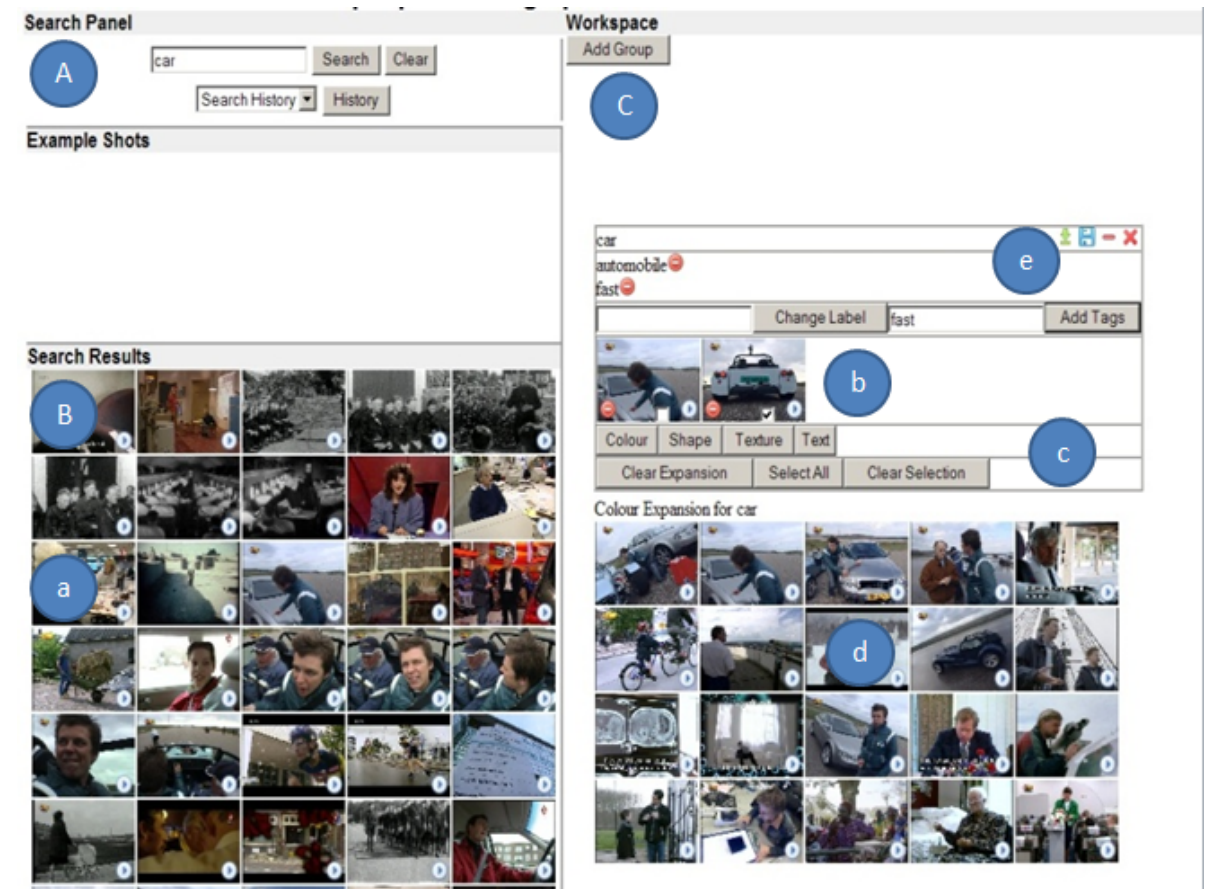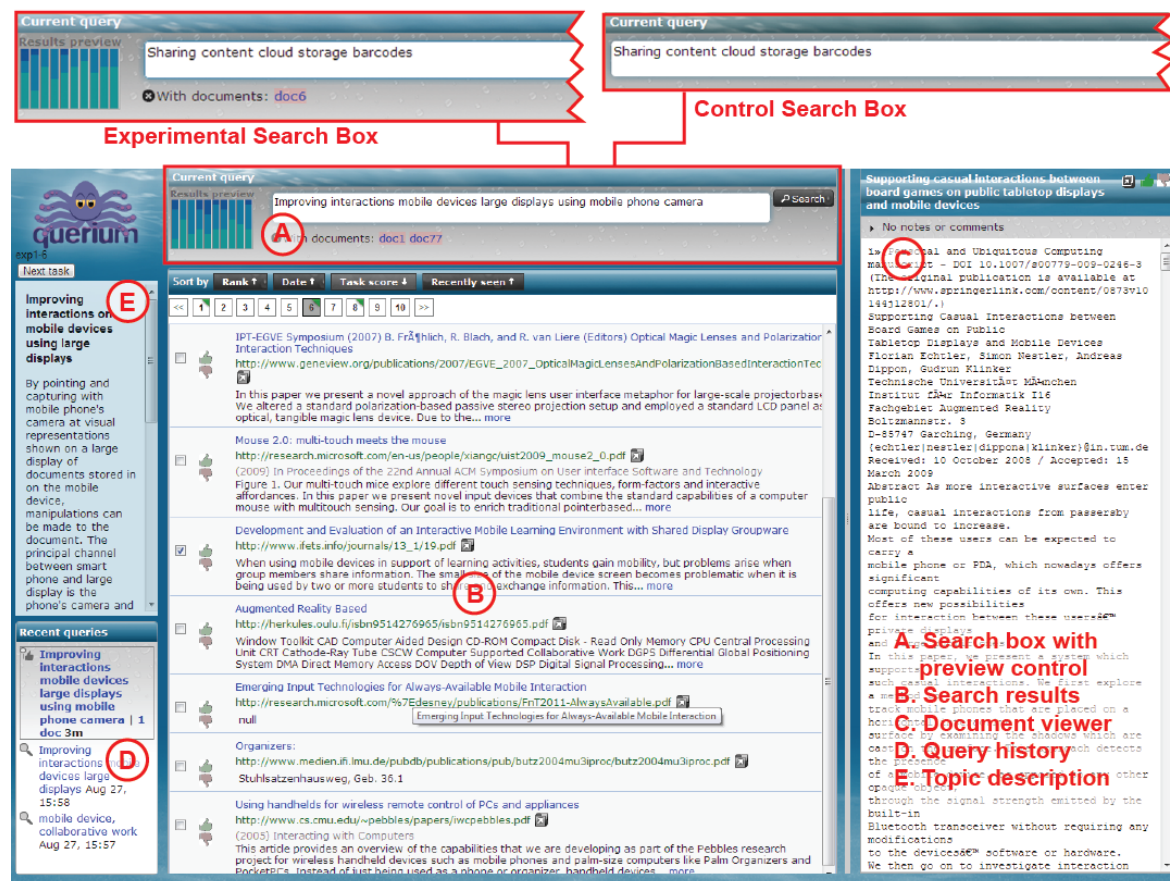# Beyond actions: Exploring the discovery of tactics from user logs

