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4/16/17

Reflections Document for Project 1

Analysis of the problem

What needs to be kept track of?

- ant direction
- color of space ant is on
- board that ant is on
- location of ant
- boundaries of board

What needs to be analyzed within the program?

- direction based on color
- whether move is in bounds
- results of invalid move
- color of recently exited space

What is the input of the program?

- size of board
- location of ant
- random or nonrandom location choice
- number of steps to take

What is the output of the program?

- prompt statements
- the board (2D array)
- statement of number of step

The ant needs to behave in such a way that it turns right when on a white space, and turns left when on a black space. When the ant encounters a boundary, it should keep trying the direction until a space is found. Ie. if it tries to go right and finds a boundary, it will go right again until no boundary is found.

Classes and variables within them

Ant class

- Private: (data members)
  - Board class object
  - Int representing row location of ant
  - Int representing column location of ant
  - Int representing color of space
  - Int representing direction of ant
  - Int representing row boundary of Board object 2D array
  - Int representing column boundary of Board object 2D array
- Public: (member functions)
  - Constructor
  - Function to start ant
  - Function to move ant
  - Function to analyze necessary direction
  - Function to analyze validity of move in direction chosen
  - Print function that accesses Board object

Board class:

- Private: (data members)
  - 2D array representing the board
  - Int to represent number of rows
  - Int to represent number of columns
- Public: (member functions)
  - Constructor
  - Function to place ant on location in board
  - Function to return the board for the Ant class
  - Print function

Pseudocode

main()

1. Use menu function to determine if user wants a random location for the ant
2. Introduce program to user
3. Ask user for size of board
    a. Save row and column input in variables
    b. Validate input
4. Ask user for number of steps
    a. Save in variable
    b. Validate input
5. Ask user for starting location of ant if user did not choose random in menu
    a. Save row and column in variables
    b. Validate input
6. Create ant object named "ant1" **(this step was moved between step 2 and 3 in the final code)**
7. Call ant1 function to initially place the ant
8. Print board with ant location
9. Enter loop for each step
    a. On the first step, have the ant move north
        i. Print the board and the ant
    b. On each step after the first, use ant1 functions move the ant according to the rule
        i. Print the board and the ant
10. End program

Menu()

1. Ask use if they would like to (1) start the program, (2) select whether to have a random starting location for the ant, or (3) quit the program
    a. Save choice in variable
2. Use variable value to select option
    a. If (1) continue in main with no random starting point
    b. If (2) continue in main with selection of random starting point recognized
    c. If (3) exit the program

Ant::move()

1. If new position is white
    a. Store color as variable and place ant in new location of Board object
2. If new position is black
    a. Store color as variable and place ant in new location of Board object
3. Reverse color of previous location

4. Save new location of ant in data member variables

Ant::chooseDir()

1. Determine color
    a. Determine previous direction
    b. Determine new direction based on color rules
        i. Save new direction in data member variable

