

Pictogramming Workshop
- Learning Programming Concepts with Pictogram Contents Creation -

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The IAFOR International Conference on Education – Hawaii 2020
Official Conference Proceedings

Abstract

We have been developing content creation environment using human pictogram, called “Pictogramming.” This application can be accessed freely. Pictogramming is coined from two words, “pictogram” and “programming”. Pictograms are widely used in various fields such as counseling, safety, and facilities. Thus, the pictogram has been researched in various fields. Pictogramming also has aspects of a programming learning environment. Pictogramming is designed with the goal of creating pictograms, so its command set and functions are limited compared to general programming languages. It leads to fit for educational use and it also has the advantage that an understanding of the concepts of programming such as sequential execution, parallel execution, variables, looping, conditional statements, etc. can be achieved through pictogram creation without much learning cost. Our past research proved that posturing human shaped pictogram by this application generates humor and surreal emotions, which also promotes communications between learners. This time, we would like to introduce this application and show off some practice examples and after that we held short workshop that each participant makes pictogram signs.

Keywords: Pictogramming, Pictogram, Programming education, Design education, Python, Block

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Introduction

We have been developing a programming learning environment for novices called “Pictogramming [Ito 2018a],” which has been released on the web (<http://pictogramming.org/>). This name originates from a combination of words: “pictogram,” and “programming.” Pictogramming is designed to learn programming concepts through the creation of pictograms. This paper describes the outline of this application and shows syllabus examples of classes or workshops using Pictogramming.

Pictogramming

Pictogramming is a web application. Figure 1 shows a screenshot of the application when it is accessed using a PC browser. The application comprises three areas: the human pictogram display panel on the left side of the screen, the program code description area on the right, and several buttons to help code input on the bottom.

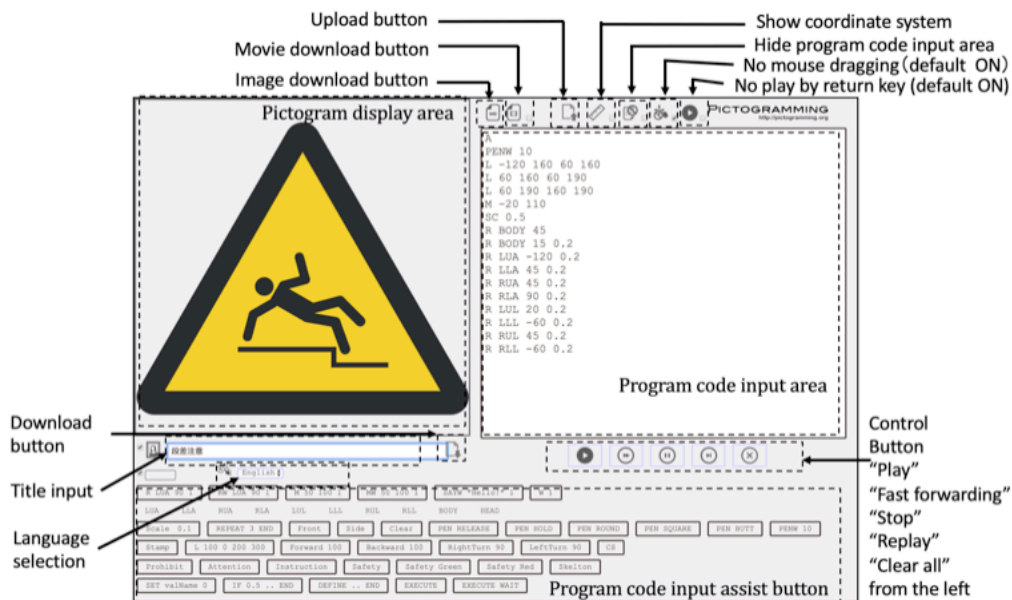


Figure 1: Screen shot of Pictogramming

A large human-shaped pictogram is displayed in the human pictogram display panel. The panel can display the human pictogram in either the front direction or the side direction, as defined by the ISO 3864’s appendix section. The human pictogram consists of nine parts: body and head (considered a single part), two upper arms, two lower arms, two upper legs, and two lower legs. The size of each part conforms to ISO 3864.

