Department of
Information Engineering
and Computer Science DISI

UNIVERSITY OF TRENTO - Italy

DISI - Via Sommarive 5 - 38123 Povo - Trento (Italy)
http://www.disi.unitn.it

MINIMALIST METADATA VISUALIZATION: THE MINIMAL SET OF CONTEXT DEPENDENT ATTRIBUTES FOR ENTITY IDENTIFICATION

Fausto Giunchiglia, Khandaker Tabin Hasan, Sheikh Shaugat Abdullah and Rezwan Ahmed

April 2013

Technical Report # DISI-13-022

Also: accepted at INES 2013 (IEEE 17th International Conference on Intelligent Engineering Systems)

Minimalist Metadata Visualization: The Minimal Set of Context Dependent Attributes for Entity Identification

Fausto Giunchiglia*, Khandaker Tabin Hasan*, Sheikh Shaugat Abdullah** and Rezwan Ahmed**
* University of Trento, Italy
** American International University-Bangladesh, Bangladesh
{fausto, tabin}@disi.unitn.it, {shaugat, a.rezwan}@aiub.edu

***Abstract*—The purpose of our study is to addresses fundamental issues of minimalist metadata visualization that make an entity identifiable by human inspection. Minimalist metadata visualization for entity depends on the context of use of that entity, i.e., who is asking for what/whom at when and where. Therefore, we seek to recognize the need for requisite types, amount and order of metadata in different context. A survey result and user study on YouTube is presented revealing interesting facts based on our common understanding and practice of metadata visualization. In the first survey, we took one entity type with five different contexts to illustrate how variant the user reacts in different requirements. Afterwards, in user study we tried to plot our findings on popular video sharing website "YouTube" and identified some key problems as well. The results of our study will help to understand the importance of the minimal attribute set to identify an entity which can accelerate any sort of entity search in an efficient way[1].**

I. INTRODUCTION

Metadata are data that defines higher level of data. The relation between data and metadata remains always the same from one level to another in the information hierarchy. Use of metadata is extremely important both in machine reasoning as well as for human inspection in large information space. Our query results come with some meta-information by which user should perform successful hits. Unfortunately, this does not happen in most cases. Data describing data are often more ambiguous and/or confusing than the data itself and appears out of context. Data have been categorized, modeled and recorded by researchers and practitioners based on their meta-information.

The Center for International Earth Science Information Network (CIESIN) at Columbia University is applying research on text visualization to the world of scientific data catalogs to increase efficiency in dealing with large metadata collections [3]. Vijay Kumar and Richard Furuta described a general framework for modeling and presenting temporal and other metadata [6]. Paul Mutton and Jennifer Golbeck worked on Visualization of Semantic Metadata and Ontologies, and revealed interesting information about the data relationships that can be extracted through visualization of the physical graph structure [7]. Another framework VisMeB is presented by Peter Klein and Frank Mu□ller that support users to find relevant data and to enhance the possibilities of browsing and filtering an information space(e.g. digital library, web, geodata base, movie data base) [4]. Thomas Nocke and Heidrun Schumann proposed a way where they specified a variety of metadata supporting for visual mining tasks [5]. They developed an effective strategy for gathering metadata and included it in a general framework.

Our current study treats entity for data and property for metadata. Set of properties being associated with each entity is not completely intended for human comprehension, rather only a part of it is to be visualized. There is a need for quick preview of entity properties. This can be accommodated in a tooltip or a popup box with minimalist view of entity properties. Another important aspect of the design is to determine the order of their arrangement i.e. setting the order of precedence of metadata visualization. In order to reduce user's cognitive load, we have conducted a user study for minimalist metadata visualization. There are three fundamental questions we had to encounter:

- What are the metadata to be visualized to make an entity identifiable by human inspection?
- How much is sufficient?
- In which order?

Answering these questions is not a trivial task; therefore, no simple solution exists. For each entity, there exist numerous contexts where the answer varies.

II. METADATA

Metadata is structured information that describes, explains, locates, or otherwise makes it easier to retrieve, use, or manage an information resource. Metadata is often called data about data or information about information [9].

