DAML Tools for Rules Next-Phase Plan

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WWW-2004 DevDay last week

- Way cool!
- Lots of tools and use cases now!

- Themes:
  - Mostly LP/RuleML expressible rules
  - Many combine LP or HornFOL rules with OWL ontologies or OO syntax

DAML Rules Plan Overview

- Vision: studio for developers, studio for rule authors and users
- Approach: Composable Tools Suite supporting RuleML/SWRL
  - inferencing, translation/interoperability, authoring, testing
- Infrastructure: SemWebCentral, SWeDE
- MIT Sloan (Benj. Grosof lead) : SweetRules RuleML tools:
  - translation and inferencing; architecture for suite integration
- BBN (Mike Dean lead): SWRL tools:
  - translator to Jena2; editor; validator
- Stanford (Mark Musen lead): Protégé support for rule authoring
- More about Implementing SWRL
- *Later: More about FOL*
- Others Very Much Invited!
  - some good candidates: those presented at WWW-2004 Developers Day Rules on the Web Track

MIT Sloan Plan:

SweetRules:
Tools for RuleML Inferencing and Translation

Outline

- Concept, Architecture, and Goals
- Rule and Ontology Languages/Systems involved
- Capabilities and Components Today
- More about Combining Rules with Ontologies
- Application Scenarios and Examples
- Plans
- Motivations, revisited: Conclusions and Directions
- Acknowledgements
- Resources

Context and Players

- Part of SWEET = "Semantic WEb Enabling Tools" (2001 –)
  - Other parts:
    - SweetDeal for e-contracting
      - Which uses SweetRules

- Cross-institutional. Collaborators invited!
  - Originated and coordinated by MIT since 2001
  - Code by MIT, UMBC, U. Karlsruhe, U. Zurich
  - Uses code by IBM, SUNY Stonybrook, Sandia Natl. Labs, Helsinki
  - More loosely, several other institutions cooperating: BBN, NRC/UNB, Stanford
  - Many more are good targets: subsets of Flora, cwm, Hoolet, ROWL, Triple, Jena, DRS, KAON (main), JTP, SWI Prolog, ...

Concept, Architecture, and Goals

- Concept and Architecture: Tools suite for Rules and RuleML
  - Translation and interoperability between heterogeneous rule systems (forward- and backward-chaining) and their rule languages/representations
  - Inferencing including via translation between rule systems
  - Authoring and testing of rulebases
  - Open, lightweight, extensible, pluggable architecture overall

- Goals:
  - Research vehicle: embody ideas, implement application scenarios (e.g., contracting, policies)
    - Situated Courteous Logic Programs (SCLP) KR
    - Description Logic Programs (DLP) KR which is a subset of SCLP KR
  - Proof of concept for feasibility, including of translations between heterogenous families of rule systems
    - Encourage others: researchers; industry esp. vendors

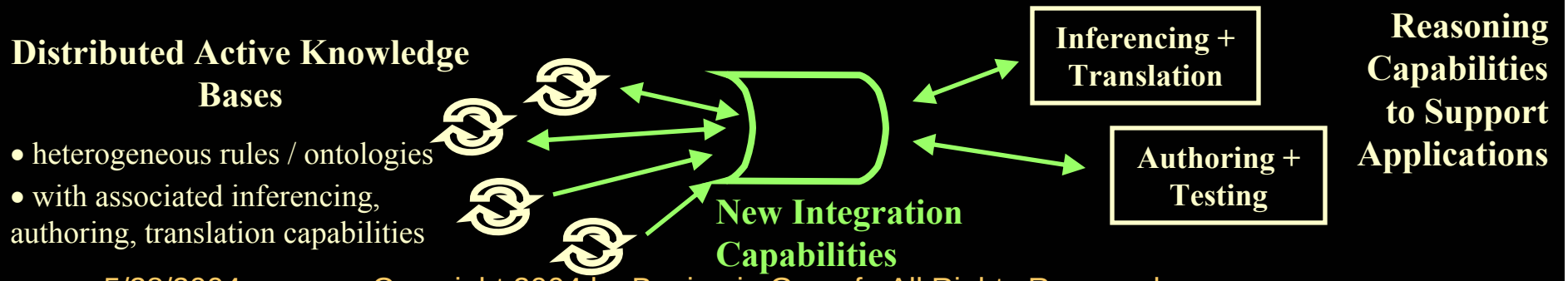
SweetRules Overview

Key Ideas:

