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Python基础

邹博

本次说明

- 本PPT后面仅列举使用Python库的效果截图，详细内容请参考该PPT的配套代码。

Python库

- Pip
  - 安装Python包的推荐工具：https://pypi.python.org/pypi/pip
- Numpy
  - 为Python提供快速的多维数组处理能力
- Pandas：PythoN Data AnalysiS Library
  - 在Numpy基础上提供了更多的数据读写工具
- Scipy
  - 在NumPy基础上添加了众多科学计算工具包
- Matplotlib
  - Python丰富的绘图库
- 官网：
  - Numpy/Scipy：http://www.scipy.org
  - Pandas：http://pandas.pydata.org/
  - Matplotlib：http://www.matplotlib.org

pip

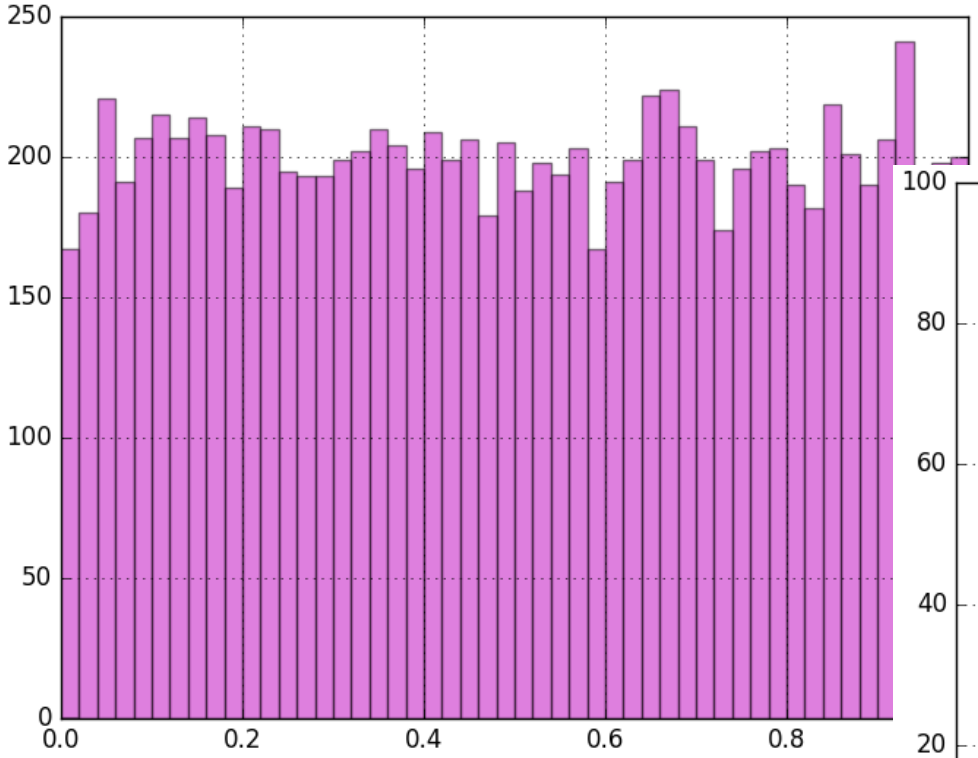
```
C:\Users\zouwang>pip install pandas --upgrade
Collecting pandas
  Downloading pandas-0.19.1-cp27-cp27m-win32.whl (6.7MB)
    100% |████████████████████████████████| 6.7MB 81kB/s
Collecting python-dateutil (from pandas)
  Downloading python_dateutil-2.6.0-py2.py3-none-any.whl (194kB)
    100% |████████████████████████████████| 194kB 103kB/s
Collecting numpy>=1.7.0 (from pandas)
  Downloading numpy-1.11.2-cp27-none-win32.whl (6.5MB)
    100% |████████████████████████████████| 6.5MB 103kB/s
Collecting pytz>=2011k (from pandas)
  Downloading pytz-2016.7-py2.py3-none-any.whl (480kB)
    100% |████████████████████████████████| 481kB 244kB/s
Requirement already up-to-date: six>=1.5 in c:\python27\lib\site-packages (from python-dateutil->pandas)
Installing collected packages: python-dateutil, numpy, pytz, pandas
  Found existing installation: python-dateutil 2.5.2
    Uninstalling python-dateutil-2.5.2:
      Successfully uninstalled python-dateutil-2.5.2
  Found existing installation: numpy 1.11.1+mkl
    Uninstalling numpy-1.11.1+mkl:
      Successfully uninstalled numpy-1.11.1+mkl
  Found existing installation: pytz 2016.3
    Uninstalling pytz-2016.3:
      Successfully uninstalled pytz-2016.3
  Found existing installation: pandas 0.18.1
    Uninstalling pandas-0.18.1:
      Successfully uninstalled pandas-0.18.1
Successfully installed numpy-1.11.2 pandas-0.19.1 python-dateutil-2.6.0 pytz-2016.7
```

