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Galileo and the Inverse Precision/Recall Relationship

Medieval Attitudes in Modern Information Science

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The tight adherence to dogmas, created and advocated by authorities and disseminated through hearsay, constitutes an impediment to the progress badly needed in view of the low effectiveness of the vast majority of our bibliographic information systems. The Italian mathematician and physicist Galileo has become famous not only for his discoveries but also for his being exposed to the rejective and even hostile attitude on the part of his contemporaries when he contradicted several dogmas prevailing at that time. This obstructive attitude can be traced throughout the centuries and manifests itself in the field of modern information science, too. An example is the allegedly necessary, inevitable precision/recall relationship, as most recently postulated again by Lancaster (1994). It is believed to be confirmed by empirical evidence, with other empirical evidence to the contrary being neglected. This case even constitutes an example of the suppression of truth in the interest of upholding a dogma. (Author)

1. Introduction

The Italian physicist and mathematician Galileo (1564-1642) is famous for having shocked his contemporaries with several revolutionary ideas and discoveries which caused a storm of emotional resistance. The dispute that arose from them is highly instructive as well as indicative of the resonance that scientific novelties have always encountered, present times not excluded. Max Planck, the originator of the Quantum Theory in physics and Nobel prize winner, is said to have expressed his disappointment with many contemporary scientists' rigidity and reluctance towards new ideas. The common acceptance of a new theory, he said, largely depends on how fast the advocates of the old and refuted theories die out, because they refuse to become convinced. Often in the history of science it has even proved unwise and dangerous to forgo conformity with prevailing opinions. Those who dared to do this have often been pursued by their contemporaries, at least through polemics and even been threatened with prison or arrest as, in particular, Galileo went through because of the support he gave to the Copernican notion of heliocentricity.

At the time of Galileo it was commonly accepted that the speed of a falling body was dependent on its weight. Galileo's dissent and his revelation of the truth is a model example of how reliance on pure empiricism can lead the human astray and how reluctant people are to become convinced of something that runs contrary to what they have learned or originated themselves and that is uncommon to them.

This pattern of scientific battle has not become outdated as we shall realize in the example of the erroneous but still prevalent opinion that there is a natural, necessary "inverse relationship between precision and recall" in an information system.

2. Galileo's physical cases

In Galileo's time, the opinion prevailed that the speed of a falling body was *dependent on its weight.* Nobody is known to have called this assertion into doubt at that time. Much empirical evidence had been compiled in supported of it. There was an obvious difference in the speed of the falling (light) bird's feather or of a leaf falling from a tree on the one hand and the falling (heavy) stone on the other hand.

Galileo, however, compared two falling stones of different weight and could not observe any difference in their speed in falling down. Thus, his statement that their speed in falling down was *independent of their weight* was revolutionary, but empirically founded, too. But this evidence to the contrary of the prevailing opinion was widely neglected and even violently combatted.

Galileo could not resolve the contradiction between both these opinions because at those times the vacuum had not yet been discovered, and air resistance, which constituted a *disturbing experimental condition* in all these experiments, could not yet be eliminated. When Galileo's student Torricelli later repeated the experiments with stones and bird's feathers in the vacuum, he splendidly confirmed Galileo's statement: All bodies fell at equal speed, independent of their weight.

Mere *reasoning* could also have supported Galileo's assertion and refuted the opposite notion very early: If two stones were tied together (and the weight of the body was thus increased), there was no reason that they should fall faster than when remaining isolated. For completely unexplainable reasons, at least one of them would have to fall faster under these changed circumstances and would have to pull the other one. Alternatively and likewise strange, both of them would have to fall faster when merely tied together by a string.

Another widely accepted assertion at that time was that a body in motion required a continuously effective force to remain in continued motion. Galileo, together with Newton, dared to call this assertion into doubt, although there was no empirical evidence to the contrary, at least not on earth (and only in the universe). The factor concealing the truth and always disturbingly effective in the experiments and in physical reality was *friction.* It was not (and could not yet be) eliminated from the experimental conditions.

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3. Present days' information scientific cases

Likewise dominant in present times is the statement that there is a necessary, *inevitable* "inverse relationship between precision and recall" in an information system. Again, empirical evidence gives support to this assertion: The behaviour of many contemporary information systems, in which, in fact, such an inverse relationship can be observed.