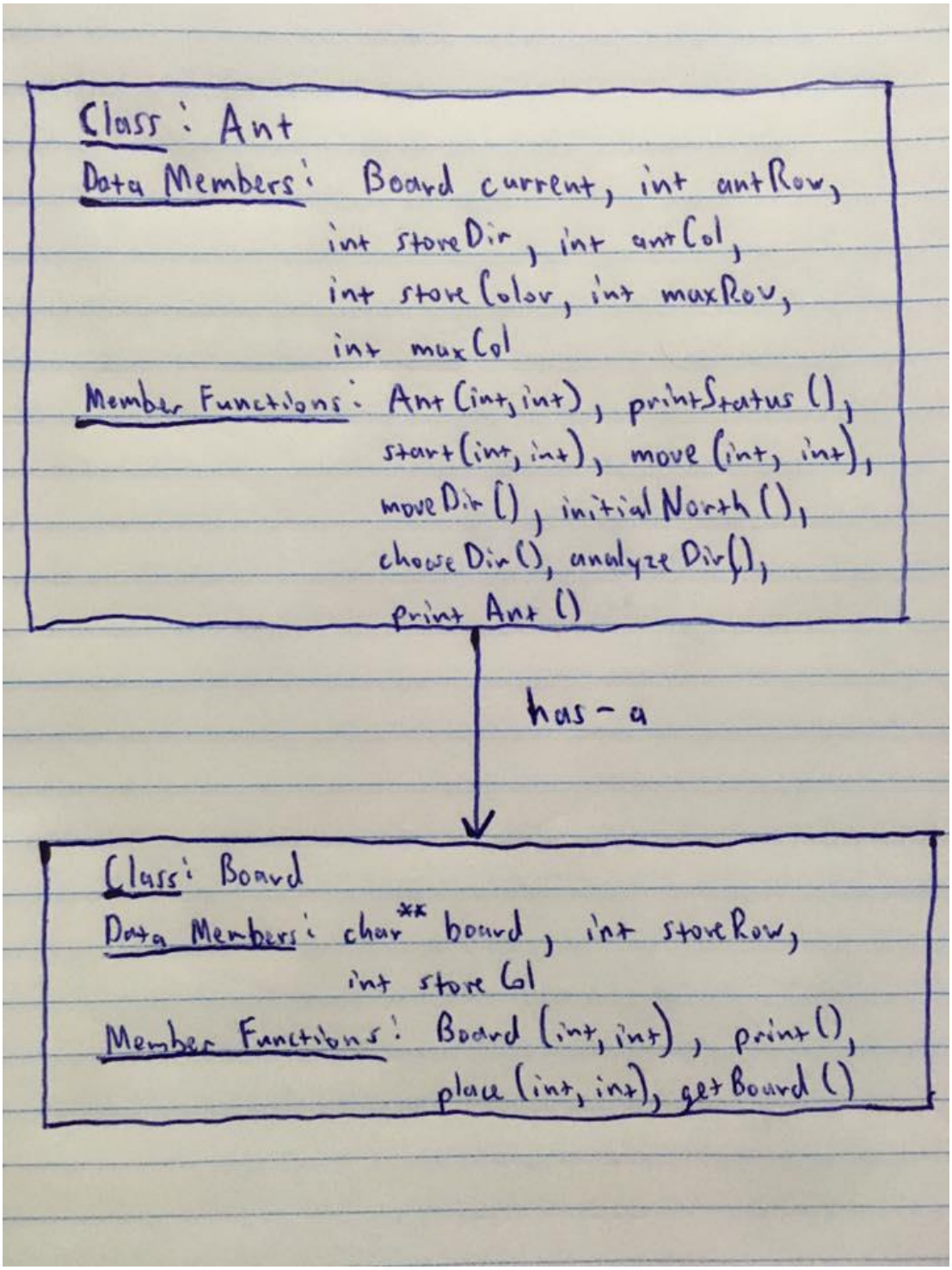
Ant::analyzeDir()

1. Determine direction (as set in data member by chooseDir function)
    a. Determine if the next location on the board corresponding to the direction is within bounds of the board
        i. If so, return true
        ii. If not, return false

Ant::moveDir()

1. Use do-while loop (condition is if ant has not moved)
2. Determine direction and validity of directional move (use data member set by chooseDir function and use return value of analyzeDir function)
    a. If valid, use move function of same class to take the move
    b. If not valid, change direction based on color and check validity again