Jiyin He, Pernilla Qvarfordt, Martin Halvey,
(the late) Gene Golovchinsky

Search log analysis: at action level

A. Search box with preview control
B. Search results
C. Document viewer
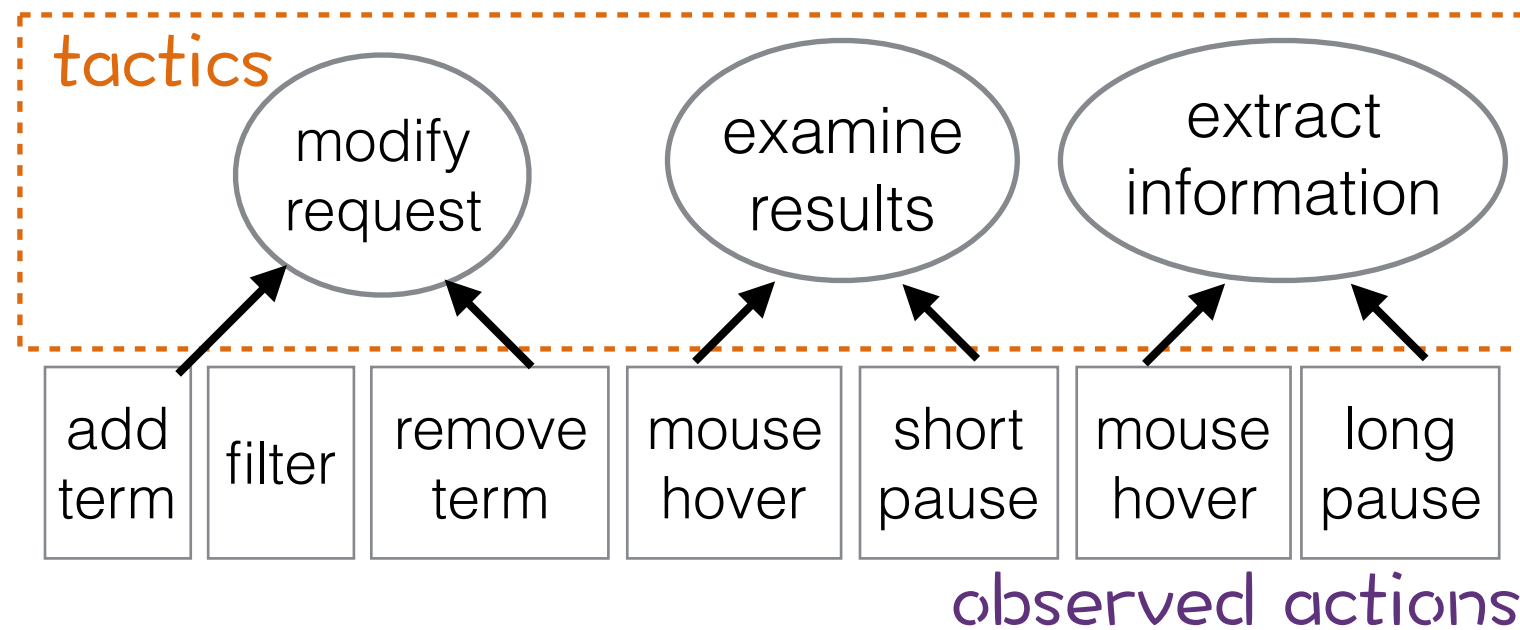D. Query history
E. Topic description

How do we compare user search behaviours between the two systems?

Issues: comparability and interpretability

Search log analysis: beyond actions

- Describe user activities as tactics defined in information seeking theory

- Interpretability

  Explicitly model associations between user actions and tactics

- Comparability

 Users apply the same tactics to different search interfaces

- In lab studies: with manual coding — hard to scale

- Clustering based approach (e.g. HMM) — hard to interpret the resulting clusters

What is this study about?

- How do we identify search tactics from search logs in a scalable and interpretable manner?

  ‣ An exploration of methods

- How do we use the identified tactics to compare user search activities across different systems?

