

# python

The Python logo, consisting of two interlocking snakes, one blue and one yellow, is positioned below the word "python".

```
import turtle
turtle.setup(650,350,200,200)
turtle.penup()
turtle.fd(-250)
turtle.pendown()
turtle.pensize(25)
turtle.pencolor("purple")

for i in range(4):
    turtle.circle(40, 80)
    turtle.circle(-40, 80)
    turtle.circle(40, 80/2)
    turtle.fd(40)
    turtle.circle(16, 180)
    turtle.fd(40 * 2/3)
```

# 实例8: 科赫雪花小包裹

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# "科赫雪花小包裹"问题分析

# 科赫雪花

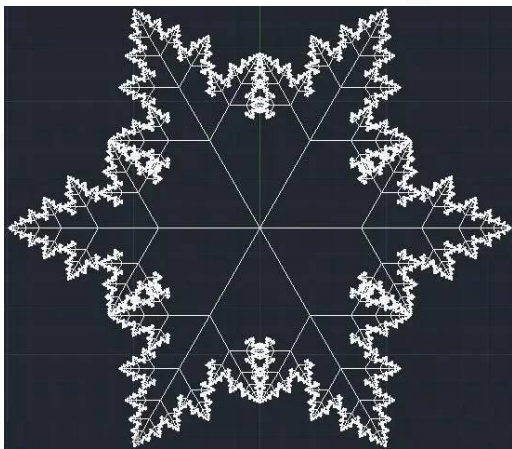
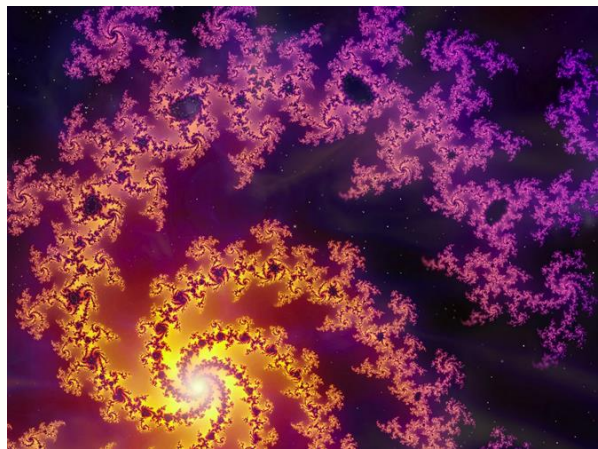
## 高大上的分形几何



- 分形几何是一种迭代的几何图形，广泛存在于自然界中

# 科赫雪花

科赫曲线，也叫雪花曲线



# 科赫雪花绘制

## 用Python绘制科赫曲线

0阶科赫曲线



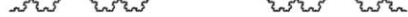
1阶科赫曲线



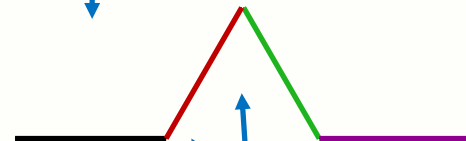
2阶科赫曲线



5阶科赫曲线



取1/3长



60度

每分隔一次为一阶

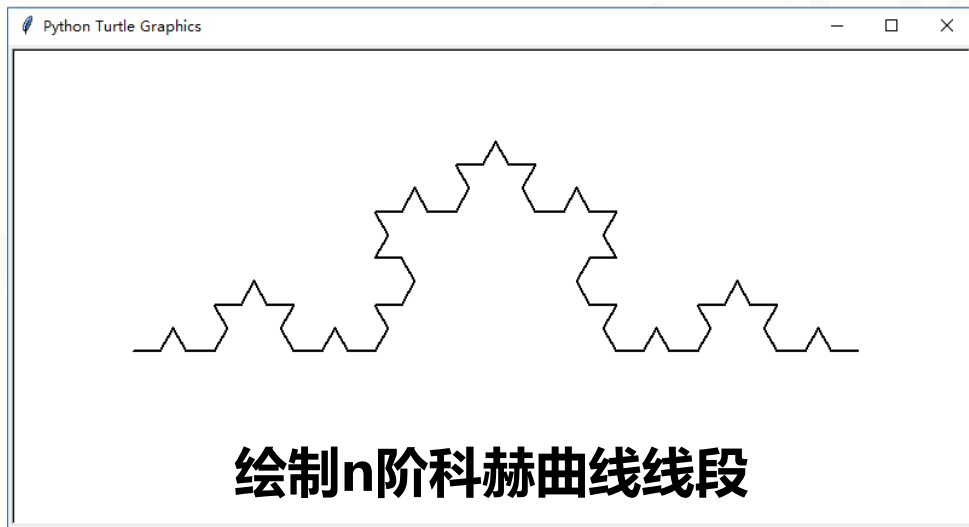


# "科赫雪花小包裹"实例讲解(上)



# 科赫雪花小包裹(上)

## 科赫曲线的绘制





# 科赫雪花小包裹(上)

#KochDrawV1.py

import turtle

def koch(size, n):

if n == 0:

turtle.fd(size)

else:

for angle in [0, 60, -120, 60]:

turtle.left(angle)

koch(size/3, n-1)

