Project: SCRABBLE

Introduction:

Scrabble is a captivating word game that challenges players' linguistic abilities and strategic thinking. The objective is to form words on a game board using letter tiles. Each letter carries a specific point value, and players aim to maximize their scores by strategically placing their words. With its focus on vocabulary and skillful word construction, Scrabble provides an enjoyable and mentally stimulating experience for players of all levels.

Why SCRABBLE?

It was our desire since the beginning of semester to make an interesting project for Data Structures, in which we can show case our true potential in coding. We took interest in learning and playing Scrabble physically on board and decided to make it as our project in Data Structures.

Project Explanation:

Programming Language: C++

Data Containers:

- **LinkedList**
  For storing tiles of a word as LinkedList.
- **Vectors (STL)**
  For storing words (Adj-List) and rack of a player.
- **Adjacency-Matrix (Graph)**
  2D array for making board and displaying it.
- **Adjacency-List (Graph)**
  Vector who's each index has a word (LinkedList).
- **Unordered set (STL)**
  For storing words from "CompleteDictionary.txt" file.

Classes:

- **Struct tile()**
  Attributes:
  char letter, int number, int locx, int locy
- **Class bag()**
  Attributes:
  Int initialcount, tile A, tile B, …., tile Z, vector<tile> tilecollection
- **Class node()**
  Attributes:
  Tile data, node* next
- **Class word()** *"LinkedList"*
  Attributes:
  Node* head
- **Class board()**
  Attributes:
  Bag bg, tile arr[n][n], int checkdirection
- **Class player()**
  Attributes:
  Int score, string name, vector<tile> rack, vector<word> allwords
- **Int main()**
  `player* players = new player[num];`
  (all other declarations and inputs in main() depends upon input number of players-**num**)

Global declarations:

- `HANDLE hConsole = GetStdHandle(STD_OUTPUT_HANDLE); //(for giving colors to the text in console)`
- `int checkcentre = 0; //(for board)`
- `const int n = 15;  //for 15x15 board`
- `static board b; //(for static one board for each player)`

Functions in each class:

→Struct tile()

- default and parametrized constructors
- setters and getters

→Class bag()

- default constructor
  All the 98 tiles get inserted in the **tilecollection** vector.
- `vector<tile> withdrawtiles(vector<tile> v,int initialC)`
  Called whenever tiles count of rack of any player gets less than 7.

→Class node()

- default and copy constructors
- setters and getters

→Class word() *"LinkedList"*

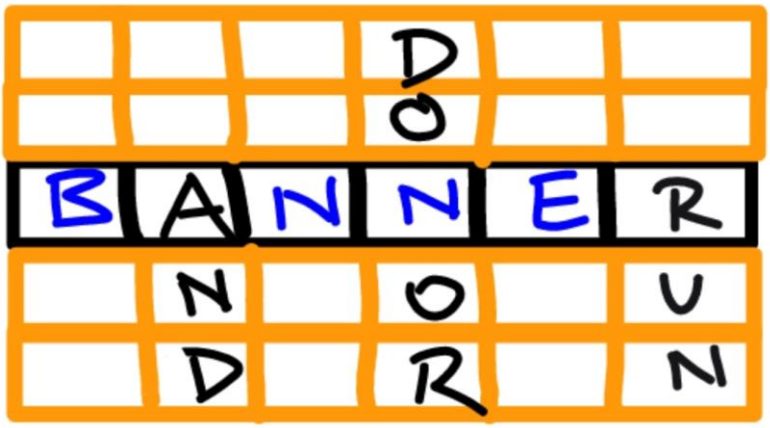
- default constructor
- getter→gethead()
- `void IAS(tile a)`
- To insert tile at the start of word. It is called in **checkadjacentletters()** function of class **board()** and in **IAE()** function of class **word().**
- `void IAE(tile a)`
  To insert tile at the end of word. It is also called in **checkadjacentletters()** function of class **board().**
- `void IAAP(tile a, int pos)`
  To insert tile at any position in the word. It is also called in **checkadjacentletters()** function of class **board().**
- `int size()`
  To know the size of the word.