For example, what is the name of the data set? Who developed the data set? What geographic area does it cover? What themes of information does it include? How current are the data? Are there restrictions on accessing or using the data? Metadata is capable of performing the following tasks [8]:

[1] This work has been partially done during the PhD thesis research of Hasan K. T. under the title "A User Centric Interface for the Management of Past, Present and Future Events" at the University of Trento, Italy in 2011.

- Describing what resources are and what they are about, and organizing those resources according to controllable criteria.
- Allowing resources to be found by relevant criteria.
- Facilitating metadata exchange and enabling interoperability.
- Providing digital identification and description for archiving and the preservation of resources (NISO, 2004).

III. Context Boundary and Metadata Visualization

Context is formed out from different entities. Basically it answers who, what, when and where [2]. The question "who"; applies the context where people are explicitly associated. Furthermore, "which" is the question that essentially comes in play when an answer is incomplete or given in more general term. For instance, if an answer is "Joe is standing besides the car parking", then the obvious question may come to mind "which car parking?", if there are many around. If there is only one car parking area in the context and it is relatively large, then another "which" may come to place. The word "which"; is substitutive and replaced with the appropriate interrogation. This semantic gap can be sketched as a context boundary and the following illustration shows how recursively it runs till the desired result is found:

- Person X asks Person Y "where are you?"
- Person Y replies "At the car parking"

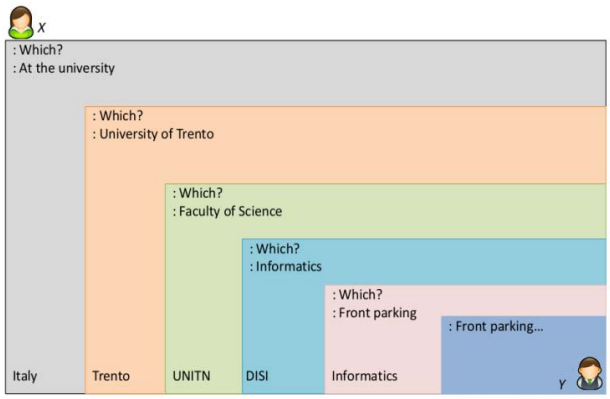


Figure 1. The less number of context boundary, the less semantic gap.

If X were somewhere near the Y's position, then no more information would have been necessary to find Y. This context boundary is the essence of making metadata visualization decision. A prior knowledge of the information seeker determines how much information would be necessary to find an answer. This is not however says in which order they are to be visualized.

IV. Context Query

The definition of context, as plainly as it is seen, is not so plain. In many occasions, it may raise more questions than it answers like answering the questions to a child. If we consider a scenario where two persons are involved and want to see what exactly happening there, a finite number of inquiry (for known subject) or an infinite number of inquiry (for partially known subject) will arise. If the context boundary is reduced with answering to a person already familiar with the scenario, it will end up soon with completeness.

However, describing to someone else far outside the context would result in a recursive query. Understanding the right context for both the user and the subject is required to provide some knowledge of what information should come first, i.e., who is asking for what.

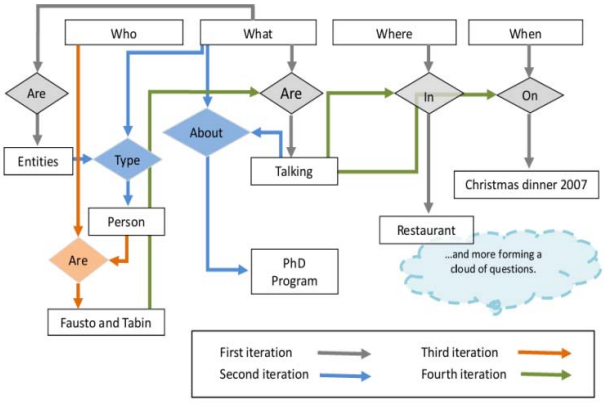


Figure 2. Questions are iterated demanding more answers if context boundary increases and goes on until a desired state is reached.

