1.正态分布

随机变量X符合正态分布记为:$X\sim N(\mu,\sigma^2)$ 其中$E(X)=\mu$，方差为σ^2

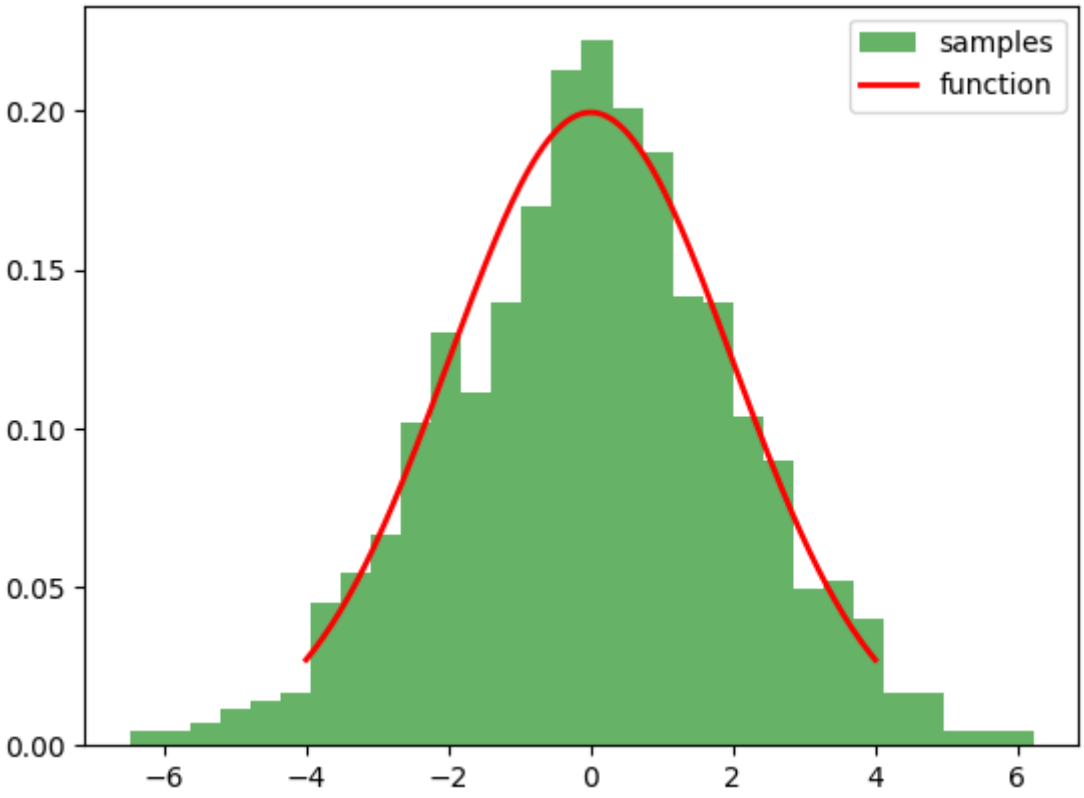
```
import numpy as np
import matplotlib.pyplot as plt
import scipy as sp

# defin c mu sigma
mu = 0
sigma = 2

# 随机分布样本 numpy.random.normal(mu,sigma,nums of points)
samples = np.random.normal(mu,sigma,1000)

plt.hist(samples, bins=30, density=True, alpha=0.6, color='g',
label='samples')

# 概率密度函数 scipy.stats.norm.pdf(X,mu,sigma)
x = np.linspace(-4,4,200)
pdf = sp.stats.norm.pdf(x,mu,sigma)
plt.plot(x, pdf, 'r', lw=2, label='function')
plt.legend()
plt.show()
```



