AGENT–BASED DECISION SUPPORT SYSTEM

Introduction to Multi-Agent Systems
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Outline

01 Introduction

Brief introduction of the project

02 Implementation

Explanation of our approach. The system functionality as well as the code structure are presented.

03 Results

The results obtained in the testing stage are presented.

04 Conclusions

Presentation of the different insights we extracted from the project as well as limitations and future improvements.

01. INTRODUCTION

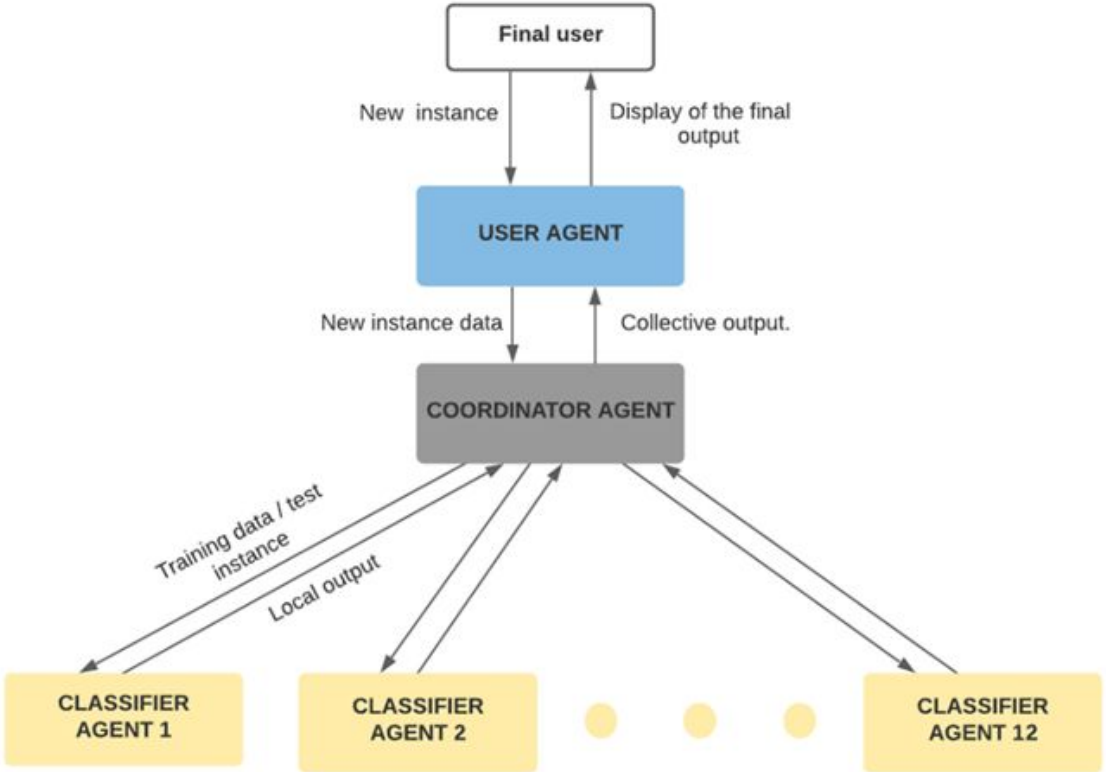
Multi Agent System: systems composed by two or more intelligent agents, which interact between them, which are extremely useful for solving distributed problems .

MAIN GOAL

Develop an A-DSS to help audits detect fraudulent firms by wrapping a machine learning problem into a MAS.

- ☑ Define the ADSS with JADE, which complies with FIPA standards.
- ☑ Coordinate the agents by means of the FIPA standard.
- ☑ Wrap the ML classification task in the system: J48 decision tree classifier from WEKA.

02. IMPLEMENTATION: ADDS ARCHITECTURE



02. IMPLEMENTATION: SYSTEM AGENTS

USER AGENT: provides an interface for the human user to interact with the system. Provides a way of introducing the input instances and shows the result of the system to the user.

INTERFACE agent

REACTIVE architecture

PROPERTIES

- Reactivity: Interacts with the owner by receiving its orders.
- Rationality: Acts in order to achieve the general goals.
- Autonomy: Ability to perform required tasks by himself.
- Social ability: Cooperates/communicates with other agents.
- Temporal continuity: Runs all the time.

02. IMPLEMENTATION: SYSTEM AGENTS

COORDINATOR AGENT: Splits the training data for the classifiers. Splits the test data for the classifiers. Serves as a decision system.

COLLABORATIVE agent

DELIBERATIVE architecture

PROPERTIES

- Rationality: Acts in order to achieve the general goals.
- Autonomy: Ability to perform required tasks by himself.
- Social ability: Cooperates/communicates with other agents.
- Temporal continuity: Runs all the time.

02. IMPLEMENTATION: SYSTEM AGENTS

CLASSIFIER AGENT: Classify the instances as fraudulent or not. Send the results to the coordinator agent.

WRAPPER agent

REACTIVE architecture

PROPERTIES

- Learning: Performs a ML classification task.
- Flexibility: Adapts to the environment. Learning makes it flexible.
- Rationality: Acts in order to achieve the general goals.
- Autonomy: Ability to perform required tasks by himself.
- Social ability: Cooperates/communicates with other agents.
- Temporal continuity: Runs all the time.

02. IMPLEMENTATION: SYSTEM INITIALIZATION

USER AGENT

1) Registration to the DF

COORDINATOR AGENT

1) Registration to the DF

2) Split training instances.

