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A mechanism of customizing learning programs for older adults' lifelong learning

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Abstract

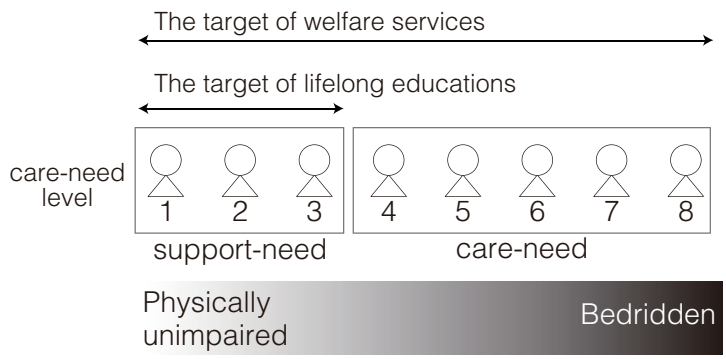
Many of the Asian countries are facing aging society problems, and lifelong learning is becoming more and more important. In order to provide the chances to join the learning programs for older adults, suitable learning programs must be provided. However, designing learning programs for older adults is not easy because they are in various physical and mental conditions. To approach the problem, the authors have proposed a mechanism for personalizing learning programs for older adults. In this paper, algorithm and data structures of the mechanism is explained, and examples of the results are shown.
Keywords: personalization system, database system, Therblig

Introduction

According to the Long-Term Care Insurance Act of Japan (Ministry of Health, Labour and Welfare, Japan, 1997), the targets of welfare services are divided into two types; **1) need of nursing support** and **2) need of nursing care**. They are subdivided into three levels and five levels respectively. Figure 1 illustrates the target of the Long-Term Care Insurance Act of Japan. In this figure, care-need level one to three correspond to "state need of nursing support" and care-need level 4 to 8 correspond to "state need of nursing care."

"State need of nursing care" is defined as a state in which cares are required for normal activities in a daily life, e.g., bath, egestion, and dining. Meanwhile, "state need of nursing support" is defined as a state in which supports are required for preventing deterioration of

Figure 1
Outline of long-term care insurance act of Japan.



disorder of fundamental actions in a daily life caused by physical and mental problems. In the situation, supports for relieving symptoms are also expected.

Japanese government attaches great importance on lifelong learning (Ministry of Education, Culture, Sports, Science and Technology Japan, 2018). Currently, many learning programs for older adults are designed for people who do not have serious disorder in their physical and mental health. In other words, people who need nursing care (over the level four) are not the targets of the programs. Considering the government policy, i.e., "open and linked social educations (Ministry of Education, Culture, Sports, Science and Technology Japan, 2018)," such people also should be the target of lifelong educations. However, designing learning programs for older adults is not easy because they are in various physical and mental conditions.

As an approach to the problem, we have proposed a mechanism for personalizing learning programs for older adults (Suto, 2023). In this paper, an implementation of the proposed mechanism and examples of the outputs are shown.

Proposed System

Extended Therblig

Therblig (Gilbreth, 2000) is a set of fundamental motions required for conducting a task. Therblig is developed for improving actions and operations in a task. Table 1 shows eighteen fundamental motions defined in Therblig. Usually, each fundamental motion is indicated by an icon or a code. In Therblig analysis, process of the target task is represented as a series of icons or codes, and analyzed. In this paper, the set of code is used for representing fundamental actions.

Usually, Therblig is used for analyzing motion economy in a workspace. Thus, it is designed on the assumption that the operators have standard physical and mental abilities. Hence each fundamental motion has only two states, "can" or "cannot." Meanwhile, an older adult's abilities cannot be represented with these two states. For example, even if a person can transport

Table 1

Fundamental motions defined in Therblig.

No.	Fundamental motion	code
1	search	SH
2	find	F
3	select	ST
4	grasp	G
5	hold	H
6	transport loaded	TL
7	transport empty	TE
8	position	P
9	assemble	A
10	use	U
11	disassemble	DA
12	inspect	I
13	preposition	PP
14	release load	RL
15	unavoidable delay	UD
16	avoidable delay	AD
17	plan	PN
18	rest	R

a 1,000g object, he/she cannot always transport a 10,000g object. In addition, the original Therblig does not include motions of lower limbs and abilities of basic communications, i.e., hearing and speaking. Thus, it is difficult to apply it for representing older adults' abilities.