If the context boundary is reduced with answering to a person already familiar with the scenario, it will end up soon with completeness.

However, describing to someone else far outside the context would result in a recursive query. Understanding the right context for both the user and the subject is required to provide some knowledge of what information should come first, i.e., who is asking for what.

V. User Study

A. *Same entity in different contexts*

Minimalist metadata visualization for each entity type is subject to the context of use. We, therefore, tried to understand the need for required types, amount and order of metadata in different context. The study took one entity type with five different contexts to illustrate how variant the user response in such understanding of requirements. There were 40 participants in the study seeking for a person in five different contexts given a set of properties (metadata) presented to them. We used online survey tool to perform the study. There were eight common properties while the ninth one was subjectively different. The participants had the freedom to add properties of their own choice. Only one participant came up with an addition affiliation in few occurrences. They were -

1. Picture of the person
2. Full Name
3. Nick name
4. Current location
5. Profession
6. Date of birth
7. Hometown
8. Nationality

a) *The types and amount of metadata*

We perceived five scenarios for five contexts and asked in a form of questions with predefined answers

(mentioned in the previous section). The questions were as follows –

1. You are looking for your younger brother/sister (who happens to reside at the same home) on the net, what is the information sufficient to identify him/her from a search result? (Minimum context boundary)

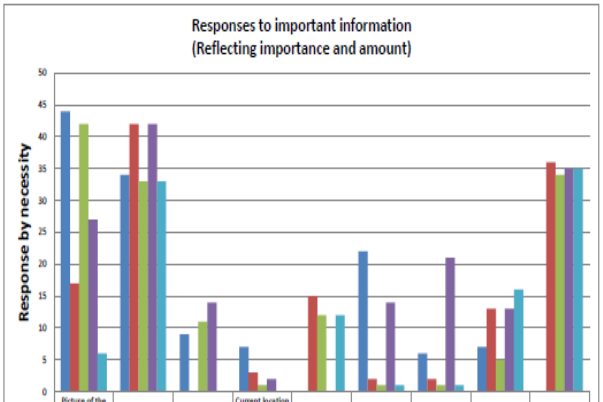
2. You are looking for your favorite author on the net, what are the information can help you to find him/her from a search result? (Medium context boundary)

3. You are looking for your favorite actor/actress on the net, what are the information would you think sufficient to identify him/her from a list of people? (Medium context boundary)

4. You are looking for your childhood school friend after 15 years of disconnection on the net, what are the information would you think necessary to identify him/her? (High context boundary)

5. You are looking for the author of a famous quote (you know it partially), what are the information would you think sufficient to identify him/her from a list of people? (Higher context boundary)

What usually thought to be more or less close was profoundly different from each other when users responded with their opinion. Here is the summarized table (Figure 3) with graph showing the result.



	Picture of the person (1)	Full Name (2)	Nick name (3)	Current location (4)	Profession (5)	Date of birth (6)	Hometown (7)	Nationality (8)	A - 9
Q - 1	44	34	9	7	0	22	6	7	
Q - 2	17	42	0	3	15	2	2	13	36
Q - 3	42	33	11	1	12	1	1	5	34
Q - 4	27	42	14	2	0	14	21	13	35
Q - 5	6	33	0	0	12	1	1	16	35

Figure 3. Responses to required metadata in five different contexts.

For question 1, picture, full name, date of birth ranked high respectively. Others being dwarfed can be considered less relevant or necessary. There was no ninth property for this question. If only three pieces of information are enough for this context, then we are probably very close to a minimalist view of entity properties.

The result is similar for the third context (question) where still the picture and the full name dominate – "List of movies that s/he acted in". Note that another issue came to surface about the size of the list. We are not sure at this point how big the list could be since it may demand another study in its own right.

Other than contexts one and four, people hardly cared for date of birth and this is surprisingly true for the fifth context that an image is not necessary.

For context four, full name, List of schools s/he attended and a picture appear to be sufficient with the date of birth could help in some situations.

For question two, picture and profession followed by the full name and the list of literatures (ninth property) and for five, the full name and the list of similar quotes (ninth property) are towering high in the graph.

