Decision Support System for the Negotiation of Bilateral Contracts in Electricity Markets

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Abstract. Currently, it is possible to find various tools to deal with the unpredictability of electricity markets. However, they mainly focus on spot markets, disfavouring bilateral negotiations. A multi-agent decision support tool is proposed that addresses the identified gap, supporting players in the pre-negotiation and actual negotiation phases.

1 Introduction

Nowadays, electricity markets (EM) are increasingly competitive and complex, making them increasingly unpredictable [1]. This was due, in large part, to the liberalization of the sector but also to the increasing use of renewable energy. Therefore, there is a need for tools to study and understand the EM's operation and support the participating entities. In order to reach this objective, it is recurring the use of Artificial Intelligence (AI) techniques, namely multi-agent simulation, given its quality of representation of dynamic systems with complex interactions between its stakeholders. Currently, it is possible to find several tools in this domain, such as AMES, EMCAS, GAPEX and MASCEM, among others [2]. However, current tools are mainly focused on spot markets and do not provide adequate decision support for bilateral negotiations between players. This work proposes a multi-agent decision support system that addresses the identified gap.

2 Proposal

The proposed system considers two phases: pre-negotiation and negotiation, identified in [3] as these are the most relevant phases in automated negotiation between agents.

In the pre-negotiation phase, the system determines the opponent(s) which allows the best transaction for the supported player. For this purpose, the player

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indicates the amount of energy to be transacted; the minimum and maximum price; possible opponents (if a filter is intended, otherwise, all known players are considered); and transaction date. Upon receiving this information, the system with transaction context determination. This is very important since the opponents can have very different behaviours, depending on the context in which they are (for example, if it is a weekday or weekend). By knowing the context, the possible scenarios are determined as well as the actions that the player can take (all possible distributions of the energy to be transacted by the opponents under analysis). For each scenario the expected price for each amount of energy, for each possible opponent, is determined . This value will be forecast but, in case there is not enough data, an estimation is performed with available data. The decision process is performed after the process of defining the scenarios and all the possible actions. In this process, the utility value for each possible action is calculated considering both the economic (total price) and the reputation (average reputation of the selected opponents) components. The chosen action depends on the selected decision method that can be one of the following: Pessimistic, the mini-max game theoretic approach in which the action with the highest utility value is selected for the scenario with the lowest global utility; Optimistic, in which the action with the highest value of utility of all the scenarios is selected; And Most Probable, where the selected action is the one with the highest utility of the scenario with the highest probability of occurrence.

After the determination of the best action to take, the player can request the system to support him in the negotiation with each of the selected opponents. To this end, the system recommends the best strategy for negotiating with the opponent in question. For each counter-offer, the system updates the rating of each strategy and recommends a change of strategy when the current one is no longer the best ranked. The classification of each strategy to use with each opponent and in a given context is accomplished by combining information about: the opponent; players similar to the opponent; and all players in general. The contribution of each information type is updated according to the success of the negotiations.

Through the described functionalities, the proposed tool intends to be a viable option to support the decision of EM players in the negotiation of bilateral contracts.

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