pset4: Sudoku

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Today's Music

- Ephixa (Zelda Step)
  - Lost Woods
  - Saria's Song
  - Dragon Roost Island
  - Song of Storms

Today

- Distro code
- ncurses
- moving the cursor
- inputting numbers
- move legality
- inputting blanks
- checking if won

Sudoku

- do **not** try to use the terminal window in gedit
  - sudoku needs ALL the pixels!

Sudoku

- goal: every square has a number
  - one of each number in every **row**
  - one of each number in every **column**
  - one of each number in every 3x3 **block**

sudoku.c

- lots, but don't worry!
- `main`
  - error checking
  - load board
  - loops to continue to ask user for input
  - handle user input

case-switch

```
if (c == 'a')
    // do something
else if (c == 'b')
    // do something
else if (c == 'c')
    // do something
```

case-switch

```
switch(c) {
        case ’a’:
        // do something
        break;
    case ’b’:
        // do something
        break;
    case ’c’:
        // do something
        break;
}
```

sudoku.c

- `struct`s allow you to group variables into a single structure
  - `g` is a global struct containing game information
  - variables can be of different types!
- `g.y`, `g.x`: row and column of cursor
- `g.board`: 2D array representing board
  - sound familiar?
- `g.top, g.left`: coordinates of top-left point of board (since `(0,0)` is the top of the terminal window)
- `g.number`: number of board

sudoku.c

- `restart_game()`
  - start a new game with the board specified in `g.board`
- `draw_borders()`
- `draw_grid()`
- `draw_logo()`
- `draw_numbers()`

sudoku.c

- `show_cursor()`
  - set the position of the cursor based on `g.y` and `g.x`
- `show_banner(char* b)`
  - show the string `b` as a banner
- `hide_banner()`
  - hide the currently-shown banner

Using GDB

- Sudoku takes over the whole terminal, so can't simply `gdb ./sudoku`
- `./sudoku debug 1` in terminal
- open new terminal tab
- `pidof sudoku` gives you the unique ID of the process `sudoku`
- now, `gdb ./sudoku #`
  - where # is the PID from `pidof`

Using GDB Like a Hacker

- `gdb -tui ./sudoku #`
  - **T**ext **U**ser **I**nterface
  - displays source above gdb prompt!

ncurses

- library to write GUI (graphic user interface) applications
- still in the terminal, but so much nicer than pset3

ncurses

- pset3: print each row, one at a time
  - once you `printf`, no way of going back
- ncurses: print wherever you want!
  - write a `char` to any `(y, x)` on the screen

Output

- `move()`
  - move the cursor to the given `(y, x)` location
- `mvaddch(int y, int x, char c)`
  - move to `(y, x)`, then print `c` there
  - don't forget difference between `1` and `'1'`!

Input

- `getch()`
  - get a single character from the user (returns a `char`)
  - `KEY_UP`, `KEY_DOWN`, `KEY_LEFT`, `KEY_RIGHT` represent arrow keys
    - `#define`'d constants by ncurses
  - `CTRL('l')` represents Ctrl+l
    - we wrote that one!

TODO

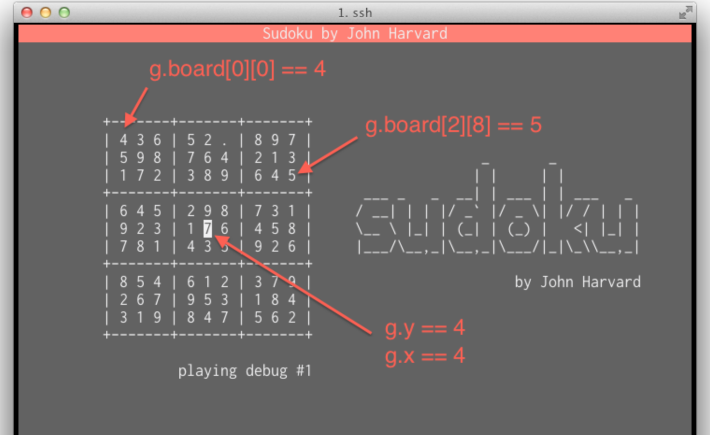
- move cursor
- input number
- move legality
- input blank
- check if won

show_cursor()

- remember, `show_cursor()` moves the cursor based on `g.y` and `g.x`
  - different `g.y` or `g.x`? different cursor location!
  - don't need to worry about `move` or `mvaddch`

