

Analysis of User Needs and Information Features in Natural Language Queries Seeking Music Information

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Abstract

Our limited understanding of real-life queries is an obstacle in developing music information retrieval (MIR) systems that meet the needs of real users. This study aimed, by an empirical investigation of real-life queries, to contribute to developing a theorized understanding of how users seek music information. This is crucial for informing the design of future MIR systems, especially the selection of potential access points, as well as establishing a set of test queries that reflect real-life music information seeking behavior.

Natural language music queries were collected from an online reference Website and coded using content analysis. A taxonomy of user needs expressed and information features used in queries were established by an iterative coding process. This study found that most of the queries analyzed were known-item searches, and most contained a wide variety of kinds of information, although a few features were used much more heavily than the others. In addition to advancing our understanding of real-life user queries by establishing an improved taxonomy of needs and features, three recommendations were made for improving the evaluation of MIR systems: (i) incorporating user context in test queries, (ii) employing terms familiar to users in evaluation tasks, and (iii) combining multiple task results.

Introduction

One of the major issues in current music information retrieval (MIR) research is the lack of empirical studies of real-life users and their music information seeking and retrieval processes. The absence of rigorous and comprehensive studies of the MIR system users in the field (Byrd & Crawford, 2002; Downie & Cunningham, 2002; Futrelle & Downie, 2003; Cunningham, 2003) has led researchers to rely on anecdotal evidence and a priori assumptions of typical usage scenarios for designing MIR systems (Downie & Cunningham, 2002; Cunningham, Reeves, & Britland, 2003). Without rich understanding of user needs and behaviors, the MIR community is running the risk of developing ill-suited systems for the users (Cunningham et al., 2003). Futrelle and Downie (2003) argued that the almost complete nonexistence of studies on the needs

of potential MIR system users is the very reason why current MIR research is weak on evaluation and application to real users.

In the general field of information seeking and retrieval, we have well-developed literatures, and various information seeking theories and models exist. To name a few, there are Bates' (1989) Berrypicking model of information seeking, Kuhlthau's (1991) Information Search Process model, Dervin's (1992) sense-making, Savolainen's (1995) Everyday Life Information Seeking (ELIS) model, Ingwersen's (1992) cognitive model, Wilson's (1999) model of information seeking and more. These theories and models, however, mostly concentrate on describing the general processes of information seeking/searching from a broad perspective. Therefore, applying these theories and models only provides limited information for information seeking/searching behaviors in specific contexts such as music information seeking and retrieval. MIR presents some distinctive issues, thus warranting further investigation.

One clue that MIR differs in important respects from the general text IR can be found in the nature of how people encounter and interact with music. People often first encounter new music from various media (e.g., a movie, TV commercial, radio) without ever knowing the artist name and song title, or they often forget the information over the course of time. This brings challenges to known-item searches for music as those users must attempt to describe the sought music other than using the bibliographic information. In addition, the universal appeal of music to an extremely broad and diverse group of people can make seeking music information more difficult and frustrating. For instance, people who had no formal music education or people who seek music from different cultures or music in nonnative languages can experience difficulties describing the music they seek (Lee, Downie, & Cunningham, 2005; Orio, 2006). Furthermore, the concept of subject in music has always been uncertain and more difficult to grasp than in text (McLane, 1996; Byrd & Crawford, 2002; Kim & Belkin, 2002). One may conduct a search using lyric words, but not all musical works are accompanied by lyrics. Even for vocal music, it is often difficult to comprehend the lyric terms, thus they are often misheard, especially for foreign songs.

These unique aspects of music are the very reasons why common bibliographic access points (e.g., author, title, and subject) alone may not be sufficient for users seeking music objects or information about those objects, and it is particularly interesting to study the users' behaviors in this context. It is generally acknowledged that the multidimensional nature of music requires multiple features in order to represent a music object, but there is little research as to which features are in fact most useful for searching (McLane, 1996; Downie, 2003; Goodrum, 2003). Among the several conditions required for a feature to be deemed useful for searching, the first and foremost condition is that users have to be able to make use of that

feature, that is, they need to be able to provide some accurate and helpful information about that particular feature. Studying real-life examples of music information searches is essential for improving our understanding of this issue.

The lack of empirical data regarding the various aspects of real-life queries is also an obstacle in designing and evaluating usable MIR systems. This is especially so because the common assumptions of MIR researchers regarding the nature of music queries are found to be remarkably different from the real-world situation (Futrelle & Downie, 2003). For the evaluation tasks of various MIR systems and techniques (e.g., Music Information Retrieval Evaluation eXchange (MIREX) (Downie, 2008), a set of test queries must be selected for each task. Although some degree of arbitrariness is inevitable in selecting these test queries, the method of selection can certainly be improved. One way is to make them more realistic by using knowledge of what kinds of information we can reasonably assume users will have in hand when they are conducting particular searches in MIR. The empirical data that are currently available to us, however, are very limited.

The objective of this study was to improve our understanding of the common patterns and parameters in real-life music information seeking. More specifically, this study aimed to further our understanding of the kinds of information features provided by users in real-life music information queries. Music information queries here mean the natural language query statements of the users searching for music objects or information about those objects (i.e., metadata), not bounded by the limited set of features provided in currently available catalogs or MIR systems. In their queries, people generally provide information they believe will be useful for the search, not necessarily all they can possibly say about the sought object. Thus, analyzing queries will also help understand how users conceptualize the search by learning which information users think is relevant for each search task. This is part of a broader agenda that is best characterized by Downie's assertion (2003) that discovering which facets of music information are essential, potentially useful, and superfluous to the construction of robust MIR systems is one of the central questions confronting future MIR research. This study provides much needed information to the MIR community which, in addition to improving our general understanding of real-life queries and helping us identify potential new access points, can also provide an empirical basis for MIR system design and evaluation.

Review of Related Works

User Studies in MIR

Despite the increasing interests in user studies in the MIR domain, there exist only a limited number of prior studies of MIR system users' needs and behaviors. Nonetheless, these studies provided invaluable preliminary information on the needs, uses, and information behaviors of the MIR system users, and also helped raise general awareness of the importance of

understanding users among MIR researchers. Studies that are based on transaction log analysis (Itoh, 2000; McPherson & Bainbridge, 2001) and semi-structured interviews (Cunningham et al., 2003; Taheri-Panah & MacFarlane, 2004; Laplante & Downie, 2006) are more commonly found, although some studies employ methods such as ethnographic observations (Cunningham et al., 2003; Cunningham, Jones, & Jones, 2004), diary study (Cunningham, Bainbridge, & McKay, 2007) or user experiments (Kim & Belkin, 2002). The studies based on surveys or interviews (e.g., Downie, 1994; Lee & Downie, 2004; Taheri-Panah & MacFarlane, 2004; Inskip, Macfarlane, & Rafferty, 2008) generally focus on collecting quantitative information about what users *say* they did or might do in certain MIR scenarios. This study shifts the focus to what users *actually* do in real-life music information seeking and retrieval tasks. This study also intends to be distinct from MIR system usability studies focusing on user behavior exhibited in specific MIR systems and analyzing transaction logs. While these kinds of studies can provide information on what actions people take in an existing system, they do not inform us about their motivations, degree of success or failure of the search, or their general search strategies that are not bound to a given set of usable features (Cunningham, 2002).

Analyzing natural language music queries was suggested as an alternative method and a few studies employing this method published some preliminary findings (Downie & Cunningham, 2002; Bainbridge, Cunningham, & Downie, 2003; Lee et al., 2005). Instead of the search statements entered in a specific MIR system, these studies analyze users' natural language queries in which users can provide any kind of information which may or may not be usable in existing MIR systems. These studies provided preliminary information regarding the basic types of information features identified in queries, some descriptions of those features, and the categories of music information needs along with some quantitative data.

Downie and Cunningham (2002) analyzed 161 music-related information requests posted to the rec.music.country.old-time newsgroup, and categorized the types of information used to characterize the user's information need, types of music information requested, intended uses for the information, and additional social and contextual elements present in the requests. Although the queries analyzed in this study were limited to a single genre, it clearly demonstrated how this kind of study can inform the development of effective and usable MIR system interfaces, and indicate the types of document representations required to support specific user needs.

Following this study, Bainbridge et al. (2003) analyzed 502 music queries posted to the Google Answers Website to learn how users of MIR systems express their needs in real-life situations. Bainbridge et al. analyzed a considerably larger number of queries, and the scope of research questions was broadened as well. Authors presented 10 main categories of the need description types, and the bibliographic metadata category was further divided into 10 subcategories. They found that users

experienced difficulty in coming up with clear descriptions for several of the categories such as date or genre, indicating a need to support “fuzzy” metadata values and query-by-example (more things like this) features.

Building on this study, Lee et al. (2005) did a comparative analysis of 107 music queries from the Korean knowledge search portal Naver 지식 iN and 150 music queries from Google Answers to explore the challenges in cross-cultural/multilingual music information seeking and retrieval. They found that users experienced difficulty in precisely describing bibliographic metadata, genre, and lyrics, and relied on contextual metadata such as the information about the use of the sought music in other cultural objects (e.g., movie, TV commercials) or association-based concepts (e.g., “Give me some music similar to this particular song(s) or artist(s)”). A main interest of this study is to explore what alternative access points are used by the inquirer in situations like this when standard MIR access points such as title and creator are not available or deemed unreliable.

