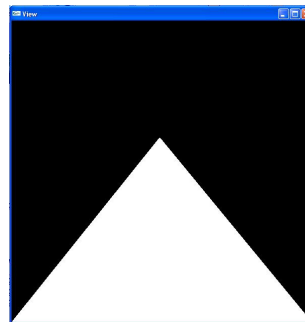


Introduction to Fractal Geometry


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A simple triangle


```
class point {  
public:  
    GLfloat x,y;  
};  
  
point a,b,c;  
  
void triangle(point P, point Q, point R){  
glBegin(GL_POLYGON);  
    glVertex2f(P.x, P.y);  
    glVertex2f(Q.x,Q.y);  
    glVertex2f(R.x,R.y);  
glEnd();  
}  
  
Main(){  
a.x=-1.0; a.y=-1.0;  
b.x=1.0; b.y=-1.0;  
c.x=0.0; c.y=0;//or 2*sin(pi/3) -1;  
triangle(a,b,c);  
glFlush();  
}
```




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Let's make a more exciting triangle



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Let's make a more exciting triangle

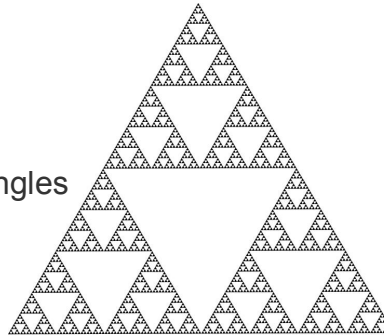


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Let's make a more exciting triangle

