Human-Computer Interaction

Practical Assignment 4: Interaction Design

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Introduction

In this project, we are going to focus on the game with adjustments for people with vision problems. To be more specific, vision impairment and color blindness. Globally, it is estimated that at least 2.2 billion people have a vision impairment. Also, about 8% of males (including Mark Zuckerberg, Bill Clinton, and Prince William) and 0.5% of females are colorblind in some way. Simple tasks such as selecting ripe fruit, choosing clothing, and reading traffic lights can be more challenging. Unfortunately, not every software is capable of helping those people. We decided to make a Sudoku game, with some features, nice to people with vision problems mentioned above.

User analysis

People with vision impairment mostly have problems with reading small letters. Sometimes it is difficult for them even with a bigger font. This can cause problems with using applications or playing games. Especially if the games strongly rely on reading letters or numbers.

Colorblind people have problems with color recognition. This happens because, one or more of the types of cone cells in their eyes, the cells we use to detect color, do not work normally. There are three main types of this problem: protanopia, deuteranopia, and tritanopia. Deutan color vision deficiencies are by far the most common forms of color blindness. It is called the green-red color blindness. Affected people have problems with red and green colors but, there are also, for example, some gray, purple and a greenish blue-green which can’t be distinguished very well. Protans have either defective long-wavelength cones (L-cones) or the L-cones are missing at all, they are less sensitive to red light. If they are missing it is called protanopia or sometimes red-dichromacy. Affected persons are dichromats because they have only two working cone types, short- and medium-wavelength, compared to persons with normal vision with three different cone types. People affected by tritan color blindness confuse blue with green and yellow with violet. It can be observed that tritanopes usually have fewer problems in performing everyday tasks than do those with red-green dichromacy. Maybe this is because our society associates green with good/go and red with bad/stop.

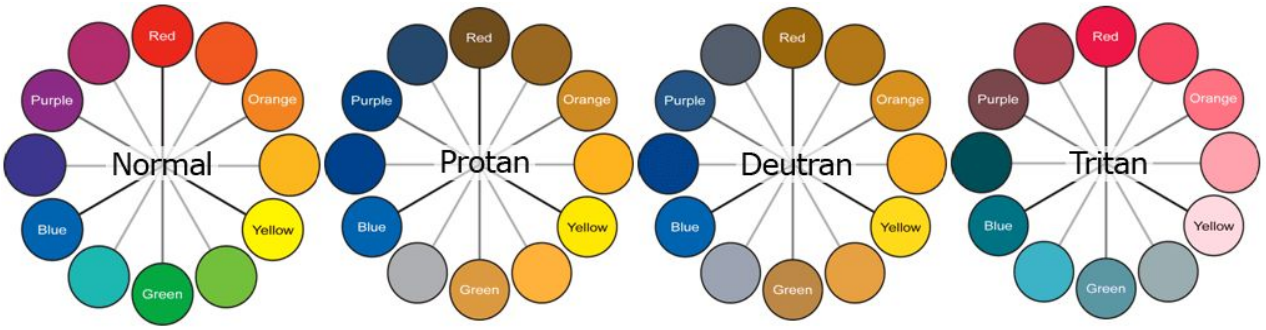


Fig 1. The color spectrum of affected people.

Task analysis

While designing our game, we need to take into consideration all of the user's problems mentioned in the previous section. Starting with people with vision impairments. We have to assume that every information could be unreadable. To avoid a situation, that the user can't play our game because it is not possible to see the option clearly, we need to make sure everyone can reach the desired information. To do this, we can provide an option to make the font as big as it becomes readable. On the other hand, it is not necessary to rely only on one sense. If the user has a healthy sense of hearing, we can use it to provide the information. Simple reader function can improve the experience a lot.

Color blindness is not an as serious problem in terms of the Sudoku game as vision impairments, but still, it can cause some discomfort while playing. When we do the verification of the board of the game, we want to use colors to indicate what gone wrong, and what is done well. Common colors will be the green for good and the red for bad as it is the most common concept. People that have problems with green and red recognition won't be able to benefit from this feature. To solve this, we can specify the color palette in the game options. Users should be able to choose between the normal colors or the ones customized to color blindness.

Prototype

To get a prototype done we used Adobe XD. This is the concept of the game presented:

Fig 2. Main menu

Simple main menu with two buttons, one leading to options and the other to start the game. To help people with vision impairments, the reader is turned on by default. Also, to turn off the game, there is a classic cross at the top left corner.

