

Case-based Argumentation Infrastructure for Agent Societies

Jaume Jordán

Departamento de Sistemas Informáticos y Computación
Universitat Politècnica de València

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Motivation

- Argumentation theory has produced important benefits on its applications in Multi-Agent Systems (MAS).
- Argumentation skills increase the agents' autonomy and provide them with a more intelligent behaviour.
- Agents must have the ability of reaching agreements to solve their conflicts.
- It is important to offer support for agent societies and their agents' social context.
- It allows to simulate different models of organizations and societies to solve problems.

Proposal

- We propose an **infrastructure** to develop and execute **argumentative agents** in an open MAS.
 - It offers the necessary components to develop agents in an **open MAS** with **argumentation capabilities**, including the **communication skills** and the **argumentation protocol**.
 - It offers support for **agent societies** and their agents' **social context**.
 - Agents use **Case-Based Reasoning** (CBR) to store **domain knowledge** of past solved problems and to store **argumentation knowledge** of previous dialogues.
 - Agents try to reach an **agreement** about the best solution to apply for each proposed problem.

Open Multi-Agent Systems

- Agents can **enter** or **leave** the **system**, interact and dynamically **form groups** to solve problems.
- Provides great **flexibility** and **diversity** to the system.
- Open communications due to the **heterogeneity** of the agents.
- Establish **control** and **security** agents.
- Agents acquire a **role** for which a set of rules are established to control their behaviour.

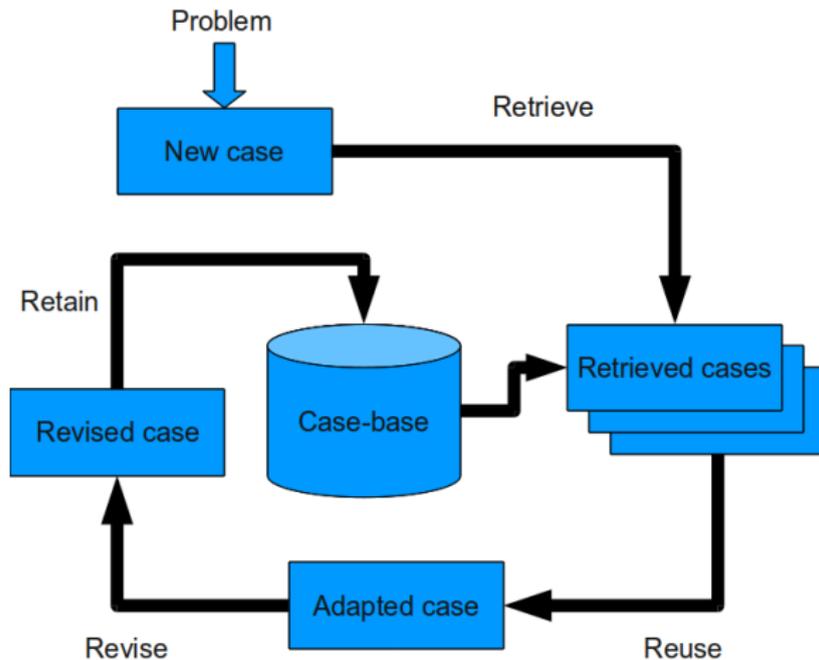
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- **Magentix2**: agent platform that provides new services and tools to manage open MAS.
- **THOMAS**: open MAS framework based on modular web services to manage organizations. The *OMS* controls the organizations and the *SF* controls the services. Integrated in *Magentix2*.

Case-Based Reasoning

- Solved problems of past situations represented as cases are stored in a database called case-base.



CBR Applications of Argumentation in AI

- The PERSUADER system: a **mediator agent centralises the negotiation** process between two parts. *Negotiation.*
- CBR for Argumentation with Multiple Points of View: is centred on the **argument diagramming for humans**, helping agents to follow the discussion and supporting them with tools to pose better arguments. *Deliberation.*
- Case-based Negotiation Model for Reflective Agents: all agents are autonomous and able to start and manage a **direct dialogue** with other agents. *Negotiation.*
- Argument-based selection Model (ProCLAIM): deals with the internal deliberation of the **mediator agent**, supporting only this agent to make the **best decision** among the set of potential winners. *Deliberation.*
- Argumentation-based Multi-Agent Learning (AMAL): all agents **decide the best classification** tag for a specific object and **cooperate** by aggregating their **knowledge** in the deliberation process. *Deliberation.*