Learning Programming Concept and Pictogram Design Principle with Pictogramming

The lessons and workshops using Pictogramming are designed to be able to transit following three phases smoothly in a limited time.

Phase 1: Posing and Human Motion

Operations on the human pictogram constitute the inputs and are defined in the “Program code description area.” Pictogram focuses on pictogram creation and uses a simple and limited instruction set. The input string to change states (positions) follows a format that separates opcode and arguments with blanks, as follows.
opcode arg1 arg2 ...

Figure 2 shows an example of program.

```

R LUA -120 1
RW RUL 10 1
IF 0.3
  REPEAT 2
    RW LLA -60 0.3
    RW LLA 60 0.3
  END
M 100 0 1
END

```

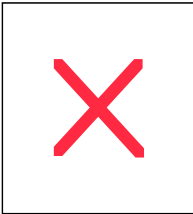


Figure 2: Sample Program

In figure 2, “R LUA -120 1” as illustrated in line 1. R is an operation to rotate a part of the body specified with the first argument. The human pictogram has a total of nine parts, body and head (considered as a single part), two upper arms, two lower arms, two upper legs, and two lower legs. That first argument LUA means the Left Upper Arm. The second argument gives the degrees counterclockwise of the angle of rotation, and the third argument represents the seconds required to rotate. If the third argument is omitted, then, it would be treated as 0. Hence, line 1 means "Rotate the Left Upper Arm 120° clockwise for 1 s and next command executes simultaneously. The character “W” in “RW RUL -10 1” shown line 2 means that next command executes when this rotation has finished. Line 2 indicates "Rotate the Right Upper Leg 10° counterclockwise for 1 s and the next command is not executed until the movement is complete. Line 3 “IF 0.3” means execute following commands until corresponding “END” at a probability of 30%, and Line 4 “REPEAT 2” means execute following commands 2 times. Hence, lines 3–8 represent waving the Left Lower Arm (LLA) two times at a probability of 30%. R and M are most used command to formulate posture and human motions. Table 1 shows a specification of these commands.

Table 1: The specification of R and M command

Command Format	Process
R arg1 arg2 [arg3]	Rotate arg1, a part of the body, arg2 degrees counterclockwise over arg3 seconds. If arg4 is omitted, then arg4 is treated as 0. If arg3 are omitted, the arg3 is treated as 0. The next command executes simultaneously. If R changes to RW then the next order is not executed until the rotation is complete.
M arg1 arg2 [arg3]	Move arg1 pixels in an X-axis positive direction and arg2 pixels in a Y-axis positive direction with linear uniform motion over arg3 seconds. If arg3 is omitted, then arg3 is treated as 0. The next command executes simultaneously. If M changes to MW then the next order is not executed until the rotation is complete.

It is also possible to describe basic programming concepts such as looping, conditional branching, and procedures.

Phase 2: Drawing objects by human motion

Line drawings such as Turtle graphics is often used in programming learning. Pictogramming has PEN command to provide line drawing method drawn with the movement history of the human pictogram. The specification of PEN command is shown in Table 2. This method enables to transit from Phase 1 naturally and easily [Ito 2019b].

Table 2: The specification of PEN command

Command Format	Process
PEN arg1 arg2	Release Pen if arg1 is "RELEASE" or "UP", hold pen if arg1 is "HOLD" or "DOWN." A part of body can be set as arg2 to set the location of releasing or holding the pen only if arg1 is "RELEASE", "UP", "HOLD" or "DOWN." IF arg2 is omitted, it is considered to set "BODY". Initial state of pen is released for all parts of body.

