Argumentation within Software Agents

"Argue tuProlog":

A Lightweight Argumentation Engine for Agent Applications

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Presentation Overview

- **Introduction**
- **Motivations**
- **Previous Work and Limitations**
- **Current Work**
- **Future Work**
- **Questions**

Introducing Software Agents…

- **… a computer system that is capable of *autonomous (i.e. independent)* action on behalf of its user or owner**
- **"An autonomous software agent is a system situated within an environment that senses that environment and acts on it, over time, in pursuit of its own agenda and so as to effect[sic] what is senses in the future."**

(Franklin and Graessar, 1997)

Why Software Agents?

- **Key enabling technology for next-generation of online services**
  - Large-scale e-commerce (Guilfoyle *et al*, 1997)
  - Service-Oriented Computing (Papazoglou, 2003)
- **Agents will enable automated**
  - Communication and coordination
  - Knowledge discovery
  - Decision-making
  - Practical reasoning (deciding what is to be done)

Automated Reasoning

- **Agents require a reasoning component (engine?)**
  - Just as humans need a brain!
- **Originally agents used classical logic to represent**
  - Beliefs
  - Knowledge
  - Rules

However…

- **In large-scale open multi-agent systems classical logic-based approaches to reasoning are often unsuitable (Amgoud *et al*, 2005)**
- **Information may be**
  - Incoherent
  - Inconsistent
  - Contradictory
- **The classic approach to inconsistency in computing is not to tolerate it (Hunter, 2006a)**

A New Paradigm - Argumentation

- **Based on Argumentation Theory (Philosophy)**
- **Argument = Reason for some conclusion**
- **Argumentation = Reasoning about arguments**
  - i.e. deciding on the conclusion
- **Benefits**
  - Additional information can be exchanged
  - Agents can modify/revise their beliefs
  - The opinion of the agent is explicitly explained

However…

- **Argumentation incorporates computationally expensive reasoning**
  - Selection of a "consistent subset" of formulae
  - Finding minimal set of premises that entail conclusion
- **Therefore it is computationally challenging**
  - Deciding whether a set of propositional classic formulae is classically consistent is **NP-complete**
  - Deciding whether a set of first-order classical formulae is consistent is **undecidable**

Previous Work and Limitations

- **IACAS (Vreeswijk, 1995)**
- **Deimos (Maher *et al*, 2001)**
- **DeLP (Garcia *et al*, 2004)**
- **P-DeLP (Chesnevar *et al*, 2004)**
- **All support only one type of argumentation scheme (default logic, defeasible reasoning…)**
- **Good practical reasoning is complex and requires multiple argumentation schemes…**

(Girle *et al*, 2004)

Our Position…

Agents should have access to a general purpose argumentation engine, that can be configured to conform to a range of different schemes

Need to empirically investigate the performance of a variety of argumentation schemes

(Bryant, Krause and Vreeswijk, 2006), (Bryant and Krause, 2006)

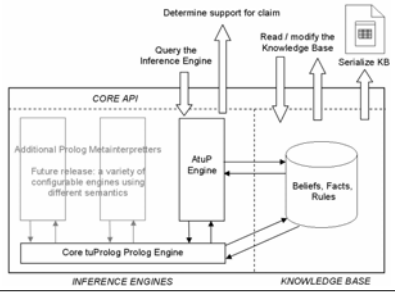
Current Work

- **Created a prototype argumentation engine based on tuProlog (Denti *et al*, 2005)**
- **tuProlog**
  - Existing open-source Prolog engine
  - Good design principles (Lightweight, thread-safe..)
  - Easily deployable into Internet/Agent Applications
  - Building a good relationship with tuProlog team
- **Re-engineering tuProlog to include a variety of argumentation schemes in Java**

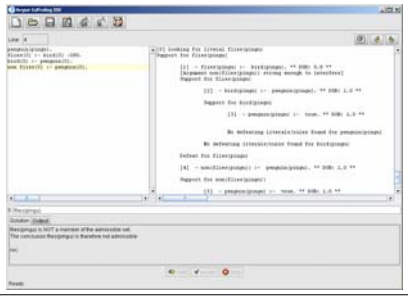
Current Work

- **The first algorithm we have implemented**
  - ASPIC model for establishing acceptability of arguments (Amgoud *et al*, 2005)
  - Construct dialectic-style proof of argument acceptance over an inconsistent knowledgebase (Jakobovits and Vermeir, 1999)
  - Specify a main claim to be "proved"

"Argue tuProlog" – Component API



"Argue tuProlog" – Offline GUI



Current Work

- **Developed Argue tuProlog using NetBeans IDE**
- **Installed NetBeans Application Profiler (Sun Microsystems, 2006)**
- **Allows monitoring and analysis of**
  - CPU usage
  - Memory usage
  - Program branch/loop counting
  - Thread profiling
  - And more…

Future Work

- **Finish prototype of application**
  - Support for more argumentation schemes
- **Investigate enhancing arguments with possibilities ("probability of provability")**
  - (Krause *et al*, 1995), (Amgoud and Prade, 2004) and (Chesnvar *et al*, 2004)
- **Set up several large scale knowledge bases**

Conclusion

- **First step to set up real world experiments**
- **Presented a prototype argumentation engine**
- **Aiming for a general purpose engine**
  - No prior disposition to one model of argumentation
- **Independent evaluation of a range of models**
  - Expressive power
  - Performance
  - Scalability

Conclusion

- **Argumentation is computationally challenging**
- **Need to investigate theoretical approaches to overcome this (eg Hunter, 2006b)**
- **We feel it is important to release ours and others "pragmatic" implementations**
- **Stimulate scientific evaluations of what is practically possible**

Thanks for listening…

- **Any questions, comments, criticism?**

- **Advert for my next presentation:**
  - "Software Agents and the Matrix: The Real Agent Smith"
  - 2pm 39BB02 14th August 2006

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