## 科赫曲线的绘制

- 递归思想：函数+分支
- 递归链条：线段的组合
- 递归基例：初始线段

```
#KochDrawV1.py
```

```
import turtle
```

```
def koch(size, n):
```

```
    if n == 0:
```

```
        turtle.fd(size)
```

```
    else:
```

```
        for angle in [0, 60, -120, 60]:
```

```
            turtle.left(angle)
```

```
            koch(size/3, n-1)
```

```
def main():
```

```
    turtle.setup(800,400)
```

```
    turtle.penup()
```

```
    turtle.goto(-300, -50)
```

```
    turtle.pendown()
```

```
    turtle.pensize(2)
```

```
    koch(600, 3)      # 3阶科赫曲线, 阶数
```

```
    turtle.hideturtle()
```

```
main()
```

# 科赫雪花小包裹(上)

## 科赫曲线的绘制



PY01B25 毕同

```
#KochDrawV2.py
```

```
import turtle
```

```
def koch(size, n):
```

```
    ... (略)
```

```
def main():
```

```
    turtle.setup(600,600)
```

```
    turtle.penup()
```

```
    turtle.goto(-200, 100)
```

```
    turtle.pendown()
```

```
    turtle.pensize(2)
```

```
    level = 3          # 3阶科赫雪花, 阶数
```

```
    koch(400, level)
```

```
    turtle.right(120)
```

```
    koch(400, level)
```

```
    turtle.right(120)
```

```
    koch(400, level)
```

```
    turtle.hideturtle()
```

```
main()
```

# 科赫雪花小包裹(上)

科赫曲线的绘制



科赫雪花的绘制

```
#KochDrawV2.py
```

```
import turtle
```

```
def koch(size, n):
```

```
    ... (略)
```

```
def main():
```

```
    turtle.setup(600,600)
```

```
    turtle.penup()
```

```
    turtle.goto(-200, 100)
```

```
    turtle.pendown()
```

```
    turtle.pensize(2)
```

```
    level = 3          # 3阶科赫雪花, 阶数
```

```
    koch(400, level)
```

```
    turtle.right(120)
```

```
    koch(400, level)
```

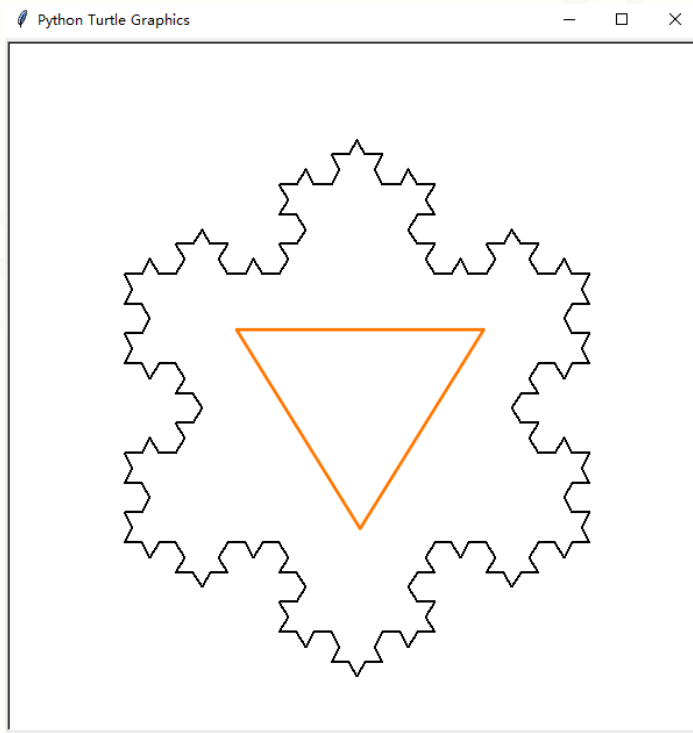
```
    turtle.right(120)
```

```
    koch(400, level)
```

```
    turtle.hideturtle()
```

```
main()
```

