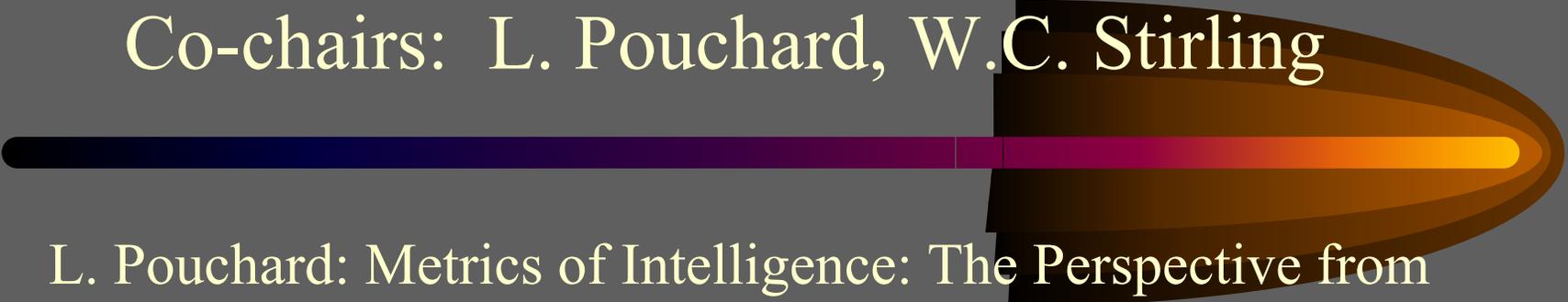


Metrics and Comparison of Alternatives: General Issues

Co-chairs: L. Pouchard, W.C. Stirling



L. Pouchard: Metrics of Intelligence: The Perspective from Software Agents.

J. Spall, et al.: Towards an Objective Comparison of Stochastic Optimization Approaches.

W.C. Stirling, R.L. Frost: Intelligence with Attitude.

v. Grishin, A. Meystel: Using Visualization for Measuring Intelligence of Constructed Systems.



Metrics of Intelligence: the Perspective from Software Agents

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Overview

- Background: Agents and Multi-Agent Systems
- Agent Communication Languages
- Aspects of intelligence measures specific to Multi-Agent Systems

Features of software agents

- Autonomous, goal-directed, adaptive (deliberative or reactive, learning), collaborative, mobile
- Encapsulated programs whose methods cannot be automatically called upon by others
- Provide a powerful abstraction for intuitively representing user and component interactions with the system

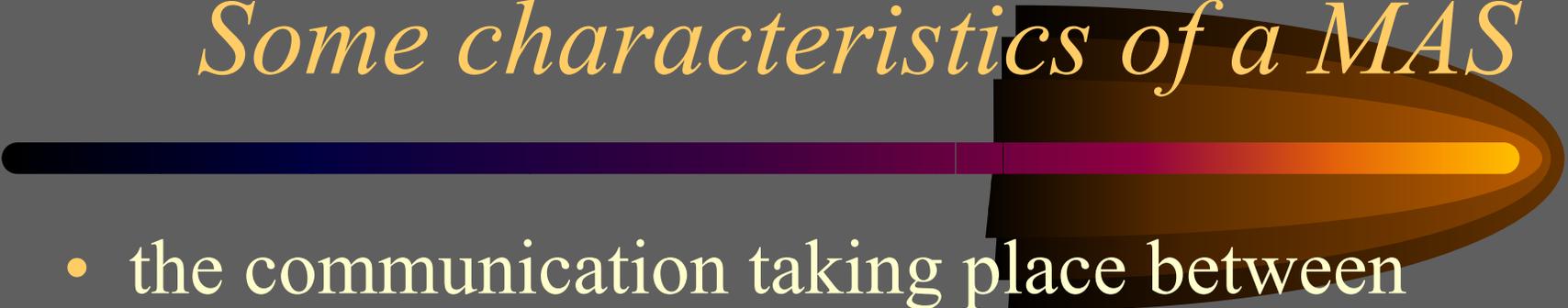
Multi-Agent Systems (MAS) and Community of Agents

- A system where autonomous agents must coordinate their actions:
 - interconnecting agents are created by different developers on different platforms (a strict definition)
 - agents interact for a purpose, form a team
 - provide capabilities beyond those of individual agents (concurrency, common interface, proper workflow between tasks, access to heterogeneous and distributed resources)

Some characteristics of a MAS

- the model of social interaction
 - cooperative: each agent's goal is subservient to the over-arching goal of the system
 - collaborative: each agent pursues its own goals, and does not recognize a higher goal (trading agents in e-commerce)
 - both cooperative and collaborative models need coordination (task negotiation and conflict resolution)

Some characteristics of a MAS



- the communication taking place between agents
 - use of an Agent Communication Language (represent cooperation and coordination between agents, exchange complex messages)
- the degree of social interaction in a MAS
 - number of agents
 - degree of concurrency