→Class board()

- default constructor
- `vector<word> placeword(word w)`

It places the intended word by taking input location and direction from user and passing the word, row and column location and direction as argument to the **checkadjacentletters()** function. It places the intended word on board if the returned vector from **checkadjacentletters()** function is **not empty** (meaning the intended word and all the words made due to intended word are present in dictionary).

- `vector<word> checkadjacentletters(word w, int x, int y, int dir)`
  Called by **placeword()** function of the same class **board()**. It detects letters in the way which are present straight in the direction of word and makes the whole intended word. It also detects adjacent nonempty blocks to make crosswords. For example,



In this example **AND, DO, OR** and **RUN** are already placed on the board. Our intended word to be made is **BANNER**, by using already placed tiles **A** (of AND), **R** (of RUN). Here there is need of location of only tile **B**, the function will automatically add up letters to word while going from input direction location to the end of intended word. Here one more word **DONOR** is made along the way. In this example you will make inputs **B, (ENTER), N, (ENTER), N, (ENTER), E, (ENTER)**, **/** (for ending your input tiles), **(ENTER), 1** (for rightward direction), **(ENTER)** and finally enter Row and Column numbers for tile **B.**
(*Most of our time was utilized in making this efficient function capable of detecting tiles already placed in way and in the adjacent blocks of board).

- `bool checkwordvalidatyindictionary(string w)`
  Called by checkadjacentletters() function of the same class board(). It checks whether a word is present in dictionary or not.
- `void displayboard()`
  Displays board after being called in **dispBoard()** function of class **player().**
- `vector<tile> withdraw(vector<tile> v,int a)`
  Withdraws tiles by calling **withdrawtiles()** function of class **bag().**

→Class player()

- default constructor
- setters and getters
- `int addword()`

Takes input letters to make intended word by calling **placeword()** function of class **board().**

- `void subtractRack(word w)`
  Removes the tiles from the rack of player when used successfully in making a word.
- `void scorecount(word w)`
  Adds up new points in the score count of player, when a word is successfully placed on the board.
- `void displayrack()`
  Displays rack of the player.
- `void displayscore()`
  Displays a player's total and individual score of words.
- `void displayallwords()`
  Displays all the words a player had made at that time.
- `void dispBoard()`
  Calls **displayboard()** function of class **board()** to display board.

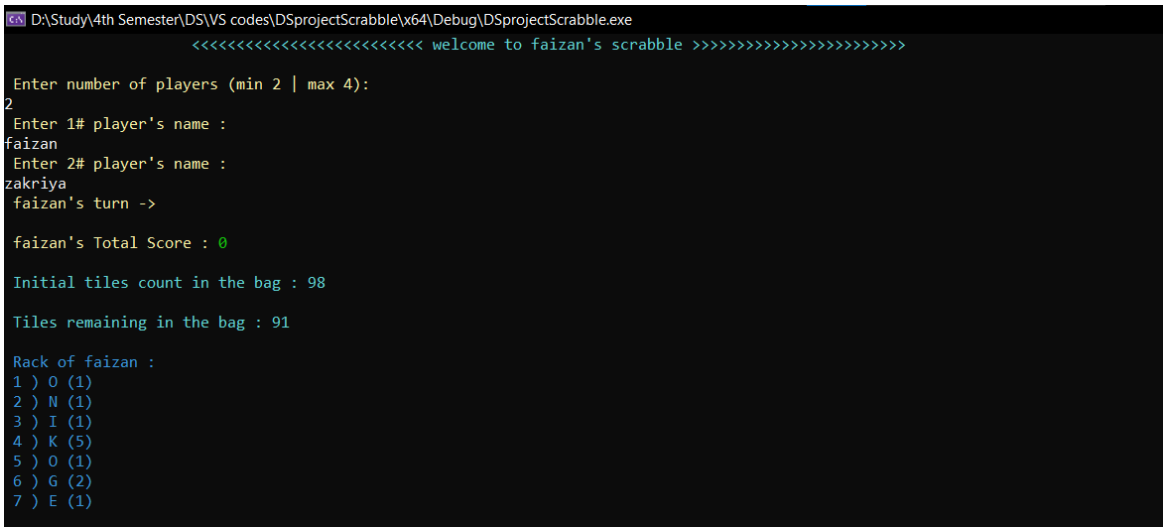
→Int main()

Main function takes input number of players and their names. Each player does their turn and once the rack of any player gets empty or the consecutive turn passing increases by the number of players, game gets ended and final score calculation and winner declaration happens.