- Unite the commercially most important kinds of rule and ontology languages via a a new, common knowledge representation (SCLP) in a new standardized syntax (RuleML), including to cope with *heterogeneity* and resolve contradictory *conflicts*.
  - Capture most of the useful expressiveness, interoperably and scalably.
- Combine a large *distributed* set of rule and ontology knowledge bases that each are *active:* each has a different *associated engine* for reasoning capabilities (inferencing, authoring, and/or translation).
- Based on recent fundamental KR theory advances, esp. Situated Courteous Logic Programs (SCLP) and Description Logic Programs.
  - Plus semantics-preserving translations between different rule languages/systems/families

Application Areas (prototyped scenarios):

- Policies and authorizations; contracting, supply chain management; retailing, customer relationship management; business process automation and e-services; financial reporting and information; etc.



RuleML KR Expressiveness

- SweetRules supports: RuleML in its highly expressive Situated Courteous Logic Programs (SCLP) extension, V0.8
  - Horn LP …
  - + Negation-As-Failure = "Ordinary" LP (OLP)
  - + Courteous feature: prioritized conflict handling (partially ordered priorities, mutual exclusion integrity constraints, e.g., for partial-functionality; limited classical negation of atoms, e.g., p vs. not-p in heads)
  - + Situated feature: procedural attachments
    - Sensors: external queries when rule body atoms are tested
      - Built-ins in SWRL V0.6 correspond to sensors.
    - Effectors: external actions triggered when rule head atoms are concluded
- RuleML also supports *referencing* OWL/DAML+OIL ontologies
    - URI predicate name (in RuleML rule) refers to class or property (in OWL axioms)
  - This was pioneered in SweetDeal using SweetRules
  - The same approach was then taken in SWRL V0.5+

Rule and Ontology Languages/Systems That Interoperate via SweetRules and RuleML, Today

1. RuleML
   - SCLP extension, V0.8
2. XSB (the pure subset of it = whole Ordinary LP)
   - Backward. Prolog. Fast, scalable, popular. Good support of SQL DB's (e.g., Oracle) via ODBC backend. Full well-founded-semantics for OLP. Implemented in C. By SUNY Stonybrook. Open source on sourceforge. Well documented and supported. Papers.
3. Jess (a pure subset of it = a large subset of Situated Ordinary LP)
   - Forward. Production Rules (OPS5 heritage). Flexible, fast, popular. Implemented in Java. By Sandia National Labs. Semi-open source, free for research use. Well documented and supported. Book.
   - *Uses recent novel theory for translation between SOLP and Production Rules.*
4. IBM CommonRules (whole = large subset of stratified SCLP)
   - Forward. SCLP. Implemented in Java. Expressive. By IBM Research. Free trial license, on IBM AlphaWorks (since 1999). Considerable documentation. Papers. Piloted.
   - Implements the Courteous Compiler (CC) KR technique.
     - which reduces (S)CLP to equivalent (S)OLP, tractably.
   - Includes bidirectional translators for XSB, KIF, Smodels.
   - Its overall concept and design was point of departure for several aspects of SweetRules

Rule and Ontology Languages/Systems That Interoperate via SweetRules and RuleML, Today, continued

5. Knowledge Interchange Format (KIF) (a subset of it = an extension of Horn LP)
   - First Order Logic (FOL). Semi-standard, morphing into Simple Common Logic ISO standard. Several tools support, e.g., JTP. Research language to date.
     - Note: FOL is superset of DLP and of SWRL's fundamental KR.
6. OWL (the Description Logic Programs subset)
   - Description Logic ontologies. W3C standard. Several tools support, e.g., FACT, RACER, Jena, Hoolet, etc.
   - *Uses recent novel DLP theory for translation between Description Logic and Horn LP.*
7. Process Handbook (large subset = subset of SCLP)
   - Frame-style object-oriented ontologies for business processes design, i.e., for services descriptions. By MIT and Phios Corp. (spinoff). Large (5000 business processes). Practical, commercial. Good GUI. Open source license in progress. Available free for research use upon request. Includes extensive textual information too. Well documented and supported. Papers. Book. Dozens of research users.
   - *Uses recent novel SCLP representation of Frames with multiple default inheritance.*
8. Smodels (NB: somewhat old version; large subset = finite OLP)
   - Forward. Ordinary LP. Full well-founded-semantics or stable semantics. Implemented in C. By Helsinki univ. Open source. Research system.

