


# **A Method For Enterprise Knowledge Map Construction Based On Social Classification**



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# Background

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- .. Many organizations accumulate knowledge along with their business progresses.
- .. While organizations learn and create knowledge
  - ✘ They do not remember the acquired knowledge
  - ✘ Or lose track of it

*(Argote et al., 1990; Darr et al., 1995)*
- .. Enterprises possess a large number of knowledge resources involving complicated structures
- .. The employees have to spend so much time and effort on knowledge searching and selection

# Knowledge map

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- .. Knowledge map is an effective knowledge management tool.

*(Davenport, Prusak, 1998; Mertens et al., 2003; Vail, 1999; ).*

- .. Generally, a knowledge map is the display of acquired knowledge and relationships *(Davenport,*

*Prusak, 1998; Vail, 1999).*

- .. Essentially, the knowledge mapping process is *the process of knowledge organization and classification.*

# Knowledge map

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- .. The knowledge in knowledge map may involve ***various shared contents***, such as text, graphics, videos, models and data.
- .. The relationships among them are determined by ***linking concepts or topics*** discovered from these shared contents.
- .. Knowledge mapping is defined as the process of associating items of information or knowledge in such a way that ***the mapping itself also creates additional knowledge.***

(Vail, 1999)

# Knowledge map

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- .. Building directories
  - n YAHOO! Directory
  - n Open Directory Project
  
- .. The interface of directory becomes increasingly difficult for users to navigate as the hierarchy grows larger  
*(Drabenstott, Weller, 1996; Massicotte, 1988)*

# Knowledge map

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- .. Manually Drawing Knowledge Maps
  - ✘ Concept Maps (*Novak, Gowin, 1984; Chang, 2002*)
  - ✘ Topic Maps (*Pepper, 2002*)
- .. However, the manually creation process requires highly creator's cognitive skills and significant time and effort.

# Knowledge map

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- Automatic Knowledge Classification / Clustering
  - n VSM (Vector Space Model)
  - n Self-Organizing Map (SOM)
- It's difficult to give a *sound explanation* of the result and to control the quality of the process.
- The classification scheme should be *systematic, logic and reliable*.

# Knowledge map

- Knowledge map should serve as a *navigation of the required knowledge*, as is almost forgotten by most designer when they are designing knowledge maps.



# Social Classification

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## .. Tagging

- ✧ It allows users to *publicly add keywords* to the shared contents, as is totally different from the traditionally categorizing performed by an authority or authors.
- ✧ Keywords tagging is nothing new; the interesting thing is that when persons tag in a public space, the collection of their keyword/value associations *becomes a useful source of data in the aggregate* (Gruber 2005).

# Social Classification

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- For instance, ambiguity can emerge as users apply the same tag in different ways, while the lack of synonym control can lead to different tags being used for the same concept, precluding collocation (*Mathes, 2004*).

