Relevance: A Review of the Literature and a Framework for Thinking on the Notion in Information Science. Part II: Nature and Manifestations of Relevance*

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> Relevant: Having significant and demonstrable bearing on the matter at hand.
> Relevance: The ability (as of an information retrieval system) to retrieve material that satisfies the needs of the user.
> —Merriam-Webster Dictionary (2005)

Relevance is a, if not even *the*, key notion in information science in general and information retrieval in particular. This two-part critical review traces and synthesizes the scholarship on relevance over the past 30 years and provides an updated framework within which the still widely dissonant ideas and works about relevance might be interpreted and related. It is a continuation and update of a similar review that appeared in 1975 under the same title, considered here as being Part I. The present review is organized into two parts: Part II addresses the questions related to nature and manifestations of relevance, and Part III addresses questions related to relevance behavior and effects. In Part II, the nature of relevance is discussed in terms of meaning ascribed to relevance, theories used or proposed, and models that have been developed. The manifestations of relevance are classified as to several kinds of relevance that form an interdependent system of relevances. In Part III, relevance behavior and effects are synthesized using experimental and observational works that incorporate data. In both parts, each section concludes with a summary that in effect provides an interpretation and synthesis of contemporary thinking on the topic treated or suggests hypotheses for future research. Analyses of some of the major trends that shape relevance work are offered in conclusions.

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Prologue: How Part II and III are Connected Across Time to Part I and What This Work Is All About

In 1975, I published a review about relevance under the same title, without, of course, "Part I" in the title (Saracevic, 1975). (A substantively similar article was published as a chapter in volume 6 of *Advances in Librarianship*; Saracevic, 1976.) There was no plan then to have another related review published 30 years later—but things happen. The intent of the 1975 work was "to explore the meaning of relevance as it has evolved in information science and to provide a framework within which various interpretations of relevance can be related" (Saracevic, 1975, p. 321).

Building on the examination of relevance in the preceding (1975) review, this work (2007) updates the travails of relevance in information science for the past 30 years or so. Relevance still remains a basic notion in information science, and particularly in information retrieval (IR). The aim of this work is still substantially the same: It is an attempt to trace the evolution of thinking on relevance in information science for the past three decades and to provide an updated, contemporary framework within which the still widely dissonant ideas on relevance might be interpreted and related to one another.

Introduction: How Information Technology Made the Study of Relevance Ever More Relevant

In human history, relevance has been around forever, or as long as humans tried to communicate and use information effectively. Computers have been around for the last 50 years or so, the Internet for some 25, the Web for about 15. In this short time, the contemporary information technology (IT), including its communication components, and information systems based on IT, changed or transformed a great many things in society—from education to health care, from earning a living to leisure, from physics to classics,

from government to being governed, from being young to being old, ... IT changed information activities dramatically, namely, the way we acquire, organize, store, preserve, search, retrieve, communicate, interact with, and use information. In all of those information activities, relevance plays a most significant, underlying, and yet elusive role. Similarly, relevance plays a significant, underlying role when these activities are performed by a great many information systems in general, and information retrieval (IR) systems in particular as well; for these systems are designed primarily to respond with information that is potentially relevant to people.

Information technology is not elusive; relevance is. Information technology is tangible; relevance is intangible. Information technology is relatively well understood formally; relevance is understood intuitively. Information technology has to be learned; relevance is tacit. Information technology has to be explained to people; relevance does not.

In his 1776 book, *An Inquiry into the Nature and Causes of the Wealth of Nations*, Adam Smith, regarded as the "Father of Economics," set out the mechanism by which he believed economic society operated; among others, he explained market decisions as often being governed by an "invisible hand." In the same spirit, while the hand of relevance is invisible, it is governing. Somewhere, somehow, the invisible hand of relevance, under its own or other names, enters the picture in all information activities and a great many information systems. As far as people are concerned, relevance is tacitly present and inescapable. Relevance is the main reason people use IT in their information activities. Conversely, many types of information systems, IR systems being a major example, are primarily designed to provide potentially relevant information or information objects to people. In this lies the significance of relevance.

Positioning people and IT together in this discussion is deliberate to point out basic premises, distinctions, problems, and conflicts. Information retrieval systems, through a complex set of operations based on ever-changing and improving algorithms, retrieve and offer their versions of what may be relevant. People go about their ways and assess their own version of relevance. Both treat relevance as a relation. Nevertheless, each may have different premises for what is involved in the relation and in assessing that relation. There are two interacting worlds—the IT world and the human world—and two basic categories of relevance—systems' and humans'. The two worlds interact with various degrees of problems and conflict, from no problems and conflict to a lot. Our concern here is primarily with the human world of relevance. Relevance is treated here as a human condition, which it is. Although we can never get far from systems, this review does *not* cover how systems deal with relevance. Treatments of relevance in IR—in algorithms, measures, evaluation—are beyond the scope of this review.

In information science, as well as other related fields, the emergence and proliferation of IT provided an impetus for study of the notion of relevance, aimed at a better and more formal understanding of it. Lexical definitions are very important, but do not suffice; besides, we are not really able to resolve issues of relevance through definition alone (Froelich, 1994). In science, phenomena are studied as to their nature, manifestations, behavior, and effects. Thus, as in all other scientific and scholarly endeavors, when faced with a basic phenomenon or notion, scholarly inquiry does not ask the naïve question, "What is relevance?" Instead, the basic question was and still is, "What is the *nature* of relevance?"

Following are more precise questions:

- What are the *manifestations* of relevance?
- What is the *behavior* of relevance? Or more precisely: How do *people behave* in respect to relevance?
- What are the *effects* of relevance? Or more precisely: What *influences* are related to relevance?

The organization of the present review, presented in two parts, follows this reasoning. Part II starts with an *Introduction* and a *Historical Footnote*. Next, the nature of relevance is elaborated on in sections on meaning, theories, and models of relevance. Part II concludes with a section about various manifestations of relevance. Part III (this issue, pp. 2126–2144) deals with experimental and observational findings on human relevance behavior and effects of relevance. Part II is oriented toward scholarship that addressed relevance concepts, whereas Part III is oriented toward scholarship that provided tangible results based on experimentation or observation. Part II contains the *Introduction* through the *Manifestations of Relevance* section; Part III continues with section, *Relevance Behavior* through the *Epilogue*. A number of sections end with a summary that provides a personal interpretation and synthesis of contemporary thinking on the topic treated in the cited studies or suggests hypotheses for future research. The rationale for summaries was to concentrate on specific data and findings, rather than on discussions and conjectures. Analyses of some of the major trends that shape relevance work are offered in conclusions.

Although knowledge for knowledge's sake in investigations of the notion of relevance is sufficient impetus, there is also pragmatic potential. The history of science and technology is full of instances where a better understanding of the basic notions or phenomena underlying a technology led to development of more effective and successful technologies and systems. A fruitful, though sometimes convoluted and arduous, translation was realized. Hopefully, a better understanding of relevance may lead to better information systems. This clearly illustrates the significance of relevance research. Considering and understanding relevance as a notion is still relevant, if not even more so, to building and operating information systems—now ever more complex in the Web environment—that effectively provide information to users pertaining to their problems at hand.

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Historical Footnote: A Reminder of How Relevance Came Into Being in Information Retrieval and Affected a Lot of Things

The term *information retrieval* was coined by the mathematician and physicist Calvin N. Mooers (1919–1994), a computing and IR pioneer, just as the activity started to expand from its beginnings after World War II. He posited that IR "embraces the intellectual aspects of the description of information and its specification for search, and also whatever systems, technique, or machines that are employed to carry out the operation" (Mooers, 1951, p. 25). Over the next half century, IR evolved and expanded, but basically, it continues to concentrate on the topics Mooers described.

The key difference between IR and related methods and systems that long preceded it, such as those developed in librarianship for bibliographic description and classification, is that IR specifically included "specification for search." The others did not. From Charles Ammi Cutter (1837–1903), who postulated bibliographic requirements at the end of the 19th century to the contemporary International Federation of Library Association and Institutions' (IFLA) *Functional Requirements for Bibliographic Records (FRBR)—Final Report*, the goal was to "provide a clearly defined, structured framework for relating the data that are recorded in bibliographic records to the needs of the users of those records" (IFLA, 1998, §2.1). Such user needs are defined in relation

> to the following generic tasks that are performed by users when searching and making use of national bibliographies and library catalogues:
>
> - using the data to **find** materials that correspond to the user's stated search criteria
> - using the data retrieved to **identify** an entity
> - using the data to **select** an entity that is appropriate to the user's needs
> - using the data in order to acquire or **obtain** access to the entity described (emphasis in the original; IFLA, 1998, §2.2).

In the FRBR (and all the way back to Cutter), the process of search is not specified, it is assumed that it would happen. User needs, which should be fulfilled, are specified only in terms of the given four search criteria, but how the search should be performed was not. Data in bibliographic records were then organized to fulfill the specified criteria. In IR, the user's needs are assumed as well, but the search process is specified in algorithmic details and data is organized to enable the search.

The fundamental notion used in bibliographic description and in all types of classifications or categorizations, including those used in contemporary ontologies, is *aboutness*. The fundamental notion used in IR is *relevance*. It is not about any kind of information, and there are great many, but about *relevant* information. Fundamentally, bibliographic description and classification concentrate on describing and categorizing information objects; IR is also about that *but, and this is a very important "but,"* in addition IR is about searching as well, and searching is about relevance. Therein, similarity and difference lie. Relevance entered as a basic notion through the specific concentration on searching. Budd (2004, p. 449) lamented that the preponderance of writing on relevance comes from information science, and little or none can be found in librarianship. The explanation is simple: Librarianship was concerned with aboutness and thus, it produced a considerable literature about aboutness and little or none about relevance. Conversely, information science was concerned about relevance and thus, it produced a considerable literature about relevance and little or none about aboutness.

