# Mobile Agents communication for knowledge representation

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# Introduction

The general structure of the paper is the following:

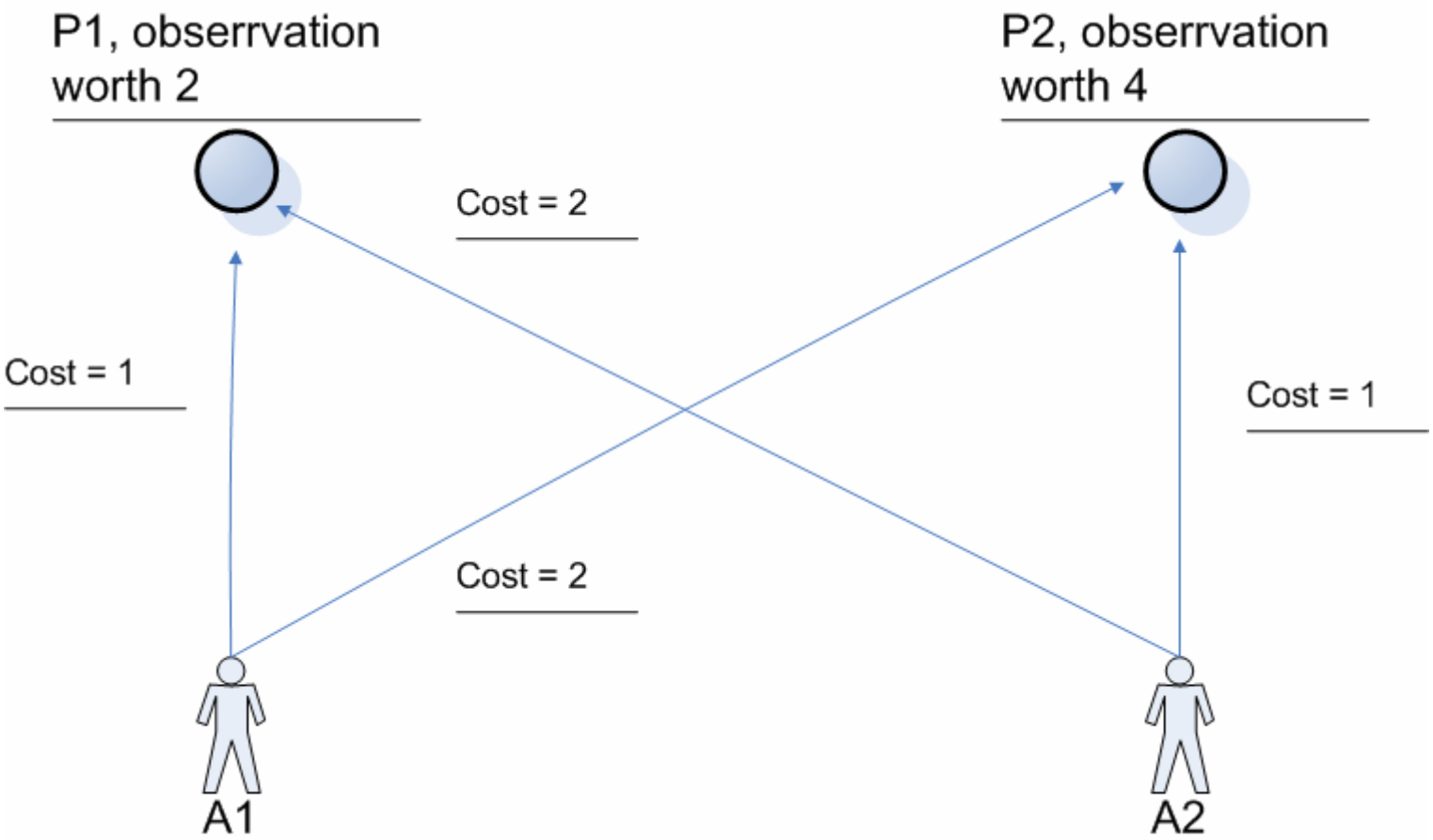
- We use the formalism of the Recursive Modelling Method for the purpose of decision theoretic calculations
- We consider examples of various types of communicative acts.
- The results address the communicative acts that agents can use to share information about their environment (I call these modeling agents)
- We then present results on the agreement between the method of message selection and messages that humans choose, and show an experimental validation of our framework in a simulated multi-agent environment.

