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Applying Information Theory to Formal Models of Play - Exploratory Modelling of User Interaction in Real Time

Masterstudium:
Visual Computing

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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 prestudy 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.

[1] Wallner, S., Pichlmair, M., Hecher, M., & Wimmer, M. (2015). Modeling Routinization in Games - An Information Theory Approach. In Proceedings of the Second ACM SIGCHI Annual Symposium on Computer-human Interaction in Play (p. pp). London, UK: ACM. doi:10.1145/2793107.2810286

Syntax

The proposed model is only based on raw game-controller input. The state of the various buttons and analogue controls on the game controller form 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 'jump' 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 class as 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 thus *expect* and *predict* player actions based on the knowledge that is stored in the model. In Markov chains, this knowledge is represented in the transition matrix, but in this approach this matrix is not defined beforehand. Its values, the intrinsic knowledge, is learned from observing the player's actions at run time. This on-the-fly training allows the model to adapt dynamically to different games or new play situations.

The stochastic model together with its intrinsic knowledge has a direct analogy in the designers experience and anticipation of players' actions. A designer has an intuitive expectancy of the player's actions, and what they might do next.

Surprisal

During playtests, designers look for surprising and unexpected behaviour that did not match their design intent, and the most interesting situations arise when their predictions fail. Analogous to that, the most information can be gained when our stochastic model fails and does not predict actions correctly.

The Idea of surprising, unexpected behaviour and interesting situations translates nicely to information theory. In information theory, the amount of abstract information of an event can be measured by looking at how surprising this event is. The more surprising an event is, the more information we gain from it and vice versa. We can thus use information theory to quantify this surprisal in an intuitive way.

As an abstract example, consider learning that a friend tells you that they are awaiting a bay. Now consider learning that they are actually awaiting twins! The second event certainly is much more surprising and thus carries much more information.

Interaction

By not only looking at how unexpected or surprising certain player actions are and what patters 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 predicable. 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 does the interaction take place?