Context-Aware Music Recommendation Systems for Driving - a MIR Approach

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1 Introduction

1.1 Motivation

Although assistance systems can provide a lot of assistance during driving, the driver's alertness is still essential for safe driving. It is not easy to maintain a good driving state, especially in more dangerous situations, such as long-distance driving or night driving. Playing music in cars is one of the methods that drivers use to boost their spirits. However, current music streaming software can only provide pre-organized playlists. There is no way to adjust the playlists according to the current driving situation, so it is passive assistance. A Context-Aware Recommendation System(CARS) can play a more active role.

1.2 Context-Aware Music Recommendation System

Context means the information to characterize the ongoing situation of an entity. It can be a driver's physical information, such as mood, heartbeat, EEG signals, or environmental conditions like traffic or weather. A challenge for the CARS is the recommendation process itself. In some studies [3, 6], we know that the tempo of the music may be a distinct feature that can influence driving behavior, so this prompted us to discuss the influence of tempo of music in the music recommendation system. Therefore, in this report, we collect the tempo information of the songs in an CARS and analysis the relation between the tempo and the user preference during driving.

1.3 Contribution

In this project, we discussed the between the tempo of the music and the user preference during driving.

1.4 Report Organization

The reminder of this thesis is structured as follows. First, related works about the CARS are introduced in chapter 2. Subsequently, the dataset description, pre-processing pipeline, and the details of model settings

and implementation are provided in chapter 3. The experiment results are described in chapter 4. Finally, the conclusion and future work are in chapter 5.

2 Related Work

2.1 Context-Aware Music Recommendation System

Linas *et al.* [1] provided a dataset for in-car CARS, and also build an Application. Erion *et al.* [4] presented a proof of concept of a mood-based music recommendation system targeting at regulating the driver' s mood and trying to have a positive influence on their driving behaviour. They recommended tender music during the day and happy music during the night, and evaluated the influence of music by observing the driving style through OBD-II module. Dimitrakopoulos *et al.* [5] proposed to recommend optimal genre to the drivers when they want to make a certain journey through a Bayesian network.

2.2 Influence of Music on Drivers

Miao *et al.* [6] performed an experiment involving a total of 37 novice drivers to explore how music tempo affects two aspects of novice drivers' cognitive functioning. They found that fast tempo music impacted mental load and diminished cognitive capacity compared to slow tempo music. Meanwhile, listening to slow tempo music did not increase novice drivers' mental load but benefited their hazard perception. Wen *et al.* [7] discussed how the genre of music affects driver's physiological, psychological response, and driving performance. Their experiment involved drivers with different personalities, such as choleric, sanguine, phlegmatic, and melancholic. They found that lane crossing frequency is higher when driving under the influence of rock music than when driving under the influence of soft or no music. As a result, recommending calming musical pieces to drivers in a state of high arousal can help them calm down and break the cycle of emotional reinforcement through self-selected music [3].

3 Method

The architecture of the system is presented in Figure 1. InCarMusic is a dataset proposed by [2], it contains music tracks rating by different drivers under different context information. The spotify API offers pre-computed audio features such as tempo, valence and loudness for tracks. The CARS module is a basic CARS developed by Oskar Jarczyk[1].

3.1 InCarMusic dataset

There are 26 kinds of context type, such as driving style, landscape, mood, sleepness, traffic conditions, and weather. For the music, there are totally 139 tracks, involving 10 kinds of genres, the detail is presented in Table 3.1. 42 drivers are asked to provide their ratings for the music under those context condition.

[1] `https://github.com/ShowMeModel/car-music-recommender`

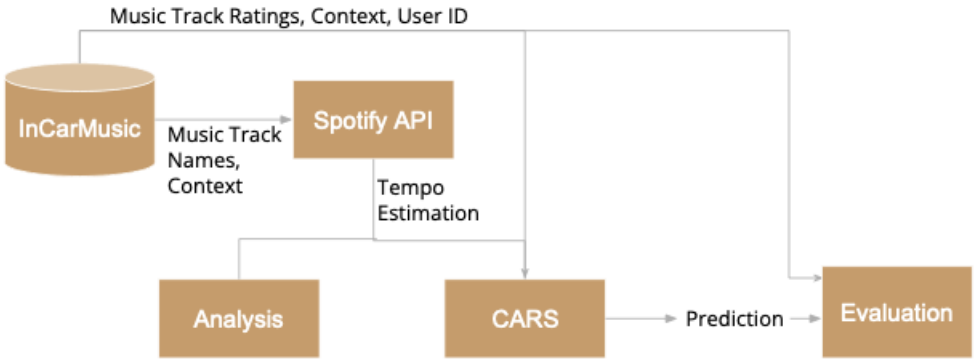

Figure 1: Schematic view of the method.

1	Blues music
2	Classical music
3	Country music
4	Disco music
5	Hip Hop music
6	Jazz music
7	Metal music
8	Pop music
9	Reggae music
10	Rock music

Table 1: Genre of the music pieces.

