

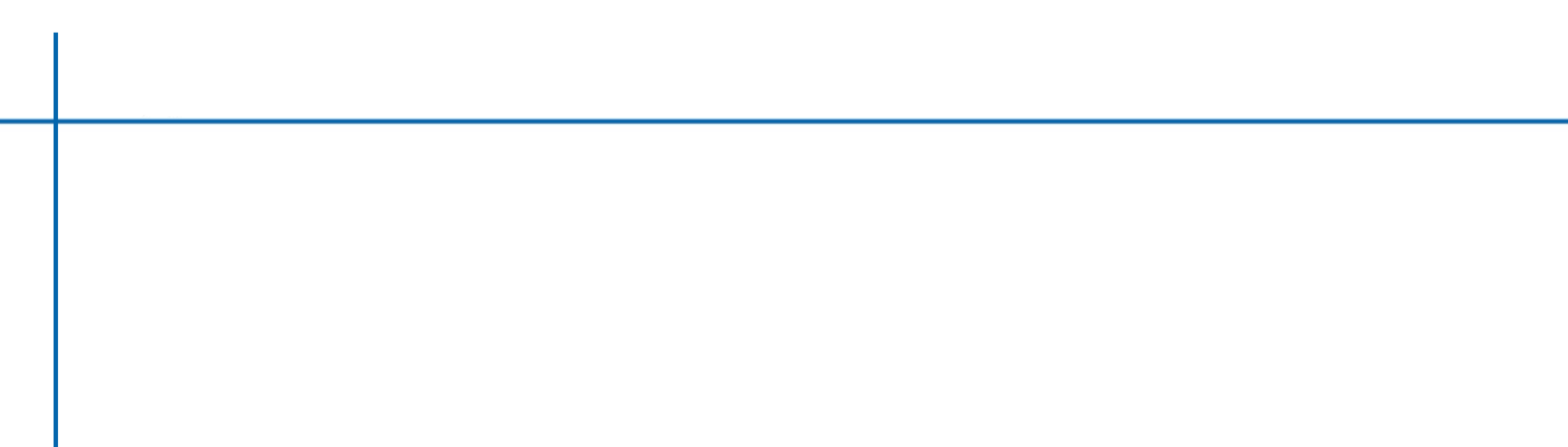


FAKULTÄT FÜR
INFORMATIK

Collaborative Information Seeking: On tracability, sensemaking and recommendation

Andreas Nürnberger, Dominic Stange,
Tatiana Gossen, Michael Kotzyba



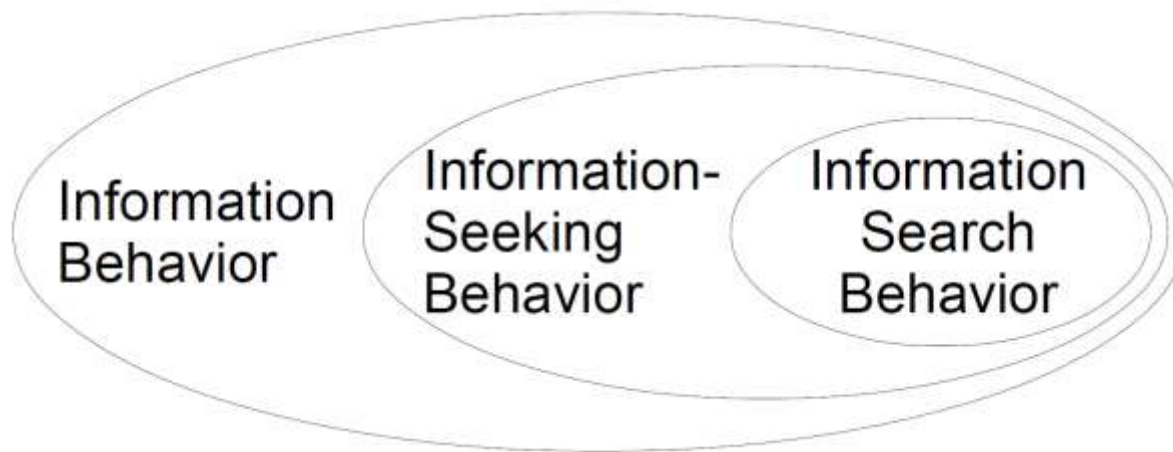


INFORMATION SEEKING

AN INFORMAL DEFINITION...

Information Seeking

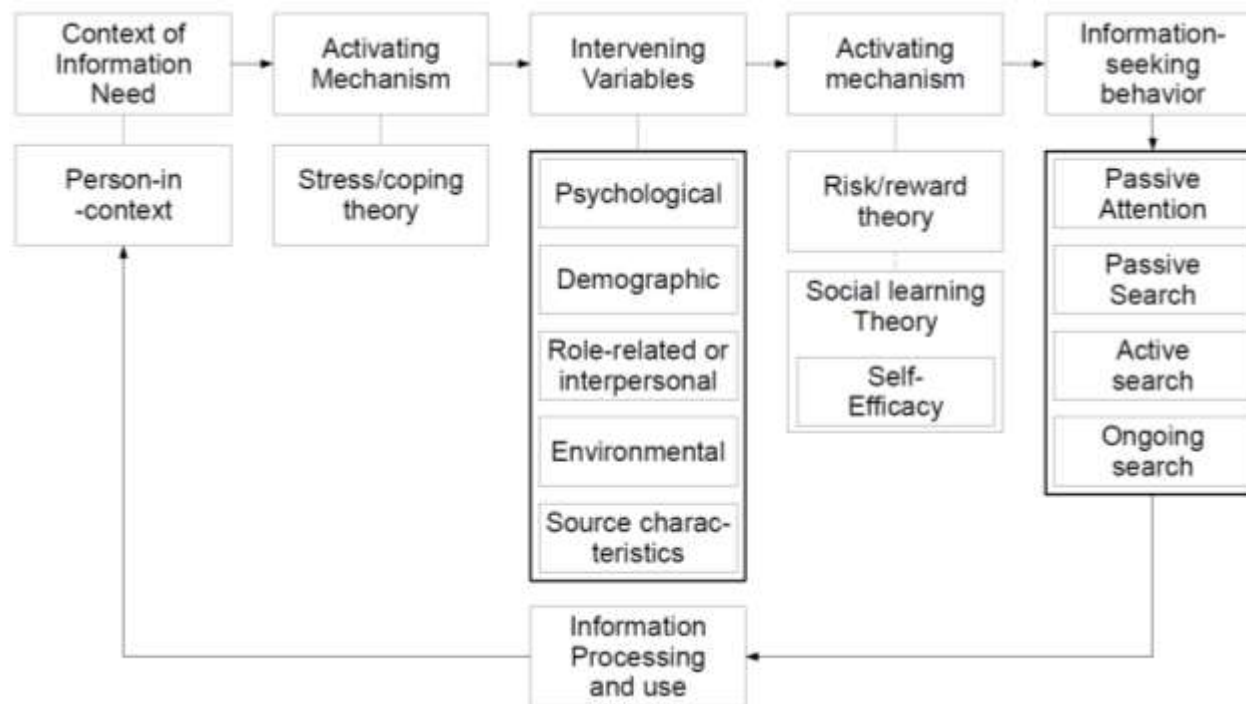
- **Information seeking** is the process or activity of attempting to obtain information in both human and technological contexts. [Wikipedia]



Wilson's nested model of information behavior areas (Wilson, 1999)

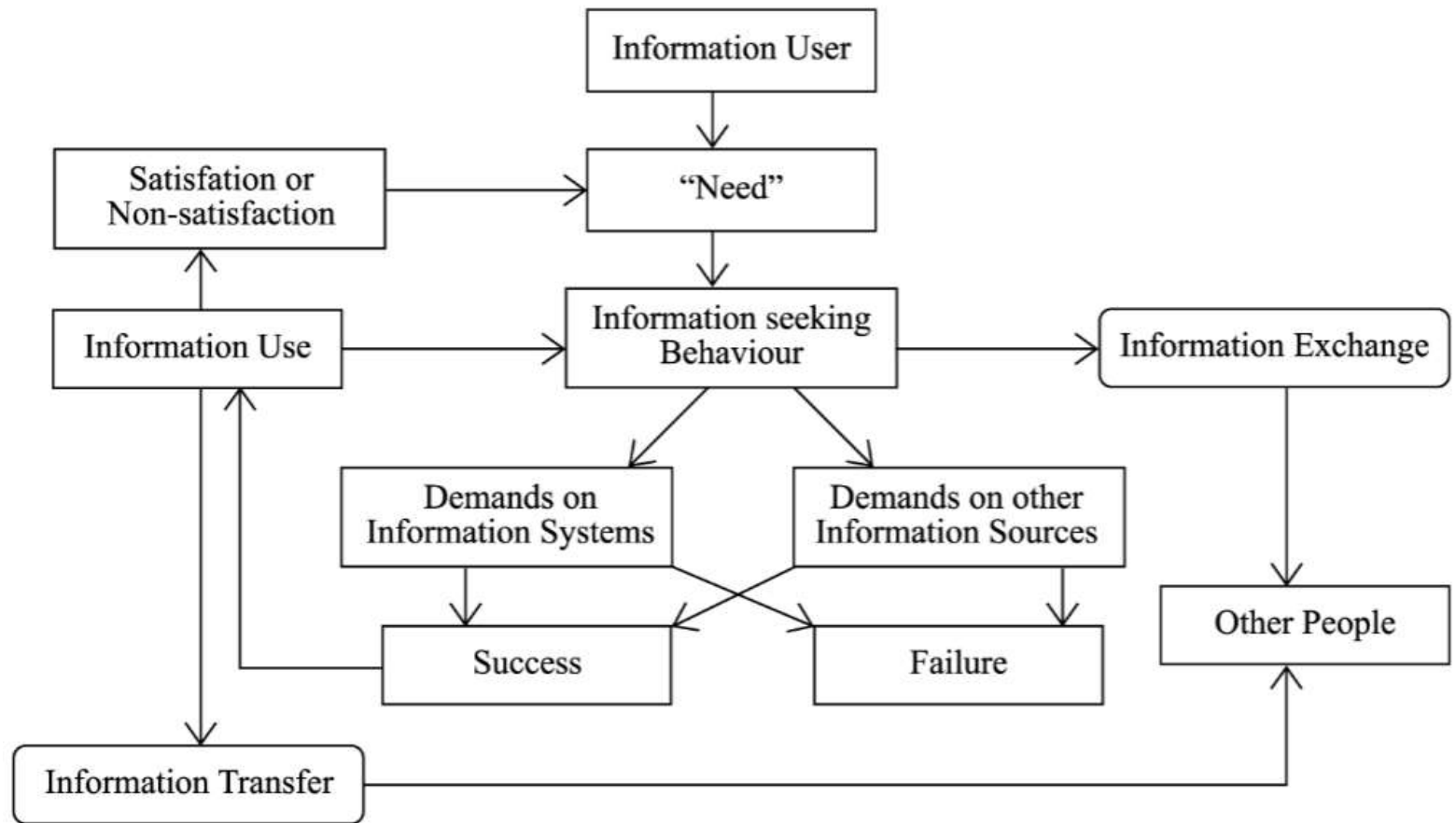
Information Behaviour

- By **information behaviour** is meant those activities a person may engage in when identifying his or her own needs for information, searching for such information in any way, and using or transferring that information. [Wilson, 1999]



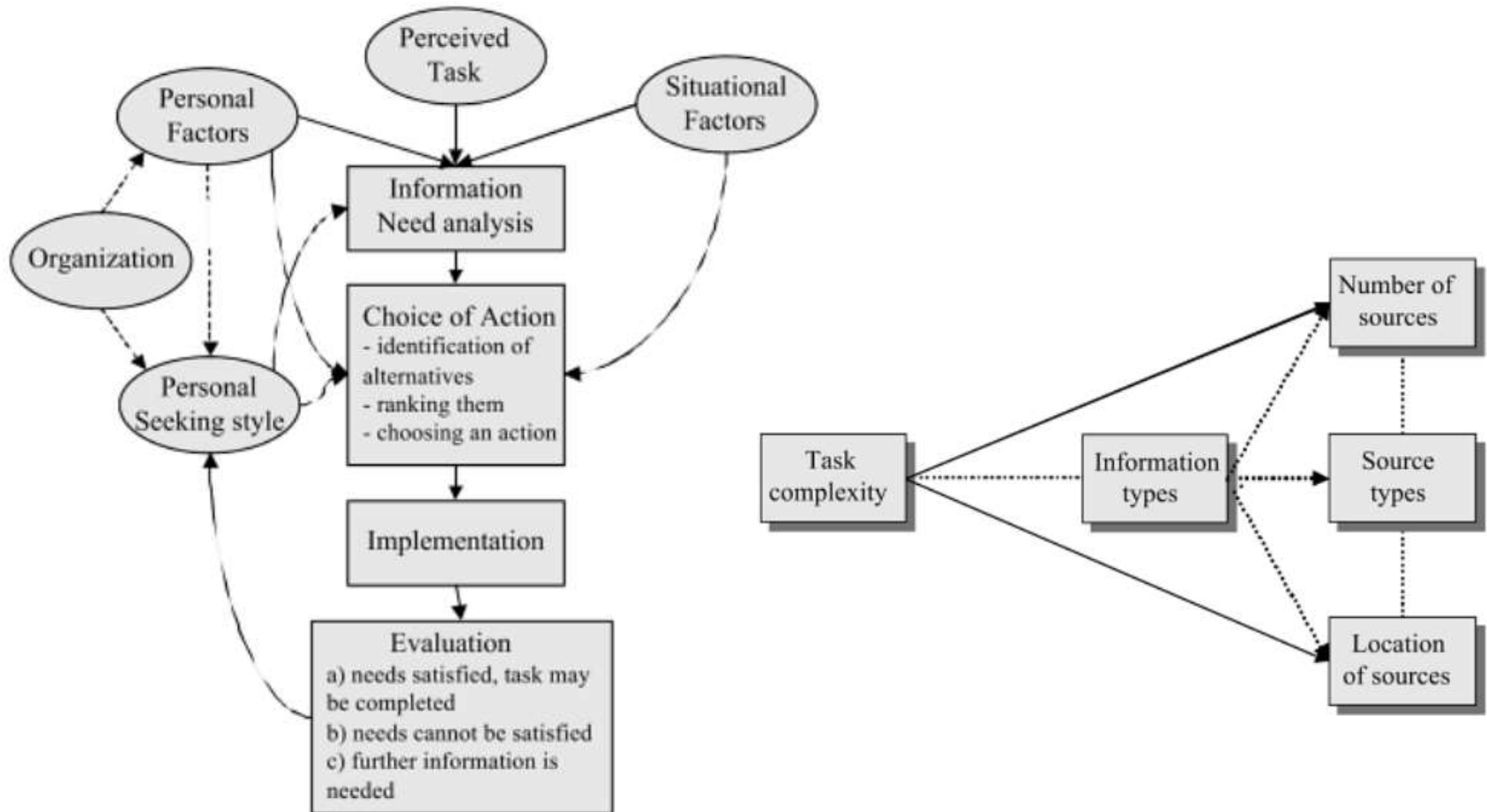
Wilson's extended version of information behavior [Wilson, 1996]

Wilson's Model of Information Behaviour



Wilson's Model of Information Behaviour [Wilson, 1981] includes collaborative activities of a searcher.

