Karel the Robot World Converter

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ABSTRACT

This paper proposes the development of a program for the faculty members of Mars Hill University, which will integrate with a software tool known as Karel the Robot. Karel the Robot is designed to simplify the learning process of beginner-level programming by eliminating the complexities typically associated with programming languages. Despite the proficiency of Karel the Robot, there is still room for improvement in the software. By closely analyzing Karel the Robot, it is discovered that there are two versions available: Karel and Jarel. Although both versions share similarities, they differ in their world files. For instance, if a user creates a Karel world file, the same file cannot be opened in Jarel software. The proposed program will resolve this issue by identifying whether the world file is a Jarel or Karel file, locating the bytes that are distinct between Jarel and Karel, and converting either world file to the opposite Jarel or Karel file format. The proposed program is intended to enhance the user experience by streamlining the process of converting world files between Karel and Jarel. This program is expected to be an invaluable tool for beginner-level programmers who are seeking to develop their skills in programming without being overwhelmed by the complexities of programming languages. The proposed program's effectiveness in facilitating the learning process for beginner-level programmers is expected to be tested and validated through further research and experimentation.

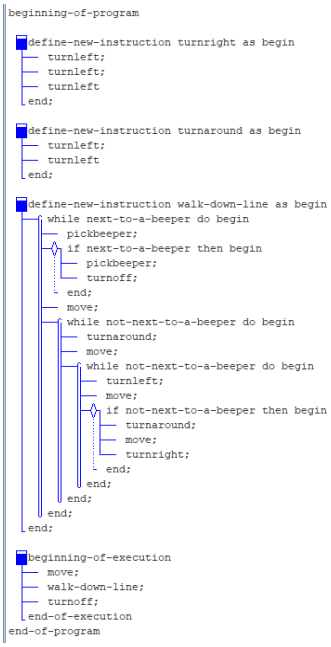

Figure 1. Example of new commands in the programming.

1 INTRODUCTION

Karel the Robot is an incredibly innovative programming tool that has been revolutionary in beginner-level computer science courses. The program was designed by Rich Pattis, a graduate student at Stanford University, with the intention of teaching students how to think like programmers and tackle problems systematically from start to finish. The program revolves around a simple robot named Karel, living in a straightforward world.

The tool provides a set of commands already embedded in the program, and users can instruct the robot to execute tasks within its environment. While Karel understands only four built-in commands, the real objective is to program Karel with new commands that can expand its capabilities as a robot (refer to Figure 1).

This simple yet effective approach has made Karel an excellent tool for teaching fundamental programming concepts in introductory courses. The environment provided by Karel is free from the complexities that most programming languages bring, making it easier for students to grasp the basic ideas of programming. Karel's simplicity makes it an effective teaching tool, but there are a few issues that need to be addressed. One significant problem with Karel the Robot is the existence of two different versions, Karel and Jarel. Although they appear similar at first glance and perform the same tasks, they are distinct programs.

The only way to determine which program you are using is to right-click on the world and check the cursor's top. A small menu will indicate whether you are using the Karel or Jarel program (refer to Figure 2 and Figure 3). The bigger issue arises when you try to open a Karel world file in the Jarel program or vice versa. Even though the files are identical, they cannot be opened in the other program (refer to Figure 4).