The command "R arg1 arg2" and "RW arg1 arg2", "M arg1 arg2" and "MW arg1 arg2" behaves the same way when viewed in terms of human motion. However, these behave the different way when drawing something by one of the body parts according to the rules mentioned below.

(Rule 1) Define a command set that consists of continuous R and M commands with time 0, or continuous R and M commands with time 0 and RW and MW commands with time 0 after that. The command set draws a line whose edges are the original position and the position the command set establishes.

(Rule 2) RW and MW commands with time 0 draws a line segment connecting the original position and the position this command establishes.

Various figures can be described with just a few commands by making good use of human actions in Phase 1 and adopted only simple rules defined above. The drawing examples are shown in Fig. 3.

Figure 3 (a) shows a program for drawing a square. Line 1 "SK" is made transparent to be able to display figure hidden by the pictogram. Line 2 "PEN HOLD LLA" specifies a part of the body and drawn as the movement history of left hand. Line 4 "RW LUA 90" has no time argument, which is equal to set 0. It means drawing a line with Rule 2, that is, drawing one side of the square. Drawing the circle is simple. Figure 3 (b) is the program, that is, hold a pen on the left hand and rotate an arm 360 degrees within a time interval greater than 0.

It is possible to draw various figures by combining more than one "R" and "M" commands. Figure 3 (c) draws a swirl and Figure 3 (d) draws a Lissajous curve by moving two joints (shoulder and elbow) simultaneously, and Figure 3 (e) draws a sine curve by moving two joints and the body itself simultaneously. Figure 3 (f) draws a diamond. It is also possible to draw by combining non-"W" commands (which means "R" and "M" commands) and "W" commands (which means "RW" and "MW" commands). Line 4 to 5 and line 7 to 8 in Figure 3 (g) draw a sector's side by bending both a shoulder and an elbow simultaneously. Line 4 to 5 and line 6 to 7 in Figure 3 (h) draw a diamond's side according to Rule 1. This is called "Human motion drawing" in our framework. "Human motion drawing" evokes emotional empathy as

in the case of turtle drawing. Participants promote self-identification to human pictograms created by other participants.

