

# CS302 -- Lab 5 -- Superball!

- CS302 -- Fundamental Algorithms
- Spring, 2022
- [James S. Plank](#)
- [This file: http://web.eecs.utk.edu/~jplank/plank/classes/cs302/Labs/Lab5/](http://web.eecs.utk.edu/~jplank/plank/classes/cs302/Labs/Lab5/)

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## What you hand in

This is split into two labs on Canvas:

- Lab 5A is for you to submit **sb-analyze.cpp**.
- Lab 5B is for you to submit **sb-play.cpp**.

They are both due on the same day, and will be graded independently. If you are late with one, but not the other, the late points will only be applied to the late one.

Please do not submit anything other than those programs. The TA's will compile them with the disjoint set implementation described below.

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## Getting Started

You should start by going to whatever directory you'll be working in (on our lab machines), and doing:

```
UNIX> sh /home/jplank/cs302/Labs/Lab5/scripts/start_lab.sh
UNIX> git clone https://jimblank@bitbucket.org/jimblank/plank-disjoint-sets.git      # You'll need a bitbucket account for this one.
UNIX> cd plank-disjoint-sets
UNIX> make clean ; make
UNIX> cd ..
UNIX> make
```

If all is successful, then you'll have three programs in your **bin** directory:

```
UNIX> ls bin
sb-analyze      sb-play      sb-read
UNIX> bin/sb-read
usage: sb-read rows cols min-score-size colors
UNIX> bin/sb-analyze
This program doesn't do anything yet.
UNIX> bin/sb-play
This program doesn't do anything yet.
UNIX>
```

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## How you are graded

The gradescript tests **sb-analyze**. It will be graded as a 50-point lab. For **sb-play**, we grade it by running **sh scripts/run\_multiple.sh** on it for at least 10 runs. It too is graded as a 50-point lab.

Remember, (and I know I'm repeating myself here), that you are only submitting two programs -- the TA's will compile with their own copy of the disjoint set code.

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## Also

Every year, someone asks me for the source to **sb-player**. Sorry, but I can't give it out, because it's too easy to modify it to solve the lab. I can try to make an **sb-player** binary for your machine, and if you want modifications, I'll listen. Let me know.

There is an **sb-player** binary for macs in **mac-binary/sb-player-mac**.

Plus, in 2015, Alex Teepe wrote a multiplatform Superball player to share. I have not tried it, but please do. Thanks, Alex!

<https://drive.google.com/file/d/0B4rzPrfwFCsKbUpwd21pMlgtc1E/view>.

There is a README [here](#).

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## Disjoint Sets

If you've done the command above correctly, in your directory **plank-disjoint-sets**, there is an implementation of disjoint sets that comes from <https://bitbucket.org/jimblank/plank-disjoint-sets>. You should have compiled the code in that directory, and then in the makefile, it will:

- Make sure that when you say `#include "disjoint_set.hpp"`, it will find it from **plank-disjoint-sets/include**.
- Link in **plank-disjoint-sets/obj/disjoint\_set.o**, so that you can use this implementation
- When you type `make` in the current directory, it should make dummy versions of **bin/sb-analyze** and **bin/sb-play**. If not, you have something wrong with your compilation.

You are not allowed to modify the disjoint set code -- you should use it as is. The TA's will compile your code with their versions of the disjoint set code, so you can't customize it. Moreover, you shouldn't copy the code into your source files, or copy it from the lecture notes, and then modify it for your lab.

**If you don't understand how to compile your program correctly, please ask the TA's or ask on Piazza. DO NOT COPY THE DISJOINT SET CODE FROM LECTURE AND INCLUDE IT WITH YOUR PROGRAM. Instead, use the code from bitbucket, as specified above.**

## Superball

Superball is a simplistic game that was part of a games CD for my old Windows 95 box. It works as follows. You have a 8x10 grid which is the game board. Each cell of the game board may be empty or hold a color:

- P - Purple: worth 2 points.
- B - Blue: worth 3 points.
- Y - Yellow: worth 4 points.
- R - Red: worth 5 points.
- G - Green: worth 6 points.

The board starts with five random colors set. On your turn, you may do one of two things:

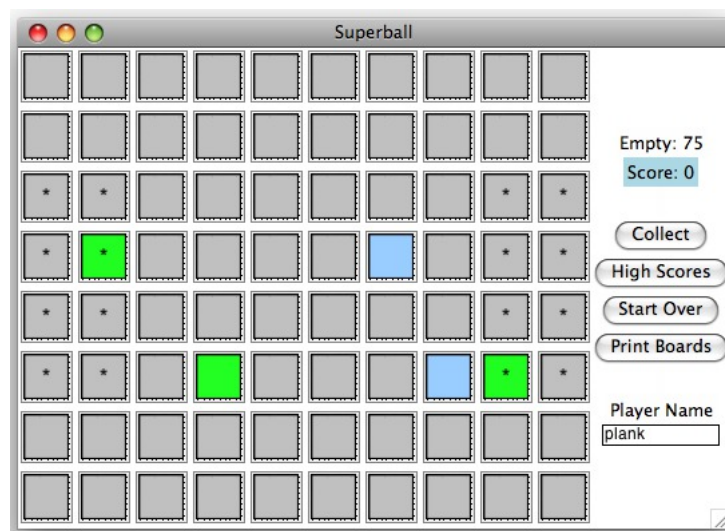
- You may swap two cells. After the swap, five new random cells will be filled with a random colors.
- You may "score" a cell. To score a cell, the cell must be one of the "goal" cells, and there are sixteen of these, in rows 2-5, columns 0, 1, 8 and 9. (Everything is zero indexed). Moreover, there must be at least five touching cells of the same color, one of which must be the goal cell that you want to score. When you score, you get the sum of the cells connected to the cell that you are scoring, and then all of those cells leave the board, and three new random ones are added.