In a sense, aboutness may be considered as topical relevance, which is one manifestation of relevance discussed later. However, topical relevance in IR is construed through indexing (or some other form of representation) to be directly searchable in specified ways—and, as pointed out, searching is about relevance.

By choosing relevance as a basic, underlying notion of IR, related information systems, services and activities—and with it, the whole field of information science—went in a direction that differed from approaches taken in librarianship, documentation, and related information services, as well as expert systems and contemporary databases in computer science. Of course, this generalization, as all generalizations, simplifies the situation, but illustrates the effect of choices.

For example, the basis of expert systems is uncertainty (or rather reduction of uncertainty based on if–then rules). As a result, expert systems are very different from IR ones. In comparison to IR, expert systems are not as widely adapted and used. One of the reasons may be due to the choice of the underlying notion. Relevance is a human notion, widely understood in similar ways from one end of the globe to the other. Uncertainty is not. Besides, the assumption that information decreases uncertainty does not hold universally; information may also increase uncertainty.

Another example is in the realm of computer science. Differences between databases and IR were often discussed in terms of differences between structured and unstructured data, which is okay, but fails to define the fundamental difference in the basic notion used: aboutness in the former and relevance in the latter. Thus, the two kinds of systems are quite different.

Historically, relevance crept in unannounced. At the start of IR, more than a half century ago, nobody made a big point about it. Information retrieval systems were constructed to do relevance, but nobody talked about it. Still, principles posited then are valid today. It was, and still is, accepted that the main objective of IR systems is to retrieve information relevant to user queries, and possibly needs. Actually, the first discussions of relevance in the early 1950s were not about relevance, but about nonrelevance or "false drops"—unwanted information retrieved by IR systems. The first full recognition of relevance as an underlying notion came in 1955 with a proposal to use "recall" and "relevance" (later,

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because of confusion, renamed *precision*) as measures of retrieval effectiveness in which relevance was the underlying criterion for these measures (Kent, Berry, Leuhrs, & Perry, 1955). Over time, many other measures were suggested, but did not take. Precision and recall remain standard measures of effectiveness to this day, with some variations on the theme. They measure the probability of agreement between what the system retrieved or constructed as relevant (systems relevance), and what a user or user surrogate assessed or derived as relevant (user relevance). Relevance became and remained the underlying criterion for measuring the effectiveness of IR.

There were, still are, and always will be many problems with relevance. This is not surprising. Relevance is a human—not a systems—notion and human notions are complex, even messy. Oh well, they are human. Problems led to investigations on the nature of relevance in information science. Exposition of many views and a number of experiments followed. Those before 1975 were synthesized in Part I, those since are in this review. However, a few of the pre-1975 works are included in this review as well to provide a historical context where appropriate.

Meaning of Relevance: How Relevance Is Universally Well Understood, How It Is Understood in Information Science and, Nevertheless, How Problems With Relevance Are in Its Understandings

Intuitive Understanding

I already stressed this in Part I: Relevance does not have to be explained; it is universally understood. It is an intuitive, primitive, "y'know" notion (Saracevic, 1975, p. 324). People understood and understand relevance similarly over time, space, cultures, and domains. "Nobody has to explain to users of IR systems what relevance is, even if they struggle (sometimes in vain) to find relevant stuff. People understand relevance intuitively" (Saracevic, 1996, p. 215).

Intuitively, we understand relevance to encompass a relation—relevance always involves some version of "to" either stated explicitly or referred implicitly. This was always so. To illustrate the point: Following the etymology for "Relevant" the *Oxford English Dictionary* (2nd ed.; Simpson & Weiner, 1989) has this quote from awhile ago: "**1646** CHAS. I *Lett. to A. Henderson* (1649) 55 "To determine our differences, or, at least, to make our Probations and Arguments Relevant." Jumping forward a few centuries to illustrate the same point, the title of an article in the *Chronicle of Higher Education* (September 30, 2005, p. B1) enthused, "Thoughtful Design Keeps New Libraries Relevant." In both cases "to," while implicit, was clearly there. The "to" is the context for relevance. For relevance context is *it*.

What is actually relevant may not be understood similarly, but what is relevance is. As already stressed, relevance is a thoroughly human notion; this is its great strength and great weakness. The role of research is to make relevance complexity more comprehensible formally and possibly even more predictable.

Beyond Intuitive

On a fundamental level, relevance is understood as a relation; relevance is an n-tuple—a notion consisting of a number of interacting parts that have a relation based on some property or criteria. In other words, relevance has a number of dimensions along which the parts may be related, connected. and interpreted. None of these are necessarily fixed; they may change as circumstances change.

Relevance always involves a relation between a P (or a number of Ps) and a Q (or a number of Qs) along some property R (or a number of Rs). Parts P and Q could be intangible objects (such as ideas, concepts, information) or tangible objects (such as documents, machines, processes) or a combination of both intangible and tangible objects (such as tasks, situations, responsibilities). Properties R (such as topicality, utility) provide a base and context for establishing a relation, i.e., relation between Ps and Qs is considered as to relevance along properties R. These properties may be explicit or implicit, well-formulated or visceral, rational or not entirely so—on a continuum.

Relevance is also considered as a measure of relatedness. If we consider communication, then our intuitive understanding is that relevance has also something to do with effectiveness of communication. Thus, the relation between objects Ps and Qs along properties Rs may also be ascertained as to some measure S (or a number of Ss), where S may be expressed along different magnitudes, such as strength, degree, or some other quantity or quality. Measures S may be explicit or implicit, well formulated or visceral, rational or not entirely—on a continuum.

Thus, relevance is considered as a *property* along which parts are related and may also be considered as a *measure* of the strength of the related connection.

Understanding in Information Science

Understanding of relevance in information science evolved over time and was adapted to specific circumstances. In information science, we consider relevance as a relation between information or information objects (the Ps) on the one hand and contexts, which include cognitive and affective states and situations (information need, intent, topic, problem, task; the Qs) on the other hand, based on some property reflecting a desired manifestation of relevance (topicality, utility, cognitive match; the Rs). As mentioned, the Ps and Qs could be tangible or intangible. In addition, we also measure the intensity of the relation on some scale (degree of relevance, or utility, or pertinence; the Ss). Thus, in information science, relevance is a relation and a measure. If Ps are considered as external and Qs as internal then relevance reflects a relation between external and internal objects along internal and external contexts, including measure(s) that reflect(s) strength or effectiveness of

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the relation. It is worth stressing that the context is formulated through a dynamic interaction between a number of external and internal aspects, from a physical situation to cognitive and affective states, to motivations and beliefs, to situations, and back to feedback and resolution. Context is complex.

This generalization corresponds with the general pattern for numerous definitions of relevance that were offered in information science as specified in Part I. The pattern is:

> Relevance is the A of a B existing between a C and a D as determined by an E," where A may be "measure, degree, estimate . . .;" B may be "correspondence, utility, fit, . . .;" C may be "document, information provided, fact . . .;" D may be "query, request, information requirement . . .;" and E may be "user, judge, information specialist." (Saracevic, 1975, p. 328)

Almost every definition offered still fits this pattern. In Part I, relevance was also considered as a measure of the effectiveness of contact in a communication process (Saracevic, 1975, p. 325).

The Big Question and Challenge

We also understand that relevance is not given, it is established. This leads to the next question and the big challenge for information science: *How does relevance happen?* That is, *how are relevance relations established and measured?* And who does it, under what circumstances, and how? Some of the relevance theories and models, reviewed in next two sections, try to answer these questions.

In information science, we consider relevance as an inference: it is *created* (or constructed) by inference, but also it is *derived* by inference. This is not an either–or proposition; rather there is a continuum from creating to deriving relevance. A simplified explanation: systems or automatons create relevance and users derive relevance.[1] However, situations could be more complex because people can act as automatons (fully or to some degree) to create relevance as systems do, and systems can be somewhat "intelligent" to derive some aspect of relevance. Thus, to account for such circumstances there is a need for a continuum, rather than a binary distinction between creation and derivation. It is a matter of degree. Still creation–derivation is a useful distinction, adding to our understanding of relevance in information science. The inference—creation or derivation—follows some intent. In other words, intentionality is involved along the general conception of intentional mental states discussed by Searle (1984). His concluding statement holds for relevance as well, "Because it is just a plain fact about human beings that they do have desires, goals, intentions, purposes, aims, and plans, and these play a causal role in the production of their behavior" (p. 15).

Information retrieval systems create relevance—they take a query, match it to information objects in the system by following some algorithms, and provide what they consider relevant. People derive relevance from obtained information or information objects. They relate and interpret the information or information objects to the problem at hand, their cognitive state, and other factors—in other words, people take the retrieved results and derive what may be relevant to them. But users can read into results a lot more than correspondence between noun phrases or some such in queries and objects, used primarily by systems for matching. Moreover, users can and do find other information objects or other information relevant to their problem that is not retrieved by a system for a variety of reasons, e.g., not reflected in the query to start with. Several excellent examples of how relevance is derived above and beyond that which is topically retrieved are given by Harter (1992, p. 607ff). Specifically, Harter provides examples of topics or problems of his interest and then analyzes a number of articles that are not directly related to the topics, but are relevant. He demonstrates through examples how relevance is derived from articles as related to the cognitive state of an individual ("psychological relevance") that is very different than topical relevance as considered by a system. "Topical relevance concerns itself only with a restricted form of language. The user is ignored" (p. 613).