Coordinates

- `g.y` and `g.x` represent the position in the 9x9 board, **NOT** the position on the screen



```
                              Sudoku by John Harvard

     +-------+-------+-------+
     | 4 3 6 | 5 2 . | 8 9 7 |
     | 5 9 8 | 7 6 4 | 2 1 3 |                 _       _
     | 1 7 2 | 3 8 9 | 6 4 5 |                | |     | |
     +-------+-------+-------+     ___ _   _  __| | ___ | | ___   _
     | 6 4 5 | 2 9 8 | 7 3 1 |    / __| | | |/ _` |/ _ \| |/ / | | |
     | 9 2 3 | 1 7 6 | 4 5 8 |    \__ \ |_| | (_| | (_) |   <| |_| |
     | 7 8 1 | 4 3 5 | 9 2 6 |    |___/\__,_|\__,_|\___/|_|\_\\__,_|
     +-------+-------+-------+
     | 8 5 4 | 6 1 2 | 3 7 9 |                     by John Harvard
     | 2 6 7 | 9 5 3 | 1 8 4 |
     | 3 1 9 | 8 4 7 | 5 6 2 |
     +-------+-------+-------+

              playing debug #1
```

g.board[0][0] == 4

g.board[2][8] == 5

g.y == 4
g.x == 4

Moving

- increment/decrement `g.y` or `g.x` based on arrow pressed
  - right now main only handles `'N'`, `'R'`, and `CTRL('l')`, hmmm
  - `(0, 0)` is top-left, `(8, 8)` is bottom-right
  - `show_cursor()` takes care of converting position on board to position on screen
- don't let user move cursor off the board!

TODO

- ~~move cursor~~
- input number
- move legality
- input blank
- check if won

Inputting Numbers

- `main` also needs to take `’1’` to `’9’` as input
- don’t forget about ASCII!
  - `’1’ != 1`
  - `’1’ == ’0’ + 1`

Updating Board

- just like pset3, `g.board[i][j]` contains the number at row `i`, column `j`
  - cursor should always be at `(g.y, g.x)`
  - changing `g.board[i][j]` changes the number there
- various `draw_` functions redraw the board based on `g`
  - still don't need to `mvaddch` yourself!
  - don't need to redraw everything if only numbers on the board changed!

Changing the Board

- don’t allow user to change numbers that came with the board
    - else Sudoku would be pretty easy
- when game is started, need to remember which numbers were already placed
    - `array1 = array2` won’t work :(
- before changing any space, check if that space can be changed (e.g. number was originally blank)

Combining Cases

```
switch (c) {
    case ’a’:
    case ’b’:
    case ’c’:
        // do something
        break;
    default:
        // do something
        break;
}
```

Design

- factor out as much code as possible
    - to try write reusable functions, then actually reuse them!
- write your changes in functions, then have existing code call those functions
    - much easier than heavily changing existing functions

TODO

- ~~move cursor~~
- ~~input number~~
- move legality
- input blank
- check if won

Legality

- after changing a number, need to check legality
  - if move is illegal, tell user via `show_banner()`
- banner does NOT need to persist
  - if I make an illegal move, then a legal move, no more banner

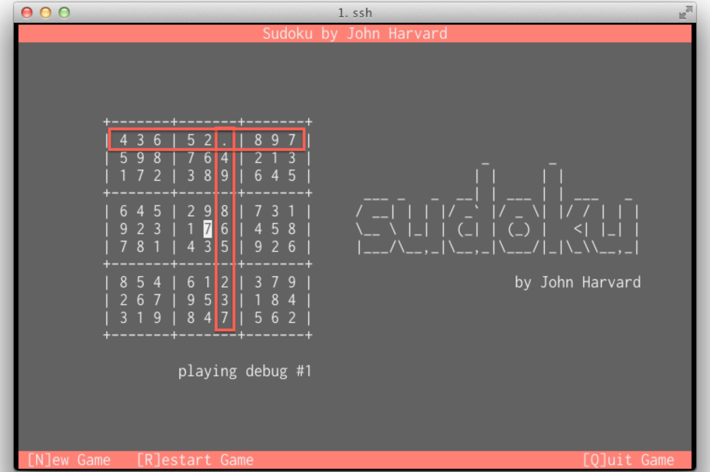
Definition

- 3 rules for move to be legal:
  - number doesn’t already exist in row
  - number doesn’t already exist in column
  - number doesn’t already exist in 3x3 block

Row and Column

- user just inputted number into `g.board[g.y][g.x]`
  - need to check `g.board[g.y][j]` for $0 \leq j \leq 8$
  - need to check `g.board[i][g.x]` for $0 \leq i \leq 8$
- if number is already found, move is illegal
  - check for **illegal** moves, not **wrong** moves
  - checking for wrong moves is much harder (Hacker Edition!)