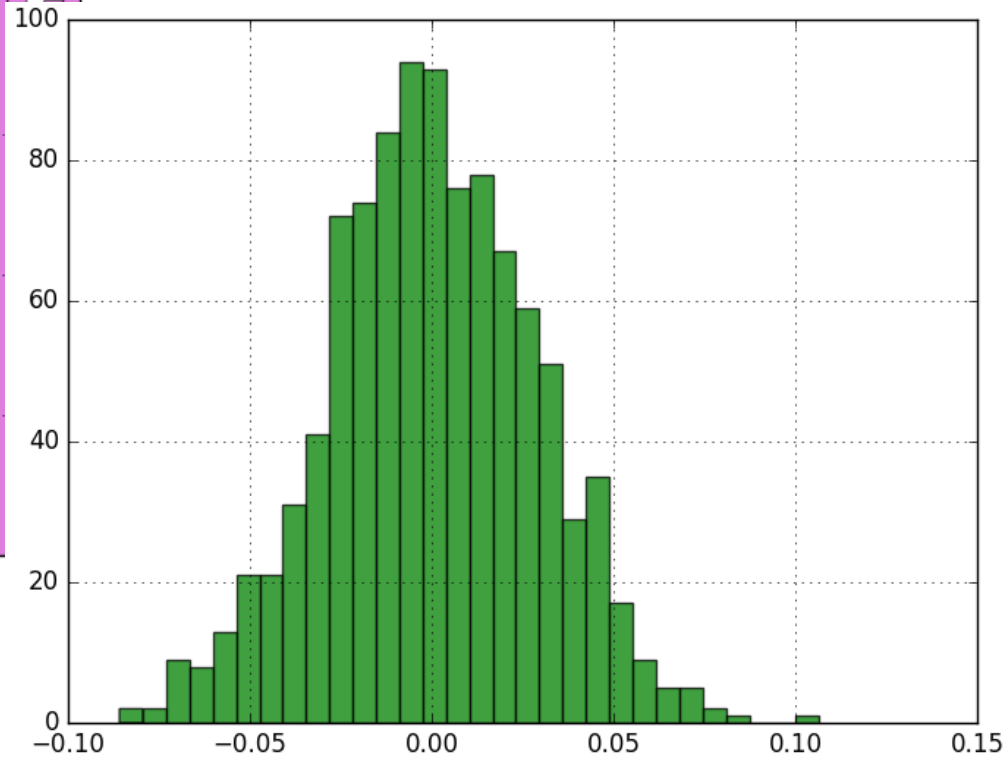
数据生成

- *a = np.arange(0, 60, 10).reshape((-1, 1)) + np.arange(6)*
- A=

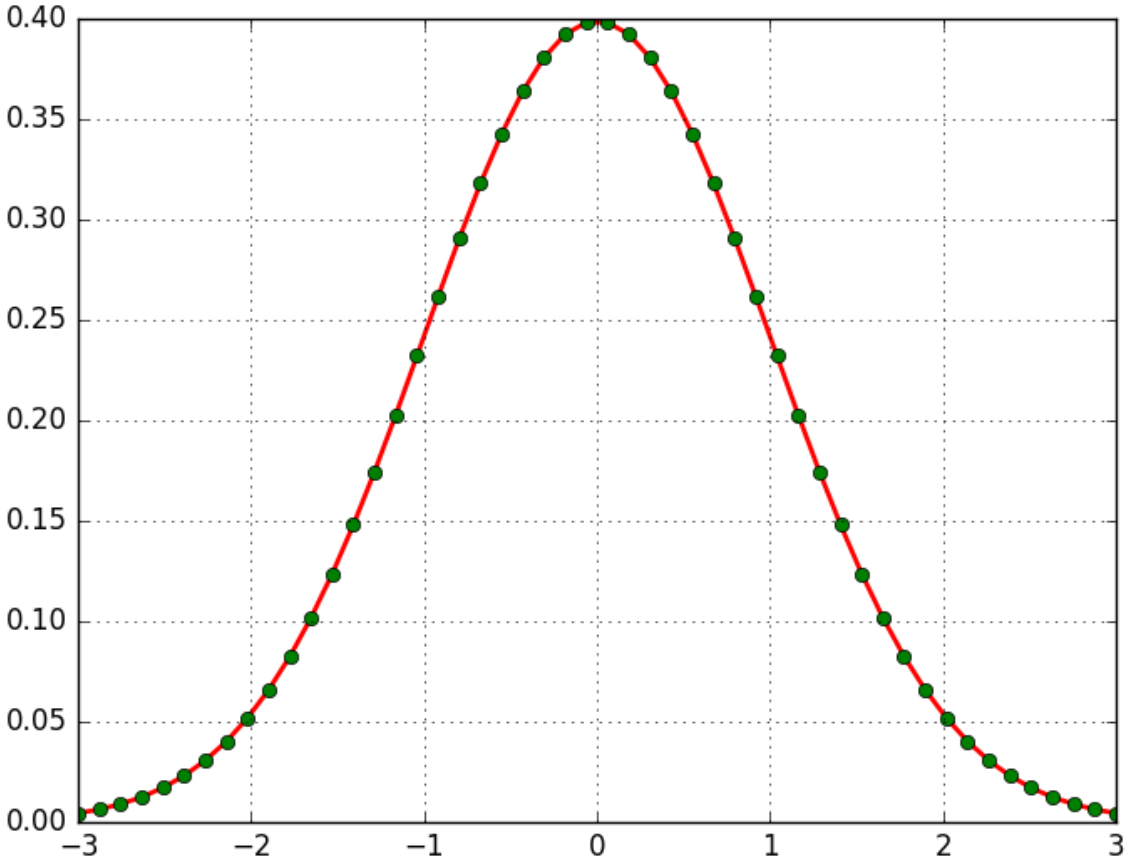
```
[[ 0  1  2  3  4  5]
[10 11 12 13 14 15]
[20 21 22 23 24 25]
[30 31 32 33 34 35]
[40 41 42 43 44 45]
[50 51 52 53 54 55]]
```