A similar argument about nonmatching topicality was provided by Green (1995). Green and Bean (1995) present extensive examples of derived relevance using the topics of a religious thematic guide and the referred passages derived in that guide. More dramatic examples are provided by Swanson and Smalheiser (1997, 1999). In these articles, they summarize a decade-long effort in which they took several areas of medicine and showed casual connections between previously unrelated phenomena to derive relevance relations where none existed before; these relations were derived from literature and later confirmed in clinical testing.

The situation is actually more complex than presented. Yes, people may and do derive relevance from ideas and clues in articles that no system could readily recognize, at least as yet. But, that depends also on domain expertise (Vakkari & Hakala, 2000). Greater expertise on a topic leads to more potent derivate powers for relevance. Lesser expertise leads to lesser powers for deriving relevance. With little expertise, one constructs relevance as an automaton. White (2007a, 2007b) discusses these hypotheses at great length, with examples throughout both articles, and provides essentially the same distinction between created and derived relevance.

Because information science deals with creation and derivation, systems and users, we understood early on that there is not only one kind of relevance, but several. They were even labeled differently, like *topical relevance, user relevance,* and so on, as reviewed later in the section *Manifestations of Relevance*. Of course, information science is

[1] *Create* is used here in a sense of "to cause, occasion, produce, give rise to (a condition or set of circumstances)" and *derive* as "to obtain by some process of reasoning, inference or deduction; to gather, deduce" (*Oxford English Dictionary*, 2nd ed.; Simpson & Weiner, 1989). In this sense, "create" is not necessarily associated with creativity. Thus, automatons can also create or construct relevance following some algorithm or set of procedural rules.

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not the only field to recognize that relevance has a number of manifestations. In information science, however, this is a very pronounced understanding because we match various kinds of relevance and evaluate performance on that basis. Among other things, this also leads to intellectual disputes as to the primacy of one kind of relevance over others.

Here are two final points about understanding relevance in information science. First, either derived or created relevance usually involves a process of selection. Information or information objects are selected as relevant (or expressed on some continuum of relevance) from a number of available existing, or even competing, information objects or information. The selection is geared toward maximization of results, minimization of effort in using the results, or both. Second, the selection process involves a series of interactions of various kinds. Thus, an understanding of relevance also recognizes that a selection and interaction process is involved.

Summary: Attributes of Relevance in Information Science

We consider relevance as having a number of dimensions or attributes:

Relevance is a relation. Relevance is a property. Relevance is a measure. Relevance has a context, external and internal. Relevance may change. Relevance has a number of manifestations or kinds. Relevance is not given. Relevance is inferred. Relevance is created or derived. Relevance involves selection. Relevance involves interaction. Relevance follows some intentionality.

These attributes of relevance can be summarized as follows (Cosijn & Ingwersen, 2000; Saracevic 1996):

- *Relation:* Relevance arises when expressing a relation along certain properties, frequently in communicative exchanges that involve people as well as information or information objects.
- *Intention:* The relation in expression of relevance involves intention(s)—objectives, roles, expectations. Motivation is involved.
- *Context:* The intention in expression of relevance always comes from a context and is directed toward that context. Relevance cannot be considered without a context.
  - *Internal context:* Relevance involves cognitive and affective states.
  - *External context:* Relevance is directed toward a situation, tasks, problem-at-hand. Social and cultural components may be involved as well.
- *Inference:* Relevance involves assessment about a relation, and on that basis is created or derived.
- *Selection:* Inference may also involve a selection from competing sources geared toward maximization of results and/or minimization of effort in dealing with results.
- *Interaction:* Inference is accomplished as a dynamic, interacting process, in which an interpretation of other attributes may change, as context changes.
- *Measurement:* Relevance involves a graduated assessment of the effectiveness or degree of maximization of a given relation, such as assessment of some information sought, for an intention geared toward a context.

These conceptualizations reflect a general understanding of the meaning of relevance in information science. But as always, the devil is in the details. When these general understandings are translated into theories, models, and practices; into systems and users; into inputs and outputs; then the general understanding, as enumerated, does not serve or guide us well—translation from a general understanding to pragmatic application is very difficult. How to actually create or derive relevance, how to measure it, who does it, and with what effect is an entirely different matter, at times even wrought with controversy. In the same category belongs the question: *How much relevance is enough?* Still, we understand relevance better than we did 30 years ago.

Theories of Relevance: What Theoretical Constructs Were Borrowed from Elsewhere and How We Still Don't Have an Applicable Theory of Relevance

After all, relevance is a universal human notion and thus of scholarly interest in fields other than information science. Extensive theories on relevance appear in several fields, among them logic, philosophy, and communication. Relevance theories in logic were not used in information science, and thus are only briefly characterized here to illustrate a possible connection. Those in philosophy were used to some extent and were extensively reviewed in Part I, thus only a synthesis is provided. Finally, a theory of relevance in communication, formulated in the 1980s and 1990s, had some impact on thinking about relevance in information science, thus it is reviewed here in some detail as theory-on-loan, that is as a theory that is used and interpreted within the context of information science.

Relevance in Logic

For some 2,000 years, logicians have been struggling with the notion of relevance, particularly in deduction of inferences. To avoid fallacies, a necessary condition for an inference from A to B is that A is relevant to B. In that sense, confirmation of conclusions from premises is based on relevance. Relevance logic is an attempt to construct logics that reject theses and arguments that commit fallacies of relevance. Several systems of relevance were developed in semantics and proof theory (Mares, 1998). The widely cited seminal work by Anderson and Belnap (1975, Anderson, Belknap, & Dunn, 1992) is a standard for contemporary treatment and critiques of relevance logic.

Several attempts were made to apply a formal system of logic to IR that involved consideration of relevance (e.g. starting with Cooper, 1971, and continuing with van Rijsbergen, 1986, Nie, Brisebois, & Lepage, 1995 and others as summarized by Lalmas, 1998, and Sebastiani, 1998), but they are outside the scope of this review because they concentrate on the possible application of logic in IR systems. However, all are based on the underlying notion that there is a connection between relevance and logical consequences.

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No attempt has been made, so far, to apply relevance logic to the study of relevance as a notion in information science. The mentioned work by Anderson and Belnap (1975) and Anderson et al. (1992) may be a plausible loaned theory for such an extension.

However, logic was used in the explication of relevance in artificial intelligence (AI). A special issue on relevance in the journal *Artificial Intelligence* deals with treatment of relevance in the domain of AI (Subramanian, Greiner, & Pearl 1997). In two articles, logic, together with the concept of belief, was used as a basis for a formal treatment of relevance and its properties. Lakemeyer (1997) formalized relevance relations in the context of propositional logical theories from an agent's point of view and relative to his or her deductive capabilities and beliefs. Beliefs were also used in developing a set of formal axioms of casual irrelevance (Galles & Pearl, 1997). Overall, interest in relevance in AI was fleeting and faded away. However, involving beliefs with relevance makes the approach interesting, even though logic formalities, as applied in cited works, may be highly restrictive in any pragmatic sense. The notion of belief has not yet penetrated relevance theorizing in information science, even though on the face of it the idea may be of interest. Beliefs are a murky concept, but they may affect relevance.

Relevance in Philosophy

A number of philosophers, particularly in the area of phenomenology, were interested in relevance. Of particular interest to information science are the works by Schutz (1970) and Schutz and Luckman (1973). The latter is a summary of Alfred Schutz's lifelong ideas, posthumously completed by his collaborator Thomas Luckman. Schutz's concepts related to relevance were already summarized in Part I (Saracevic, 1975, pp. 322–323), but are mentioned here again because they continue to have implications for theoretical thinking on relevance in information science; it is knowledge worth borrowing. Briefly, Schutz characterized structure and functioning of the "life-world"—situations that people face in the reality of everyday life. These situations form layers—life-world is stratified. Relevance is the principle for stratification and dynamic interplay among strata. But there is not a single relevance, but rather an interdependent system of relevances (plural). He proposed a typology of relevances with three main categories: thematic (in the 1970 work called *topical*), interpretational, and motivational. These concepts are echoed in many later works on relevance in information science, even without reference to Schutz.

Application in information science. Schutz is cited a number of times as an appropriate framework in information science; his viewpoint is very much reflected in works on manifestations of relevance. The two following philosophical perspectives, which emanated from information science, are very different than Schutz's.

In the first, Hjørland (2002) suggests an epistemological perspective for considering relevance and other fundamental concepts at play in IR, such as interpretation of texts and information needs. In supporting this position, Hjørland demonstrates relevance criteria in four epistemological schools: empiricism, rationalism, historicism, and pragmatism. Each provides a different criterion for considering relevance. In essence, as stated in his conclusions, he rejects "the cognitive view [which] tends to psychologize the epistemological issues (to study knowledge by studying the individual)," and advocates "the socio-cognitive view, which tends to epistemologize psychological issues (to see individual knowledge in a historical, cultural, and social perspective)" (p. 268). Epistemology is suggested as the proper way to approach relevance. In a similar vein, Froelich (1994) previously had suggested applying hermeneutics (study of how context makes and shapes interpretation) to the study of relevance because relevance is an act of interpretation.

