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MEMO GRAPH: An Ontology Visualization Tool for Everyone

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Abstract

This paper presents a user-friendly tool, called MEMO GRAPH, for visualizing and navigating ontologies. Compared to related work, MEMO GRAPH is designed to be used by everyone, including ontology experts and users not familiar with ontologies. It provides an accessible and understandable user interface that follows the "design-for-all" philosophy. Precisely, it offers an Alzheimer's patients-friendly interface. The MEMO GRAPH ontology visualization tool is integrated in the CAPTAIN MEMO memory prosthesis and it is applied for visualizing a small-scale ontology (PersonLink) and a large-scale ontology (DBpedia). We discuss the encouraging results derived from the preliminary empirical evaluation, which confirms that MEMO GRAPH is an intuitive and usable ontology visualization tool.

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Keywords: Semantic Web; Ontology; Visualization; Design-For-All; Alzheimer's Disease Patient; User Interface

1. Introduction

In the context of the VIVA* project ("Vivre à Paris avec Alzheimer en 2030 grâce aux nouvelles technologies"), we are proposing a semantic web application, based on RDF ontology, to help users to palliate mnesic problems. This memory prosthesis, called CAPTAIN MEMO, is mainly designed to be used by individuals who are showing early/moderate signs of Alzheimer's disease[1].

* http://viva.cnam.fr/

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Alzheimer's patients present particular characteristics that differ from other user groups, parts of them are related to Alzheimer's disease and the other parts are related to the normal effects of aging. These characteristics impair Alzheimer's patients to use standard user interfaces. Thus, the difficulty in using interfaces is one of the reasons that prevent Alzheimer's patients from using software applications[22, 23].

In the context of the CAPTAIN MEMO prosthesis, we need to visualize the ontology as a graph which has the particularity to be understandable and accessible to individuals showing early/moderate signs of Alzheimer's.

There are a lot of ontology visualization tools available in the literature. However, only few of them are dedicated to users less/not familiar with ontologies. In addition, to our best of knowledge, there is no ontology visualization tool which follows the "design-for-all" philosophy. This philosophy consists of considering not only intelligent healthy users who master technologies, but everybody of all ages and abilities, including obviously the elderly suffering from Alzheimer's disease.

In this paper, we propose an easy-to-use tool, called MEMO GRAPH, for visualizing and navigating OWL/RDF ontologies. Compared to related work, MEMO GRAPH is designed to be used by everybody, including ontology experts and users not familiar with ontologies. It provides a user interface that follows the "design-for-all" philosophy. Precisely, it offers an Alzheimer's patients-friendly interface.

The remainder of this paper is structured as follows: Section 2 presents some existing ontology visualization tools. Section 3 reviews the main characteristics of Alzheimer's patients and proposes a set of design guidelines which should be taken into account for designing interfaces dedicated to these particular users. Section 4 gives an overview of the MEMO GRAPH ontology visualization tool. Section 5 gives some applications of the developed tool. While Section 6, presents the evaluation of the MEMO GRAPH that it is conducted on both experienced ontology users and Alzheimer's patients. Section 7 draws conclusions and future research directions.

2. State of the Art: Ontology Visualization Tools

In this section, we present a comparison of some existing ontology visualization tools. We classify these tools, according to the target user, into two categories: "*Ontology visualization tools for only ontology experts*" and "*Ontology visualization tools for everyone*". The first category regroups the ontology visualization tools that target only ontologists. The second category regroups the tools that target not only ontologists, but also users less/no familiar with ontologies. Table 1 summarizes the main characteristics of some visualization tools.

Table 1. Comparison of the most recent ontology visualization tools.

