Sudoku in PIECES

53-471 Sudoku Variation Assignment

Inner Circle Entertainment

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2 INTRODUCTION

2.1 GENERAL DESCRIPTION

Sudoku in Pieces is a variant of the classic game Sudoku with a simple twist. Rather than filling in individual cells, on a 9x9 Sudoku board, the player is given "jigsaw" pieces that consist of multiple cells to place on the board.

Much like real jigsaw puzzles, the difficulty of the Sudoku "jigsaw" puzzles can be scaled by changing the number of pieces that the puzzle consists of, and their relative size.

2.2 WIN CONDITIONS

The Win Conditions for *Sudoku in Pieces* are the same as traditional Sudoku. The 9x9 game board must be filled in with the numbers 1-9 in each row, column, and 3x3 sub-square.

2.3 PHILOSOPHY

Sudoku in Pieces is a fun to play, relaxing variation of Sudoku. Art and sound elements of the game are design to create a relaxing experience. Easier difficulties of the game emphasize the "jigsaw" aspect of the game. The larger pieces generated by the game determine where pieces on the board fit and the Sudoku aspect of the puzzle provides hints for placing pieces with similar shapes. Harder difficulties combine both aspects of the game. Due to the smaller size of the jigsaw pieces, players must think about the shapes of the pieces as well as the numbers on them when determining placement.

3 TECHNICAL

3.1 SCREENS

1) Main Menu
    a) Start
        i) Difficulty Select
            (1) Main Game
    b) High Scores
    c) Background
    d) Credits(Unreachable)

3.2 CONTROLS

Gameplay consists of drag and drop, mouse and keyboard controls. Players click and hold on a piece to pick it up, and use 'x' and 'z' to rotate the piece 90® clockwise and counterclockwise. When a piece is released, it will try to "snap" onto the game board if possible, otherwise it will remain where the user released it.

4 GAME

4.1 PLAYER LEVEL AND EXPERIENCE

The Player Level is used to track the player's progress and how much he/she has played. New difficulties and content are background are unlocked as the player levels up.

Difficulty	Level Unlocked
Easy	1
Medium	1
Hard	5
Lunatic	10
Extra	15

Background	Level Unlocked
Original	1
Sudoku	1
Tom	6
Tree	9
Turtle	12
Pyramid	15

Players level up by playing the game. Experienced earned is based on the score a player receives when he/she completes a game. Since the a higher base score and time bonus are received for completing harder difficulties, as the player reaches higher levels, the most effective way to level up will be to play the higher difficulties.

The experience required to level up is listed in the table below.

Level	Exp Required Reach Next Level	Total Exp Earned
1	10000000	0
2	20000000	10000000
3	50000000	30000000
4	100000000	80000000
5	180000000	180000000
6	320000000	360000000
7	650000000	680000000
8	1250000000	1330000000
9	1250000000	2580000000
10	1250000000	3830000000
11	1250000000	5080000000
12	1250000000	6330000000
13	1250000000	7580000000
14	1250000000	8830000000
15	N/A	10080000000

4.2 Game Difficulty

The game contains 5 difficulty settings: Easy, Normal, Hard, Lunatic, and Extra. During puzzle generation, various parameters are set based on the difficulty that affect the sizes of the pieces generated and the number of hints provided(pre-filled cells on the game board).

4.3 Puzzle Generation

Puzzles are generated using a database of 100 preexisting Sudoku puzzles. One puzzles is selected from to be divided into "jigsaw" pieces and hints. The algorithm runs as follows:

1. Assign each cell of the 9x9 board a weight of 0
2. Choose 9 random starting points, 1 in each row. Assign each starting point a weight of 1. Based on the difficulty assign each starting cell a random integer between the minimum piece size and maximum piece size. The starting points will be turned into pieces by creating a path containing adjacent cells. The starting point and the cells in the path it connected to will form a puzzle piece.
3. For each Starting point, create a path between cells by selecting a valid cell with weight 0(meaning it hasn't been added to a path/piece yet) that is adjacent to the starting point or cell in the starting point's path. Update the added cells weight to 1. Continue until the piece contains a number of cells equal to the random number it was assigned, or no valid adjacent cells exist(all surrounding cells have been added to a piece).
4. Repeat the process in step 3 by selecting a valid cell with a weight of 0 as a new starting point. Set the starting point's weight to 1 and a assign it a random integer between the minimum piece size and maximum piece size. Repeat until all cells have a non-zero weight.
5. Finally, find generated pieces with a size less than the minimum piece size for the difficulty and set them as hints on the board. Each difficulty has a minimum number of hints that will be generated, so if there are too few hints after placing the small pieces, select pieces from the remaining ones as needed.

4.4 Gameplay

Gameplay begins with a Sudoku board with hints and a "jigsaw" pieces scattered around the scene. Players attempt to fill in the board using the "jigsaw" pieces. In order to solve the puzzle, players will need to rotate the pieces. A visual cue is given to players to indicate invalid piece placement. In easier difficulties, the shape of pieces will give players hints for placement.

When the board is full, players can submit their puzzle and review their score. A High Score list is kept with scores for each difficulty.

4.5 Scoring

Scores consist of 2 components, a base score, and a time bonus. The base score for the game is a flat score based on the difficulty. The time bonus is an exponential function that is based on the difficulty.

The time expected to solve each difficulty varies. The time bonus decays with an exponential curve. The time bonus can decay to zero.

	Base Score	Initial Time Bonus	Time Bonus = 0 Time
Easy	10000	20500	5 Minutes
Medium	15000	30500	10 Minutes
Hard	25000	50800	15 Minutes
Lunatic	50000	101600	20 Minutes
Extra	100000	203300	25 Minutes

5 Art & Visual Style

5.1 Visual Style

The Visual Style for the game was inspired by the style of many games on the Nintendo DS(bright, colorful, cartoony). In particular, the *Professor Layton* series was used for inspiration.

6 Music & Sounds

6.1 Sound

The sound effects for the game were influenced by the Visual Style. The sound effects complement the cartoonish style of the game and help create the soothing, non-serious tone the game was trying to achieve.

Most sound effects for the game were made by Inner Circle Entertainment. The “Yay” sound effect that is played at the end of the game can be found at https://www.youtube.com/watch?v=waRq6ZR7BNE and has the Standard Youtube License.

6.2 Music

The background music for the game is supposed to be calming for the player to listen too while solving the game.

The background track for the game can be found at http://freemusicarchive.org/music/Chan_Wai_Fat/Children_of_Soul_Mountain/05_dream and has a Creative Commons non-commercial license.

7 FUTURE WORK

Inner Circle Entertainment plans on publishing *Sudoku in Pieces.* In order to do this there are a couple of changes that need to be made. The “Yay” sound effect will need to be swapped out due to its license. The background music needs to be attributed somewhere in the game or swapped out for something else if we go in a commercial Direction.

Additionally, the Visual theme(fonts, buttons, style) will be unified to make for a more cohesive experience. In order to publish on the Play Store, touch controls are being developed. The current layout of the game works well for tablets, but will need to be redesigned to work well on phones.