Developing a Formal Model for Mind Maps

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Abstract. Mind map is a graphical technique, which is used to represent words, concepts, tasks or other connected items or arranged around central topic or idea. Mind maps are widely used, therefore exist plenty of software programs to create or edit them, while there is none format for the model representation, neither a standard format. This paper presents and effort to propose a formal mind map model aiming to describe the structure, content, semantics and social connections. The structure describes the basic mind map graph consisted of a node set, an edge set, a cloud set and a graphical connections set. The content includes the set of the texts and objects linked to the nodes. The social connections are the mind maps of other users, which form the neighborhood of the mind map owner in a social networking system. Finally, the mind map semantics is any true logic connection between mind map textual parts and a concept. Each of these elements of the model is formally described building the suggested mind map model. Its establishment will support the application of algorithms and methods towards their information extraction.

Keywords: mind map, knowledge organization, Web 2.0

1 Introduction

According to Buzan [1], the mind map is an expression of radiant thinking. It is used to represent graphically words, ideas, tasks, or other items linked to and arranged around a central key word or idea [2]. It is obvious that mind maps contain information, in the nodes, in the linked objects and in their structure. However, there are no formal rules on how to build a mind map, in order to express the creativity of the mind. Therefore a mind map differs from an ontology. Moreover up to today there is none standard model or at least a common file format for mind maps encoding followed by the variety of software helping the mind map development.

In order to apply information retrieval method or algorithms on mind maps, a formal model to define what exactly a mind map consists of, is necessary. Developing a formal mind map model, we propose the basic aspects of structure, content and social connections and plan the future semantics description of mind maps.

In the next section, related work about the use of mind maps in information retrieval is presented. Afterwards the basic aspects of the mind map model are presented, and finally the future directions on how we will describe the semantics of mind maps are discussed.

2 Related Work

Several ideas about the use of mind maps are currently under study. Beel,Geep and Stiller [3] explore whether data extracted from mind maps could be used to enhance information retrieval, denoting that the structure of mind map embeds a kind of semantic connections. Also a mind map can be used to define relations between documents linked in a mind map [4]. According to the researchers this process is similar to analyzing emails or other linked documents [5].

Furthermore, mind maps as a visualization tool can be used to enhance expert search document summarization, keyword based search engines, document recommender systems and determining word relatedness [3, 6]. Finally recently, mind maps have been used to model XML DTD's, XML schemas and XML documents [7].

3 The Mind Map Features

Definition: A mind map MM is a pair MM=<S,C>, where S is the structure and C is the content.

3.1 Structure

Definition 3.1.1: The structure S of a mind map is a 4-tupe S=<N,E,C,GC> where N are the nodes, E the Edges, C the clouds and GC the graphical connectors.

Definition 3.1.2: Each N_i belonging to the set of nodes N is a 5-tuple N=<T, nID, R, Frm>, where T is the node name, nID is the node ID, R are the resources, and Frm is a 7-tuple of numbers (denoting formatting values), Frm=<x_1,x_2,x_3,x_4,x_5,x_6,x_7> where x_i are the program defined values for each formatting values.

A node besides text can contain an image, an URI and LaTeX code. In the case of URI the node is a terminal node of the graph.

Definition 3.1.3: A resource R on a mind map is any text, image, URI, LaTeX and attribute value added on the mind map nodes. As mentioned, in case the resource is an URI then the node is terminal.

Definition 3.1.4: The attributes A is a pair, A=(a_i,b_i)$\subseteq$R, where a_i,b_i are user defined attribute-value pairs.

In some mind map software LaTeX is supported as content of the nodes. The tuple of an attribute can be used to add metadata or tags to a node. The metadata element can be assigned to a_i and the value to b_i.

Definition 3.1.5: The set of edges of a mind map E, is the 5-tuple E_i=<nID_i, nID_j, FmtCd, hid, EL>. nID_i, nID_j are the connected nodes IDs, FrmCd is the edge format

code, hid is a boolean parameter of hidden and EL is a relational operator value "is a" or "<>" different.

Generally the mind map's edges denote an undefined relation between two nodes. EL describes the option some software provides to assign a relational operator value to edges.

Definition 3.1.6: Each cloud Cl_i is member of the set of clouds Cl, and is defined as a connected subgraph of a mind map.

Definition 3.1.7: The Graphical Connectors set GC, is defined as a triple, $GC_i=<nID_i,nID_j,V>$, where nID_i, nID_j are the id's of the connected nodes and V a set of tags tagging a connector.

A graphical connector is a connection between two nodes, which belong to different subgraphs of the mind map. The graphical connectors do not imply a hierarchy between nodes and can be directed.

3.2 Content

The content C of a mind map is considered as a set of resources, which could be text, images, sound, video, hyperlink, spreadsheet, date and binary file. The content is attached to each node of a mind map. In some mind map software LaTeX is supported as content of the nodes.

Definition 3.2.1: Content C of a mind map MM is the set of all the resources R on the map.

3.3 Semantics

As a way of expressing radiant thinking, mind maps contain concepts connected in many undefined ways. In a formal model as described above, semantics can be defined between the concepts in the textual parts of mind map.