验证中心极限定理

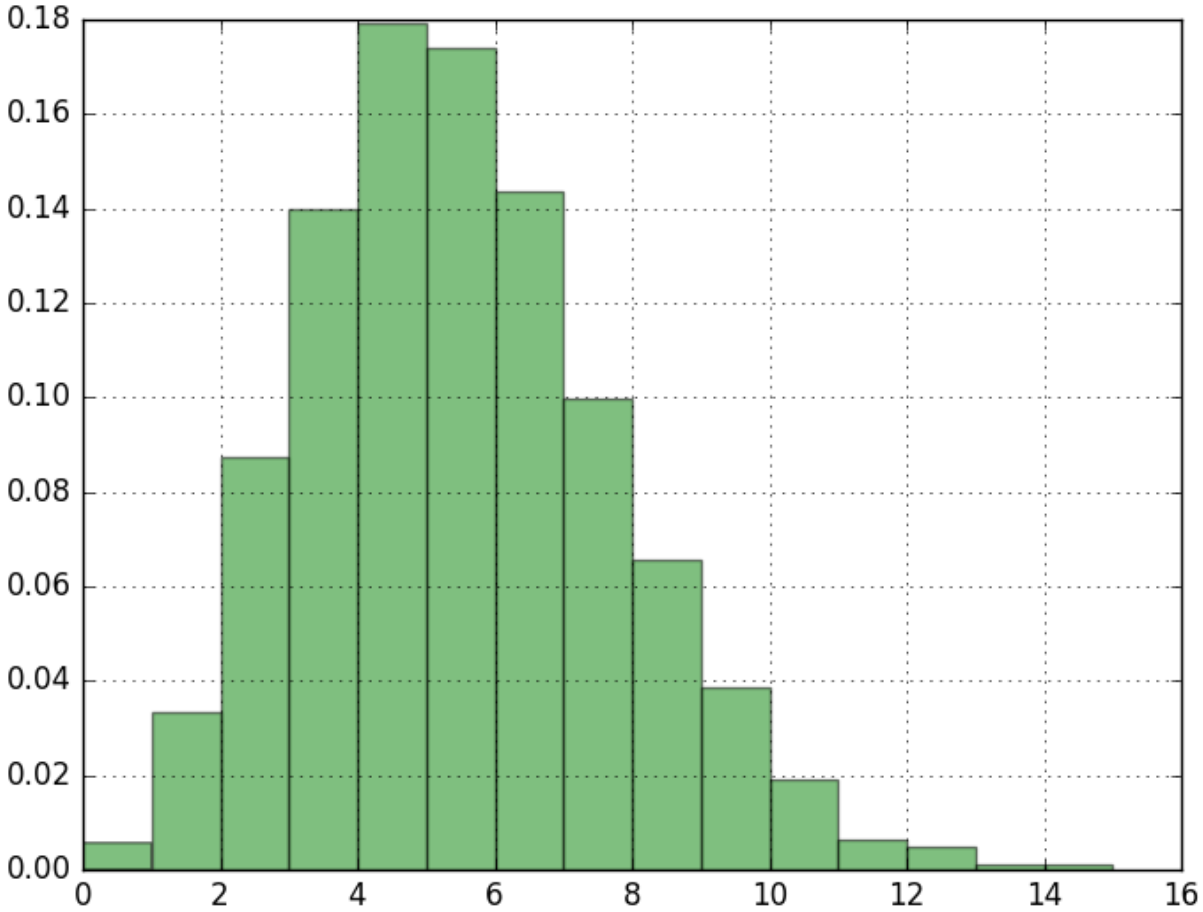

250
200
150
100
50
0
0.0
0.2
0.4
0.6
0.8


100
80
60
40
20
0
−0.10
−0.05
0.00
0.05
0.10
0.15

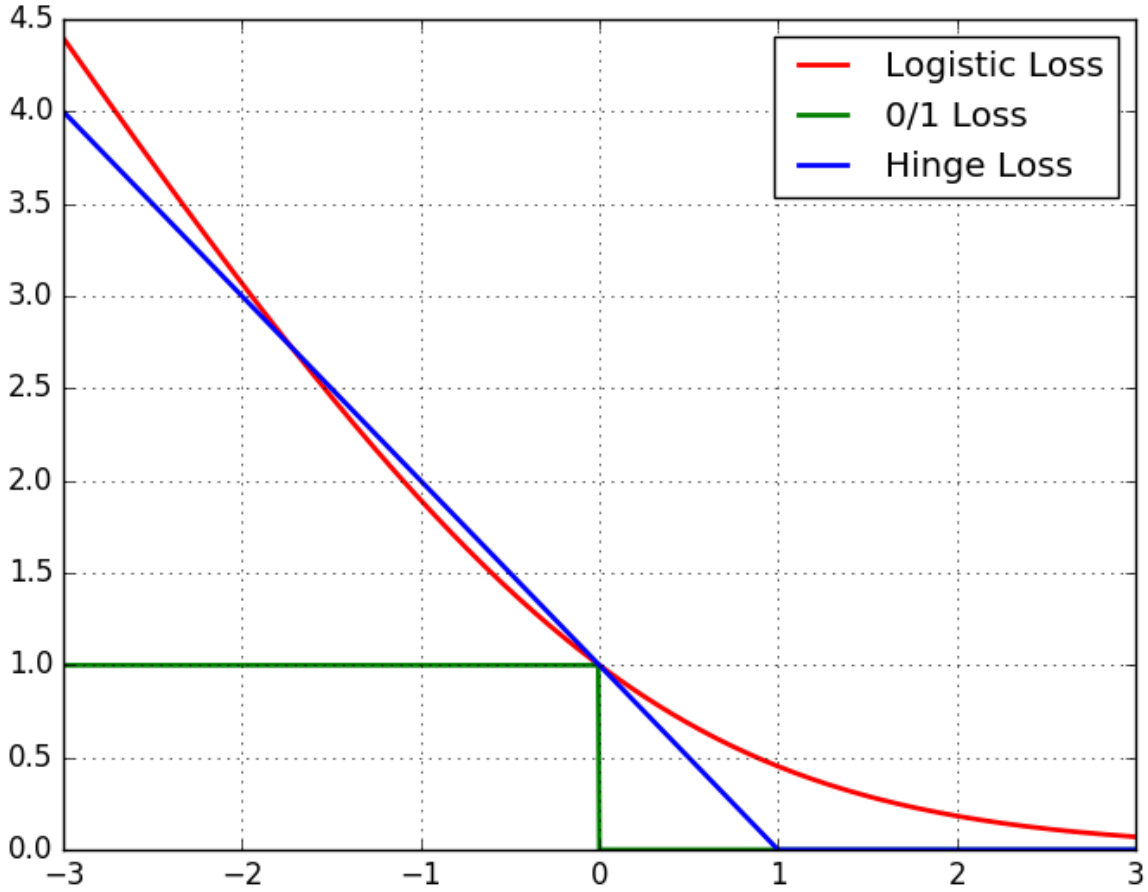
正态分布的概率密度函数



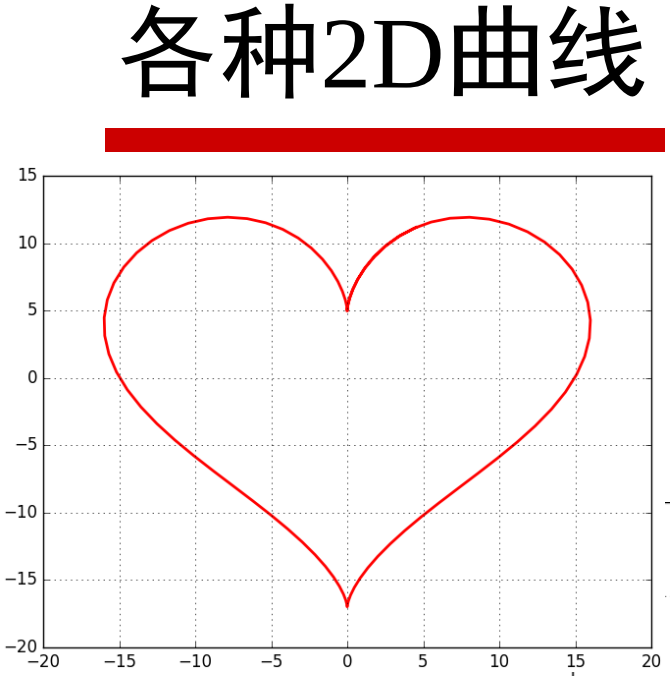
Poisson分布的概率质量函数

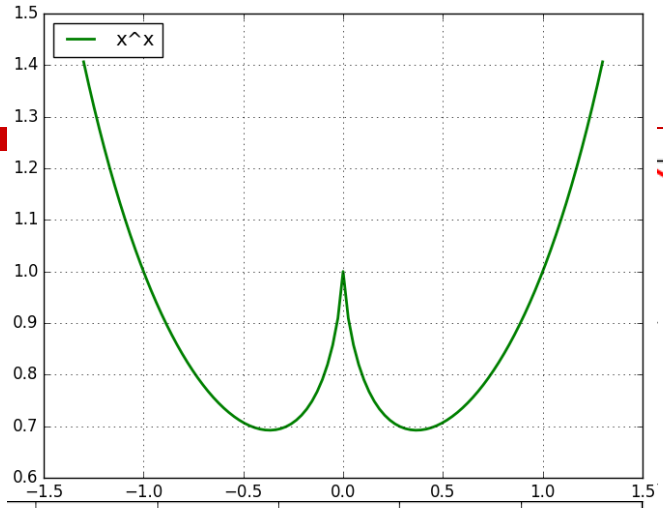


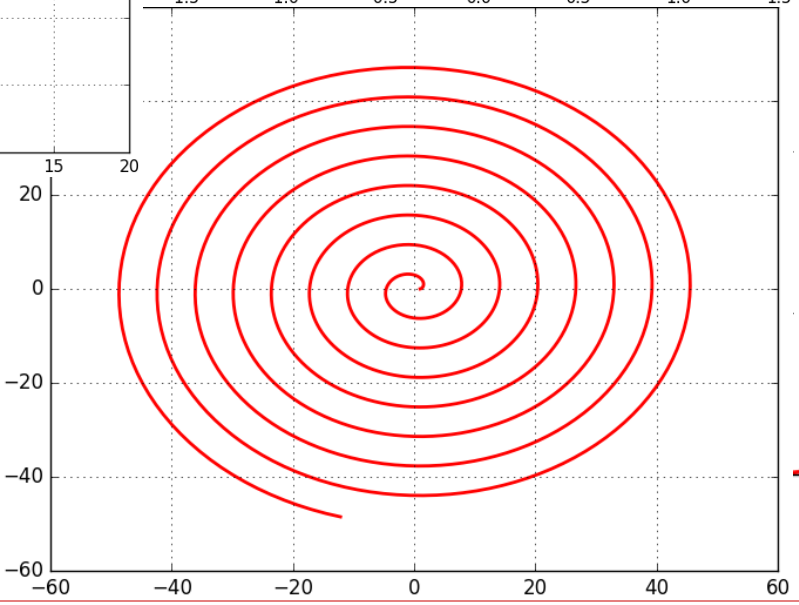
机器学习中的损失函数

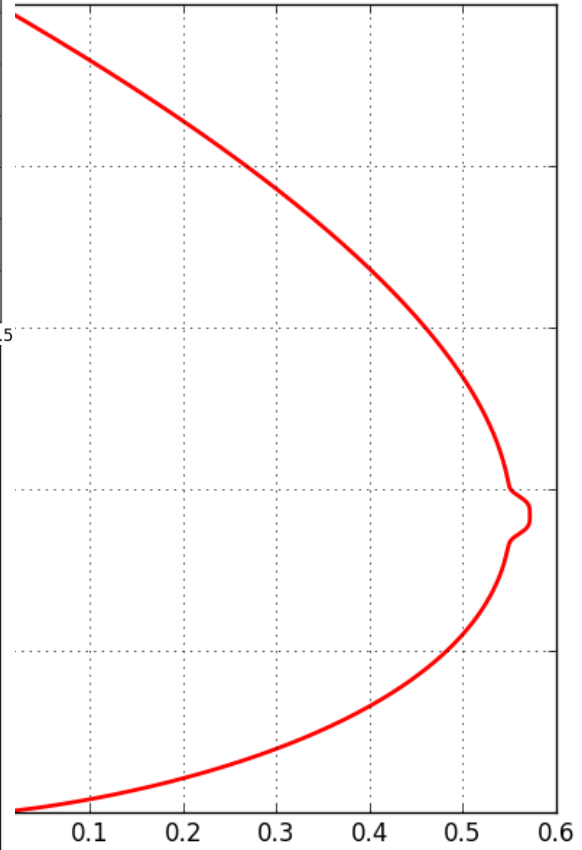

Logistic Loss
0/1 Loss
Hinge Loss
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
