ASSIGNMENT
APPLIED CALCULUS FOR IT - 501031

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1 Introduction

Think of a sequence of numbers like Fibonacci numbers - these sequences are patterns. Patterns can be seen everywhere: in animals, plants and minerals. Have you ever observed the similarity between the shape of your lungs and the structure of a tree? Or maybe the pathways of lightning and the way a river breaks through the earth? These patterns are called fractals. *"whenever you observe a series of patterns repeating over and over again, at many different scales, and where any small part resembles the whole, that's a fractal."* - Ben Weiss.
In the case of sequences, a fractal sequence contains an infinitie number of copies itself, embedded within itself. For example, The Koch snowflake can be simply encoded as a Lindenmayer system (L-System) with initial string F–F–F, string rewriting rule F = F+F–F+F, and angle $\alpha = 60$ degrees.

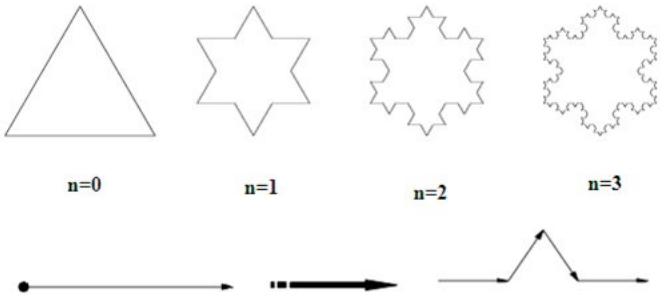

Figure 1: The Koch snowflake presents in many different levels

At each symbol 'F', it presents for moving forward by line length d drawing a line, therefore we must compute the new point as follows

$$x_{new} = x_{old} - d.cos(\alpha\frac{\pi}{180})$$
$$y_{new} = y_{old} + d.sin(\alpha\frac{\pi}{180})$$

2 Requirements

In this assignment, every student is required to implement some of the L-System in *StudentID.txt* and the corresponding parameters to create greeting cards for new year 2021.

Symbols	Descriptions
'F'	Move forward by line length drawing a line
'+'	Turn right by turning angle
'-'	Turn left by turning angle
'|'	Reverse direction (ie: turn by 180 degrees)
'['	Push current drawing state onto stack (could be replaced by vector/list/array)
']'	Pop current drawing state from the stack (could be replaced by vector/list/array)
'o'	Draw flower

Table 1: Description of symbols in L-System

Student could refer to *StudentID.jpg* to check your greeting card. Howerver, it is only used as the reference picture.

Requirement 1: ***(1 score)*** Compute the coordinate x and y of every point the heart shape.

(a) $x_h = 4sin(t)^5 + 5$ (b) $y_h = 3 * cos(t) - 1.7cos(2t) - cos(3t) + 1$

where, the $t \in [-\pi, \pi]$ and $t_{i+1} = t_i + 0.1$. Then, assign your results into **a.xh** and **a.yh** variables.

Requirement 2: ***(2 score)*** Compute the coordinate x and y of every point in the snowflake shape. Then, assign your results into **a.Pxn** and **a.Pyn** variables. The parameters are described in *StudentID.txt*

- $ID - snowflake$: the id of snowflake.
- n: the level of snowflake.
- d: the line length.
- I: axiom (these symbols the initial string)
- $F =$ or $X =$: the replacement rule.
- $alpha0$: the initial angle.
- $alpha$: the predefined angle.
- x_0, y_0: the initial coordinates of x and y.

Requirement 3: ***(2 score)*** Compute the coordinate x and y of every point in the tree shape. Then, assign your results into **a.Px** and **a.Py** variables. The parameters are described in *StudentID.txt*

- $ID - Tree$: the id of the tree fractal.
- n: the level of the tree fractal.
- d: the line length.
- I: axiom (these symbols the initial string)
- $F =$ or $X =$ or $Z =$: the replacement rule.
- $alpha0$: the initial angle.
- $alpha$: the predefined angle.
- x_0, y_0: the initial coordinates of x and y.

