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Appropriate Context for Context Aware Music Recommendation

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Abstract: There are various environmental factors that impact on selection of appropriate music. For example, selection of music in a foggy mountain is totally different with music selections in traffic jam or human sensation for listening to music on a weekend morning is extremely different with a research day's afternoon. In this study, context information which can impact on user's choices is evaluated through psychology of music inclinations, context information used in related researches and studies and also smartphones limitations and entirely most appropriate scheme will be offered. Particularly, these context information can be used in all context aware music recommendations. Finally, adopted experiments reveals that recommendations which apply these context information are acceptably similar to user's selection in all circumstances.

Key words: Context aware music recommendations, context information, clustering, behavioral analysis, personalization, internet-based applications, psychology of music inclinations

INTRODUCTION

One of the biggest problems of music enthusiasts is related to appropriate selection of audiophiles among their archive folders. For example, a music selection in quiet forest is completely different around a busy street or human sensation for listening to music on a weekend morning is extremely different with a research day's afternoon hence, providing a local music recommendation system helps users to select most appropriate music among smartphone archives at any moment and make enjoyment sense by listening to desired music.

The conventional recommender systems are included as cooperative and content-based filtering. More specifically, cooperative filtering recommends the most suitable music based on user's behavior and similarity between them and content-based filtering recommends an appropriate music according to their content (signal) and music types categorizing.

In general, context information are not considered within none of these recommenders in which context information are defined as follows: "the information that shows where you are who is keeping in touch with you and what resources are available around you" or "context data is such data which may impact on user behavior connecting with system. Meanwhile, context information within music recommender systems can be encompassed environmental information (such as spatial position, temporal status weather condition, temperature, light, traffic, etc.), personal information (such as age, gender, culture, current sense of user, etc.) or information predetermined with each music (music text, music volume) (Kaminskas and Ricci, 2012). Therefore, application of conventional recommenders regardless of context information may not contain functionality to provide suggestion proportional with current conditions. Since, users naturally store favorable and interesting music on their device and what make them to select different music in different states and situation is context information.

In this study, an appropriate context information are presented which facilitate user's selection of music at any moment respect to their sensation. Moreover, in order to evaluate proposed system's performance a android-based application has been implemented extracting context information through available sensors in smart devices. Following reports of this application reveal that users are satisfied with trends of music selection.

Literature review: The idea of context data application in a computer program has been made from 1990's where Reddy and Mascia proposed a music recommender system called life-track which could suggest a list of sufficient music for that moment based on music stored in user's device and surrounding context information (Reddy and Mascia, 2006). Meanwhile, environment data being used by these authors include geographic location (prepared by zip code) time of day (morning, afternoon, evening, night) day of the week, noise amplitude or volume (if the user is walking) and level of traffic congestion (slow, medium, full of chaos if user is driving),

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temperature (very cold, cold, temperate, hot, very hot) and weather condition (snow, rain, fog, cloudy, sunny and clear). These context data are provided through mobile's sensors. In order to determine priorities, user should label his/her music library using predetermined words. For example, user may tag specific labels such as cool, very cool and rainy for special music. Therefore, system categorizes music based on tags library and current context information.

In this regard, Cai *et al.* (2007) have conducted research for matching music with textual content. These researchers introduced a system called "music sense" which could suggest relevant music for users who are reading web documents especially weblogs. For this purpose, a series of words are considered which represents a mixture of human emotions and then these words will be marked for whole music (based on music text) and webpages user has reviewed and finally music with higher compatibility will be recommended. This idea inspired by Google's AdSense automatically suggests related music proportional with reviewed webpages by user. In this scenario, suitable music will be recommended based on text of web pages that are context information. Entirely, evaluation of this research show that their results are acceptable.

Chen *et al.* (2013), related music are suggested based on literature that user is written in the internet world Wang *et al.* (2012), user attitude will be classified into one of categories of running, walking, sleeping, reading, researching out and buying based on context information obtained by mobile phone and suitable music will be recommended according to types of music already listened in this situations. In this study, music content analysis is used to solve problem initialization. Braunhofer *et al.* (2013) and Kaminskas and Ricci (2011), spatial locations are used for recommendation of proper music. For this purpose, users are asked to tag emotional labels for music and areas according to their interests and subsequently based on these tags an appropriate music is being select respect to their positions. Similarly, Braunhofer *et al.* (2011) spatial location is used to recommend proper music but the difference is that users should directly ascribe music to different locations (North and Hargreaves, 1996), a mobile tourist guide application has been implemented which play a desired music based on tourist's emotion and situations (for example, epic music in ancient tomb and quiet and romantic music in painting's exhibition.

