

# Visualising Social Bookmarks

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## Abstract

Social bookmarking tools are very popular nowadays. In most tools, users tag the bookmarks to describe them. Therefore, it is often hard for users to discover implicit structures between tags, users and bookmarks. We think that this is essential for both end users to discover new bookmarks that could be of interest to them, and for researchers who want to study how people use social information retrieval tools. In this work, a cluster map visualisation technique is customized to enable users to explore social bookmarks in the del.icio.us and the CALIBRATE system. The design of our visualisation aims to automatically identify tag and community structures, and visualises these structures in order to increase the users awareness of them.

## 1 Introduction

The ability to store or bookmark web pages by describing them by tags or terms, has been one of the most important features of browsers since the beginning of the Web [Hammond et al., 2005]. Social bookmarking tools became possible when the process of keeping bookmarks migrated from the browser to the Web.

Tagging is the process of assigning meaning to online items, such as web pages, images, videos, etc. by labelling them with personalised keywords that are shared among users [Guy and Tonkin, 2006]. The purpose of web-based social bookmarking tools is to tag the content of other users, mainly for the benefit of the tagger, although the bookmarks and tags are generally

public, and users can establish networking opportunities [Hammond et al., 2005].

Social networks are an important factor for finding and spreading information because a big part of learning is social [Wenger, 1996]. For example, talking with your neighbour about how to build a garden house, may provide new insights about this process. Wenger introduced the idea of the “community of practice” which means that people can satisfy their need for information more efficiently if they are embedded in a community with similar interests and problems [Wenger, 1998]. “Weak ties” are relationships between people that don’t know each other very well. These weak ties are important to allow information to spread from one closely-knit community to another [Granovetter, 1983].

Implicit relationships between users, tags and content are therefore very useful in Web2.0-style social information retrieval systems. However, those relationships are not always clear in the traditional ways of accessing social bookmarks. Our research therefore focusses on using information visualisation techniques

- that enable insight to analysts in those implicit relationships, and
- that may offer end users new ways to find content and information that could be of interest to them but that would not have been found through explicit searches.

We will start this paper in section 2 with an overview of existing social bookmark tools and the traditional ways of accessing the information within those systems. Section 3 looks at the data of two existing social bookmarking systems in more detail. A number of requirements for opening the view on social bookmark spaces, are discussed in section 4. Section 5 elaborates on a prototype application with a cluster map visualisation for exploring social bookmarks. This prototype has been used to explain some typical usage scenarios in section 6. Implementation notes are presented in section 7. Section 8 discusses the prototype and presents evaluations of the methodologies. We conclude this work in section 9.

## 2 Social Bookmark Tools

There are quite a few social bookmarking initiatives, like CiteULike [CiteULike, 2008]), Connotea [Connotea, 2008]), del.icio.us [delicious, 2008]),

Furl [Furl, 2008]), BlogMarks [BlogMarks, 2008]), etc. A thorough general review can be found in (Hammond et al., 2005). A number of ways are usually available for browsing personal bookmarks:

1. First of all, one can browse through scrollable pages of bookmarks.
2. Secondly, one can perform a “tag query” of the collection by clicking on a tag [Millen et al., 2007].
3. Exploratory search activities are also often supported in social bookmark applications. Some examples are browsing bookmarks by time or by popularity like on del.icio.us.

Tagging is an unstructured bottom-up approach of classifying content, in contrast to a top-down structured approach based on taxonomies, thesauri or ontologies [Weinberger, 2007]. The semantic structures that result from a tagging approach are often referred to as a folksonomy. Tags generally produce a flat namespace, rather than the hierarchical structures that taxonomies or other formal classification systems provide [Hammond et al., 2005]. However, there can also be rich implicit structures between tags, bookmarks and users that are not immediately clear. For instance, there is a clear relationship between two separate tags that have been used to classify the same bookmarks. Two users that use exactly the same tags for different bookmarks is another example. This means that they are interested in the same topics, and therefore they might be interested in the bookmarks of the other.

On top of that, some researchers claim that social bookmarking applications become harder to navigate as the amount of tags increases and they thus become less meaningful [Chi and Mytkowicz, 2007]. The reason for their claim is that e.g. del.icio.us is moving closer and closer to the proverbial “needle in a haystack” where any single tag references too many documents to be considered useful.

An important goal of our research is thus to provide understanding in bookmarks, tags, users and the relationships between them. In related work, “tag clouds” are often used to visualise the tag structures of one or more users. Tag Clouds are visual presentations of a set of words, typically a set of tags, in which attributes of the text such as text, weight or color can be used to represent features (e.g. frequency) of the associated terms [Halvey and Keane, 2007]. When a user clicks on a tag, the user obtains an

ordered list of tag-described resources, as well a list of related tags [Hassan-Montero and Herrero-Solana, 2006]. Usually, the tags are displayed in alphabetical order.

Many other visualisation tools of tag, bookmark and network structures were created for del.icio.us and others. Notable such tools include HubLog [HubLog, 2008]) that enables graphical browsing of del.icio.us tags in a mind mapping way. Extisp.icio.us Text [Extisp.icio.us, 2008]) provides a random textual scattering of user tags, sized according to the number of times that they have been used. Revealicious [Revealicious, 2008]) is a set of 2D graphic visualisation techniques that enables the user to browse, search and select tags and bookmarks. Vizster [Heer and Boyd, 2005]) is a tool that is designed for visualising the online social network Friendster, as a browseable network of social relations. Vizster is very useful for sociological research but does not take tag structures into account.

All these initiatives are based on visualising the tag structures or the community structures but they do not take both structures into account for the visualisation at the same time, to make implicit community and tag structures more apparent, e.g. for analysts that are studying folksonomies. The remainder of this paper investigates how to use information visualisation techniques in such ways to make those structures more apparent and to make bookmarks accessible.

Two social bookmark tools were chosen as the basis of our visualisation design: del.icio.us and the CALIBRATE portal. These tools are described in the next section, together with the rationale for choosing them.

### 3 Information Characteristics

#### 3.1 del.icio.us

Del.icio.us [delicious, 2008] is probably the most well-known social bookmarking tool, designed to store and share bookmarks on the web instead of saving them in the browser. We chose del.icio.us as a source of data as it is highly popular with many users, lots of data and with a very easy API to access this data. Those characteristics makes del.icio.us a very good reference point: if the visualisation techniques prove to be effective and efficient for exploring del.icio.us, they might be valuable for other social bookmark tools as well.

A number of steps are involved in the process of collecting del.icio.us data:

1. We start from one or more del.icio.us user names and collect their bookmarks, and the tags of those users that describe those bookmarks.
2. Del.icio.us enables users to create a network of other users, so that they can access the bookmarks of these users. In the second step, we collect the tags and bookmarks for all the users that are in the network of the users identified in step 1.
3. Del.icio.us also enables users to be a fan of other users. User A “is a fan of” user B if user A has added user B to his network. This relation is not necessarily bi-directional. In this third step, the same data is again collected for all the fans of the chosen user(s) in step 1.

