KenKen puzzle solver

Tuesday, August 3, 2021   11:45 AM

Application specification:
A KenKen puzzle solver takes in a board of various sizes, a list of values for specific cells and a list of formulas for specific sets of cells. It returns the board with all correct values filled in.
Constraints:
- Size of boards are 3x3 up to 9x9.
- Formula symbols are +,-,x,/.
- If the board can be solved in multiple ways, only one of the ways will be reported.
- KenKen rules state that on a single row, values cannot repeat and are between 1 and size
- KenKen rules state that on a single column, values cannot repeat and are between 1 and size
- KenKen rules state that values in cells need to satisfy the formulas they belong to

Inputs specification:
- Board size: size is 3 to 9
- A list of values for specific cells:
  - x,y,value;x,y,value…
  - x = horizontal location on the board, 0 is left-most, 0<=x<size
  - y = vertical location on the board, 0 is top-most, 0<=y<size
  - value = value of the cell, 1<=value<=size
- A list of formulas for specific sets of cells:
  - Result, symbol,x,y,x,y…;result,symbol,x,y,x…
  - Result: the result of a formula
  - Symbol: +,-,*,/
  - x: 0<=x<size
  - y: 0<=y<size

Input file specification:
- Board size;result,symbol,x1,y1,x2,y2,x3…;

Output specification:
- If the input has no solution, it will report no solution.
- Values on row 1; values on row 2;…

Solver display overview:
- Draw a size * size table
- Each formula is outlined by a thick lines
- Top left corner of each formula shows result followed by symbol (TBD)
- Each cell displays its value

Solver logic overview:
- The value of a cell must be 1<=value<=size of board
- Cells on the same row/column must have unique values
- Each formula needs to be evaluated
  - Addition, two values+: x1+x2… = z;
  - Subtraction, 2 values: x1-x2 = z or x2-x1=z
  - Multiplication, 2 values+: x1*x2… = z
  - Division, 2 value: x1/x2=z or x2/x1=z
  - Empty symbol: x=z
- When available values for cells drop down to 1, x = available value

- When available values for cells drop down to 0, error
- When an available value changes for a cell, the formula containing the cell needs to be reevaluated
- When a cell is solved, all cells with the same x or y need to be reevaluated
- Advanced:
  - When two cells share the same two available values, it triggers all cells that share the same x or y that the above two cells share to get reevaluated (remove the two available values from those two cells…)

Rapid prototyping:

- Reduce KenKen puzzle to 3x3 board with filled cells and formula symbol of +.
- Work flow:
  - Load input from text file
  - Apply solved cells onto board, each solved cell should trigger reevaluation of certain cells (add to priority queue)
  - Apply formulas onto board, each formula should trigger reevaluation of certain cells (add to priority queue)
  - Process priority queue until it is empty
  - Return the results
    - unsolved board can show available values
- Re-evaluation types:
  - Solved a cell: Re-evaluate all cells where x = solvedCell.x || y = solvedCell.y, add job to remove solvedCell.value from all thoses cells onto the priority queue
  - A formula: see above, each case should add one or more items to the priority queue
- Priority queue:
  - Happens in a priority queue,
  - (TBD) if it becomes empty before the board is solved, then guessing is needed; incomplete rules
  - Each queue item needs information on: cell location (x,y), remove available values a,b,c… from cell (can only remove since all cells are assumed to have all values available)
  - Each cell needs to have location (x,y), value, count of available values (availArr.length), available values (availArr)
  - Error if availArr.length === 0;
  - Solve cell if availArr.length === 1; call solvedCellRe-evaluation
- When priority queue is empty
  - if Solved board === cells.solveCount, board is solved
  - Otherwise, board is not solved

What's the relationship between formulas, cell info and work items?

- Formula's format: result, symbol, cell coordinates
- CellInfo's format: value, formula, cell coordinates
- Work item: a simple todo; cell coordinate, value to remove from possible values; trigger reevaluation of the cell
- Some default rules need to be applied somehow:
  - Cell values across a row/column have to be unique <= need to trigger whenever a possible value is removed
  - Cell values have to be between 1 and size <= built in the possibleValues

What causes work items to be created?

- Whenever a cell's possible value changes

What changes a cell's possible value?