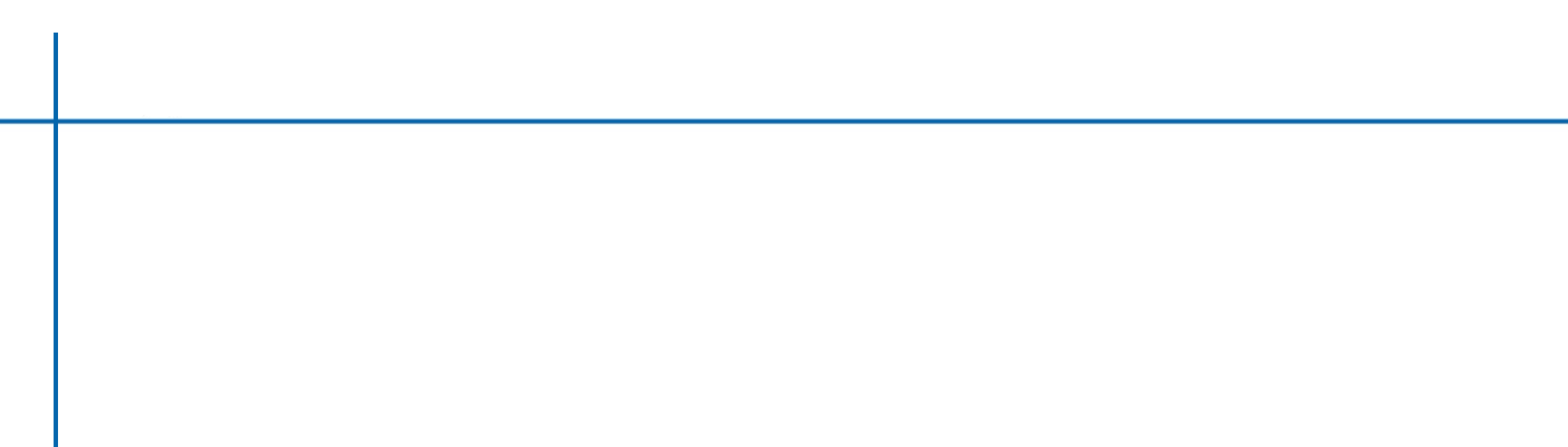
Byström and Järvelin's Model



The Information Seeking Surface Model [Byström and Järvelin, 1995] takes into account task complexity and problem solving aspects of information seeking in a work environment.

More on seeking...

- Models are rather complementary than contrary and can focus on different aspects, e.g.:
 - Kuhlthau's more phenomenological model with 6 stages and corresponding activities [Kuhlthau 1991, 1994]: Initiation, Selection, Exploration, Formulation, Collection, Presentation
 - [Ellis 1989, 1993] empirically categories or "features": Starting, Chaining, Browsing, Differentiating, Monitoring, Extracting, Verifying, Ending
 - Models can be aggregated, e.g. by [Wilson'1999] and can be used for HCI-Design
- Some models are rather seen as instance or a class of information-seeking behavior, e.g.:
 - Exploratory Search



EXPLORATORY SEARCH

AN INFORMAL DEFINITION...

Exploratory Search

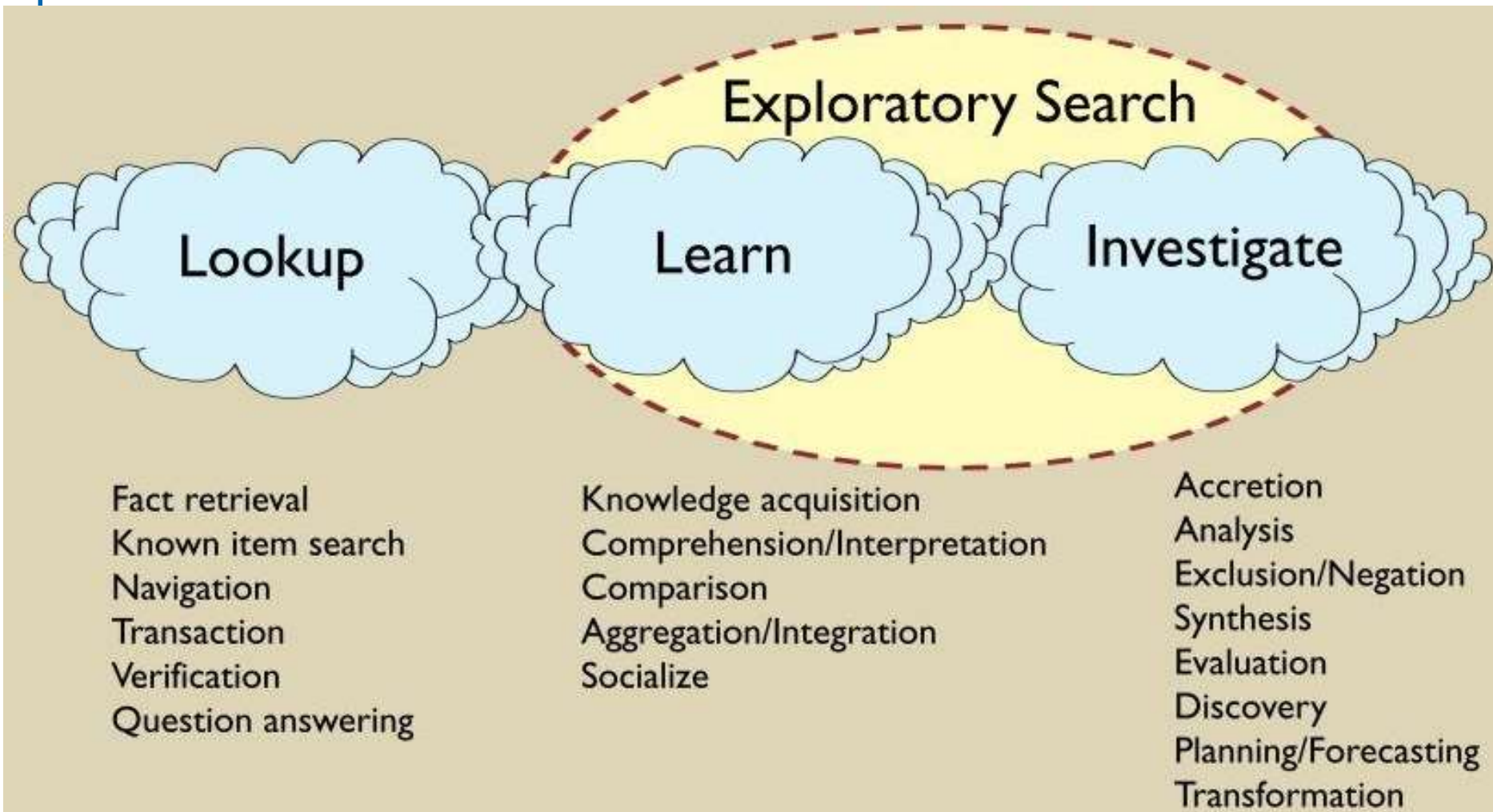
- **Exploratory search** is a specialization of information exploration which represents the activities carried out by searchers who are either:
 - unfamiliar with the domain of their goal
 - unsure about the ways to achieve their goals
 - or even unsure about their goals in the first place

[Wikipedia, 2015]

- **Exploratory search** is a highly dynamic process (of a user) to interact with an information space in order to satisfy an information need that requires learning about structure and/or content of the information space.

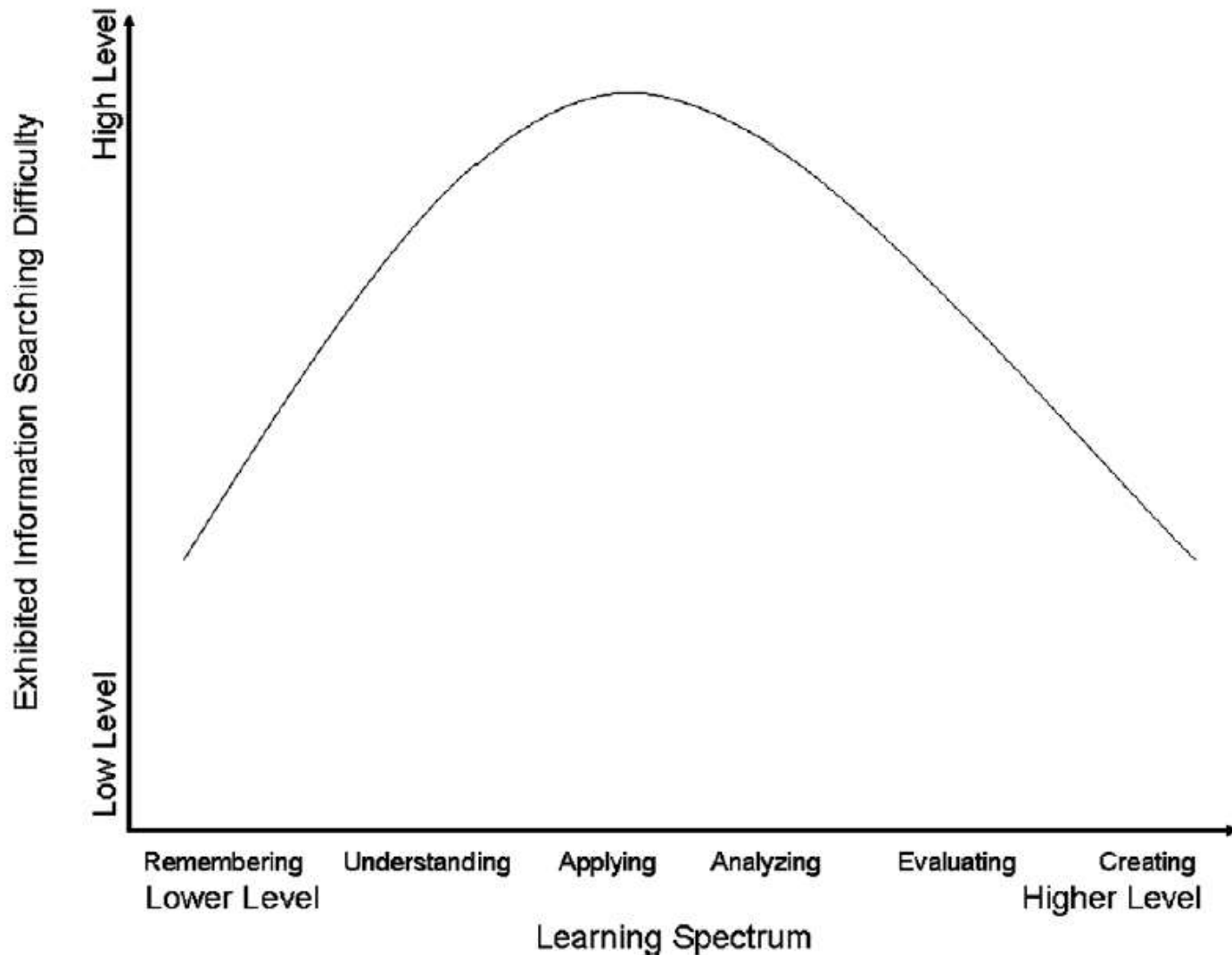
[Gossen et al., 2012]

Learning as Part of Information Seeking



[Marchionini, 2006]

Information Seeking as Part of Learning

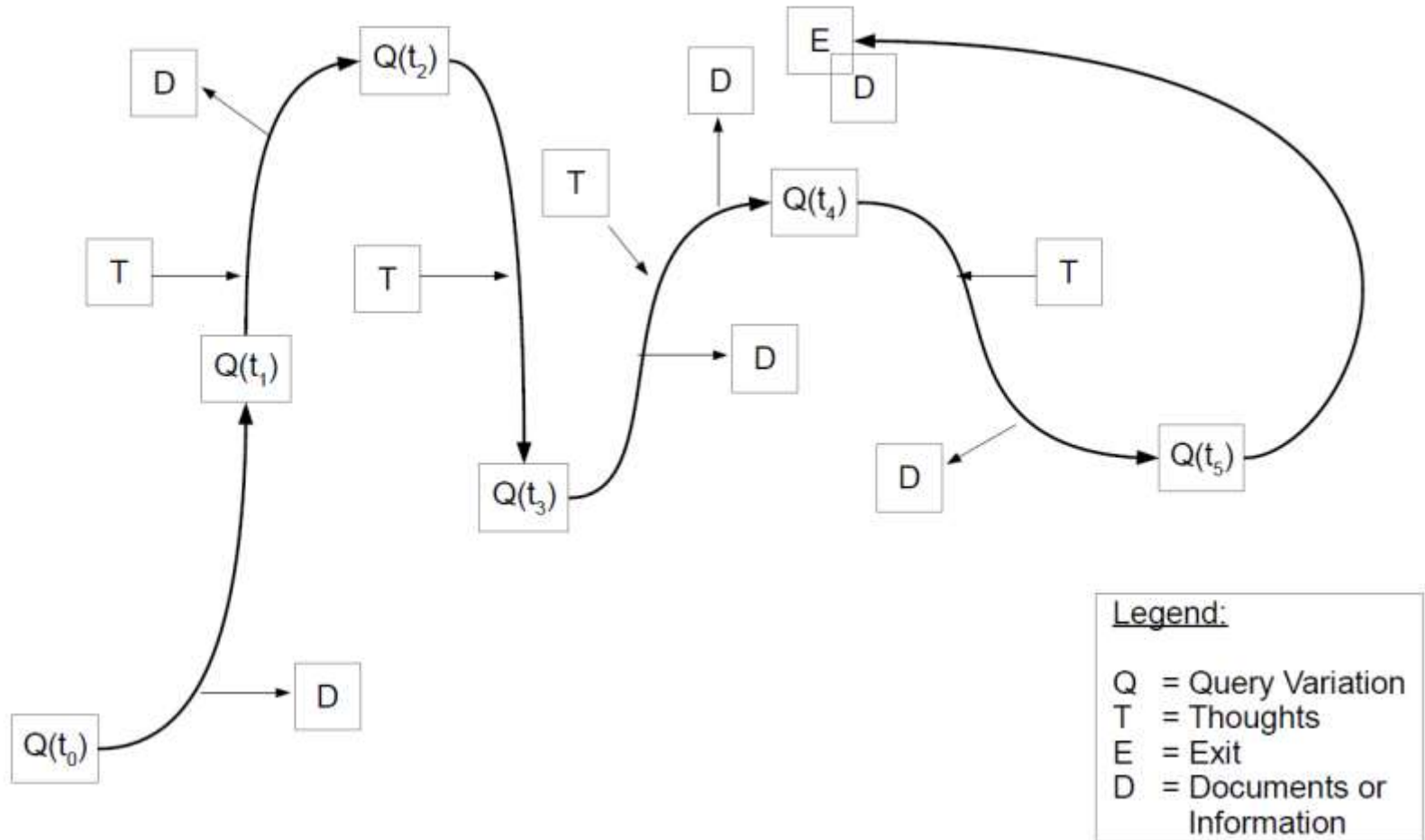


Relationship between learning activities and searching difficulty based on a user study by [Jansen et al, 2009].