  ‣ An exploration of measures and applications

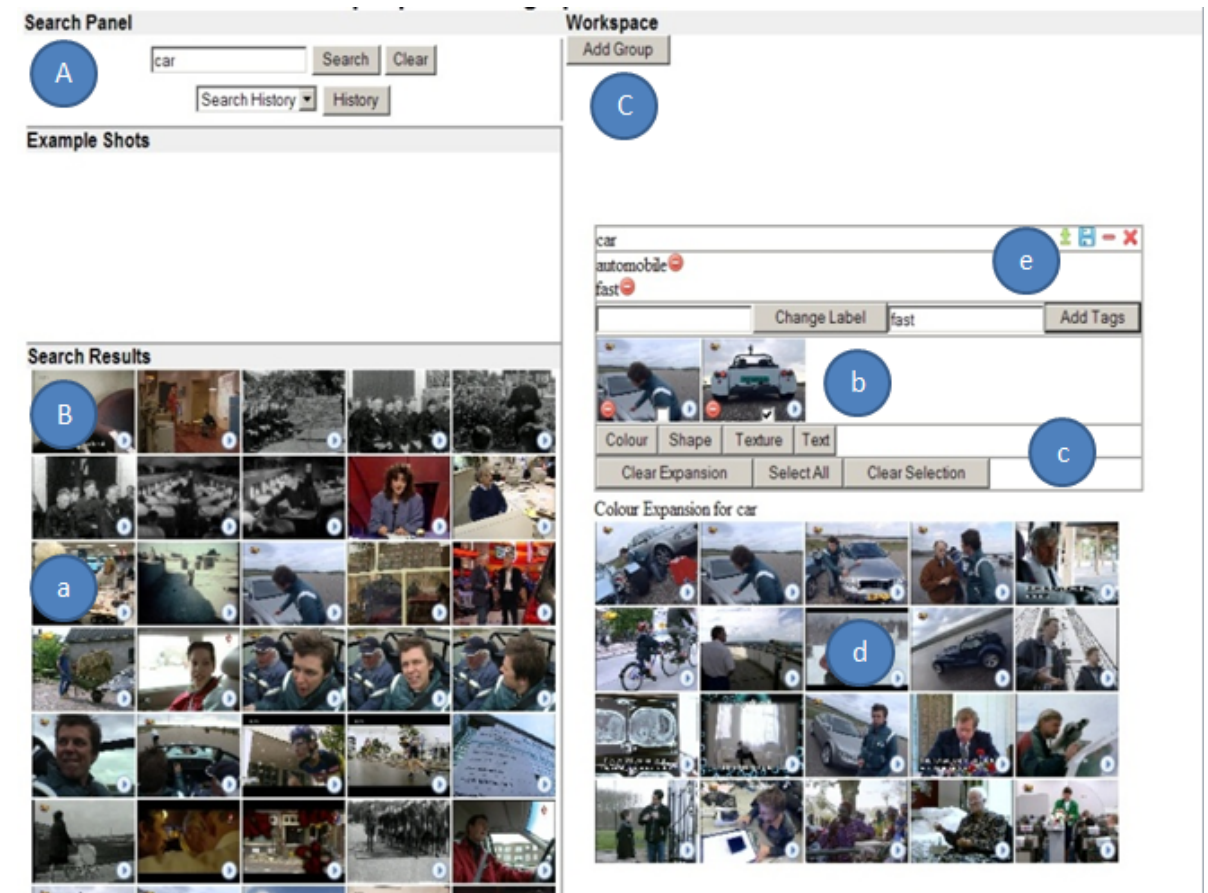# Reference systems

Querium
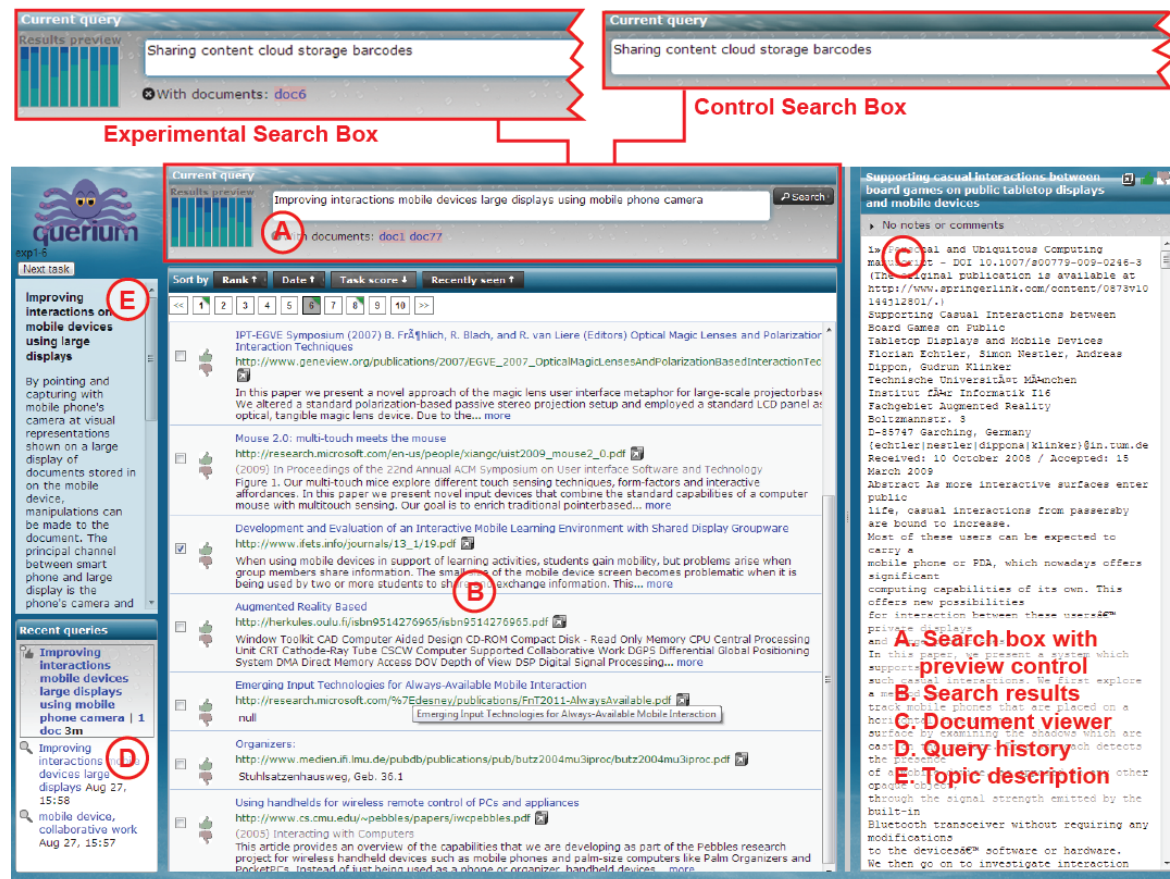
ViGOR

13 participants, 6 tasks,
78 sessions
conditions: w/wo preview
9 action types

16 participants, 8 experts, 8 novices
96 sessions
conditions: w/wo grouping
17 action types

Procedure for search tactic identification

- **Action parsing**: parse the log and prepare the data to provide necessary information for tactic identification.

- **Determine target tactics**: decide on a set of tactics that are supported by the system and can be observed from system usage.

- **Action segmentation**: segment action sequences in a log into meaningful units e.g. that can be interpreted as search tactics.

- **Tactic classification**: classify the action segments into target search tactics.

Target tactics

- "A move made to further a search" (Bates 1979)

  ‣ Various proposals/models (e.g. Bates 1979, Marchionini 1995, Belkin 1995)

- Our approach to determine a set of target tactics

  ‣ tactics should be supported by the system

  ‣ tactics should be identifiable from the log

  ‣ tactics are at operational level rather than cognitive level (due to limited information recorded in our data)

  ‣ Modified Marchionini's ISP model (1995):

    ‣ "formulate query (FQ)," "execute search (ES)," "examine result (ER)," and "extract information (EI) + "Review history" (RV); "Organising results (ORG)"

Action segmentation and tactic classification

- Manual: resolve disagreements through discussion

- Heuristic rules

  ‣ Segmentation: rules to group repeating (L1), semantically close (L2), fixed combination (L3), and un-intentional triggered actions (L4)

  ‣ Classification: rules to map individual actions, disambiguate actions, and handle L3 and L4 segments

- Statistical models

  ‣ A sequence labelling approach with CRFs

  ‣ Training data: heuristic rules + manual correction

A lot more details in the paper …

Lessons learnt

- Manual coding: accurate, but tiring, even with a dedicated labelling tool (yes, we made one)

- Heuristic rules: possible to derive a set of simple rules to achieve high accuracy (F1 > 0.95)

  ‣ Rule coverage: depending on the log/system, user behaviours turn out to be more diverse/regular

    - Segmentation: Querium (>60% data), ViGOR (>20% data)

    - Tactic classification: Querium (>20% data), ViGOR (>40% data)

- CRFs based method: similar accuracy (F1 > 0.9) with a small training set (20% data)

Numbers in the paper ...