This process of collecting data takes place at runtime but can also be performed beforehand. However, the del.icio.us API does have some limits:

- Only those bookmarks, tags and users in the network can be used that are explicitly made public by the user that added them.
- The del.icio.us API does not allow to submit a web page and query and retrieve information on the users that tagged that particular web page. If this would be allowed, we could for instance take a number of random webpages, ask which users tagged them, and afterwards visualise the implicit social structures that possibly exist between those users. What can be retrieved for specific web pages is the number of users that tagged the web page and added it to their collection. We could use this number to visualise the popularity of a web page if we consider a higher number as more popular.
- The usage throttling and abuse monitoring software at the del.icio.us website limits the amount of queries that can be performed in order to prevent the harvesting of all the data of del.icio.us [del.icio.us, 2008]. On top of that, a maximum of a hundred bookmarks per user can be retrieved in one query.

Summarised, the available information characteristics on bookmarks are:

- the URL, e.g “www.google.com”,
- tags that describe the web page, e.g “search, search engine, web”,

- title of the bookmark, e.g. “Google search engine”, and
- number of users that tagged the bookmarks, e.g “saved by 22974 people”.

The characteristics of a particular user are:

- the del.icio.us username, e.g “jkofmsk”
- the users in his network, and
- fans of the given user.

### 3.2 CALIBRATE portal

Applying social tagging and bookmarking to an educational setting, CALIBRATE users are teachers who create a social bookmark and add tags on learning material, for their own use and to share them with their students or other teachers. This work is done in the context of the CALIBRATE project [CALIBRATE, 2008], which makes K-12 digital learning resources available to 78 schools in Hungary, Austria, Estonia, Czech Republic, Lithuania and Poland in different curriculum areas. Schools can access material in different languages through a portal that is connected to a federation of learning resource repositories (GLOBE) [Globe, 2008] in the pilot countries. Within this portal, a personal bookmarking and tagging tool has been available to all users since the beginning of 2007. The data of these users, their tags and their bookmarked learning resources are taken into account for our visualisation where it is used to visualise the implicit structures between users, tags and learning resources.

Learning material is described by Learning Object Metadata (IEEE LOM [IEEE, 2002]). A goal of LOM is to enable sharing of descriptions of learning resources between resource discovery systems, which should lead to a reduction in the cost of providing services based on high quality resource descriptions [Duval and Hodgins, 2003]. The availability of LOM works to our advantage because it contains more metadata than the available metadata in traditional social bookmark systems like del.icio.us. This metadata can be taken into account while visualising them to further enable insight in the collection. Compared to the features that were available in del.icio.us, we use the following extra elements that describe the resources and are important in the exploration process:

- authors; e.g. while searching for material on the semantic web, a learner might prefer material created by Tim Berners-Lee, rather than an unknown author.
- language; e.g material in Spanish is not interesting for non-Spanish speaking learners.
- unique identifier; e.g. important for actually retrieving the material if it is interesting.
- creation date; e.g. material might be out-of-date and therefore less interesting than newer created material.

On top of this, we have access to information about the users in CALIBRATE, like the languages they speak and their country of residence. This information will for instance be used to filter out material that cannot be understood by the user.

The information from CALIBRATE and del.icio.us is summarised in Table 1. The data itself for this analysis came from a period of ten months, January 1 to October 31 2007 and includes real data. There were 142 teachers, hereafter referred as users, who made 1022 posts of favourite learning resources. These bookmarks covered 682 different learning resources or items. There were 1029 multilingual tags recorded in the system, some of which were reused by users.

## 4 Prototype Requirements

Our research therefore focusses on using information visualisation techniques

- that provides insight to analysts in the implicit relationships between bookmarks, tags and users;
- that may offer end users new ways to find content and information that could be of interest to them but that would not have been found through explicit searches.

This section discusses a number of requirements for applications that are designed with the goal of opening up the view on social bookmark spaces. A prototype application that uses information visualisation techniques, has been designed with these requirements in mind.

Table 1: Overview data features in del.icio.us and CALIBRATE portal

Object	Feature	del.icio.us	CALIBRATE Portal
Resource	authors	x	✓
	language	x	✓
	ID	x	✓
	timestamp	x	✓
Bookmark	user ID	✓	✓
	tag(s) ID	✓	✓
	resource ID	✓	✓
	timestamp	✓	✓
User	ID	✓	✓
	country	x	✓
	language(s)	x	✓
	repository Information	NA	✓
Tag	ID	✓	✓
	language	✓	✓
	timestamp	x	✓



1. Hypertext makes a dynamic organisation of information, i.e. nodes with content, possible through links or connections. Navigation between the information is possible by following those links. Many rich hypertext systems are criticised since its users may suffer from the “lost-in-hyperspace” syndrome which means that they cannot identify where they are, or that they cannot remember what they have covered already [Theng and Thimbleby, 1998]. Much work has been done to address this problem, like providing breadcrumbs that show the trail of links leading to the current page [Blustein et al., 2005]. A number of visualisations of hypermedia systems have been developed to address this problem by using a novel paradigm instead of the hypertext paradigm [Mukherjea, 1999]. Most of them have been based on the node and link graph diagram metaphor like the “Navigational view builder” [Mukherjea and Foley, 1995] where web pages are represented as nodes.

Social bookmarking tools like [delicio.us](http://delicio.us) consider both users and bookmarks as pieces of content. Tags are presented as links between those users and bookmarks and can therefore be used to navigate through the social bookmark space. Applications with the goal of opening up the view on social bookmark spaces should be careful not to create the same lost-in-hypertext syndrome that can be found in traditional hypertext systems. In our design, we use a novel paradigm, called a cluster map visualisation, for browsing and exploring social bookmarks. This paradigm and the reason for choosing it, will be explained in section 5.2.

2. Secondly, we want the visualisation system to be able to automatically identify implicit tag and community structures. Such a structure is formed when two or more tags or users describe or share common bookmarks. After the identification of these structures, they should be visualised for the users, so that these users can become aware of them. We think that this can lead to the discovery of interesting material for those users, that could not have been found through explicit searches.
3. We consider visualisation as a technology. This means that visualisation has to be effective and efficient or that it should do what it is supposed to do by using a minimal amount of resources [Van Wijk, 2006]. Information exploration should be a joyous experience, but

many commentators talk of information overload and anxiety (Wurman, 1989). A key challenge for information visualisation researchers, often suggested by the community, is to make their systems usable by common computer users [Mukherjea, 1999]. Visualisation applications do not always fit in the normal workflow of users. If we therefore want that our visualisation design is useful, efficient and effective, users should be able to explore the social bookmarks in a playful manner in a fun and engaging space.

4. Human-computer information retrieval (HCIR) has emerged in research as the study of information retrieval techniques that brings human intelligence into the search process [Marchionini, 2006]. To achieve this, users should be able to interactively create a selection of bookmarks and get details on them when needed [Shneiderman, 1996].

## 5 Social Bookmark Visualisation

Figure 1 shows that our visualisation consists of three parts:

1. a selection widget that presents lists of the users and tags in the currently loaded data (section 5.1),
2. a cluster map visualisation (section 5.2), and
3. a filter pane with integrated results list (section 5.3).

These panes are synchronised with each other. We discuss these panes in detail in the next paragraphs. Typical usage scenarios will be described in section 6 where we focus on exploring and discovering new bookmarks, by identifying and visualising those implicit structures that are e.g. formed when two or more tags or users describe or share common bookmarks.