Exploratory Search

- The user's goal is to learn, to investigate, to understand, to conceptualize, ...
- Therefore, we need methods to
 - search, navigate and browse
 - sort, structure, filter (interactively)
 - change perspective
 - ...
- Remark: For some cases ideas and approaches from exploratory data analysis can be transferred

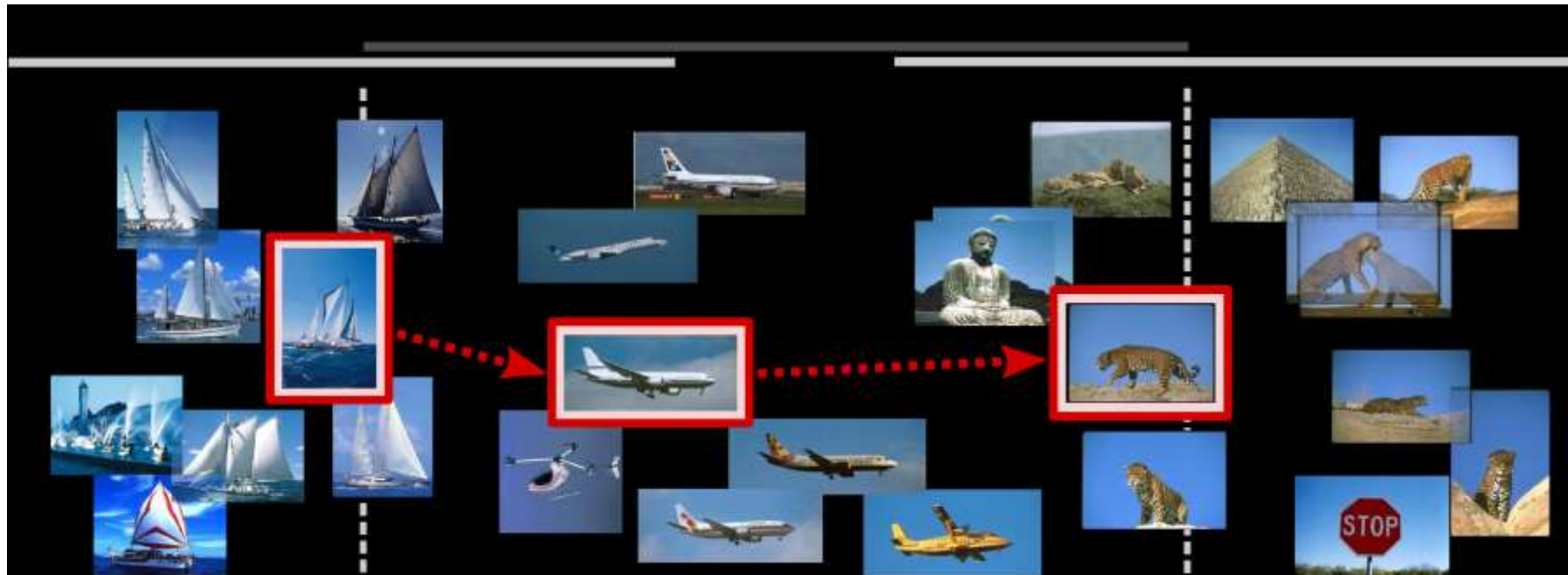
Berry Picking Model



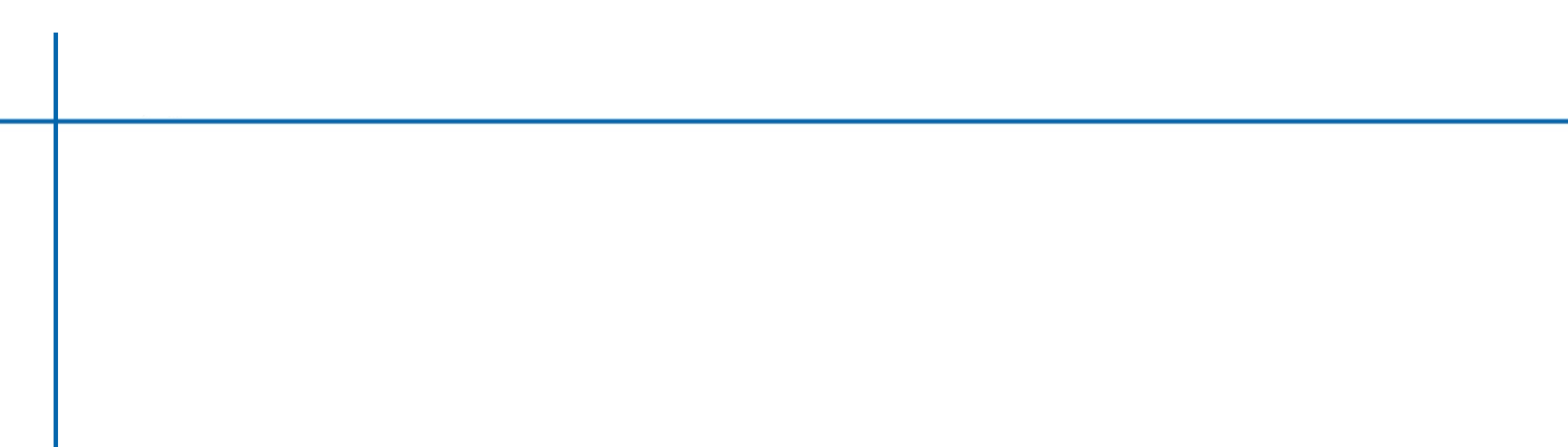
According to Bates' Berry Picking Model [Bates, 1989] to illustrate a sequence of search behavior.

An Example: Visual Berrypicking

- Motivation:
 - Support Users in Exploring big collections of documents (here: Images)
 - Main Goal: Provide overview and context



T. Low, C. Hentschel, S. Stober, H. Sack, and A. Nürnberger, *Visual Berrypicking in Large Image Collections*. NordiCHI, 2014.



USER INTERFACES

HOW TO EFFICIENTLY INTERACT WITH INFORMATION...

The HCI aspects of usability...

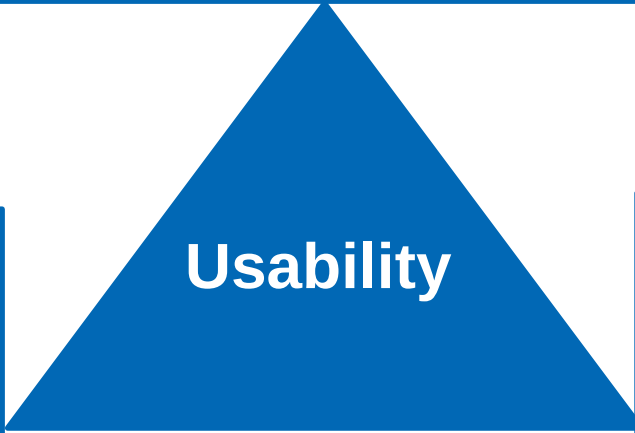
Effectiveness:

The accuracy and completeness with which users achieve certain goals

Efficiency:

The relation between (1) effectiveness and (2) the resources expended in achieving it

Usability



Satisfaction:

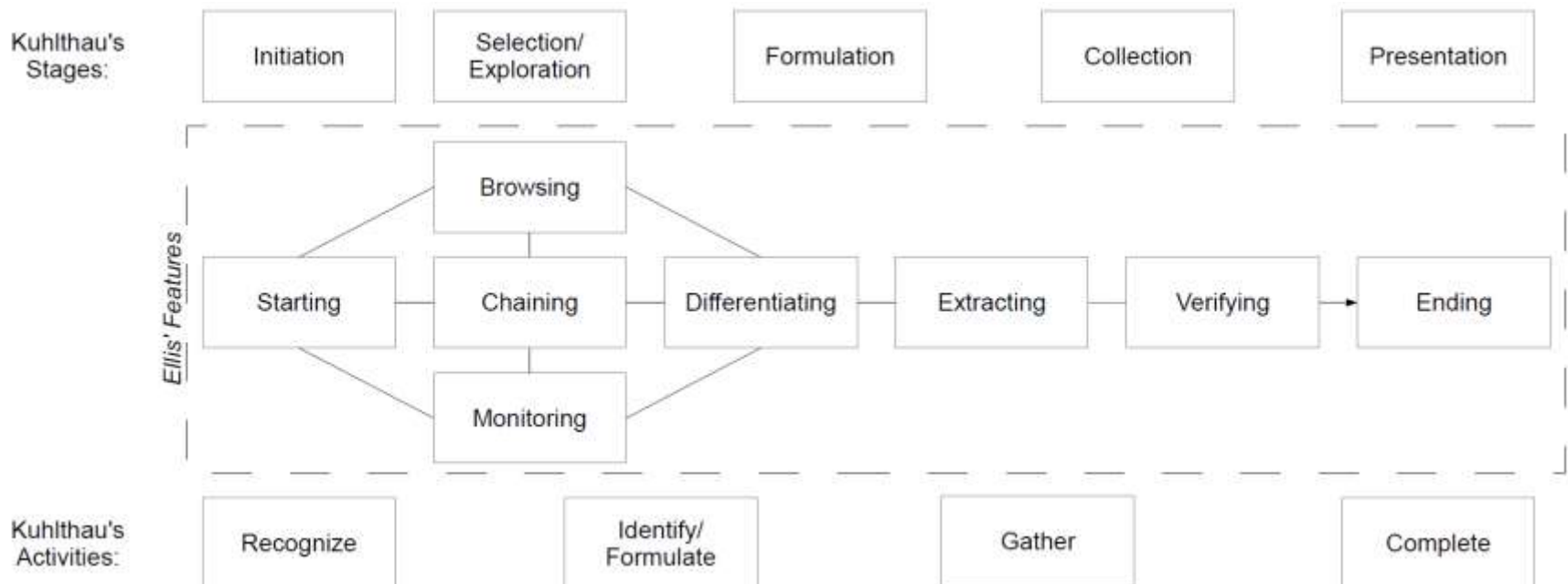
The users' comfort with and positive attitudes towards the system

[ISO 9241-110]

HCI Aspects of Information Seeking

- Ultimate goal: Support all steps of seeking processes

Initiation Selection Exploration Formulation Collection Action



Wilson's aggregation of Kuhlthau's and Ellis' Models [Wilson 1999; Kuhlthau 1991, 1994; Ellis 1989, 1993].

