Can We Detect Non-playable Characters' Personalities Using Machine and Deep Learning Approaches?

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Abstract: Personality recognition and computational psychometrics data have become prevalent in personnel selection processes. Such assessment tools are adequate for human resources seeking tools to assess a large volume of diverse player personalities in the current "war of talents." Recently, studies about using Gamified situational judgment test approaches have shown positive results in assessing players' behavior and personality. Gamified situational judgment tests combine the advantages of gamification, such as enhancing players' reactions and flow state, with the acknowledged traditional situational judgment test approach. To gamify a situational judgment test, an innovative approach using the visual novel game genre has shown positive results in the gamification by adding game elements such as narrative scripts, non-player characters, dialogs, and audiovisual assets to the test. Indeed, these elements play an essential role in the validity of the players' personality results by using a stealth-assessment method to minimize social bias and player's stress. However, to our knowledge, as gamification in personality detection is still recent, little is known on the possible positive outcomes of designing game elements such as the dialogues and non-player character personalities in the validity of the team cohesion measure. To this end, we propose an empirical study to build personality trait models based on non-players characters' speeches. We used the Myers–Briggs Type Indicator based on four dichotomies to classify the personalities as one of companies and organizations' most used personality typology. For each of the four dimensions, we train twenty-four separate binary classifiers and one 16-class classifier, using well-established machine learning and a convolutional neural network in the domain of natural language processing, text analytics, and computational psychometrics. The results of this study show that it is possible to recognize non-playable characters' personalities and thus can help game designers to understand their characters' personalities using natural language processing.

Keywords: Natural Language Processing, Personality Recognition, Machine Learning, Visual Novel Game.

1. Introduction

Human resources (HR) and companies have shown a growing interest in applying game-based approaches (GBA) in personnel training, recruitment, and selection. Serious games, gamification, simulation, and learning games are a non-exhaustive list of GBA already well-established for training purposes (De Freitas, 2018). However, GBA selection processes have just risen (Bina, Mullins and Petter, 2021). They tend to encourage the right people to candidates and enable the people's hard and soft skills assessment to fit the right person with the right corporate team. Consequently, companies and HR departments are researching and developing reliable and valid gamified tools such as serious games or gamified procedures to enhance recruitment processes (Armstrong, Landers and Collmus, 2016).

Bina, Mullins and Petter (2021) reveal in their literature review, which examines game-based approaches in HR recruitment and selection, that for a decade, the industry field and companies created games to attract candidates and enhance applicant reaction towards the company attractiveness (Georgiou, Gouras and Nikolaou, 2019). In addition, technology-driven solutions enhance the effectiveness of gamified tools for assessment, and personnel selection (Woods *et al.*, 2020). Indeed, the new generations are used to play games on different platforms such as mobile, tablets, computers, and virtual headsets. Moreover, with the advancement and the simplification of video game engines such as RPG Maker, Unity 3D, or Unreal Engine, creating and providing digital games and gamified tools for human resources purposes is more accessible for companies, nowadays. However, Bina *et al*. (2021) highlighted that the academic literature is still limited regarding the development of easy-to-use tools for HR people.

Traditional soft skill and personality recognition tests are commonly based on well-known behavioral and personality models such as the Myers-Briggs type indicators (MBTI) (Myers, 1962). Such tests traditionally use situational judgment tests (SJT) approaches to assess the different soft skills or individuals' traits. In personnel

selection, SJT are used by companies because of their ease to develop and deploy. SJT are also efficient in assessing a large panel of candidates' behaviors (Motowidlo, Dunnette and Carter, 1990). Indeed, companies are currently focusing on developing tools that enable soft skills and personality detection as companies' success is highly related to employees' hard and soft skill combination (Heckman and Kautz, 2012).