Class Hierarchy Diagram



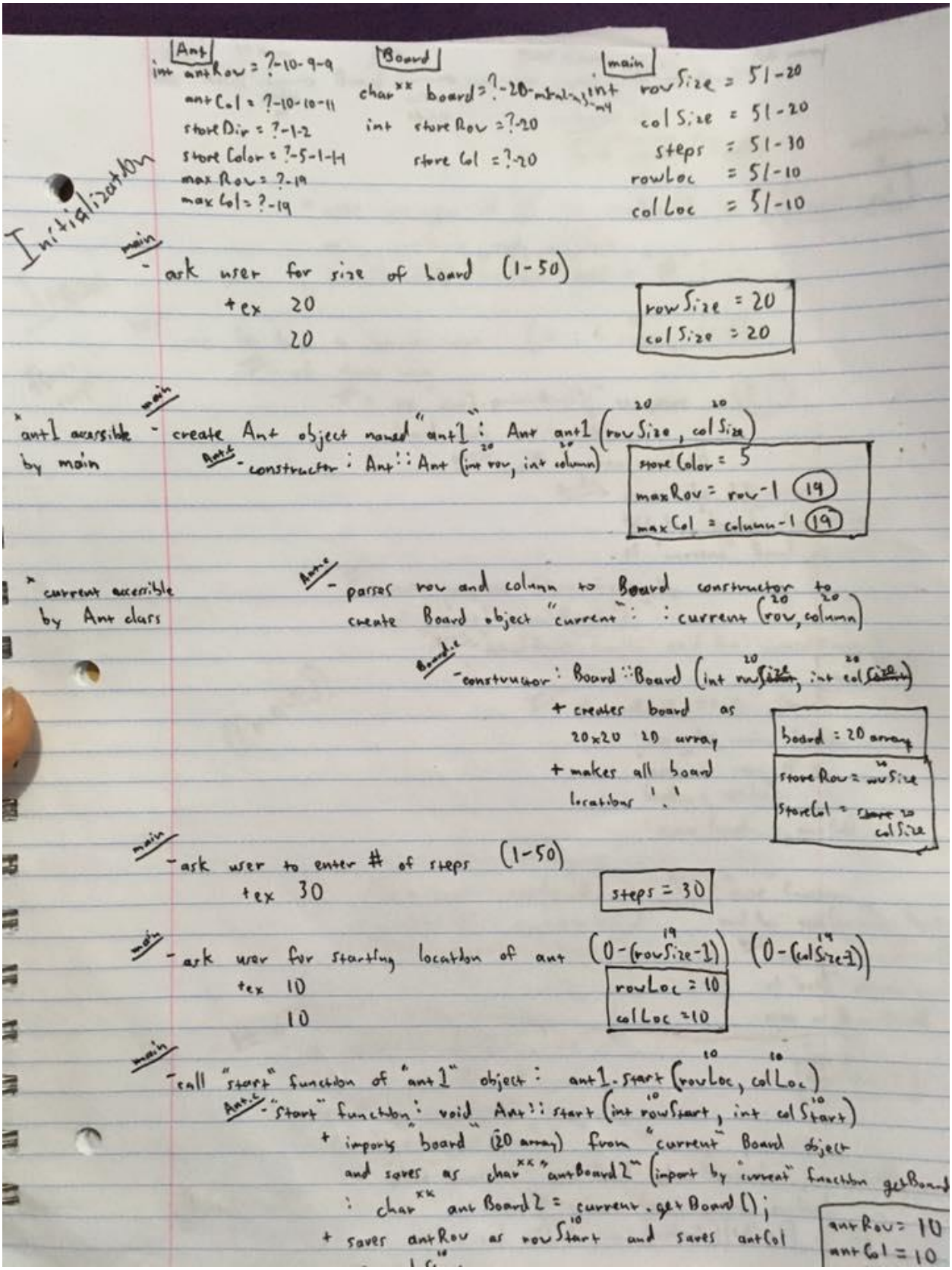
Testing Plan

Test	Input Values	Expected Outcome	Observed Outcome
Input for row or column size too low	Input < 2	Output prompt for invalid input and loop back to variable input	Output prompt for invalid input and loop back to variable input
Input for row or column size too large	Input > 50	Output prompt for invalid input and loop back to variable input	Output prompt for invalid input and loop back to variable input
Input for menu functions out of range	0 < input < 4	Output prompt for invalid input and loop back to variable input	Output prompt for invalid input and loop back to variable input
Input for number of steps out of range	0 < input <10000	Output prompt for invalid input and loop back to variable input	Output prompt for invalid input and loop back to variable input
Input for location of ant out of range	0 <= input < maxSize	Output prompt for invalid input and loop back to variable input	Output prompt for invalid input and loop back to variable input

Reflection statement

Throughout this project, I learned the value of separating functions by what they do and making. I originally wrote a lot of the code with very few class functions and almost all functionality within one function. It made for an extremely hard read and eventually became too large to debug and I had to re organize much of the code. I also learned the value of using classes as opposed to putting everything in the main function or another function. I included the original unwieldy code in the last section of this PDF, after the following logic tracing section.