−3
−2
−1
0
1
2
3

各种2D曲线

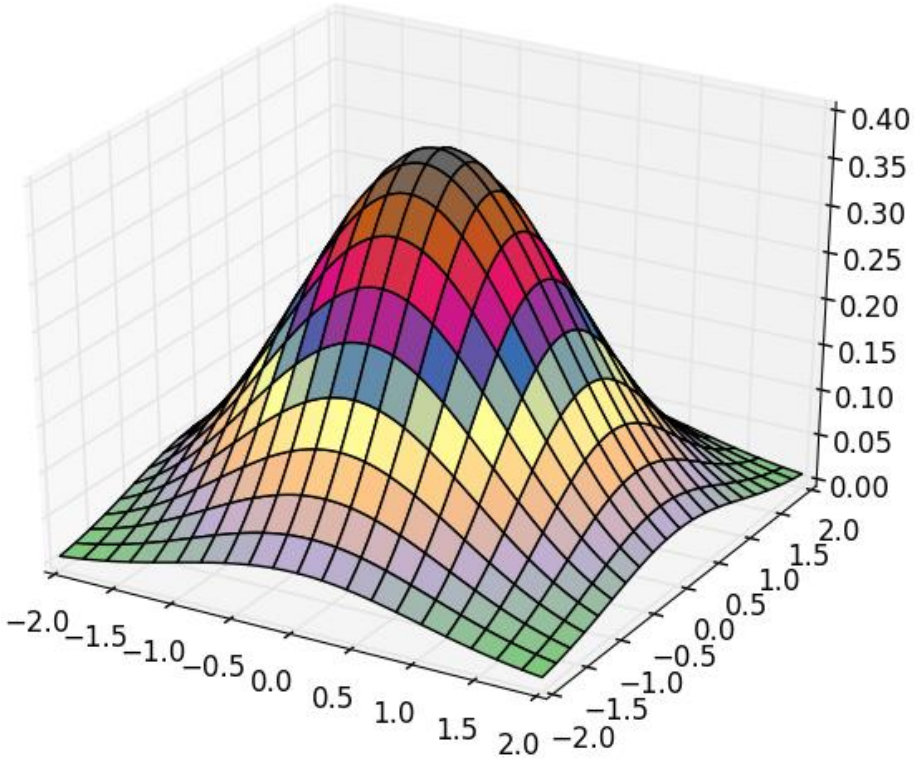

15
10
5
0
−5
−10
−15
−20
−20
−15
−10
−5
0
5
10
15
20

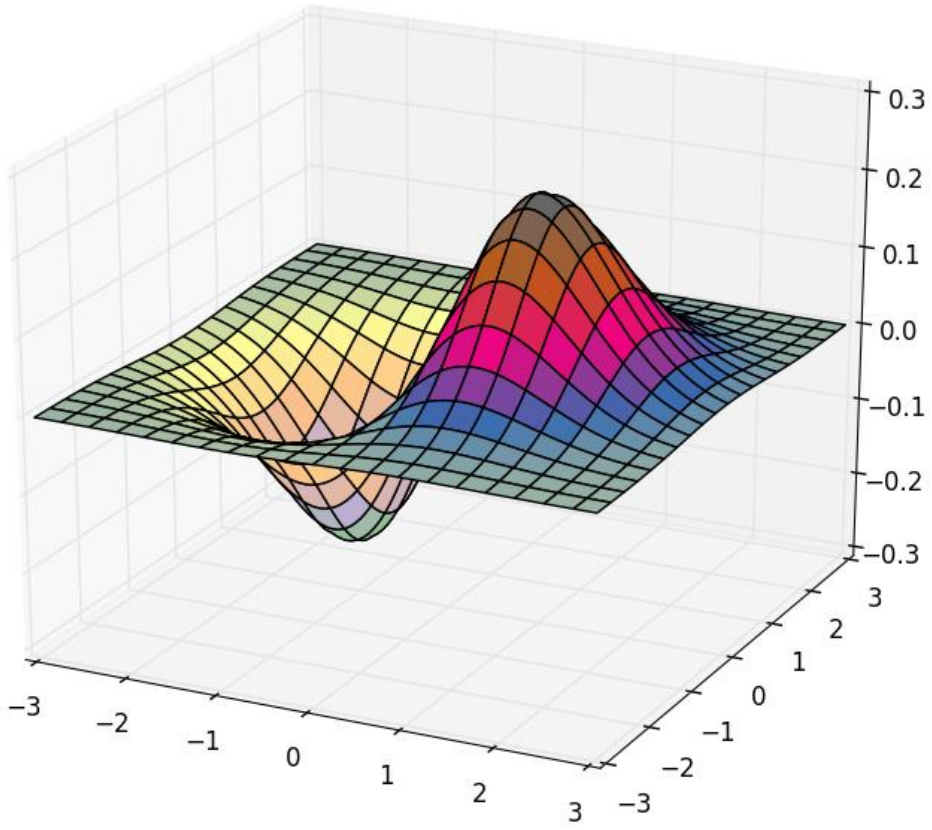

x^x
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
−1.5
−1.0
−0.5
0.0
0.5
1.0
1.5


20
0
−20
−40
−60
−60
−40
−20
0
20
40
60


0.1
0.2
0.3
0.4
0.5
0.6

3D


0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
−2.0
−1.5
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0

