Task 1: Preference Profiles

Artificial Intelligence Techniques (IN4010-12)

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Introduction A negotiation initially has a pre-negotiation phase, in which the negotiation domain and its issue structure is determined. It is important to know what exactly is being discussed and which issues must be included in the discussion. Consequently, the actual negotiation scenario consists of the previously structured negotiation domain and the preference profiles of parties involved in the negotiation. It is crucial to construct accurate preference profiles of the different parties such that the agent knows how it could optimize its utility and work towards an optimal result.

In our particular scenario the negotiation domain is the party domain, which consists of the six issues as listed in Table 1. Additional information on these issues can be divided into two types. The first being the weight that is assigned to each issue. This weight is a value between 0 and 1, which must be chosen such that the sum of the weights of all the issues equals 1. The weight represents the value that the negotiating party attaches to certain a issue. The second part of the preference profile has to do with the value options for each issue. Each issue has certain possible values. For example, the issue 'music' has the value options 'band', 'DJ', and 'MP3'. The preference order of these values should be quantified to describe a preference distribution amongst the issue values.

The total utility of an agent is calculated according to $U_{total} = \sum_{i=1}^{n} w_i \cdot U_i$, where w_i represents the weight of issue i and U_i represents the utility of issue i for the agent. This utility U_i is defined as $U_i = \sum_{j=1}^{n} \frac{v_j}{n} \cdot I_j$, where I_j is the j^{th} issue value.

Methods used In order to estimate quantization of value options, as well as weights per criteria, we have used a method based on the Analytics Hierarchy Process (AHP) as described in by Chen and Pu [1]. Classical AHP uses a multi-level hierarchical structure of objectives, criteria, sub-criteria, and alternatives. With the use of pairwise comparisons, it allows us to obtain weights of importance of the different issues, as well as the quantization of alternatives.

Because AHP assumes that all alternatives are considered, we have used parts of the method to avoid performing $M^2 * N + N^2$ pairwise comparisons, with M being the number of alternatives and N being the number of criteria. Instead, we have chosen to determine the issue weights and value option quantization according to the following method:

1. Per criteria, setup a pairwise comparison using values available in the set {9, 8, 7, 6, 5, 4, 3, 2, 1, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, $\frac{1}{6}$, $\frac{1}{6}$, $\frac{1}{7}$, $\frac{1}{8}$, $\frac{1}{9}$}. From these, calculate the right principle eigenvector, and normalize the results such that they sum up to 100. This gives us the quantization of value options.

2. Next, create the same matrix as was created for each of the criteria to get a pairwise comparison-based weight distribution for the different issues (after which again we compute the right principle eigenvector and normalize to sum up to 1 instead of 100).

These two steps allow us to make grounded decisions on exact numbers when setting up the preference profiles for different parties. The reason why this works so well is because parties only have to make small decisions as to how they prefer one value option to another at the time, with only a small range of values which are easy to imagine. This makes the method less prone to error and is more precise than when simply asking for values as direct input for the final profile.

We have used this method to derive preference profiles for each of our group members, which are depicted in Table 1 - Table 4.

Limitations and Inaccuracies Limitations of this approach include the fact that we cannot handle conditional preferences, although we know from interviewing each other that there are definitely conditional preferences present in this domain. Also, inaccuracies are introduced in the final profile as it remains difficult for parties to quantify their preferences in the pairwise comparison, even when using the predefined scale. These inaccuracies, however, are compensated for through complete pairwise comparison, calculation of right principle eigenvectors, and normalization of results.

Issue	Issue weight	Issue items and preference values
Food	0.07	Chips and Nuts (13), Finger-Food (13), Handmade Food (25), Catering (50)
Drinks	0.31	Non-Alcoholic (3), Beer Only (30), Handmade Cocktails (18), Catering (50)
Location	0.23	Party Tent (3), Your Dorm (10), Party Room (33), Ballroom (54)
Invitations	0.05	Plain (3), Photo (46), Custom Handmade (31), Custom Print (20)
Music	0.30	MP3 (9), DJ (64), Band (28)
Clean-up	0.04	Water and Soap (7), Specialized Material (52), Special Equipment (16), Hired Help (25)

Table 1: Preference Profile Lizzy

Issue	Issue weight	Issue items and preference values
Food	0.31	Chips and Nuts (4), Finger-Food (9), Handmade Food (32), Catering (54)
Drinks	0.36	Non-Alcoholic (4), Beer Only (59), Handmade Cocktails (14), Catering (23)
Location	0.13	Party Tent (55), Your Dorm (6), Party Room (26), Ballroom (13)
Invitations	0.03	Plain (8), Photo (23), Custom Handmade (14), Custom Print (56)
Music	0.13	MP3 (62), DJ (25), Band (13)
Clean-up	0.04	Water and Soap (9), Specialized Material (27), Special Equipment (49), Hired Help (15)

Table 2: Preference Profile Joost

Issue	Issue weight	Issue items and preference values
Food	0.07	Chips and Nuts (13), Finger-Food (13), Handmade Food (25), Catering (50)
Drinks	0.31	Non-Alcoholic (3), Beer Only (30), Handmade Cocktails (18), Catering (50)
Location	0.24	Party Tent (3), Your Dorm (10), Party Room (33), Ballroom (54)
Invitations	0.05	Plain (3), Photo (46), Custom Handmade (31), Custom Print (20)
Music	0.29	MP3 (9), DJ (64), Band (28)
Clean-up	0.04	Water and Soap (7), Specialized Material (52), Special Equipment (16), Hired Help (25)

Table 3: Preference Profile Boris

Issue	Issue weight	Issue items and preference values
Food	0.09	Chips and Nuts (25), Finger-Food (56), Handmade Food (13), Catering (6)
Drinks	0.43	Non-Alcoholic (3), Beer Only (54), Handmade Cocktails (32), Catering (10)
Location	0.13	Party Tent (24), Your Dorm (12), Party Room (57), Ballroom (7)
Invitations	0.03	Plain (53), Photo (29), Custom Handmade (5), Custom Print (13)
Music	0.27	MP3 (12), DJ (62), Band (27)
Clean-up	0.05	Water and Soap (56), Specialized Material (26), Special Equipment (12), Hired Help (6)

Table 4: Preference Profile Roy

References

[1] Li Chen and Pearl Pu. Survey of preference elicitation methods. 2004.