Foundations of User-Oriented Information Retrieval: History, Theories, Models, Future

Nicholas J. Belkin

School of Communication & Information, Rutgers University

belkin@rutgers.edu

Outline

- Why are there two lectures today on *user*-oriented IR?
- A selective survey of user-oriented models of IR over the years
- Attempts at re-integration of user- and system-oriented IR
- *Interactive* IR – approaches, major concepts, major issues

Can (Should) IR be *Non*-User-Oriented? Part 1

- The information retrieval situation
  - A person (or persons) engaged in some task, or desiring to achieve some goal, finds that their internal resources are inadequate with respect to accomplishing their task or achieving their goal (in a *problematic situation*)
  - The person, or group, therefore engages with some external knowledge resource, e.g., another person, or a library, or a web search engine
- The information retrieval system consists of
  - Some collection of information objects, represented and organized in some way
  - The person, with task/goal/problematic situation
  - An intermediary mechanism, supporting the person's access to, and appropriate *interaction* with, the set of information objects

Can (Should) IR be *Non*-User-Oriented? Part 2

- The goal of IR systems
  - That the person(s), through *interaction* with the other components of the system, in particular the information objects, is able to complete the task, or achieve the goal, that led them to engage in information seeking.
- Achieving, and evaluating achievement, of the goal of IR, seems to require:
  - Participation of the information seeker;
  - Knowledge and/or understanding of information seeker by intermediary
- IR CANNOT BE NON-USER-ORIENTED
- So, why am I talking about user-oriented IR?

A Little Bit of IR History

- IR started out user-oriented
  - Librarians and computer scientists working together; goal of IR was understood as providing *useful* information
- Problems in evaluating IR performance
  - Goal is too difficult a criterion – proxy for goal: topically *relevant* documents
  - Users are too variable – standard user model of someone who wants all and only relevant documents in response to a query
  - Leads to Cranfield/TREC model for IR system evaluation
- Bifurcation of IR research
  - Designing and evaluating IR systems – computer science, no users
  - Investigating and understanding information seeking – library & information science, only users
- Cool, C. & Belkin, N.J. (2011) Interactive information retrieval: history and background. In: I. Ruthven & D. Kelly (Eds.) *Interactive information seeking, behaviour and retrieval* (pp. 1-14). London: Facet Publishing

On to User-Oriented IR Models

- Some more history, mostly

Taylor's Levels and Filters

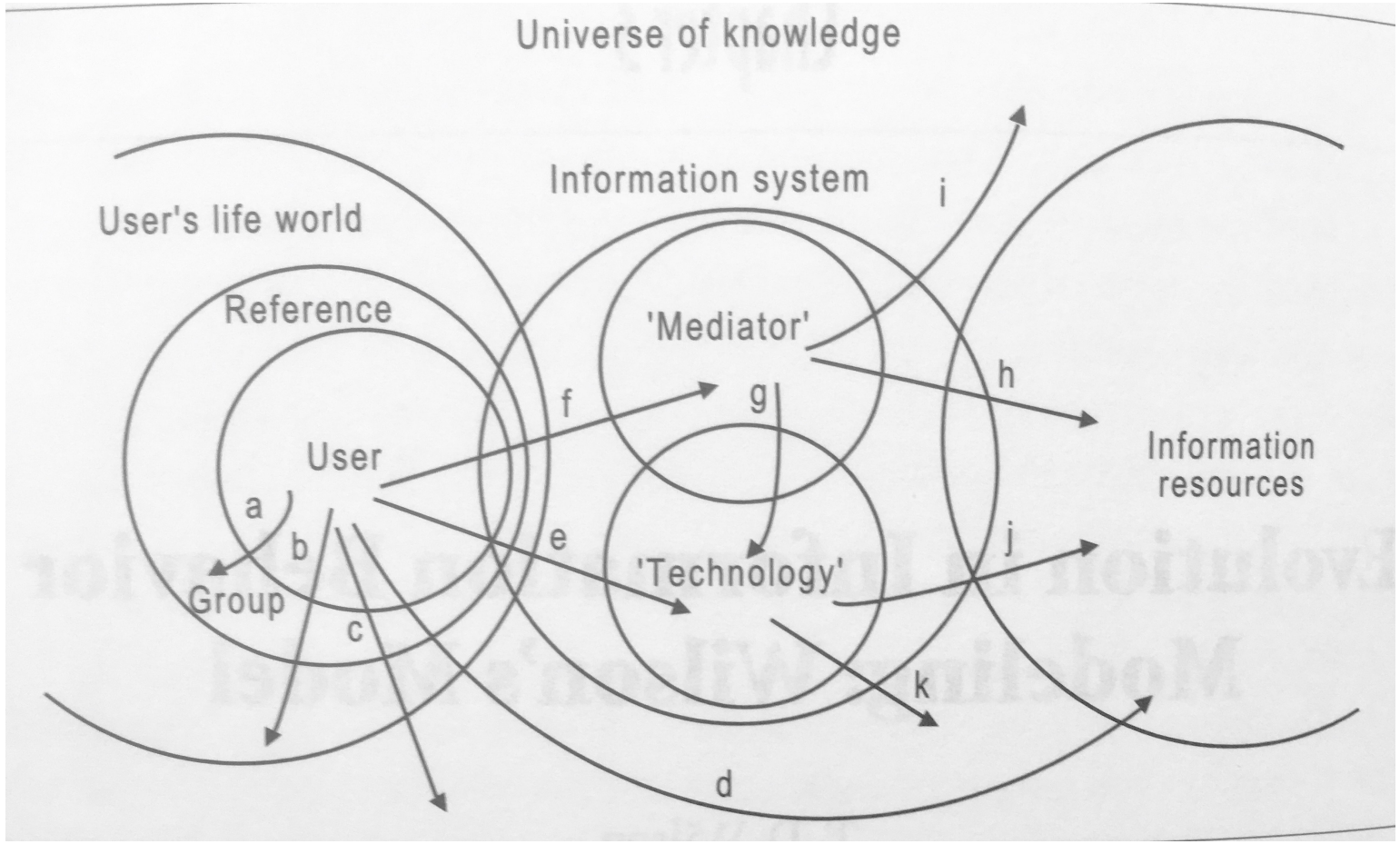
- Levels of Information Need

1. Actual, *visceral*, unexpressed
2. *Conscious*, within brain
3. *Formal* statement
4. Presented to system, *compromised*

- Negotiation Filters
  - Determination of subject
  - Objective and motivation
  - Personal characteristics of inquirer
  - Relationship of inquiry to collection
  - Anticipated or acceptable response(s)