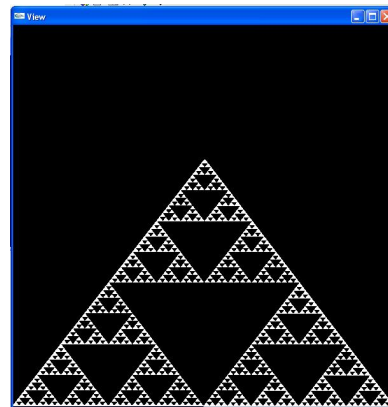


Serpinsky triangles

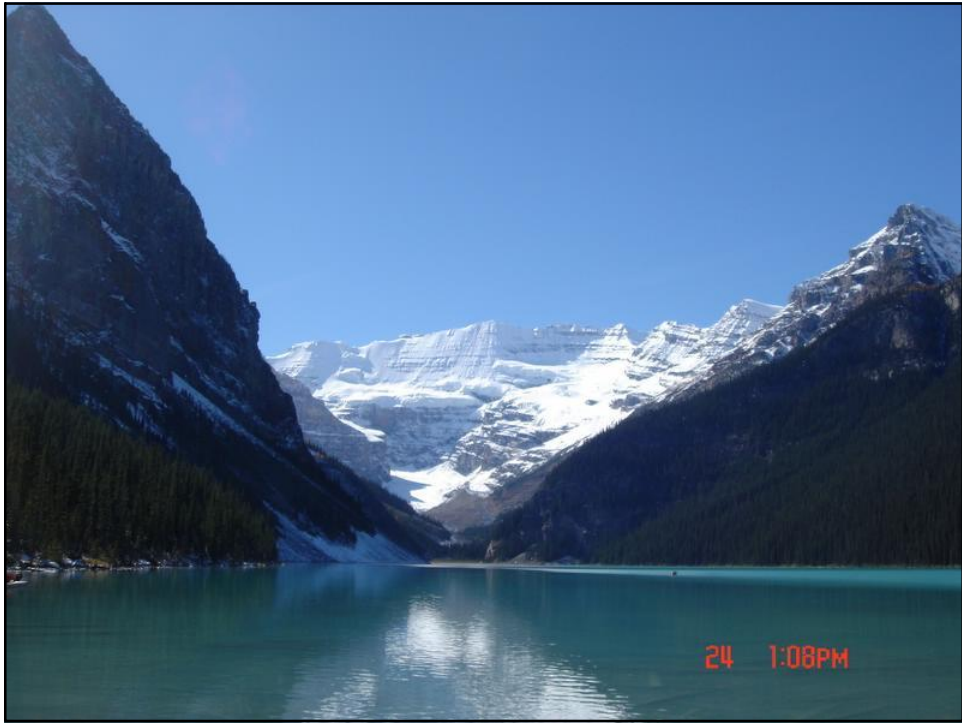


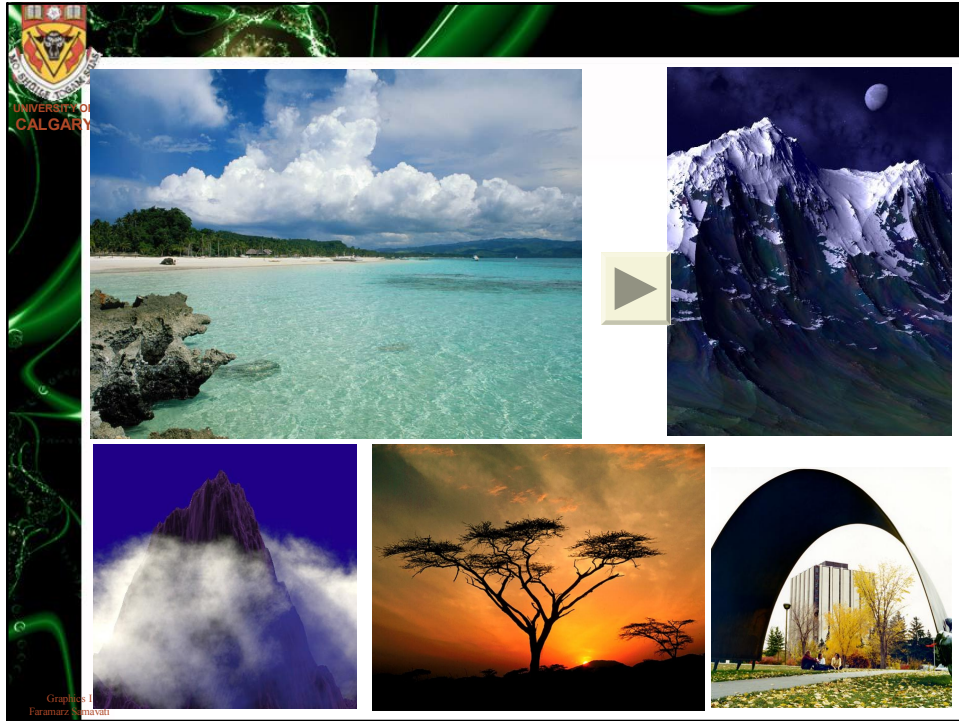
How to generate Sierpinsky triangle?

```
void divide_triangle(point a, point b, point c, int m){
//triangle subdivision using vertex numbers
point v0, v1, v2;
int j;
if (m > 0){
v0.x=(a.x+b.x)/2;
v0.y=(a.y+b.y)/2;
v1.x=(a.x+c.x)/2;
v1.y=(a.y+c.y)/2;
v2.x=(c.x+b.x)/2;
v2.y=(c.y+b.y)/2;
divide_triangle(a, v0, v1, m-1);
divide_triangle(c, v1, v2, m-1);
divide_triangle(b, v2, v0, m-1); }
else (triangle(a,b,c));
// draw triangle at end of recursion
}
```



Fractal





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What are common factors/aspects?

