Building Structured Manuals for Elderly Care as a Computer Interpretable Knowledge Resource

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Abstract. Long-term care costs and burdens of care workers are increasing. Emerging related problems that must be solved include reducing staff education costs. Few knowledge resources exist to which care workers can refer to learn methods of caring for elderly people in specific situations. We proposed an 'Example of structured manuals for elderly care' as the first step to compilation of a referenceable knowledge resource formalized in computer interpretable manner. As described herein, we constructed the schema for the structured manuals and then transform the graphical image to a computer-interpretable form. The knowledge resource is open for use and useful for on-the-job training (OJT).

Keywords: Elderly care service, Knowledge engineering, Serviceology

1   Introduction

Because of the progress of Japan's aging society, medical and long-term care costs are increasing [4]. Therefore, care process productivity must be raised by reducing staff education costs. Some projects have been undertaken to resolve those difficulties. Robotic Care Equipment Development and Introduction Project are aimed at reducing physical burdens of staff using care robots[1]. Nishimura et al. developed a system for reducing the recording time for producing handover records [6].

However, such information systems have no semantics of their own. The data can be managed from a human-interpretable perspective if the information systems understand the data semantics. One use of semantic technology is to realize such data management, including data schema and structured dataset [3]. A well-structured dataset takes a role of reference to other data like incident reports and handover records.

The ultimate goal of this research is to provide a referenceable knowledge resource of elderly care actions. The knowledge resource provides a controlled vocabulary to annotate data along with an information system to retrieve data via relations among vocabularies. Such knowledge resource will contribute to data management.

As the first step, this paper provides a goal-oriented representation of elderly care actions as a referenceable knowledge resource that contains goals of actions as context information. First, we constructed structured manuals of eight kinds of care as graphical

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[1]   http://robotcare.jp/?lang=en

images. Second, we built RDF schema. Third, we formalized elderly care actions of eight kinds according to the schema. Then, we obtained knowledge resources of elderly care actions in the Resource Description Framework (RDF)[2] format, therefore the information system can retrieve the information according to their relations. We designated them as an 'Example of structured manuals for elderly care.'[3]

2   Structured Manuals for Elderly Care

We employed CHARM as a goal-oriented, tree-structured model [5] to structure the elderly care processes. An action is interpreted as a state change of a target object. A single action is realized as a goal by a sequence of detailed actions. For example, an action 'move an elderly person' is modeled as a state change of location of the elderly person. The action is decomposed into the sequence of actions, which are 'a care worker moves the elderly person onto a wheelchair', 'a care worker pushes the wheelchair' and 'the wheelchair moves the elderly person'. The same 'move an elderly person' action is also decomposed into another sequence of actions using a cane. Based on CHARM, we can describe both sequences as achieving the same goal action in a different way.

We constructed eight structured manuals, which covers entire direct-care in a care facility, based on the CHARM. First, we read two textbooks related to elderly care actions [1, 7]. From these books, we extracted the essence of care actions and systematized them in the goal-oriented manner. The result is presented as graphical images as depicted at the left part of Fig. 1. Second, we asked a care expert with more than five years' work experience working at a care facility for confirmation of its propriety. According to his advice, we corrected the structured manuals. After the construction process, we constructed structured manuals of eight kinds of care.

Table 1. RDF Schema for structured manuals

Property name	domain	range	Description
sm:Achieve	sm:Action	sm:Action	An action contributes to achieve another action, e.g. "Raise casters" and "Go down to slope forwardly" achieves "Go down to slope."
sm:AchievedBy	sm:Action	sm:Action	This property is an inversed property of sm:Achieve.
sm:Order	sm:Action	sm:Action	The property shows an order of actions, e.g. an action A sm:Order an action B denotes that the action A is performed before the action B.
sm:NonOrder	sm:Action	sm:Action	An execution order does not care but the both actions are necessary to achieve the goal, e.g. The order of confirmation of the safety of a wheel chair and the condition of the elderly person does not care but both are necessary to achieve the goal: preparation of moving by the wheel chair.
sm:InversedOrder	sm:Action	sm:Action	This property is an inversed property of sm:Order.
sm:has Actor	sm:Action	xsd:string	This property represents an actor of the action, e.g. elderly person is an actor of "Hold on arm-support" action.
sm:has Attribute	sm:Action	xsd:string	This property represents the action's characteristics, e.g. "slowly" is interpreted as an attribute of "Move" action.
sm:hasCondition	sm:Action	xsd:string	This property denotes a constraint or preferable situation to choose the sequence.
sm:hasRisk	sm:Action	xsd:string	Risk is something bad for caretakers, care facilities, care receivers, and their family.
sm:hasDetailed Information	sm:Action	xsd:string	This property represents other information which is denoted above.
PREFIX sm: <http://coto.pj.aist.go.jp/ontologies/structured-manual#> PREFIX owl: <http://www.w3.org/2002/07/owl#> PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>			