Capabilities and Components Today

- Translators in and out of RuleML:
  - RuleML ↔ {XSB, Jess, CommonRules, KIF, Smodels}
  - RuleML ← {OWL, Process Handbook} (one-direction only)
  - SOLP RuleML ← SCLP RuleML (Courteous Compiler)
- Inferencing engines in RuleML via translation:
  - Simple drivers translate to another rule system, e.g., CommonRules, Jess, or XSB, then run inferencing in that system's engine, then translate back.
  - Observation: Can easily combine components to do other kinds of inferencing, in similar indirect style, by combining various translations and engines.
- Authoring and Testing front-end: currently rudimentary, partial
  - Command-line UI + Dashboard GUI with set of windows
  - Edit rulebases. Run translations. Run inferencing. Compare.
  - Edit in RuleML. Edit in other rule systems' syntaxes. Compare.
  - View human-oriented presentation syntax. View XML syntax. (Future: RDF.)

Capabilities and Components Today, cont.'d

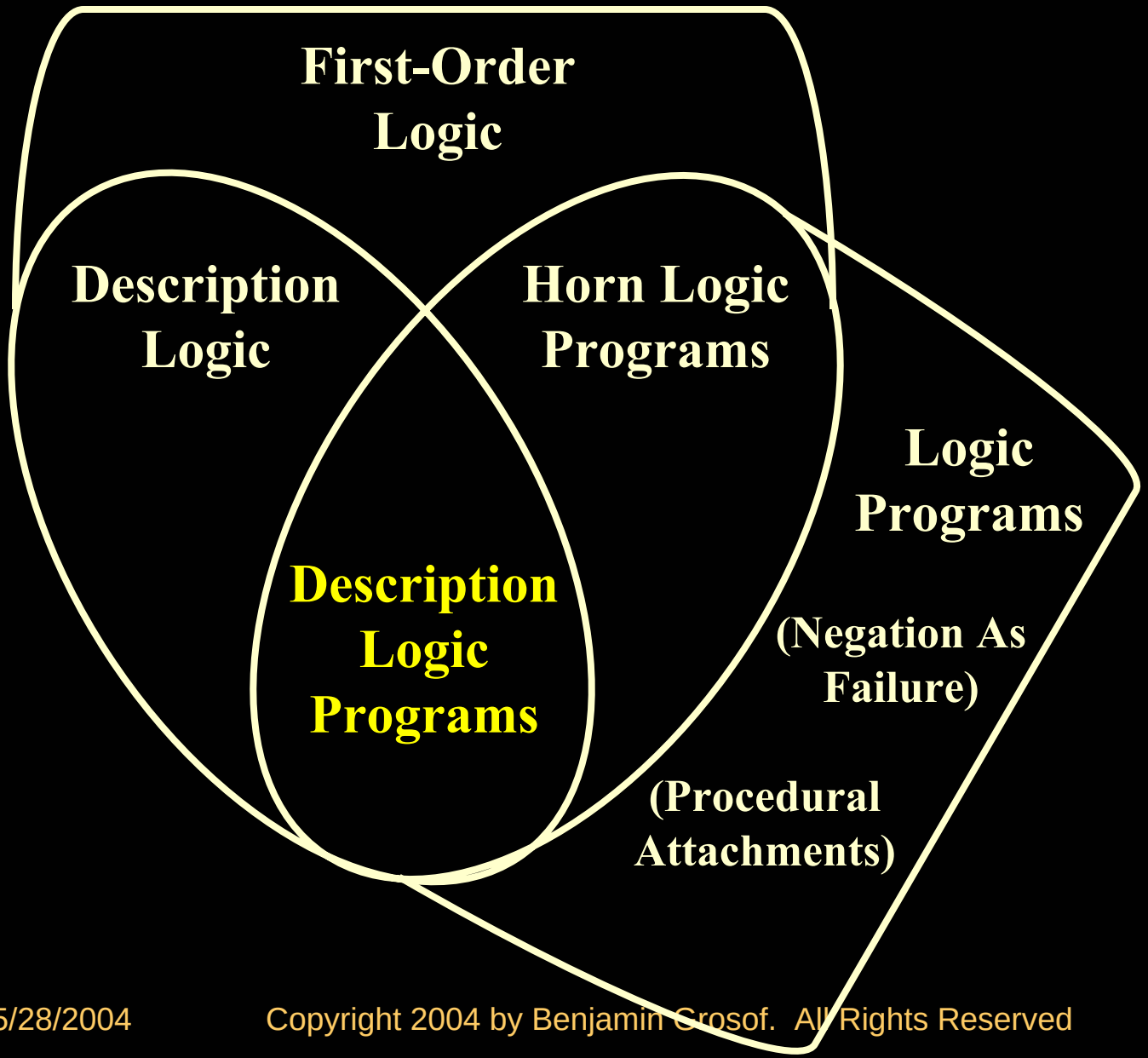
- Uses Courteous Compiler to support Courteous feature (prioritized conflict handling) even in systems that don't directly support it, as long as they support negation-as-failure
  - E.g., XSB Prolog, Jess, Smodels
  - Uses Courteous Compiler component from IBM CommonRules
- Uses IBM CommonRules translators: CommonRules ↔ {XSB, KIF, Smodels}
- Some components have distinct names (for packaging or historical reasons):
  - SweetJess translation and inferencing RuleML ↔ Jess
    - Available upon request free for research use as download.
  - SweetOnto translation RuleML ← OWL
    - Available currently as part of KAON open-source code base, called "DLP" component there
- Code base: Java, XSLT, shell scripts (for testing drivers)

