Distributed Ontology for the Needs of Disabled People

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Abstract: In French society, much help is provided to people. In the particular case of disabled people, it is quite difficult to deal with all the different information coming from heterogeneous contexts. Such different knowledge cannot be directly integrated, so we propose to build ontologies for each aspect. Three ontologies are built, each from different existing sources (thesaurus, ontology, …). Disability ontology includes the medical and social domain. Service ontology represents generic and local services. Individual needs ontology allows the individual file description and the link with the other ontologies. Each ontology will cooperate with the others. Then, the cooperation of these distributed ontologies must solve the problems of semantic conflicts. A framework is proposed to build each ontology and also to manage ontology collaboration.To ensure the representation of the guidance interactive process, we model a workflow to follow an individual file through its successive steps. This allows better long term assistance monitoring and proves the necessity for evolutive knowledge representation like ontologies.

1 INTRODUCTION

In France, disabled people can be helped in many different ways, for example the adaptation of one's home or lessons with a private teacher. Philosophically, Doat (2013) points out the necessity for the human society to have a good support for the weak or people with difficulties. Every case is particular however, there can be similar proposals. For the people concerned and their family, it may be baffling to know one's right. In fact, they have to summon up lots of heterogeneous knowledge and build a personal file to obtain help and services.

Our issue comes from two different problems. First, to create a help file for a disabled person, we have to manage a large amount of heterogeneous data and documents. They cannot be described with only one model. Some data is already described through ontologies. Some come from thesaurus. Lastly, some documents are not really organized. We suppose that ontology cooperation is an efficient way to deal judiciously with these sets of knowledge. Ontology modeling deals with the question of how to describe in a declarative and abstract way the domain information of an application, its relevant vocabulary, and how to constrain the use of the data, by understanding what can be drawn from it (Angele & Lausen, 2004)?

So, as we also have to solve semantic conflicts (Naiman & Ouksel, 1995) due to the cooperation of heterogeneous sources, we choose to use the ontology concept. The ontologies allow to recognize the concepts contained in the different sources; these concepts can be linked with synonymy, homonymy, etc. relations between sources. The ontology definition of Studer (Studer et al., 1998) based on (Gruber, 1993) is:"An *ontology is a formal, explicit specification of a shared conceptualization".* A 'conceptualization' refers to an abstract model of some phenomenon in the world by identifying the relevant concepts of that phenomenon. 'Explicit' means that the type of concepts used and the constraints on their use are clearly defined. 'Formal' refers to the fact that the ontology should be machine understandable and excludes natural language. 'Shared' reflects the notion, an ontology captures consensual knowledge, that is, it is not private to some individuals, but shared by a group.

Secondly, various people are present around a disabled person. They may reason in different ways and their words may be abstruse for each other. Building different ontologies and processing their cooperation will alleviate these communication problems. We must also be conscious that the context may be very sensitive for the people concerned.

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Distributed ontology is a relevant framework for the articulation between domain ontologies, knowledge management and activity. We apply this framework, at first, on the domain of disability. In this framework, we develop the basis of an infrastructure that connects information and processes. Our first goal is the description of each ontology. The second step is ontologies collaboration. At the end, we hope to propose a tool for managing individual files to obtain services linked to needs. In this paper, we propose to follow the building of the file through different steps using dedicated ontologies. The first step deals with the concerned entities. We build a conceptual structure to show the feasibility of a computer-aided process.

After a brief description of the context and some related works, we present the different conceptual schema of ontologies which contain knowledge. Finally, the individual needs ontology, which manage individual files, is described.

2 CONTEXT

2.1 Real Life Analysis

How can we associate and use together scientific resources, individual information and rehabilitation service documentation in the framework of an activity? We propose a distributed ontology that articulates different types of resources in the framework of this activity. It is founded on personal files and its objective is the proposition of services to a person. Of course, this person can receive one service: in this case the activity evaluates the relevance of this service and if it agrees with the needs. This process is then recursive. Our purpose is anchored on a specific activity: guidance of people with disability to relevant services.

