ANL488 FINAL PROJECT REPORT

The Evolution of Popular Bilingual Song Lyrics

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Table of Contents

Abstract

As the digital era dawned, songs, a combination of music and lyric, were widely accessible and gradually became a part of an individual's daily life. Songs have changed alongside society over the decades. To discover the evolution of songs as well as understand a songwriter's state of mind, lyrics were an ideal aspect to employ as they tend to communicate their state of being. Thus, the study examines the evolution of bilingual lyrics through sentiment analysis and text classification, as well as comprehends the shift in cultural and societal values by correlating the words used with the events in the specific decade. The aforementioned approaches were built on a total of 200 popular songs, with 100 songs each for English and Chinese, covering the years between 1970 to 2020. Due to a lack of resources in handling Chinese characters, Chinese lyrics were translated to English prior to modeling. Therefore, Support Vector Machine (SVM) and Naïve Bayes (NB) were built based on the translated lyrics. It was concluded that the SVM model outperformed the NB model in classifying song lyrics for both English and Chinese, with an overall accuracy of 60% and 56% respectively. Other evaluation metrics such as precision, recall, and F1-score were used to validate the model as the data employed was perceived to be imbalanced based on sentiment analysis findings, with the majority classified as having positive sentiment. Furthermore, as lyrics were composed under the influence of cultural, social, and emotional impact, and different songwriters express themselves differently, there are likely to be variations in the words used over decades. However, it is observable that there was a shift in the set of significant words used in English lyrics but not in Chinese. In addition, the words used in English lyrics produce positive sentiment which was aligned to the sentiment analysis findings but contrasted for Chinese lyrics. Hence, it is concluded that machine learning is not optimal in evoking the same sentiment as listeners and language is subjective for analysis.

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Chapter 1 Introduction

Music first originated back in the Paleolithic period, with purely instrumental sounds. It is known for its significant therapeutic effects that can reduce anxiety, promote relaxation, and improve an individual's quality of life (Music Magic, 2008). As a result, it is regarded as an essential component in our daily life, whether for music production, performance, enjoyment, or emotional response (Galindo, 2003).

As time progressed, lyrics, also known as the text in the song, were written to complement the music. According to Winston (2017), lyrics was composed in such a way that it reflects the surrounding and communicate with listeners by introducing context to the song, enabling them to view and connect things from their perspective. However, what was communicated differs from songwriters as they express themselves differently. Thus, songs were regarded as an effective medium for non-verbal communication.

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In order to comprehend the songwriter's thoughts, text mining approach is employed. It is a technique to obtain relevant and valuable information from the text after it has been processed. Lyrics, in particular, were used to provide sentiment insights and comprehend the shift of cultural and social values.

Therefore, this study will look into various approaches to analyze textual data and aim to apply and evaluate the sentiment of popular English and Chinese song lyrics that were composed between 1970 to 2020. Furthermore, it also aims to investigate the relationship between cultural and societal values with the evolution of bilingual lyrics over time.

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Chapter 2 Literature Review

As songs and society are intimately connected (Music Magic, 2008), Winston (2017) mentioned that songwriters aim to produce songs based on their personal experiences. It is thus fair to assume that lyrics are composed in such a way that it gives context to a specific era.

According to Huang (2015), songs impact society in three ways: social, cultural, and emotional, which are described as follows:

Social Impact

Social impact refers to how songs connect and bring individuals together, such as live and street performances, concerts, festivals, which illustrate how individuals with similar interests are brought together to develop social and support networks. As a result, a community of like-minded people is formed. Furthermore, in the internet era, the internet eases the accessibility for global fans to convey their love for their musical idol easily and garner respect greater than any other differences of beliefs they have (Ford, 2020). According to Silva (2013), having the right combination of lyrics, rhythm, and instruments aided in establishing a collective identity, arousing emotions, and engaging audiences.

Hoeven and Hitters (2019) validated the factors of social and cultural impacts by performing qualitative content analysis on musical reports to analyze the cultural and societal values. They utilized ATLAS.ti software to uncover similar themes across reports, a program that does qualitative analysis on massive volumes of textual data and identifies relevant terms related to the theme. As a result, it revealed that social values are associated with social identity, public engagement, and social capital whereas musical creativity, cultural vitality, and talent development are associated with cultural values.

Commented [MK7]: ok good summary overall.

5

Cultural Impact

Cultural impact dictates how songs were composed in the music industry, where they reflect the culture of a particular period. The Chainsmokers' song, "#SELFIE", is a very spot-on example that reflected the youth and media culture in 2015.

Songs were an effective medium for non-verbal communication and can also be used as a tool to learn different languages. They are perceived as an important element in shaping cultural identity for their entertaining and captivating music and lyrics (Huang, 2015). Interestingly, despite the fact that there are few approaches for analyzing multilingual data, Yan, He, Shen, and Tang (2014) made an exception and explored models such as SVM and N-grams using English and Chinese data to determine the optimal model for text classification. Furthermore, Yan et al. (2014) addressed several significant pointers about the Chinese language, where there are several approaches to perform word segmentation and Chinese has a distinct way of conveying emotions. As a result, using English methodologies in Chinese may be inappropriate. Thus, they employed IKAnalyzer, a widely used open-source tool built on Java programming language, to analyze the Chinese language with the advantage of being efficient. The study concluded that SVM outperforms N-gram, with the Chinese model achieving an accuracy rate of 85% in classifying the data, but a slightly lower accuracy than that of the English model.

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Emotional Impact

Emotional impact defines as the mood delivered through songs. They are known to have a direct impact on individuals in society, as reflected by how listeners feel when they listen to them. Songs are played depending on the settings. For instance, an upbeat playlist would be played during a workout, while a classical playlist would be played when calming down. Similarly, when presented in the same context, songs composed in the past differ from the present.

In addition, song lyrics represent the emotions of the songwriter. Hu, Downie, and Ehmann (2009) explored the approach of identifying the mood of lyrics by employing Music Information Retrieval (MIR) tasks and classifying them with SVM models. They collected lyrics from an online database and social tags from last.fm. After assessing the accuracy of several models, Bag-of-Words (BOW) with stemming and TF-IDF, which uses a float value-weighted vector to identify the significance of words, obtained a higher average accuracy of 0.6043. Thus, this model was used to analyze the performance of combined features. Although the performance of combined features does increase the accuracy, the study noted that purely lyrics can outperform audio if they are categorized under the appropriate mood.

Furthermore, understanding the mood of lyrics aid in predicting the emotions listeners will experience. Napier and Shamir (2018) demonstrated this understanding by collating popular songs with lyrics that were ranked by the Billboard Hot 100 from 1951 to 2016. They utilized IBM Watson Tone Analyzer (IBM WTA) to evaluate the lyrics, which employs linguistic analysis to identify emotions and musical sentiments in written text ([1]IBM, 2020). Additionally, Pearson correlation and linear regression tests were performed to identify the relationships between the year of composition and the tone of lyrics. It was discovered that songs associated with negative emotions like fear and despair rose with time while songs associated with joy and confidence declined. The study concluded that words used in lyrics reveal information about a songwriter's tone and state of mind, and the impact on the mood and atmosphere.

To conclude, these papers suggest that there are several ways to evaluate lyrics. Furthermore, as society evolves, the influence on these impacts will alter to fit the society. The following research will investigate the sentiment and comprehend the shift in cultural and societal values in English and Chinese lyrics over five decades.

Chapter 3 Data Understanding and Preparation

3.1 Data Understanding

In this study, the lyrics of popular English and Chinese songs were used to analyze the sentiments, employ text classification, as well as comprehend the shift of cultural and societal values between decades. To begin, assumptions were developed during the data collection process. As a result, an informative list of popular songs from 1970 to 2020 was manually compiled from the internet, assuming that songs became popular after being released. In particular, English and Chinese lyrics were collected from https://www.azlyrics.com/ and https://baike.baidu.com/ respectively.