What can we do with the identified tactics?
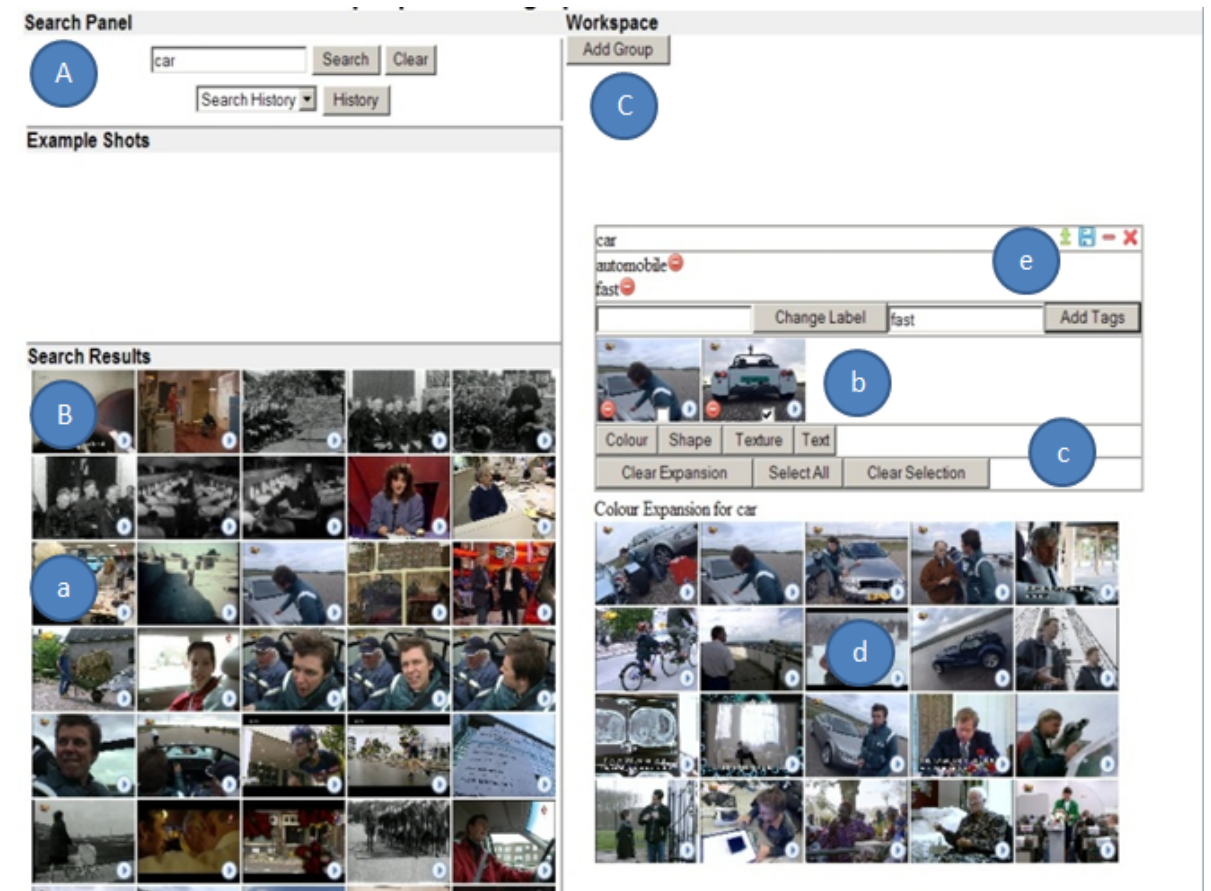