Context information categorization: Despite, several categories proposed for these context information here we will use triple categories provided (Kaminskas and Ricci, 2012).

MATERIALS AND METHODS

Environmental information: In this filed, conducted researches indicated that our environment has a great impact on a user's mind or emotional state and may indirectly influence on human interests in music selection. These researches have shown that there is a direct relationship between terms of listening to music and human's favorites into music (North and Hargreaves, 1996). For example, human inclination toward music in Winter is totally different than summer season (Pettijohn *et al.*, 2010) hence environmental parameters must be included when recommending a proper music. In particular, environmental context information being used for recommendation of a suitable music can be classified into the following general categories: user's location, time, weather information, traffic congestion, environment's noise volume or amount of environment light.

Information related to users: Generally, user's activity or modes are introduce as waking, running, driving, walking speed or heart rate and user personal information are classified as: age, gender, nationality, social groups, personality and so on and finally user's emotional states are expressed as being happy, sad, excited. Indeed these types of context information may have a direct effect on user's tastes in music. For example, a person listen to specific music during resting interval against practicing intervals in a gym.

Multi-media information along with music: Since, music is a multimedia content its integration with other multimedia data will be sufficient and useful. These information define as following: music's text, music picture or volume.

Analysis of context information: In this study, we analyze context data. Initially psychology of music is examined and then we will review context information used in other researches and finally, we explain limitations of smartphones.

Psychology of music inclinations: People listen to their favorite music everyday all over the world which these music have a strong influences on various aspects of their lives eithertheir treatment with others or making an appropriate decision so that these music can be considered as a means of recognizing individuals (Rentfrow, 2012). In this regard, several researches have been developed in which showing that individual's personality has a great impact on their interests respect to different music. In fact, these studies are based on big five personality traits. These researches are not limited to

culture and climate condition of a particular country because in the whole world from Japan to Germany and Spain they have obtained similar and important results.

Psychologists believe that a person's character can be divided into 5 categories such as openness to experience, extraversion, agreeableness, neuroticism and conscientiousness.

In order to determine relationship between these 5 factors and human interests into music various researches are provided. The explanation of these 5 factors will be described in future research but general comprehension is that human personality has a great influence on music selection.

Indeed, different circumstances have a great impact on human interests into music. In 1996, many of participants were asked to say which kinds of music was preferable for them. Corresponding results showed that different situations have had a great impact on human interests in music selection (North and Hargreaves, 1996). In the following, some important factors will be explained.

Sex: Among various researches conducted about impacts of genderon music interests (Premuzic *et al*., 2010) shows that women make significance sense to music than men. Moreover, Rawlings and Ciancarelli (1997) show that women inclinations to popular music is more than men. In addition, study shows that men's tendency into bass based music is more than women.

Age: Age is an important factor in choosing proper music. Naturally, nostalgia sensation has greatest impact on human interest to music so that music giving a certain nostalgia to users is more favorable (Barrett *et al*., 2010). In a study conducted on young canadians it is shown that teens who listened to heavy metal genre have low self-esteem, represent uneasy feeling toward family. Moreover, teens who listened to light music may be involved in appropriate issues and they may have problem on balancing dependence and independence (Schwartz and Fouts, 2003). In this regard, studies have been done on British teenagers which shows interests and human perspective toward a music will be changed over time (Crowther and Durkin, 1982).

Season: Another, important factors in the choice of music is season. Studies developed by Pettijohn *et al*. (2010) show that humans usually incline toward reflective and complex music in fall and winter season while in spring and summer they will be absorbed into energetic and rhythmic music.

Mood: Another, important factor in music selection is spiritual state. Typically, if a person was sad or happy it may has a great impact on his/her music selection (Vuoskoski and Eerola, 2011). Researches show that music can intensify creativity and feeling and on the other hand filter out violence (Pool and Miller, 2011). Also, if a person experienced emotional memories with a favorable music, this may increase his/her satisfaction and pleasure (Nusbaum and Silvia, 2011).