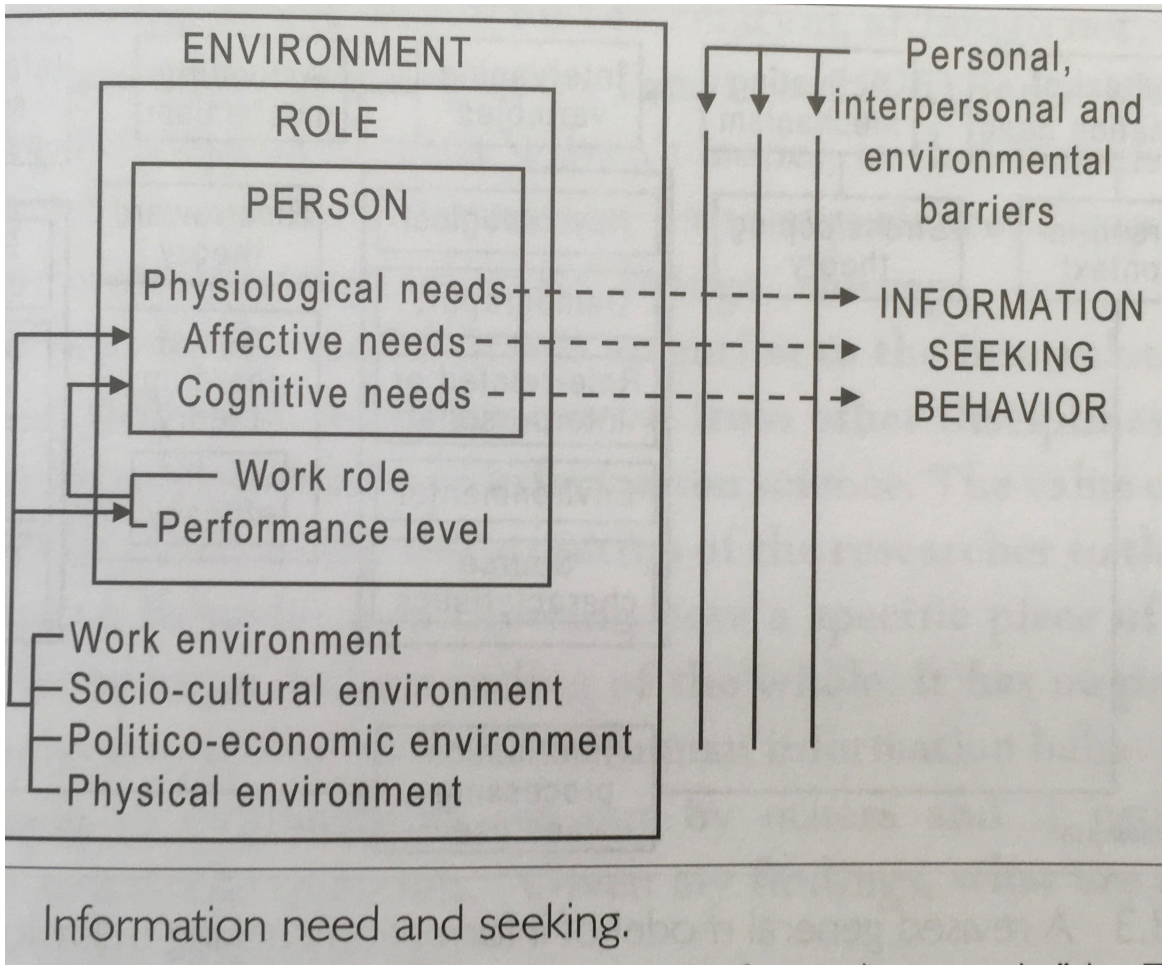
Taylor, R.S. (1968) Question-negotiation and information seeking in libraries. *College and Research Libraries*, v. 28: 178-194.

Wilson's User Context



Wilson, T.D. (1981) On user studies and information need. *Journal of Documentation*, v. 37(1): 3-15.

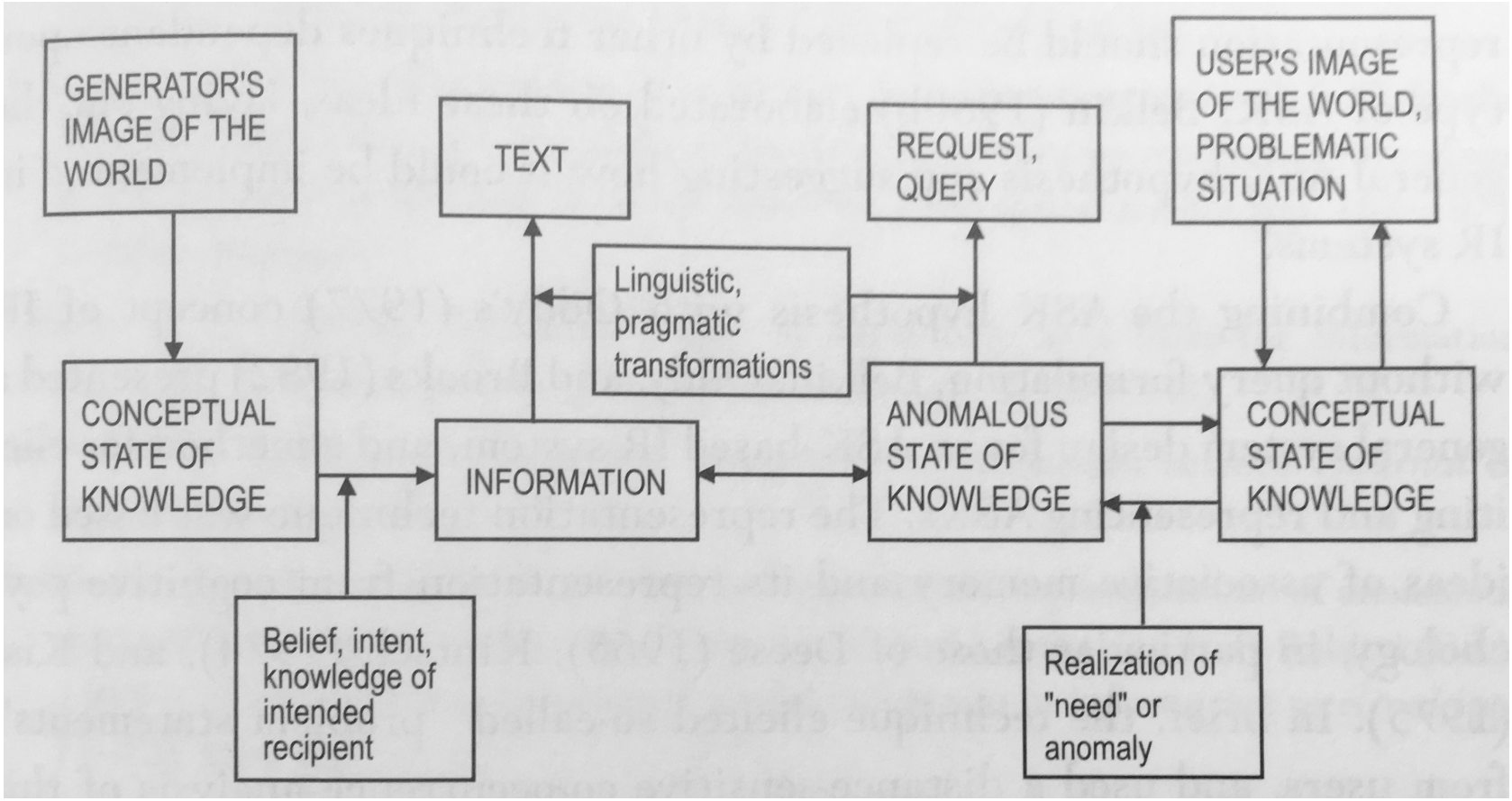
Wilson and "Information Need"



Information need and seeking.