- 12 sets of 300 instances with 6 different attributes
- Send each set to a new classifier agent
- Set its state to IDLE

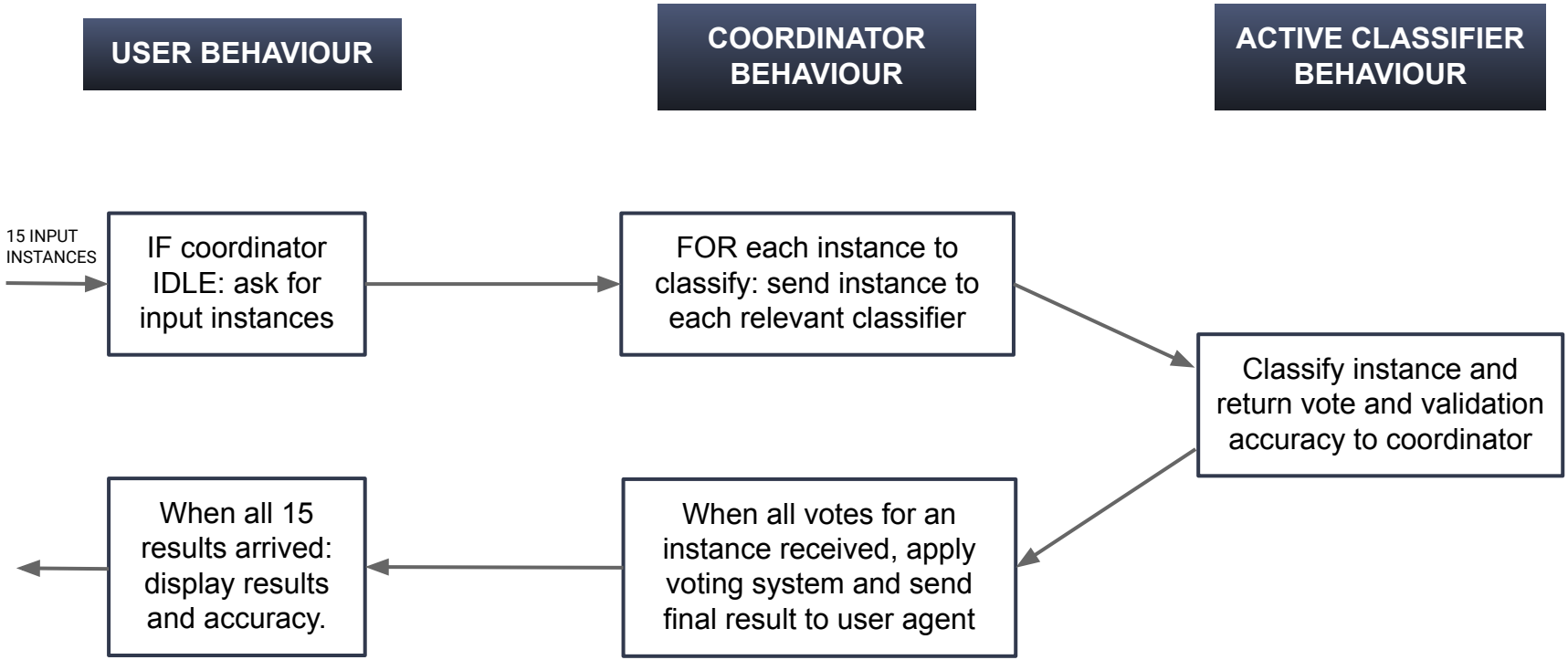
CLASSIFIER AGENTS

1) Registration to the DF

2) Training.

- Train its J48 with the 75% of train data
- Evaluate the J48 with the 25% of train data
- Save the classifier and performance as attributes.

02. IMPLEMENTATION: SYSTEM USAGE



02. IMPLEMENTATION: VOTING SYSTEM

Weighted voting:

Weighted mean of each active classifier result (**0** if no risk or **1** if risk exists). Highly related to the **plurality system**: each agent has one vote to give to one of the two possible alternatives: risk or not risk.

Not all the agent votes are equally considered, which breaks the anonymity property of the social choice rule.

Eq. 1. Weighted voting

$$Result = \frac{\sum_{i=1}^{I} v_i * w_i}{\sum_{i=1}^{I} w_i}$$

- V_i: Vote of classifier i
- W_i: Validation accuracy of classifier i
- I: Number of classifiers

02. IMPLEMENTATION: COMMUNICATION

ACL Message: Uses the structure of a message determined by FIPA (Foundation for Intelligent Physical Agents). In our system, the same performative (INFORM) of the ACL message have been used in all cases. The communication in our system is completely **explicit**.

Example: Structure of ACL message used in our system

(**INFORM**

:sender (agent-identifier :name UserAgent)

:receiver (agent-identifier :name CoordinatorAgent)

:content input dataset

)

03. RESULTS

Table of results: The following table shows three different measures (accuracy, sensitivity and specificity) for each one of the input datasets tested. Additionally, it shows the average result of the three inputs for each one of the measures.

Table 1. System performance metrics based on test files.

	Accuracy	Sensitivity	Specificity
Test file 1	93.33%	85.71%	100%
Test file 2	100%	100%	100%
Test file 3	93.33%	85.71%	100%
TOTAL	95.56%	90.47%	100%

04. CONCLUSIONS

OVERALL CONCLUSIONS

- Importance of the coordination and cooperation between the agents
- The MAS presents an accuracy of 95.56%
- MAS are a suitable option also for classification tasks

FUTURE IMPROVEMENTS

- Add the possibility to create or terminate classifier agents during usage
- Try different voting thresholds for increasing sensitivity

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A-DSS FOR FRAUDULENCE PREDICTION

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