Seminar in Visual Languages

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1 Abstract

Due to the on-going threat that is global warming, educating people on its causes and ways to prevent it has become a global responsibility. In this project, we develop a block-based visual language that aims to educate children on the effects of non-sustainable day-to-day activities on the environment as well as teaching them about sustainable alternatives that would help fight climate change.

2 Introduction

2.1 Motivation

Global warming, which is the long-term rise in the Earth's surface temperature, is one of our world's most dire problems as it imposes a fundamental threat to lands, species and people's livelihoods. Although global warming has been happening very gradually ever since the Earth was created, it is being greatly accelerated by human-induced actions. Since climate change is considered to be one of our time's most defining issues, and since awareness campaigns are flooding our Facebook timelines and street billboards, we believe

that it is also essential to teach the multiple ways of preventing global warming to children using visual programming methods.

2.2 Aim of the Project

Developing a block-based visual programming language targeted at children (similar to Scratch) that allows children to mix and match between different day to day actions through a simple user interface, and letting them see the effects that these actions have on the environment.

3 Background

3.1 Visual Languages

Languages are most commonly known as being spoken or being written, however, according to the Theory of Multiple Intelligences by Howard Gardner, communication cannot be limited to only verbal-linguistic methods, especially in education. Therefore, languages can also be 'visual', where graphical elements–known as visual elements–are used to convey meaning and help users perceive and comprehend visual signs. Visual elements include pictures, lines, shapes and colors; things that can be perceived and understood. Just like any language, a visual language has both grammar and semantics. Visual elements are composed of:

- Visual alphabet; a set of graphical primitives used in a visual language;
- Visual syntax; a composition of visual alphabet forming visual statements;
- Interaction; communication techniques between the user and the system;

- Structure; a set of rules that combine sub-languages into a full visual language. [1]

3.2 Visual Languages in Various Fields

3.2.1 Visual Languages in Education

Visual Languages can be used in educational systems to ease the roles of instructors/teachers and increase the benefit of the students. One example is the eXtended Learning Activity Diagram (XLAD) which can be used to design collaborative learning paradigms in organizing e-learning courses.. XLAD extends UML Activity Diagrams by adding more visuals that would help facilitate the flow for such courses by giving the instructional designer a degree of control over how the students should explore these courses.[2]

3.2.2 Visual Languages in Programming

A visual programming language (VPL) is a programming language that allows users to develop programs through the manipulation of graphical programming elements. These elements include text, symbols and icons that represent variables, loops and conditional statements. The use of VPL makes creating programs and applications easier for students with minimal programming background, especially since they would be a lot easier to learn than traditional languages such as C, C++ and Java.

Visual programming systems facilitate developing attractive programs (interactive stories, games, etc) and applications by linking together objects such as pictures, sounds and text. Two tools that can be used for this purpose are Scratch and Visual Environment for Designing Interactive Learning Scenarios (VEDILS). [3]

3.2.3 Visual Languages in Data Science

Some fields require prior learning and understanding of fundamental programming concepts such as machine learning, data science and robotics which might be intimidating for non-computer science majors as they will have to understand it through online courses.

There has been increasing growth in the field of Machine Learning and Data Science over the past couple of years, however, the industry is still lacking in numbers of job applicants. One of the reasons why this is occurring is due to the fact that the field is restricted to applicants that have gone through a university program that offers extensive courses in at least one programming language.

This is also a case where visual programming would contribute in higher level education. Therefore, some web-based visual programming environments have been developed to help students without any prior knowledge in programming languages. An example of these environments is "Milo", and it allows non-computer science majors to approach concepts such as Data Science and Machine Learning. It is a block-based program that allows the use of visual elements that support very important concepts in the Machine Learning and Data Science fields. [4]

4 Methodology

As for the implementation, Java GUI was used to build our block-based program. A snippet of how the interface looks is shown below. The program's layout is pretty much close to Scratch's layout, where we have a section on the left for the blocks that the child can drag and use, a section in the middle to which the blocks will be dragged (where they will be effective), and a section on the right that dis-

plays the "Earth Status" and illustrates any changes that may occur in it when the child changes the states in the blocks.