2.泊松分布 poisson

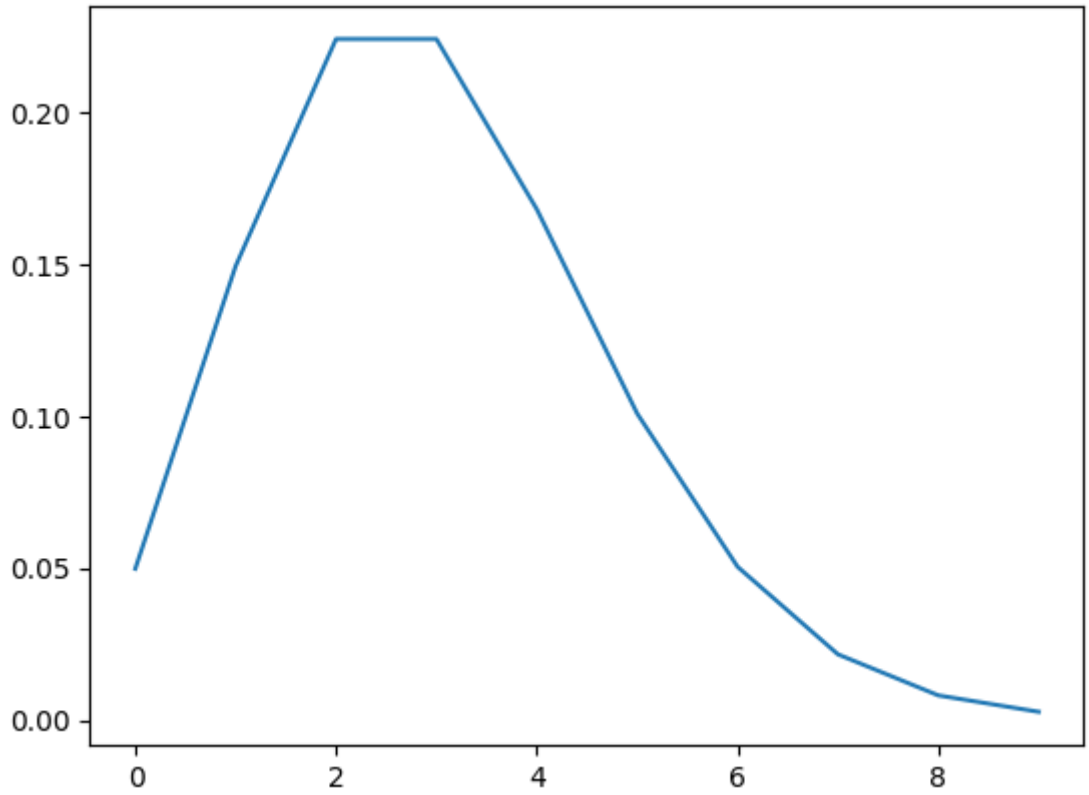
随机变量X符合参数为λ的泊松分布记为:X~$P(\lambda)$,Poisson分布的数学期望和方差都为λ.其概率密度函数为

$P(X=k)=\frac{\lambda^k}{k!}e^{-\lambda}, k=1,2,\cdots,\lambda>0$

```
# poisson分布随机数生成:scipy.stats.poisson.rvs(lambda,size)
lambda_poisson = 3
X = sp.stats.poisson.rvs(lambda_poisson, size = 20)
print(X)

# poisson分布概率密度函数:scipy.stats.poisson.pmf(X,lambda)
k = np.arange(0,10)
probability = sp.stats.poisson.pmf(k, lambda_poisson)
plt.plot(k, probability)
plt.show()
```

```
[1 3 4 3 3 2 2 2 2 2 1 2 4 5 3 1 2 2 2 0]
```