	2D/3D	Representation			Interaction			Development platform	Ontology	Availability
		Classes And instances	Object properties	Datatype properties	Filter	Search	Zoom			
"Ontology visualization tools for only ontology experts"										
Protégé class browser [2]	2d	Classes as nodes in an indented tree. Instances displayed in a separate window.	-	+	+	+	-	Java	RDF, OWL	+
OWLViz [†]	2d	Labeled colored ellipses.	-	-	+	-	+	Java	OWL	+
KC-Viz [3]	2d	Classes as labels.	+	-	+	-	+	Java	OWL	+
OntoGraf[‡]	2d	Classes as labeled rectangles with a small brown circle. Instances as labeled rectangles with a purple diamond.	+	-	+	+	+	Java	OWL	+
TGViz Tab[4]	2d	Classes and instances as labels of different colors.	+	-	+	+	+	Java	OWL	+
GrOWL[5]	2d	Classes as labeled rectangles	+	+	+	+	+	Java	OWL	-
OWLPropViz[8]	2d	Classes as labeled ellipses.	+	-	+	-	+	Java	OWL	+

† http://protegewiki.stanford.edu/wiki/OWLViz

‡ http://protegewiki.stanford.edu/wiki/OntoGraf

SOVA[**]	2d	Classes as labeled rectangles.	+	+	+	-	+	Java	OWL	+
Jambalaya[6]	2d	Rectangles inside their parent node. Different colors for classes and instances.	+	-	+	+	+	Java	OWL	+
GLOW[7]	2d	Various layouts are available. Top class is placed in the outer ring having sub-classes placed in consecutive inner circles (inverted radial trees). Classes as labels around the central node (force-directed graph).	+	+	-	-	+	Java	OWL	+
ezOWL[8]	2d	Class as a table (name /properties).	+	+	+	-	+	Java	OWL	+
IsaViz[††]	2d	Classes and instances as labeled ellipses.	+	+		+	+	Java	RDF	+
OntoViz Tab[9]	2d	Rectangle nodes with different colors for classes and instances.	+	+	-	-	+	Java	OWL	-
OntoSphere[10]	3d	Classes and instances as spheres.	+	-	-	-	+	Java	OWL, RDF	+
Ontorama[11]	2d	Classes and instances as labels around the central node.	+	+	-	-	-	Java	RDF	-
Onto3DViz[12]	3d	Classes are represented as 3d spheres. Instances are represented as 3d boxes.	+	+	+	-	+	Java	OWL	-
NavigOWL[13]	2d	Classes and instances as circles. Different colors for classes (yellow) and instances (purple).	+	-	-	+	+	Java	OWL, RDF	+
RDF Gravity[‡‡]	2d	Classes and instances as labeled rectangles. Different colors for classes and instances.	+	+	+	+	+	Java	RDF, OWL	+
CropCircles[15]	2d	Classes and instances as concentric circles.	+	-	-	+	+	Java	OWL RDF	+
OWLGrEd[16]	2d	Class as a table (name /properties).	+	+	-	-	+	Java	OWL	+
OntoTrack[17]	2d	Tree nodes are rectangles containing a label.	-	+	-	+	+	Java	OWL	+
Knoocks[20]	2d	Classes represented as blocks (rectangles).Every block stands for a class with its subclasses.	+	+	+	+		C#	OWL Lite	
VOM[§§]	2d	Classes represented as labeled rectangles.	+	+	-	-	+	Java	OWL-DL	+
OntoTrix[21]	2d	Classes represented as labels.	+		+	+	+	Java	OW, RDF	+
"Ontology visualization tools for everyone"										
OWLeasyViz[14]	2d	Classes as labeled ellipses.	+	+	+	+	+		OWL	-
WebVOWL[18]	2d	Classes as labeled circles.	+	+	+	-	+	HTML, CSS JavaScript	OWL	+
ProtégéVOWL[19]	2d	Classes as labeled circles.	+	+	+	-	+	Java	OWL	+

The careful analysis of the mentioned ontology visualization tools, leads us to the following comments: First, most tools are designed only for ontology experts. Second, there is no tool that illustrates the "design-for-all" philosophy (e.g., there is no tool that uses the speech-to-text modality for the key word search option). Third, few of the mentioned tools represent all key elements of the ontology (i.e., classes, instances, datatype properties and object properties) and show data properties as labeled links. Finally, few of the tools are implemented as standalone applications; most are provided as plug-in for ontology editors like Protégé.

