Search Patterns in Nature: Informing Computer Search Interfaces

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Summary

A common pattern of search recurs at every level in nature, from insect behavior to plate tectonics. In every case, the search is for the most efficient route to resolution, where the location of the resolution is not known in advance. This is achieved by an "Always Forward" search mechanism that reduces stress while providing for maximum overall search efficiency.

This natural search mechanism is strikingly suited to the needs of information search.

An "Always Forward" Search UI presents results in the context of multitudes of other results, creating unlimited navigational paths, all of which bring the user closer to the desired result with every selection. The data tagged and coded into the Semantic Web provides the three-dimensional, relational infrastructure on which to build such a UI.

Advantages include reduction in mental stress and fatigue, an efficient path to desired information, and a truly satisfying search experience.

The Challenge

Many elements of today's computer search interfaces are antagonistic to the natural thinking patterns of the human mind. Forcing users to backtrack from dead ends and to cycle between data processing modes (filtering, skimming, and reading) creates mental tension, resistance and fatigue. These problems are exacerbated on the mobile device platform, with its limited input capability, minimum display size, and high data download costs of fees and time.

A frustrated, opt-out user uses less data network time, views and clicks through fewer ads and links, and is less satisfied with his mobile device. "If the user ain't happy, ain't nobody happy."

The challenge: to create the ultimate "win-win" mobile search environment. Win for the operators, win for the manufacturers, win for the advertisers and content providers. This all depends upon a positive user experience. In this essay, I explore the overall usability benefits of three-dimensional input methods, and their application to mobile search specifically.

On a more practical level, real-world barriers to creating a truly wonderful search experience include the need to coordinate the roadmaps of multiple strategic and business partners. Maintaining creative and forward-thinking dialogue between manufacturers, content providers and operators requires a substantial effort for implementation of any novel interface to be realized. In this case, the challenge is to create a search environment from the ground up that places realistic demands on the hardware, software, and network technologies that will be widely available in the coming 2-5 years.

Identifying the Need

MARKET NEED. As society relentlessly moves towards an always-connected and increasingly mobile lifestyle (laptops outselling desktops, one-laptop-per-child project, number of mobile devices sold vs. number of computers), mobile search will inevitably take on increasing importance to individuals as a portal to information and sales [1].

Additionally, mobile service operators urgently seek to increase data usage revenues, coinciding with a plateau in voice service usage.[2]

As expectations for free information and applications grow, new and recycled models for monetizing search services must be implemented. This notably includes sponsored links and paid ad placement (eg, banner ads), among others.

For any revenue model to be successful on the mobile platform, issues relating to the parceling of valuable display space become paramount. Ads that take up too much of a search results screen will not only be resented, they will render useless the search itself.

USABILITY NEED. Core elements of today's computer search engines work in direct opposition to the comfort zone of the human mind and its patterns of thinking. For example, the linear presentation of results provided by the most frequently-used search engines (Google, Yahoo!, Ask) demands that the person searching cycle between visually filtering batches of results by title, website, or excerpt for potential relevance (first level filtering); opening and scanning promising pages to confirm their relevance (horizontal search); and reading page contents in-depth, following further links or switching pages within a site, to retreive the relevant information (vertical search).

Constant switching between different modes of data filtering substantially slows mental processing, increases load on short-term memory, and is generally more mentally fatiguing.

Some current methods that attempt to relieve this unnecessary mental effort include: tag cloud results presentation (providing a simultaneous second dimension of information, such as relevance or popularity, eg, Quintura); options to "Find other links like this" (eg, Google); grouping results by file type (MP3, image, maps, businesses, eg, Ask.com); and increasing contextual request information (guiding the user to select a search category such as directions, business or web, eg, Yahoo! Go; gathering ZIP or GPS

[1] Search Counts
Google is the number one web site visited by both US and UK mobile users, accessed by about 62% and 31% of smartphone users respectively. In the US, search engine giant Yahoo! comes in second with approximately 34% of visits. In the UK, mobile operator Orange is number two with 22% of smartphone users accessing their site. *(Source: M:Metrics, Inc.)*

Estimates of mobile web use range from 15 percent of US wireless subscribers (M:Metrics) to 30 percent (iCrossing). Of those using their mobile devices to access the internet, about 75 percent use mobile search. *(sources: M:Metrics, Inc. and iCrossing)*

[2] Kendall, P., Wireless Operator Performance Benchmarking Q1 2007. Strategic Analytics (as quoted at dhdeans.blogspot.com, June 23, 2007).

data; incorporating user search history). All of these methods serve to minimize the quantity of information that the user must filter at the top level. None of them directly address the issue of how the user navigates within and between the results that are presented.