In the second perspective, taking a philosophy stance (but not Schutz's or Hjørland's), Budd (2004) reviews treatment of relevance in information science (with a lament that it is not treated in librarianship), and invokes ideas from a number of philosophers, including Wittgenstein and Habermas, as possible explanations. Although Budd's review does not offer a theoretical synthesis, but only a selective enumeration, it provides a juxtaposition of a wide range of different views and concepts related to relevance, involving philosophy as well.

Relevance is also philosophical. The works reviewed, however, were not much more than proposals for what to do rather than philosophical treatises on relevance in information science.

Relevance in Communication

Information and communication are related, but there is also a distinction. Information is a *phenomenon*. Communication is a *process*: a process in which information is dispersed or exchanged. The process of communication encompasses a vast array of human activities and has many facets and manifestations. Similarly, the phenomenon of information encompasses many manifestations—there are many kinds of information—and is interpreted in many senses. The concept of communication could be understood and used, similarly as information, in numerous ways. Not surprisingly then, the field of communication is also broad and expansive. The study of communication intersects with a number of other fields, including linguistics, semantics, psychology, cognition, philosophy, and related areas. The study of relevance in communication also comes from an interdisciplinary tradition. Because one of the theories about relevance that emerged in the study of communication was prominently treated in information science, it is described here in some detail.

The most comprehensive and ambitious contribution to theorizing on relevance in a communication framework was made by Sperber and Wilson (1986, 1995; abbreviated here as S&W), with the latest synthesis by Wilson and Sperber (2004; abbreviated here as W&S). Their Relevance Theory

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has an overarching goal of explaining what must be relevant and why to an individual with a single cognitive intention of a conceptual nature. it is based on an inferential model of communication that views communicaion in terms of intentions, as opposed to the more traditional source-message–destination model (also called the classical code model–or in computing the *Shannon-Weaver model*–since messages are coded and decoded). The inferential model considers that the critical feature of most human communication—verbal or nonverbal—is an expression and recognition of intentions.

Relevance Theory was originally associated with everyday speech or verbal communication, but later was extended to cover wider cognitive processes. Authors consider it a cognitive psychological theory. It has a high goal of being a theory of cognition and of communication, tying them together on the basis of relevance. However, the basic problem addressed in the theory is how relevance is created in dialogs between persons. It explains "what makes an input worth picking up from the mass of competing stimuli" (W&S, 2004, §1[2]). In somewhat awkward language, they argue about ostensive behavior or ostention, manifestations, and presumptions of relevance. Simply put, out of many stimuli, we pay attention only to information which seems relevant to us; furthermore, to communicate is to claim someone's attention, and hence to imply that the information communicated is relevant. They firmly anchor relevance in a given context and talk about contextual effects—relevance is contextual. They also consider relevance assessment as comparative, not quantitative—relevance is comparative.

At the center of their theory they postulate two principles, claiming to reflect universal tendencies:

- *Cognitive Principle of Relevance*—the claim that human cognition tends to be geared to maximization of relevance
- *Communicative Principle of Relevance*—the claim that every ostensive stimulus conveys a presumption of its own relevance

In other words, human cognition is relevance-oriented, and so is human communication. The two principles lead to the specification of how relevance may be assessed in terms of two components: *cognitive effects* and *processing effort*:

> Relevance to an individual:
>
> 1. Other things being equal, the greater the positive cognitive effects achieved by processing an input, the greater the relevance of input to the individual at that time.
> 2. Other things being equal, the greater the processing effort expended, the lower the relevance of the input to the individual at that time." (W&S, 2004, §2(1))

This serves as an explanation as to what makes us "pick out the most relevant stimuli in [our] environment and process them so as to maximise their relevance" (W&S, 2004, §3). The two Principles of Relevance and the two components of assessment are at the heart of the theory, with the first being explanatory and the second predictive.

The proposition of maximization in the Cognitive Principle of Relevance evokes a similar, if not identical, explanation postulated by Zipf (1949) in the Principle of Least Effort. Treating relevance as an underlying principle in both cognition and communication evokes the explanation of what makes the life-world tick by Schutz (1970), as mentioned above. Neither was considered in S&W's Relevance Theory.

Needless to say, Relevance Theory, as a major, comprehensive attempt to provide explanations and principles about cognition and communication anchored in relevance, attracted followers and critics. Critics voiced a number of themes, among them restriction in scope, contradictions in arguments, and the total absence of any connection to human motivations—in other words, in the theory they treated humans as perfect rational beings. Gorayska and Lindsay (1993) summarized these critiques, pointing out the theory's shortcomings from the point-of-view of the pragmatic use of the notion in everyday language—it does not fit—but also recognized the value of the theory and proposed future directions for research.

The strength of the theory lies in proposing a number of explanations and operational, predictive principles about cognition and communication in terms of relevance. A relevance theory at last! Two weaknesses are mentioned here, beside the ones mentioned by critics as cited above. The first weakness concerns the nature of their proofs and grounds for generalization. They use hypothetical conversations between two protagonists, Peter and Mary, to provide both examples and proof. (Peter/Mary dialogs get tiring fast). But more seriously, proof by example is no proof. The second weakness is that in the two decades since its first appearance, the theory was not tested empirically or experimentally. A theory is scientific if it is refutable, i.e., testable. Although the authors proposed a number of possible tests and talked about forthcoming experiments (W&S 2004, §6), such tests and experiments have not come forth as yet. Moreover, none are in sight. Relevance Theory is appealing, but it is also untested. It awaits verification and possible modification as a result. Of course, the fact that a theory is not tested is not grounds for rejection. However, an untested theory may also be untestable. In that case, it is not a scientific theory. The question is still open whether Relevance Theory is testable to start with. Nevertheless, it does provide a number of insights and conjectures about relevance and its behavior.

Applications in information science. In information science, Harter (1992) provided the first attempt to apply S&W's Relevance Theory to information science in general and information retrieval in particular. He starts with an emphatic rejection of topical relevance, that is, the notion and practice in IR where relevance is treated as to topicality. As a solution, he embraced the notion of relevance as being

[2] "§1", "§2". . . refers to how sections are numbered in the original.

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exclusively related to cognitive states that change dynamically, calling this "psychological relevance." Relevance is what causes cognitive changes in a given context. This will be further discussed in the section on Manifestations of Relevance below because the essence of Harter's proposal is to consider a given type or manifestation of relevance as the primary or even exclusive property.

Harter deduced a number of excellent insights into relevance behavior. The strength of Harter's notion of psychological relevance is that he has attempted to base the concept on a broader theoretical basis, namely S&W's Relevance Theory. The weakness is that actually he has not done that, beyond borrowing some concepts and terminology. Besides, as with S&W's Relevance Theory, Harter's construct was not tested. He discussed, however, the difficulty of testing and applying it in practice. Still, the value of his attempt to gain some theoretical footing for relevance in information science is in itself groundbreaking. Unfortunately, he did not get there, but he pointed the way and opened a wide-ranging and raging discussion.

A second and much more comprehensive attempt to transfer S&W's Relevance Theory into an information science framework was done recently by White (2007a, 2007b). In this massive work, White confines S&W's Relevance Theory to the application of the cognitive effects and processing effort. He did not use directly their Cognitive and Communicative Principles of Relevance. In an effort to integrate Relevance Theory, IR and bibliometrics, he proposed that cognitive effects and processing effort are also components in relevance assessments in the context of IR and can be used as predictive mechanisms for the operational assessment of relevance. Briefly, White translated the widely applied approach in IR based on terms called tf*idf (term frequencies, inverse document frequencies) into bibliometric retrieval based on citations; used this to create a new two-dimensional visual display of retrieved bibliometric results called a *pennant diagram* (because it looks like it); interpreted the dimensions of the diagram in terms of cognitive effects and processing effort; derived a number of practical examples; and engaged in extensive interpretation of results and discussion of reasoning behind them, in a similar vein as S&W. (Even Peter and Mary made a prominent appearance.) White has significantly extended the interpretation of S&W Relevance Theory to information science circumstances and interests, with both the strength and weaknesses of the theory present. Its strength is that he actually put his constructs to practical work. Although the proposed bibliometric retrieval and associated pennant diagram may have been done without recourse to Relevance Theory, the borrowed constructs (cognitive effects and processing effort) provided grounds for extensive abstract explanations of both processes and results. They offer insight about retrieval above and beyond the statistical nature of the process and rank-listing of results. However, the weakness of the nature of proof present in S&W's work is also present here. Besides, White's work is not a test of Relevance Theory as claimed; it is structures, concepts and terminology on loan.

Both works—Harter's and White's—are worthwhile in their efforts to adapt a theory. The field should be stimulated to think about such adaptations and think about theory, but the question remains whether the theory being adapted is worthwhile to start with.

Summary: Still in Search of a Theory

As yet, authors on relevance in information science have not developed any indigenous theory-cum-theory about the notion, nor have they successfully adapted theories from other fields, despite a few attempts. Where theories were borrowed for use, they were merely described, interpreted, and declared appropriate. They were not tested. However (and to their credit), they were conceptual and terminological borrowings used for extending our collective insight about relevance. They made us think.

We are still in search of a theory of relevance applicable to the context of information science and particularly IR. In other words, we are still in search of a conceptual basis, a set of testable principles and propositions, to explain the notion of relevance applicable to information science practice, to explain its manifestation, and to predict its behavior and effects. Of course, practice can be successfully pursued in absence of a theory. The history of technology has a great many examples, IR being just one of them. But, a great many substantial advances have been achieved based on a theory; the history of modern technology has even more such examples.

