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PREDICTING ANIMATED FILM OF BOX-OFFICE SUCCESS WITH NEURAL NETWORKS

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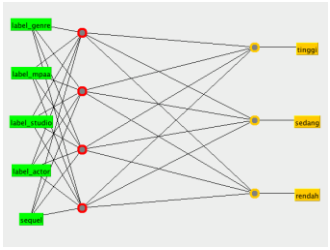
Graphical abstract



Abstract

Animation industry involves huge funds in production process and its success will give great income. Predicting the box-office of animated film has become an interesting topic to be discussed, because past studies are shown to be contradictory. Sharda and Delen conducted a similar study that used seven parameters, i.e. MPAA rating, competition, star value, genre, special effects, sequel and number of screens; and generated pinpoint accuracy (i.e. Bingo) with 36.9% and within one category (1-Away) with 75.2%. The authors proposed new and simple parameters that can be used to predict the success of animated films, i.e. the actors/actress, animation studio, genre, MPAA rating and the sequel of the film. These five parameters are relatively simple because it can be easily collected. In this study, the use of neural networks in predicting the financial performance of 120 animated films from 1995 until 2013 was explored. There are three categories of financial performance that become the class label of this study, they are: low, medium and high. Our prediction result in bingo is 58% and 1-away is 89,7%. By using the simple parameters, this study can reach a better accuracy. It is expected that this prediction can help animation film industry to predict the expected revenue range before its theatrical release.

Keywords: Animated films, neural network, box-office

1.0 INTRODUCTION

The animation industry is one of the fastest growing industry, as can be seen from the size of the global animation industry was about USD 222 billion in 2013 [1]. According to www.the-numbers.com, the best box-office animation or digital movie between 1995 and 2014 was Shrek 2, with a total gross of US$441,226,247. Besides being orable to generate a huge income, the animation industry also involves substantial funds due to the technology used. As such, forecasting box-office receipt becomes a difficult and challenging problem. Thus, there is an opportunity for researchers to predict the success of the animated films.

Animation studio requires a prediction of the success of animated films that have been produced. Several studies on the prediction of the box-office success of past film have been done, one of them was a study by Ramesh Sharda and Dursun Delen in 2006 [2]. In addition, the research about prediction of the film success based on the attention of the audience was also done by Robin Sloan and Santiato Martinez in 2012 [3].

The previous research by Phillipp [14] indicated that there are several features to view rating, number of ratings, average director rating and average actor rating. These features or parameters can give the best results. The rating is used as the class label of successful films with the values of 1-10 and determined by IMDb users. But, rating in our study will not be used as the class label, because this study will focus on the total gross of the film like the Sharda and Delen's study. The number of ratings refers to how many people watched the movie. This feature is difficult to be used, because

to collect this number must be in the same or a specific period with the movie release, and it seems to be difficult to collect the number of people who watched the film that has long passed away. With regards to average director rating, based on the Sharda and Delen's research, this parameter would be less significant in determining the film's box-office success. Based on these four parameters, the average actor rating seems to be most suitable in our research.

Borga and Robert's study [15] showed that sequel, genre (animation adventure), star value and budge contribute significant value to the movie success. Budget parameter is hard to be accessed because its value is known to be industry trade secrets and is not publicly released [2].

The success of animated films can be viewed from various supporting aspects. Several studies have shown the results of the film's success is based on income and the application of the principles of animation [2][3]. The box-office animation film is a film that has a value of mass interest, distributed through a network of cinema and watched in bulk quantities [4]. One of the media that provide information about the success of the film can be seen from www.the-numbers.com. Sharda and Delen have examined the level of film success using neural network, table 1 shows the list of input parameters [2]. Some variables can be obtained from the database of the film, but the study had limitations due to several parameters those were used can be obtained after finish watching the whole film.

Table 1 Summary of independents variables used by Sharda & Delen

Independent variable name	No. of values	Possible values
MPAA Rating	5	G, PG, PG-13, R, NR
Competition	3	High, medium, low
Star value	3	High, medium, low
Genre	10	Sci-Fi, historic epic drama, modern drama, politically related, action, documentary
Special effects	3	High, medium, low
Sequel	1	Yes, no
Number of screens	1	Positive integer

Tthe characteristic of quality movies are: fresh ideas and plot of the story flowing, narrative and sad ending, talented director, actor and strong characterizations, dialogue and costumes, location shooting and effects [5]. Based on the site www.the-numbers.com, the characteristics of successful film can be seen from the actors / actresses, directors, writers, makeup and so forth. These parameters can be obtained without having to watch the whole movie; so do not have to wait quite a long time to collect the data. In addition, the animation studio is a party directly involved in the technical side and the creative generation to produce animated films, merchandise and other related products. Animation studio will also require the prediction of the success of the film also saw the possibility of a sequel to the film. The data of animation studio can also be obtained from www.the-numbers.com. The authors agree with the statement of Pixar studio, which states that animation studio must have a creative team to produce animation film.