People, which present some disability, must complete a file and give it to the regional house of disabled people, in French MDPH. MDPH role is to meet and take care of people presenting disability. It brings together social worker, doctor, nurse to assess the needs of the disabled person. The disabled people and their family are guided and informed along the development of their individual file by the MDPH. Then, a multidisciplinary team studies the personal objective and the specific needs of each people. This team is the CDAPH (committee of rights and autonomy of disabled people). It decides on the orientation and awarding of helps and services. In fact, the disabled person completes a form and join a medical certificate. It is the first step of official file submission. The MDPH studies this file with the concerned person. After validation of this document by the disabled person and the different members of the team of MDPH, the CDAPH assesses this file. The different decisions are recorded and a notification is send to all the concerned people (the claimer, social structures concerned by the decisions but also the paymaster).

2.2 Preliminary Proposition

Different users interact (see Figure 1). A disabled person creates its individual file. The information is stored in the "individual needs ontology". To create and select the different information, he is guided to choose the impairments and the needs in the "disability ontology" and the services in the "service ontology". After, social workers and the medical staff complete the individual file in coordination with the disabled person. At the end, the CDAPH assign services linked with the needs of the disabled person and the possible places in the local services.

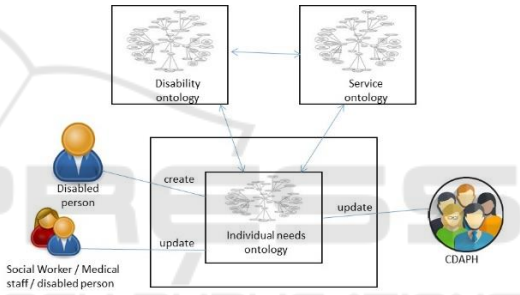

Figure 1: Users.

We focus on the conceptual model that allows the organization of the different information sources: bibliographic resources, personal files and services description. These sources are very distinctive both in their structure, description and organization.

It seems now established that Web, AI and database communities have successfully used ontologies as modeling and reasoning frameworks for the management of complex data, providing logical formalism or model theory (Parreiras et al. 2007). Furthermore, ontology aids in common understanding of domain conceptualization by providing enriched semantics (Banerjee & Sarkar, 2016). So, we propose a distributed ontology that represents independently each component. Each component is structured in a way to be used by the activity. We describe by three ontologies this activity: the first one describes knowledge organization for the disability, the second one the services and the third one describes the process of file creation leading to decision and regulation. These three parts concern people or individuals. But each considers distinctively the individual: for the

knowledge organization, it's a generic individual. For the process, individual is the object of the activity, it's the description of a real person.

Individual is the central notion that allows the distribution of ontologies. Need is the central concept that organizes the link from individual needs to disability regarding existing needs. Need is the issue of the deductions in the disability ontology. Activity is based on the expression and evaluation of the needs. At last, the process begins by a need and ends by its satisfaction.

The disability domain is unlike medical and health domain because it's a dynamic building that begins by the identification of a disease or disorder and that ends by identified disabilities. This process requires a succession of scientific investigations, including sociology, on the individual.

The organization of the scientific knowledge is only one part of the model. The individual needs ontology represents how the individual expresses his needs in the social context of an assistance and the rehabilitation service attribution. The last ontology links the individual needs and the individual rehabilitation. It represents schematically an activity. These three ontologies manage heterogeneous types, instances and references. They are partly inspired by Smith and Ceusters (2010) in their methodology for coordinated evolution of scientific ontologies.

Each ontology has a distinctive function:

- Knowledge organization for disability domain allowing to link libraries to practice, especially for individual description,
- Knowledge organization for service description in relation to individual needs,
- Workflow for file elaboration and sharing.

3 RELATED WORKS

We have chosen not to use an existing model, such as HI-ONTO (El-Diraby & Kashif, 2005) for example, because these models are not founded on the association of heterogeneous entities and they postulate the unity of the domain. In our case the domain is itself distributed and oriented to an individual satisfaction of a need. Disability is described by an international classification (ICF, 2001). This has been criticized because logical conceptual construction is not consistent. The second knowledge organization is the French thesaurus (French Thesaurus, 2012). These tools organize the domain following a modular principle. In this way they are organized by "micro-thesaurus" or sub-domains, (Ruggieri et al., 2001). Some efforts are engaged to build ontology on the basis of the classification, (Cuenot, 2015). We propose the elaboration of a specific ontology level that maps classes and thesaurus concepts to ontology. Our ontology integrates active and dynamic dimensions defined by a social characterization of disability. In this framework, disability is considered as a phenomena that aggregates different points of views, from medicine to socials. We follow this principle, considering that these different approaches are dependent. The ordering of these dependencies allows the consistency of the ontology and the use of the BFO vocabulary, (Arp et al., 2015). As in Basic Formal Ontology (BFO), (Grenon & Smith, 2004), the three top-level categories of independent continuant, dependent continuant and occurrent are used in our framework.