- Processing formulas (board.processFormulas())
  - when board is initially loaded

    - when a cell's possibleValue changes (cellInfo.formula)
- When a cell's value is set (board.setCellValue(x, y, value))
    - When first processing formula where symbol === ' '
    - When available values for a cell goes down to 1 <= when will board checks this? TBD

When does a cell's value gets set?

- Initial formula processing where symbol is ' '
- possibleValues.length drops down to 1

Work items and bugs:

- ✓ When loading board initially, show initial set values, process formulas later
    - Instead of calling processing of formulas or removing possible values across cells right away, add them as work items in **board.workitems** (a priority queue).
    - Each work item should have a function to call and a list of arguments
    - Processing of the work items is triggered by solve(), which continuously process each work item until the queue is empty.
- ✓ Add console logging
- ✓ Add support for -
- ✓ Add support for /
- ✓ Add support for + and -
    - Given: **formula.coordinates** cells, a symbol **formula.symbol === '+'**, a result **formula.result**
    - Each cell contains an array of possible values **cells[i].possibleValues**
    - Find: remove possible values that cannot satisfy the formula
    - Thoughts: result = c1 + c2 + c3…cN; to check a possible value **c1.one**; all c2 to cN's values need to be checked; if this formula c1.one = result -c2-c3…cn is satisfied. The value is right.
    - Brute force: take a possible value, calculate possible = result - c1.one, since we don't know what n is until run time, use recursive until the last loop. So a base case for the recursion is index of **coordinates === coordinates.length - 1,** then **return cN.possibleValues.find(x => x === possible);** the reduction loop should be check each possible value for the current coordinate **coordinates[index]**, calculate the possible values and call the next loop **validateAgainstPossibleValues(table, coordinates, index, result, getPossibles);**
- ✓ Add support for when same set of possible values exist for x number of cells on the same row (like 1,5 at [0,1],[1,1]), then the rest of the cells of the same row (1) cannot have those values (remove 1 and 5 from x sets of cells
    - In a simple two cell one, the possible values of the two cells are the same <- easy, just check to see if the possible values are equal
    - In a more complicated 3 cell one, it can look like this 1,4; 2,4; 1,2; there are 3 cells and the 3 cells hold 3 possible values 1,2,4
    - Can I do a count of possible values? For x = 6,

V = 1	2	3	4	5	6
Y = 1	1	1	1	1	
2	2		2	2	2
3	3		3	3	3
	4	4	4		4
5		5			
6		6			

    - What's the brute force way to do this?
        - Maybe first to just to compare the cells for ones that are the same? If they are and their possible values.length === 2, then remove those possible values from the rest of the cells:
    - Can I sort the cells by their possible values?

        - For x = 6, sort possible values' lengths from shortest to longest, y=5,6,4,1,2,3; start with 5's, cells = 1, possible values = 2, add 6's, cells = 2, possible values = 2, cells count === possible values count; remove possible values 1 and 3 from the rest of the cells; return
        - For x = 4, max possible values = 6 - 1 = 5 5; start from the shortest y = 6, cells = 2, possible values = 2 (<5), add 1's, cells = 4, possible values = 4 (<5), add 3's, cells = 3, possible values = 5 (<5? False) return
        - For y = 6, first x = 1, cells = 1, p = 2; add 4's, cells = 2, p = 3, (1,2,4), add 6's, cells = 3, p = 5 (1,2,3,4)… return; the correct way is to do 2,3,4 to make (2,4,5)

6	**{1,5}**	**{1,2,3,4,5}**	**{1,2,3,4}**	**{1,2,3,4}**	**{1,2,3,4,5}**
{1,3,5}	**{1,5}**	**{1,2,3,4,5,6}**	**{1,2,3,4,6}**	**{1,2,4,6}**	**{1,2,4,5,6}**
{1,2,4,5}	**3**	**{1,2,4,5,6}**	**{1,2,4,6}**	**{1,2,4,5,6}**	**{1,2,4,5,6}**
{1,2,3,4,5}	**{1,2,4,5,6}**	**{1,2,3,4,5,6}**	**{1,2,3,4,6}**	**{1,2,3,6}**	**{2,3,4,6}**
{1,4}	**{1,2,6}**	**{2,3,6}**	**5**	**{1,2,3,6}**	**{1,3}**
{1,4}	**{2,4,5}**	**{2,4,5}**	**{2,4}**	**{1,2,3,6}**	**{1,3}**