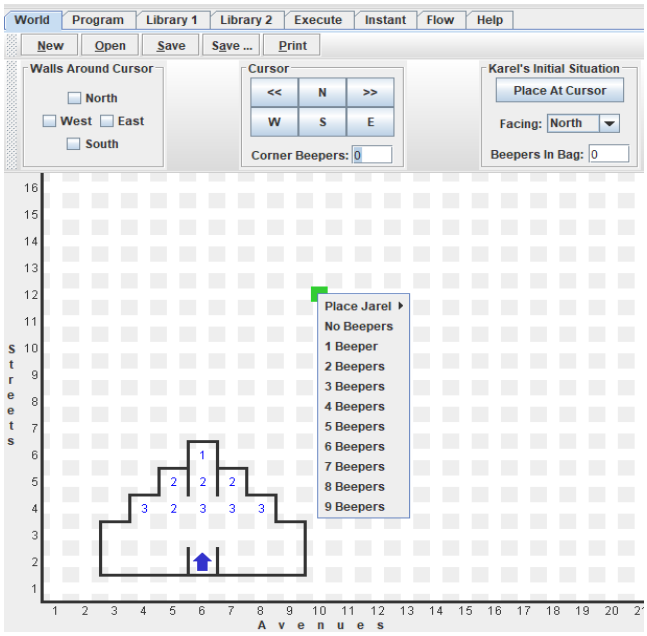

Figure 2. Jarel World

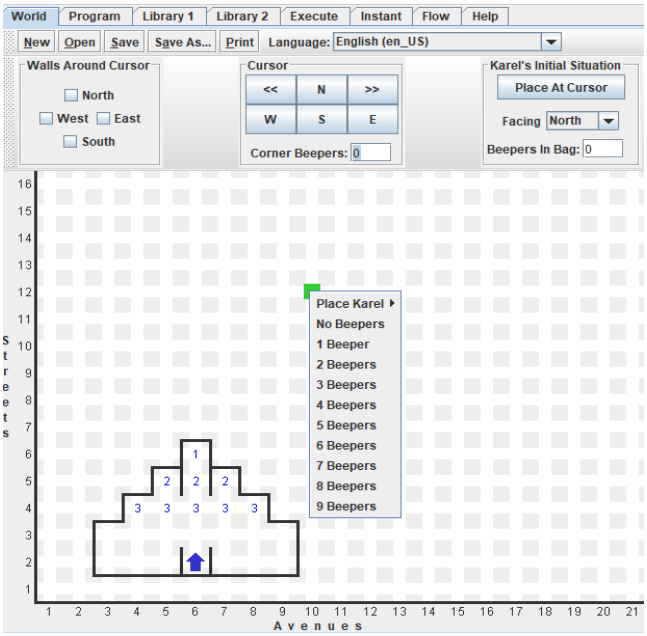

Figure 3. Karel World

Figure 4. Error that occurs when crossing world files

Further analysis has revealed that the two world files differ by eight bytes (refer to Figure 5 and Figure 6), 32 bytes from the bottom of each file. When these eight bytes are swapped between the two files, the world files can be read by the initial program they were programmed on. However, this process is inconvenient and time-consuming. It requires users to open each Karel or Jarel program to identify which world file corresponds to which program, then open a hex editor to convert the eight bytes to the desired program format.

To solve this problem, a program can be developed that identifies whether the world file is a Jarel or Karel file and automatically converts it. By running the world file through this program, users can open the original Jarel world file into the Karel program and vice versa. The motivation for developing this program is simple to make it more efficient for users to run their world files through the program and convert them. The program will also help professors grade assignments more quickly, giving them more time to address students' other queries about more complex assignments. Ultimately, the program will improve the user experience by making it easier to convert world files between Karel and Jarel, further enhancing the tool's effectiveness in facilitating the learning process for beginner-level programmers.

Extensive testing and experimentation will be conducted to validate the program's effectiveness in achieving this goal. It is an exciting development that will make Karel the Robot even more accessible and user-friendly, ultimately benefiting students and teachers alike.

