automated Internet service.

Negotiation, esp. B2B

- Use Interlingua to represent contents of:
  - Requests For Quotation or Proposal, i.e., statements of buyer interests, that initiate inter-enterprise negotiation.
  - responses to such RFQ's / RFP's by seller.
  - proposals and counter-proposals and "side information" exchanged during back-and-forth negotation / bargaining between buyer and seller.
  - statements of seller/supplier capabilities/interests, e.g., important for source selection as well as bargaining.
- Configure auction mechanisms based on contract templates. (with U. Mich.)
- In collaboration with U. Mich. and:
  - in EECOMS overall effort, negotiation is a main '99 focus of demos and scenarios.

Security Authorization Policies

- Use rule-based executable specification of security authorization policies, a.k.a. trust management: including delegation, certificates.
  - We have the first step of an expressive extension of courteous LP's to handle delegation and certificates.
- Often, authorization policy is really a part of overall business policy, at app-level. This contrasts with authentication.
- Advantages of rule-based approach, esp. from declarative semantics:
  - principled handling of negation and conflict.
  - provable guarantees of behavior of implementation.
  - more human-understandable and easy to modify.
  - easier integration with general business policy.

Security Authorization Policies (continued)

- In collaboration with:
  - Joan Feigenbaum of ATT Research which has a leading effort on trust management, and her PhD student Ninghui Li of NYU.
  - EECOMS: as a main focus of EECOMS innovation in Security SIG (area of consortium).

overall key Challenges identified

- **Exchange & update business rules**, dynamically. E.g.,
  - compose an application from multiple components.
    - Net.Commerce-type B2C: marketing manager, data miner, ...
  - buy/sell or integrate between heterogenous peer applications.
    - B2B inter-enterprise supply chain in manufacturing industry.
      - E.g., when and how to order or return items, that impact planning.
    - Internet purchasing: terms & conditions.
- **Facilitate specification**, dynamically, of a given rule set by
  - multiple authors.
    - e.g., cross-enterprise or cross-application.
  - non-technical/non-programmer authors.
    - make abstraction level more easily human-understandable.

