

Multi-agent architectures and framework

Extended AgentSpeak by implementing a Jason-inspired testbed for BDI agents, capable of:

- Modelling and manipulating **uncertain information**.
- Allowing agents' **belief change**

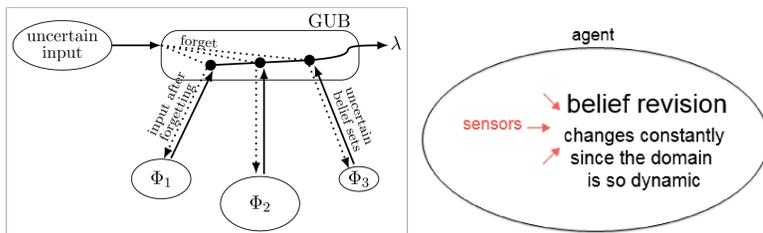
```
fact(0,1).
+fact(X,Y)
: X < 5
<- +fact(X+1, (X+1)*Y).

+fact(X,Y)
: X == 5
<- .print("fact 5 == ", Y).
```

Situational Awareness and Decision Making

Combine **belief revision** and **planning** into a single framework

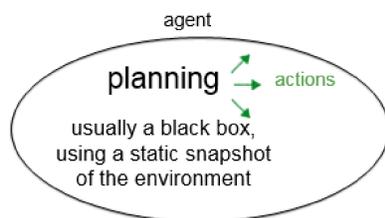
BELIEF REVISION



Modeling many **different uncertain representations of beliefs**

- Epistemic States (ES)
- Global Uncertain Beliefs (GUB)

DYNAMIC PLANNING UNDER UNCERTAINTY



- Risk seeking vs risk aversion
- Dynamic changes on **risk aversion levels**

Currently developing a **multi-agent planning algorithm in risk-pervaded scenarios**



Decision theory ← Rewards



Agent's individual **rationality**

CONSTRAINTS: Resources, time, etc.

SEE RISK-AWARE PLANNING POSTER

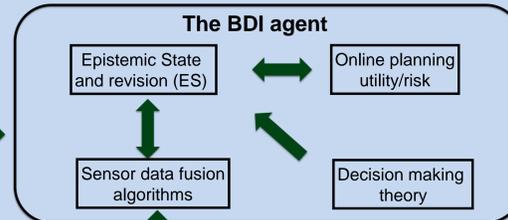
OUTLINE

Objective

Enable multi-agent, **autonomous, intelligent system** technologies to most efficiently and effectively manage **distributed, complex control problems, in dynamic and uncertain environments**

Main Results

OTHER PROJECTS:
Streaming data analytics for monitoring and prediction of anomalies, outliers, etc.



NEXT STEPS:

- Developing event reasoning framework for security: *anomalies*
- Multi-agent planning with *cooperative agents*

sensor networks and streaming data

Uncertainty tolerance at all levels

No one theory to "rule" all different flavours of **uncertainty**

- Action effects
- Trust between agents
- Preferences

- **Inconsistent** data/information from **multiple sources**.
- **Anomalous** information (e.g. security related).

Developed a **context-dependent** algorithm for **uncertain information fusion** from **sensor networks**

- Handle **ignorance, uncertainty and reliability**
- Combined evidence to **revise agents' beliefs (ES)** for **decision making and online planning**



SEE UNCERTAIN INFORMATION FUSION POSTER

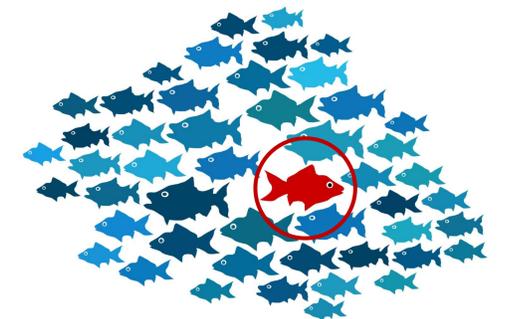


Security Vulnerability and Protection

- Identifying **vulnerabilities**.
- **Gathering knowledge** about anomalies/attacks
- Real-time **anomaly/attack detection**

OUTPUTS FROM OTHER RESEARCH PROJECTS

- Real time information extraction systems, **Big Data analytics**, etc.



ACHIEVEMENTS AND PROGRESS:

- **Detecting anomalous sensor values** during fusion → Identifying potential problems
- **Dynamic re-planning**
- **Attack detection**, using knowledge from data analytics and attack trees.

