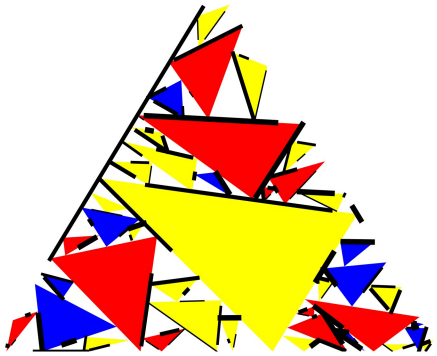
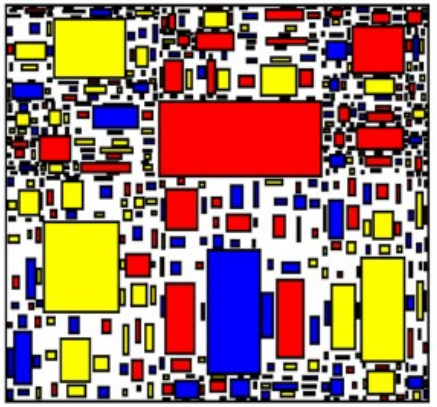
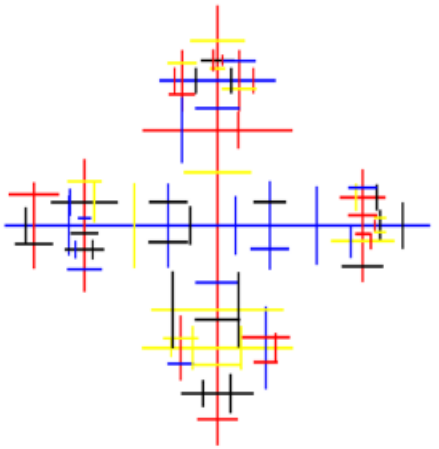
# Fract'Art : harsard et géométrie pour tous

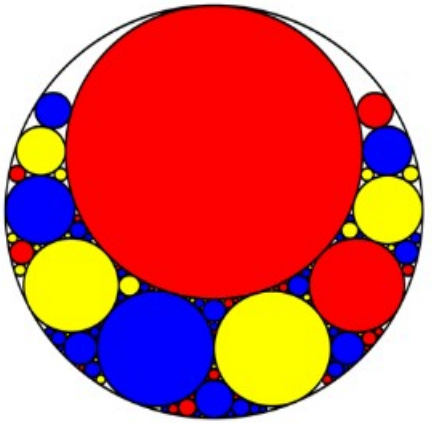
**Auguste Gires**

(auguste.gires@enpc.fr)



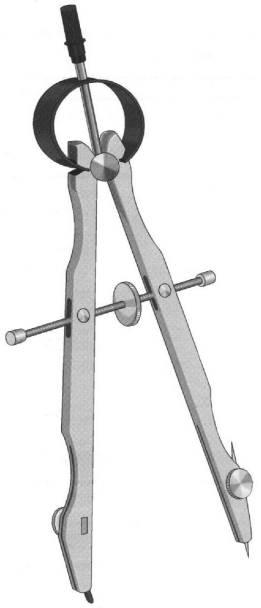


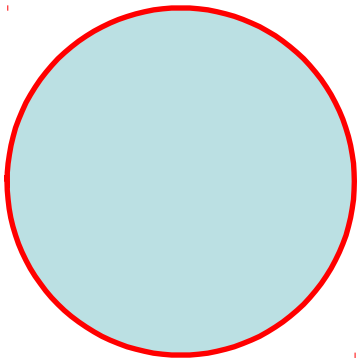


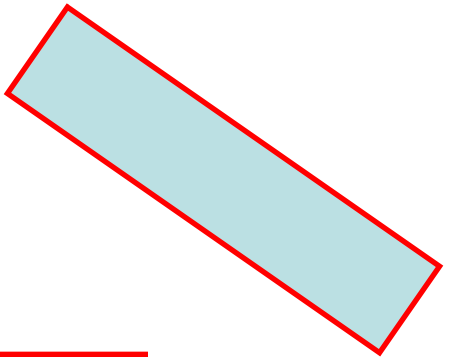


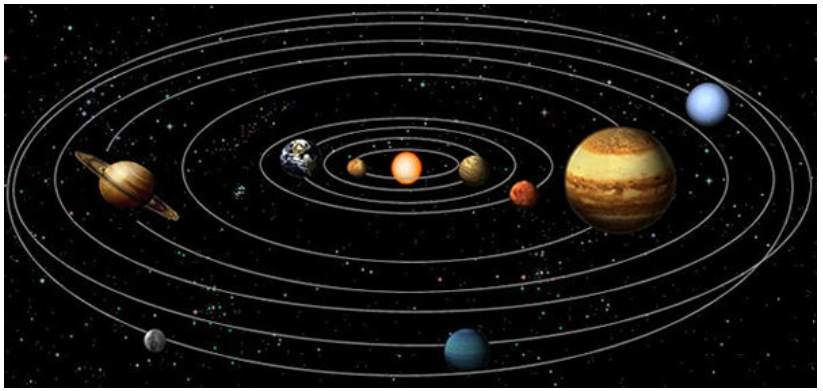
**Exploradôme, Vitry, France, 16 avril 2016**

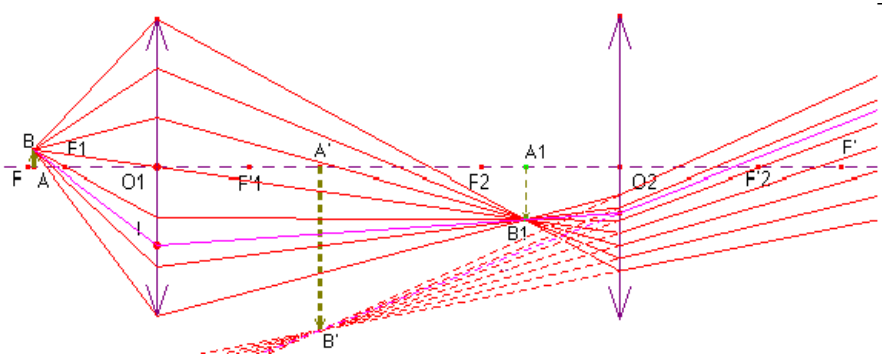
# Géométrie euclidienne (classique)

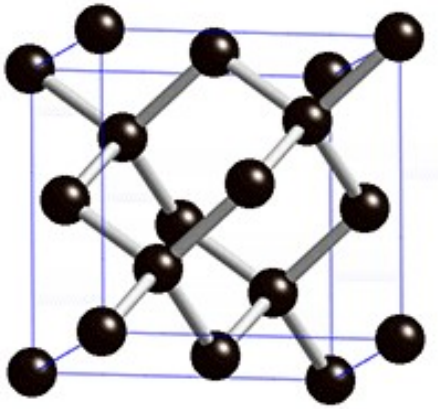


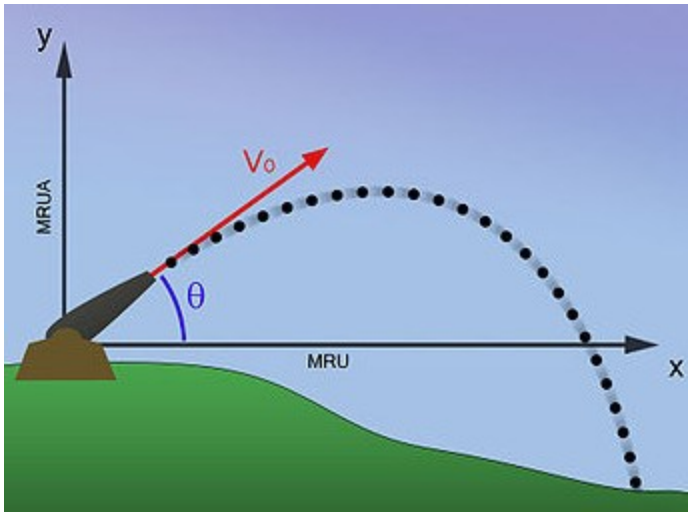







B
F1
F
A
O1
A'
F'1
F2
A1
O2
F'2
F'
I
B1
B'




y
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θ
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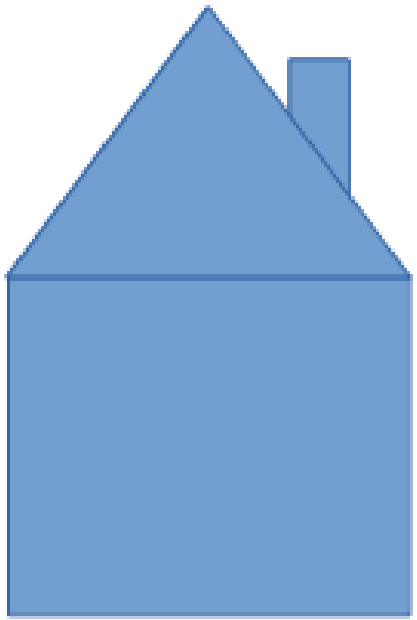
x



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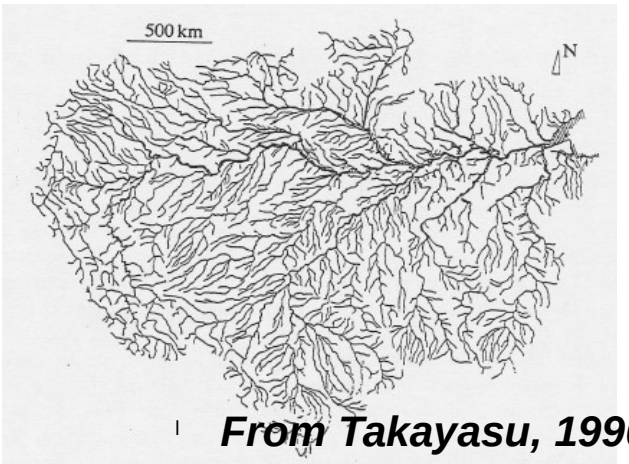
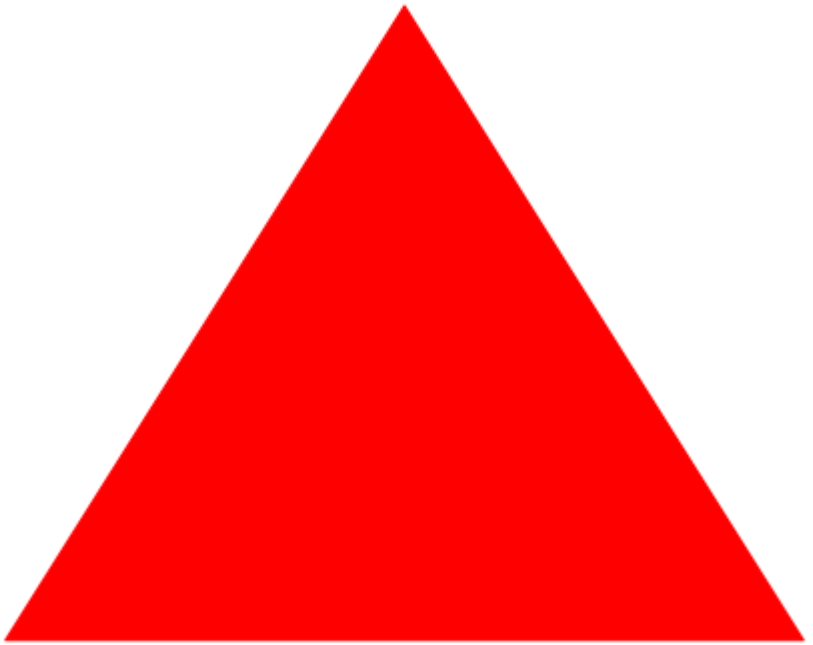