Before diving into data understanding, it is critical to understand the distinction between English and Chinese sentence structure. East Asian Student (2011) defined the differences as follows:

1. English sentences include whitespace between words whereas Chinese does not.

2. English is a subject-prominent language. The subject, also known as the doer of the action, would be placed first in the sentence and followed by the context. However, Chinese is a topic-prominent language. The topic, also known as the context, would be mentioned first in the sentence.

Table 1 illustrates an example of how English and Chinese sentence structure differ.

Table 1 – Example of English and Chinese sentence structure

'I' is the subject while 'homework' is the topic.	
English	**Chinese**
i.e., I have already done my homework	i.e., 作业我已经做完了 (Homework I have already done)

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8

Therefore, analyzing textual data in English and Chinese requires a different approach. Due to a lack of resources to analyze Chinese language, Chinese lyrics would be translated into English using the 'googletrans' module which leveraged on Google Translate API (PyPI, 2020) at 85% accuracy (The Language Doctors, 2021). In a song, lyrics are not the only element expressing sentiments, where music, which consists of rhythms, beats, and tempo, is also influential in contextualizing the sentiments of the song. However, as Chinese lyrics were translated automatically without taking music into account (Zivkovic, 2021), it is less precise in conveying the same meaning as the original lyrics.

Figure 1 illustrates the information of the dataset. A total of 200 records were obtained, with English and Chinese having 100 records each as illustrated in Figure 2.

```
data.info()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 200 entries, 0 to 199
Data columns (total 9 columns):
year                     200 non-null int64
song title               200 non-null object
song artist              200 non-null object
language                 200 non-null object
genre                    200 non-null object
no. of views             200 non-null object
lyrics                   200 non-null object
ibm_nlu_lyrics_sentiment 200 non-null object
translated_lyrics        200 non-null object
dtypes: int64(1), object(8)
memory usage: 14.2+ KB
```

Figure 1 – Information of the dataset

```
data['language'].value_counts()

Chinese    100
English    100
Name: language, dtype: int64
```

Figure 2 – Number of records for each language

In the following section, the data were grouped into five decades: 1970 – 1980, 1980 – 1990, 1990 – 2000, 2000 – 2010, 2010 – 2020.

Figures 3 and 4 illustrate the sample data for English and Chinese songs, respectively.

	year	song title	song artist	language	genre	no. of views	lyrics	ibm_nlu_lyrics_sentiment	translated_lyrics
0	1977	You Light Up My Life	Debby Boone	English	Pop	4,697,244	So many nights\nI'd sit by my window\nWaiting …	Positive	So many nights\nI'd sit by my window\nWaiting …
1	1976	Tonight's The Night (Gonna Be Alright)	Rod Stewart	English	Pop	15,298,153	Stay away from my window\nStay away from my ba…	Negative	Stay away from my window\nStay away from my ba…
2	1978	Le Freak	Chic	English	Pop, Dance, Electronic	8,716,366	(One, two)\n\nAh, freak out!\nLe freak, c'est …	Negative	(One, two)\n\nAh, freak out!\nLe freak, c'est …
3	1977	How Deep Is Your Love	Bee Gees	English	Rock	415,858,874	I know your eyes in the morning sun\nI feel yo…	Positive	I know your eyes in the morning sun\nI feel yo…
4	1977	I Just Want To Be Your Everything	Andy Gibb	English	Rock, Pop, Country music	37,592,564	For so long\nYou and me been finding each othe…	Positive	For so long\nYou and me been finding each othe…

Figure 3 – Sample data for English songs

	year	song title	song artist	language	genre	no. of views	lyrics	ibm_nlu_lyrics_sentiment	translated_lyrics
195	2016	大鱼	周深	Chinese	Mandopop	23,485,537	海浪无声将夜幕深深淹没\n漫过天空尽头的角落\n大鱼在梦境的缝隙里游过\n凝视你沉睡的轮廓\…	Negative	The silent waves drowned the night\nOver the c…
196	2017	光年之外	邓紫棋	Chinese	Pop	240,490,962	感受停在我发端的指尖\n如何瞬间冻结时间\n记住望着我坚定的双眼\n也许已经没有明天\n面对…	Negative	Feel the fingertips that stop at my origin\nHo…
197	2019	無名之輩	陳雪燃	Chinese	Pop	15,187,533	城市黎明的灯火\n总有光环在陨落\n模仿者一个又一个\n无人问津的角色\n你选择去崇拜谁呢 …	Positive	The lights of the city at dawn\nThere is alway…
198	2011	时间都去哪儿了	王铮亮	Chinese	Pop	8,401,135	门前老树长新芽\n院里枯木又开花\n半生存了好多话\n藏进了满头白发\n记忆中的小脚丫\n肉…	Negative	The old tree grows new sprouts in front of the…
199	2010	洋葱	丁噹	Chinese	Pop	10,340,818	如果你眼神能够为我 片刻的降临\n如果你能听到 心碎的声音\n沉默的守护着你 沉默的等奇迹\…	Positive	If your eyes can come for me for a moment\nIf …

Figure 4 – Sample data for Chinese songs

The column, 'ibm_nlu_lyrics_sentiment', represents the sentiment of the lyrics that was derived from IBM Watson Natural Language Understanding (IBM WNLU), a program that analyzes and extracts information such as sentiment, emotion, and keywords from text ([2]IBM, n.d.). Following that, the column, 'translated_lyrics', consists of the translated lyrics that were performed prior to data preparation.

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Figure 5 shows the color legend that was used to differentiate between English and Chinese songs in subsequent visualizations.
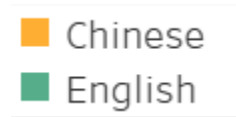

Figure 5 – Color legend visualization

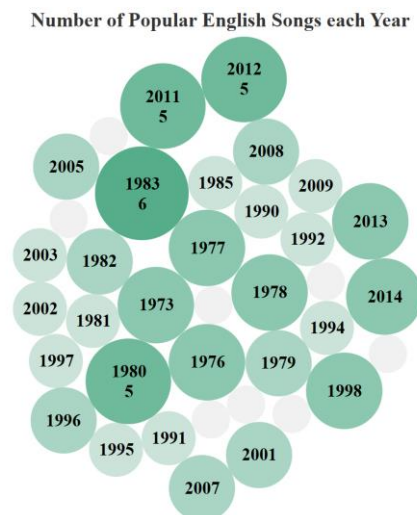Figures 6 and 7 display the count of songs that were released each year.

Figure 6 – Number of English songs in each year

Number of Popular Chinese Songs each Year
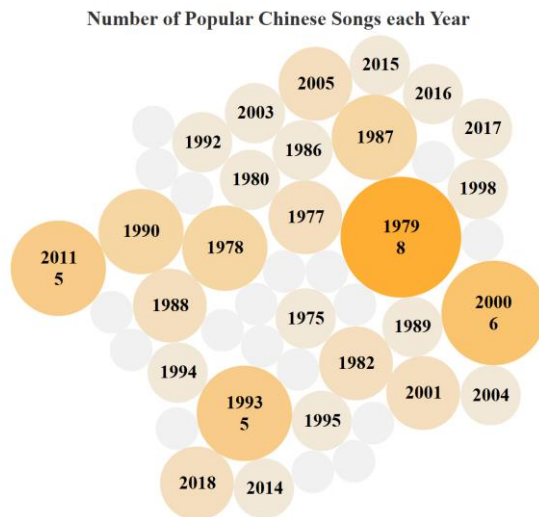
Figure 7 – Number of Chinese songs in each year

Both the size and color represent the number of songs that were popular each year. For example, the larger and darker the circle is, it represents that more songs released in that year became popular. Figure 6 depicts that there are more popular English songs, with six tracks released in 1983, followed by five tracks each in 1980, 2011, and 2012, while Figure 7 depicts that there are more popular Chinese songs, with eight tracks released in 1979, followed by six tracks in 2000 and five tracks each in 1993 and 2011.