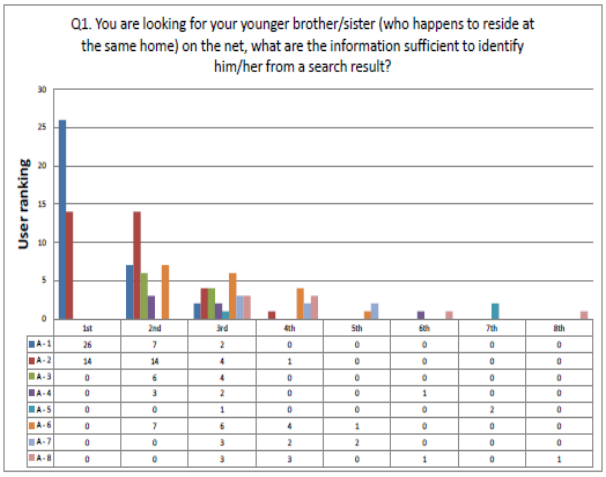
Now if we have a quick look on the landscape, not much metadata is really needed given a specific context.

b) The order of precedence

When we look at the order of precedence for the given contexts, there is a tradeoff between the natural order and the user's choice. Our contemplation counted both for achieving correctness and completeness.

Context 1: The person is very well known to the user.

A user looking for his/her brother/sister on the net provides the context of minimum context boundary. Here is how people responded.



	1st	2nd	3rd	4th	5th	6th	7th	8th
A - 1	26	7	2	0	0	0	0	0
A - 2	14	14	4	1	0	0	0	0
A - 3	0	6	4	0	0	0	0	0
A - 4	0	3	2	0	0	1	0	0
A - 5	0	0	1	0	0	0	2	0
A - 6	0	7	6	4	1	0	0	0
A - 7	0	0	3	2	2	0	0	0
A - 8	0	0	3	3	0	1	0	1

Figure 4. The picture should have sufficed though name is a necessity.

Figure 4 is the picture that tops all when we know the person with maximum possible details. Some participants ranked full name first to be ordered while others put it at the second position. No other metadata came at the first position.

The picture and the name both are voted, but in some cases name comes above the picture. Though the reason not clearly understood, we conceived from the common paradigm of metadata visualization, we always put picture above the name label, should they come together.

Context 2: The person is known by his/her name and work.

In figure 5, the picture goes on the top where an author (person) is mostly remembered by his/her name. Considering the order by picture first, then the list of literature and name at the last may appear little strange in reality.

Therefore, again the picture-name pair stays at the top followed by the list in order to maintain the convention as long as it does not conflict with the goal.

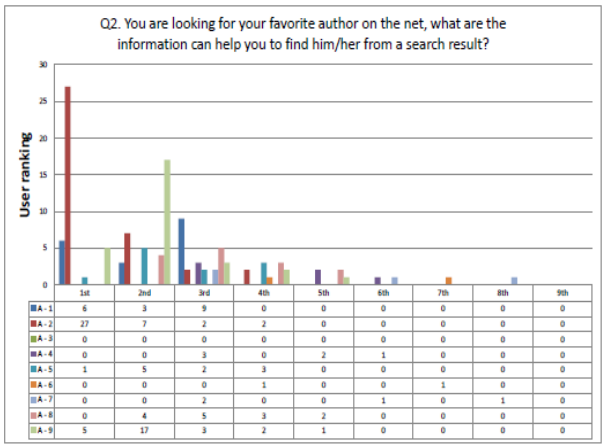


Figure 5. Our favorite author is known by his/her name though people ranked picture at the top.

Context 3: The person is known by his/her face and work.

While looking for our favorite actor/actress, the picture and the name pair alone makes the entity identifiable. Surprisingly, the anticipation did not work when participants put their opinion. It's the name first followed by the picture and the list of the movies (figure 6).

