

Measuring Information: An Information Services Perspective. JEAN TAGUE-SUTCLIFFE. Academic Press, New York (1995). 206 pp

Professor Tague-Sutcliffe has provided an excellent resource for serious students of information systems. In some ways this book serves as a model for the organization of research in the area of systems evaluation. In others, it points up the challenges of conducting such research in a rigorous way, within the limitations of the mathematics usually known to advanced students of library and information systems.

There are three broad ways in which one might assess the value of an information service: holistically, by gaining some impressions of its impact on the organizations and communities that it serves; atomistically in terms of service events, by examining a representative sample of such events, and atomistically in terms of items retrieved or presented, by methods such as the ones discussed in this book.

Tague-Sutcliffe begins (correctly, in my view) by noting that the “value” of an information item depends upon the specifics of the query at hand. The only acceptable judge of this value is the person presenting the query. At this point we encounter the problem that this person, and hence his judgments, will be influenced by items already seen. Thus we should (Tague-Sutcliffe is not explicit about this) imagine that, before any evaluations are to be made the user person is replicated [devices for accomplishing this seem to exist only in the comic strip “Calvin and Hobbes” by Bill Watterson]. For an entire reservoir of N retrievable items, $N(N-1)/2$ such replicates are needed. Each is asked to make exactly one pairwise judgment is the starting point of Tague-Sutcliffe’s analysis. It is presumed (again, quite reasonably) that for every pair of items a, b , the corresponding user replicate will announce “ a is more informative than b ”, or “ b is more informative than a ”, or “they are equally informative” or “none of the above”. In the latter case a and b are said to be “not comparable”.

Tague-Sutcliffe’s analysis is presented in an axiomatic form although, as we shall note below, the axioms are sometimes elaborated by “rules of calculation” which are, in effect, additional axioms, and which are not so apparent to a casual reader. In Chap. 2 a number of such axioms (called “properties”) are laid out, representing desirable characteristics of a measure of informativeness. Here there are many possible logical pitfalls, not all of which are avoided. For example, Property 2 states that “information has magnitude” which may be “. . . ordinal, interval, ratio or absolute in scale”. And again in Section 2.2.2 “. . . the informativeness measure will be an ordinal one”. Yet in Property 5, “. . . informativeness of a subsequence is approximately proportional to the logarithm . . .”. The very thoughtful discussion of Property 5 fails to mention that it requires that informativeness be measured on a ratio scale or absolute scale, in order to be an allowed statement about meaningfulness.

This example shows that Tague-Sutcliffe has chosen to enter some of the deepest waters in the study of information systems, and that the reader must follow with great care.

The third chapter surveys “earlier measures of information”. Particular emphasis is given to entropy type measures. All such measures require an ensemble of possible messages, with known or estimated probabilities. As Tague-Sutcliffe points out, this makes them of limited usefulness in dealing with the “messages” that readers extract from libraries or large databases. Some of the discussion of extensions of the entropy concept seem to me uncritical, and the reader should be alerted to the existence of a huge and rigorous literature on application of the Shannon measure to a host of problems. This literature can be accessed starting with any issue of the *IEEE Transactions on Information Theory*. Unfortunately (a problem to which I shall return) this literature is essentially incomprehensible to most students of L/IS. There is an interesting discussion of the Fisher Information. Similarly, there is a discussion of the time discounting of value, which will be drawn upon in subsequent analysis of the value of an entire retrieval.

I would have liked to see the various measures critiqued in terms of the Properties set forth in Chap. 3. But Tague-Sutcliffe has left some work to be done by others. I personally feel that a more thorough discussion of the economic analysis of imperfect information would have been of great value to students of L/IS, and will eventually be seen to unify and resolve several thorny problems of evaluation. An excellent source point for this literature is the review by Hirshleifer and Riley.