Garrido (2011) studied how negative emotions in songs were interpreted as sorrowful. Hence, assumptions were made in this study where aggressive and mournful were regarded as negative sentiments, and pleasant, love and romance were perceived as positive sentiments.

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Figure 8 illustrates the total sentiment count.

Figure 8 – Total count of sentiment

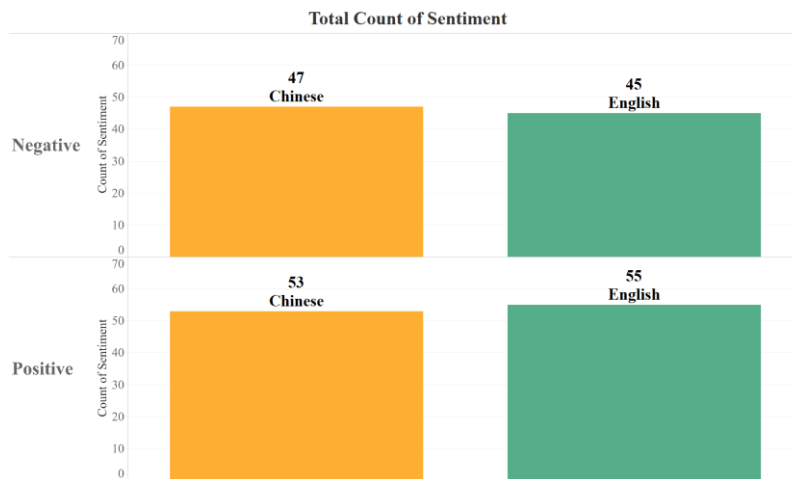It is possible to conclude that Chinese and American songwriters were in a similar state, resulting in a comparable count of positive and negative sentiments.

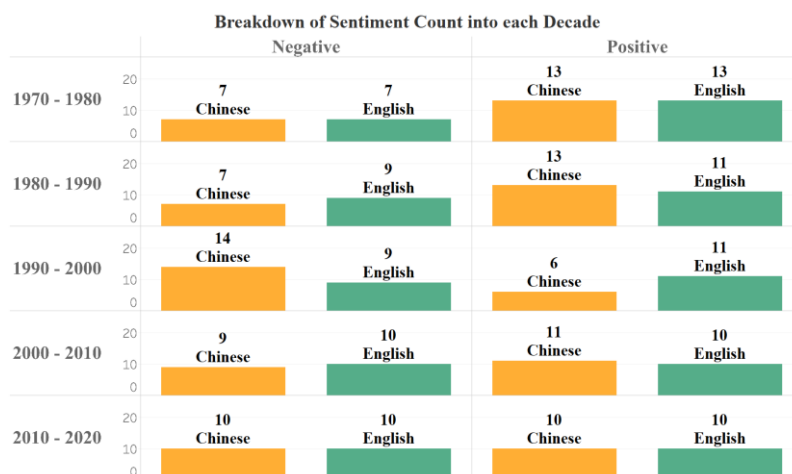Figure 9 illustrates a breakdown of sentiment counts.

Figure 9 – Breakdown of Sentiment Count into five decades

With the exception of the 1990 decade, a significant difference in the number of sentiment counts could be observed in Chinese lyrics, where sentiments in other decades were comparable between English and Chinese. Furthermore, it was discovered that in the 1990s, Chinese lyrics had a more negative sentiment than English lyrics, which might be attributed to songwriters reminiscing the happenings of Tiananmen Square in the 1980s, when individuals were denied liberty.

Figure 10 illustrates the total number of YouTube views in each decade.

Figure 10 – Breakdown of the total number of views

It revealed that there was a substantial disparity in the total number of views for both English and Chinese songs across the decades. With English songs reaching over billions of views while Chinese songs reached merely millions. This implied that listeners preferred English songs over Chinese songs since English is a universally recognized language with stronger rhythms.

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Commented [MK17]: So the assumption we are making here is that the songs are easily digitized. However, unless you are from that era, what is the likelihood of you looking on youtube for old songs? I suspect a lot of it is wordof mouth and not actively searched.
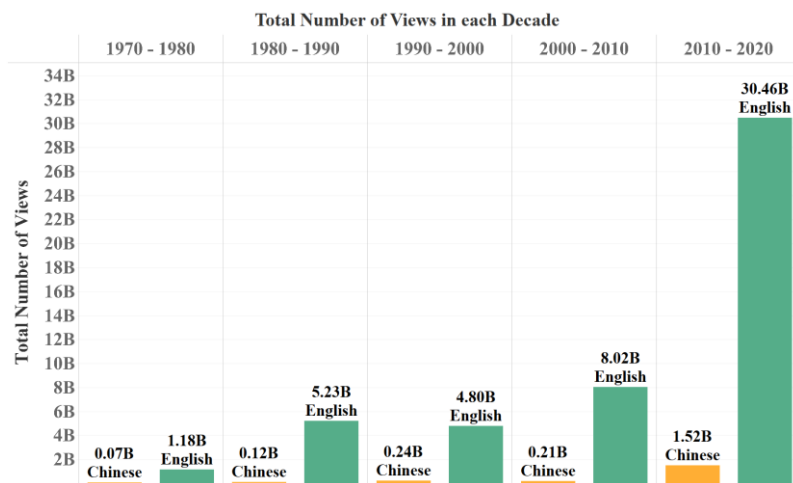
14

Furthermore, as observed, there were relatively high views in the 2010s, which could be attributed to the advancement of recording technology that happened in the twentieth century, where songs were accessible 24/7 with a click on YouTube or Spotify (Music Magic, 2008). Although the number of views may be used to evaluate a song's popularity, it contradicts the purpose as the internet was not popular until the 2000s, and they were uploaded as technology advanced. As a result, the variable 'no. of views' is an unreliable indicator for assessing the popularity of songs from prior decades, thus will be eliminated.

3.2 Data Quality

There were no concerns regarding data quality as the data were collected manually. However, text pre-processing was necessary to clean and analyze the data so that sentiment analysis and text classification can be performed effectively, as well as to comprehend the shift in cultural and social values over the decades.

3.3 Data Preparation

The following section outlines the steps to pre-process the lyrics, by utilizing natural language toolkit (nltk) library and speller module.
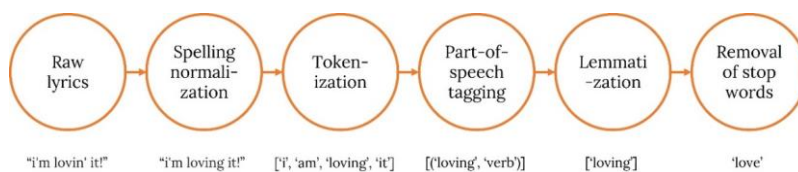
Figure 11 illustrates the pre-processing stages.

Figure 11 – Text pre-processing stages

15

Firstly, spelling normalization was performed by employing the speller module to transform misspelled or incomplete words to their correct spelling. For instance, the words 'shakin' and 'stayin' were corrected to 'shaking' and 'staying' respectively. In addition, a contraction dictionary was established to expand contraction words such as 'you'll' to 'you will'.