# 科赫雪花小包裹(上)



**准备好电脑，与老师一起编码吧！**



# "科赫雪花小包裹"实例讲解(下)

# 科赫雪花小包裹(下)

打包才能上路...

```
pyinstaller -i curve.ico -F KochDrawV2.py
```

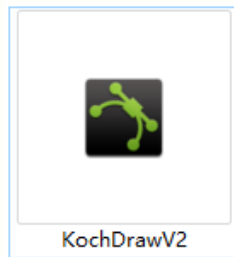


+



KochDrawV2

=



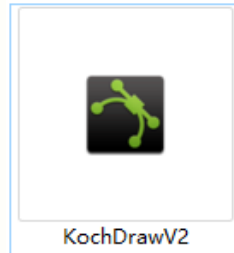
- 对编写后的科赫雪花代码进行打包处理



# 科赫雪花小包裹(下)

```
命令提示符 - pyinstaller -i curve.ico -F KochDrawV2.py

D:\PYECourse>pyinstaller -i curve.ico -F KochDrawV2.py
62 INFO: PyInstaller: 3.3.1
62 INFO: Python: 3.6.4
62 INFO: Platform: Windows-10-10.0.15063-SP0
62 INFO: wrote D:\PYECourse\KochDrawV2.spec
62 INFO: UPX is not available.
62 INFO: Extending PYTHONPATH with paths
['D:\\PYECourse', 'D:\\PYECourse']
62 INFO: checking Analysis
62 INFO: Building Analysis because out00-Analysis.toc is non
existent
62 INFO: Initializing module dependency graph...
62 INFO: Initializing module graph hooks...
62 INFO: Analyzing base_library.zip ...
```

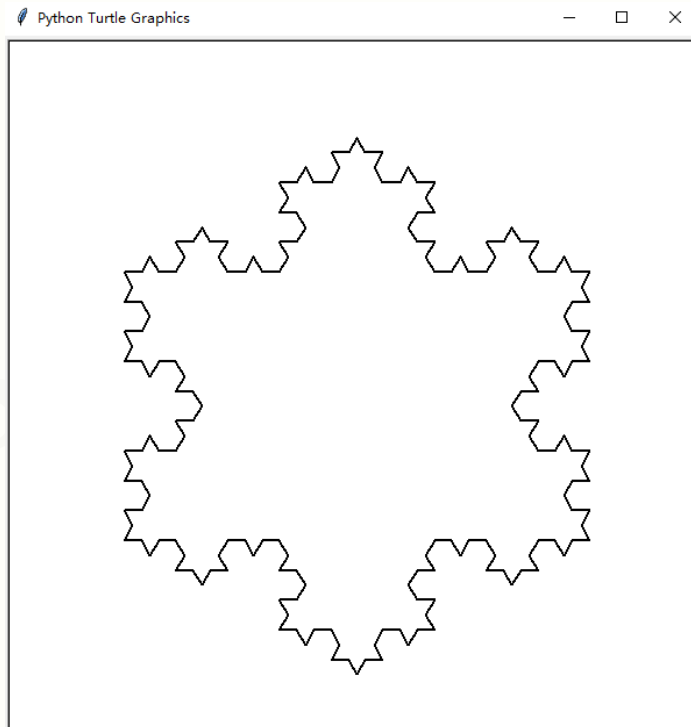


**准备好电脑，与老师一起编码吧！**



# "科赫雪花小包裹"举一反三

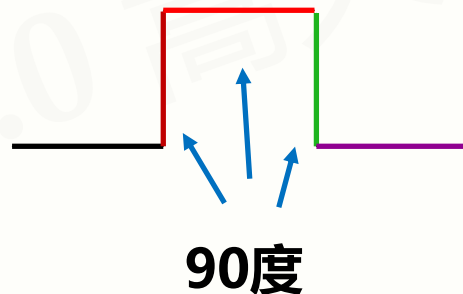
```
#KochDrawV2.py
import turtle
def koch(size, n):
    if n == 0:
        turtle.fd(size)
    else:
        for angle in [0, 60, -120, 60]:
            turtle.left(angle)
            koch(size/3, n-1)
def main():
    turtle.setup(600,600)
    turtle.penup()
    turtle.goto(-200, 100)
    turtle.pendown()
    turtle.pensize(2)
    level = 3      # 3阶科赫雪花, 阶数
    koch(400, level)
    turtle.right(120)
    koch(400, level)
    turtle.right(120)
    koch(400, level)
    turtle.hideturtle()
main()
```



# 举一反三

## 绘制条件的扩展

- 修改分形几何绘制阶数
- 修改科赫曲线的基本定义及旋转角度
- 修改绘制科赫雪花的基础框架图形



# 举一反三

## 分形几何千千万

- 康托尔集、谢尔宾斯基三角形、门格海绵...
- 龙形曲线、空间填充曲线、科赫曲线...
- 函数递归的深入应用...