3.二项分布

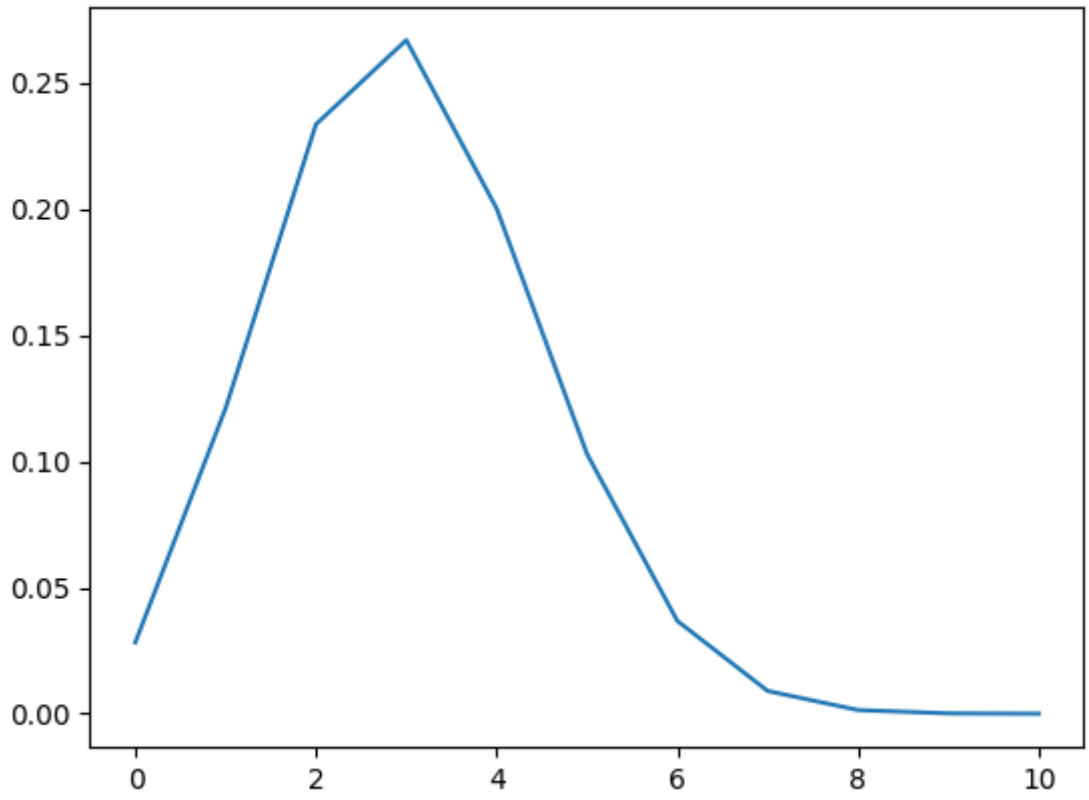
随机变量X符合二项分布记为:X~$B(n,p)$,其中p是单次实验的成功率，n是实验次数

$E(X)=np, \sigma^2(X)=np(1-p),\ P(X=k)=C_n^k p^k(1-p)^{n-k}$

```python
# 二项分布随机数生成:scopy.stats.binom.rvs(n, p, size)
n = 10
p = 0.3
X = sp.stats.binom.rvs(n, p, size = 10)
print(X)

# 二项分布概率密度函数:scipy.stats.binom.pmf(X, n, p)
X = np.arange(0,11)
Probability = sp.stats.binom.pmf(X, n, p)
plt.plot(X,Probability)
plt.show()
```

```
[2 4 4 3 4 6 0 2 5 3]
```



