THEORY OF ANTICIPATION

VOLUME I:

FORMULATION OF FUN AS ANTICIPATION AND ITS LOCAL FORM

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ABSTRACT

abstract

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1 Background and Motivation

2 Introduction to Theory of Anticipation

3 Mathematical Framework

3.1 Core Components

3.2 Multi-Turn Anticipation

3.2.1 Global Desire

Modern player-versus-player (PvP) games are typically complex multi-turn games in which game sessions persist over time, and the game state evolves continuously. The local desire function, $D_{local}(s)$, is insufficient to fully capture the dynamics of these multi-turn games, as it only considers the intrinsic desirability of a state at a single point in time. To address this, we introduce the global desire function, $D_{global}(s)$, which models the expected desirability of a state over multiple turns by incorporating both future states and transition probabilities.

The global desire is computed using a backpropagation method, akin to dynamic programming, which aggregates the desirability of future states to compute a player's overall desire for a given state s. This approach ensures that the desirability of a state reflects not only its immediate value but also its long-term significance in the evolving game state.

While $D_{global}(s)$ is essential for understanding the dynamics of multi-turn games, this volume primarily focuses on the single-turn formulation. Readers can consider this section as an introduction to concepts that will be explored in greater detail in future volumes.

Definition 1 (Global Desire)**.** *The global desire function backpropagates desirability from future states. Circular dependencies are avoided in the Theory of Anticipation, ensuring that the process converges. The global desire for a state s is given by:*

$$D_{global}(s) = D_{local}(s) + \sum_{t \in T_s} [P(t) \times D_{global}(t.s)]$$

3.2.2 Perspective Desire

While $D_{global}(s)$ reflects the overall desirability of reaching state s from an initial state s_{initial}, players evaluate transitions based on their current state in the game. To capture this, we introduce the concept of **Perspective Desire**, which measures how desirable a transition is from the player's current state.

Definition 2 (Perspective Desire)**.** *For a transition $t = (s_1 \to s_2)$, the perspective desire is defined as the difference in the global desires of the two states:*

$$D_{perspective}(t) = D_{global}(s_2) - D_{global}(s_1)$$

This formulation reflects the intuitive notion that players are less likely to desire transitions to states that are perceived as less desirable than their current state. A transition is only desirable if it leads to a state with a higher global desire.

3.2.3 Anticipation

Definition 3 (Anticipation in Multi-Turn Games)**.** *For a state s with possible transitions T_s, anticipation $A_{global}(s)$ is:*

$$\mu_s = \sum_{t \in T_s} P(t) \times D_{perspective}(t)$$

$$A_{global}(s) = \sqrt{\sum_{t \in T_s} P(t) \times (D_{perspective}(t) - \mu_s)^2}$$

This multi-turn version of anticipation captures the player's engagement throughout a game session by modeling how players predict and respond to future outcomes.

4 Future Work