# Toward a deeper understanding of user intent and query expressiveness

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# Toward a deeper understanding of user intent and query expressiveness

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## ABSTRACT

Understanding the intents of the search users have recently been a popular research topic among Information Retrieval community. Accurate inference of the intent is a major goal of today's search engines. Ranking the relevant Web documents, targeting better advertisements, assisting the user with better suggested queries are just a few applications where understanding the intent plays a key role. In order to better understand how users formulate their intents into queries, we conducted a preliminary experimental study in which users agreed to be recorded during their search activity. Monitoring the user behavior and discussing the process with them at the end of their search activities allows us to gather some fascinating insights about intents.

## Keywords

user intent understanding, search tasks, empirical studies on user behavior, intent complexity

## 1. INTRODUCTION

Inferring users' intents has been a popular topic among Web and Information Retrieval researchers. But what is an intent? In his seminal work, Broder [1] defines an intent as " the need behind a query". However this definition can not be leveraged for designing effective search engines that are aware of the mental model of the user. To the best of our knowledge, not much effort has been spent in order to deeply understand the mental path that connects this need to its textual representation in the form of queries.

In the attempt to reveal the basic nature of *intent*, namely what is in the user's mind when they enter a search query, we conducted an experimental study [5] on 10 volunteers who agreed to give a verbose description of the intent of their queries during the search process. Such a study was quite informative about the nature of the intent and allowed us to gain deep insights into how intents are related to each other. A better understanding of the above aspects are fundamental in order to arrive to an operational definition of

intent necessary to develop next generation tools for inferring user intents and refine the guidelines for annotators to make better decisions.

Previous studies are mainly focused on intent modeling or on clustering intents into categories or taxonomies. The tacit assumption on which most of the earlier work relies is that human annotators can easily infer the main intent of each query. However, whether or not human judges may infer user's intents by observing their queries and/or the URLs they browse is still an open question. In the attempt of answering to such a question, we realize that more fundamental matters need to be investigated first. In particular, we need to understand *i)* what constitutes an intent and *ii)* what are the factors that affect the user to articulate what is in her mind in the form of queries.

Our qualitative analysis [4] has revealed that there are at least three main factors to consider when we look at the expressiveness of the queries; in other words, the competence of a set of queries to articulate the user intent:

1. the **complexity** of the task the user wants to accomplish; as explained in Section 3 such a complexity is measured in terms of the number of dimensions and choices that the user needs to explore at the time she engages with the search engine;

2. the **number of dimensions** already explored; such a factor determines how much effort needs to be spent by the user to complete the task;

3. the **specificity** of what she is looking for; each task can involve general or specific aspects of the task, which are influenced by the user's past experiences.

Far from being exhaustive, the current analysis is radically novel and opens up future discussions about the relationship between queries and their underlying intents.

The rest of the paper is organized as follows. In Section 2 we explain the empirical study in detail and we present some of the collected data[1]. Section 3 presents the answers to the two main questions about intent definition and expressiveness of the queries and presents some further insights about intents. Section 4 discusses how our findings can be leveraged by search engines in order to satisfy users' intents.

## 2. EMPIRICAL STUDY

In order to elaborate a definition of intents and mine the factors that influence query expressiveness, we asked 10 par-

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[1]The complete list of queries can not be reported due to space constraints but all the conclusions reported here also apply to the remaining of the user sessions.

ticipants to perform a number of search tasks.[2] Each participant agreed to be video-recorded during her search session and let us collect quantitative data, that is, queries, search results, clicked urls, landing pages, dwell times, and so on. Before joining the video-session, the participants were asked to list up to 10 things they were interested in conducting a search about. Before starting the session they were instructed to use the search engine of their choice (Google, Y!, Bing, etc.) and they were given 55 minutes to perform their search tasks. It was not required to complete each search topic on the list[3] since we wanted the participants to take as much time as needed to find the information they were looking for. During this time frame, the participants were encouraged to perform their searches as they would have normally done; e.g. reviewing any Web pages or information as needed, making changes, trying multiple times, etc. We used the "Think Aloud" protocol [2] to collect their thoughts throughout the search process. The participants' sessions were recorded by a moderator who only interfered to remind them to keep talking out loud or to instruct them to move onto the next search topic on their list. At the end of the session, each participant was interviewed by the moderator to gather qualitative insights about what the user intent was.