### 5.1 Selection Widget

Users of social bookmarking tools most frequently browse the bookmark space by other people and by tags [Millen and Feinberg, 2006]. Providing easy access to the people and tag space is therefore important as we want to create a visualisation that is both effective and efficient while exploring the social bookmark space. End users of e.g. del.icio.us know how to

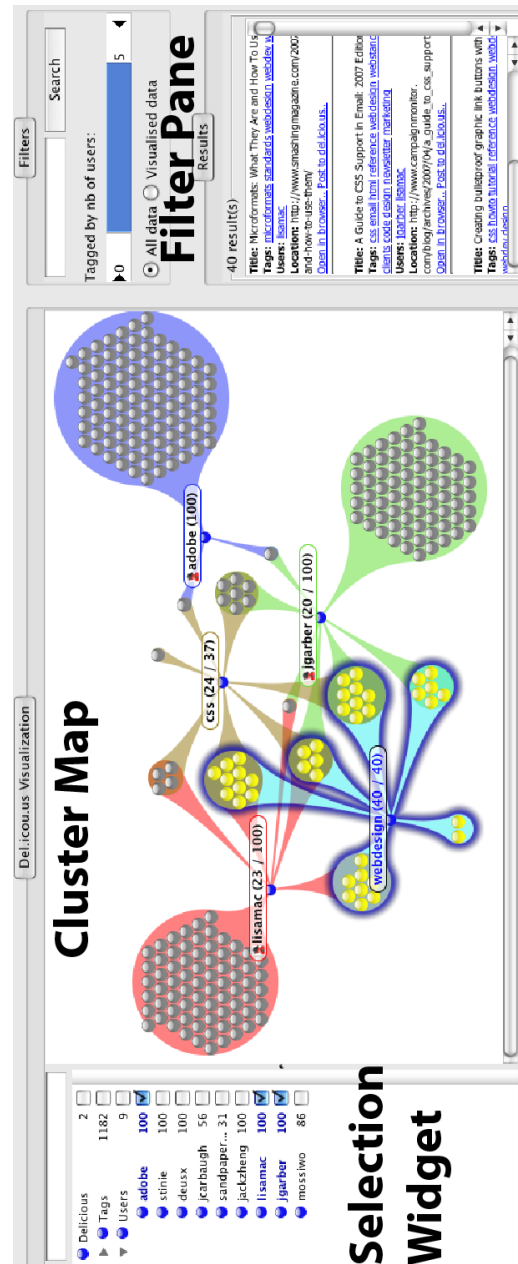


Figure 1: Cluster Map visualisation

find interesting items within lists. Therefore, the selection widget presents overview lists of both users and tags, that are currently loaded in the system. Alternatives to list presentations are e.g. tag clouds [Halvey and Keane, 2007]. However, our main goal is not to find interesting tags on itself but to provide understanding of relationships between users, tags and bookmarks. A simple list presentation is sufficient as a starting point for selecting interesting tags and users for this goal.

Figure 2(a) shows that each item is presented as a node in the list. A node consist of the particular tag or user and the number of bookmarks that are described with that tag or user. In CALIBRATE, more information is available about the resources. Therefore, Figure 2(b) not only shows the tags and users but also countries and languages. Each node also contains a check-box that can be used to create a selection of items that should be added to the visualisation. To optimise browsing of tags, users, countries and languages, a filter widget has been built that is visible on top of the selection widget and that can be used to find items faster. Figure 2(a) shows for instance only those items in the lists that start with “web” because the word “web” has been typed in the widget.

In our design, we have chosen to follow the philosophy of “start with what you know, then grow” [Heer et al., 2005]. This means that, by default, nothing is visualised in the cluster map but the bookmarks of the current user. The user can thus start from his own bookmarks, and afterwards use checkboxes of tags, users, languages or countries, to include the corresponding items in the visualisation. In this way, the initial visualisation carries less perceptual and computational burden to start with, because the user does not need to figure out complex structures that could be visual if more information was added to the visualisation. An example of this can be seen in Figure 8 which shows a rather complex cluster map of 7 users and one tag “java”. When a user would see this visualisation from the start, he would need a some time to make sense of the patterns.

The same philosophy is also adopted in related research like Vizster which is a visualization system for playful end-user exploration and navigation of large-scale online social networks [Heer et al., 2005]. HubLog [HubLog, 2008]) enables graphical browsing of del.icio.us tags in a mind mapping way and starts from one tag that a user should fill in. The del.icio.us network explorer [explorer, 2008] starts with one user and enables the exploration of that users’ network.

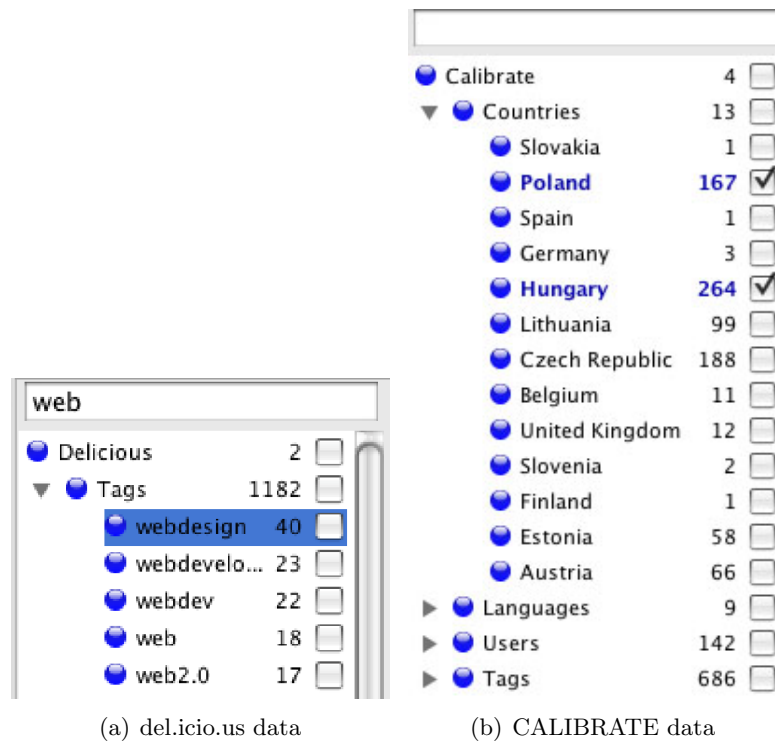


Figure 2: A view of the selection widget. When a user clicks a checkbox, the item is added to the cluster map visualisation. (a) shows the lists for del.icio.us, (b) for the CALIBRATE portal.

## 5.2 Cluster Map Visualisation

Visualisation should show the data: it should reveal what the data is about [Tuft, 2001]. Our visualisation of the social bookmark space should therefore be expressive. Clear visualisation of the triple users, items and tags should be supported to create an effective navigational and exploration tool. Many visualisations have been developed for web resources (see [Fluit et al., 2005] and [Dodge and Kitchin, 2001] for an extensive overview). Especially in the context of social bookmark tools, a number of graph visualisations have been created (see section 2). Another metaphor that has frequently been used for accessing social bookmark tools is the landscape metaphore like the “Islands of Music” where tags of music songs are represented as islands on a map [Pampalk, 2006]. Similar tags are located closer to each other.