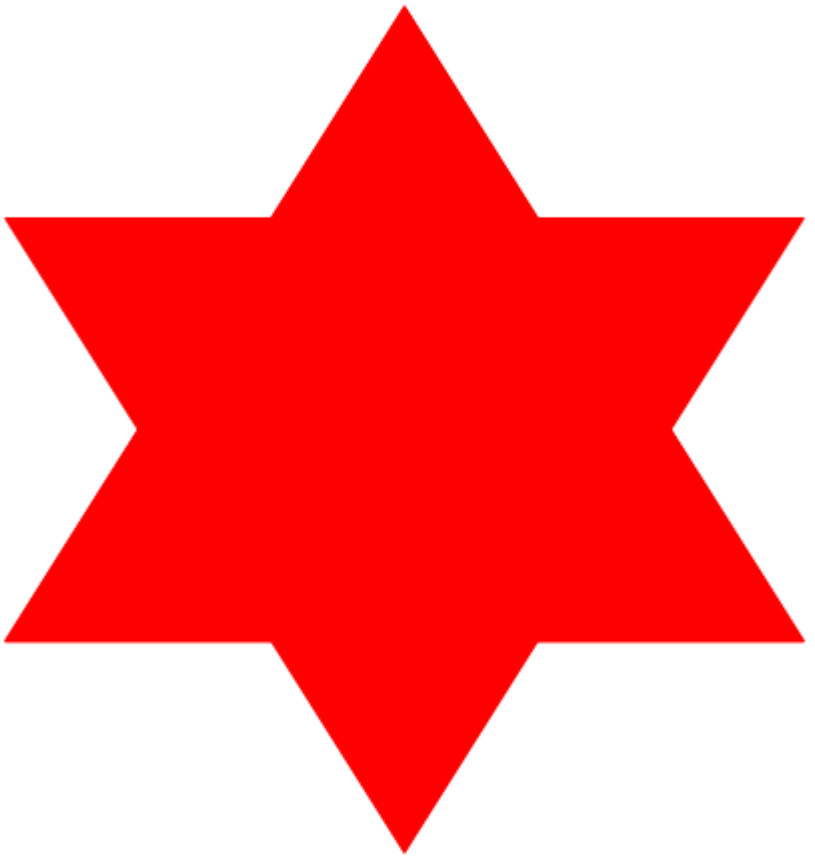

*From Takayasu, 1990*

# Flocon de Koch (1904)

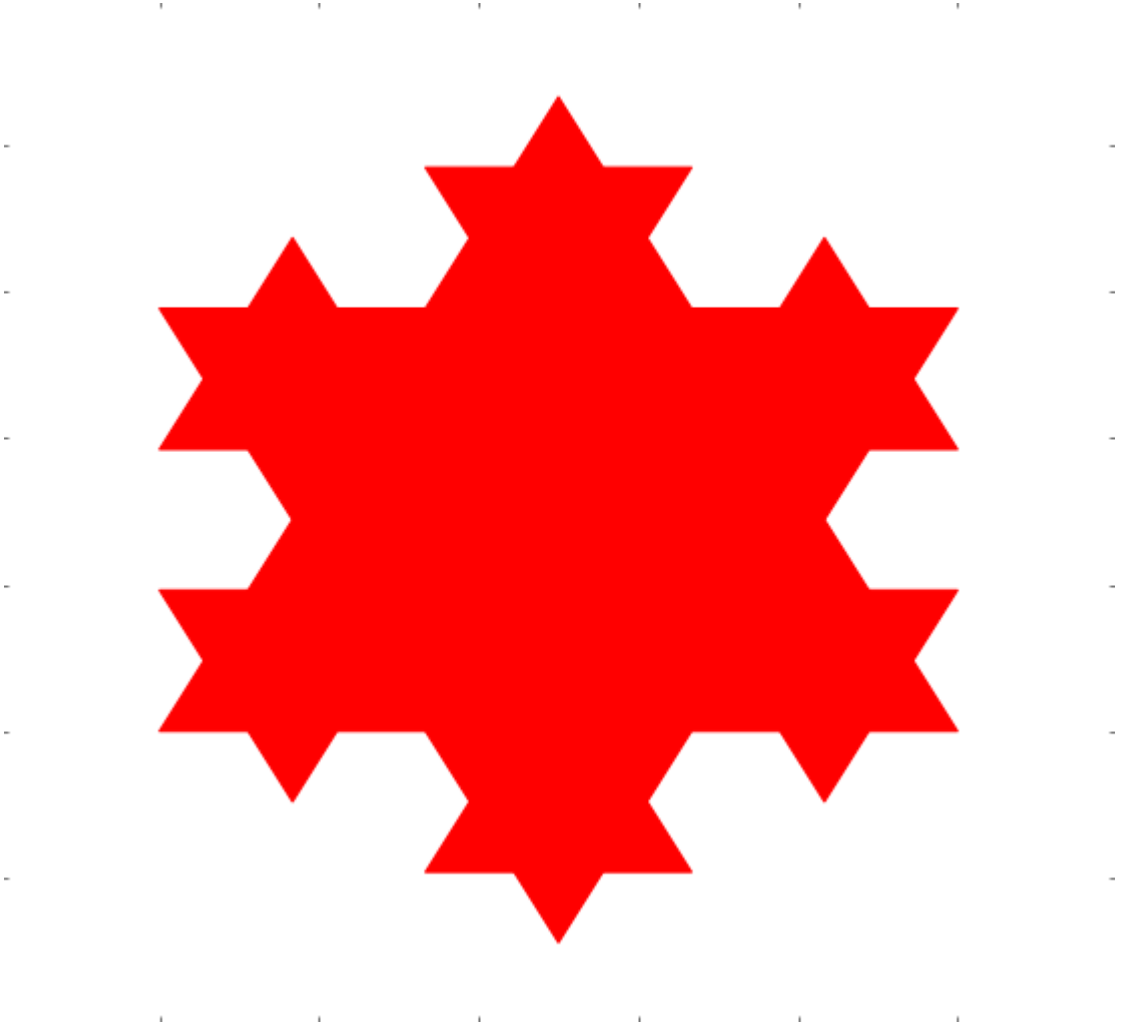


**Étape 0**

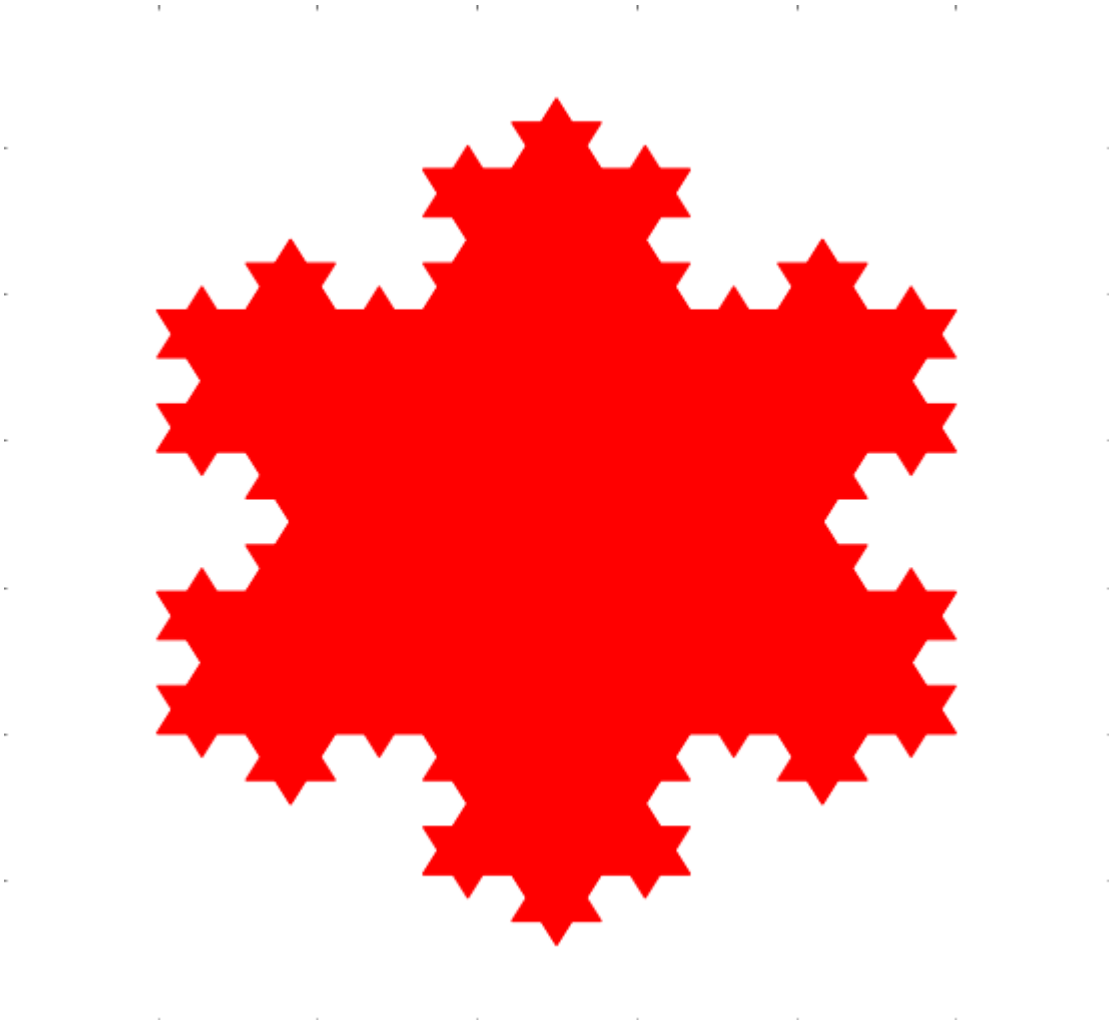
**Helge van Koch**
Mathématicien Suédois (1870-1924)



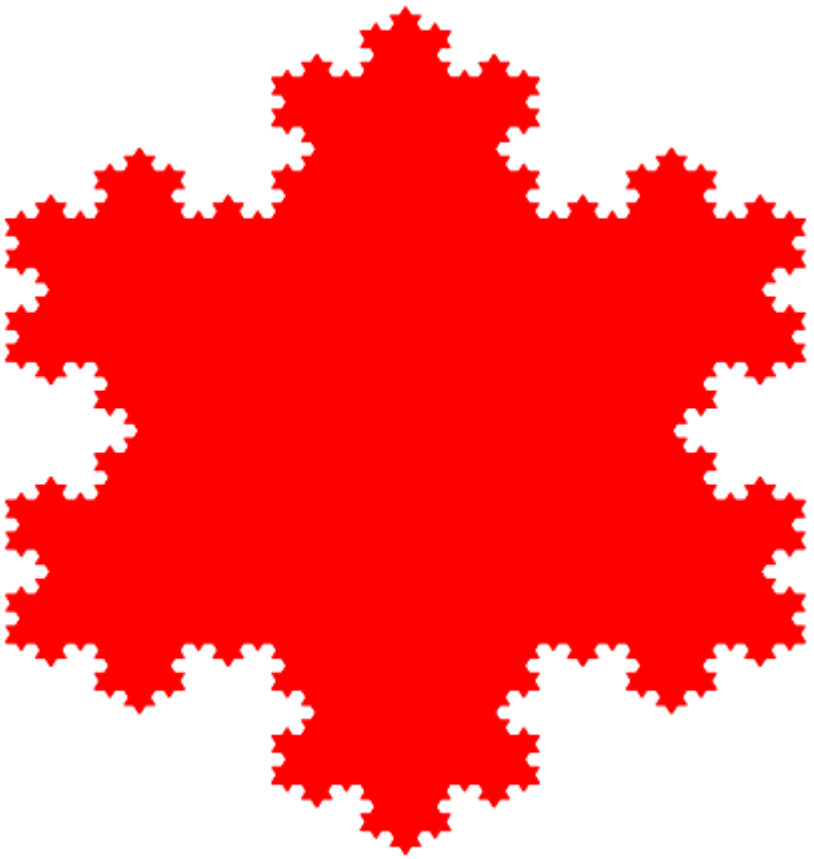
**Étape 1**



**Étape 2**



**Étape 3**



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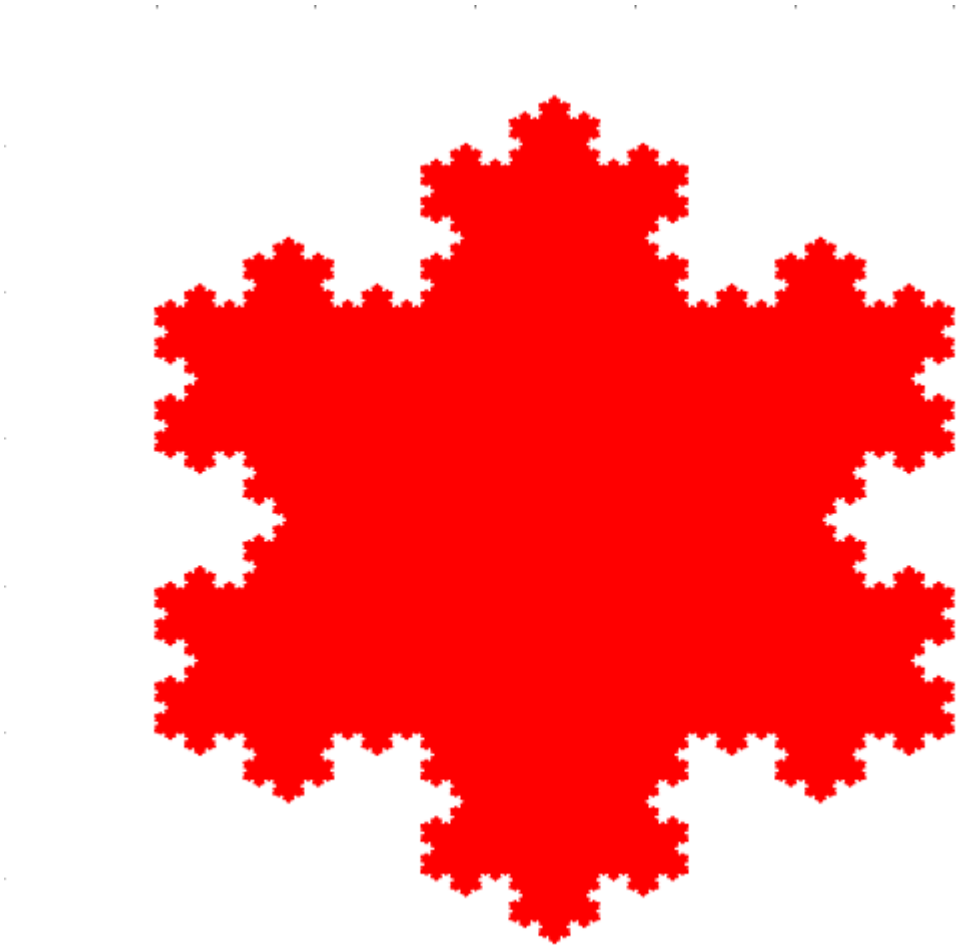
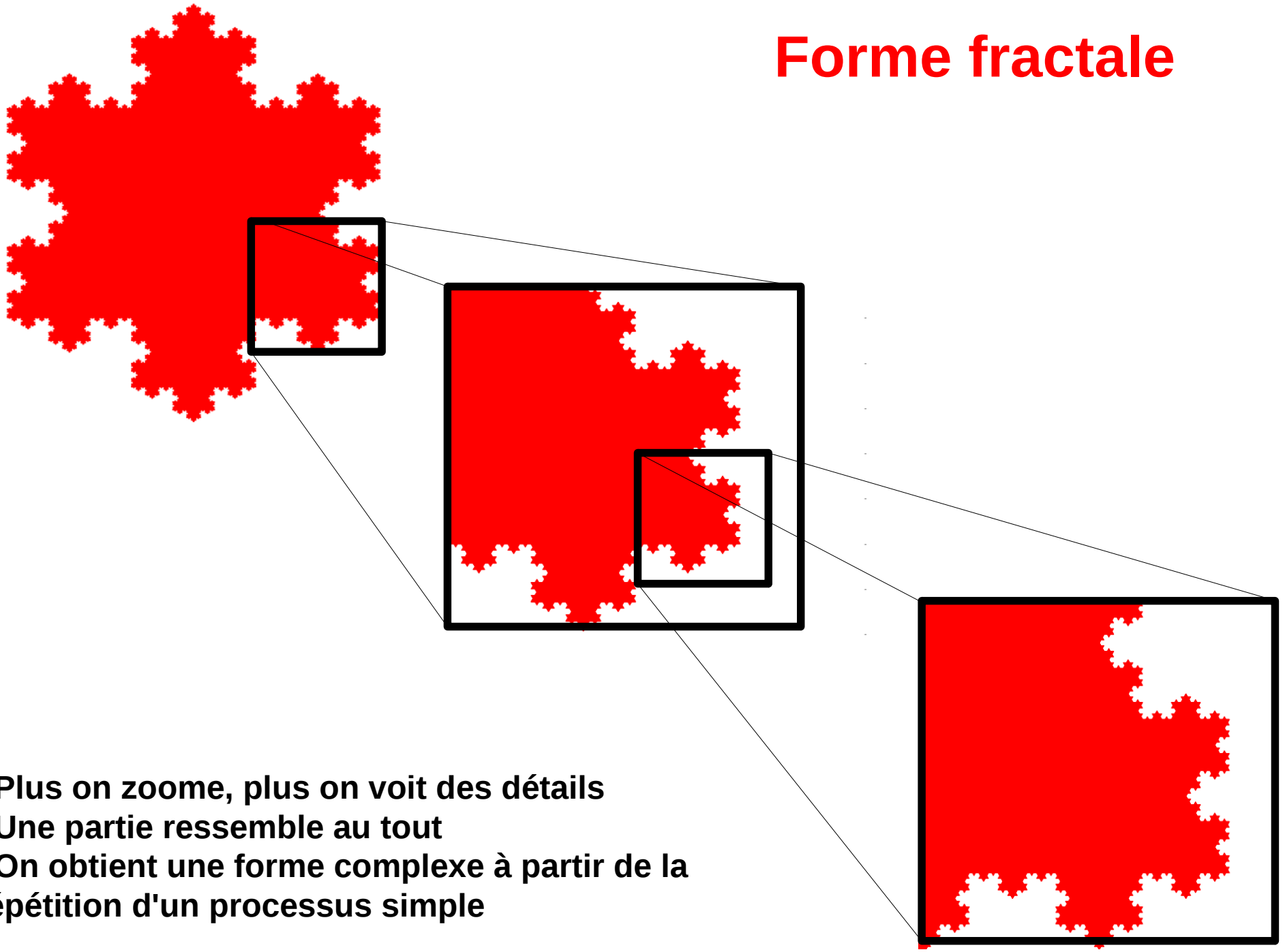
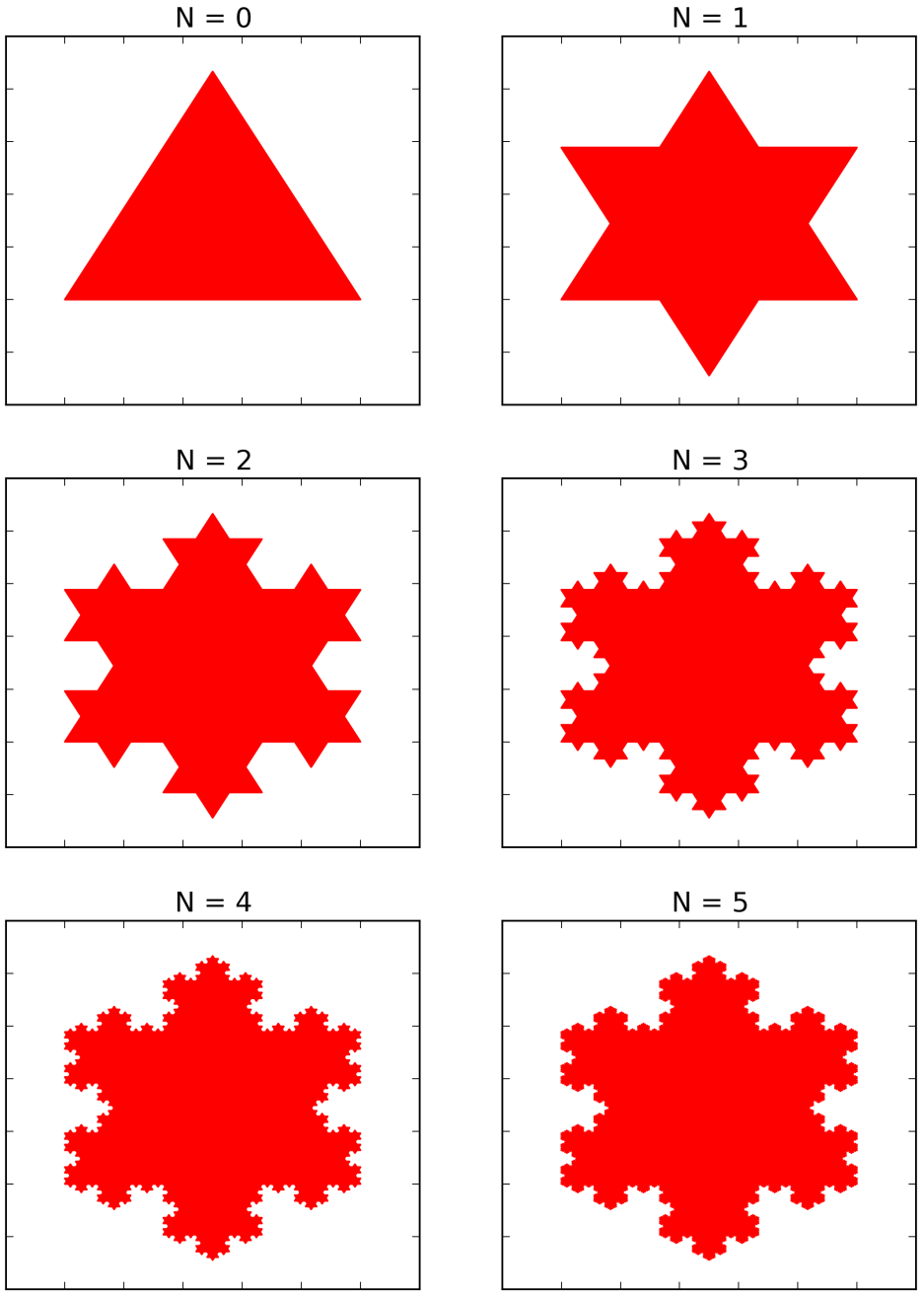


