RANGANATHAN'S THEORY OF FACET ANALYSIS AND KNOWLEDGE REPRESENTATION

MA Gopinath

Documentation Research and Training Centre, Indian Statistical Institute
Bangalore-560 059

Abstract

Presents the basis of Ranganathan's theory of Facet Analysis and identifies its application to the analysis of knowledge. Discusses its value in knowledge representation in different contexts.

1. Preamble

1992 is the birth centenary year of Dr SR Ranganathan, National Research Professor in Library Science (1965-1972). Government of India. He was a savant of library and information services; who promoted & organised university library system, public library network on state-wide basis, specialised R&D, industrial, and business information centres. He also promoted and cultivated specialised personnel with expertise and skills for handling knowledge in different ways. He created and contributed to the literature of library science and propounded the Five laws of Library Science, dynamic theory of Library Classification, normative principles for cataloguing, scientific principles for library management, efficient approaches to handling library measurements, development of national documentation systems and library networks. He developed standards, specifications and guidelines through the National Standards Bureau of India. In short, he built many infrastructures to promote organised library services in India . This article highlights the value of facet analysis in knowledge representation in the contemporary scene.

2. Introduction

Ranganathan strived to develop an analytico-synthetic structure of

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knowledge. He identified his studies on the way knowledge gets embodied in books, periodical articles, and other rendered material; and based it on the way in which the seekers approach knowledge. Further, his analysis of conceptual aspects of an information storage and retrieval system would provide for achieving the following aspects :

(a) Providing better access to contents of documents;

(b) Narrowing down and broadening the search;

(c) Providing alternative search patterns;

(d) Distinguishing between no matches due to search error, and no matches between the items not in the database.

However, this analysis of information retrieval should be backed up by the ability to analyse and synthese texts in a variety of ways. His postulates on analysis lead to facet analytic approach. Ranganathan said on the role of classification thus : 'A traveller will be helped much more, saved many wrong turns and attracted to the home more easily, if the light put up by the host is a search light, which not only acts as a beacon but also lights up the region through which he has to walk. Then there will not merely the goal be glimmering but every inch of the way will be illuminated. The formula of facets and phases of a well-designed analytico-synthetic scheme of classification will serve the purpose of such a light'(see reference 1).

3. Facet-analytic Approach

In concept modelling through analytico-synthetic approach, we can adopt Ranganathan's approch (see reference 2). In his model, he proposed a universe of discourse, called 'Basic Subject'; with each basic subject, several entities, their properties, and actions can be studied in relation to space and time. Based on this analysis he identified a scheme for classification. he postulated categories that gave generalised abstractions. In each instance, a subject may have the presence of one or more of these categories. These categories are stated as follows :

- **Time**: The pervasive temporal aspects of the world such as day, night, year, century, etc.
- **Space**: Geo and other spatial concepts in the relational system such as India, USA, USSR, etc.
- **Energy**: Actions of various varieties such as running, managing, communicating, modelling, etc.
- **Matter**: The properties and other attributes of our object, such as name, valency, mobility, viscosity, etc.
- **Personality**: The objects, their instantial variations, such as automobiles, passenger cars, sports car, etc.
- **Basic subject**: Chunk of a field of knowledge, convenient as a field of activity; such as 'Vehicle Engineering, Land Vehicle Engineering and Motor Vehicle Engineering.'

This is a core model from which one can derive any number of representations of knowledge embodied in documents and other kinds of materials.

4. Examples From Design Database For Public Finance

Example 1 Economic and political foundations of tax structure. (Published in *American Economic Review.* 1988, **78**(4), 701-12).

Analysis:
Time : 1988

Space : USA
Matter: Tax Structure
Personality 1 : Political System
in relation to
Personality 2 : Economic System
Basic Subject : Public Finance

Here we see no instance of 'Energy' category.

Example 2 Another concept : Federal Government Budget deficits and interest rates : an empirical analysis for the US, 1955-84. (Published in *Public Finance.* 1988, **43**(3), 337-48)

Analysis:
Time : 1988
Space : USA
Energy : Analysis Empirical analysis
Matter : Rate of interest
Personality : Public Expenditure
Basic Subject : Public Finance
in correlation with
Personality : Economic System
Sub Field : Deficit Budget
correlated with
Co-entity : Political System
Sub Field: Federal Government
Basic Subject : Public Finance

Thus, we see that the expressions of summarisation of information contents of objects can be analysed into Basic subject, Personality, (=Entity) and other categories. Such an analysis leads to an intermediate lexicon of ideas which can be used as modelling media for input information in any specialised field as well as a media for searching information from the database. Lists of various features of Political System and Economic System for Public Finance, useful for analytic-system can be easily built into a design database. We shall discuss this process in knowledge-based Management systems also.