Test Run:

Note: *Scrabble is a game played with some additional rules called House-Rules, determined mutually by the players in the beginning of the game. Hence, first House-Rule determined here is that, when a player is unable to make a word, they can pass the turn to the next player and if this passing continues without any break and reaches to the first player who first passed the turn, then the game ends there and final score calculation and winner declaration occurs. The second House-Rule is that there are no Bonus Squares.*

(Game Start)



(Entering letters - input validation)

```
 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
O
 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
J
 You do not have this letter tile in your rack OR you have already picked this tile ! Please enter letter again which is present in your rack.
 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
N
 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
/
 you want to place downward or rightwards? press 0 for downward, 1 for rightward
1
Word (ON) is in the dictionary.
 Word placed successfully !

 Tiles remaining in the bag : 89

 Updated rack of faizan :
 1 ) I (1)
 2 ) K (5)
 3 ) O (1)
 4 ) G (2)
 5 ) E (1)
 6 ) R (1)
 7 ) E (1)


 faizan's Total Score : 2
 faizan's words with their individual scores in the bracket :
 1 ) ON (2)
```

(Board display)

```
                                    <<<<   Board   >>>>
      1)    2)    3)    4)    5)    6)    7)    8)    9)    10)    11)    12)    13)    14)    15)

 1  )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
      ---------------------------------------------------------------------------------------------
 2  )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
      ---------------------------------------------------------------------------------------------
 3  )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
      ---------------------------------------------------------------------------------------------
 4  )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
      ---------------------------------------------------------------------------------------------
 5  )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
      ---------------------------------------------------------------------------------------------
 6  )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
      ---------------------------------------------------------------------------------------------
 7  )    |     |     |     |     |     |  O  |  N  |     |     |      |      |      |      |      |
      ---------------------------------------------------------------------------------------------
 8  )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
      ---------------------------------------------------------------------------------------------
 9  )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
      ---------------------------------------------------------------------------------------------
 10 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
      ---------------------------------------------------------------------------------------------
 11 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
      ---------------------------------------------------------------------------------------------
 12 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
      ---------------------------------------------------------------------------------------------
 13 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
      ---------------------------------------------------------------------------------------------
 14 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
      ---------------------------------------------------------------------------------------------
 15 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
      ---------------------------------------------------------------------------------------------
```

(Next player’s turn - input validation)

```
/ zakriya's turn ->

 zakriya's Total Score : 0

 Tiles remaining in the bag : 82

 Rack of zakriya :
1 ) I (1)
2 ) T (1)
3 ) N (1)
4 ) D (2)
5 ) R (1)
6 ) Z (10)
7 ) E (1)

 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
E
 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
E
 You do not have this letter tile in your rack OR you have already picked this tile ! Please enter letter again which is present in your rack.
 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
/
 you want to place downward or rightwards? press 0 for downward, 1 for rightward
1
 Enter Row and Column numbers for letter (E) of your intended word
 Row : 7
 Column : 9
Word (ONE) is in the dictionary.
 Word placed successfully !

 Tiles remaining in the bag : 81

 Updated rack of zakriya :
1 ) I (1)
2 ) T (1)
3 ) N (1)
4 ) D (2)
5 ) R (1)
6 ) Z (10)
7 ) I (1)


 zakriya's Total Score : 3
 zakriya's words with their individual scores in the bracket :
1 ) ONE (3)
```

(Board display)

```
                                    <<<<   Board   >>>>
      1)    2)    3)    4)    5)    6)    7)    8)    9)    10)    11)    12)    13)    14)    15)

 1  )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
 2  )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
 3  )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
 4  )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
 5  )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
 6  )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
 7  )    |     |     |     |     |     |  O  |  N  |  E  |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
 8  )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
 9  )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
 10 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
 11 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
 12 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
 13 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
 14 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
 15 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
```