I have a tcl/tk/shell-scripted Superball player at **/home/jplank/Superball**. Simply copy that directory to your home directory:

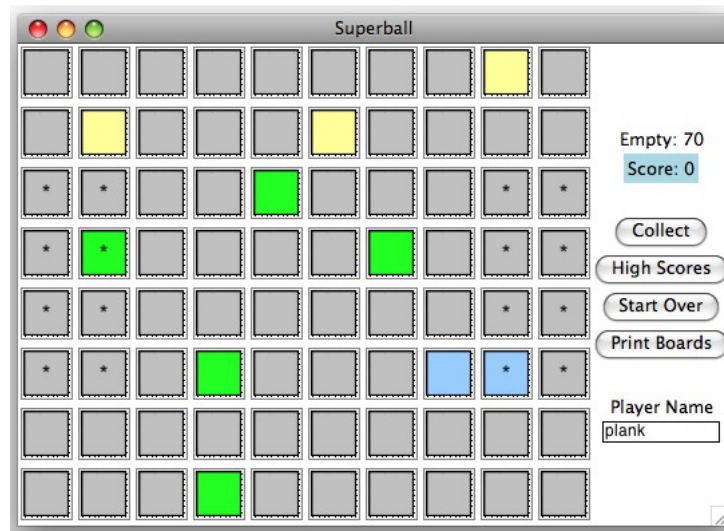
```
UNIX> cp -r /home/jplank/Superball $HOME
```

Then you can play it with **~/Superball/Superball**. The high score probably won't work -- you'll have to change the **open** command in the file **hscore** to the name of your web browser.

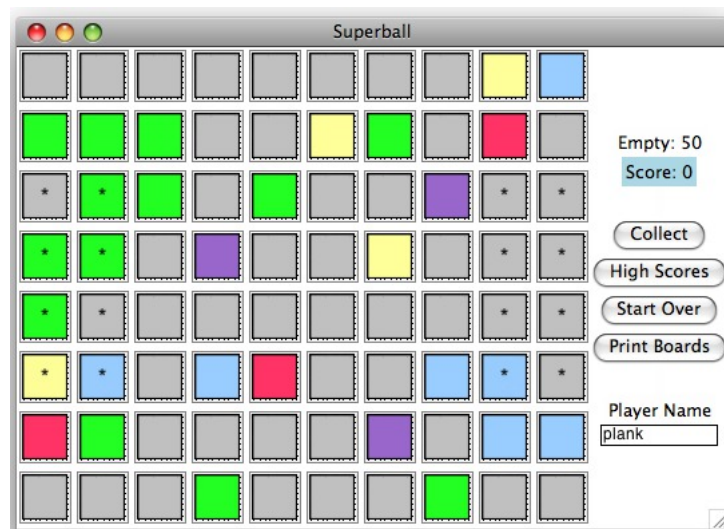
Let's look at some screen shots. Suppose we fire up **Superball**:



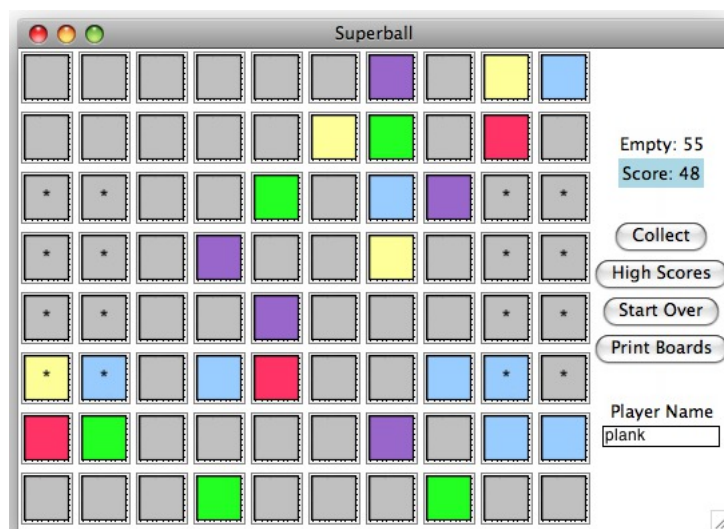
The "goal" cells are marked with asterisks, and there are five non-empty cells. Our only legal action is to swap two cells -- I'm going to swap cells [3,6] and [5,8]. This will make those two blue cells contiguous. In the game, I do that by clicking on the two cells that I want to swap. Afterwards, five new cells are put on the screen. Here's the screen shot:



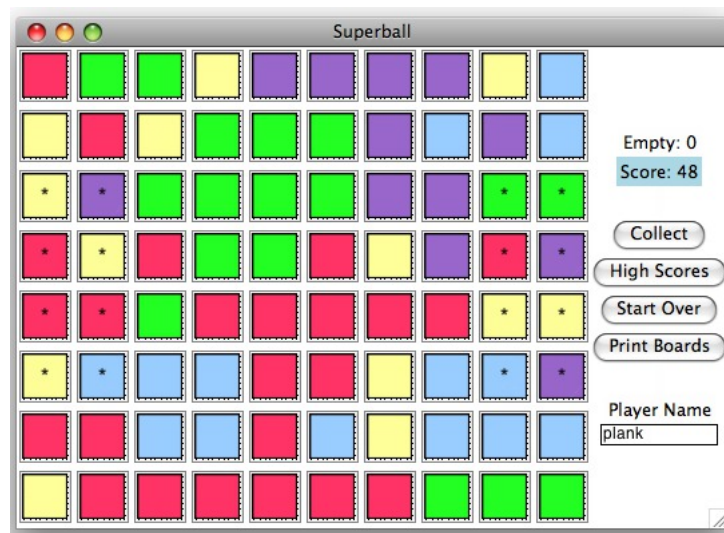
I do a bunch more swaps and end up with the following board:



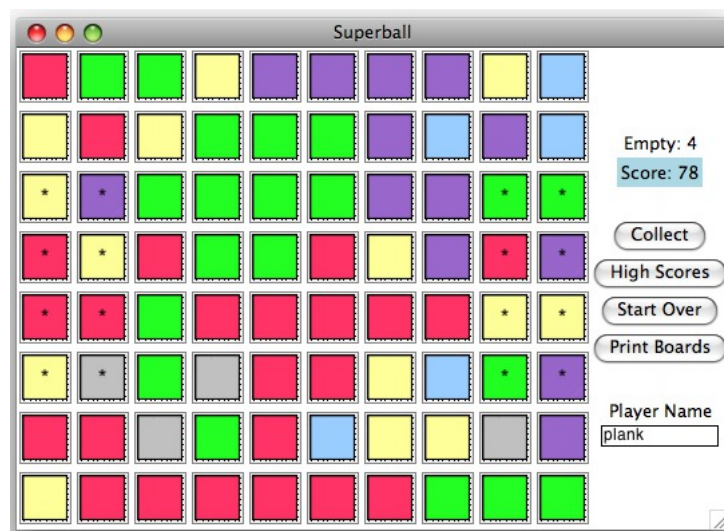
I can score the green cells by clicking on cell [2,1], [3,0], [3,1] or [4,0] and then clicking "Collect". This will score that group of eight green squares, which gets me 48 points ( $8 \times 6$ ), and three new cells will be added:



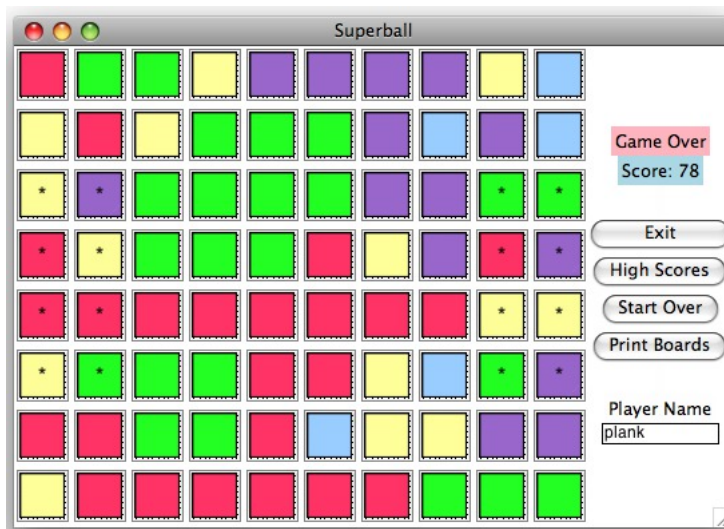
There are no cells to score here (the blues ones in the lower right-hand part of the board only compose a group of four). So I revert to swapping. Suppose I keep doing so until I reach:



I'm in trouble. I've got these beautiful groups of red, green and purple cells, but I can't score any of them because they are not connected to a goal cell. Dang. I can only score those two groups of blue cells. When I do that, I'm only left with four open squares, and I can't score anything:



Perhaps I should have been a little more thoughtful while playing the game. Regardless, I'm stuck. I simply swap two random squares and end the game:



Oh well -- should have done that swap a little sooner....

For this lab, we are going to deal with a text-based version of the game. Our programs will have the following parameters:

- **rows** - the number of rows on the game board. Although the tcl/tk version has that set to eight, our programs will handle any number.
- **cols** - the number of columns on the game board.
- **min-score-size** - the number of contiguous cells that have to be together in order to score them. This is 5 in the tcl/tk version

- colors** - this must be a string of distinct lower-case letters. They represent that the colors that a cell can have. The point value of the first of these is 2, and each succeeding character is worth one more point. To have the same values as the tcl/tk game, this parameter should be "pbyrg".

I have written an interactive game player. I'll discuss all the parameters later. Call it as done below:

```
UNIX> cd /home/jplank/cs302/Labs/Lab5/
UNIX> bin/sb-player
usage: sb-player rows cols min-score-size colors player interactive(y|n) output(y|n) seed
UNIX> bin/sb-player 8 10 5 pbyrg - y y -
Empty Cells: 75      Score: 0

.....
**b...b**
**...b.**
**.g....**
**.....**
.....
..g.....
```

Your Move:

The format of the board is as follows: When a letter is capitalized, it is on a goal cell. Dots and asterisks stand for empty cells -- asterisks are on the goal cells. If you click on the **Print Boards** button in the tcl/tk game, it will print out each board on standard output in that format. That's nice for testing.