Georgiou *et al*. (2019) propose the development of a digital and gamified assessment for employee selection, resulting in positive preliminary findings by combining GBA and SJT approaches. Similarly, Hernandez *et al.* (2021) propose a framework to help game designers and stakeholders to develop and deploy a gamified SJT based on the visual and interactive narrative novel game genre incorporating game elements such as audiovisual assets, graphics assets, and interacting non-playable characters. In the context of behavioral recognition and to pursue Bina *et al*.'s (2021) research agenda about studying game elements that assess social interaction as desirable candidate abilities, we propose to study the non-playable character (NPC) game element in this article. To clarify the context, the company we work with for this research (Origamix) followed the Hernandez *et al*. (2021) approach to create visual novel games that contain numerous real-life situations and non-playable characters for behavioral and team cohesion assessment purposes. Furthermore, we think in concordance with the company goals that designing non-playable characters to reflect the real future candidates' teammates may enhance the construct validity of the gamified tool in the personnel selection context where companies want to fit the right person in the right team.

For this reason, we propose in this article to generate personality text-based classifiers to categorize visual novels' non-playable characters to help game designers and writers in creating better gamified selection tools. We use natural language processing approaches and compare different machine learning and deep learning methods to classify the non-playable characters according to their speeches. Therefore, on the one hand, we support in this article that machine and deep learning enable viable NPCs' personalities recognition. On the other hand, we propose comparing and finding the best algorithms methods to generate personality traits classifiers.

The remainder of this paper is organized as follows. Section 2 presents an overview of related works using natural language processing to detect personality from text-based documents. Section 3 describes the MBTI typology used for the study and the data collection process. Section 4 presents the methodology applied to generate the different classifiers. Finally, section 5 deals with the outcomes, compares the classifiers' results and concludes with the proposition of possible future works to pursue.

2. Related work

2.1 Human-Like NPCs

Non-playable characters' personality studies have risen along with the development of digitals games at the end of the 2000s. Park and Henley (2007) revealed the importance of giving life to believable NPCs for the players based on emotional, personality, and social relations models. Early experiments in imbuing personality to NPCs were based on probabilistic approaches (Min *et al.*, 2008). For instance, Cho, Song and Um (2007) use a combination of a probabilistic state machine with a Gaussian random distribution to make NPCs make stochastic decisions in-game. However, this approach enables a character to act with randomly pre-defined actions taking into account its environment but does not imbue the NPC with a complex personality based on behaviors, cognitive abilities, and emotional patterns. In addition, such approaches are not used for dialogues generation, which is the main game element of a visual novel. For these reasons, others developed personality and emotional models and frameworks intending to imbue human-like behaviors and personalities. For example, Bosch *et al*. (2012) propose a framework based on the Belief-Desire-Intention concept (Georgeff *et al.*, 1998) to individualize NPCs with their own personality. The researchers developed a game where they model NPCs with a combination of an extrovert or introvert trait with an agreeable or non-agreeable trait to strengthen the NPCs' human-like behavior and enhance the flexibility of these latter. Furthermore, these personality dichotomies are also represented in the MBTI typology. Indeed, the MBTI's personalities result from several human behaviors and psycho-sociological studies. Hence, following such typology to shift no-social behavior NPCs into human-like characters with rich personalities and emotions enhance players' gaming experience and engagement. The latter statement is particularly true in high interactive narratives games like visual novel games. For instance, project Scheherazade (Aljammaz *et al.*, 2020) combined social simulation, natural language processing, and knowledge modeling to enhance NPC interactions, players' engagement and interest in the game.

2.2 Natural Language Processing

Deep neural networks and machine learning approaches (Goodfellow, Bengio and Courville, 2016) are currently widely applied to natural language processing (NLP) (Khan *et al.*, 2016). Aikawa, Schwartz and Pahud (2005) proposed a Story Maker tool to generate animated scenes and direct visual output to the users in response to their textual input. This study provides preliminary findings on the potential positive results in the use of NLP for creating stories. NLP tasks and applications may play an important role in enhancing the game creation processes and the players' experience (Picca, Jaccard and Eberlé, 2015). This statement is all the more relevant for visual novel games (Domsch, 2017) where textual interaction, storytelling, dialogues, and speeches are the core elements of such games (see figure 1).

