Capturing and evaluating exploratory search processes on the Web

ISIC2012

Makiko Miwa

Outline

• DEFINITION
• MOTIVATION
• CRES Project
  – Describing Exploratory Search Processes
  – Measuring Exploratory Search Processes
• FUTURE DIRECTIONS

Definition: EXPLORATORY SEARCH

Exploratory search is a specialization of information exploration which represents the activities carried out by searchers who are either:

• unfamiliar with the domain of their search,
• unsure about the ways to achieve their goals,
• unsure about their goals in the first place.

http://portal.acm.org/citation.cfm?id=1719970.1721998

Definition: EXPLORATORY SEARCH

Marchionini,April 2006/Vol. 49, No. 4 COMMUNICATIONS OF THE ACM, p.42

Research tools critical for exploratory search success involve the creation of new interfaces that move the process beyond predictable fact retrieval.
Motivation: Exploratory Search Experience

• My Professional Life
  1978 MLS (U. of Pittsburgh)
  1979-1983 Doctorate (Keio U.)
  1981-1983 Database Manager (U. of Tsukuba)
  1983-1994 Epoch Research Corporation
  1994-2000 Ph.D. (Syracuse U.)
  2000-2009 National Institute of Multimedia Education
  2009-now The Open University of Japan

Sequence of Tasks as a Professional Searcher

– Define information needs and desirable output
– Identify promising information source
– Design well-structured query
– Conduct online search
– Re-define query based on system feedback
– Examine search results
– Obtain documents
– Read documents and extract relevant information
– Interpret information
– Presentation / write a report

Epoch Research Corporation 1983-1994
• Searcher
• Consultant

Writing Magazine Articles

Monthly magazine articles “Adventure of Searchers”
On the Line (House Magazine of a telecom company)

Requisites
• Use online database to locate information on an interesting topic and synthesize obtained information as an informative essay (4 pages)
• Illustrator draw pictorial graphs based on relevant statistical data obtained from databases.
• Unlimited uses of online databases.
Sequence of Tasks as a Writer of “Adventure of Searchers”
- Explore online databases to look for topics
- Tentatively choose a topic
- Search online databases
- Talk to people to get feedback
- Find a focus
- Retrieve numerical data for pictographs
- Interpret information and data
- Develop a storyline
- Write an article

Outline
- DEFINITION
- MOTIVATION
- CRES Project
  - Describing Exploratory Search Processes
- MEASURING EXPLORATORY SEARCH PROCESSES
- FUTURE DIRECTIONS

Mediated-searching vs. Self-searching

<table>
<thead>
<tr>
<th>Search type</th>
<th>Mediated-searching</th>
<th>Self-searching</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topic</td>
<td>Well-defined</td>
<td>Ill-defined</td>
</tr>
<tr>
<td>Process</td>
<td>Structured</td>
<td>Unstructured</td>
</tr>
<tr>
<td>Strategy</td>
<td>Step-wise procedure</td>
<td>Trials and errors</td>
</tr>
<tr>
<td>Feeling</td>
<td>Stable</td>
<td>Unstable</td>
</tr>
<tr>
<td>Knowledge</td>
<td>Deepen</td>
<td>Shift &amp; expand</td>
</tr>
<tr>
<td>Theme</td>
<td>Accomplishment</td>
<td>Creativity</td>
</tr>
</tbody>
</table>
Describing Exploratory Search Process

Objectives
– Understand influence of task types and user types on exploratory search behaviors on the Web
– By conducting psychological experiments
– By transcribing exploratory search by
  • browsing histories
  • screen shifts
  • Eye-movement data
  • Think-aloud protocols
  • Post-experimental interviews

Research Questions
• How users explore on the Web over the result of search engine?
• What users think when they explore on the Web?
• What users learn and how while they are exploring on the Web?

Analysis of server side logs is not enough!

In depth analysis of user information seeing behavior is important

Experimental Design
• Participants:
  – Eleven undergraduate students (Ages 19 – 21; Males: 5, Females: 6) Majors: Economics, literature, electronics engineering, Spanish language, psychology, chemistry, and civil engineering
  – Five graduate students (Age 23 – 28; Males:4, Females:1) Major: Library and Information Science
• Two Search Task (topic = experimental factor):
  – Report task: Gathering information concerning a topic on world history to prepare a report
  – Trip task: Gathering information to plan a trip for their friends and families.