You can type two commands:

SWAP r1 c1 r2 c2

SCORE r c

In the board above, you can't score anything, so you'll have to swap. We'll swap the blue cell in [2,2] with the green one in [7,2]:

Your Move: **SWAP 2 2 7 2**

Empty Cells: 70 Score: 0

.r.....
.....
\*\*g...b\*\*
\*\*...b.\*\*
\*\*g...Y
\*\*.....\*P
.....rF...
..b.....

Your Move:

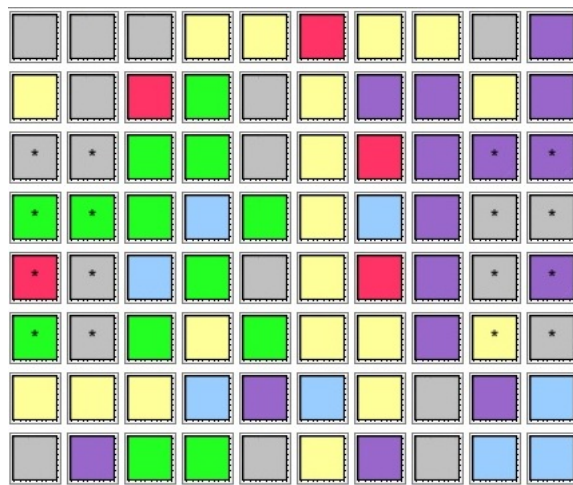
It's incredibly tedious -- play along with me:

Empty Cells: 70      Score: 0	Empty Cells: 65      Score: 0	Empty Cells: 60      Score: 0	Empty Cells: 55      Score: 0	Empty Cells: 50      Score:
.r..... ..... **g...b** **...b.** **g...Y **.....*P .....rF... ..b.....	.b..... ..... **g...bB* **...b.** P*.g...RY **.....*P .....rF... .gry.....	.b.....p ....g.... **g.p..bB* **r...b.*R **g...YY **.....*P .....rF... .grr.....	.b..r...pp ....g...b. **g.p..bB* **g...b.*R P*.g...YY **g...*P .....rF... rrrr.....	.r..rgy.pp ....g...b. **g.p..bB* **g...b.*B P*.g...YY **g...*P p...rrr... rrrr.p....
Your Move: <b>SWAP 0 1 7 2</b>	Your Move: <b>SWAP 7 3 4 8</b>	Your Move: <b>SWAP 3 2 7 1</b>	Your Move: <b>SWAP 3 9 0 1</b>	Your Move: <b>SWAP 6 0 0 1</b>
Empty Cells: 45      Score: 0	Empty Cells: 40      Score: 0	Empty Cells: 35      Score: 0	Empty Cells: 30      Score: 0	Empty Cells: 37      Score:
.p..rgy.pp .g..g...b. **g.p..bB* **g...b.*B P*.g..y.YY **g..yp*P r...rrr... rrrr.py...	.p..rgy.pp .g..g...b. **g.p.pbB* R*g...by*B P*.g..y.YY P*.g..yp*Y r...rrrb.. rrrr.pp...	.p..pgy.pp .g..g.r.b. G*g.p.pbB* R*g...by*B P*.g..y.YY R*.g..yp*Y r..grrrb.. rrrrbppy..	.p..pgy.pp .g.pg.b.b. G*g.p.pbB* R*g.r.by*B P*pg..y.YY R*.g.bypBY r..grrrb.. rrrrrppy..	.p..pgy.pp .g.pg.b.by G*g.p.pbB* R*g.r.byGB P*pg..y.YY **g.bypBY ...g...b.. .p...ppy..
Your Move: <b>SWAP 5 9 7 6</b>	Your Move: <b>SWAP 5 0 0 4</b>	Your Move: <b>SWAP 7 4 1 6</b>	Your Move: <b>SCORE 5 0</b>	Your Move:

You'll note, I could have scored cell [5,0] when there were 35 empty cells, but I really wanted to make that patch of red cells bigger.

Program #1: Sb-read

I have written [src/sb-read.cpp](#) for you. This program takes the four parameters detailed above, reads in a game board with those parameters and prints out some very basic information. For example, the following board:



May be represented by the following text (in [txt/input-1.txt](#)):

```
...YYYY.p
y.rg.yppyp
**gg.yrpPP
GGgbgybp**
R*bg.yrp*P
G*gygyypY*
yyybpby.pb
.pgg.yp.bb
```

When we run **bin/sb-read** on it, we get the following:

```
UNIX> bin/sb-read 8 10 5 pbyrg < txt/input-1.txt
Empty cells:          20
Non-Empty cells:     60
Number of pieces in goal cells:  8
Sum of their values:    33
UNIX>
```

There are three purple pieces in goal cells, one yellow, three green and one red. That makes a total of  $3*2 + 4 + 5 + 3*6 = 33$ .