Secondly, tokenization, part-of-speech (POS) tagging and lemmatization were performed. Tokenization is the process of breaking down sentences into individual words, while POS tagging labels words with their appropriate word classes, such as a noun or a verb. Lemmatization, on the other hand, is the process of transforming words to their base form, such as 'kicked' to 'kick'.

Finally, a list of common stop words was used to filter and retain words of substantial significance. The process was iterated several times, with each iteration incorporating more inconsequential words such as 'la', 'em', 'uh' etc.

Figures 12 and 13 illustrate the document-term and term frequency-inverse document frequency (TF-IDF) matrices respectively.

accept	accompany	affection	afraid	ahead	air	alive	already	alright	also	...	wine	wing
0	0	0	0	0	0	0	0	0	0	...	0	0
0	0	0	0	0	0	0	0	3	0	...	0	1
0	0	0	0	0	0	0	0	0	0	...	0	0
0	0	0	0	0	0	0	0	0	0	...	0	0
0	0	0	0	0	0	0	0	0	0	...	1	0
0	0	0	0	0	0	0	0	0	0	...	0	0

Figure 12 – Document-term matrix

accept	accompany	affection	afraid	ahead	air	alive	already	alright	also	...	wine	wing
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	...	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.420764	0.000000	...	0.000000	0.146155
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	...	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	...	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	...	0.116425	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	...	0.000000	0.000000

Figure 13 – Term Frequency – Inverse Document Frequency

Both matrices are statistical techniques to identify the significance of a word in a document, with the former scoring words using integer count and the latter using a float-value weighted vector.

Document-term, also known as term frequency, ranks terms based on the number of occurrences in each document. This matrix will thus be used to calculate the TF-IDF.

TF-IDF, on the other hand, was calculated by multiplying term frequency and inverse document frequency, with the former representing the document-term matrix while the latter representing the scoring of the uncommon terms across documents. The final TF-IDF results will therefore define the term's value, with a greater weight indicating that the term is significant (Góralewicz, n.d.).

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17

Chapter 4 Modelling and Evaluation

4.1 Sentiment Analysis

Sentiment analysis is a technique for interpreting emotions through text by scoring the words which reflect the underlying sentiments. To compute sentiment polarity, this study used the VADER algorithm, a lexical approach, known to better perform with slang language, and achieved a high accuracy rate of 56% when compared to other sentiment algorithms (Es, 2021). The algorithm returns four values: positive, neutral, negative, and compound, with the former three being sentiment probability, which sums up to 1, and the latter returning the normalized compound score, ranging from -1 to 1 (Pipis, 2020).

Figures 14 and 15 illustrate the sample data for English and Chinese songs after performing sentiment analysis.

	year	song title	language	cleaned_lyrics	scores	n_sentiment_type	sentiment_type
0	1977	You Light Up My Life	English	so many nights i would sit by my window waitin...	0.9169	1	Positive
1	1976	Tonight's The Night (Gonna Be Alright)	English	stay away from my window stay away from my bac...	0.9325	1	Positive
2	1978	Le Freak	English	one two ah freak out le freak best chic freak...	-0.7579	-1	Negative
3	1977	How Deep Is Your Love	English	i know your eyes in the morning sun i feel you...	0.9922	1	Positive
4	1977	I Just Want To Be Your Everything	English	for so long you and me been finding each other...	0.9958	1	Positive

Figure 14 – Sample data for English songs after sentiment analysis

	year	song title	language	cleaned_lyrics	scores	n_sentiment_type	sentiment_type
195	2016	大鱼	Chinese	the silent waves drowned the night over the co...	-0.8834	-1	Negative
196	2017	光年之外	Chinese	feel the fingertips that stop at my origin how...	-0.9201	-1	Negative
197	2019	無名之輩	Chinese	the lights of the city at dawn there is always...	0.9852	1	Positive
198	2011	时间都去哪儿了	Chinese	the old tree grows new sprouts in front of the...	0.9723	1	Positive
199	2010	洋蔥	Chinese	if your eyes can come for me for a moment if y...	-0.1779	-1	Negative

Figure 15 – Sample data for Chinese songs after sentiment analysis

The compound score was employed as a metric to analyze the sentiment of the lyrics. Following that, these scores were categorized into three categories: with scores less than 0 were labeled as '-1' or 'Negative', scores greater than 0 were labeled as '1' or 'Positive', and scores equal to 0 were labeled as '0' or 'Neutral'.

Figure 16 illustrates the overall sentiment count after sentiment analysis.

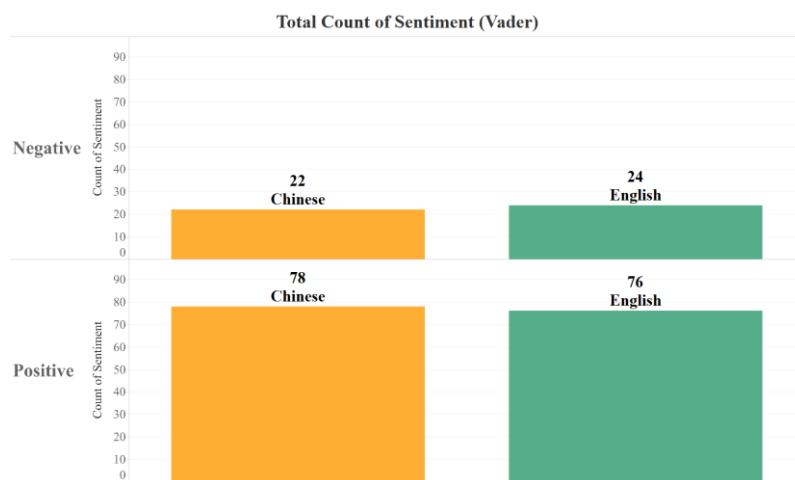*Figure 16 – Overall count of sentiment after sentiment analysis*

Overall, it was evident that the sentiment analysis findings contradicted the actual label count. It is possible to assume that majority of the words used in each lyric were positive, yielding a positive compound score when being aggregated, resulting in the majority of both English and Chinese lyrics conveying a positive sentiment.

Figure 17 shows the breakdown of sentiment counts in each decade.

Breakdown of Sentiment Count in each Decade (Vader)
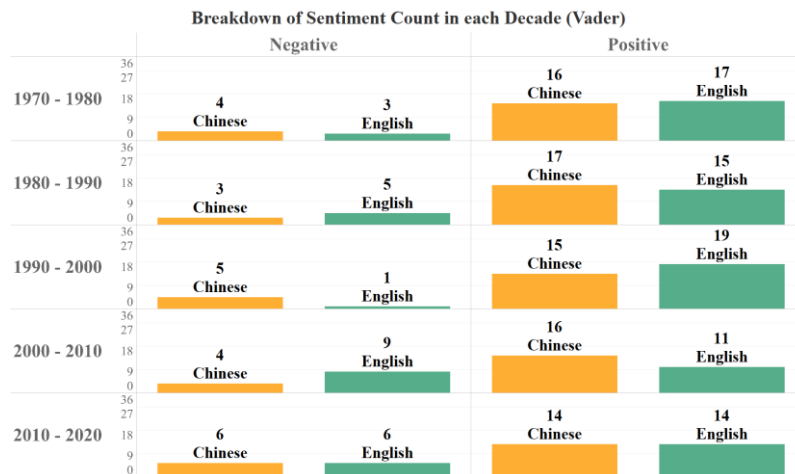
Figure 17 – Breakdown of sentiment count after sentiment analysis into five decade

The breakdown of sentiment count was comparable between languages in each decade, with the exception of English lyrics in the 1990s and the 2000s which illustrate a slight difference over the decades. In the 1990s, songwriters incorporated more positive words in their lyrics, with 19 songs identified as positive sentiment and only one labeled as negative sentiment. Whereas in the 2000s, songwriters incorporated more negative words, with 11 songs classified as positive and the remaining nine as negative sentiment.