4.指数分布

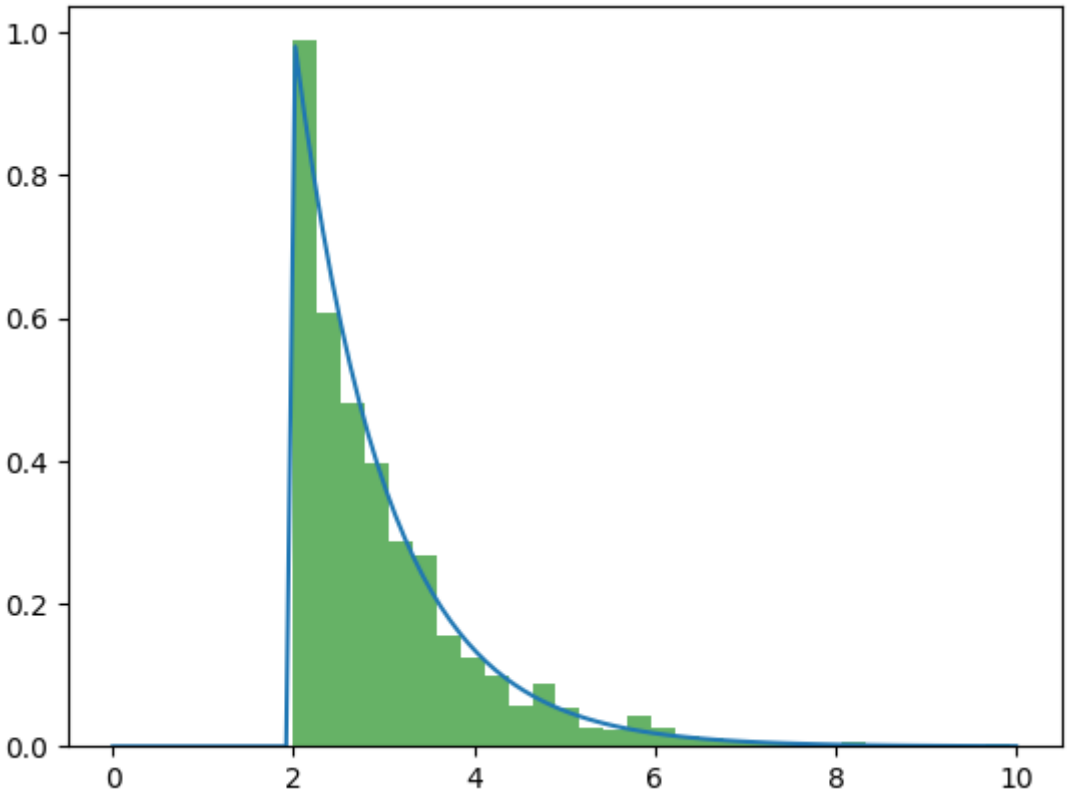
随机变量X符合参数为λ或者β的指数分布记为:$X \sim Exp(\lambda)$或者$X \sim Exp(\beta)$

$E(X) = \frac{1}{\lambda} = \beta, \sigma^2(X) = \frac{1}{\lambda^2} = \beta^2$

$$f(x,\lambda) = \begin{cases} \lambda e^{-\lambda x} & x \geq 0 \\ 0 & x < 0 \end{cases}$$

```python
# 指数分布随机数:scipy.stats.expon.rvs(bata, size)
lambda_exp = 0.5
beta = 1/lambda_exp
samples = sp.stats.expon.rvs(beta, size = 1000)
plt.hist(samples, bins = 30, density=True, alpha=0.6, color='g',
label="samples")

# 指数分布概率函数:scipy.stats.expon.pdf(X,beta)
X = np.linspace(0,10,100)
probability = sp.stats.expon.pdf(X, beta)
plt.plot(X,probability)
plt.show()
```