Downie and Cunningham (2002), and Lee et al. (2005) both report the needs identified from the analyzed music information queries. Downie and Cunningham (2002) described the needs in two dimensions – desired information and intended uses, whereas Lee et al. (2005) listed the types of needs by the users’ underlying objectives (e.g., identify work/artist, get recommendations). A few features were used in all of the studies and labeled the same, but for most features the terms or phrases used to describe them vary across the studies. Even when the feature with the same label is used in multiple studies, we cannot be certain if they are actually referring to the same kind of information due to the lack of definition and/or description of the feature in each study.

In particular, these studies contributed in identifying the basic types of real-life music information needs and the types of information features that people use when seeking music information. Nevertheless, our current understanding of the real-life music information queries is still astonishingly poor. This study attempts to address some limitations of the prior studies, namely the deficiency of formal definitions of the categories of needs and the features for representing MIR queries and limited information regarding the use patterns of the features.

The deficiency of a formal taxonomy of user tasks and queries in MIR is perceived as a major barrier in appropriate evaluation design (Goodrum, 2003; Downie, 2004). In the prior studies of natural language music information queries (Downie & Cunningham, 2002; Bainbridge et al., 2003; Lee et al., 2005), authors already started to identify the general types of needs expressed and the types of information elements provided by users. However, proper definitions and detailed explications of each feature (referred to as “category” in some studies) were not sufficiently provided in these studies. We still do not have a taxonomy of standardized terms and definitions for each feature, meaning we will not be able to reliably

reproduce the results or easily compare results from different studies. This taxonomy is necessary as part of the formal model of users' music information seeking behaviors and without this kind of model, experiments and evaluation of information retrieval (IR) techniques will not yield valid results, nor contribute to the development of IR theory (Ingwersen, 1992).

Building on the results from prior studies, especially on the category of needs description types in Bainbridge et al. (2003), this research aims to contribute to building a taxonomy to represent the information needs expressed and features used in users' music information queries. Existing taxonomies of reference questions and searches are reviewed in order to gain insights into how to establish this taxonomy. Some definitions of musical terms are based on authoritative sources such as Grove Music Online, the *Harvard Dictionary of Music*, the *Penguin Dictionary of Music*, and so on. The definitions of the features that are not found in dictionaries of music are sought from other reference sources, or developed based on the uses in empirical query data. Categories of features are refined so that they are sufficiently specific, mutually exclusive, and exhaustively cover all information features used in the analyzed queries as a whole. These refined categories are the building blocks of the taxonomy.

The categories in the taxonomy resulting from this research are not meant to be complete, but comprehensive. The taxonomy should not be final, but revised and updated by the MIR research community members. The main purpose of building this taxonomy is to establish the starting point for this collaboration by providing a basis for critical examination and discussion of the features in queries. It is also aimed to contribute in generating results from future query analyses that are more easily comparable to each other.

Studies of Real-Life Investigation of Human-Mediated Search

Many of the earlier major investigative studies of real-life human-mediated search examined aspects of the reference interview such as communication and interactions between the user and the intermediaries (Ingwersen & Kaae, 1980; Cochrane, 1981; Ingwersen, 1982). More recently, one of the most notable large-scale projects was conducted by Spink, Wilson, Ford, Foster, and Ellis (2002a), who investigated the processes of mediated information retrieval searching during human information-seeking processes and published a series of articles characterizing certain aspects of these processes including uncertainty (Wilson, Ford, Ellis, Foster, & Spink, 2002); successive searching (Spink, Wilson, Ford, Foster, & Ellis, 2002b); cognitive styles (Ford, Wilson, Foster, Ellis, & Spink, 2002); and user-intermediary interaction (Ellis et al., 2002). The research project involved observational, longitudinal data collection based on questionnaires, interviews, recorded search

transaction logs and search processes of 198 information seekers participating in a mediated online search with a professional intermediary using the Dialog Information Service in the United States and United Kingdom (Spink et al., 2002a).

The main differences between prior research of human-mediated search such as the project led by Spink et al. and this study are as follows: First, this study involves an Internet-based reference service rather than reference interviews for using a commercial database such as Dialog, thus dealing with a broader user group seeking music information for a wider range of purposes than for work or research. Second, the search type that researchers mainly dealt with in prior studies was “subject search” due to the nature of the information service based on a commercial online database. Previous studies of music reference questions (Christensen, Du Mont, & Green, 2001), multimedia retrieval (Hertzum, 2003), and query analysis (Downie & Cunningham, 2002; Bainbridge et al., 2003; Lee et al., 2005) suggest the strong presence of “known-item search” as well as “subject search,” thus a broader range of searches will be included in this research. Also collecting query documents from the Web has certain advantages over observing the off-line or mixed on/off-line music information seeking and retrieval situations. In an off-line situation, nonverbal cues may be involved in the information seeking and retrieval process (e.g., inquirer’s look, hesitation, confidence) that can be hard for the researcher to pick up and thoroughly record. However, in an online situation, the query documents collected from the Website contain all the information (including the answer and comments when available) that is communicated between the user and the mediated searcher, providing rich context information of the information seeking and retrieval processes.

Additionally, Spink and Saracevic (1997) discussed the effectiveness of search terms used during mediated real-life online searching and found that search terms from users’ written question statements (equivalent to “query” in this study) and term relevance feedback were the most productive sources of terms contributing to the retrieval of items judged relevant by users. One of their findings was that less than one-twentieth of all search terms retrieved relevant answers only, and more than one-third of all search terms produced nothing but nonrelevant answers or had no retrieval at all. The finding suggests that certain information features may be relatively more important in retrieving the sought information than others. This study is an attempt to learn what those features would be for various music information seeking tasks.

Method

Queries are an essential component of the IR process and also an excellent source for collecting information to identify and evaluate the kinds of information features that are relevant for various user tasks (Downie & Cunningham, 2002; Cunningham, 2003), especially for searches in which conventional access points are unusable (e.g., searching by lyric or

melody). In order to arrive at a definitive understanding of IR processes, many IR researchers believe that empirical studies of *real users* performing *real tasks* in *real environments* are necessary (Downie & Cunningham, 2002; Petrelli, Beaulieu, Sanderson, & Hansen, 2002; Goodrum, 2003). Following this logic, the queries asked by real users based on their real needs in an operational system from a natural setting are collected for this study.

Content analysis was employed to systematically collect and organize queries into a standardized format that allows one to make inferences about the characteristics and meaning of recorded material (Krippendorff, 2004). The main advantages of content analysis are that the results can be expressed in quantitative terms as well as qualitative judgments and interpretation (Case, 2002) and it provides a measure for checking the intercoder reliability.

Data Collection

Since the early 1990s, expert question-answers services such as Google Answers, Yahoo! Answers, ChaCha, and Mahalo began to appear on the Internet and have been extremely popular. The particular Website selected for the source of query documents was the Google Answers Website, an online reference service provided by Google. The rationale for selecting Google Answers is that the amount of information the users provide in their queries and the quality of the replies are impressive because it is a fee-based service and queries are not completely limited to easy-to-answer questions (Katz, 2002/2003). On Google Answers, the user pays a nonrefundable listing fee of \$0.50 per question plus an additional price they set for the question reflecting how much they are willing to pay for an answer. The price range is set from \$2 up to \$200 (Google, 2003). The questions are then answered by the Google Answers Researchers who are search experts hired by Google. Queries from Google Answers tend to be rather difficult, which makes it more appropriate for this particular study, as the author is interested in discovering features that can be useful for searching beyond the common bibliographic access points such as title or artist name.

Upon receiving the approval from the Institutional Review Board (IRB) at the University of Illinois, 2,208 queries were collected from the Google Answers' music category in 2005. These were all the queries posted under the music category on the site as of April 27, 2005. A total of 3,318 queries were posted under the same category before Google discontinued this service in December 2006. A query document consists of the following three main components: (1) Question (referred to as "query" in this research) where the user describes their information needs and provides information features as search clues to the intermediaries (2) Answer where the Google Researcher provides an answer to the query; and (3) Comments that can

be posted by any user who viewed the Web document on the Google Answers Website. The question (query) part is what is encoded, although the whole document including the answer and comments were reviewed during the coding process.

Since the main interest of this study is to identify and study the information features found in the queries comprehensively, the diversity of features is more important than their representativeness of the data in hand. Rather than adopting a particular sampling measure to analyze part of our dataset and make inferences about the whole query data collection, all the queries available were analyzed. The queries that are of interest to this study are those in which the user is searching for music objects or information about those objects.

Data Coding

A total of 1,705 out of 2,208 queries were coded by the author from February to November 2007. In all, 503 queries (22.8%) were discarded as they were deemed to be off-topic or unfitting (e.g., queries asking about legal issues, business aspects, tools/equipment related to music). This number is comparable to what was originally estimated (~20% discard rate) based on the previous study of Google Answers queries (Bainbridge et al., 2003). The data coding process involved identifying the needs expressed in queries and marking up all the instances of information features in the query text with proper tags. An example of a coded query is presented below.

Original query: I heard this song by a female singer in an ARBY's. I believe it is from the 70s or early 80s. The main chorus of the song says, "over and over again." Kind of a sad, slow, easy listening love song.