Procedure and Methods
Pre-questionnaire
Report writing or Trip planning
Post-questionnaire
Interview
Instructions
✓ Use your favorite search engines
✓ Bookmark useful Web pages for topics
✓ Time limit is 15 min.
Describing Exploratory Search Process

Experimental setting

- 19-inch LCD monitor
- Eye-tracking system
- Participant A Headrest to prevent them from moving their heads

Recording of experimental data:
- Screen captured video
- Logs of browsing histories
- Eye movements

Windows XP
Firefox

Screen captured video
Eye movements

Participants

Web Graduates
Undergraduates

<table>
<thead>
<tr>
<th>Web action categories</th>
<th>Graduates</th>
<th>Trip</th>
<th>Mean(SD)</th>
<th>Mean(SD)</th>
<th>Undergraduates</th>
<th>Trip</th>
<th>Mean(SD)</th>
<th>Mean(SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Search 9.20 (2.99)</td>
<td>7.80 (5.27)</td>
<td>5.03 (4.97)</td>
<td>6.27 (4.69)</td>
<td>7.80 (5.27)</td>
<td>5.03 (4.97)</td>
<td>6.27 (4.69)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Link 28.60 (17.39)</td>
<td>32.20 (8.57)</td>
<td>13.29 (18.93)</td>
<td>26.44 (8.65)</td>
<td>32.20 (8.57)</td>
<td>13.29 (18.93)</td>
<td>26.44 (8.65)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Next 0.80 (0.75)</td>
<td>0.20 (0.40)</td>
<td>0.45 (0.78)</td>
<td>0.91 (1.08)</td>
<td>0.20 (0.40)</td>
<td>0.45 (0.78)</td>
<td>0.91 (1.08)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Back 10.40 (8.11)</td>
<td>10.80 (7.19)</td>
<td>17.45 (7.51)</td>
<td>22.27 (13.80)</td>
<td>10.80 (7.19)</td>
<td>17.45 (7.51)</td>
<td>22.27 (13.80)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jump 2.20 (1.72)</td>
<td>3.40 (2.25)</td>
<td>2.64 (1.61)</td>
<td>2.64 (1.92)</td>
<td>3.40 (2.25)</td>
<td>2.64 (1.61)</td>
<td>2.64 (1.92)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Browse 0.80 (1.01)</td>
<td>0.60 (1.20)</td>
<td>1.82 (2.25)</td>
<td>0.18 (0.57)</td>
<td>0.60 (1.20)</td>
<td>1.82 (2.25)</td>
<td>0.18 (0.57)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Submit 7.60 (11.1)</td>
<td>4.60 (8.48)</td>
<td>1.27 (2.60)</td>
<td>3.00 (2.80)</td>
<td>4.60 (8.48)</td>
<td>1.27 (2.60)</td>
<td>3.00 (2.80)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bookmark 8.50 (1.25)</td>
<td>2.50 (5.76)</td>
<td>4.55 (2.30)</td>
<td>4.55 (2.30)</td>
<td>2.50 (5.76)</td>
<td>4.55 (2.30)</td>
<td>4.55 (2.30)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change 43.40 (23.55)</td>
<td>28.45 (13.65)</td>
<td>2.45 (5.37)</td>
<td>3.55 (3.33)</td>
<td>28.45 (13.65)</td>
<td>2.45 (5.37)</td>
<td>3.55 (3.33)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Close 4.20 (3.54)</td>
<td>6.00 (8.79)</td>
<td>0.36 (0.64)</td>
<td>2.36 (1.71)</td>
<td>6.00 (8.79)</td>
<td>0.36 (0.64)</td>
<td>2.36 (1.71)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Bold string and gray background intend to group influence
Italic and underline intend to task influence

Describing Exploratory Search Process

Data Analysis Procedure

- Indexing Data Using Time-stamp (COPATT)
  - Browser log; Screen-captured video; Eye-movement data; Video-captured interview data...
- Content Analysis (Atlas.ti)
  - Think-aloud data; Interview data
- Taxonomy of Knowledge Modification
- Taxonomy of Knowledge Use