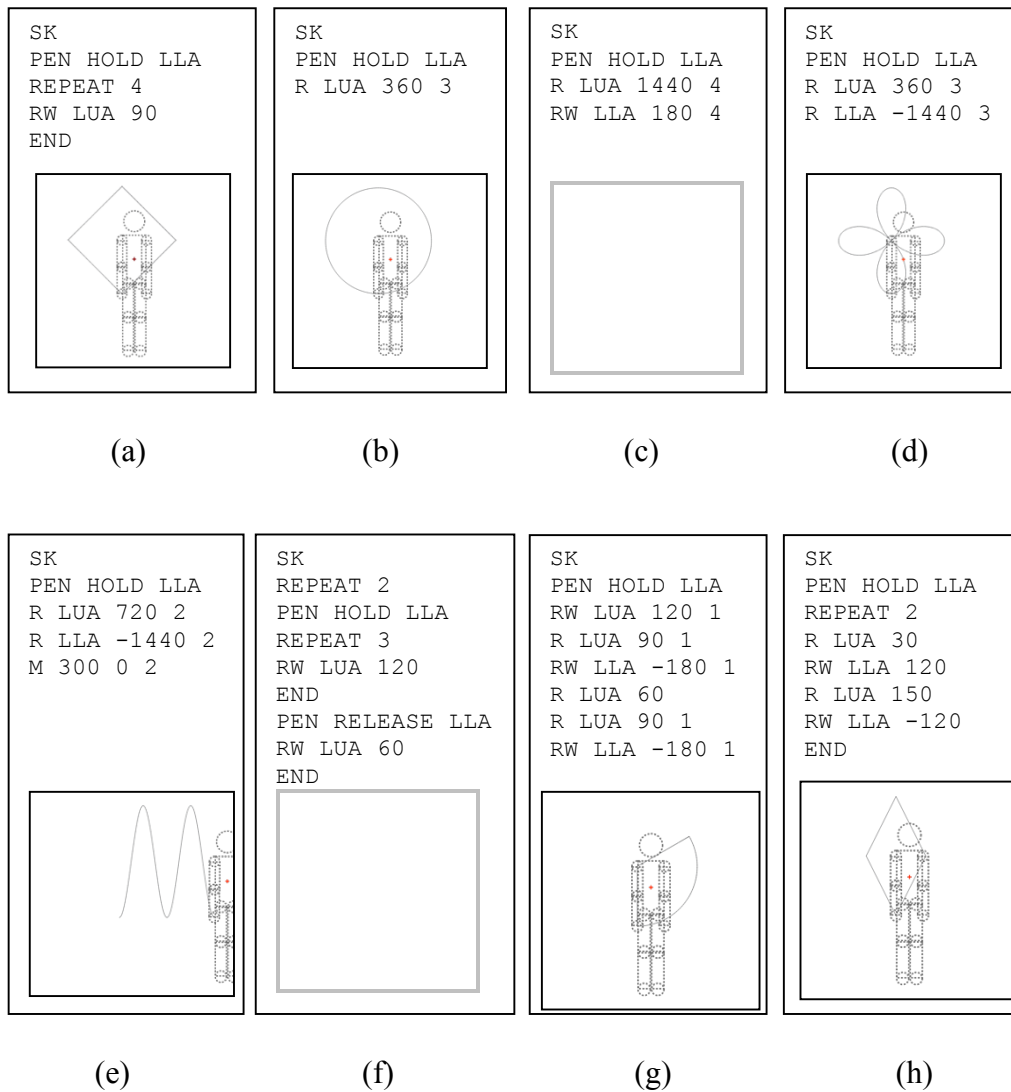


Figure 3: Sample drawings by human motion

Phase 3: Designing

To create a design-oriented pictogram, an L command that draws a line segment by specifying coordinates is also provided. There are also options for changing the shape of the end points of the PENW command, which changes the line thickness and the PEN command. Table 3 shows the specification of these commands. And, Figure 4 shows an example program. By combining these, it is possible to draw circles and rectangles.

Table 3: The specification of PEN option, PENW and L commands

Command Format	Process
PEN arg1	The shape of line's both edges set square if arg1 is "SQUARE", set round if arg1 is "ROUND". No shape is attached at both edges if arg1 is "BUTT". As for kinds of pen, draw solid line if arg1 is "NORMAL", erase line if arg1 is "ERASE", and erase the part already drawn and draws a part not so if arg1 is "XOR".
PENW arg1	Set width of pen to arg1. (Initial state is 1)
L arg1 arg2 arg3 arg4 [arg5]	Draw line from coordinate (arg1, arg2) to coordinate (arg3, arg4) over arg5 second(s). If arg5 is omitted, then arg5 is treated as 0. The next command is executed simultaneously. But if L changes to LW then the next order is not executed until the rotation is complete.

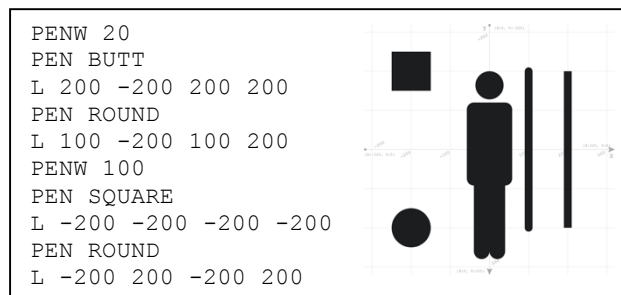


Figure 4: An example of drawing shapes

Reference colors, which indicate attention, prohibition, indication, and three kind of safety. This makes it possible to create design-oriented pictograms that are used all over the world. An example of safety sign is shown in Figure 5. Hence, it was possible to add the commands "prohibition," "attention," "instruction," "safety," "safety green," and "safety red" mode, all of which could set only single command P, A, I, S, SG, SR respectively.