Therefore, the authors propose a system of prediction with simple parameters to determine the level of income from a movie. The prediction system is obtained by using the neural network method.

The neural network is a computational model of learning that resembles a human neural network. The most popular type of neural network is back propagation with supervised learning system [6]. This study used Weka application to implement the back propagation [17]. Back propagation is a popular technique in neural network [13]. This study used back propagation because according to [12] this is an excellent method for data input and output. The results of several studies that have been conducted, produced contradictory results. For example, the result of Sharda and Delen's report was the significant parameters turned out contrary to the results of previous studies [2]. The functions used in the Weka application are multilayer perceptrons, with 4 hidden layers, learning rate = 0.3, momentum = 0.2 and the node activation function was using a sigmoid function.

The use of neural networks requires the input data, the initial weight and target data. For this study, the necessary input data inputs were parameters of animated film that can be obtained from www.the-numbers.com. Based on the parameters used by Sharda and Delen, only genre, MPAA rating, star value and a sequel that can be used as input data.

Therefore, based from the several previous researches, this study was expected to build a system prediction of the success of the animated film using neural network with parameters genre, MPAA rating, star value, sequel and animation studio which ca help studio owners to predict the success of the film.

Several previous studies using the holdout procedure by dividing the data to obtain training set and testing set, and there is also the use of k-fold cross validation.

Holdout procedure uses a one-time experiment, the use of this method due to the stochastic nature of the training of the neural network [11]. There is several alternative composition data usage for training set: testing set, i.e. 30:70, 50:50, 70:30 and 80:20. The testing process is expected to be able to include the four ratios of such data [7]. On the other hand, k-fold cross-validation can be used for any data at least once been a training data and testing the data. Thus, in this study, the results of holdout procedure and the use of k-fold cross-validation will be compared.

2.0 EXPERIMENTAL

The previous research about the prediction of the box office success has been using neural network in predicting the success of the film. Sharda made comparison with some method, namely: logistic regression, discriminant analysis, classification and regression tree and neural networks. The result was the use of neural network provided the highest accuracy result compared with three other methods.

Some studies using one time experiment in the process of training and one time in the training process, this due to the stochastic nature of neural network. On the other hand, some also use the k-fold cross-validation of the trial process because this method divides the data into equal portion as dataset (D) which will be used as training set and training set as much as k times.

Sharda and Delen's research about prediction of the box-office success used 10-fold cross-validation and generated an average prediction accuracy of 36.9%. In that study, the parameters used were the MPAA rating, competition, star value, genre, special effect, sequel, and number of screens. The three parameters, which provide a major contribution in that prediction, were number of screens, special effects and star value.

The present research does not use all of the same parameters as the previous research. This is because we want to predict data from parameters that the data is available and can be processed immediately. Data sourced from www.the-numbers.com, for example MPAA rating, star value, genre, and animation studios. Parameter number of screens and special effect on Sharda research did not provide significant results, but requires a long time to collect that data. For example, the special effects can be collected after watch the whole film. While the number of screen had a significant contribution in previous study, but it needs a long time to collect data. The amount of film used is 120 animated films from 1995 through 2014 [8].

In addition, sequel parameters are considered necessary to be used, because this data can be easily obtained, also sequel give enough contribution for the audience' s point of view about the film that will be released. Helmer research presents the statistic film on the site www.boxofficequant.com, it shows there is a tendency for audience to see the continuation of a film masterpiece; there is also the hope that there will be no continuation of a movie [10].

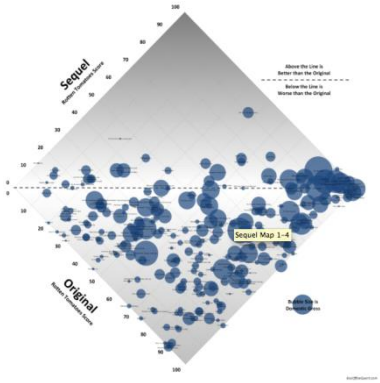


Figure 1 The sequel map, are sequel truly better or worse than their originals

That study illustrated that there is a sequel which has the highest rating, same and lower than the prequel. The sequel will be used in this study, although the research of Sharda and Delen's showed that a sequel did not give a significant effect.

Table 2 shows the possible parameters and values used in the study.

Table 2 Summary of variables

Variable	No. of values	Possible values
MPAA rating	5	G, PG, PG-13, R
Star value	1	Positive integer
Genre	5	Action, adventure, comedy, drama, thriller/suspense
Studio	1	Positive numeric
Sequel	1	Yes, no

Box Office film assessed based on total gross earned from the production of a film. In this study, the total gross will be a class label prediction of the success of the animated film box office. Discretization process will be applied to the total gross. Discretization reduces the value of continuous attributes into intervals. This interval will replace the actual value of the data [10].

