

# Exploring Video Game Searches on the Web

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## ABSTRACT

As video games are developing fast, many users issue queries related to video games in a daily fashion. While there were a few attempts to understand their behavior, little is known on how the video game-related searches are done. Digesting and analyzing this search behavior may thus be faced as an important contribution for search engines to provide better results and search services for their users. To overcome this lack of knowledge and to gain more insight into how video game searches are done, we analyze in this paper, a number of game search queries submitted to a general search engine named Parsijoo. The analysis conducted was performed on top of 372,508 game search records extracted from the query logs within 253,516 different search sessions. Different aspects of video game searches are studied, including, their temporal distribution, game version specification, popular game categories, popular game platforms, game search sessions and clicked pages. Overall, the experimental analysis on video game searches shows that the current retrieval methods used by traditional search engines cannot be applied for game searches, thus, different retrieval and search services should be considered for these searches in the future.

## CCS CONCEPTS

• Information systems ~Web log analysis

## KEYWORDS

Video game search, Query log analysis, Web search

## 1 Introduction

Great advances in video games, made them one major target for spending leisure time for people of different ages. Based on the report from Global games market intelligence firm Newzoo<sup>1</sup> in 2017, there are 2.2 billion active gamers in the world, of which 47%, or 1.0 billion gamers, spend money while playing. Video games became quite popular in the 1980s when arcade video games, gaming consoles and home computer games were introduced to the general public. More recently, the emergence and the spread of cellphones with high speed internet connection together with devices dedicated to games, such as PlayStation4, Xbox and online dissemination app platforms such as Google Play, and Apple Store has created a new trend dedicated to online games.

Currently, there are many websites available providing information regarding video games for their users. For instance, Ign (Imagine Games Network) ([www.ign.com](http://www.ign.com)) is a video game and entertainment media

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<sup>1</sup> <https://newzoo.com/insights/articles/newzoo-2017-report-insights-into-the-108-9-billion-global-games-market>

website providing information on video games for different consoles such as Xbox, PlayStation and PC. Another game-oriented website is GameFAQs ([www.gamefaqs.gamespot.com](http://www.gamefaqs.gamespot.com)), which hosts FAQs and walkthroughs for video games. The site has a database of video game information, cheat codes, reviews, game saves, box art images and screenshots, almost all of which is submitted by volunteer contributors. Recently, there has been some effort to develop video game-oriented search engine. For instance, Piwag ([www.piwag.com](http://www.piwag.com)), was founded in March 2016 as a search engine for video games where also gamers can share their experience from around the world. However, to build a vertical search engine dedicated to video games, gamers' search behavior should be studied first. Despite the existence of several websites related to video games, little is known on how game searches are done and to the best of our knowledge, this paper is the first to investigate this matter. We try to shed light on different aspects of gamers search behavior that can be used by search engines to provide better search services to their users. For instance, looking at the temporal distribution of video games searches, may give us information on the days or on the period of the day, where people have more leisure time. One such information can have multiple advantages for search engines and content providers. For example, game advertisement which is a quite common way of getting gamers attention, may be put online at specific days of the week. Also, general search engines can provide query suggestion and query auto-completion for video games at specific times of the day, especially for users interested in video games (based on their search profile) as the chance of a user looking for video game is higher. Another observation is the correlation between the devices that the query was issued from and the video game platform they were looking for. Mobile users are mostly looking for mobile games while queries issued from PC, are particularly tuned to PC video games. Search engines should consider this point while retrieving the documents, giving higher ranks to webpages related to the device from which the query was issued. In this paper, we aim to study gamers' search behavior, by using two-year query logs of the Persian search engine, Parsijoo ([www.parsijoo.ir](http://www.parsijoo.ir)). To extract game searches, we relied on a list of popular video games and extracted queries containing their names. In order to complement this initial list, we also used the frequent words that are used for video game searches that were missing in our initial seed terms. We decided to set our research goals and answer the following research questions:

- RQ1: What is the temporal distribution of game searches and how do they differ from the general ones?
- RQ2: How do users specify the game version they are looking for?
- RQ3: What type of game categories are searched more often?
- RQ4: What platforms are mostly searched in game searches?
- RQ5: How do the game search sessions differ from the general ones?
- RQ6: What type of web pages are mostly clicked by users in game searches?