However, based on the disparity between actual sentiment and sentiment analysis findings, it can be argued that machine learning cannot elicit emotions but is able to offer a gauge of the underlying sentiment of the text, although sentiment remains subjective in general.

4.2 Text Classification

SVM and NB models were built to evaluate and identify the optimal classifier model for each language based on the frequency of words. SVM is a supervised machine learning technique that gathers data points and returns a hyperplane, also known as the decision boundary, that best differentiates the target for binary classification problems. Furthermore, SVM performs well with limited data ([1]Stecanella, 2017). NB, on the other hand, is a family of probabilistic algorithms that anticipate the target of a text using probability theory and Bayes' Theorem. The algorithm analyzes each text and returns the tag with the highest likelihood. Moreover, despite its simplicity, NB works well and is reliable ([2]Stecanella, 2017).

As the dataset is limited, the above models were constructed using k-fold Cross-Validation (CV) rather than train-test split. The former approach randomly divides the data into "k" folds, with one of the folds being used as the testing data and was repeated 'k' times. Train-test split, as opposed to k-fold CV, splits the dataset into "train" and "test" sets to construct the model. In this study, the models were built using 7-fold CV for maximum accuracy.

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Figure 18 illustrates the process of a 7-fold CV.

Figure 18 – 7-fold Cross-Validation process

21

Table 2 shows the overall accuracy of different models built for English and Chinese lyrics.

Table 2 – Accuracy of different built models

ACCURACY					
	MNB (Multinomial Naïve Bayes)	SVM1 (Radial Basis Function)	SVM2 (Polynomial)	SVM3 (Sigmoid)	SVM4 (Linear)
ENGLISH	59%	55%	55%	60%	63%
CHINESE	57%	56%	54%	56%	59%

The term "accuracy" refers to the average performance score of the trained models in classifying lyrics their actual sentiment. In general, the overall accuracy for both English and Chinese built models yield comparable results of approximately 50% to 65%.

When comparing the various English models, Multinomial NB (MNB), SVM3, and SVM4 achieve higher accuracy of 59%, 60%, and 63% respectively. Whereas for Chinese models, MNB, SVM1, SMV3, and SVM4 yield higher accuracy of 57%, 56%, 56%, and 59% respectively. This suggested that among other built models, the aforementioned models were decent for deployment.

However, the achieved accuracies indicate that the models attained average performance and were considered relatively low. This might be attributed to the uncertainty of translation, thus affecting the accuracy of the result. Furthermore, as the dataset is imbalanced based on the sentiment analysis findings in Figure 16, accuracy may not be a reliable measure to evaluate the model. Hence, additional measures such as precision, recall, and F1-score were used to evaluate the selected models in order to identify the optimal model for each language.

Precision determines the ratio of the correctly predicted labels to the total predicted labels, while recall determines the ratio of the correctly predicted labels to their actual label. F1-score, on the other hand, is obtained by computing the average of precision and recall (Exsilio Solutions, 2016).

Logistic regression (LR) is a simple yet efficient approach for classification, it is thus appropriate to be used as the baseline model, setting a benchmark to evaluate the selected models for both English and Chinese lyrics.

Table 3 shows the precision, recall, and F1-score of the Top 3 English built models and the baseline model.

Table 3 – Evaluation measures of English Top 3 models

ENGLISH				
	LR **(Logistic Regression)**	**MNB**	**SVM3** **(Sigmoid)**	**SVM4** **(Linear)**
Precision	63%	62%	59%	65%
Recall	80%	66%	96%	76%
F1-score	69%	63%	73%	69%

In terms of precision, SVM4 was the only model that outperformed the baseline model in classifying lyrics to its label at 65% and 63%, respectively. However, in terms of recall, SVM3 outperformed the baseline model at 96%, indicating that the model was capable of predicting its actual sentiment almost accurately, whereas MNB and SVM4 performed less optimal at 66% and 76%, respectively. Furthermore, when F1-scores of the models were examined, SVM3 produced better results of 73%. As a result, despite having a slightly lower precision than the

baseline model, SVM3 was regarded as the best model for its high recall of 96% and F1-score of 73%.

Table 4 shows the precision, recall, and F1-score of the Top 4 Chinese built models and the baseline model.

Table 4 – Evaluation measures of Chinese Top 4 models

	CHINESE				
	LR **(Logistic** **Regression)**	**MNB**	**SVM1** **(Radial Basis** **Function)**	**SVM3** **(Sigmoid)**	**SVM4** **(Linear)**
Precision	56%	59%	57%	56%	60%
Recall	65%	53%	70%	76%	61%
F1-score	59%	55%	63%	64%	59%

The selected models except SVM3 outperformed the baseline model in categorizing lyrics to their label, by a slightly higher precision. In terms of recall, SVM1 and SVM3 marginally surpassed the baseline model at 70% and 76% respectively. Furthermore, when the F1-scores of the models were examined, SVM1 and SVM3 outperformed the baseline model and yield comparable results of 63% and 64% respectively. Although SVM1 performed slightly better for all three metrics than the baseline model, SVM3 was regarded as the best model for its high recall and F1-score despite achieving a similar precision to the baseline model.

Overall, given its high recall, the SVM3 model was regarded as the optimal model for classifying both English and Chinese lyrics to their actual sentiment accurately.

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Chapter 5 Discussion

5.1 Lyrical timeline (ENG)

Figure 22 illustrates the Top 20 ten most representative lyrical keywords that were extracted from the English lyrics in each decade.
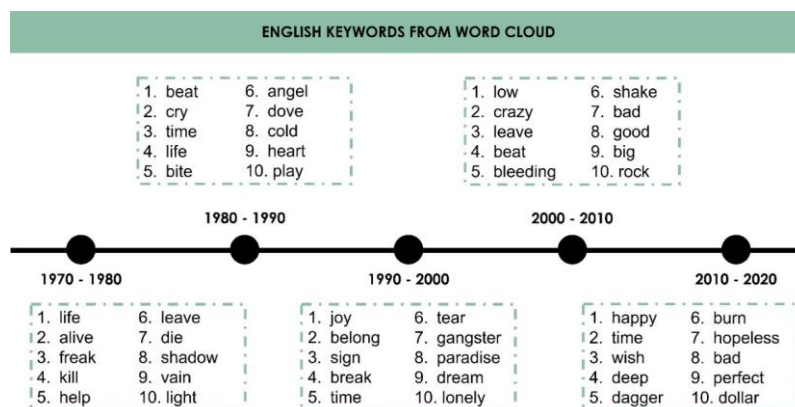
ENGLISH KEYWORDS FROM WORD CLOUD

1. beat 6. angel	1. low 6. shake
2. cry 7. dove	2. crazy 7. bad
3. time 8. cold	3. leave 8. good
4. life 9. heart	4. beat 9. big
5. bite 10. play	5. bleeding 10. rock

1980 - 1990   **2000 - 2010**

1970 - 1980   **1990 - 2000**   **2010 - 2020**

1. life 6. leave	1. joy 6. tear	1. happy 6. burn
2. alive 7. die	2. belong 7. gangster	2. time 7. hopeless
3. freak 8. shadow	3. sign 8. paradise	3. wish 8. bad
4. kill 9. vain	4. break 9. dream	4. deep 9. perfect
5. help 10. light	5. time 10. lonely	5. dagger 10. dollar

Figure 19 – English lyrical timeline

Based on the findings, Americans appeared to be more individualistic, having their own opinions ("101 Characteristics of Americans/American Culture", n.d.), as well as being upfront in expressing their views (Kelly, 2020).