✓ - Make row and column scrubbing into formula
    - Scrub row y => formula result = y, symbol = 'r', coordinates = ''
    - Scrub column x => formula result = x, symbol = 'c', coordinates = ''
    - Make a cell to be able to point to several formulas

Add sudoku puzzle solving

Tuesday, November 2, 2021 1:36 PM

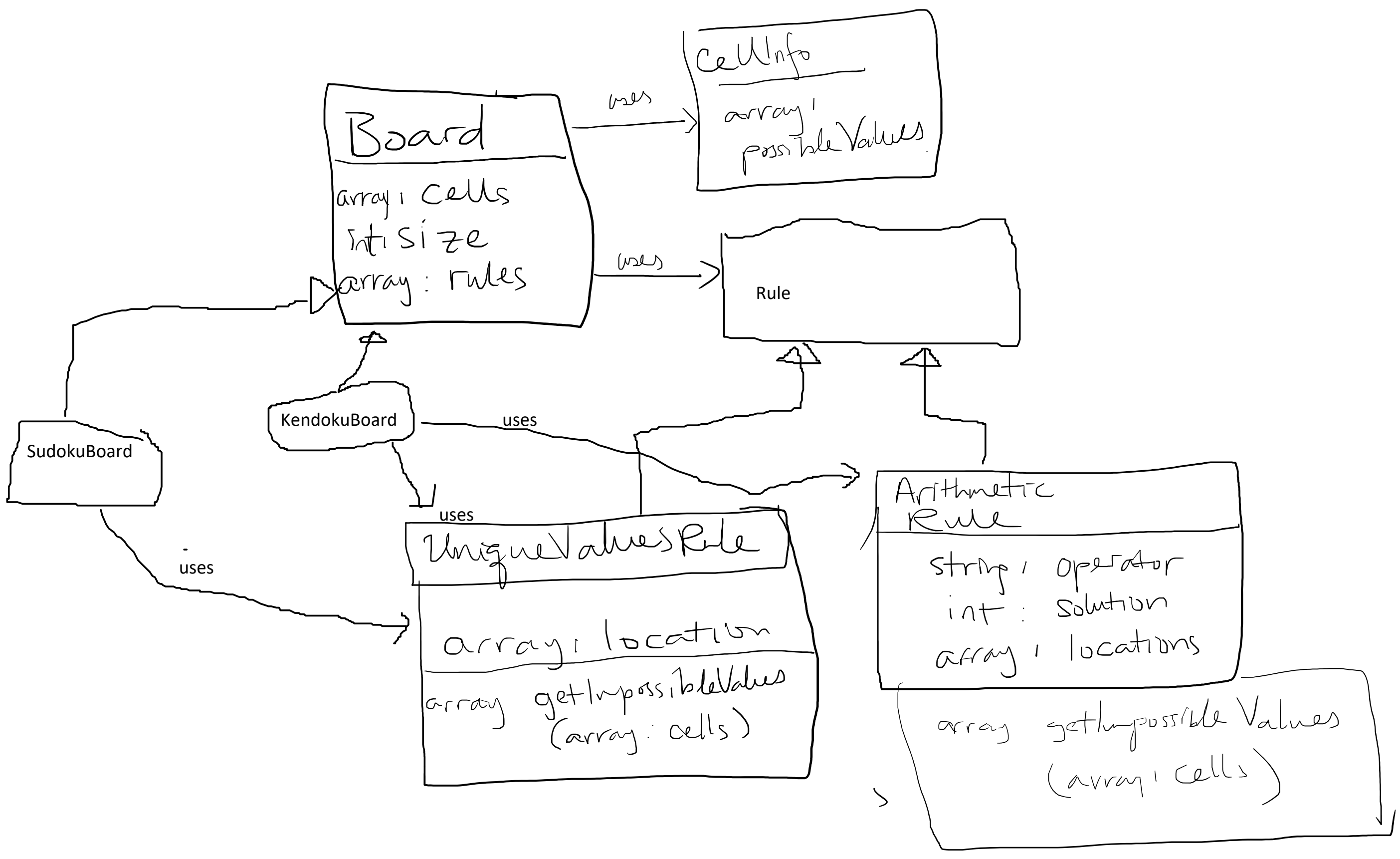
Sudoku is similar to KenDoku. It has a size of 9x9. Each row, column and 3x3 squares need to have unique integer values of 1-9.