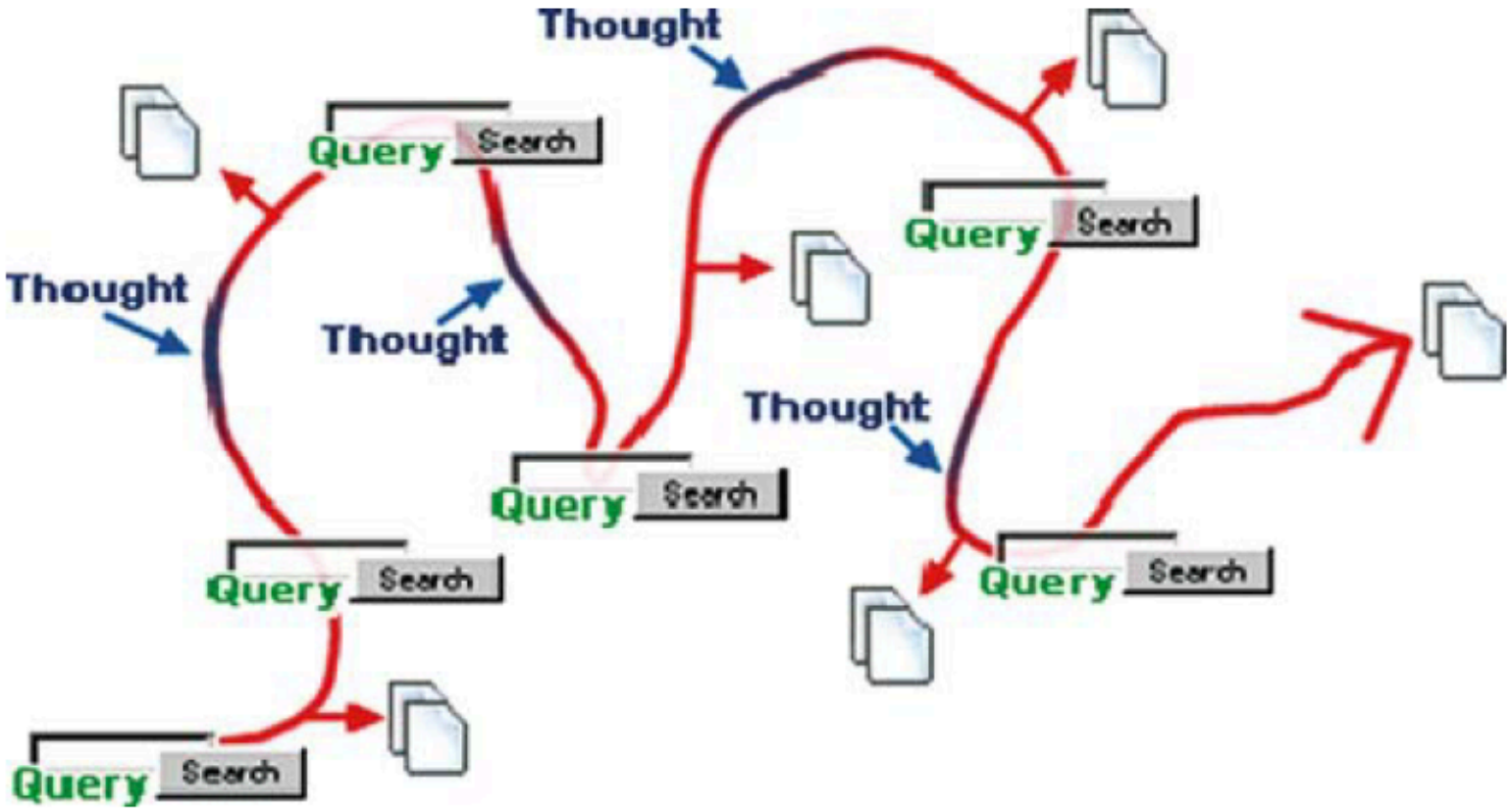
Wilson, T.D. (1981) On user studies and information need. *Journal of Documentation*, v. 37(1): 3-15.

Belkin's ASK and Communication System



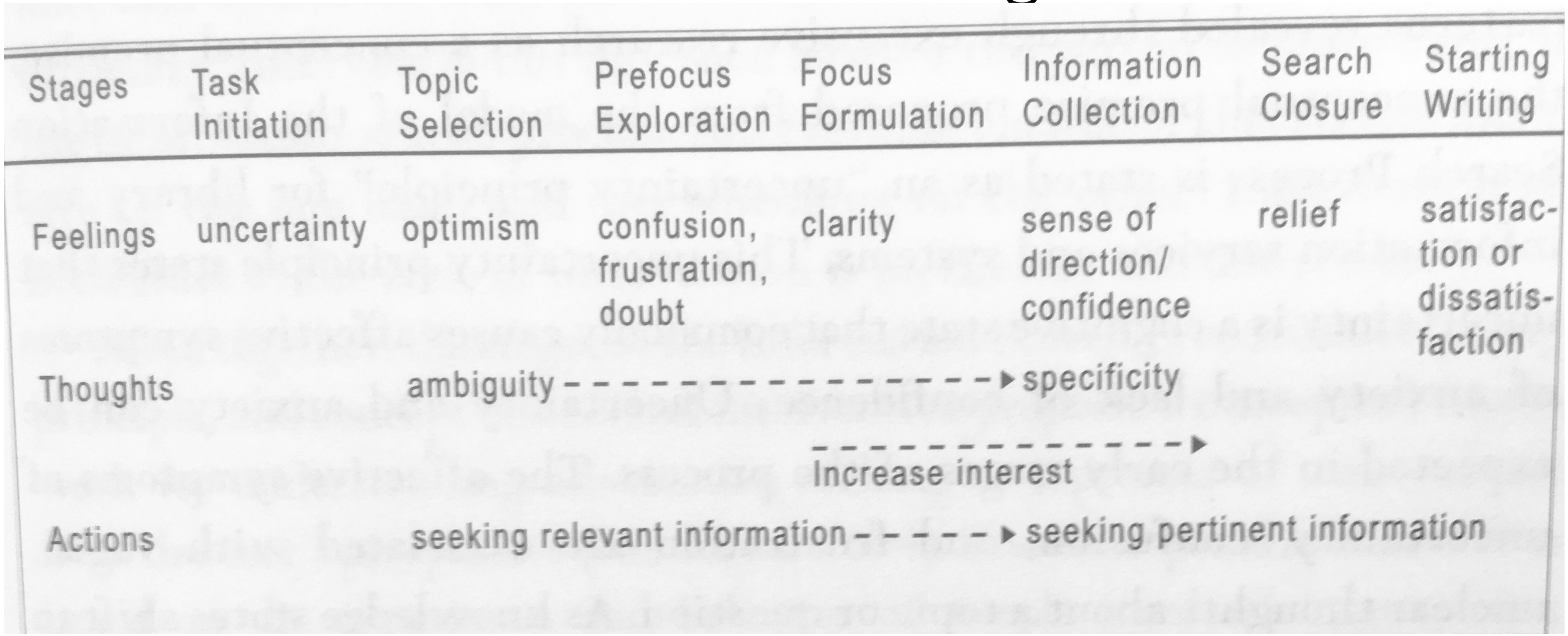
Belkin, N.J. (1980) Anomalous states of knowledge as a basis for information retrieval. *Canadian Journal of Information Science*, v. 5: 133-143.

