CAP6671 Intelligent Systems

Lecture 2:

Multiagent Systems

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Schedule: T & Th 9:00-10:15am

Location: HEC 302
Office Hours (in HEC 232):
T & Th 10:30am-12

Homework

- Reading: D. Nau, Current Trends in Automated Planning, AI Magazine (posted on web site once I scan it in)

What is an agent?

What is an agent?

- MAS: “loosely coupled network of problem solvers that interact to solve problems that are beyond the individual capabilities or knowledge of each problem solver”
- Belief-Desire-Intention model of agency:
  - Situated
  - Goal-directed
  - Reactive
  - Social
- Framework for constructing BDI agents: Procedural Reasoning System

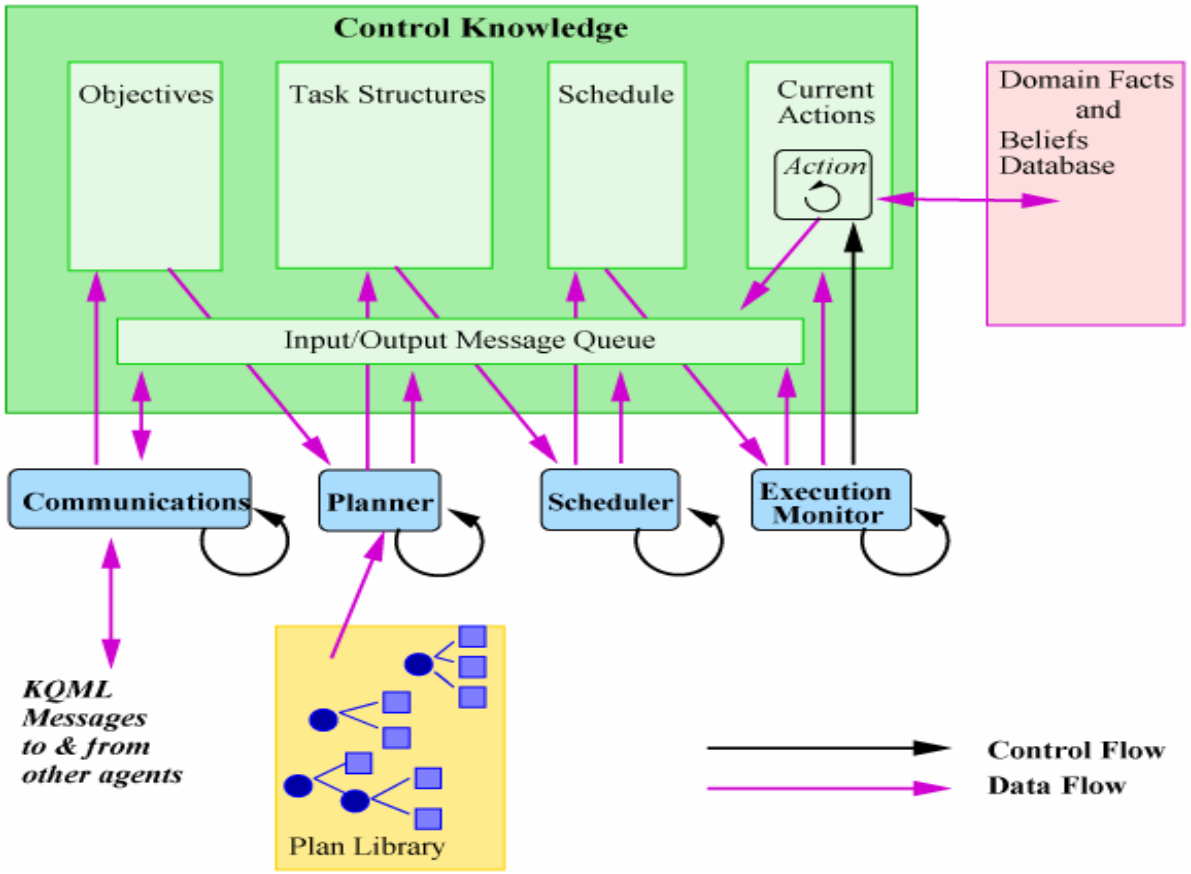
Deliberative vs. Reactive

- What is the difference?

Deliberative vs. Reactive

- Deliberative:
  - Attempt to attain a set of goals
  - This paper only really talks about deliberative agents.
    - Each individual agent is an intelligent system.
- Reactive:
  - Respond to the current environment using a stimulus/response paradigm
  - Agents are individually dumb and “intelligence” is an emergent property of the way that the system is connected.