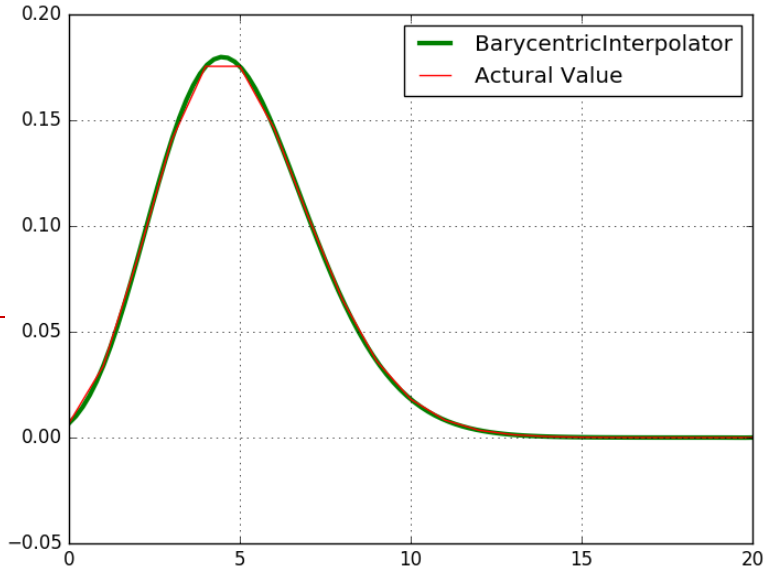

0.3
0.2
0.1
0.0
−0.1
−0.2
−0.3
−3
−2
−1
0
1
2
3

类/继承类

```
class People:
    def __init__(self, n, a, s):
        self.name = n
        self.age = a
        self.__score = s
        self.print_people()
        # self.__print_people()   # 私有函数的作用

    def print_people(self):
        str = u'%s的年龄：%d，成绩为：%.2f' % (self.name, self.age, self.__score)
        print str

    __print_people = print_people


class Student(People):
    def __init__(self, n, a, w):
        People.__init__(self, n, a, w)
        self.name = 'Student ' + self.name

    def print_people(self):
        str = u'%s的年龄：%d' % (self.name, self.age)
        print str


def func(p):
    p.age = 11


if __name__ == '__main__':
    p = People('Tom', 10, 3.14159)
    func(p)     # p传入的是引用类型
    p.print_people()

    # 注意分析下面语句的打印结果，是否觉得有些“怪异”？
    j = Student('Jerry', 12, 2.71828)

    # 成员函数
    j.print_people()
    People.print_people(j)
```

```
Tom的年龄：10，成绩为：3.14
Tom的年龄：11，成绩为：3.14

Jerry的年龄：12

Tom的年龄：11，成绩为：3.14
Student Jerry的年龄：12

Tom的年龄：11，成绩为：3.14
Student Jerry的年龄：12，成绩为：2.72
```

重心插值



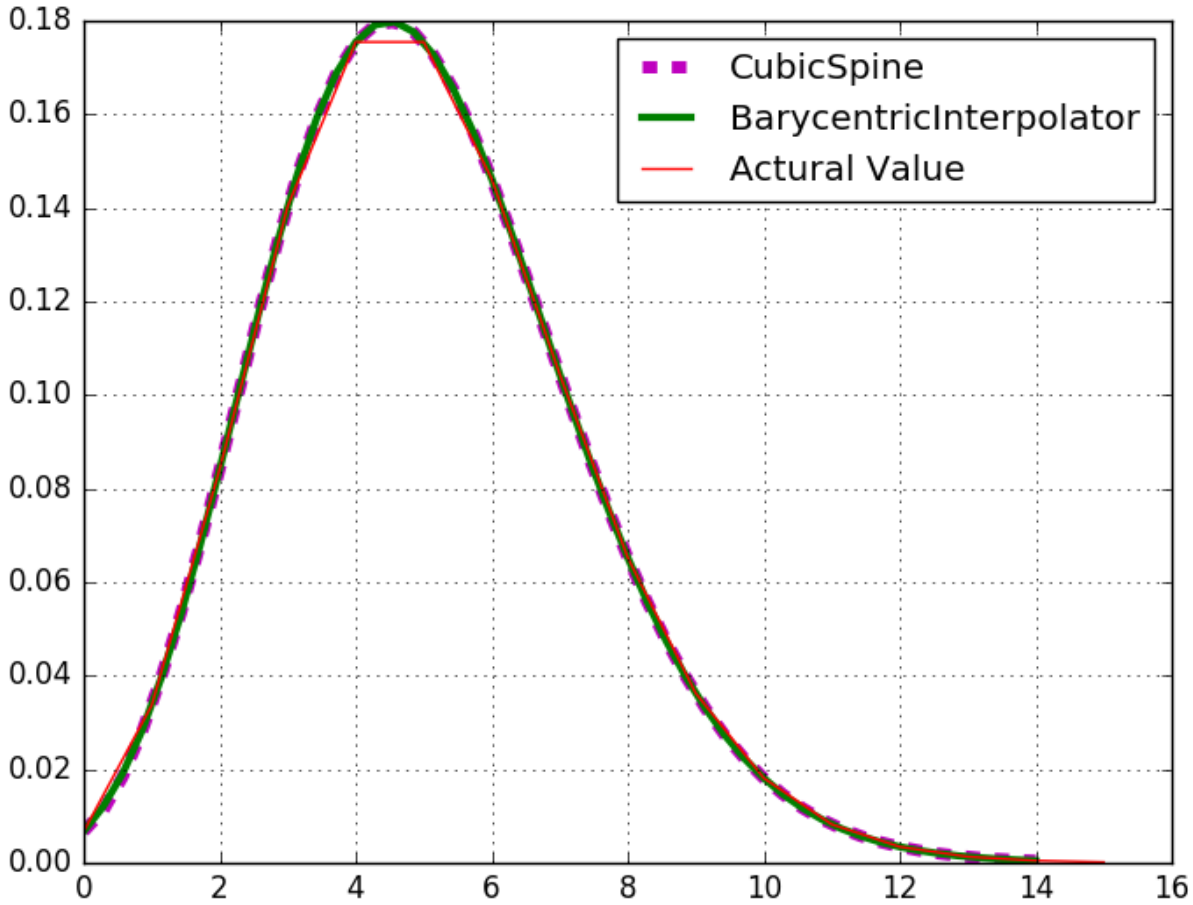
- 给定实数对 $\{(x_j, y_j),\ j=0,1,\cdots n\}$
  - x_j互不相同。
- 对于给定的n+1个权值 $\{u_j \neq 0,\ j=0,1,\cdots n\}$

  有：

$$f(x)=\frac{\sum_{j=0}^{n}\frac{u_j}{x-x_j}y_j}{\sum_{j=0}^{n}\frac{u_j}{x-x_j}}$$

- 则函数f(x)在x_k处的值为y_k。
  - 对于权值，可以选择 $\{u_j=(-1)^k,\ j=0,1,\cdots n\}$

样条插值 – 重心插值


CubicSpine
BarycentricInterpolator
Actural Value
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0
2
4
6
8
10
12
14
16

Taylor展式

- 数值计算：初等函数值的计算(在原点展开)