The overall purpose of this research is twofold. First, we aim to analyze how gamers use search engines. Second, we try to understand how can search engines may benefit from these answers in order to provide better services for their users. The remainder of this paper is organized as follows. Section 2 presents some of the related works. Section 3 describes the experimental setting and how we used Parsijoo query logs for our analysis. Section 4 discusses the results obtained. Finally, Section 5 outlines some conclusions and future work.

## 2 Related work

Related work to ours can be divided into two groups. The first group of researches, use search engine query logs to study users' behavior on general or specific topics to improve search engine effectiveness. The second group, is mostly related to study the effect of these video-games on human behavior. In this section, we try to cover some of the related researches to both of the categories.

Different works have been presented to understand users' search behavior. Query log analysis is a well-known research topic in the area of information retrieval and data mining which leverages the recorded information in the search engine query logs to study real users search behavior and based on the patterns found in their behavior enhance search engine effectiveness. One of the earliest works on query log analysis was proposed by Broder et al. [4]. In this work, the authors introduced a new taxonomy for web searches consisting of three categories: navigational, informational and transactional where for each category,

different retrieval results may be presented. Query logs were also used to understand the different type of queries, for which search engines failed to provide good results. For instance, Bendersky et al. [3] brought attention to the long queries and studied issues involved with using them effectively. They showed that user click behavior is correlated with the query length. In turn, Kravi et al. [11] studied multi-click queries where the same user may click more than one page in the same search session. They analyzed both queries and clicked pages, in addition to proposing a basic classifier to predict these types of queries.

While many previous researchers studied general web searches, there has been many attempts to explore specialized searches. For example, the study by Herskovic et al. [10] focused on PubMed query logs which is an interface to MEDLINE, the largest biomedical literature database. They studied search features such as length of query and session, size of the results sets and use of Boolean operators. The results obtained showed that users tend to issue a variety of queries on a broad range of topic most of which are informational. Another specialized research on query logs was conducted by Li et al. [12] where they studied academic searches focusing on the failures in these type of searches and providing an algorithmic solution for it. The last example to mention is the work of Spina et al. [18] where searches related to job and talent were investigated. In this work, the query log records of a vertical search engine, SEEK, were used to explore job searches observing different users' behavior compared to general searches. Despite all these works on the specialized searches, we believe no previous research so far has attempted to characterize game searches. By exploring web query logs of general search engine and extracting game-related queries, we aim to understand whether the behavior of a gamer is different from other common searches. This might be very useful for search engines seeking to provide better search results and dedicated services to their users.

As mentioned earlier, the second group of researches related to ours, are those regarding video games. These researches are mostly focused on how playing video games may affect human behavior. For instance, the recent experimental study by Hasan et al. [9] on 70 people showed that there is a stronger evidence of short-term violent video game effects than of long-term effects. In turn, Granic et al. [8] focused on the benefits of playing video games, mainly targeting motivational, emotional and social benefits of gaming. While most of these studies were conducted by user study with profiling users' searches, query logs can also be used on this matter. However, in this research we are not focusing on this issue and it can be considered as a potential future work.

### 3 The Video Game Search Dataset

To conduct our analysis, we resort to a Persian general-purpose search engine, named Parsijoo, in particular to a query log consisting of 27M queries and corresponding users' interaction collected during two consecutive years, from March 2015 to March 2017. Transaction log in web search engines is a record of the communication between users and search engines during a search session. The search log format is similar to the extended file format containing data such as user query, query issue time and clicked URLs. Table 1 shows these transaction logs with field SessionId, the submitted query, query issue time, Search type, Clicked URL, Click Time and Mobile. (note: queries are translated from Persian to English. Also due to space limit, URL and SessionID are shortened.) The "Mobile" column, shows if the query was issued from a mobile device (True value) or from a PC. Also, Parsijoo assign each Session Id when the browser is opened and a connection is made between user and the search engine. The same Session Id will remain for the user until the browser is not closed and the connection is not ended. As it may be possible that the user does not close the browser, we decided to partition the sessions into more realistic search session when there is no interaction between the user and the search engine for 60 minutes or more.