Describing Exploratory Search Process

Quantitative Analysis: Web action categories

- Search: searching with a search engine
- Link: clicking on a page link
- Next: going forward to the next page
- Back: going backward to the previous page
- Jump: going to a page in the Bookmark or History
- Browse: browsing the next search results of search engine
- Submit: clicking a submit button on a Web service
- Bookmark: adding bookmarks
- Change: changing from one tab to another
- Close: closing a tab or window
Describing Exploratory Search Process

Quantitative Analysis: Web action categories

<table>
<thead>
<tr>
<th>action categories</th>
<th>Graduates</th>
<th>Undergraduates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Report</td>
<td>Trip</td>
</tr>
<tr>
<td></td>
<td>Mean(SD)</td>
<td>Mean(SD)</td>
</tr>
<tr>
<td>Search</td>
<td>9.20 (2.99)</td>
<td>7.80 (5.27)</td>
</tr>
<tr>
<td>Link</td>
<td>28.80 (1.28)</td>
<td>33.20 (8.57)</td>
</tr>
<tr>
<td>Next</td>
<td>0.80 (0.75)</td>
<td>0.20 (0.46)</td>
</tr>
<tr>
<td>Back</td>
<td>10.40 (8.11)</td>
<td>10.80 (7.19)</td>
</tr>
<tr>
<td>Jump</td>
<td>2.20 (1.72)</td>
<td>3.40 (2.25)</td>
</tr>
<tr>
<td>Browse</td>
<td>0.80 (1.17)</td>
<td>0.60 (1.20)</td>
</tr>
<tr>
<td>Submit</td>
<td>7.60 (11.29)</td>
<td>6.60 (4.84)</td>
</tr>
<tr>
<td>Bookmark</td>
<td>8.00 (1.26)</td>
<td>6.00 (5.78)</td>
</tr>
<tr>
<td>Change</td>
<td>43.60 (23.59)</td>
<td>28.80 (17.85)</td>
</tr>
<tr>
<td>Close</td>
<td>4.20 (3.54)</td>
<td>6.00 (8.79)</td>
</tr>
</tbody>
</table>

Bold, string and gray background intend to group influence
Italic and underline intend to task influence

Number of SERP pages viewed for each task and each group

Conceptual diagram of Link Depth

Visualization of Link Depth

Examples of visualization for all search behaviors for a single undergraduate student

The participant’s behaviors are different from each task
Report task
Most of pages viewed by the participant are near the SERP.
Trip task
The participant explored more deeply.
Examples of visualization for all search behaviors for a single graduate student

The graduate student behaviors are little differences between tasks.

The participant view various Link Depth's pages

Link Depth values during the execution of each task

Describing Exploratory Search Process

Characteristics of Exploratory Search on the Web

- Begins with learning topic of the search
- Focus formulation leads to structured search on the topic
- Encountering with non-relevant but interesting information leads to temporal deviation from the task goal
- Search process is isomorphic with the berrypicking model
  - Begins with a broad query
  - Encountered chunks of information give new ideas and directions
  - New questions and queries emerge throughout the process
  - Identify useful (pertinent) information on each step

Differences Between Report vs. Trip Task

Report Task
- Everyone used Wikipedia
- Experienced writers seem to have a schema in preparing papers
  - Pick a general topic of the report => Obtain a sketch of the topic (Wikipedia)
  - Pick-up important citations => Check review articles including customer reviews
  - Look for books using library OPAC
  - Look for journal articles using E-journals and bibliographic data bases

Trip Task
- Need to make decision to go to new step.
- Decision-making is based mainly on feelings.
- Experienced trip-planners using Web seem to have a scheme in preparing trips
  - Destination and activities
  - Transportation and route
  - Accommodation
  - Food and Souvenir

Participants explored deeper in Trip task than in Report task.

- May reflect the relationship between tasks and the physical characteristics of the Web.
  - Report task: desired information may be static Web pages available directly from search engines.
  - Trip task: required to use Web services (eg. hotels, transportation methods etc.)

Graduates viewed pages with Link Depth more than undergraduates.
- Graduates added bookmark more than undergraduates.
- Graduates clicked links more than undergraduates for report task.