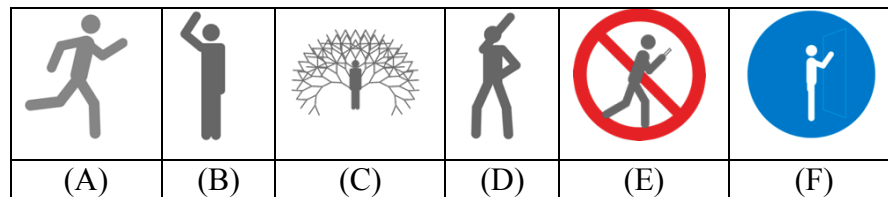
Figure 5: Color of Safety Sign

Syntonic Learning

Papert developed Logo and noted that it is very important that children can execute Logo commands by pretending to be a turtle using their own bodies; this is called "syntonic learning" [Papert 1977][Papert 1980]. Papert also noted the following:

1. Body syntonic: Strongly associated with the senses of children and knowledge of their bodies.
2. Ego syntonic: Consistent with the self-consciousness of children as humans with intention, purpose, desires, likes, and dislikes.
3. Cultural syntonic: Linked to personal activities that are firmly and positively rooted in one's culture.

The human pictogram resembles a body that represents the ego and the illustrated pictograms represent one's culture. Thus, the human pictogram conforms to these three types of syntonic learning. Figure 6 shows works that were all created by the application.



(A) Running (B) Waving hand (C) Cupid (D) Famous Japanese TV character's pose (E) Do not use smartphone while walking (F) Please knock when you enter a room

Figure 6: Example of works influenced by various type of syntonic learning

Figure 6(A)–(B) shows typical human movement, created mainly based on body syntonic learning. Figure 6(C)–(D) represents artistic, humor, some major person's famous action, and so on. These pictograms are difficult to categorize, but all are based on ego syntonic. Figure 6(E)–(F) shows the pictograms linked to personal activities based on rules, morals, and culture, and some of these are widely used in one's culture. Of course, these types of syntonic learning cannot be separated clearly, but these works are based on a combination of various kinds of syntonic learning.

Practical examples

We illustrate some practical examples for using Pictogramming in classes and workshops.

(1) Class lesson style

Table 4 shows an example of 5-lessons (45 minutes each) in class from the viewpoint of learning programming concepts. In the first lesson, a lecture on the pictogram has been given to raise interest to the pictogram. The pictogram is a public sign that has deeply penetrated everyday life, and all students are familiar with it. In the last of the first lesson, they create works with multiple instructions of RW command, that is operations by simple sequential processing.

They learn sequential execution and parallel execution in the second lesson. It is easy to understand for learners because it can change to parallel execution when single character W is removed like R and RW.

They learn repetition in the third lesson. They are easy to select a theme, since repeated movements are frequently seen in human movements.

The fourth lesson is drawing with a pen on the body part. It can be transited naturally based on the learning content from the third lesson.

They create a socially used pictogram after learning commands corresponding to the thickness and type of lines and several safety signs specified by ISO in the fifth lesson.

When we think about lessons in class, it is important for each lesson to be able to achieve learning goals in predetermined time while minimizing new commands and concepts.

Table 4: An example of class lessons syllabus focuses on programming

#	Contents	Phase	min
1	1. Short lecture about pictogram		30
	2. Posing and Animation	1	15
2	1. Sequential execution and parallel execution	1	45
3	1. Looping	1	45
4	1. Human graphics	2	45
5	1. Short lecture about difference between art and design	3	10
	2. Free work from the viewpoint of design	3	35

Another example consisting of 5 lessons is shown in Table 5. Instead of setting a learning unit for each class as a programming learning, the purpose is to learn the difference between art and design [Ito 2019a]. Starting with pictograms lecture are the same as in the Table 5, but the second and third lessons are freely created, and examines the pictograms created by each learner in the second half of the third lesson. Explain the difference between art and design at the beginning of the fourth lesson. Here, “art” means that the creator can freely create and express the work, while the viewer can freely interpret it. On the other hand, “design” means it is important that everyone can interpret correctly. After this explanation, works are created with design in mind, and examines as before in the second half of the fifth lesson.

