软件工程上机报告

Project 1

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问题描述

> **In a box bounded by $[-1, 1]$, given $m$ balloons(they cannot overlap) with variable radio $r$ and position $mu$, find the optimal value of $r$ and mu which maximize sum r^{2}**

问题分析

可以在方框的空白部分寻找最大的空白，然后用最大的圆进行填充，如图所示：

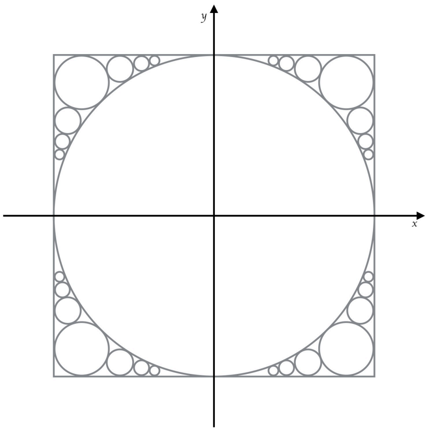


图1

我们按上述方案从大到小依次填满空隙，但是可能会出现下面的情况：

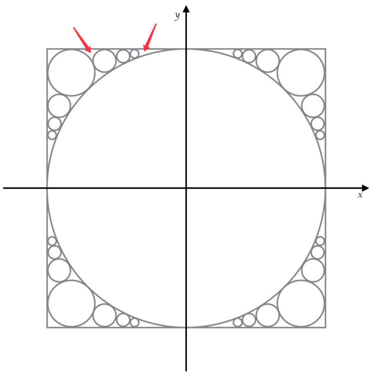


图2

箭头表明的部分右边的可能会出现比左箭头小的情况，这种情况由于计算过于复杂，所以我们寻求次优解，将圆按图1的方式填满

图1由大到小的顺序顺序依次填，可以分为多种圆，各种圆的个数分别为$1,4,8,8,8,\dots$

第一个圆的半径为$R1=r1=1$，第二总圆的半径为$R2=r2=r3=r4=r_5=\frac{\sqrt{2}-1}{\sqrt{2}+1}$

当圆的类别大于三时，可以用一下公式计算半径

$$\left{
\begin{array}{1}
Rn = \left(\frac{1-C{n-1}}{2(1+R{n-1})} \right)2, n=3,4,5,\dots \
Cn = \sum{i=2}{n-1}2\sqrt{RiR{i-1}}+R2, n=3,4,5,\dots \
C2 = R2 \
r{5+8(n-3)+i} = Rn, i=1,2,\dots,8, n=3,4,5,\dots
\end{array}
\right.
$$

关键函数实现

```python
def sub_solution_r(m):
    circles = []
    R = [1]
    circles.append(Circle(radius=1))
    sym_x = [1, 1, -1, -1]
    sym_y = [1, -1, 1, -1]
    if m == 0:
        return []
    if m == 1:
        return circles
```

```
    if m > 1:
        R1 = 3 - 2 * math.sqrt(2)
        R.append(R1)
        y = x = 1 - R1
        for i in range(0, 4):
            circles.append(Circle((x * sym_x[i], y * sym_y[i]), R1))
            if len(circles) == m:
                break

    if m > 5:
        pend_height = 0
        k = m - 5
        if k % 8 == 0:
            k = int(k / 8)
        else:
            k = int(k / 8) + 1
        pend_current = R[1]
        for i in range(1, k+1):
            r = ((1 - pend_current)/ (2 * (1+math.sqrt(R[i])))) ** 2
            pend_current += 2 * math.sqrt(r * R[i])
            R.append(r)
            x = 1 - r
            y = 1 - pend_current
            for j in range(4):
                circles.append(Circle((x * sym_x[j], y * sym_y[j]), r))
                if len(circles) == m:
                    break
                circles.append(Circle((y * sym_y[j], x * sym_x[j]), r))
                if len(circles) == m:
                    break
    return circles
```

测试用例：

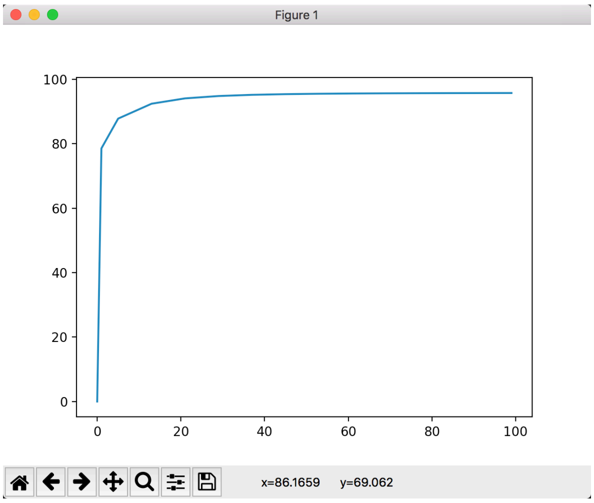
n	m	R_n
1	1	1
2	2 ~ 6	$3-2\sqrt{2}$
3	7 ~15	$0.0857864376\dots$
4	16 ~ 24	$0.0513207883\dots$