karel_world2

Offset(h)	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	Decoded text
00000000	AC	ED	00	05	73	72	00	0D	65	6E	76	2E	53	61	76	65	¬í..sr..env.Save
00000010	57	6F	72	6C	64	D6	3D	2B	FC	63	62	54	7B	02	00	07	WorldÖ=+ücbT{...
00000020	49	00	06	61	76	65	6E	75	65	49	00	09	62	65	65	70	I..avenueI..beep
00000030	65	72	42	61	67	49	00	0A	6C	61	73	74	43	6F	72	6E	erBagI..lastCorn
00000040	65	72	49	00	06	73	74	72	65	65	74	49	00	0B	75	73	erI..streetI..us
00000050	65	64	43	6F	72	6E	65	72	73	5B	00	06	63	6F	72	6E	edCorners[..corn
00000060	65	72	74	00	0D	5B	4C	65	6E	76	2F	43	6F	72	6E	65	ert..[Lenv/Corne
00000070	72	3B	4C	00	06	66	61	63	69	6E	67	74	00	0F	4C	65	r;L..facingt..Le
00000080	6E	76	2F	44	69	72	65	63	74	69	6F	6E	3B	78	70	00	nv/Direction;xp.
00000090	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	....
000000A0	00	00	01	75	72	00	0D	5B	4C	65	6E	76	2E	43	6F	72	...ur..[Lenv.Cor
000000B0	6E	65	72	3B	EF	95	9B	AA	80	79	EB	BC	02	00	00	78	ner;ï•›ª€yë¼...x
000000C0	70	00	00	00	02	73	72	00	0A	65	6E	76	2E	43	6F	72	p....sr..env.Cor
000000D0	6E	65	72	89	A8	D1	6E	FF	EA	F6	2D	02	00	05	49	00	ner‰¨Ñnÿêö-...I.
000000E0	06	61	76	65	6E	75	65	49	00	09	62	65	65	70	65	72	.avenueI..beeper
000000F0	43	6E	74	5A	00	08	65	61	73	74	57	61	6C	6C	5A	00	CntZ..eastWallZ.
00000100	09	6E	6F	72	74	68	57	61	6C	6C	49	00	06	73	74	72	.northWallI..str
00000110	65	65	74	78	70	00	00	00	00	00	00	00	00	00	00	00	eetxp...........
00000120	00	00	00	73	71	00	7E	00	06	00	00	00	10	00	00	00	...sq.~.........
00000130	00	00	00	00	00	00	06	73	72	00	0D	65	6E	76	2E	44	.......sr..env.D
00000140	69	72	65	63	74	69	6F	6E	C0	75	00	C5	4F	EC	2E	52	irectionÀu.ÅOì.R
00000150	02	00	01	49	00	0C	74	68	65	44	69	72	65	63	74	69	...I..theDirecti
00000160	6F	6E	78	70	00	00	00	00									onxp....

Figure 5. Karel world file in a hex editor.

jarel_world2

Offset(h)	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	Decoded text
00000000	AC	ED	00	05	73	72	00	0D	65	6E	76	2E	53	61	76	65	¬í..sr..env.Save
00000010	57	6F	72	6C	64	D6	3D	2B	FC	63	62	54	7B	02	00	07	WorldÖ=+ücbT{...
00000020	49	00	06	61	76	65	6E	75	65	49	00	09	62	65	65	70	I..avenueI..beep
00000030	65	72	42	61	67	49	00	0A	6C	61	73	74	43	6F	72	6E	erBagI..lastCorn
00000040	65	72	49	00	06	73	74	72	65	65	74	49	00	0B	75	73	erI..streetI..us
00000050	65	64	43	6F	72	6E	65	72	73	5B	00	06	63	6F	72	6E	edCorners[..corn
00000060	65	72	74	00	0D	5B	4C	65	6E	76	2F	43	6F	72	6E	65	ert..[Lenv/Corne
00000070	72	3B	4C	00	06	66	61	63	69	6E	67	74	00	0F	4C	65	r;L..facingt..Le
00000080	6E	76	2F	44	69	72	65	63	74	69	6F	6E	3B	78	70	00	nv/Direction;xp.
00000090	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	....
000000A0	00	00	01	75	72	00	0D	5B	4C	65	6E	76	2E	43	6F	72	...ur..[Lenv.Cor
000000B0	6E	65	72	3B	EF	95	9B	AA	80	79	EB	BC	02	00	00	78	ner;ï•›ª€yë¼...x
000000C0	70	00	00	00	02	73	72	00	0A	65	6E	76	2E	43	6F	72	p....sr..env.Cor
000000D0	6E	65	72	89	A8	D1	6E	FF	EA	F6	2D	02	00	05	49	00	ner‰¨Ñnÿêö-...I.
000000E0	06	61	76	65	6E	75	65	49	00	09	62	65	65	70	65	72	.avenueI..beeper
000000F0	43	6E	74	5A	00	08	65	61	73	74	57	61	6C	6C	5A	00	CntZ..eastWallZ.
00000100	09	6E	6F	72	74	68	57	61	6C	6C	49	00	06	73	74	72	.northWallI..str
00000110	65	65	74	78	70	00	00	00	00	00	00	00	00	00	00	00	eetxp...........
00000120	00	00	00	73	71	00	7E	00	06	00	00	00	02	00	00	00	...sq.~.........
00000130	00	00	00	00	00	00	0C	73	72	00	0D	65	6E	76	2E	44	.......sr..env.D
00000140	69	72	65	63	74	69	6F	6E	0E	32	EE	46	72	93	7C	F8	irection.2îFr"|ø
00000150	02	00	01	49	00	0C	74	68	65	44	69	72	65	63	74	69	...I..theDirecti
00000160	6F	6E	78	70	00	00	00	00									onxp....