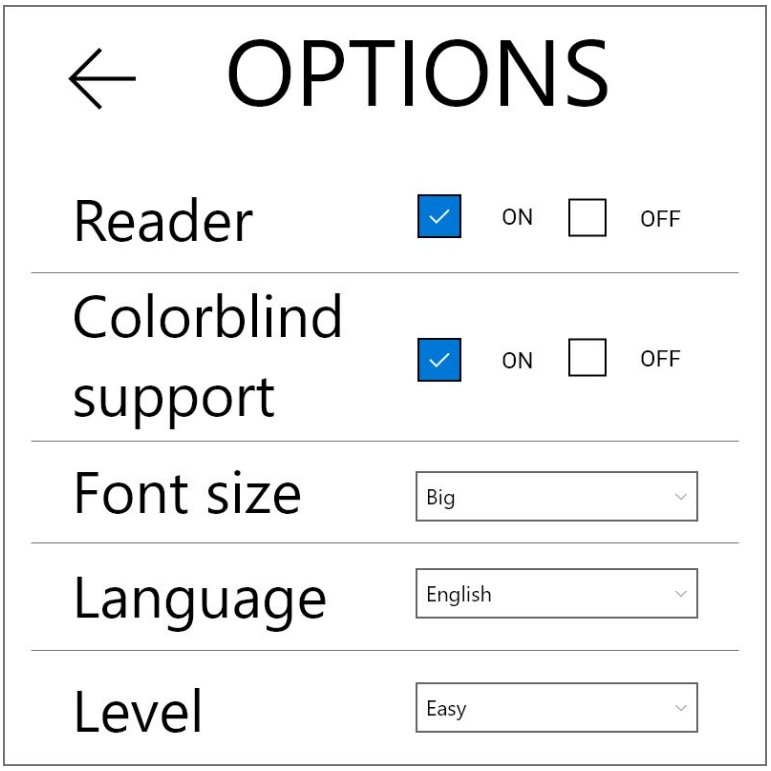


Fig 3. Options

When the “option” button is pressed, the user is navigated to this page. Here we can change the settings of the game. The first option is the reader. User can choose if wants the voice support or not. By default, it is on. The second option is for colorblind people. In the game, there is a feature that colors some of the numbers to help with the solution. The user can choose the colorblind color palette to change the color of this feature for more friendly for them. The font size option is set to big by default, but the user can choose between big, medium, and small. The big font is set because of the users with vision problems. If the size is too big for the average user, it can be easily changed. Also, we provided three languages: Portuguese, English, and Polish. The last option is for setting the difficulty. There are three levels: easy, medium, and hard. To go back to the main menu, there is an arrow pointing backward.

