
python
import turtle
turtle.setup(650,350,200,200)
turtle.penup()
turtle.fd(-250)
turtle.pendown()
turtle.pensize(25)
turtle.pencolor("purple")
turtle.seth(-40)
for 1 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)

Python语言程序设计

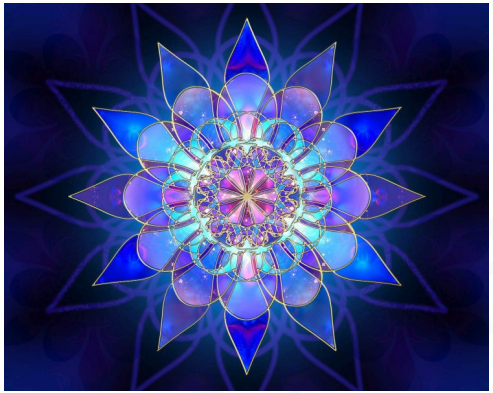
实例8: 科赫雪花小包裹

嵩 天
北京理工大学

"科赫雪花小包裹"问题分析

科赫雪花

高大上的分形几何

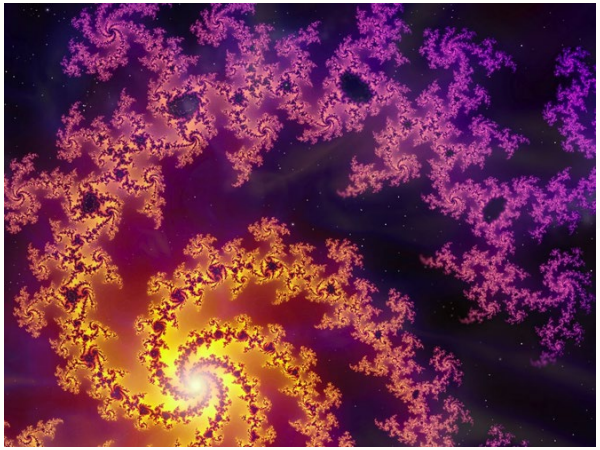


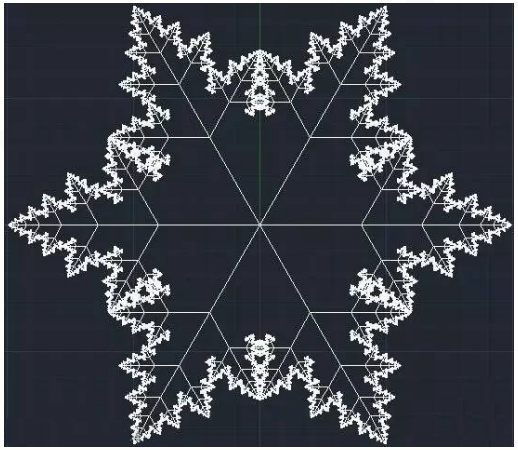


- 分形几何是一种迭代的几何图形，广泛存在于自然界中

科赫雪花

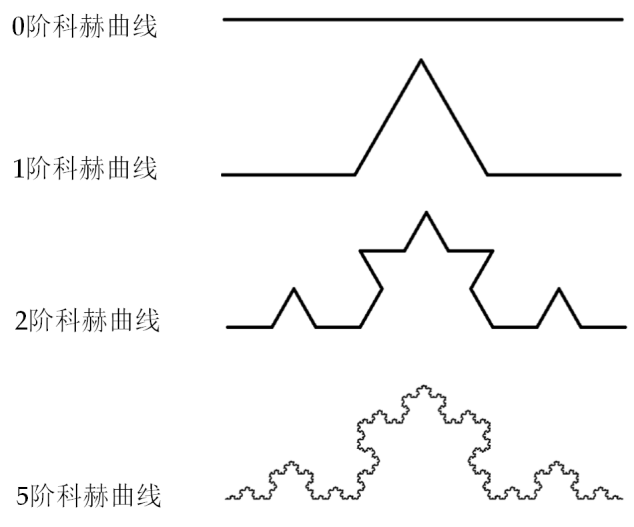
科赫曲线，也叫雪花曲线

