# Wishful Thinking In Effective Decision Making

# (Extended Abstract)

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## ABSTRACT

Creating agents that act reasonably in uncertain environments is a primary goal of agent-based research. In this work we explore the theory that wishful thinking can be an effective strategy in uncertain and competitive decision scenarios. Specifically, we present the constraints necessary for wishful thinking to outperform Expected Utility Maximization and take instances of popular games from Game-Theoretic literature showing how they relate to our constraints and whether they can benefit from wishful-thinking.

## 1. INTRODUCTION

Creating agents that act reasonably in uncertain environments is a primary goal of agent-based research. One traditional manner of implementing rational behavior is expected utility maximization. Therefore, any improvement or addition to this fundamental theory has the potential to dramatically impact computational decision making.

In this work we explore the theory that decisions biased by wishful thinking can be effective in uncertain and competitive decision scenarios. Specifically, we present constraints necessary for these decisions to outperform unbiased Expected Utility Maximization. Additionally, we explore instances of games from Game-Theoretic literature, namely *Battle of the Sexes* and *Chicken*, and show that wishful thinking performs at least as well as unbiased EU-Maximization in a majority of reasonable scenarios in *Battle of the Sexes* but performs no better than EU-Maximization in a similar majority of scenarios in *Chicken*.

Our previous work [3] in self-deceptive wishful thinking established wishful-thinking as a concrete decision strategy derived from psychological concepts [6] within the framework of EU-Maximization. Later work [4] explored wishful thinking from a normative context, which was inspired by recent and parallel work in the psychological communities exploring the idea that emotional bias is *essential* in rational human decision-making [5, 2, 1].

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## 2. WISHFUL THINKING

We now summarize our previous work on self-deceptive wishful thinking [3]. Wishful thinking is defined as a specific instance of self-deception in which a decision maker is biased towards believing positive outcomes are more likely to occur than reality would suggest.

The most positive outcome in a decision scenario occurs when act $a_{\mathrm{k}}$ is taken under state $s_{\mathrm{c}}$ such that the maximum achievable utility is realized. We therefore define wishful-thinking as a bias *towards* $s_{\mathrm{c}}$ by means of the probability function $\mathrm{p_w}(s_j)$ in (1). This formulation specifies the desired belief state by leveraging the preferences of the decision maker encoded through utility. The wishful thinking based action, $a_{\mathrm{w}}$, is given in (2) where $\alpha$ is referred to as the self-deceptive constant and $0 \leq \alpha \leq 1$ . This constant controls the degree of self-deception evinced by the decision-maker.

$$\mathrm{p_w}(s_j) = \begin{cases} 1 & \text{if } s_j = s_{\mathrm{c}} = \underset{s_k \in S}{\operatorname{argmax}} \max_{a_i \in A} \mu(a_i, s_k) \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

$$a_{\mathrm{w}} = \underset{a_i \in A}{\operatorname{argmax}} \sum_{s_j \in S} \left( (1-\alpha)\,\mathrm{p}(s_j) + \alpha \mathrm{p_w}(s_j) \right) \cdot \mu(a_i, s_j) \quad (2)$$

## 3. WISHFUL THINKING EFFECTIVENESS

We now explore the effectiveness of wishful thinking as a decision-making strategy. Specifically, we compare a decision biased by wishful thinking with that of a decision

| | foot | opera |
|---|---|---|
| foot | $(1, z'_{\text{bos}})$ | $(x_{\text{bos}}, x'_{\text{bos}})$ |
| opera | $(0, 0)$ | $(z_{\text{bos}}, 1)$ |

**Table 1: Battle of the Sexes**

| | swerve | straight |
|---|---|---|
| straight | $\left(1, \frac{8}{10}\right)$ | $(0, 0)$ |
| swerve | $\left(\frac{9}{10}, \frac{9}{10}\right)$ | $\left(\frac{8}{10}, 1\right)$ |

**Table 2: Player Utilities for Chicken**

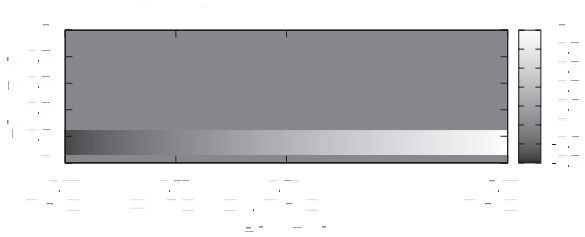

**Figure 1: Benefit of Wishful Thinking when $\alpha = \frac{1}{5}$**

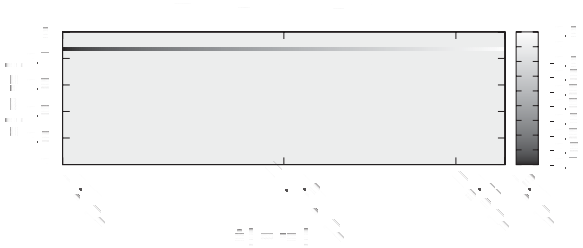

**Figure 2: Benefit of Wishful Thinking when $\alpha = \frac{1}{5}$**

based solely on EU-maximization. The basis of comparison will be the resulting objective expected utility in which the objective probabilities are expressed by the probability function $\hat{\mathrm{p}}(s_j)$. By utilizing this metric we define the *benefit* of employing wishful-thinking over EU-Maximization as (3) where $a_{\text{w}}$ is the action biased by wishful-thinking and $a_{\text{u}}$ is the action based on EU-maximization.