Tracing of code by hand



store board → 20 array member of → Board class → with object → current Board object → called using getBoard() and saved to → antBoard2 20 array

Board current: board

board = m1

modification 1

+ sets position of "@" in antBoard2 by using rowStart and colStart
: antBoard2[rowStart][colStart] = '@';

main
- uses for loop to iterate steps (if i < steps; i=0)

main
- if first step
+ use "ant1.printAnt();" to print board with ant location

Ant.c
- call "current.print()"

Board.c
- cout the 2D array held by "board" data member of "current" Board object

P1

main
+ ~~initial~~ complete first move by calling "ant1.initialNorth();"

Ant.c
- "initialNorth" function: void Ant::initialNorth()

storeColor = 1

Ant.c
- if antRow-1 >= 0 (true)
- use Ant member function "move" to move '@' to (antRow-1, antCol)
: move (antRow-1, antCol)

((move))

local variable: storeColorOld
storeColorOld = storeColor=1

Ant
- "move" function:
void Ant::move(int rowLoc, int colLoc)

Ant
- imports "board" member of "ant1" object and saves as antBoard

Ant
- if antBoard[rowLoc][colLoc] == '.'
- storeColor = 1

storeColor = 1

- move '@' to new location using "current.place(rowLoc, colLoc);"
- "place" function: void Board::place(int rowLoc2, int colLoc2)
- move '@' to new location using rowLoc2 and colLoc2: board[rowLoc2][colLoc2] = '@';

board = m2

bool function: analyzeDir = ?

local variable: storeDir Old
storeDirOld = storeDir = 2

- "moveDir" function of "ant2" object
  - do / (while analyzeDir == false) (?)
  (true) - if storeDirOld == 2 && analyzeDir() == true

analyzeDir()

Ant
- "analyzeDir" function of "ant1" object: "bool Ant::analyzeDir();"
  - if storeDir == 2 (true)
    - if (antCol+1) <= maxCol (true)
      - return True

storeCtor = 1
antRow = row Loc = 9
antCol = colLoc = 11
board = m4

Ant
- use "move" function of ant1 object to move '@' to new location using antRow and antCol+1
"move(antRow, antCol+1);"