- ❖ Complicated geometry
- ❖ Repetitive structure
- ❖ low-scales details (Wiggly)
- ❖ Self-Similarity

↓

Fractals

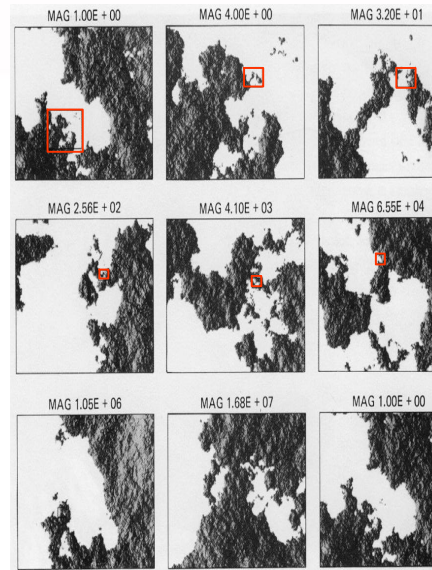
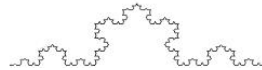
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Self Similarity

- ❖ "self similarity" in nature
- ❖ zoom sequence of a coastline
- ❖ clouds, mountains, trees and plants



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Self Similarity around us



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Euclidean Dimension

❖ What is the dimension of ?

o Line



o Curve



S

❖ What is the dimension of ?

o Plane



o Surface



❖ What is the dimension of ?

o Cube

o Volume



An Aluminum sheet

- ❖ Bend and fold the sheet gradually
- ❖ Continuous deformation of shape
- ❖ Discontinuous variation of “dimension”
- ❖ Extension of “dimension” to “fractions” or even any real numbers




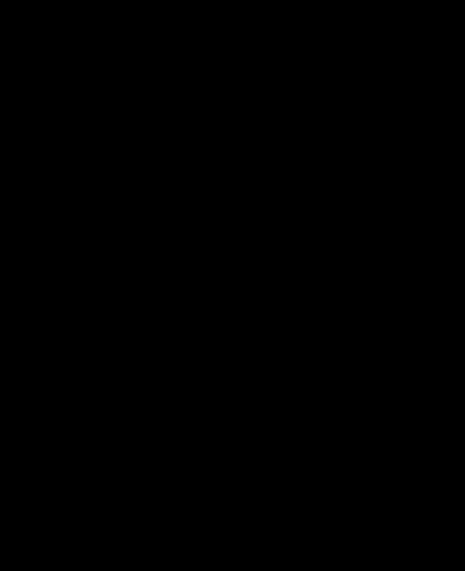
 **Effective Factors**

- ❖ Measuring of wiggleness and wrinkles
- ❖ Much wiggleness means more dimension
- ❖ Self similarity: small portion of object, when magnified, can reproduce larger portion



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 **Self Similarity in mathematics**



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Self similarity as a measure: Fractal Dimension

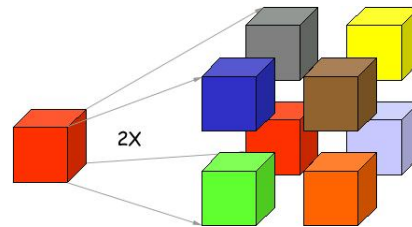
- ❖
- ❖ It relates to self-similarity property
- ❖ e : magnification factor
- ❖ N : number of small self-similar objects
- ❖ D_F : dimension
- ❖ $1/e$ is contraction factor



$$e=2, N=4, D=2$$

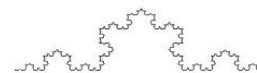
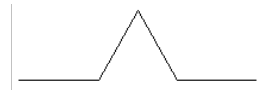
$$D_F = \log_e N$$

$$e=2, N=8, D=3$$



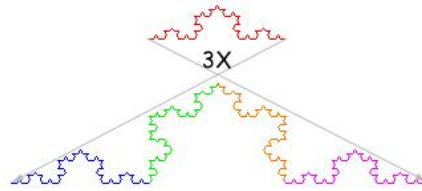
Von Koch Snowflake

- ❖ A math monster !
- 1) Divide a given line into 3 equal segments
- 2) Replace middle one by two equal segments forming part of an equilateral triangle
- ❖ Repeat steps 1 and 2 for any new line segments