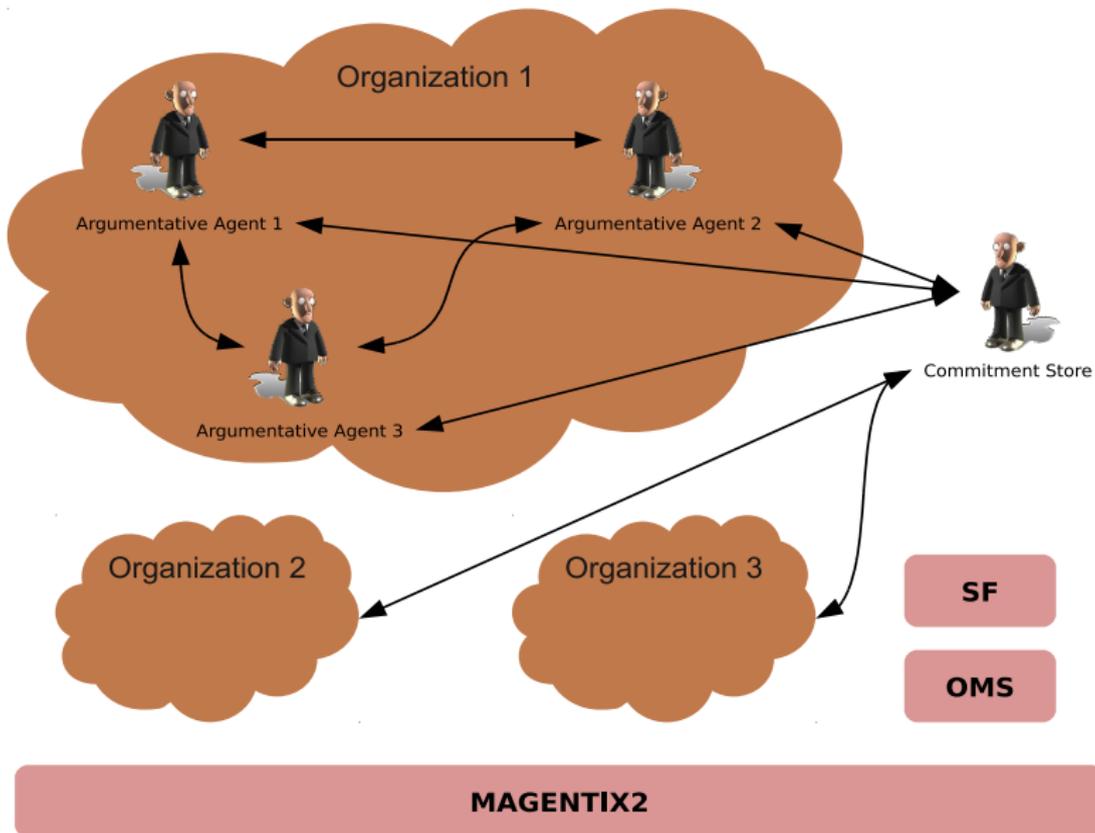
CBR Applications of Argumentation in AI

- CBR methodology has been mostly used to generate, select or evaluate arguments considering previous similar experiences.
- All frameworks are domain specific.
- None of them offers support for agent societies and their agents' social context.
- Not suitable for open MAS.

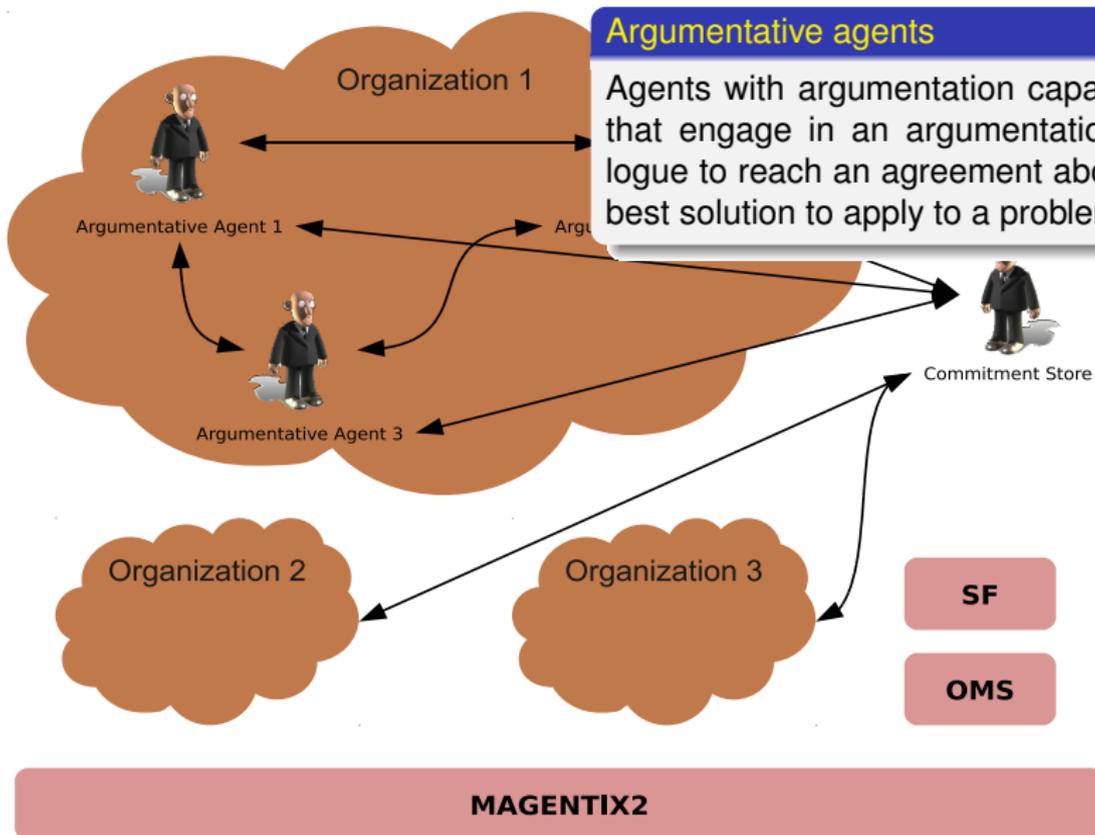
Argumentation framework

- Agent society: *agents* that play a set of *roles*.
 - Dependency relation between roles: *charity, authorisation, power*.
 - Groups: Collaborate and reach the global objectives.
 - Promoted values by agents and group.
- Knowledge resources:
 - Domain cases: represent **previous problems** and their solutions. Domain-dependent.
 - Argument cases: represent **previous arguments** and their final outcome.
- Arguments:
 - To **support** a position (solution).
 - To **attack** a different position.