Again, observations to the contrary have also been made, but they have widely been neglected for scientifically unjustified reasons. Under certain circumstances,

- an increase in precision is by no means *always* accompanied by a corresponding decrease in recall, and, conversely,
- an increase in recall is by no means observed to have *always* in its wake a decrease in precision.

It is even perfectly possible to attain *both 100% precision and 100% recall* at the same time, for example in searches for chemical compounds and classes of compounds, which has been done routinely for several decades and is now being done worldwide in files of the more than 15 million records of Chemical Abstracts Service.

This perfectly justifies the claim of the
invalidity of an *inevitable* inverse
precision-recall relationship.

Again, and besides experimenting, mere reasoning could early have refuted the statement of the stipulated inverse relationship: When searching for the name of an individual person in a hypothetic telephone directory, it may be impossible to use the first name as a search parameter. The search will be rather imprecise. After making the first names available for search,

precision will be enhanced but recall
will by no means decline.

On the other hand, several names may have been in use for a country or an industrial company in the course of time. When only one of these names is used as a search parameter, recall will be low. *Recall can be enhanced* through the inclusion of several of these names as alternative search parameters. But

by no means will precision decline
simultaneously with the increase of recall

in this case.

Under which particular circumstances can an inverse relationship occur and under which circumstances can it be avoided? Unreliable indexing (as encountered in free indexing and in other variations of the neglect of Cutter's rule) causes

lack of representational predictability[1, 2]

Under these circumstances the stipulated inverse relationship in fact exists. Where, however, representational predictability prevails, no inverse relationship of the stipulated type will occur.

It does not come as a surprise that this attack on a dogma provokes opposition, most recently by W.F. Lancaster[3] in his review of a book by the author. But if a prevailing dogma is so evidently refuted through practice, one should no longer adhere to it, nor undertake every effort to defend it. Rather, one should investigate which particular, hitherto hidden circumstances have so far concealed the truth and have given rise to the dogma now to be abandoned.

Still another controversial issue is pending in the literature: Widespread, interindexer consistency is looked upon as a criterion of good indexing quality. But even the worst variety of indexing can be a most consistent one. This has already repeatedly been pointed out, for example by W.S Cooper[4]. All variations of automatic indexing are perfectly consistent, and in spite of that they differ widely in quality as is obvious from ongoing research. This fact alone should have cast doubt on consistency as a quality criterion. On the other hand, it is intuitively felt that consistency has something to do with indexing quality. The notion of *representational predictability* reveals that interindexer consistency is neither a necessary nor a sufficient requirement for indexing quality (cf. 2, p. 95ff).

Here, too, the discussion follows the common, but obstructive pattern of dispute: Conclusive arguments against a dogma are widely neglected. In other words, a wrong goal continues to be set through the criterion of interindexer consistency.

In view of all these fallacies we should not be surprised that our contemporary information systems are far from being satisfactory. Saracevic[5] rightly writes: "...the present design of online subject access does not accommodate human variability in searching (or indexing). This calls for radically different design principles and implementations..."

The case of Lancaster's book review[2] even constitutes an interesting example of the suppression of truth. Lancaster writes:

"...he completely rejects the inverse relationship between recall and precision..."

whereas the book says in paragraph 1002 (p.204):

"It is true that in practice such a relationship is often observed, but this is the consequence of either an inadequate mode of working or of particular difficulties inherent in the field to be served."

The editor of the Journal of Documentation refused to print a short note in one of the immediately successive issues of the journal. Hence, the truth on what the book actually says had to be revealed elsewhere.

Notes and References

1 Here we are leaning on J. Mills: Progress in Documentation. J.Doc. 26(1970) p. 123

2 Fugmann, R.: Subject Analysis and Indexing - Theoretical Foundation and Practical Advice. Frankfurt: INDEKS Verlag 1993. 256p.

3 Lancaster, F.W.: In J. Doc. 50(1994)No.2, p.149-151 (Lancaster's review of the author's book.) Several additional weaknesses have crept into this review. Their revelation is laid down in a treatise that can be ordered from the author of this article or from the publisher of the book.

4 Cooper, W.S.: Is Interindexer Consistency a Hobgoblin?. J. Amer. Soc. Inform. Sci. 42(1969)p.1-6.

5 Saracevic, T.: Indexing, Searching, and Relevance. In: Weinberg, B. H. (Ed.): Indexing, the state of our knowledge and the state of our ignorance". Proc. 20th Ann. Meeting Amer. Soc. Indexers. Medford, NJ.: Learned Inform.

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