More about Combining Rules with Ontologies

There are several ways to use SweetRules to combine rules with ontologies:

1. By reference: via URI as name for predicate
2. Translate DLP subset of OWL into RuleML
   - Then can add SCLP rules
     - E.g., add Horn LP rules and built-in sensors
       ⇒ interesting subset of the SWRL V0.6 KR
     - E.g., add default rules or procedural attachments
3. Translate non-OWL ontologies into RuleML
   - E.g., object-oriented style with default inheritance
     - E.g., Courteous Inheritance for Process Handbook ontologies
4. Use RuleML Rules to map between ontologies
   - E.g., in the spirit of the Extended COntext Interchange (ECOIN) approach/system.
   - SWRL V0.6 good start for mapping between non-DLP OWL ontologies.

Venn Diagram: Expressive Overlaps among KR's



Some New Research Application Scenarios for Rule-based Semantic Web Services

- SweetDeal [Grosof & Poon WWW-2003] configurable reusable e-contracts:
  - Represents modular modification of proposals, service provisions
    - LP rules as KR. E.g., prices, late delivery exception handling.
    - On top of DL ontologies about business processes from MIT Process Handbook
  - Evolved from EECOMS pilot on agent-based manufacturing SCM ($51M NIST ATP 1996-2000 IBM, Boeing, TRW, Vitria, others)
- Financial knowledge integration (ECOIN) [Firat, Madnick, & Grosof 2002]
  - Maps between contexts using LP rules, equational ontologies, SQL DB's.
- Business Policies:
  - Trust management (Delegation Logic) [Li, Grosof, & Feigenbaum 2003]: Extend LP KR to multi-agent delegation. Ex.: security authorization.

SweetRules Tools Available Now

- Available currently:
  - SweetJess
  - SweetOnto = KAON's DLP component
- Rest of Suite being updated and prepared for release on SemWebCentral

SweetRules Plans

- Update, integrate, and polish suite overall
- Support latest versions of RuleML and CommonRules
- Open source on semwebcentral.org
- Scenarios: Explore applications in SW Services, e.g., trust policies, contracting, monitoring, semantic interoperability mappings
- Requirements analysis

SweetRules Plans, cont.'d

- Pluggable architecture for Rules tools
  - SemWebCentral aspects
  - SWeDE aspects
  - Eclipse wrappers for tools
  - Ontology of tools
  - Composition patterns, high-level interfaces design

SweetRules Plans, cont.'d

- Additional Goals:
  - *Via suite integration:* More interoperability between SWRL and RuleML
  - *Ongoingly:* Update RuleML spec in synch with SWRL spec (in RuleML Initiative, Joint Committee)
  - *Via suite integration:* More authoring/UI capabilities

SweetRules Plans, longer-term

- *Later:* Justifications and proof, e.g., via suite integration with InferenceWeb
- *Later:* More wrt additional kinds of rule systems:
  - ECA rules, SQL (needs some theory work, e.g., events for ECA)
  - RDF-Query and XQuery
- *Later:* More wrt connections-to / support-of web services:
  - Importing knowledge bases / modules, procedural attachments, translation/inferencing, events, …

SweetRules Groups/People

- Collaborators: Said Tabet, RuleML; Mike Dean, BBN; Mark Musen, Stanford; Harold Boley, NRC/UNB