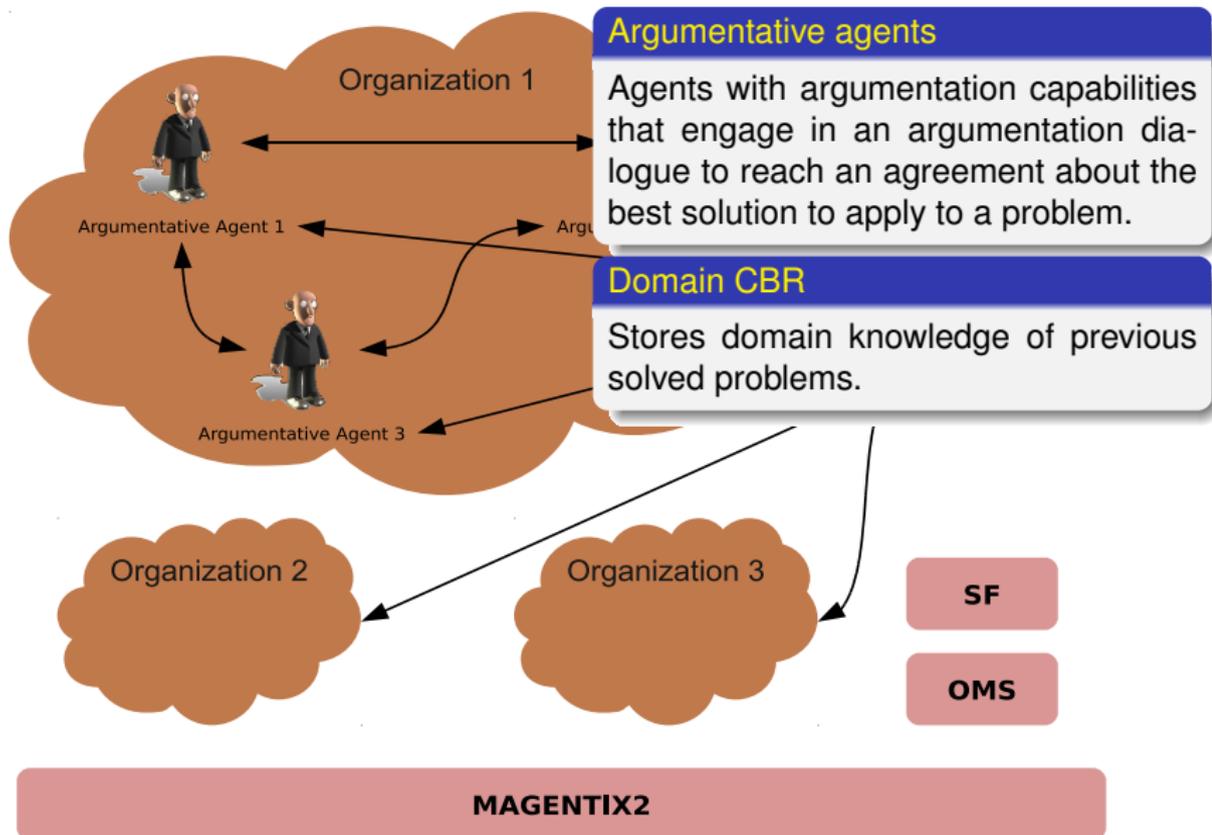
Infrastructure diagram



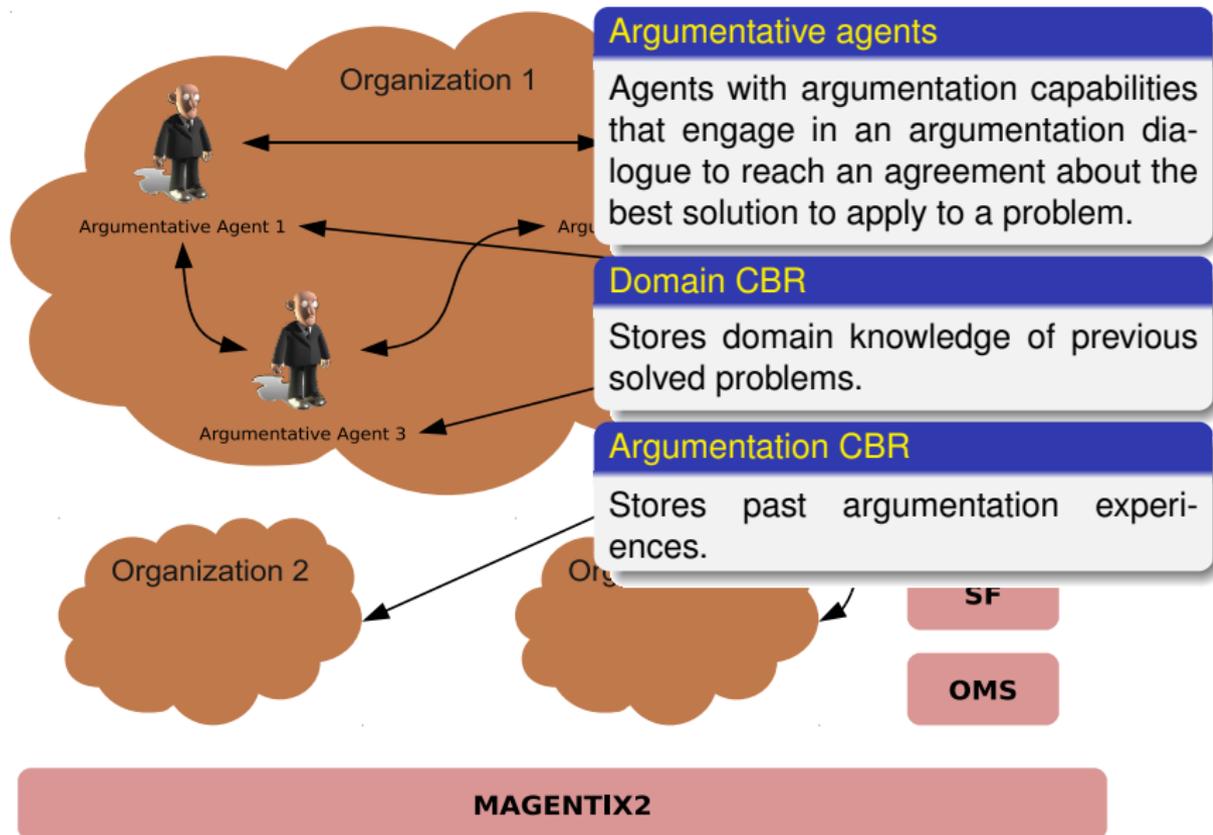
Argumentative agents



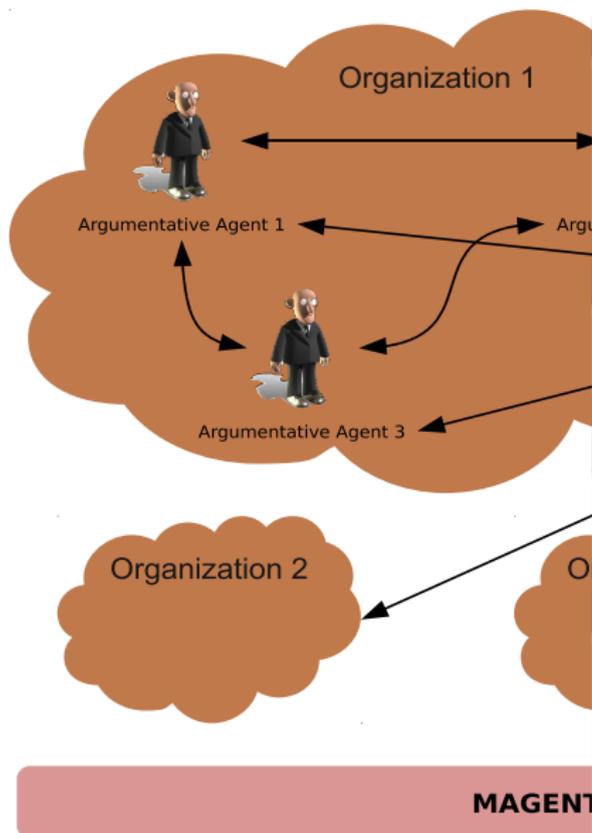
Argumentative agents



Argumentative agents



Argumentative agents



Argumentative agents

Agents with argumentation capabilities that engage in an argumentation dialogue to reach an agreement about the best solution to apply to a problem.

Domain CBR

Stores domain knowledge of previous solved problems.