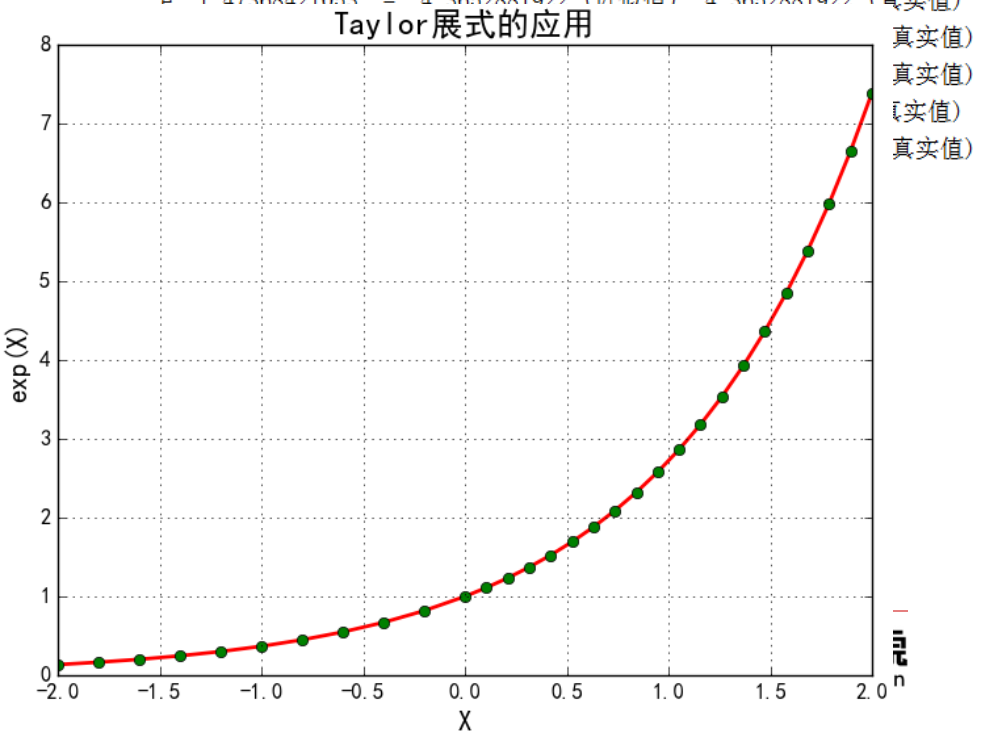
$$\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \frac{x^9}{9!} + \cdots + (-1)^{m-1}\frac{x^{2m-1}}{(2m-1)!} + R_{2m}$$

$$e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \cdots + \frac{x^n}{n!} + R_n$$

Taylor展式的应用

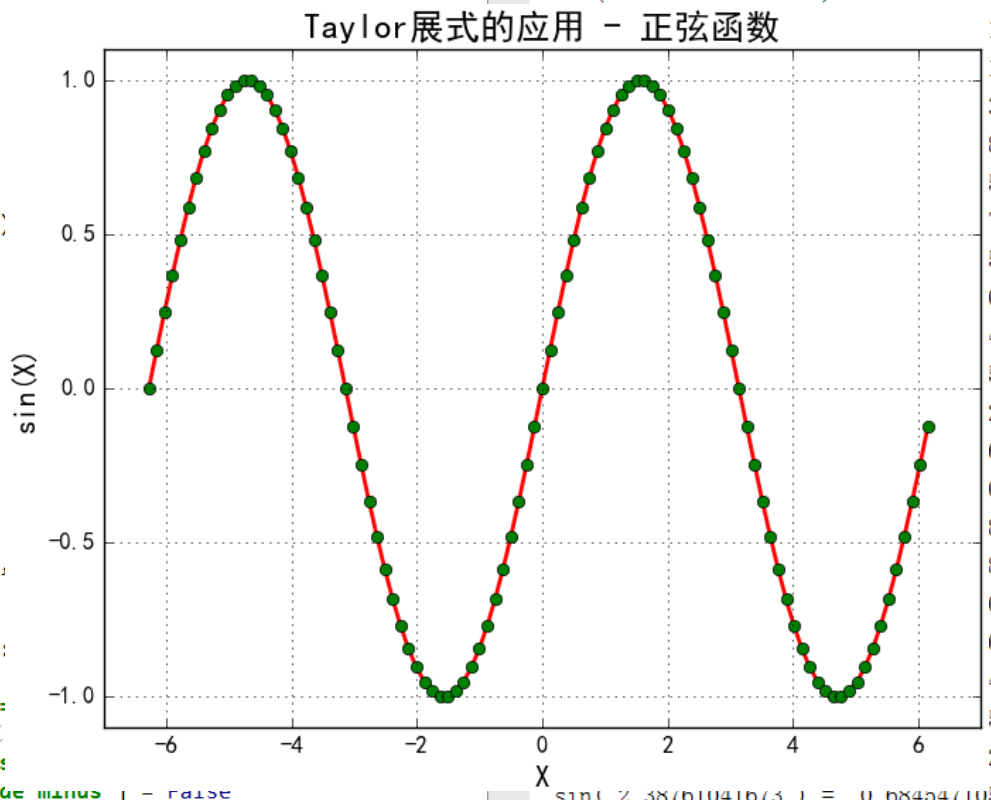
```
e^ -0.8  =  0.449328964117 (近似值) 0.449328964117 (真实值)
e^ -0.6  =  0.548811636094 (近似值) 0.548811636094 (真实值)
e^ -0.4  =  0.670320046036 (近似值) 0.670320046036 (真实值)
e^ -0.2  =  0.818730753078 (近似值) 0.818730753078 (真实值)
e^ 0.0  =  1.0 (近似值) 1.0 (真实值)
e^ 0.105263157895  =  1.11100294108 (近似值)  1.11100294108 (真实值)
e^ 0.210526315789  =  1.2343275351 (近似值) 1.2343275351 (真实值)
e^ 0.315789473684  =  1.37134152176 (近似值)  1.37134152176 (真实值)
e^ 0.421052631579  =  1.5235644639 (近似值) 1.5235644639 (真实值)
e^ 0.526315789474  =  1.69268460033 (近似值)  1.69268460033 (真实值)
e^ 0.631578947368  =  1.88057756929 (近似值)  1.88057756929 (真实值)
e^ 0.736842105263  =  2.08932721042 (近似值)  2.08932721042 (真实值)
e^ 0.842105263158  =  2.32124867566 (近似值)  2.32124867566 (真实值)
e^ 0.947368421053  =  2.57891410565 (近似值)  2.57891410565 (真实值)
e^ 1.05263157895  =  2.86518115618 (近似值) 2.86518115618 (真实值)
e^ 1.15789473684  =  3.18322469126 (近似值) 3.18322469126 (真实值)
e^ 1.26315789474  =  3.53657199412 (近似值) 3.53657199412 (真实值)
e^ 1.36842105263  =  3.92914188683 (近似值) 3.92914188683 (真实值)
e^ 1.47368421053  =  4.3652881922 (近似值)  4.3652881922 (真实值)
```

```python
def calc_e_small(x):
    n = 10
    f = np.arange(1, n+1).cumprod()
    b = np.array([x]*n).cumprod()
    return np.sum(b / f) + 1


def calc_e(x):
    reverse = False
    if x < 0:   # 处理负数
        x = -x
        reverse = True
    ln2 = 0.69314718055994530941723212145818
    c = x / ln2
    a = int(c+0.5)
    b = x - a*ln2
    y = (2 ** a) * calc_e_small(b)
    if reverse:
        return 1/y
    return y


if __name__ == "__main__":
    t1 = np.linspace(-2, 0, 10, endpoint=False)
    t2 = np.linspace(0, 2, 20)
    t = np.concatenate((t1, t2))
    print t     # 横轴数据
    y = np.empty_like(t)
    for i, x in enumerate(t):
        y[i] = calc_e(x)
        print 'e^', x, ' = ', y[i], '(近似值)\t', math.exp(x)
        # print '误差: ', y[i] - math.exp(x)
    mpl.rcParams['font.sans-serif'] = [u'SimHei']
    mpl.rcParams['axes.unicode_minus'] = False
    plt.plot(t, y, 'r-', t, y, 'go', linewidth=2)
    plt.title(u'Taylor展式的应用', fontsize=18)
    plt.xlabel('X', fontsize=15)
    plt.ylabel('exp(X)', fontsize=15)
    plt.grid(True)
    plt.show()
```



