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Task 1. (Introduction)

Suppose that we have three coloured boxes r (red), b (blue), and g (green).

- Box r contains 3 apples, 4 oranges, and 3 limes,
- Box b contains 1 apple, 1 orange, and 0 limes, and
- Box g contains 3 apples, 3 oranges, and 4 limes.

If a box is chosen at random with probabilities p(r) = 0.2, p(b) = 0.2, p(g) = 0.6, and a piece of fruit is removed from the box (with equal probability of selecting any of the items in the box), then what is the probability of selecting an apple?

If we observe that the selected fruit is in fact an orange, what is the probability that it came from the green box?

Solution: *Probability of apple A = probability of apple in red, blue and green.*

- $P(a)=P(a\cap r)+P(a\cap b)+P(a\cap g)$
  Product rule for P(a)
- $P(a)=(P(a|r)\times P(r))+(P(a|b)\times P(b))+(P(a|g)\times P(g))$
- $P(a)=((0.2\times 0.3)+(0.2\times 0.5)+(0.6\times 0.3))$
- $P(a)=0.34$
  Thus the probability of selecting an apple is 0.34.

  Probability of selecting an orange from green box
- $P(g|o)=P(g\cap o)P(o)$
- $P(g\cap o)=P(g)\times P(o|g)$
- $P(g\cap o)=0.6\times 0.3$
- $P(g\cap o)=0.18$
- $P(o)=P(o\cap g)+P(o\cap b)+P(o\cap r)$
- $P(o)=(P(r)\times P(o|r))+(P(b)\times P(o|b))+(P(g)\times P(o|g))$
- $P(o)=((0.2\times 0.4)+(0.2\times 0.5)+(0.6\times 0.3))$
- $P(o)=0.36$
  The probability of selecting the orange 0.36.

After Substituting on P(g|o)

- $P(g|o)$=$\frac{0.3*0.6}{0.36}$
- $P(g|o)$=0.5

Thus the probability of selecting the orange from the green box is 0.5

Task 2. (Introduction)

Consider a Gaussian distribution $p_x(x)$ over x with mean μ = 6 and standard deviation σ = 1. Plot this distribution.
Next, draw a sample of N = 50000 points from this distribution and plot a histogram of their values, which as expected agrees with the distribution $p_x(x)$.
Now consider a non-linear change of variables from x to y given by
$x = g(y) = ln(y) - ln(1 - y) + 5$
The inverse of this function is given by
$y = g^{-1}(x) = \frac{1}{1+exp(-x+5)}$
which is a logistic sigmoid function. Plot this function in the same Figure.
Plot the curve $p_x(g(y))$ that is a transformation of $p_x(x)$ as a function of x $p_x(g(y))$