Designing for Information Seeking

- Some fundamental requirements on seeking tools:
 - Open-ended exploration
 - Information management
 - Monitoring

Information Seeking: Open-ended Exploration

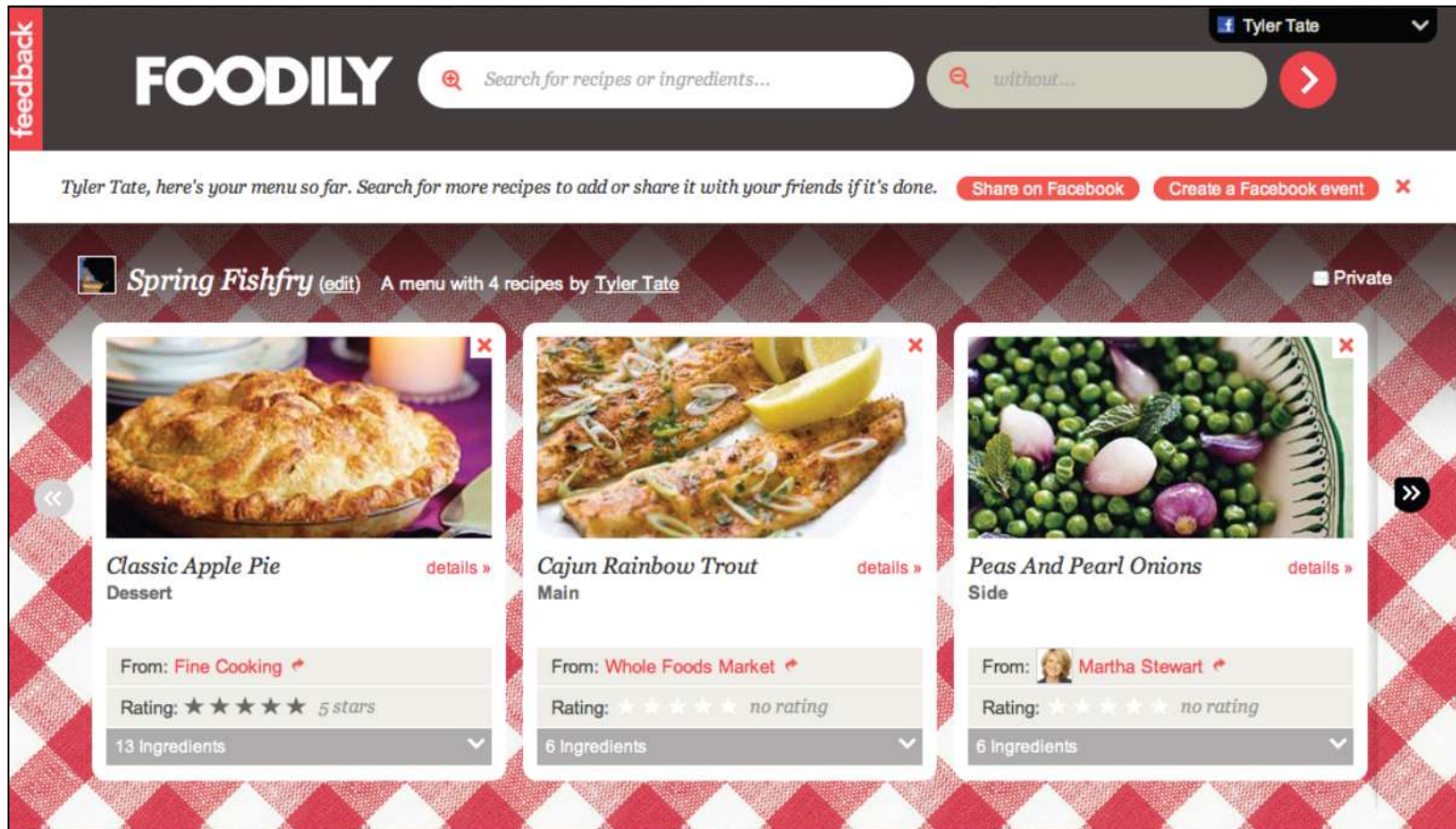
- User in initial phase deals with uncertainty
 - Help users to explore

The screenshot displays the Motors.co.uk website interface. At the top, the logo 'MOTORS' is followed by the tagline 'Search Smart. Buy Right .co.uk'. A banner states 'Over 312,018 used cars listed at Motors.co.uk' and '1,000s of cars reduced by £1,000s - as seen on TV!'. Navigation links include 'Used', 'New', 'Sell', 'Smart Search', 'Reduced Cars', 'Vans', 'Know How', and 'Recently Viewed'. A 'Welcome to Motors.co.uk' message is accompanied by social media icons and a 'Sign in or Register' link.

The main search area is divided into two sections. On the left, 'Find it Fast with our Classic Search' includes fields for 'Postcode', 'Distance' (set to 'National'), 'Make/Model' (with 'Make (Any)' and 'Model (Any)' dropdowns), 'Price' (with 'Monthly Cost' toggle), and 'Min Price (Any)' / 'Max Price (Any)' dropdowns. A 'Reset search' button and a 'Search' button with a plus icon are at the bottom. A summary shows 'Total used cars for sale at motors.co.uk: 312,018'. On the right, 'Or use Smart Search to find your personalised results' features 'My budget' (a slider from £0K to £40K+), 'Road tax' (a slider from £0 to £700), and a large green box stating '312,018 cars listed' with a 'Show me my matches' button. Below this, 'I want to' includes icons for 'turn heads', 'go off-road', 'take the dog', and 'take a pushchair'. 'Colour' is represented by a grid of color swatches. At the bottom right, there are links for 'extended smart search' and a 'reset' button.

Information Seeking: Information Management

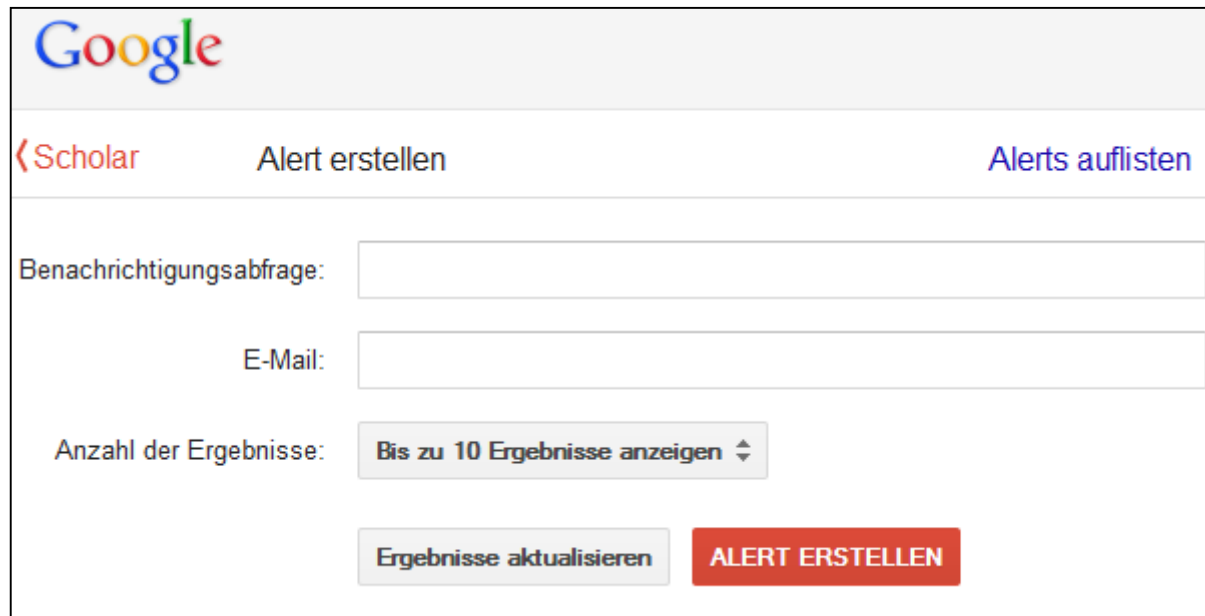
- Bookmarks, grouping in categories, annotations



Foodily, a recipe search engine, allows users to save their favorite recipes and organize them into meal plans [Russell-Rose & Tate, 2013]

Information Seeking: Monitoring

- Towards the end of the journey
- Monitor for new opportunities given the same criteria
 - Automatically
 - On demand



The screenshot shows the Google Scholar 'Alert erstellen' (Create Alert) page. At the top is the Google logo. Below it, there are links for '< Scholar', 'Alert erstellen', and 'Alerts auflisten'. The main form contains three input fields: 'Benachrichtigungsabfrage:' (Notification query), 'E-Mail:', and 'Anzahl der Ergebnisse:' (Number of results). The 'Anzahl der Ergebnisse:' field is a dropdown menu currently set to 'Bis zu 10 Ergebnisse anzeigen'. At the bottom, there are two buttons: 'Ergebnisse aktualisieren' (Update results) and 'ALERT ERSTELLEN' (Create Alert).

Google

< Scholar Alert erstellen Alerts auflisten

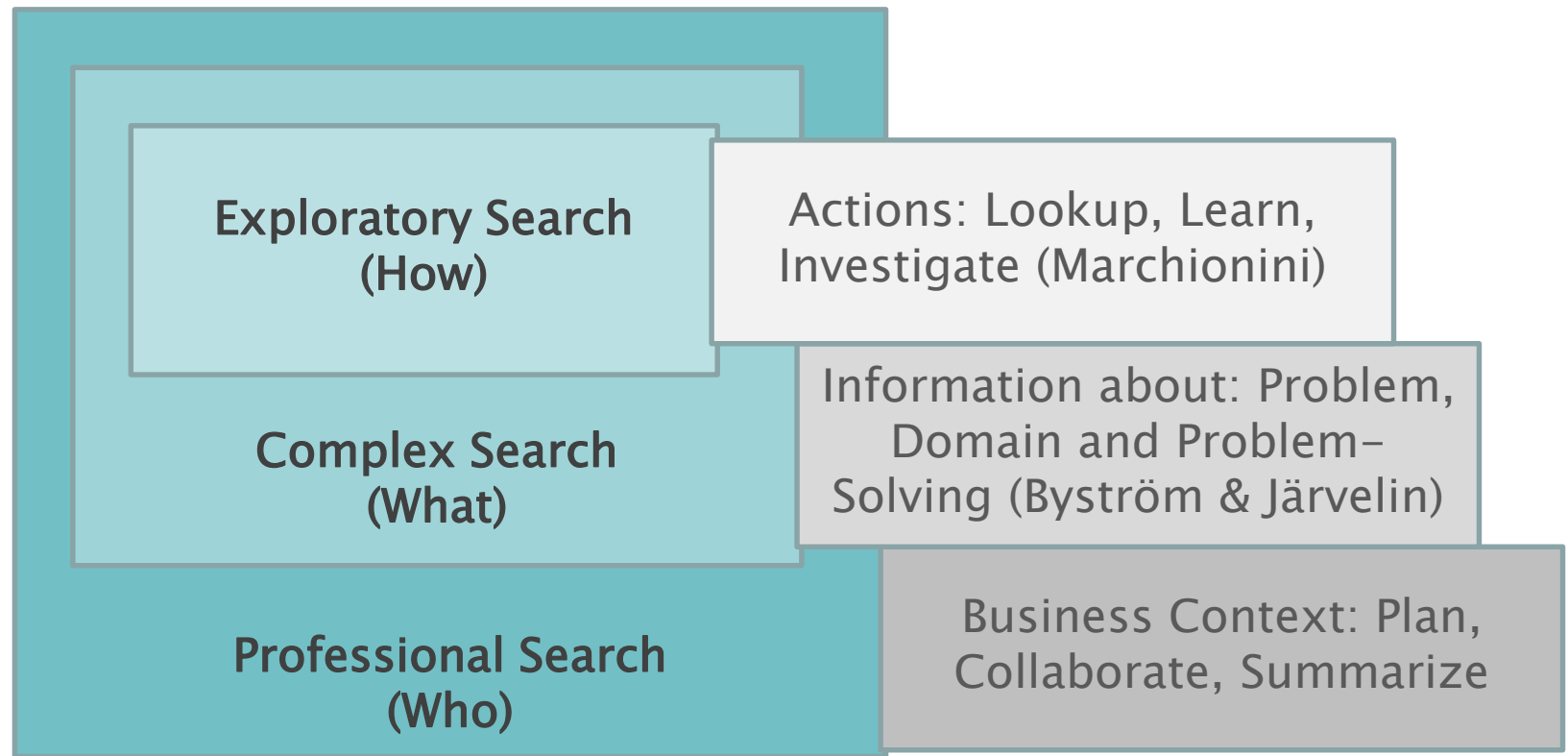
Benachrichtigungsabfrage:

E-Mail:

Anzahl der Ergebnisse: Bis zu 10 Ergebnisse anzeigen ▾

Ergebnisse aktualisieren ALERT ERSTELLEN

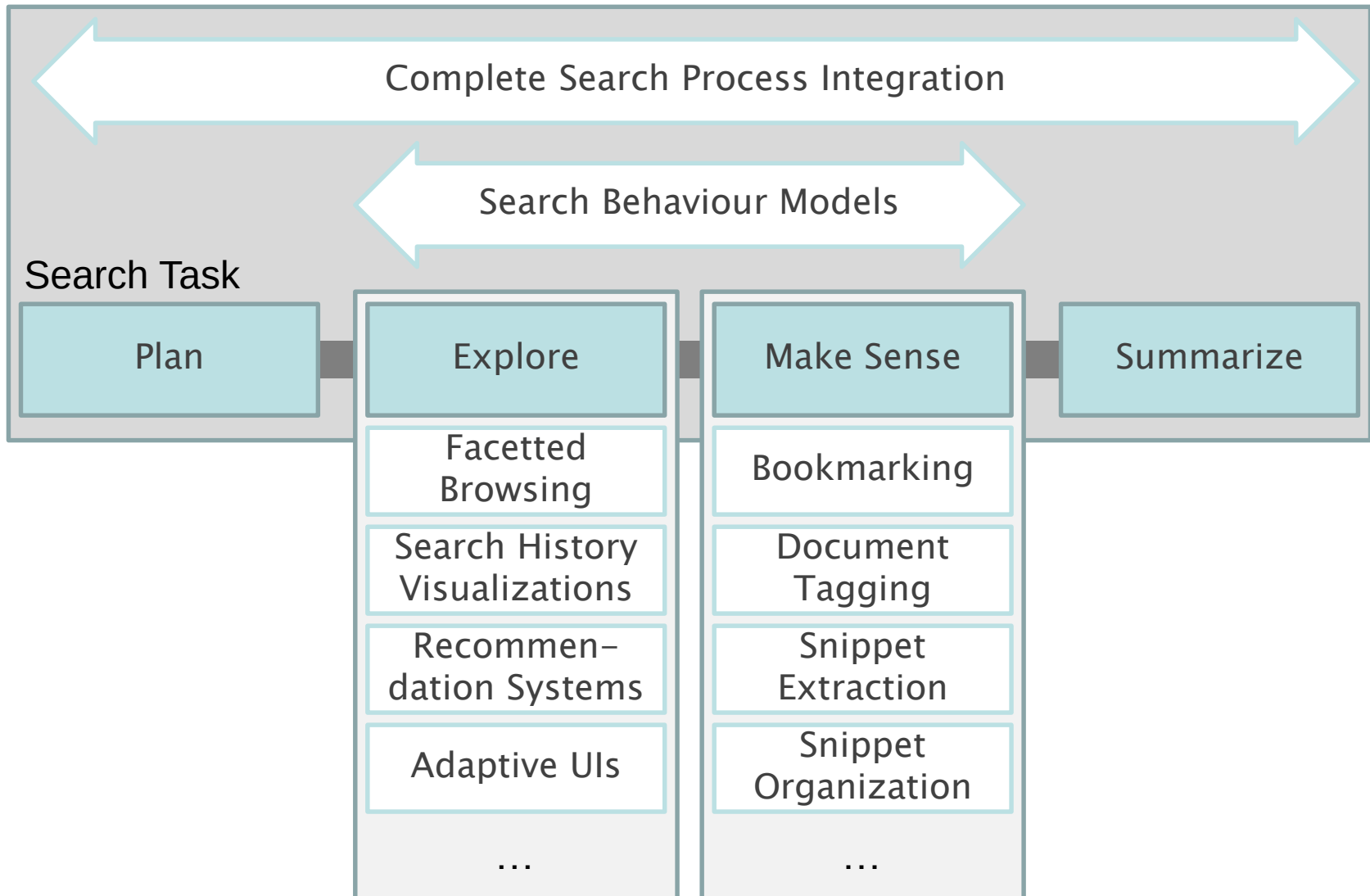
A Different Perspective...