=> Graduates may search more effectively than undergraduates in the report task.
Differences Between LIS Graduates and Undergraduates

Use Wikipedia
- LIS Graduates: look for literature to be cited in paper
- Graduates: look for chunks of information to be used as a content of paper

Use of Amazon
- LIS Graduates: look for relevant books and customer reviews

Use of OPAC
- LIS Graduates: check holdings, reserve, ILL

Use of Tabs
- LIS Graduates > Undergraduates

Use of Copy & Paste
- LIS Graduates > Undergraduates

Query style: Graduates tend to use keywords combined with information sources (e.g., "Hawaii wiki")

=> LIS Graduates tend to use wider range of search techniques than graduate probably because they are more used to literature search

=> LIS Graduates tend to conduct more efficient search than Undergraduates for Report task but not for Trip task.

Theoretical Implications

Type of Knowledge Used

How to Use Search Engine
LIS Graduate > Undergraduates

How to Use Information Sources
- Report Task: LIS Graduates > Undergraduates
- Trip Task: LIS Graduates > Undergraduates

How to Proceed Web Searching
- Report Task: LIS Graduates > Undergraduates
- Trip Task: LIS Graduates = Undergraduates

Preliminary Knowledge on the Topic:
- Context dependent

A New Question: What is Exploratory Search Skills?

Methodological Implications

Do Eye-movement data help recall search process?

Easier to remember thought process for exploratory search when you see eye-movement data on the screen

No difference for Lookup Search whether you see eye-movement data on the screen

Outline

- DEFINITION
- MOTIVATION
- CRES Project
  - Describing Exploratory Search Processes
  - Measuring Exploratory Search Processes
- FUTURE DIRECTIONS

Research: CRES Project

Measuring Exploratory Search Process

- Background
  - Previous studies on user-centered evaluations and exploratory search systems:
    - Can users effectively seek information?
    - Can they conduct Exploratory Search by interaction with the systems?
    - Previous studies: What can users acquire from information sources found?
  - Focus: users' cognitive changes during exploratory search

- Objectives
  - User's cognitive changes by search:
    - How can we measure changes in the user's knowledge structure, before/after Exploratory Search?
  - Concept map: describe learners' knowledge modifications

Concept Map (Cmap)

Example of concept map about plants
**Measuring Exploratory Search**

**Conceptual Framework & research Questions**
- Related Studies in IR & IS context:
  - Cole et al., 2007; Halttunen and Järvin, 2005; Pennane and Vaarani, 2008

**Method**
- Used Concept maps to represent user's knowledge structures & changes

**CRES project**
- Tool to analyze effectiveness of Exploratory Search supporting systems
- Measure depth/width of knowledge modification
- Examine affects of topics for searching and affects of search task scenarios

**Research Questions**
- RQ1: What differences can be observed between pre- and post-search concept maps?
- RQ2: How do differences between topics, scenarios and browser types influence changes in user's concept maps?

---

**Procedure**

<table>
<thead>
<tr>
<th>Preparation</th>
<th>1st Search Task</th>
<th>Post-Search Cmap for Topic</th>
<th>Questionnaire for Task</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**1st Search Task**

<table>
<thead>
<tr>
<th>Practice of Cmap</th>
<th>Instruction of Task</th>
<th>Pre-search Cmap for Topic</th>
<th>Search</th>
<th>Post-search Cmap for Topic</th>
<th>Questionnaire for Task</th>
<th>Instruction of Task</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Closing**

<table>
<thead>
<tr>
<th>Closing</th>
<th>Closing Questionnaire</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Analysis Method: Overview (1)**

- **concept map → directed graph**

**Using graph components**
- Node
- Link
- Link label

**Data preparation**

Each concept map transcribed into graph's format.
Example of concept map generated using GraphViz dot command

Numbers of nodes, links, and link labels

Effect of change in government

Hatoyama Mrs. Sachi Hatoyama

Anxiety

Yamba Dam

Akihabara Electric City

Otaku

Aso, former PM

Hall of Fame in Animation

Politicians

Initiative

Bureaucrat

Yamba Dam voters

Rights to vote is caused by decreases with desire, have dropped the plan of planned support that attracts the interest of its counterpart of is consistent with

