Mind Your Language: Effects of Spoken Query Formulation on Retrieval Effectiveness

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Abstract. Voice search is becoming a popular mode for interacting with search engines. As a result, research has gone into building better voice transcription engines, interfaces, and search engines that better handle inherent verbosity of queries. However, when one considers its use by non-native speakers of English, another aspect that becomes important is the formulation of the query by users. In this paper, we present the results of a preliminary study that we conducted with non-native English speakers who formulate queries for given retrieval tasks. Our results show that the current search engines are sensitive in their rankings to the query formulation, and thus highlights the need for developing more robust ranking methods.

Keywords: Voice Search, Query Formulation, Evaluation

1 Introduction

With the maturation of automatic speech recognition (ASR), voice search systems have presented a new interface for information retrieval. These voice search systems transcribe spoken queries and use the text output for retrieval. However, as shown by Crestani et. al [1], spoken queries tend to be longer and more natural. Also, even though ASR systems are improving rapidly, it has been shown [2] that transcription errors greatly influence the performance of voice search systems.

Along with these challenges, search engines also need to adapt to the variations in spoken query formulations. Compared to desktop search queries, spoken queries can be more varied and loosely structured as people begin to use natural language. While recent research has vastly improved the transcription quality of ASR frontend of search engines, as well as their handling of verbosity in ranking, it is not clear how sensitive are the rankings to the linguistic structure of the spoken query itself. This is particularly interesting for non-native English speaking users of voice search.

In this paper, we present the preliminary results of our study which involved a number of users who had training in English as foreign language (EFL). Using a set of standard TREC topics, we first studied if there is a difference in the way these users naturally formulate their queries for the information need with a more well-formed sentence as given in the TREC decriptions themselves. Next, we evaluated the effectiveness of results returned by Google - the most popular Web
search engine which provides an easy voice search interface for us to experiment with. Our results show that although search engines, as exemplified by Google, are very good in handling various speech artefacts and verbose queries, their rankings are quite sensitive to the query formulations. We observed a reduction of 20-30% in the ranks where the most relevant results were shown as a result of this.

2 Setup

Our major objective was to compare how the search engine performed when users formulated their own spoken queries as compared to the well-structured queries for the same topics.

For our evaluation, we used Google’s voice search app on iOS with 20 TREC topics from the Web Track. Another advantage of using Google’s voice search system was that it is already believed to be tuned to conversational queries with the new ‘Hummingbird’ algorithm. This would give us a greater clarity of whether these state-of-the-art systems are able to handle variations in query formulation compared to well-structured queries.

Though some studies show that most mobile voice search queries are local, similar to Jiang et. al [2], we didn’t want to restrict ourselves to just local queries because our experiment didn’t simulate mobile conditions and voice search systems are being used on the desktop as well. Thus, we used 20 informational queries from TREC Web Track in 2010, 2011 and 2012. Table 1 shows the list of these topics.

| Year | Topic numbers |
|------|---------------|
| 2010 | 54, 55, 58, 69, 71, 74, 81 |
| 2011 | 110, 117, 125, 130, 131, 142 |
| 2012 | 157, 161, 166, 170, 175, 180, 181 |

For the experiments, we used the latest version of Google’s voice search app for iOS set up to transcribe Indian English. We created new Google accounts for each one of our participants with the ‘Web History’ setting switched on to record their transcribed queries as well as their clicks, based on which we calculated Mean Reciprocal Rank for each query.

Our experiment was conducted in two stages with these topics. We called in 13 participants (9 males & 4 females), all students in higher education who have received formal education in English as foreign language throughout their life. In the first stage, we gave them each of the 20 TREC topics along with the information need, and then asked them to formulate their own voice query. They then explored the results while their ‘clicks’ were being recorded.
After the first stage was over will all participants, we called them in for the second stage on the experiment. In this stage, we gave them a well-structured query in the form of 'Description' for each TREC topic from the Web Track. The participants then spoke these queries into the Google Voice Search app and again browsed the results.

It was important to conduct this stage after the first one so that participants aren’t exposed to well-structured queries for the same topics beforehand, thus influencing their queries. We also ensured that participants do not type any queries and only speak them into the app. Throughout the experiments, we allowed participants to correct voice transcription errors, if any, while keeping a record of these errors. We later used the knowledge of these transcription errors in our evaluation to calculate 'best’ and ‘worst’ MRR scores for each spoken query.