5.超几何分布

随机变量X服从参数为K，N的超几何分布记为:$X \sim H(n, K, N)$

$E(X) = \frac{nK}{N}, \sigma^2(X) = \frac{nK(N-K)(N-n)}{N^2(N-1)}$

其概率密度函数为:$f(k; n, K, N) = \frac{C_K^k C_{N-K}^{n-k}}{C_N^n}$

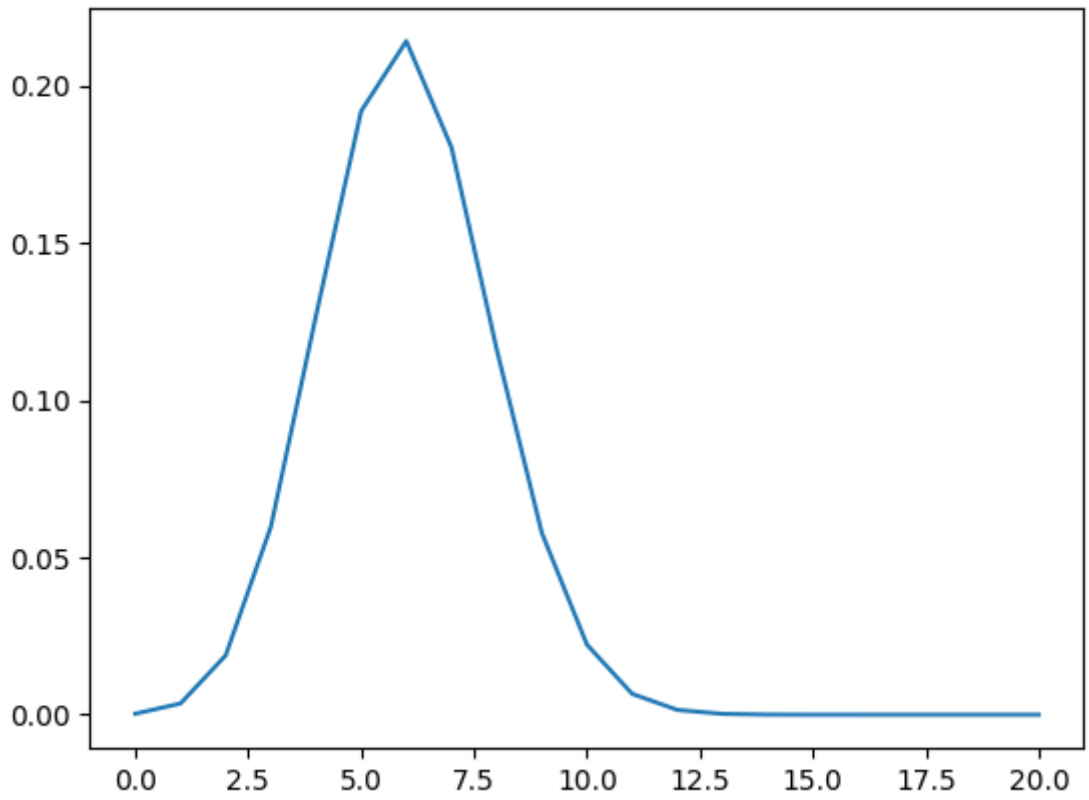
```python
# 参数定义
N = 100 # 100件
K = 30 # 次品
n = 20

# 超几何分布随机数:scipy.stats.hypergeom.rvs(N, K, n, size)
X = sp.stats.hypergeom.rvs(N, K, n, size = 10)
print(X)

```

```
# 超几何分布概率函数:scipy.stats.hypergeom.pmf(k, N, K, n)
k = np.arange(0,n+1)
probability = sp.stats.hypergeom.pmf(k, N, K, n)
plt.plot(k, probability)
plt.show()
```

```
[5 4 8 7 6 5 4 7 8 5]
```




```