5. Knowledge Representation Systems

Knowledge bases have to be organised and structured as the rules embodied in them go on increasing. Thus, knowledge representation language comes into play. Many issues in this context handle both conceptual factoring and computational efficiency. In techniques such as semantic nets, conceptual taxonomies, frame systems, etc; knowledge is conceptually factored according to a hierarchy or generalisation structure. It is a kind of taxonomic or classificatory structure. *KL-ONE*, is a knowledge representation system oriented around a taxonomy of structured concepts. The taxonomy for organising a knowledge base of rules is described in the following paragraphs.

A *concept* mode in *KL-ONE* is associated with a set of rules (a generalisation) of the notions of attribute, part, constituent feature, etc) and a set of structured conditions expressing relationships among them. These concepts are linked to more general concepts by explicit links. The more general concept in such a relationship is called the super concept and is said to subsume the more specific subconcept. Some of the concepts' roles and structural conditions are attached to it directly, while others are inherited indirectly from more general concepts.

The concepts and roles of *KL-ONE* are similar in structure to classical data structure notions of record and field or the 'frame'/'scheme'/'unit' and 'slot' of much AI terminology. However, they differ subtly in function and interpretation since they are motivated more by an attempt to model the semantics and conceptual structure of an abstract space of concepts, than by issues of data and

referral operations. This difference manifests itself in a variety of details, such as the way subsumption is defined and used, the pressure of associated structural conditions attached to a concept, and the representation of explicit relationships between roles at different levels.

The ability to assimilate new descriptions into an existing taxonomy at any level permits an evolutionary system design that achieves the same standards of rigour as a "top-down design" without requiring concepts to be defined in a predetermined order. For most applications, even if one could get the initial design carefully laid out in top-down mode, subsequent changes will require an ability to modify a system in more flexible ways.

A system's taxonomy of recognisable situations should be viewed as an evolving knowledge structure that continues to be defined and developed throughout the lifetime of a system, just as it is for human beings. In particular, conceptually-factored, taxonomic representation systems such as *KL-ONE* appear to be well suited to such applications (see reference 3). These knowledge structures can be used to perform a kind of parsing of the situation, using the patterns and schemata of the knowledge base as its 'grammar'. The way in which elements of knowledge base are accessed in this process, differs substantially from the way in which elements of a traditional databases are accessed.

Such access will require techniques that are analogous to and generalisations of tradional parsing algorithms to achieve reasonable response times. A substantial challenge lies ahead of us to combine the insights of natural language understanding and knowledge representation research, with those of database organisation and retrieval in order to develop the techniques necessary to handle large knowledge bases of rule-like formation.

6. Development Of Decision Support System For Information Retrieval

Knowledge representation languages can provide a base for an intermediate lexicon. The creation of an intermediate lexicon as a base for inputs and outputs in information referral helps in the development of intermediary system. The intermediary system will have the following features :

(a) It would accept statements made in a natural language as expression of the query by the information seeker.

(b) It would structure this statement into descriptions or key words/phrases for matching the same with system's thesaurus.

(c) It arranges descriptions in a sequence wherein the search for information is conducted efficiently and productive retrieval results are provided.

(d) It would interactively negotiate with the information retrieval system in modulating the response to a query. It would trigger interaction between user and the system.

(e) It would ask the user for terminology modulation in understanding the user's request and system's term (synonym, homonym, and other hierarchical structuring). These actions would of course be well structured by :

(i) Establishing the field of knowledge to be searched in the database (boundaries) and the comprehension of an information retrieval thesaurus.

(ii) Understanding of user's levels of expertise in the subject area concerned.

(iii) Protocols in the system to negotiate with the user on and off the search time and process.

Ranganathan speaks of classification features in this vein 'Classification is an uncovering of the thought-content of a written or expressed unit of thought. In all its minutest details it is what it should be only when the thought-content as a whole is uncovered including all the phases, facets, and foci by those faculties which apprehend all the details exhaustively, and yet in terms of entirety rather than in terms of merely parts. It is only an analytico-synthetic scheme that can uncover thought-content in such a holistic way' (ref. 1, p. 115). Thus, classification provides a kind of relational framework for knowledge-base systems.

7. Conclusion

The development of conceptual structure, classification structure, and the knowledge structure representation techniques indicate the varieties of ways in which concept modelling can proceed towards developing the basic taxonomy for information processing and modelling for use in information retrieval systems. With the hardware development for compact storage, faster retrieval and search processes are to be made efficient and effective. The software in the form of concept codes/models for knowledge representation is one of the primary ways we can develop software for utilising the large knowledge base systems for intelligent front-end usage. This has been expressed by Ranganathan aptly,'Classification can illumine the field of knowledge, it can be prophetic.' To make it fit for this new role, it must be placed on a new type of foundation and built in a new way. This calls for considerable research. Communication of thought has to depend on helpful arrangement and selection. Whatever be the psychology of the arranging and selecting process, this process is facilitated by the use of artificial counters or symbols . . . imply as much purposive abstraction as mathematical symbols or symbols of formal logic (ref. 1, p. 260).

References

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"Man's personality is dynamic. It is ever in flux. It seeks unfoldment at its own speed, in its own way, and towards its own fullness. Such unfoldment is true education."

-*SR Ranganathan* in Library Book Selection