Coded query: I heard this song by <number>a <gender>female</gender> <role>singer</role></number> <placeref association="contact">in an ARBY's</placeref>. I believe it is from <date association="music">the 70s or early 80s</date>. <lyricdesc>The main chorus of the song says</lyricdesc>, <lyric>"over and over again."</lyric> Kind of a <affect>sad</affect>, <tempo>slow</tempo>, <genre>easy listening</genre> <about association="music">love song</about>.

The categories of needs and features from the previous MIR user studies (Downie & Cunningham, 2002; Bainbridge et al., 2003; Lee et al., 2005) were used to establish the initial set of features (categories) as the precoding scheme. These features were regarded as tentative and subject to revision based on the further analysis of queries. The revision included adding new categories, deleting categories, re-labeling, and refining (subdividing) categories. The main reason for starting with the categories from previous studies rather than developing them from scratch was to maintain some comparability of the features with the ones used in the previous studies. By an iterative coding process the features in the taxonomies were modified several times and refined to a sufficient level so that they are exclusive, unambiguous, and comprehensive when

taken together for expressing the information provided in the music information queries. The whole process of category development can be found in Lee (2008).

Results

TABLE 1. FORMs of needs (FINAL)

Group	Description
Identification	Questions asking for assistance in identifying information objects
Location	Questions asking about the location of a specific information object and/or source
Verification	Questions asking for assistance in verifying some information the user has
Recommendation	Questions asking for a list of music related information objects
Evaluation	Questions asking for an evaluative discussion of a particular subject (e.g., review)
Ready reference	Questions asking for simple, factual answers (e.g., birth/death date of an artist, record label)
Reproduction	Questions asking for text, taken directly from an information source and unchanged (e.g., lyrics)
Description	Questions asking for a description of something (e.g., description of artist, album)
Research	Questions asking for involved answers requiring some effort and wide use of information sources to formulate.
Other	(Questions that do not fit into any of the categories above)

Information Needs

Tables 1 and 2 present the final sets of 26 needs by their FORM and TOPIC accordingly, including 10 different types by their FORM, and 16 by their TOPIC. Information needs are categorized in two different dimensions, FORM and TOPIC allowing more than one way to compare the usage of features across different types of needs. The FORMs of needs refer to different acts of providing information to the user, regardless of the TOPICs. The TOPICs are the things that users are seeking, in other words, the different kinds of information that is required to answer the user's question. Downie and Cunningham (2002) also had two dimensions of needs in their study, desired information and intended uses, similar to TOPIC and FORM, respectively. The categories in previous taxonomies are somewhat similar to the FORMs of needs. In studies of taxonomies such as Pomerantz (2005) and in the FRBR (Functional Requirements for Bibliographic Records) report by the IFLA Study Group (1998), the forms of expected answers or the main four "user tasks" are employed to categorize the different needs. The TOPICs are added as another dimension in this study to observe the variations in the frequency of occurrences among different topics, and the co-occurrence patterns of the FORMs and TOPICs of needs.

TABLE 2. TOPICs of needs (FINAL)

Group	Description and examples of the typical forms of expressions
Lyrics	<p>Questions asking for lyrics of a song</p> <ul style="list-style-type: none"> • <i>I want to know the words for the song X.</i> • <i>What are the lyrics of the song X?</i>
Translation	<p>Questions asking for the translation of lyrics of a song</p> <ul style="list-style-type: none"> • <i>I need the translation of the lyrics of song X.</i>
Meaning	<p>Questions asking for the meaning of lyrics of a song</p> <ul style="list-style-type: none"> • <i>What is the meaning of the lyrics in song X?</i> • <i>In song X, artist Y refers to Z. What does Y mean by that?</i>
Score	<p>Questions asking for/about music scores</p> <ul style="list-style-type: none"> • <i>Where can I buy/download the score for work X?</i> • <i>I am looking for a guitar tab for song X.</i>
Work	<p>Questions asking for musical works and/or information about musical works</p> <ul style="list-style-type: none"> • <i>Name this song./What is the song that goes like...?</i> • <i>Where can I buy/download song X?</i> • <i>Can you recommend a list of songs suitable for novice Jazz listeners?</i> • <i>I am looking for the details of this work X. (e.g., origin of the song, released date)</i>
Version	<p>Questions asking for a particular version of a musical work</p> <ul style="list-style-type: none"> • <i>Where can I buy/download a techno remix version of the song X?</i> • <i>I am looking for a cover of song X by artist Y.</i>
Recording	<p>Questions asking for music recordings and/or information about music recordings</p> <ul style="list-style-type: none"> • <i>Which album has the song X?</i> • <i>Where can I buy/download the album X?</i> • <i>Is the album X available on CD?</i> • <i>Can someone tell me more about the album X? (e.g., track listing, musicians featured, artwork, date released, availability in certain region)</i>
Related Work	<p>Questions asking for information about non-musical/non-printed works related to music</p> <ul style="list-style-type: none"> • <i>I want to locate a music video that is about...</i>
Genre	<p>Questions asking for information about a musical genre</p> <ul style="list-style-type: none"> • <i>What is the genre of song X?</i>
Artist	<p>Questions asking for information about artists</p> <ul style="list-style-type: none"> • <i>Who composed X?</i> • <i>Who sings the song that goes like...?</i> • <i>Which Symphony Orchestra is better? A or B? And why?</i> • <i>I want to know more about this composer Y. (e.g., birth/death date, discography)</i>
Publisher	<p>Questions asking for information about record labels/publishers</p> <ul style="list-style-type: none"> • <i>Which record company released the album X?</i> • <i>Who published this score X?</i>
Instrument	<p>Questions asking for information about musical instruments</p> <ul style="list-style-type: none"> • <i>What is the instrument played in this song X?</i> • <i>What is artist X playing in this album Y? Is it instrument A or B?</i> • <i>I need short summaries of the history of instrument X and Y.</i>

Statistics	Questions asking for music related statistical information <ul style="list-style-type: none"> • <i>I need the international sales chart for year 19xx.</i> • <i>What was the number one hit in the ...chart in 19xx?</i>
Background	Questions asking for background information related to music (e.g., history, musical term) <ul style="list-style-type: none"> • <i>What is the difference between the music styles in region X and Y?</i> • <i>Please help me to understand the characteristics and differences of genre X and Y.</i> • <i>What does musical term X mean?</i>
Resource	Questions asking for specific information sources <ul style="list-style-type: none"> • <i>I want a list of websites where I can find more information about...</i> • <i>What are some good places to go to find new reggae music/download music/purchase albums/search by lyrics?</i>
Other	Questions that do not fit into any of the categories above

Information Features

Tables 3 and 4 present the final set of features resulting from the iterative coding process. The final set consisted of 102 features (including feature-attribute pairs). There were 50 features without attributes and seven features with a total of 52 attribute values. There were two major changes in the structure of the whole scheme. First, the features are grouped into 10 main classes: OBJECT:Music, OBJECT:Recording, OBJECT:Score, OBJECT:Related work, ARTIST, SUBJECT, CIRCUMSTANCE, RESPONSE, USER, and OTHER¹ (Table 4). Second, attribute values were added to seven features, namely, PERSONNAME, CORPORATENAME, TITLE, DATE, PLACEREF, LINK, and ABOUT. The features with attributes were separated from the rest of the features and were organized in a different table (Table 3). The main reason for this division was to simplify the structure as the number of categories of features grew significantly larger than the initial set. If the features were kept in a simple list as they were before, there would have been more than a hundred different features and coders would have to go over several pages to find the exact feature they need to use. Some of these features were essentially the same in their forms (how they appear in the queries), but were different in what they were referring to. For example, PERSONNAME “John Smith” can sometimes be referring to an artist, or an author of a book related to music, or an actor who played a role in the movie featuring a particular musical work. If they were listed separately as three different features ARTIST-NAME, AUTHOR-NAME, and OTHER-PERSONNAME, coders then would have to look up three different locations under different classes in the whole scheme in order to be sure of which feature to use to code this information. Using the revised scheme, however, coders can find all the attribute values under a single feature PERSONNAME, making it easier to select the appropriate attribute value to pair with the feature. All the categories of

¹ The class OBJECT:Printed material was originally included as one of the 11 classes, but it was omitted from the table and the instruction prepared for coders because the features that would fall under this class all had attributes (e.g., PERSONNAME, CORPORATENAME, TITLE) and ended up being listed in a separate table.

features are also accompanied with detailed definitions and examples for an easier understanding of the features. Many of the features, particularly the ones related to the class OBJECT:Music and the class OBJECT:Recording, were adopted from the definitions of attributes in the FRBR (IFLA Study Group on the FRBR, 1998) report.