- do / (while analyzeDir ==

Original Code for move function in Ant class

```
void Ant::move()
{
      char** antBoard2 = current.getBoard();
      if (storeColor == 1)// && (antBoard2[antRow][antCol] ==' ') &&
(storeDir == 1))
      {
            if (storeDir == 1)
            {
                  if (antBoard2[antRow][antCol+1] == ' ')
                  {
                        location(antRow, antCol+1);
                        storeColor = 1;
                        storeDir = 2;
                  }
                  else if (antBoard2[antRow][antCol+1] == '#')
                  {
                        location(antRow, antCol +1);
                        storeColor = 0;
                        storeDir = 2;
                  }
                  else
                  {
                        if (antBoard2[antRow+1][antCol] == ' ')
                        {
                              location(antRow+1, antCol);
                              storeColor = 1;
                              storeDir = 3;
                        }
                        else if (antBoard2[antRow+1][antCol] == '#')
                        {
                              location(antRow+1, antCol);
                              storeColor = 0;
                              storeDir = 3;
                        }
                        else
                        {
                              if (antBoard2[antRow][antCol-1] == ' ')
                              {
                                    location(antRow, antCol-1);
                                    storeColor = 1;
                                    storeDir = 4;
                              }
                              else if (antBoard2[antRow][antCol-1] ==
'#')
                              {
                                    location(antRow, antCol-1);
                                    storeColor = 0;
                                    storeDir = 4;
```

```
                        }
                        else
                        {
                              if (antBoard2[antRow-1][antCol] == '
')
                              {
                                    location(antRow-1, antCol);
                                    storeColor = 1;
                                    storeDir = 1;
                              }
                              else if (antBoard2[antRow-1][antCol]
== '#')
                              {
                                    location(antRow-1, antCol);
                                    storeColor = 0;
                                    storeDir = 1;
                              }
                              else
                              {
                                    location(antRow, antCol);
                                    storeColor = 1;
                                    storeDir = 1;
                              }
                        }
                  }
            }
      }

      if (storeDir == 2)
      {
            if (antBoard2[antRow+1][antCol] == ' ')
            {
                  location(antRow+1, antCol);
                  storeColor = 1;
                  storeDir = 3;
            }
            else if (antBoard2[antRow+1][antCol] == '#')
            {
                  location(antRow+1, antCol);
                  storeColor = 0;
                  storeDir = 3;
            }
            else
            {
                  if (antBoard2[antRow][antCol-1] == ' ')
                  {
                        location(antRow, antCol-1);
                        storeColor = 1;
                        storeDir = 4;
                  }
                  else if (antBoard2[antRow][antCol-1] == '#')
                  {
```

```
                        location(antRow, antCol-1);
                        storeColor = 0;
                        storeDir = 4;
                    }
                    else
                    {
                        if (antBoard2[antRow-1][antCol] == ' ')
                        {
                            location(antRow-1, antCol);
                            storeColor = 1;
                            storeDir = 1;
                        }
                        else if (antBoard2[antRow-1][antCol] ==
'#')
                        {
                            location(antRow-1, antCol);
                            storeColor = 0;
                            storeDir = 1;
                        }
                        else
                        {
                            if (antBoard2[antRow][antCol+1] == '
')
                            {
                                location(antRow, antCol+1);
                                storeColor = 1;
                                storeDir = 2;
                            }
                            else if (antBoard2[antRow][antCol+1]
== '#')
                            {
                                location(antRow, antCol+1);
                                storeColor = 0;
                                storeDir = 2;
                            }
                            else
                            {
                                location(antRow, antCol);
                                storeColor = 1;
                                storeDir = 2;
                            }
                        }
                    }
                }
            }

            if (storeDir == 3)
            {
                if (antBoard2[antRow][antCol-1] == ' ')
                {
                    location(antRow, antCol-1);
                    storeColor = 1;
```

```
                    storeDir = 4;
                }
                else if (antBoard2[antRow][antCol-1] == '#')
                {
                    location(antRow, antCol-1);
                    storeColor = 0;
                    storeDir = 4;
                }
                else
                {
                    if (antBoard2[antRow-1][antCol] == ' ')
                    {
                        location(antRow-1, antCol);
                        storeColor = 1;
                        storeDir = 1;
                    }
                    else if (antBoard2[antRow-1][antCol] == '#')
                    {
                        location(antRow-1, antCol);
                        storeColor = 0;
                        storeDir = 1;
                    }
                    else
                    {
                        if (antBoard2[antRow][antCol+1] == ' ')
                        {
                            location(antRow, antCol+1);
                            storeColor = 1;
                            storeDir = 2;
                        }
                        else if (antBoard2[antRow][antCol+1] ==
'#')
                        {
                            location(antRow, antCol+1);
                            storeColor = 0;
                            storeDir = 2;
                        }
                        else
                        {
                            if (antBoard2[antRow+1][antCol] == '
')
                            {
                                location(antRow+1, antCol);
                                storeColor = 1;
                                storeDir = 3;
                            }