A cluster map [Fluit et al., 2005] is a technique that is very expressive in visualising classes and item that belong to those classes. One can also consider Items like tags, users, language and countries as classes where bookmarks belong to one or more of those classes. Those classes and relationships between them need to be easy to detect. A cluster map makes use Venn diagrams which makes it easy to detect those relationships between those classes [Venn, 1880]. Therefore, we decided to customise a cluster map for visualising social bookmark spaces with the goal of validating the use of this technique for exploring those spaces.

A cluster map visualises the objects of a number of selected classes. Those classes and their relationships are easy to detect. It is immediately apparent which items belong to one or multiple classes, which classes overlap and which do not. A bookmark is represented as a small circle in the visualisation. Each bookmark belongs to the collection of one or more users. In Figure 3, two users are shown, each with a hundred bookmarks in their collection. A small icon of a human, followed by a user name identifies a user. Those two users have six bookmarks in common which is represented by the label “6 / 100”. This is represented in the visualisation by the smaller common cluster of bookmarks in the middle. By using the selection widget that has been described in the previous paragraph, users can select which users and tags are drawn on the cluster map.

Bookmarks can be clustered by the users that have them in their collection, or by the tags that describe them. This can be seen in Figure 4, where the tag “email” is shown. Users “lisamac” and “jgarber” have one bookmark in common which is tagged by “email”. The user “jgarber” has

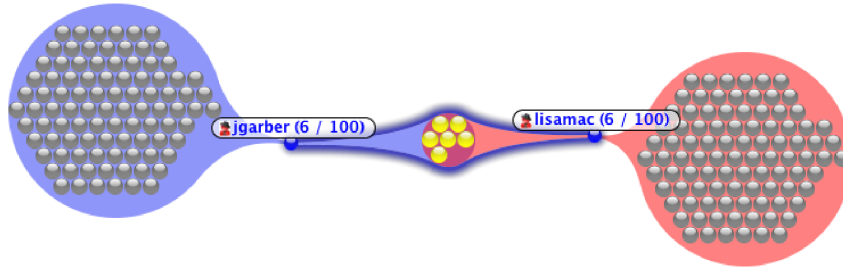


Figure 3: Cluster Map showing 2 users with 100 bookmarks and 6 of them in common. An icon followed by a username identifies a user.

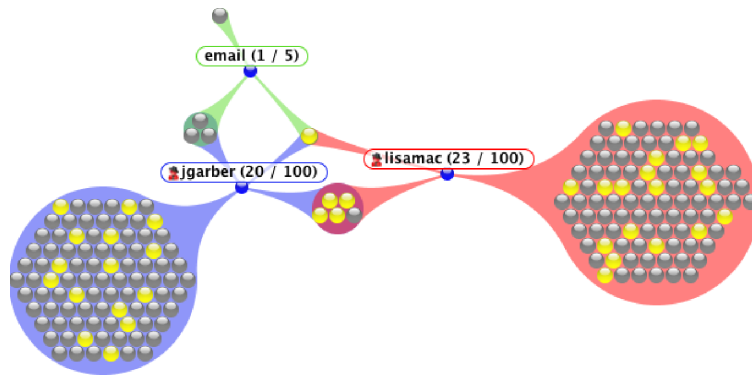


Figure 4: Cluster Map visualisation, showing 200 bookmarks with 2 users and 1 tag “email”. 20 bookmarks of user “jgarber” and 23 bookmarks of users “lisamac” are about “webdesign”. The selection of bookmarks on webdesign has been created by using the filter pane (section 6(a)).

3 extra bookmarks tagged with “email” that are not in the collection of the other user.

An important feature of social bookmarking tools is the popularity of bookmarks. For instance, if a web page on the topic of “java” is added by 10.000 people, and another web page on the same topic is only added by a hundred people, one might trust the first web page more than the latter. The rapid and accurate identification of popular bookmarks is therefore an important requirement in the design of our visualisation. Color is an important and frequently-used feature for information encoding [Healey, 1996a] because well chosen colors allow for rapid and accurate identification of individual data elements by users [Healey, 1996b] [Few, 2004]. In Figure 4, two main colors are used to represent bookmarks yellow and grey. A color-saturation sequence is used for the yellow color to identify the popularity of the bookmarks among the users. This means that a bookmark that is presented with a brighter yellow color, is more popular among users.

Such a set of selected bookmarks can be created by clicking on a user, a tag, a country or a language in the selection widget, or by performing a keyword query in a search box. A selection of bookmarks is color-encoded in the visualisation:

- grey bookmarks are items that were filtered out by the users because they were less interesting, and
- yellow bookmarks are items that are in their interest.

The yellow bookmarks in Figure 4, belong to a selection of bookmarks that were tagged with the tag “webdesign”. The yellow bookmark between “lisamac” and “email” therefore belongs to the collection of the users “lisamac” and “jgarber” and is described by the tags “email” and “webdesign”. This selection was created by clicking on this tag in the list of tags in the selection widget, which can be seen in Figure 2(a) where this tag is highlighted.

Looking at CALIBRATE data, we can visualise bookmarks belonging to countries. Figure 5 shows that people from Poland and Hungary tagged respectively 167 and 264 learning resources in total of which there are 29 in common.

### 5.3 Filter pane with Integrated Result List

In the previous paragraph, we already mentioned that users should be able to interactively create a selection of bookmarks and get details on them



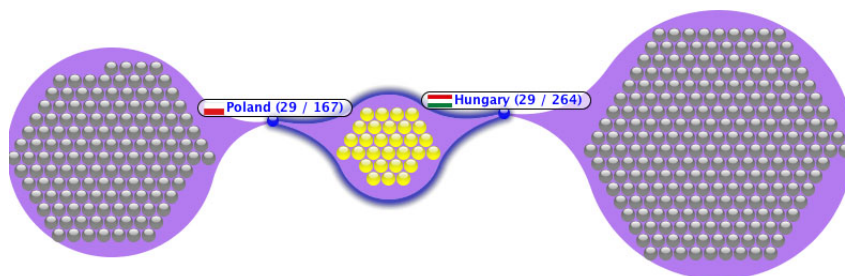


Figure 5: A view of shared learning resources: of all the 167 learning resources that were bookmarked and tagged by users from Poland, 29 are shared with the 264 learning resources that were tagged by users from Hungary.

when needed [Shneiderman, 1996]. In this way, they can zoom in on potentially relevant bookmarks and continuously keep an overview of how the additional search criteria restrict the remaining number of bookmarks. Therefore we integrated a filter pane with a number of controls that can be used to filter out less interesting bookmarks or add more interesting ones. Figure 6(a) shows controls that can currently be used:

1. The first one is a search box where a typical keyword query like “javascript” can be performed.
2. The second one is a data visualisation slider [Eick, 1994] that can be used to indicate an interval of the number of people that tagged a bookmark.

These combined controls allow users to quickly find popular bookmarks on a particular topic. This is a basic use-case that is available in most social bookmarking tools like del.icio.us and Dogear [Millen et al., 2006]. Other controls could be added to the filter pane as well. In the case of CALIBRATE, we could e.g. choose to add a drop box for the language of the resources. Users would then be able to filter out languages they do not master. The results of the combination of these filters are shown in two places:

1. **the clustermap visualisation**, where selected resources that do match the criteria in the filter pane are represented as yellow circles. The resources in Figure 5 that are represented in yellow match the

criteria in the search pane (Figure 6(a)) where the user added the keyword “javascript” to include only results on this topic, and also changed the slider to include only the objects that were tagged by at least 2 users and at the most 4 users.