(Next player's turn)

```
/ faizan's turn ->

 faizan's Total Score : 2

 Rack of faizan :
1 ) I (1)
2 ) K (5)
3 ) O (1)
4 ) G (2)
5 ) E (1)
6 ) R (1)
7 ) E (1)

 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
G
 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
/
 you want to place downward or rightwards? press 0 for downward, 1 for rightward
1
 Enter Row and Column numbers for letter (G) of your intended word
 Row : 7
 Column : 6
Word (GONE) is in the dictionary.
 Word placed successfully !

 Tiles remaining in the bag : 80

 Updated rack of faizan :
1 ) I (1)
2 ) K (5)
3 ) O (1)
4 ) E (1)
5 ) R (1)
6 ) E (1)
7 ) F (4)


 faizan's Total Score : 7
 faizan's words with their individual scores in the bracket :
1 ) ON (2)
2 ) GONE (5)
```

(Board display)

```
                                <<<<   Board   >>>>
     1)    2)    3)    4)    5)    6)    7)    8)    9)    10)    11)    12)    13)    14)    15)

1  )     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
2  )     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
3  )     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
4  )     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
5  )     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
6  )     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
7  )     |     |     |     |     |  G  |  O  |  N  |  E  |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
8  )     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
9  )     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
10 )     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
11 )     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
12 )     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
13 )     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
14 )     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
15 )     |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
```

(Next player's turn)

```
/ zakriya's turn ->

 zakriya's Total Score : 3

 Rack of zakriya :
 1 ) I (1)
 2 ) T (1)
 3 ) N (1)
 4 ) D (2)
 5 ) R (1)
 6 ) Z (10)
 7 ) I (1)

 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
T
 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
I
 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
/
 you want to place downward or rightwards? press 0 for downward, 1 for rightward
0
 Enter Row and Column numbers for letter (T) of your intended word
 Row : 5
 Column : 8
Word (TIN) is in the dictionary.
 Word placed successfully !

 Tiles remaining in the bag : 78

 Updated rack of zakriya :
 1 ) N (1)
 2 ) D (2)
 3 ) R (1)
 4 ) Z (10)
 5 ) I (1)
 6 ) U (1)
 7 ) V (4)


 zakriya's Total Score : 6
 zakriya's words with their individual scores in the bracket :
 1 ) ONE (3)
 2 ) TIN (3)
```

(Board display)

```
                                <<<<   Board   >>>>
     1)    2)    3)    4)    5)    6)    7)    8)    9)    10)    11)    12)    13)    14)    15)
 1 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
    ---------------------------------------------------------------------------------------------
 2 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
    ---------------------------------------------------------------------------------------------
 3 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
    ---------------------------------------------------------------------------------------------
 4 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
    ---------------------------------------------------------------------------------------------
 5 )    |     |     |     |     |     |     |  T  |     |     |      |      |      |      |      |
    ---------------------------------------------------------------------------------------------
 6 )    |     |     |     |     |     |     |  I  |     |     |      |      |      |      |      |
    ---------------------------------------------------------------------------------------------
 7 )    |     |     |     |     |  G  |  O  |  N  |  E  |     |      |      |      |      |      |
    ---------------------------------------------------------------------------------------------
 8 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
    ---------------------------------------------------------------------------------------------
 9 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
    ---------------------------------------------------------------------------------------------
 10 )   |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
    ---------------------------------------------------------------------------------------------
 11 )   |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
    ---------------------------------------------------------------------------------------------
 12 )   |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
    ---------------------------------------------------------------------------------------------
 13 )   |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
    ---------------------------------------------------------------------------------------------
 14 )   |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
    ---------------------------------------------------------------------------------------------
 15 )   |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
    ---------------------------------------------------------------------------------------------
```

(Next player's turn – intended word did not exist in the dictionary)

```
/ faizan's turn ->

 faizan's Total Score : 7

 Rack of faizan :
 1 ) I (1)
 2 ) K (5)
 3 ) O (1)
 4 ) E (1)
 5 ) R (1)
 6 ) E (1)
 7 ) F (4)

 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
K
 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
/
 you want to place downward or rightwards? press 0 for downward, 1 for rightward
0
 Enter Row and Column numbers for letter (K) of your intended word
 Row : 8
 Column : 8
Word (TINK) is not in the dictionary.
 Word can't be placed !
 Try Again !
 faizan's turn ->
```