Definition 3.3.1: Semantics on a mind map is a function f: $K \rightarrow c$, where K is the powerset of the textual sets of the mind map and c is a concept.

The semantics of a mind map is an issue for further study, aiming to represent explicitly the knowledge (of a domain or a workflow) that a mind map carries. For this purpose the semantics of higher order logics will be studied and exploited in the proposed model. Figure 1 presents a mind map that concludes the concepts of the proposed model.

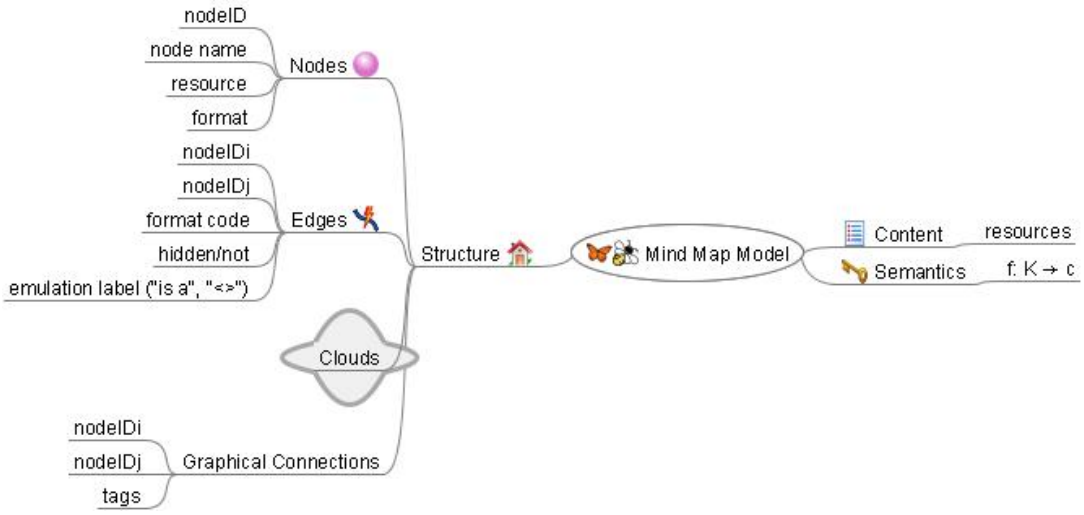

Fig. 1. The Mind Maps Features

4 Social Connections

According to the bibliography, mind maps can be used by social networking applications, to depict user interests, profiles and reflecting attitudes in performing tasks and workflows. Therefore there is the need for the definition of features that might affect the structural and content characteristics of a specific mind map, as well as its creation process.

In a mind map library a user can share his mind maps with other users, tag and organize them. Therefore, a user develops a folksonomy to tag his mind maps. This folksonomy might overlap with other users' folksonomies, reflecting their common interests.

Definition 4.1.1: User mind maps MM_u is the collection of the mind maps of user u.

Definition 4.1.2: User folksonomy Flk is the set of tags, $Flk_u=\{tag_1,tag_2,\ldots,tag_n\}$, the user tagged all the mind maps of his collection.

Definition 4.1.3: Mind map tags MM_{tags} is the set of tags, $MM_{tags}=\{tag_1,tag_2,\ldots,tag_n\}$, where $(tag,tag_i)\in A$ for i = 1,2,…,n, are the tags the users tagged the mind map nodes.

Definition 4.1.4: User's friends mind maps is the set $MM_{UF}=\{MM_1,MM_2,\ldots,MM_n\}$, where MM_i, i=1,2,…,n, are the mind maps of user's friends.

Definition 4.1.5: User's F_1 folksonomy expansion F_{1e} through the folksonomy of user F_2 is the set F_2-($F_1 \cap F_2$).

Definition 4.1.6: A user's U_1 recommended friends RU_u is the set of users $RU_U=\{U_1,U_2,\ldots,U_n\}$, where U_i, i=1,2,…,n, are the users with at least one similar mind map with the user U_1.

Definition 4.1.7: A user U_1, with folksonomy F_1, is a common friend to user U_2, with folksonomy F_2, if a user U, exists with folksonomy F_u, where $(F_1-(F_1 \cap F_U)) \cap (F_2-(F_2 \cap F_U)) \neq \varnothing$.

The crucial concept for the complete definition of the social features of a mind map and in particular the definition of the concept "recommended friend" is that of "mind map similarity". Even though the concepts "friend" and "common friend" denote the observed overlap between the folksonomies of two users, the similarity between two mind maps is a more general concept that incorporates the structural similarity of them as well as the semantic similarity of their content.

5 Conclusions and Further Research

Mind maps are becoming a popular tool for the representation of user interests, customs and tasks and therefore it is considered a suitable tool for defining user models. Hence, the proposed model aims to reveal and define the main characteristics of the mind map. The issue on which we will focus in the future is the integration of the mentioned features so that to derive a model for measuring the similarity between two mind maps. As mentioned, the first step for this direction is the study of the semantics of a specific mind map and how they could be compared with the semantics of a mind map collection.

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