# Communication between Mobile Agents

- The concept of mobile agent
- Agents has to include information about the possible states of knowledge, abilities and references of the other agent(s) present in the environment.
- Without a model of the other agents mental states it would be impossible to properly assess the impact of a communicative act.
- With each communicative act we identify its decision-theoretic pragmatics

# Communication between Mobile Agents

- Describe a simple interaction between two agents, and present a compiled representation of a state of knowledge of one of them that we will use during further discussion of communication.

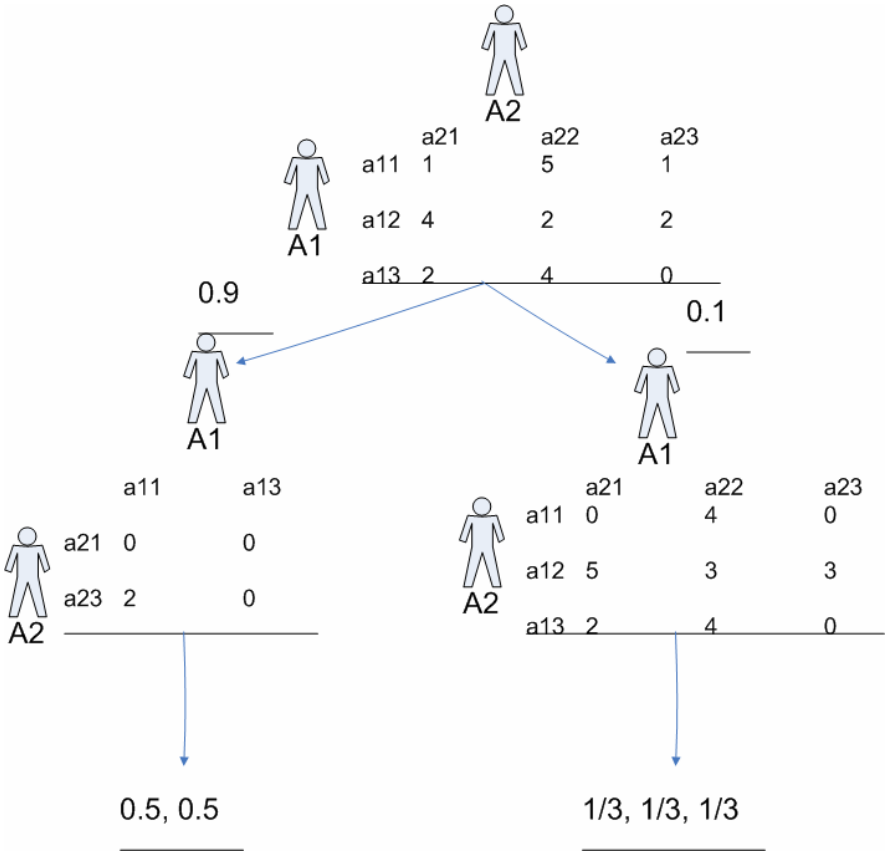


# Communication between Mobile Agents

- A1 has to make a decision as to whether to pursue the observation from P1 (well label this option a11 ), from P2 (a12 ), or do neither and just sit still (a13 )
- would like to do so in a way the maximizes the total value of information obtained by both agents, since its a joint mission, reduced by its own cost. We assume that these two factors are the only ones that determine A1 expected utility in this case.
- If A2 observes from P2 then A1 is best off observing from P1 for the total payoff of 2 + 4 - 1 = 5, i.e, total value of observations minus A1s own cost.
- If A2 decides to observe from P2 or do nothing at all, then its best for A1 to observe from P2.
- The expected payoffs of alternative behaviors of A1 can be assembled into a payoff matrix, and so on for A2.

# Communication between Mobile Agents

- We call them modelling probabilities.
- In general, modelling probabilities are associated with alternative models, or branches, on any level of the recursive model structure.



# Communication between Mobile Agents

The bottom-up solution of the structure in Figure 2 amounts to computing the expected behaviors of agents given what they, in turn, expect of other agents.