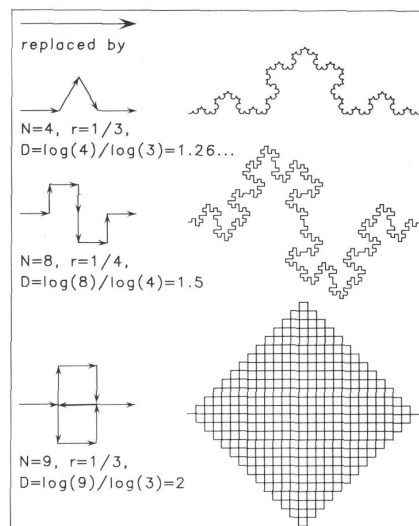
Fractal Dimension of Snowflake

- ❖ $e = 3$, $N = 4$
- ❖ $D_F = \log_3 4 \simeq 1.26$
- ❖ D_F isn't an integer number
- ❖ the Euclidean dimension (D_E) is one
- ❖ snowflake is a fractal!



More Examples

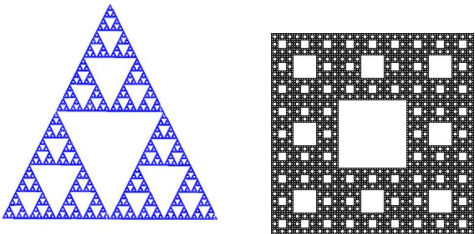
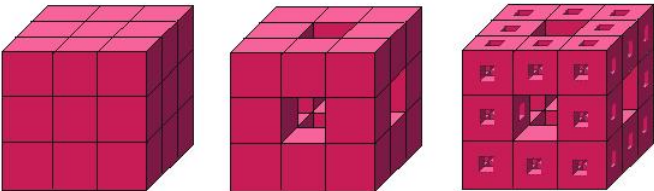
- ❖ $e = 1/r$



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More Monsters

- ❖ Sierpinsky triangle and carpet
- ❖ Menger sponge





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Application!

Google videos Search Videos



Nova - Hunting The Hidden Dimension (fractals)
50:22 · 8 months ago

[Email this video](#)
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First assignment was released today!

University of Calgary, CPSC453
Assignment 1
Fractal Shop

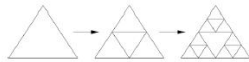
Release Date: Friday September 18, 2009
Due Date: Sunday October 4, 2009 at 11:59 pm
Weight of this assignment: 25%
Total Marks: 100 Marks (on top 20 marks as bonus)

General Specification of the Assignment

In this assignment you will be writing a program that produces the fractals below. You will be marked on both implementation and documentation.

Note: The dashed lines indicate lines that are from the previous state of the fractal.

Sierpinski Triangle (5 Marks)



Koch Snowflake (10 Marks)



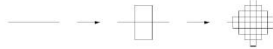
Quadratic Koch (15 Marks)



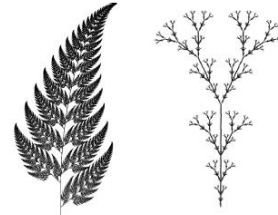
Dragon (15 Marks)



Peano's Space Filling Curve (15 Marks)



BONUS: fern (10 marks) and tree (10 Marks)



Non-functional Requirements (20 Marks)

Documentation

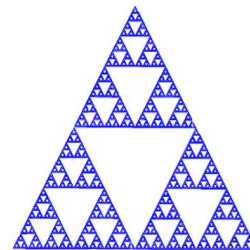
1. You must provide a README file (Preferably in Adobe PDF format).
2. Your README file should contain:
 - (a) Your name and login id.
 - (b) Short description of algorithm used to generate each type of fractal.
 - (c) A brief description of the data structures you used to implement the assignment.

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summary

- ❖ Complex shapes (strange length and volume!)
- ❖ Self similarity
- ❖ Good models for natural shapes and complicate mathematical models
- ❖ Simple recursive algorithm for definition



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