# Social Classification

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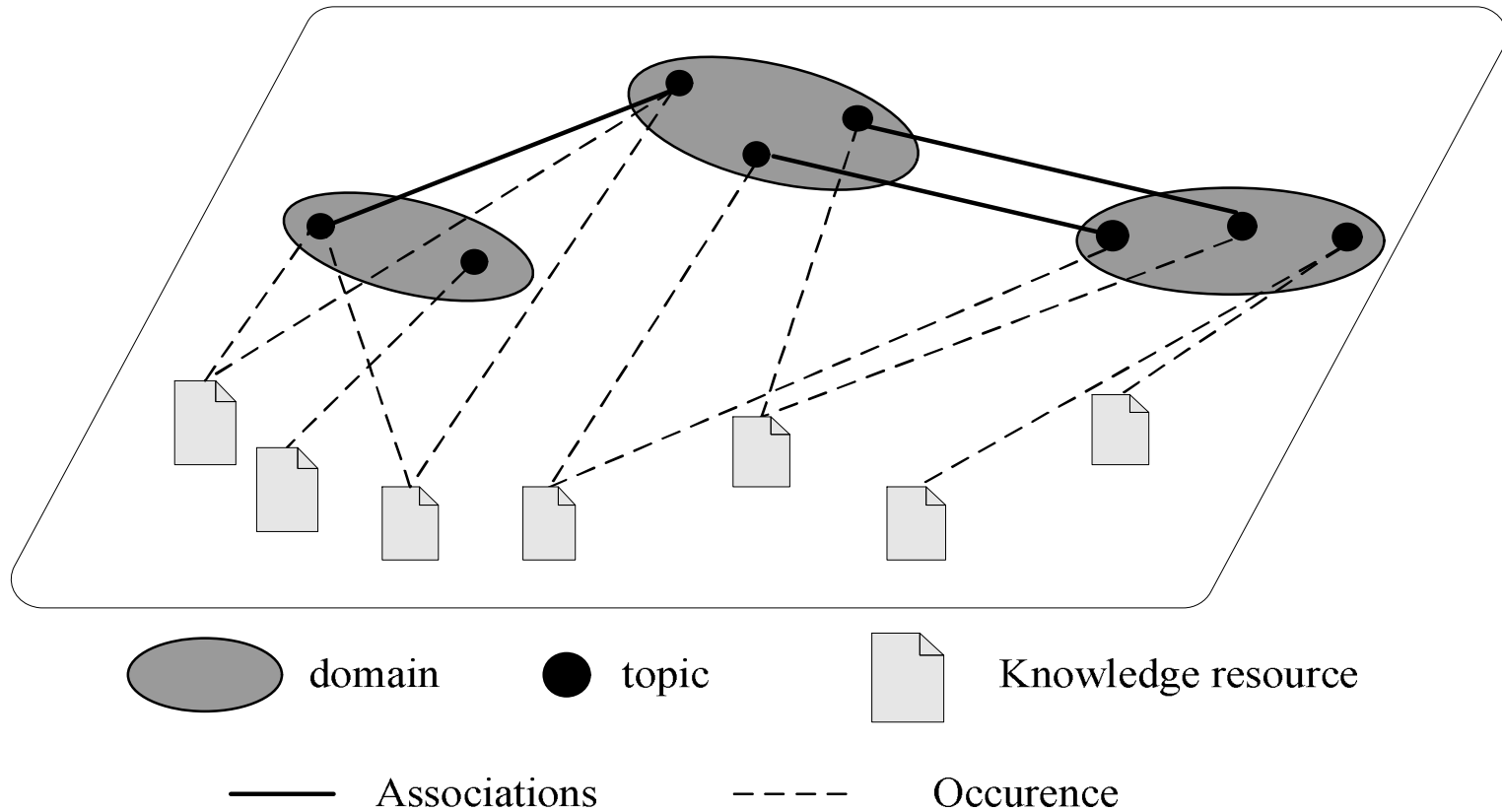
- Social classification would be a fruitful way when it is applied in the knowledge organization.
  - ⌘ For the employees, especially those *who work in the same or similar domain*, share common business goals and have relatively similar business background, the problem in uncontrolled vocabulary will be solved to some extent.
  - ⌘ Social classification generated by employees will facilitate workplace democracy and *the distribution of knowledge organization tasks among people who actually use them*, which will reflect the real situation of knowledge understanding and using by users.