**Étape 5**

# Forme fractale



- Plus on zoome, plus on voit des détails
- Une partie ressemble au tout
- On obtient une forme complexe à partir de la répétition d'un processus simple

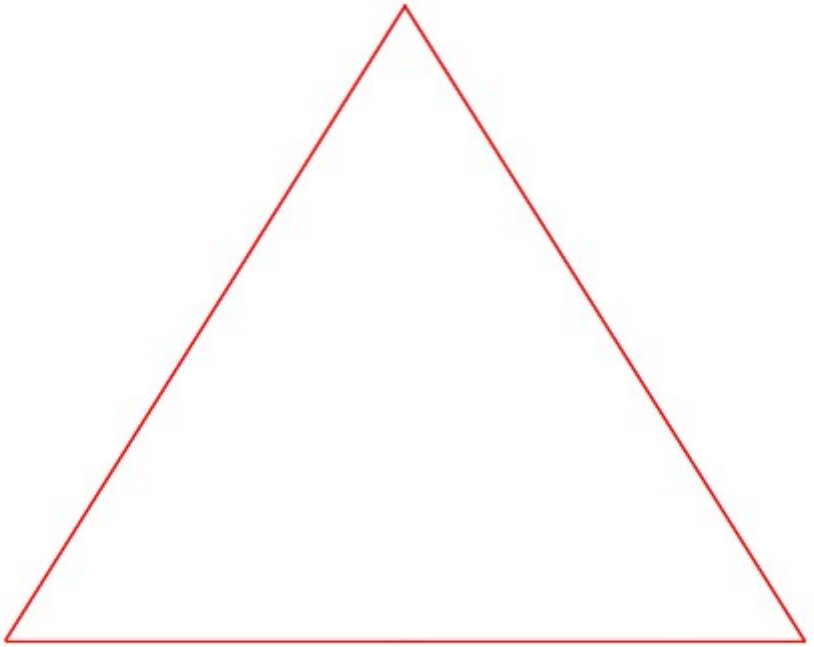



**Aire ?**

**Périmètre ?**

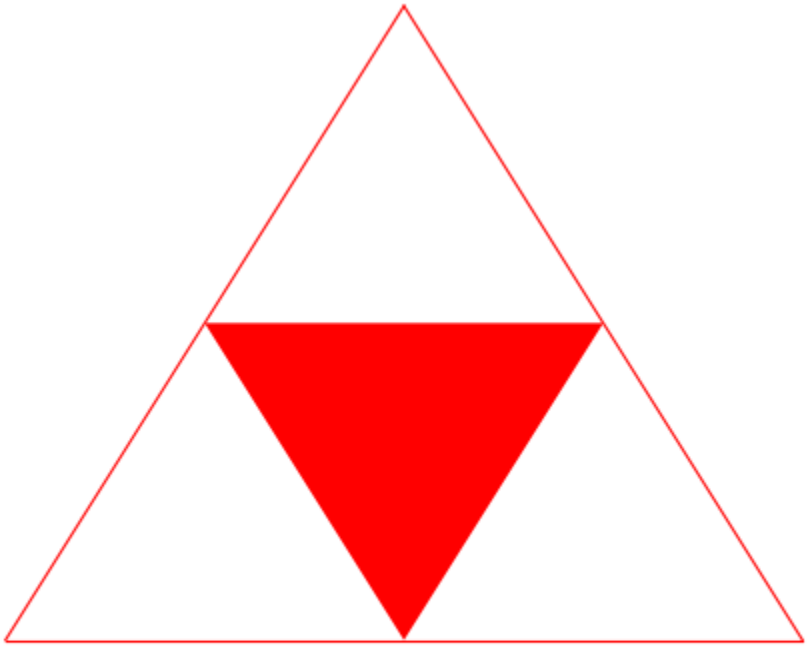
**Le périmètre tend vers l'infini alors que l'aire reste bornée**

# Triangle de Sierpiński (1915)

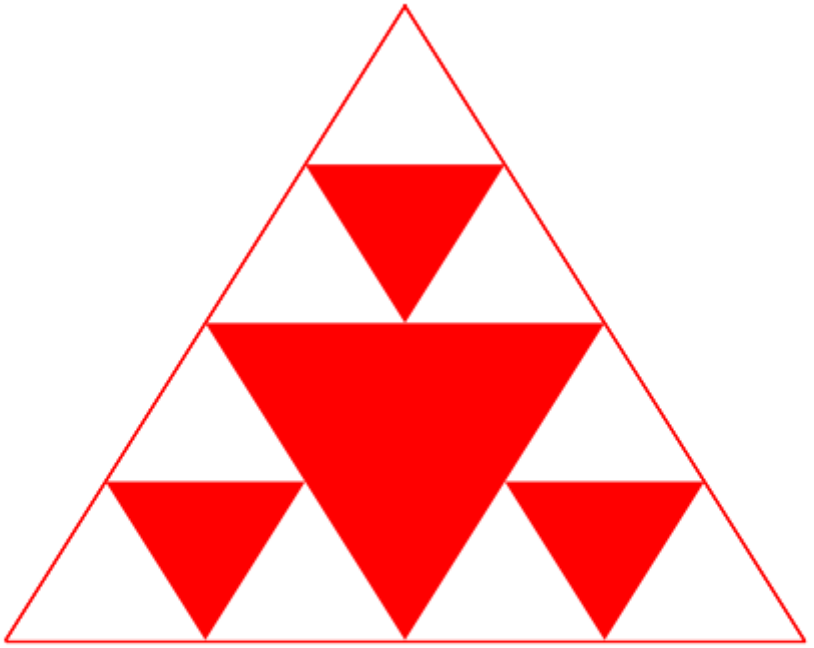


**Wacław Sierpiński**
Mathématicien polonais (1882-1969)

**Étape 0**



**Étape 1**



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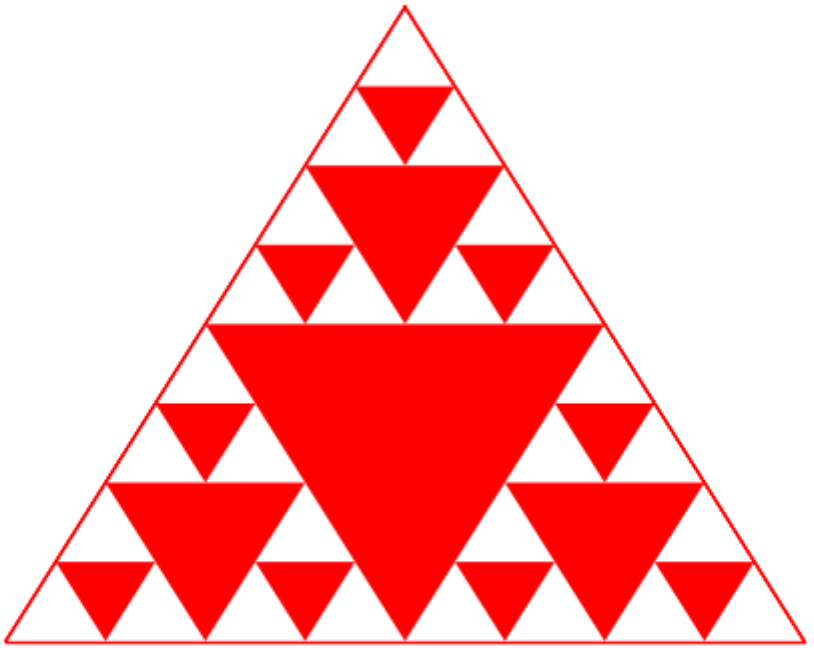
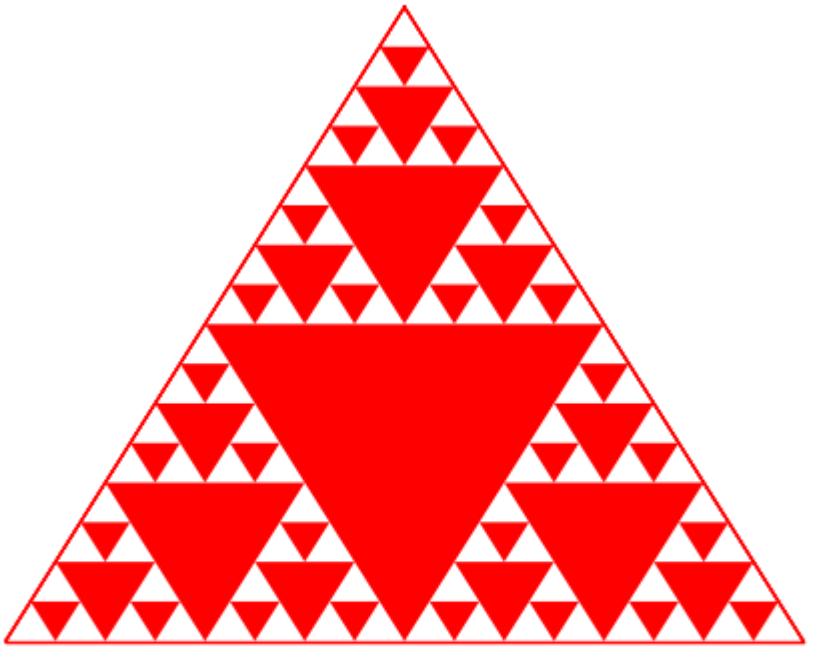
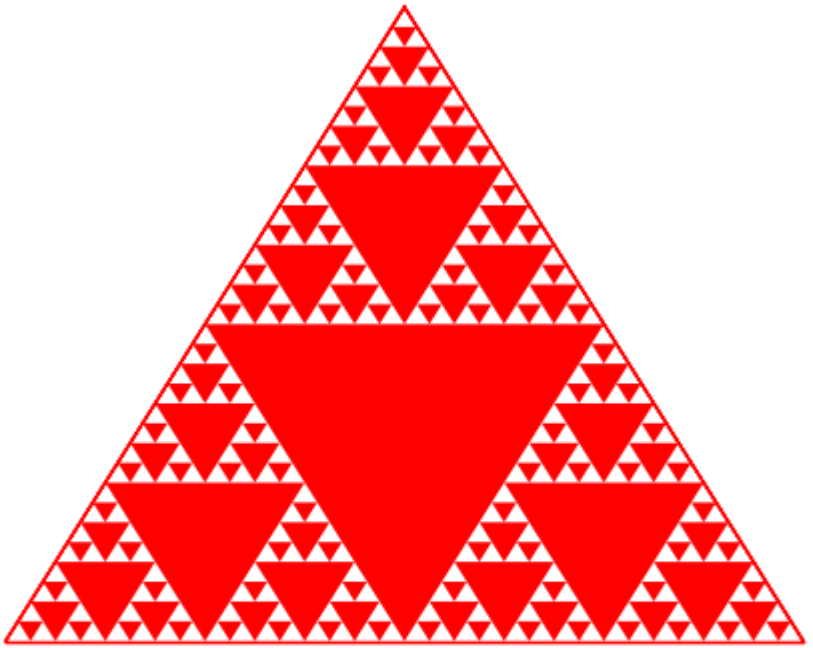