Therefore, an extended Therblig has been proposed for representing older adults' abilities for learning (Suto, 2023). In the extended Therblig, "transport loaded (lower limb)," "transport empty (lower limb)," "hear" and "speak" are added as fundamental actions. Meanwhile, "unavoidable delay," "avoidable delay" and "rest" are not used because they do not represent humans' abilities.

In addition, the concept of "level" is added. Each fundamental action divided into levels from two to four. Table 2 shows the extended Therblig. In the table, level 4 of "use" is defined as "can use tools." It means that the learner can do a detailed work with a tool.

In the database shown in the next section, the extended Therblig is used for describing older adults' abilities and abilities required for conducting a learning program.

Table 2

Fundamental motions defined in extended Therblig.

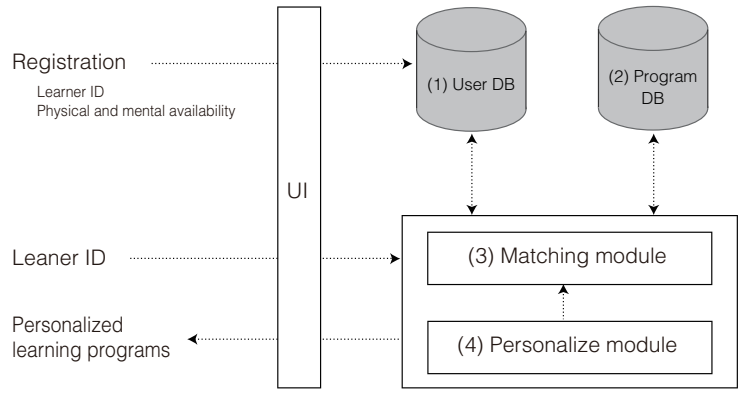
No.	Fundamental motion	code	level				
			0	1	2	3	4
1	search	SH	NA	can	-	-	-
2	find	F	NA	can	-	-	-
3	select	ST	NA	can	-	-	-
4	grasp	G	NA	can	-	-	-
5	hold	H	NA	can	-	-	-
6	transport loaded (upper limb)	TLU	NA	$\leq 300g$	$\leq 10Kg$	$> 10Kg$	-
7	transport loaded (lower limb)	TLL	NA	can stand up	can walk	can run	-
8	transport empty (upper limb)	TEU	NA	can	-	-	-
9	transport empty (lower limb)	TEL	NA	can	-	-	-
10	position	P	NA	can	-	-	-
11	assemble	A	NA	can	-	-	-
12	use	U	NA	can touch	can push	can draw	can use tool
13	disassemble	DA	NA	can	-	-	-
14	inspect	I	NA	can	-	-	-
15	preposition	PP	NA	can	-	-	-
16	release load (upper limb)	RL	NA	can	-	-	-
17	plan	PN	NA	can	-	-	-
18	hear	HR	NA	difficult	can	-	-
19	speak	SP	NA	difficult	can	-	-

Outline of the systems

Figure2 shows an outline of the proposed system. The system has two databases, i.e. (1) User database (User DB) and (2) Program database (Program DB), and two modules, i.e. (3) Matching module and (4) Personalization module.

Figure 2

Outline of the proposed system.



(1) User DB

This database has the learners' physical and mental ability information. This database has four tables, (1) elderly_table, (2) dominant, (3) non_dominant, and (4) perception. The structure of elderly_table is shown in Table 3, the structure of dominant and non_dominant is shown in Table 4, and the structure of perception is shown in Table 5, respectively. In the tables, levels of extended Therblig are described associated with the user's ID.

Table 3

Structure of elderly_table table in user_db database.

Field	Type	Null	Key	Remarks
id	NUMERIC	NO	PRI	
name	TEXT			

Table 4

Structure of dominant_hand and non_dominant_hand tables in user_db database.