To extract game-related queries, we used the same keyword-based approach as Mansouri et al. [14]. In the mentioned research, editors were asked to manually construct a list of phrases for each of 100 events that were selected to study spiky events. Queries were then matched against these lists. In our research, we used a list of 600 popular games (published by a national computer and video games foundation), from online games, such as "Clash of Clans", PC games such as "Call of Duty", PlayStation games like "Mortal Kombat" to old video games like "Super Mario". Each popular game was then issued into the query log records. Any query containing all of the terms of the popular games is considered as a game search related query. For

**Table 1. Parsijoo transaction logs for two search sessions with game queries.**

Session ID	Query	Issue Time	Clicked URL (Site shown)	Click Time	Mobile
B12A561CB6	Clash of clans update	2016-12-22 21:45:30			True
B12A561CB6	Clash of clans Christmas update	2016-12-22 21:46:02			True
B12A561CB6	Clash of clans Christmas update iOS	2016-12-22 21:47:10	cafeapple.net	2016-12-22 21:47:23	True
C31B4235A7	mortal kombat instructions	2016-03-03 23:15:34			False
C31B4235A7	mortal kombat finishing moves	2016-03-03 23:16:02	zoomg.ir	2016-03-03 23:16:38	False
C31B4235A7	mortal kombat Scorpion moves	2016-03-03 23:20:39			False
C31B4235A7	scorpion mortal kombat finishing moves ps4	2016-03-13 23:21:00	gamefa.com	2016-03-13 23:21:24	False

instance, the query “release date of call of duty” is considered as a game-related query as it contains “call of duty”.

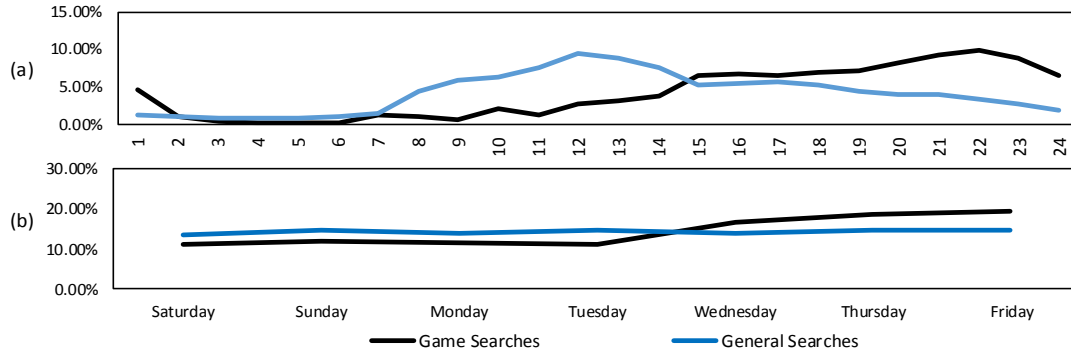
In the next step, we explored the extracted records to identify other frequent terms that are used in game search queries. For this purpose, we start by considering the top-100 frequent terms but selected only those related to the game search task. Eventually, 50 more terms such “online games”, “Lan game” or “pc multiplayer game” to name but a few, were selected, thus totalizing 650 seed terms. With this method, we ended up selecting a considerable number of 372,508 game search records from the query logs, corresponding to 253,516 search sessions which we would regard them as game search sessions. A game search session does not necessarily start with a game-related query, but contains at least one query related to video games. To compare the game searches with general searches (those not related to video game), with the same constraint about search session length, we randomly selected search sessions until we reach the same amount of records as game searches (372.5K).

## 4 Experimental Results

In this section we present the results of our analysis on the game-related queries. All the concepts that we decided to study were determined after our initial exploration on game queries and the patterns observed. First the top-2000 frequent queries were selected to find patterns. As temporal expressions and name of platforms were used in nearly 62% of these queries, we decided to explore how users used them in their video-game queries. The same approach was used for the clicked-pages. By looking at the URL (not the content) of top-1000 clicked pages, our assumption was that users mostly click on game-oriented and application download websites rather than other web pages. Finally, we selected a set of 100 random game search sessions to observe the number of queries and based on our previous knowledge on general searches, the number of queries was nearly the same, however in the query reformulation, some patterns could be observed. The following subsections will verify if our initial assumption about video game-related queries were correct or not.