Bates's Berry-Picking Model



Bates, M.J. (1989) The design of browsing and berrypicking techniques for the online search interface. *Online Review*, v. 13: 407-431.

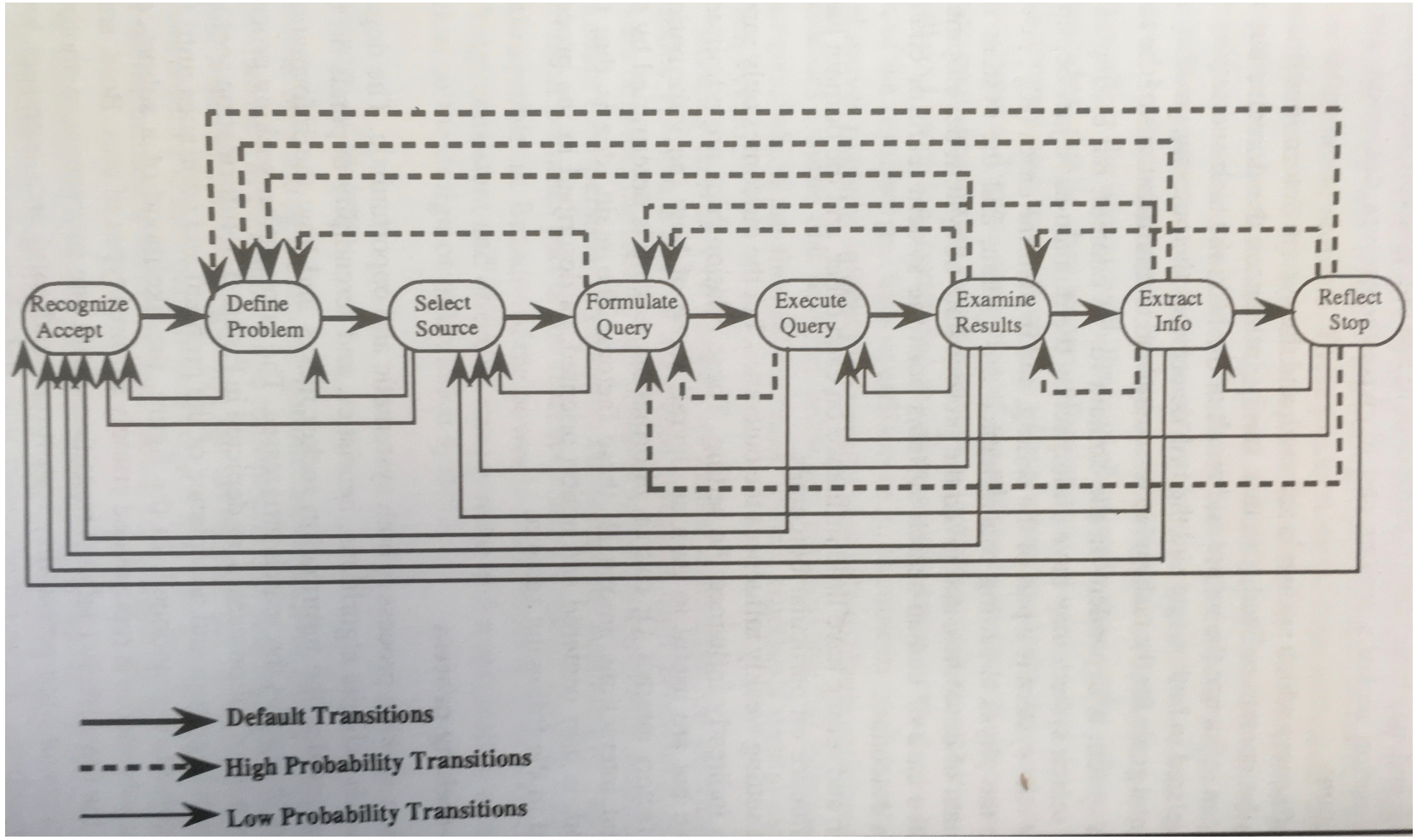
Kuhlthau's Information Seeking Process



Stages	Task Initiation	Topic Selection	Prefocus Exploration	Focus Formulation	Information Collection	Search Closure	Starting Writing
Feelings	uncertainty	optimism	confusion, frustration, doubt	clarity	sense of direction/ confidence	relief	satisfaction or dissatisfaction
Thoughts		ambiguity – – – – – – – – – – – – – – – – – ▸			specificity		
				– – – – – – – – – – – – – – – ▸			
				Increase interest			
Actions		seeking relevant information – – – – – ▸			seeking pertinent information		