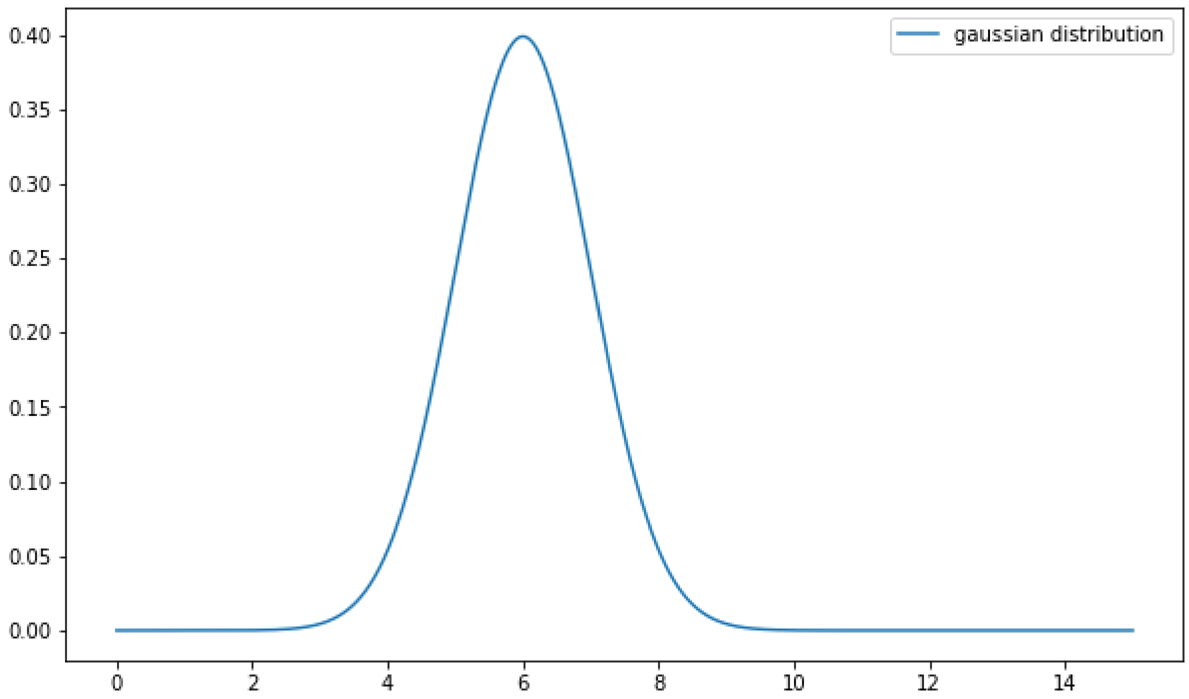
Gaussian Distribution

In [15]:

```
import numpy as np
from scipy.stats import norm
import matplotlib.pyplot as plt
#plotting gaussian distribution
m=6
s=1
n=50000
x = np.linspace(0, 15,n)
p = norm.pdf(x,m,s)
fig = plt.figure(figsize=(10,6))
plt.plot(x,p,label='gaussian distribution')
plt.legend()
```

Out[15]:

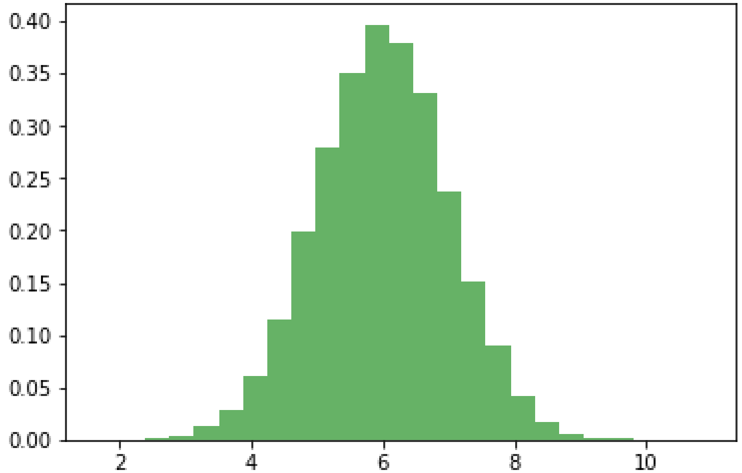
```
<matplotlib.legend.Legend at 0x7ff2dae0ecf8>
```



Histogram of Gaussian distribution

In [11]:
```
#plotting histogram of gaussian
his=m+s*np.random.randn(n)
plt.hist(his, bins=25, density=True, alpha=0.6, color='g')
```

Out[11]:
```
(array([2.16263464e-04, 4.86592794e-04, 1.08131732e-03, 3.35208369e-03,
        1.27054785e-02, 2.80061186e-02, 6.09322309e-02, 1.15376558e-01,
        1.97989201e-01, 2.79250198e-01, 3.50184614e-01, 3.96789390e-01,
        3.78677325e-01, 3.31261561e-01, 2.37132888e-01, 1.51708820e-01,
        9.05603255e-02, 4.26579682e-02, 1.65441550e-02, 5.62285006e-03,
        1.89230531e-03, 6.48790391e-04, 1.62197598e-04, 0.00000000e+00,
        5.40658659e-05]),
 array([ 1.65384908,  2.02376824,  2.39368741,  2.76360657,  3.13352574,
         3.5034449 ,  3.87336407,  4.24328323,  4.6132024 ,  4.98312156,
         5.35304073,  5.72295989,  6.09287906,  6.46279822,  6.83271739,
         7.20263656,  7.57255572,  7.94247489,  8.31239405,  8.68231322,
         9.05223238,  9.42215155,  9.79207071, 10.16198988, 10.53190904,
        10.90182821]),
 <a list of 25 Patch objects>)
```