Field	Type	Null	Key	Remarks
id	NUMERIC	NO	PRI	
TEU	NUMERIC	NO		transport empty (upper limb)
TEL	NUMERIC	NO		transport empty (lower limb)
G	NUMERIC	NO		grasp
TLU	NUMERIC	NO		transport loaded (upper limb)
TLL	NUMERIC	NO		transport loaded (lower limb)
RL	NUMERIC	NO		release load (upper limb)
P	NUMERIC	NO		position
U	NUMERIC	NO		use
A	NUMERIC	NO		assemble
DA	NUMERIC	NO		disassemble
H	NUMERIC	NO		hold

Table 5

Structure of perception table in user_db database.

Field	Type	Null	Key	Remarks
id	NUMERIC	NO	PRI	
SH	NUMERIC	NO		search
ST	NUMERIC	NO		select
PN	NUMERIC	NO		plan
I	NUMERIC	NO		inspect
PP	NUMERIC	NO		preposition
UD	NUMERIC			unavoidable delay (not used)
AD	NUMERIC			avoidable delay (not used)
R	NUMERIC			rest (not used)
SP	NUMERIC	NO		speak
HR	NUMERIC	NO		hear

(2) Program DB

This database has learning programs' information. This database has five tables, (1) program, (2) module, (3) dominant, (4) non_dominant, and (5) perception. The structure of program is shown in Table 6, the structure of module is shown in Table 7, the structure of dominant and non_dominant is shown in Table 8, and the structure of perception is shown in Table 9, respectively.

Table 6

Structure of program table in program_db database.

Field	Type	Null	Key	Remarks
id	NUMERIC	NO	PRI	
name	TEXT	NO		
module_no	NUMERIC	NO		
flag	NUMERIC	NO		T: can be omitted / F: cannot be omitted

Table 7

Structure of program_modlue table in program_db database.

Field	Type	Null	Key	Remarks
module_no	NUMERIC	NO	PRI	
name	TEXT	NO		

Each learning program consists of some modules. Each module is a step of a procedure of learning program. Modules which are not essential for the program has "true" as the value of field "flag" shown in Table 7. It means these modules can be omitted or can be conducted by others instead of the learner. Meanwhile, essential modules have "false" as the value of the field. For example, a learning program "make cookies" consists of four modules shown below:

1. Make cookie dough
2. Make a figure by using cookie cutter
3. Bake cookies
4. Dish the cookies up elegant

Table 8
Structure of dominant_hand and non_dominant_hand tables in program_db database.

Field	Type	Null	Key	Remarks
module_no	NUMERIC	NO	PRI	
TEU	NUMERIC	NO		transport empty (upper limb)
TEL	NUMERIC	NO		transport empty (lower limb)
G	NUMERIC	NO		grasp
TLU	NUMERIC	NO		transport loaded (upper limb)
TLL	NUMERIC	NO		transport loaded (lower limb)
RL	NUMERIC	NO		release load (upper limb)
P	NUMERIC	NO		position
U	NUMERIC	NO		use
A	NUMERIC	NO		assemble
DA	NUMERIC	NO		disassemble
H	NUMERIC	NO		hold

Table 9
Structure of perception table in program_db database

Field	Type	Null	Key	Remarks
module_no	NUMERIC	NO	PRI	
SH	NUMERIC	NO		search
ST	NUMERIC	NO		select
PN	NUMERIC	NO		plan
I	NUMERIC	NO		inspect
PP	NUMERIC	NO		preposition
UD	NUMERIC			unavoidable delay (not used)
AD	NUMERIC			avoidable delay (not used)
R	NUMERIC			rest (not used)
SP	NUMERIC	NO		speak
HR	NUMERIC	NO		hear

Module 1 can be omitted if prepared cookie dough is used. Module 3 can be conducted by a helper if a learner does not have ability to use an oven. Even if the modules are omitted, the learners can enjoy the program. Thus, in this case, module 1 and module 3 are considered as not-essential.

Each module data has a set of extended Therblig codes which represent required ability for conducting the module.

(3) Matching module

This module finds suitable learning programs for a learner based on his/her interests. A collaborative filtering method is used in the module. This module has not been implemented yet.

(4) Personalization modules

This module personalizes a learning program in order to enable it for learners who are interested in the program but they cannot conduct it because of his/her disabilities.