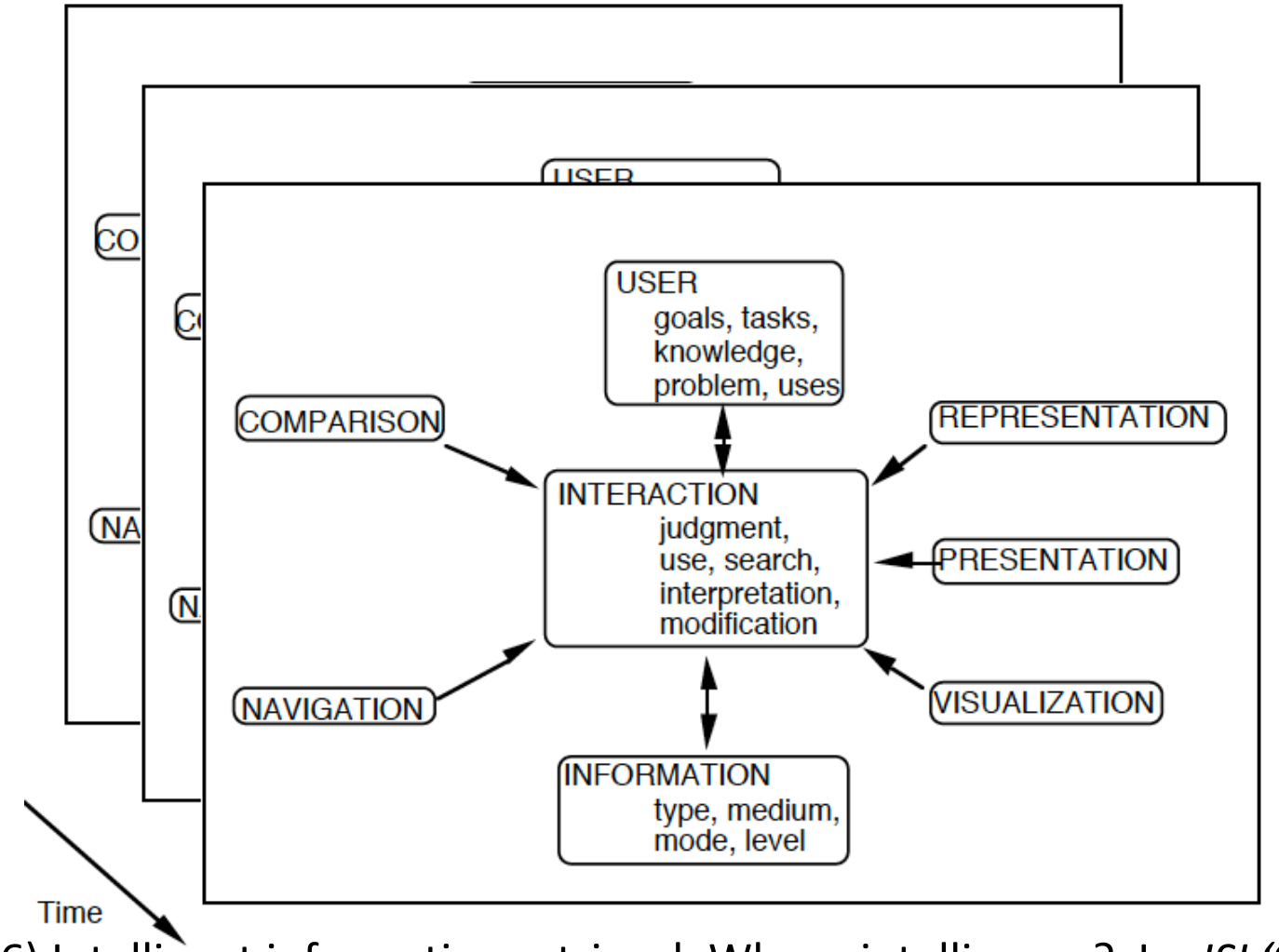
Kuhlthau, C.C. (1993) *Seeking meaning*. Norwood, NJ: Ablex

Marchionini's Information Seeking Process



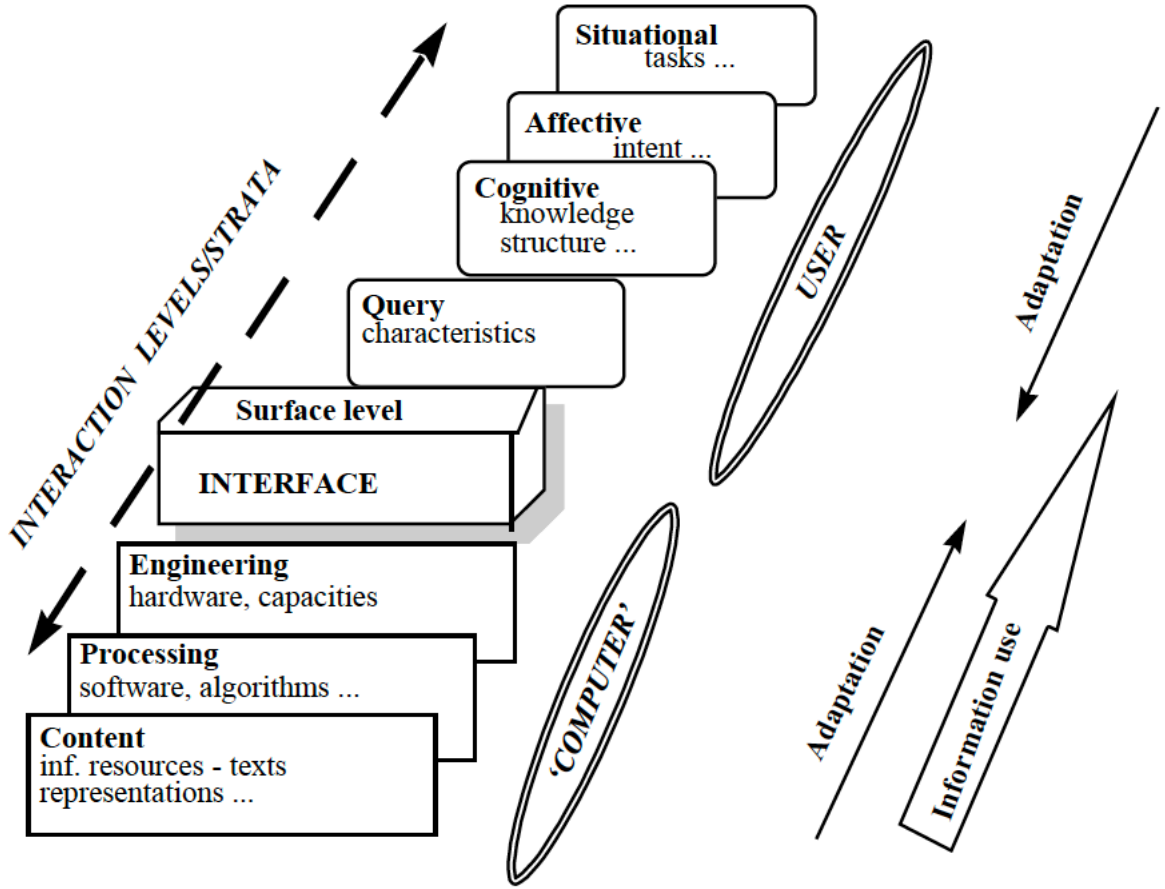
Marchionini, G. (1995*) Information seeking in electronic environments*. Cambridge: Cambridge University Press.

