STAT2005 Programming Languages for Statistics
Assignment 1
Due: 7 February 2025

1. Using `rep()` and `seq()` as needed to create the following vectors. (The use of `c()` function is prohibited in this question.)

(a) `10 12 14 16 18 20 22 24 26 28 30`

(b) `1 2 3 4 5 2 3 4 5 6 3 4 5 6 7 4 5 6 7 8 5 6 7 8 9`

2. Search for an R function that solves the roots of polynomial equations.

(a) Find all roots of the following equation and save it as `roots`.

$$5x^5 + 4x^4 + 3x^3 + 2x^2 + x = 0.$$

(b) What is the mode of `roots`?

(c) Use a single line command to sort the values in `roots` by ascending order of its imaginary part.

(Note: the imaginary part of a complex number $a + bi$ is b, where $i = \sqrt{-1}$. You can read the help document of the `order()` function by entering `help(order)`.)

3. A standard deck of playing cards can be created in R as a data frame with the following command.

```
deck <- data.frame(
      suit = rep(c("D","C","H","S"), 13),
      # D = ♦ Diamond, C = ♣ Club, H = ♥ Heart, S = ♠ Spade
      rank = rep(2:14, 4)
      # 11 = Jack, 12 = Queen, 13 = King, 14 = Ace
)
```

(a) Describe the structure of the data frame `deck`, what are the information contained in its row and column?

(b) A poker hand is a set of five playing cards. Sample a poker hand using the data frame `deck` and name it as `hand`.

(c) A flush is a hand that contains five cards all of the same suit. Create a logical value named `is.flush` which is `TRUE` if and only if `hand` is a flush.

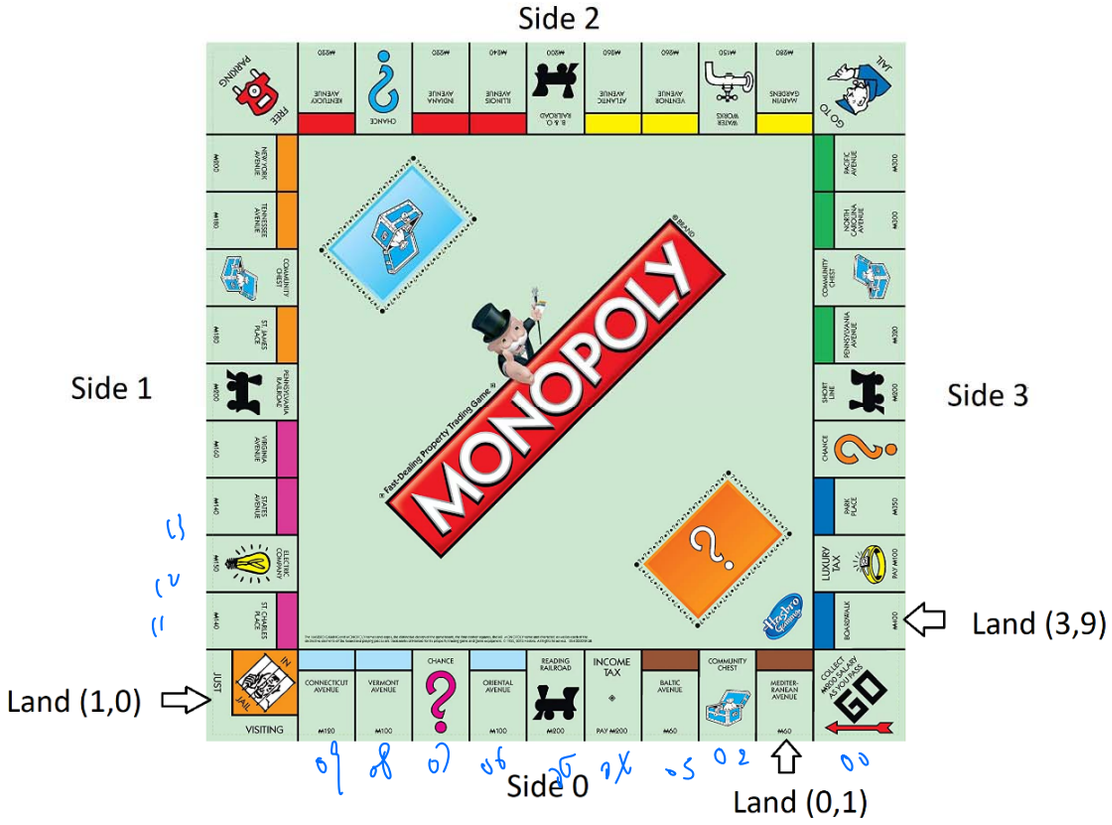
Hint: You may use `hand <- deck[c(17,9,1,49,41),]` as a test case. The `unique()` function could be useful.

(d) A straight is a hand that contains five cards of sequential rank. Note that both A♦ K♣ Q♣ J♦ 10♠ and 5♥ 4♠ 3♥ 2♣ A♦ are considered to be straight, but Q♠ K♠ A♣ 2♥ 3♦ is not. Create a logical value named `is.straight` which is `TRUE` if and only if `hand` is a straight. Use a test case similar to that in (c) to verify your answer.

Hint: The `all()` function could be useful.

(e) A straight flush is a hand that is both a straight and a flush. Create a logical value named `is.straightflush` which is `TRUE` if and only if `hand` is a straight flush. Modify the logical values `is.flush` and `is.straight` in (c) and (d) such that they becomes `FALSE` if `hand` is a straight flush. Use a test case similar to that in (c) to verify your answer.

4. The Monopoly game board consists of forty spaces as shown below.



The four sides of the gaming board are labelled as side 0, 1, 2, 3 clockwise beginning from the bottom as shown in the picture. Each land space is labelled with two digits, the first is the side number from 0 to 3, the second is the land space number from 0 to 9 along one side. For instance, the beginning GO land space is labelled as (0,0).

(a) We would like to simulate the movement of a single player in the game. For simplicity, we ignore all teleport events such as sending to jail from Land (3,0). To begin, a player will start at Land (0,0). In each round, a player will roll two dice of six faces, and the player will move clockwisely with step size equal to the sum of the two dice. Create a data frame named `moves` with 100 observations and two variables `die_1`, and `die_2` which are the results of rolling the two dice.

(b) Add new columns to `moves` with the following information.

`step`: sum of `die_1` and `die_2`.

`total_step`: cumulative sum of `step`.

`round`: the number times a player passes through the GO land.

`side`: the side number of the current position.

`land`: the land space number of the current position.

A sample is shown below.

```
> head(moves)
  die_1 die_2 step total_step round side land
1     6     1    7          7     0    0    7
2     3     2    5         12     0    1    2
3     6     1    7         19     0    1    9
4     6     2    8         27     0    2    7
5     2     6    8         35     0    3    5
6     4     6   10         45     1    0    5
```

(c) Create a logical value which equal `TRUE` if and only if the player has landed on both PARK PLACE and BOARDWALK (the two lands in dark blue) throughout its 100 moves.

You should submit a file `asg1.r` via Blackboard, which contains all the R codes you use to finish this assignment. The codes should be commented as clearly as possible. Written work (if any) should also be attached.