Compared to related work, MEMO GRAPH is designed to be used by everybody, including ontology experts and users not familiar with ontologies. It provides a user interface that follows the "design-for-all" philosophy. Precisely, it offers an Alzheimer's patients- friendly user interface. Thus, to adapt MEMO GRAPH to the special needs of an Alzheimer's patient; we have to know their main problems and the design guidelines which should be taken into account for designing user interfaces for the particular users.

3. Designing User Interfaces for Alzheimer's Patients

Interfaces devoted to Alzheimer's patients are not that common[22]. The difficulty in using interfaces is one of the reasons why Alzheimer's patients are not comfortable to use a computer or software[22, 23]. The design of the

§ http://protegewiki.stanford.edu/wiki/OWLPropViz
** http://protegewiki.stanford.edu/wiki/SOVA
†† https://www.w3.org/2001/11/IsaViz/overview.html
‡‡ http://semweb.salzburgresearch.at/apps/rdf-gravity/
§§(Visual Ontology Modeler) http://thematix.com/tools/vom

interfaces should suit the user's needs[23] to be accessible and easily used. In this section, we discuss the expected changes which accompany the Alzheimer's patients. We propose a set of design guidelines, collected from the literature, which should be taken into account for designing interfaces dedicated to Alzheimer's patients.

Most Alzheimer's patients are elderly and thus have the normal limitations associated with aging[24]. So, the changes which accompany the Alzheimer's patients can be grouped into seven groups:

- *"Memory impairments"* - One of the most common symptoms of Alzheimer's disease is memory loss[23], especially short-term memory/forgetting recently learned information. The semantic data is preserved in long-term memory[24].

The interface should give some feedback after every action, use short messages[27], support users in their interaction e.g. through a speaking front-end[27] and use consistent navigation throughout the application.

- *"Cognitive impairments"* - The cognitive ability is one of the functions that decline due to Alzheimer's disease[23]. Cognitive ability is the ability to generate ideas, to think, to remember and to focus on. Alzheimer's disease causes a decrease in cognitive abilities such as the level of intelligence, speed of information processing, ability to learn, reasoning, judgment, attention ability[25], ability to solve problem and concentration ability[25].

The information should be summarized and categorized semantically into short categories. The headlines should be displayed on the top of the interface[30]. Images and icons should be simple, meaningful and easy to understand[30]. Text should be clear and avoid abbreviations[26, 27].Links should be underlined to make them identifiable. The design should be simple[24] and only main information should be displayed[29, 28]. The interface's distracting elements should be avoided[28, 30]. Multimodal solutions facilitate the comprehension[29].

- *"Visual impairments"* - Old people experience a decline in their vision[26, 25]. Aging is accompanied by a loss in visual acuity[23, 27], decline in peripheral vision[26], decrease in dark adaptation[29], impairment of near-focus[24] including a computer screen[26], and decline in color sensitivity[26, 29]. The Alzheimer's association reports that over 60% of Alzheimer's patients experience a decline in at least one visual capacity.

The interface should have an appropriate size of design elements and text, use at least 12-points to 14-points type size[28, 25] and 16-points for headings, avoid large blocks of bold or underlined text[26], use left aligned text[30], put the ability of zoom in the interface[24, 29, 30], use a sans-serif font type[26] and a medium face type[30], use soft colors[26], avoid decorative fonts[24] and maximize the contrast between foreground and background colors[28, 26, 30].

- *"Hearing impairments"* - Aging is related to declines in auditory acuity[24, 29, 27, 25, 26, 28]. Old people may suffer from another complaint that they can hear people talking, but they can't make out the words[24]. They may also find it hard to understand synthetic speech[29].

So, it is recommended to use, by default, higher sound[30], increase the duration of sound signal[30] and place a volume control in an easy to find spot[30]. The auditory information should be spoken slowly, pause slightly after each statement [24], use male voice[30, 28] and use natural speech[24, 29].

- *"Mobility impairments"* – The mobility decline with aging[27, 29, 26, 25, 28]. Seniors with manual dexterity impairments have difficulties to operate with the mouse and keyboard. It is difficult for them to position the cursor if the target is small, and they have problems with control of fine movements.