Complex and Professional Search: Stages

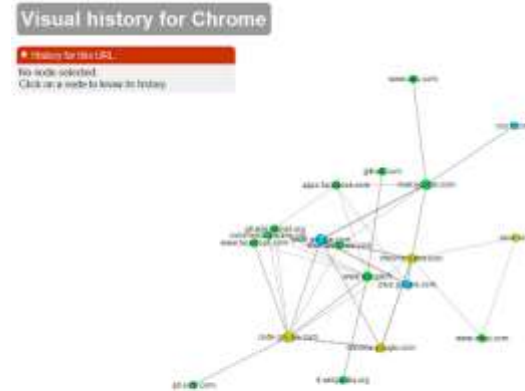
- Plan
 - Repeating search topics (evolving domains, updates)
 - User roles during search
- Explore, Collect and Collaborate(!)
 - Share ideas and findings
 - Contribute
 - Discuss and evaluate
- Summarize
 - Synthesize and contextualize
 - Formulate for decision makers

Enhancing the Search Experience



Exploratory Search

- Search History Visualization
- Query Suggestion
- Facets
- Context
- Adaptive UI

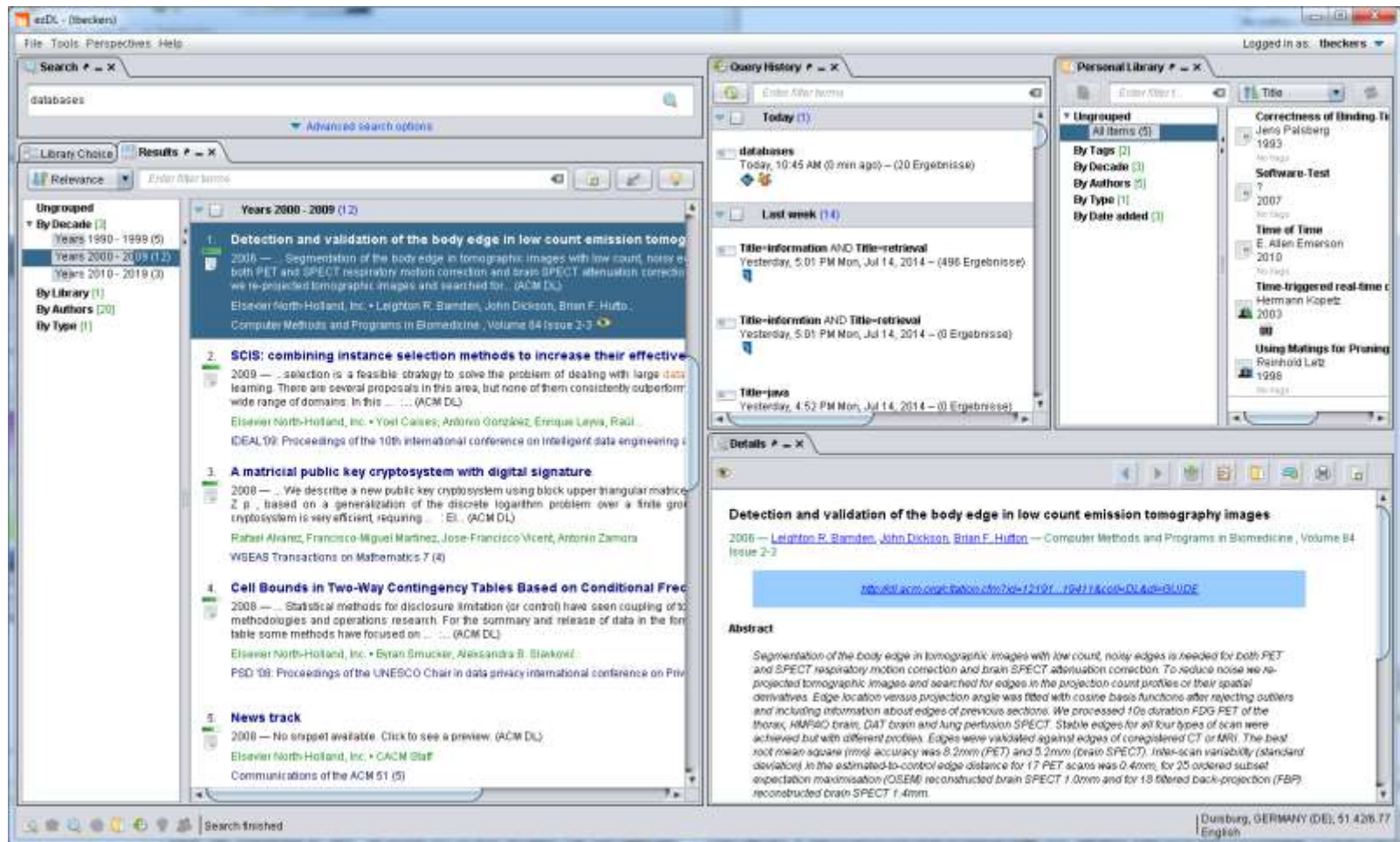


2012: <https://chrome.google.com/webstore/detail/visual-history/emnpeciqdqlcgfabfnmlphhqfdifaan>

Evaluation of a Scatter/Gather Interface for Supporting Distinct Health Information Search Tasks, Zhang et al., 2014

Complex Search

➤ Multistage Search Sessions



ezDL: An Interactive IR Framework, Search Tool, and Evaluation System, [Beckers et al., 2014]

Complex Search

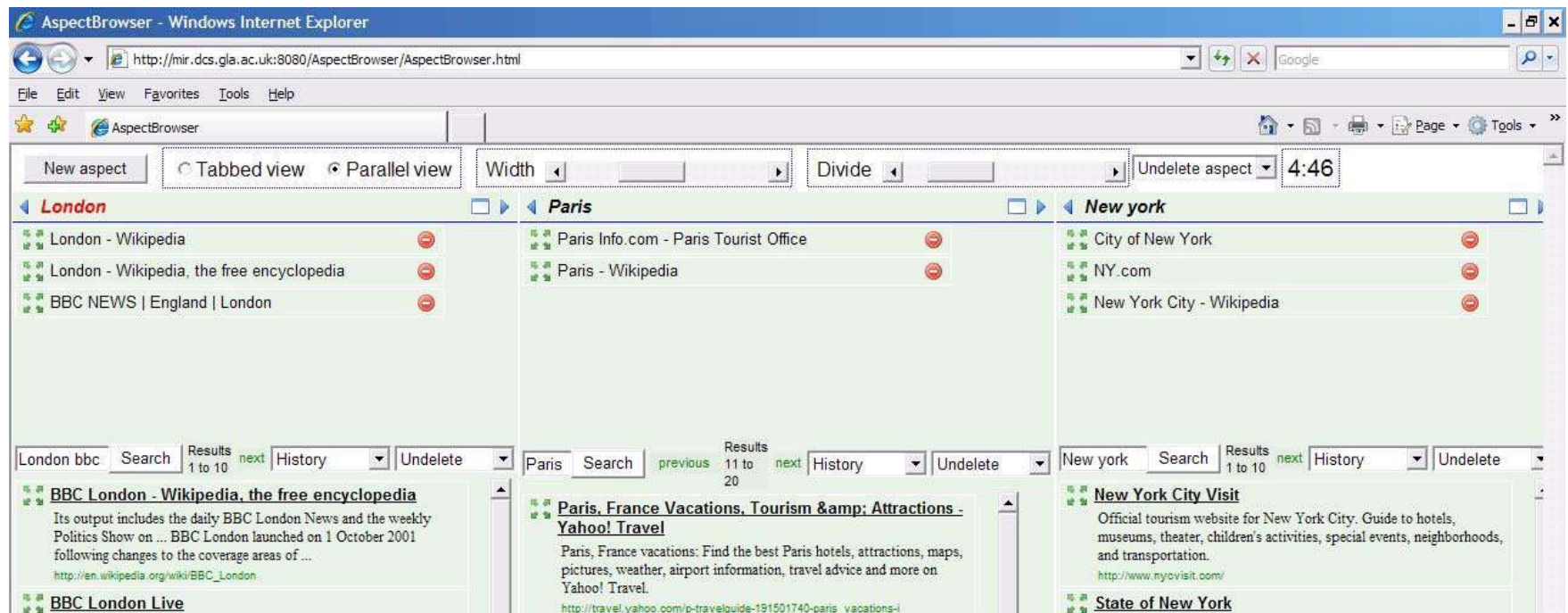
- Multistage Search Sessions
- Tagging and Content Organization

The screenshot displays a complex search interface with multiple panes. On the left, a 'Search' pane shows the query 'touch screen' and search results for 'Touch screen image setting frame'. The middle pane, 'Tagged Documents', shows a list of documents with tags like 'focus 1', 'configuration', and 'touch screen'. The right pane, 'Document Details', shows the full text of the selected document, including a description and claims. The interface is designed for multistage search sessions and tagging of content.

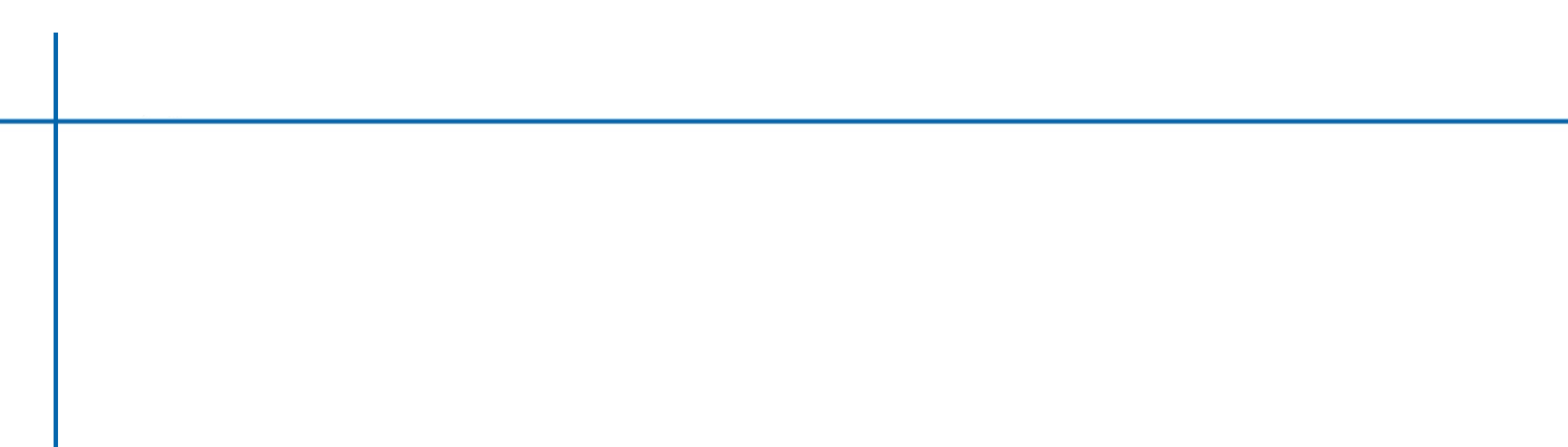
Sewing the Seams of Sensemaking, [Hearst and Degler, 2013]

Complex Search

- Multistage Search Sessions
- Tagging and Content Organization
- Search Aspects



An interface that displays „aspects“ of search results for better evaluation ([Villa et al., 2009])



COLLABORATIVE INFORMATION SEEKING

HOW TO SUPPORT COLLABORATING SEARCHERS...

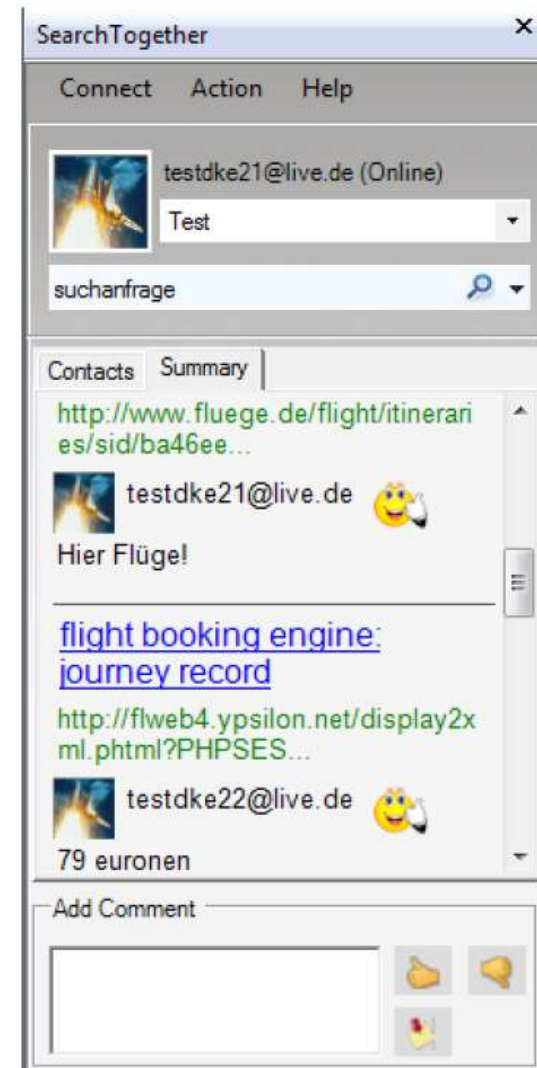
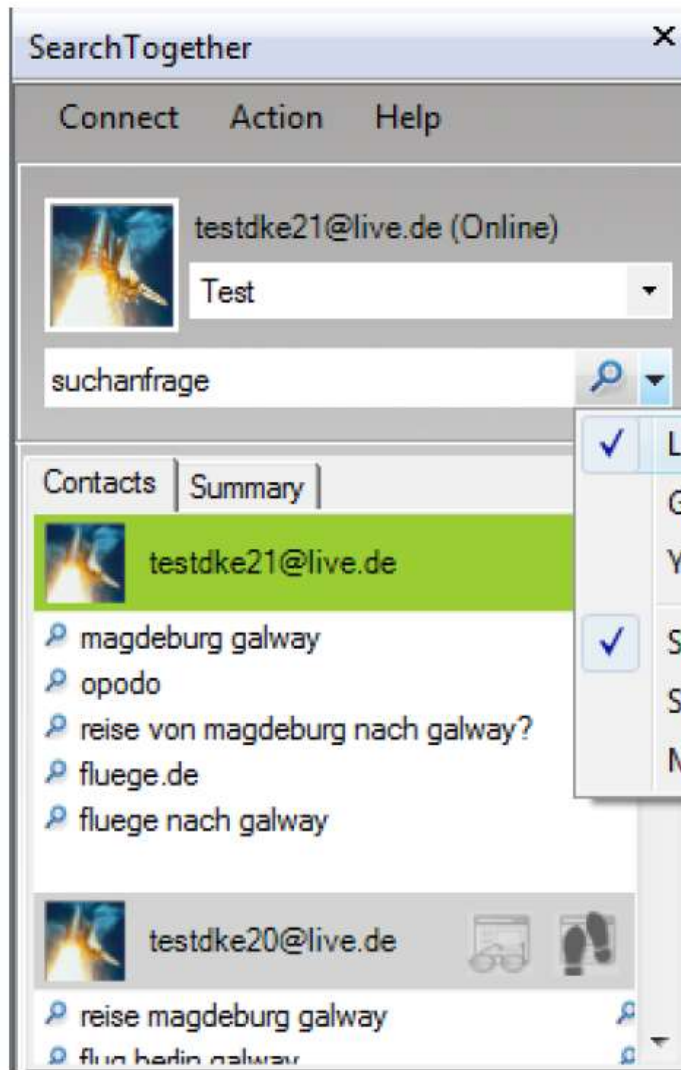
Collaborative Search: A definition