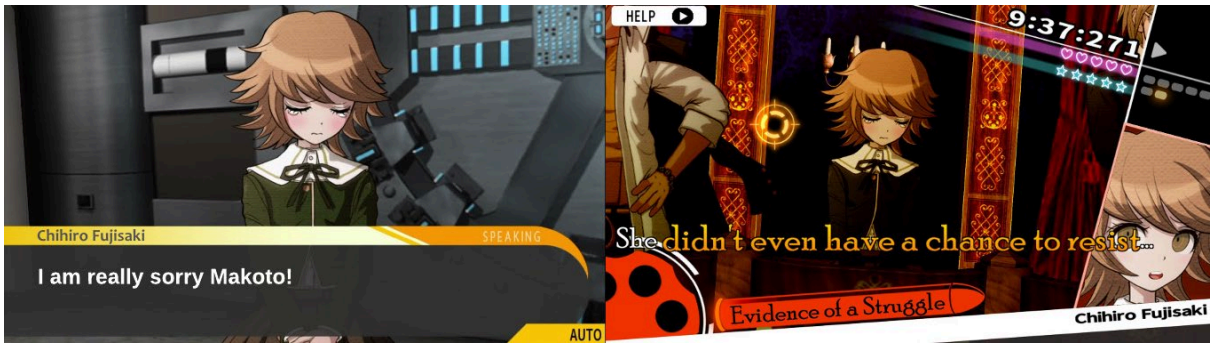

Figure 1: Screenshots of Danganronpa: Trigger Happy Havoc Visual Novel Game

2.3 Personality Detection

The company supporting this research receives inquiries to generate visual novel games to assess people's personalities using the MBTI typology. Although such model is usually used to describe real-life human personality, Ochs, Sabouret and Corruble (2009), also support the use of psycho-sociological and personality models to enhance NPC.

Research about personality recognition using NLP with a machine and deep learning approach has yielded positive results. For instance, Golbeck, Robles and Turner (2011) reveal that analyzing socials users' footprints, such as sentences or words used in social media, may become an efficient way to predict individuals' behavior and personalities. Indeed, Sönmezöz, Uğur and Diri (2020), also support and highlight that social media are rich in psychometrics data and information that enable machine learning and deep learning algorithms to predict personalities efficiently from textual documents. Following these previous works, some researchers compared different deep learning and machine learning approaches based on personalities typologies. Tripathy, Agrawal and Rath (2016) reveal in their literature review that support vector machine, decision tree, and naive Bayes algorithm are well used in sentiment analysis based on text classification. Likewise, some researchers also proposed in their projects or reviewed the random forest, linear regression, and deep learning approaches for such NLP tasks (Cui and Qi, 2017). Majumder *et al*. (2017) also highlight that deep learning and neural networks approaches are powerful means to detect personality from a text.

Many methods and approaches have already been studied using social media datasets such as the open sources Kaggle's datasets or Gjurkovic and Snajder's (2018) dataset that regroup several posts from social users and the users' personalities. However, social posts are written by one user following a monologue structure that may semantically differ from NPC dialogues and speeches. Amongst the existing research projects that study serious games to detect players' personalities and behavioral profiles (Palhano, Machado and De Almeida, 2020), to our knowledge, no research studies the use of NLP to detect NPCs' personalities. Hence, following the previous related works approaches, we propose a preliminary research on text-based classifiers to categorize NPC's personality. Accordingly, we offer the following hypothesis and research question:

Hypothesis. We can generate viable classifiers to detect non-playable characters' personalities from their dialogues following the various literature approaches on using natural language processing for personality recognition.

Research Question. Which supervised learning methods generate the best binary classifier for each personality trait among the MBTI typology?