The design should contain large targets for accurate selections, use an audio supported menu, avoid the use of scrolling[30, 26] and pull-down menus[26] and use touch screens[25, 28].

- *"Declining speech abilities"* – Speech ability declines with aging[25]. Old people have problems in pronouncing complex words. Therefore, the speech input can be limited by voice tremors.

So, to accommodate this problem, acoustic models specialized for the elderly should be used for the speech-to-text modality[28].

- *"Decent/no literacy skills"* – The illiteracy rate of seniors aged 65 years and above is important. Besides, many seniors are literate; however they have basic literacy skills. They may not fully understand text-based information. Most seniors have difficulties with typing; they may forget how to write words.

It is recommended to use graphical metaphors or sounding when users cannot read easily[29], identify buttons by icons and labels, minimize the use of a keyboard and use the dictation mode for typing.

Based on these design guidelines, we develop the user interface of MEMO GRAPH, since we believe that the mentioned changes related to Alzheimer's and the aging process impairs the patient to use standard user interfaces.

4. Overview of the MEMO GRAPH Ontology Visualization Tool

The MEMO GRAPH ontology visualization tool is designed to be used by everyone, including ontology experts and users not familiar with ontologies. It provides a user interface that follows the "design-for-all" philosophy. Precisely, it offers an Alzheimer's patients-friendly user interface. Based on the accessibility guidelines mentioned in section 3, we make the design of MEMO GRAPH.

MEMO GRAPH represents OWL/RDF ontology as a graph. The visualization is displayed using a force-directed algorithm. This algorithm presents 3 main advantages: (a) It optimizes the use of screen space. (b) It helps to reflect the relative importance of the classes in the resulting graph since it arranges the nodes in a way that highly connected classes are placed more to the center of the visualization, while less connected ones are rather placed in the periphery. (c) It tends to increase the readability of the visualization since it tends to avoid edge crossings.

MEMO GRAPH visualizes all key elements of the ontology as it displays classes, instances, datatype properties and object properties. The role relations between related nodes are represented, in the graph, using labeled links.

In contrast to related work, the MEMO GRAPH ontology visualization tool identifies nodes by using pictures and labels. The use of the picture facilitates the comprehension and makes nodes distinguishable from each other. The picture can automatically be extracted from Google by our interface if not provided by users.

The interface has the appropriate size of design elements and text. We use 15 pt to 25 pt type size for displayed texts and we provide large nodes. We use a black font on soft colored background to maximize the contrast between foreground and background.

We put the ability of zoom in the graph. The right-clicking on the graph allows the user to zoom-in or zoom-out. The zoom in is only geometric. We use a simple and slow animation speed. Clicking on a node allows it to be bigger and distinguishable from the others.

MEMO GRAPH supports the search functionality in two ways. First, a key word search option is supported to search and highlight a specific element in the graph. For the key word search option, we provide two modalities for typing: the traditional mode and the dictation or speech-to-text modality. We give the possibility of alternating between modalities. Second, the developed tool gives the possibility to search via the graph i.e., whenever a node is selected in the graph, its details are shown in the sidebar.

We use an easy to understand wording and we don't use the ontology jargon, in order to have an understandable user interface to everyone and not only for ontology experts.

We add an auditory background to MEMO GRAPH in order to support the users in their interactions. We use, by default, higher sound for delivering the auditory information. We enable users to adjust the volume at their will. The auditory background can turn on or off. We use a male voice and natural speech.

The layout of the user interface is designed to be simple as possible. The interface of MEMO GRAPH is divided into three parts: The "MEMO GRAPH Viewer" displaying the ontology visualization as a graph, the "MEMO GRAPH details" listing details about a selected node, and the "MEMO GRAPH search" providing a key word search option. In order to make these three parts distinguishable, we use different color for each frame.

MEMO GRAPH is a semantic web application based on J2EE platform. So, it is not limited to any platform machine and requires only a valid ontology as input. It is developed as a standalone application and it can be integrated in other projects.