Architecture changes to allow to add sudoku puzzle solving:

- ✓ Separate arithmetic rule and unique value rules into their own classes since they're not the same:
  - Four function formula: example 5 + a,b means the sum of a,b is 5; cells
    - Only 1,2,3,4 can be the values of a or b.
    - Currently a and b's possible values are 1-9
    - So cells' possible values will change; when a cell's possible values change, this should trigger business logic to inspect the change to decide what to do next: if # of possible values = 1, then trigger set value; if change is related to a formula, then need to evaluate formula
- ✓ Board should set value and possible values, not rules. Rule can evaluate cells against itself, then return a list of possible values to remove for its coordinates. (Inversion of control, higher class calls lower class).
  - ✓ Arithmetic rules
  - ✓ Unique values rules
- ✓ Make Board's cells private
- ✓ Board needs to create unique value rules for each cluster of cells (every row and column)
- ✓ A cell should not track its rules
- ✓ Correct board setup cells[row][col] instead of cells[x = col][y=row]
- ✓ Remove value property from cell info
- ✓ Add rule: when a cell's value is set, then its cell cluster should not have its value listed in their possible values
  - ✓ Current rule.coordinates only gives cell location but hard to access and find cell info. Make it into a hash table with key = JSON.stringify(coordinate) and value = cellInfo to make it easier to search?
- ✓ Board binds cells to their rules via a hash where key = JSON.stringify(cell's coordinate) and value = cell's value
- ✓ Move removePossibleValues from Table to Cell

Model Architecture

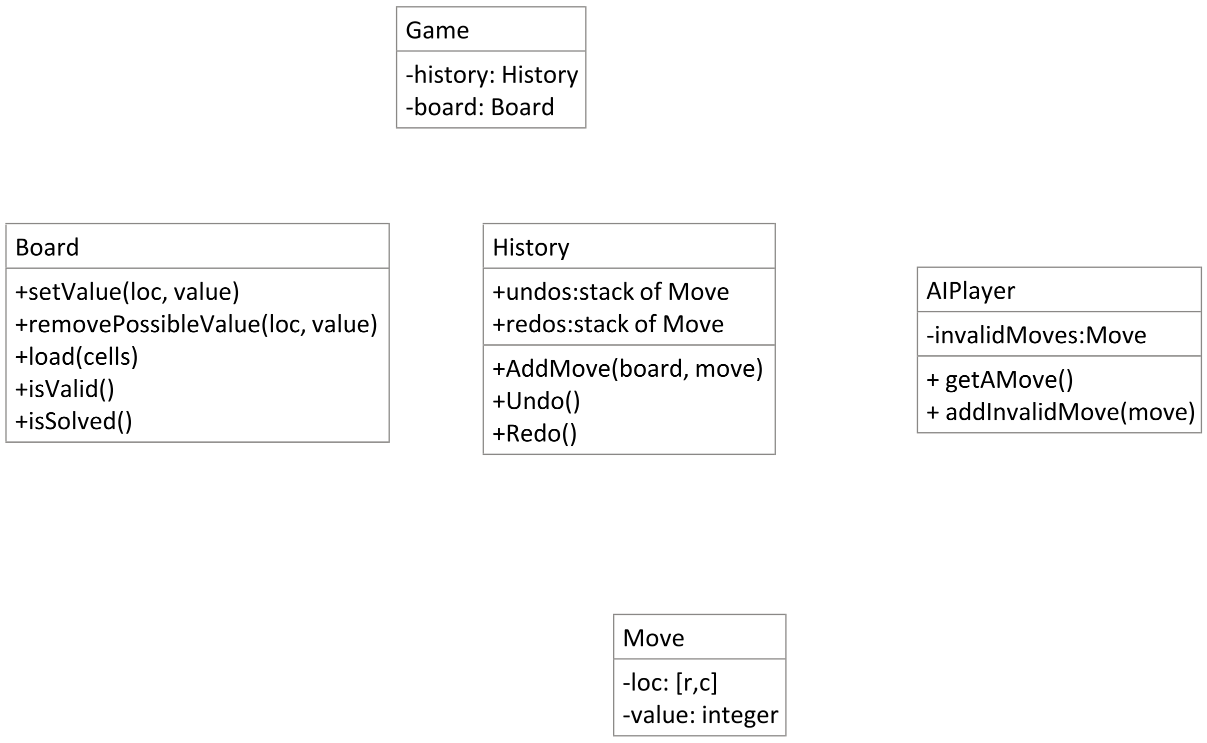
Thursday, November 4, 2021 9:41 AM



Add ability to make moves

Friday, November 12, 2021 7:34 PM

User can choose to solve the game. User can make a move (set value or possible value, or remove possible value). History will record the state of the board before the move. Then the board will execute the move. User can choose to undo moves to bring the board to a valid state.