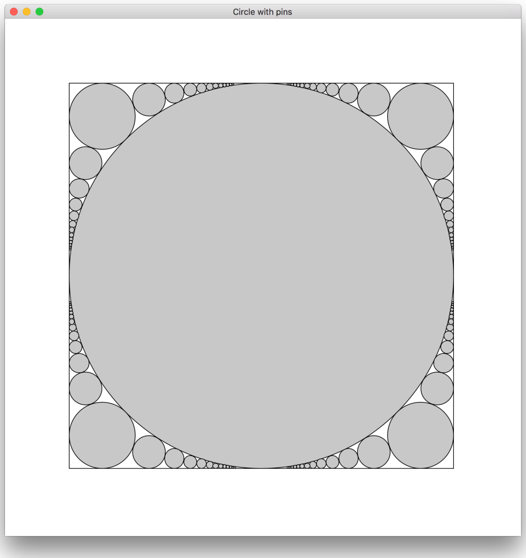
运行结果：

```
Center: ( 0.000000,  0.000000)  Radius:1.0000000000
Center: ( 0.828427,  0.828427)  Radius:0.1715728753
Center: ( 0.828427, -0.828427)  Radius:0.1715728753
Center: (-0.828427,  0.828427)  Radius:0.1715728753
Center: (-0.828427, -0.828427)  Radius:0.1715728753
Center: ( 0.914214,  0.414214)  Radius:0.0857864376
Center: ( 0.414214,  0.914214)  Radius:0.0857864376
Center: ( 0.914214, -0.414214)  Radius:0.0857864376
Center: (-0.414214,  0.914214)  Radius:0.0857864376
Center: (-0.914214,  0.414214)  Radius:0.0857864376
Center: ( 0.414214, -0.914214)  Radius:0.0857864376
Center: (-0.914214, -0.414214)  Radius:0.0857864376
Center: (-0.414214, -0.914214)  Radius:0.0857864376
Center: ( 0.948679,  0.281509)  Radius:0.0513207883
Center: ( 0.281509,  0.948679)  Radius:0.0513207883
Center: ( 0.948679, -0.281509)  Radius:0.0513207883
Center: (-0.281509,  0.948679)  Radius:0.0513207883
Center: (-0.948679,  0.281509)  Radius:0.0513207883
Center: ( 0.281509, -0.948679)  Radius:0.0513207883
Center: (-0.948679, -0.281509)  Radius:0.0513207883
Center: (-0.281509, -0.948679)  Radius:0.0513207883
Center: ( 0.965886,  0.197825)  Radius:0.0341137321
Center: ( 0.197825,  0.965886)  Radius:0.0341137321
Center: ( 0.965886, -0.197825)  Radius:0.0341137321
Center: (-0.197825,  0.965886)  Radius:0.0341137321
Center: (-0.965886,  0.197825)  Radius:0.0341137321
Center: ( 0.197825, -0.965886)  Radius:0.0341137321
Center: (-0.965886, -0.197825)  Radius:0.0341137321
Center: (-0.197825, -0.965886)  Radius:0.0341137321
Center: ( 0.975694,  0.140235)  Radius:0.0243059818
...
```

结论

当m从0增长到99时，计算每个m值下的覆盖率，得出一下函数图像：





从图中可以看出，用此种方案填放并不能达到最优，当m达到一定大小时，对覆盖率的提供并不大，空缺的部分就是图2中类似左箭头的部分已经成为主要的空缺部分

附录

Gitlog

Git

```
commit 9e9c441469f16ee13c8797c1fb0817bc846a0eb2
Author: BluesJiang <763400095@qq.com>
Date:   Thu Jun 1 11:43:50 2017 +0800

    fix when m < 3 ,result goes wrong

commit 834494816cb0729923c505ecef89a2ee0131e7bd
Author: BluesJiang <763400095@qq.com>
Date:   Thu Jun 1 10:56:47 2017 +0800

    bug fixed

commit 017a074fc3b1b28dc07fd1314ae2fb13aa485ecd
Author: BluesJiang <763400095@qq.com>
Date:   Thu Jun 1 10:30:55 2017 +0800

    clear the formula

commit c851ac95780a02f307bbac35886900cb99cc4af2
Author: BluesJiang <763400095@qq.com>
Date:   Fri May 5 20:45:27 2017 +0800

    sub_solution
```