Analysis Results:
Number of nodes = 16
Number of links = 15
Number of link labels = 15

Summary: number of graph components in concept maps (n=70)

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>Median</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of nodes</td>
<td>6</td>
<td>61</td>
<td>22.89</td>
<td>21</td>
<td>9.92</td>
</tr>
<tr>
<td>Pre_Node</td>
<td>8</td>
<td>57</td>
<td>23.93</td>
<td>21</td>
<td>10.72</td>
</tr>
<tr>
<td>Post_Node</td>
<td>5</td>
<td>60</td>
<td>23.06</td>
<td>21</td>
<td>10.20</td>
</tr>
<tr>
<td>No. of links</td>
<td>7</td>
<td>77</td>
<td>24.76</td>
<td>22</td>
<td>11.35</td>
</tr>
<tr>
<td>Pre_Link</td>
<td>0</td>
<td>36</td>
<td>12.51</td>
<td>11</td>
<td>9.57</td>
</tr>
<tr>
<td>Post_Link</td>
<td>0</td>
<td>35</td>
<td>12.86</td>
<td>12</td>
<td>10.10</td>
</tr>
<tr>
<td>No. of link labels</td>
<td>0</td>
<td>36</td>
<td>12.51</td>
<td>11</td>
<td>9.57</td>
</tr>
<tr>
<td>Pre_LLabel</td>
<td>0</td>
<td>35</td>
<td>12.86</td>
<td>12</td>
<td>10.10</td>
</tr>
<tr>
<td>Post_LLabel</td>
<td>0</td>
<td>36</td>
<td>12.51</td>
<td>11</td>
<td>9.57</td>
</tr>
</tbody>
</table>

• Average number of nodes (22–23) and links (23–24)
• Numbers of nodes and links show similar tendencies
  => One node usually has a single link

Similar tendencies

Summary: number of graph components in concept maps (n=70)

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>Median</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of nodes</td>
<td>6</td>
<td>61</td>
<td>22.89</td>
<td>21</td>
<td>9.92</td>
</tr>
<tr>
<td>Pre_Node</td>
<td>8</td>
<td>57</td>
<td>23.93</td>
<td>21</td>
<td>10.72</td>
</tr>
<tr>
<td>Post_Node</td>
<td>5</td>
<td>60</td>
<td>23.06</td>
<td>21</td>
<td>10.20</td>
</tr>
<tr>
<td>No. of links</td>
<td>7</td>
<td>77</td>
<td>24.76</td>
<td>22</td>
<td>11.35</td>
</tr>
<tr>
<td>Pre_Link</td>
<td>0</td>
<td>36</td>
<td>12.51</td>
<td>11</td>
<td>9.57</td>
</tr>
<tr>
<td>Post_Link</td>
<td>0</td>
<td>35</td>
<td>12.86</td>
<td>12</td>
<td>10.10</td>
</tr>
<tr>
<td>No. of link labels</td>
<td>0</td>
<td>36</td>
<td>12.51</td>
<td>11</td>
<td>9.57</td>
</tr>
<tr>
<td>Pre_LLabel</td>
<td>0</td>
<td>35</td>
<td>12.86</td>
<td>12</td>
<td>10.10</td>
</tr>
<tr>
<td>Post_LLabel</td>
<td>0</td>
<td>36</td>
<td>12.51</td>
<td>11</td>
<td>9.57</td>
</tr>
</tbody>
</table>

Numbers of pre- and post-search graph components show similar tendencies.

Metrics of Difference between Pre- and Post-search Concept Maps

• Metrics of difference between pre- and post-search concept maps:
  – Common, New, and Lost graph components
• Analysis:
  – Numbers of common, new, and lost graph components

Common nodes

Common nodes: those having the same label

By the same participant
Summary: common, new, and lost graph components (n=70)