Figure 6. Jarel world file in a hex editor

2 IMPLEMENTATIONS

The conversion of world files involves a series of steps that require careful attention to detail and the use of appropriate tools. The first step in this process involves conducting thorough research on how to open, manipulate, and close a file. In order to facilitate file manipulation, a library called fstream is utilized, which provides access to a range of functions specifically designed to support file manipulation.

Once this foundation of knowledge is established, the next step in the process involves the development of a program that is capable of extracting the eight bits that are different between Karel and Jarel world files. This program is designed to ensure that the project can be completed within the given timeframe. Furthermore, it ensures that the converted world file can be converted back and still work with the original software in which it was created.

To identify the differences between a Karel and Jarel world file, a second program is developed that can detect the specific byte differences between the two types of files. This is achieved by converting the eight hex bytes to binary bytes and searching through the whole file until the eight bytes from either Jarel or Karel match up with the relevant array.

The third step of the process involves utilizing the fstream library to open a file, and in doing so, we encounter difficulties when attempting to insert the Karel or Jarel world file into a new file. To overcome this issue, we utilize a command from the fstream library called Ofstream, which enables us to insert any file we wish to create.

The final step of the process involves combining all previous steps into a single program, with the addition of functionality that enables the program to convert entire directories of Jarel or Karel world files. To achieve this, we utilize the dirent.h library, which enables us to call the built-in command lstat to gather information about each file in a directory. By using this library, we can traverse through any directory file by file and check to see if the file is of Karel or Karel type and have the program convert Karel or Jarel world files.

Moreover, the final program provides additional functionalities such as identifying the type of the world file (Karel or Jarel) and prompts the user if it encounters an unfamiliar file, which allows the program to skip such files.

In conclusion, the process of converting world files involves several steps, including research, program development, library utilization, and functionality implementation. The use of appropriate tools, such as fstream and dirent.h libraries, plays a crucial role in ensuring that the program is capable of converting not only individual files but entire directories of world files.

3 RESULTS

The program was designed with the goal of converting world files from one format to another, specifically between Karel and Jarel world files. The program was built to meet this objective by following a step-by-step process.

The first step was to research the process of opening, manipulating, and closing files. This led to the discovery of the fstream library, a file manipulation library that provides access to tools for file manipulation. The fstream library was used to create a program that can extract the eight bytes that differ between Karel and Jarel world files, ensuring that the project could be completed within the given timeline. This conversion process maintains the integrity of the original software that the file was created in, allowing it to be converted back and still function as intended.

The second step involved creating a program that could differentiate between Karel and Jarel world files by analyzing the eight hex bytes that differ between the two file types. This

program successfully identified the differences between the two file types and generated an array that could be used to search through a file and locate whether it was a Karel or Jarel world file.

The third step involved implementing the fstream library to open files and insert Karel or Jarel world files into a new file. The Ofstream command from the fstream library was utilized to accomplish this task.

The final step was to combine all the previous steps into one program that could convert entire directories of Karel or Jarel world files. The program utilized the dirent.h library to call the built-in command lstat, which retrieves information about a file and places it in a designated area of memory. The program could then traverse through a directory, file by file, and convert any Karel or Jarel world file that it encountered. The program also included a feature that would prompt the user if the world file was not of Karel or Jarel type and would skip the file to move on to the next one.

Overall, the program successfully met the expectation of converting Karel and Jarel world files. The program accurately identified the differences between the two file types and provided a streamlined process for converting them. The program also provided additional functionality by allowing the conversion of entire directories of files and identifying whether a file was of Karel or Jarel type. This program has proven to be a valuable tool for those who need to convert Karel and Jarel world files.