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2 https://www.w3.org/TR/rdf11-primer/
3 https://github.com/satoshinishimura2460/Example_of_structured_manuals_for_elderly_care

3 Formalization of Structured Manuals using RDF

To make the original structured manuals computer-interpretable, we construct a schema of structured manuals to formalize them. We formalized the structured manuals according to ten properties as shown in Table 1. First, we made a table whose column corresponds to each property and each row in the table denotes one action. Then, we translated the table to RDF format.

Fig. 1 presents an example of correspondence of a part of graphical image of the structured manuals and with RDF formatted one in Turtle serialization[4]. Each part surrounded by a large rectangle denotes each action. For example, an act:259 represents 'Go down to slope' as rdfs:label property. An orange rectangle denotes an actor of the action. In Fig. 1, sm:hasActor 'Elderly person' representing 'Elderly person' is an actor of act:259. When the actor is 'care worker', it is omitted from the graphical image because the term occurs too often. In the RDF format, we complemented the information. A yellow rectangle denotes a condition of the action sequence, e.g. 'Gentle slope' is a condition of the action sequence that consists of act:263 and act:264. The information is used to choose alternative sequences for goal achievement. A red rectangle denotes a risk of the action, e.g. 'Falling down to forward' is a risk of act:264.

4 Concluding Remarks

We proposed knowledge resources with procedural knowledge for elderly care services called the 'Example of structured manuals for elderly care'. The first version of the resource includes graphical images for humans, which is difficult for systems to understand. Therefore, we provided the RDF schema for the structured manuals. Then, we transformed the graphical images to RDF format according to the schema.
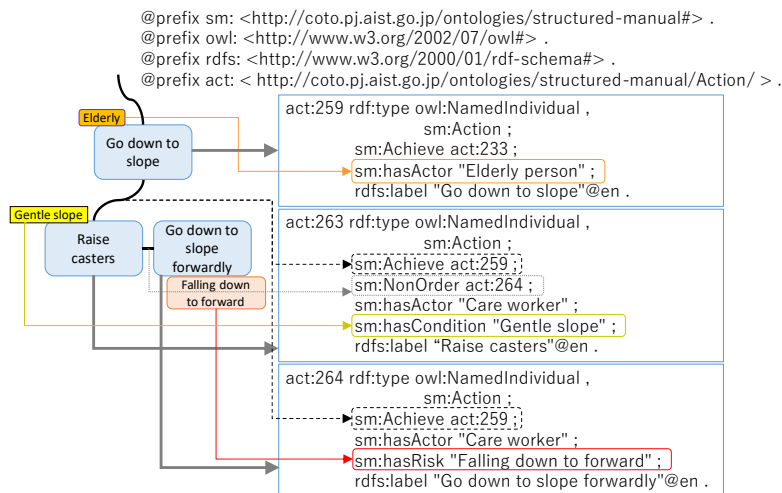

Fig. 1. Conversion of structured manuals to RDF format.

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[4] https://www.w3.org/TR/2014/REC-turtle-20140225/

The limitations of this study are as follows. The aim of the first step is to propose the referenceable resource. Further requirements should be clarified through the hearing to care facilities. In this stage, the proposed schema contains only one class, which is sm:Action. We are planning to revise the schema according to the clarification of the requirements.

As future work, we will link other related knowledge resources. The International Classification of Functioning, Disability and Health (ICF) [9] and the Foundational Model of Anatomy (FMA) [8] are well-structured resources related to elderly care services. The ICF provides vocabulary to represent elderly people's physical and mental state, functions and needs. The FMA provides anatomical entities and structural relations among the entities. The resources are complementary to our proposed knowledge resource. On the other hand, the current description of actions in the proposed resource is almost in natural language sentences, which creates difficulty to make the knowledge consistent. Therefore, we break down the actions to make them more fine-grained according to the thought of state-change, which is provided in [2].

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