Applying Information Theory to Formal Models of Play

Information Theory, Markov Chains, Interaction, Games

Game development is a complex process that requires a lot of testing and feedback from players. Designers and developers regularly sit down with players to play certain segments of a game, to get their feedback and to see how they react.

In this setting, designers have to observe many things at once: the player’s actions, body language, verbal comments and more. The amount of information to observe can be overwhelming and thus a way to analyse and objectify play is needed as a tool to find patterns and issues in games.

Play, or in other words, interaction in games, is objectified by formally modelling it with stochastic models and by applying information theory to give the results an intuitive meaning.

A number of different video games from various genres have been analysed with the model, and various patterns could be found. The detailed results of this study can be found in the thesis. Additional research on routinisation in games based on the developed model was published as a works-in-progress paper at the CHI-PLAY conference [1].

In conclusion, this work quantifies the high-level concept of interaction in games, by modelling it through the low-level feature of raw game-controller input. It is the first work in this area that uses modelling and information theory in this context.

---

**Syntax**

The proposed model is only based on raw game-controller input. The state of the buttons and analogue controls on the game-controller forms the metaphorical letters, words and sentences that induce the higher-level concepts of interaction and play.

Relying only on the pure syntax without looking at its concrete meaning in games like ‘snap’ or ‘shoot’, makes this approach independent of the individual game and applicable out-of-the-box to the large class of game-controller based games without further modification or adaptation.

**Semantic**

Even though the approach is only based on syntax, meaning is generated by choosing an appropriate model that matches the semantic structure. Game-controller input is modelled with Markov chains, a stochastic model that assigns a probability value to each input event.

The model can learn what and predict player actions on the basis of the knowledge that is stored in the model. In many respects, this knowledge is represented in the transition matrix, but in this approach the matrix is not defined beforehand.

Actually, the intrinsic knowledge is learned by observing the player’s actions at run time. The player input is used to assess dynamically by allowing learning or new situations.

**Surprisal**

The stochastic model together with its intrinsic knowledge has a direct analogy to the designers’ experience and anticipation of player actions. A designer has an intuitive expectancy of the player actions, and where they are headed next.

**Interaction**

During playtests, designers look for unexpected and interesting moments in their games. Interaction in information theory, the amount of information that is gained when a new event is observed, the more interesting it is. If the information is always the same, the event is as predictable as possible.

The idea of surprising, unexpected behaviour can be modelled and interesting moments in the game can be predicted. This can be used by designers to improve their design intent, and the most interesting situations arise when their predictions are surprising to the player. As an example, consider a case in which the designer knew that the player was awaiting a certain appearance.

By not only looking at how unexpected or surprising certain player actions are and what patterns they form, but by interpreting it as abstract information that is flowing from the player to the game, new possibilities for game analysis open up.

Can we imagine a game where all player actions can be fully predicted and can we still regard it as a game? Take a perfect game of Guitar Hero (Harmonix 2005) for example.

Some players reached a level of proficiency where they manage to hit every note in a song, thus making their actions perfectly predictable. Yet, they seem to enjoy it a lot and would definitely describe it as a proper game.

In this example, no, or at least very little, information is flowing from the player to the game system. But if there is no information flowing and we assume games to be an interactive medium, where the interaction take place.