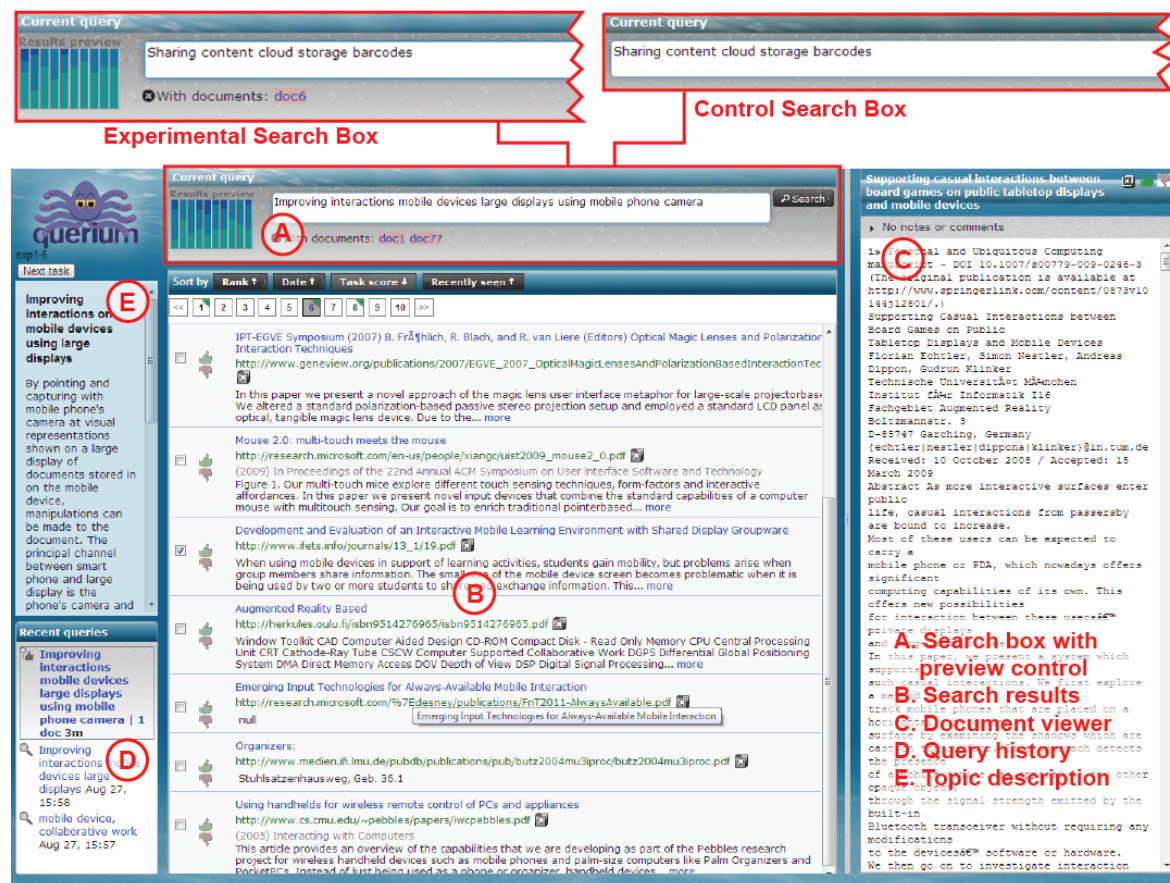
Can we now compare user search behaviours between the two systems?