# Social Classification

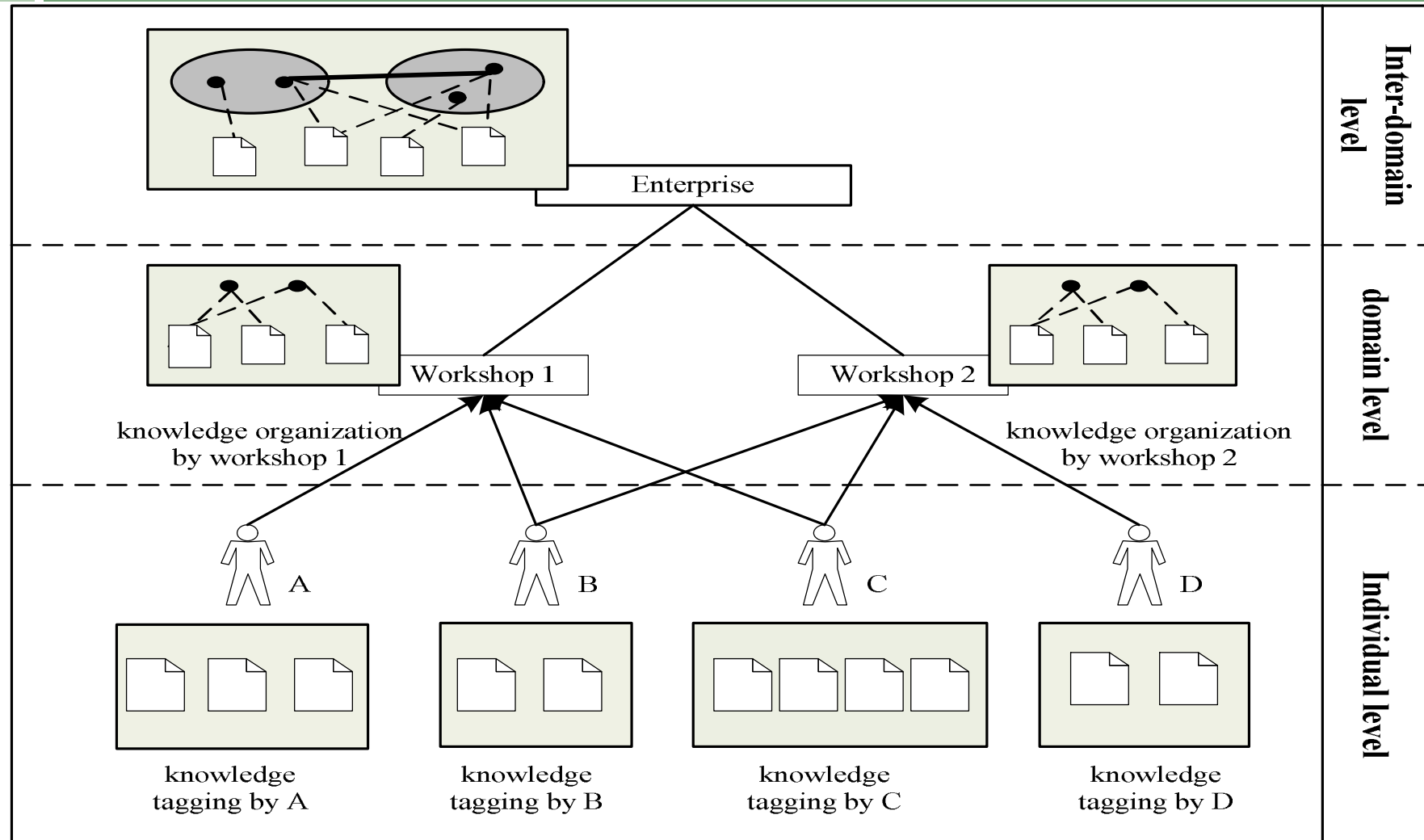
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- ✘ Social classification is embedded in the worker's business processes, and could minimize the cognitive load for KM tasks.
- ✘ Social classification is most helpful for an enterprise when there is nobody in the “librarian” role or there are too many unordered contents for few authorities to classify.
- ✘ Social classification can provide insights into an individual's expertise and facilitate learning from others.

# Knowledge map structure



# Knowledge Map Construction



# Individual knowledge tagging

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- .. Individual tagging is a process for an employee *to organize the knowledge of interest and form a personal knowledge map*, which records every user's ideas about knowledge classification and his knowledge usage manners.
- .. When individuals refer to some documents, which are helpful or important to his work, they will tag them.