3. Psychometry and Dataset

3.1 Myers Briggs Type Indicators

This study focuses the research on the MBTI, briefly explained in section II to measure personality traits:

- Extraversion/Introversion (E/I) dichotomy reveals how an individual interacts with his/her environment and the others.
- Intuition/Sensing (N/S) dichotomy reflects how an individual perceives the collected information from his/her surroundings.
- Feeling/Thinking (F/T) dichotomy depicts how an individual decides to act.
- Judging/Perception (J/P) dichotomy determines the attitude that influences an individual's way of living or working.

Combining the four individuals' dichotomous traits leads to 16 possible personality types. These types are represented by four letters that describe an individual personality. An individual with the Extraversion, iNtuition, Feeling, and Perception traits is an ENFP type. An ENFP individual is a free spirit who is a cheerful, communicative person, attached to his values and in search of existential harmony.

3.2 Data Collection

We created our dataset by extracting the characters' speeches (12600 speeches/dialogues) from nine famous visual novels. Figure 2 details the data collection and dataset generation processes needed to generate the classifiers.

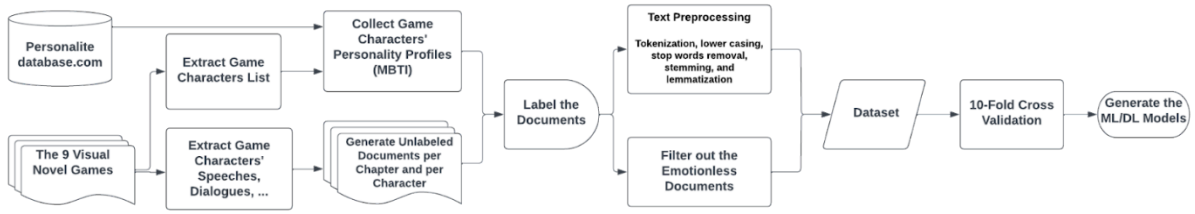

Figure 2: Data Collection and Dataset Generation Processes

In supervised machine learning, labeled data are required as input to train the model. Hence, each character must be tagged with multiple labels corresponding to the four MBTI dichotomies. The players are the most predisposed to tag the characters as they directly interact with the NPCs. Therefore, we used the *"personalitydatabase.com"* (PersonalityDatabase LTD, 2022) platform that enables players to vote for the personality of any fictional characters from numerous video games. We extracted 170 non-playable characters' personalities from the game pool and labeled each characters' speech with their corresponding personalities.

We observed that each game chapter is a particular context where the characters' personalities are displayed in a certain way connected to the chapter situation. In addition, keeping the entire dialogues and speeches of a character in a single document may confuse the training as the character may display a broad panel of emotion during the entire game. Furthermore, we also use deep learning in the study that may capture the emotional behavior of a character in a specific situation connected to its personality. In other terms, a character may display its emotions differently depending on the context and situation, with its personality as a constant.

For this reason, we proposed to regroup the speeches and dialogues into several documents that represent all the sentences used by a specific character in a specific game chapter. This process provides 6200 labeled points in the form (document, MBTI traits).

4. Methodology

This research aims to discover preliminary findings on supervised learning and natural language processing to enable non-playable character personality recognition. Following Rahman *et al*. (2019), and Majumder *et al*. (2017) approaches, splitting and studying the personality traits independently analysis results in better outputs than studying the combination of the traits as a single type. Therefore, we proposed to compare various character speech-based binary classifiers for each of the four MBTI dichotomies. We also use deep learning algorithms to generate and compare a 16-class classifier.

We use the dialogues/speeches and the characters' psycho-metrics as the data entry points to train the models. The process of training classifiers in natural language processing is globally divided into three steps:

- Dataset Analysis
- Data Preprocessing
- Model Training

The following subsections of this section explain the details of those steps.

4.1 Dataset Analysis

We performed a preliminary analysis of the MBTI's types distribution and the various personality traits distribution independently to ensure we can use the collected dataset. Figure 3 reveals that the dataset is not uniformly distributed among the sixteen personalities depicted by the MBTI typology. For example, the least frequent personality among the data points is INFJ with 35 occurrences, whereas the most frequent personality is ISFJ with 936 occurrences.