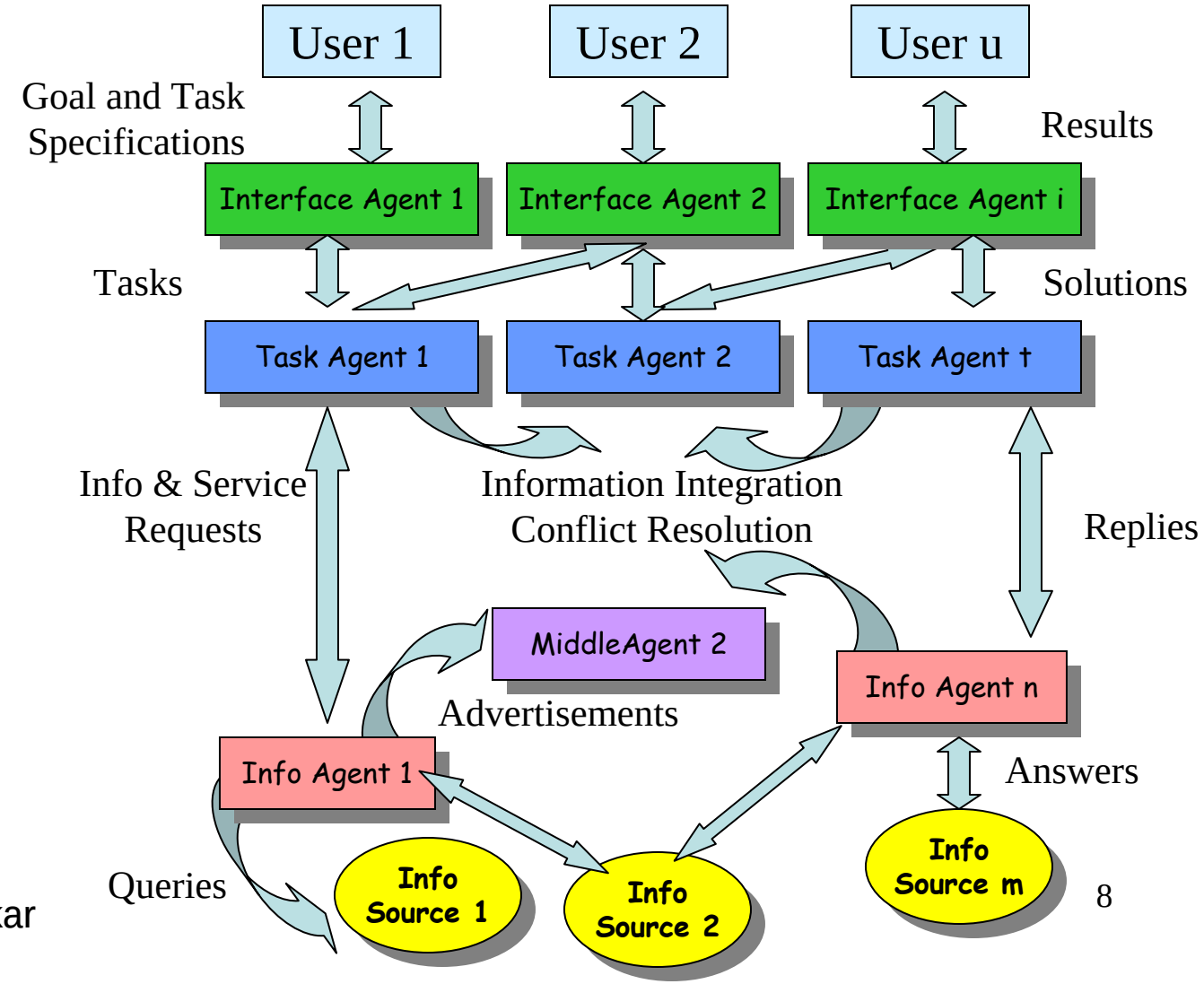
RETSINA Agent



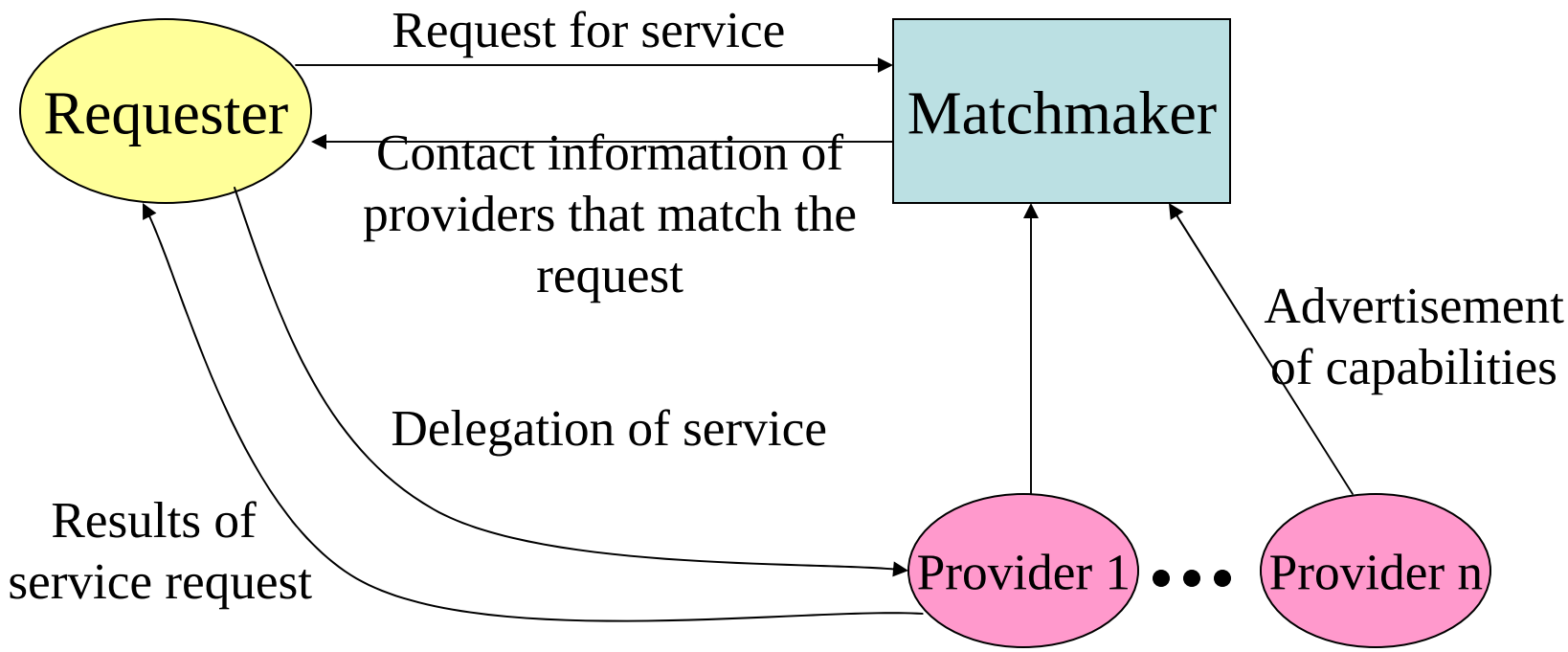
KQML: knowledge query machine language

Multi-Agent Organization

distributed adaptive collections of agents that help users by retrieving information, providing advice and anticipate user's information needs.



Matchmaker



Yellow-page system

MAS Coordination

Teamwork: Agents share a common set of goals and each contributes to the fulfillment of these goals through teamwork. No explicit modeling of individual agent utility

Coalitions: Agents seek to maximize individual utility and group utility (coalition stability is an issue)

Coordination: Agents pursue their individual goals and utilities; coordination with others is done only to avoid harmful interactions (e.g. traffic)

Negotiation: Agents seek to maximize their individual utility but are willing to compromise (i.e. better off if they reach agreement than not)

Game Theoretic Interactions: Agents seek to maximize individual utility while taking into consideration other's options

Adversarial Interactions/Zero Sum Games: Agents seek to maximize own utility while minimizing utility of opponent