**Étape 3**



**Étape 4**



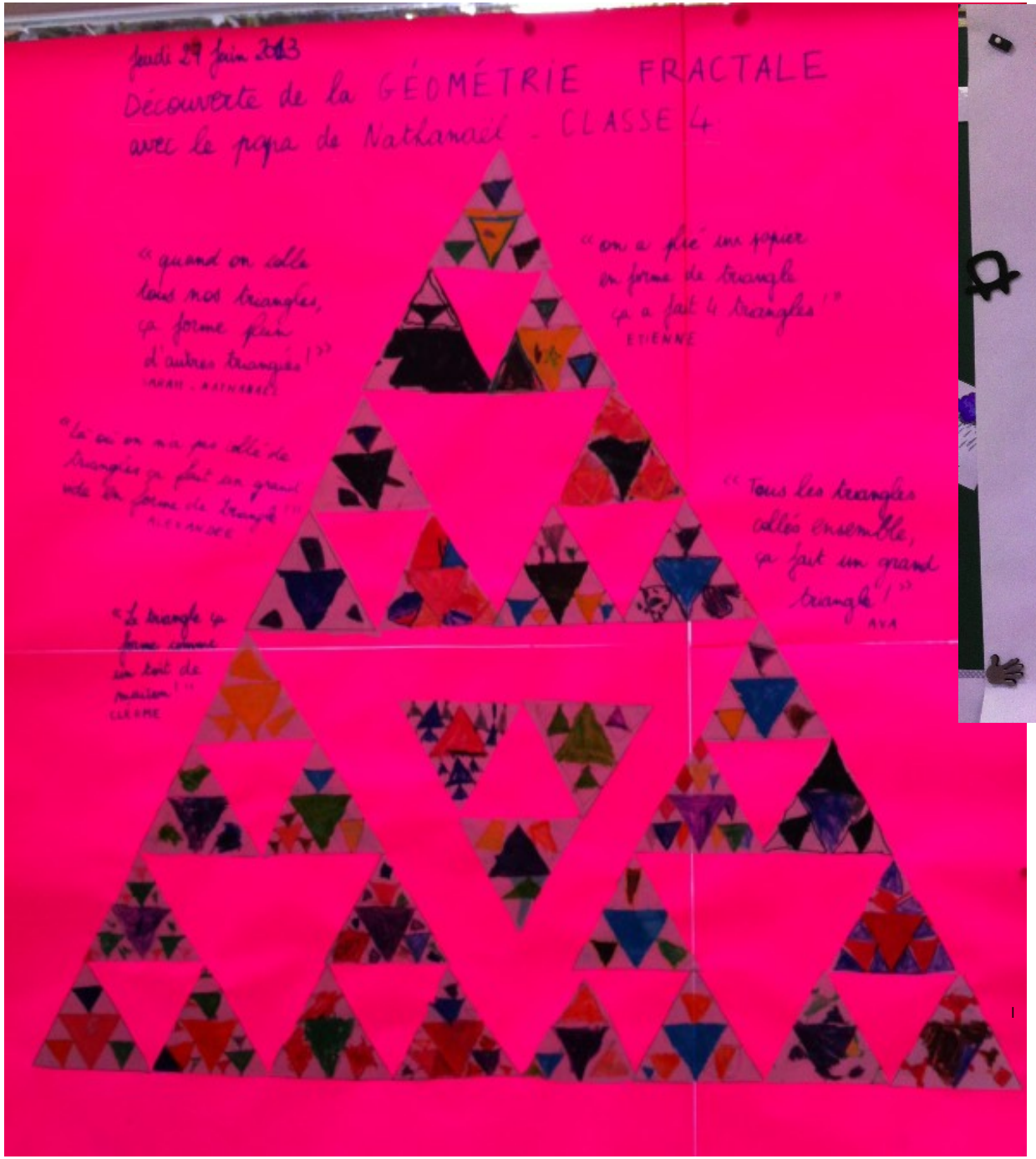
**Étape 5**

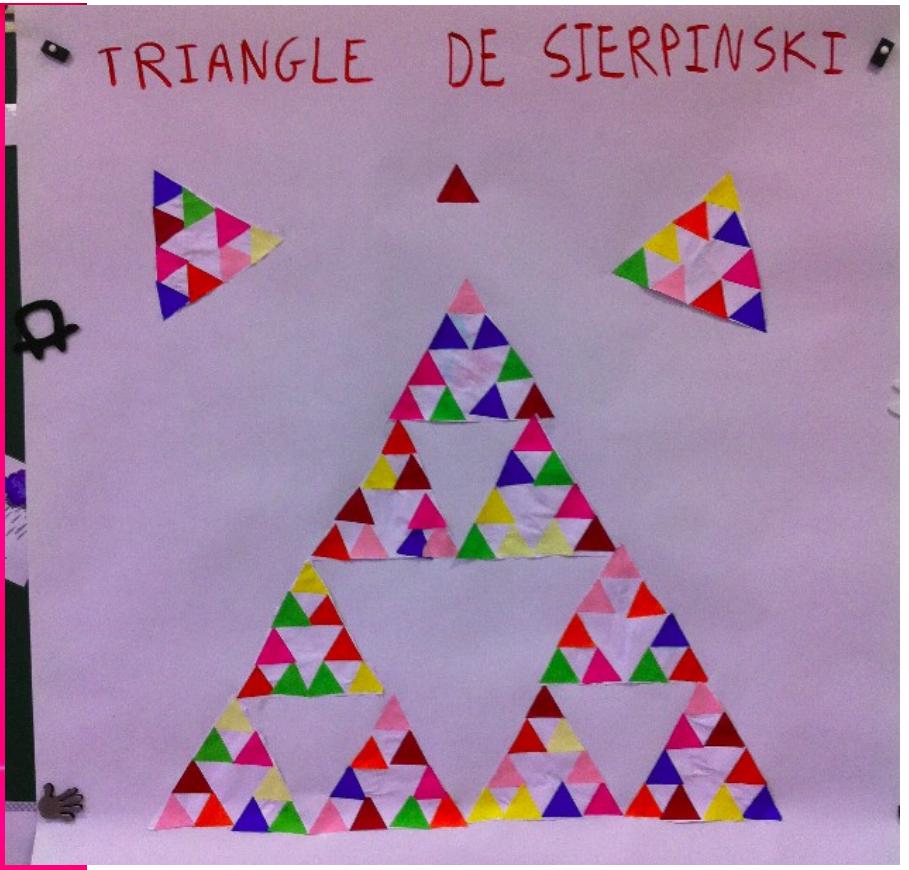
# Les “Cosmati”

**Des familles de marbriers entre le XIe siècle et le XIVe siècle, initialement à Rome**

http://www.westminster-abbey.org/conservation

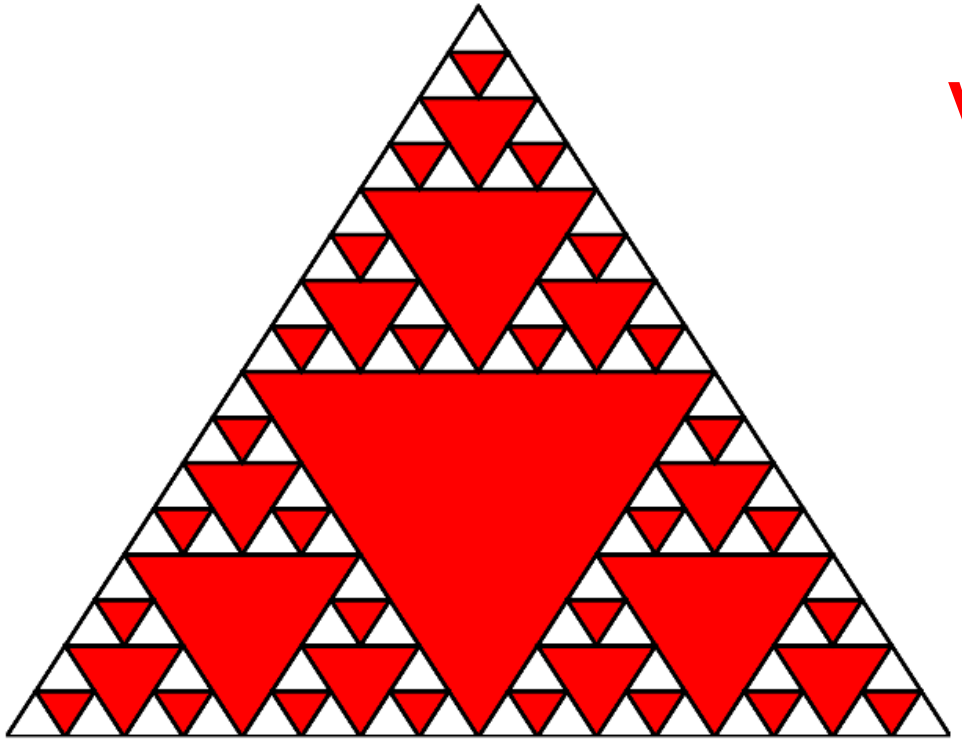
# En coloriage ou collage



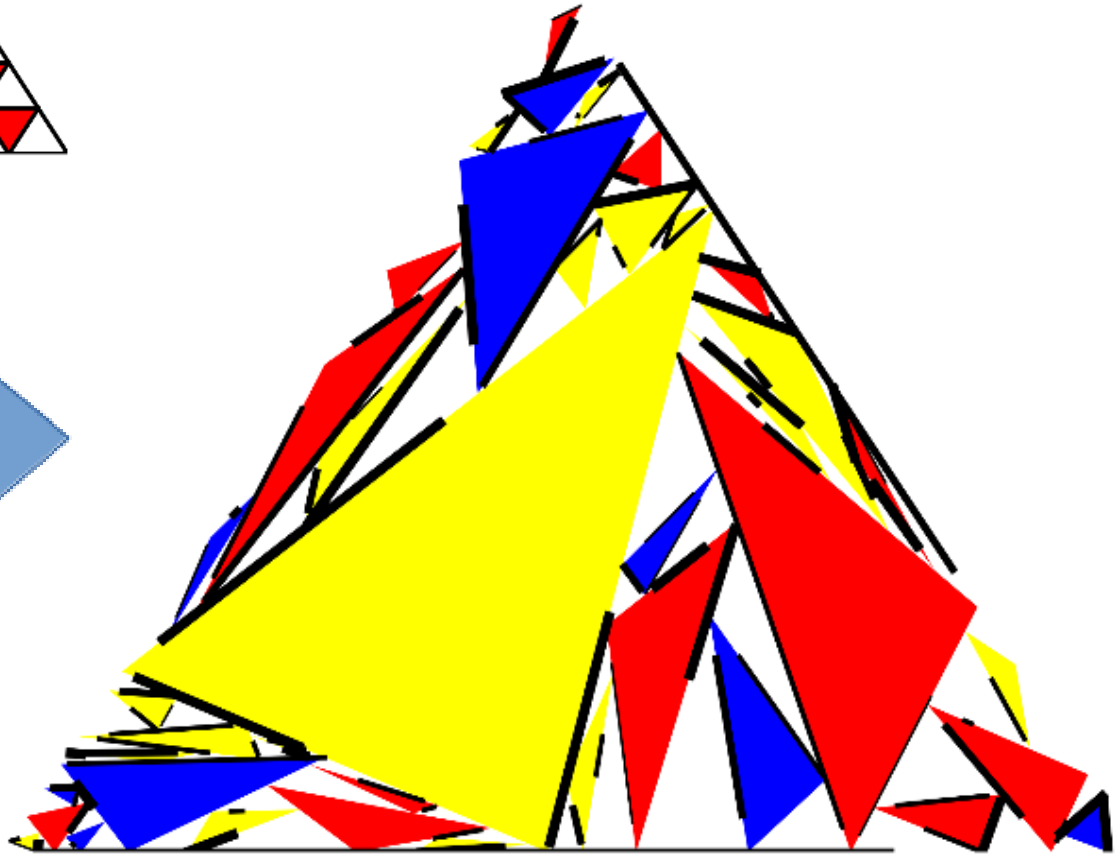

**Gires, Martin, Moyenne Section 3 (Enfants de 4-5 ), Ecole des Clos Saint-Marcel, Sceaux, Fev 2016**

**Gires, Villepoux, Moyenne Section 4 (enfants de 4-5 ans), Ecole des Clos Saint-Marcel, Sceaux, June 2013**

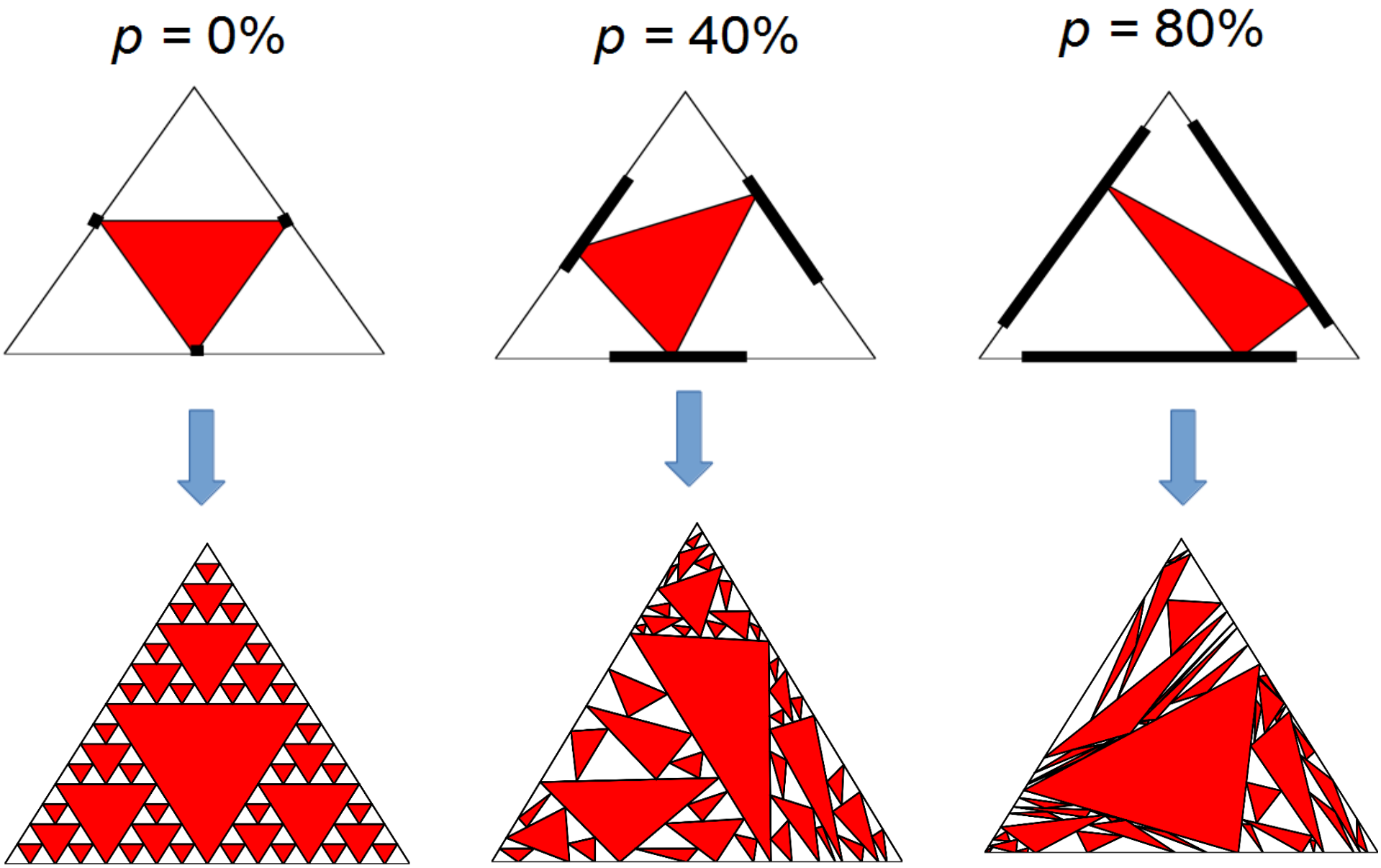


## Vers des formes fractales encore plus originales :

**Hasard**

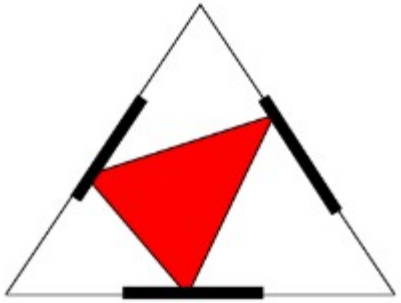


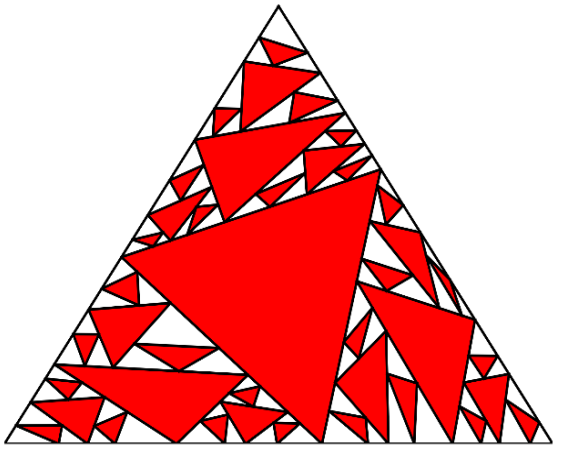
# Position des sommets : Pourquoi donc toujours au milieu ?

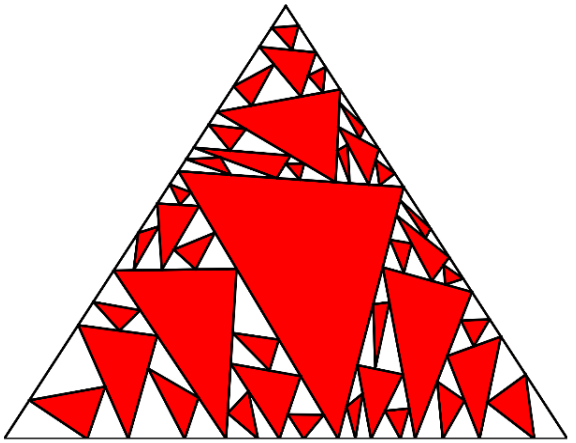


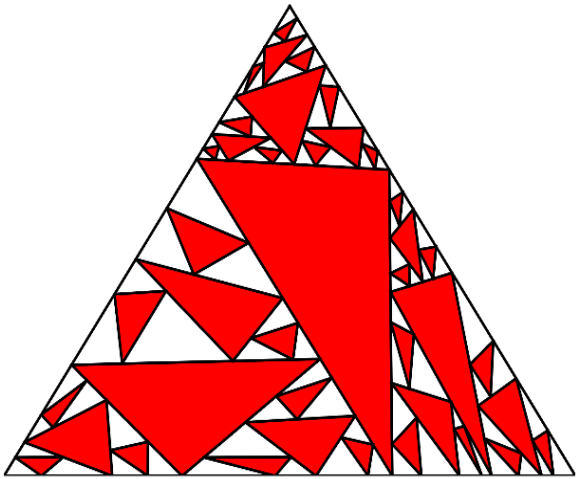
# Tous pareils ou tous différents ?

