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# Homework 4: Distributed Cognition

## Procedural Description

The behavior of the system under observation (the subject, her browser, and the Internet) can be usefully described at multiple levels of detail. Two of these shall be detailed below: first, the details of a specific technique the subject used frequently during completion of the task, and second, the overall procedural structure of her solution.

### Search Technique

Research questions always began with a Google search in a new tab in Firefox. She'd glance through the first handful of links, then click some while holding down the Command key on her Mac, causing the links to open in new tabs to the right of the Google tab. (See image below.)
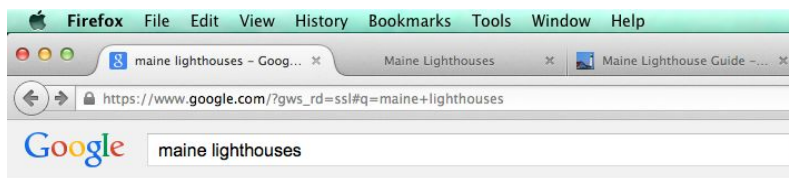


Once she opened three to five links that she'd decided may provide useful information, she proceeded to view them in sequence, glancing through each to evaluate whether it provided relevant information. Tabs whose contents did provide useful information remained open, while those that did not were closed.

If the searched question was not sufficiently answered by the end of the tab sequence, she returned to the Google search results, and either (a) opened more links in new tabs if there more were available with sufficient apparent relevance, or (b) rephrased her search. If her question *was* sufficiently answered, then she Googled her next follow-up question in a new tab (leaving the previous question's tabs open).

### Research Structure

The research process followed a cyclical pattern, alternating between quick exploration of multiple independent options (breadth-first search) and deeper analysis and evaluation of those options (depth-first search).

1. **Breadth-first search**
   ➔ Initially in head
      ◆ "Maine is where Americans go to see lighthouses"

◆ "Prince Edward Island is beautiful and special [to my spouse and me]" [1]
→ Google "**maine lighthouses**"
  ◆ Open / skim two tabs
  ◆ Realize 5-year anniversary is "special" and "decide" on P.E.I.
  ◆ Close "maine lighthouses" search and result tabs
→ Google "**prince edward island lighthouses**"
  ◆ Open / quickly browse two tabs
→ Re-Google "**maine lighthouses**"
  ◆ "Maine could still be fun"
  ◆ Re-click previously clicked links

Once the primary search points were established, she began fleshing out the options and exploring depth-wise, answering questions like "*What would we do if we went here?*", "*Are there interesting things to do there [for me and/or my spouse]?*", or "*How many interesting things are there to do there?*"

2. **Depth-first search**
   → [cont'd.] Re-Google "**maine lighthouses**"
     ◆ Read open tabs more thoroughly
   → Reread task description
   → Google "**average temperature maine july**"; read
   → Google "**average temperature prince edward island july**"; read
   → Google Maps search "**prince edward island from maine**" (brings up directions)
     ◆ Zoom out to view where the destinations are in relation to one another
   → Google Maps search "**niagara falls**"
     ◆ Get directions from Maine, see travel time [~11 hours]
     ◆ "Nope"
   → Google "**things to do in maine**"
     ◆ "Top 30 Things to Do in Maine" (TripAdviser.com)
     ◆ View pictures; open attraction details; read reviews for...
       ● Cellardoor Winery
       ● Colby College Museum of Art

After this period of depth-first search, she appeared unsatisfied with the progress, and returned to a breadth-first search strategy:

3. **Breadth-first search**
   → Google "**where to look at lighthouses in usa**"
     ◆ "10 Best Scenic Lighthouses around the USA" (USA Today)
     ◆ #1: Portsmouth, New Hampshire
     ◆ "The lighthouse looked really pretty, so I Googled Portsmouth"
   → Google "**visit portsmouth**"
     ◆ "5 Reasons to Visit Portsmouth, New Hampshire" (Boston.com)

before again transitioning back to depth-first:

4. **Depth-first search**
   → [cont'd] Google "**visit portsmouth**"

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[1] Prince Edward Island was the location of the subject and spouse's honeymoon.

◆ "Just 60 miles north of Boston"
◆ "We could get the small-town charm of Portsmouth, while being close to Boston where I know there's stuff to do. It's the best of both worlds."

I distinguish the two search types by purpose: in breadth-first search, the goal is to cast a wide net and gather viable ideas; in depth-first search, the goal is to further refine those ideas and evaluate their relative merits. The line is crossed once the idea has been established as a reasonable possibility.

## External Representations & Processes

Beyond the basic interpretation of pages on the Internet as memory, there are a number of other persistent and ephemeral representations involved in the modern Internet research process.

One such representation is the **search query** itself, exchanged verbally (as typed words) between the subject and Google's servers through the search box. This representation is ephemeral and translational: it is a best-effort projection of the user's intended search concept into language, for the sole purpose of inducing the same concept into Google's distributed representation as relevant search results. When Google misidentifies the intended search concept, the user revises her query to communicate more thoroughly and induce a more precise concept.

A more persistent, distributed representation exists in the form of **Google's search indexes**, which are accessed after interpretation of the search query. Retrieval of information from this long-term memory store proceeds in much the same way as human long-term memory: associative links are followed between the query and the stored information, and candidate documents are sorted by both the strength of the association between the query and the document, and the absolute weight assigned to the document itself due to its recency, popularity, etc. (i.e. strength of the memory).[2]

As a way to help manage sifting through and evaluating the data returned from the Google search, the subject took advantage of a modern web browser feature known as **tabs**. Browser tabs acted as a sort of executive working memory store, keeping track of the subject's context as she explored different regions of the pertinent concept graph, freeing up internal cognitive resources for the less computer-friendly task of evaluating the information presented by a particular page.

## Internal Representations & Processes

The subject's primary cognitive task through the whole process was to develop a clear mental picture of what a trip to each candidate destination might look like. Accordingly, the primary representations in her mind were the concepts she had of each destination, which were modified over the course of the task as more information was gathered and applied to the image.

The modern external representations available to the subject freed up significant internal resources,

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[2] Ranking based not only on query terms, but also on properties such as number of references by other documents was the competitive basis of Google's innovative PageRank algorithm.

permitting entirely new modes of accomplishing the task that were not possible 20 years ago. The existence of search engines like Google allowed her cognitive emphasis to be on formulating a picture and posing questions to add detail to that picture, leaving much of the implementation detail of retrieving the information (often previously accomplished by going to the library) to the computer.

Additionally, at a lower-level view, the development of the modern tabbed web browsing experience has simplified the actual executive process of searching for, perusing, and evaluating the relevant information. According to the subject, tabs allowed her to feel like she was consistently moving "forward" in her search, always progressing through new tabs, in sequence, to the right. The feeling of movement provided a physical visual structure from which she could scaffold the mental structure of her internal evaluation process.

## Conclusion

The distribution of cognitive representations in an informal research task freed up significant internal resources for the subject, permitting effective and efficient search strategies to thrive. The computer system provided an increased capacity for both executive memory and long-term memory, permitting the subject's analogous internal resources to be dedicated to visualization, as well as retrieval and application of personal experiences and preferences to the situation at hand.