We do not create an ontology centered on the notion of service availability like (Ferrario & Guarino, 2009) but we deal with the building and the evolution of an individual file through the process in our ontologies. Our ontologies have not an upper level as DOLCE, (Gangemi et al., 2002), but a lightweight that focus on the needs of a specific domain: disability domain.

Like (Santos & al.,2009), our aim is providing help to clarify the users'demands. But our work is different as we do not provide computer mediated services. Of course, at the end, personal care services will be proposed to the disabled person. Nevertheless, we help him to build his file to claim those services.

Disability can be considered in the framework of non-formal ontology by (Edwards et al., 2014). They propose a social and embodied ontology that provides a theoretical framework for situating disability in the "ground of being", as an encapsulation of the limitations that are essential to the whole body-environment. Hence, embodied ontology moves beyond both the medical and social models of disability, both these models seek to reject limitation in different ways. Within the medical model, physical limitations are considered surmountable, while the social model rejects environmental limitations. From an embodied perspective, both physical and environmental limitations are essential to our humanity.

IAO-Intel contains ontologies applied to the explanation of data models and other terminology resources. The terms in these ontologies are linked together. Each ontology uses terms which are defined in terms of other ontologies (Smith et al., 2013). In our framework, the ontologies are also linked and we have also different levels as IAO-Intel.

We have chosen to consider the individual as the

basis of the relations between the different structures. The unity is characterized at first at the instance level. At the type level, the concept of individual is a guarantee of generality. The second basic concept is the need. It can be defined at the two levels too. This realistic foundation for ontology is articulated to a dynamic representation of a domain. These positions have been defined by Smith and Ceusters (2010) but have never been applied on complex domains like disability. This domain is intrinsically built by the articulation between a scientific knowledge, processes and services. These considerations are evidences for the actors but they have not been applied. Knowledge organization stays always static without any connection to the other dimensions of the domain: the proposition of services and the process have never been represented as we know. Especially, the relation between these three dimensions has never been conceptualized. This fact can be explained by the distinction between library, knowledge management and service representation.

4 GENERIC MODEL

We propose a generic model to articulate three different information sources:

- Scientific publications on disability, numerous resources, combined to achieve the disability ontology.
- The services ontology characterizes the matching of a personalized service with the individual needs and society offers.
- Process which attributes services to a person. This ontology describes a workflow implying different actors and a decision.

In opposite to monolithic domain ontology, we have proposed a distributed ontology to capture the different dimensions of a domain. This domain is built on an activity: the rehabilitation of people with disabilities. This activity requires different actors and at first the person called individual and one objective: the rehabilitation of this person.

The academic knowledge organization is unsatisfying to represent a pluri-disciplinary knowledge structure that integrates both scientific knowledge, individual expression and the availability of rehabilitation services in a specific location and time.

The link between these different dimensions is founded on the individual that is the object of the activity. This individual has needs and the satisfaction of these needs is the goal of the activity.

The process is the actors and files that allows the individual expression of the need and the representation of its evolution in time.

The process representation is intrinsically dynamic and requires for the examination of the individual situation a similarly logically knowledge representation. We have postulated that the building of the knowledge domain follows the path from a health perspective to a particular social, individual or contextual disability. This path is fundamental for the characterization of a need and identification of the tools or services that allow the satisfaction of this need.

Our aim and challenge is to manage two different levels of abstraction. On one hand, we try to deal with a great amount of knowledge stored in heterogeneous resources. On the other hand, we cope with individual information about the person's impairments and life. We propose, then to connect this individual data with documented and referenced information. The PROV-Ontology is shortly described with the following: "It provides a set of classes, properties, and restrictions that can be used to represent and interchange provenance information generated in different systems and under different contexts" (PROV, 2013). So, we have chosen to work with the PROV-Ontology to manage our dual issues described above.

Our three information sources are heterogeneous but they are interdependent. At a high level of generality, we distinguish clearly three entities: Individuals, Needs, Tools or Services. These structuring entities are always situated in context. Individual as singular entity participates to the different ontologies:

- As a categorized entity, an individual is a person with disability.
- As a person with needs, he participates to the personalized services.
- As a person that produces files and expresses its needs for the social services, it participates to the workflow.