(Passing the turn – Next player's turn)

```
 faizan's turn ->

 faizan's Total Score : 7

 Rack of faizan :
 1 ) I (1)
 2 ) K (5)
 3 ) O (1)
 4 ) E (1)
 5 ) R (1)
 6 ) E (1)
 7 ) F (4)

 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
!
 zakriya's turn ->

 zakriya's Total Score : 6

 Rack of zakriya :
 1 ) N (1)
 2 ) D (2)
 3 ) R (1)
 4 ) Z (10)
 5 ) I (1)
 6 ) U (1)
 7 ) V (4)
```

(Entering letters – input validation)

```
 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
U
 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
R
 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
N
 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
/
 you want to place downward or rightwards? press 0 for downward, 1 for rightward
1
 Enter Row and Column numbers for letter (U) of your intended word
 Row : 59
 Invalid index of Row ! Enter number between 1 to 15.
 Row : 5
 Column : 9
Word (TURN) is in the dictionary.
 Word placed successfully !

 Tiles remaining in the bag : 75

 Updated rack of zakriya :
 1 ) D (2)
 2 ) Z (10)
 3 ) I (1)
 4 ) V (4)
 5 ) O (1)
 6 ) H (4)
 7 ) E (1)


 zakriya's Total Score : 10
 zakriya's words with their individual scores in the bracket :
 1 ) ONE (3)
 2 ) TIN (3)
 3 ) TURN (4)
```

(Displaying board)

```
                                    <<<<   Board   >>>>
      1)    2)    3)    4)    5)    6)    7)    8)    9)    10)   11)   12)   13)   14)   15)
 1 )    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
 2 )    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
 3 )    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
 4 )    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
 5 )    |     |     |     |     |     |     |  T  |  U  |  R  |  N  |     |     |     |     |
 6 )    |     |     |     |     |     |     |  I  |     |     |     |     |     |     |     |
 7 )    |     |     |     |     |  G  |  O  |  N  |  E  |     |     |     |     |     |     |
 8 )    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
 9 )    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
 10 )   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
 11 )   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
 12 )   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
 13 )   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
 14 )   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
 15 )   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
```

(Next player’s turn)

```
/ faizan's turn ->

 faizan's Total Score : 7

 Rack of faizan :
 1 ) I (1)
 2 ) K (5)
 3 ) O (1)
 4 ) E (1)
 5 ) R (1)
 6 ) E (1)
 7 ) F (4)

 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
U
 You do not have this letter tile in your rack OR you have already picked this tile ! Please enter letter again which is present in your rack.
 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
E
 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
R
 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
/
 you want to place downward or rightwards? press 0 for downward, 1 for rightward
1
 Enter Row and Column numbers for letter (E) of your intended word
 Row : 5
 Column : 12
Word (TURNER) is in the dictionary.
 Word placed successfully !

 Tiles remaining in the bag : 73

 Updated rack of faizan :
 1 ) I (1)
 2 ) K (5)
 3 ) O (1)
 4 ) E (1)
 5 ) F (4)
 6 ) N (1)
 7 ) L (1)


 faizan's Total Score : 13
 faizan's words with their individual scores in the bracket :
 1 ) ON (2)
 2 ) GONE (5)
 3 ) TURNER (6)
```

(Displaying board)

```
                                    <<<<   Board   >>>>
      1)    2)    3)    4)    5)    6)    7)    8)    9)    10)   11)   12)   13)   14)   15)

 1 )    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
       ---------------------------------------------------------------------------------------
 2 )    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
       ---------------------------------------------------------------------------------------
 3 )    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
       ---------------------------------------------------------------------------------------
 4 )    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
       ---------------------------------------------------------------------------------------
 5 )    |     |     |     |     |     |     |  T  |  U  |  R  |  N  |  E  |  R  |     |     |
       ---------------------------------------------------------------------------------------
 6 )    |     |     |     |     |     |     |  I  |     |     |     |     |     |     |     |
       ---------------------------------------------------------------------------------------
 7 )    |     |     |     |     |  G  |  O  |  N  |  E  |     |     |     |     |     |     |
       ---------------------------------------------------------------------------------------
 8 )    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
       ---------------------------------------------------------------------------------------
 9 )    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
       ---------------------------------------------------------------------------------------
 10 )   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
       ---------------------------------------------------------------------------------------
 11 )   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
       ---------------------------------------------------------------------------------------
 12 )   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
       ---------------------------------------------------------------------------------------
 13 )   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
       ---------------------------------------------------------------------------------------
 14 )   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
       ---------------------------------------------------------------------------------------
 15 )   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
       ---------------------------------------------------------------------------------------
```