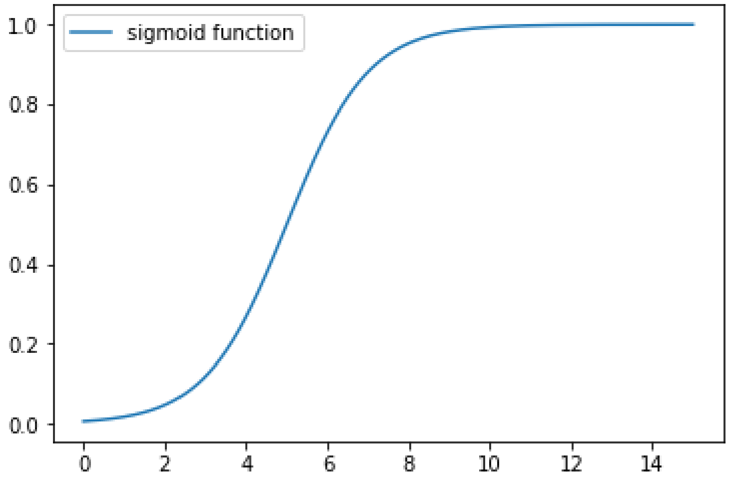


Sigmoid function

In [16]:

```
# sigmoid function g(y)
def fun(a):
    eqn= 1.0/(1+np.exp(-a+5))
    return eqn
y=fun(x)
plt.plot(x,y,label='sigmoid function')
plt.legend()
```

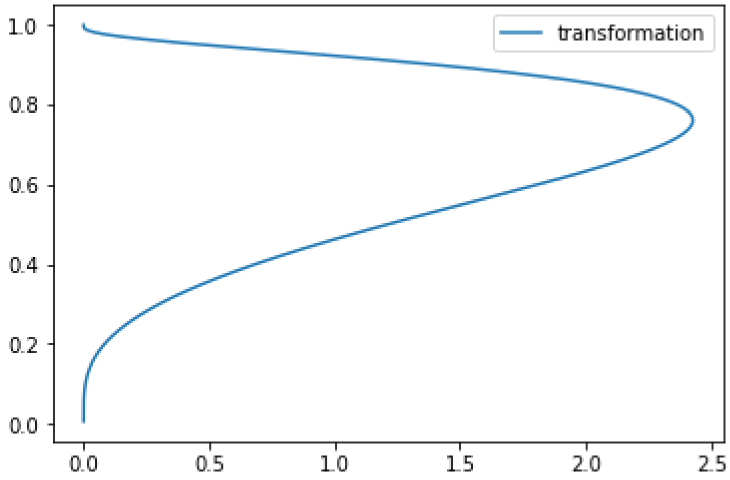
Out[16]: <matplotlib.legend.Legend at 0x7ff2dade7fd0>



Transformation

In [17]:
```
# transformation of  px(x)  as a function of x  px(g(y))
pgy = p*(np.log(y)-np.log(1-y)+5)
plt.plot(pgy,y,label='transformation')
plt.legend()
```

Out[17]: <matplotlib.legend.Legend at 0x7ff2dada8da0>

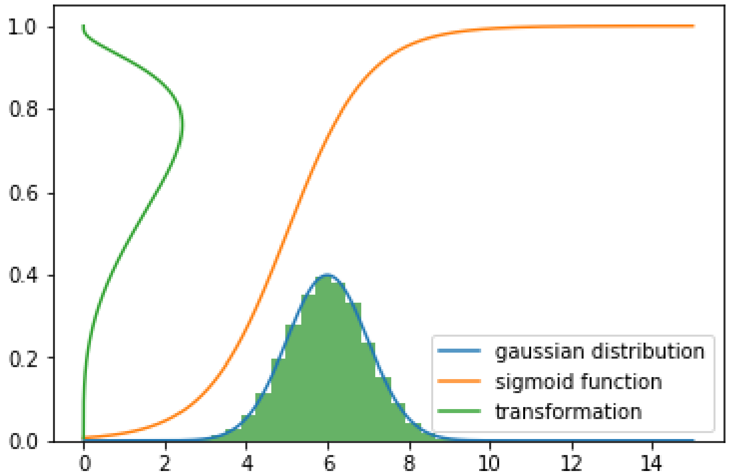


Legend Plot

In [14]:

```python
#plotting
plt.hist(his, bins=25, density=True, alpha=0.6, color='g')
plt.plot(x,p,label='gaussian distribution')
plt.plot(x,y,label='sigmoid function')
plt.plot(pgy,y,label='transformation')
plt.legend()
```

Out[14]: <matplotlib.legend.Legend at 0x7ff2dadfc320>



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