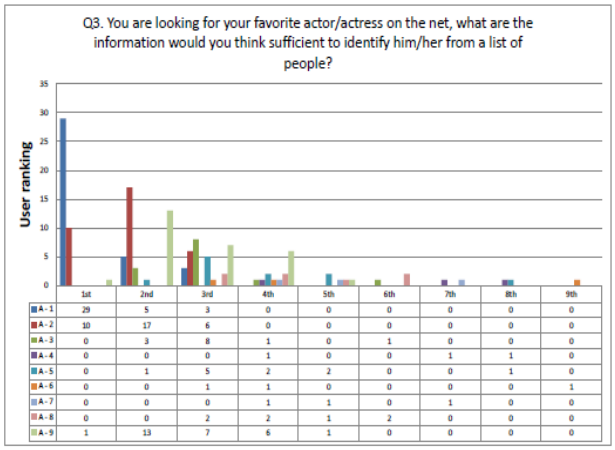


Figure 6. Our favorite actor/actress is known by appearance and identified by his/her name and picture.

Context 4: The person is remembered from childhood memories.

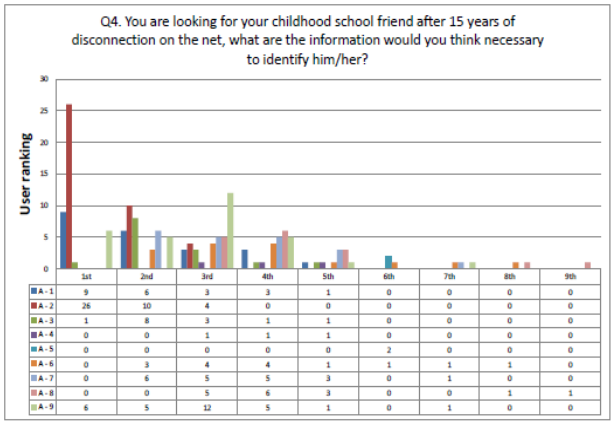


Figure 7. No matter what 15 years mean to make a big difference, people wanted to see the picture first.

Twenty six participants ranked name at the top followed by the list of schools she/he attended and the name. Nick name also has significance shown in figure 7.

Context 5: The person is not known, but a few of his/her words.

One of the participants suggested to treat this context differently as the person is search by the quote not by any prime properties of a person. Therefore, consider this totally a different context than the previous four. The person can only be identified by matching quotes as appears in the graph and can be learnt with other metadata. The contest between similar quotes and name could have occurred due to the chances that the person is known, but not with relation to the given quotation.

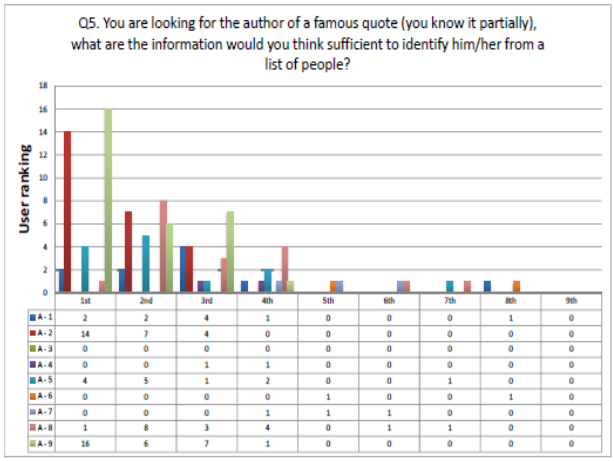


Figure 8. Other properties may help learn about the person if found correctly.

For all five contexts, different opinions exist and for the values being smaller, we put them aside from discussion. However, those less relevant but ranked metadata are considered for extended view when necessary.

B. Case study on YouTube in Different Contexts

YouTube is a video-sharing website on where users can upload, view and share videos which is subsidiary of Google. When a user registers in YouTube he /she provide the information like Email, country, time zone, Date of Birth etc. So for a valid user of Google/YouTube, the server records the above information in Database. Now when a user uploads a video these information become the metadata of that video. We tried to identify the application of required types, amount and order of metadata in YouTube for different context. In this study we prepared five contexts and asked the user to search each of them in YouTube using a given set of keywords. These keywords are taken from frequently searched queries stored by Google engine. There were 50 participants in the study seeking for a specific video in five different contexts given a set of keywords (metadata) presented to them. A video can be identified by following five criteria, though participants had the freedom to add properties of their own choice.

