

Bases of Social Power for Agents

(Extended Abstract)

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ABSTRACT

One of the most pervasive concepts in human interactions is social power since many social situations entail disputes of social power. These disputes are power games and range from simple personal reasoning to the exercise of specific power strategies, which enhance or assert one's power. Recognizing the importance of such interactions and how they can enhance autonomous agents' socially intelligent behaviors, we present a conceptual framework integrating the different bases of power as social forces that can underlie an agent's deliberative decision process. This work establishes a theoretical basis for social intelligent agents capable of both being aware of and manipulating social power.

Categories and Subject Descriptors

I.2.0 [Artificial Intelligence]: General—*Cognitive simulation*; H.1.2 [Models and Principles]: User/Machine Systems—*Human Factors*

General Terms

Algorithms, Design, Human Factors

Keywords

social power, autonomous agents, social intelligence

1. INTRODUCTION AND MOTIVATION

The motivation for studying social power, relates to its ability to act as a *social heuristic* in many social situations such as friends' interactions, organizations or even laboratory experiments among others. The pervasiveness of power is due to its impact on many social processes such as coordination, delegation and conflict resolution. As such we argue that it is fundamental to understand and emulate such power-based social dynamics in multi-agent systems to build socially intelligent agents.

The subject of social power, namely the representation of power and the formalization of the associated dynamics have been previously researched from several perspectives, e.g. autonomy[3], dependence [1], norms[4]. However, current approaches do not take into account the particular dynamics

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and contrasting effects of using different bases of power[2]. Modeling the different bases of social power is then crucial to simulate the complex processes behind social power and its ubiquitous influence in social interactions.

To address this we propose a conceptual framework to support agent perception, reasoning and intelligent use of social power aimed at multi-agent and agent-human interactions. By using those concepts in modeling agent decision and interactions we argue that a broader range of social settings can be more accurately modeled in agent simulations.

2. POWER BASED AGENTS

2.1 Elements of Social Power

What is social power? The subject has been researched from different perspectives and there are many definitions. However, the one we follow defines it as: “**Social Power** of A over T regarding a possible change in T is the resultant potential force that A can induce on T towards that change.”. This definition captures the essence of power as a potential force that results from the accumulation of a variety of social power components with different sources.

In any power interaction there are three central elements. First, the **Actor (A)** is the agent exerting power over the actions of another. Second, the **Target (T)** is the agent whose actions are affected by the Actor's power. Third, the **Action (C)** evaluated by the Target in a given interaction.

2.2 Different Bases of Power

The identification of different bases of social power is essential to an agent's situational analysis of social power and dynamic update of social powers. Several social power studies propose a set of bases of power. However, most can be represented by one of the first sets introduced by French and Raven [2]. Their work presents a differentiation and dynamics of social power grounded on five bases of power: reward, coercive, legitimate, referent and expert. Our work is inspired on French and Raven's bases[2] due to their simplicity, behavior expressive potential and repeated validation over the years. We conceptualized the five bases of power with four categories, abstracting the reward and coercive bases under a welfare category due to their symmetric dynamics.

2.3 Operating Social Power

To operate social power we must understand the diverse factors influencing the Target's decision deliberative process. The basis of our approach derives from the concept of power as a force inducing change in a given direction. However,

there is another fundamental force at play: Utility. It plays a fundamental part in balancing the social powers in the decision of the agent regarding its goals. Utility can function either as a catalyst towards the compliance of the Action or as a resistance to it. If the cost/damage to a Target is very high the utility acts as resistance and can overcome the power of the Actor, directing the Target not to do Action.

The context for operating social power is an interaction of an Actor and a Target regarding a decision C of the Target. Considering the initial state of the environment S_i (before the Target's decision), then the possible evolutions of the multi-agent system environment are presented in definitions (1) and (2). In (1) we represent the possible outcome of the world state in case the Target decides to do the action C , corresponding to the final state $S_{f,C}$.

$$S_{f,C} = Do(T, C, S_i) \quad (1)$$

In (2) we represent the possible outcome of the world state in case the Target decides not to do the action C , corresponding to the final state $S_{f,-C}$.

$$S_{f,-C} = \neg Do(T, C, S_i) \quad (2)$$

The utility force is calculated based on the possible outcomes of the world state according to definition (3): the utility force of T regarding the execution of C . The $utility(T, S) \in \mathbb{R}$ function measures how much does T value the state of the world where S is performed. The utility force increases with the increase of $utility(T, S_{f,C})$ or decrease of $utility(T, S_{f,-C})$ and vice versa. Negative values represent harmful situations (favoring final state $S_{f,-C}$), positive values beneficial ones (favoring final state $S_{f,C}$) and 0 represents indifference.

$$utility_force(T, C) = utility(T, S_{f,C}) - utility(T, S_{f,-C}) \quad (3)$$

The social power force exerted by the Actor is determined by the different bases of power[2]. In a given situation, the Target can be subjected to several social power forces. For instance consider a situation where there are two agents, playing the role of father and son, and a single decision, the son arriving home at the ordered time. The agent in the role of son can be subjected to the legitimate power of the father since there is an informal norm stating that the son should obey the father. Additionally the father also has the coercive power to withdraw the son's allowance in case of non-compliance. These forces can share the same base of power or be different bases. Any combination of any number of forces from different bases of power are possible as it happens in human interactions. To the set of all identified power situations independently of their bases we call *IdentifiedPowers (IP)*. Each identified power over the Target contributes individually to an overall social power. This individual contribution is defined as *Force* and has two components, a probability and a magnitude. The meaning of these components varies depending on the power base. For each *Force* identified power, its specific contribution can be determined by multiplying the corresponding probability by the corresponding magnitude, according to equation (4).

$$p \in IdentifiedPowers$$

$$Force_p = probability_p * magnitude_p \quad (4)$$

The probability function ranges between $[0, 1]$ and the highest it is the greater the contribution of the respective

power value to the overall influence power exerted from A on T . The magnitude component assumes values in \mathbb{R} where negative values reflect negative power (towards $S_{f,-C}$), positive values positive power (towards $S_{f,C}$) and 0 its absence. Similarly to the probability component, the highest the value of the magnitude function the greater the contribution of the respective *Force* to the overall social power force exerted from A on T . Based on this, a simple formalization of the social power force is presented in definition (5). The social power force is represented as the sum of the influence of all identified powers at play in a given social situation. Notice that there can be multiple powers from the same power base, for example an individual can have multiple ways to coerce or reward another.

$$social_power_force(A, T, C) = \sum_{p \in IP} Force_p \quad (5)$$

Finally, assuming a simple resultant force approach, the deliberation process of the agent on what action to take C or $\neg C$ is formalized in definition (6).

$$res_force(T, A, C) = utility_force(T, C) + social_power_force(T, A, C)$$

$$Decision = \begin{cases} Do(T, C, S_i), & \text{if } res_force(T, A, C) > 0 \\ \neg Do(T, C, S_i), & \text{if } res_force(T, A, C) \leq 0 \end{cases} \quad (6)$$

If the value is positive then the agent choses C , if not then it choses $\neg C$. Notice that this decision formalization takes into account the possibility of resistance at two distinct levels. First, if an utility is negative it represents an opposing force to the social power being exerted. Second, for any *Force* the magnitude can reflect negative power and thus form a different opposing force to the influence attempt.

3. CONCLUSIONS

In this work we introduced a conceptual framework for agent social intelligence regarding social power awareness targeted for increased behavioral believability in diverse agent-based applications. It consists in the definition of the basic mechanisms for an agent's decision making processes including the conceptualization of a social power force composed by different forces emerging from distinct bases of power.

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