TABLE 3. Features with attributes (FINAL)

Feature	Description
Person-name	<p>All proper names, words, phrases or codes that are used to refer to one or more individuals or groups responsible for the creation and/or realization of a work. (modified from FRBR, 1998, p. 60)</p> <p>ATTRIBUTE: type (must select at least one)</p> <ul style="list-style-type: none"> • artist: Name of person who contributed to the creation and/or realization of a musical work in any way. (e.g., composer, performer, lyricist, arranger). • author: Name of person who wrote a book, paper, or other printed material related to music. • other: Name of person who contributed to the creation and/or realization of a work related to a particular musical work. (e.g., actor starring in a movie which used music X). <p>ATTRIBUTE: relationship</p> <ul style="list-style-type: none"> • original: Name of artist who is the original composer/performer of the sought musical work. • adaptation: Name of artist who is responsible for creating an adaptation of the sought musical work. (e.g., artist of a remake, remix, sampled work) • similar: Name of a known artist used to define attributes of the sought musical work/artist. (e.g., it sounded like artist X...) • example: Name of artist provided by users as an example to characterize certain aspect of the music sought by the user. • collaborated: Name of artist who collaborated with the artist of the sought music. • otherrelated: Name of artist related to the sought artist in any other way.
Corporate-name	<p>All proper names, words, phrases or codes that are used to refer to the individual, group or organization responsible for the publication, distribution, issuing, or release of the information objects. (modified from FRBR, 1998, p. 42)</p> <p>ATTRIBUTE: association (must select at least one)</p> <ul style="list-style-type: none"> • recording: Name of the record label responsible for producing and distributing a music recording. • score: Name of the publisher responsible for producing and distributing a music score. • printedmaterial: Name of the publisher responsible for producing and distributing music related books or other printed materials. • rwork: Name of the sponsor/company responsible for producing and distributing a non-musical work related to a musical work. • other: Name of the sponsor/company responsible for producing and distributing any other product related to music.
Title	<p>All proper names, words, phrases or codes that are used to refer to a work, assigned by the creator or a social group. (modified from ICOM/CIDOC CRM SIG, 2006, p.17)</p> <p>ATTRIBUTE: type (must select at least one)</p> <ul style="list-style-type: none"> • music: Title of a musical work. • recording: Title of a music recording (e.g., album, LP, CD, audiotape). • printedmaterial: Title of a music-related book, paper or other printed material. • rwork: Title of other non-musical, non-printed work that is related to a particular musical work, primarily by using the musical work. (e.g., commercial, movie, TV show, video clip, website that used the sought music)

	<p>ATTRIBUTE: relationship</p> <ul style="list-style-type: none"> • original: Title of the original work of the sought musical work. • adaptation: Title of a work which is an adaptation of the sought musical work. • similar: Title of a known work used to define attributes of the sought music/artist. • used: Title of a work which used the sought music. • example: Title of a work provided by the user as an example to characterize certain aspects of the music sought by the user. • otherrelated: Title of a work related to the sought music in any other way.
date	<p>All forms of names, numeral codes, or description such as historical periods, and dates, which are used to refer to a specific time or time span. This may be a single date or a range of dates. The instances may vary in their degree of precision, and they may be relative to other time frames. (modified from ICOM/CIDOC CRM SIG, 2006, p.22)</p> <p>ATTRIBUTE: association (must select at least one)</p> <ul style="list-style-type: none"> • music: The date associated with a musical work. (e.g., the date a musical work was originally created or released) • recording: The date associated with a music recording. (e.g, the date a recording was released or published) • performance: The date associated with a music performance. (e.g., the date when song <i>X</i> was performed) • score: The date associated with a music score. (e.g., published date, copyright date) • printedmaterial: The date associated with a book, paper, or other printed material related to music. (e.g., published date, copyright date) • rwork: The date associated with the creation or release of a work related to a particular musical work. (e.g., release date of a movie which used music <i>X</i>, date when a commercial using music <i>X</i> was aired) • artist: The date associated with the birth/death, activities of an artist. • contact: The date when the user encountered a particular musical work, a music recording, or a performance. (e.g., date of purchase of a CD, date when the user saw the performance of song <i>X</i>) • popular: The date when a particular musical work, music recording, or artist was popular. • user: The date by which the query should be answered, as specified by the user. • other: The date information that do not fit into any of the categories above.
placeref	<p>All forms of names, numeral codes, or description used to refer to a place (e.g., a country, city, town, or other locality). The instances may vary in their degree of precision, and they may be relative to other places. (modified from ICOM/CIDOC CRM SIG, 2006, p.21, p. 24)</p> <p>ATTRIBUTE: association (must select at least one)</p> <ul style="list-style-type: none"> • music: The place reference associated with the origin, creation, or release of a musical work. • recording: The place reference associated with the release of a music recording. • performance: The place reference associated with a music performance. • score: The place reference associated with the publication of a score. • printedmaterial: The place reference associated with the publication of a book, paper, or other printed material related to music. • rwork: The place reference associated with the creation or release of a work related to a particular musical work. • artist: The place reference associated with the birth, activities, or death of an artist. (e.g., nationality) • contact: Reference of the place where the user encountered with a particular musical work, music recording, or performance. • popular: Reference of the place where a particular musical work, music recording, or artist was popular. • user: Reference of the place where the user is currently located, or where the user intends to have music related objects shipped to. • other: The place reference that do not fit into any of the categories above.

link	<p>URL providing a link to further information related to the search. (modified from Bainbridge et al., 2003)</p> <p>ATTRIBUTE: association (must select at least one)</p> <ul style="list-style-type: none"> • example: Links to audio/video representation of the desired work. (e.g., links to MP3) • bib: Links to bibliographic information about a musical work, music recording, and/or artist. • other: Links to other files/websites.
about	<p>Description of the subject of a work (i.e., what a work is about).</p> <p>ATTRIBUTE: association (must select at least one)</p> <ul style="list-style-type: none"> • music: Description of what the music/song is about (theme (e.g., love, war, Christmas), topic, storyline). • recording: Description of what the music recording is about. • rwork: Description of what the related work (e.g., music video, TV show, commercial) is about.

TABLE 4. Features without attributes (FINAL)

Class	Feature	Description
OBJECT: Music Features of a musical work	lyric	Accompanying words to a musical work.
	language	Specification of the language in which the lyrics are expressed.
	lyricdesc	Description of the lyrics. (e.g., chorus, refrain, the beginning, repeated <i>X</i> times)
	melodydesc	Description of a series of notes of different pitches. (e.g., mi ra si do si ra)
	workform	The class to which the work belongs. (e.g., symphony, concerto, sonata, etc.) (FRBR, 1998, p. 33)
	numdesig	A numeric designation such as a serial number, opus number, or thematic index number assigned to a musical work by the composer, publisher, or a musicologist. (FRBR, 1998, p. 34)
	key	Key, in tonal music, is the set of pitch relationships that establishes a single pitch class as a tonal centre (e.g., D major). (FRBR, 1998, p. 34)
	tempo	The speed at which music is performed. (The Harvard Dictionary of Music, 2003)
	rhythm	The pattern of musical movement in time. (Modified from the Harvard Dictionary of Music, 2003)
	length	The length of a musical work.
	version	The description that indicates a difference in either content or form between the musical work and a related work previously issued. (Modified from FRBR, 1998, p. 42)
otherworkdesc	Any other distinguishing characteristic that serves to differentiate a work from other works. (Modified from FRBR, 1998, p. 33)	
OBJECT: Recording Features of a music recording	albumtype	Type of a music recording (e.g., single, compilation, soundtrack)
	sumcontent	A summarization or description of the content such as a list of songs, etc. (modified from FRBR, 1998, p. 37)
	tracknumber	The specific number of track of a musical work as listed in a particular recording.
	identifier	A number or code uniquely associated with the recording. (e.g., music publisher's

		number). May comprise both a numeric component and a textual or coded component identifying the system under which it was assigned and/or the agency or individual that assigned the number, so as to render the identifier unique to the recording. (modified from FRBR, 1998, p. 44)
	albumcover	Description of an album cover.
	carrierform	The form of carrier is the specific class of material to which a physical carrier of a work belongs. (e.g., sound cassette, videodisc, printed books, scores, CDs, DVDs, etc.) (modified from FRBR, 1998, p. 43)
	carriernum	A quantification of the number of physical units making up the carrier (e.g., number of sheets, discs, reels, etc.). (modified from FRBR, 1998, p. 43)
	filetype	File characteristics for an electronic resource include standards or schemes used to encode the file. (modified from FRBR, 1998, p. 48)
	seqpattern	Sequencing pattern is the form anticipated to be used in designating volumes/issues, etc. for the individual units of the serial (e.g. volume <i>X</i> , number <i>Y</i>). (modified from FRBR, 1998, p. 38)
	availability	Description regarding the availability of a recording. (e.g., hard-to-find)
	albumdesc	Any other distinguishing characteristic that serves to differentiate a music recording from other recordings.
OBJECT: Score Features of a music score	scoretype	Type of score is the format used to represent a musical composition. (e.g., sheet music for piano, short score, full score, tab, etc.) (FRBR, 1998, p. 38)
OBJECT: Related Work Features of a non-musical/ non-printed work related to a musical work	rworktype	Type of a work (not music) related to a particular musical work. (e.g., commercial, movie, movie trailer, music video)
	rproduct	Name of the product associated with the related work. (e.g., “diet coke” commercial)
	scene	Description of the scene/part where the sought music appeared in the related work.
	rworkdesc	Any other distinguishing characteristic that serves to differentiate a related work from other works.
ARTIST Features of a music artist	role	Role of artist(s) (e.g., composer, arranger, lyricist, performer, singer, guitarist, etc.)
	gender	Gender of artist. (male/female) ²
	age	Age of artist. The instances may vary in their degree of precision. (e.g., 23 years old, young, a child)
	number	Explicit expression of the number of artist(s). ³
	race	Race/ethnicity of artist(s).
	artistdesc	Any other distinguishing characteristic that serves to differentiate an artist from other artists (e.g., band, high-pitch voice, low tone, accent, color of hair)
SUBJECT Features of a subject/topic of	genre	Name of a particular style or category of musical works, a type of musical work characterized by a particular form, style, or purpose. (e.g., jazz, rock, classical, folk, pop, dance, camp song, lullaby) (modified from OED, 1989)

² When the gender pronouns are used in the query text, only the first instance of the pronoun was tagged.