## 3. OBSERVATIONS

We report the insights obtained by the analysis of 18 search tasks. Our findings are derived by a cross comparison between the set of the issued queries and the participants' detailed explanations on what their actual intent was. Participant's descriptions was definitely instrumental to understand the real intent of the queries and to assess the extent at which the queries express such an intent. Given space constraints, we can give compact summaries of only 5 of the 18 tasks[4]:

◇ **Peruvian literature**: This was a very comprehensive session. The volunteer explained that all the different queries were related to the same unique intent. The intent was to replace some readings from a text book with easier and shorter readings from the Web. The list of things the teacher has in mind at the time of the query are the list of chapters and the topic of each chapter, which is related to a specific culture, and each query reflects that structure of the book.

◇ **Bugaboo stroller**: The participant wants to sell an used bugaboo stroller. Hence, she wants to determine the right price for it, considering that she has bought a number of accessories that she can add to the basic model. In none of the queries she mentioned that she want to sell as opposed to buy a stroller. It is communicated only verbally to the mediator but not to the search engine.

◇ **San Francisco restaurants** : The participant's daughter's 21st birthday is approaching. She is looking for places to eat in San Francisco. She is specifically looking for a restaurant she has never been before. She does not have a restaurant in mind, but she rather wants to see what is out there. Furthermore, she is seeking to find something fun to do after dinner that night. These are the list of things she

has consciously in her mind at the time of the query.

◇ **A's spring training** : The intent is to find the right resource for organizing an A's spring training outing including organizing a trip to A's spring training, looking for schedules/dates, places to stay, and so on. She is looking for specific websites dedicated to spring training that contain detailed information, not necessarily A's own website.

◇ **Things to do in Las Vegas** : The participant will have a trip to Las Vegas soon and would like to do research on things to do there. She is interested to know what others have done that she may be interested in doing if she has not done so already.

One major observation resulted from this exercise is that intent is always composed of two components: known and unknown. This is a simple observation in hindsight but it has not been well understood and exploited in the IR models. There is a part of the intent known to the user (from past experience, education, etc.) and the rest constitutes the unknown part. It is the unknown part that the user searches for. The size of the two components with respect to each other varies from intent to intent and user to user. We provide more detailed discussions on this subject in Sections 3.1 and 3.2

### 3.1 Deeper Analysis of the Search Sessions

We studied the user search sessions in detail with respect to answering the following fundamental questions:

**(1)** *What is the complexity of the search task?*
- Does the search task consist of multiple factors to consider?
- How much information needs to be conveyed to satisfy the searcher?
**(2)** *What is the known component of the intent?*
**(3)** *What is the unknown component of the intent?*
**(4)** *How much effort does the searcher have to put to spot what she is looking for or complete the search task?*
- Does a simple answer satisfy the user? e.g. someone searching for the weather forecast in Boston on a particular day will be satisfied by a simple answer; hence minimal effort is needed. - Does the searcher have to go through a number of different results to make a decision? e.g. someone looking to buy a car needs to investigate a number of different models, prices, mileage, etc.; hence major effort is required.
**(5)** *Is the intent articulated well by the set of queries?*
- If the intent is perfectly predictable from the search queries, then we conclude that the intent is totally expressed (TE).
- If the intent is mostly clear from the search queries in the session, then we conclude that the intent is mostly expressed (ME).
- If the intent can be guessed partially with significant confidence, then we conclude that the intent is fairly expressed (FE).
- If there is little signal to predict the intent from the search queries, then we conclude that the intent is mostly unclear (MU).
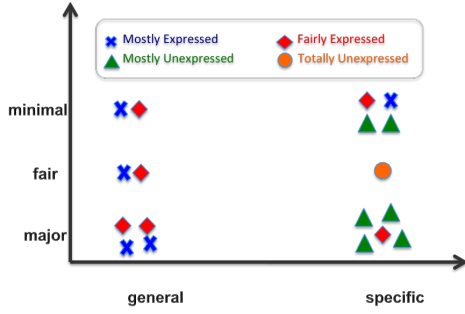- If the underlying intent can not be inferred from the search queries, then we conclude that the intent is totally unclear (TU).