                            else if (antBoard2[antRow+1][antCol]
== '#')
                            {
                                location(antRow+1, antCol);
                                storeColor = 0;
                                storeDir = 3;
```

```
                              }
                              else
                              {
                                    location(antRow, antCol);
                                    storeColor = 1;
                                    storeDir = 3;
                              }
                        }
                  }
            }
      }

      if (storeDir == 4)
      {
            if (antBoard2[antRow-1][antCol] == ' ')
            {
                  location(antRow-1, antCol);
                  storeColor = 1;
                  storeDir = 1;
            }
            else if (antBoard2[antRow-1][antCol] == '#')
            {
                  location(antRow-1, antCol);
                  storeColor = 0;
                  storeDir = 1;
            }
            else
            {
                  if (antBoard2[antRow][antCol+1] == ' ')
                  {
                        location(antRow, antCol+1);
                        storeColor = 1;
                        storeDir = 2;
                  }
                  else if (antBoard2[antRow][antCol+1] == '#')
                  {
                        location(antRow, antCol+1);
                        storeColor = 0;
                        storeDir = 2;
                  }
                  else
                  {
                        if (antBoard2[antRow+1][antCol] == ' ')
                        {
                              location(antRow+1, antCol);
                              storeColor = 1;
                              storeDir = 3;
                        }
                        else if (antBoard2[antRow+1][antCol] ==
'#')
                        {
                              location(antRow+1, antCol);
```

```
                              storeColor = 0;
                              storeDir = 3;
                        }
                        else
                        {
                              if (antBoard2[antRow][antCol-1] == '
')
                              {
                                    location(antRow, antCol-1);
                                    storeColor = 1;
                                    storeDir = 4;
                              }
                              else if (antBoard2[antRow][antCol-1]
== '#')
                              {
                                    location(antRow, antCol-1);
                                    storeColor = 0;
                                    storeDir = 4;
                              }
                              else
                              {
                                    location(antRow, antCol);
                                    storeColor = 1;
                                    storeDir = 4;
                              }
                        }
                  }
            }
      }

      if (storeColor == 0)
      {
            if (storeDir == 1)
            {
                  if (antBoard2[antRow][antCol-1] == ' ')
                  {
                        location(antRow, antCol-1);
                        storeColor = 1;
                        storeDir = 4;
                  }
                  else if (antBoard2[antRow][antCol-1] == '#')
                  {
                        location(antRow, antCol -1);
                        storeColor = 0;
                        storeDir = 4;
                  }
                  else
                  {
                        if (antBoard2[antRow+1][antCol] == ' ')
```

```
                        {
                              location(antRow+1, antCol);
                              storeColor = 1;
                              storeDir = 3;
                        }
                        else if (antBoard2[antRow+1][antCol] == '#')
                        {
                              location(antRow+1, antCol);
                              storeColor = 0;
                              storeDir = 3;
                        }
                        else
                        {
                              if (antBoard2[antRow][antCol+1] == ' ')
                              {
                                    location(antRow, antCol+1);
                                    storeColor = 1;
                                    storeDir = 2;
                              }
                              else if (antBoard2[antRow][antCol-1] ==
'#')
                              {
                                    location(antRow, antCol-1);
                                    storeColor = 0;
                                    storeDir = 2;
                              }
                              else
                              {
                                    if (antBoard2[antRow-1][antCol] == '
')
                                    {
                                          location(antRow-1, antCol);
                                          storeColor = 1;
                                          storeDir = 1;
                                    }
                                    else if (antBoard2[antRow-1][antCol]
== '#')
                                    {
                                          location(antRow-1, antCol);
                                          storeColor = 0;
                                          storeDir = 1;
                                    }
                                    else
                                    {
                                          location(antRow, antCol);
                                          storeColor = 0;
                                          storeDir = 1;
                                    }
                              }
                        }
                  }
            }
```

```
            if (storeDir == 2)
            {
                  if (antBoard2[antRow-1][antCol] == ' ')
                  {
                        location(antRow-1, antCol);
                        storeColor = 1;
                        storeDir = 1;
                  }
                  else if (antBoard2[antRow-1][antCol] == '#')
                  {
                        location(antRow-1, antCol);
                        storeColor = 0;
                        storeDir = 1;
                  }
                  else
                  {
                        if (antBoard2[antRow][antCol-1] == ' ')
                        {
                              location(antRow, antCol-1);
                              storeColor = 1;
                              storeDir = 4;
                        }
                        else if (antBoard2[antRow][antCol-1] == '#')
                        {
                              location(antRow, antCol-1);
                              storeColor = 0;
                              storeDir = 4;
                        }
                        else
                        {
                              if (antBoard2[antRow+1][antCol] == ' ')
                              {