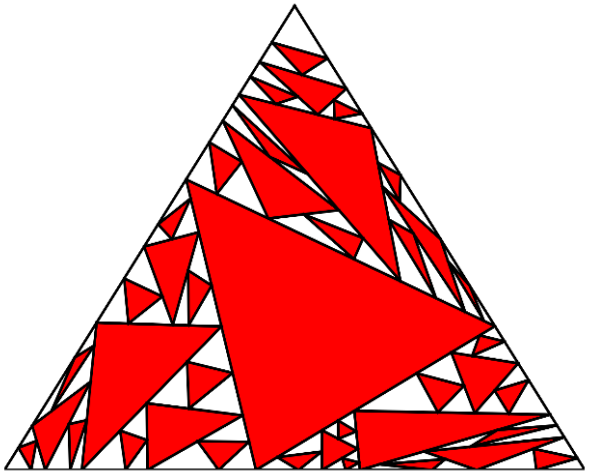
$p = 40\%$

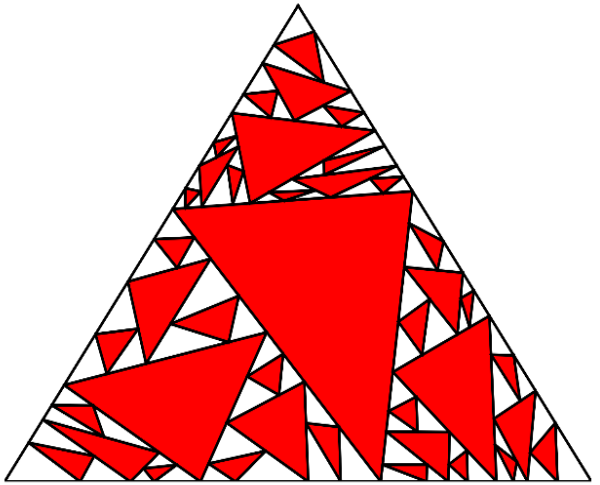




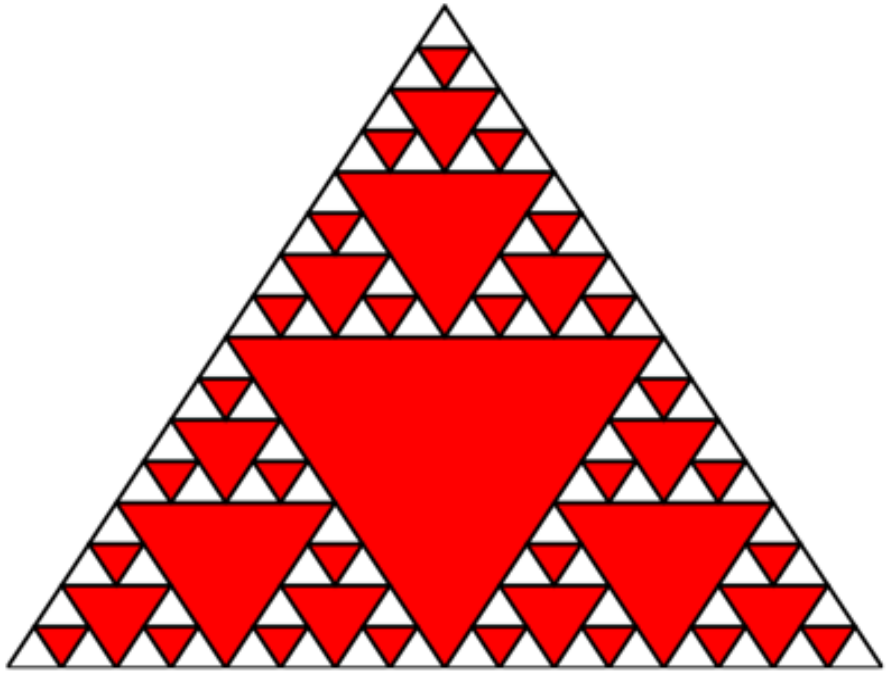


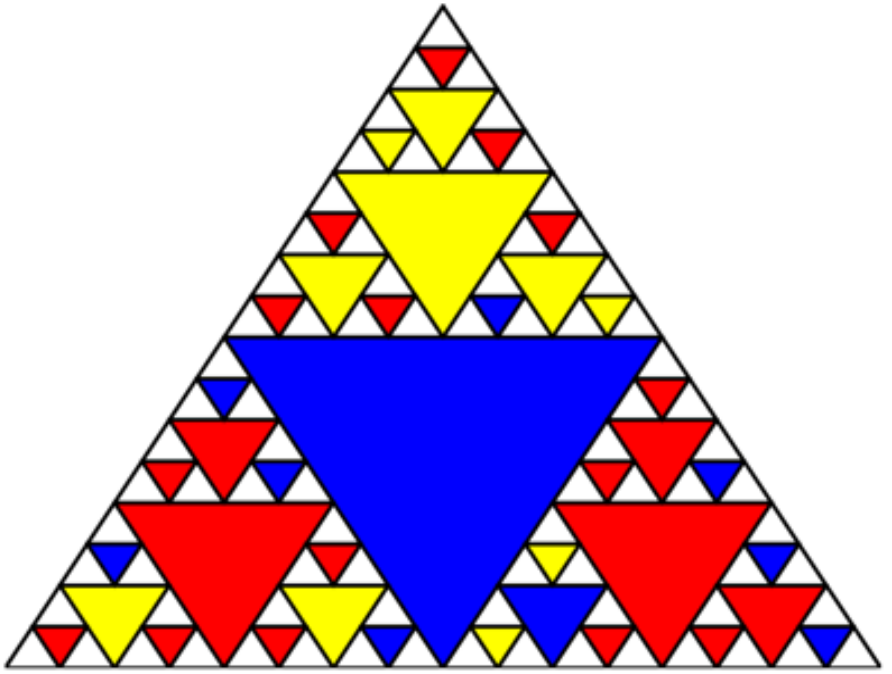






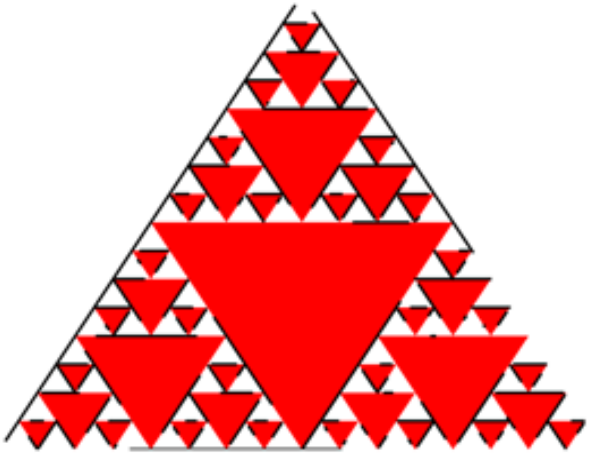
# Couleur des triangles : pourquoi toujours en rouge ?

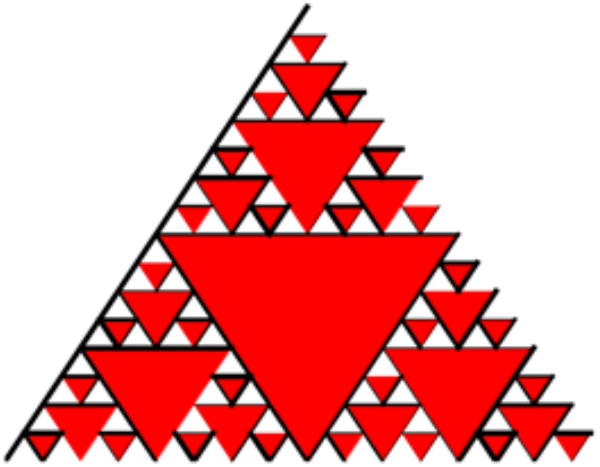




# Contours des triangles : faut-il vraiment toujours les tracer ?

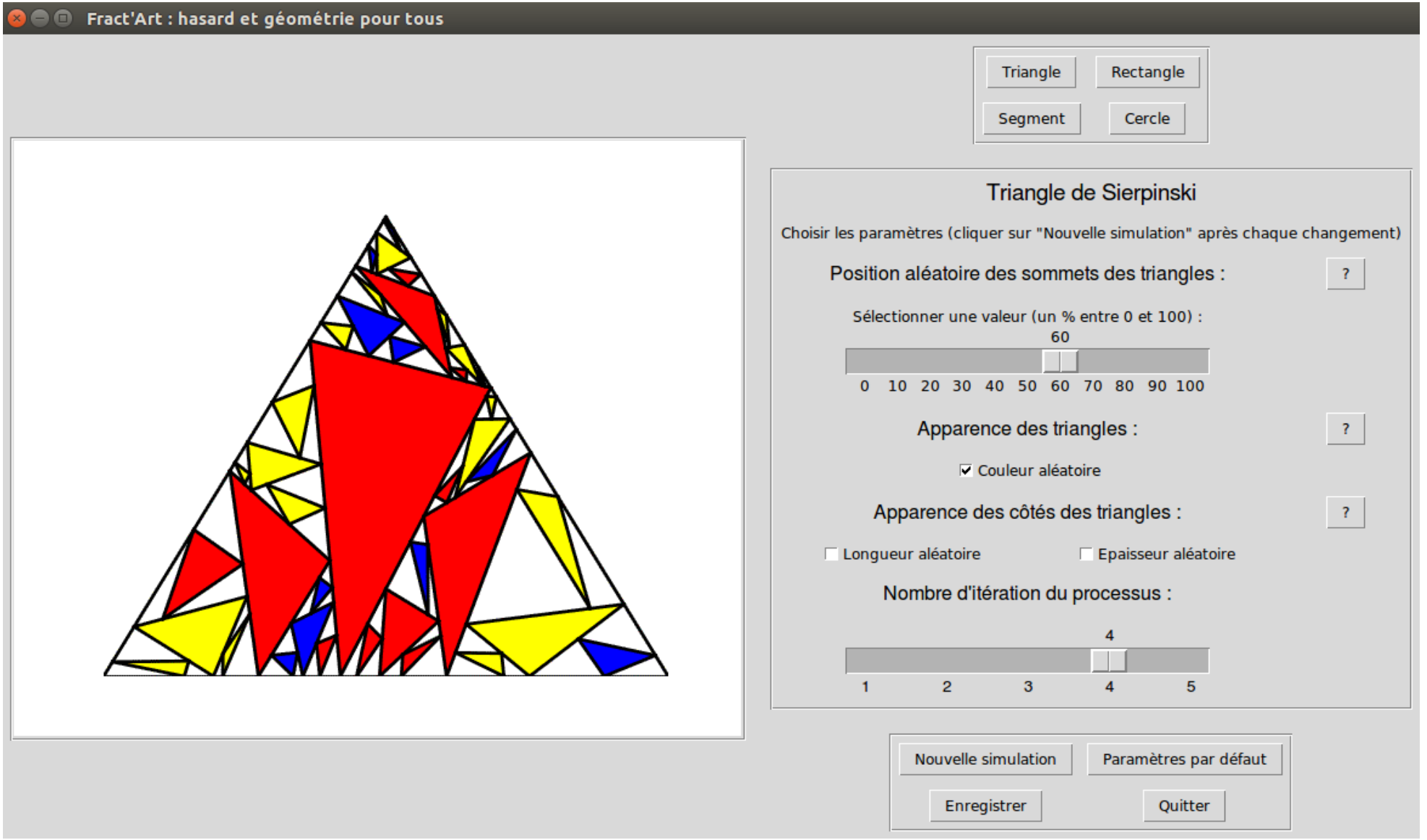
| | Longueur des côtés | Epaisseur des côtés |
|---|---|---|
| Non aléatoire | | |
| Aléatoire | | |

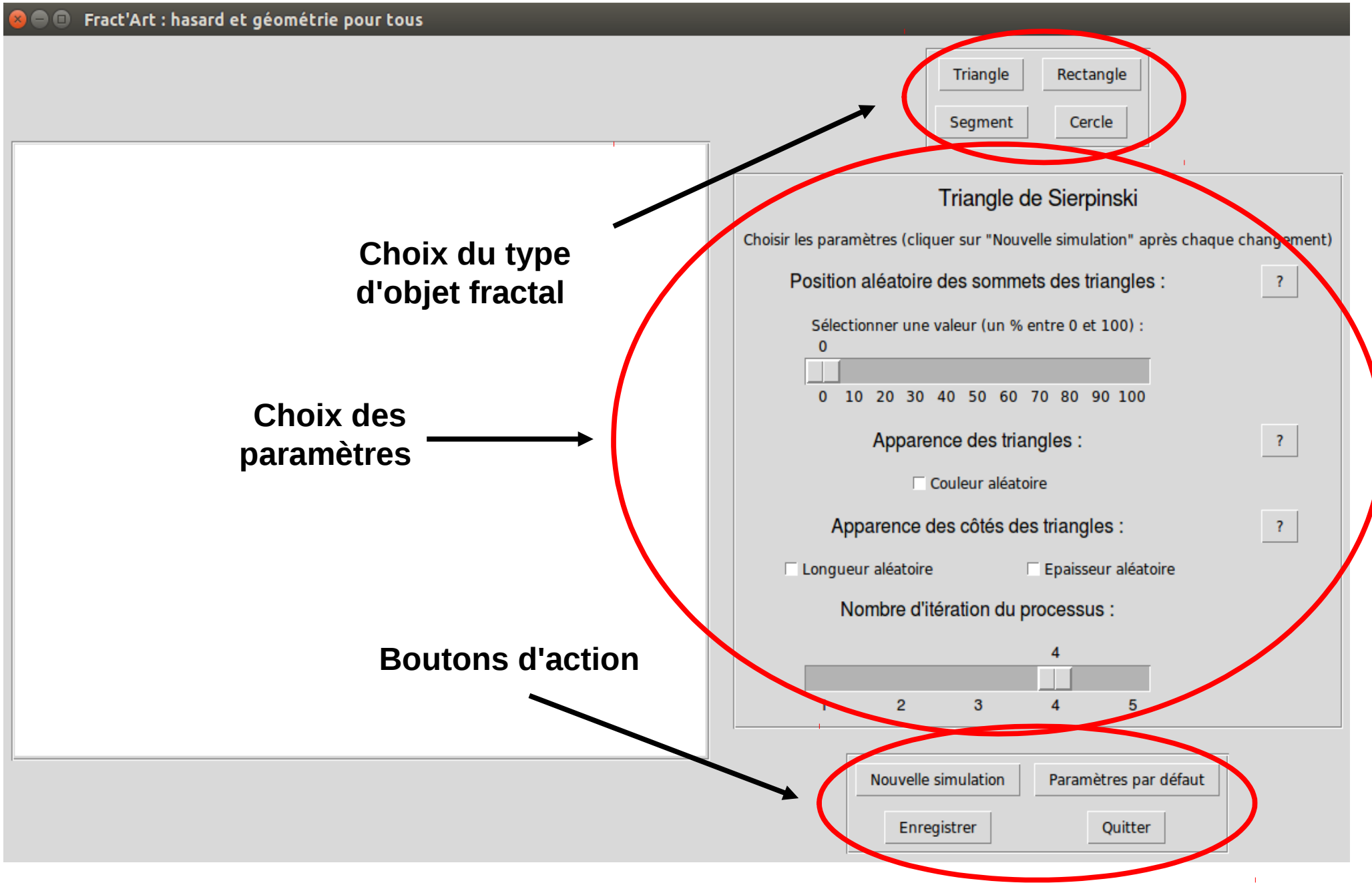




*“Des goûts et des couleurs, on discute pas”...*

# Choisissez vous même !!




Fract'Art : hasard et géométrie pour tous
Triangle
Rectangle
Segment
Cercle
Choix du type d'objet fractal
Choix des paramètres
Boutons d'action
Triangle de Sierpinski
Choisir les paramètres (cliquer sur "Nouvelle simulation" après chaque changement)
Position aléatoire des sommets des triangles :
?
Sélectionner une valeur (un % entre 0 et 100) :
0
0 10 20 30 40 50 60 70 80 90 100
Apparence des triangles :
?
Couleur aléatoire
Apparence des côtés des triangles :
?
Longueur aléatoire
Epaisseur aléatoire
Nombre d'itération du processus :
4
1 2 3 4 5
Nouvelle simulation
Paramètres par défaut
Enregistrer
Quitter