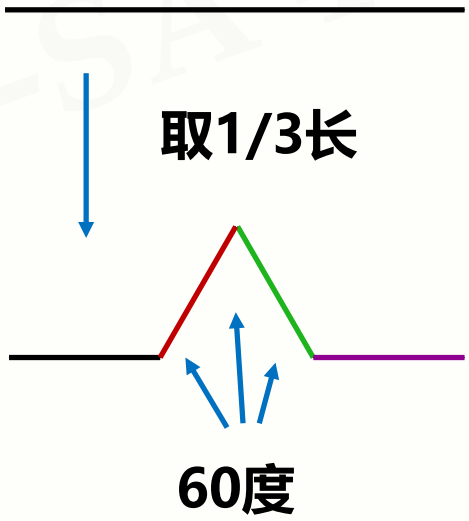




科赫雪花绘制

用Python绘制科赫曲线



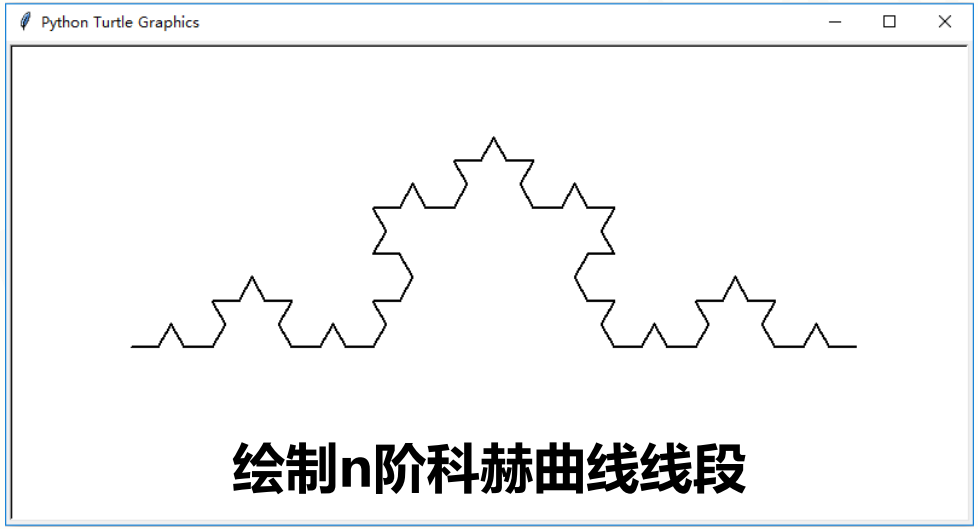


每分隔一次为一阶

"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

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)
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()
```

科赫曲线的绘制

科赫雪花小包裹(上)

```
#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()
```

科赫曲线的绘制

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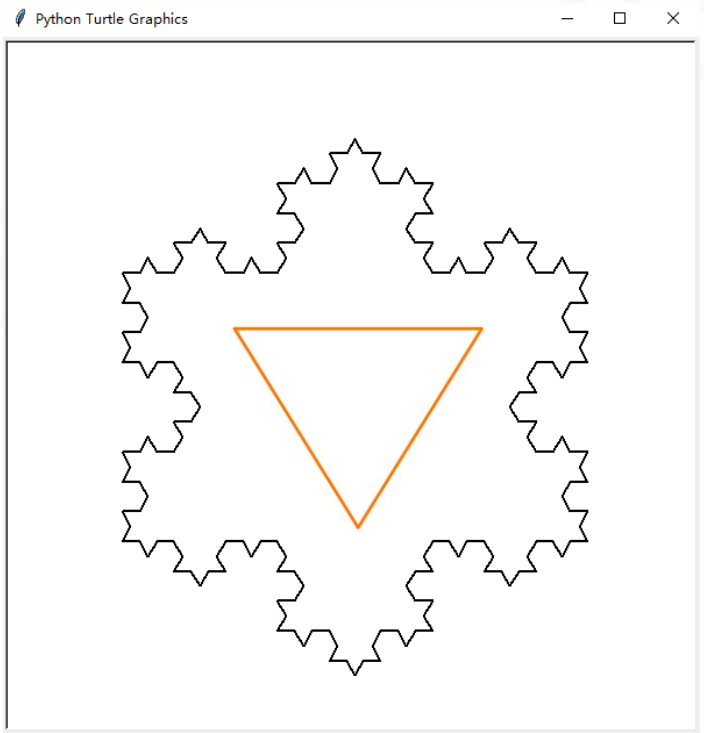
科赫雪花的绘制

科赫雪花小包裹(上)