3.2 Spotify API

Spotipy[2] provides a Python version to query the Spotify back-end. The way to get the audio features of a music piece is as follows:

1. Register an Application and get the client ID as well as client secret key.
2. Given a music track, use the name of the track to query the Spotify back-end and get a list of the search result.
3. Among the list, check whether the artist name of the track matches the artist name of the target music track. If there is a match, then the target track is found. Record the ID of the track.
4. Use the ID to query the pre-computed audio features. To be specific, we use the features involving danceability, loudness, valence, and tempo.

[2] `https://github.com/plamere/spotipy`

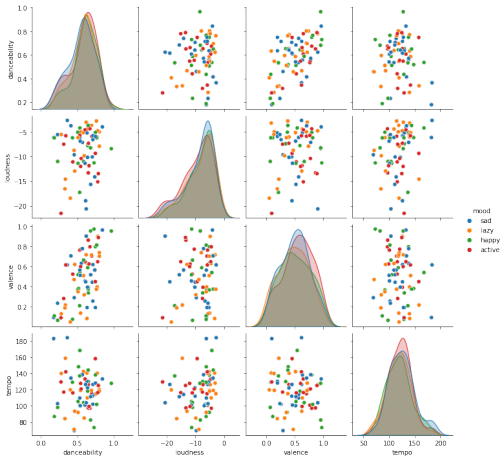

Figure 2: Mood

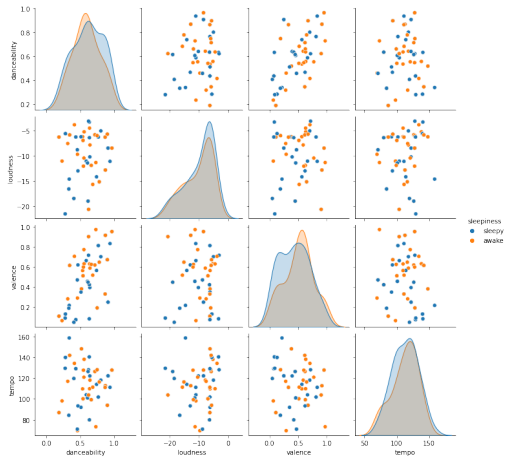

Figure 3: Sleepiness

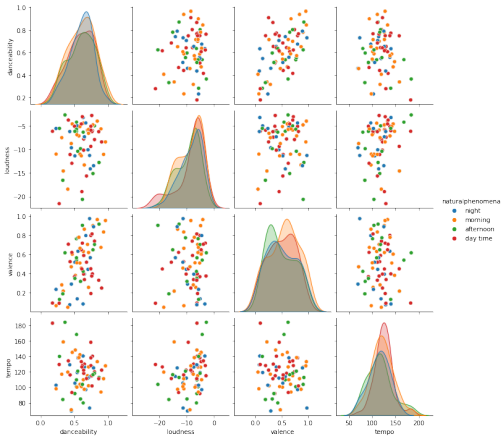

Figure 4: Natural Phenomena

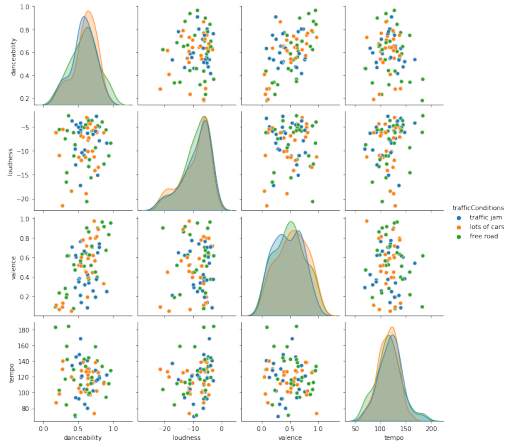

Figure 5: Traffic Condition

3.3 CARS Module

Given a sequence of features related to the context and the genre of the music, a gradient boosting classifier is used to predict the rating of the music.

3.4 Analysis

Figure 3.4, 3.4, 3.4, 3.4 shows the relation between audio features and context condition. In each Figure, different color indicates different kind of context. For the mood-related context, there is no big different kind of mood in all audio features. For the sleepiness-related context, we can see the there is a left-shift on valence when the driver feels sleepy. For the Natural Phenomena-related context, the difference in valence is more obvious.

3.5 Classification Accuracy

The Table 3.5 shows the recommendation accuracy, recall, and precision. We can see that with the audio features, the performance is improved.

Method	Accuracy	Macro Avg. Recall	Macro Avg. Precision
Original	0.66	0.66	0.70
With audio feature	0.69	0.69	0.73

4 Conclusion

In this project, we investigated the influence of the tempo information of the songs to the preference of the driver. Although there is no significant difference between different kind of context in audio features, the audio features still improve the accuracy of the context-aware music recommendation system. This result shows the promising usage of the audio features in an context-aware music recommendation system.

References

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