3 Evaluation Results

In this section, we present the results of our experiments by focusing mainly on the Reciprocal Rank (MRR) measure. The reciprocal rank is simply the reciprocal of the position of the first result that was marked relevant by the user in the rankings. In the perfect ranking of results by a search engine, this should be 1.

In table 2, we show the summary of performance for each of the 20 TREC queries we considered in this study. It shows RR values under four different settings – first two columns show the results for queries that were naturally formulated by users, and the next two show the results when TREC description queries were spoken by the same users. For each of these two queries, we also show the worst reciprocal rank obtained – to account for the transcription errors.

These results show many interesting aspects: first of all, as recent results have also shown, transcription errors do play an important role in the quality of results. There is difference of about 0.12 in the MRR values with and without transcription, even with TREC queries. At the same time, equally strong is the effect of query formulations themselves. Specifically, the MRR value for TREC queries is 0.9 while for the naturally spoken queries for the same topics have only 0.76 which is much more than the reduction in quality due to transcription errors alone.

We also highlight that these reductions are, though consistent, are more pronounced in some topics and for some users. We illustrate this point further by considering only those users whose natural queries yielded low MRR values, and compare the MRR values for the same users when they spoke TREC queries to the search system. These results are shown in table 3. As these results show, there is a significant reduction in the quality of rankings when users are allowed for formulate their own queries, even when there are no errors due to transcriptions alone.
Table 2. MRR for all TREC queries

| Topic # | Natural Queries | TREC queries |
|---------|-----------------|--------------|
|         | RR  | Worst RR | RR  | Worst RR |
| 54      | 0.72 | 0.65    | 0.79 | 0.79    |
| 55      | 0.65 | 0.61    | 0.96 | 0.92    |
| 58      | 0.82 | 0.75    | 1.00 | 0.83    |
| 69      | 0.77 | 0.73    | 0.92 | 0.67    |
| 71      | 0.54 | 0.52    | 0.85 | 0.73    |
| 74      | 0.96 | 0.83    | 1.00 | 0.92    |
| 81      | 0.74 | 0.55    | 1.00 | 0.82    |
| 110     | 0.43 | 0.37    | 0.47 | 0.39    |
| 117     | 0.69 | 0.46    | 0.69 | 0.43    |
| 125     | 0.96 | 0.88    | 1.00 | 0.95    |
| 130     | 0.88 | 0.72    | 1.00 | 0.88    |
| 131     | 0.89 | 0.72    | 0.92 | 0.58    |
| 142     | 0.67 | 0.67    | 0.91 | 0.68    |
| 157     | 0.92 | 0.92    | 0.96 | 0.83    |
| 161     | 0.64 | 0.53    | 0.86 | 0.62    |
| 166     | 0.58 | 0.58    | 0.88 | 0.38    |
| 170     | 0.81 | 0.67    | 0.78 | 0.61    |
| 175     | 0.95 | 0.91    | 1.00 | 1.00    |
| 180     | 0.87 | 0.87    | 0.92 | 0.50    |
| 181     | 0.72 | 0.58    | 1.00 | 0.77    |
| **MRR** | 0.76 | 0.68    | 0.90 | 0.72    |

Table 3. Avg. MRR for users with low MRR

| No. of users | Natural Queries | TREC queries |
|--------------|-----------------|--------------|
| 8            | 0.715           | 0.911        |

Table 4. Examples of Natural Queries with Low Result Quality

| TREC Query                                                                 | Natural Query                                                                                           |
|---------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| “Find information about the war in Afghanistan”                           | “get me some information about the war in afghanistan”, “tell me about the war history of afghanistan”, “history of afganistan wars” |
| “I want to buy a road map of Brazil”                                      | “i want to buy brazil’s map”, “i want to buy a map of brazil”, “i want to buy a printed map of brazil”, “from where can i purchase map of brazil”, “shopping results for map of brazil”, “buy brazil map” |
| “Find information about the office of President of the United States”    | “give me some information about the current president of u s a”, “who is u s president”, “tell me something about the president of the u s a” |
4 Conclusion

In this paper we presented the preliminary results of our study in understanding the current state of modern search engines in supporting voice queries from a wide range of users. The results, though preliminary and were conducted on a population of users who had much higher levels of EFL training, show that there is a significant gap in the performance of search engines for queries which are spontaneously formed by users. This gap is as significant, and sometimes more than the gap observed due to transcription errors alone.

In future, we would like to expand our study to include users with different levels of EFL training as well as wider range of queries. In addition, we are also interested in developing improved search systems which are robust for these artefacts.

References

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