**Proposition pour tester le programme :**

**(i) Avec le triangle de Sierpiński**

**- Tester les différents paramètres**

**- Choisir le jeu de paramètres qui donne une forme qu'on apprécie**

**- Enregistrer l'image et l'imprimer**

**(ii) Les autres formes**

**- Découvrir le principe de construction en jouant avec le nombre d'itération**

**- Jouer avec l'aléatoire et refaire ce qui a été fait avec le triangle de Sierpiński.**

**(iii) Questionnaire avec votre avis**

**Diapositives complémentaires :**

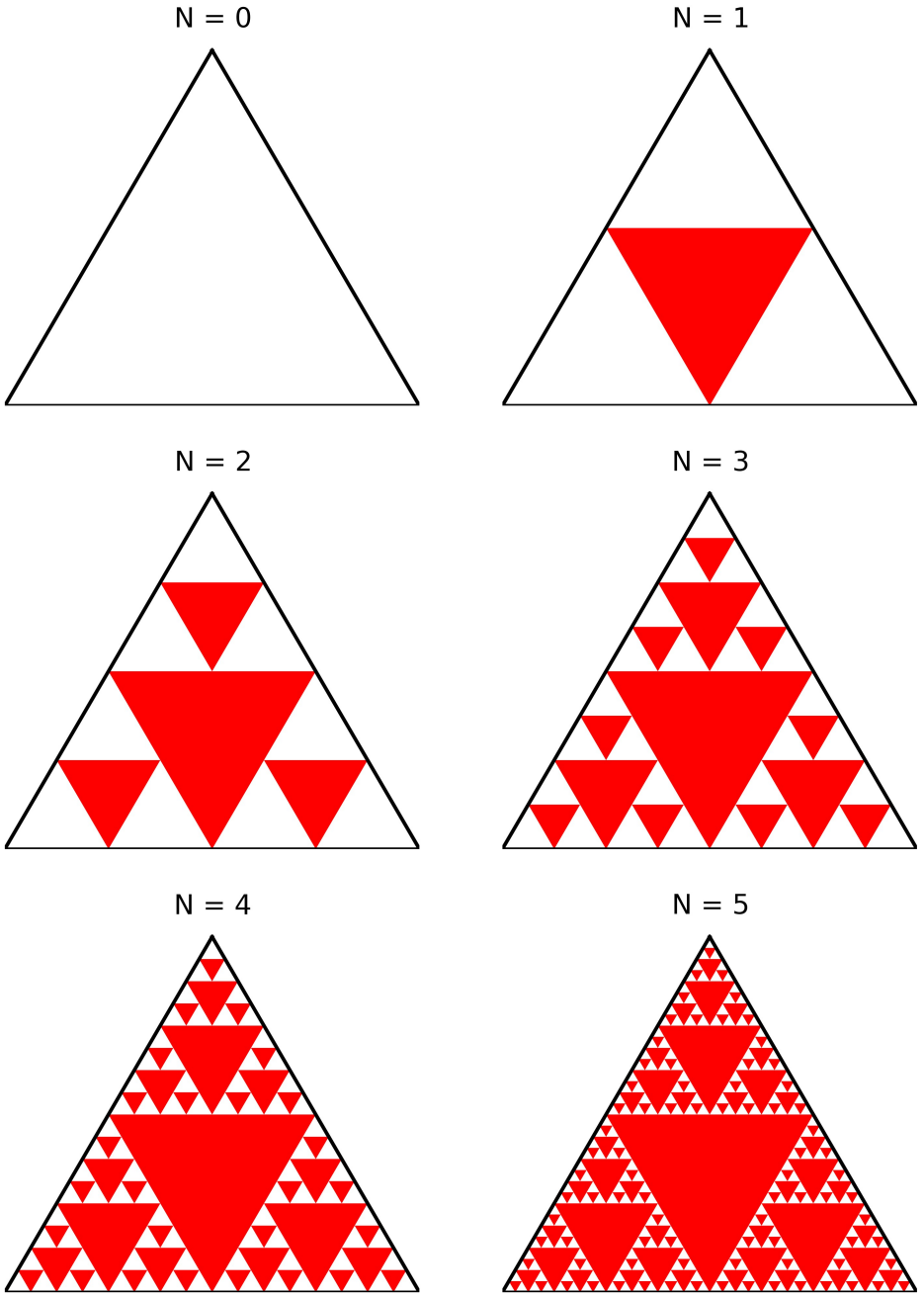
# Quelle est la longueur des côtes de Grande-Bretagne ?

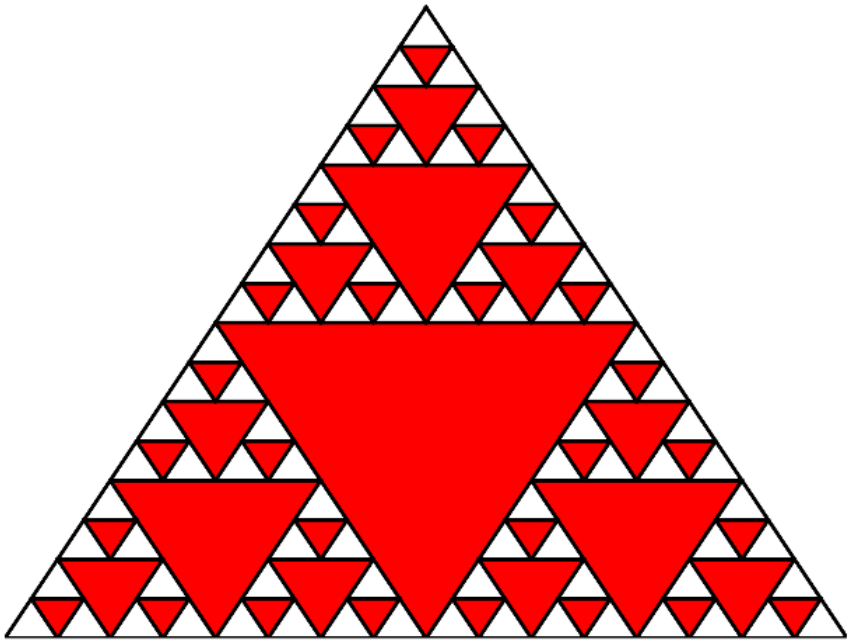
**Benoit Mandelbrot**
Mathématicien
Franco-Américain
(1924-2010)

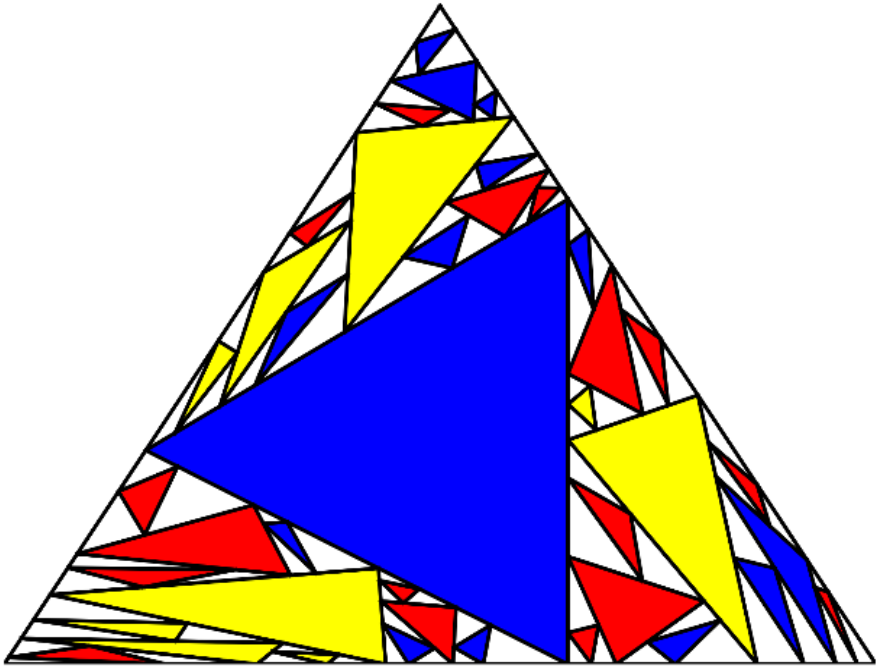
**How long is the coast of Britain?**
**B. Mandelbrot, Science 1967**

Image de
:https://en.wikipedia.org/wiki/How_Long_Is_the_Coast_of_Britain
%3F_Statistical_Self-Similarity_and_Fractional_Dimension

