

# Recommendation of Videogames with Fuzzy Logic

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**Summary**— A videogame as software and as a product presents a great variety of characteristics: gender, theme, platform, target audience, among others. In recent years, the number of videogames developed has grown notably thanks to the industry, as users have a large catalog available, who often may be curious to play another videogame that has not been presented in an advertising medium. In present investigation we propose a videogame recommendation architecture and a recommendation system using Fuzzy Logic, in the construction we have designed 16 rules with fuzzy sets. A database of approximately 55,000 games and of its 16 attributes of which 5 were used for the recommendation system was used: 4 attributes (Critic Score, User Score, Global\_Sales, Year) to establish membership functions with the 16 rules of recommendation formed based on the opinion of experts in the field of videogame analysis and 1 attribute (Age) to develop the content filter according to age applying an ethics model in Artificial intelligence. The results of our computational experiments with the proposed architecture reached an accuracy percentage of 80,0%.

## I. INTRODUCTION

Currently, artificial intelligence allows solving problems in different fields such as medicine, education [41] [42] [43] [44] [45], likewise, video games require artificial intelligence algorithms to recommend to users.

In a given field, a recommendation system is an intelligent agent that provides users with a list of suggestions based on the user's profile, the features expressed in the user's profile allow exploring other patterns that relate to the user's interest, to relate and calculate those relationships there are many algorithms and techniques such as collaborative filtering [46], first order logic, fuzzy logic and probabilities that allow you to build the inference engine of an intelligent system.

The videogames market benefits greatly from the recommendation models and architectures, thanks to these models they can offer new games to their users more personally, the production of new videogames also grows exponentially, to insert these new varieties to the market is necessary to calculate directly the target audience, minimizing losses.

According to research, several models have been proposed to recommend videogames; in fact, these models are improvable or have problems. In [1], a recommendation model based on a collaborative filtering technique is used, which recommends videogames based on similarity of tastes with other users so that they largely depend on the rating of the user community. In [2], the model they propose is based on the content filtering technique, unlike the previous one, it uses exclusively the elements of the game to generate new recommendations, which can generate that very similar games are always recommended and not allowed to expand the user's

horizons. In contrast, in [7] they present a recommendation system based on a combination of evaluation criteria.

In [3], the proposed system learns from different cases, a person can play a game that is not compatible with his personality and thus update the content that will be used for future recommendations. Similarly, in [5] they used machine learning techniques, extracting user experience information. they used the development process and the testers as feedback. In [6], the behavior as a player and as a buyer is evaluated with a model similar to [5], focused on Extremely Randomized Trees (ERTs) and Deep Neural Networks (DNNs), they propose the recommendation of videogames.

In contrast to the previous models, in [4] several of the above criteria are applied and at the same time they perform a ranking system using the Bayesian networks technique, in which the information of each user is evaluated (primary criteria in [1], [2] and [7]), then the products (videogames) are categorized based on their individual information and relationships with users (evaluation similar to [3], [5] and [6]), concluded that the characteristics when combined with traditional matrix factorization techniques, they can lead to the generation and recommendation of highly effective bundles.

Carrying out an analysis of the previous proposals where they use different filters and models in the videogame recommendation, it was observed that they do not fit precisely the profile of the player user, because the moment of choosing their videogame depends on the emotion in a certain time, also the age is an important factor because it clearly differentiates the taste of games between an adult and a child.

Ethics in artificial intelligence raises the moral behavior of intelligent machines. As discussed in [13] about Autonomous Ethical (Ro) bots, on the other hand, intelligent systems such as bots, robots and autonomous assistants who make permanent decisions.

In this investigation we present a videogame recommendation architecture using fuzzy logic with an Artificial intelligence ethical filter module, additionally we propose an application that allow us to recommend videogames to users based on the characteristics (Critic Score, User Score, Global\_Sales, Year).

The videogame recommendation system collects from the user attributes of interest related to the videogame Critic Score, User Score, Global\_Sales, Year, which you can change or regulate at ease to asses and receive the recommendation of the system. This will allow a list of resulting videogames to be obtained that responds to the qualities that the user values most. To apply the necessary rules that guarantee the optimal functioning of the expert system with fuzzy logic, the rules imposed by the "Entertainment Software Rating Board" were

