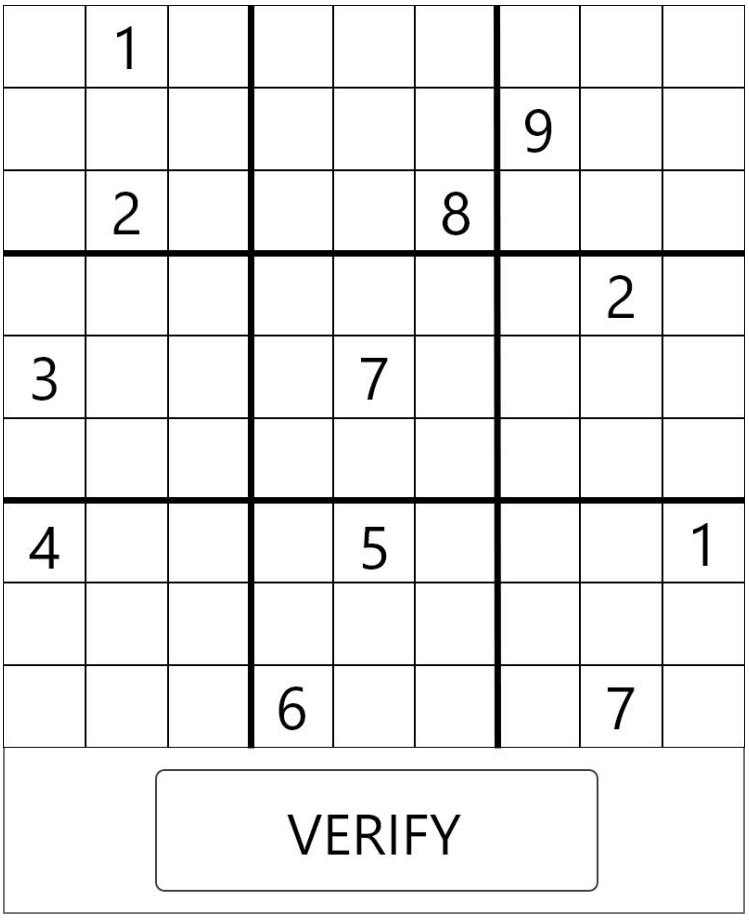


Fig 4. Game view

The “play” button leads to the actual game. Sudoku is a logic-based, combinatorial number-placement puzzle. The objective is to fill a 9×9 grid with digits so that each column, each row, and each of the nine 3×3 subgrids that compose the grid contain all of the digits from 1 to 9. Depending on the difficulty level, the number of starting numbers can be different. The user fills the squares with numbers from 1 to 9 with simple input from the keyboard. When the user is ready to check the correctness of the solution, there is a verification button.

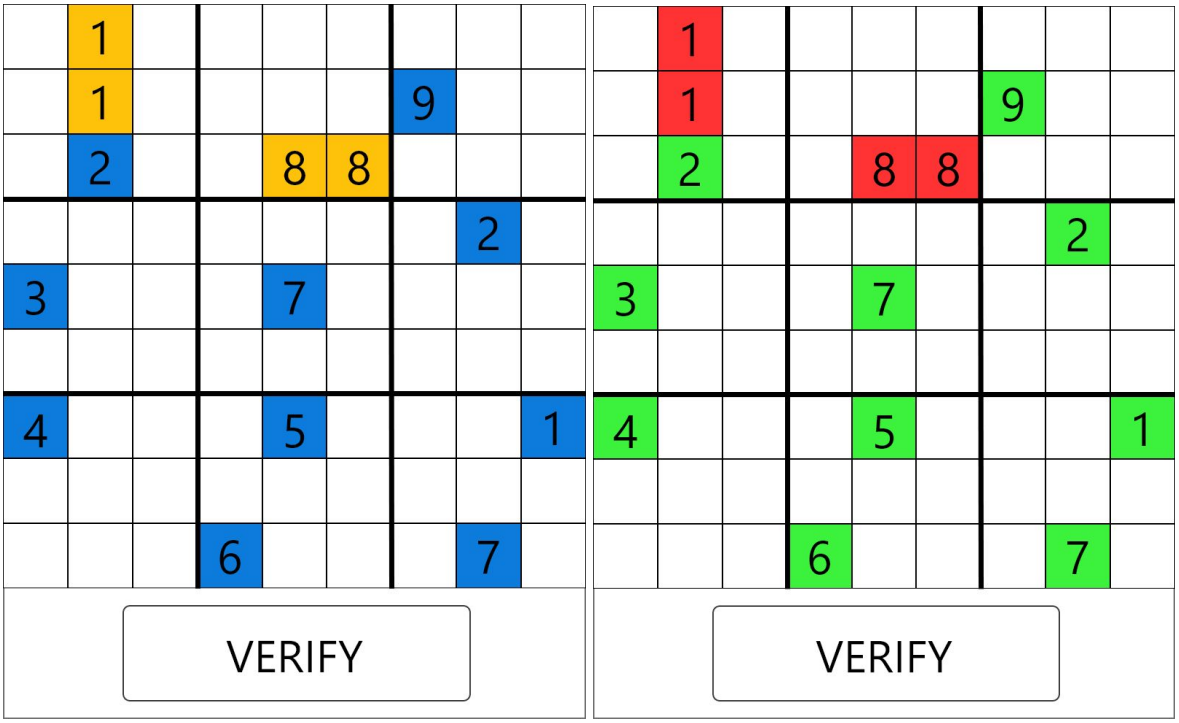


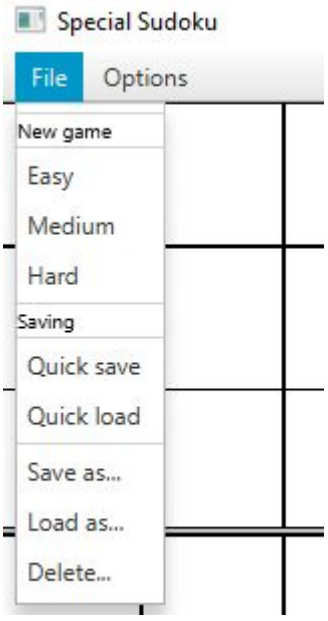
Fig 5. and 6. Game checked with two versions: colorblind support on (left) and off(right)