1. Title of the video
2. Thumb of the video
3. Upload Date
4. Number of Views
5. Uploaded Person

a) The types and amount of metadata

We perceived five scenarios for five contexts and asked in a form of questions with predefined answers (mentioned in the previous section). The users are also given a set of keywords as mentioned earlier to search the video. The questions were as follows –

1. To search the latest video footage of Hurricane in Bangladesh. Sample keyword: (hurricane in Bangladesh, hurricane in Bangladesh in most recent year etc.)

2. To search the last Euro cup football final video. Sample keyword: (last euro cup football final, current video of euro cup final etc.)

3. To search videos of live performance of Madonna last year. Sample keyword: (live performance of Madonna in last year etc.)

4. To search a video uploaded by user with the title "My son's first walk". Sample keyword: (my son's first walk on "uploaded date", my son's first walk by "username" etc.)

5. To search the latest episode of Big Bang Theory with sample keyword (latest episode of Big Bang Theory, recent update of Big Bang Theory etc.)

For most of the scenarios, user failed to identity their desired video but in some cases user recognized the videos by Title of the video and Upload Date. All of the users used our given keyword lists for searching though they had option for adding new query.

We used confusion matrix on the result of the survey to calculate the true positive rate for each of the given queries/keywords on each of the criteria in different contexts.

Now if we look at the results, some of the required metadata are not tagged in different contexts which failed the user to find preferred video result.

b) Accuracy in different contexts

Though the context query list was prepared from the frequently searched keywords and user had permission to add new queries, but in most of the cases user couldn't find their desired video in different contexts.

Context 1: The event type and place is known.

The user looked for the videos of hurricane in Bangladesh on YouTube provide the context of minimum context boundary in figure 9.

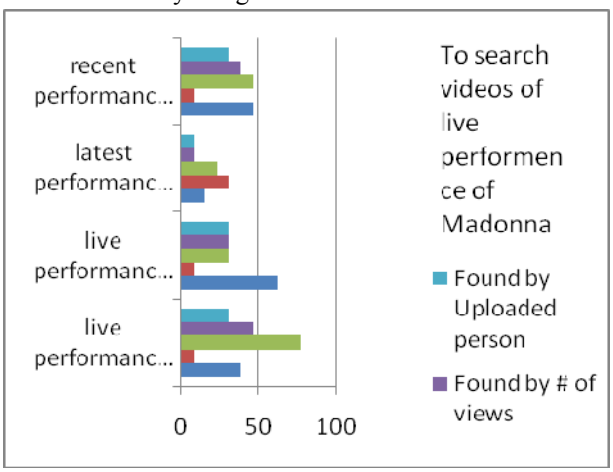


Figure 9. Some of the user recognized recent hurricane footage from the Thumb results though it's practically impossible.

The actual result of this search came up with series of videos containing "Hurricane", "Bangladesh" etc in its title or description though most of them are irrelevant and the result are not recent though we searched from most recent Hurricane which actually occurred in 2009.

Context 2: The event and time boundary is known.

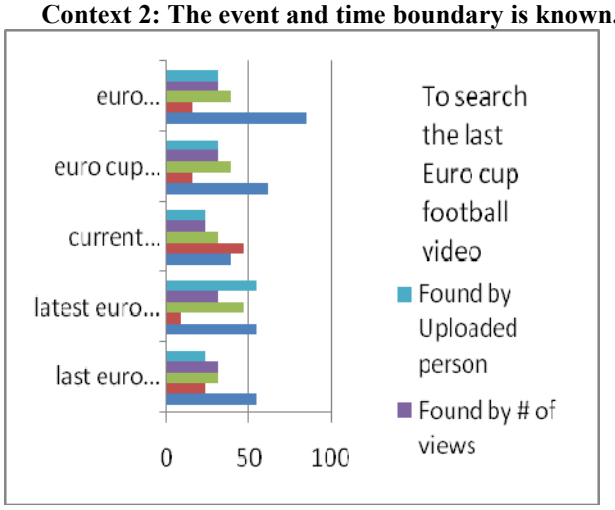


Figure 10. Pair of title and upload date shows comparatively high accuracy.