A number of authors have suggested outlines of an applicable theory of relevance. For instance, Park (1994), echoing Harter, suggested a possible framework for "a theory of user-based relevance" (title) to emerge from qualitative research using a naturalistic approach and paradigm. The attempt was interesting, but the proposal led nowhere. Several other proposals of the same genre are not treated here for the same reason.

These attempts to borrow and adapt theories have a positive effect on clarifying empirical knowledge and understanding about relevance in information science. Schutz's reference to systems of relevances (plural) suggests a number of manifestations of relevance that are already recognized, and his reference to "horizon" suggests the inclusion of contexts as inevitable. S&W's cognitive effects and processing efforts suggest dimensions used in assessing relevance, including its dynamic nature, are also well recognized.

When it comes to relevance theory (or theories) a question should be raised: Is a grand theory of relevance presently possible to start with? And then: Should it be pursued? Is a relevance theory that explains everything equivalent to a quest for the Holy Grail? It may be because of the abundance of variables involved. Relevance may be just way too complex and complicated to sort out theoretically all at once. Instead of a generic, grand theory we could concentrate on a smaller scale substantive theory (or theories) that involve a limited number of key factors or aspects of relevance.

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Of course, to be of use such small scales relevance theories must also be testable.

Although we were not successful in developing or adapting a "good" theory of relevance for information science, we were certainly rich in proposing a number of models depicting elements or variables involved in relevance, as summarized in the next section. Yet, there are differences between theories and models in scientific endeavors. Theories explain and predict; models enumerate. Theories are about why and how; models are about what is involved or occurring. Theories guide; models provide structure—so, on to models.

Models of Relevance: How Relevance Was Reviewed and Reviewed, and How a Few Models Came out of Reviews

For whatever reason, relevance is an eminently suitable subject for review. Interestingly, there was a 15-year gap in relevance reviews between mine (Saracevic, 1975) and those that began appearing on an almost regular basis after 1990.

In addition to reviewing the progress in relevance research or challenging a prevalent paradigm or line of thought, these reviews also provided a synthesis on the basis of which relevance models were projected. We concentrate here on several models proposed in major reviews. Models are abstractions forming general ideas from specific examples; they are a simplified version of a reality. Their importance is great because they are a basis for given standpoints that predicate given types of actions and exclude other types. Indeed, different relevance models suggest different actions.

Dynamic Model

For a fleeting decade, relevance had its Camelot. It was in Syracuse, New York. From about the mid-1980s until about the mid-1990s, a series of doctoral dissertations at the School of Information Studies, Syracuse University, addressed various aspects of relevance, reflecting a vigorous research environment under the guiding spirit of Robert Taylor and Jeffrey Katzer. These dissertations resulted in a number of articles (Carol Berry, Michael Eisenberg, Myke Gluck, Joseph Janes, Linda Schamber) reviewed later in this work. The "Syracuse Relevance School" also produced a notable and widely cited review that had an extensive impact and changed the view of what is important in relevance. When well done, critical reviews can do that.

Schamber, Eisenberg, and Nilan (1990) reexamined thinking about relevance in information science, addressed the role of relevance in human information behavior and in systems evaluation, summarized major ideas and experiments, and came to a forceful conclusion that relevance should be modeled as being dynamic and situational. The idea was echoed in Schamber (1994), in which she connected the wider area of human information behavior studies with relevance, organized along the issues of relevance behavior, measurement, and terminology. Of course, dynamic properties of relevance had been discussed in previous decades and demonstrated in experiments as readily acknowledged by the authors, but it was their insistence on the primacy of the dynamic and situational nature of relevance— all is flux— that struck a chord.

They went further and proposed a rich research agenda for the investigation of users and relevance. Research questions were asked about criteria that users employ in assessing relevance and consistency of their application, the characteristics of documents that are included in these criteria, indicators or clues in documents reflecting these characteristics, recognition of document-based clues by users, and recognition of document-based clues by systems.

The strength of the review was that it suggested a model of relevance in terms of the dynamics of human information behavior and situations in which this behavior occurs. Moreover, it directed attention to a connection between aspects of documents—documentary relevance clues—and human relevance assessment. It modeled document clues as to relevance. As a result, a clues-oriented research developed, as synthesized in the section Behavior of Relevance.

The weakness was twofold. First, stating by itself that relevance is dynamic and situation-dependent is not much more than a truism recognized in one way or another since Plato when he contemplated the nature of knowledge. It falls under the category, "What else is new?" or "Can it be any other way?" Second, the concept of situation really was not elaborated on, even though promised in the title. Other investigations, reviewed later, specifically addressed both the dynamic and situational behavior of relevance. Still, this conceptual contribution attracted wide attention and set the stage for further research.

Dual Model

Another review with high resonance was produced by Mizzaro (1997) entitled "Relevance: The Whole History." The review was a comprehensive classification of 157 studies divided over three periods: Before 1958, 1959–1976, and 1977–1997. Within each period, he classified articles as dealing with one or more of seven different aspects: methodological foundations, different kinds of relevance, beyond-topical criteria adopted by users, modes for expression of the relevance judgment, dynamic nature of relevance, types of document representation, and agreement among different judges.

In effect, the seven aspects provide a convenient model along which works, conceptualizations, and findings about relevance may be categorized and compared.

In his conclusions, Mizzaro posits the orientation of works in different periods: "The '1959–1976' period is more oriented toward relevance inherent in documents and query. In the '1977–present' period . . . the researchers try to understand, formalize, and measure a more subjective, dynamic, and multidimensional relevance" (p. 827).

This duality reflects approaches to modeling relevance to this day.

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Split System and User Models

Relevance is a participant in a wider battle royal that started in the 1980s and is still going on. It involves two opposing views or models of IR: systems and users. The user side vehemently criticized the system side. The systems side barely noticed that it was attacked. A few reconciliatory authors (such as Ingwersen & Järvelin, 2005, discussed later) tried to resolve the differences. In effect, the invisible hand of relevance is behind the battle—how to deal with relevance is really what the battle is all about. The arguments resemble those presented in the late 1950s in C. P. Snow's memorable, though dated work, *The Two Cultures*, in which he discusses the failure of communication between the sciences and the humanities (the "two cultures" of the title; Snow, 1959/1993).

In a massive study of cocitation patterns in information science for the period 1972–1995, White and McCain (1998), among others, mapped the structure of the field showing two broad clusters or subdisciplines calling them *domain analysis* and *information retrieval*:

> Specialties can be aggregated upward in two large subdisciplines: (1) The analytical study of learned literatures and their social contexts, comprising citation analysis and citation theory, bibliometrics, and communication in science and R&D; and (2) the study of the human–computer–literature interface, comprising experimental and practical retrieval, general library systems theory, user theory, OPACs, and indexing theory. . . . [Authors] are essentially ''literatures people'' or ''retrieval people.'' (p. 337)

Their conclusion: "Two subdisciplines of information science are not yet well integrated" (p. 337) and, ". . . as things turn out, information science looks rather like Australia: heavily coastal in its development, with a sparsely settled interior" (p. 342). This holds for relevance—it indeed has two cultures, each with its own model; they are not integrated, and they map like Australia. Despite attempts at bridging, as reviewed below, the two cultures are mostly foreign to each other.

The systems viewpoint, obviously, considers IR from the systems' perspective ignoring the user. It is based on a model of IR, called the *traditional* or *laboratory IR model*, in which the emphasis is on systems processing information objects and matching them with queries. The processing and matching is algorithmic; the goal of the algorithms is to create and maximize retrieval of relevant information or information objects. In the purest form of this model, the user is represented by a query and not considered in any other respect; in addition, interaction is not a consideration. The model has been in continuous and unchanged use since the Cranfield experiments (Cleverdon, 1967) to experiments conducted under the fold of Text REtrieval Conference (TREC; Voorhees & Harman, 2005). [TREC, started in 1992, is a long-term effort at the (U.S.) National Institute for Standards and Technology (NIST; Gaithersburg, MD), that brings various IR teams together annually to compare results from different IR approaches under laboratory conditions.]

The user viewpoint considers IR from the user's rather than the systems' side, taking the system as a given. The user is considered way beyond the query by seeking to incorporate a host of cognitive and social dimensions, and interaction into the model. The user viewpoint does not have a firmly established model, although quite a few have been proposed (e.g. Ingwersen, 1996).

Although there were rumblings long before, the frontal attack championing the user side came in a critical review by Dervin and Nilan (1986). While reviewing alternative approaches to the assessment of information needs, they issued a call for a significant paradigm shift in information needs and uses research from systems orientation to user orientation, underscoring that the systems approach is inadequate. The review, considered a turning point in user studies, was much cited, often as a sort of a manifesto. The Dervin and Nilan review did not consider relevance per se, but nevertheless relevance was predominant. Of course, studies of human information behavior (which include information seeking and user studies) can investigate aspects that do not involve relevance. However, when considering any aspect of retrieval, relevance is present either explicitly or as an invisible hand.

Relevance-oriented user studies became a burgeoning area of research with the following justification: "By looking at all kinds of criteria users employ in evaluating information, not only can we attain a more concrete understanding of relevance, but we can also inform system design" (Schamber et al., 1990, p. 773).

"Informing systems design" became a mantra for a majority of relevance behavior and effects studies (including relevance-oriented user, use, and information seeking studies); it even concludes the introduction in this review. It seems logical, but it is not really happening. Why? The question was analyzed and lamented upon by a number of researchers and commentators about the state-of-affairs in information science (e.g., Ingwersen & Järvelin, 2005; Ruthven, 2005— reviewed below). Researchers representing the systems viewpoint simply took a stance: "Tell us what to do and we will do it." But the user side was not "telling" much beyond the mantra. Unfortunately, "telling" is not that simple. The mentioned lack of theory is also a contributing factor. Relevance is a feature of human intelligence. Human intelligence is as elusive to "algorithmize" for IR as it was for AI.