The complexity of the visualisation can be high when many tags are added with a lot of overlaps between those tags. An important aspect of using the filter controls, is therefore, that they can be used to reduce this complexity.

2. **the result list**(Figure 6(b)), that shows detailed metadata about the bookmarks that are selected in the cluster map, or bookmarks that match the search terms when a query was performed. In the case of the data from del.icio.us, the metadata cover the title, the location, user(s) that added the bookmark and tag(s) that describe the bookmark. On top of those, the metadata covers the language and the country of the users in the case of the CALIBRATE portal. A user can interact with the detailed information by clicking on e.g. a tag that describes a bookmark. If this tag is not already drawn on the cluster map, the visualisation automatically updates itself and the tag classification is shown, together with the possible relationships between this tag and currently visualised bookmarks. The results should preferably be ordered by relevance because users always want to find the most relevant items. Therefore, we would e.g. need relevance feedback from users. However, capturing and incorporating this feedback is has been of less priority because our main goal has been to visualise the relationships between users, tags and bookmarks. The results are therefore ordered alphabetically in the result list for the time being. Ordering by relevance has been moved to future work.

## 6 Exploring Social Bookmarks

We mentioned in the introduction that the use of information visualisation techniques offers end users new ways to find content and information that could be of interest to them. On top of that, it is important that these techniques enable insight in the implicit relationships as they are not always clear in the traditional social bookmark tools (section 4); insight that could enable them to find interesting material that would not have been found

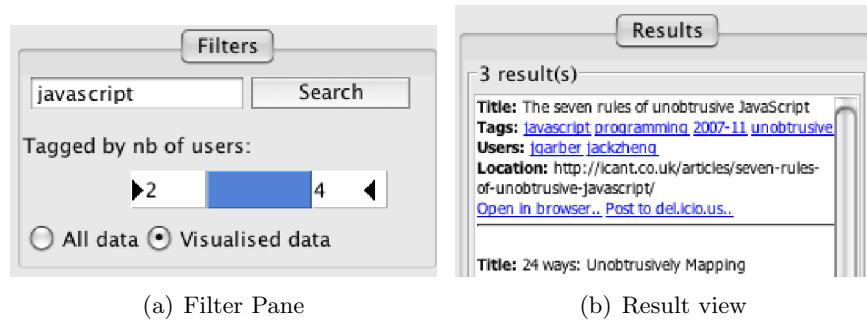


Figure 6: (a) shows the filter pane with a search box, a slider for the number of users that tagged a bookmark and radio buttons for indicating on which data set to search. (b) shows the result view with detailed metadata about bookmarks.

through explicit searches. For example, if a user finds a relationship with another user, he can find material that has been tagged by that user that is interesting to him. As an alternative to exploring social bookmarks on the del.icio.us and CALIBRATE portal, we offer a novel access paradigm that tries to enable a user to explore social bookmarks in a playful manner in a fun and engaging space by creating a cluster map visualisation. The cluster map visualisation enables users to identify tag and community structures. The following sections will explain how users can become aware of them by interpreting the visualisation.

## 6.1 Exploration Ways

Users can explore the social bookmark space by using the cluster map visualisation in a number of ways.

1. First of all, the basic exploratory functionality on the del.icio.us website is supported because this is the basic functionality that typical end users of social bookmark tools expect to be able to do: One
  - can look at one's own bookmarks,
  - see which tags are used to tag a web page, either by the user himself or by others in his network, and
  - see all other users in one's own network that have saved the same bookmark. Note that this means that a user will not see

del.icio.us users that added the same bookmarks but are not in the same network. The reason for this is the usage throttling and abuse monitoring software at the del.icio.us website (section 3.1).

We chose to let a user start from an egocentric point-of-view, with a visualisation of one's own bookmarks, much along the lines of the philosophy of start with what you know, then grow [Heer et al., 2005]. Users will see those bookmarks from the start, which will give them a more comfortable feeling because they are already familiar with those bookmarks and tags. They can then select a number of bookmarks in the visualisation or perform a keyword query in the filter pane, after which detailed metadata about the resulting bookmarks is shown in the result list. Only those bookmarks that are also currently visualised, are added to the result list because both the visualisation and the result list are continuously synchronised with each other or tightly coupled. This is needed to have comprehensible and consistent affordances to guide the end users [Ahlberg and Shneiderman, 1994]. The metadata of the results contains all the tags that describe the bookmarks, i.e. not only the tags of the user itself. The metadata also contains all the users that added the specific bookmarks. The user can click on those tags and users, and by doing this add them to the cluster map, where the layout of the bookmarks updates itself to represent the new sub-clusters, like in the example of Figure 4 where the tag “email” is added.

2. The first way of exploring is not sufficient for efficiently exploring social bookmarks. Users should also be able to explore all tags that are in the data to find interesting bookmarks. A second way of exploring is therefore by browsing the selection widget to find those tags. This can be compared with sifting through a list or cloud of tags on the del.icio.us website. Users can order the tag list alphabetically or by the number of bookmarks they describe. When ordering them in the latter way, one can see which tags are used the most. By adding tags to the visualisation, the corresponding bookmarks, possibly tagged by different users, can be explored in the cluster map. Moreover, tags often denote concepts, so relationships between those concepts may also be discovered. An example of this, is shown in Figure 7 where users can see the relationships between the concepts “programming”,

“dev” which stands for development, and “java”. However, it’s the responsibility of the users to interpret the visualised relationships. “Coffee” is for example related with the coffee brand “java” but “coffee” is not related with the concepts of “programming” and “dev”.

3. Highly interactive applications support human-computer information retrieval (HCIR) [Marchionini, 2006]. Users should for instance be able to easily see all metadata, associated tags and users of a bookmark in the visualisation. This can easily be done by clicking upon the bookmark in the visualisation after which this information is also shown in the result list.
4. When a user finds an interesting bookmark, he should be able to keep it for further reference [Shneiderman, 1996]. Implementing and maintaining a system with user information and the history of his actions is not in the scope of our design because we can use the del.icio.us system for this purpose. Users can easily post newly found bookmarks to del.icio.us by clicking upon them in the visualisation. For the same reason, Users that are found to have the same interests, can also be easily added to the del.icio.us network of the current user by clicking on the corresponding nodes in the visualisation. This is only possible when the user that is currently exploring the social bookmark space, has a user account on del.icio.us.
5. Only a fraction of data is loaded from the start as we follow the philosophy of “start with what you know, then grow” (section 5.1). To enable further exploration, one can click the nodes in the visualisation that represent users after which the network and the fan data of those users are loaded into the system so that they become available for exploring. The reason that we do not add the data of all users that saved a bookmark automatically from the start is twofold:
  - the data is loaded incrementally which reduces the volume of data that has to be retrieved [Chaudhuri and Dayal, 1997].
  - the usage throttling and abuse monitoring software at the del.icio.us website, that we discussed in section 3.1, prevents us of adding this information from the start. In the case of CALIBRATE, we do have this information and the data is therefore immediately loaded.