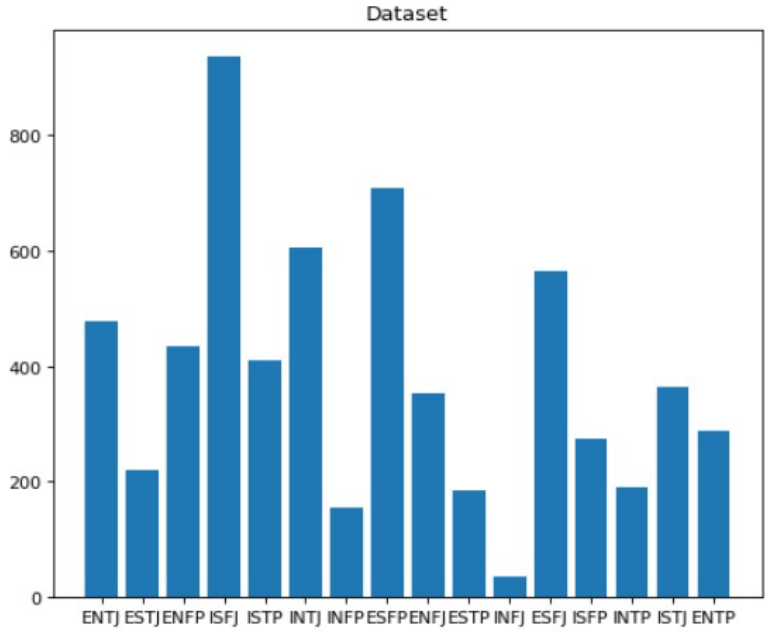

Figure 3. MBTI Dataset Distribution Analysis

Nevertheless, the study aims to compare binary classifiers for each personality trait following Majumder *et al*. (2017) methodology. Hence, Table 1 reveals that the data are better distributed among the four MBTI dichotomies independently of one another. The difference between the two possible labels in a specific trait is too slight to consider a remediation method such as class duplication or reduction (Cui and Qi, 2017). As a result, we are training on the original dataset with 6200 data points for the MBTI dataset.

Table 1: MBTI's Traits Distribution

MBTI Personality Trait	Occurrences
E / I	3231 / 2969
S / N	3663 / 2537
T / F	2736 / 3464
J / P	3556 / 2644

4.2 Data Preprocessing

To train our models efficiently, emotionless characters' documents that do not carry any personality cues are filtered out of the dataset to avoid noise in the model training. Afterward, we apply standard text preprocessing steps such as tokenization, lower casing, stop words removal, stemming, and lemmatization to enhance the training process.

4.3 Model Training

The MBTI typology suggests that collecting the four traits defines a character or an individual's personality. In section III, we highlighted that each personality traits were dichotomous. In other words, each personality trait contains only two possible categories to which an individual or a character may belong. Hence, we generate classification models that enable a character's category identification for each personality trait. For this reason, we propose to compare several supervised learning approaches that generate binary classifiers. We use five machine learning algorithms for text classification and one convolutional neural network to generate the various classifiers for each personality trait and the 16-class classifier.

4.4 Supervised Machine Learning Algorithms

The academic literature reveals that logistic regression algorithms (LR), support vector machine algorithm (SVM), decision tree algorithms (DT), Naive Bayes Algorithm (NB), and random forest algorithms (RF) are well-established and effective supervised machine learning for natural language processing and text-classification (Khan *et al.*, 2020). We use a bag-of-word algorithm to generate our vector representations for words by considering each word count in a document as a feature. Finally, we perform 10-fold cross-validations for each personality trait and for each supervised machine learning algorithm to obtain the models' accuracy and F1-Score (see table 2).