# Individual knowledge tagging

- we define the tagging to be a three-place relation  $Tagging (tagger, object, label)$

$$Tagging = \{tg_1, tg_2, \dots, tg_k, \dots, tg_s\}$$

- Let  $S_k$  be the set of tagging records,

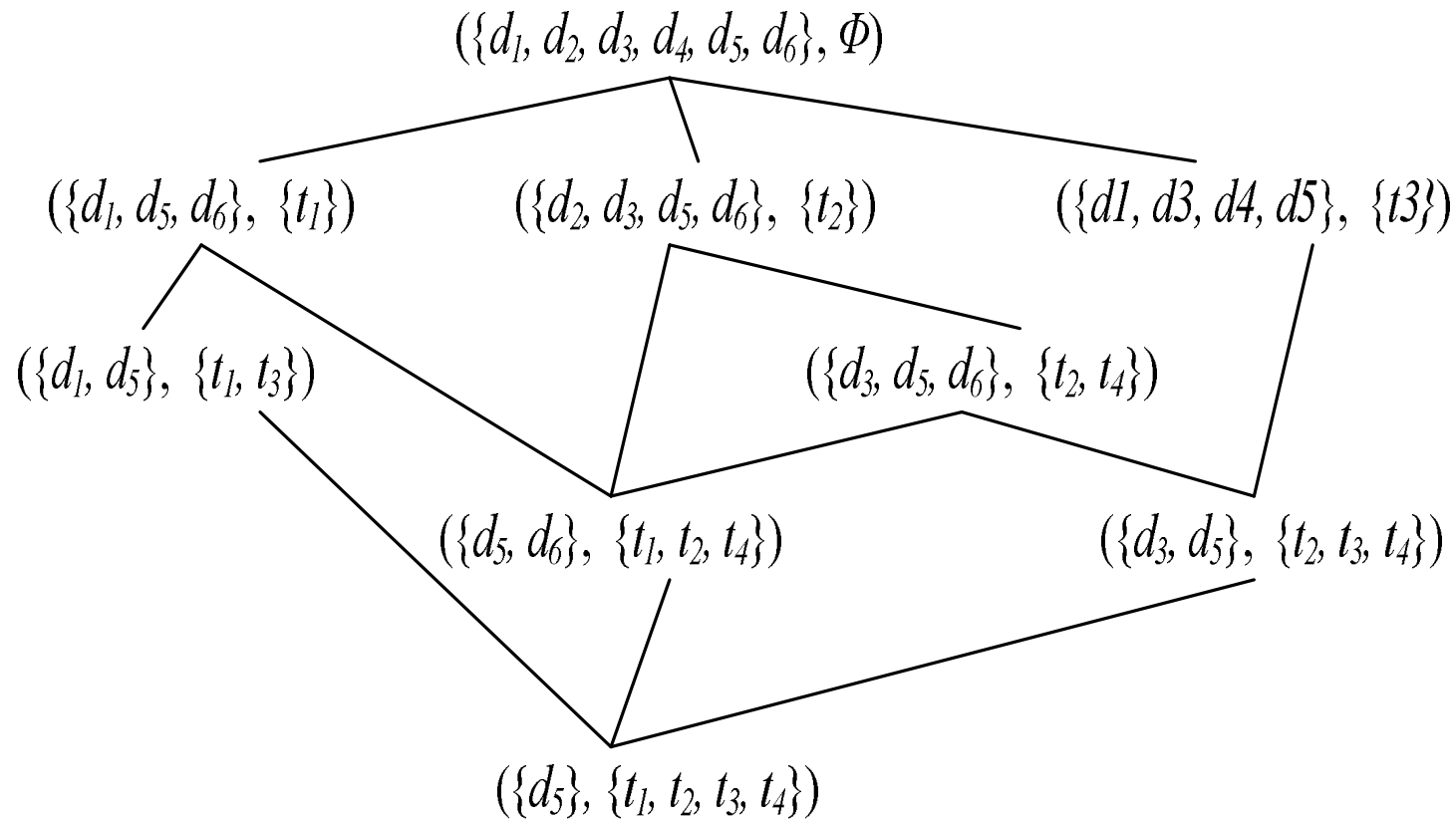
$$s_k = (p_l, d_i, t_j) \quad tg_k (k = 1, 2, \dots, s)$$

where  $p_l (l = 1, 2, \dots, h)$ ,  $d_i (i = 1, 2, \dots, m)$ ,  $t_j (j = 1, 2, \dots, n)$  is a piece of tagging record.  $p_l$ ,  $d_i$ ,  $t_j$  respectively denotes an individual employee, a knowledge item and a tag.

