Problem 220: Heighway Dragon

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Code

Function string(D0, n)

Input: D0 = the initial string, n = the number of times the function will go through and replace all the 'a's and 'b's with the given string.

Output: A list of letters created after replacing the a and b in D0 n times.

Variable: m = keeps track of how many times all of the 'a' and 'b' values are replaced.
Variable: a = the specified string 'aRbFR'.
Variable: b = the specified string 'LFaLb'.

```
Set D0 to a list where each letter in the string D0 is a value
in the list.

While m is less than than n.
    [Cycle through the list D0 and replace a with the string 'aRbFR' and
    b with the string 'LFaLb'.]
    [Cycle through the new list and parse the variables into it into lists
    where each letter is a value in the list.]
    [Collapse the list so it is a single list of variables instead of a
    list of lists.]

Return D0
```

Function points(list_of_letters)

Input: list_of_letters = the list of characters created using the string function.

Output: a list containing the two lists x_values and y_values.

Variable: x_values = a list to store the x coordinates containing the starting x value 0.

Variable: y_values = a list to store the y coordinates containing the starting y value 0.

Variable: x = [0,1,0,-1] these values refer to how the x value changes when you move in each direction. Starting by going up the x value doesn't change, moving right the x-value increases by one, going down the x-value doesn't change, and moving left the x-value decreases by 1.

Variable: y = [1,0,-1,0] these values refer to how the y value changes when you move in each direction. Starting by going up the y value increases by 1, moving right the y values doesn't change, going down the y value decreases by 1, then moving left the y value doesn't change.

Variable: start = This value is used to keep track of how the position is going to change the next time the 'bug' moves forward depending on how the 'bug' turns. It starts at 0 because in the beginning the 'bug' is at the origin facing the positive y-axis.

Variable: position = this is used to keep track of where the 'bug' is.

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For i in list_of_letters.
    If i = 'F'
    Set position at index 0 to to position at index 0 plus the value x at
    index start.
    Set position at index i to to position at index 1 plus the value y at
    index start.
    Append the value of position at index 0 to the list x_values.
    Append the value of position at index 1 to the list y_values.

    If i = 'R'
    Increase start by one.
    However if the start value is set to the largest index of the list x
    then the start value is set to 0.

    If i = 'L'
    Decrease start by one.
    However if the start value is set to 0 then the start value is set to
    the largest index of the list x.

Return a list containing x_values and y_values
```

Function connectpoints(x,y)

Input: x = the list x_values created in the points function, y = the list y_values created in the points function.

Output: None

Variable: px = an x value in the list x_values.

Variable: nx = the next x value in the list x_values.

Variable: py = a y value in the list y_values.
Variable: ny = the next y value in the list y_values.

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For ii in the range of the length list of x values minus 1.
    Set px to the value of x_values at index ii
    Set py to the value of y_values at index ii
    Set nx to the value of x_values at index ii+1
    Set ny to the value of y_values at index ii+1
    Plot a line between the point (px,py) and the point (nx,ny).
```

Main Code:
Variable: D0 = the initial string
Variable: n = the number of times the function will go through and replace all the 'a's and 'b's with the given string.
Variable: x_and_y = runs the string function in the points function to get a list of the x-values and y-values.
Variable: x = takes the list of x-values from the list x_and_y.
Variable: y = takes the list of y-values from the list x_and_y.
Run the function connectpoints with x and y
Scale the axes in relation to the shape of the graphed line.
Print the graph to the screen.

Questions

1

How does the order of 'a' and 'b' in the starting string influence the shape of the graph? What is changed when the 'a' and 'b' are flipped in a pattern?

The shape that results form replacing 'a' with 'b' and 'b' with 'a' seems to be influenced by the number of characters in the initial string. If the initial string has more counts of 'a' and 'b' then there appears to be less variation between the graphs compared to initial strings that have fewer characters there is a significant difference between the graphs. However, it appears as if the repeating the letters 'a' or 'b' cause the graph to spiral and alternating letters cause the graph to flatten out. So by using an initial string containing alternating and non-alternating letters the curling and uncurling cancels out and creates a more linear figure centered around the x-axis with rotational symmetry.

2

How does the value n influence the positioning of the graph?

As n increases it seems like the graph is not only increasing in size but it the general shape seems to be rotating clockwise as n increases. This appears to be true no matter what the initial string is.