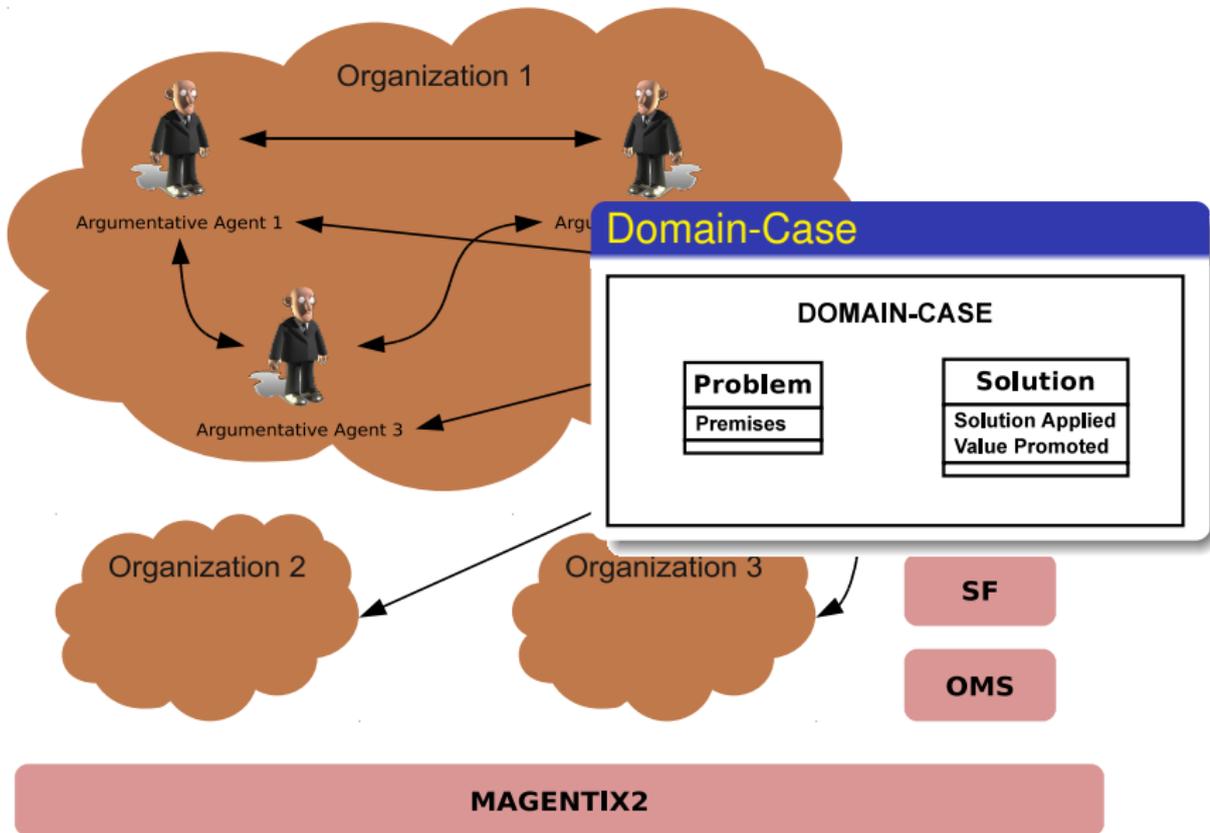
Argumentation CBR

Stores past argumentation experiences.

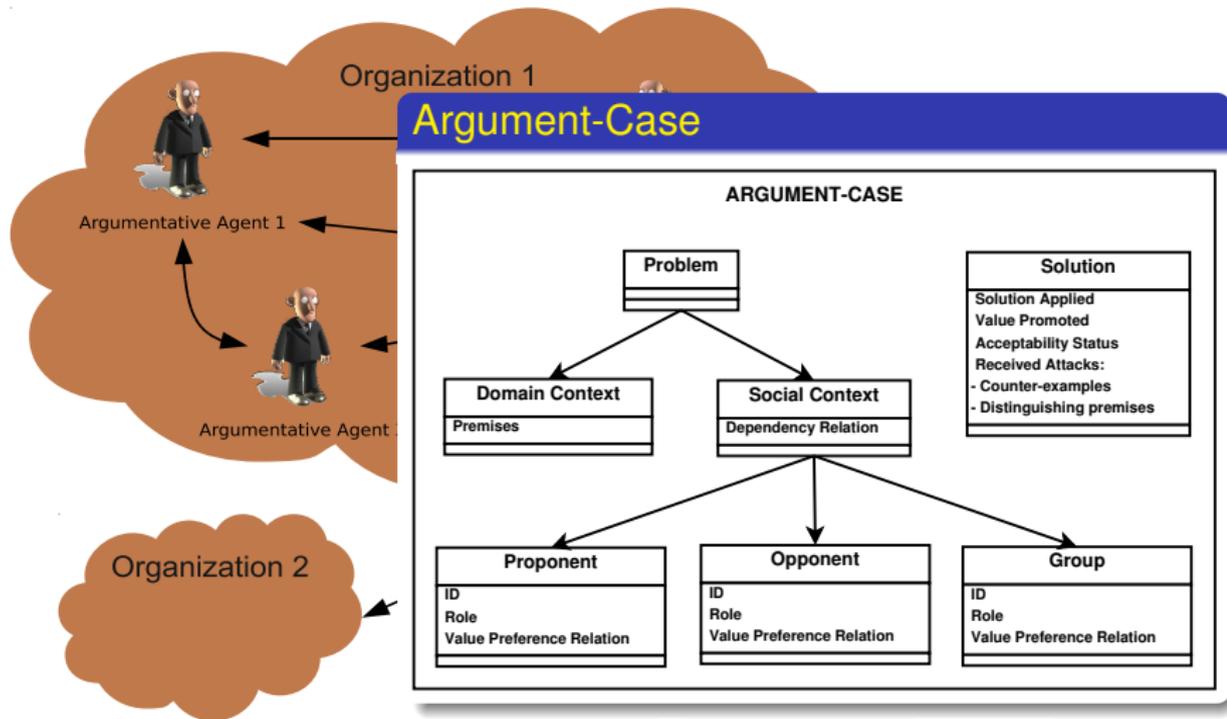
Argument management process

How the positions, support arguments and attack arguments are generated by the agents using their knowledge resources and their CBRs. It also defines the argumentation mechanism.