Table 5: An example of class lessons syllabus focuses on design education

#	Contents	Phase	min
1	1. Short lecture on pictograms	1	30
	2. Exercise on how to operate Pictogramming		15
2	1. Free work	1,2	45
3	1. Free work (cont.)	1,2	20
	2. Competitive exhibition from the viewpoint of art	1,2	25
4	1. Short lecture about the difference between design and art	3	20
	2. Work from the viewpoint of design	3	25
5	1. Work from the viewpoint of design (cont.)	3	20
	2. Competitive exhibition from the viewpoint of design	3	25

(2) Workshop

Table 6 shows an example of workshops based on past experiences. As with the class lesson style, assigns time to create works freely after the lecture on pictograms and the minimum usage of the application. At the end, an exhibition is held to look other participants' work and know the background to making the work are shared with the

participants. This is just an example, and it can be changed flexibly depending on the purpose of the workshop and the facilitator that can be arranged.

Table 6: An example timetable of workshops

Contents	min
1. Short lecture on pictograms	20
2. Exercise on how to operate Pictogramming	10
3. Free work	60-80
4. Break	10
5. Competitive exhibition	20-30

Collaborative Learning between Human and Human pictogram

Now, we consider class lesson or some workshops using Pictogramming. Figure 7(1) represents a typical relationship between participants of the workshop. The human pictogram is introduced and the student starts to command or operate it (Figure 7(2)), and then begins to communicate with one's human pictogram (Figure 7(3)). Figure 7(a) is a scene using the Pictogramming application. One participant talks to another participant about his/her pictograms and mimics the movement. As the pictogram is highly visible, the participants happen to see the pictograms in the monitors naturally and acts with them. Our past research proved that posturing human shaped pictogram by this application generates humor and surreal emotions, which also promotes communications between learners. This means that one participant communicates with other participants' human pictograms (Figure 7(4)), and communicates with other participants on human pictograms (Figure 7(5)). The participants program and create numerous works with collaborative learning process [Ito 2018b].

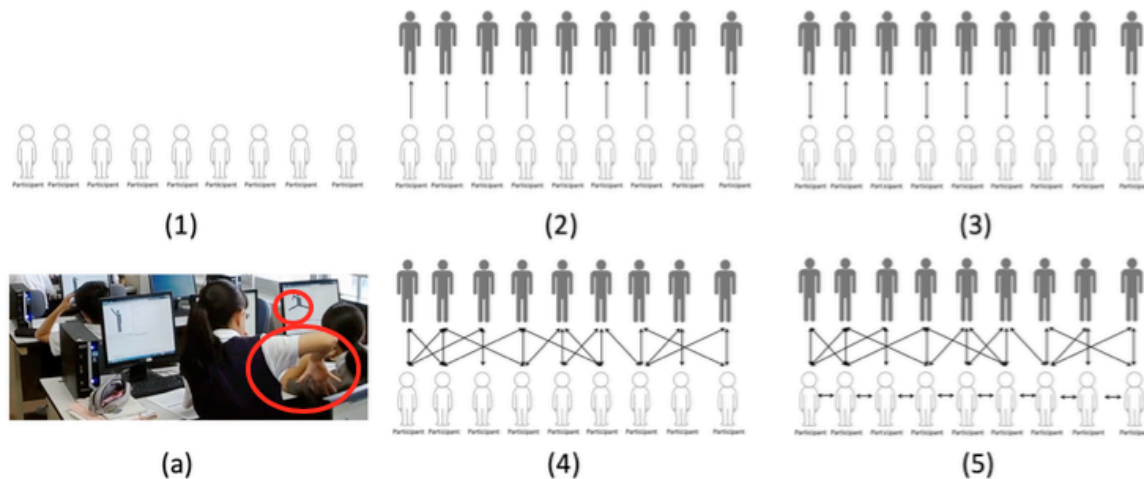


Figure 7: Construct relationship between the participants via human pictograms

Pictogramming Series

It has many extended applications based on Pictogramming. These can be used properly according to the school age and purpose when used in class lessons or workshops.