Add doku puzzle editor and loader

Tuesday, November 2, 2021 1:37 PM

- [x] Architecture considerations to allow for multiple views
    - Model is Board, View is new class View and Controller is new class Controls
    - Investigate reactJS
- [ ] Add a view for sudoku board
    - [x] Investigate REACT for frontend support
- [ ] A cell should not track its view elements
- [ ] Fix formula view of sudoku board

Add ability to load and save game

Wednesday, November 3, 2021 3:56 PM

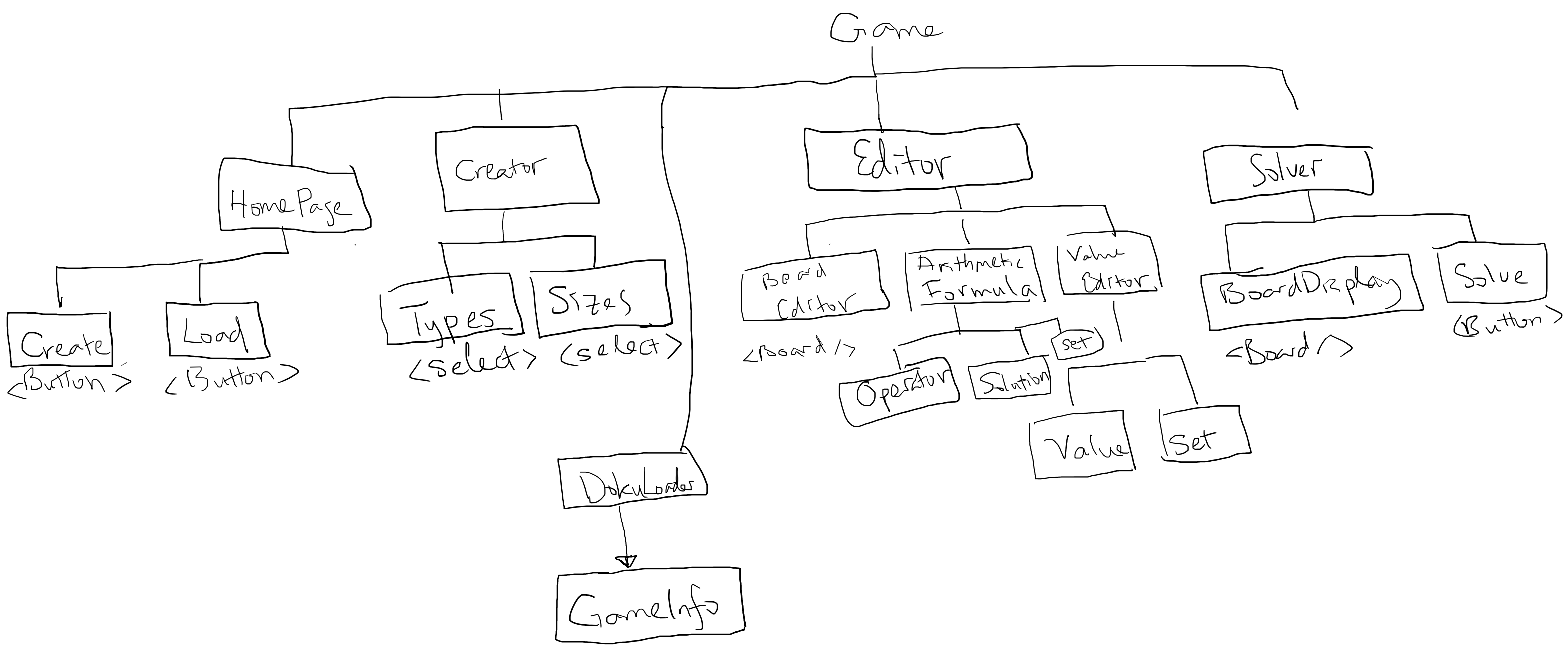
Add ability to generate games

Friday, November 12, 2021 10:01 PM

UI via React

Thursday, November 4, 2021 9:11 AM

COMPONENTS



- Home page has options to create or load a doku game
- Loader lets user select from the doku repository
- Creator lets user select the type of game and the sizes (if KenDoku)
- Editor lets user create a new doku game and save to the repository
- Solver solves the doku game