```

贝叶斯分类器

原理：贝叶斯分类器基于贝叶斯定理，旨在利用已知数据来模拟出新数据属于不同类别的概率，然后选择具有最高概率的类别作为分类结果，做出相应的决策

```
class NaiveBayesClassifier:
    def __init__(self) :
        self.classes = set() # 存储所有C_i类别
        self.classes_prob = dict() # 每个C_i出现的可能性
        self.condition_prob = dict() # 每个C_i在A下的条件概率
        self.P0 = 1 # 先验概率

    # 训练函数
    def fit(self, spam_data_matrix, ham_data_matrix):
```

```
        from math import log
        spam_dim = len(spam_data_matrix)
        ham_dim = len(ham_data_matrix)
        dim = spam_dim + ham_dim
        self.P0 = log(spam_dim / dim)

        for line in spam_data_matrix:
            self.classes.update(set(line))
        for line in ham_data_matrix:
            self.classes.update(set(line))

        # C_i总体概率 和 条件概率
        for word in self.classes:
            spamif = 0
            hamif = 0
            for line in spam_data_matrix:
                if word in line:
                    spamif += 1
            for row in ham_data_matrix:
                if word in row:
                    hamif += 1
            self.classes_prob[word] = (spamif + hamif) / dim
            self.condition_prob[word] = (spamif) / spam_dim
        class_prob_sum = sum(self.classes_prob.values())
        condition_prob_sum = sum(self.condition_prob.values())
        self.classes_prob = {key:value/class_prob_sum for key,value in
self.classes_prob.items()}
        self.condition_prob = {key:value/condition_prob_sum for key,value
in self.condition_prob.items()}

        spam_p = (spam_dim + ham_dim) / dim
        return spam_dim, self.classes_prob, self.condition_prob

    # 判断每一个行是不是一个符合A
    def IsSpam(self,data_list):
        from math import log
        condition_prob = 0
        # 在计算条件概率时，添加平滑值（alpha）到分子和分母中
        alpha = 1  # laplace平滑参数
        dim = len(self.classes)
        for word in data_list:
            if word in self.classes:
                condition_prob += log((self.condition_prob[word] + alpha) /
(self.classes_prob[word] + alpha * dim))

        P = self.P0 + condition_prob

        # 将1/2的对数概率作为阈值来判断
        threshold = log(1/2)
        if P >= threshold:
            print(P)
            return True
        else:
            return False

        # 做总体预测
```

```
63      def predict(self, data_matrix):
64          total_dim = len(data_matrix)
65          isspam = []
66          for item in data_matrix:
67              if self.IsSpam(item) == True:
68                  isspam.append(True)
69              else:
70                  isspam.append(False)
71          return isspam
72
73
74  class BayesFile:
75      def __init__(self, pwd) :
76          self.pwd = pwd
77          self.excluded_words = set()
78          self.load_excluded_words()
79
80      def load_excluded_words(self):
81          with open(self.pwd+"/excluded_words.txt","r",encoding="utf-8") as
    file:
82              self.excluded_words = set(word.strip() for word in
    file.readlines())
83
84      def process_file(self, file_path):
85          # 读取文件并将文章分割成单词
86          words = []
87          with open(file_path, 'r', encoding='utf-8') as file:
88              text = file.read()
89              words = text.split()  # 简单地使用空格分割
90          words = [word for word in words if word.lower() not in
    self.excluded_words]
91          return words
92
93      def build_matrix(self):
94          from os import path
95          SpamMatrix = []
96          HamMatrix = []
97          for i in range(1, 26):
98              file_name = f'{i}.txt'
99              file_path = path.join(self.pwd+"/email/spam", file_name)
100             if path.isfile(file_path):
101                 words = self.process_file(file_path)
102                 SpamMatrix.append(words)
103             file_path = path.join(self.pwd+"/email/ham", file_name)
104             if path.isfile(file_path):
105                 words = self.process_file(file_path)
106                 HamMatrix.append(words)
107
108         return SpamMatrix,HamMatrix
109
110 def detect():
111     NBC = NaiveBayesClassifier()
112     FileMatrix =
    BayesFile(pwd="/home/jxluo/ubuntu/WorkPlace/grade3/Computer-
    Simulations/Homeworks/hw02")
113
```

```
    FileMatrix.load_excluded_words()
    ham, spam = FileMatrix.build_matrix()

    NBC.fit(ham_data_matrix=ham, spam_data_matrix=spam)
    # 随机选择一些样本
    def choice():
        indexLst = []
        detect_file = []
        from random import choice
        for index in range(20):
            k = choice([0,1])
            index = choice(range(1,25))
            if k == 1:
                indexLst.append(True)
                detect_file.append(spam[index])
            else:
                indexLst.append(False)
                detect_file.append(ham[index])
        return detect_file, indexLst

    Matrix, lst = choice()
    result = NBC.predict(Matrix)
    RightNum = sum(1 if result[index] == lst[index] else 0 for index in
range(len(lst)))
    ratio = RightNum/len(lst)
    return ratio

print("检测成功率:{:.2f}%".format(detect()*100))
```

```
检测成功率:65.00%
```

上述代码创建了一个朴素bayes选择器类NaiveBayesClassifier，用类BayesFIles做文件处理，传递给选择器。重现了实例demo_email_spam.pdf