(1) Picthon

Picthon is a learning environment of Python language through pictogram content creation. Python is an interpreted language having features such as dynamic typing and multi-paradigms. Libraries are provided in a wide range of fields focusing on science and technology, such as machine learning, data science, and matrix operations.

The application is based on Pictogramming. The screenshot is shown in Figure 8. The difference point is only Python language is written in “Program code description area” and Python language is inserted by assist buttons in “Program code assist button area”. This application also can be accessed at <https://pictogramming.org/>.

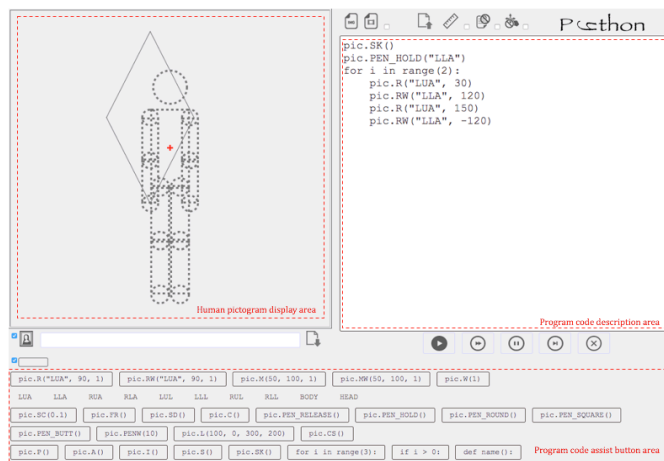


Figure 8: Screenshot of Picthon

(2) Block Pictogramming

The characteristic of Block Pictogramming is that you can create pictogram content by connecting visual blocks. And the functions are all same as Pictogramming. The screenshot is shown in Figure 9. Of course, it is designed to learn programming concepts with Block Programming. Blockly (<https://developers.google.com/blockly>) is used to build programs with visual blocks located in right side of the application.

This application also can be accessed from <https://pictogramming.org/>.

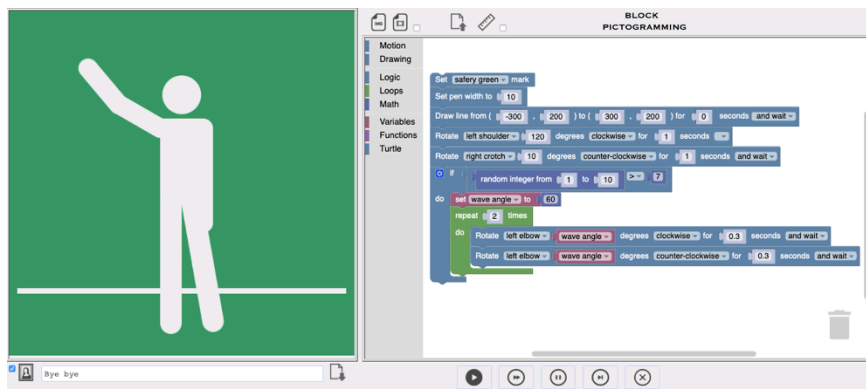


Figure 9: Screenshot of Block Pictogramming

Conclusion

This paper presents an overview of a pictogram contents creation called Pictogramming. And illustrated some key points that helps giving lectures or facilitate workshops with Pictogramming.

Acknowledgements

This study was supported by JSPS KAKENHI Grant Number 16K01125 and 17K01115.

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