When a search query is very specific (for example, the search for a company's phone number), a search engine will typically do a very good job of bringing that data in the first three presented links. When a search query is more general, a lack of knowledge of the user's intentions will be expressed as a lack of specificity in search results. (For example, "rice history" might be a question about Rice University, Condoleezza Rice, or the history of a grain.) Frequently, users themselves are not clear about the precise goals of a search ("I want to know what's going on with my favorite music band.") Thus, even in theory it not possible for every search query to have "one right answer". *Navigation of results must be addressed.* [3]

Particularly on the mobile platform, which is designed for a usage pattern of instant results on-the-go, any application must feel incredibly efficient in use. A sense of wasted time (frustration), excessive download and page selection (expense), or difficulty (failure) will spell the death of any mobile application intended for mass consumption.

"Mobile Search" = I want it NOW. I can't wait, I won't wait.

When a user gets the sense that "I'm not going to find what I want right now" *he stops looking*, because that is almost always the path of least resistance. At the same time, he will also have a small sense of failure. This sense of failure will have a tendency to impede future uptake of the search function. A build-up of many such experiences erodes the likelihood of that the user will try searching in the future, and a greater effort will be required to overcome that tendency — perhaps an urgent need, or strong social pressure.

If search cannot deliver on the promise of "I want it NOW", *it won't be utilized*.

As a universally relevant and frequently accessed function, mobile search is well-placed to serve as a focus for testing mobile usability engineering.

"Always Forward" Search

THE INSPIRATION. If we could understand better how the human mind prefers to process, filter, and navigate large quantities of information, we could create a human-centered search interface that would provide an intuitive, comfortable and non-frustrating search environment.

There is a very strongly recurring pattern that may be seen when a natural force searches for an efficient way to get from a specific point A to a result point B, where the location of point B is not known in advance.

In nature, what is generally seeking to be resolved is a buildup of tension or imbalance — mechanical tension (pressure, faults); movement (water, insect search); growth pressure (veins, nerves, fractals, branches, roots, frost); electrical tension (lightning, nerve signals). There is a tension of built-up movement potential that must go somewhere, and must find its own way to wherever "somewhere" is *(see images)*.

When viewing these images side-by-side, it becomes stunningly clear that there is a similarity of purpose and function. The branching patterns expressed exhibit too much commonality to be ignored.

What do all of these natural phenomena share?

• They are searching for a specific result, not a specific location;

• There is no a priori correct path for getting from point A to point B;

• Efficiency is important to the system (the path of least resistance);

• Multiple paths are explored simultaneously, rather than all resources being invested

[3] Mobile Interface Pain
Mark Grandcolas, CEO of Caboodle Networks, notes the generally accepted wisdom that for each click into the menu system, 50% of users will give up trying to buy something, such as a ringtone. *(Source: Search SIG and Mobile Monday session on Mobile Search, reported at www.hojohnlee.com)*

"Surfing the mobile Internet is still hard. The wired Internet didn't really start to explode until search tools like Google made it much easier to find things online." — Eric McCabe, vice president of marketing for JumpTap *(Source: CNET)* The same is proving to be true for the mobile internet, as well.

**Natural Search:
Always Forward**

blood vessels, plant vessels

frost

lightning

insect search behavior

oxidization

in the "most likely" solution

• The search is "Always Forward" — it never backtracks on itself. The path may not always describe a straight line (the shortest path), but it always moves closer to the desired result.

The defining principles may be summarized thusly: Push in all directions at once. Find the path of least resistance. Never look back.

An Always Forward search is incredibly efficient at finding the most efficient path to success, balancing expenditure of energy with the shortest overall time to results. The search path may be visualized as starting from a generally cohesive point, and splitting into a multitude of ever-smaller branches.

THE THEORY. I suggest that human beings, too, have a natural tendency to search following this natural Always Forward pattern, specifically when the search does not have an *a priori* known specific single correct answer.

When filtering large amounts of data, it is imperative that we reduce the number of choices to a manageable level, otherwise we will be simply unable to make any choice at all. Doing this demands filtering, whether by style, color, language or size. By filtering, we categorize as "irrelevant" as much data as possible, so that we can get down to the business of evaluating what is meaningful.