Requirement 4: ***(1 score)*** Compute the coordinate x and y of every flower. Then, assign your results into **a.Pfx** and **a.Pfy** variables.

Requirement 5: ***(1 score)*** Compute the number of the snowflake. The equation is defined as

$$n_s = \lceil \int_{x_{min}}^{x_{max}} \frac{1}{2}x \rceil + 5 \tag{1}$$

where $x_{min} = min(d^{n-1}, d^n)$, $x_{max} = max(d^{n-1}, d^n)$, d^{n-1} and d^n are the last two digits of your student id. Then, assign your result into **a.nsnowflake**

Requirement 6: ***(3 score)*** Create a greeting card:

(a) Adding text *Happy New Year 2021* to picture. This text is drawn at $x_t = 50$, $y_t = 0$

(b) Adding all snowslakes to picture. It notes that every snowsflake is reduced to the corresponding *scale* value (this value is found in *StudentID.txt*).The new coordinates of every snowsflake are computed as

$$x_{n_{new}}^{(i)} = \frac{a.Pxn}{scale} + \Delta x + (i-1)20 \tag{1}$$

$$y_{n_{new}}^{(i)} = \frac{a.Pyn}{scale} + \Delta y + (i-1)20 \tag{2}$$

where Δx and Δy are the random values in $[-50, 50]$, and i denotes the i^{th} snowflake.

(c) Adding fractal tree to picture.

(d) Adding the heart shape to picture. It note that the position x_h and y_h of the heart shape are re-computed as $x_{h_{new}} = 2x_h + x_t - 20$ and $y_{h_{new}} = 2y_h$, then fill color in the heart shape. Colors are used to draw each shape, described as

- The heart shape is drawn and filled by **'red'** color and *line-width = 1*.
- The snowflake is drawn by **'blue'** color and *line-width = 1*.
- The tree shape is drawn by **'green'** color and *line-width = 2*.
- The flower is drawn by z color which based on your student ID. The last digit d^n in your student id is satisfied by:
  - d^n mod 3 = 0 then z color is **'r'**
  - d^n mod 3 = 1 then z color is **'y'**
  - otherwise, z color is **'m'**

  Assign z color into **a.color** ***(0.5 score)***
- The flower symbol is selected by the d^{n-1} digit.
  - d^{n-1} is '0' then symbol is **'p'**
  - d^{n-1} is '1' then symbol is **'h'**
  - d^{n-1} is '2' then symbol is **'*'**
  - d^{n-1} is '3' then symbol is **'o'**
  - d^{n-1} is '4' then symbol is **'+'**
  - d^{n-1} is '5' then symbol is **'v'**
  - d^{n-1} is '6' then symbol is **'x'**
  - d^{n-1} is '7' then symbol is **'d'**
  - d^{n-1} is '8' then symbol is **'s'**
  - d^{n-1} is '9' then symbol is **'>'**

  and *line-width = 3*. Assign the symbol value into **a.flower** ***(0.5 score)***

Then, your picture will be saved with file name *picStudentID.jpg*.

Note:

- Every floating value is computed and rounded with 1 digit.
- Every shape presents in the viewpoint.
- At each symbol ']', put *NaN* before adding new point into the set point.

3 Submissions

The student must perform the following requirements before submitting your assignment.

- Create a SStudentID folder and put your assignment file with name *SStudentID.m* into this folder. For example, if your StudentID is 520H0676 then your assignment file will be **S520H0676.m** and folder name will be **S520H0676**.
- SStudentID folder is compressed to **SStudentID.rar** or **SStudentID.zip**
- **DO NOT COPY** resource code from the different students. Remember that student will not be attended the final examination if you copy resource code from the different students.
- Make sure you upload your work to the correct link.
- Student will receive **ZERO** point if you do not comply the requirements or your code doesn't run.