```
#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()
```



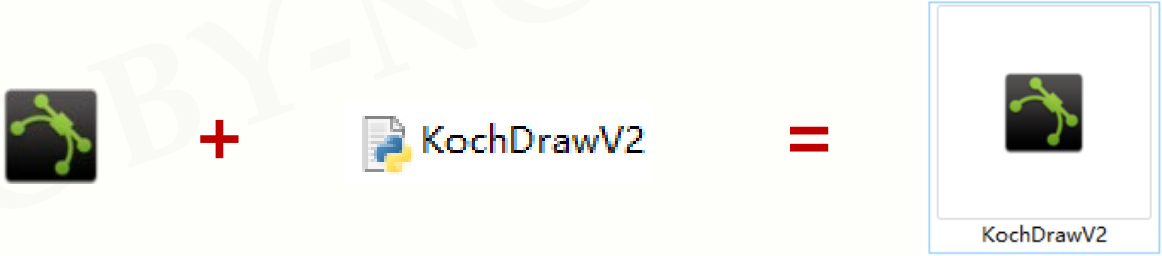
准备好电脑，与老师一起编码吧！

"科赫雪花小包裹"实例讲解(下)

科赫雪花小包裹(下)

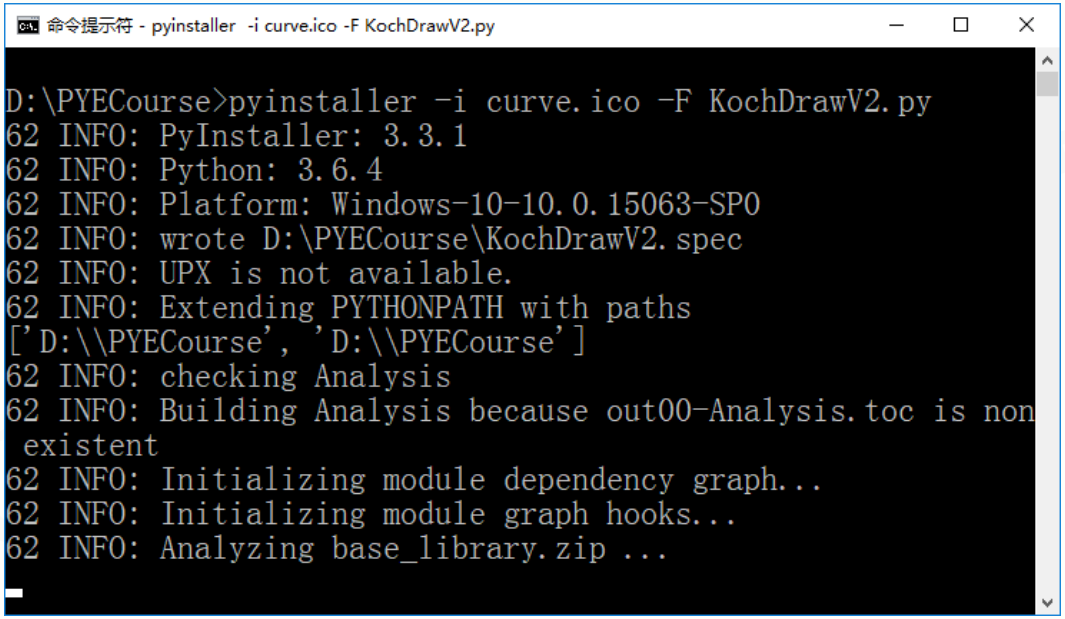
打包才能上路...

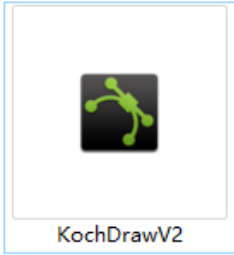
pyinstaller –i curve.ico –F KochDrawV2.py



- **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)

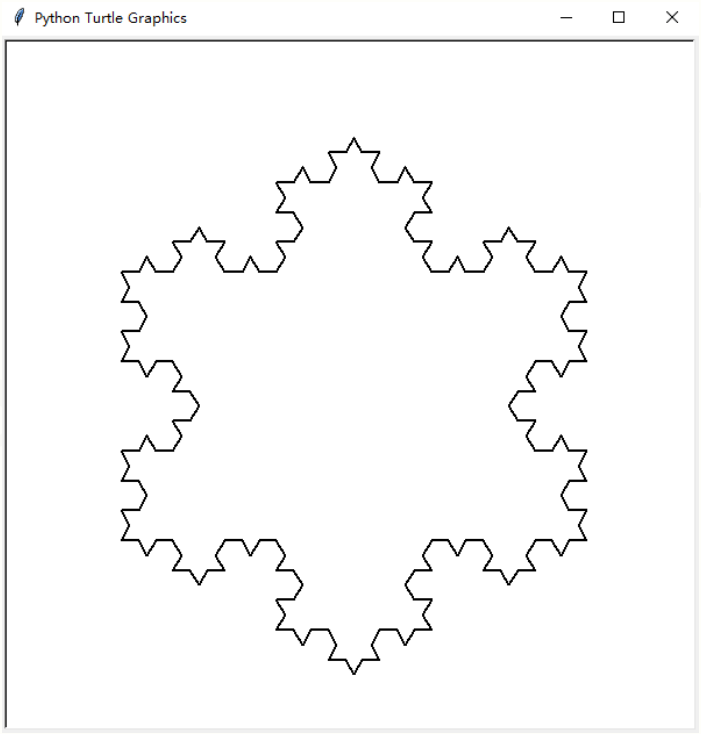

命令提示符 - pyinstaller -i curve.ico -F KochDrawV2.py
D:\PYECourse>pyinstaller -i curve.ico -F KochDrawV2.py
62 INFO: PyInstaller: 3.3.1
62 INFO: Python: 3.6.4
62 INFO: Platform: Windows-10-10.0.15063-SP0