You should take a look at [src/sb-read.cpp](#). In particular, look at the **Superball** class:

```
class Superball {
public:
    Superball(int argc, char **argv);
    int r;
    int c;
    int mss;
    int empty;
    vector<int> board;
    vector<int> goals;
    vector<int> colors;
};
```

**Mss** is min-score-size. **Empty** is the number of empty cells in the board. **Board** is a vector of  $r * c$  integers. The element in  $[i,j]$  is in entry **board** $[i*c+j]$ , and is either '!', '\*' or a lower case letter. **goals** is another array of  $r * c$  integers. It is equal to 0 if the cell is not a goal cell, and 1 if it is a goal cell. **Colors** is an array of 256 elements, which should be indexed by a letter. Its value is the value of the letter (e.g. in the above example, **colors** $['p'] = 2$ ).

**sb-read** does all manner of error checking for you. It is a nice program from which to build your other programs.

## Program #2: Sb-analyze

You are to write this one.

With **bin/sb-analyze**, you are to start with **sb-read.cpp** as a base, and augment it so that it prints out all possible scoring sets. For example, in the above game board (represented by [txt/input-1.txt](#)), there are two scoring sets -- the set of 10 purple cells in the upper right-hand corner, and the set of 6 green cells on the left side of the screen. Here is the output to **sb\_analyze**:

```
UNIX> sb-analyze
usage: sb-analyze rows cols min-score-size colors
UNIX> bin/sb-analyze 8 10 5 pbyrg < txt/input-1.txt
Scoring sets:
  Size: 10 Char: p Scoring Cell: 2,8
  Size:  6 Char: g Scoring Cell: 3,0
UNIX>
```

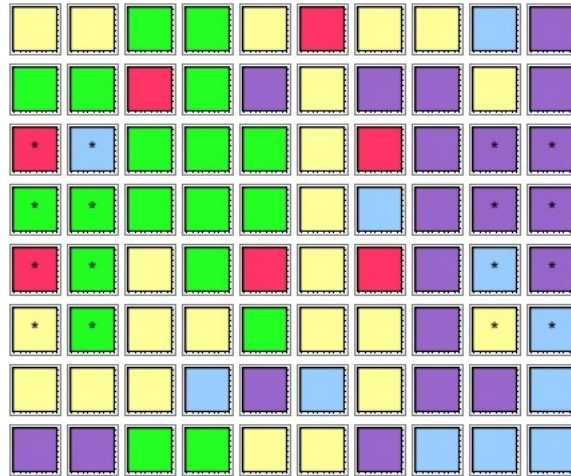
Each set must be printed exactly once, but in any order, and with any legal goal cell. Thus, the following output would also be ok:

```
UNIX> bin/sb-analyze 8 10 5 pbyrg < txt/input-1.txt
Scoring sets:
  Size:  6 Char: g Scoring Cell: 3,1
  Size: 10 Char: p Scoring Cell: 2,9
UNIX>
```



Think about how you would use the disjoint sets data structure to implement this -- it is a straightforward connected components application. I would recommend augmenting your **Superball** class with a **Disjoint\_Set**, and then having a method called **analyze\_superball()**, which performs the analysis.

Here's another example:



This is in the file [txt/input-2.txt](#):

```
yyggryyybp
ggrgpyppyp
RBgggyrppP
GGgggybpPP
RGygryrppP
YGyygyypYB
yyybpbyppb
ppggyyppbb
```

```
UNIX> bin/sb-analyze 8 10 5 pbyrg < txt/input-2.txt
Scoring sets:
  Size: 14 Char: g Scoring Cell: 5,1
  Size: 15 Char: p Scoring Cell: 4,9
  Size: 7 Char: y Scoring Cell: 5,0
  Size: 5 Char: b Scoring Cell: 5,9
UNIX>
```

### Program #3: Sb-play

Your next program takes the same arguments and input as **sb-analyze**. However, now its job is to print a single move as would be accepted as input for the **sb-player** program. In other words, it needs to output a SWAP or SCORE line with legal values.

If you have fewer than five pieces and cannot score any, you will lose the game -- you should do that by swapping two legal pieces so that the game can end.

The **sb-player** program takes as its 5th argument the name of a program that it will use for input. I also have three programs - **sb-play**, **sb-play2** and **sb-play3** in that directory. **sb-play** simply swaps two random cells until there are fewer than five empty, then it scores a set if it can. The other two are smarter, but are by no means the best one can do.

Here's **sb-player** running on **bin/sb-play2** (note, **sb-player** creates a temporary file, so you must run it from your own directory):

```
UNIX> /home/jplank/cs302/Labs/Lab5/bin/sb-player 8 10 5 pbyrg /home/jplank/cs302/Labs/Lab5/bin/sb-play2 y y -
Empty Cells: 75      Score: 0
```

```
g.....
*.....
**.....
*Pr.....
**.....
**..p....
.....b.
.....
```

Type Return for the next play

It waits for you to press the return key. When you do so, it will send the game board to **/home/jplank/cs302/Labs/Lab5/sp-play2** and perform the output. Here's what happens:

```
Move is: SWAP 5 4 3 2
```

```
Empty Cells: 70      Score: 0
```

```
g.....g
.....y..
**.....
*Pp.....
**.....G*
**..r....
..g.....b.
.....g.
```

Type Return for the next play

You can bet that the next move will swap that **b** with one of the **g**'s:

Move is: SWAP 6 8 0 0

Empty Cells: 65      Score: 0

```
b.....g
.....y..
**..b...**
*Pp.g...**
**.....gG*
**..r...**
..g.....g.
.p...p..g.
```

Type Return for the next play

And so on. If you run it with **n** for the 6th argument, it will simply run the program without your input:

```
UNIX> /home/jplank/cs302/Labs/Lab5/bin/sb-player 8 10 5 pbyrg /home/jplank/cs302/Labs/Lab5/bin/sb-play2 n y -
Empty Cells: 75      Score: 0
```

```
.....
.....
**.....**
**y..y...**
**.....**
*P.....**
.....
.....p.g.
```

Move is: SWAP 3 5 3 2

*... a bunch of output skipped...*

Empty Cells: 1      Score: 505

```
yyrrgggppy
grrbpgg.yg
GYbggyggPB
GBggpgbpPB
PPgggggrYB
YBbybgpbYR
pprrrggggr
byyrrpppgg
```

Move is: SWAP 0 1 7 5

Game over.    Final score = 505  
UNIX>

Even though there were no good moves at the end, the program did a final SWAP so that the game could finish.

If you run with the 7th argument as **n**, it will only print out the end result, and the last argument can specify a seed (it uses the current time if that argument is "-"), so that you can compare multiple players on the same game:

```
UNIX> /home/jplank/cs302/Labs/Lab5/bin/sb-player 8 10 5 pbyrg /home/jplank/cs302/Labs/Lab5/bin/sb-play n n 1
Game over.    Final score = 0
UNIX> /home/jplank/cs302/Labs/Lab5/bin/sb-player 8 10 5 pbyrg /home/jplank/cs302/Labs/Lab5/bin/sb-play2 n n 1
Game over.    Final score = 855
UNIX> /home/jplank/cs302/Labs/Lab5/bin/sb-player 8 10 5 pbyrg /home/jplank/cs302/Labs/Lab5/bin/sb-play3 n n 1
Game over.    Final score = 2572
UNIX>
```

It can take a while for these to run -- if it appears to be hanging, send the process a **QUIT** signal and it will print out what the current score is.

## Shell Script to Run Multiple Times

The file [scripts/run\\_multiple.sh](#) is a shell script to run the player on multiple seeds and average the results. Examples:

```
UNIX> sh scripts/run_multiple.sh
usage: sh scripts/run_multiple.sh r c mss colors player nruns starting_seed
UNIX> sh scripts/run_multiple.sh 8 10 5 pbyrg bin/sb-play 10 1
Run 1 - Score: 38 - Average 38.000
Run 2 - Score: 0 - Average 19.000
Run 3 - Score: 0 - Average 12.667
Run 4 - Score: 57 - Average 23.750
Run 5 - Score: 0 - Average 19.000
Run 6 - Score: 0 - Average 15.833
Run 7 - Score: 89 - Average 26.286
Run 8 - Score: 15 - Average 24.875
Run 9 - Score: 0 - Average 22.111
Run 10 - Score: 20 - Average 21.900
UNIX> sh scripts/run_multiple.sh 8 10 5 pbyrg bin/sb-play2 10 1
Run 1 - Score: 855 - Average 855.000
Run 2 - Score: 979 - Average 917.000
Run 3 - Score: 650 - Average 828.000
Run 4 - Score: 833 - Average 829.250
Run 5 - Score: 832 - Average 829.800
Run 6 - Score: 3326 - Average 1245.833
Run 7 - Score: 1507 - Average 1283.143
```



```

Run 8 - Score: 3643 - Average 1578.125
Run 9 - Score: 610 - Average 1470.556
Run 10 - Score: 862 - Average 1409.700
UNIX> sh scripts/run_multiple.sh 8 10 5 pbyrg bin/sb-play3 10 1
Run 1 - Score: 2572 - Average 2572.000
Run 2 - Score: 2708 - Average 2640.000
Run 3 - Score: 745 - Average 2008.333
Run 4 - Score: 424 - Average 1612.250
Run 5 - Score: 1888 - Average 1667.400
Run 6 - Score: 7140 - Average 2579.500
Run 7 - Score: 3475 - Average 2707.429
Run 8 - Score: 1701 - Average 2581.625
Run 9 - Score: 2699 - Average 2594.667
Run 10 - Score: 2291 - Average 2564.300
UNIX>

```

Obviously, to get a meaningful average, many more runs (than 10) will be required.

Oh, and make your programs run in reasonable time. Roughly 5 seconds for every thousand points, and if you are burning all that time, your program better be killing mine....

---

## Hints

Play the game for a bit to try to figure out some strategies. However, one good way to write a game player is to figure out a way to come up with a rating for a game board. Then when you are faced with making a move, you analyze all potential moves by trying them out (in other words, enumerate all potential swap operations) and choosing the one that gives you the resulting board with the highest rating.

Ideas for ratings? How about the total number of disjoint sets on the board (do you want that to bif or small)? Maybe some metric related to the sizes of the disjoint sets? Maybe add a fudge factor for a disjoint set that can be scored?

---

## The Superball Challenge

To get credit, your player needs to average over 100 points on runs of 100 games.

I will run a Superball tournament with all of your players with extra lab points going to the winners:

- 1st place: 40 extra lab points.
- 2nd place: 25 extra lab points.
- 3rd place: 10 extra lab points.