Characteristics of an MAS

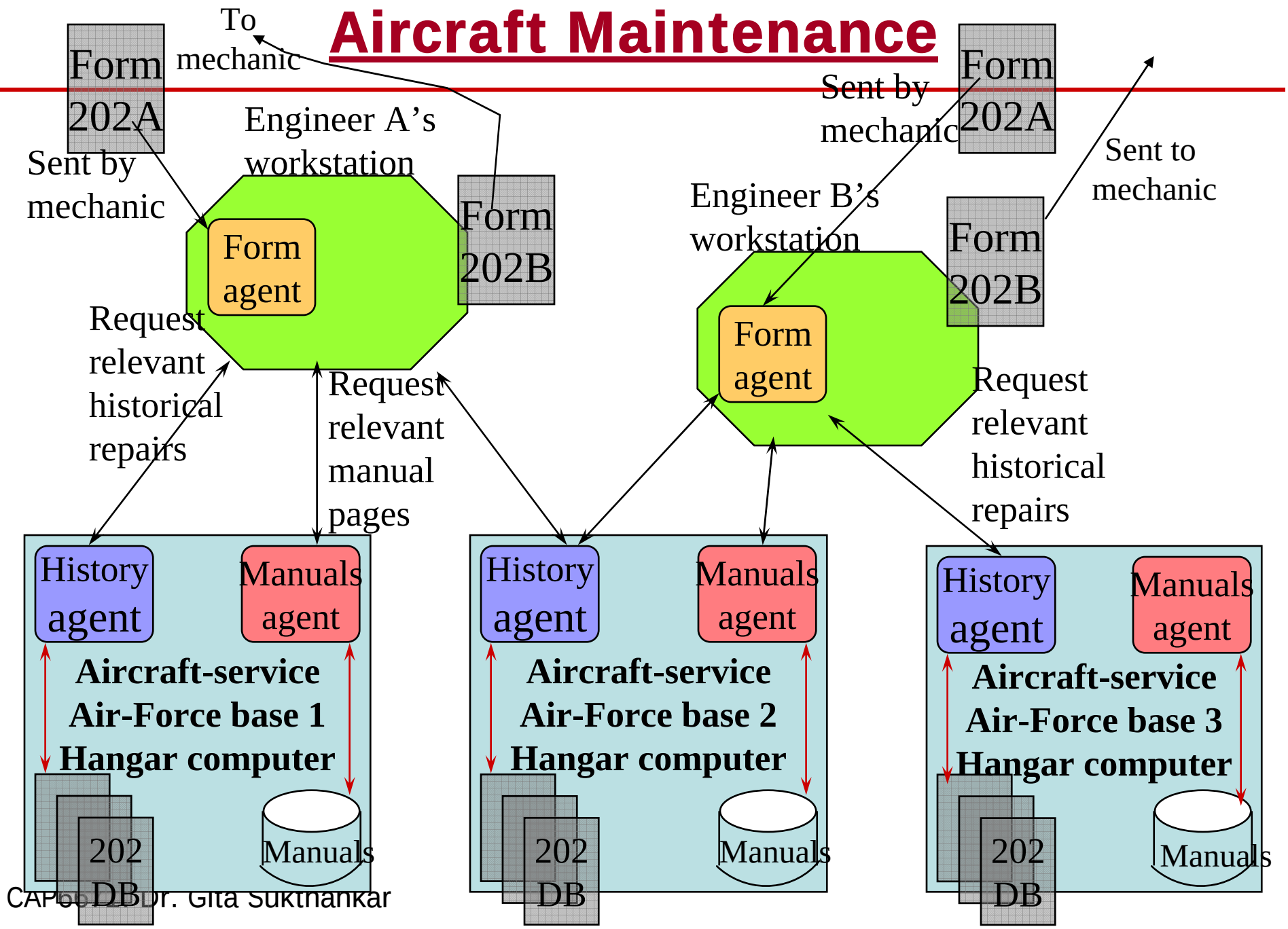
- Incomplete information
- No global control
- Data is decentralized
- Computation is asynchronous

Why use an MAS?

Why use an MAS?

- Solve problems too huge for one agent
- Interoperation of existing legacy systems
- Preserve privacy of user data
- Use spatially separated information sources
- Distributed expertise

Aircraft Maintenance



Aircraft Maintenance

- Shehory, Sukthankar, and Sycara 1998
- Why use an MAS?
  - User interface agents needed to be lightweight and run on either a tablet computer or desktop
  - Utilize legacy systems that the military already had in place

Agent-based Programming

- Does it improve system performance?