(Next player’s turn)

```
/ zakriya's turn ->

 zakriya's Total Score : 10

 Rack of zakriya :
 1 ) D (2)
 2 ) Z (10)
 3 ) I (1)
 4 ) V (4)
 5 ) O (1)
 6 ) H (4)
 7 ) E (1)

 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
Z
 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
D
 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
/
 you want to place downward or rightwards? press 0 for downward, 1 for rightward
0
 Enter Row and Column numbers for letter (Z) of your intended word
 Row : 4
 Column : 12
Word (ZED) is in the dictionary.
 Word placed successfully !

 Tiles remaining in the bag : 71

 Updated rack of zakriya :
 1 ) I (1)
 2 ) V (4)
 3 ) O (1)
 4 ) H (4)
 5 ) E (1)
 6 ) D (2)
 7 ) R (1)


 zakriya's Total Score : 23
 zakriya's words with their individual scores in the bracket :
 1 ) ONE (3)
 2 ) TIN (3)
 3 ) TURN (4)
 4 ) ZED (13)
```

(Displaying board)

```
                                <<<<   Board   >>>>
     1)    2)    3)    4)    5)    6)    7)    8)    9)    10)    11)    12)    13)    14)    15)
 1 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
 2 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
 3 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
 4 )    |     |     |     |     |     |     |     |     |     |      |  Z   |      |      |      |
     ---------------------------------------------------------------------------------------------
 5 )    |     |     |     |     |     |     |  T  |  U  |  R  |  N   |  E   |  R   |      |      |
     ---------------------------------------------------------------------------------------------
 6 )    |     |     |     |     |     |     |  I  |     |     |      |  D   |      |      |      |
     ---------------------------------------------------------------------------------------------
 7 )    |     |     |     |     |  G  |  O  |  N  |  E  |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
 8 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
 9 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
 10 )   |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
 11 )   |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
 12 )   |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
 13 )   |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
 14 )   |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
 15 )   |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
     ---------------------------------------------------------------------------------------------
```

(Next player's turn)

```
/ faizan's turn ->

 faizan's Total Score : 13

 Rack of faizan :
 1 ) I (1)
 2 ) K (5)
 3 ) O (1)
 4 ) E (1)
 5 ) F (4)
 6 ) N (1)
 7 ) L (1)

 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
L
 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
O
 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
O
 You do not have this letter tile in your rack OR you have already picked this tile ! Please enter letter again which is present in your rack.
 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
I
 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
N
 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
/
 you want to place downward or rightwards? press 0 for downward, 1 for rightward
0
 Enter Row and Column numbers for letter (L) of your intended word
 Row : 5
 Column : 6
Word (LOGIN) is in the dictionary.
 Word placed successfully !

 Tiles remaining in the bag : 67

 Updated rack of faizan :
 1 ) K (5)
 2 ) E (1)
 3 ) F (4)
 4 ) E (1)
 5 ) B (3)
 6 ) I (1)
 7 ) N (1)


 faizan's Total Score : 19
 faizan's words with their individual scores in the bracket :
 1 ) ON (2)
 2 ) GONE (5)
 3 ) TURNER (6)
 4 ) LOGIN (6)
```