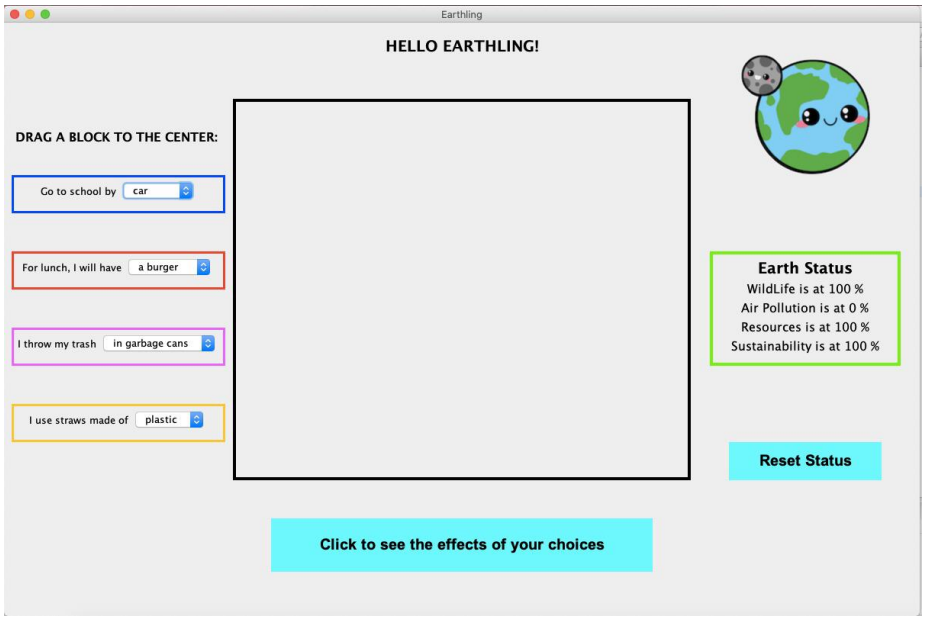

Figure 1: Earthling GUI

For the blocks section, four blocks are implemented. The first one allows the child to select a means of transportation by which he will go to school; either "car", "bus", or "bicycle". Changing the state of the transportation block will affect the status of "Air Pollution" in the Earth Status section. Air pollution could be considered one of the major problems adding to Global Warming since it leads to the destruction of the Ozone layer, as all vehicle exhaust are harmful to it. It also emits carbon dioxide which is a greenhouse gas that traps heat within the Earth. If the child chooses to go to school by bicycle, air pollution will be at 0 percent since this is the most environmentally friendly option, whereas, if he chooses bus or car, it will increase the air pollution. The bus, however, will cause less

damage than the car since using the bus means less people use cars so it is still a better option.

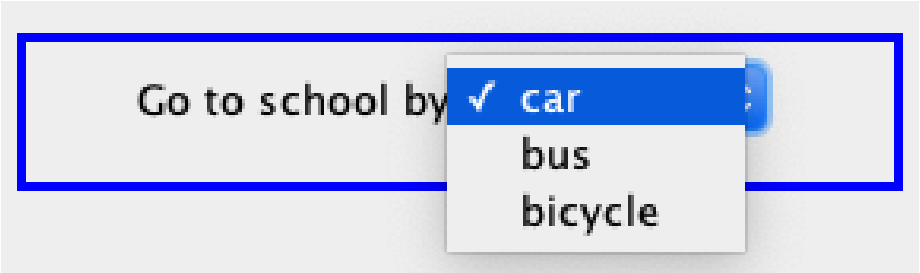

Figure 2: Block 1 States.

As for the second block, it allows the child to change the state of his food intake between either a beef-based meal, chicken-based, or vegetable-based. Dragging this block to the center area makes it effective, and depending on the choice of the child for the food it will affect the "Wildlife" in the Earth Status section. The child can change the state and then run the program via the "Click here to see the effects of your choices" button below. This in turns illustrates the effect of the food we consume whether on a daily basis or mostly on our environment since this choice dedicated the fate of the wildlife on the long run.

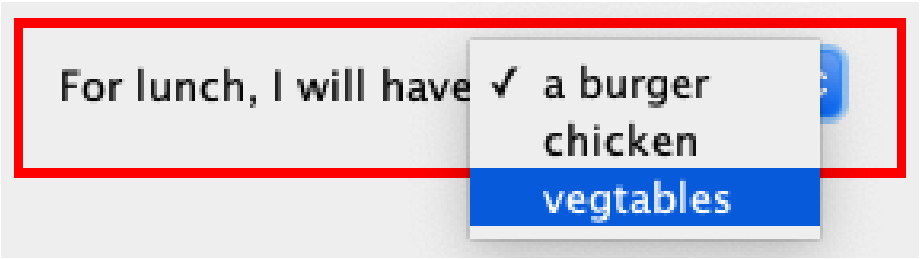

Figure 3: Block 2 States.