<table>
<thead>
<tr>
<th>Component Type</th>
<th>Min.</th>
<th>Max.</th>
<th>Mean</th>
<th>Median</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common Node</td>
<td>1</td>
<td>30</td>
<td>6.1</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>New Node</td>
<td>6</td>
<td>52</td>
<td>15.9</td>
<td>14.8</td>
<td></td>
</tr>
<tr>
<td>Lost Node</td>
<td>3</td>
<td>51</td>
<td>16.7</td>
<td>14.5</td>
<td></td>
</tr>
<tr>
<td>Common Link</td>
<td>9</td>
<td>15</td>
<td>2.7</td>
<td>2.1</td>
<td></td>
</tr>
<tr>
<td>New Link</td>
<td>7</td>
<td>54</td>
<td>22.0</td>
<td>18.3</td>
<td></td>
</tr>
<tr>
<td>Lost Link</td>
<td>4</td>
<td>56</td>
<td>20.3</td>
<td>19.5</td>
<td></td>
</tr>
<tr>
<td>Common Link Label</td>
<td>0</td>
<td>8</td>
<td>1.1</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>New Link Label</td>
<td>0</td>
<td>31</td>
<td>11.5</td>
<td>11.1</td>
<td></td>
</tr>
<tr>
<td>Lost Link Label</td>
<td>0</td>
<td>34</td>
<td>11.1</td>
<td>11.1</td>
<td></td>
</tr>
</tbody>
</table>

- Numbers of common components smaller than numbers of new & lost components
- Post-search cmaps are greatly modified from pre-search cmaps

Influences of experimental factors: Topics, scenarios, and browser types

- ANOVA analysis: number of common, new, lost graph components and three experimental factors
  - Significant differences in only common nodes and common link labels between scenario factors

Research: CRES Project

- Measuring Exploratory Search Process

  - RQ1: What differences observed between pre- and post-search cmaps?
    - Analysis: Major changes between concept maps before and after exploratory search tasks
    - Many graph components in pre-search concept maps were lost
    - Many new components appeared in post-search concept maps
  - RQ2: How do differences between topics, scenarios and browser types influence changes in user’s concept map?
    - No differences: Topic and Browser type
    - Scenario factor: Numbers of both common nodes and link labels in As-Many-As scenario smaller than in Selective scenario

Conclusions

- Concept maps: evaluated how users change knowledge structure through exploratory search process
- User experiment:
  - Task: Information-gathering
  - Factors: topic, scenario, browser type
- Analysis: concept maps as directed graphs
  - Metrics: Common, new, and lost graph components
- Results:
  - Concept maps changed significantly after web search
  - Fewer common nodes and link labels in As-Many-As scenario than in Selective scenario

Outline

- DEFINITION
- MOTIVATION
- CRES Project
  - Describing Exploratory Search Processes
  - Measuring Exploratory Search Processes
- FUTURE DIRECTIONS
Future Directions

Describing Exploratory Search Processes:
- Synthesize qualitative and quantitative data
- Study Exploratory Search Processes of a Wider range of population

Measuring Exploratory Search Processes:
- Develop a user-based measure for exploratory search

Ultimate Goal:
- Design a friendly user-interface for exploratory search

Tools Developed by CRES Project

Analytical Frameworks
- Lookzone: set of categories indicating parts of result pages was looked at
- Web action categories: 10 action categories for analyzing users' behavior
- Taxonomy for knowledge modification
- Taxonomy for knowledge use

Tools for collecting and analyzing data
- Scanpath2SVG: visualization tool for eye movement data
- CORINT: platform for integrating browsing history logs, screenshot video, eye movement, and annotating user actions
- CP: Money new client side logging tool based on Lemur Query Log Toolbar (Jemur project)
- VizCMaps: combines pre- and post-search concept maps with common, new, lost graph components, helps to analyze changes in two maps visually

For more detail, please visit our Web site.
http://cres.jpn.org/

Information behavioral Grammar Model

Distal Goal
- Goal-generating Factors
- Pretended Rationality
- Deadline
- Time-pressure
- Type of Expected Information
- Evaluation of Mediated Search Service
- Perceived Self-efficacy
- Shift of Emotion
- Mental Model of the Mediated Search service
- Use Experience of the Mediated Search Service

Immediate Goal
- Prior Self-searching Results
- Shift of Emotion
- Use Experience of the Mediated Search Service

Degree of Freedom
- Change of Information Needs

For more details, please visit our Web site:
http://cres.jpn.org