Dr. Emrich and I have now performed the challenge eleven times:

- CS140 in Fall, 2007: Plank
- CS302 in Fall, 2010: Plank
- CS302 in Fall, 2011: Plank
- CS302 in Fall, 2012: Plank
- CS302 in Fall, 2013: Plank
- CS302 in Fall, 2014: Plank
- CS302 in Fall, 2015: Plank
- CS302 in Fall, 2018: Plank
- CS302 in Spring, 2019: Emrich
- CS302 in Spring, 2020: Emrich
- CS302 in Fall, 2020: Plank

Here's the Superball Challenge Hall Of Fame (scores over 500):

Rank	Average	Name	Semester
1	31814.13	Grant Bruer	CS302, Fall, 2015
2	24278.49	Alexander Teepe	CS302, Fall, 2015
3	17367.77	Joseph Connor	CS302, Fall, 2014
4	17021.37	Cory Walker	CS302, Fall, 2014
5	16963.40	Seth Kitchens	CS302, Fall, 2015
6	14555.83	Ben Arnold	CS302, Fall, 2012
7	14555.83	Adam Disney	CS302, Fall, 2011
8	13657.79	Isaac Sikkema	CS302, Fall, 2018
9	12963.47	Jake Davis	CS302, Fall, 2014
10	12634.29	Jake Lamberson	CS302, Fall, 2014
11	11722.05	Parker Mitchell	CS302, Fall, 2014
12	11418.77	James Pickens	CS302, Fall, 2014
13	11380.74	Nathan Ziebart	CS302, Fall, 2011
14	11291.39	Michael Jugan	CS302, Fall, 2010
15	10576.96	Tyler Shields	CS302, Fall, 2014
16	10087.23	Maxwell Marcum	CS302, Spring, 2022
17	8770.67	Nathan Swartz	CS302, Spring, 2019 (Under Dr. Emrich)
18	7607.98	Riley Crockett	CS302, Spring, 2022
19	7475.07	Jared Smith	CS302, Fall, 2014

20	7216.28	Michael Bowie	CS302, Fall, 2018
21	7003.56	Andrew LaPrise	CS302, Fall, 2011
22	6100.28	Chris Nagy	CS302, Fall, 2015
23	5467.56	Tyler Marshall	CS302, Fall, 2013
24	5262.80	Harry Channing	CS302, Fall, 2018
25	5116.13	Kyle Bashour	CS302, Fall, 2014
26	4808.03	Matt Baumgartner	CS302, Fall, 2010
27	4586.51	Jeremy Harrison	CS302, Fall, 2013
28	4531.96	Philip Hicks	CS302, Spring, 2019 (Under Dr. Emrich)
29	4057.08	Phillip McKnight	CS302, Fall, 2015
30	3882.53	Pranshu Bansal	CS302, Fall, 2013
31	3882.28	Kemal Fidan	CS302, Fall, 2018
32	3852.87	Yaohung Tsai	CS302, Fall, 2015
33	3849.24	Chris Richardson	CS302, Fall, 2010
34	3809.41	Arthur Vidineyev	CS302, Fall, 2015
35	3588.35	Kevin Dunn	CS302, Fall, 2014
36	3545.96	Caleb Fisher	CS302, Spring, 2022
37	3464.83	Patrick Slavick	CS302, Fall, 2012
38	3460.00	Brandan Roachell	CS302, Fall, 2020
39	3436.21	sb-play3	CS140, Fall, 2007
40	3400.50	Kody Bloodworth	CS302, Fall, 2018
41	3080.15	Andrew Messing	CS302, Fall, 2013
42	3059.06	Stephen Qiu	CS302, Spring, 2022
43	2903.38	Adam LaClair	CS302, Fall, 2013
44	2736.85	Christopher Canaday	CS302, Spring, 2022
45	2728.86	Alexander Yu	CS302, Spring, 2022
46	2616.00	Rus Refait	CS302, Spring, 2020 (Under Dr. Emrich)
47	2555.36	Mohammad Fathi	CS302, Fall, 2014
48	2532.89	Trevor Sharpe	CS302, Fall, 2015
49	2521.44	Justus Camp	CS302, Fall, 2018
50	2487.24	Befikir Bogale	CS302, Spring, 2022
51	2473.69	Colin Canonaco	CS302, Spring, 2022
52	2354.00	Zach Deguira	CS302, Fall, 2020
53	2335.88	Mark Clark	CS302, Fall, 2012
54	2307.16	John Burnum	CS302, Fall, 2012
55	2205.17	Shawn Cox	CS302, Fall, 2011
56	2163.70	Alex Wetherington	CS302, Fall, 2011
57	2134.99	Julian Kohann	CS302, Fall, 2013
58	2062.54	Gitasuk Jur	CS302, Spring, 2022
59	2011.38	Wells Phillip	CS302, Fall, 2015
60	1919.72	Ravi Patel	CS302, Spring, 2019 (Under Dr. Emrich)
61	1854.00	Sam Aba	CS302, Spring, 2020 (Under Dr. Emrich)
62	1849.73	Andrew Lay	CS302, Spring, 2022
63	1828.05	Fatima Bowers	CS302, Spring, 2022
64	1778.83	Keith Clinart	CS302, Fall, 2011
65	1740.19	Luke Bechtel	CS302, Fall, 2014
66	1635.30	Justin Bowers	CS302, Spring, 2022
67	1634.49	William Brummette	CS302, Fall, 2013
68	1602.83	Forrest Sable	CS302, Fall, 2014
69	1498.87	Tom Hills	CS302, Spring, 2019 (Under Dr. Emrich)
70	1470.84	Christopher Tester	CS302, Fall, 2014
71	1446.00	Noah Burgin	CS302, Spring, 2020 (Under Dr. Emrich)
72	1433.48	Xiao Zhou	CS302, Fall, 2015
73	1430.54	Jonathan Burns	CS302, Fall, 2018
74	1399.08	Meghan Brandt	CS302, Spring, 2022
75	1340.32	John Murray	CS302, Fall, 2012
76	1329.34	Benjamin Brock	CS302, Fall, 2013
77	1301.00	Henry Brand	CS302, Spring, 2022
78	1257.56	Dylan Lee	CS302, Fall, 2018
79	1202.06	Bandara	CS302, Fall, 2014
80	1149.80	Will Houston	CS302, Fall, 2010