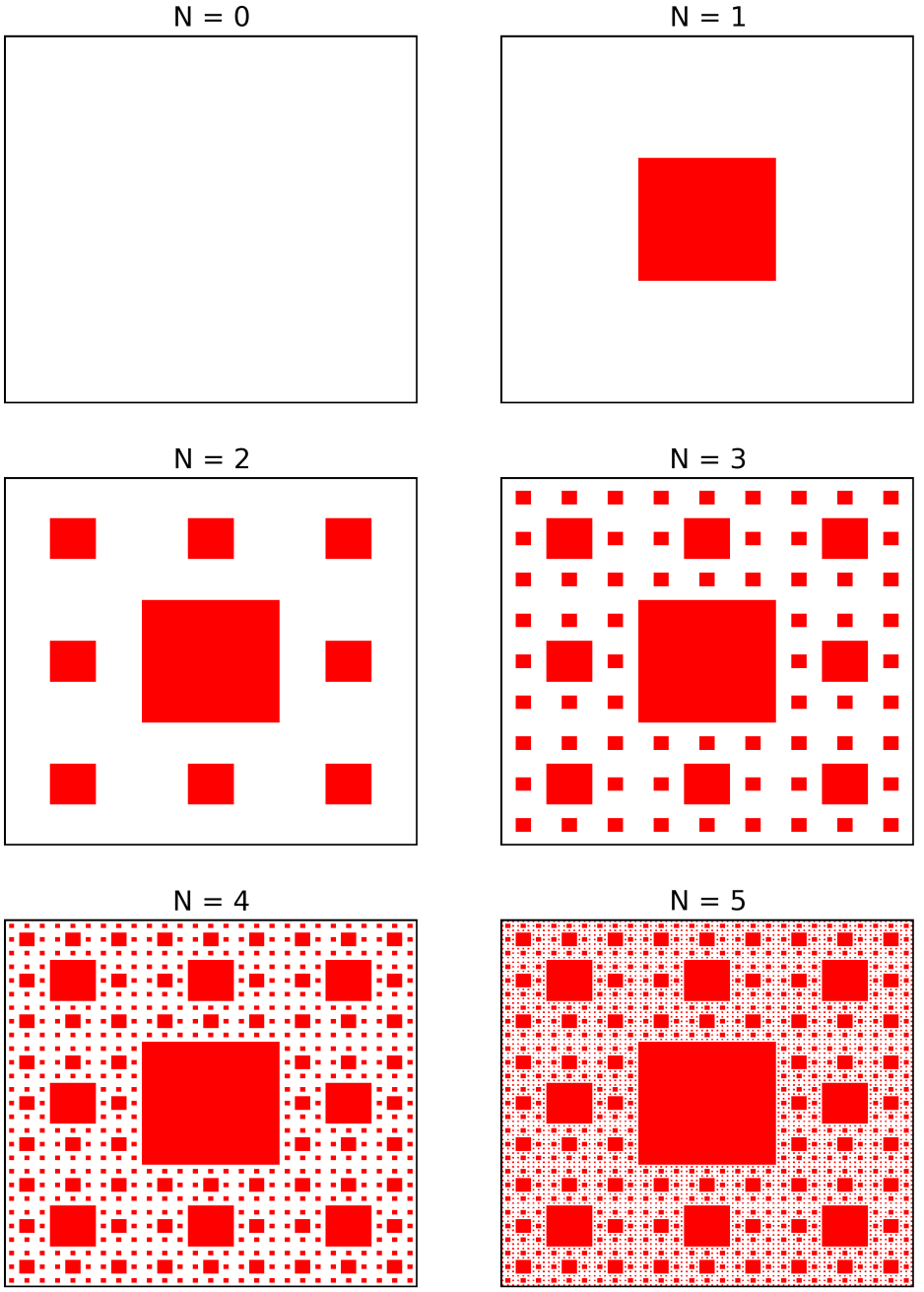
# Triangle de Sierpiński

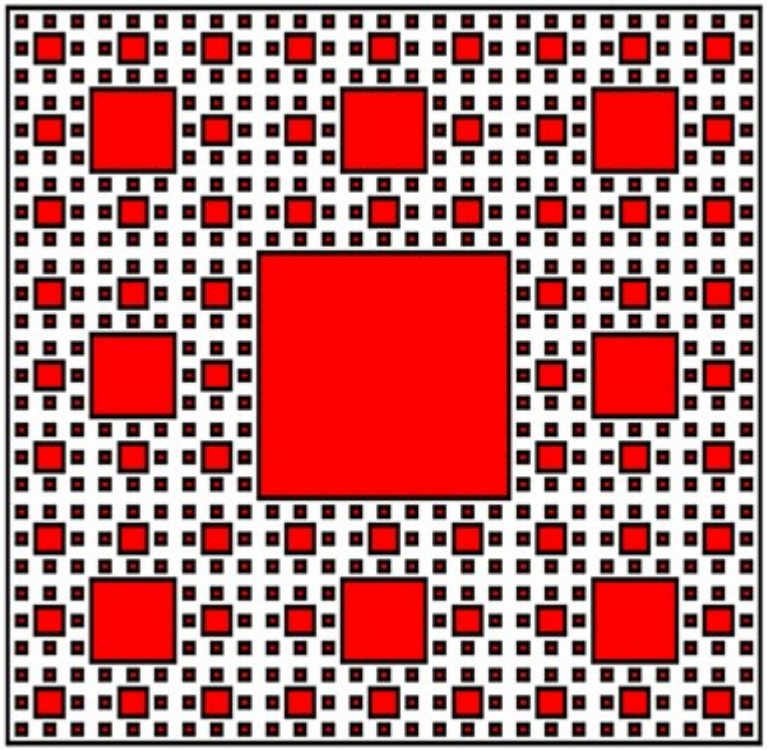


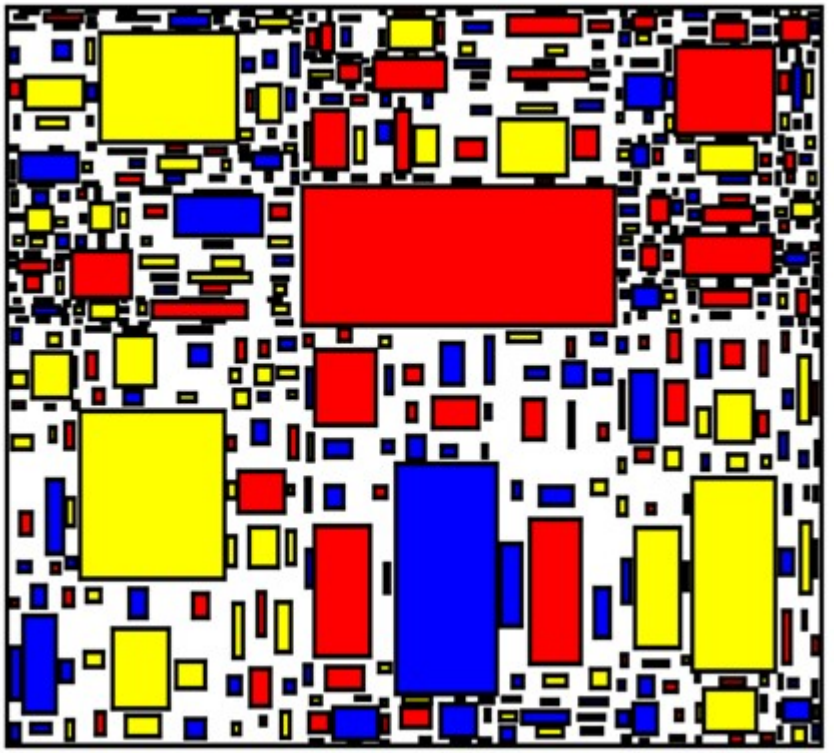




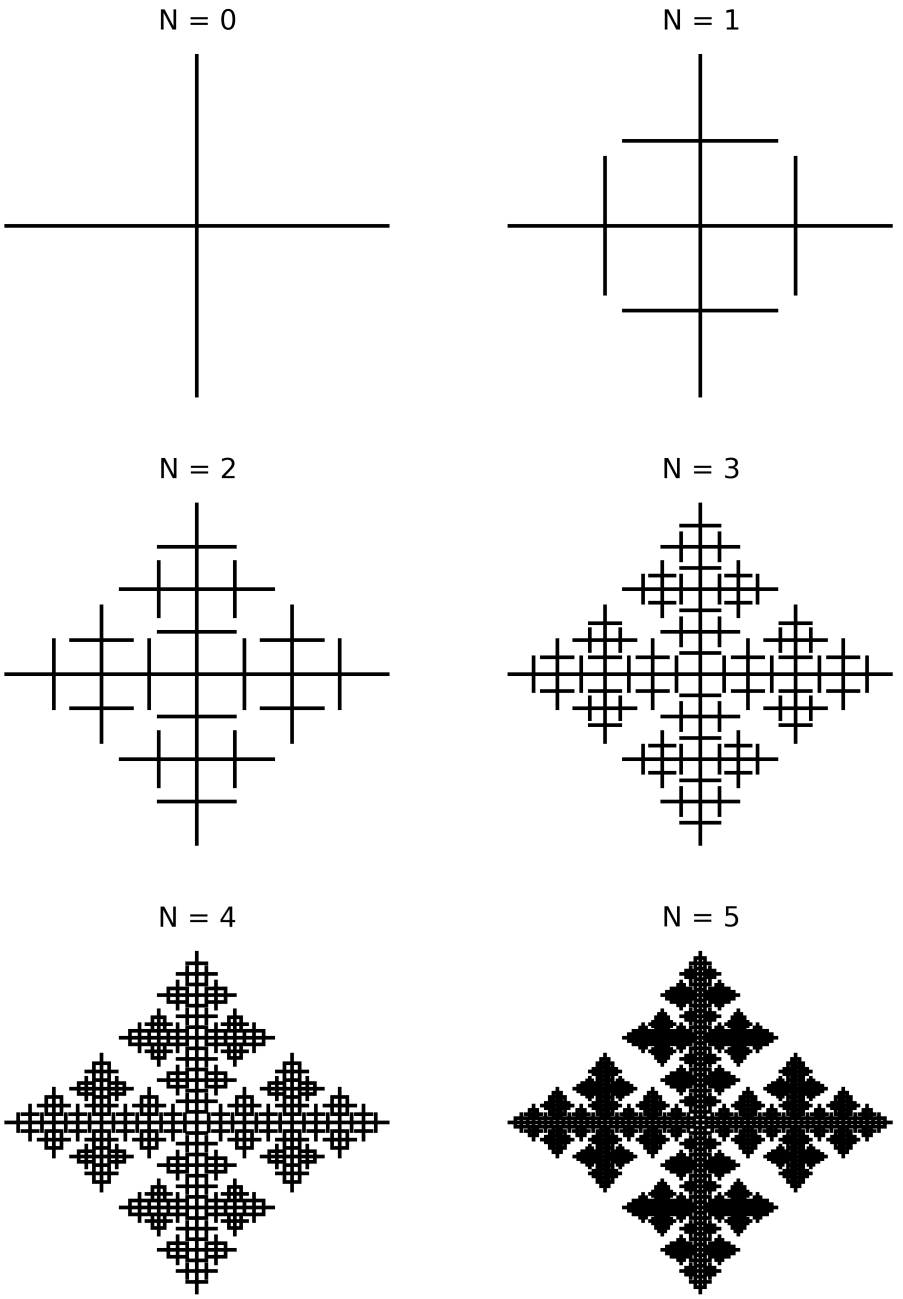
# Tamis de Sierpiński

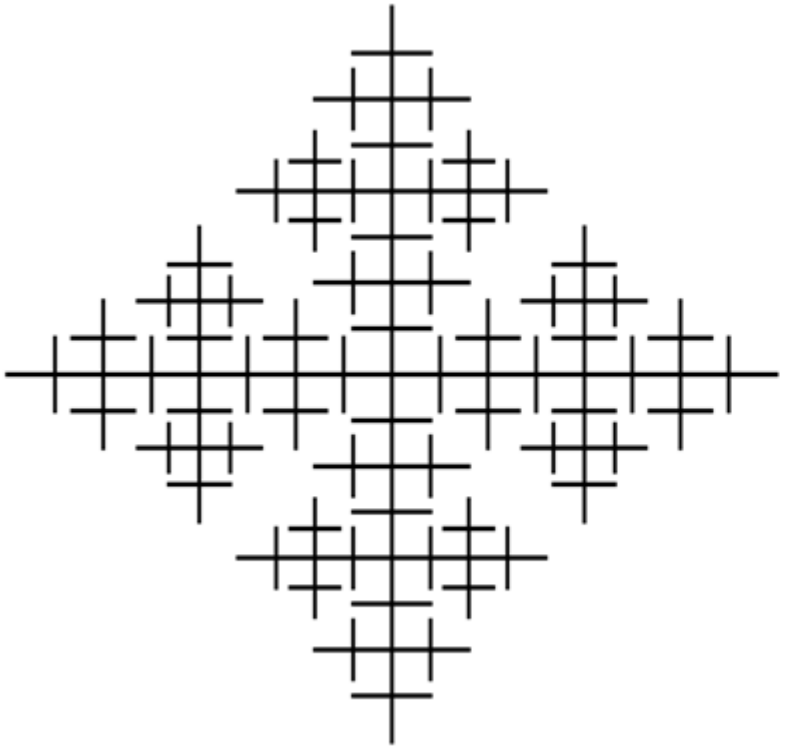


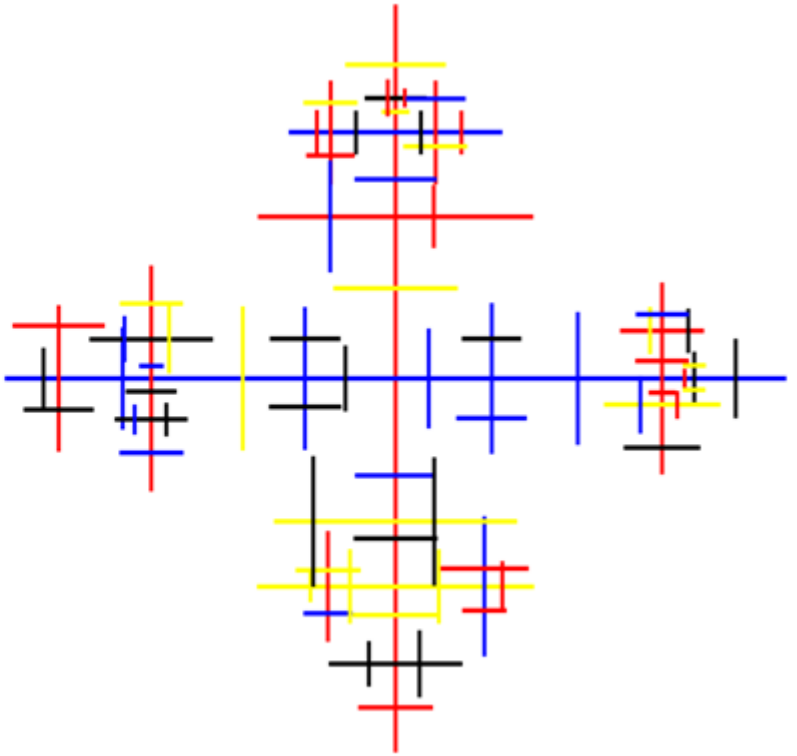




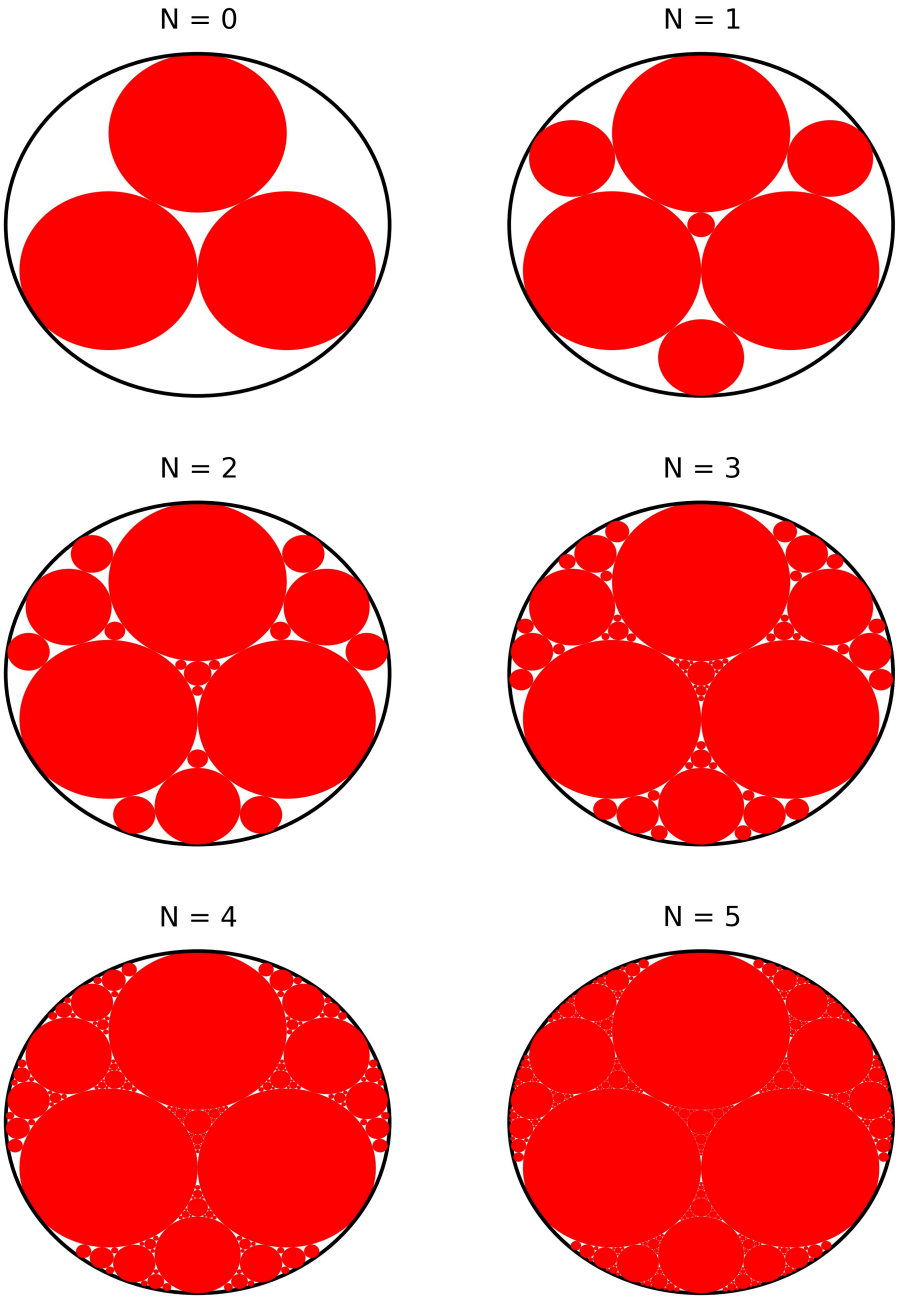
# Antenne fractale

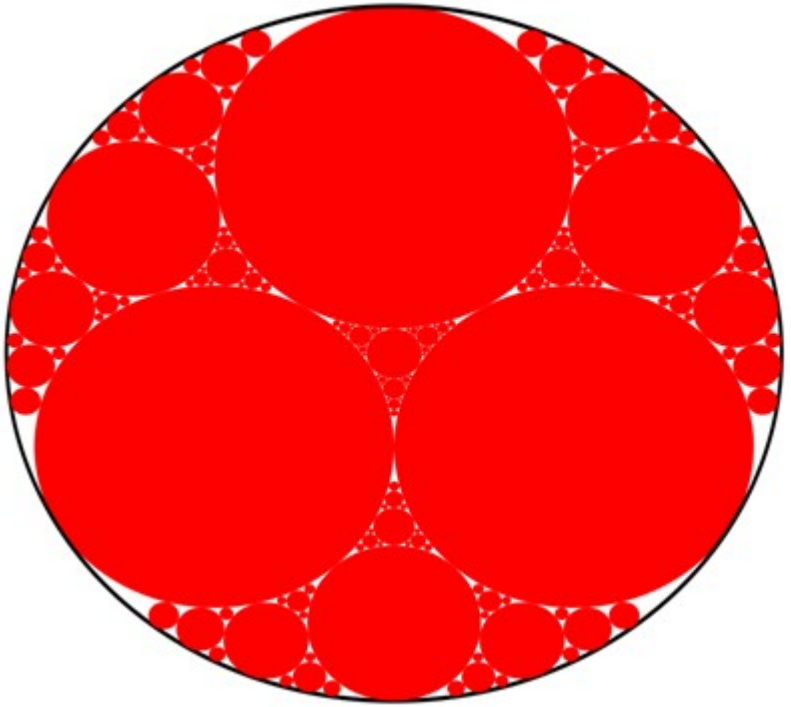


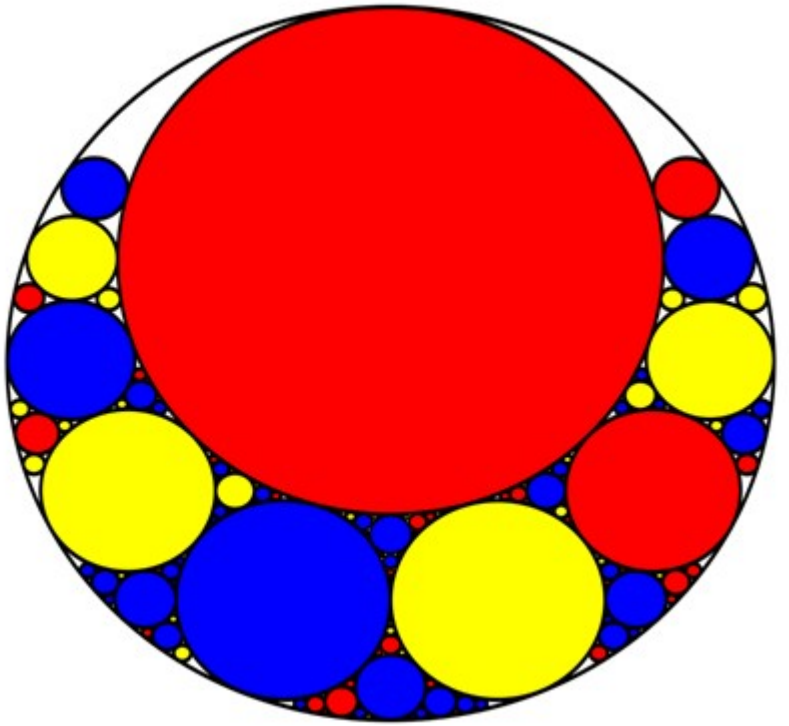




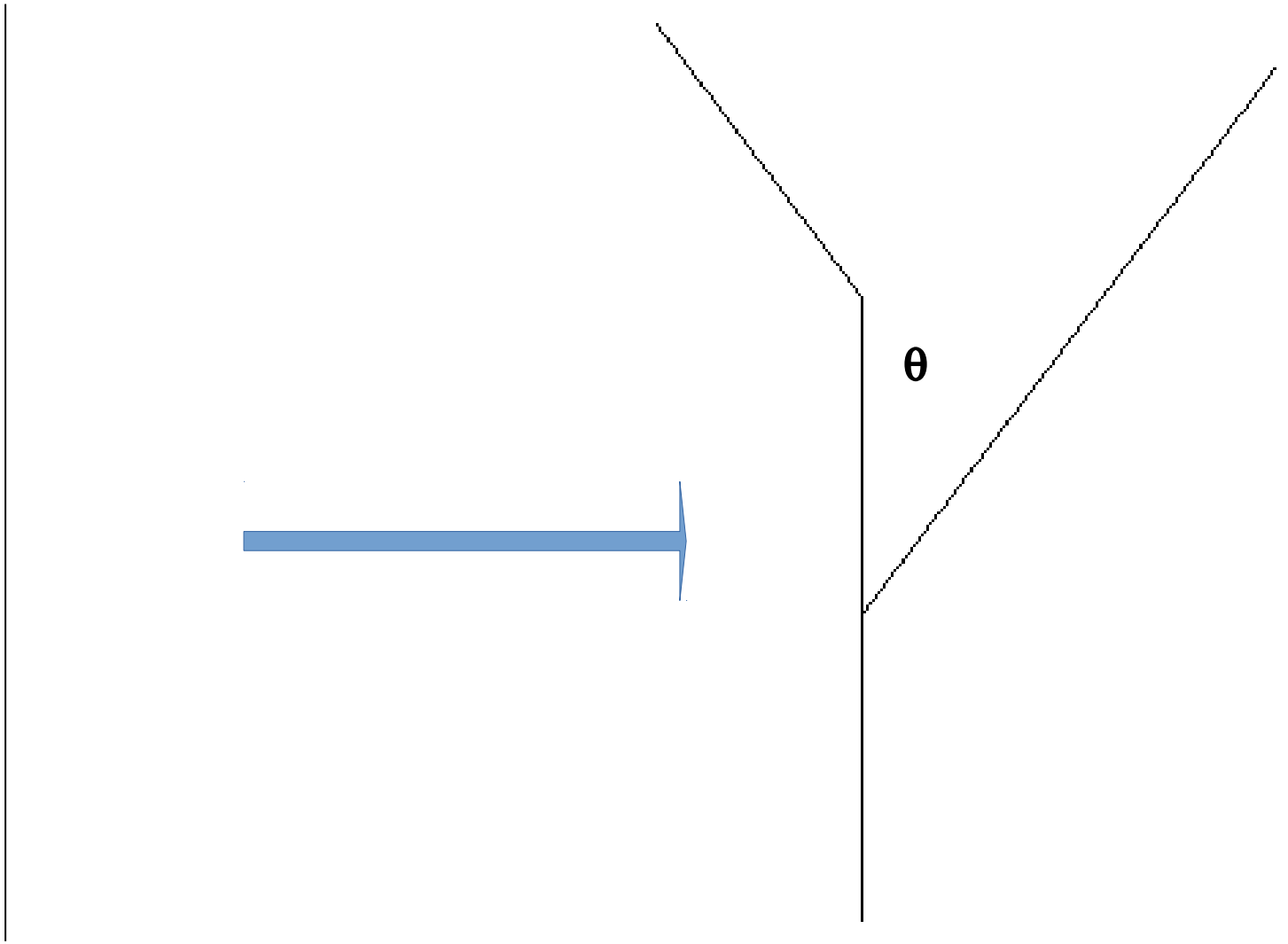
# Baderne d'Apollonuis



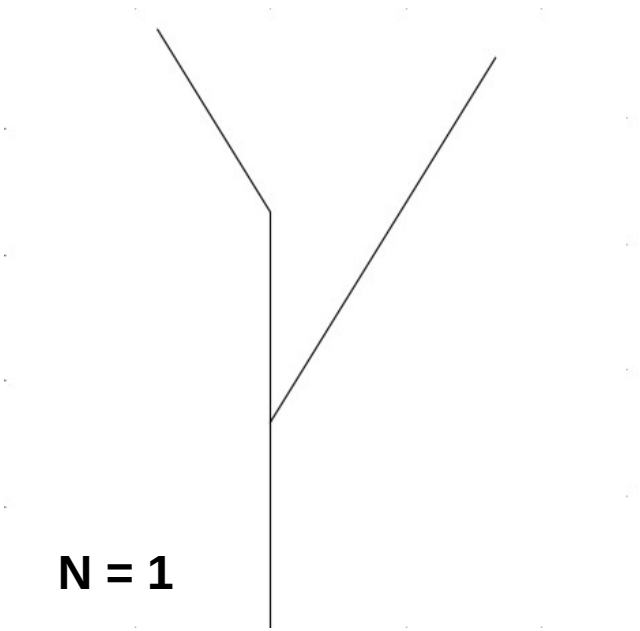




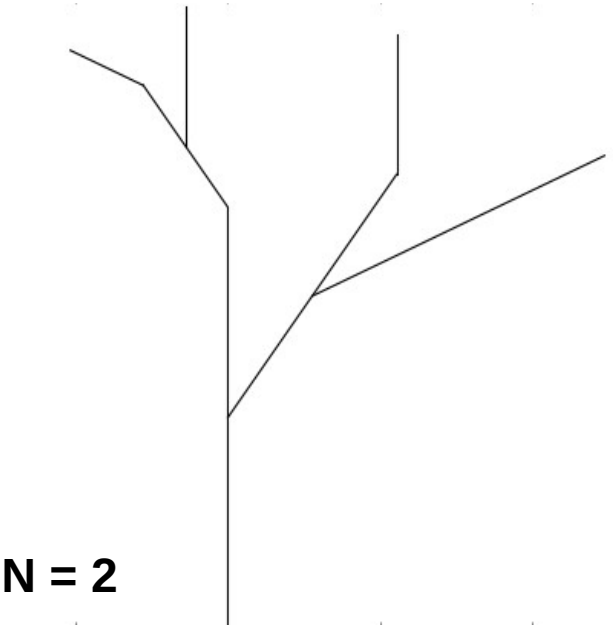
# Arbres fractals



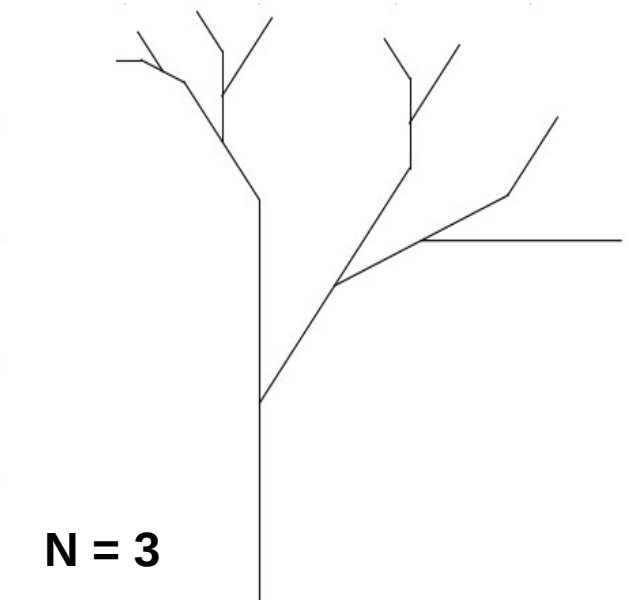
θ = 30°



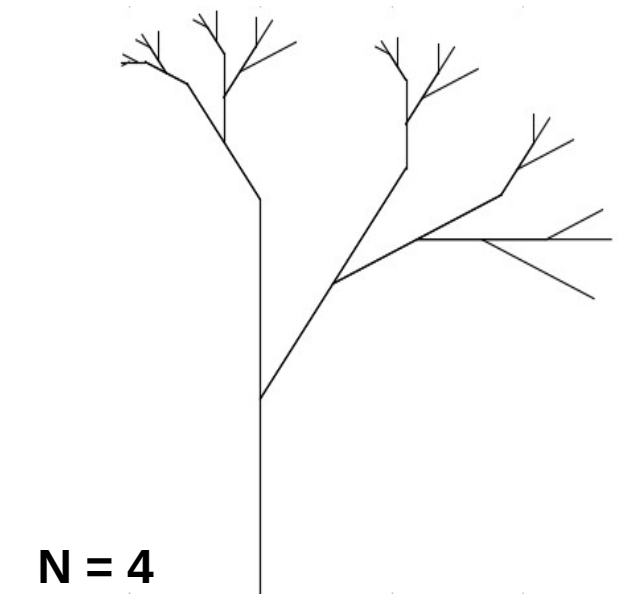
N = 1



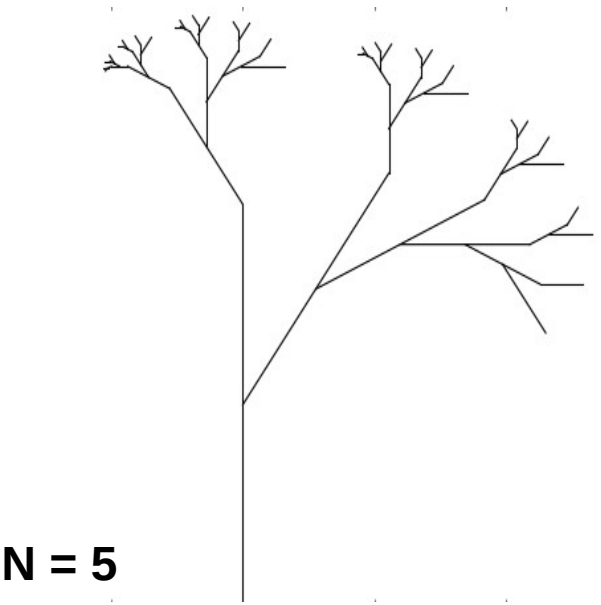
N = 2



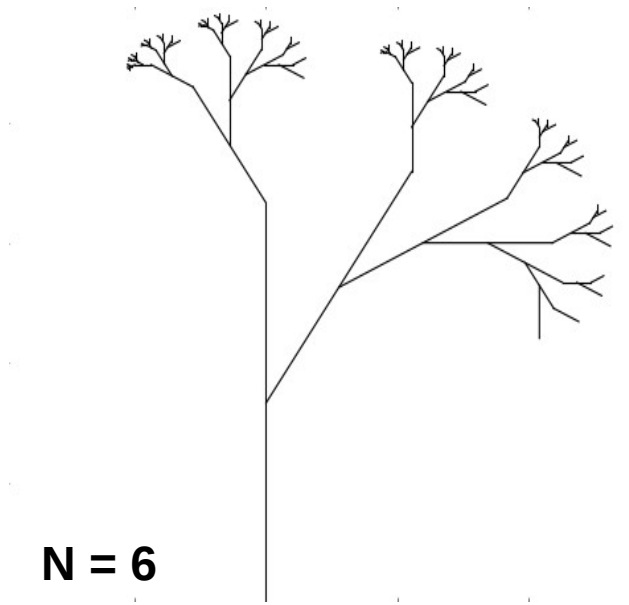
N = 3



N = 4

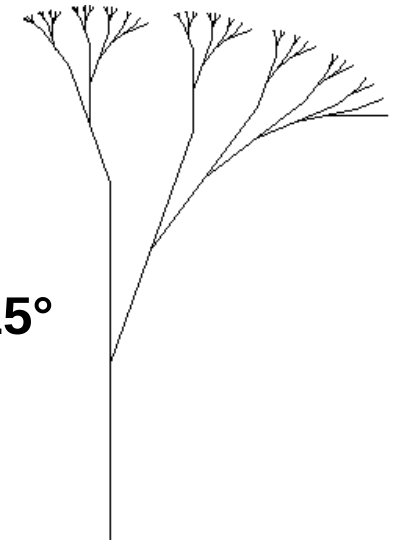


N = 5

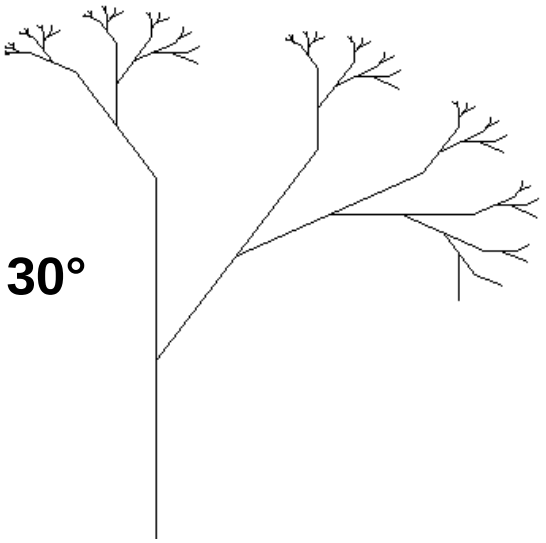


N = 6

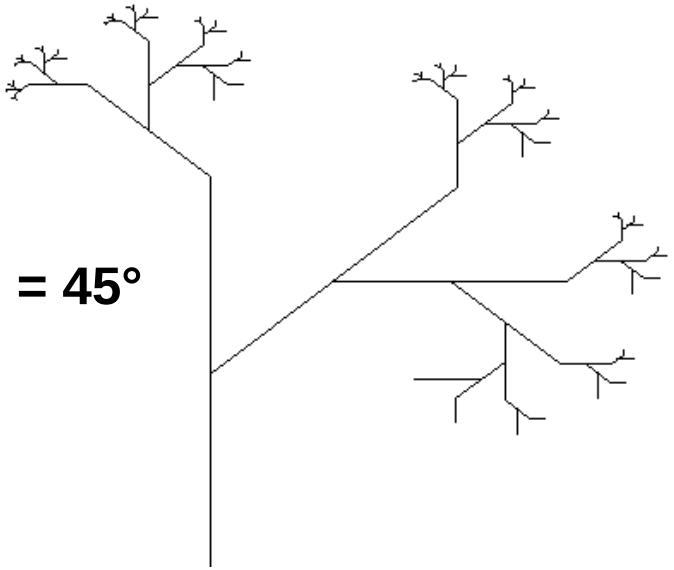
θ = 15°



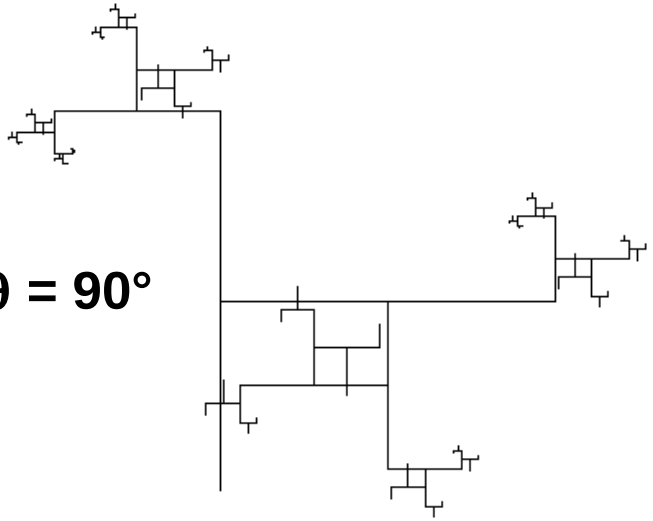
θ = 30°



θ = 45°



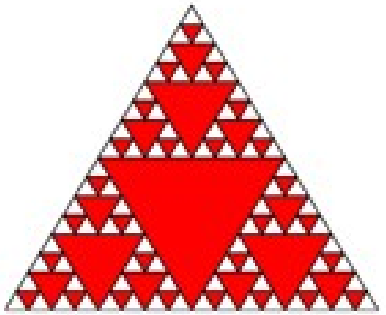
θ = 90°



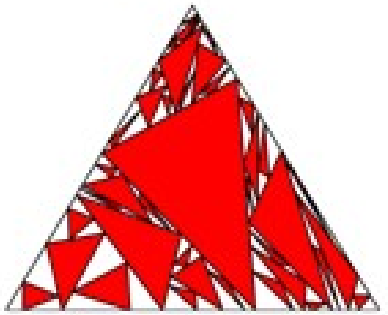
- **Trees from Le Puy-en-Velay and Sceaux (centre) (Winter 2012, France)**

- **Trees from Les Estables (left) and Le Puy-en-Velay (Winter 2012, France)**