Taylor展式的应用

```
def calc_sin_small(x):
    x2 = -x ** 2
    t = x
    f = 1
    sum = 0
    for i in range(10):
        sum += t / f
        t *= x2
        f *= ((2*i+2)*(2*i+3)
    return sum


def calc_sin(x):
    a = x / (2*np.pi)
    k = np.floor(a)
    a = x - k*2*np.pi
    return calc_sin_small(a)


if __name__ == "__main__":
    t = np.linspace(-2*np.pi,
    print t      # 横轴数据
    y = np.empty_like(t)
    for i, x in enumerate(t):
        y[i] = calc_sin(x)
        print 'sin(', x, ') =
        # print '误差: ', y[i
    mpl.rcParams['font.sans-s
    mpl.rcParams['axes.unicode_minus'] = False
    plt.figure(facecolor='w')
    plt.plot(t, y, 'r-', t, y, 'go', linewidth=2)
    plt.title(u'Taylor展式的应用 - 正弦函数', fontsize=18)
    plt.xlabel('X', fontsize=15)
    plt.ylabel('sin(X)', fontsize=15)
    plt.xlim((-7, 7))
    plt.ylim((-1.1, 1.1))
    plt.grid(True)
    plt.show()
```



5.2.calc_sin

```
sin( -1.25663706144 ) =  -0.951066447544 (近似值)   -0.951056516295 (真实值)
sin( -1.13097335529 ) =  -0.904843692145 (近似值)   -0.904827052466 (真实值)
sin( -1.00530964915 ) =  -0.844355457307 (近似值)   -0.844327925502 (真实值)
sin( -0.879645943005 ) =  -0.770558254809 (近似值)  -0.770513242776 (真实值)
sin( -0.753982236862 ) =  -0.684619861245 (近似值)  -0.684547105929 (真实值)
sin( -0.628318530718 ) =  -0.587901575106 (近似值)  -0.587785252292 (真实值)
sin( -0.502654824574 ) =  -0.481937724358 (近似值)  -0.481753674102 (真实值)
sin( -0.376991118431 ) =  -0.368412871668 (近似值)  -0.368124552685 (真实值)
sin( -0.251327412287 ) =  -0.249137247033 (近似值)  -0.248689887165 (真实值)
                          1027336 (近似值)  -0.125333233564 (真实值)
                          197e-16 (近似值)  8.881784197e-16 (真实值)
                          33564 (近似值)  0.125333233564 (真实值)
                          87165 (近似值)  0.248689887165 (真实值)
                          52685 (近似值)  0.368124552685 (真实值)
                          74102 (近似值)  0.481753674102 (真实值)
                          52292 (近似值)  0.587785252292 (真实值)
                          05929 (近似值)  0.684547105929 (真实值)
                          42776 (近似值)  0.770513242776 (真实值)
                          5502 (近似值)  0.844327925502 (真实值)
                          2466 (近似值)  0.904827052466 (真实值)
                          6295 (近似值)  0.951056516295 (真实值)
                          0729 (近似值)  0.982287250729 (真实值)
                          8428 (近似值)  0.998026728428 (真实值)
                          8428 (近似值)  0.998026728428 (真实值)
                          0729 (近似值)  0.982287250729 (真实值)
                          6295 (近似值)  0.951056516295 (真实值)
                          466 (近似值)  0.904827052466 (真实值)
                          5502 (近似值)  0.844327925502 (真实值)
                          2775 (近似值)  0.770513242776 (真实值)
sin( 2.38761041673 ) =  0.684547105927 (近似值)  0.684547105929 (真实值)
sin( 2.51327412287 ) =  0.587785252288 (近似值)  0.587785252292 (真实值)
sin( 2.63893782902 ) =  0.481753674088 (近似值)  0.481753674102 (真实值)
sin( 2.76460153516 ) =  0.368124552648 (近似值)  0.368124552685 (真实值)
```

计算圆周率

```
import numpy as np

if __name__ == '__main__':
    print np.sqrt(6 * np.sum(1 / np.arange(1, 100000, dtype=np.float) ** 2))
```

$$\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \frac{x^9}{9!} + \cdots + (-1)^{m-1}\frac{x^{2m-1}}{(2m-1)!} + R_{2m}$$

$$\sin\frac{1}{x} = \frac{1}{x} - \frac{1}{3!}\left(\frac{1}{x}\right)^3 + \frac{1}{5!}\left(\frac{1}{x}\right)^5 - \frac{x^7}{7!}\left(\frac{1}{x}\right)^7 + \frac{x^9}{9!}\left(\frac{1}{x}\right)^9$$

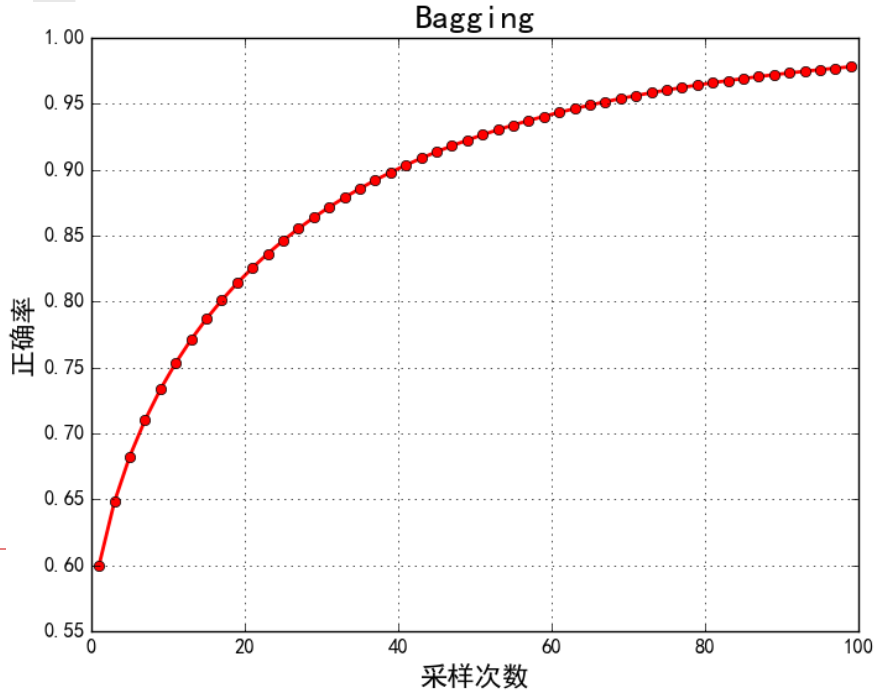
$$= \left(x - \frac{1}{\pi}\right)\left(x + \frac{1}{\pi}\right)\left(x - \frac{1}{2\pi}\right)\left(x + \frac{1}{2\pi}\right)\left(x - \frac{1}{3\pi}\right)\left(x + \frac{1}{3\pi}\right)\cdots$$