The users searched for the last Euro cup football final video. Some of the user recognized the video from title and the upload date. So the pair of title and upload date can identify this context though the accuracy is not satisfactory (figure 10).

Context 3: The event type, entity and time boundary is known.

While the user searched for videos of live performance of Madonna in last year, the results from different queries are totally irrelevant. For some of the keywords accuracy of thumb is higher but in other cases they are astonishingly low (figure 11).

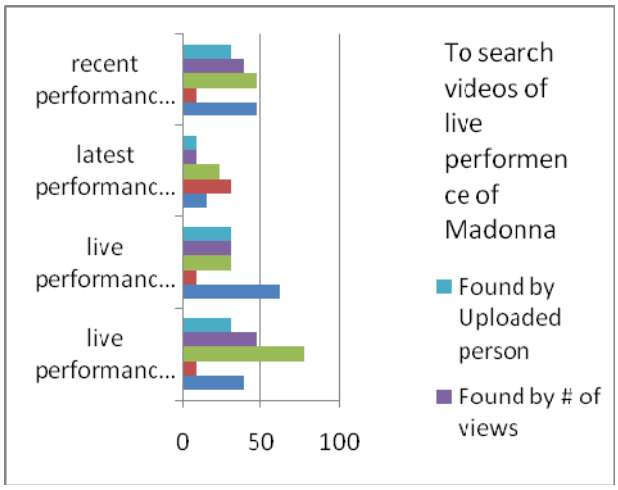


Figure 11. For context query 1, thumbs show higher accuracy but for other quires, results are scattered and not much accurate.

Context 4: The event title, entity and upload time.

User looked for a video uploaded by the user few moments ago with the title for example "My son's first walk". For most of queries user couldn't find the video they had uploaded moments ago (figure 12).

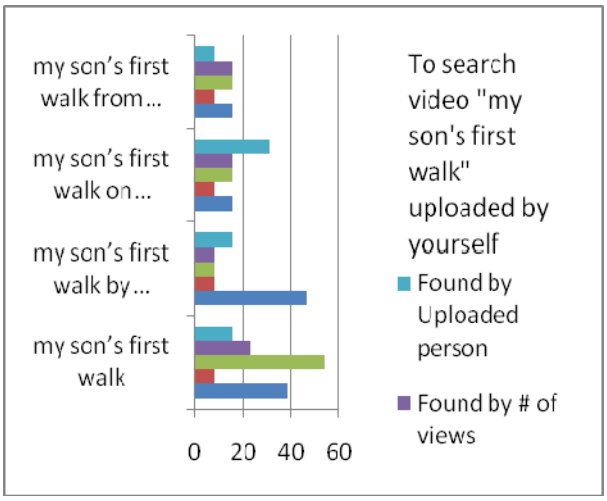


Figure 12. Most of the context queries showed very low correctness because of the user failed to find desired video.

Context 5: The event title and time edge is known.

User tried to search the latest episode of a famous TV serial named "Big Bang Theory" in figure 13. Though they got results containing "latest" keyword in title but the episodes were actually not latest. Rather than considering upload date the search engine showed all the videos of "Big Bang Theory" that contains the keyword "latest" in title (figure 13).

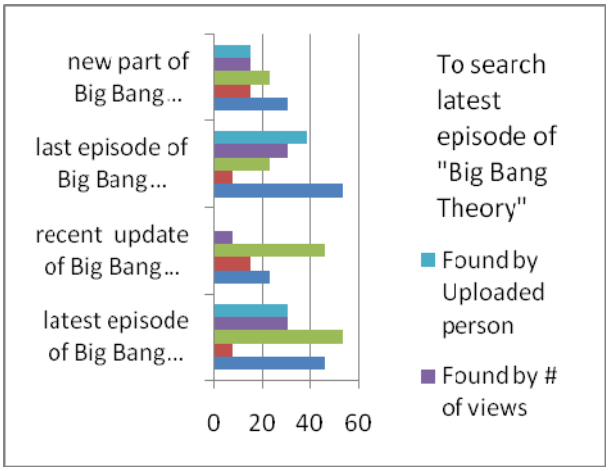


Figure 13. Though the entity and timeframe are known but results from different queries are not relevant.