³ The instances did not have to be precise, but they must be explicit.

music	styledesc	Description of features that characterize the works or performances of a period, region, genre, individual composer or performer, or of a society, identifying the significant characteristic that distinguishes one or more works or performances from others. (e.g., boy band type music, 80s retro style, music that would be popular in clubs) (Modified from the Harvard Dictionary of Music, 2003; Grove Music Online)
	iaudience	The class of user for which the work is intended, as defined by age group (e.g., children, young adults, adults, etc.), educational level (e.g., primary, secondary, etc.), or other categorization. (modified from FRBR, 1998, p. 34)
	affect	Mood or emotional state induced by the musical work. (e.g., “funny”, “silly”, “plaintive”). (Bainbridge et al., 2003)
CIRCUM-STANCE Features related to the circumstances surrounding the encounter with music	event	Name or description of a particular event at which a song was performed or broadcasted.
	media	Description of media from which the music was heard. (e.g., radio, TV, Internet).
	contact person	Name or description of one or more individuals or groups associated with the user’s contact with the music. (e.g., <i>My father</i> used to sing this song to us...)
	contactlevel	Description of different aspects of the user’s contact with the music such as the frequency or intimacy. (e.g., I used to <i>hear this music all the time</i> back in..., I <i>only heard this song once</i> , I used to <i>own this record</i>)
RESPONSE Features related to the reactions of users to the music	attitude	Description reflecting the user’s positive or negative attitude toward music. (e.g., I love this song, great music, the singer was awful)
	popularity	Description of the level of popularity and awareness of the music among the public. (e.g., number 1 song, this song was <i>really popular</i> , it is <i>somewhat of an obscure song</i> ..., <i>no one seems to know or have heard</i> this song)
USER	purpose	User’s purpose for the search. (e.g., to settle a bet, for a funeral, to use in a video clip, for a gift to a friend)
	numberofitems	Number of items (e.g., songs, artists) requested by the user.
	cost	User’s specification of the cost of the items sought.
	psearch	Description of and/or information from the prior searches conducted by the user. (e.g., I tried calling the radio station..., I tried googling the lyric words..., After my own research, I now know that the singer is <i>X</i> , but I still don’t know...)
OTHER	perfmedium	Medium of performance is the instrumental, vocal, and/or other medium of performance. (e.g., instrumental, piano, violin, orchestra, men’s voices, soprano, tenor, falsetto, etc.). (modified from FRBR, 1998, p. 38)
	other	Any other information feature that is closely related to the search.

Distribution of Needs and Features Across All Queries

Each of the 1,705 queries was assigned at least one type of need by TOPIC and one type of need by FORM. More than one need could be assigned when appropriate. Table 5 shows the distribution of needs across all analyzed queries. The overall distribution of needs shows that most of these queries were identifying or locating work(s)/recording(s)/artist(s). The

TABLE 5. Frequency of occurrences of needs across all queries

NEED by TOPIC			NEED by FORM		
Need	Count of queries	Percentage	Need	Count of queries	Percentage
Work	838	49.1%	Identification	747	43.8%
Artist	620	36.4%	Location	567	33.3%
Recordings	284	16.7%	Reproduction	185	10.9%
Lyrics	178	10.4%	Research	143	8.4%
Score	92	5.4%	Description	115	6.7%
Resource	89	5.2%	Ready reference	96	5.6%
Version	74	4.3%	Recommendation	81	4.8%
Instrument	39	2.3%	Verification	50	2.9%
Meaning of lyrics	34	2.0%	Evaluation	8	0.5%
Background	31	1.8%	Other	6	0.4%
Publisher	29	1.7%			
Statistics	24	1.4%			
Genre	21	1.2%			
Related work	20	1.2%			
Translation of lyrics	19	1.1%			
Other	14	0.8%			

most dominant needs by FORM were IDENTIFICATION (43.8%) and LOCATION (33.3%), and by TOPIC, WORK (49.1%), ARTIST (36.4%), and RECORDING (16.7%). REPRODUCTION follows as the next most commonly expressed need by FORM (10.9%) which often appeared together with the TOPIC-LYRICS (10.4%). The connection between REPRODUCTION and LYRICS is discussed in later sections. Other types of needs appeared much less frequently compared to the needs just identified. Tables 6 and 7 present the frequencies of occurrences of all features across all analyzed queries showing the counts of all queries that contained each feature. Table 6 lists all the features and Table 7 shows the breakdown of the distribution of feature-attribute value pairs for the features with attributes. The distribution of features shows that users rely heavily on a relatively small number of features; only seven of all features were used in more than 25% of all query data, and 15 were used in more than 10%. This is most likely related to the highly skewed distribution of the needs. Since most queries were seeking help in identifying/locating musical works/artists/recordings and obtaining lyrics, it seems natural that

TABLE 6. Feature count across queries⁴

FEATURE	Count of queries	Percentage	FEATURE (cont'd.)	Count of queries	Percentage
Person name	903	53.0%	Attitude	124	7.3%
Title	867	50.9%	Style description	98	5.7%
Date	778	45.6%	Purpose	98	5.7%
Genre	634	37.2%	Scene	96	5.6%
Role	577	33.8%	Affect/Mood	92	5.4%
Lyric	470	27.6%	Language	86	5.0%
Place reference	437	25.6%	Score type	86	5.0%
Performance medium	322	18.9%	File type	83	4.9%
Carrier form	315	18.5%	Event	82	4.8%
Other artist description	308	18.1%	Album type	77	4.5%
Gender	290	17.0%	Album description	55	3.2%
Related work type	250	14.7%	Tempo	51	3.0%
Prior search	228	13.4%	Related work description	46	2.7%
Media	225	13.2%	Number of items	44	2.6%
Lyric description	196	11.5%	Availability	41	2.4%
Corporate name	155	9.1%	Summary of content	38	2.2%
Other	154	9.0%	Identifier	34	2.0%
About	153	9.0%	Work form	28	1.6%
Number of artists	149	8.7%	Contact Person	26	1.5%
Link	145	8.5%	Cost	26	1.5%
Popularity	145	8.5%	Related product	24	1.4%
Other work description	140	8.2%	Track number	22	1.3%
Version	137	8.0%	Album cover	18	1.1%
Contact level	131	7.7%	Race	18	1.1%

the distribution of the features used is also highly skewed. The traditional bibliographic access points such as PERSONNAME (53.0% of all queries) and TITLE (50.9%) had strong presence overall. Various aspects of artist(s) such as ROLE, GENDER, and OTHER ARTIST DESCRIPTION also were frequently used. The majority of names were artist names (95.6% of all PERSONNAME instances) and most of the TITLE instances were those of a musical work (68.9%), a

⁴ Length, Age, Rhythm, Key, Number designation, Intended audience, Carrier number, Melody description, and Sequence pattern are found in less than 1% of all queries.

related work (24.9%), and an album recording (22.0%). The most prominent relationship among people was based on their similarity (7.2% of all PERSONNAME instances) and among works was based on which works “used” musical works (21.5% of all works). Dates related to music were most commonly provided (36.2% of all DATE instances), but dates associated with related works (26.2%) or recordings (18.9%) were also often used. As for the PLACE REFERENCE, most were describing the place where the user encountered the music (46.7% of all PLACEREF instances) rather than the places related to artists (20.6%) or music (15.6%). LINK instances were mostly directing to audio/video examples of music (42.8% of all LINK instances) and aboutness was mostly of music (77.8% of all ABOUT instances), but sometimes of related works as well (24.8%). Further discussion about needs and features is provided in the next section.