3.0 RESULTS AND DISCUSSION

In the prediction process, the strength of the model is measured from the level of accuracy obtained. The more training set, the more significant model will be resulted. The more data testing, the more accurate error estimates [11]. This study used two methods in the process of training and testing. First, it used a holdout procedure that divided data into training and testing with the data portion of the training set and testing set sequentially were 30:70, 50:50, 70:30 and 80:20, and using 10-fold cross-validation.

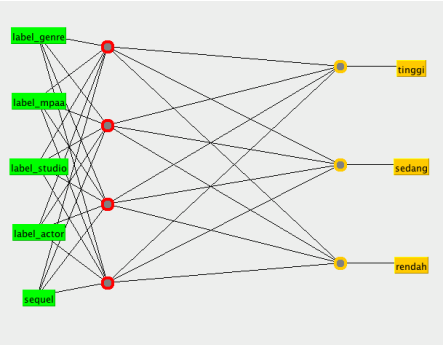


Figure 2 Graphical Representation of Backpropagation Neural Network Model

The results obtained using the holdout procedure, the percentage correctly classified instances of the data portion of the testing for each training set contained in table 3, but it also added correctly classified results for method 10-fold cross-validation.

Table 3 Comparison of correctly classified instances of holdout procedure and 10-fold cross-validation

	Holdout procedure Training set: Testing set				10-fold cross-validation
	30:70	50:50	70:30	80:20	
Correctly Classified Instances in Testing Set (%)	57.14	65	55.56	62.5	60

Table 3 shows that the ratio of training and testing in 80:20 produce the highest classified correctly instance which reached 62.5%. Comparing with the learning process using 10-fold cross-validation, holdout procedure with 80:20 ratios has a value that does not look much different.

Furthermore, Sharda's research that used 10-fold cross-validation was also compared with the results of this study. The percent of success rate is used to measure the predictive performance of the generated neural network results. By using the measure of Bingo and 1-Away from the confusion matrix, this study calculated value APHR (as known as average percent hit rate) that indicates the level of performance resulting classification. The bigger values of APHR should indicate better classification performance [3]. APHR formula can be seen in EQS. (1) - (3).

$$APHR = \frac{Number\ of\ samples\ correctly\ classified}{Total\ number\ of\ samples} \quad (1)$$

$$APHR_{Bingo} = \frac{1}{n}\sum_{i=1}^{g} p_i \quad (2)$$

$$APHR_{1-Away} = \frac{1}{n}((p1 + p2) + \sum_{i=2}^{g-1} p_{i-1} + p_i + (p_{i+1} + p_g) \quad (3)$$

In classification, APHR indicated the rate at which the testing set is classified into the correct class label. APHR and the value of the confusion matrix can be seen in Table 4. Bingo is the percent of correct classified rate to the exact class. While the 1-Away counts the correct and (or maybe) even two categories on either side within one class. Table 4 presents the aggregated of 10-fold cross-validation in confusion matrix. Confusion matrix commonly represents the classification result, which the columns

represent the actual classes and the row represent the predicted class.

Table 4 Confusion matrix of 10-fold cross-validation neural network

		Actual categories			Avg.
		a	**b**	**c**	
Classified as	**a**	16	12	6	
	b	10	22	9	
	c	6	6	34	
	Bingo	0.500	0.550	0.694	0.581
	1-Away	0.813	1.000	0.878	0.897

4.0 CONCLUSION

Comparing with the previous studies conducted by Sharda and Delen's by using the same method of 10-fold cross-validation, obtained that in this study the prediction using five simple parameters such as genre, MPAA rating, star value, sequel, and animation studio produce higher accuracy percentage compared with seven parameters that was used by Sharda. The result came from the accuracy of bingo and 1-away percentage. The result of Sharda and Delen's study with pinpoint accuracy (Bingo) is 36.9% and 1-Away accuracy is 75.2%. These results are not as high as our study's result which reached 58.1% in Bingo and 89.7% in 1-Away accuracy.

While the use of holdout procedure that divides the data into training and testing, the authors found that the ratio of 80:20 produce the best value compared to other portion. However, this result is not much different with the use of 10-fold cross-validation.

Based on the Sharda's research which analyze data with seven parameters such as MPAA rating, competition, star value, genre special effect, number of screens and sequel, there are three parameters that have major significant impacts to determine the success of a movie, they are a number of screens, high technical effects and high star value. By removing the rnumber of screens and high technical effects and combining important star value parameter with our new parameter of animation studio, the result is better than Sharda's research.

Therefore, both parameters of star value and animation studio seem to have a major significant contribution to the prediction of animation box-office success.

Our focus on this study is how to get prediction using simple parameters. In previous studies, using the media social information such as Wikipedia can predict the success of movies by measuring and analyzing the activity level of editors and viewers [18]. These parameters are handy to be collected with time period information. So, it seems to be combined with our five parameters.

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