Now, based on the survey and research, we found out search results on YouTube is not always precise and efficient as well as they can provide a far better result based on the data they recorded from users. For all the cases the common factor was, the search engine only has the capability to detect the words separately, rather than considering the minimal data set because the engine isn't intelligent enough to understand the context of the query. The engine failed to recognize "who is asking for what/whom at when and where", which leads to irrelevant results. Another reason is, YouTube engine considers same set of metadata for all contexts rather than considering different set of minimal metadata for different contexts, as we discovered in previous survey. Moreover, the engine doesn't have the ability to perform iterative query for unknown or large context which directs to completely unrelated results like context 1 (figure 9).

Besides, there is no verifying for date and time field; as a result it doesn't come up with the information of searching date and time. In addition, it cannot detect the user's location. As a result, when a user search something regarding his/her own location, the engine may provide some anonymous data from where user finds difficulties to get the required information. One more important finding is, in YouTube if somebody uploads his/her videos, it is really difficult to find the video, using the given video name even for the user, because of minimal hits.

VI. CONCLUSION AND FUTURE WORK

We have done a brief study to address fundamental issues of minimalist metadata visualization that makes an entity identifiable by human inspection. Minimalist metadata visualization for entity recognition has been investigated through user studies and we came up with valuable findings and directions. We believe the findings of our study will help to reduce cognitive load as well as it will help to reduce the error and effort.

In future, we have planned to develop a complete semantic engine that will understand the context boundary by collecting information about entity, context or event, try to reduce the context edge and minimize context metadata. The engine will have the ability to use iterative query if context boundary is unknown or too large.

REFERENCES

[1] Hasan K.T. A User Centric Interface for the Management of Past, Present and Future Events: International Doctorate School in Information and Communication Technology, DISI - University of Trento, April 2011.

[2] Abowd G., Dey A., Brown P., Davies N., Smith M., and Steggles P. Towards a better understanding of context and Context-Awareness.In Hans-W Gellersen, editor, Handheld and Ubiquitous Computing, volume 1707 of Lecture Notes in Computer Science, chapter 29, pages 304–307. Springer Berlin / Heidelberg, Berlin, Heidelberg, November 1999.

[3] Mateescu I., Nowell L., Williams L., Moe K.L. Advanced visualization of scientific metadata. Center for International Earth Science Information Network, Columbia University.Support for this paper was provided by U.S. National Aeronautics and Space Administration under Contract NAS5-98162.

[4] Klein P., Mueller F., Reiterer H., Limbach T. Metadata Visualization with VisMeB. 7th International Conference on Information Visualisation 2003 (2003) Publisher: IEEE Computer Society, Pages: 600-605.

[5] Nocke T., Schumann H. Metadata for Visual Data Mining. Meta (2002) Volume: 2, Publisher: Citeseer.

[6] Kumar V., Furuta R., Allen R.B. Metadata Visualization for Digital Libraries: Interactive Timeline. Editing and Review. In DL '98: Proceedings of the third ACM conference on Digital libraries (1998), pp. 126-133.

[7] Mutton P. and Golbeck J. Visualization of Semantic Metadata and Ontologies: Proceedings of the Seventh International Conference on Information Visualization (IV'03) 1093-9547/03 $17.00 © 2003 IEEE.

[8] Zeng M.L. and Qin J. Metadata: Published by Neal-Schuman Publishers, Inc. 100 William St., Suite 2004 New York, NY 10038.

[9] Understanding Metadata: NISO Press National Information Standards Organization 4733 Bethesda Avenue, Suite 300 Bethesda, MD 20814 USA Email: nisohq@niso.org URL: www.niso.org

[10] Video Archive: www.youtube.com, Retrieved on: May 2012.