TABLE 7. Frequency of occurrences of features with attributes

FEATURE	ATTRIBUTE	Count of queries	Percentage (over all queries)	Percentage (over each feature)
Person name	type = “artist”	863	50.6%	95.6%
	type = “author”	6	0.4%	0.7%
	type = “other”	59	3.5%	6.5%
	relationship = “similar”	65	3.8%	7.2%
	relationship = “example”	43	2.5%	4.8%
	relationship = “original”	38	2.2%	4.2%
	relationship = “adaptation”	29	1.7%	3.2%
	relationship = “collaborated”	21	1.2%	2.3%
	relationship = “otherrelated”	28	1.6%	3.1%
Corporate name	association = “recording”	99	5.8%	63.9%
	association = “rwork”	31	1.8%	20.0%
	association = “score”	7	0.4%	4.5%
	association = “printedmaterial”	6	0.4%	3.9%
	association = “other”	15	0.9%	9.7%
Title	type = “music”	597	35.0%	68.9%
	type = “rwork”	216	12.7%	24.9%
	type = “recording”	191	11.2%	22.0%
	type = “printedmaterial”	13	0.8%	1.5%
	relationship = “used”	186	10.9%	21.5%
	relationship = “example”	50	2.9%	5.8%
	relationship = “original”	36	2.1%	4.2%

	relationship = “adaptation”	26	1.5%	3.0%
	relationship = “similar”	16	0.9%	1.8%
	relationship = “otherrelated”	14	0.8%	1.6%
Date	association = “music”	282	16.5%	36.2%
	association = “contact”	204	12.0%	26.2%
	association = “recording”	147	8.6%	18.9%
	association = “artist”	90	5.3%	11.6%
	association = “rwork”	67	3.9%	8.6%
	association = “popular”	44	2.6%	5.7%
	association = “performance”	37	2.2%	4.8%
	association = “user”	14	0.8%	1.8%
	association = “printedmaterial”	8	0.5%	1.0%
	association = “score”	6	0.4%	0.8%
	association = “other”	25	1.5%	3.2%
Place reference	association = “contact”	204	12.0%	46.7%
	association = “artist”	90	5.3%	20.6%
	association = “music”	68	4.0%	15.6%
	association = “recording”	48	2.8%	11.0%
	association = “performance”	32	1.9%	7.3%
	association = “user”	32	1.9%	7.3%
	association = “popular”	19	1.1%	4.3%
	association = “rwork”	10	0.6%	2.3%
	association = “printedmaterial”	5	0.3%	1.1%
	association = “score”	4	0.2%	0.9%
association = “other”	13	0.8%	3.0%	
Link	association = “example”	62	3.6%	42.8%
	association = “bib”	27	1.6%	18.6%
	association = “other”	23	1.3%	15.9%
About	association = “music”	119	7.0%	77.8%
	association = “rwork”	38	2.2%	24.8%
	association = “recording”	2	0.1%	1.3%

Discussion on Needs and Features

Types of Queries Based on Expressed Needs

Most of the Google Answers queries turned out to be queries seeking help in identifying (43.8%) musical works (49.1%) and artists (36.4%), and locating (33.3%) music recordings (16.7%). Various taxonomies of questions and types of searches exist in the LIS literature; nonetheless it is still difficult to find a specific type of question or type of search among the categories of those taxonomies that would adequately describe these kinds of music queries.

The majority of Google Answers queries could be broadly described as “known-item searches.” In the sense that users are seeking identification and/or location information about specific information objects, there is little doubt that these queries are, in nature, closer to “known-item searches (KIS)” rather than “subject searches.” However, one may still question if those queries are truly KIS or not due to the fact that they do not conform to some of the key assumptions that LIS researchers have about the concept of known-item search. Lee, Renear, and Smith (2006) surveyed various conceptual and operational characterizations of known-item search in LIS literature and investigated what these definitions imply or infer about knowledge and knowing, and how they pertain to the nature of the item being sought. The authors evaluate each definition/characterization of KIS by asking the following questions to understand the necessary part of the definition:

1. Is a special epistemic relationship required (between the seeker and the sought item)?
2. Is knowledge beyond a simple knowledge of existence required?
3. Is knowledge required at all?
 - a. Is the existence required? / b. Is belief required?
4. What exactly is being sought?

The authors start with a common characterization of a KIS as “a search for a particular item that the user knows from previous contact” and revise this characterization after investigating the assumption entailed in each of the questions raised above. Through various counterexamples, they show that all of these assumptions can be challenged. As a result, among the features that are ordinarily associated with a KIS, the only aspect that could be confidently said to be essential to the concept was that the search is concerned with a particular thing.

Many of the music queries on Google Answers (especially the ones containing incorrect information about the sought object) can in fact work as a counterexample to the second requirement of knowledge beyond a simple knowledge of existence. If someone were looking for music they previously heard, but all of the information they think is relevant to

finding the item and is attempting to use in the search is incorrect, the search does seem to be a known-item search yet it is difficult to say the user really knows the object beyond its existence. Even when the user is doubtful about the existence of the song (e.g., “Does such a song exist?? Can anybody remember it or is it a figment of my imagination perhaps?”), the search itself is not at all different from when the user believes that the song exists.

One aspect that is unique to these music queries is that they are often searches for information about the object (i.e., metadata) rather than the object itself and for that reason, they may also serve as a counterexample to the assumption that the “item” is the object being sought. Without a doubt, many users will use the metadata to find music recordings themselves from various sources, but at least in some cases, the users simply wanted to know the title and/or artist of the music they have heard and remembered for many years. In such cases, the actual “seeking” (i.e., obtaining) of the object might never occur and the search will end when the correct metadata is acquired. In such cases, what the users are seeking is not necessarily an item, but information about that item (or manifestation, expression, work) yet the nature of the search and the search process closely resembles other known-item searches.

Interesting Types of Searches

Close examination of the Google Answers queries revealed some interesting types of searches that may be more common in the particular context of MIR. Examples include “dormant” searches, long-term searches, and searching based on information from other people. Dormant searches refer to relatively inactive searches that may become active again, typically triggered by a certain event. For example, a user may first hear some music and want to know what it is (they may even go on to attempt to search for it unsuccessfully); they give up due to lack of information about the music, or in time simply forget about the search. However, when the user happens to hear the music again, perhaps from some other source such as radio, television, or a movie, it reminds them about their previous music information need and reactivates their search for the music. Dormant searches are different from latent searches (i.e., searches based on latent user needs). A latent information need refers to a need that users are unaware of, but will benefit from once it is fulfilled (i.e., need that is recognized after the fact) (Bodoff, 2006; Kim & Jarvenpa, 2008). For dormant searches, however, the user already recognizes the need; the problem is that the need cannot be fulfilled until more clues are obtained and the user is reminded of the search. An example of dormant searches is provided below:

I've heard the spooky tune, The Death March, several times tonight for Halloween. There are not words, just music. I've also heard the tune used in B-rated movies or cartoons to signify that someone or something has died. What is the origin of this tune? Who wrote it, when, and for what reason?

Another interesting aspect about music searches on Google Answers is that some of them have been going on for a long period of time, up to several years (e.g., "it has been on my mind for 10 or so years and I'd really like to put it to rest") or sometimes even for most of the user's lifetime if the sought music is from the user's childhood ("The vague memory of one particular song on the tape has remained with me for the past 30 years"). Then it is not surprising that the information users have about the sought music is often vague, incomplete, and incorrect. What is surprising is that the users seem to remember enough about the music, even after many years, to be able to determine if the suggested answer is correct or not, and in most cases they seem fairly certain about their decision to accept or reject the answer. However, it does occasionally happen that several Google Answers researchers are certain that the answer suggested is correct, yet the user keeps rejecting the answer. These problems are often due to the fact that there are many different versions of the same song and when the user is searching for a song based on information about one particular version, the information may not be true for other versions of the same song. Even when the correct song is found, if the version found is different from what the user expected, the user may listen to the song and deny that it is the right song (especially if the version is in a different genre, tempo, or vocal).

Many users also seem to search for music based on information from other people, especially when they are searching for lullabies or folk songs. For example, they heard a song repeatedly from a family member when they were younger and later they try to search for the right song often based on the fuzzy memory they have from their childhood (e.g., "My grandfather, who was born in 1899, used to sing me to sleep with this song and I can't remember the words"). This type of search can turn out to be quite difficult because often the information that was relayed to them in the first place might not be precise or accurate. The difficulty is amplified as there are frequently many different versions of lullabies and folk songs available. Other interesting cases include queries where the users have somehow obtained the music without any metadata and are trying to identify what music it is that they have (e.g., "I've somehow acquired a song which I have no information about").

Comparison of Features with Previous Studies

The kinds of features that Google Answers users provided in their queries turned out to be numerous, although several of them seemed to emerge as the key features. The features PERSONNAME (53.0%), TITLE (50.9%), and GENRE (37.2%) from the bibliographic facet (as referred to by Downie, 2003) were among the ones that were most commonly used. DATE

(45.6%), ROLE (33.8%), LYRIC (27.6%), and PLACEREF (25.6%) were also used in more than one-fourth of the queries. One of the main interests for conducting this research was to discover new features in addition to the conventional attributes provided in typical bibliographic records; thus, we will compare the features found in music queries to the conventional attributes in the FRBR model. The findings of this study may help extend the FRBR model to include the kinds of attributes and relationships commonly found in music information queries in addition to the conventional attributes found in typical bibliographic records already represented in FRBR. Table 8 shows which features were new and unique to this particular study compared to previous studies on music information queries, as well as the attributes of the Group 1 entities in the FRBR report. When we compare the scheme derived from this study to the attributes of FRBR Group 1 entities, we can see that the classes of features that are unique to this scheme are OBJECT:Related work, RESPONSE, and USER. Categories under CIRCUMSTANCE are also unique to the studies of music queries, and do not appear in the FRBR attribute set. Overall, it seems that features related to how a user encountered the music, especially through which related work they heard it, how they responded to and felt toward the music, and information about the users themselves and their previous search attempts are what is lacking in the traditional descriptions of bibliographic entities as represented by FRBR.

TABLE 8. Comparison of features used in Google Answers queries to features/attributes in other studies⁵

CLASS	FEATURE	Previous music query studies ⁶	Attributes in FRBR (1998)
OBJECT: Music	title-music	•	•
	title-original		
	title-adaptation		•
	title-similar	•	
	title-used		
	title-example		
	title-otherrelated		
	date-music	•	•
	placeref-music	•	
	about-music		
	lyric	•	
	language	•	•

⁵ The labels for the features and attributes in the other studies may not be exactly the same as the ones used in this study, however if they were deemed to be equivalent based on the description, they were marked as “present.”