Home Page

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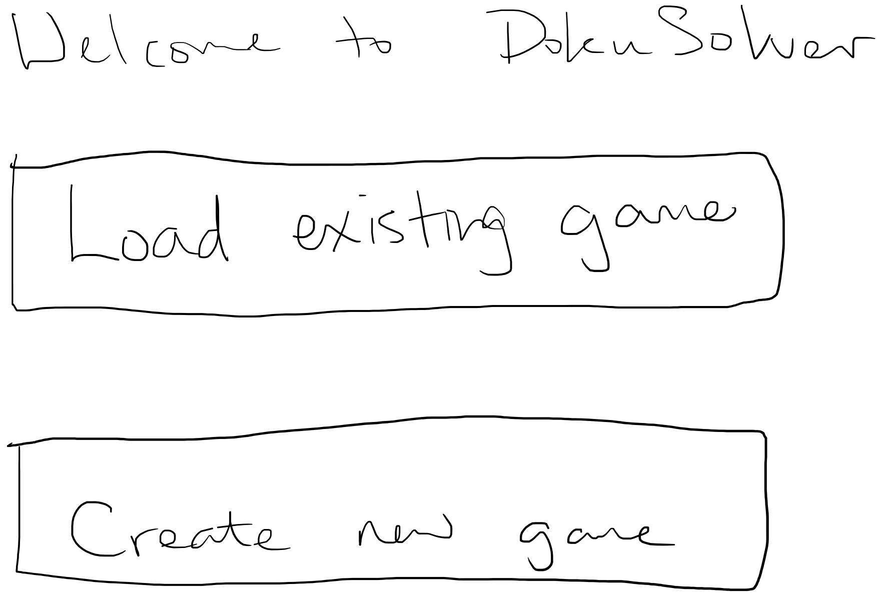

Game Editor Initial

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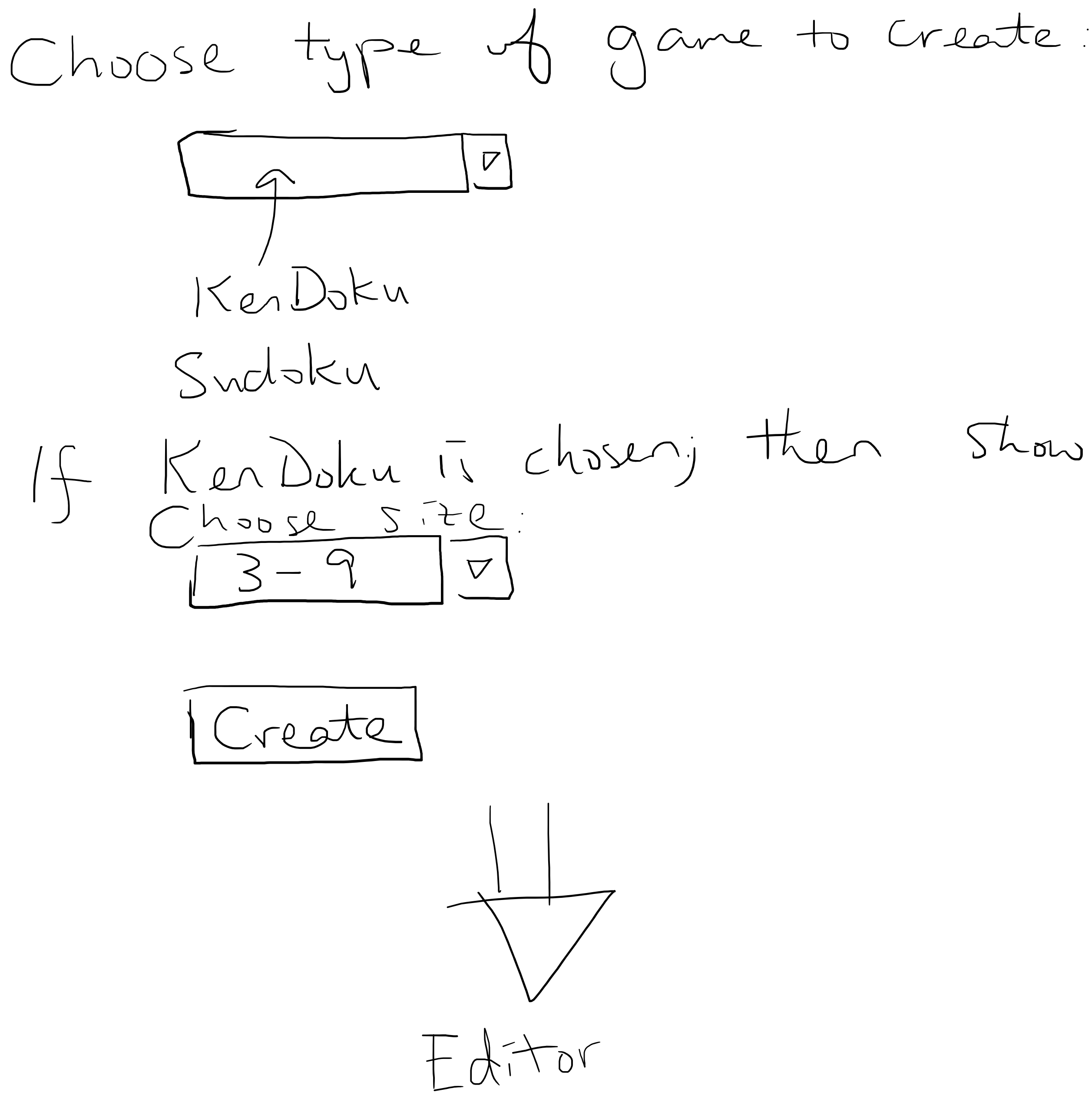