- Collaborative search is a set of search activities that make use of social interactions with others before, during and/or after the search [Evans & Chi, 2008].
- These interactions may be explicit or implicit, co-located or remote, synchronous or asynchronous [Evans & Chi, 2008].
- During collaborative search all participants have the same searching goal and actively conduct a specific search together in order to achieve this goal [Gossen et al., 2011].

Dimensions [Golovchinsky et al., 2008]

- Intent
 - Explicit
 - Implicit (collaborative filtering)
- Depth of mediation
 - User interface
 - Algorithm
- Concurrency
 - Synchronous
 - Asynchronous
- Location
 - Co-located
 - Remote

SearchTogether by Microsoft



Professional Search

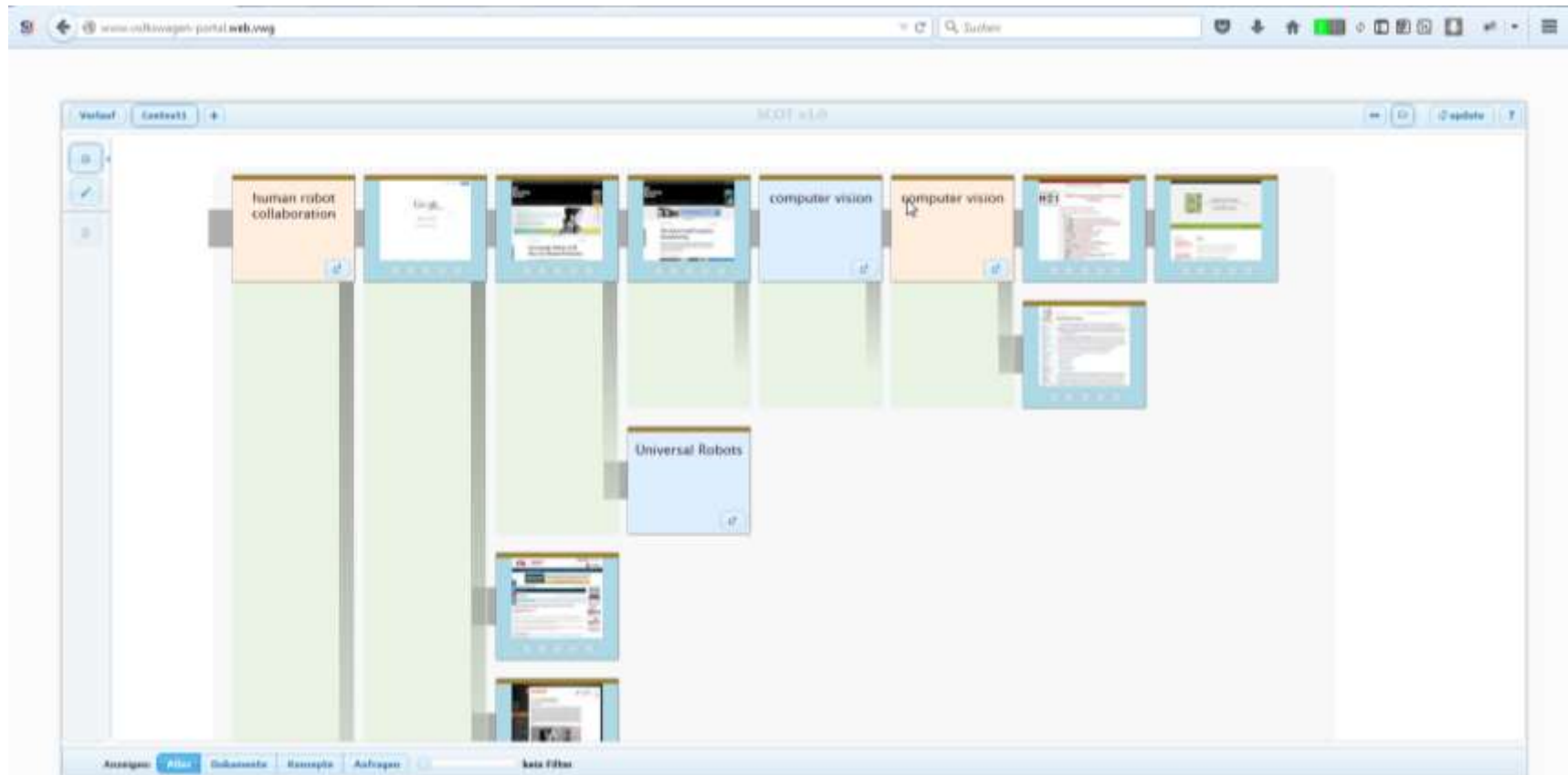
What is needed to support a team of searchers?

- Traceability
 - Understand joint search strategy and findings
- Sensemaking
 - Bottom-up approach
- Recommendation
 - Exploit prior information and strategies (of yourself and other users)

Traceability

- Traceability in collaborative search describes a team's ability to understand the contents and semantics of their joint search strategy
 - How did the team approach a search topic?
 - What search directions did they take?
 - How did they find novel/relevant information?
 - What did they make of this information with respect to their search goal?
- Traceability can be seen as an extension of awareness in an information seeking task (e.g. group, workspace, contextual, and peripheral awareness, Liechti and Sumi, 2002)

Visualizing Team Search with SCOT

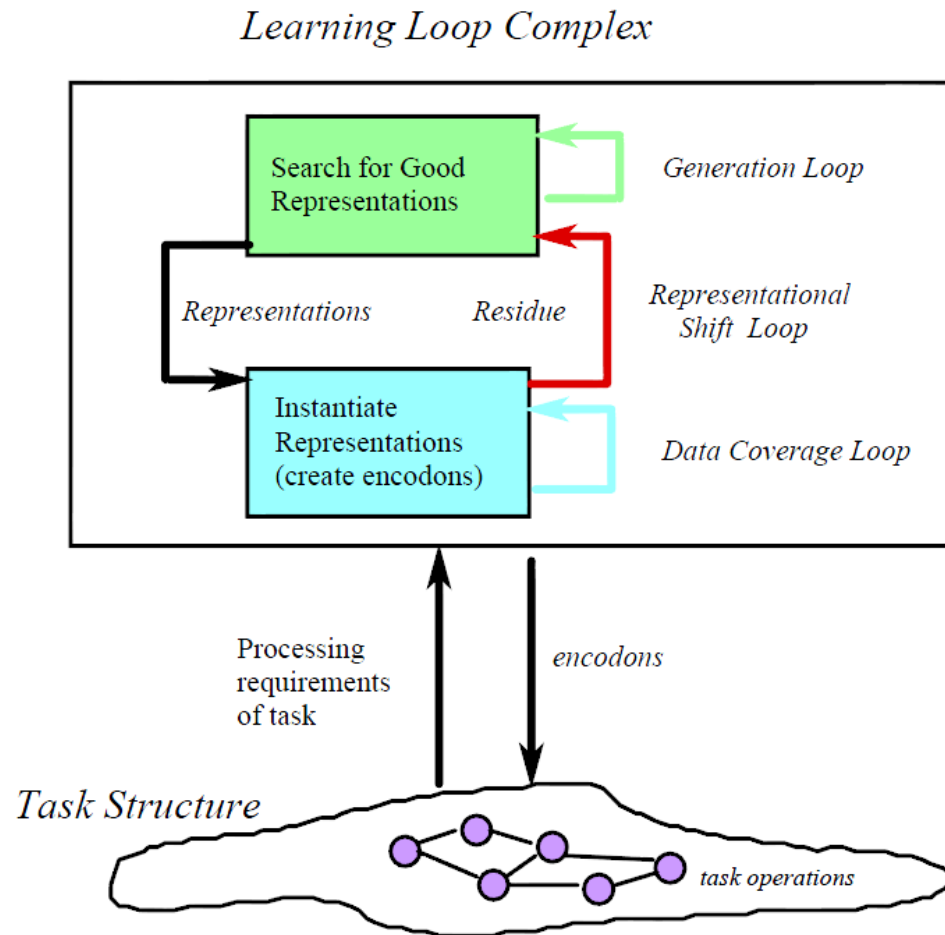


An interface visualizing a teams joint search activity as an horizontal tree of search actions, Stange and Nürnberg, 2014

Sensemaking

- Process through which people assimilate new knowledge into their existing understanding [Russell–Rose & Tate, 2013]
- From internal to external schemas
 - The mental image of the world around you... is a model
 - People use selected concepts and relationships to represent the real system

Sensemaking



Sensemaking as finding a representation that organizes information to reduce cost of an operation in a search task, Russell et al., 1993

Sensemaking: Four stages

1. Search

- Locate documents that may be meaningful for investigation

2. Extract

- Meaningful information must be extracted from those documents

3. Encode

- Extracted ideas must be integrated into user's semantic memory
- Construction of domain schema

4. Analyze

- Analyze the schema to gain insights

Sensemaking

From internal to external schemas...

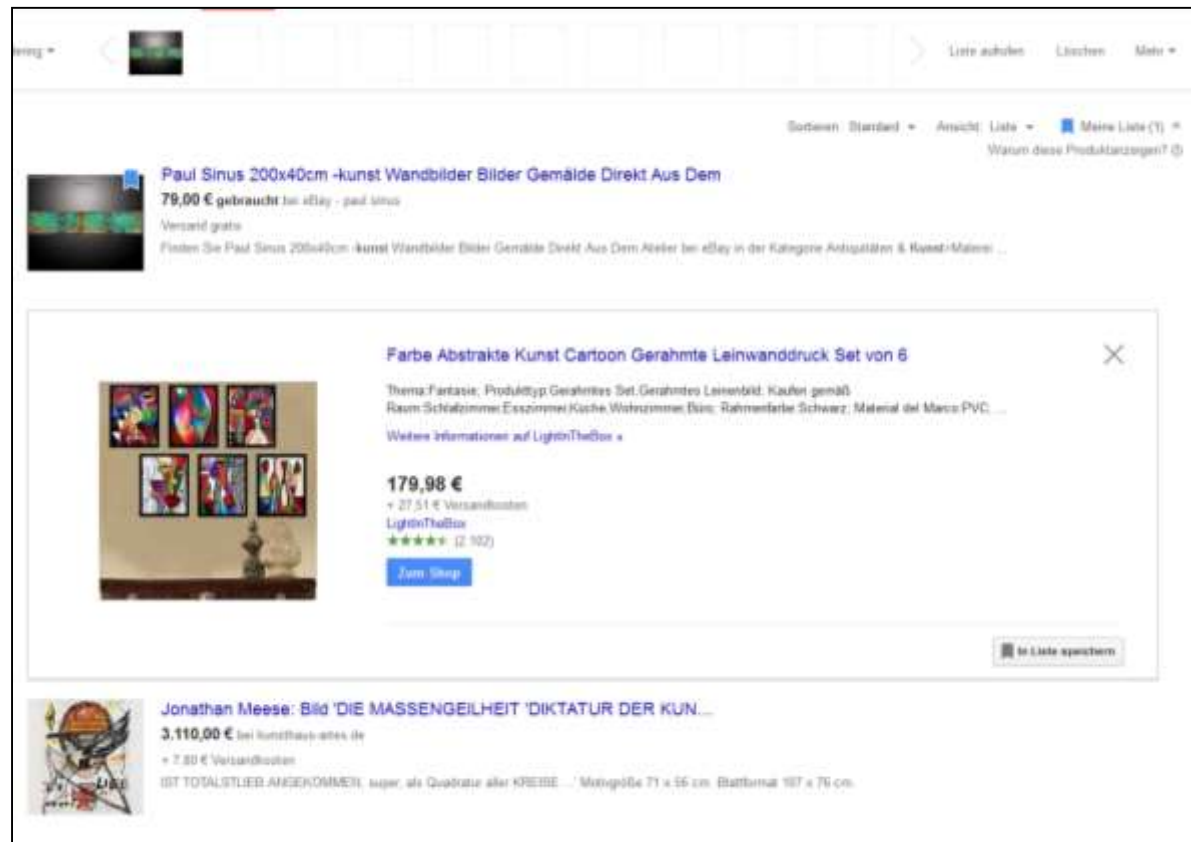
- Sophisticated information tasks demand that one's internal semantic model be disseminated into an external schema.
- ✓ Designing for sensemaking
 - Shoebox
 - Evidence file
 - Schema

Sensemaking: Shoebox

➤ Add documents to a collection/shoebox as rapidly as possible, e.g. using:

- Text link
- Checkbox
- Icon

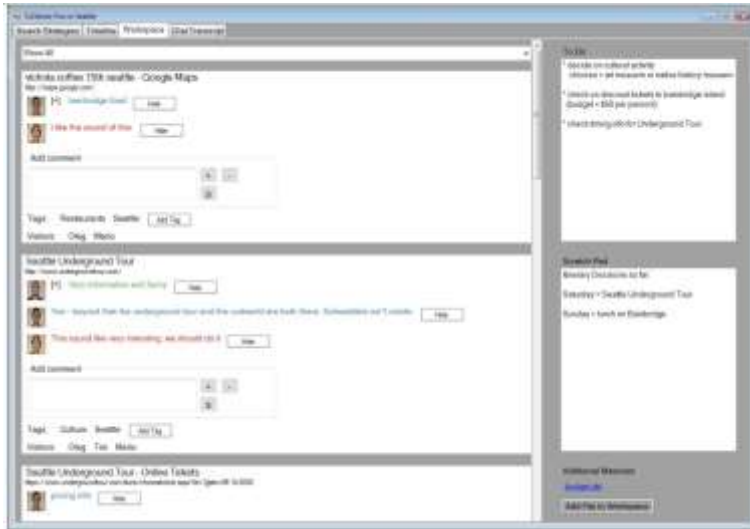
Google shopping:
stores intermediate
results in a list



Sensemaking: Evidence file

- Provide clues to how and why information or documents have been considered as being relevant to the information need
- More thorough examination of the curated collection
 - E.g. extract and save snippet to the evidence file

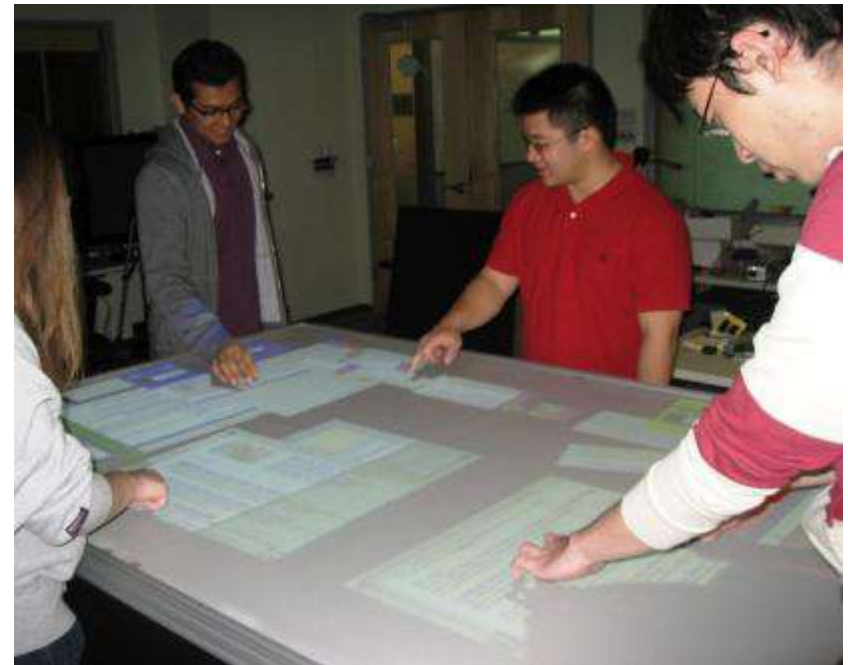
Collaborative Sensemaking



Workspace View in SearchTogether

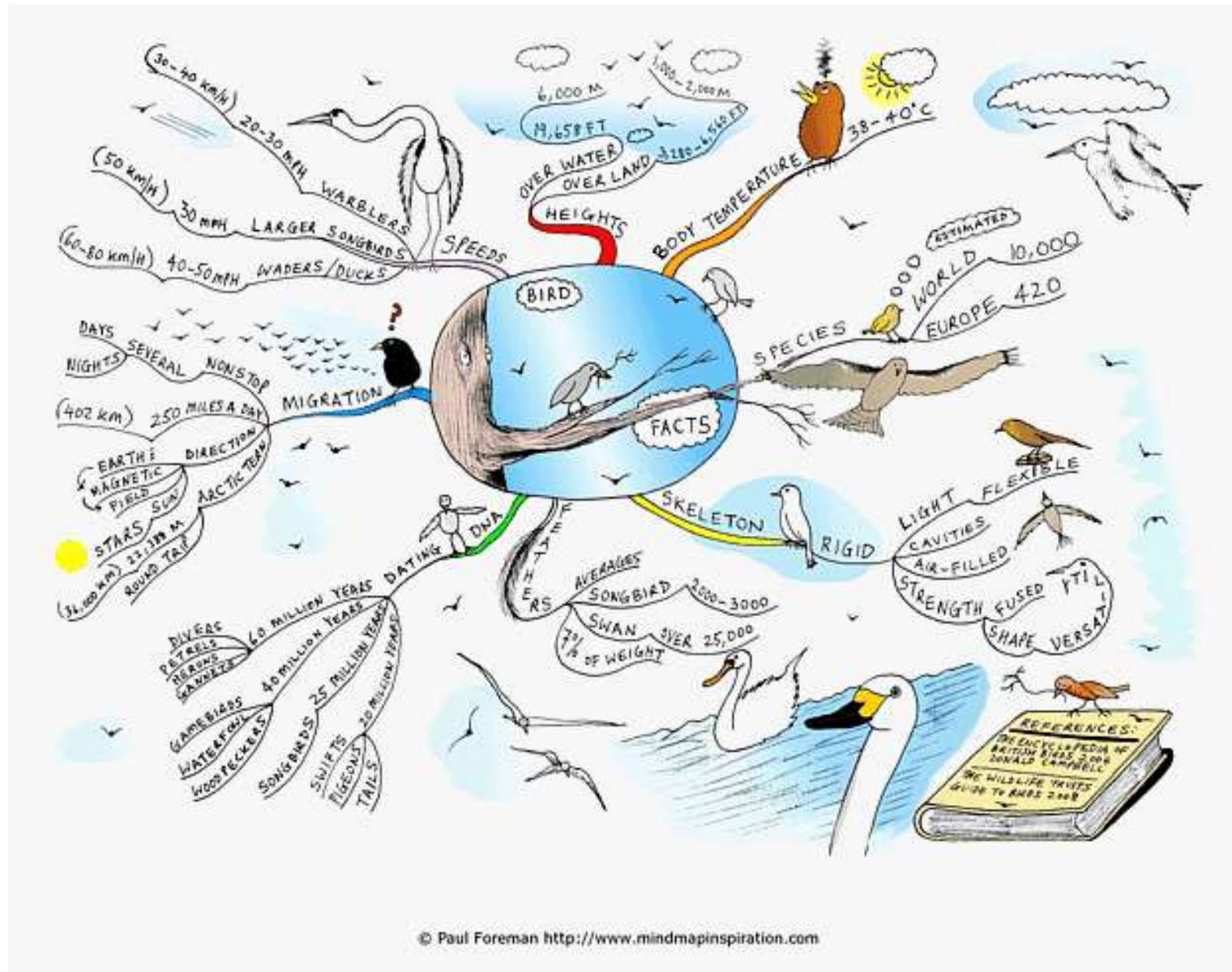


Making notes and compiling reports with Coagmento, Shah, 2010



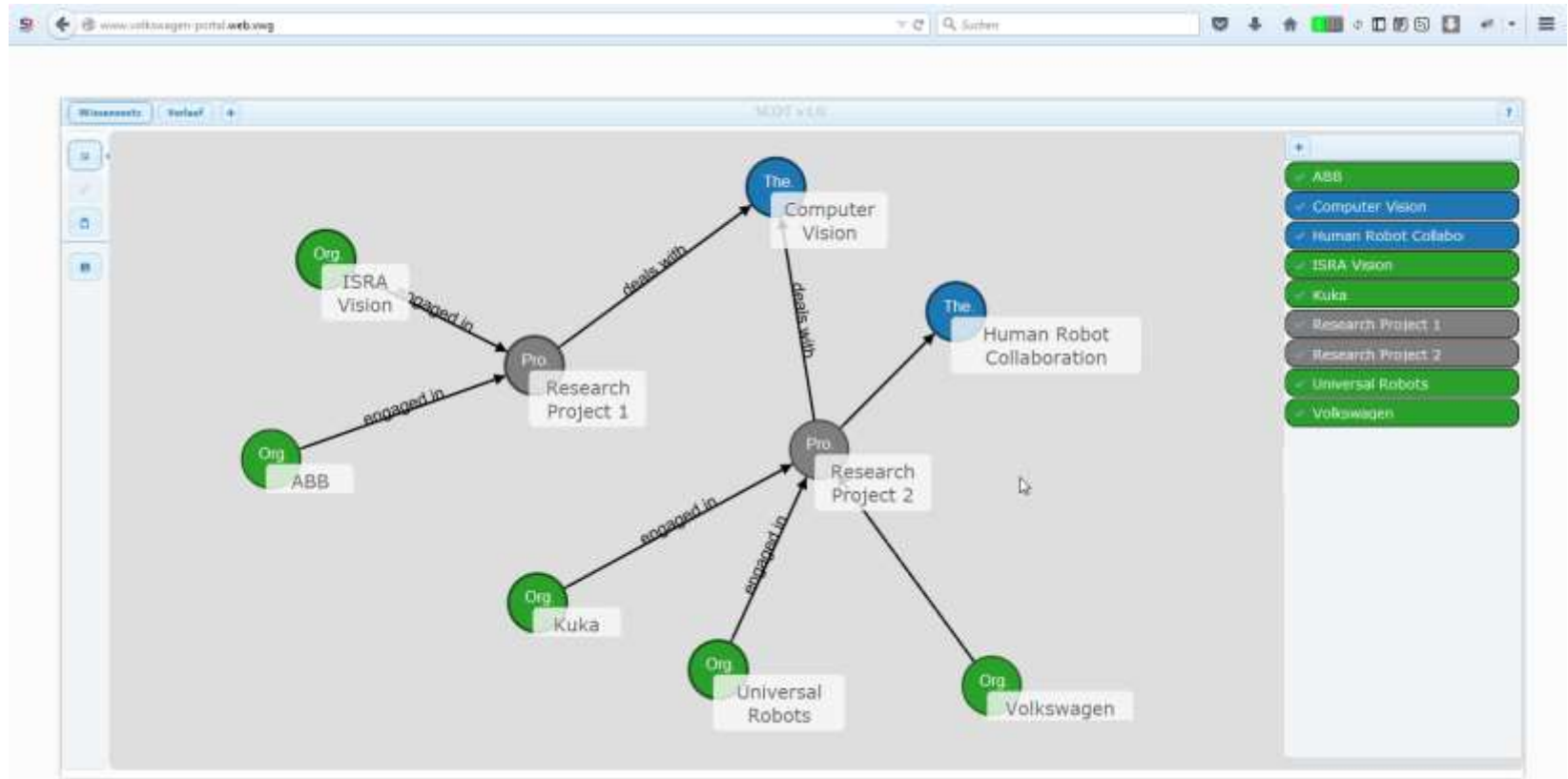
Collaborative sensemaking using a Tabletop Display, Morris et al., 2010

Sensemaking: Schema



Sensemaking for Teams in SCOT

- Making sense of collected information during a search task



- Co-searchers work together to interpret and contextualize the information they retrieve.
- Relationships between entities are restricted to what is specified in a domain ontology.

Recommendation

➤ Recommender systems are about discovery

The screenshot displays the Amazon Prime video interface for the movie **Star Trek Into Darkness** (2013). The page features a large movie poster, a star rating of 4.5 stars from 12,337 reviews, and a "Watch Trailer" button. A description states: "When a ruthless mastermind, Khan (Benedict Cumberbatch), declares a one-man war on the Federation, Captain Kirk (Chris Pine), Spock (Zachary Quinto), and the crew of the U.S.S. Enterprise set out on their most explosive manhunt of all time." It also lists the starring actors and runtime. On the right, it offers the movie for free with Prime membership, or for rent/buy at various prices. Below the main content, a section titled "Customers Who Bought This Item Also Bought" displays a row of recommended movies, including **Star Trek**, **Gladiator**, **Star Trek: The Motion Picture**, **World War Z**, **Star Trek: The Next Generation**, **Star Trek: Voyager**, and **Star Trek: Enterprise**.

Recommendation

- A good recommender brings up items that are
 - Relevant
 - Novel
 - Surprising

Common approach: Collaborative Filtering

- Task of predicting user preferences on new items by collecting “taste” information from a large number of other users

Recommendations

- How can we make recommendations more interesting?
 - increase serendipity!
- An example
 - create an environment where serendipitous recommendations become more likely
 - leverage the effect of bisociations!

Bisociations

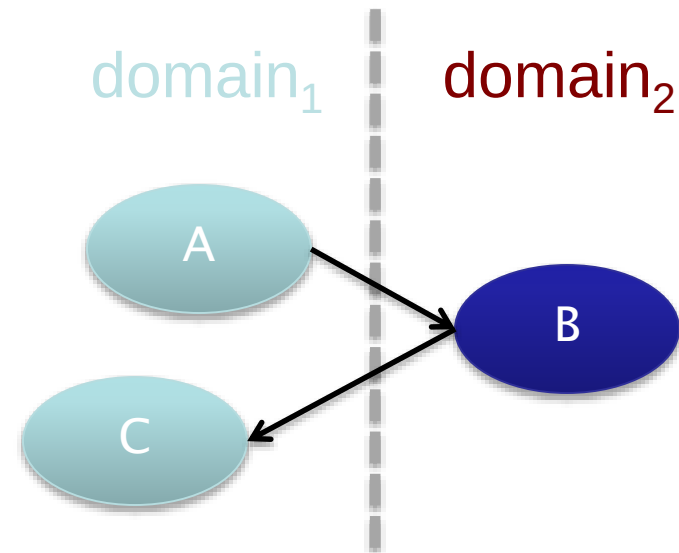
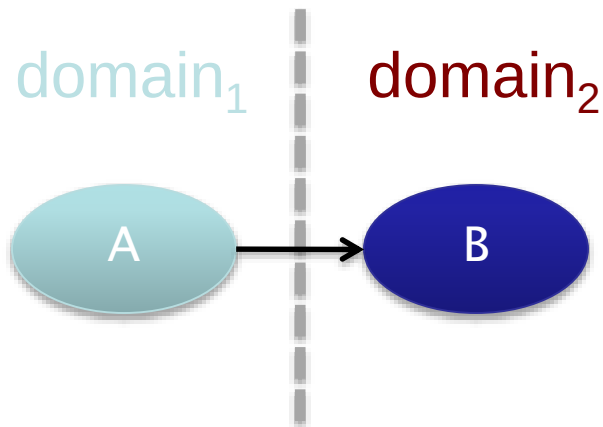
➤ Arthur Köstler: *The Act of Creation* (1964)

“the perceiving of a situation or idea, L , in two self-consistent but habitually incompatible frames of reference, M_1 and M_2 . The event L , in which the two intersect, is made to vibrate simultaneously on two different wavelengths, as it were. While this unusual situation lasts, L is not merely linked to one associative context but bisociated with two.”