As it turns out, both sides in the battle are wrong. Dervin and Nilan and followers were wrong in insisting on the primacy or exclusivity of the user approach. Systems people were wrong in ignoring the user side and making the traditional IR model an exclusive foundation of their research for decades on end. Neither side got out of their box. Deep down the issue is really not a system *versus* user approach. It is not system relevance *against* user relevance. The central issue and problem is: *How can we make the user and system side work together for the benefit of both?* When IR systems fail,

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the main reason is a failure in relevance; thus, that is the best reason for advocating the resolution of the system-user problem in an integrative manner.

A number of works have tried to reconcile the two viewpoints, suggesting integrative relevance models as a resolution to the problem. Starting from the user viewpoint, Ingwersen and Järvelin (2005) produced a massive volume outlining the integration of approaches in information seeking and IR in context. They outlined the goal of their effort: "It is time to look back and to look forward to develop a new integrated view of information seeking and retrieval: the field should turn off its separate narrow paths of research and construct a new avenue" (p. vii).

This they did, with relevance playing a major and explicit role. They reviewed any and all models used in IR and in information seeking research, and produced an extensive model integrating cognitive and systems aspects of IR. The Ingewersen–Järvelin integrative model, anchored in cognition, is complex, reflecting the complexity of the process and situation. The model has five central components "each consisting of data structures representing the cognitive structures of the actors involved in their generation, maintenance, and modification in time: 1) the IT setting; 2) the information space holding objects of potential information value to 3) information seekers via 4) interface mechanism – all set in 5) socio-organizational context" (p. 306).

The model is also an integrated relevance model. In addition, they defined several manifestations or kinds of relevance as discussed in the next section.

In a similar vein, Ruthven (2005) reviews various approaches to relevance, from systems to situational to cognitive, and advocates an approach that integrates IR and information seeking research. Although he starts from a systems viewpoint, he also fully recognizes the limited nature of the ensuing relevance definition in that model. Among others, he reviews different kinds of relevance assessments (nonbinary, consensus, completeness) and suggests that "allowing users of IR systems to make differentiated relevance assessments would seem a simple extension to the standard IR interface" (p. 71). (Well, is it really "simple?") He also deals with relevance dynamics—the issue of changing user assessments of relevance over time and comments how IR systems have responded poorly to this phenomenon. Ruthven rightly concludes: "How we use relevance in the design of IR systems—what evidence of relevance we see as important, how we believe this evidence should be handled, what inference we draw from this evidence—define what we see as the task of retrieval systems" (p. 77).

Stratified Model

Relevance is a tangled affair involving interaction between and among a host of factors and variables. In philosophy, Schutz (as reviewed in the earlier section *Theories of Relevance*) considered people in their everyday social world (life-world); as mentioned, he suggested that the life-world is stratified into different realities, with relevance being at the root of the stratification of the life-world. Models that view a complex, intertwined object (process, structure, system, phenomenon, notion) in a stratified way were suggested in a number of fields from linguistics to medicine to meteorology to statistics and more. *Stratified* means that the object modeled is considered in terms of a set of interdependent, interacting layers; it is decomposed and composed back in terms of layers or strata.

In 1996, after reviewing and reconsidering various relevance models, I proposed a stratified model for relevance. It is another integrative model. I further extended the stratified model to include IR interactions in general, encompassing a number of specific processes or notions that play a crucial role in IR interaction: relevance, user modeling, selection of search terms, and feedback (Saracevic 1997). Various elements in and derivations from the model were also elaborated on and extended by Cosijn and Ingwersen (2000). Relevance is placed within a framework of IR interaction. In the stratified model, IR interactions are depicted as involving a number of layers or strata; inferences about relevance are created or derived in interaction and interplay among these strata.

The stratified model starts with assumptions that

1. Users interact with IR systems to use information.
2. The use of information is connected with cognition and then situational application and context, that is, it is connected with relevance (Saracevic & Kantor, 1997).

These assumptions also follow from relevance attributes as summarized in the section Meaning of Relevance. The major elements in the stratified model are user and computer, each with a host of variables of their own, having a discourse through an interface, as portrayed in Figure 1. The figure is a graphic depiction of the model, to be considered as an illustration of elements, variables, and processes involved, rather than an inclusive enumeration and specific ordering. The strata are not necessarily imbedded within each other, nor do they form a hierarchy. The relations between strata are much more complex and could be in flux.

The user side has a number of levels. I suggest three to start with: *Cognitive*, *Affective*, and *Situational*. The suggested computer levels are *Engineering* (hardware), *Processing* (software, algorithms), and *Content* (information resources). It should be recognized that each level can be further delineated or that others may be added, depending on the given set of conditions or emphasis in analysis. Furthermore, situational and/or general context may change affecting changes or adaptations in various strata; content and other aspects on the computer side may change, again affecting adaptations. The direction of use follows the second assumption above, namely it is governed by cognitive, affective, situational, and/or broader contextual aspects.

A note on the notion of context: While context has been recognized as a major aspect affecting information seeking in general and relevance in particular, the very notion of what constitutes context in information science is relatively

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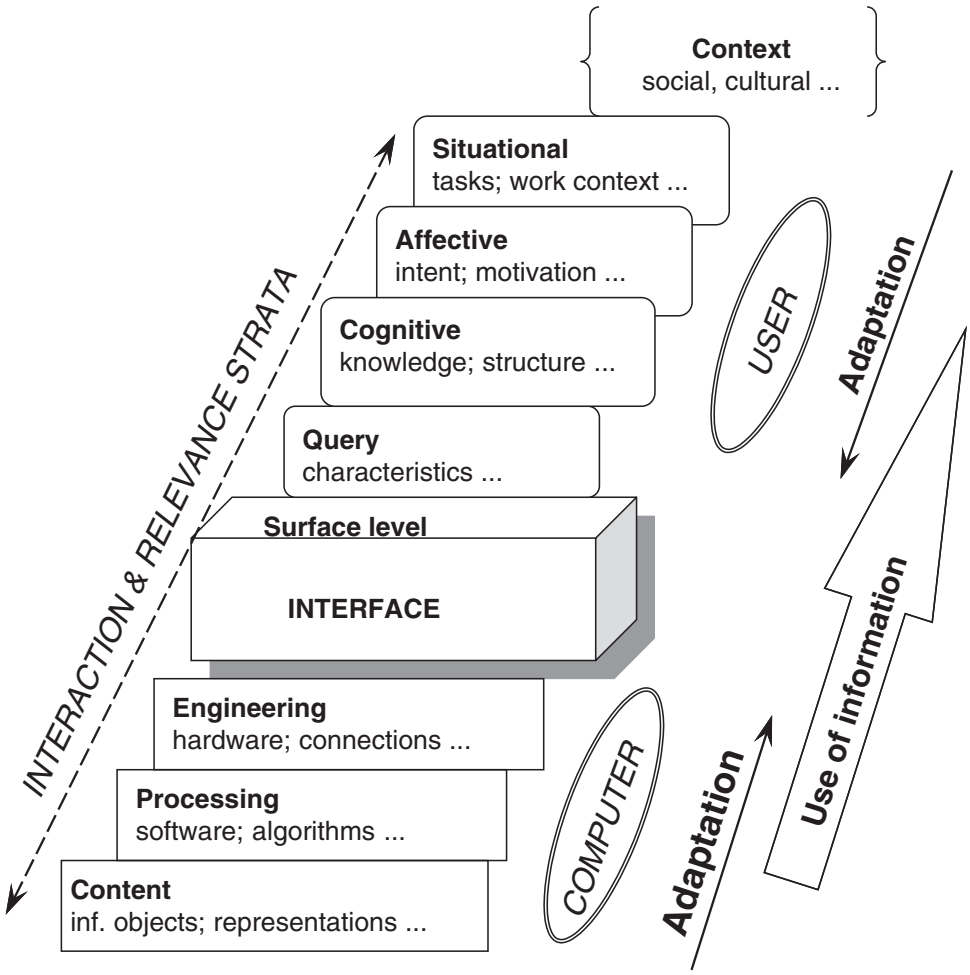

FIG. 1. Stratified model of relevance interactions.

ambiguous, even amorphous—a number of interpretations and models exist, but a consensus of what context entails has not yet emerged (Kelly, 2006). In the stratified model, context is treated as also appearing in strata; from specific situational or work context to more general social (including organizational, institutional, community . . .) and cultural (historical. . .) contexts. To a large extend, context(s) determine the problem/situation-at-hand. This corresponds to the notion of "problematic situation" as conceptualized by Schutz and Luckman (1973, p. 116ff). Context is a plural.

A variety of interactions are instantiated on the interface or surface level, but the interface is not the focus of interactions despite the fact that it can, in its own right, effectively support or frustrate other interactions. We can think of interaction as a sequence of processes occurring in several connected levels or strata.

The IR interaction is then a dialogue between the participants—elements associated with the user and with the computer—through an interface, with the main purpose being to affect the cognitive state of the user for effective use of relevant information in connection with an application at hand, including a context. The dialogue can be reiterative, incorporating among other things, various feedback types, and can exhibit a number of patterns—all of which are topics for study.