4. FUTURE WORK

Given additional time and resources, it is feasible to expand the scope of this program beyond the exclusive use of professors and allow students to benefit from its functionality as well. As students are frequently given Karel or Jarel world files that may not be compatible with the software on their operating systems, this program could serve as a valuable tool for them to easily convert these files to the appropriate format for their system.

One potential area of improvement for this program would be to create a version that can process only Jarel or Karel file types, as some users may prefer to work with only one type of file. For instance, if a user has software that only accepts Jarel world files, it would be convenient to have a program that can exclusively handle Jarel files without having to differentiate between the two file types.

Furthermore, a possible extension to this project would be to develop a graphical user interface (GUI) for the program, which would enable users who are not familiar with Linux terminal commands to easily utilize the program's functionality. This could be accomplished using a language like Java, and would enhance the user-friendliness of the program for both professors and students alike.

By creating a GUI version of the program, it would be able to run on a wider range of operating systems, including Windows, Mac OS, and Linux, thereby increasing the accessibility of the program to a broader audience. Such a development would allow the program to become an even more valuable tool for both professors and students, ultimately improving the efficiency and ease with which they can work with Karel and Jarel world files.

5. CONCLUSION

The outcomes of this project were highly successful. Developing this program presented various challenges, with one of the most demanding aspects being the process of opening a file and modifying the eight bytes of the world file. Nonetheless, this program is a valuable tool that will benefit not only myself, but also professors who teach CS110 courses for years to come.

The program efficiently determines if the file type is of Karel or Jarel type and then converts any Jarel or Karel world file types to their opposite world file type. Once the conversion process is completed, the program creates a new file with the original name of the world file, appending a "_Converted" suffix to indicate that the Karel or Jarel world file is converted. This feature ensures that the user can easily determine the file type of the original world file and has a new converted world file that they can utilize in the opposite Karel or Jarel program.

Moreover, the program can convert individual world files and directories containing multiple Karel or Jarel world files. As such, it provides an efficient and effective solution for students and educators who face compatibility issues with their existing operating system. Overall, this project is a testament to the importance of addressing issues that impact the learning experience in computer science. By creating this program, I have taken a significant step towards ensuring that students and educators can access a solution that allows for seamless integration with their preferred platform, ultimately contributing to a more positive learning environment for all.

6. REFERENCES

- Binary literals in C++14 with examples. Geeks for Geeks. (2021, January 28). Retrieved May 3, 2022, from https://www.geeksforgeeks.org/binary-literals-in-c14-with-examples/

- Binary Search C++. Binary search in C++. (n.d.). Retrieved May 3, 2022, from https://www.tutorialspoint.com/binary-search-in-cplusplus

- Binary searches. Dot Net Tutorials. (2022, February 20). Retrieved May 3, 2022, from https://dotnettutorials.net/lesson/binary-search-in-cpp

- C++ Arrays. C++ arrays. (n.d.). Retrieved May 3, 2022, from https://www.tutorialspoint.com/cplusplus/cpp_arrays.htm#:~:text=To%20declare%20an%20array%20in%20C%2B%2B%2C%20the%20programmer,type%20can%20be%20any%20valid%20C%2B%2B%20data%20type.

-C++ fstream: How fstream work in C++: Examples: Advantages. EDUCBA. (2021, March 4). Retrieved May 3, 2022, from https://www.educba.com/c-plus-plus-fstream/

- C++ Library -. C++ Library -. (n.d.). Retrieved May 3, 2022, https://www.tutorialspoint.com/cpp_standard_library/fstream.htm

- C++ tutorials. C++ Tutorial: fstream - input and output - 2020. (n.d.). Retrieved May 3, 2022, from https://bogotobogo.com/cplusplus/fstream_input_output.php

- C++ using fstream https://stackoverflow.com/questions/13321644/c-using-fstream

Std::Ofstream. cplusplus.com. (n.d.). Retrieved May 3, 2022, from https://www.cplusplus.com/reference/fstream/ofstream/

- Karol the robot. Karol the Robot. (n.d.). Retrieved May 16, 2022, from https://lingo.life/texts/karol_the_robot

Pattis, R. E., & Roberts, J. (1995). Karel the Robot: A Gentle Introduction to the art of programming (2nd edition). Wiley.6