# A knowledge-tag matrix of an individual employee

	$t_1$	$t_2$	$t_3$	$t_4$
$d_1$	1	0	1	0
$d_2$	0	1	0	0
$d_3$	0	1	1	1
$d_4$	0	0	1	0
$d_5$	1	1	1	1
$d_6$	1	1	0	1

# An individual knowledge map



# Table 1

## All tagging records of a domain

	$d_1$	$d_2$	$d_3$	$d_4$	$d_5$	$d_6$	$d_7$	$d_8$	$d_9$
$p_1$	$t_1, t_3$	$t_2$	$t_2, t_3, t_4$	$t_3$	$t_1, t_2, t_3, t_4$	$t_1, t_2, t_4$			
$p_2$	$t_1$	$t_1, t_3$	$t_2, t_3$			$t_4$	$t_1, t_4$		$t_4, t_5$
$p_3$	$t_1, t_3$	$t_1, t_2, t_5$		$t_3$	$t_1, t_2, t_5$			$t_2, t_5$	$t_5$
$p_4$	$t_2, t_3$	$t_2, t_3$	$t_2$	$t_3$	$t_2$		$t_4$		$t_5$
$p_5$	$t_1, t_3$				$t_1, t_2$				

# Domain topic selection

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- .. A domain provides a context where knowledge items and their relationship are displayed.
- .. A domain has its specific structure of knowledge which is divided into categories.
- .. As a specific task is going on in a domain, the tag space will consist of many unique terms, words or phrases that are tagged on these documents involved in this process.

# Domain topic selection

- Assume that the set of categories made by domain expert is

$$C = \{c_1, c_2, \dots, c_m\}$$

- The domain topic is selected through analyzing domain members' tagging data and calculating the information gain of each tag. (Yang, Y. and Pedersen, J.O. 1997)

$$\begin{aligned} IG(t) = & - \sum_{i=1}^m P(c_i) \log P(c_i) \\ & + P(t) \sum_{i=1}^m P(c_i / t) \log P(c_i / t) \\ & + P(\bar{t}) \sum_{i=1}^m P(c_i / \bar{t}) \log P(c_i / \bar{t}) \end{aligned}$$

# Table 3 knowledge-tag matrix of domain A

	$t_1$	$t_2$	$t_3$	$t_4$	$t_5$
$d_1$	4	1	4	0	0
$d_2$	2	3	2	0	1
$d_3$	0	3	2	1	0
$d_4$	0	0	3	0	0
$d_5$	3	4	1	1	1
$d_6$	1	1	0	2	0
$d_7$	1	0	0	2	0
$d_8$	0	1	0	0	1
$d_9$	0	0	0	1	3