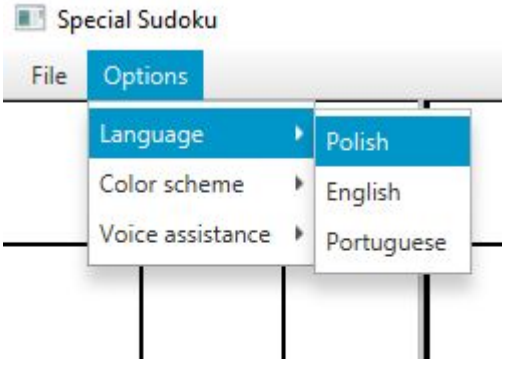
The “verify” button starts the checking algorithm. It changes the colors of the squares, distinguishing whether it is correct or not. In colorblind support mode off, the colors are green for good and red for bad. This can be problematic for colorblind people when they have problems with green and red recognition. That’s why when the colorblind support option is on, the colors are more readable for them.

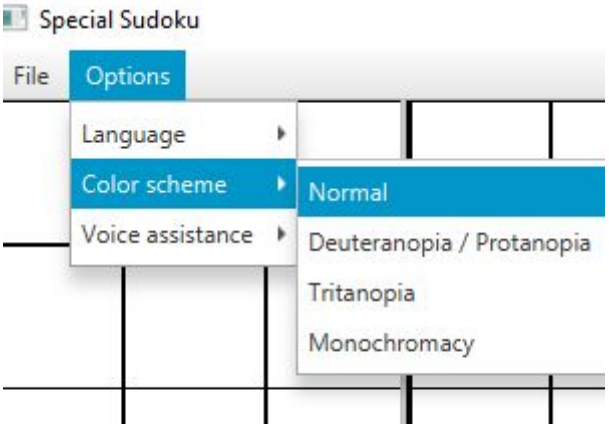
Implementation

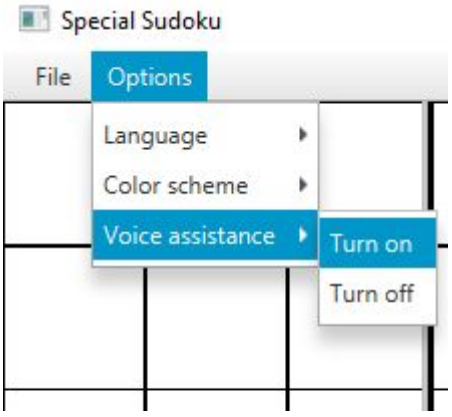
To implement our idea we used Java as the main language. It offers great flexibility and makes the application platform-independent, meaning, later on, we can export it on any operating system that supports Java Runtime Environment and also both as a web or mobile application. In addition, we used a handful of libraries such us JavaFX, FreeTTS, SQLite and jUnit.

First of them, JavaFX is a library allowing us to implement Graphical User Interface and customize it to our needs. Not only is it a very well known graphical library, but also we were familiar with it so it made the development process faster and easier for us. FreeTTS provides text-to-speech feature and allows the program to read desired columns, rows, and boxes. We also used SQLite to provide saving and loading sudoku games and jUnit to write tests of our application to reassure that at any point in development every feature works flawlessly.