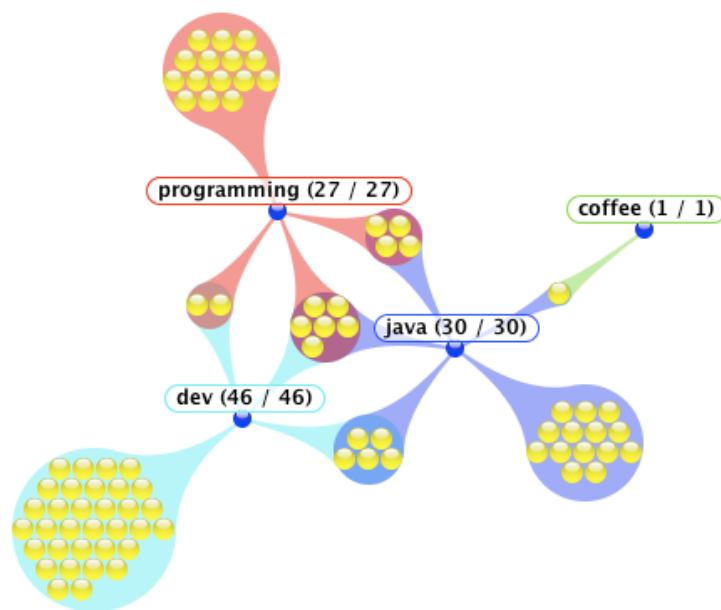


Figure 7: Cluster Map visualisation, showing the relationships between a number of concepts, denoted by tags.

## 6.2 Example 1

The following relationships exist between the users in the underlying del.icio.us data:

- “jkofmsk” has two users in his network: “cougare” and “mmeire”.
- “cougare” has two users in his network: “phOng” and “vuorikari”.
- “phOng” on his turn has two users in his network: “pieterjelle” and “woumpousse”.

While exploring the bookmarks and tags of these users, one might want to find out if there are implicit relationships between the non-related users of them. One can easily find tags that are frequently used by ordering the list of tags by popularity. Figure 8 shows the visualisation of the users above and the tag “java” that is mostly used in this data. Showing this tag leads to the uncovering of an implicit community of users that are not originally in the same network of users, and thus probably are not acquainted. However, they all seem to be interested in the concept of the “java” programming language. By adding those other users to one’s own network, one can create a sort of community-of-practice [Wenger, 1998] with a similar interest: programming in java. Establishing this community may prove useful in the future while searching for new material on this topic. This kind of visualisation therefore offers the opportunity to find content and information that could be of interest.

This example also shows that semantic closeness results in geometric closeness. If two items share many objects, they are semantically close [Fluit et al., 2005]. The user “vuorikari” did not tag a bookmark with “java”. Therefore this user is drawn further away from the item that represents this tag “java”.

## 6.3 Example 2

Examining the social bookmark space of the CALIBRATE portal with the cluster map visualisation allows users to get an impression of the resources that are “used” across country and language barriers. Some researchers in ARIADNE [Vuorikari et al., 2007], are interested in learning resources that “travel well”. In the context of this work, we may define a learning resource as “travels well” if it satisfies one or more of the following criteria:

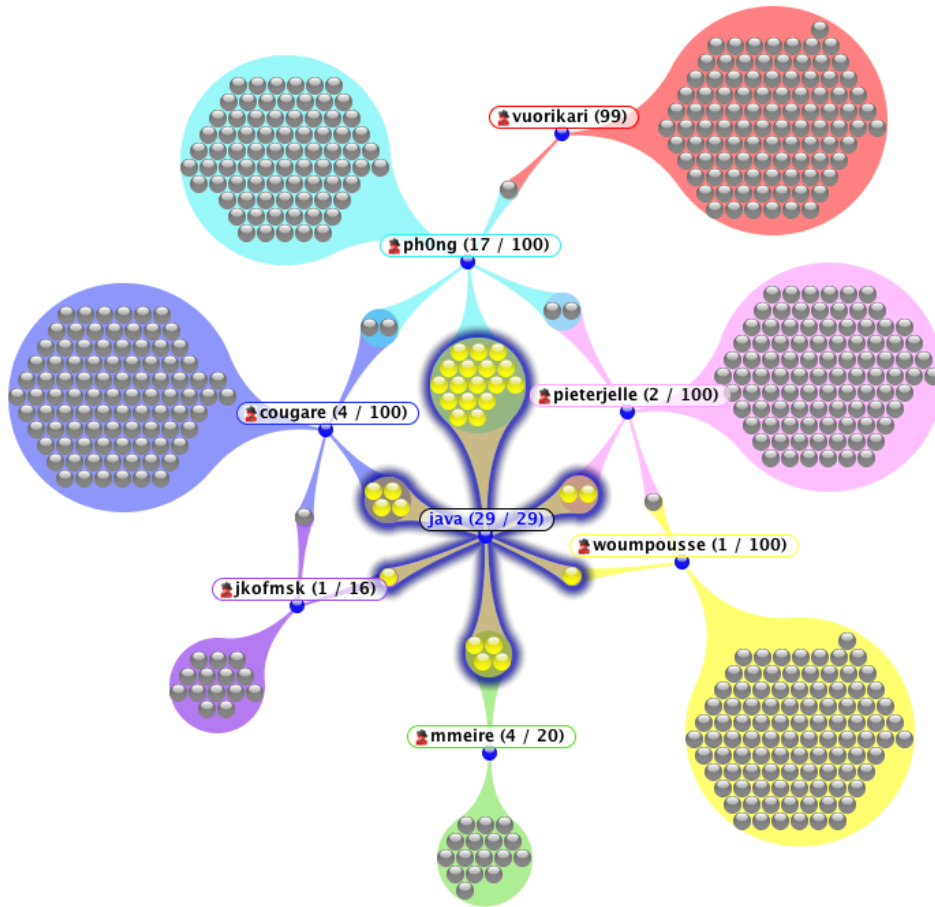


Figure 8: A Cluster Map visualisation showing a network of users, formed by common bookmarks that are all tagged by “java”.



- an item that is bookmarked by a user is of a different language than user’s mother tongue,
- an item has tags in (a) different language(s) than that of the item language,
- an item is from a different country than where the user is from.

Travel well resources may be interesting for e.g repository owners or researchers, in seeing what kind of resources users from other countries bookmark. An example of this is shown in Figure 9 that gives an overview of the hungarian learning resources that travel well: from 226 hungarian resources, that are represented by the green color:

1. 5 are shared by users from both Poland and Estonia,
2. 15 are shared by Estonian users that are not shared by Polish users,
3. 20 are shared by Polish users that are not shared by Estonian users, and
4. 1 is shared by German users.

These hungarian resources that “travel well”, mainly cover an advanced music education area, which contains hardly any explanatory text, but mostly images and animations, which could explain why they are popular in the other countries as well.