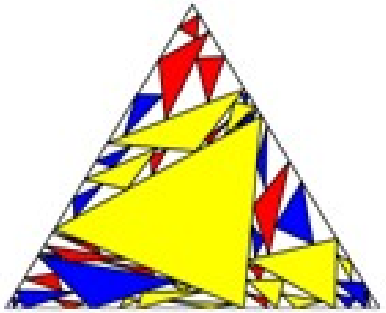
No randomness



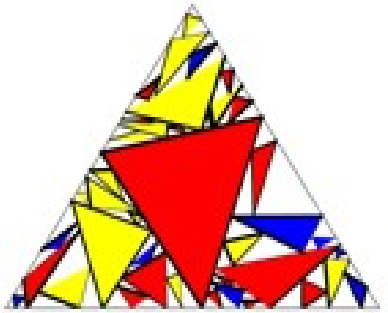
Adding random determination of triangle position



Adding random determination of triangle colour



Adding random determination of side width



Adding random determination of side length

Intro

Géométrie fractale

Mettre arbre + exemple d'utilisation après
+ réfléchir à l'ordre, faut-il parler dès de début d'application ?

Bcp d'exemple
- flocon de van koch (+ qq illustration aire bornée, périmètre pas bornés …
- plus on zoom plus on voit de détails,
(exemple de la longeurs des côtes de bretagne (Mandelbrot ?)

- triangle de sierpinki , pas d'échelles carctérisques, les formes se ressemblent toute, une partie du triangle ressemble au tout.
- arbre
- complexité ne vient pas d'un processus, mais de l'intération

Introduction du hasard petit à petit pour avoir des formes plus amusantes, mettre une dose de harsard, ça change tout !

Présentation de l'outil

A quoi ça sert ?
hydrologie, structure du poumon, granulation des bétons, paradoxe d'Olbers, turbulences en mécanique des fluides, urbanisme des villes, et même trous de l'Appenzelle, cerveau ….
- pluie
- représentation d'objet / forme complexe
- fracture dans la pierre (grotte kartisque)