Table 1 summarizes the answers for each of the above questions. It is worth to stress that such findings were in-

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**Figure 1: Expressiveness of the set of queries used in each task with respect to the dimensionality of the problem (X axis) and the effort to completion (Y axis)**

ferred looking both at the search activity and at the users' verbose description of what they are trying to achieve. Search tasks are classified according to a number of different aspects or dimensions the user needs to browse in order to be satisfied. Some tasks, like buying a house, are naturally complex since a lot of information needs to be conveyed to the user before she actually purchases the house. The complexity of the task is directly related to the effort for analyzing all the dimensions of the task. Effort is maximal if the user is at the beginning of his search task, i.e. if the unknown part of the intent is much larger than the known part. This is not always the case: in the example *Vacation to Cabo*, the user has already bought his holiday package so he has already analyzed all the possible dimensions (i.e., flights, hotels, sightsee tours) and the effort to complete his current need (to know whether there is a better deal) is minimal. Motivated by the notion of where the users are positioned with respect to how much is unknown to them, the effort can be **minimal**, **fair** or **maximal**. The last aspect we considered is the generality of the task. In some examples like the *bogaboo stroller* or *things to do in SF* , the main aspect of the unknown part is related to the personal experience of the users or concerns very specific attributes of a more complex object. In the previous cases: we define the task **specific**. All the other tasks are considered to be **general**.

Figure 1 shows how generality and effort influence the expressiveness of the set of queries issued to satisfy an intent. If the task is very general the intent is always expressed (ME, FE) regardless of the effort taken to complete the task. Surprisingly the intent is poorly expressed in the most of the cases in which the search is specific. In such cases the expressiveness is also conditioned on the effort: the intent is poorly expressed in the case of major effort required whereas the expressiveness increases when the effort to completion is minimal.

## 3.2 Insights

During the lab study, we have discussed a number of useful insights that help us understand how users form their intents, and the characteristics of each intent. In this section, we discuss these insights in detail with supporting evidence from the search sessions.

- *Intents have a structure that reflects the user's mental*

model (cognitive objects) [3] at the time of their search for information. The structure may consist of several objects and the relationships between these objects and past experiences.

In the Peruvian literature session, a latin literature teacher searches for readings to include into her course, and she relies on the structure of the text book to shape her search. The book contains chapters, each chapter refers to other books, each book has an author and authors have poems and articles. She follows the same structure when she forms her queries. Hence, they are not reformulations of the same intent or multiple intents, but rather individual pieces of the structure which as a whole defines her intent.

- *There can be a conjunction of intents in which one intent is combined with another in order to complete a task.* One intent may be prerequisite of another intent; hence they are executed in conjunction.

In the bugaboo stroller example, the participant's intent is to sell a used bugaboo stroller in order to buy a double jogging stroller. Hence, some of her queries serve for the selling intent, e.g. "prices for used bugaboo strollers", and the rest serve for the buying intent; e.g. "double jogging stroller".

- *Intent may not solely be limited to what someone wants/needs, but also what someone does not want/need.*

In the example where the participant is looking for things to do in Las Vegas, he is specifically interested in the activities he has not done before during his past trips to Vegas. Similarly, in the example where another participant is looking for restaurants in San Francisco, she wants to find a restaurant that she has never been before. This important detail has not been explicitly conveyed to the search engine in neither case. Since search engines are tailored to retrieve most popular results, these participants will likely not be satisfied by the results. They will need to spend extra effort to spot what they were looking for.

- *Not all queries convey the intent.* Among the queries that are issued with the same underlying intent, there are some queries that do not express the intent. Depending on how articulate the user is, the ratio of such queries may vary.

In the air traffic example[5], the searcher issues a total of 14 queries from which only 5 convey the intent whereas the rest is related but missing the fact that she is interested in knowing the job description and duties of a traffic management coordinator.