Table 1: Frequency of used context information from 2003 until now

Row	Context information's name	X number of usage from 2003 until now (times)
1	Geographical location	9
2	Time of day	6
3	Date (day of month, month of year, day of week, season)	5
4	weather	4
5	Texts generated by user	4
6	Noise of environment	4
7	Speed	3
8	Temperature	3
9	Sex	2
10	Age	2
11	Traffic congestion	2
12	Music cover picture	2
13	Brightness	2
14	Physical activity	1
15	Moving direction	1
16	Battery consumption level	1
17	Contamination	1
18	Electromagnetic activity	1
19	Ramp	1
20	Metal penetration	1
21	Heart beat	1

Showing off: The trends that a person inclines to be seen from others will also impact on his/her tendency. This has been significantly observed in men (Premuzic *et al*., 2010). Moreover, it is possiblepeople listen to specific music to empower their personality. For example, conservative people prefer to listen conventional style music while people with distinctively sporty characteristics listens to music with a fast rhythm (Rentfrow and Gosling, 2003).

Context information used in related researches: As mentioned in study 3, all these context information can be divided generally into 3 categories:

- Environmental information
- Users information
- Multimedia information which is along with music (music text and volume)

Now, we can claim that third category is being used less than other categories through precisely investigating following table and conversely context information in the first category had the most attentions so that geographic location and hours of every day with 9 and 6 times usage is being located in the top of table, respectively. Similarly, second category is rarely used in which corresponding used context information and their frequency arespecified in Table 1. Therefore, it can be concluded that during

recently conducted researches first category's context information or environmental information have achieve most of all attentions and two other categories are less frequently used.

Smartphones restrictions: In general, battery, memory, processor of mobile phones are weaker respect to Personal Computers (PC) and are denoted as bottlenecks. Indeed, paying attention to these elements in order to obtain user satisfaction and most importantly designing system that support different smartphone's hardware is very important therefore it is preferable to consider constraints and their use of various resources during choosing context information.

Third category context information (i.e., multimedia information that is along with music such as text and volume music) require more memory due to image processing and alsochecking and indexing music's text and music comparison with countless available texts in the internet and impose huge computational burden and naturally also increases battery consumption.Therefore, application this category of context information for mobile phones is not preferable. On the other hand, most of these information are not available within our country or incorrectly introduced site's providers.

Proposed context information: According to mentioned topics in the previous section, we eliminated portion of introduced three categories about context information as below. The second category or user-based information in the second part or user's profile such as age and gender for a user will be unchanged whilewe are supposed to suggest music among an specific user's music archive. Therefore, if we use this category of context information we will not observe any impact either positive or negative hence, we ignore them. It is noteworthy that if we use this system to offer music these categories of context information will outline very important role because according to the explanations provided in section 1-4, personal information such as age and gender will be very effective on human tendency in the selection of appropriate music.

Third category (multimedia context information is along with music) will be neglected due to similar reasons mentioned in the previous section such as high computational burden and lack of appropriate content for them. The first category is being used completely and the second and third part of second category will be utilized. If we look at Table 1 which shows application of context information during recent years before we can observe that they importantly require first category's information more that other two categories. Table 2 reveals context information along with their ranges that will be used in the following. Moreover, selected context information are determined as following factors.

Table 2: Appropriate context information for context aware music recommendation

Row	Factor	Factor intervals
1	Geographical location	0-farthest point
2	Time of day	0-24
3	Day of week	0-6
4	Day of the month	1-31
5	Months of the Year	1-12
6	Temperature	-30-50
7	Humidity	0-100
8	The rain level in 3 h	0-the maximum available value
9	The snow level in 3 h	0-the maximum available value
10	Wind speed	0-the maximum available value

Geographical location: As certainly known, user's location will be more impressive on music selection. For example, music selection is different at home, workplace or university and also music selection during walking into research or college or home is different so that listening to music when walking on busy streets of big cities are very different againstlistening to music while walking around forest or beach. Thus, this factor has been selected for this study. In order to obtain user geo-location, there are two common techniques.

Application of mobile phone's GPS: Typically, user's geo-location can be determined with reasonable accuracy through GPS system subject to enabling corresponding sensors and user may drain it off in order to prevent battery consumption.