The basic ideas are 1) eliminating optional steps in a learning program, and 2) proposing collaboration with others in a learning program.

Examples

In this section, examples of output of the implemented system are shown. Eleven virtual learners' data are used for the experiments. The data were created based on actual older adults profiles. Table 10 shows abilities of the virtual learners. In this table, a circle stands for "can well", a triangle stands for "can in part", and a x-mark stands for "cannot."

Table 10

Physical abilities of learners.

ID	Hearing	Speaking	Upper extremity	Lower extremity
1	○	○	○	○
2	△	○	△	○
3	○	×	○	○
4	○	○	○	△
5	○	○	△	○
6	△	○	△	△
7	○	○	○	×
8	△	×	△	△
9	○	○	△	○
10	○	○	△	△
11	○	○	×	×

The following nineteen learning programs are stored in Learning DB.

1. Drawing class (1 modules)
2. Count down game (3 modules)
3. Smartphone class (SNS message sending) (2 modules)
4. Picture book making (3 modules)
5. Cursive Reading class (2 modules)
6. Bibliobattle game [1] (2 modules)
7. Mukkuri [2] class (3 modules)
8. Eraser stamp making (3 modules)
9. Watching movies on tablet (5 modules)
10. Tricky Paper-rock-scissors (3 modules)
11. Robot football (1 modules)
12. Word wolf game (5 modules)
13. Ceramic art class (9 modules)
14. Personal computer class (Painting) (4 modules)
15. Music appreciation (4 modules)
16. What's on the menu today's dinner? (5 modules)
17. Harmonica class (2 modules)
18. Floor curling (4 modules)
19. Fine calligraphy (3 modules)

[1] A book review match game.

[2] A traditional string musical instrument of Ainu race.

Figure 3

Examples of output of the system.

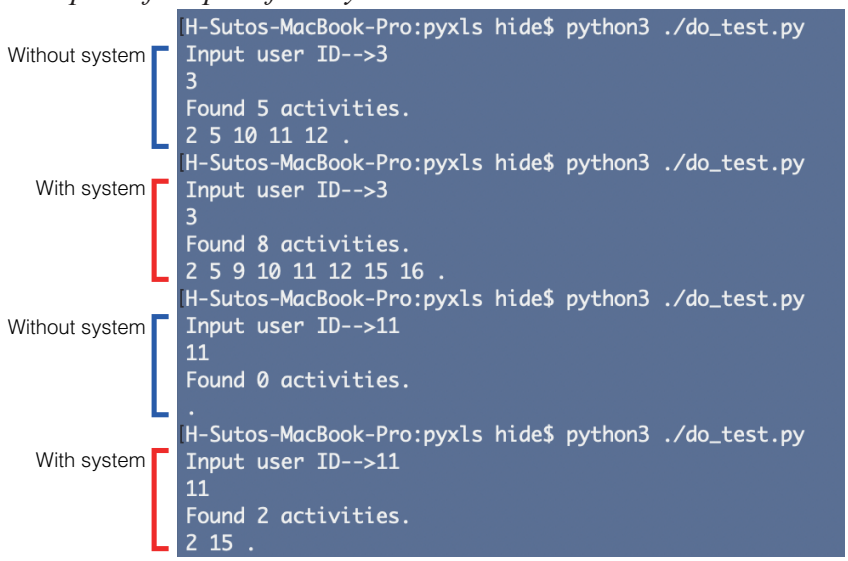


Figure 3 shows examples of the output of the system. The lines which indicated by a blue bracket show an output of a traditional system, and the lines which indicated by a red bracket show an output of the proposed system. We can see that the number of activity which can be done by user 3 increased from five to eight, and the number of activity which can be done by user 11 increased from zero to two.

Conclusion

In this paper, an implementation of personalizing system of learning programs for older adults is explained. Then, examples of outputs of the system are shown.

The personalize module shown in Fig. 2 has two functions; 1) eliminating optional steps in a learning program, and 2) proposing collaboration with others in a learning program. Here, the first function is implemented. In the next step, the second function must be implemented. Furthermore, the matching module also must be implemented.

Acknowledgment

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