Table 2: Supervised Machine Learning Classifiers Evaluation and Comparison

	Logistic Regression		**Support Vector Machine**		**Naive Bayes**		**Decision Tree**		**Random Forest**	
MBTI Traits	**Accuracy**	**F1-Score**	**Accuracy**	**F1-Score**	**Accuracy**	**F1-Score**	**Accuracy**	**F1-Score**	**Accuracy**	**F1-Score**
E/I	.714	**.718**	.691	.696	.613	.551	.626	.638	.687	.697
S/N	.710	**.613**	.689	.599	.682	.542	.615	.519	.681	.502
T/F	.719	**.755**	.689	.728	.663	.732	.604	.649	.694	.751
J/P	.717	.764	.686	.731	.666	.745	.618	.671	.714	**.784**
Overall	.261	**.254**	.225	.222	.185	.163	.144	.144	.232	.206
Average	.715	**.713**	.689	.689	.656	.643	.616	.619	.694	.684

4.5 Deep Learning Algorithm Using Convolutional Neural Network

A convolutional neural network (CNN) is a kind of neural network that includes convolutional layers that enable classifying text-based documents. Figure 4 roughly explains the following Zhang and Wallace (2015) classification approach using a CNN for NLP tasks such as binary classifying documents or sentences. First, an embedding process is applied to represent the text using vectors. Afterward, the documents or sentences are encoded into matrices taking account of the document context and using the CNN architecture. Then, a prediction phase enables to infer the classification using a multi-layer perceptron.

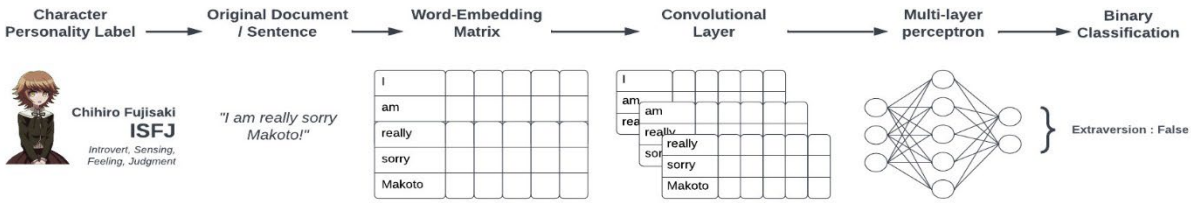

Figure 4: Classification process using CNN approach with spaCy library

CNN enables the training of a multi-class classifier for the sixteen MBTI personality types. In addition to the personality traits binary classifier training, we train a 16-class classifier to analyze whether a deep network could obtain better results than our binary classifiers. The results show an accuracy value of 0.728 and an F1-Score value of 0.715 for the 16-class classifier. Alternatively, Table 3 shows our best results for the binary classifiers after tuning multiple parameters and randomly training the CNN several times.

Table 3: Convolutional Neural Network Classifiers Evaluation

MBTI Traits	**Accuracy**	**F1-Score**
E/I	.721	.707
S/N	.704	.638
T/F	.721	.684

MBTI Traits	Accuracy	F1-Score
J/P	.734	.775
Overall	.269	.239
Average	.720	.701

5. Results and Discussion

5.1 Supervised Learning Methods Comparison

Table 4 reveals our best-performing models for the MBTI typology with O.Acc, O.F1, A.Acc, and A.F1 representing the overall accuracy, the overall F1-score, the average accuracy, and the average F1-score respectively.

Table 4: Methods Comparison for the MBTI Typology

Model Type	O.Acc	O.F1	A.ACC	A.F1
Logistic Regression	.261	.254	.715	**.713**
Support Vector Machine	.225	.222	.689	.689
Naive Bayes	.185	.163	.656	.643
Decision Tree	.144	.144	.616	.619
Random Forest	.232	.206	.694	.684
Binary CNN	.269	.239	**.720**	.701
16-Class CNN	**.728**	**.715**		

The results highlight that the 16-Class classifier generated by the CNN approach for the MBTI typology outperformed the overall results of the binary classifiers. In other terms, the 16-Class CNN model is the one to use if we are looking to classify documents following MBTI's personality types. However, game stakeholders and writers may be more interested in recognizing a sole personality trait than the MBTI types. Although the overall accuracy and F1-score are not jaw-droppingly high, the average accuracy and F1-score reveal better results in classifying the MBTI's dichotomies.