In the right branch, for example, given that A2 assigns equal probabilities of 1/3, the expected utilities of A2s actions can be computed as:

- 1/3(0 + 4 + 0) = ¾
- 1/3(5 + 3 + 3) = 11/3
- and 1/3(2 + 4 + 0) = 6/3,

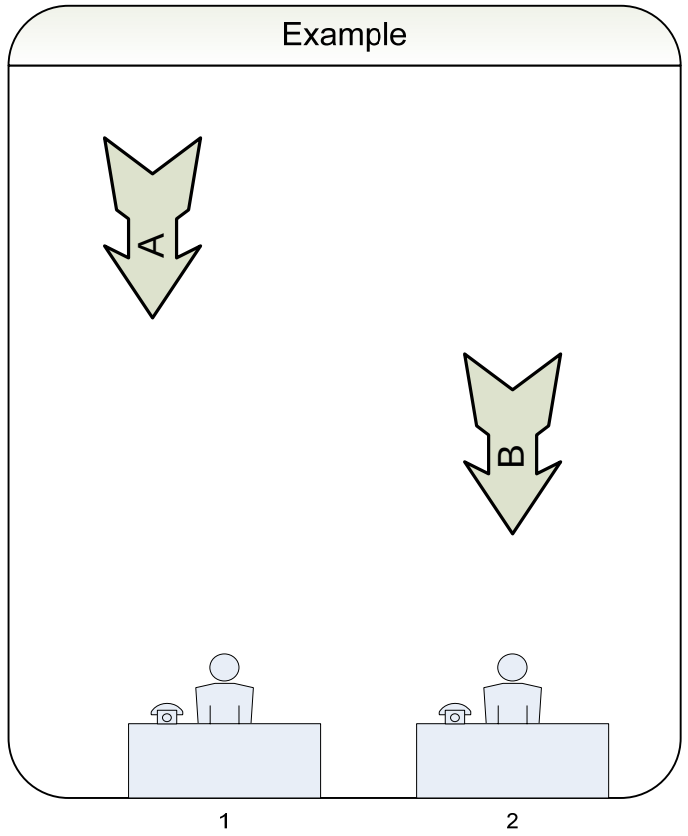
for the consecutive alternatives.

# An application which uses communication between Mobile Agents

- my experiments of coordination with communication in the air defense domain, in which two defense batteries have to coordinate their actions of intercepting multiple incoming threats.
- we will consider optimal communicative behavior of Battery1 only, and assume that Battery2 is silent but can receive messages.
- Further, for simplicity, in all of the anti-air defense scenarios considered below Battery1 is assumed to have a choice of six communicative behaviors, generated by a communication planning module:
- No Communication: No communication
- M1: Ill intercept Missile A.
- M2: Ill intercept Missile B.
- M3: I have both long and short range interceptors.
- M4: There is a missile A, whose position and warhead size are *PA* and *WA*, respectively.
- M5: There is a missile B, whose position and warhead size are *PB* and *WB*, respectively.

# An application which uses communication between Mobile Agents

- Here, the defense batteries face an attack by missiles A and B.
- The state of Battery1s knowledge before communication is summarized as a two-level recursive model structure.



# An application which uses communication between Mobile Agents

- To compute the value of communication we solve both model structures and compare results.
- The resulting distribution is Battery1s overall expectation of Battery2s actions, given all of the remaining uncertainty. The combined probability distribution describing Battery2s actions is used to compute the expected utility of Battery1s action of shooting A.
- The results of human choices are also summarized in Figure 4.

| Messages | Agents | Human First | Second |
|---|---|---|---|
| No communication | 0 | 4 | 8 |
| M1: I'll shoot down A | 7.31 | 24 | 5 |
| M2: I'll shoot down B | -1.26 | 3 | 10 |
| M3: I have both ammo | 0 | 0 | 3 |
| M4: A-(7,3),500 | 0 | 1 | 1 |
| M5: B-(14,10),100 | 0 | 0 | 5 |

# Conclusions

In conclusion, I shall follow:

- define the space of the recursive model structures.
- To handle the issue of predicting the other agents action, while the other agent attempting to do the same, we suggest a knowledge-based approach.
- In application, I shall show that Recursive Modeling Method cases agrees with selections chosen by human subjects in simple defense scenarios.
- Then, i shall show results of scaled up defense episodes in which agents perform slightly better than the human subjects.
- The results obtained can improve effectively the problem of performance in communication between mobile agents.

# Open problems and future work

The following open problems arise from this paper:

- Comparative study concerning these modeling: compared the performance of the automated agents with that of communicating humans and showed that agents are more competent.
- Study the case when an mobile agent has toured for all nodes having no faults before that it does re-connect with the faulty nodes.
- Investigate techniques that can be used to compile the results of full-blown Recursive Modeling Method into situation/communication pairs, to be used to urgent situations.


# Thank you!