Domain-Case structure

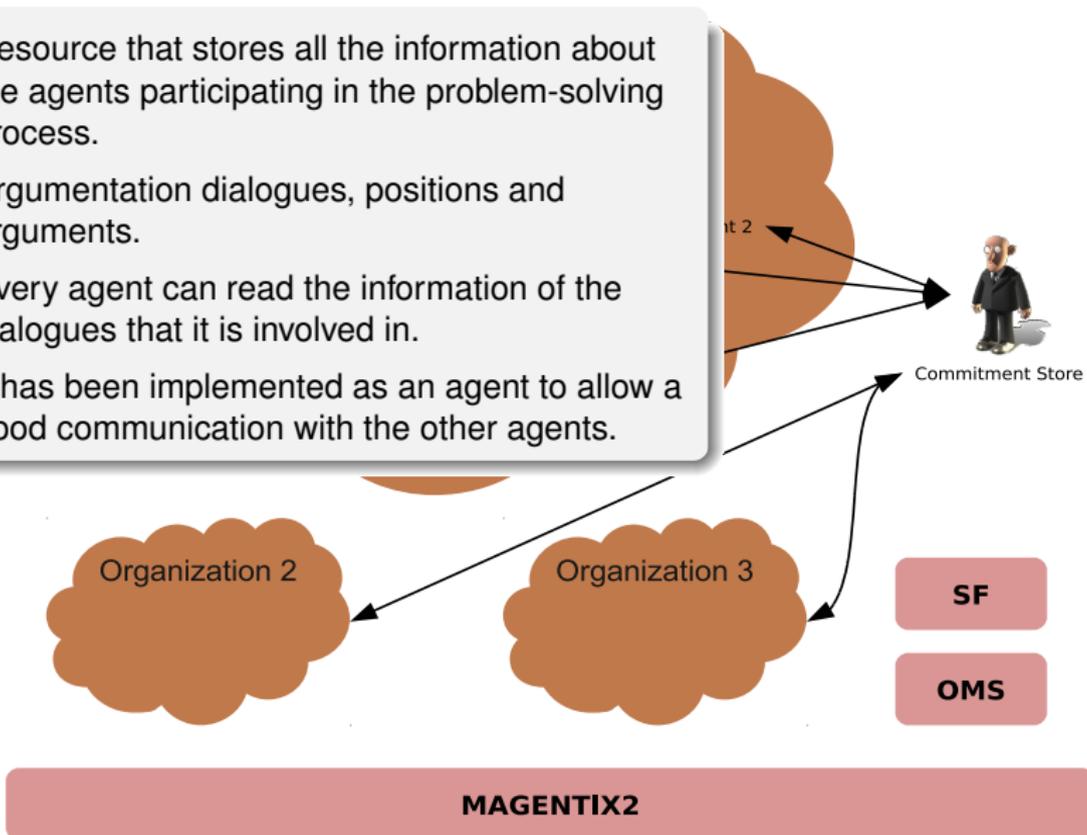


Argument-Case structure



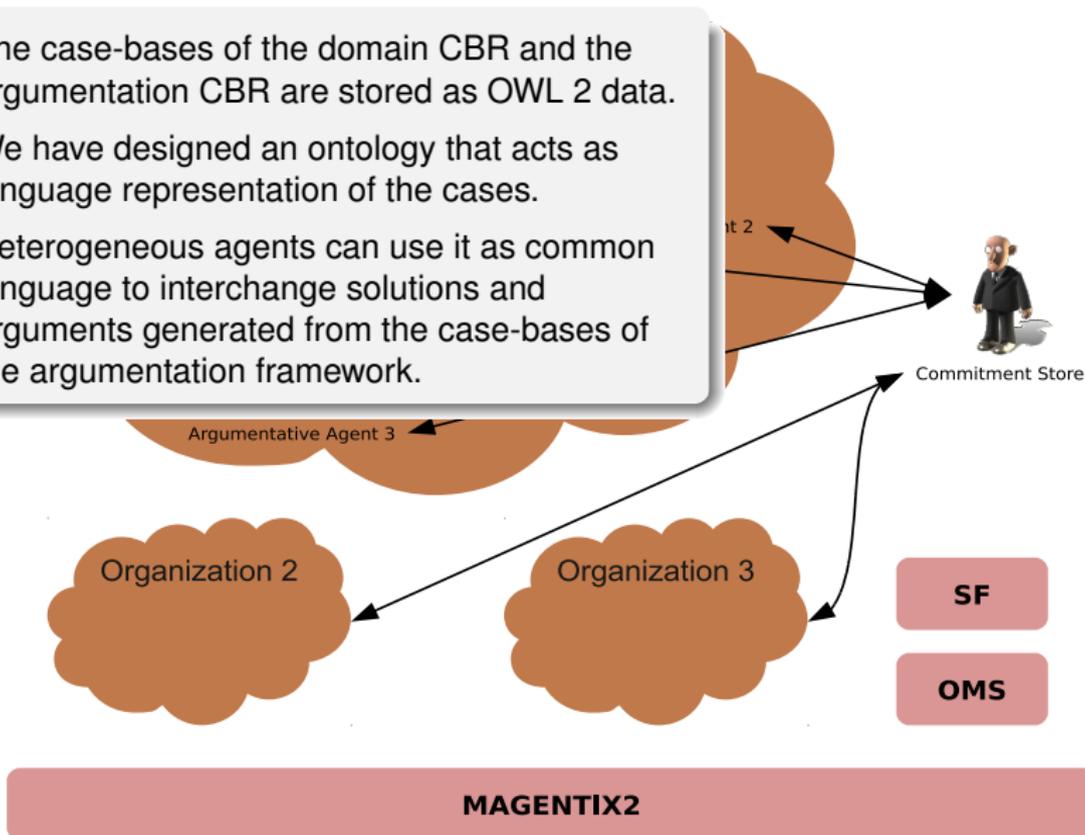
Commitment Store

- Resource that stores all the information about the agents participating in the problem-solving process.
- Argumentation dialogues, positions and arguments.
- Every agent can read the information of the dialogues that it is involved in.
- It has been implemented as an agent to allow a good communication with the other agents.