5. Applications of the MEMO GRAPH Ontology Visualization Tool

In this section, we give some applications of the MEMO GRAPH ontology visualization tool. MEMO GRAPH is integrated in the ongoing CAPTAIN MEMO memory prosthesis and it is applied, as a standalone application, for visualizing a small-scale ontology (PersonLink) and a large-scale ontology (DBpedia).

5.1. Integration of MEMO GRAPH in the ongoing CAPTAIN MEMO memory prosthesis

The ongoing CAPTAIN MEMO[1] prosthesis is a semantic web application to help individuals showing early/moderate signs of Alzheimer's disease to palliate mnesic problems. In particular, it helps patients remind their family members and their surroundings. It is also devoted to "remember things about people" e.g., retrieving a

person by navigating in the family/entourage tree. CAPTAIN MEMO is based on RDF ontology which describes people, animal and the relationship that may exist between them. It comprises 4 classes described by 138 properties. We integrate MEMO GRAPH into CAPTAIN MEMO to show this ontology as a family/entourage tree. Fig. 1 shows a screenshot of CAPTAIN MEMO which shows the family/entourage tree generated using MEMO GRAPH.

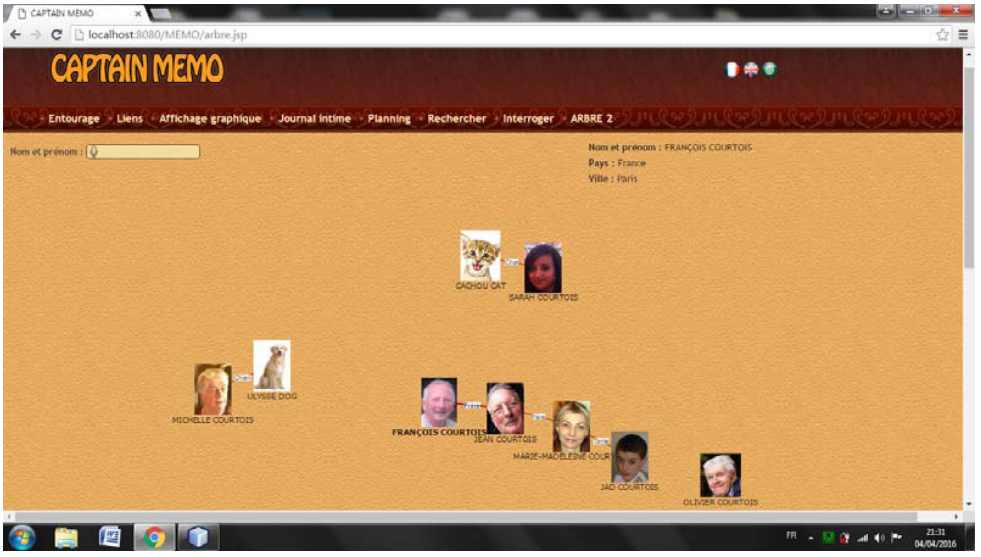

Fig. 1. Screenshot of the ongoing CAPTAIN MEMO prosthesis which shows the family/entourage tree generated using MEMO GRAPH.

5.2. Visualization of the PersonLink Ontology with MEMO GRAPH

PersonLink[31] is a multilingual and multicultural ontology for modeling, storing and reasoning on "family relationships". This ontology comprises 3 classes, 86 properties and 227 instances. Fig. 2 shows a screenshot of the MEMO GRAPH ontology visualization tool that it is used to visualize the PersonLink ontology.