⁶ Downie and Cunningham (2002), Bainbridge et al., (2003), and Lee et al. (2005a)

	lyricdesc		
	melodydesc		
	workform		•
	numdesig		•
	key		•
	tempo	•	
	rhythm		
	length		
	version		
	otherworkdesc	•	•
OBJECT: Recording	title-recording	•	
	corporatename -recording	•	•
	date-recording		•
	placeref-recording		•
	about-recording		
	albumtype		
	sumcontent		•
	tracknumber		
	identifier		•
	albumcover		
	carrierform		•
	carriernum		•
	filetype		•
	seqpattern		•
	availability		
albumdesc			
OBJECT: Printed material	personname-author		•
	corporatename-printedmaterial		•
	title-printedmaterial		
	date-printedmaterial		•
	placeref-printedmaterial		•
OBJECT: Score	corporatename-score		•
	date-score		•

	placeref-score		•
	scoretype		•
OBJECT: Related work	personname-other		
	corporatename-rwork		
	title-rwork	•	
	date-rwork		
	placeref-rwork		
	about-rwork		
	rworktype		
	rproduct		
	scene		
	rworkdesc		
ARTIST	personname-artist	•	
	personname-original		
	personname-adaptation		
	personname-similar	•	
	personname-example		
	personname-collaborated		
	personname-otherrelated		
	date-artist		•
	placeref-artist	•	
	role		•
	gender	•	
	age		
	number		
	race		
artistdesc	•		
SUBJECT	genre	•	
	styledesc	•	
	iaudience		•
	affect	•	
CIRCUMSTANCE	date-contact	•	
	placeref-contact	•	

	event	•	
	media	•	
	contactperson		
	contactlevel		
RESPONSE	date-popular		
	placeref-popular		
	attitude		
	popularity		
USER	date-user		
	placeref-user		
	purpose		
	numberofitems		
	cost		
	psearch		
OTHER	date-performance		
	placeref-performance		
	corporatename-other		•
	date-other		
	placeref-other		
	link-example	•	
	link-bib	•	
	link-other		
	perfmedium	•	•
	other		

One notable aspect of these features is that they are not musical features (i.e., features derived from music itself), but rather they are extra-musical features (Downie, 2000) describing relationships among multimedia works as well as the user context. The analysis showed that information about related works had slightly higher positive effects on queries being answered than information surrounding the circumstance of the user's contact with music. This may be due to the limitation of the currently available search systems. There are better sources of information that can be exploited for information about related works, such as IMDb, official Websites of movies and TV shows listing the music tracks used, music rights clearance databases, and various Websites relying on user-generated content such as Wikipedia, and YouTube. Conversely, information

about the circumstances with regard to where, when, and how someone heard the music may be helpful in narrowing the potential song candidates or verifying what is suspected to be the right answer, but tools for searching music databases using such information seem to be close to nonexistent. This is likely because it is extremely difficult to develop and maintain such databases or systems given the diversity of sources that would have to be monitored and mined, and the fact that almost all the information will be relative to a particular user's experience.

Note that in the FRBR model the user is situated outside of the bibliographic universe as an entity who is navigating the bibliographic universe, not as a type of *Person* in Group II entities; however, in our taxonomy the user and the object are situated much more closely. The information derived from the user's encounter with the music such as the information about the circumstance surrounding when the music was heard (e.g., particular event, date, media, place) and the reactions (e.g., mood, similarity, meaning) are important features. Whereas the FRBR model is largely based on bibliographic "facts," in queries the users' "beliefs" and assertions based on those beliefs play important roles. The bibliographic information also tends to be more stable and static compared to the users' information that can be vague, incomplete, and dynamic.

The major difference between FRBR research and this study was that the attributes and relationships were derived from empirical music information seeking and retrieval data rather than bibliographic records. One limitation of the FRBR model is that although FRBR provides a comprehensive set of attributes, there are still certain types of attributes missing in the model. For instance, the kinds of attributes that are derived from the context of using music in other cultural objects and/or events (e.g., used in a TV show, commercials, place or event where music was heard) are not included in FRBR. Although the context of the entity is already listed as one of the external attributes in FRBR, the context information with which FRBR is concerned is mostly from the context of creation, not the context of use, as we can infer from the descriptions of the context attribute from FRBR at the work level and expression level.

The attributes that relate to the user's reaction to an entity (e.g., mood) are also absent and the list of relationships defined in FRBR may also need to be extended. For instance, the similarity-based relationship (similar artists/works) which seems important in the context of MIR is not represented in the FRBR model. The kinds of information features that people use as clues to find music objects may be derived from sources other than the music object itself, which would imply that even very comprehensive bibliographic information may not be enough.

TABLE 9. Summarization of the MIREX tasks (2005-2007) (Downie, 2008)

Type		2005	2006	2007	2008
Micro ↑	Audio Onset Detection	•	•	•	
	Multiple Fundamental Frequency Estimation & Tracking			•	•
	Audio Drum Detection	•			
	Audio Chord Detection				•
	Audio Key Finding	•			
Audio	Audio Beat Tracking		•		
	Audio Tempo Extraction	•	•		
	Audio Melody Extraction	•	•		•
	Audio Artist Identification	•		•	•
↓ Macro	Audio Genre Identification	•		•	•
	Audio Cover Song Identification		•	•	•
	Audio Music Similarity and Retrieval		•	•	
	Query-by-Tapping				•
	Query-by-Singing or Humming		•	•	•
	Audio Music Mood Classification			•	•
	Audio Tag Classification				•
↑ Micro Symbolic	Symbolic Key Finding	•			
	Score Following		•	•	•
↓ Macro	Symbolic Genre Classification	•			
	Symbolic Melodic Similarity	•	•	•	

Recommendations for Music Information Retrieval Evaluation eXchange (MIREX)

The main motivation for this study was to improve our understanding of real-life music queries in order to develop a better set of tasks and queries for evaluating various MIR systems and techniques. To understand the progress made so far in MIREX, it is necessary to review the tasks that were carried out in the last 3 years. Table 9 summarizes all the MIREX tasks run from 2005 to 2007.

Downie (2008) differentiates the tasks representing micro-level MIR research from macro-level research. Tasks such as “Audio Onset Detection” represents micro-level MIR research as they tend to be very narrow and technical tasks (i.e., onset detection seeks to accurately locate music events in audio files), and the results are often used as part of other more complex

tasks. Tasks such as “Symbolic Melodic Similarity,” however, represent macro-level research as they are concerned with higher level retrieval tasks based on many different aspects of music.

Another way to understand this notion is to consider how close the tasks resemble the real-life user tasks. For common users, tasks such as “Audio Onset Detection” or “Multiple Fundamental Frequency Estimation & Tracking” would not be very relevant, as they are the kinds of tasks that are more useful for MIR system developers. Common music users would probably relate more to tasks such as “Query-by-Singing or Humming” or “Audio Cover Song Identification,” which are more similar to the kinds of needs that would arise in their everyday lives and would directly provide results that they would be interested in. Looking at the past MIREX tasks and how they evolved over the years, it seems like the later tasks tend to be more concerned with the needs of real-life users, although there are some exceptions (such as “Multi F0 Estimation”). The tasks also seem to reflect a growing interest in music similarity and mood in recent years in the MIR community. Based on the findings of this research, a few recommendations can be made regarding the directions for future MIREX tasks.

Incorporate More User Context in Test Queries

The first recommendation is to consider the user context more for tasks such as music similarity evaluation. There has been a great deal of interest in music similarity among MIR researchers recently. Evaluation tasks based on audio and symbolic music similarity have been run in past MIREX, thus the discussion among MIR researchers surrounding what is really meant by “music similarity” has also been a topic of debate for several years now. Music similarity has been typically associated with playlist generation or music recommendation, but the analysis of Google Answers data shows that it is also used for seeking a particular music object. The SIMILAR attribute was used in conjunction with ARTIST and TITLE features to code references to known artists or works used to describe attributes of the sought music. In the analyzed queries, 65 queries (7.2%) contained references to similar artist(s), whereas only 16 queries (1.8%) referenced similar musical work(s). Although they are not labeled as “similar,” the attribute value “example” associated with features TITLE (2.9%) and PERSONNAME (2.5%) were also based on the similarity among musical works and artists as they exemplified certain traits in a similar group of music/artists.

MIREX started incorporating music similarity evaluation contingent on subjective human evaluation in 2006 (Downie, 2008). The instructions given to human evaluators explained the tasks as follows (Downie, Lee, Gruzd, & Jones, 2007; Jones, Downie, & Ehmann, 2007):

Evaluate how well various algorithms retrieve results that are...

Symbolic Music Similarity (SMS): MELODICALLY similar to a given query. You will find in the candidate files a variety of different instrumentations as set by the creators of the MIDI files. We need you to look beyond the differences in timbre and instrumentation in assigning your grading scores.

Audio Music Similarity (AMS): MUSICALLY similar to a given query. You will be presented with files from a number of different music genres. Please assign the scores according to what you find “sounds” similar and do not take into account whether you like the music or not.