### 4.1 Temporal distribution

Understanding changes in queries over time can help search engines providing better web search services. For instance, Shoukouhi and Radinsky [17] proposed a time-sensitive approach for query auto-completion, ranking the candidates queries according to their forecasted frequencies. Another benefit of knowing the temporal distribution of special topic queries is advertisement. Many game producers rely on introducing their games to consumer by advertising them online. By knowing when the specific audience in the market is available (doing the web search), search engines can have better timing for their ads. In sponsored search,



**Figure 1. The distribution of game search and general web search queries during day hours (a) and week days (b).**

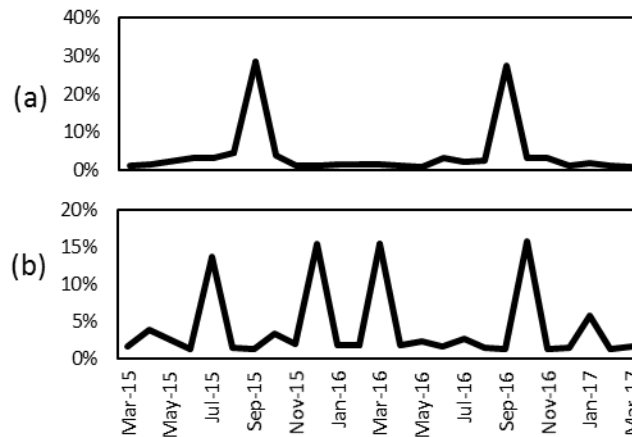
an advertiser only pays if its ads get clicked by the user [1], and putting video game ads at these time will increase the chance of having them clicked.

In the research of Beitzel et al. [2], authors studied how the popularity of topically categorized queries changes on a daily, weekly and monthly basis. Their study on game category showed that, the number of related queries were, more or less the same, regardless the hours of the day and the day of the week. However, based on our observation, these queries might be more issued at the end of the day and weekends when talking about game search queries. To conduct this analysis, we used the query issue time and plotted the frequency of game and general searches over the hours of the day and the days of the week. The result of our experiment, on temporal distribution of game queries when compared to general ones, is shown in Figure 1 by daily hours (a) and week days (b).

Exploring the distribution of game queries, these queries are mostly issued during the night when people are usually back at home and willing to spend their leisure time. The frequency of game searches, starts to increase from 15h and reaches its peak at 22h when approximately 25% of the game queries is issued. In contrast, the frequency of general searches increases from the morning to the noon and then gradually decreases as it approaches the end of the day.

Our further analysis on the distribution of game and general searches during week days indicates that, while the frequency of general searches, remained more or less the same during the week day, games searches were more issued during the weekend (in Persian calendar, Thursday and Friday are the weekend days, and Saturday marks the beginning of the week). From Saturday to Tuesday, both game and general searches show the same constant trend. But while general searches continue their stable frequency, game queries show a sudden increase in the number of game queries posed by users from Wednesday (which anticipates the beginning of the weekend) to Friday when it reaches its peak with approximately 20% of the game search queries issued.

We also studied temporal distribution for some of the popular games. For many of the games the time-series built on their query frequency had multiple spikes. Queries with multi spikes in their frequency time series are usually temporal ambiguous. Temporal ambiguous queries have been studied by several researches [5, 15, 16], indicating the need for different retrieval methods. For games such as PES (pro evolution soccer), there were periodic spikes around release dates, with multiple queries regarding the release date and new features. On the other hand, for games such as “Clash of Clans”, there were aperiodic spikes in the frequency time series. These spikes were due to updates on the game and users were looking for update links. For both type of periodic and aperiodic spikes, search engines should try to adopt different retrieval method based on query issue time [14]. Figure 2, shows the time series built on the monthly frequency of queries related to games “PES” (a) and “Clash of Clans” (b).



**Figure 2. Distribution of queries for games PES (a) and Clash of Clans (b) in Parsijoo query logs.**

## 4.2 Game Version Specification

Users mostly try to disambiguate their query by adding extra terms to their initial queries. As the previous section showed queries related to games, may have temporal ambiguity; that is for the search engine, it is not clear which of the time ranges are of the interest for the user. One way to solve this problem is to add temporal expression to the query, specifying the desired time range. Therefore, we studied if users have used a temporal expression when specifying their game-related query. To study this matter, we used a Persian Time tagger, ParsTime [13].

