Computational Social Choice: Between AI and Economics

Umberto Grandi[1], Andrea Loreggia[2], and Francesca Rossi[2,3]

[1] University of Toulouse
[2] University of Padova
[3] Harvard University

1 Introduction

During the last few decades, the trend has been for disciplines to converge on common techniques to be used in similar problems, besides focusing on specific techniques to be used in narrow domains. AI is one of the best examples: the cross-fertilisation process has led to very fascinating solutions. Consider for example genetic algorithms, which mimic evolutionary mechanisms to solve search and optimization problems [Gol89]. Or think of bird flocking or fish schooling, which are reproduced in particle swarm optimization [EK95] and used in coordinating autonomous driverless cars [GGLV12].

The individualistic approach of problem solving becomes insufficient: concepts, techniques and experts need to collaborate to get a better understanding of the problems they would like to solve. The techniques that AI makes available are being used by many other disciplines. Just think of the variety of machine learning techniques used in medicine, physics or astronomy, or the constraint programing algorithms that AI researchers use to solve planning problems. AI nowadays inundates our everyday life with tools and methods that are hidden in our household electrical devices, smartphones and much more.

Starting from the field of multi-agent systems, researchers in AI recently considered the use of models and problems from economics. Notable examples are voting systems used to aggregate the results of several search engines [DKNS01], game theoretic methods that analyse the complex interaction of autonomous agents [SLB09], and matching procedures implemented on large-scale problems such as the coordination of kidneys transplants [ABS07] and the assignment of students to schools [GC10].

In this scenario, a number of research lines federated under the name of computational social choice [RVW11]. The need for a computational study of collective decision procedures is clear. On the one hand, from crowdsourcing to university admission ranking, many real-life applications apply existing social choice methods to large scale problems. On the other hand, collective decision-making is not a prerogative of human societies, and multi-agent systems can use these methods to coordinate their actions when facing complex situations.

A prime example is the Sydney Coordinated Adaptive Traffic System (SCATS) is a real-life multi-agent system implementation used in different cities of 27 countries around the world to manage city traffic. The system uses an adaptive approach [Sys14] which permits to adjust the management plan to the different daily traffic situations. Each intersection has a computer that manages the traffic based on an assigned plan. There are also sensors to analyse the traffic flow, this analysis allows to adjust the management of the traffic by extending or reducing the green phase. But the adjustment cannot be computed using only what a single traffic light can capture. Data from the different traffic lights of the city is sent to a central computer which produces different plausible plans. The plan is then chosen by the intersections using a voting system: each intersection votes for its preferred plan basing its preferences on what have been captured by the sensors. The plan with more preferences is chosen to manage the traffic for a specified period of time.

In this talk, we would like to focus on two additional examples that highlight the impact of a computational approach to classical problems of collective choice. First, by studying repeated collective decisions (that models opinion polls that precede an election) to evaluate the quality of the result, and, second, by devising innovative procedures to predict the preferences of a collection of individuals.

1.1 Iterative Voting

Iterative voting models an electoral process during which voters are allowed to change their mind when the outcome of the election does not satisfy them. Voters can change their preferences in order to make another more preferred candidate win the election. The process can reproduce a multi-agent system where agents cannot share their complete knowledge (in this case their preferences), either because of media limitations which do not allow to send enough information or simply because they do not trust one anoother. In this scenario the iterative process helps the system to reach an equilibrium where all the agents are satisfied. During the talk we will show some theoretical results describing under which assumptions this systems converges to a stable state where no voter has incentive to cheat, either because she is satisfied, or because she cannot affect the outcome. We will also show the results of our simulations, showing that the quality of the winner after iteration is often higher than that of the winner of the initial state [GLR$^+$13].

1.2 Sentiment Analysis

Sentiment analysis is used to classify the collective opinion about a given item [Liu12]. This is done by extracting the individual opinions from text that individuals write, such as Twitter or blog posts, via natural language processing techniques. Sentiment analysis is then used to predict the opinion of the collectivity. More often it is used to predict the outcome of political elections or guessing the trend of the stock market. While sentiment analysis works quite well when we have just one item for which we would like to know what the community thinks, things change when we would like to compare multiple entities. In this talk we present our proposal to cope with the challenges of sentiment analysis over multiple items [GLRS14]. Nevertheless, the problem of generalising existing sentiment analysis techniques to account for more complex individual expressions remains mostly an open and interesting area of research.

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