1970 – 1980

The 1970s was regarded as a continuation of the 1960s in several aspects, including political and military conflicts that created a tumultuous decade ([1]Editors, 2010). With the ongoing war in Vietnam, many Americans participated in the violent protest to halt the war, risking their lives in the process. Terms such as 'life', 'alive', 'kill', 'help', 'leave', 'die' and 'shadow' indicated the life state in the 1970s and how songwriters utilized songs to encourage and motivate people to persevere in the face of adversity.

Commented [MK24]: Just a bit cofused, but the earlier bits have you predicting the sentiment (positive negative, neutral) but this is almost something separate, where you are just anylysing the lyrics?

I guess I don't see the link between the results of the prediction and the work here.

Commented [MK25]: good analysis

Whereas the terms 'vain' and 'light' suggested that Americans were entering a new phase of life following the end of the Vietnam war in 1975. In the technological aspect, the beginning of the third industrial revolution brought about the introduction of transistors and integrated circuits in the 1960s, which aided in the rise of television and the establishment of Microsoft and Apple Computer Company (The People History, n.d.).

Music had also grown in popularity from the proliferation of Discothèques (Discos) around the world, having soul music as the primary genre with a powerful bass and drum rhythm that motivate audiences to move to the groove ([1]RetroWaste, n.d.).

1980 – 1990

The 1980s was considered a watershed decade in American history, where significant transformations took place, such as the adoption of new socially, economically, and politically conservatism, as embodied in President Ronald Reagan's policies ([2]Editors, 2018). For instance, the Reagan Administration intensified the War on Drugs, which was promoted through anti-drug campaigns, as drugs were a major concern in the 1980s, leading to high crime rates ([3]Editors, 2017). The terms 'life' and 'bite' could be crucial in such a situation where the lives of Americans were at stake, hence the administration addressed it cautiously.

Furthermore, the emergence of dance music together with the new wave in the 1980s led to a decline in the popularity of discos. The introduction of Music Television (MTV) transformed the recording industry significantly in the 1980s (ushistory, n.d.), which cause a surge in the popularity of dance-pop and rock genres (Davis, 2021). Several legendary artists, such as Michael Jackson and Prince, became iconic with their hit songs, 'Beat It' and 'When Doves Cry'. These hit songs were associated with the terms 'beat', 'cry', 'dove', and 'cold' which were composed based on their personal experiences and integrated with rock music. As such, as the songs were repeatedly broadcasted on MTV, listeners were able to connect to them if

they had similar experiences. While the terms 'time', 'angel', 'heart', and 'play' rose from the rise of MTV, which aided in the transition from a tumultuous decade in the 1970s to a period where individuals started to imitate their idol's fashion sense in music videos ([2]Editors, 2018).

1990 – 2000

The 1990s was viewed as a comparatively peaceful and affluent decade with the collapse of the Soviet Union, the end of the decades-long Cold War, and the development of the internet. The advent of the internet resulted in a revolution in communication, businesses, and entertainment ("1990s", n.d.). The quality of life of an American had thus improved significantly and developed with the popular culture, also known as 'pop culture'. Video games, the Harry Potter series, Tamagotchi pets, and the film titled 'Friends' were some significant characteristics of American pop culture (Emma, 2020), which were indicated by the terms 'joy', 'time', 'paradise', and 'dream'.

When homosexualism peaked in America, they were being discriminated against for being different. The terms such as 'break', 'tear', and 'lonely' suggested that such behaviors were less masculine thus resulting in discrimination ("The 1990s Lifestyle and Social Trends: Overview", n.d.). However, the terms 'belong' and 'sign' suggested that homosexuals were being embraced and accepted by a presidential contender in 1992 who significantly contributed to relevant campaigns (Knickerbocker, 1993).

Gangster rap and grunge, a type of hip-hop music and alternative rock genres, respectively, created significant impacts on individuals' lifestyles in terms of their fashion sense, activity, and music preference ([2]RetroWaste, n.d.). For instance, in the aspect of fashion, individuals wore a flannel shirt to exhibit that they are constantly up to date with the decade's fashion that was influenced by grunge music.

2000 – 2010

The 2000s was recognized as a digital decade marked by the rapid evolution of the internet, which was heavily depended on for communication. In this aspect, smartphones and text messaging had grown in popularity, introducing new forms of connection that were not feasible in the past. However, technology brought both benefits and drawbacks to individuals' forms of communication. The formerly brought convenience in exchanging information and connecting people globally, which were associated with the terms 'big' and 'good'. The latter caused social impacts such as cyberbullying and increased the number of road accidents due to distraction of the smartphones while driving, thus associating terms such as 'leave', 'bleeding', and 'bad'.

As technology advanced, auto-tune programs were developed to adjust vocal recordings. The dominant music genre shifted from gangster rap in the 1990s to hip-hop in the 2000s, where it incorporated different elements such as rap with electronica, to achieve edgy music (Kasian, 2020) that was suggested by the terms 'crazy', 'shake', and 'rock'.

The fashion milestone of individuals shifted to 'low' cut following the 42nd Grammy event in 2000, where Jennifer Lopez, an American singer, showed up in a low-cut dress. Aside from that, emotional music shaped a subculture, emo parade, which caused the original emotional music to die down (Kasian, 2020), that was associated with the term 'beat'.

2010 – 2020

The 2010s was perceived as a decade of social media due to the advent of a key communication game-changer, which altered the way individuals interact (Marshall, 2020). It is an online platform that stole the opportunity for face-to-face interaction. Furthermore, the increased usage of social media assisted large protest movements such as "Occupy Wall Street" and "Black Lives Matter", connecting individuals with similar ideologies globally (Pruitt, 2019). The lyrical terms 'happy' and 'deep' implied that social media is a platform where individuals

28

share snippets of life while fostering relationships. Whereas the terms 'dagger', 'burn', 'hopeless', and 'bad' suggested the negative influence of social media that was replaced with online interaction.

As the internet become widely accessible, social media provided a platform for content distributors to share and monetize their material. The terms 'time', 'wish', 'perfect', and 'dollar' referred to how individuals or influencers used social media as an ideal platform to monetize their content which was produced with effort and demand.

5.2 Lyrical timeline (CHI)

Figure 23 illustrates the Top 20 ten most representative lyrical keywords that were extracted from Chinese lyrics in each decade.
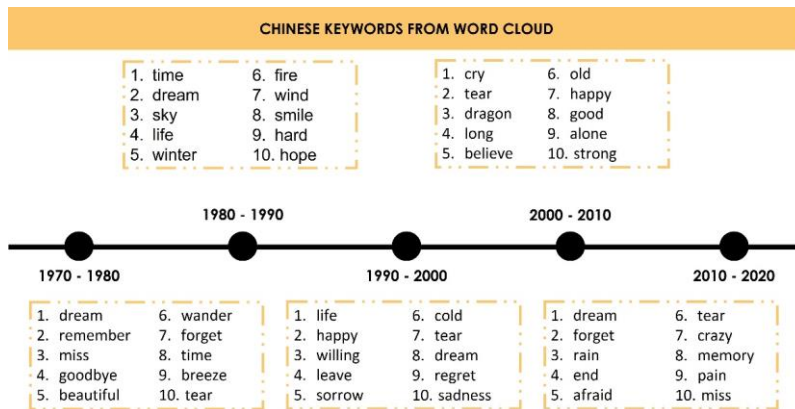
CHINESE KEYWORDS FROM WORD CLOUD

1980 - 1990		2000 - 2010	
1. time	6. fire	1. cry	6. old
2. dream	7. wind	2. tear	7. happy
3. sky	8. smile	3. dragon	8. good
4. life	9. hard	4. long	9. alone
5. winter	10. hope	5. believe	10. strong

1970 - 1980		1990 - 2000		2010 - 2020	
1. dream	6. wander	1. life	6. cold	1. dream	6. tear
2. remember	7. forget	2. happy	7. tear	2. forget	7. crazy
3. miss	8. time	3. willing	8. dream	3. rain	8. memory
4. goodbye	9. breeze	4. leave	9. regret	4. end	9. pain
5. beautiful	10. tear	5. sorrow	10. sadness	5. afraid	10. miss

Figure 20 – Chinese lyrical timeline

In general, the Chinese were conservative, collectivistic, and self-conscious (Hays, 2021). This implied that they are resistant to change; prefer traditional over contemporary, value group over individual, and are concerned with their "mianzi" (face), which is associated with an individual's dignity, ego, and reputation, that facilitates in establishing "guanxi" (relationships) with others.