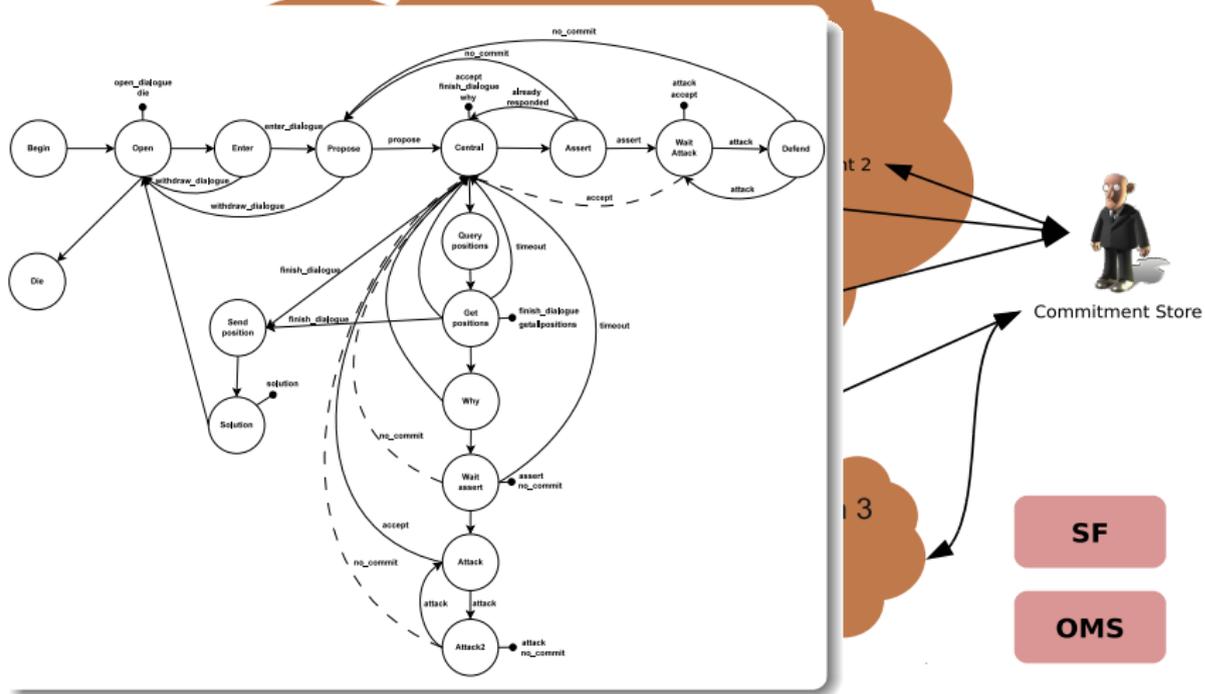


Knowledge interchange mechanism

- The case-bases of the domain CBR and the argumentation CBR are stored as OWL 2 data.
- We have designed an ontology that acts as language representation of the cases.
- Heterogeneous agents can use it as common language to interchange solutions and arguments generated from the case-bases of the argumentation framework.



Argumentation protocol



MAGENTIX2

Messages interchange

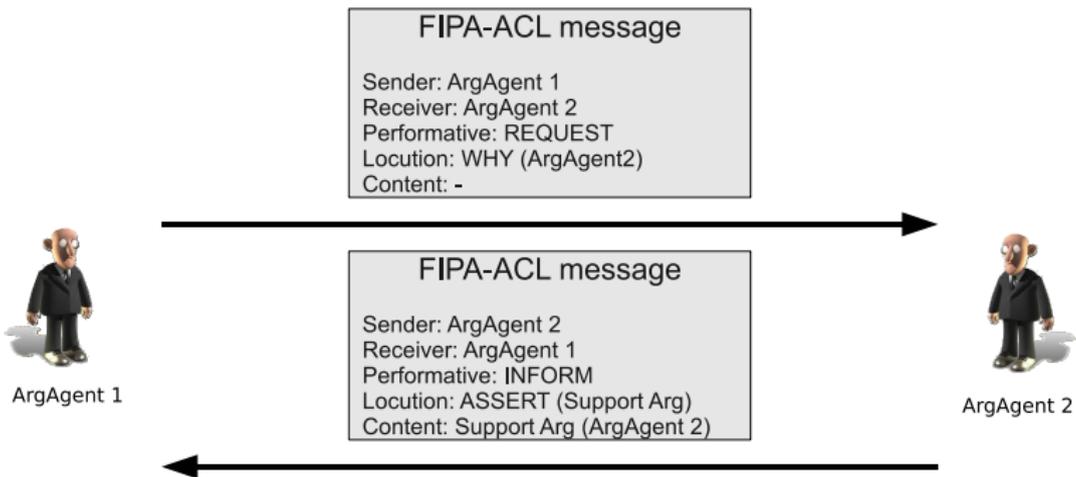


Figure: Messages interchange between argumentative agents

Call Centre Problem

- A Call Centre provides *technological* and *customer support* services.
- The operators attend to customer requests by means of a **Call Centre**. Typically organised in 3 levels:
 - Base operators.
 - Expert operators.
 - Managers.
- The *Call Centre* receives the request and creates a new incidence (**Ticket**).
- The operators work **cooperatively** to solve the **Ticket**.
- We represent the operators by means of **argumentative agents**.