                                    location(antRow+1, antCol);
                                    storeColor = 1;
                                    storeDir = 3;
                              }
                              else if (antBoard2[antRow+1][antCol] ==
'#')
                              {
                                    location(antRow+1, antCol);
                                    storeColor = 0;
                                    storeDir = 3;
                              }
                              else
                              {
                                    if (antBoard2[antRow][antCol+1] == '
')
                                    {
                                          location(antRow, antCol+1);
                                          storeColor = 1;
                                          storeDir = 2;
```

```
                                    }
                                    else if (antBoard2[antRow][antCol+1]
== '#')
                                    {
                                          location(antRow, antCol+1);
                                          storeColor = 0;
                                          storeDir = 2;
                                    }
                                    else
                                    {
                                          location(antRow, antCol);
                                          storeColor = 0;
                                          storeDir = 2;
                                    }
                              }
                        }
                  }
            }

            if (storeDir == 3)
            {
                  if (antBoard2[antRow][antCol+1] == ' ')
                  {
                        location(antRow, antCol+1);
                        storeColor = 1;
                        storeDir = 2;
                  }
                  else if (antBoard2[antRow][antCol+1] == '#')
                  {
                        location(antRow, antCol+1);
                        storeColor = 0;
                        storeDir = 2;
                  }
                  else
                  {
                        if (antBoard2[antRow-1][antCol] == ' ')
                        {
                              location(antRow-1, antCol);
                              storeColor = 1;
                              storeDir = 1;
                        }
                        else if (antBoard2[antRow-1][antCol] == '#')
                        {
                              location(antRow-1, antCol);
                              storeColor = 0;
                              storeDir = 1;
                        }
                        else
                        {
                              if (antBoard2[antRow][antCol-1] == ' ')
                              {
                                    location(antRow, antCol-1);
```

```
                              storeColor = 1;
                              storeDir = 4;
                        }
                        else if (antBoard2[antRow][antCol-1] ==
'#')
                        {
                              location(antRow, antCol-1);
                              storeColor = 0;
                              storeDir = 4;
                        }
                        else
                        {
                              if (antBoard2[antRow+1][antCol] == '
')
                              {
                                    location(antRow+1, antCol);
                                    storeColor = 1;
                                    storeDir = 3;
                              }
                              else if (antBoard2[antRow+1][antCol]
== '#')
                              {
                                    location(antRow+1, antCol);
                                    storeColor = 0;
                                    storeDir = 3;
                              }
                              else
                              {
                                    location(antRow, antCol);
                                    storeColor = 0;
                                    storeDir = 3;
                              }
                        }
                  }
            }
      }

      if (storeDir == 4)
      {
            if (antBoard2[antRow+1][antCol] == ' ')
            {
                  location(antRow+1, antCol);
                  storeColor = 1;
                  storeDir = 3;
            }
            else if (antBoard2[antRow+1][antCol] == '#')
            {
                  location(antRow+1, antCol);
                  storeColor = 0;
                  storeDir = 3;
            }
            else
```

```
                {
                        if (antBoard2[antRow][antCol+1] == ' ')
                        {
                                location(antRow, antCol+1);
                                storeColor = 1;
                                storeDir = 2;
                        }
                        else if (antBoard2[antRow][antCol+1] == '#')
                        {
                                location(antRow, antCol+1);
                                storeColor = 0;
                                storeDir = 2;
                        }
                        else
                        {
                                if (antBoard2[antRow-1][antCol] == ' ')
                                {
                                        location(antRow-1, antCol);
                                        storeColor = 1;
                                        storeDir = 1;
                                }
                                else if (antBoard2[antRow-1][antCol] ==
'#')
                                {
                                        location(antRow-1, antCol);
                                        storeColor = 0;
                                        storeDir = 1;
                                }
                                else
                                {
                                        if (antBoard2[antRow][antCol-1] == '
')
                                        {
                                                location(antRow, antCol-1);
                                                storeColor = 1;
                                                storeDir = 4;
                                        }
                                        else if (antBoard2[antRow][antCol-1]
== '#')
                                        {
                                                location(antRow, antCol-1);
                                                storeColor = 0;
                                                storeDir = 4;
                                        }
                                        else
                                        {
                                                location(antRow, antCol);
                                                storeColor = 0;
                                                storeDir = 4;
                                        }
                                }
                        }
```

```
                        }
                    }


            }


    }
```