Agent Communication Languages

- Use performatives (one per message):
 - ask-if, tell, subscribe, reply, recommend-all
 - inform-if, confirm, request, propose
- Each performative has attribute/value pairs:
 - (:content, :language, :sender, :receiver, :ontology ...)
- Standardization efforts in progress: FIPA

ACL example

- OrchardBot sends an invoice to ShopBot

- (inform

- :sender (OrchardBot)

- :receiver (ShopBot)

- :in-reply-to (ShopBot_local_dstruct100)

- :ontology (fruitmarket)

- :content (invoice ShopBot_goal 187 (:type :id :modifier

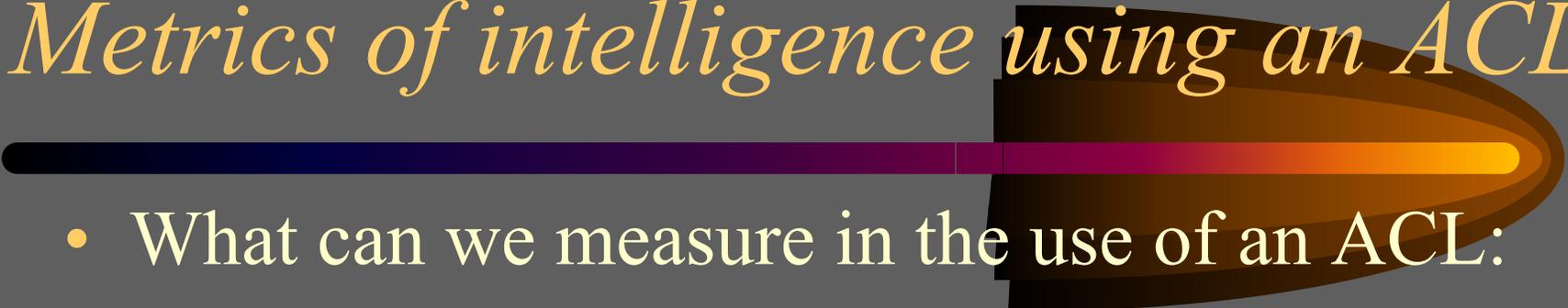
- :attributes (amount 10.00)))

- :content can nest another message -- a possibility for constructing more complex messages

Intelligence in a multi-agent system

- Linked to intelligence in the use of an ACL by multi-agent systems (MAS)
 - some agents use domain knowledge in the content of the messages
 - not all agents exchange messages that use intelligence
- Social intelligence
 - synergy of intelligence in a MAS (ex: information retrieval agent system)

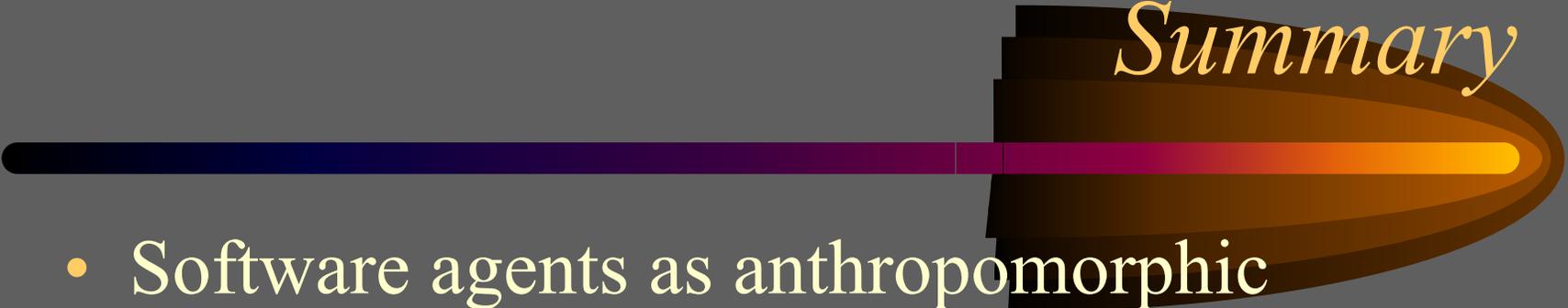
Metrics of intelligence using an ACL



- What can we measure in the use of an ACL:
 - number and variety of performatives used in the agents' conversations
 - complexity of messages (nested content)
 - existence of semantic-based definitions for objects referred to in the content of messages
 - amount of domain knowledge expressed in the message content

Metrics of intelligence using an ACL

- domain knowledge is represented in the ontology
 - ratio of amount and diversity of used facts in regard to amount and diversity available to the MAS in the ontology
 - scope and breadth of the ontology
 - degree of granularity in the ontology driven by agent goals
 - test the ontology for completeness and consistency



Summary

- Software agents as anthropomorphic abstractions
- Use high-level communication language to achieve goals
- Measuring the pragmatics of language (how the MAS uses it) for rating the intelligence of a MAS

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