The practical objective of determining the similarity between two musical works has not been clear to the evaluators or even to researchers. The past evaluations have focused on determining the similarity between two music files after listening to them, and users were not provided with any metadata such as artist names or genre labels when they were evaluating these music files. However, in Google Answers data similarity among artists was used approximately four times more than similarity among musical works. This may be due to the fact that most of these queries were for searching music objects and information rather than generating playlists or browsing a music collection. Nevertheless, it certainly demonstrates that the notion of music similarity in users’ minds is a lot more complex than just two musical works sounding similar. The similarity between two artists can be based on many different reasons, independent of the features that can be directly extracted from the music itself (e.g., looks, influences, perspectives, similar/same appearances and origins in time and space).

One of the most difficult issues here is how to put this notion of similarity into evaluation. MIREX organizers found that narrowing the concept of similarity by specifying which aspect human evaluators are supposed to focus on produced better results (Downie et al., 2007; Jones et al., 2007). By analyzing the 7,602 similarity judgments collected for SMS and AMS evaluation tasks for MIREX 2006, Downie et al. (2007) found that, compared to the AMS evaluators, the SMS evaluators seemed to have “a more concrete understanding of melodic similarity than musical similarity” as they more often gave the perfect similarity scores, auditioned the music files fewer times, and also modified their score less often than AMS evaluators. For obtaining more reliable evaluation data, the notion of similarity needs to be narrowed down, but the similarity notion that is more relevant to users in their casual searches for music objects seems to be based on a complex mix of the various aspects of the artists. One suggestion for resolving this issue would be to specify the objective of the task more clearly, in other words, what the similarity evaluation result will be used for.

A great deal of effort has been made regarding how to evaluate the music similarity of two music files in the past “Audio Music Similarity and Retrieval” task. The concept of music similarity has been extremely difficult to deal with, because there

are so many different aspects one can consider when we say a musical work or an artist is similar to another work/artist. As an example, take a look at the following four cases of real-life query examples:

Q1: It has a female voice similar to Lora Logic or Linder Sterling from Ludus (I always thought this was a song by Ludus but now I have their complete discography and it isn't there).

Q2: Sounds like the Temptations or some band from the 1960s.

Q3: The whole thing sounds a little John Mayersque. In that genre, with Jack Johnson, Jason Mraz, etc.

Q4: They were the sort of hyper skinny 26 year old white guys you think of when you think of Red Hot chili peppers... sort of a repetitive pop song in the spirit of, say, FatBoy Slims "wonderful night"...

In all four cases the users provided information about artists/works similar to the ones they are seeking. However, what exactly was similar between the mentioned artists/works and the sought artists/works are different for each case. In the first case, we can see that the similarity between the artists originates from the voice of the artist, therefore the similarity in vocals would be more important than similarity in instrumentation, genre, etc. Compare it to the second case where the similar artist was mentioned as a representative band from the 1960s. In this case, the overall characteristics of the sounds of 1960s bands would be the most important thing to consider. In the third case, the similar artists were mentioned to refer to "that genre" which can be described by several exemplary artists. In the fourth case, two different bands were mentioned: the first was mentioned to explain the physical resemblance of the sought artist with the referenced one, and the second was mentioned to explain the similarity in musical style between the two bands. These cases show that our natural perception of music similarity in everyday life is much more complex to be evaluated on a single specific aspect.

Another possible way to improve the evaluation results would be to incorporate more description of the user's context in the search. Consider the four examples again. Although we can attempt to answer them by using similarity information, the way the user will evaluate the results will be very different for each case. For instance, for the first case, the candidate music files containing similar vocals would receive a higher score, whereas for the second case the overall timbre or instrumentation might be more important in determining the relevance score. As another example, take a look at the following two queries:

Q5: I need a list of the 200 or so best known celebration songs, anthems of a sort from 1975 to the present. The type of song is like celebration by Kool and the gang.

Q6: What is the name of this song and who sang it? ... She was more country artist than star, along the lines of Allison [sic] Krauss or Emmylou Harris (I thought it might have been Allison Krause in the duet, but if so, can't find it.) ...

If we were to use some similarity algorithm to generate the results for the first query, they should not include the particular song and the artist mentioned by the user as it would not provide any new additional information. However, for the second query, if the system were to find a song by one of the artists mentioned by the user (i.e., “Allison Krauss”), it would make sense to return that result to the user since it could be the very song that the user is looking for, unlike the first case. These query examples suggest that the user context information not only helps us understand which aspect of music similarity is of interest to the user, but can also help us improve the way the system provides the returned results. This is exactly why it is important to consider user context in better evaluating the results of these tasks.

Employ Terms That Are Familiar to and Are More Likely to be Used by Real-Life Users

The second recommendation is to incorporate more terms and phrases that are more likely to be used by real-life users as descriptors, especially for things such as affect/mood of music or genres. Here we will discuss Mood Classification Task as an example. Examining the 92 queries that contained the AFFECT/MOOD feature, Affect/mood information seems to work as important “hooks” in the minds of the searchers when they are trying to remember and describe the sought music. There were a total of 128 unique mood terms used in these queries. Among these, 25 terms were used more than once.

TABLE 10. The five mood clusters used for the “Mood Classification” task in MIREX 2007

Cluster 1	passionate, rousing, confident, boisterous, rowdy
Cluster 2	rollicking, cheerful, fun, sweet, amiable/good natured
Cluster 3	literate, poignant, wistful, bittersweet, autumnal, brooding
Cluster 4	humorous, silly, campy, quirky, whimsical, witty, wry
Cluster 5	aggressive, fiery, tense/anxious, intense, volatile, visceral

In the past “Mood Classification” task, human evaluators were asked to listen to the music clips provided and select the mood cluster that best fits the music in order to generate the ground truth. There were multiple clusters of moods that the evaluators could choose from when categorizing the music clips. For each cluster, several terms were used to refer to a particular mood of the songs as a whole (Table 10). The task organizers explained that these mood clusters were derived from the AMG (All Music Guide) mood repository (Hu & Downie, 2007). Some of the terms provided for describing these clusters do not seem like terms that common users would use to describe the mood of music (e.g., rollicking, campy). In fact, when the terms in these clusters are compared against the 128 unique instances of affect/mood description given by users in Google Answers queries, only seven of the 31 terms overlap with the user’s mood labels. The exact numbers of times they

appear in the Google Answers data are as follows: rousing (1), fun (3), sweet (2), humorous (1), silly (1), quirky (2), and aggressive (1). Presumably, the quirkiness of the terms is a result of running a cluster analysis on a large number of mood terms (thus naturally including some uncommon ones) used by AMG. However it is questionable if using these terms is a better option over using the terms that lay people would actually use to describe the sought music. One way to improve the mood classification would be to consider incorporating the terms that are actually used by real-life music users. For instance, would it be possible to substitute some of the terms used for cluster 3 to “sad” or “melancholy”? For cluster 2, could we use terms like “happy” or “playful” instead of “rollicking”? It is possible that these terms may not be the best choice for deriving mood clusters that are most distinct from each other, but they may be terms that users can easily understand and relate to, which should, at least in theory, help the evaluation process. Another way to improve the mood classification would be to consider what kinds of mood clusters would be most meaningful and relevant for the users by examining the mood labels provided in real-life queries and observing their browsing behaviors of music by moods.

Explore Ways to Combine and Evaluate the Results from Multiple Tasks for a Test Query

The last recommendation is to explore ways to combine and evaluate the results from multiple tasks for users’ queries. Suppose a user wants to identify a particular musical work of which they know some information. Although users tend to heavily rely on a small number of features when posing their queries, the analysis also showed that there is a diversity of kinds of features that were used. For instance, the user might be able to hum the melody of the sought music, as well as specifying another song that sounds similar to the one that they are seeking. The user might also be able to describe the mood of the song and guess which genre it will fit into. The way that MIREX tasks are organized now, this one search scenario will be partitioned into four different tasks – “Query by Singing/Humming,” “Audio Music Similarity and Retrieval,” “Music Mood Classification,” and “Audio Genre Identification.” However, in a real-life situation the results from all of these tasks must be consolidated to one set of results to be given to the user. Therefore, to make the tasks more realistic and useful for real-life users, it will be necessary to move beyond focusing on evaluating the results for each task and find a way to combine the efforts from multiple tasks.

Conclusion

A pervasive theme emerges from these analyses that user queries are very complex and it is difficult to derive simple user patterns based on needs expressed and features provided by users. To summarize the findings, there were various FORMS and TOPICS of needs that were present in Google Answers data, but the most important needs in the Google Answers were to

identify a musical work and/or an artist, locate a recording, and obtain the lyrics of songs, which can be referred to as known-item searches in a broad sense.

In addition, the study suggests that users seeking music objects and information about these objects on Google Answers make use of a large number of different types of information as they seek music objects and music information, although a few key features are much more heavily used than the rest. Only seven features were used in more than 25% of the queries, and 15 features were used in more than 10% of the queries. Person name, Title, Date, Genre, Role, Lyric, and Place reference were some of the most heavily used features. Date information was used surprisingly often, even more so than lyric information. The study also reveals that the kinds of information features provided in Google Answers queries tend to be highly personal and user-centered, compared to the traditional descriptions of bibliographic entities.

Some recommendations are made for improving MIR systems and system evaluation, including: (i) incorporating user context in test queries, (ii) employing terms familiar to users in evaluation tasks, and (iii) combining multiple task results. Information about related multimedia works may also help improve the current MIR systems.

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