When using desktop search applications, we compensate for the linear presentation of the data by quickly filtering link titles, site addresses, and excerpted text. We choose to "Search only pages in English" (or the language we are most comfortable with). We might also open links into new browser tabs, to help segregate the different mental tasks involved in reviewing the data. None of these compensatory actions is functionally possible on a mobile device, and a single layer of filtering is simply inadequate for the purposes of human search behavior, placing too many demands on the user to provide mental processing power.

When navigating large quantities of information, humans will naturally categorize into general groupings (colors, sizes, types) in order to then cope with each group independently. Then within each group, we again sort and filter, and so on. For the most part, there is no need to retrace our decision-making process; by filtering the data at hand adequately, we can always move forward to the next sorting group, confident that eventually we will come to a manageable number of options which may be considered in more depth. (Some of those options may have been arrived at via more than one path.)

Search in all directions. Find the best choice. Never look back. At its essence, natural search is Always Forward.

THE APPLICATION. We therefore created a storyboard for an "Always Forward" search environment *(see images, appended at end)*. In a practical implementation, the environment would depend not only on standard search algorithms, but would also incorporate semantic web information. Semantically coded data contains the three-dimensional infrastructure of conceptual linkage needed to present a complete, yet manageable, search environment.

By visually presenting results as points in relation to "magnetic" themes, we can hone in quickly on the area of interest most likely to be relevant. At no time are we over-committing ourselves or heading into a dead-end of exploration. Every node, when approached, reveals not only information about itself, but reveals its connectedness in multiple dimensions to other nodes and themes — conceptually (description, FAQ, opinion, news), textually, visually (videos, images), by site type (corporate, blog), by color, by topic. We have become free to navigate and explore the results space according to the meaning and relevance patterns most meaningful to us.

For example, in seeking information about a certain model of mobile phone, we might start with a review, and find that we are working our way over to the blogs. Alternatively, we may find that what draws our interest are product announcements, repair

information, or photographs. Given an appropriate environment, the path we take through the search space will look very much like a natural search, an Always Forward search, because that is the trail that our mental filtering process leaves.

Discussion

A three-dimensional, semantically linked mobile search interface has the potential to radically alter the way we interact and interpret the wide world of information made available to us through the internet. Using a natural model of search may provide a far easier and more satisfying user experience. Further research and development will be required to prove an advantage, and to demonstrate the practical integration of the technologies to support the interaction.

The potential advantages of applying an "Always Forward" approach to mobile internet search include:

- Reduction in overload stress: only a limited number of options need be considered at any one time (major categories at the current level).

- Reduction in task-shifting stress: the processing and short term memory buffers can function most powerfully when similar mental activities are grouped.

- Reduction in decision-points and double-guessing: by always moving forward, the goal becomes clearer as the path becomes defined. Changes in direction are not perceived as mentally costly.

- Overall increased search efficiency: while not always the shortest route in a specific case had the answer been known in advance (for example, to find information again that you once previously found, you would likely choose different search terms), natural search likely offers the highest odds of getting where you want to go in a rational amount of time. One node always leads to other nodes. Mesh connectivity vs. linearity.

A more satisfying mobile search environment can be generated by creation of a fully three-dimensional interface. Such a UI would have results not linearly connected to the link before and after by relevance, but interconnected by meaning, type, popularity and relevance to multitudes of other results, creating an almost unlimited number of navigational paths. Utilizing the data being tagged and coded into the Semantic Web (of whatever type) would give us an open, relational infrastructure on which to build such a UI.

Navigation of a semantic UI requires a dimensional interface / input means, of which some are technologically reaching maturity now, including the technology being developed by Power2B. Along with the logical and software infrastructures, the necessary factors are coming into alignment. Ultimately, we have a vision of a satisfying search environment; a win-win interface for users, search providers, manufacturers, and operators.

Next steps will require integration of hardware, software, and algorithms to build functioning environments in which to perform user studies and guide further development, including validation of the underlying approach, standardization of the UI to increase inter-session predictability, and optimization of the range and variation of 3D space utilized. Cooperation between the market influencers of manufacturers, content providers and operators promises the fastest route to implementation of any novel interface.

Related Reading

Better: A Surgeon's Notes on Performance, by Atul Gawande

The Paradox of Choice: Why More Is Less, by Barry Schwartz

Taking Mobile Search to New Heights, Sarah Lipman, http://www.mobilemonday.fi/event/mobile-search

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Power2B "Always Forward" Semantic Search Interface: Concept Design