Each strata/level involves different elements and/or specific processes. On the human side, processes may be physiological, psychological, affective, and cognitive. On the computer side, they may be physical and symbolic. The interface provides for an interaction on the *surface* level in which:

1. Users carry out a dialogue by making utterances (e.g., commands) and receiving responses (computer utterances) through an interface with a computer to not only do searching and matching (as depicted in the traditional IR model), but also to engage in a number of other processes or "things," beyond searching and matching, such as understanding and eliciting the attributes of a given computer component, or information resource; browsing; navigating within and among information resources, even distributed ones; determining the state of a given process; visualizing displays and results; obtaining and providing various types of feedback; making judgments; and so on.
2. Computers interact with users with given processes and "understandings" of their own, and provide given responses in this dialogue; they also may provide elicitations or requests for responses from the user in turn.

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Let me elaborate on the nature of relevance from the stratified model point of view. We assume that the primary (but not the only) intent on both the user and computer side of IR interaction deals with relevance. Given that we have a number of strata in interaction, and that in each of them may be considerations or inferences as to relevance, then relevance can also be considered in strata. In other words, in IR we have a dynamic, interdependent *system of relevances* (note plural). Similarly, this plurality was depicted by Schutz, from whom I took the term *system of relevances*, and by Sperber and Wilson, who talked about principles of relevance. In IR, relevance manifests itself in different strata. Often there may be differences in relevance inferences at different strata; nevertheless, these inferences are still interdependent. The whole point of IR evaluation, as practiced, is to compare relevance inferences from different levels. We can typify relevance as it manifests itself at different levels, and we can then study its behavior and effects within and between strata—as treated in Part III (this issue, pp. 2126–2144).

Summary

All IR and information seeking models have relevance at their base either explicitly or as an invisible hand—in effect they are relevance models. A variety of integrative relevance models, above and beyond the simple traditional IR model, have been proposed. Basically, the models sought a framework within which the complexity of relevance may be analyzed, and the widely dissonant ideas on the notion may be interpreted and related to one another.

Among them, the stratified model has been suggested not only for modeling relevance but also for modeling interaction in IR, and more broadly in human–computer interaction (Saracevic, 1997). As examples, Rieh and Xie (2006) adapted it for a study of patterns of interactive reformulation of queries posed on the Web, and also Spink and Cole (2005) for deriving a multitasking framework for cognitive information retrieval. At its base, relevance involves interaction. Interaction is interplay between numbers of elements—so is relevance. Interaction is a tangled affair—so is relevance. The stratified model is suggested as one way to untangle them.

Proposing more complex models was an advance in relevance scholarship. However, suggesting models and applying them are two different things. Time will tell if the integrative models and approaches to IR will be successful in furthering research and practice.

Research and practice in AI is presently in a winter period. Research and practice in IR is not; it is flourishing. Why? Here is a possible explanation. Artificial intelligence chose human intelligence as its basic notion. Information retrieval chose relevance. Relevance is part of intelligence but intelligence as a whole is immensely more complex and harder to deal with. As yet, "intelligent agent" is an oxymoron. "Relevant information" is not. However, IR systems chose to deal with a (if not even "the") most simplified model and manifestation of relevance (later called *weak relevance*). Within that model, IR is a proven success. Now that much more complex models and manifestations of relevance have been identified, together with suggestions to be incorporated in IR, the challenge to translate them into IR research and practice has increased a lot. *A LOT!*

Manifestations of Relevance: How Relevance is Not One Thing But Many and How They Are Interpreted

"How Many Relevances in Information Retrieval?" is the title of an article by Mizzaro (1998). Indeed, how many? Manifestation is a realization, a display of existence, nature, qualities or presence of some thing. Like many other notions or phenomena, relevance has a number of manifestations. Think of energy: Potential energy and kinetic energy are some of its manifestations. For some phenomena or notions, it is not that easy to identify the variety of manifestations and to distinguish among them. Think of manifestations of love. . . or information. . . or relevance.

As already pointed out, in information science, relevance was early on distinguished as comprising various kinds. It was an explicit realization that relevance has different manifestations. With time and recognition of a number of problems with relevance, a cottage industry has developed in identifying and naming different kinds or manifestations of relevance, or presenting arguments about various manifestations. Manifestations of relevance also became argumentative.

As noted, relevance, among other things, indicates a relation. Efforts to specify manifestations of relevance have concentrated on identifying what given objects are related by a given kind of relevance—the Ps and Qs discussed in the section Meaning of Relevance. Different manifestations are manifested by different objects being related and/or by different properties used for a relation. Sometimes, the efforts also involved naming different manifestations—such as adding a qualifier in the form of [*adjective*] relevance, e.g., "topical relevance;" or using a distinct name to denote a distinct manifestation, e.g., "pertinence." Relevance gained adjectives. Relevance gained names. But that which we call relevance by any other word would still be relevance. Relevance is relevance is relevance is relevance. The arguments about manifestations concentrated more on the primacy of given manifestation rather than their nature. Here is an attempt to interpret the proposed manifestations and replay the manifestation arguments.

Starting from Duality

In 1959, Brian Vickery was first to recognize that relevance has different manifestations (Vickery, 1959a, 1959b). Inadvertently, the way in which he did it also precipitated a pattern of discussion about relevance manifestations that continues to this day. In an article in the *Proceedings of the International Conference on Scientific Information* (a highly

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influential conference and publication), Vickery defined the "controlling [criterion] in deciding on the optimum level of discrimination, we may call *user relevance*" (italics in original; 1959a, p. 863). In another article about terminology and retrieval, he discussed what is meant by "relevant to a particular sought subject" (1959b, p. 1227). He identified a duality of relevance manifestations *and* he treated each separately.

> *User relevance* on the one hand and *subject* (*topic, system*) *relevance* on the other. These represent the basic relevance manifestations. Each involves different relations. Each can and was further refined and interpreted; each can be thought as a broad class with subclasses. In retrieval they interrelate, sometimes in intricate patterns and with various levels of success. This is the nature of any and all retrievals of information. This is why we consider relevance as interaction. The interplay between the two manifestations cannot be avoided; however, the effectiveness may differ greatly depending on how the interplay is accomplished. The two should be complementary, but at times they are in conflict. The duality was explicit in reviews discussed in the preceding section.

In an article with the shortest title in the history of relevance writings, Bookstein (1979) pursues the formalization of an operational interpretation of relevance for IR "[to help] the reader disentangle at least part of the web of notions surrounding one of the most basic concepts of our discipline" (p. 272). In discussing what people intend when they use the term "relevant" (quotes in original) and what the basic functions of an IR system are, Bookstein explicitly recognizes a "duality of viewpoints," and concludes that it "accounts for much of the confusion surrounding the notion of relevance" (p. 269). Relevance is confusing. Yes it is, but the duality cannot be avoided despite the confusion such duality creates. It can only be made less confusing.

In a different way, the tension within the relevance duality was expressed as "objective versus subjective relevance" (Swanson, 1986, p. 389). As to the two types of relevance, Swanson equates them to Popper's "Worlds" and opines:

> Whatever the requester says is relevant is taken to be relevant; the requester is the final arbiter . . . Relevance so defined is subjective; it is a mental experience." "A possibility exists that such a request is logically related to some document. . . . That relationship is then the basis that the document is objectively related to the request." (pp. 391, 392)

Swanson's argument about objective relevance is based on logical relations between requests and documents, and a possible degree of confirmation. Pessimistically, Swanson concludes, "[For the purpose of an IR search] I believe that the problem of accounting for or describing subjective relevance is essentially intractable" (p. 395). This pessimism is in stark contrast to the optimistic mantra of user studies, described in the preceding section, stating that such studies have a potential of contributing to better designs. Thus, we have another duality: optimistic and pessimistic relevance. To date, the pessimistic kind is pragmatically ahead. So far, it has not been really possible to substantively integrate aspects of "subjective relevance" into information objects and retrieval algorithms.

In a similar vein, Ingwersen and Järvelin (2005) considered algorithmic relevance as an "objective assessment made by a retrieval algorithm," and topical relevance, pertinence, situational relevance, and sociocognitive relevance as being "of higher order due to their subjectivity" (pp. 381, 385).

Although it is hard to think about anything in relevance as fully objective, considering relevance in these terms follows ideas of Karl Popper (1972; thought of as the greatest philosopher of science in the 20th century) and his three interacting "Worlds" interpreted here as follows:

> World One, is the phenomenal world, or the world of direct experience. World Two is the world of mind, or mental states, ideas, and perceptions. World Three is the body of human knowledge expressed in its manifold forms, or the products of the second world made manifest in the materials of the first world (e.g.–books, papers, symphonies, and all the products of the human mind). World Three, he argued, was the product of individual human beings. The influence of World Three, in his view, on the individual human mind (World Two) is at least as strong as the influence of World One.

At its base, relevance is dual, perhaps a product of interaction between different Worlds, but from that dualism grows a pluralistic system of relevancies.

Beyond Duality

Relevance manifestations are cornucopian. There is much more to relevance manifestations than duality. A number of works suggested other or additional relevance manifestations. For instance, Cooper (1971) introduced "logical relevance," and improving on this, Wilson (1973) introduced "situational relevance." Harter (1992) championed "psychological relevance." "Topical relevance" was a perennial topic of discussion. "Pertinence" and "utility" were used by a number of authors. And we also have "system relevance," "documentary relevance" and so on, as discussed below.