$$\sum_{s_j \in S} \hat{\mathrm{p}}(s_j) \cdot \mu(a_{\text{w}}, s_j) - \sum_{s_j \in S} \hat{\mathrm{p}}(s_j) \cdot \mu(a_{\text{u}}, s_j) \qquad (3)$$

*Battle of the Sexes*, representative of a coordination problem, is depicted in Table 1. Each outcome is represented by a 2-tuple of the utilities for players *row* and *column* respectively. The game traditionally involves a couple attempting to coordinate activities without any prior communication. While each individual has differing preferences over which event they attend, they would each rather attend an event together than go separately. The utility values are constrained such that $0 < x_{\text{bos}} < z_{\text{bos}} < 1$ and $0 < x'_{\text{bos}} < z'_{\text{bos}} < 1$ which is indicative of player *row* preferring the football game and player *column* preferring the opera.

By instantiating the scenario such that $x_{\text{bos}} = x'_{\text{bos}} = \frac{1}{3}$, $z_{\text{bos}} = z'_{\text{bos}} = \frac{2}{3}$, and $\alpha = \frac{1}{5}$ we generate the plot in Figure 1. The plot depicts the net utility gain of *row* represented as a color gradient moving from dark to light as the net gain in utility increases when biased by wishful thinking with respect to both *column*'s actual mixed strategy (x-axis) and *row*'s subjective belief of *column*'s strategy (y-axis). Note that a significant portion of the plot is indicative of wishful thinking having no impact on overall utility. This occurs when the act specified by wishful thinking is identical to that specified by EU-maximization. The x-axis of the plot also labels several reasonable strategies that *column* might take. The net gain in utility is given by $\frac{4}{3}\hat{\mathrm{p}}(\text{football}) - \frac{1}{3}$. In this particular instantiation of *Battle of the Sexes*, against all but one of the reasonable opponent strategies wishful-thinking performs at least as well as EU-maximization.

A similar analysis of *Chicken*, a model of conflict between two players, may also be performed. An instantiation of *Chicken* is given in Table 2. It is traditionally depicted by two players approaching head-on in cars who must simultaneously decide whether to continue straight or swerve. The principle of the game is that while both players prefer not to yield, i.e., swerve, the worst possible outcome occurs when neither yields which resulting in a collision.

Setting $\alpha = \frac{1}{5}$ we create the plot in Figure 2. The net gain of wishful-thinking is $\frac{9}{10}\hat{\mathrm{p}}(\text{swerve}) - \frac{8}{10}$. So we can see that in all but one of the given opponent behaviors wishful-thinking performs no better than EU-maximization.

# 4. CONCLUSION

We have presented an analysis on the effectiveness of decisions biased by wishful thinking in both a general form and within the context of two specific games. This analysis is conducted with respect to EU-Maximization, a traditional means of implementing rational behavior. We have found that wishful thinking can be effective in *Battle of the Sexes*, representative of conflicts involving cooperation and coordination, across a wide range of reasonable opponent behaviors. However, we have also shown that wishful thinking is detrimental in *Chicken*, representative of struggles involving brinkmanship, across a similar range of opponent behaviors. Our analysis suggests that wishful thinking can indeed be beneficial in uncertain decision contexts, given *specific constraints*, even when the uncertainty is attributable to the unpredictability of human decision makers.

# 5. REFERENCES


[1] A. Damasio and S. Sutherland. *Descartes'error: Emotion, reason, and the human brain*. Papermac London, 1996.

[2] R. Frank. *Passions within reason: The strategic role of the emotions*. Norton, New York, 1988.

[3] J. Ito, D. Pynadath, and S. Marsella. Modeling self-deception within a decision-theoretic framework. *Autonomous Agents and Multi-Agent Systems*, pages 1–11.

[4] J. Y. Ito, D. V. Pynadath, and S. C. Marsella. Self-deceptive decision making: Normative and descriptive insights. In *Proceedings of AAMAS*, May 2009.

[5] Z. Kunda. The case for motivated reasoning. *Psychological Bulletin*, 108(3):480–498, 1990.

[6] A. Mele. *Self-deception unmasked*. Princeton Univ Pr, 2000.