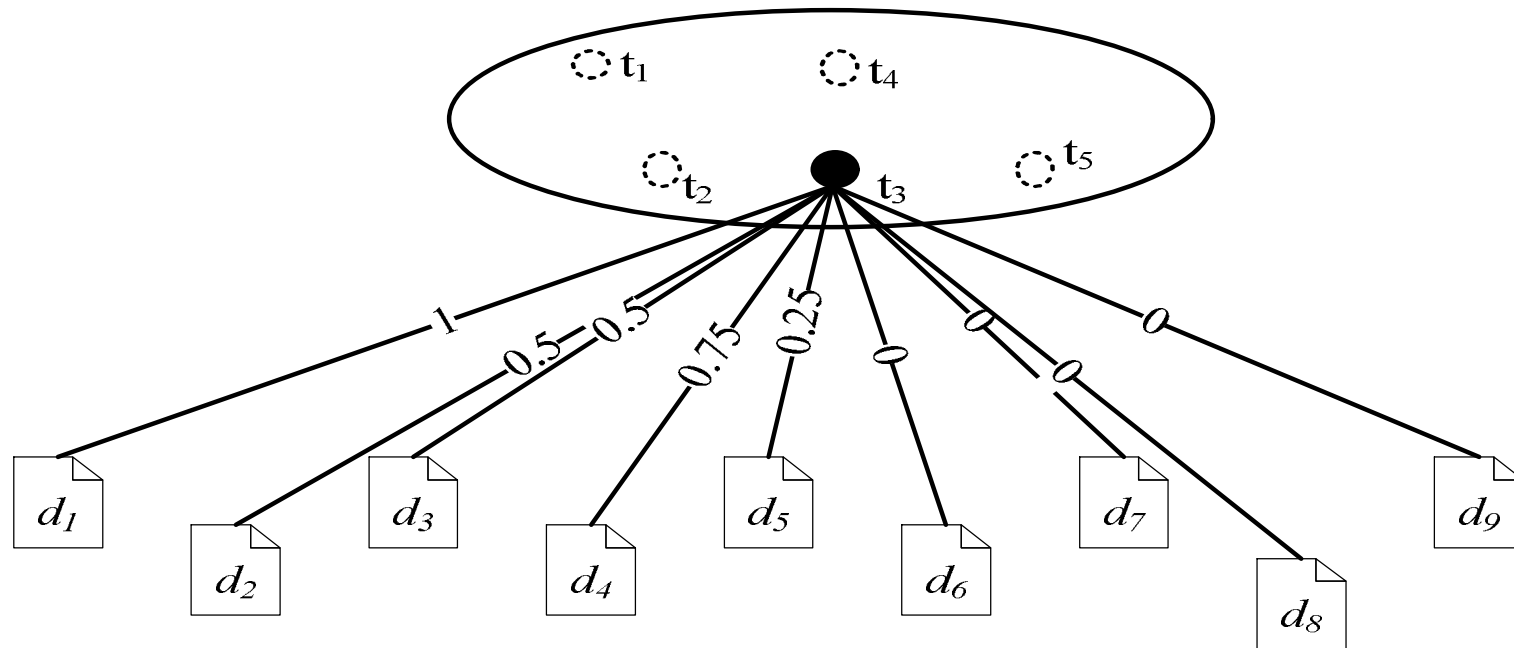
- Let  $B = \{b_{ij}\}$  be the matrix, where  $b_{ij} = \begin{cases} u & \text{if } d_i \text{ is labelled with } t_j \\ 0 & \text{else} \end{cases}$
- define  $\text{Support}_j$  to measure the support of tag  $t_j$  from all knowledge items,  $\text{Support}_j = \{s_{1j}, \mathbf{L}, s_{ij}, \mathbf{L}, s_{mj}\}$ ,

where

$$s_{ij} = \frac{b_{ij}}{\max_{i=1}^m b_{ij}}$$

- the support of tag  $t_3$  is  $\text{Support}_3 = \{1, 0.5, 0.5, 0.75, 0.25, 0, 0, 0, 0\}$

# A domain knowledge map



# Inter-domain topic association analysis

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- .. It is a process to construct the enterprise knowledge map.
- .. In order to facilitate knowledge reuse among the organization scope, it is necessary to *relate the topics of different domains by similarity*, which is the process of the enterprise-wide knowledge map construction.