In the previously cited article, Mizarro (1998) tried to create order and clarify the issue of relevance manifestations by suggesting a classification that accommodates all of them. He proposed that relevance manifestations can be classified in a four-dimensional space: (a) *information resources* (documents, surrogates, information); (b) *representation of user problem* (real information need, perceived information need, request, query); (c) *time* (interaction between other dimensions as changed over time); and (d) *components* (topic, task, context). Accordingly, Mizzaro suggests that each manifestation of relevance can be represented by where it fits into this four-dimensional space as a partial

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order. For example, "*rel (Surrogate, Query, t(q_0), {Topic}* stands for the relevance of a surrogate to the query at time *t(q_0),*with respect to the topic component (the relevance judged by an IR system)" (p. 311).

If we agree to these four dimensions, including the given definitions of what they contain, then Mizzaro is right: Various manifestations can indeed be consigned to various dimensions. But is it a space? Hardly, for the expression of some logical placements of and distances between different manifestations cannot be derived.

Starting from the cognitive viewpoint and the idea that relevance judgments evolve during the process of IR interaction, Borlund (2003) developed a framework for viewing relevance that also can be considered a classification of various manifestations of relevance. She analyzed three instances of relevance relations, also enumerating aspects or variables involved: (a) the types of relevance relationships employed in traditional noninteractive IR during an IR session; (b) the types of relevance relationships involved in a given instance of an IR session, which includes situational relevance as viewed by Wilson (1973); and (c) the types of relevance relationships that include the interrelationship between judgment of situational relevance and the development of the information need during a dynamic and interactive IR session. Depicted manifestations are from noninteractive to situational to interactive. The three instances build on each other, and the third, as expected, is most comprehensive. Topical, situational, and cognitive relevances are modeled.

Both of these works provide a framework for conceptualizing various attributes of relevance and a classification for relevance manifestations. But as the first sentence of this section ponders: We still do not know "how many relevances" there are.

User relevances. User relevances follow from user context. And user context was a main consideration in a number of relevance models already discussed. But what does that mean? What manifestations are involved? One way is to classify them is as internal and external.

Internally, the most prominent variable in which relevance plays a role is in changes in the cognitive state. This prompted Harter (1992) to introduce *psychological relevance*; more often labeled *cognitive relevance*—meaning a relation between *information objects or information* and the *user's cognitive state*. But this is not the only internal aspect. Carol Kuhlthau studied extensively and longitudinally the process of information seeking (her work, beginning in the 1980s, is synthesized in Kuhlthau, 2004). Although she did not study relevance per se, she derived a model of information seeking ("Kuhlthau's Model") that involved not only cognitive, but also affective aspects of users. Following this, I (Saracevic, 1996) added to other relevance manifestations also *motivational or affective relevance*—a relation between *information or information objects* and *intents, goals, motivations, frustrations of a user*. Cosijn and Ingwersen, (2000) elaborated further on this work (Saracevic, 1996), and defined five manifestations of relevance: *algorithmic*, *topical*, *cognitive*, *situational*, and *socio-cognitive*. However, they made a distinction between motivation and intention or intentionality, and even "placed affective relevance not as a manifestation nor as an attribute, but as a dimension in line with time" (p. 546). They considered that affective relevance is time-dependent over all manifestations except algorithmic relevance. Affective relevance is also contentious.

Externally, we consider that a user is faced with something in relation to which relevance is inferred. This introduced *situational relevance*—a relation between information or information objects and situation, task, or problem at hand facing the user. However, "external" really is not wholly external—it also involves user interpretation of that externality. Cosijn and Ingwersen, (2000, p. 547) made a further distinction: In addition to situational relevance, they introduced *socio-cognitive relevance*, a relation between information or information objects and situation, task or problem at hand *as perceived in a sociocultural context*. The context of relevance has a further context.

Topical relevances. Vickery (1959b) labeled it *subject relevance*, but, more often than not, we call it *topical relevance*. Both terms denote the same relation: between information or information objects and the topic or subject under consideration. Topical relevance may be inferred from the output of an IR system, or completely independent of any system—from any set of information objects, e.g., from the pile of documents in my office that I gathered there over the years. Topical relevance may or may not involve an IR system.

Documentary relevance also denotes topical relevance, but is restricted to documents as texts, rather than a whole class of information objects that include not only texts, but other informational artifacts such as images, music, speech, or multimedia. Ingwersen and Järvelin (2005) introduced *bibliographic relevance*—a relation between *representations of metadata* (e.g., as found in a catalogue) and *the topic or subject under consideration*.

To narrow relevance manifestation down to systems, we have *system relevance*—a relation between *information or information objects retrieved by the system* and *the query*. Sometimes, it is also called *algorithmic relevance* to denote the method of inference. It has been argued that in a narrow sense system relevance is always perfect; the system retrieved that which the query asked for. Not so. The whole point of the evaluation of different algorithms is that they produce different outputs for the same query and from the same set of documents in the system.

Issue of primacy—weak and strong relevance. Does topical relevance underlie all others? Do all other manifestations of relevance follow from topical relevance and does it have primacy among relevance manifestations? As we can imagine, there are two schools of thought: yes and no.

In the first, topicality is basic. For example, in summarizing definitions of topical relevance, pertinence, and utility,

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Soergel (1994) suggests a nested set of relevances: an entity—information object—is topically relevant if it can help to answer a user's question; it is pertinent if topically relevant and appropriate for the user—a user can understand and use the information obtained—and it has utility if pertinent and gives the user new information. In this view, pertinence and utility follow from topicality.

In the second school of thought, topicality is not basic, there is relevance beyond topicality. Nontopical relevance can be derived, as discussed in the section Meaning of Relevance, from information objects that are not directly topically related. Here is a further example of the discussion about problems with topical relevance. In considering requirements for evidence-based medicine, Hersh (1994) explored the limitations of topical and situational relevance from a medical perspective, arguing that topical relevance "is ineffective for measuring the impact that systems have on users. An alternative is to use a more situational definition of relevance, which takes account of the impact of the system on the user" (p. 201).

The issue boils down to the query and request on the one hand, while on the other hand, it is information interpretation and derivation. In a strict correspondence between a query and request, topical relevance is basic. But, if we approach the issue with human intellect and imagination, then many interpretations can be made. Topical relevance is restricted to a single, direct correspondence—it is but one manifestation; others may be of even more interest to users. Arbitrarily, topical relevance by itself may be labeled as weak relevance. The second interpretation, relevance beyond topicality includes derivate powers of the intellect and is more argumentative. This may be labeled as *strong relevance*. There is weak relevance and strong relevance.[3] Weak relevance goes with systems, strong with people. Duality strikes again.

Topical relevance is certainly the basis for system or algorithmic relevance (Borlund, 2003). A simple line of reasoning is that systems retrieve what is asked for in a query; a query represents a topic of interest. As is practiced today, a large majority of IR systems organize information objects around words; queries are expressed in words, and matching is based on words or derivative connections. These words are mostly noun phrases. Even when documents are matched on similarity, such matching is based on words. More sophisticated handling involves patterns, such as in music or image retrieval, or links, such as in citation retrieval or Google's page-rank retrieval. But word-based retrieval is still on the throne. In turn, word-based retrieval is based on trying to establish topical relevance. In this sense, it is also the simplest kind of relevance, no matter the sophistication of algorithms and procedures involved. Systems construct weak relevance. This does not mean that the task is simple; for words, arranged in language, are by no means a simple proposition to handle. They are a human creation—complex and complicated. It is very hard to deal even with the simplest, weakest kind of relevance.

Summary

Relevance is like a tree of knowledge. The basic structure of the system of relevances in information science is a duality. The tree of relevance has two main branches, system and human, each with a number of twigs, but it is still the same tree. The roots of the branches and the fruits—results—are a matter for exploration.

Here is a summary of the manifestations of relevance in information science, mainly following Cosijn and Ingwersen (2000), Borlund (2003), and my earlier work (Saracevic, 1997):

- *System or algorithmic relevance*: Relation between a query and information or information objects in the file of a system as retrieved or as failed to be retrieved, by a given procedure or algorithm. Each system has ways and means by which given objects are represented, organized, and matched to a query. They encompass an assumption of relevance, in that the intent is to retrieve a set of objects that the system inferred (constructed) as being relevant to a query. Comparative effectiveness in inferring relevance is the criterion for system relevance.
- *Topical or subject relevance*: Relation between the subject or topic expressed in a query and topic or subject covered by information or information objects (retrieved or in the systems file, or even in existence). It is assumed that both queries and objects can be identified as being about a topic or subject. Aboutness is the criterion by which topicality is inferred.
- *Cognitive relevance or pertinence*: Relation between the cognitive state of knowledge and of a user, and information or information objects (retrieved or in the systems file, or even in existence). Cognitive correspondence, informativeness, novelty, information quality, and the like are criteria by which cognitive relevance is inferred.
- *Situational relevance or utility*: Relation between the situation, task, or problem at hand, and information objects (retrieved or in the systems file, or even in existence). Usefulness in decision making, appropriateness of information in resolution of a problem, reduction of uncertainty, and the like are criteria by which situational relevance is inferred. This may be extended to involve general social and cultural factors as well.
- *Affective relevance*: Relation between the intents, goals, emotions, and motivations of a user, and information (retrieved or in the systems file, or even in existence). Satisfaction, success, accomplishment, and the like are criteria for inferring motivational relevance. It can be argued that affective relevance underlies other relevance manifestations, particularly situational relevance.

Author's Note

A general conclusion is presented at the end of Part III (this issue, pp. 2126–2144).

[3]Harter (1992, p. 608) used the term "*weak relevance"* in a different sense: he labeled "weak relevance" that which is based on assessment of bibliographic representations, "representing [users] best guess (or hope) of what will happen when the corresponding article is retrieved and read."

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