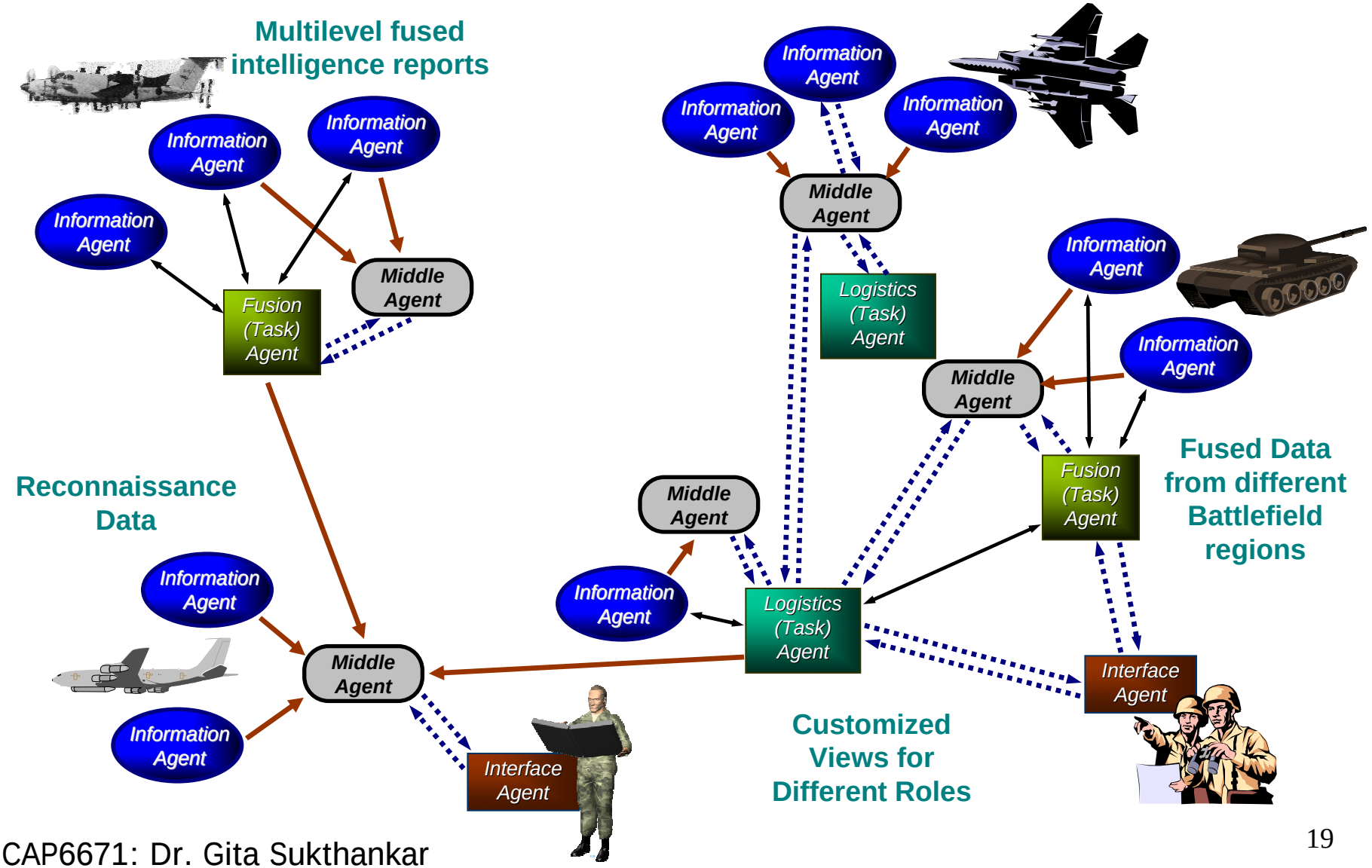
Claims

- Computational efficiency
- Reliability
- Extensibility
- Robustness
- Maintainability
- Responsiveness
- Flexibility
- Reuse
- Does agent-based programming really offer all those advantages?

Examples of MAS Applications

- Sensor nets
- Smart buildings
- Shopping bots/financial agents
- Information-gathering
- Manufacturing
- Personal information management agents
  - Calendar scheduling
- Air traffic control
- Virtual humans/embodied conversational agents

Information Fusion with MAS



Research Issues

- Task allocation
  - CNP, auction-based frameworks
- Multiagent planning: resolving sub-gal interactions
  - Decentralized MDP, PGP (partial global planning)
  - Teamwork
- Modeling other agents
  - Plan recognition
- Resource/Communication limitations
  - Distributed constraint optimization
- Adaptation and learning
  - Multi-agent RL

What remains unsolved?

- When this article was written:
  - Lack of systematic methodology
  - Industrial-strength MAS toolkits
- Now:
  - Larger-scale systems
  - Human-agent interfaces
  - Global interoperability
  - Dynamic planning/problem-solving
  - Lifelong learning

Vision: 10 Years Out

- Memory augmentation
- Personalized services
- Nano-robots/smart matter
- Self-updating media (content and context).
- Ambient anytime anywhere information access (safe mobile info environments for people)
- Highly realistic agents that inhabit large virtual environments