The committee of the rights and the autonomy of the disabled people called CDAPH in France allocates services. But, it is in the "departmental house of the disabled people" (MDPH in France) that an individual can find all the information and the help to fill in the individual file. The impairments and the needs expressed in the file are chosen respectively among these drawn up by the thesaurus handicap (French Thesaurus, 2012) and SERAFIN-PH nomenclature (SERAFIN-PH, 2016).

The individual entity contains many attributes as the birthday, profession..., and refers to the different carers who can help him in the social context. It is the role of each of them which is displayed in Figure 2. The OBO

Relations Ontology (Oborel, 2017) has been used to represent the relations between the concepts.

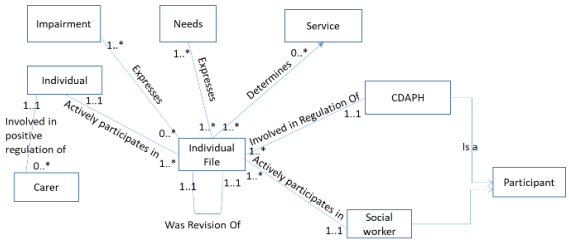

Figure 2: Individual needs Ontology.

We have chosen OBO Relations as they are meant for biological ontologies and each relation is well defined. The individual file describes the individual, this one is an entity but also an actor who participates in the building of his file. The individual must also list his carers. The individual, with the help of the social worker, expresses his impairments and his needs. Finally, services are expressed. Therefore, the social worker is also an entity and an actor. The CDAPH determines the possible services linked with the request and real life (places available in special institutes, home helpers,..). It is a recursive process. Each year, the individual updates his request and it is re-evaluated by the CDAPH.

5 ONTOLOGIES COLLABORATION

We are building three dependent ontologies (see Figure 3).The individual is central in the three but is described by categorization in the disability ontology. Artifacts are about this individual but represent only some relevant categories for the decision. At last, the process associates a service devoted to this individual considering some of its specificities.

We have not a mapping between these different ontologies but a knowledge distribution in conformity to action relatively to disabled people.

The disability ontology is built from different sources (French thesaurus, international classifications …) but also taking into account the social dimension. It is very important to deal also with the context of the person and not only the disability. The MDPH is the house of handicap social sciences. National and international scientific exchanges inside it allowed the creation of a thesaurus (French Thesaurus, 2012). This one in 2001 had 10992 terms. Now we reached the 4th version and the thesaurus contains 12825 terms. It includes the social and psychosocial angles of the handicap in France. It is the result of several resource centers collaborative work in the field of handicap.

We describe a need as a relation between an identified disability, an individual expression and a rehabilitation process. Need has a dual definition: at a type level, it is a relation between a disability, an expression and a rehabilitation service. By this information flow, we characterize how the three ontologies are connected under the question of the needs. A need is then defined both by the disability and the individual expression.

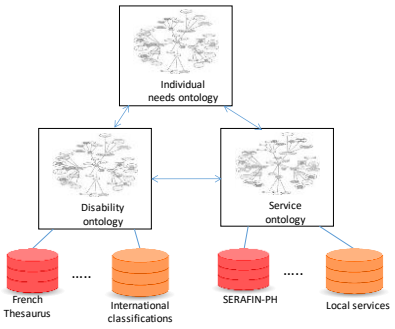

Figure 3: Ontologies.

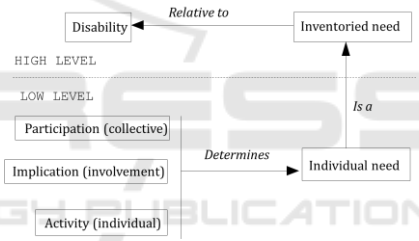

Figure 4: Need characterization.

Disability is a complex domain that can't be reduced to disease aspects or social action. In a way to represent the consistency of the domain, we propose different phases to characterize the path from a disease to a social action.

The ontology is a cognitive representation characterized by a two levels structure (see Figure 4):

- At the high level, the characterization of the person with eventually disability. This is the global consistency of the disability domain.
- At the low level, the context of the disabled person is segmented into a succession of situations where the internal disease is evolved into successive frames.