1970 – 1980

The 1970s was regarded as a gloomy decade that was brought about by the Cultural Revolution (CR) and the principles of communist dictatorship (Burianek, 2009). In 1966, Mao Zedong (Mao), the founding father of the People's Republic of China (PRC), decided to commence the "revolution", which marked the beginning of the CR (Phillips, 2016), a social-political movement that aimed to reform China from its old ways to an ideal society. However, the act of CR was to reclaim the power and prestige Mao lost after the failure of the Great Leap Forward (Lieberthal, n.d.), and it lasted a decade until his death in 1976. During the CR, family life was disrupted as Mao saw families as institutions and kept them imprisoned thus giving orders to break down family structure, where deceased were cremated rather than buried, and ancestors' tablets and ancestral halls were destroyed (Cao & Tom, n.d.). The terms 'remember', 'miss', 'goodbye', 'forget', 'time', and 'tear' denoted how CR had negatively impacted the lives of families, with the majority losing records of their extended families, leading to a shift to three living generations (Cao & Tom, n.d.).

Propaganda art, on the other hand, was used as a communication tool to convey information to mass audiences. Similarly, in terms of music, songwriters composed lyrics in a political manner including patriotism and revolutionary songs designed to represent a legacy. Therefore, the terms 'dream', 'beautiful', 'wander', and 'breeze' were used in a deceptive way to portray society in the 1970s.

1980 – 1990

The 1980s was viewed as the turning point for the Chinese when Deng Xiaoping (Deng) came to power and liberalized China's economy after a series of significant political, economic, and cultural reforms (Gao, 2015). Individuals living in this generation were heavily engaged in democratic ideologies, in which rather than opposing the Chinese Communist Party (CCP),

Commented [MK31]: this is interesting

they yearn for the society to improve (Huang, 2019), with systems that were beneficial to them (Rosen, 2014). The terms 'time', 'life', 'winter', 'fire', 'wind', 'hard', and 'hope' suggested that China had gone through tough times and hoped that in the future, individuals will be given more freedom of speech thus incorporating a vibrant culture.

In the music industry, Taiwanese singers dominated the charts, prompting the music culture to evolve from patriotic songs to love ballads, as well as the internationalization of production (Huang, 2019). As a result, the once-heavily produced propaganda content faded. The terms 'dream', 'sky', and 'smile' signify that the individuals dream to live in a society where they will be able to exercise their privilege, rather than living under propaganda. Thereby, to live an exciting life.

1990 – 2000

The 1990s was regarded as a period of economic prosperity, with economic growth and political stability (Li, 2019). It was primarily due to procedures established during Deng's era, as well as a generational change from peasant revolutionaries to well-educated, professional technocrats. The terms 'life', 'happy', 'willing', 'leave', and 'dream' signify that as the evolution began in the 1980s, individuals were benefitting from education where the majority with sciences-related degrees aspired to develop and live outside of China.

In the music industry, despite the fact that Chinese rock was still considered popular in the 1990s, songs of this genre were subjected to restrictions in terms of exposure and airtime after the Tiananmen Square incident that happened in 1989. The terms 'sorrow', 'cold', 'tear', 'regret', and 'sadness' describe how rapid economic changes influenced individuals' lives, with the majority believed that they were denied opportunities and personal freedom.

Commented [MK32]: good

Commented [MK33]: excellent

31

2000 – 2010

With the effects of globalization and technological growth, the 2000s was regarded as a period of diversified cultures. Individuals were exposed to international cultures through movies, music, and art over the internet (velocityglobal, 2020). As a result, Chinese culture gradually gave way to world culture. Thus, the terms like 'dragon', 'long', 'believe', 'old', 'happy', and 'strong' were used to reintroduce Chinese culture through music. Furthermore, the term 'dragon' represents Chinese unwavering and pioneering spirit of keeping up with the times, as well as having a strong connotation of power, strength, and luck, whereas the term 'old' denoted how ancient Chinese dressed in Chinese Han costumes to relive the depths of China history (China, n.d.).

In addition, Hu Jintao (Hu), the CCP's fourth-generation leader, inherited social, political, and economic inequalities left from Jiang's era. However, Hu was more concerned with equality, focusing on areas of the Chinese populace that have been neglected by economic reform and bridged wealth disparity. Furthermore, they conducted high-profile trips to poor states of China with the aim to better understand each state and assist in the transformation. The terms 'cry', 'tear', 'good', and 'alone' were used to describe the emotions of individuals by the actions of the leaders who were philanthropic and concerned with equality for all regions, urban or rural, rather than only metropolitan regions.

2010 – 2020

The decade of 2010s was considered as an economic growth decade where China was the primary source of global economic development. As China is an incredibly wealthy and intellectually endowed nation that has always been deeply dedicated to learning and education, the Chinese increasingly engaged in innovative inventions, accounting for over half of all

patent filings worldwide (Jacques, 2019). The term 'dream' was used to describe the Chinese yearning for the country's position in terms of progress from the past to the present.

As China advanced, internet restrictions were enforced on foreigners, preventing them from accessing restricted information without the use of a Virtual Private Network (VPN). The government limits information about political opponents, free speech, sex, news, and academic research, which brought a negative impact. Hence, the term 'afraid' suggested that if individuals were allowed to access these contents, it would create a negative impact on the government or even the country. In addition, the term 'crazy' referred to how individuals used the internet on a daily basis, with an average of 125 minutes per day spent on a single app (Qu, 2021), Douyin (Chinese version of TikTok), which gained popularity in 2016 by allowing individuals to create and share short videos online, often featuring background music, resulting in the implementation of mandatory pauses to tacker viewer's addiction.

Following the China Wind, the decade of 2010s was seen as a decade of shifting roles in Chinese popular music (Lin, 2020) as well. Songs were composed in a nostalgic emotion whilst reminiscing the past, as evidenced by the terms 'forget', 'rain', 'end', 'tear', 'memory', 'pain', and 'miss'. For example, Chen Xi's 2011 workpiece "where did all the time go" (时间都去哪了) was composed as though time had passed in the blink of an eye, with her source of inspiration from her mother's 60th birthday celebration.

Commented [MK35]: cool, I learnt something new here.

5.3 Overview

As observed from the cultural and societal aspects of each decade, regardless of English or Chinese lyrics, they were composed related to the society which could be politically, economically, or socially influenced. Furthermore, achieved results align with Goehr's (1994) observation that music was composed for the people by the people and if music loses its sense of community, it loses itself.

Chapter 6 Conclusion

This study evaluates the sentiment of 200 popular bilingual songs using text mining on lyrics. The majority of the songs were tagged to positive sentiment, despite the fact that they have a comparable actual sentiment count for positive and negative, with the combined scores for positive words accumulated to have a higher ratio as compared to negative words.