(Displaying board)

```
                                    <<<<   Board   >>>>
      1)    2)    3)    4)    5)    6)    7)    8)    9)    10)    11)    12)    13)    14)    15)

 1 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
       ---------------------------------------------------------------------------------------------
 2 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
       ---------------------------------------------------------------------------------------------
 3 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
       ---------------------------------------------------------------------------------------------
 4 )    |     |     |     |     |     |     |     |     |     |      |  Z   |      |      |      |
       ---------------------------------------------------------------------------------------------
 5 )    |     |     |     |     |  L  |     |  T  |  U  |  R  |  N   |  E   |  R   |      |      |
       ---------------------------------------------------------------------------------------------
 6 )    |     |     |     |     |  O  |     |  I  |     |     |      |  D   |      |      |      |
       ---------------------------------------------------------------------------------------------
 7 )    |     |     |     |     |  G  |  O  |  N  |  E  |     |      |      |      |      |      |
       ---------------------------------------------------------------------------------------------
 8 )    |     |     |     |     |  I  |     |     |     |     |      |      |      |      |      |
       ---------------------------------------------------------------------------------------------
 9 )    |     |     |     |     |  N  |     |     |     |     |      |      |      |      |      |
       ---------------------------------------------------------------------------------------------
10 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
       ---------------------------------------------------------------------------------------------
11 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
       ---------------------------------------------------------------------------------------------
12 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
       ---------------------------------------------------------------------------------------------
13 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
       ---------------------------------------------------------------------------------------------
14 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
       ---------------------------------------------------------------------------------------------
15 )    |     |     |     |     |     |     |     |     |     |      |      |      |      |      |
       ---------------------------------------------------------------------------------------------
```

(Next player's turn – passing the turn – passing again – passing again)

```
/ zakriya's turn ->

 zakriya's Total Score : 23

 Rack of zakriya :
1 ) I (1)
2 ) V (4)
3 ) O (1)
4 ) H (4)
5 ) E (1)
6 ) D (2)
7 ) R (1)

 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
!
 faizan's turn ->

 faizan's Total Score : 19

 Rack of faizan :
1 ) K (5)
2 ) E (1)
3 ) F (4)
4 ) E (1)
5 ) B (3)
6 ) I (1)
7 ) N (1)

 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
!
 zakriya's turn ->

 zakriya's Total Score : 23

 Rack of zakriya :
1 ) I (1)
2 ) V (4)
3 ) O (1)
4 ) H (4)
5 ) E (1)
6 ) D (2)
7 ) R (1)

 Enter your word(in capital letters) letter by letter and enter '/' to end your word OR enter '!' to pass the turn
!
```

(Game Ended because of House-Rule of passing turns)

```
*Game Ended by giving up the turns*
faizan's Final Score : 3
zakriya's Final Score : 9
            <<<<<<<<<<<<<<<  Winner of this game is *** zakriya *** having highest score (9)  >>>>>>>>>>>>>>>
```

Here result calculation was done by calculating total points of racks of each player and subtracting them from their total scores:

Faizan's total score = 19

Faizan's rack tiles points = 5(K) + 1(E) + 4(F) + 1(E) + 3(B) + 1(I) + 1(N) = 16

Faizan's final score = 19 – 16 = 3

Similarly,

Zakriya's total score = 23

Zakriya's rack tiles points = 1(I) + 4(V) + 1(O) + 4(H) + 1(E) + 2(D) + 1(R) = 14

Zakriya's final score = 23 – 14 = 9

Hence, in this game test run, Zakriya is the winner.

Limitation and conclusion:

No one's project is perfect. Every project has some shortcomings and there is always a door for improvement. Our project has implemented almost every aspect of SCRABBLE. Most of our time was consumed in making an efficient algorithm which can detect letters in way and in the adjacency to make the complete intended word. For which so many hours were consumed in debugging and making the code more and more efficient. Still there is one thing left which cannot be more than 5% of what we have already done, it is the implementation of Bonus Squares. These squares do nothing more than just increasing scores of players. SCRABBLE can be played without considering these Bonus Squares in the House-Rules before starting a game. In this game, our second House-Rule is already mentioned above, that there are no Bonus Squares.

References:

Dictionary Source:

https://docs.oracle.com/javase/tutorial/collections/interfaces/examples/dictionary.txt

For changing text color:

https://www.youtube.com/watch?v=MvX4tVETjHk

https://www.geeksforgeeks.org/how-to-print-colored-text-in-c/

For general help:

- GeekforGeeks
- StackOverflow
- Quora