## 4. DISCUSSIONS

Our lab experiment has yielded a number of important findings and given us insights to re-visit how search engines should be designed. Depending on whether the user is seeking general or specific information, how well the queries express the intent varies. It is not enough to consider a single query in the session to predict the intent even in the case of well-articulated intents. Furthermore, the position of the user with respect to how much she knows about the search topic changes the criteria for her satisfaction. Although personalization is an emerging topic, the current search engines

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[5]See http://donade.net/papers/2011/QueryRepresentationUnderstanding/queries.pdf for the example

Table 1: Analysis of the Sessions

| Task | Complexity | Known | Unknown | Effort | Clarity | generality |
|---|---|---|---|---|---|---|
| Peruvian literature | complex | content of a course book, latin literature | simpler and shorter readings than those in the book | minimal | MU | specific |
| Things to do in SF | complex | restaurants been before | restaurants not been before, things to do after dinner | major | MU | specific |
| College scholarships | complex | daughter starting UC | college scholarships | major | ME | general |
| A's spring training | complex | Oakland's spring training in Phoenix | lodging, schedule, what to do | fair | FE | general |
| Bareroot roses | simple | the kind of roses | taking care of them | fair | ME | general |
| NFL playoffs 2008 | simple | nfl playoffs 2008 | expert picks, who will win | major | MU | specific |
| Vacation to Cabo | complex | trip already booked | the best deal possible | fair | TU | specific |
| Job Hunt | complex | wants a job | where to look, interview preparation | major | MU | specific |
| Buying a car | complex | buy a Lexus in 2-4 years | their future appearance, pros and cons | major | MU | specific |
| Iphone apps | simple | there exists apps for iphone | all apps, how to do things on iphone | minimal | ME | general |
| Samsung lcd | simple | brand and size he wants | models, reviews, prices | minimal | ME | specific |
| Estate for sale | complex | san jose houses for sale | prices, pictures, whom to contact | major | ME | general |
| Xbox | simple | xbox 360 | news, future releases | major | FE | general |
| Bogaboo stroller | simple | bogaboo model owned, accessories | price to sell | minimal | MU | specific |
| Things to do in Vegas | complex | trip to vegas | interesting things not done before | major | FE | specific |
| Best restaurants in bay area | simple | review sites | particular review site | major | FE | general |
| 2009 cars | simple | there will be new models for 2009 | how the models will look like | minimal | FE | general |
| Car rental | complex | rental car reservation already done | cuopons, deals | minimal | FE | specific |

do not differentiate the retrieval models according to how much information the user has acquired thus far. Ideally, the search engines could alter the results after the user visits a number of links and comes back to the result page. The change should clearly depend on how much the user's knowledge has changed after her visit to the clicked sites. This is certainly a challenging task but it could make a big difference in terms of user satisfaction. Furthermore, the lab studies such as the one we described in this paper could be leveraged to determine if there are any common patterns in the unknown components of similar intents. If this is the case, then we can build models to capture these patterns focusing on the unknown (missing) piece of information.

The notion of result set modification based on the user's current knowledge is only one component of a truely personalized search experience. We have observed that the search tasks are broader and more specific than an one-size-fits-all interface can adapt. We believe that personalization is far more beyond than simple information about the user's gender, age, location, etc. True personalization should take into account an entire spectrum of information about the user; e.g. past actions and history, preferences, cultural and economical information, and so on. We further believe that mere diversification of the search results is inadequate to compensate for the search engine's lack of knowledge of what is in the user's mind. Every user is unique; hence, a general diversification scheme is far from satisfactory to truly cover all possible alternatives.
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## 5. REFERENCES

[1] A. Broder. A taxonomy of web search. *SIGIR Forum*, 36(2):3–10, 2002.

[2] K. A. Ericsson and H. A. Simon. *Protocol Analysis: Verbal Reports as Data*. MIT Press, 1993.

[3] G. Lakoff and M. Johnson. *Philosophy in the Flesh: The Embodied Mind and its Challenge to Western Thought*. Basic Books, New York, 1999.

[4] M. B. Miles and A. M. Huberman. *Qualitative Data Analysis*. Sage Publications, Thousand Oaks, CA, 1994.

[5] J. P. Spradley. The ethnographic interview. *Forth Worth*, 1979.