Our analysis shows that in 19.32% of game queries users included temporal expressions in their queries of which (based on the query issue time), 88.3% of the users were looking for the most recent version of the game, while only 9.1% were looking for older versions and a tiny portion of 2.6% were interested in future versions. This emphasizes the need for search engines to adopt special retrieval techniques that take into account the freshness of the results when talking about game search queries, which is a challenging task [6]. Another point is that, the version of games can also be specified by numbers, specially the roman number such as (I, II and III). Considering the numbers as the version of the games, 25% of the users have specified the version of the game they were looking for. However, these numbers cannot be studied to check the user target time.

## 4.3 Game Categories

There are different categories of video games and users may share a same taste. For instance, a type of video game can be popular in a specific region or be popular between people of a certain age range. Also a user might be only interested in a certain type of video games. For game search engines with game recommendation module, the validity of this assumption is crucial as they can benefit from one such information in a task such of query suggestion. In our query logs, user profiles are not known; that is, we do not have the history of a user search. However, we try to study if users attempt to change the game category within a same search session. Also by having user IP, we can study the distribution of video game categories in different regions. To do so, we begin by asking 3 editors of the search engine crowdsourcing team, to specify the genre of 500 selected video games (in our seed from Section 3) based on their own knowledge or

**Table 2. The distribution of different game categories searched by users.**

Category	Distribution(%)	Category	Distribution(%)	Category	Distribution(%)
Sports	26.30	Racing	9.90	Puzzle & Word	3.90
Action	13.40	Adventure	8.50	Other	7.40
Strategy	25.70	Board & Card	4.90		

on the game description, according to google play game categories. An inter-rater reliability analysis using the Fleiss Kappa statistics [7] was performed to determine consistency among the editors. Overall, the annotators obtained about 0.78 of agreement level, which represents a high agreement between editors. Overall, in 81.6% of game queries the game was specified (which can be due to our method for extracting game queries), The distribution of different game categories is shown in Table 2.

As this table suggests certain categories such as sports, strategy and actions games are more popular than the other categories. Our analysis on game search sessions, shows that in 14.5% of game sessions, users tend to search for different video games. In these search sessions, however, only in a minority of 0.9% sessions, users changed the category of the game there are looking for. This indicates that in game search sessions, users mostly target certain category of games and if search engines are planning to consider query recommendation module, games of the same category should be suggested.

The next experiment was conducted on the popularity of game categories within cities. The result of our analysis shows categories such as actions and strategy games were dominantly issued in industrial cities (84.8% on average). On the other hand, categories such as “Puzzle & Word” and “Board & Card” games were not popular in these cities (16.2% on average). One such information can also be used by game oriented web pages to suggest games based of user’s location.

## 4.4 Game Platforms

If users do not specify their desired game console, search engines cannot distinguish which console the user was targeting thus impeding a diversity of the results based on the platforms. In this section, we study how often users specify the device for which they are searching games. As there has been noticeable increase on number of mobile video games, we also plan to study if there is a correlation between the device from which the query was issued (mobile or PC) and the platform users are looking for. Overall, in 47.4% of the game queries, users have specified the platform. Table 3 shows the distribution of the devices specified by users in games queries (over all the queries with device specified). The other category refers to platforms such as Sega and Atari. Also it should be mentioned that the mobile category includes queries with “Android” and “IOS”. Games for Personal computer and Mobile were mentioned in more than half of the game queries in which the platform was specified.

By using “Mobile” field from query logs, it was observed that 92.8% of the game queries with mobile as the specified platform, were issued from mobile and 84.7% of the queries related to PC platform were issued

**Table 3. The distribution of game platforms specified by users in game queries.**

Platform	Distribution(%)	Platform	Distribution(%)
PC	27.4	PlayStation	14.9
Online	24.3	Mobile	26.7
Xbox	3.3	Other	3.4

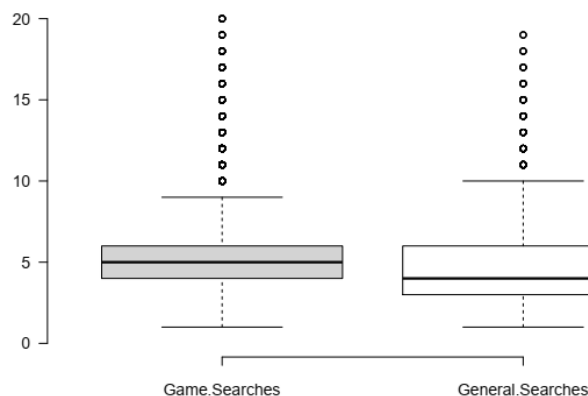
from desktop PCs. This clearly state that, the device from which the query is issued, can be used for query suggestion; that is to say, if the user is posing a query related to game by a mobile device (Android or other operating systems), the results should be related to that operating system. Likewise, if the search is issued on a personal computer, then video games related to PC should be suggested.