Belkin's Interaction Model of IR



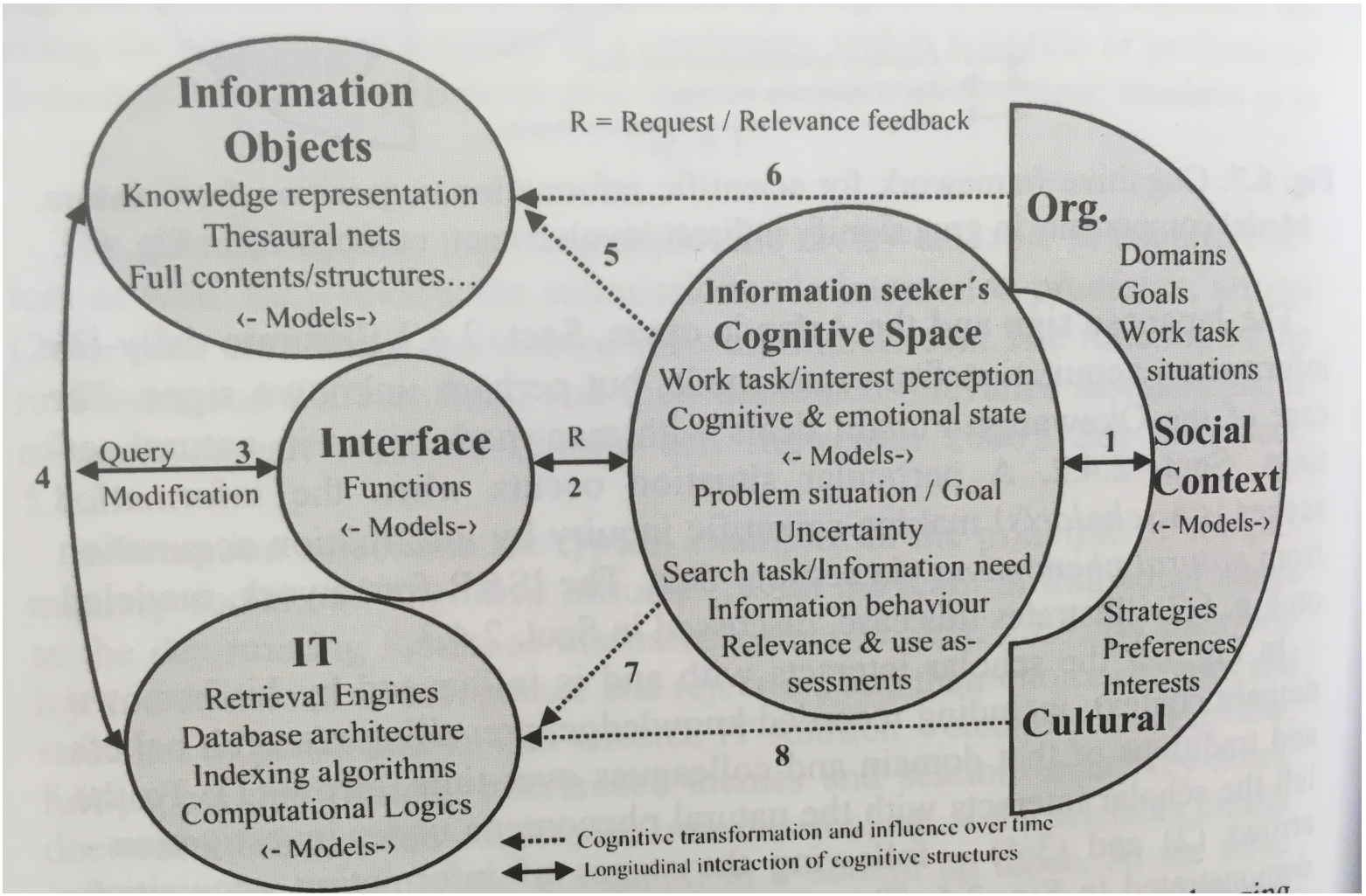
Belkin, N.J. (1996) Intelligent information retrieval: Whose intelligence? In: *ISI '96: Proceedings of the Fifth International Symposium for Information Science*. Konstanz, Universitätsverlag Konstanz: 25-31

Saracevic's Stratified Model of IR



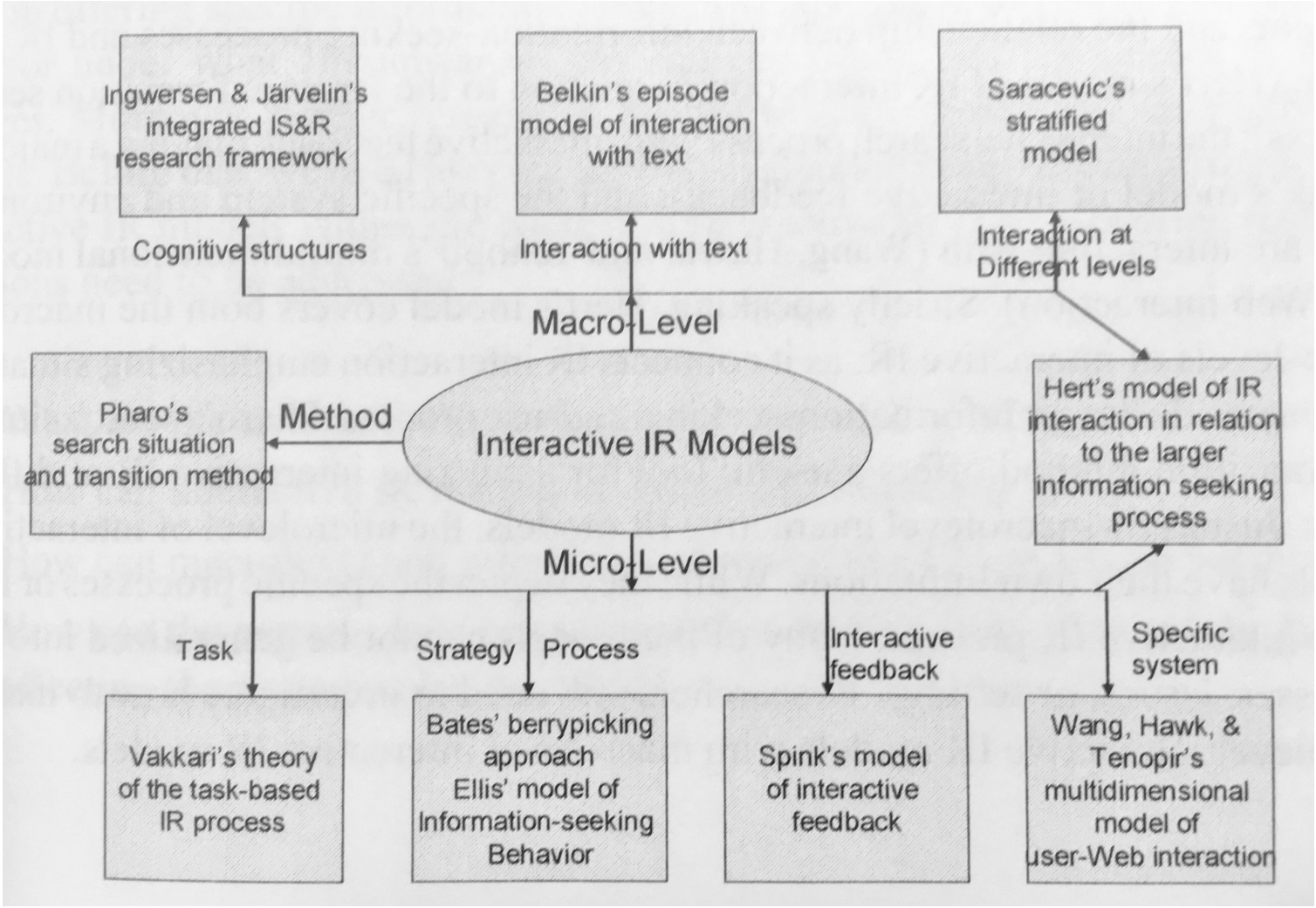
Saracevic, T. (1997). The stratified model of information retrieval interaction: extension and applications. In *Proceedings of the American Society for Information Science*, v. 34: 313-327.