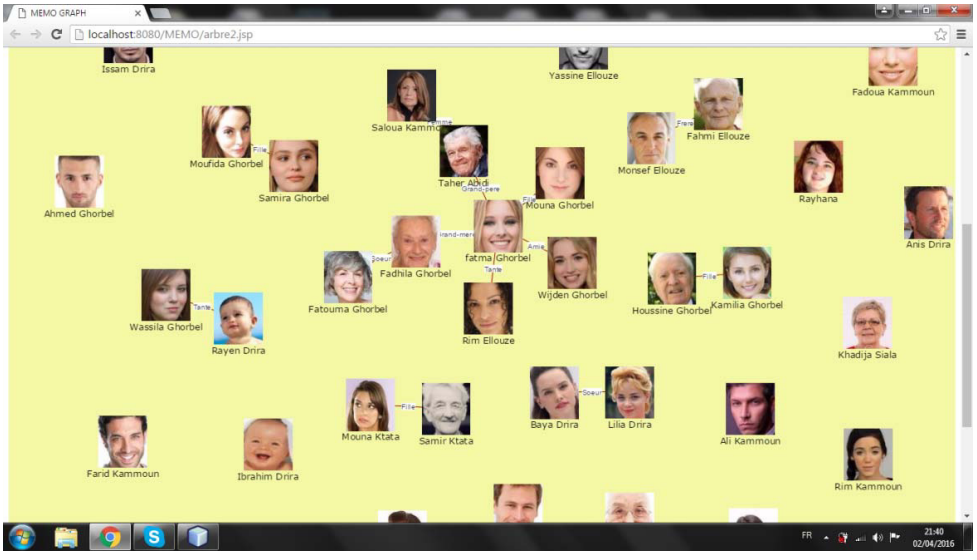

Fig. 2. Screenshot of the MEMO GRAPH ontology visualization tool used to visualize the PersonLink Ontology.

5.3. Visualization of the DBpedia Ontology with MEMO GRAPH

We have tested MEMO GRAPH on a part of the well-known DBpedia ontology[***] which is a knowledge base built from extracted and structured data from Wikipedia. We visualized the instances of the "Sport" class. Compared to related work, MEMO GRAPH presents the highlight that it automatically adds pictures, from Google, to the visualized nodes. Fig. 3 show a Screenshot of MEMO GRAPH used to visualize a part of the DBpedia Ontology. We select the instance "Tejo" to display details about it in the "MEMO GRAPH details" frame.

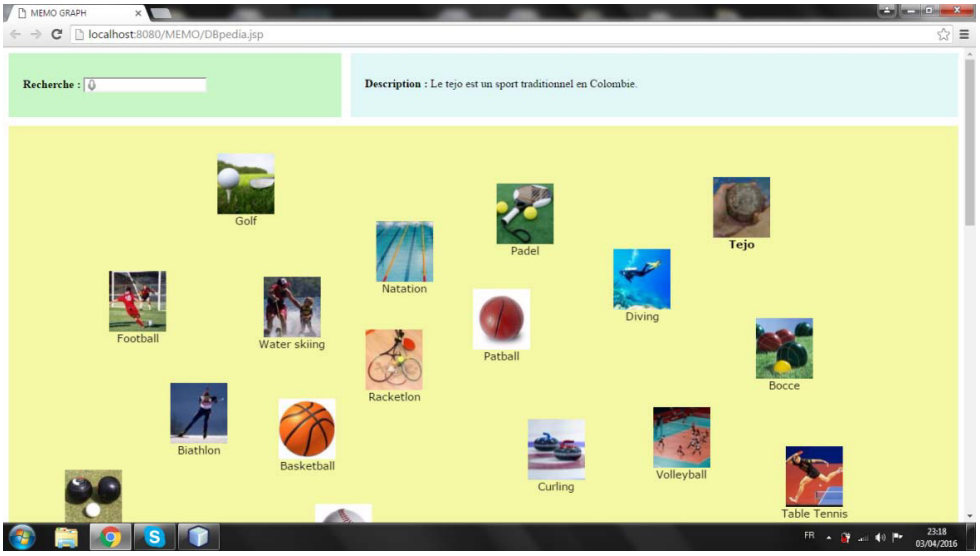

Fig. 3. Screenshot of the MEMO GRAPH ontology visualization tool used to visualize a part of the DBpedia Ontology.

The current version of MEMO GRAPH does not offer the necessary interaction elements to support the visualization of the whole DBpedia ontology (it currently covers 685 classes which are described by 2,795 different properties and contains about 4,233,000 instances).