- More Collaborators Invited!
  - Many more rule/ontology systems are good targets for interoperation/translation:
    - Flora, cwm, ROWL, Hoolet, Triple, DRS, KAON, JTP, SWI Prolog, …

Resources

- See papers, talk slides, and links at http://ebusiness.mit.edu/bgrosof
- ../#RecentSoftware : Links to SweetJess, SweetOnto, CommonRules (where can download)
- ../#RecentPapersByTopic : (for most below, there are earlier versions too)
  - "Representing E-Commerce Rules Via Situated Courteous Logic Programs in RuleML", *Electronic Commerce Research and Applications*, 2004.
  - "SweetDeal: Representing Agent Contracts With Exceptions using Semantic Web Rules, Ontologies, and Process Descriptions", *International Journal of Electronic Commerce*, to appear summer 2004.
  - "Description Logic Programs: Combining Logic Programs with Description Logic", WWW-2003.
  - "SweetJess: Inferencing in Situated Courteous RuleML via Translation to and from Jess Rules", 2003 working paper updating RuleML-2002 Workshop paper.
  - "A Declarative Approach to Business Rules in Contracts: Courteous Logic Programs in XML", EC-99.
  - "Beyond Monotonic Inheritance: Towards Semantic Web Process Ontologies", 2003.
  - "SWRL: A Semantic Web Rules Language Combining OWL and RuleML", 2004.
- RuleML http://www.ruleml.org
- DAML Rules http://www.daml.org/rules
- Joint Committee http://www.daml.org/committee
- SemWebCentral http://www.semwebcentral.org

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More about Implementing SWRL

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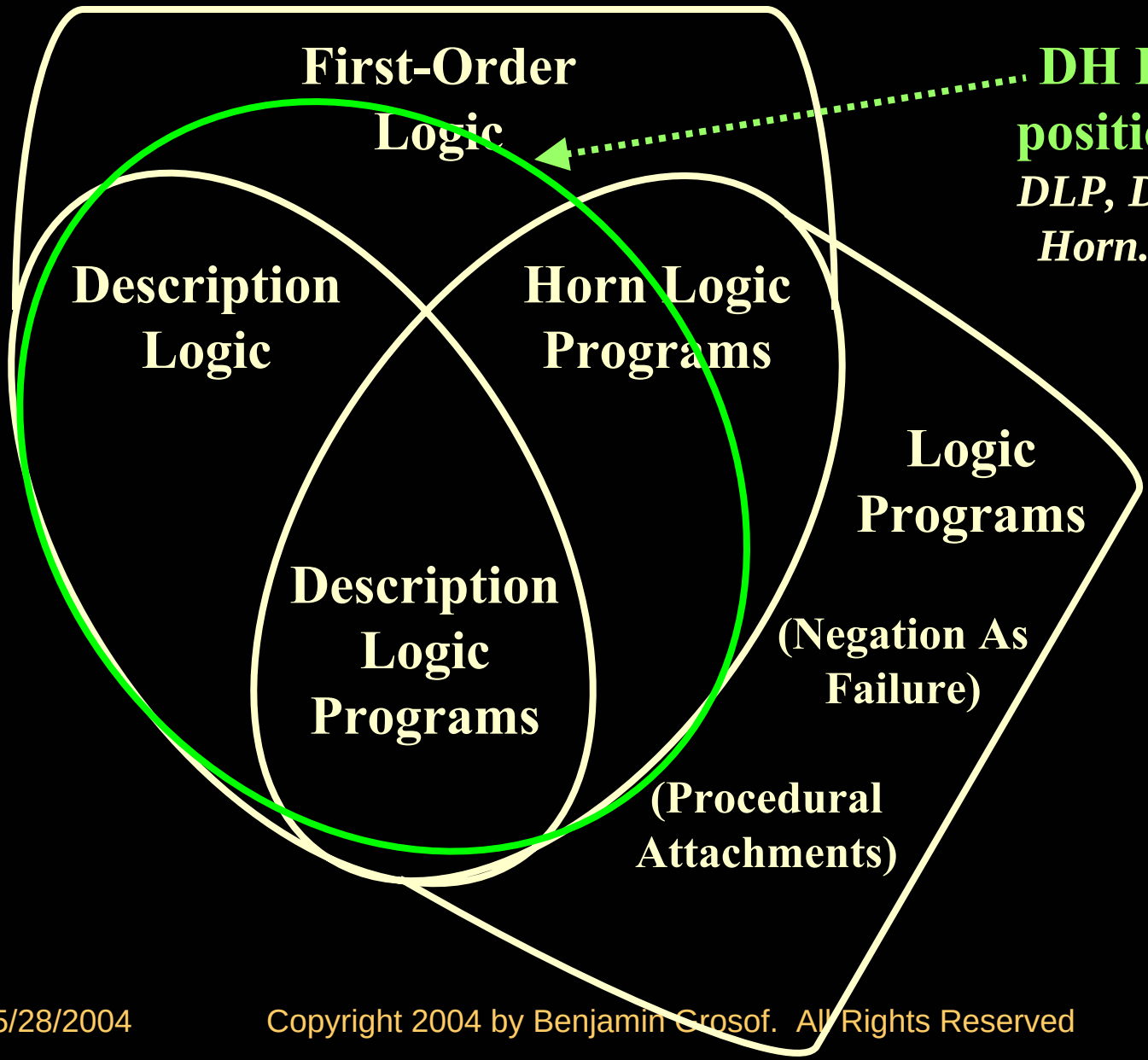