Entropy as a single measure of tactic transition patterns

- Tactic sequences as Markov chains

- Entropy rate of the chain $\quad H_t = -\sum\limits_{i=1}^{s} \pi_i \sum\limits_{i,j=1}^{s} p_{ij} \log p_{ij}$

  ‣ Low H_t: user's tactic transitions are highly predictable

  ‣ High H_t: user makes no clear patterns in progress

- Entropy of the stationary probability $\quad H_s = -\sum\limits_{i=1}^{s} \pi_i \log \pi_i$

  ‣ Low H_s: some tactics are preferred over others

  ‣ High H_s: there is no clear preference among tactics

Some possible hypotheses

- **Comparing systems:** *when introducing a new feature in a search system, users are likely to*

  H1.1: display a higher level of randomness in choice of search tactics compared to traditional search systems independent of type of search (i.e. increase H_t).

  H1.2: display a less uniform distribution of search tactics since the new features are targeted towards particular tactics. (i.e. increased H_s)

- **Comparing user groups and search sessions:**

  H2.1: Search experts are likely to be more predictable in their choice of search tactics compared to novices independent of search user interface.

  H2.2: Search experts have developed a set of search tactics they prefer over others, while novices use search tactics more uniformly.

  H2.3: While working with a search system novices will find a preferred method of transitioning from one search tactic to another, i.e., their search tactics transitions will become more predictable over time.

  H2.4: While working with a search systems novices will find preferred search tactics to use, i.e., their distribution of search tactics will become less uniform over time.

Comparing systems: tactic transitions

- No significant main effects, but a significant interaction effect (F(1, 24)=20.226, p < .0001)

  ‣ Two-way repeated measurement ANOVA: systems (Querium vs. ViGOR) and conditions (Control vs. Experimental);

  ‣ each subject performs 2 tasks, sample from two systems rebalanced

- Introducing new features has different effect on user tactic transition patterns in different systems

  ‣ Querium: decreased H_t (v = 0.586, p < .01)

  ‣ ViGOR: increased H_t (v=-0.792, p < .001)
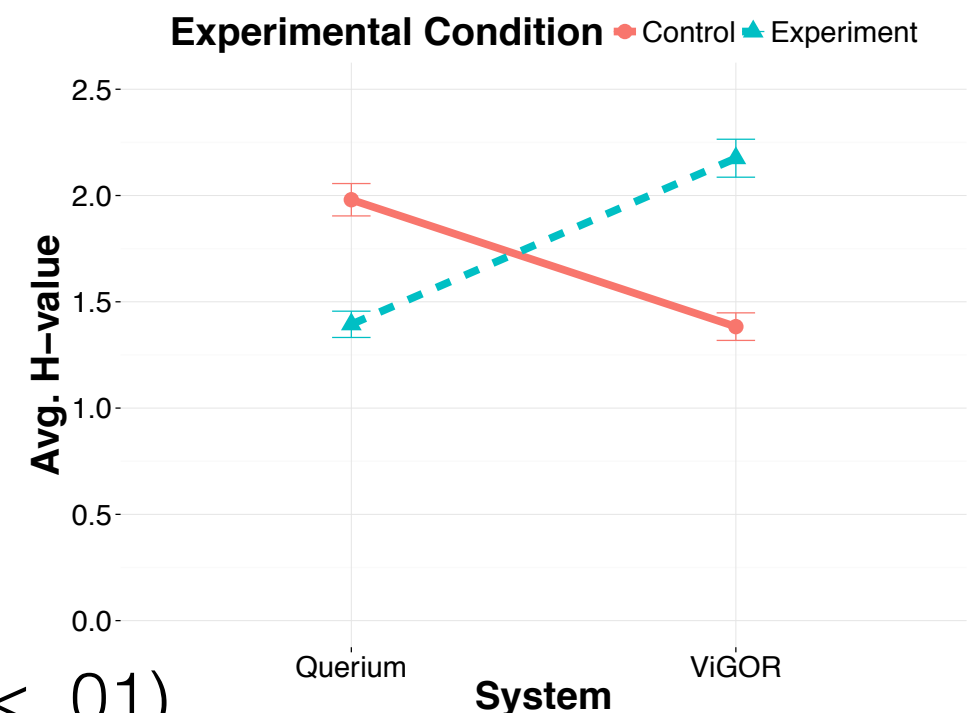
Comparing systems: tactic preference

- ViGOR users have a lower H_s than Querium users (F(1, 29)=22.956, p < .0001)

  ‣ ViGOR searchers developed preferences for particular search tactics to a higher degree than users of Querium

- No effect on condition (Control vs. Experimental) was found

  ‣ cannot confirm whether new features have an effect on tactic preference

Summary

- We investigated various methods to identify search tactics from search logs

- Explored what is possible with tactic based analysis

- More details in the paper

- More possibilities out there