The fourth and fifth chapters are the heart of the new contribution of this book. In the fourth, Tague-Sutcliffe develops a scheme for combining the pairwise judgments described above, in to a single total ordering of the retrievable items. This requires that for all chains of items, developed during the course of this analysis, the user (or another replicate of the user) can provide a complete ordering of the chains in terms of the “importance” of the rule by which the elements of the various chains are ordered. This is of course a suspect assumption, since it is far stronger than the requirement of pairwise comparability of items taken as a starting point. In addition, the user may verify that following Tague-Sutcliffe’s construction for the user preferences shown in Fig. 1 would lead to a construction of informativeness in which parts of the chain which the user judges to be most important are completely lost! This suggests that alternative ways of constructing the total order might be worth exploring.

After providing a method for completely ordering the retrievable items with regard to informativeness, Tague-Sutcliffe then provides a measure of item informativeness satisfying the logarithmic property mentioned above. In doing so, the very reasonable notion that several items which are indistinguishable have the same informativeness is implemented in such a way that when there are n such items, each is assigned an informativeness which is one n -th of the informativeness that would be assigned to a single item occupying the same position in the item ordering (following Equation 4.2). I'm afraid that I find this to be unreasonable. It means, in plain terms, that if I find the definition of my word in the only dictionary containing that word the event is 10 times as informative as if I find it in one of ten dictionaries containing exactly the same definition. I may be "luckier to find it", but I don't think I am "more informed". The reader seeking a definition of informativeness finds it on p. 47 "Informativeness is the extent to which a record provides information to an individual, the user." This notion of "extent" is further elaborated reference to the "extent" of a "conceptualization in short-term memory". This language suggests important links between L/IS and the cognitive scientists, who are the natural group to seek a definition of "extents" in short-term memory, and to determine whether those have some sensible correlation with what we think we mean by "an amount of information".

Chapter 5 addresses a classical difficult problem: aggregating the individual user-item interactions to provide a measure of the effectiveness of the system overall. Tague-Sutcliffe discusses first the aggregation of user-item interactions into "retrieval trails" which are ordered sequences of such interactions. This is done by introducing a new construct: the ideal or optimal item order. It is not quite clear how we would use our user replicates to establish this. I suppose that one very energetic such replicate would scan the entire library and indicate the optimal retrieval order. It is presumed that the order imposed on a subset of the items (by yet another replicate) would be consistent with this global optimal order. I think that this [which is, in a sense, the entire problem of education] is a debatable assumption. In any case, given this assumption, Tague-Sutcliffe combines item informativeness with a standard measure (Spearman's) of "out-of-orderness" to assign an informativeness score to the entire ordered sequence. Two scoring models are proposed, depending on whether the user has bounded or unbounded patience in examining items.

Chapter 5 also explores an entirely different approach, in which the user of items in a collection is taken as a surrogate for their informativeness. This contains an interesting and thorough discussion of the consequences of assuming that the user of any single item follows a Poisson distribution and that the distribution of use over items follows a gamma distribution. The discussion is unusually thorough in that it includes determination not only of point estimates but also of confidence intervals. It stands independently of all the material in Chaps 2, 3, 4 and the rest of Chap. 5.

Finally, Chap. 6 contains a good discussion, with examples, of experimental design in the evaluation of one or more features of an information retrieval system. Of particular importance is the discussion of analysis of variance based on ranks, given in Table 6.7 and in Appendix 6.2. The discussion in the Appendix, for three-fold comparisons, addresses some very subtle issues, as the method of Meddis, adopted by Tague-Sutcliffe involves combining several hypotheses about order into a single statement. Since the development of the work cited there have been some improvements in statistical theory about this issue. Related results are given in the book by Hochberg and Tamhane (Chap. 2, Sects 2.3 and 4.2.4; Chap. 9, Sect. 2.3.3).