Ingwersen & Järvelin's Cognitive Context of IR



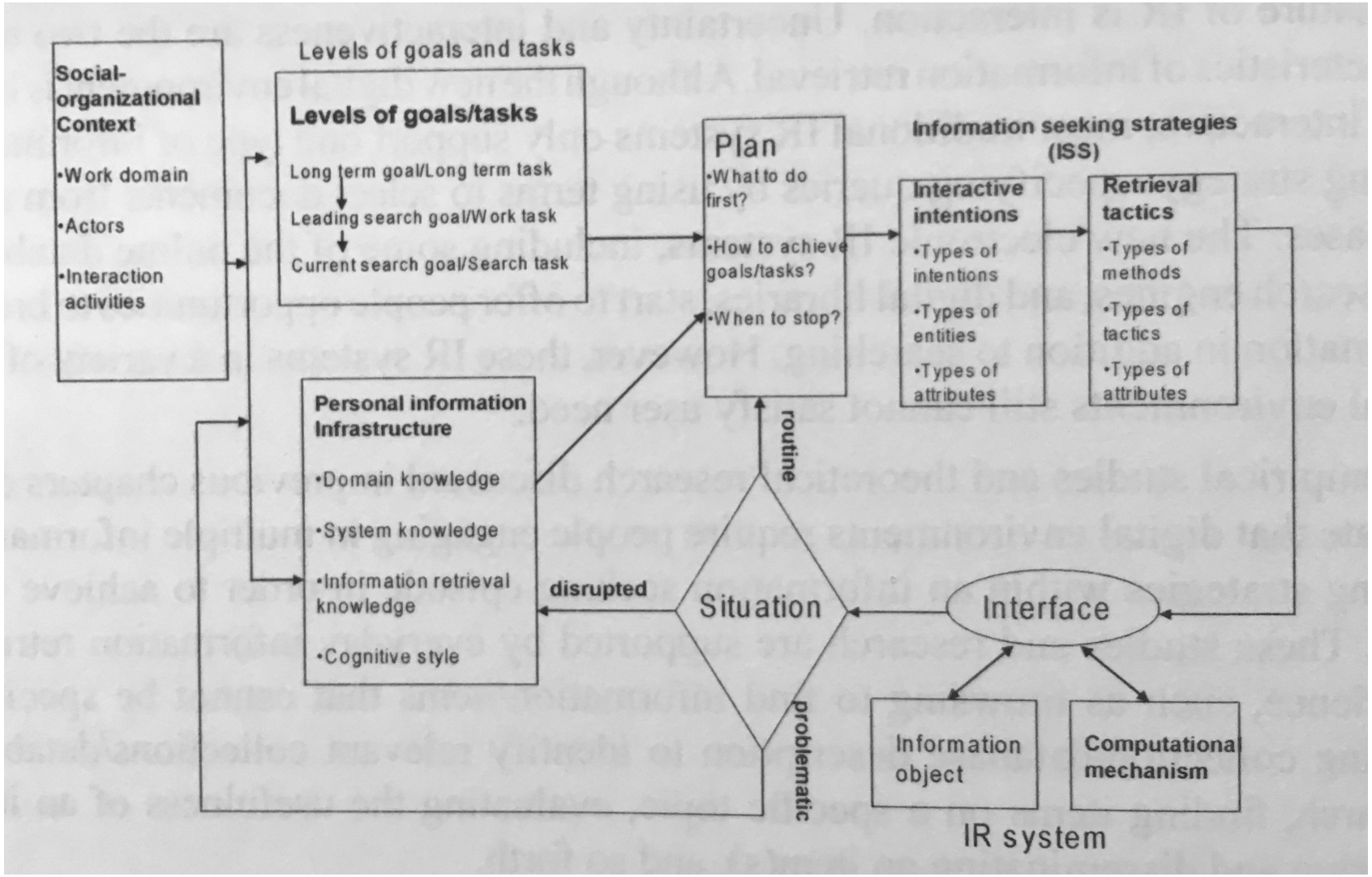
Ingwersen, P. & Järvelin, K. (2005*). The turn: integration of information seeking and retrieval in context*. Heidelberg: Springer.

Xie's Classification of IIR Models



Xie, I. (2008) *Interactive information retrieval in digital environments*. Hershey, PA: IGI Publishing

Xie's Planned-Situational IR Model



Xie, I. (2008) *Interactive information retrieval in digital environments*. Hershey, PA: IGI Publishing

Integrating User- and System-Oriented IR

- A few examples of system design/implementation

Oddy's IR Without Query Formulation

- Oddy, R.N. (1977) Information retrieval through man-machine dialogue. *Journal of Documentation*, v 33 (1): 1-14
- Through dialogue with the user, the "intermediary" (*system* in Oddy's terms), " forms an image (rather as a man does) of the view of the human enquirer, without requiring him to ask a precise question, and responds with references according to its image."
- THOMAS operated by presenting the searcher with a single document, asking the searcher to comment on aspects of the document, revising its image, and presenting a new document
- In a very explicit way, presages Bates's Berrypicking

ASK for Information Retrieval

- Belkin, N.J., Oddy, R.N. & Brooks, H.M. (1982) ASK for information retrieval. Part I: Background and theory; Part II: Results of a design study. *Journal of Documentation*, vol. 38, nos. 2&3: 61-71; 145-164 . Part I reprinted in: *Readings in Information Retrieval*, K. Spärck Jones and P. Willett, eds. San Francisco, Morgan Kaufmann, 1997: 299-304.
- Proposes a dynamic system design in which: searchers describe that which they wish to accomplish, and what they already know (the *ASK*); the intermediary constructs an image of the current ASK; selects and presents potentially appropriate response(s); the searcher's responses modify the image; and so on.