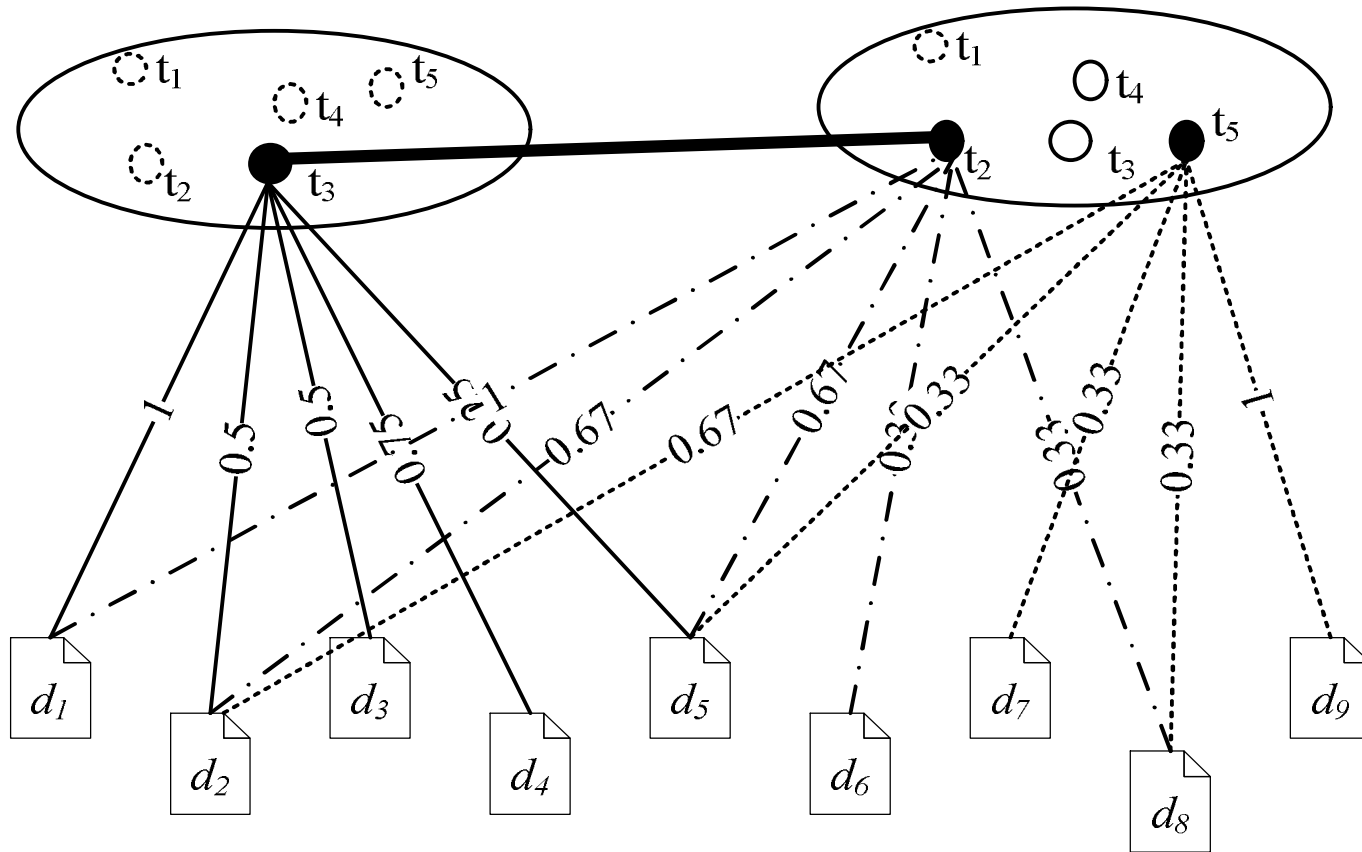
- Topic is represented in vectors  $topic_x = \{w_{1x}, w_{2x}, \dots, w_{mx}\}$ , Where  $w_{ix}$  each is a weight for document  $d_i$  for topic  $x$  and

$$w_{ix} = s_{ix} \quad (i = 1, 2, \dots, m)$$

- Similarity of two topics in different domain equals to cosine of the angle between them

$$sim(topic_x, topic_y) = \cos(\mathbf{q}) = \frac{topic_x \cdot topic_y}{|topic_x| |topic_y|} = \frac{\sum_i w_{ix} \times w_{iy}}{\sqrt{\sum_i w_{ix}^2} \sqrt{\sum_i w_{iy}^2}}$$

# Inter-domain topic association



# Implementation of a knowledge map system

- When a user tags a document in the repository, the tagging action will be stored as a record and the tag will be saved as an attribute.
- We design a virtual collaboration environment, work center, to manage the knowledge in a domain, which is a platform where members can share opinions about knowledge classification application.
  - ⌘ Every member's tagging data will be collected and analyzed, and a recommendation based on collaborative tagging will be given.
  - ⌘ An expert in this domain draws the domain knowledge map according to his expertise and experiences.


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# Conclusion

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- .. Unlike other methods for knowledge map construction, the proposed method develops the enterprise knowledge map as a multi-level system including knowledge tagging on individual level, topic selection on the domain level and topic association on the inter-domain level.
- .. Our method proposes that the knowledge structure in a business domain can be analyzed and integrated from individual knowledge tagging.

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# Thank you for your attention.

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.. Q & A?