62 INFO: wrote D:\PYECourse\KochDrawV2.spec
62 INFO: UPX is not available.
62 INFO: Extending PYTHONPATH 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 ...


KochDrawV2

准备好电脑，与老师一起编码吧！

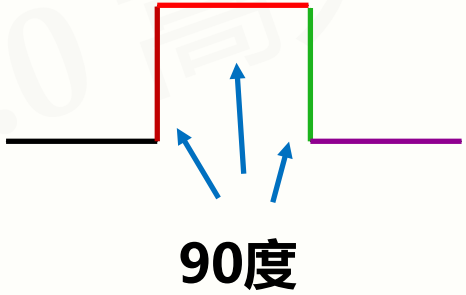
"科赫雪花小包裹"举一反三

```
#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...

小花絮

感觉Python很有趣，如何深入学习呢?

- 新时代学习方式：明确学习目标 + 在线课程 + 教材或教程
- 若以编程为职业：Python要学出深度，请关注嵩老师Python全内容体系
- 若以编程为能力：Python要学得宽泛，请关注嵩老师数据分析等内容
- 若以编程为素质：Python入门要学得精，请把这门课及教材好好看几遍

嵩老师倡导用最高效方式学好编程(及其他)，符合认知规律的教+有限时间专心的学=高效

鉴于躲避主观评价及争议原因，嵩老师暂不推荐其他学习资源，请多多理解!