- ➡ simultaneous mental association of an idea or object with two fields / frames of reference ordinarily not regarded as related
- ➡ combine two different views on a music collection

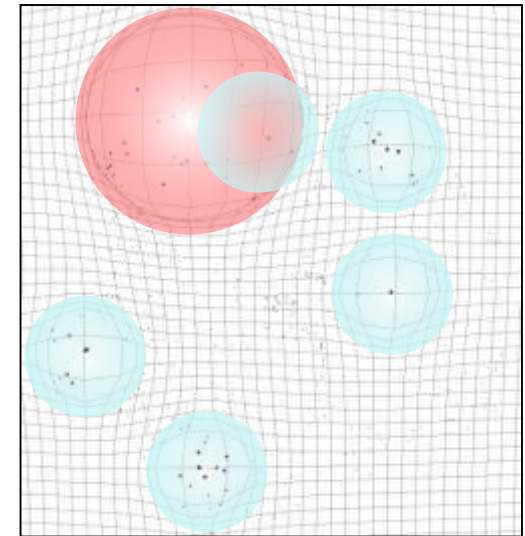
Bisociations by Bridging Graphs

- = path that connects ideas or objects
 - a) of different domains (ordinarily not regarded as related)
 - b) by incorporating another domain



For further discussions on exploration using bisociations see, e.g., [Gossen et al, 2012]

Combining Orthogonal Similarity Spaces



projection weights

dynamics	0.0
rhythm	1.0
timbre	0.0

distortion weights

dynamics	1.0
rhythm	0.0
timbre	1.0

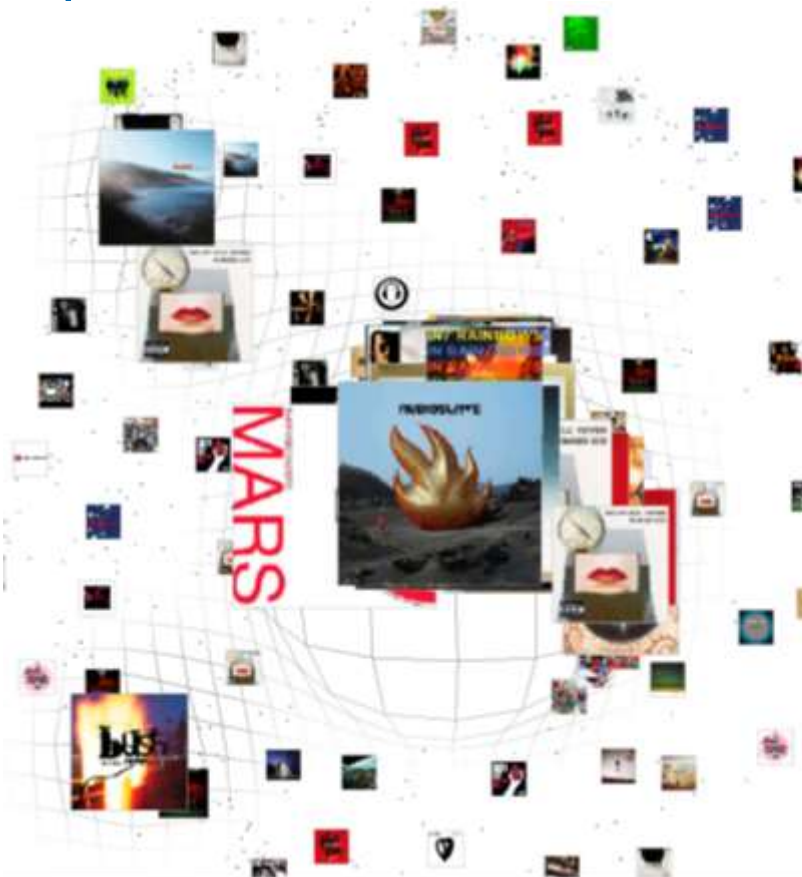
S. Stellmach, S. Stober, A. Nürnberg, R. Dachsel, *Designing gaze-supported multimodal interactions for the exploration of large image collections*, In: Proc. of 1st Conf. on Novel Gaze-Controlled Applications (NGCA), 2011

Bisociations in Graphs

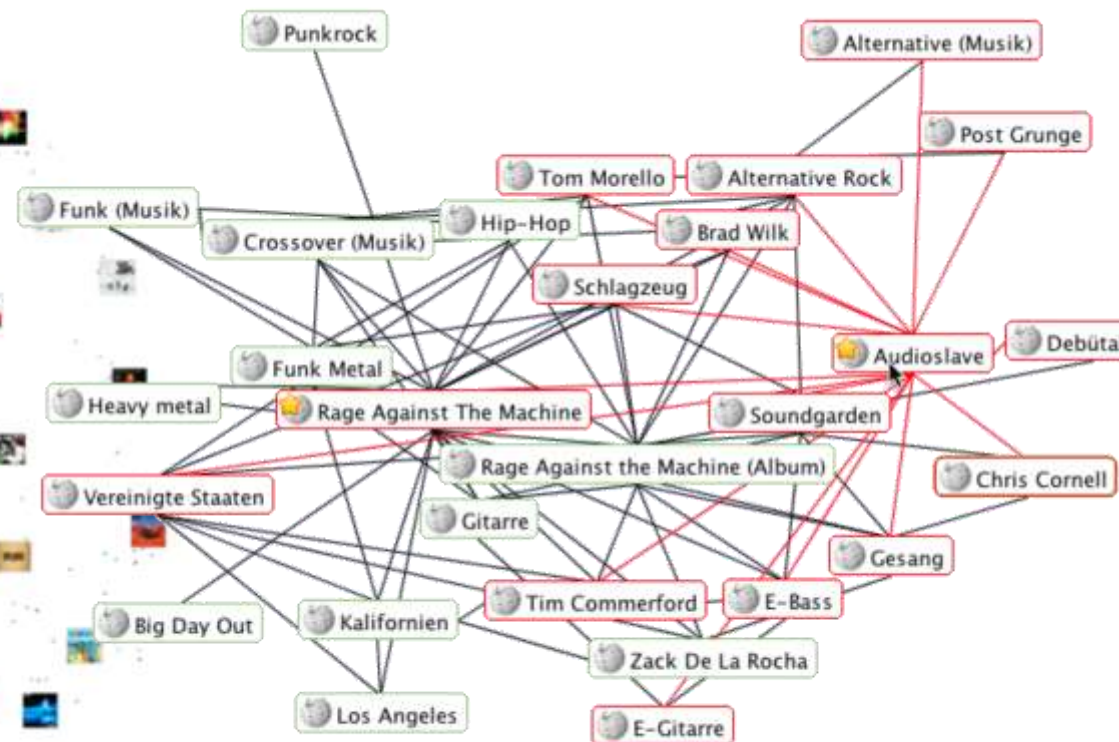
- bridging concepts
 - established by ambiguous terms or metaphors
 - word-plays (context switching leads to a surprising outcome often perceived as joke)
- bridging graphs
 - connect concepts from different domains by inducing one or multiple paths between those concepts.
 - either the two concepts must lie in different domains or the path must contain at least one vertex in a different domain
- structural similarity
 - common structures in the context of each concept, i.e., similar subgraphs
 - may lead to same / very similar abstraction of both concepts

Similarity Space + Linked Data (Graph)

projection:
content-based similarity



nearest neighbors:
graph traversal



Conclusions

- Collaborative Information Seeking is still far from being well supported by IT systems
- Main challenges:
 - How to model user interests? (Yes, still an issue!)
 - How to model users search strategies?
 - How to visualize in order to support efficient traceability and sensemaking?
- Research requires close collaboration between IR, ML and HCI communities.

References (1)

- [Bates, 1979] Bates, M. J., Information Search Tactics Journal of the American Society for Information Science, 1979, 30, 205–214
- [Bates, 1989] Bates, M. J. The design of browsing and berrypicking techniques for the online search interface. Online Information Review, 13(5):407–424, 1989.
- [Beckers et al, 2014] Beckers, T. and Dungs, S. and Fuhr, N. and Jordan, M. and Kontokotsios, G. and Kriewel, S. and Paraskeuopoulos, Y. and Salampasis, M., ezDL: An Interactive IR Framework, Search Tool, and Evaluation System. Professional Search in the Modern World LNCS, 8830:118–146, 2014.
- [Byström & Järvelin, 1995] Byström, K. and Järvelin, K., Task complexity affects information seeking and use. Journal of Information Processing and Management, 31(2):191–213, 1995.
- [Ellis, 1989] Ellis, D., A behavioural approach to information retrieval design. Journal of Documentation, 45(3):171–212, 1989.
- [Ellis, 1993] Ellis, D., Cox, D. and Hall, K., A comparison of the information seeking patterns of researchers in the physical and social sciences. Journal of Documentation, 49(4):356–369, 1993.
- [Evans & Chi, 2008] Evans, B.M. and Chi, E.H. Towards a model of understanding social search. In Proceedings of the ACM conference on Computer supported co-operative work, pages 485–494. ACM New York, NY, USA, 2008.
- [Golovchinsky et al., 2008] Golovchinsky, G., Pickens, J. and Back, M. A taxonomy of collaboration in online information seeking. In Proceedings of the Workshop on Collaborative Information Retrieval, 2008.
- [Gossen et al, 2011] Gossen, T., Korinna, B., Nürnberger, A. A comparative study of collaborative and individual web search for a social planning task, In: LWA 2011 Workshop, 2011.
- [Gossen et al, 2012] Gossen, T., Nitsche, M., Haun, S. and Nürnberger, A. Data Exploration for Bisociative Knowledge Discovery: A Brief Overview of Tools and Evaluation Methods. In: Bisociative Knowledge Discovery, pages 287–300, 2012.
- [Hearst & Degler, 2013] Hearst, M. A. and Degler, D., Sewing the Seams of Sensemaking: A Practical Interface for Tagging and Organizing Saved Search Results. HCIR '13 Proc. of the Symposium on Human–Computer Interaction and IR, 2013.
- [Kuhlthau, 1991] Kuhlthau, C.C., Inside the search process: information seeking from the user's perspective. Journal of the American Society for Information Science, 42, 1991, 361–371.
- [Kuhlthau, 1994] Kuhlthau, C. C. Seeking meaning: a process approach to library and information services. Norwood, NJ: Ablex Publishing, 1994.
- [Kelly, 2009] Kelly, D., Methods for Evaluating Interactive Information Retrieval Systems with Users. Found. Trends Inf. Retr., 3(1–2):1–224, 2009.

References (2)

- [Liechti & Sumi, 2002] Liechti, O. and Sumi, Y., Editorial: Awareness and the WWW, *Int. J. on Human-Computer Studies*, 56:1–5 2002.
- [Marchionini, 2006] Marchionini, G. Exploratory search: from finding to understanding *Communications of the ACM*, ACM, 2006, 49, 41–4
- [Morris et al, 2010] Morris, M. R. and Lombardo, J. and Wigdor, D., WeSearch: supporting collaborative search and sensemaking on a tabletop display, *Proc. of the ACM conference on CSCW*, 2010.
- [Russell-Rose & Tate, 2013] Russell-Rose, T. and Tate, T.: *Designing the Search Experience: The information architecture of discovery*, Morgan Kaufmann, 2013.
- [Russell et al, 1993] Russell, D.M. and Stefik, M. J. and Pirolli, P. and Card, S. K., *The cost structure of sensemaking*, *Proc. Of InterCHI*, 1993.
- [Shah, 2010] Shah, C., *Coagmento – A Collaborative Information Seeking, Synthesis, and Sense-making Framework*, *CSCW*, 2010.
- [Stange & Nürnberger, 2014] Stange, D. and Nürnberger, A., *Search Maps: Enhancing Traceability and Overview in Collaborative Information Seeking*, *LNCS*, 8416:763–766, 2014.
- [Stange & Nürnberger, 2015] Stange, D. and Nürnberger, A., *When Experts Collaborate: Sharing Search and Domain Expertise within an Organization*, *15th Int. Conf. On Knowledge Technologies and Data-Driven Businesses*, 2015. (to appear)
- [Stellmach et al.] S. Stellmach, S. Stober, A. Nürnberger, R. Dachsel, *Designing gaze-supported multimodal interactions for the exploration of large image collections*, In: *Proc. of 1st Conf. on Novel Gaze-Controlled Applications (NGCA)*, 2011
- [Stober & Nürnberger, 2013] Stober S., Nürnberger, A., *Adaptive music retrieval—a state of the art*, *Multimedia Tools and Applications*, 65(3):467–494, 2013.
- [Villa et al, 2009] Villa, R. and Cantador, I. and Joho, H. and Jose, J.M., *Proc. of the 32nd international ACM SIGIR conference*, 2009.
- [White & Roth, 2009]: White, R. W. & Roth, R. A., *Exploratory search: Beyond the query-response paradigm Synthesis Lectures on Information Concepts, Retrieval, and Services*, Morgan & Claypool Publishers, 2009, 1, 1–98
- [Wilson, 1981] Wilson, T. D., *On user studies and information needs*. *Journal of documentation*, 37(1):3–15, 1981.
- [Wilson, 1999] Wilson, T. D., *Models in information behaviour research*. *Journal of documentation*, 55(3):249–270, 1999.
- [Zhang et al, 2014] Zhang, Y. and Broussard, R. and Ke, W. and Gong, X., *The Evaluation of a Scatter/Gather Interface for Supporting Distinct Health Information Search Tasks*, *Journal of the Association for Information Science and Technology*, 65(5):1028–1041, 2014.