Scripts for Guiding Information Seeking Dialogues

- Belkin, N.J., Cool, C., Stein, A. & Thiel, U. (1995) Cases, scripts, and information seeking strategies: on the design of interactive information retrieval systems. *Expert Systems with Applications*, vol. 9: 379-395.
- “we propose a model of information retrieval system design based on the ideas of: a multidimensional space of information-seeking strategies; dialogue structures for information seeking; cases of specific information-seeking dialogues; and, scripts as distinguished prototypical cases”

Formal Models of Interactive Information Retrieval

- Norbert Fuhr has proposed a probabilistic framework for modeling IIR; Cheng Xiang Zhai and students have suggested other formal models for IIR. Although no systems have yet been built according to such models, they represent attempts to extend methods of CS IR to the IIR context.
- Fuhr, N. (2008) A probability ranking principle for interactive information retrieval. *Information Retrieval*, *11*(3), 251-265.
- Fuhr, N. (2017) Modeling interactive information retrieval as a stochastic process. Keynote address in *Proceedings of the 2017 ACM Conference on Human Information Interaction and Retrieval (CHIIR '17)* (p. 1). New York: ACM.
- Zhang, Y., & Zhai, C. (2015, August). Information retrieval as card playing: A formal model for optimizing interactive retrieval interface. In *Proceedings of the 38th International ACM SIGIR Conference on Research and Development in Information Retrieval* (pp. 685-694).New York: ACM.

Significant Directions in Interactive Information Retrieval Research

- Studying and evaluating interactive IR
- Significance of motivating *task*, studies of search *intentions*
- IR as dialogue, and conversational IR

The TREC Interactive Track

- Explicit attempt to study interaction in IR systems, and to evaluate support for searchers within a “standard” IR evaluation model.
- Developed standard methods for investigating IIR
- Demonstrated inability of standard evaluation model to evaluate IIR
- Led to TREC Session Track
- Dumais, S.T. & Belkin, N.J. (2005) The TREC interactive tracks: Putting the user into search. In E.M. Voorhees & D.K. Harman (Eds.) *TREC. Experiment and evaluation in information retrieval* (pp. 123-152). Cambridge, MA: MIT Press.

Motivating Task

- *Why* people engage in information seeking turns out to be the most significant factor in understanding and supporting information seeking
- Two (of many) approaches to understand/classify motivating task or goal:
  - Li, Y. & Belkin, N.J. (2008) A faceted approach to conceptualizing tasks in information seeking. *Information Processing & Management*, v. 44 (6): 1822-1837
  - Kelly, D., Arguello J., Edwards A., & Wu W.C. (2015). Development and evaluation of search tasks for IIR experiments using a cognitive complexity framework**.** *Proceedings of ACM SIGIR International Conference on the Theory of Information Retrieval (ICTIR '15)* (pp. 101-110). New York: ACM

Motivating Tasks and Search Behaviors

- Significant research has been done on the relationships between type of motivating task, and information seeking behaviors
- Controlled task studies in the laboratory, e.g.
  - Cole, M.J., Hendahewa, C., Belkin, N.J. & Shah, C. (2015) User activity patterns during information search. *ACM Transactions on Information Systems*, 33 (1): Article No. 1 (39 p.)
- Uncontrolled task studies in real environments, e.g.
  - He, J. & Yilmaz, E. (2017) User behavior and task characteristics: a field study of daily information behavior. In *Proceedings of the 2017 ACM Conference on Human Information Interaction and Retrieval (CHIIR '17)* (pp. 67-76). New York: ACM

Search Intentions (*not* Intents)

- Studies of information seeking in IR systems (of all sorts) indicate that people try to do a variety of things during the course of an information seeking episode; these can be understood as *search intentions.*
- One example from a series of studies:
  - Liu, J., Mitsui, M., Belkin, N.J. & Shah, C. (2019) Task, information seeking intentions, and user behavior: toward a multi-level understanding of Web search. In *Proceedings of CHIIR 2019, the 2019 ACM SIGIR Conference on Human Information Interaction and Retrieval* (pp. 123-132). New York: ACM.

IIR as Dialogue

- General concept is to simulate aspects of the functionality of human-human information interaction (e.g. Taylor (1968)
- Long history (starting with Oddy (1977) of this idea, in a variety of manifestations
- One example of how this could be applied in a complex IIR system
  - Yuan, X. & Belkin, N.J. (2014) Applying an information-seeking dialogue model in an interactive information retrieval system. *Journal of Documentation*, 70 (5): 829-855.

IR as Social Interaction

- Cool, C. (1997). The nature of situation assessment in new information retrieval environments. In *Proceedings of the 60th Annual Meeting of the American Society for Information Science* (pp. 135-146). Medford, N.J.: Information Today, Inc.
- The “machine” intermediary and the information resource, in the IR system, according to symbolic interaction theory, are understood by the human in the system as other social actors in the IR interaction – construed as a situation, following norms for social situations.
- A major concern in such interaction is establishing common understanding of one another, through a process of *situation assessment* or calibrating the extent of mutual understandings.
- Failures of IR interaction result from lack of/inability to judge and correct misunderstandings and to re-establish common ground.

Conversational IR

- Advent of mobile search and of “intelligent agents” (e.g. Alexa, Siri) leads to a (re)new(ed) emphasis on conversational search, especially, but not only, in verbal modality
- Connections possible to previous research in human-human information interaction and dialogue models of IR interaction
- Good deal of preliminary-stage research; here’s a basic reference:
  - Radlinski, F., & Craswell, N. (2017). A theoretical framework for conversational search. In *Proceedings of the 2017 Conference on Human Information Interaction and Retrieval (CHIIR ‘17)* (pp. 117-126). New York: ACM.

In Summary

- Developments in technologies, and a great deal of experience of people interacting in IR systems, have enabled (forced) CS IR to move from a purely system-centered stance.
- Early, and continuing research in information seeking behavior (more broadly, interaction with information), can now be seen to have direct relationships to IR system design, by both LIS and CS IR
- Strong evidence for re-integration of these two stances in the context of Interactive Information Retrieval
  - e.g. de Rijke's lecture yesterday, Croft's Keynote at SIGIR 2019, CHIIR
- Many major problems remain, especially evaluation of IIR.

Basic References for User-Oriented IR

- Ruthven, I & Kelly, D., eds. (2005) *Interactive information seeking, behaviour and retrieval.* London: Facet Publishing
- Ingwersen, P. & Järvelin, K. (2005*). The turn: integration of information seeking and retrieval in context*. Heidelberg: Springer.
- Xie, I. (2008) *Interactive information retrieval in digital environments*. Hershey, PA: IGI Publishing
- Kelly, D. (2009). Methods for evaluating interactive information retrieval systems with users. *Foundations and Trends® in Information Retrieval*, *3*(1–2), 1-224.
- Proceedings of ACM *CHIIR* conferences (started in 2016, merging previous *IIiX* Conferences and *HCIR* Workshops)