For the third block, it tackles the trash disposal methods and its effects on the earth's resources. We all know that recycling is the way to maintain our resources from perishing and our environment from decaying. If the child drags this block to the center, he can change its state from disposing trash in recycle bins or trash cans and he can see the effect of these changes on the Resources in the Earth Status section.

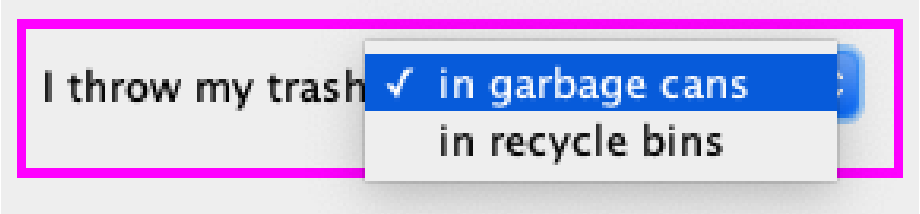

Figure 4: Block 3 States.

The last block gives the child a gist about sustainability, and how a small choice like choosing your straws could affect the environment. Sustainability is a very important concept for saving our environment. Many countries now are aiming to be more sustainable and environment friendly, and as small as the choice of picking your straw type is, the greater effect it has on the larger scope of people. The child can pick three states to change and see their effect: steel, which is the most optimal source as it lives the longest, paper, which is the second most optimal however not the best because it decays fast, and plastic which is one of the elements that take more than a thousand years to decay, endangering any animals or sea creatures who can come across it and also harming our ozone layer if disposed of it incorrectly such as burning it.

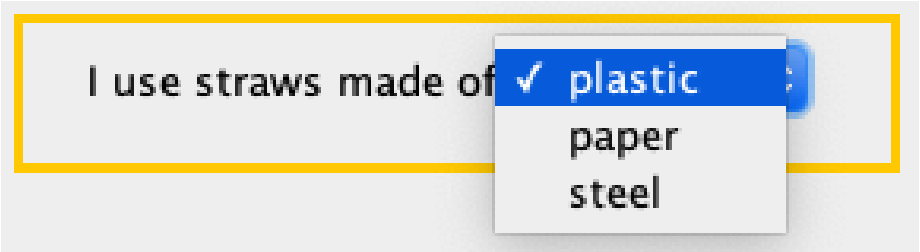

Figure 5: Block 4 States.

In the right section, there is a reset button that resets Earth's Status to its original percentages that is pure and unharmed. The child can use this button in multiple ways including resetting the earth status while testing the change in one block or in all of them. It can also show him the pure status of how earth should be.

Figure 6: Reset Earth Status.

5 Conclusion

Languages do not always have to be textual or verbal; they can be visual, where the visual elements themselves convey meaning through images, symbols, shapes and colors. Visual languages are used in several fields, the most prominent of which is education, and in our implementation, we are using visual languages to educate children about climate change; what causes it and what accelerates it; and ways to fight it in our day-to-day routines.

6 Future Work

Further blocks could be implemented, they could take the shape of an if then structure, for example: we can have a block that says "if (in garden) then pick flowers = (True/False)" or another that says "if (in house) then switch lights = (True/False)" and the child would pick whatever block and see the effect of changing its state. Another future work recommendation could be adding a count of days where the effect would be shown of his/her choices over the scope of these days, in other words, a child can select e.g. 11 days and the Earth Status will be a cumulative more realistic estimate of the effect of the states the child chose in the blocks over 11 days. This means we can also change how the Earth Status values are updated, as for our basic implementation, we made it show us a given estimate for how we think this state change is going to be effecting the Earth on the longer term. Another thing we can change in the Earth Status is that we can make all the 4 blocks (or any more added in the future) to collectively affect each of the 4 statuses mentioned, so that not only one block affects one status as we have illustrated for the sake of simplicity and for the fact that this is the most dominant effect for each block selected.

References

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[2] G. Casella, G. Costagliola, F. Ferrucci, G. Polese, and G. Scanniello, "Visual languages for defining adaptive and collaborative e-learning activities," 02 2020.

[3] J. M. R. Corral, I. Ruíz-Rube, A. C. Balcells, J. M. Mota-Macías, A. Morgado-Estévez, and J. M. Dodero, "A study on the suitability of visual languages for non-expert robot programmers," *IEEE Access*, vol. 7, pp. 17 535–17 550, 2019.

[4] A. Rao, A. Bihani, and M. Nair, "Milo: A visual programming environment for data science education," in *2018 IEEE Symposium on Visual Languages and Human-Centric Computing (VL/HCC)*. IEEE, 2018, pp. 211–215.