## 4.5 Search Sessions

So far we have mostly focused on the game queries. Instead, in this section we study the game search sessions and the queries issued in these sessions to better understand game search sessions. First, we study how user search effort is different in game searches compared to general ones. For this, we considered average query length and average query per search session. The comparison between query length of game and general web queries shows that game searches are about 2.9 terms longer than general web searches, with an average of 5.4 terms per query (while only 2.5 terms on general queries). This might be explained by the fact that users may specify the name of the game, game console, and game's version and also use terms such as “download” in their queries. To better understand the difference between query length in game and general searches, we drew the boxplot of distribution of the queries for both types of searches in Figure 3. By looking at this figure we can observe that most frequent game search queries have a length between 4 to 6 terms, with queries with more than 9 terms being very rare.

Next, we study the average number of queries posed by a user in each search session in order to understand whether there is any difference between game and general web searches. Our analysis on the average number of query per session in game and general searches shows that users pose fewer queries in game search sessions compared to general search sessions. The average query per session in game searches is 1.46 queries per session which though quite similar is less than the 1.68 queries posed on general searches. This indicates that users may put less effort in game searches as they can find the appropriate result for their information need more quickly. Overall, our analysis revealed that at the current moment, users put less effort in game searches compared to general ones which may indicate that search engines can provide appropriate result for game searches. The query reformulation mostly happened 24% of game search sessions. In these search sessions adding words reformulation (where user add one or more new term to the previous term) dominantly occurred for 78% of times.

Going into the details, in search sessions with adding word reformulation 67.3% of queries were reformulated by adding the platform names where 22.9% of reformulation were done by adding the temporal expressions and numbers to the initial queries. For instance, in a search session the user initial query was “Clash Royal update”, reformulated by adding temporal expressions to “Clash Royal December Update” and then reformulated by adding platform to “Clash Royal December Update for Android”. Another example is the search session in which user first issues the query “Hay Day download” and without clicking any results issue another query by adding the platform “Hay Day download iPhone” and by clicking



**Figure 3. Boxplot of query length distribution for game and general web searches.**



on two pages finished the search session. This shows that users may not specify the platform in their initial query, hoping they can find their desired results in the first try.

## 4.6 Clicked Web Pages

Our final analysis was on the type of clicked pages by users in game searches. Our initial observation on the clicked pages showed that certain web pages related to video games and pages providing download links for them are more clicked. Among the top-500 clicked web pages which account for 82% of total clicked pages in video game searches, 55.3% of web pages were game-oriented, 24.6% were application download web sites, 15.8% were websites dedicated to mobile application downloads and 4.3% of the web pages belong to other categories (this was done by only one annotator based on the simplicity of the task.) A deeper analysis enables to conclude that within the top-10 clicked web pages, 6 out of 10 are game-oriented, 3 refer to mobile applications and one to download web pages. This information may be used by search engines to give higher ranks to web pages belonging to these three categories for game related queries.

## 5 Conclusion

In this paper the web queries related to video games were explored. The analysis on queries, search sessions and clicked pages showed that search engines should provide different approaches for both retrieval and search services they provide for game searches. We studied different aspects of game searches and provided solutions for search engines to improve their effectiveness. For instance, the temporal distribution of video game searches is different from general searches usually being done at the weekends and at the end of the day. One such information can be used by search engines who plan to advertise video game, indicating appropriate time to put on the ads to meet the expected audience. Another example of our findings is the correlation between the platform users are targeting and the device the query was issued from. 92.8% of the game queries with mobile as the specified platform, were issued from mobile and 84.7% of the queries related to PC platform were issued from desktop PCs. This information can be used by search engines to retrieve the related pages based on the device from which the query was issued; that is if the game query is issued from mobile device, perhaps the user is looking for the mobile version of the game. As part of our future work, we plan to explore video game searches deeper and also develop a vertical search engine for video games.

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