Application of operator's SIM card: The approximate coordinates of user can be obtained through cell towers that cover a user's SIM card. This method is less accurate compared to previous methods but its battery consumption is beneficiary. Finally, data obtained in both methods is coordinates of width and height so that we should convert these data into one dimensional to be consistent with following approach. For this purpose as an initialization phase user's origin will be stored when he/she uses the system for the first time and we also assume 0 value for stored music. Subsequently, we calculate distances from this point per meter account and save them. Moreover, interval factor will be considered equal to 0 to farthest point.

Time of day: The time of day is also important factors for music selection. For example, our spiritual manner at night before going to bed is totally different with morning and require so different music. For this purpose, we also we adopt hour of the day factor. This data is easily extracted from mobile phone's hours and its range is between 0 and 24 h.

Day of the week: In is evident that human's feeling and modes differ during weekends or holidays against first week so this factor is also included. Indeed, value of this

factor is during intervals that is combined with time of day. For example, Friday afternoon or Monday morning. This data is easily extracted from mobile phone's calendar and its range is between 0-6.

Day of the month and months of the year: These data are easily extracted from mobile phone's calendar and are essential for music selection. For example, listen to music under falling leaves during autumn or under snowfalls in the winter months or sunshinein the summer months and specific sense of spring months have high influences on music selection. On the other side, recording days of months could also save our moods and habits. Evidently, day of month range from 1-31 and month of year limited between 0 and 12.

Weather condition: This factor is also very important to us because human sensing to listen music on the days with an average temperaturealong with light rain will extremely different compared with snowy cold days. Since, context information will be used ascontinuous values within music scoring algorithm such values namely sunny, rainy are not applicable for our study; hence we transform weather conditions information as continuous data. In particular, there are a lot of APIs to acquiesce weather information so thatone of them is open weather map. This API is free and can provides weather information as json or xml format by inserting name of city or town numbers or geographic coordinates or zip code. For example, the following Json reveals climate condition of science and culture university coordinates.

Alogrithm:

{"coord": {"lon":51.33, "lat": 35.69},
"weather": [{"id": 8θ1, "main": "clouds", "description": "few clouds", "icon": "θ2d"}],
"base": "cmc stations",
"main": {"temp": 5.51, "pressure": 1θ25, "humidity": 39, "temp-min": 3, "temp-max": 1θ},
"wind": {"speed": 1, "deg": 12θ},
"clouds": {"all": 2θ},
"rain": {"3 h": 3},
"dt": 14533542θθ,
"sys": {type": 1, "id": 7θ32, "message": θ.θθ32, "country": "IR":, "sunrise": 1453384212},
"id": 6659521,
"name": Kuy-e Ekhtesasa

The Json includes: weather as sunny, cloudy, snowy (weather.id), temperature (main.temp), air pressure (main.pressure), moisture content (main.humidity), wind speed (wind.speed), wind direction (wind.speed), rain level in last 3 h (rain. 3 h), snow rate in the last 3 h (snow. 3 h) and so on Appendix 1. According to aforementioned issues, weather conditions are divided into following measurable factors:

- Temperature per Celsius: range of 30-50
- RH (Resistive Humidity): range of 0-100

Wind speed: meters per second: The highest wind speed reported by "World record wind gust" is equal to 114 m/sec but for Tehran the highest wind speed according weatherspark report was obtained equal to 8 m/sec between 1996 and 2012; hence user's location area for determination of this period is very important and if this interval is spread too big its accuracy decreases. Accordingly, its range is outlined 0 up to maximum value plus one.

The rain level in last 3 h/mL with an interval between 0 increments up to maximum available value. The snow level in the last 3 h/mL with an interval between 0 increments up to maximum available value.

RESULTS AND DISCUSSION

All studies that have been conducted in this area showthat users who utilized proposed systems for context informationfor music recommendation are more satisfied than random mode. Unfortunately, we cannot compare our proposed approach results in a specific figure with other researches since, our method is different. Therefore, we need to implement a program to measure user's satisfaction about this application. To implement this application, we used method presented by Dolatkia and Azimzadeh (2016) for adopting context information for recommending appropriate music.

In this application in addition to user's authorities for music selection, a distinct button is embedded as 8 so that by pushing it an appropriate must will be respect to current situation. Moreover, Google analytic program is used for realization of system performance reporting.

In addition, reported observations show that 54% of users are satisfied with music selection by their own authority and their satisfaction rate will be 51% when they have been used our application. This indicates that that our system is acceptably close to user's selection. However, this percentage will be even higher by taking into account other factors and adopting excessive times for system's training.

