Developing a Formal Model for Mind Map Representation

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Mind Maps

- "The mind map is an expression of radiant thinking and is therefore a natural function of the human mind. It is a powerful graphic technique which provides a universal key to unlocking the potential of the brain. The Mind map can be applied to every aspect of life where improved leaning and clearer thinking will enhance human performance" (Buzan, 1996).

Essential Characteristics

- the Mind Map has four characteristics (Buzan, 1993):
  - The subject of attention is crystallized in a central image.
  - The main themes of the subject radiate from the central image as branches.
  - Branches comprise a key image or key word printed on an associated line. Topics of lesser importance are also represented as branches attached to higher level branches.
  - The branches form a connected nodal structure.

Related Work

- "…similar to analyzing emails or other documents authored by a user, each node in a mind map may be taken as a description of the user's skills or interests…" (Beel, 2010).
- *"…How can data retrieved from mind maps be used to enhance search applications?" (Beel, 2010).*
- "Two documents are related if they are both linked by a mind map" (Beel & Gipp, 2010).

Related Work

- “Mind maps could be used to enhance expert search, document summarization, keyword based search engines, document recommender systems and determining word relatedness” (Beel, Gipp & Stiller, 2009).
- “Use mindmaps to succesfully model, design, modify, import and export XML DTDs, XML schemas and XML dooc, getting very manageable, easily comprehensible, folding diagrams “(Dalamagas, Farmakakis, Maragkakis & Hatzigeorgiou, 2010).

Mind Map Model

A 4-tuple MM = < S, C, SC, SM >

where:

- S: structure
- C: content
- SC: social connections
- SM: semantics

Structure

A 4-tuple S = <N, E, C, GC>

where:

- N: nodes (set of N_i)
- E: edges (set of E_i)
- C: clouds (set of C_i)
- GC: graphical connector (set of GC_i)

Node

A 5-tuple N = <T, nID, Nt, A, Frm>, where:

- T: node text
- nID: node ID (e.g. ID_1986153009)
- Nt: text content of the node (text or LaTeX)
- A: attributes, where
  - A = (a_j,b_j), where a_j, b_j user defined content
- Frm: 7-tuple of numbers (denote formatting values), where:
  - Frm = $<x_1,x_2,x_3,x_4,x_5,x_6,x_7>$

Edges

- The edges of the mind map are a set m edges which connect the nodes, E = {E_i}, i=1,2,…,m, where:
  - edge E_i = <$nodeID_i$, $nodeID_j$, FmtCd, hid, EL> where:
    - nodeIDi, nodeIDj: the connected node ID's
    - FrmCd: the edge format code
    - hid: boolean parameter of hidden
    - EL: relational operator value "is a" or "<>"

Clouds

- The clouds of the mind map are a graphical way to group m nodes and n edges of a subgraph,
  $Cl = \{N_1, N_2, \ldots, N_m, E_1, E_2, \ldots, E_n\}$, where:
  - $N_1, N_2, \ldots, N_m$: the m nodes
  - $E_1, E_2, \ldots, E_n$: the n edges

Graphical Connectors

- The Graphical Connectors is a set of graphical connectors, $GC = \{GC_i\}$
- A graphical connector GC_i is a graphical connection between two nodes, beyond the basic mind map structure,
  $GC_i = <nodeID_i, nodeID_j, T>$, where:
  - $nodeID_i$, $nodeID_j$: the connected tag ID's
  - T: a set of tags $T = \{tag_i\}$ tagging a connector

Content

- The content C of the mind map MM is a set of resources R_i, $C = \{R_i\}$.
- A resource R_i is a 4-tuple,
  R_i = <nodeID, label, URI, type>, where
  - nodeID: the node ID
  - label: the resource filename or the resource the same is the node text
  - URI: Uniform resource identifier
  - type: the type of the resource (text, photo, URL)

Content

- Node Tag Cloud $NTC_i=\{tag_1,tag_2,\ldots tag_n\}$ for node i, where $tag_i=b_j$ if $a_j=tag$, $(a_j,b_i) \in A$.
- Neighbor Nodes is a set $NB_i=\{nodeID_1, nodeID_2,\ldots,nodeID_n\}$, where $nodeID_i$ are all the nodes connected through an edge.
- Format Classes is a set of nodes $FCN_i=\{nodeID_1,nodeID=,\ldots ,nodeID_n\}$, where each $node_i$ has the same format.
- Icon Class is a set $IC_i=\{nodeID_1,nodeID_2,\ldots,nodeID_n\}$, where each node has the same icon.

Semantics

- Semantics on a mind map is a function f: K ⟶ c, where
  - K is the powerset P(NTC∩GCTC∩Flk∩T)
  - c is a concept

Social Connections – Web 2.0 (1/3)

Mind maps connections in a social network:

- User mind maps MM_u is the set of the user mind maps $MM_u = \{MM_i\}$.
- User folksonomy Flk is the set of the user's mind map tags, $Flk_u = \{tag_1, tag_2, \ldots, tag_n\}$, where $tag_i \in A$ for $i = 1,2,\ldots,n$.
- Mind map tags MM_{tags} is the set of user tags on a mind map, $MM_{tags} = \{tag_1, tag_2, \ldots, tag_n\}$, where $tag_i \in A$ for $i = 1,2,\ldots,n$.

Social Connections – Web 2.0 (2/3)

- User's friends mind maps is the set $MM_{UF} = \{MM_1, MM_2, \ldots, MM_n\}$ where MM_i , $i=1,2,\ldots,n$, are the user's friend's mind maps.
- User's F_1 folksonomy expansion F_{1e} through the folksonomy of user F_2 is the set $F_2-(F_1 \cap F_2)$.

Social Connections – Web 2.0 (3/3)

- User's recommended friends is the set $R_U = \{U_1, U_2, \ldots, U_n\}$, where U_i, i=1,2,…,n, are the users with at least one similar mind map with the user.
- User U_1, with folksonomy F_1, is a common friend to user U_2 ,with folksonomy F_2, if there exists a user U, with folksonomy F_u, if $(F_1-(F_1 \cap F_U)) \cap (F_2-(F_2 \cap F_U)) \neq \varnothing$

Mind Map Model