数值计算

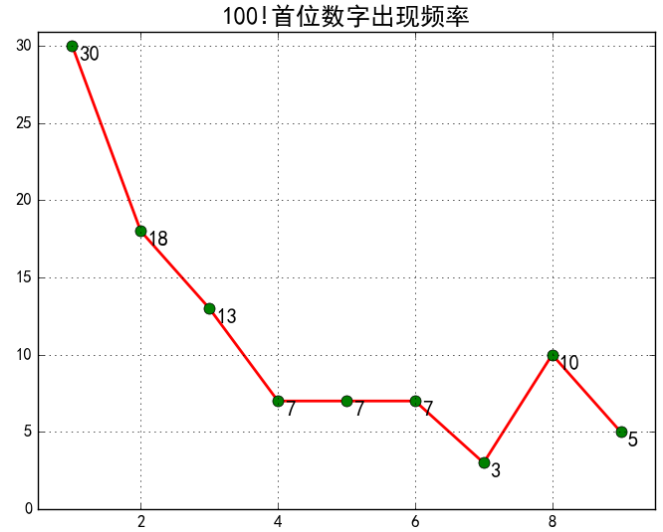
- 对于某二分类问题，若构造了九个正确率都是0.6的分类器，采用少数服从多数的原则进行最终分类，则最终分类正确率是多少？
  - 若构造99个分类器呢？

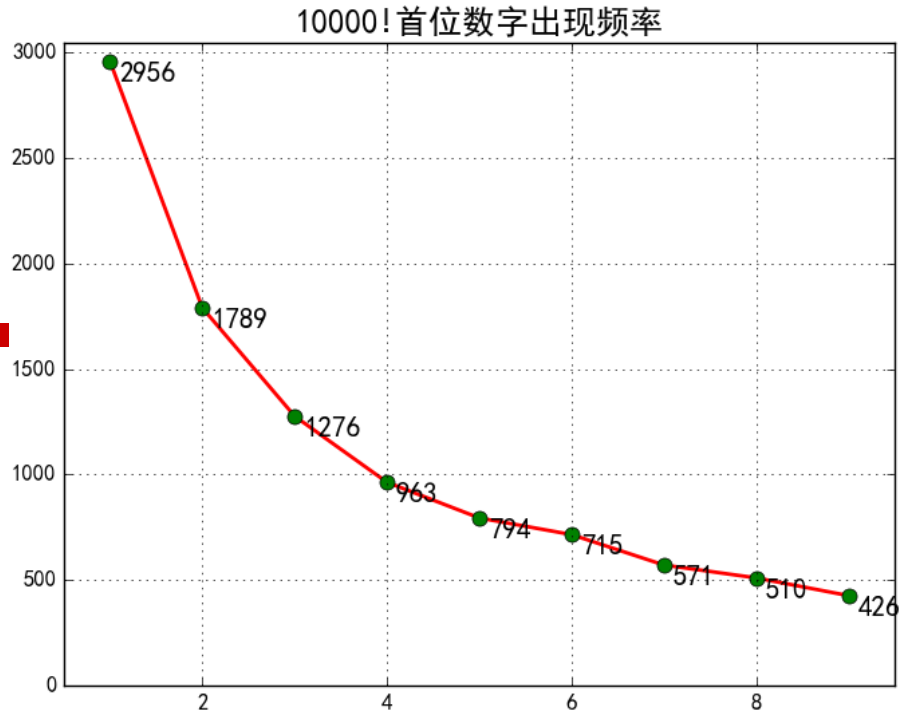
```
def bagging(n, p):
    p = 0.6
    s = 0
    for i in range(n / 2 + 1, n + 1):
        s += c(n, i) * p ** i * (1 - p) ** (n - i)
    return s


if __name__ == "__main__":
    for t in range(9, 100, 10):
        print t, '次采样正确率：', bagging(t, 0.6)
```

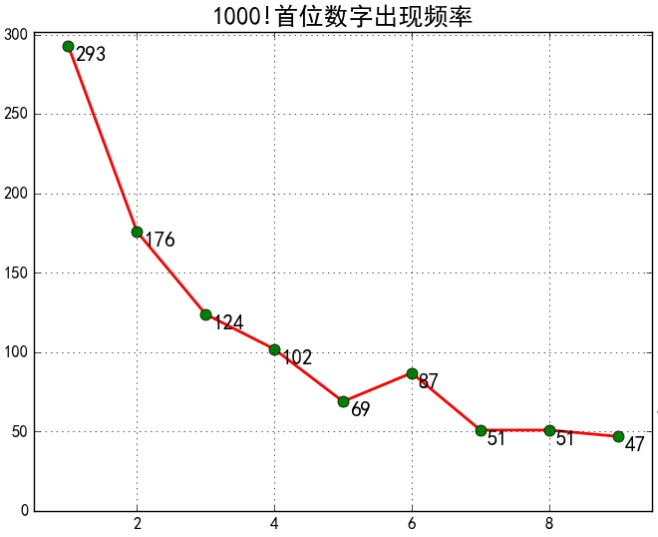
```
Ensumble
C:\Python27\python.exe D:/Python/Ensumble.py
9 次采样正确率： 0.73343232
19 次采样正确率： 0.813907978585
29 次采样正确率： 0.863787051336
39 次采样正确率： 0.897941368711
49 次采样正确率： 0.922424437652
59 次采样正确率： 0.940447995732
```

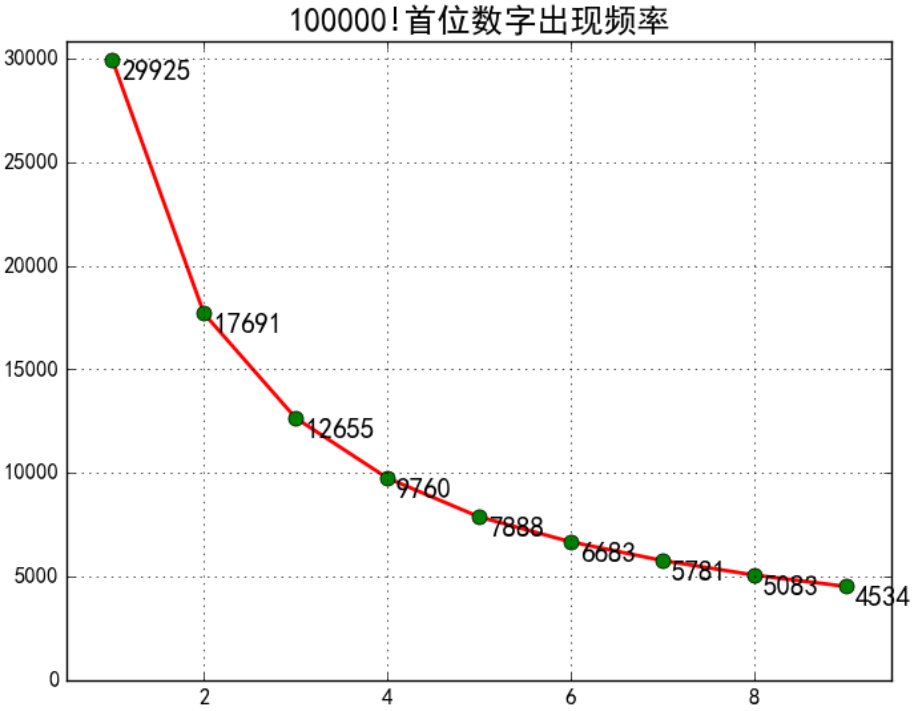


本福特定律


100!首位数字出现频率
30
18
13
7
7
7
3
10
5


10000!首位数字出现频率
2956
1789
1276
963
794
715
571
510
426


1000!首位数字出现频率
293
176
124
102
69
87
51
51
47


100000!首位数字出现频率
29925
17691
12655
9760
7888
6683
5781
5083
4534

作业

- 实现任何一个函数曲线/曲面的Python显示。
  - Matplotlib
- 利用Python提供的SVD库函数，实现图像恢复。
- 数值计算

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感谢大家！

恳请大家批评指正！