6. Evaluation of the MEMO GRAPH Ontology Visualization Tool

The MEMO GRAPH ontology visualization tool targets everybody and provides a user interface accessible to Alzheimer's patients. Thus, the evaluation phase is performed in two steps. Firstly, we evaluate the performance of the implemented tool with experienced ontology users. Secondly, we evaluate the accessibility of the interface of the MEMO GRAPH ontology visualization tool with Alzheimer's patients. These two points are presented in the next paragraphs.

6.1. Evaluation by Experienced Ontology Users

In order to gather initial data about the performance of the MEMO GRAPH ontology visualization tool, we have carried out an empirical evaluation, which required 24 experienced ontology users to perform some ontology engineering tasks. The participants are members of the MIRACL laboratory (University of Sfax, Sfax-Tunisia). They are selected based on their scientific profiles. Before the experiment, participants are asked about their expertise in web semantic, ontology, ontology representation languages, and ontology visualization tools.

[***] http://dbpedia.org/

The participants are randomly allocated to three different groups, labeled GX, GY, and GZ, where each group used a particular configuration of ontology engineering tools. The members of the group GX solved the tasks using RDF Gravity. The members of group GY are asked to carry out the tasks using the WebVOWL. The members of group GZ carried out the tasks using the MEMO GRAPH. Finally, the participants in groups GX and GY are given a demo of MEMO GRAPH and asked to provide feedback about the developed tool. This allows us to get feedback about MEMO GRAPH from all 24 subjects in the evaluation.

At the beginning of the session, a participant is briefed about the aim of the experiment. To avoid being in favor or against a specific tool, the participants are told that the aim of the experiment is "to evaluate the different configurations of some ontology visualization tools". Then, we give the participants a tutorial, on the specific set of tools he/she wants use.

For the tasks we use the PersonLink[31] ontology (mentioned in section 5.2). For each task, we gave the participant a 5 minutes time slot. If he/she is not able to solve the task within 5 minutes, that task would be recorded as "fail". Table 2 shows the results of the experiment.

Table 2. Ontology engineering tasks and experimental results.

Ontology Engineering Tasks	RDF Gravity (GX)		WebVOWL (GY)		MEMO GRAPH (GZ)	
	Mean (min:secs)	Number of "fail"	Mean (min:secs)	Number of "fail"	Mean (min:secs)	Number of "fail"
Task 1: Which class has the highest number of direct connection classes in the ontology?	4:23	4	1:15	0	1:07	0
Task 2: Which data properties the class "Fatma Ghorbel" has?	0:56	0	3:05	5	0:47	0
Task 3: Which object properties the class "Fatma Ghorbel" has?	0:59	0	3:13	5	0:54	0
Overall mean/Total number of 'fail"	2:06	4	2:31	10	0:56	0

All tasks performed with MEMO GRAPH are completed within the 5 minutes time limit; while 14 tasks, performed with RDF Gravity and WebVOWL, are recorded as "fail".

On each of all tasks, the fastest mean performance is with MEMO GRAPH. The overall mean time is about 1 minute and 35 seconds faster than WebVOWL and about 1 minute and 10 seconds faster than RDF Gravity.

Those two ascertainments, confirm that the MEMO GRAPH is, comparatively, an efficient ontology visualization tool.

For the first task, the slowest mean time is with RDF Gravity. WebVOWL and MEMO GRAPH have approximately the same mean time and are about 3 minutes faster than RDF Gravity. This time gap is explained by the fact that WebVOWL and MEMO GRAPH display ontologies using a force-directed algorithm. This algorithm arrange the nodes in a way that highly connected classes are placed in the center of the graph, while less connected ones are placed in the periphery.

For the second and third tasks, RDF Gravity and MEMO GRAPH have approximately the same mean time and are about 2 minutes faster than WebVOWL. This time gap is explained by the fact that WebVOWL do not support a key word search option. Thus, the user takes more time to find the required node.

Participant in group GX and GY provide encouraging feedbacks about MEMO GRAPH. They say that it is intuitive and preferment. In particular, they appreciate the use of pictures to visualize classes and instances.