Row and Column



```
                          Sudoku by John Harvard

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| 1 7 2 | 3 8 9 | 6 4 5 |    ___ _   _  __| | ___ | | ___   _
+-------+-------+-------+   / __| | | |/ _` |/ _ \| |/ / | | |
| 6 4 5 | 2 9 8 | 7 3 1 |   \__ \ |_| | (_| | (_) |   <| |_| |
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+-------+-------+-------+

        playing debug #1


 [N]ew Game   [R]estart Game                               [Q]uit Game
```
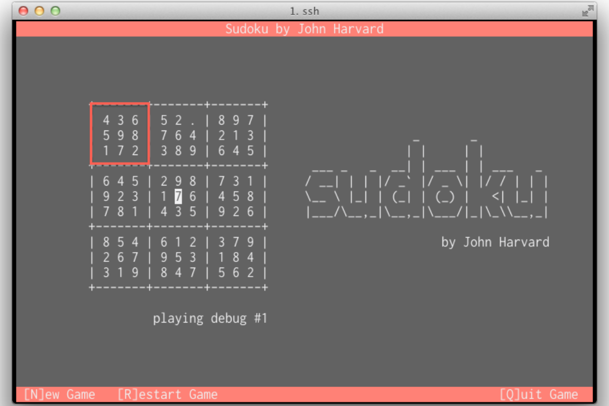

3x3 Block

- board divided into contiguous 3x3 blocks



```
                    Sudoku by John Harvard



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+-------+-------+-------+               | |     | |
| 6 4 5 | 2 9 8 | 7 3 1 |     ___ _   _  __| | ___ | | ___   _
| 9 2 3 | 1 7 6 | 4 5 8 |    / __| | | |/ _` |/ _ \| |/ / | | |
| 7 8 1 | 4 3 5 | 9 2 6 |    \__ \ |_| | (_| | (_) |   <| |_| |
+-------+-------+-------+    |___/\__,_|\__,_|\___/|_|\_\\__,_|
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| 3 1 9 | 8 4 7 | 5 6 2 |
+-------+-------+-------+

       playing debug #1




[N]ew Game   [R]estart Game                          [Q]uit Game
```

3x3 Block

- need to check within defined block, not necessarily 3 columns right and 3 rows down from cursor
- given some `(y, x)`, determine coordinates of top-left of block
  - sounds like a job for division and friends!
  - then, check 3 columns right and 3 columns down
  - only need to check one 3x3 block, not every single one!

TODO

- ~~move cursor~~
- ~~input number~~
- ~~move legality~~
- input blank
- check if won

Blanks

- user must be able to delete number via `KEY_BACKSPACE`, `KEY_DC`, `.`, or `0`
  - doing the same thing on multiple cases again? combine them!
- according to `draw_numbers()`, blank represented by `0` in `g.board`

Blanks

- can't delete numbers that came with the board!
    - good thing we wrote a **reusable** function for that!
- is inputting a blank always a legal move?
- can the game be won if I removed a number?

TODO

- ~~move cursor~~
- ~~input number~~
- ~~move legality~~
- ~~input blank~~
- check if won

Won

- game is won if:
  - every square is filled in
  - every row contains every number
  - every column contains every number
  - every 3x3 block contains every number
- need to check if game is won whenever user makes a move

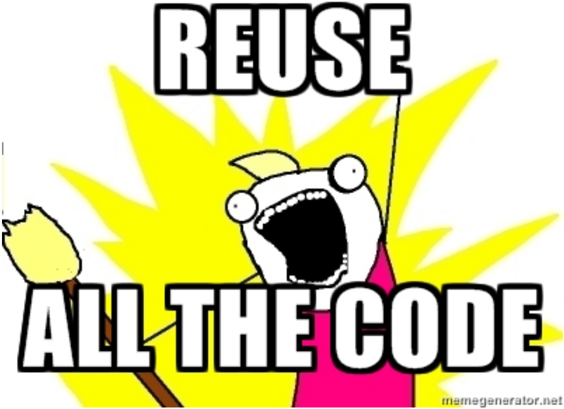
Won

- only need to look at every row/column once
  - check if every number is found?
  - check if any number is found twice?
- using an array to keep track of what we've seen sounds helpful

Won

- need to check every 3x3 square once
    - good thing we already wrote a **reusable** function for that!
- do we need to separately check if every blank is filled?

Design



TODO

- ~~move cursor~~
- ~~input number~~
- ~~move legality~~
- ~~input blank~~
- ~~check if won~~

Additional Features

- don’t forget to implement an additional feature!
    - turn all numbers green when won
    - turn column/row red until mistake is corrected
    - enable cursor wrapping
    - use different color for numbers that came with board
    - keep track of amount of time
    - allow user to undo with U or Ctrl-z