On Game Information Dynamics

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Abstract. This paper is concerned with game information dynamics. Information and information kinetic energy are derived using existing models. Based on Einstein's special relativity theory, it is suggested that when the velocity of information particles is slightly smaller than the speed of light, our mental concentration increases enormously.

Keywords: Information Dynamics, Energy, Relativity Theory, Emotion.

1 Introduction

A central problem in game research has been to obtain the relationship between information of game outcome and game length (or time), e.g. [4]. Here information of game outcome represents the data, which is the certainty of the game outcome. A natural extension is to obtain, e.g., information velocity and information acceleration. Recently, game information dynamic models have been proposed based on fluid mechanics ([2]). In the models, information is mathematically expressed as a continual smooth function of the game length (or time). The two models are expressed, respectively, by

$$\text{Model 1: } \xi = \eta^n, \tag{1}$$

and

$$\text{Model 2: } \xi = [sin(\pi/2 \cdot \eta)]^n, \tag{2}$$

where ξ is non-dimensional information, η non-dimensional game length (or time), and n a positive real number parameter. The value of the parameter n might depend on fairness of the game, strength of the two opponents, and strength difference between the two opponents. Information dynamics may be discussed using these models. Information kinetic energy, for example, can be obtained by using Model 1 or Model 2, following the definition in physics. It is considered that game information is closely related to emotions of observers or players ([3]).

The main purpose of the present paper is to clarify how information and information kinetic energy depend on game length, using previously proposed game information dynamic models ([2]).

2 Information Dynamics

Game information dynamics are, e.g., information, information momentum, information force and information energy, in relation to game length or time during a game. If information particles have mass in our brain (or informatical world) and flow exactly the same as fluid particles in the physical world, it is possible to discuss information dynamics. We have observed similarities between information momentum, information force and information kinetic energy with respect to game length. Therefore, we feel it is sufficient in the present study to consider only information kinetic energy. We assume that information particles flow as electromagnetic particles (photons) or electrochemical particles in our brain and form a homogeneous fluid.

Since Model 1 is expressed by (1), non-dimensional information velocity (first derivative) is

$$d\xi/d\eta = n\eta^{n-1}. \tag{3}$$

Since Model 2 is expressed by (2) the non-dimensional information velocity is derived as

$$d\xi/d\eta = n \cdot \pi/2[sin(\pi/2 \cdot \eta)]^{n-1} \cdot cos(\pi/2 \cdot \eta). \tag{4}$$

Non-dimensional information kinetic energy E_k is defined as

$$E_k = 1/2 \cdot \phi \cdot (d\xi/d\eta)^2. \tag{5}$$

Under the assumption of a homogeneous information fluid, non-dimensional information mass $\phi = 1$, and thus (5) becomes

$$E_k = 1/2 \cdot (d\xi/d\eta)^2. \tag{6}$$

This particular case has been considered. It is possible to calculate the value of E_k by substituting either (3) or (4) into (6).

Figure 1 shows how non-dimensional information kinetic energy E_k depends on non-dimensional game length η for Model 2. When $n \geq 2$, E_k increases with increasing η, takes a peak value and becomes zero at the end. However, the larger the value of n, the greater the peak value of E_k as well as the value of η at which E_k takes the peak value. When $n \leq 1$, E_k decreases from an initial positive value to zero with increasing η.

3 Discussion and Conclusion

The slowing of time in a moving inertial frame with constant velocity v, has been derived by Einstein([1]) as follows,

$$\Delta t = \Delta t_0[1 - (v/c)^2]^{1/2}, \tag{7}$$

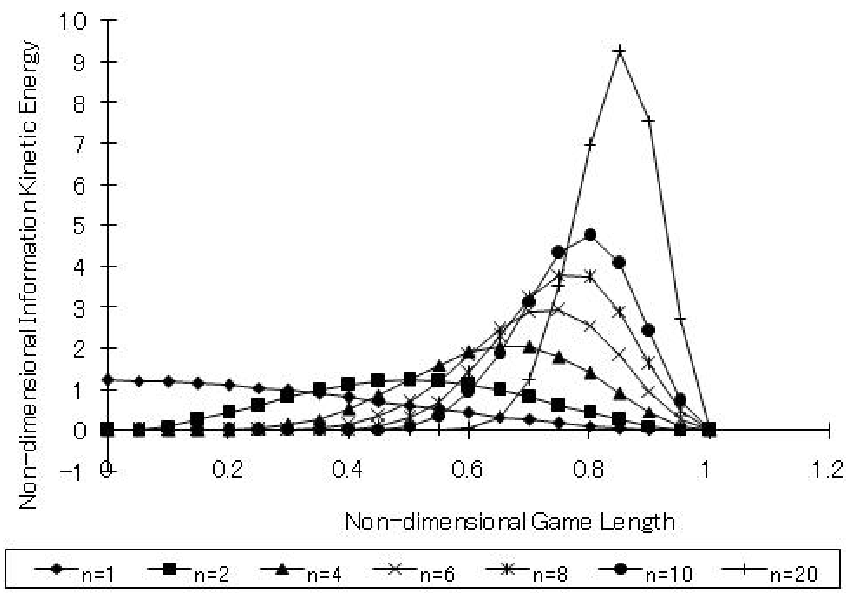

Fig. 1. Non-dimensional information kinetic energy E_k against non-dimensional game length η for Model 2.

where Δt is the elapsed time on the first inertial frame with velocity v, as seen by an observer on the second inertial frame, and Δt_0 the elapsed time on the second inertial frame. This denotes that the greater the velocity v is, the slower time proceeds on the first inertial frame, and vice versa.

Let us consider the case that the information particles (on the first inertial frame) move with a constant velocity v, relative to our body (the second inertial frame). Assuming again that motion of information particles reflects our emotions, when $v \leq c$, we may feel as if time stops, for the elapsed time on the information particles, corresponding to the first inertial frame with velocity v, becomes nearly equal to zero, as to be detected by a sensor on the second inertial frame. For example, when an event proceeds on the first frame with constant velocity v, the elapsed time on the first inertial frame is shorter than that on the second inertial frame. This means that the time on the first inertial frame proceeds slower than that on the second inertial frame, so that a sensor fixed to our body (the second inertial frame) perceives the event, being compacted within a shorter time on the first inertial frame. This may be the reason why our mental concentration increases with increasing velocity v. It is inferred that when $v \leq c$, our mental concentration increases enormously, and thus we can possess very high potential to overcome any problem or difficulty. Under this situation, a player equipped with high mental concentration in games such as Chess, Shogi, Go, Base Ball or Soccer can choose the best move or play.

References

1. A. Einstein. Zur Elektrodynamik bewegter Körper. *Annalen der Physik*, 17:891–921, 1905.
2. H. Iida, T. Nakagawa, and K. Spoerer. A novel game information dynamic model based on fluid mechanics: case study using base ball data in world series 2010. In *Proceedings of the 2nd International Multi-Conference on Complexity Informatics and Cybernetics*, pages 134–139, 2011.
3. H. Iida, K. Takehara, J. Nagashima, Y. Kajihara, and T. Hashimoto. An application of game refinement theory to mah-jong. In *International Conference on Entertainment Computing*, pages 333–338, 2004.
4. P. Májek and H. Iida. Uncertainty of game outcome. In *3rd International Conference on Global Research and Education in Intelligent Systems*, pages 171–180, 2004.