We present now, in the Figure 5, for a part, the ontology of services. This ontology allows the characterization of the satisfaction of the need. It integrates some characteristics of the service ontology like the distinction between a service prescription and a service description. This distinction allows the link

between the generic SERAFIN-PH nomenclature (SERAFIN-PH, 2016) and the local organizations presentation of services.

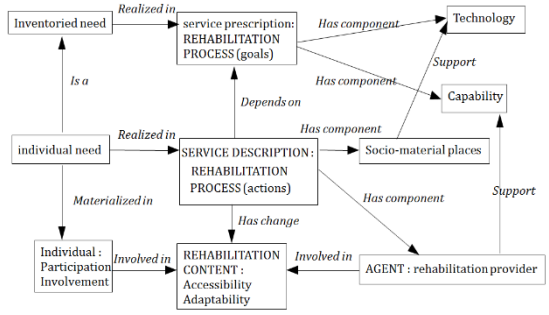

Figure 5: Service Ontology.

The service ontology is built from the serafin-PH nomenclature, it's constituted of needs nomenclature and service nomenclature. It contains:

- Need descriptions of assisted people
- Service descriptions address person's needs.

The local services are also added with the place number in each health care facility with the free places.

The building of the disability and service ontologies are a challenge because they are built up using different databases or thesaurus in French and in English. The mapping between the terms and the heterogeneity of terms is a real complexity. The process must find in the disability and service ontologies the good impairments, needs and services consistent with the needs of the concerned disabled person and reference them in the last ontology. We insist on the individual participation by the concept of "rehabilitation content" that describes the benefit of the service.

6 WORKFLOW

In the Figure 6, the UML use case diagram (Rumbaugh et al., 2004) represents the functionality of the individual file building by the disabled person. It's followed by its updating by the medical staff and social worker. The disabled person describes his diseases and his environment. He chooses the impairments and his needs thanks to the disability ontology. In fact, many propositions are made to him from his situation. After, the request is evaluated by the social worker and the medical staff and is updated in agreement with the concerned person. For example, many services are automatically selected in the service ontology by the system and are proposed. The staff helps the user to choose the right ones. Finally, the CDAPH studies the request and offers services in connection with the demand and with the local possibilities.

The PROV Ontology, (PROV, 2003), has been used to describe the "individual file" creation and evolution. At the end, services are or not attributed to the individual which has expressed the needs.

Prov family of documents is described in (NOTE-PROV, 2013): "Provenance is information about entities, activities, and people involved in producing a piece of data or thing, which can be used to form assessments about its quality, reliability or trustworthiness. The PROV Family of Documents defines a model, corresponding serializations and other supporting definitions to enable the inter-operable interchange of provenance information in heterogeneous environments such as the Web."

PROV-O contains three classes: prov:Agent, prov:Entity, prov:Activity (PROV, 2013). The agents are represented by pentagons in the figures; they take act on the entities through activities. These one are rectangles, they can generate entities but also modify, use, … entities. These one are ovals in the figures, they can be physical, conceptual or other.

The scenario allows describing the building of individual files. The entities are the individual file, the selected impairments, the needs among all the existing ones and the attributed services. Three agents take part in the activities : an individual which describes his needs corresponding to his impairments, a case worker modifies the file by adding or deleting needs relatively to the impairments and the individual situation. Finally, the concerned CDAPH studies the individual file and decides the services to allocate. The different agents are helped respectively by the disability and service ontologies.

As you can see on Figure 7, an individual creates his "individual file" which contains, at the beginning, his impairments descriptive analysis and a first needs list. The composition activity (:compose1) uses the impairments selected by the indivual1. This activity automatically generates the relevant data. After, another composition activity generates the selected needs. Finally, the :individualFile1 is produced by individual1. He is an agent, a person described by attributes : age, name, profession and the carers that can help him.

In a second step (see Figure 8), a case worker completes the :IndividualFile1. :caseWorker1 is an agent, a person, who works in an organization which is itself an agent. The selected needs by individual1 are revised and a new composition is created. A new individual file with better expression of needs is produced; it is a revision of the previous.