6.2. Evaluation by Alzheimer's Disease Patients

The evaluation of the accessibility of the user interface of the MEMO GRAPH ontology visualization tool is carried out with 22 Alzheimer's disease patients who are living in an assisted living environment in Sfax-Tunisia (Street Manzel Chaker km. 8). The participants have an average age of 64 years. Their profiles are summarized in terms of age, stage of Alzheimer's disease, difficulties in vision/hearing, computer skills and literacy skills.

This study was performed from July 2015 for about two months. For the tasks, we used the user interface that visualizes the same ontology used in 7.1. Tasks were performed on tablet PC. A stylus pen was used to input commands to the touch-screen. The questionnaire covers five dimensions which include: "*Overall Reaction*", "*Visibility*", "*Speech-to-Text*", "*Terminology*" and "*Auditory Background*". A five point scales are used: strongly

disagree (1), disagree (2), neutral (3), agree (4) and strongly agree (5). Table 3 summarizes the results and the mean score for each dimension.

Table 3. Summary of the questionnaire's results.

Question	(1)	(2)	(3)	(4)	(5)	Mean
"Overall Reaction" (overall mean=3,75)						
Is the interface easy to use?		3	3	5	9	4
Is it easy to learn to use the interface?		7	3	10		3,15
Are you satisfied about the interface?		3	3	3	11	4,1
"Visibility" (overall mean=4,57)						
Can you read the text?		2	2	1	15	4,45
Is the ability to zoom the graph useful?					20	5
Are images large enough?			3	2	15	4,6
Are the nodes large enough?			3	2	15	4,6
Is the animation speed reasonable?		1	4	5	10	4,2
"Speech-to-Text" (overall mean=3,8)						
Is the speech-to-text modality helpful for the key word option?	5			4	11	3,8
"Terminology" (overall mean=5)						
Is the wording used understandable?					20	5
Is it helpful to identify a node by using both picture and label?					20	5
"Auditory Background" (overall mean=3,93)						
Is the voice speed reasonable?	6			10	4	3,3
Are spoken interactions helpful?	6	2			12	3,5
Is the ability to adjust volume useful?					20	5

Only 20 participants fully complete all tasks. The others just start the first test. They say that they are too old and have no motivation in learning a new technology. Those participants are the oldest with Alzheimer's disease in moderate /late stage. They have no computer skills. We call them "patient-restricted users".

The overall mean score of the 5 dimension is between 3, 75 and 5. Overall, the results indicate that the users are almost agreed that the developed interface is accessible and easy to use.

25% of all participants say that it is easier for them to type with a virtual keyboard; since their voice volume is not enough to be captured by the device's microphone. Thus, in the next iteration, we will use acoustic models specialized for elderly people in the speech recognizer. Illiterate participants are satisfied with the dictation modality.

30% of all participants ignore totally the speaking front-end since they don't understand words. Thereafter, in the next version, we will use slower voice speed.

7. Conclusion and Future Work

This paper presents the MEMO GRAPH ontology visualization tool. This tool is developed to be used by everyone and not only by ontologists. It offers a user interface that follows the "design-for-all" philosophy. Precisely, it offers a user interface accessible to Alzheimer's patients. It also allows showing pictures for each node. The picture can automatically be extracted from Google by our interface if not provided by users.

At the beginning, we review some existing ontology visualization tool. This state of the art shows that most related work are designed only to be used by ontology experts and there is no tool that illustrates the principals of the universal design. Then, we discuss the expected changes related to the Alzheimer's and the aging process. Based on these changes, we believe that the interface plays a big role to ensure the accessibility of MEMO GRAPH. To accommodate those changes, we propose a set of design guidelines for interfaces to Alzheimer's patients. Based on these design guidelines, we develop MEMO GRAPH. It is integrated into the ongoing CAPTAIN MEMO prosthesis. MEMO GRAPH has also been applied, as a standalone application, for visualizing a part of the famous DBpedia large-scale ontology. Finally, a user satisfaction evaluation of MOMO GRAPH is carried out with 24 experienced ontology users and 22 Alzheimer's patients. The results confirm that the developed tool is efficient and user-friendly.

Future work will be devoted to ameliorate the actual version of MEMO GRAPH. Especially, we want to take into account the time variance and to manage the large-scale ontologies.

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