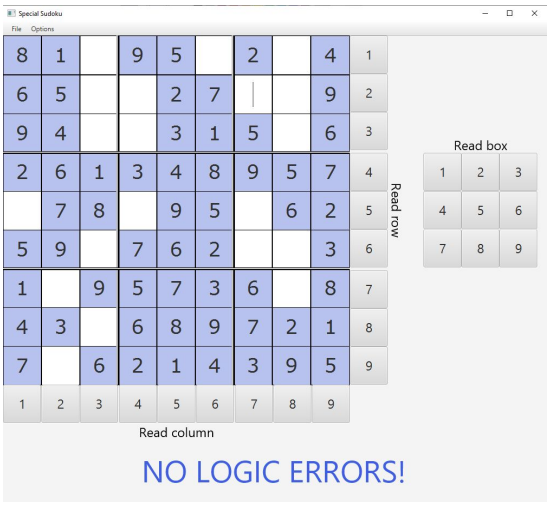


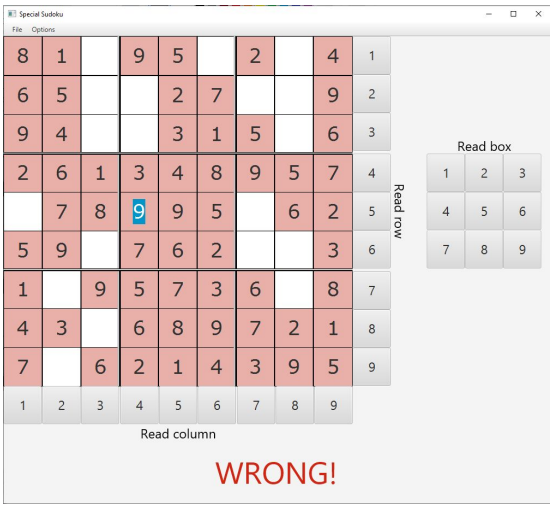


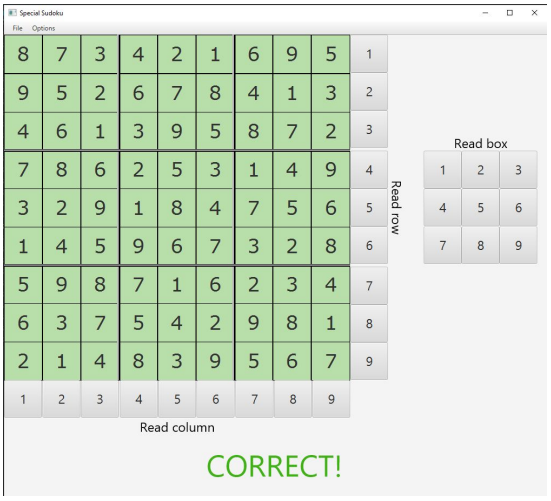


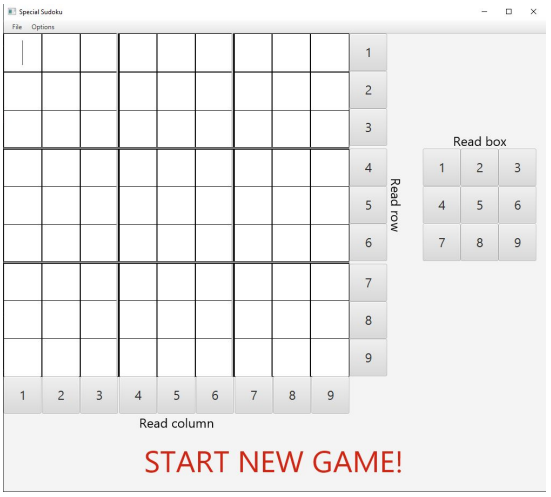
The application itself has all the features that we planned to implement. First of all, looking at the menu bar on top of the main window, there are options. A user can start a new game with a different difficulty level, quickly save or load a game (1 slot available) or save, load and delete permanent saves from the database.

In Option section user can choose one of three currently available languages - English, Polish and Portugues. Then he can choose one of four color schemes - Normal, Deuteranopia / Protanopia, Tritanopia, or Monochromacy. Finally, the user can turn on or off the voice assistant, which is turned on by default.









Sudoku itself offers an intuitive interface packed with features. When a user starts a new game, he can immediately view the board, 27 buttons responsible for reading desired fields, and, on the very bottom, information on the status of the sudoku. Possible statuses are ‘CORRECT!’, ‘NO LOGIC ERRORS!’, ‘WRONG!’ and ‘START NEW GAME!’.

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As one can see in the picture above, changing the language and color scheme also works flawlessly and allows colorblind people or people not speaking English to enjoy the game.

Game implementation differs slightly from the prototype. We made the design a bit more readable, we used bigger fonts by default and also added a lot of buttons to make it possible to read columns, rows, and boxes. The only issue we have with the current implementation is the voice assistance turning on after the user clicks the menu option. Due to the chosen technology, we are not able to resolve this problem and we weren't conscious about it till almost the end of work, at which point it was too late to change technology.

Helpful hardware

The main hardware device that helps during the game is a speaker. Without a speaker, we can't provide the reader which is a big feature for people with vision problems. Most of the laptops have built-in speakers, but PC users have to buy it separately. Also, laptops have a nice feature that we can use which is a microphone. We can use it for the input to the game. Voice recognition can replace keyboard input. People with vision problems will find it a good feature because it can be difficult for them to use an ordinary keyboard. Nowadays, voice recognition is a common solution. Big companies use it to help people with navigation on their devices. Google, Apple, or Amazon have a well-working voice assistant. Another helpful device is an eye-tracker. This device can sense where the user focuses the sight. We can combine it with our reader, to improve the performance of this feature. Pointing at the thing that we want to be read with our eyes is a better way than pointing with a mouse. As far as I'm concerned, this kind of device is well developed and is working fine, so the problem with pointing at the wrong thing is not likely.