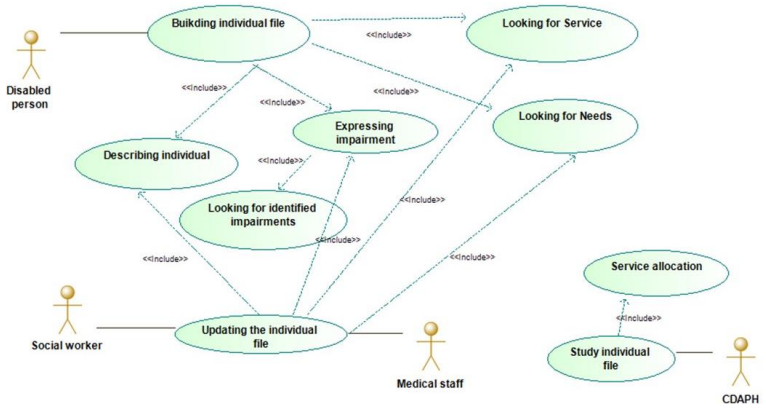

Figure 6: File building use case.

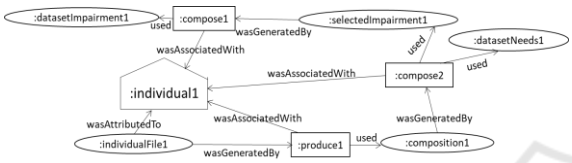

Figure 7: Individual file Creation.

Then, an instance of the CDAPH studies the individualFile2 with the data set of existing services (see Figure 9). With all this information, the allocated services are decided. A new "individual file" is created, it is a revision of ":individualFile2", allocated services are added to it by the ":CDAPH1'".

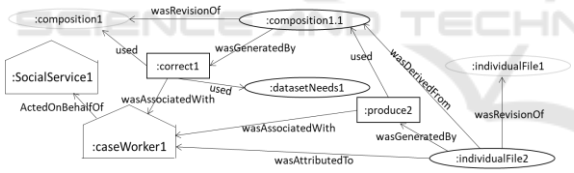

Figure 8: Individual file Revision.

This ":individualFile3" is not a final one. The individual can appeal against the CDAPH decision and, then create an ":individualFile4" to argue for a new analysis for his case and rights. Furthermore, from time to time, at least each year, a case worker will inspect the individual and may revise his individual file. This ":individualFileN" will, then, be studied again by the CDAPH. The process is gradual and iterative.

7 CONCLUSION

We have presented a first conceptual structure that allows the organization of a domain characterized by a process. The next step of the project will concern the connection to the thesaurus that indexes the scientific

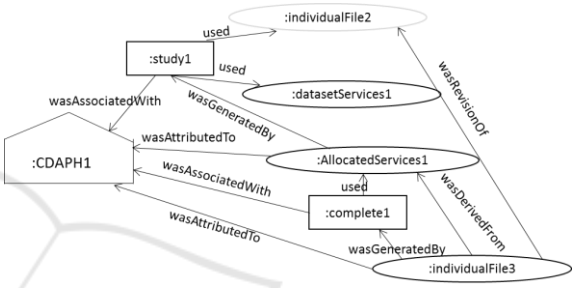

Figure 9: Individual file Update.

files, the characterization of the information artefacts that compose the process and the duality composed by the nomenclature and the available services in time, location and actors.

The heterogeneity of the files and the modalities to accede to their content (information extraction, indexation, metadata) argues the strategy of a distributed ontology.

Inside each ontology and also for the collaboration, the problem of semantic conflicts must be solved to insure the cohesion. (Fernández-Breis & Martiinez-Bejar, 2002) presents a framework that allows cooperative construction of ontologies ; various agents work on the creation of an ontology from their particular contributions, which are meant to be private ontologies corresponding to each agent. In our case, the framework must use the existing ontologies and thesaurus and the process is not the integration but the cooperation. It is not a framework to create a collaborative ontology (Farquhar & al., 1997) from others which is created but a framework for the articulation between domain ontologies, knowledge management and activity.

Another perspective is to help the individual with the step of building and updating the individual file by proposing the similar existing cases to his research. Indeed, our framework will propose allocated services

to an individual file, which has a similar context and need. The characteristics of the person do not appear, only the carer roles, the impairments, the needs and the allocated services. It is a help to describe better an individual file. Our tool will be useful for administration although for the organizations involved in the handicap field.

In our societies, people often have to build individual file dealing with heterogeneous and independent knowledge. Our framework may retrieve knowledge to build ontologies. These can, then, be used to assist people building their individual file for any domain managing help such as the elderly or children.

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