Artificial Intelligence Techniques

Negotiation Agent Design

Group 4

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January 15, 2015

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1 Introduction

Negotiation is a complex problem and humans are often not the best negotiators. Emotion and the limited processing capabilities of the human brain can prevent us from getting the best results in negotiations. This makes it an interesting area for AIs. A good negotiation agent can aid humans in negotiation, since they are not limited in the same way humans are.
The first step is knowing your own **utility**, a quantization of your preferences within the negotiation domain. This allows us to make offers that are agreeable to ourselves and also inspect offers made by other agents, to base our decision of rejection or acception of said offer on. With just this information, it is possible to create a functional agent, although a rather simple one. Such an agent would only make and accept bids that are agreeable to itself. A major issue with this approach is that we don't know in what direction to continue the negotiation, since we only know our own preferences. This means that this strategy might never converge to a solution, depending on the parameters of the scenario.
A good second step, would be to observe the other agents' behavior, to work out what their utilities are. This allows us to find the solution that gives us the highest utility, **within** the solutions we expect to be acceptable to the other parties. To this end we can think of many different ways to estimate whether a bid will be agreeable to another party, and many different ways to generate bids.

The assignment was twofold. Firstly we had to define a negotiation domain for three parties, in which different degrees of conflict can exist. The degrees of conflict were specified as collaborative, moderate and competitive. This will be discussed in section 2.
Secondly we were asked to program a negotiation agent in the Java programming language and with the GENIUS negotiation environment. The agent has to work regardless of the used scenario and has to incorporate the preferences of other agents in its decision making process. This will be discussed in section 3.

2 Domain

The domain had to exist of multiple issues, each with discrete values. Within the domain, we have created three different scenarios that correspond to different degrees of conflict.

Background: A specific land zone has turned out to be a perfect place to build a new neighborhood. Up until now it has been used by the farmer to make his cattle go around. The owner of the land is the municipality.

Parties:

- Farmer
- Construction Company
- Municipality

Issues:

- Segmentation of the land
  - S1: Split 33%, 33%, 33%
  - S2: 100% to Farmer
  - S3: 100% to Construction Company
  - S4: 100% to Municipality
  - S5: 50% to Farmer, 50% to Construction Company
  - S6: 50% to Farmer, 50% to Municipality
  - S7: 50% to Construction Company, 50% to Municipality
- Building a water canal
  - W1: Big canal
  - W2: Medium-sized canal
  - W3: Small canal
  - W4: No canal
- Part of the land reserved for a park
  - P1: Big park
  - P2: Medium-size park
  - P3: Small park
  - P4: No park
- Building functionality
  - F1: Factories
  - F2: Housing
  - F3: Shops
  - F4: Farms

Scenario 1: Competitive The municipality is selling the land. Both the farmer and the construction company want to buy it. But the municipality still wants to retain a zone for welfare structures.
It's going to be difficult for the parties to find an outcome that is agreeable to everyone.

Party	Issue	Preference	Weight
Farmer	Segmentation	S2>S5=S6>S1>S3=S4=S7	0.4
	Water Canal	W2>W3>W1>W4	0.1
	Park	Don't Care	0.0
	Functionality	F4>F2>F3>F1	0.5
Construction Company	Segmentation	S3>S5=S7>S1>S2=S4=S6	0.4
	Water Canal	W2>W3>W4>W1	0.2
	Park	P4>P3>P2>P1	0.1
	Functionality	F3>F2>F1>F4	0.3
Municipality	Segmentation	S1>S5=S6=S7>S2=S3=S4	0.1
	Water Canal	W2>W1>W3>W4	0.3
	Park	P1>P2>P3>P4	0.3
	Functionality	F1>F4>F3>F2	0.2

Scenario 2: Moderate Conflict The municipality is selling the land. Both the farmer and the construction company want to buy it. The municipality wants to support independent farmers, so its preference is more in alignment with the farmer than with the construction company.
This basically reduces to a two-party negotiation, since the preferences for the farmer and the municipality are almost perfectly aligned.

Party	Issue	Preference	Weight
Farmer	Segmentation	S2>S1>S5=S6>S3=S4=S7	0.4
	Water Canal	W2>W3>W1>W4	0.2
	Park	Don't Care	0.0
	Functionality	F4>F2>F3>F1	0.4
Construction Company	Segmentation	S3>S5=S7>S1>S2=S4=S6	0.3
	Water Canal	W4>W3>W2>W1	0.1
	Park	P4>P3>P2>P1	0.1
	Functionality	F3>F2>F1>F4	0.5
Municipality	Segmentation	S2>S1>S6>S5>S3=S4=S7	0.2
	Water Canal	W1>W2>W3>W4	0.2
	Park	P1>P2>P3>P4	0.2
	Functionality	F4>F3>F1>F2	0.4

Scenario 3: Collaborative The municipality is selling the land, they don't really care what happens to it, as long as they no longer have to maintain it. The farmer wants to buy the land and build a canal, to irrigate his other land. The construction company doesn't necessarily want to buy the land, but they don't want it to turn into a big park, and they want to build houses, shops or factories on the land.
Since the three parties all care about very different things, they should be able to find an outcome for which everyone has a high utility.

Party	Issue	Preference	Weight
Farmer	Segmentation	S2>S5=S6>S1>S3=S4=S7	0.2
	Water Canal	W1>W2>W3>W4	0.8
	Park	Don't Care	0.0
	Functionality	Don't Care	0.0
Construction Company	Segmentation	Don't Care	0.0
	Water Canal	Don't Care	0.0
	Park	P4>P3>P2>P1	0.3
	Functionality	F1=F2=F3>F4	0.7
Municipality	Segmentation	S2=S3=S5>S1>S6=S7>S4	1.0
	Water Canal	Don't Care	0.0
	Park	Don't Care	0.0
	Functionality	Don't Care	0.0