These results are constant with the scientific literature that conducted their studies using the social media posts or the different personality Kaggle datasets. According to our hypothesis question, our models show positive preliminary results in predicting NPCs' personalities based on their dialogues and speeches. In addition, three of the six supervised learning approaches performed better F1-Score results considering table 5 which compared the top classifiers by traits. Answering our research question, the logistic regression, the random forest, and the convolutional neural network are the top three approaches to classify characters' personality dichotomies among the MBTI. However, the models may need to be trained again or use transfer learning techniques to be accurate with new NPCs who are not present in the current dataset (Weiss et al., 2016).

Table 5: Top classifiers by traits

MBTI Traits	Model Type	Accuracy	F1-Score
E/I	LR	.714	**.718**
S/N	CNN	.704	**.638**
T/F	LR	.719	**.755**
J/P	RF	.714	**.784**

5.2 Limits of the study

Although the positive results emit evidence of using machine learning and deep learning approaches to detect NPCs' personalities, future research projects have to consider some limitations.

First, a range value of 0.146 between the best F1-scores in Table 5 reveals that classifiers are not equal in performance to detect personality traits among the different traits. This difference may be explained by the difference in the distribution for the dichotomies as seen in subsection 4.1. Likewise, personality indicators such as emotions present in characters' dialogs may differ in quantity. In other words, some personality traits may be more complex to analyze with NLP than others.

Second, we performed our various training with a dataset with approximately the same amount of entry as the datasets used in the academic literature. However, a more extensive and enriched dataset may result in better and more accurate outcomes to enhance the generated classifiers' reliability and validity.

Third, the current results lack neutrality as the documents from the test dataset may be related to some documents from the training dataset. The documents are unique and cannot be present in both training and test sets simultaneously. Nevertheless, they may be semantically similar as they come from the same non-playable character. Indeed, to create our entire dataset, we split characters' entire game speeches and dialogues into several documents.

Finally, as a preliminary study, we did not focus the study on tuning in the best way the different parameters or hyper-parameters of the supervised learning algorithms even though such processes may result in better classifiers' performances (Majumder *et al.*, 2017).

6. Conclusion

The present study has demonstrated preliminary findings on the viability of using machines and deep learning to detect non-playable characters' personalities from visual novel games. We train multiple binary classifiers and one 16-class classifier using a natural language processing approach based on the characters' speeches and personalities. We further proposed the best model among the generated ones for each trait among the MBTI typology. Nevertheless, a difference of 0.094 among the binary classifiers' average F1-Scores reveals that there is no significant difference among the binary classifiers' results. To clarify, any traditional supervised learning methods enable personality recognition through natural language processing.

Besides, MBTI typology is one of the most used in the industry but its validity is academically criticized. Therefore, we proposed to focus the study on the binary classifiers' training for the typology dichotomies. Indeed, each dichotomy may represent two independent soft skills that may be valued in a recruiting serious game. Although the generated models are viable in visual novel character personality prediction, further studies based on different typologies and with multiple extensive data sets are needed to overcome this study's limitations.

Furthermore, the question that arises from this research is how to use the generated models in our specific context. Our specific context asks us to develop a tool to help the sponsor company's visual novel writers. In a first use case, we used the models on two learning visual novel games that we created prior to this study. According to the result, we amended some dialogues in order to make the characters' personalities more accurate. In the same way, the company's writers may use our models to check the consistency between their characters' dialogues and the stakeholders' objectives to reflect the characters' personalities with their team employees' personalities.

However, natural language processing may also be used differently to enhance visual novel creation processes and gameplay. Reflections about text suggestions for writers and auto-generation dialogues from players' interaction are under consideration to pursue this study taking into account the sponsor company objectives.

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