Argumentation process

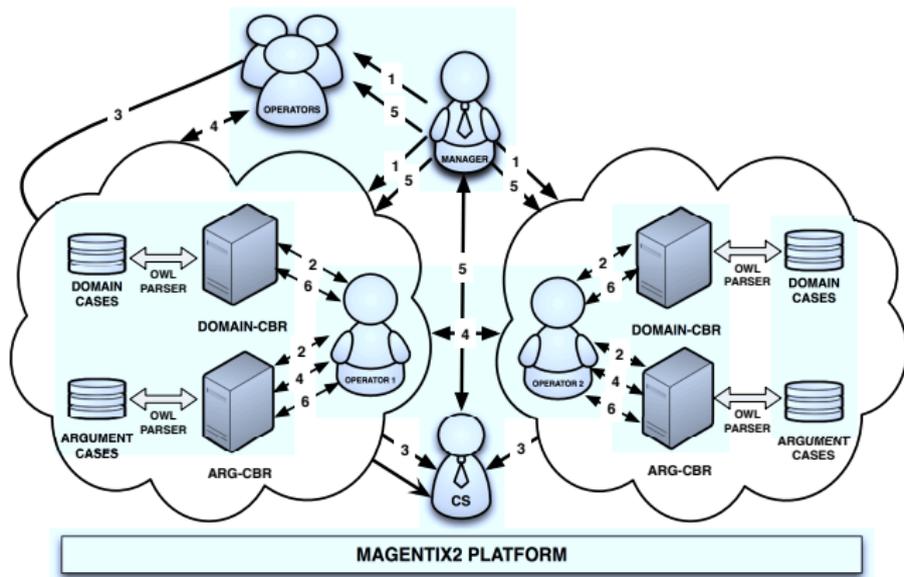


Figure: Data-flow for the argumentation process of the Call Centre application

Argumentation process

- 1 The **initiator agent** sends the ticket to the agents.
- 2 Each agent evaluates if it can engage in the dialogue offering a solution. Queries to the **Domain-CBR** and **Argumentation-CBR** to select the best position (solution) to defend.
- 3 Positions defended by agents are stored by the **CS**.
- 4 Argumentation process: agents try to **defend** their positions and **attack** other different positions.
- 5 The dialogue is stopped after a specified time or when nothing new is proposed after a specific time. The **most frequent position** will be the solution.
- 6 Each agent **updates** its Domain-CBR and its Argumentation-CBR case-bases.

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Prediction error

Testing policies:

- CBR-Random (CBR-R): choose **randomly** a solution of domain-cases case-base proposed by the agents, without using argumentation.
- CBR-Majority (CBR-M): choose **the most frequently** solution of domain-cases case-base proposed by the agents, without using argumentation.
- CBR-Argumentation (CBR-A): agents perform an **argumentation dialogue** to select the best solution of those proposed.

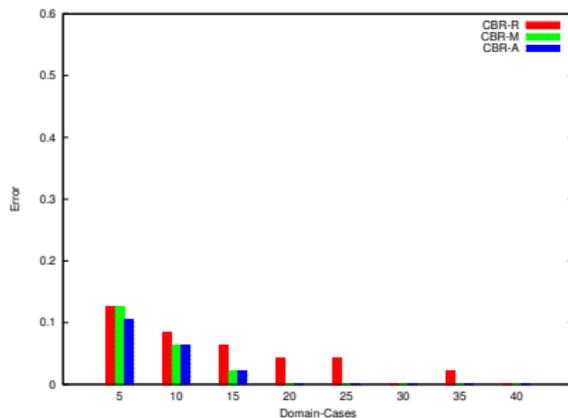
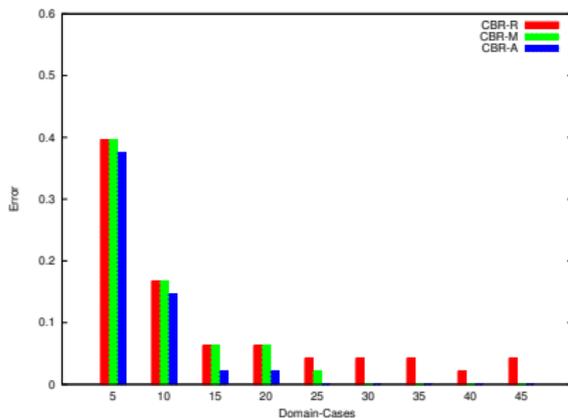


Figure: 7 operators (left), 6 operators and 1 expert (right)

Generated locutions and prediction error

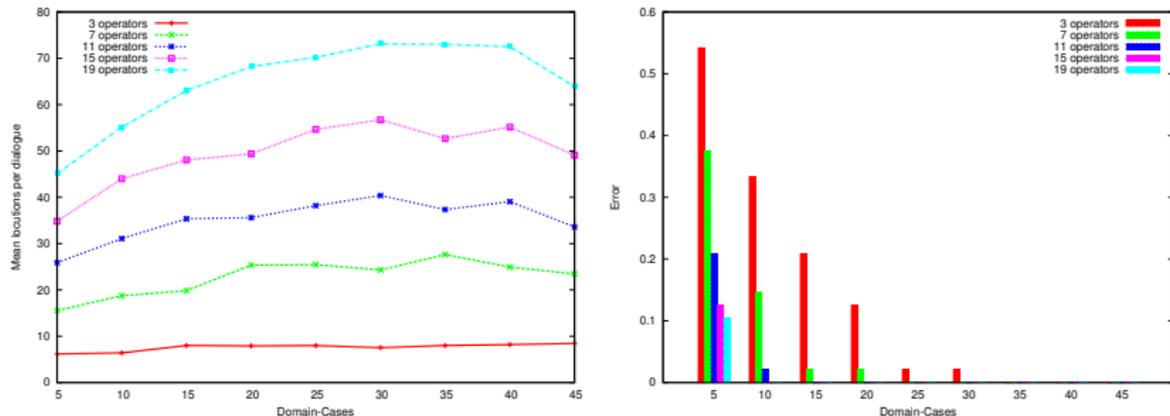


Figure: Mean locutions generated per dialogue and prediction error

Summary

- Design and implementation of an infrastructure to develop and execute argumentative agents and all the components needed.
 - The agents' logic and their argumentation protocol.
 - An ontology using OWL 2 to represent all the needed knowledge to facilitate the understanding between heterogeneous agents.
 - A knowledge interchange mechanism using FIPA-ACL messages to communicate the agents.
 - Two different CBR architectures for the domain CBR and the argumentation CBR.
- Validation and evaluation with a real example, obtaining better performance than other reasoning approaches without argumentation.
- **Future work:** Our infrastructure will be used in other domains to measure the performance and the differences having a largest database of solved problems.