81	1148.99	Fort Hunter	CS302, Spring, 2022
82	1119.85	Kevin Chiang	CS302, Fall, 2014
83	1096.48	Daniel Cash	CS302, Fall, 2011
84	1076.30	Abrian Abir	CS302, Spring, 2022
85	1059.91	Kaleb McClure	CS302, Fall, 2013
86	1058.26	sb-play2	CS140, Fall, 2007
87	1029.63	Lydia San George	CS302, Fall, 2018
88	1020.55	Jihun Kim	CS302, Spring, 2022
89	1019.72	Justin Langston	CS302, Spring, 2019 (Under Dr. Emrich)
90	1016.15	Harrison Hoytt	CS302, Spring, 2022
91	972.36	Erik Rutledge	CS302, Fall, 2013
92	959.79	Daniel Nichols	CS302, Fall, 2018
93	917.92	Vasu Kalaria	CS302, Fall, 2015
94	916.54	Cody Blankenship	CS302, Spring, 2022
95	909.35	Andrew Mueller	CS360?, Spring, 2022
96	908.09	Chris Rains	CS302, Fall, 2012
97	875.44	Allen McBride	CS302, Fall, 2012
98	856.00	Tim Krenz	CS302, Spring, 2019 (Under Dr. Emrich)
99	852.32	Jonathan Graham	CS302, Spring, 2022
100	843.69	Jacob Looney	CS302, Spring, 2022
101	840.94	Spencer Howell	CS302, Fall, 2018
102	831.74	Ethan Kessinger	CS302, Spring, 2022
103	830.79	David Cunningham	CS302, Fall, 2014
104	826.00	Kincaid Mcgee	CS302, Fall, 2020
105	817.17	Alex Nguyen	CS302, Spring, 2022
106	810.17	Collin Bell	CS302, Fall, 2012
107	763.58	Jacob Lambert	CS302, Fall, 2013
108	707.16	Shivam Mistry	CS302, Spring, 2022
109	703.71	Shanna Wallace	CS302, Spring, 2022
110	703.67	Scott Marcus	CS302, Fall, 2015
111	703.00	Don Lopez	CS140, Fall, 2007
112	700.90	Tony Abston	CS302, Fall, 2015
113	682.56	Jackson Collier	CS302, Fall, 2014
114	681.00	Holland Johnson	CS302, Fall, 2020
115	677.83	KC Bentjen	CS302, Fall, 2011
116	677.74	Andrew Artates	CS302, Spring, 2019 (Under Dr. Emrich)
117	665.60	Joshua Clark	CS302, Fall, 2012
118	659.96	Warren Dewit	CS302, Fall, 2010
119	654.67	Coburn Brandon	CS302, Fall, 2015
120	650.98	Joaquin Bujalance	CS140, Fall, 2007
121	643.13	John Blackaby	CS302, Spring, 2022
122	638.14	Justin Mcknight	CS302, Spring, 2022
123	630.73	Dylan Devries	CS302, Fall, 2018
124	630.10	Winston Boyd	CS302, Fall, 2018
125	626.62	Elliot Greenlee	CS302, Fall, 2014
126	616.00	Joseph Wehby	CS302, Spring, 2022
127	609.58	Ethan Maness	CS302, Spring, 2022
128	603.14	Joseph Eaton	CS302, Spring, 2022
129	594.02	James Tucker	CS302, Fall, 2015
130	586.71	Jonathan Ting	CS302, Spring, 2019 (Under Dr. Emrich)
131	586.56	Andrew Berger	CS302, Spring, 2019 (Under Dr. Emrich)
132	581.29	Mason Stott	CS302, Spring, 2022
133	571.02	Rocco Febbo	CS302, Fall, 2018
134	558.62	Matthew Bowlby	CS302, Spring, 2022
135	557.01	Eli Kell	CS302, Spring, 2022
136	555.40	Jovan Yoshioka	CS302, Spring, 2022
137	554.94	Jared Burris	CS302, Fall, 2015
138	546.52	Andrew Rutter	CS302, Spring, 2022
139	539.00	Braden Butler	CS302, Fall, 2020
140	534.24	Christian Graham	CS302, Spring, 2022
141	524.21	Reagan Austin	CS302, Spring, 2022

142	508.04	Victoria Florence	CS302, Fall, 2015
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