CONCLUSION

As mentioned in this study, several factors influence on appropriate music selection of users such as rain level, our relationship with family, business success, human spiritual mood and so on. In this study, we evaluated context information by considering the psychology of music inclinations, cell phone restrictions and conducted

researches in this filed and consequently appropriate information have been suggested so that if special application could completely support these context information will make recommendations with an acceptable level. The most important difference and superiority of proposed method in comparison with other studies is that context information is considered as continuous (not discrete). Indeed, similar researches proposed in this area categorized context information and have tried to incorporate current mode in one of the categories. For example, liftrack has identified several categories for each context information: time of day (morning, afternoon, evening, night), traffic congestion levels (slow, medium, full of chaos if the user is driving), temperature (very cold, cold, temperate, hot, very hot) and weather conditions (snow, rain, fog, cloudy, sunny and clear). Then, attributes and fits any data in one of these categories, for example, temperature is either very cold or cold or temperate or hot or very hot and does not have intermediate state. Finally, attempts to includecurrent mode in one of these categories during music selection which helps to obtain its similarity with acquired music. Naturally, these approaches cannot totally extract fullest sense of environment; hence, context information are considered continuously in this study. On the other side, previous studies require user's highly intervention which this issue leads to disappointment of usersto apply recommender systems whileproposed method in this paper requires no user interventionand collects its requirements data over time and automatically.

RECOMMENDATIONS

As mentioned before, spiritual moods of user such as happiness or sadness extremely impact on the selection of appropriate music in addition to all context information which was introduced but until now any deterministic approach has not been developed for its comprehension or extraction. Therefore, realization of such method for this purpose or an estimation of this scheme can injected great contributions for context aware music recommendation.

APPENDIX

Appendix 1: Context data used from 2003 until now

Writer number source	Title	Position information is used
Deng *et al.* (2015)	Exploring user emotion in microblogs for music recommendation	Texts produced by users on the internet and social groups
Pessemier *et al.* (2014)	Context-aware recommendations through context and activity recognition in a mobile environment	Geographical location, town or village, weather, movement speed, date, the time of day, battery consumption level physical activity
Schedl and Schnitzer (2014)	Location-aware music artist recommendation	Geographical location
Cheng and Shen, (2014)	Just-for-Me	Geographical location
Hyung *et al.* (2014)	Music recommendation using text analysis on song requests to radio stations	Texts produced by users on the internet
Domingues and Rezende (2013)	The impact of context-aware recommender systems on music in the long tail	Day of month, months of year, day of week, time of day, geographical location, music band, music genre
Chen *et al.* (2013)	Using emotional context from study for contextual music recommendation	Texts produced by users on the Internet
Braunhofer *et al.* (2011)	Location-aware music recommendation	Geographical location
Kaminskas and Ricci (2011)	Location-aware music recommendation using auto-tagging and hybrid matching	Geographical location
Wang *et al.* (2012)	Daily activities	Hour of the day, movement direction, noise of environment
Hariri *et al.*(2012)	Latent topic sequential patterns	Song lyrics, liked string of consecutive songs by the user
Baltrunas *et al.* (2011)	InCarMusic	Driving mode (slow or fast), road type (urban, highway and winding), landscape, sleepiness, traffic congestion level spiritual mood, weather, time of day
Kaminskas *et al.* (2013)	Adapting music to POIs	Geographical location
Ankolekar and Sandholm (2011)	Foxtrot	Geographical location
Stupar and Michel	Picasso	Picture
Li and Shan (2007)	Emotion-based impressionism slideshow	Picture
Cai *et al.* (2007)	Music sense	Web pages text
Reddy and Mascia (2006)	Life trak	Geographical location, time of day, day of week, noise of, environment, traffic congestion level
Lee and Lee (2006)	Music for my mood	Season, moon, day of week, weather, temperature, sex, age, region
Elliott and Tomlinson (2006)	Personal soundtrack	User's movement speed
Park *et al.* (2006)	CA-MIR using fuzzy bayesian network and utility theory	Temperature, humidity, nosie of environment, brightness weather, season, time of day, sex, age
Gaye *et al.* (2003)	Sonic City	Light, nosie of environment, contamination, temperature, electromagnetic activity, area, ramp, metal penetration, heart beat, speed, height

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