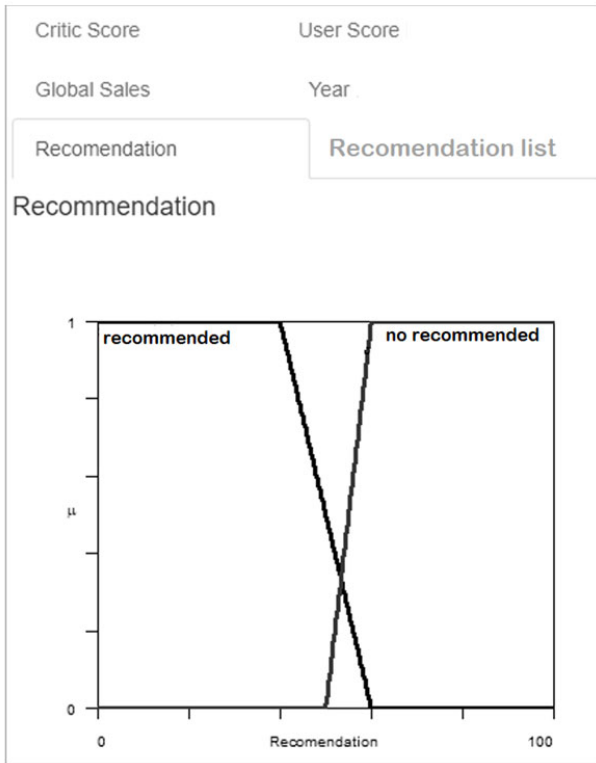


Fig. 11: Fuzzy Recommendation sets (model output)

After applying the membership functions with each fuzzy set, a previous list of recommended videogames is obtained for the data provided by a user.

Rank	Name	Genre	ESRB_Rating	Platform	evaluation
542	Saints Row 2	Action	M	X360	75.59
544	The Sims: Vacation	Simulation	T	PC	75.59
545	Call of Duty: Ghosts	Shooter	M	XOne	75.59
546	Heavy Rain	Adventure	M	PS3	75.6
547	LEGO Batman: The Videogame	Adventure	E10	DS	75.6
548	Borderlands 2	Shooter	RP	X360	75.6
549	Kung Fu Panda	Platform	E10	X360	75.6

Fig. 12. Recommended videogames list

Finally, the age filter was applied based on the ethical principle, showing a list of recommended videogames

according to age, to meet this objective a tab of recommendations is presented that allows users to consult the videogame list Fig. 8, we clarify that those videogames that do not comply with the content intended for the user's age were not taken into account.

## V. RESULTS AND DISCUSSION

### A. Results

We have tested the expert system with 100 users who made 5 queries each, the total of 1000 queries with different input values in each attempt, in order to be recommended a list of videogames. After conducting the experimentation stage, they were asked for their opinion regarding the titles that had been recommended, the results were as follows:

- Of the total of 1000 queries made, 80% had at least one videogame of interest to the user or one that he had already played and could validate the recommendation (80% success rate).
- 90.0% of users consulted considered that the use of the score of other users was an important criterion, since the specialized media score is usually influenced and does not reflect the actual valuation of the titles, so it must be supported by other factors.
- 20% of queries made by users were not useful for users because they did not like the recommendation list, concluding that the list of titles shown by the application was of considerable length and the characteristics of the videogames it contained did not present considerable variability (Critic Score, User Score or Global Sales).

### B. Discussion

In the research [11], the model proposed by the researchers shows recommendations with a success rate of 84% (4% higher than this proposal), because they use prior information on the interests of users to generate recommendations with a higher degree of recommendation, in our case we use fuzzy logic and show that this type of recommendations can be made with another technique.

In [2], the model they proposed was based on the content filtering technique, which uses exclusively the elements of the game to generate new recommendations, which can generate that very similar games are always recommended, and the user's horizons are not allowed to expand. Instead, this proposal uses a broad data set, with which you can make recommendations with a greater degree of variability, because using fuzzy sets includes the ambiguity factor.

In [3] and [5], the researchers used algorithms that are characterized by working with much larger databases and/or constantly increasing or learning user behavior, which improves their ability to recommend. In our work we use 55,000 games as a knowledge base, as for the technique we use Fuzzy Logic, of many attribute we determine the most important ones, in this regard, four variables were necessary to implement our model, in the validation we show an accuracy of 80% similar to [3] where the same accuracy was obtained. In [5] they present a list like our proposal, its algorithms stand out in scalability and level of competition from the perspective of product sales, we emphasize that the recommendation can also be made with fuzzy logic techniques.

In [11], the authors propose a model that uses genetic algorithms to find future book recommendations, we similarly recommend videogames using fuzzy logic based on attributes that make up fuzzy sets.

In the investigations [1], [2], [3] and [5] different proposals make videogame recommendations with different techniques each investigation without considering the ethical model, we in this investigation add a filter based on the ethical model [13] which presents the videogame list according to the age of the player, guaranteeing that an older videogame could not be recommended for a minor.

#### CONCLUSIONS AND FUTURE WORK

With the four attributes of videogames, a fuzzy set has been designed with each attribute, these attributes are the elements of our model.

We present a videogame recommendation system architecture, for the inference engine 16 rules are designed to calculate the recommendation, using the Mamdani model it has been defuzzified to show the associated probability in the recommendation.

Finally, we present an application, videogame recommendation system tool implemented in R.

As future work, it is possible to achieve a higher success rate by combining the proposed model with other methodologies such as content filtering or collaborative filtering, in order to generate a hybrid model that previously uses the data of interest of players and others with similar tastes, without neglecting the ethical issue presented by the current proposal regarding the recommendation of videogames with content suitable according to age.

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