DH KR's rough position. ***Subsumes DLP, DL, and part of Horn. Subsumed by FOL.***

Design Perspective

Alternative points in design space:

1. partial LP + full DL = SWRL V0.6

versus

2. full LP + partial DL = SCLP RuleML V0.8+

(with DLP OWL2RuleML)

(SCLP = Situated Courteous Logic Programs KR)

More SWRL Implementation Strategy

- Named-classes-only restriction on SWRL rules simplifies implementation including translation to rule systems (e.g., RuleML, Jess, XSB), yet does not sacrifice fundamental expressiveness.
  - Both current implementations of SWRL do this.

- Can translate full SWRL / DH $\Rightarrow\Rightarrow$ FOL for which "native" (general-purpose) reasoners are indeed available.
  - E.g., OTTER or Simple Common Logic / KIF
  - The Manchester implementation of SWRL does this.
  - Drawbacks:
    - General-purpose FOL reasoners are often not very efficient.
    - Today, they also usually don't directly support Webized syntax.

More SWRL Implementation Strategy, cont.'d

- Can translate subset of SWRL / DH into a KR for which "native" reasoners are indeed available. E.g.:

1. Horn LP expressible subset ⇒⇒ LP, e.g., RuleML, Jess, XSB
   - E.g., Horn LP SWRL rules + DLP OWL ontologies
     - Horn LP restriction on the SWRL rules means that:
       - rules are named-classes-only (no complex class expressions appear)
       - rules are definite (consequent is non-empty); and
       - ground atomic conclusions suffice.
     - The BBN implementation does this (Horn rules ⇒⇒ Jess)

2. DL-expressible subset of DH ⇒⇒ DL, e.g., OWL
   - E.g., DLP SWRL rules + any OWL-DL
     - E.g., SWRL rules are used to define some ontologies
     - No implementation of this is yet available.

More about SWRL V0.6 Built-Ins

- The built-ins (3.) can be viewed as predicates/relations that have a fixed extension.
  - Alternatively, the set of tuples satisfied by calls to the built-ins can be viewed as corrresponding to a virtual fact set adjoined to the FOL theory.
- These are similar to sensors in Situated Logic Programs RuleML.

- The built-ins can be implemented via procedural attachments that are purely informational (free of side effects)
  - Intuitively, they are typically evaluated when rule body is tested.

Punchline on Near-term Implementation Strategy

- (Unless you can invent a whole new technique…)

1. If you want full SWRL expressiveness, translate to some FOL syntax and then use a FOL theorem-prover to do inferencing.

2. If you want to translate to LP to exploit one of the many LP rule engines available (e.g., RuleML, Jess, XSB), or to exploit beyond-Horn LP expressive features (e.g., nonmon or actions), then restrict the SWRL ontologies to DLP.
   - RuleML is the obvious choice of translation target: it's SWRL's extension in direction of fuller LP expressiveness, and facilitates translations to multiple other rule languages' engines (e.g., Jess, XSB).
   - SweetOnto tool (a.k.a. KAON DLP package) translates DLP OWL to RuleML. (There are other DLP implementations too.)

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Getting Involved!

- Please contact Benjamin Grosof and Mike Dean (DAML Rules co-chairs) with your rules …
- Tools
- Ideas
- Rulebases
- Use cases
- Other resources
- Relevant plans