The book is generally well prepared, laid-out and copy-edited. Thus it is most disappointing to find some crucial remarks on p. 170 replaced by part of the typesetting code for this volume! Overall? Well, I am certainly glad that this book exists, and that I have had a chance to read it. And I will probably recommend it to all advanced Ph.D. students in the area of L/IS. It could well form the basis of a seminar for advanced

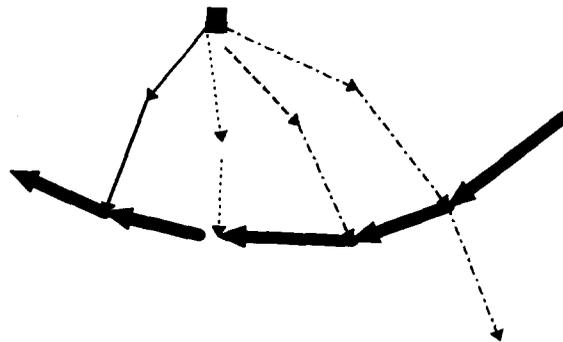


Fig. 1. The ordering algorithm of Tague-Sutcliffe.

graduate students. However, I believe that most such students (even those with backgrounds in Computer Science) are not well prepared to cope with the enormous range of ideas addressed. This is not surprising, since it is also true that a majority of the faculty in this field, in North America, are also not well prepared. But we ought to be. This suggests that curricula in L/IS should either include or pre-require a good course in Finite Mathematics. What we need from such a course, as Tague-Sutcliffe's fine book makes clear is an introduction to set theory, order relations, rudiments of graph theory, and some probability and combinatorics. These lay the foundation on which most of this book is based, and make the computations with tanks, which are the basis of much of Chap. 6, more comprehensible.

Tague-Sutcliffe has written a wide-ranging and thoughtful book. It points the way to many interesting research problems, either by varying some of its key assumptions, or by exploring the degree to which alternative schemes for measuring information have the properties and satisfy the axioms laid down. And the discussion on evaluation will serve as a model for studies of the interaction between system features and the characteristics of searches and users. It should be on the shelf of anyone seriously interested in designing and evaluating L/IS systems, anyone teaching advanced students in LI/S, and on the shelves of most of those students as well.

We suppose that there are 12 items in all. There are several partial order relations, each represented by a different style of line. We suppose that the heavy line represents the order relation which the user finds most important. However, under the algorithm proposed, the partially ordered set consisting of the topmost element, and the three joined to it by "dot-dash" lines will be extracted first. Thus only a fragment of the most important order relation will be found by the algorithm.

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Info-Rich Info-Poor. Access and Exchange in the Global Information Society. TREVOR HAYWOOD. Bowker Saur, London (1995). xiv+274 pp. ISBN 0 86291 631 3.

The book has a catchy title. The content has little to do with the title. The thesis is that the world "can be seen an information system, and events the product of a long series of 'information moments' that have cumulated in the knowledge domain that distinguish between or unite individuals, activities and communication". It purports to talk about inequality of access in such a world. It does not. It talks about the role of information in a variety of contexts like manufacturing, culture, technology . . . ; it talks about concentration of media in a few hands and who acquired whom; it talks about coca-colonization (I guess by now an obligatory topic in the information lamenting genre), it talks . . . and talks.

It tells us that the Sudanese officials are frustrated. That the collapse of British shipbuilding industry had repercussions, among them in loss of knowledge for Britain. It tells us that *The Observer* lost money because of editorial interference of the new owner. It tells us that the Rupert Murdoch owns everything, that Sony and Matsushita are now in Hollywood, that the factory wage in China is lower than in Hong Kong and the U.S., and so on. It gives endless examples of this kind. It does not tell us what does it all mean, beyond the obvious.

The book is a treasure trough of anecdotal information about information in the widest sense of the word. The main sources supporting the announced 'pessimistic' thesis of the book, that the "poor" will never catch up (meaning developing countries mostly), and the 'optimistic' thesis, that the technology will bring benefits for wealth creation and entertainment, are newspaper accounts and T.V. programs and reports. Overwhelmingly from Britain. This, of course, gives the reading a charming flavor. In contrast, no serious studies on the role (and other aspects) of knowledge and information in the evolving social order, where they play an increasingly important and complex role, have been even mentioned. None.