In addition, several classification algorithms, such as SVM and NB, were examined to identify the optimal classifier model to classify their actual sentiment. Aside from computing the model's accuracy, performance measures such as recall, precision, and F1-scores were employed as the dataset utilized was imbalanced based on the findings of sentiment analysis. As a result, the study concluded that the SVM model performed better at classifying both English and Chinese lyrics, with Sigmoid kernel, for its high recall of 96% and 76% respectively.

The study also investigates how cultural and societal values had altered through lyrics over the five decades. It was discovered that the words used in English lyrics differ from those used in Chinese. Words in English lyrics changed significantly with time, but not in Chinese. This suggested that Chinese songwriters were more sentimental than American songwriters. Furthermore, the variations in the words used were tied to the evolution of society, in which leaders who governed the country with diverse abilities had varying impacts over decades.

However, it is important to highlight that while machine learning is able to evaluate the sentiment of song lyrics, it does not indicate that listeners will have the same sentiment, considering that machine learning does not induce feelings, but listeners do.

Chapter 7 Recommendations

In this study, there were several recommendations worth considering for further research. First, while Chinese lyrics were translated prior to text pre-processing, the translation may be imperfect as they were translated automatically without taking music into consideration. Hence, there is a need to either source for reliable tools that can handle Chinese characters or get in touch with an expert with a musical background to assist in the translation to achieve more accurate results.

Second, while the study provided some preliminary insights for the validity of the models, further research is required to validate the findings. For instance, the study employed a relatively small dataset, hence, there is a need to evaluate and ratify the findings by employing a larger dataset.

Third, the study employed two methodologies, sentiment analysis and text classification, with the former employing single word features, which might lead to misclassification, and the latter adopting the two most prevalent algorithms, SVM and NB. As there are various alternative approaches for sentiment analysis, such as n-grams, and text classification like K-nearest neighbors (KNN) and random forest, it is feasible to incorporate those features and/or models. Therefore, analyzing alternative text mining algorithms and identifying the most effective approach to analyze multilingual lyrics might be a future research direction to explore.

Finally, additional future work can be included in the study, such as identifying the correlation between the years composed and the tone of lyrics and incorporating audio features to make a robust comparison between the overall musical tone and the tone of lyrics.

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Appendix

Table 5 – Variable description

S/N	Variable	Description
1	year	The year when the song is released.
2	song title	The title of the song.
3	song artist	The singer of the song.
4	language	The language of the song.
5	genre	The genre of the song.
6	no. of views	The number of views on YouTube for each song.
7	lyrics	The lyrics of the song.
8	ibm_nlu_lyrics_sentiment	The sentiment of the lyrics by IBM NLU.
9	translated_lyrics	The translated lyrics for Chinese songs.

Figure 21 – Word Cloud for English Popular songs from 1970 to 1980

Figure 22 – Word Cloud for English Popular songs from 1980 to 1990

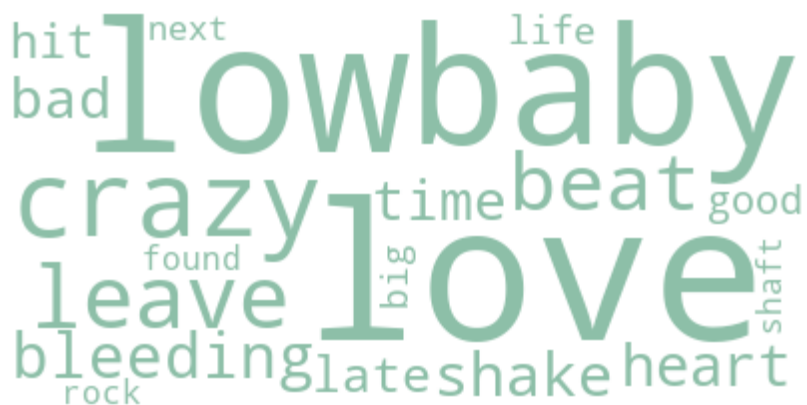*Figure 23 – Word Cloud for English Popular songs from 1990 to 2000*

43

Figure 24 – Word Cloud for English Popular songs from 2000 to 2010

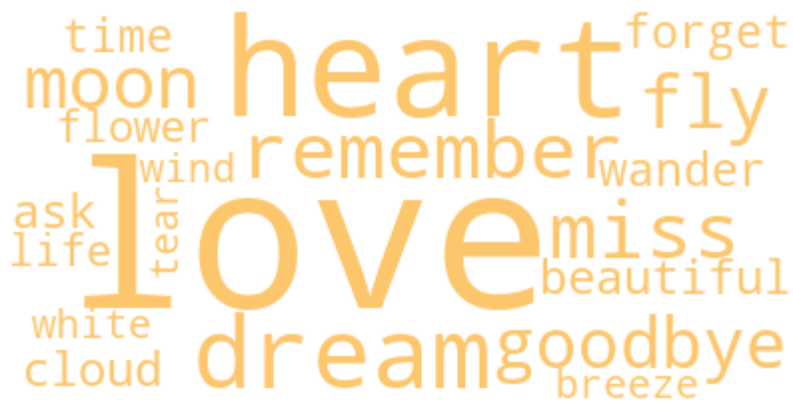*Figure 25 – Word Cloud for English Popular songs from 2010 to 2020*

Figure 26 – Word Cloud for Chinese Popular songs from 1970 to 1980

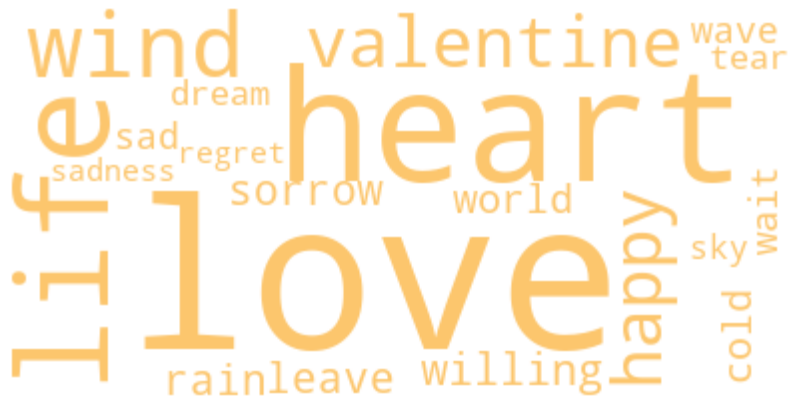*Figure 27 – Word Cloud for Chinese Popular songs from 1980 to 1990*

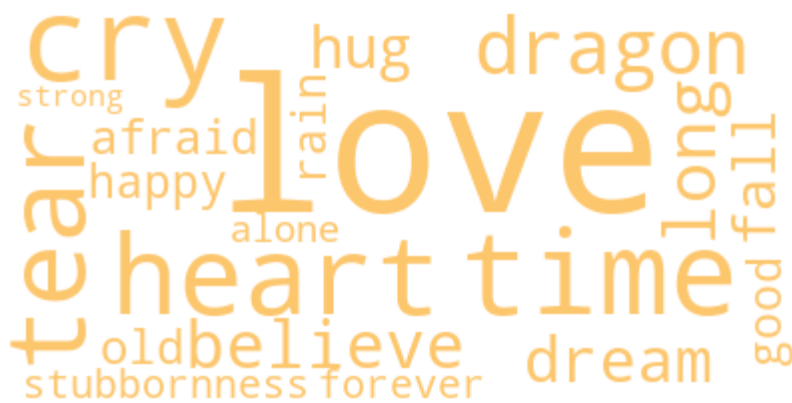*Figure 28 – Word Cloud for Chinese Popular songs from 1990 to 2000*

Figure 29 – Word Cloud for Chinese Popular songs from 2000 to 2010

Figure 30 – Word Cloud for Chinese Popular songs from 2010 to 2020