## 7 Prototype Implementation

Our prototype for visually searching and analysing del.icio.us and CALIBRATE social bookmarks is created with our open and extensible information visualisation framework that we created as part of our research on the use of information visualisation techniques for flexible and efficient access to learning repositories [Klerkx et al., 2005]. Mapping collections of objects into an interactive visual form is the core functionality of our framework. We want to make it easy to add:

- new visualisation techniques like tree-maps, hyperbolic trees, node-graphs, fisheye-views, etc., by plugging in existing visualisation components into our framework; and

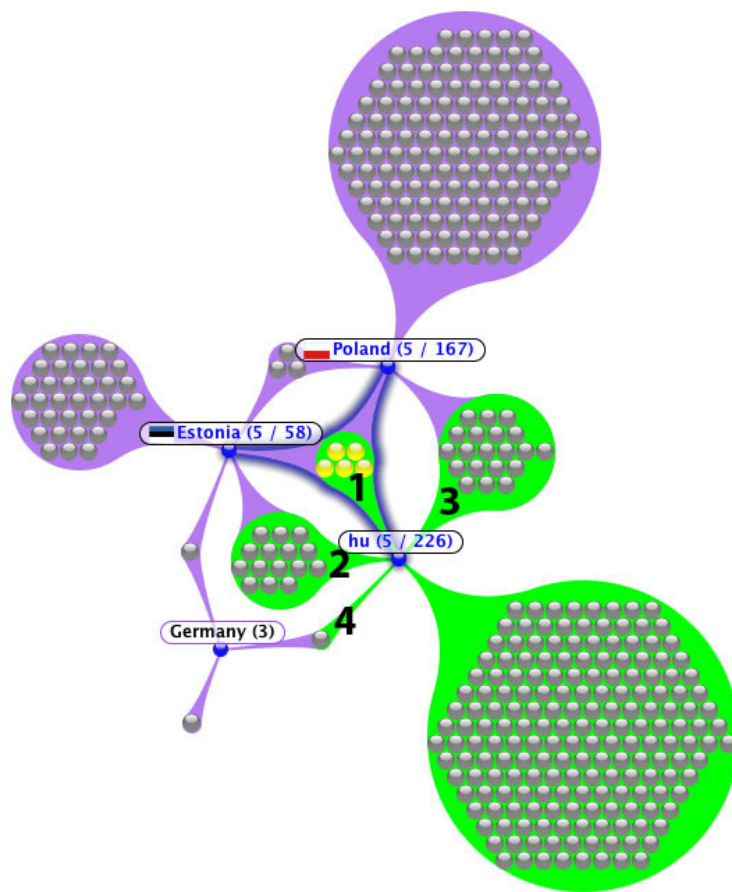


Figure 9: A view of hungarian learning resources that travel well in both Estonia as in Poland.

- new data sources, possibly delivered in various formats and structured according to various metadata schemes.

Our framework therefore consists of a software architecture that is designed to be efficient, scalable and of high-performance, with a structured API. For the cluster map visualisation, we plugged in the Aduna Cluster Map software [Aduna, 2008]. This is a library in Java<sup>TM</sup> that contains functionality for creating visualisations of collections of hierarchically classified objects. By integrating this library in our framework, the Aduna visualisation technique is available for our prototype, described in this paper, but also for other case studies that have been, or will be developed with our framework. Moreover, this integration demonstrates the open and extensible nature of our framework.

With our framework, we can for instance easily visualise the bookmarks with e.g. a tree-map where the bookmarks are classified per user in a flexible and efficient manner, or with any of the other techniques that our framework provides. A tree-map is a visualisation of hierarchical structure that makes 100% use of the available display space. It maps the complete hierarchy onto a rectangular region in a space-filling manner [Shneiderman and Johnson, 1991]. Such a tree-map may be beneficial by providing an extra overview when exploring bookmarks by visualising all of them at once. Performing a keyword query in the filter pane on the topic “web” gives users an impression of the distribution of resources on that topic over all users. This can be seen in Figure 10. It makes sense to further explore those alternatives in subsequent future work.

The Contextualized Attention Metadata (CAM) framework [Wolpers et al., 2006], is integrated into our information visualisation framework. CAM can be used to capture the attention users spend on content in an application [Najjar, 2008]. We gather user data of the prototype to evaluate the effectiveness and usefulness of our design, and adapt the design where needed. For instance, if we would notice from those logs that users never use the filter widget (section 5.1), this could mean that the functionality is:

- not clear to the users and should be explained by e.g. adding a help-function,
- not found by the users in the user interface, so a better place needs to be found for it,
- not found useful by the users so we would need to find a new way of filtering items.

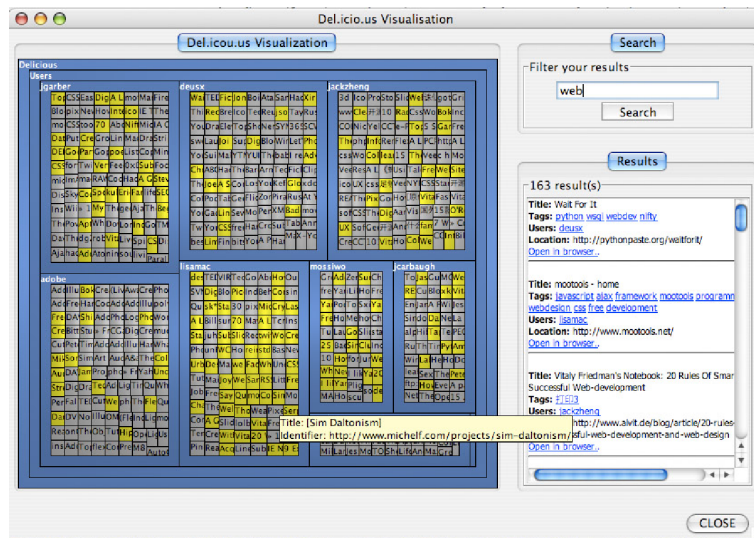


Figure 10: Tree Map visualisation: blue rectangles represent the users, yellow rectangles represent the bookmarks that match the selection made by the keyword web in the search box and grey rectangles are bookmarks that do not match.

## 8 Discussion

We strongly believe in rapid prototyping development, where software systems are delivered incrementally and requirements analysis continues throughout the process, interleaved with implementation and evolution [Luqi, 1989]. It enables us to uncover problems like usability issues in the early stage of development. During development, we have involved a number of users to solicit feedback. The results are described in the next paragraph. A user study with a rather complete prototype version of our visualisation has been conducted afterwards to validate the used techniques. These results are discussed in section 8.2.

### 8.1 Evaluation 1

A fairly small number of test users ( $4 \pm 1$ ) is enough to find most usability problems [Nielsen, 1992b]. Four users, both del.icio.us users and repository owners in the CALIBRATE project, were involved to locate problems during the design of our visualisation. We found out a number of things while using the “think aloud” method during interviews with those users. The “think aloud” method is a method for user testing where the users verbalise their thoughts while using the system that is being tested [Nielsen, 1992a]. In this way, those users reveal their view on the system and possibly, their misconceptions. We learned the following issues during those sessions:

- **Portal Integration.** Our third design requirement (section 4) stated that we want our visualisation to be useful, efficient and effective. Among other things, this means that our visualisation needs to be tightly coupled with the normal workflow of users. A browser application is normally used to access del.icio.us and CALIBRATE for exploring the bookmark space, but our visualisation is not directly integrated in those portals. If users find interesting bookmarks with our visualisation, it should be easy for them to save and tag those bookmarks within e.g. del.icio.us. Therefore, we integrated the functionality to directly post newly found bookmarks to del.icio.us but this is not enough. People want to be able to export a number of bookmarks at once in order to save time. Adding users to one’s own network on del.icio.us is a requested functionality that has recently been integrated.
- **Zooming.** This functionality could help some users while exploring

the social bookmark space to keep a good overview of the visualisation. This functionality will be added to the general framework (see section 7) so that it will be available for this application but also for other case studies that have been created with it. It still needs to be further investigated if this would actually help in keeping a good overview. On top of that, we need to make sure that this does not cause the “lost-in-hyperspace” syndrome in the visualisation that we want to avoid (section 4).

