A SCIENTOMETRIC COGNITIVE STUDY OF NEURAL NETWORK RESEARCH: EXPERT MENTAL MAPS VERSUS BIBLIOMETRIC MAPS

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This paper reports on a quantitative analytical methodology which deals with perceptions of scientific experts regarding the intellectual shape and contents ('cognitive structure') of their scientific domain. This study examines the method's utility for studying expert views in general, and, more specifically, its strengths and weaknesses as a tool for improving validation studies of bibliometric maps involving subject experts. The main premise is that expert views are based on their internal knowledge structures ('mental schemes') of which relevant features can be captured in quantitative data. This approach allows a rigorous and systematic way of studying mental schemes across subject experts. Spatial representations of their data ('mental maps') provide insight in properties underlying those knowledge structures. Data from different experts are reconciled to construct a 'common' mental map which displays a group view. This study includes a test to establish the validity of individual mental maps and common mental maps. The methodology is applied to the views of 14 researchers in the field of neural network research and related areas. Key-findings are: (i) mental maps can provide valid representations of expert mental schemes, (ii) experts sharing the same subject field are more likely to share views, (iii) expert judgements of bibliometric maps are affected by the structure of their own mental schemes, as well as (iv) by their views regarding the utility of those maps, and (v) common mental maps and a bibliometric co-word map based on the same set of items differ significantly, showing a resemblance on main features only.

Validation of bibliometric maps

Over the last two decades scientometricians have used data-reduction tools to study complex relational structures within the science system. Some of those analytical techniques provide spatial representations depicting the main findings in an easily comprehensible manner. Those 'maps of the sciencescape' are mostly derived from the analysis of quantitative literature-based (bibliometric) data and are mainly employed for displaying knowledge ('cognitive') structures within scientific areas.1 Their input consists of quantitative data referring to the degree of relatedness among research publications. For example, cross-reference frequencies (co-citations), co-
occurrences of keywords, or co-occurrences of subject-classification terms. Studies on
the relevance and usefulness of these maps mostly boils down to attempts to establish
their content validity, that is, to verify their meaningfulness and truthfulness. Often,
congruence with information is sought from sources within the scientific community
which is then used as a yardstick for calibrating these maps in terms of their degree
of 'recognizability'. Usually this involves the views of one or more scientific experts
on the cognitive structure and development of the field, its research agenda and its
practitioners. Establishing the degree of congruence with these expert perceptions is
an important element in determining a map's credibility. Particularly, if the map is to
be used as an aid for describing characteristics of scientific fields for S & T policy or
R & D management purposes.

Validating a bibliometric map is a problematic exercise. For one, explicit external
criteria for establishing the degree of congruence are often lacking. They are
developed during or after the study, mostly on an ad hoc basis. Secondly, it involves
the interaction between the analyst's data-analytical frame of reference and subject
experts whose views may be affected by a self-identification with areas on the map
and may tend to focus on interest and relevance rather than on representational
validity. Clearly, interpretation and validation interact. So, their is the danger that
such a study might degenerate into an exercise of face validity with an excessive
element of subjectivity.

Not surprisingly, validation studies may show only a limited congruence with the
views of a single expert. Including more experts in a validation study will increase
these problems due to genuine lack of consensus among experts: one should expect
to find idiosyncratic differences between experts' viewpoints, as well as a certain
degree of bias due to differences in scientific background and interests. Differences
may also arise as a result of differences in point-of-view regarding the most
appropriate type and conceptual level of elements on the map, as well as lack of
agreement on the exact meaning of those elements.

Moreover, when the map is assessed at face value only, which is probably
unavoidable due to lack of objective 'yardsticks', experts will tend to view what they
perceive as discrepancies between their views and the map as signs of error on the
part of the map, while agreement is interpreted as redundancy. However, one can
also argue that redundancy is a sign of the map's accuracy and truthfulness, while a
lack of consensus amongst experts suggest that the map can be used legitimately as
another (quasi-)objective point of view.