Choose type of game to create:

If KenDoku is chosen, then show

Game loader

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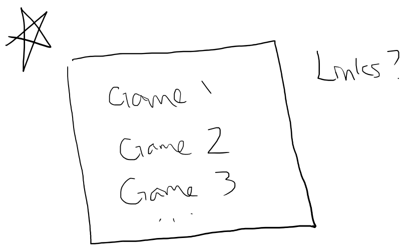
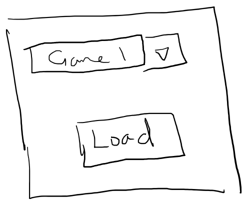


OR



* Easier to read when list gets long.

* Can add description

* Can expand to ① Multiple pages

② filter according to criteria

KenDoku editor

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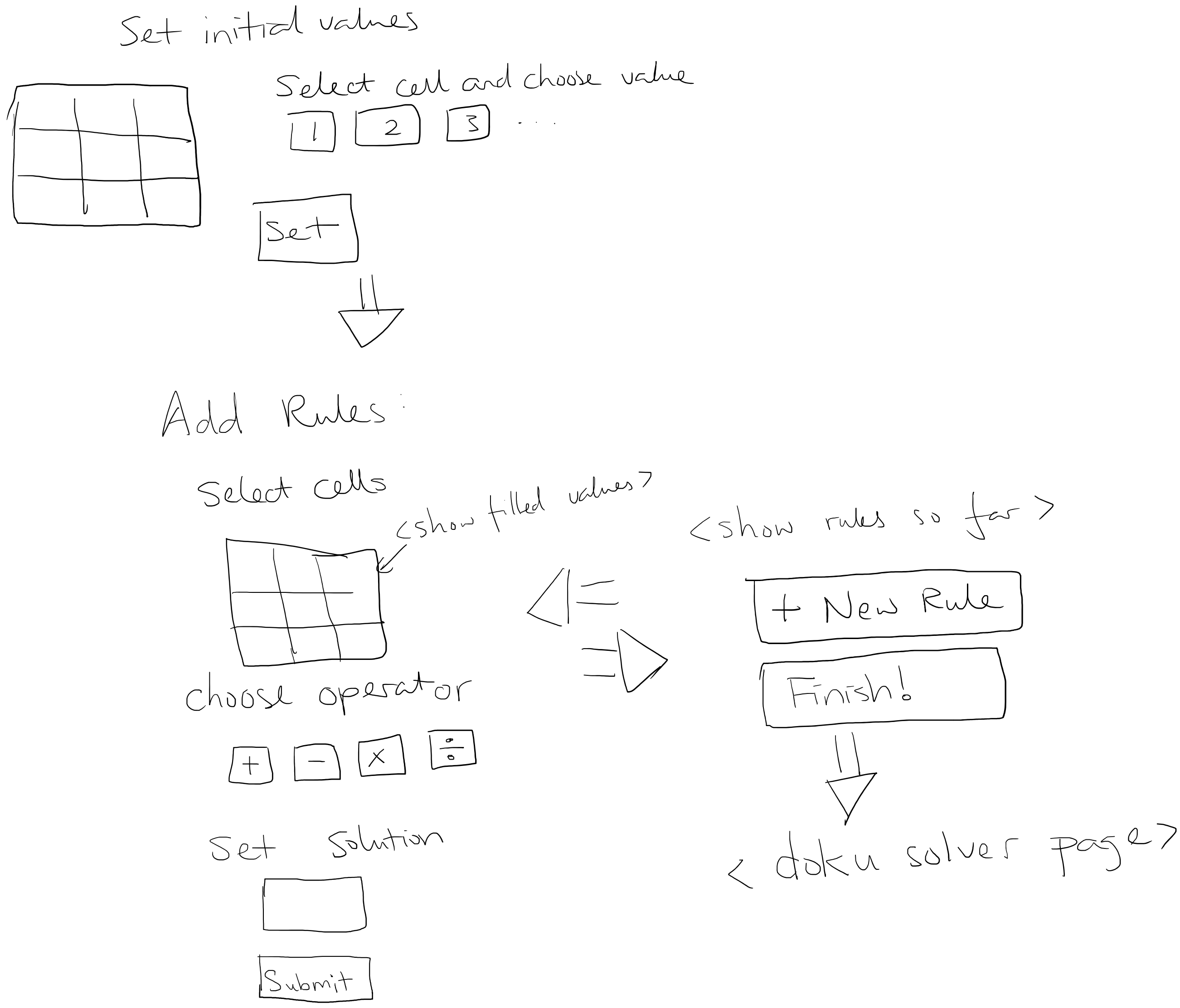

Sudoku editor

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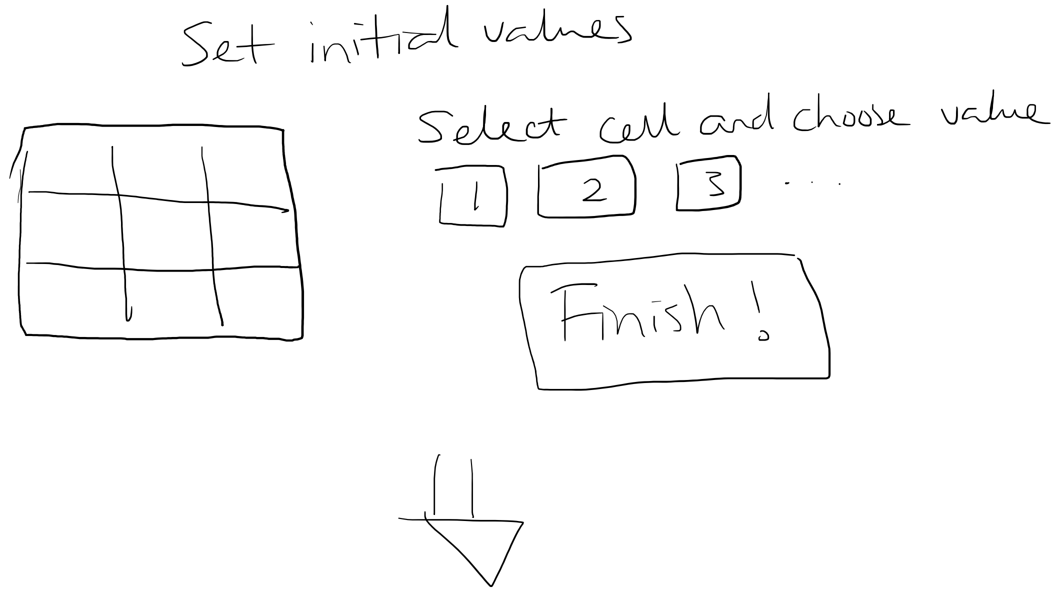

Puzzle Solver

Wednesday, November 3, 2021 3:55 PM