- **Implementation issues.** There were some issues with the visualisation prototype. For instance, we found out that some users in the educational CALIBRATE portal bookmarked some resources and tagged them by concatenating keywords like for instance “water, pollution, water pollution”, which has been used as one tag. Our prototype or the CALIBRATE portal needs to be adapted to be able to cope with this.
- **Learning Curve.** We noticed during the think-aloud sessions that the users did not directly use all available functionality because they didn’t know how to use it, or did not know it was there. Some users therefore suggested to include a help-function or create a small video-demo to keep this learning curve as small as possible.
- **Complexity.** The more tags and users are added, the more complex a cluster map visualisation can become with overlaps between social bookmarks and different categories. This would certainly be a problem if the cluster map would be a static image. However, the user is given continuously control over the items that are currently visualised and therefore the user can decide to remove items from the visualisation at any point during the exploration of the social bookmark space.
- **Timeline.** Visualisation of social bookmarks through time would enable users to learn about the evolution of their bookmarks, tags and network. This would reflect how users’ interests and focus develop over time. One idea to add time to our visualisation of social bookmark space is to represent time by moving graphics. One existing example of this is Gapminder where the authors use animated scattergrams to show statistics on world health [Rosling and Rosling, 2006].

## 8.2 Evaluation 2

The second evaluation that has been performed has been a subjective evaluation by using a web application: subjects were asked to fill out an online post-experimental questionnaire. First of all, they had the possibility to watch a short demo that explained the purpose of our prototype. After this viewing this movie, subjects were asked to explore their del.icio.us bookmark space with our prototype. The questions in the survey were stipulated in such way to ensure that the users needed to perform a number of tasks. The goals of this evaluation were threefold: (i) to assess the effectiveness of our approach to enable exploration of social bookmarks by visualising the relationships between users, tags and bookmarks; (ii) to assess the subjective acceptance of a visualisation tool for the purpose of exploring social bookmarks; (iii) to find out possible usability issues of the prototype.

### 8.2.1 Survey Statements

In total, there were 15 statements:

- 11 statements to measure the effectiveness of visually exploring social bookmarks, and the subjective acceptance of this approach. To measure the subjects agreement to those statements, we used the Likert scaling method [Likert, 1932] which is a popular scaling method. All items were rated on a 1-to-5 rating scale: strongly disagree - disagree - undecided - agree - strongly agree.
- 4 open questions where users could fill in their opinion, suggestions, and usability issues.

### 8.2.2 Findings

Table 2 presents the responses of all subjects to the statements above. The mean for the level of expressiveness was higher than 4 with a standard deviation of 0.52, meaning that all subjects found the cluster map visualisation expressive for effectively exploring social bookmarks.

Finding items by using the search box has a value of 4.44 with a standard deviation of 0.72, which means that all users found this a valuable feature for exploring their bookmarks. We believe that this is related to the fact that people are used to using keyword queries for searching bookmarks in their own contexts.

Sorting tags by frequency or name with a mean of 2.55 was perceived as not easy. From the general remarks that we received as answers to our open questions, we learned that users thought that it would be a valuable and interesting feature while exploring but it should be made more clear in the interface by e.g specific buttons for this functionality.

Except for the previous statement, all others that measured the criterion of effective exploration have values higher than 3. We can therefore assess that our design has been found effective. The statement that measured the experienced efficiency of exploring the social bookmark space, has a value of 4.11 with a standard deviation of 0.92. This means that users found our design fast and efficient. All statements that measured the subjective acceptance of our visual design have values over 3.22.

We can therefore conclude this section that users considered the use of information visualisation techniques an effective and efficient means to explore social bookmark spaces.

### 8.2.3 Recommendations

From the open questions that we asked users we received a number of recommendations for further enhancement of the design. These are summarised below:

- The items move in the visualisation, when e.g adding new items to the visualisation. The reason for this, is that the visualisation algorithm tries to recalculate the layout of the cluster map whenever new items are added. The advantage of this is that users always see a visualisation with the most optimal layout for the current elements in the visualisation. However, this makes it sometimes difficult for users to get a grip on what is visualised because the continuity is lost for them. One way to solve this, would be to only recalculate the layout when the users chooses so. This is of course something that has to be further investigated.
- Adding an initial ranking on the tags in the tag lists so that users will not have to bother to do that.
- Adding “clear”-buttons to the search box and the filter widget of the tag lists (section 5.3 and 5.1).
- The difference between users and tags should become more clear in the visualisation. For now, users are identified by an icon and a



Table 2: Effective Exploration and Subjective acceptance.

Criteria	Statement	Mean	Standard deviation
Effective Exploration	Find the amount of bookmarks of a user is easy	4.22	0.97
	Sorting tags by frequency or name is useful and easy	2.55	1.01
	Adding data of users to the visualisation is easy	3.66	1.00
	Finding items with search box is useful	4.44	0.72
	Expressiveness: Relationships between bookmarks, tags and users are easy to detect	4.44	0.52
	Filter controls are effective in exploration process	3.33	1.00
	Finding popular bookmarks in the network of users, is easy	3.55	0.88
	Result lists easy to read	3.77	0.44
Subjective acceptance	Ease of use in general was easy	3.89	0.33
	Exploring the social Bookmark Space, is fast and efficient	4.11	0.92
	Users can always stay in control of the exploration process	3.22	0.97
	Seeing relationships between tags and users, is useful	3.22	0.97
	Would use the tool to explore social bookmarks more often	3.44	0.88

username but we could for instance use different geometric shapes for users and tags.

## 9 Conclusions

In this work, we have investigated how we can effectively and efficiently provide visual access to a collection of social bookmarks? Therefore, we have presented the use of information visualisation techniques

- that enables insight to analysts in the implicit relationships between users, tags and bookmarks; and
- that offers end users new ways to find content and information that

could be of interest to them but that would not have been found through explicit searches.

For this purpose, we have created a tightly-coupled visualisation prototype that uses a cluster map visualisation for representing bookmarks, users and tags (Section 5). This prototype uses real data from del.icio.us and CALIBRATE. We chose del.icio.us as a source of data as it is highly popular with many users, lots of data and with a very easy API to access this data. Those characteristics makes del.icio.us a very good reference point (section 3.1) for other social bookmark tools. Two evaluations have been conducted to measure the effectiveness and the efficiency of our design (Section 8). From those evaluations, we learned that the use of information visualisation techniques prove useful in opening up the view on social bookmark spaces. Other possible data sources that can be used in the future, are folksonomies like Flickr [Flickr, 2008] and YouTube [YouTube, 2008], where respectively photographs and videos are described by tags.

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