In [30]:
```
# HW_4.Y_Chang_Tiange
import numpy as np
import matplotlib.pyplot as plt
import scipy.stats as sp
from scipy.stats import expon
```

In [31]:
```
M = 1000
mylambda = 2
sca = 1/mylambda
random_x = sp.norm.rvs(sca,sca,M)
print(random_x)
```

```
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 7.98637671e-01  2.53236371e-01 -2.51151555e-01  1.94867647e-01
 9.14285473e-01  1.77467294e+00  2.15046974e+00  1.21662447e+00
-1.51706888e-02  5.31342123e-01  2.55420394e-01  1.68893327e+00
 1.50895960e+00  4.90710789e-01  5.87328405e-01 -1.76356825e-01
 1.09515364e-01  7.88841268e-01  6.61635873e-01  7.68117872e-01
 2.10922591e-01  4.43505420e-01 -2.82428817e-01  4.44900704e-02
 2.21070459e-01  1.46961946e+00  1.18773884e+00  7.13632750e-01
 2.37496369e-01 -5.55472072e-02  7.09928681e-01  4.78589508e-01
 1.73221136e-01  8.47439384e-01 -3.55574060e-01  1.28802083e+00
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 1.31955922e-01  9.02958076e-01  8.45248022e-01  3.96348482e-01
 1.14125985e+00  1.36378968e-01 -3.60719540e-01  4.76508284e-01
 4.98335397e-01  2.37071301e-01  6.09949248e-01  8.90997518e-01
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 7.96918495e-01  6.64508111e-01  9.14334306e-01  5.52826284e-01
 4.32559357e-01  1.16404130e+00  3.86964499e-01 -7.80522906e-02
 5.57812724e-01  7.83985268e-01  4.67787638e-01  4.38832225e-02
 3.58091389e-01  1.03806941e+00  8.75264053e-02 -3.17931969e-01
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 3.16032423e-01  6.30121851e-01  4.79077497e-01  7.28799534e-01
 1.58289326e-01 -8.17811333e-02 -9.08617049e-02  5.58357376e-01
 7.53293543e-01  5.96838713e-01  7.90924401e-02  7.58042846e-02
 2.73000413e-02  4.95563229e-01  1.25415375e+00  3.41632382e-01
 1.16791931e+00 -2.09250925e-01  5.65427782e-01 -5.99784958e-02
-3.72499357e-01  3.38926652e-01  6.86551968e-02 -7.11667923e-02
-5.72764059e-01  1.82746302e-01  5.16365058e-01  7.15912750e-01
 1.01432024e+00  2.49675848e-01  8.22265759e-01  8.13018911e-01
 7.80313341e-01  2.85043154e-01  1.25215028e+00  7.68986882e-01
 6.74265236e-01  8.31288787e-01  3.95985869e-01  3.87485924e-01
```

```
 3.77051781e-01  4.19662906e-01  1.10975266e+00  9.34554689e-01
-5.69927087e-02 -2.99594664e-01  4.11081502e-01  1.09679654e+00
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 3.75866934e-01 -5.28950664e-01  6.69579814e-01 -3.87952153e-01
 7.44135753e-01  3.31623448e-01  2.41935279e-01  8.98576323e-01
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 5.35310040e-01  1.02531774e+00  9.52849904e-01  4.88698204e-01
 4.24621382e-01  1.81487216e-01  3.47425234e-01  1.11633433e+00
-8.08475124e-02  4.07218672e-01 -3.50743947e-01  1.37296504e+00
 4.94689301e-01 -6.38166276e-01  9.71570444e-01  1.15532774e+00
-1.48003710e-01 -3.00528631e-01  1.12896160e+00 -2.56787050e-01
 3.50900014e-01  8.31761594e-01  3.38452923e-01  1.94020543e+00
 6.97473883e-02  1.16914425e-01  5.58531827e-01  5.45023178e-01]
```
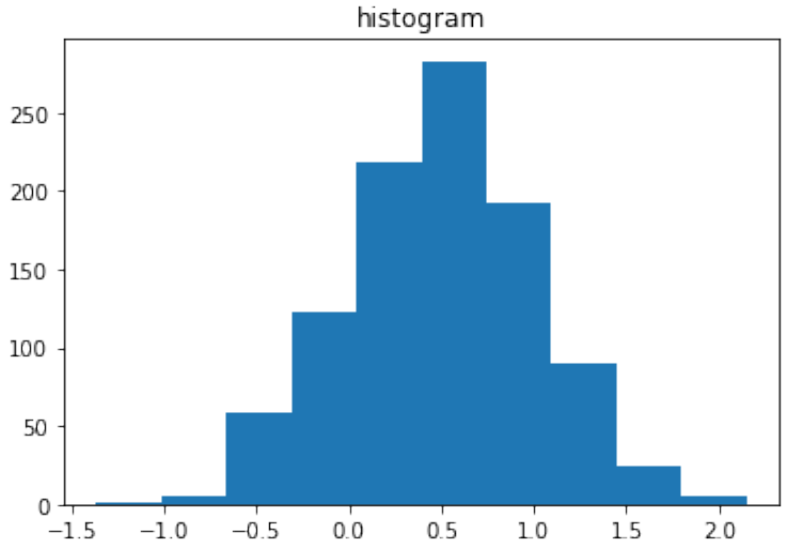

In [32]:
```
sca_x = np.mean(random_x)
print('mean exact  = ',sca)
print('mean sample = ',sca_x)
```

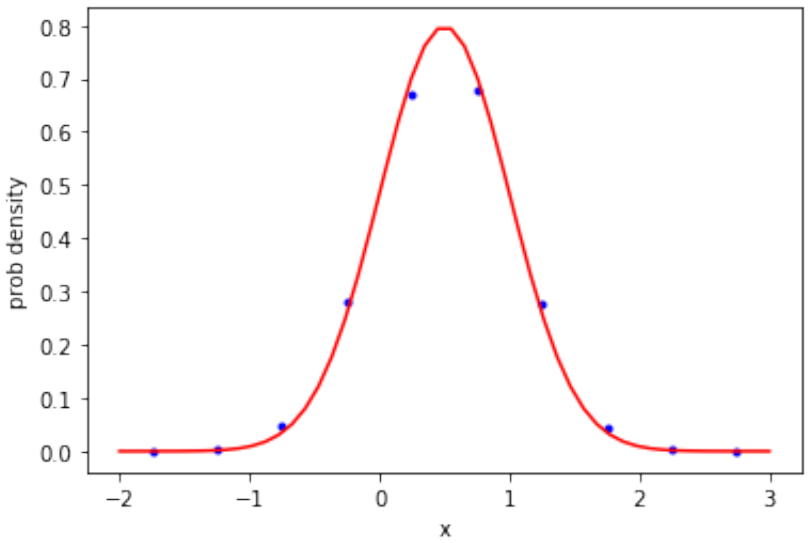
```
mean exact  =  0.5
mean sample =  0.49515061292336837
```

In [33]:
```
plt.hist(random_x, bins = 10)
plt.title("histogram")
plt.show()
```

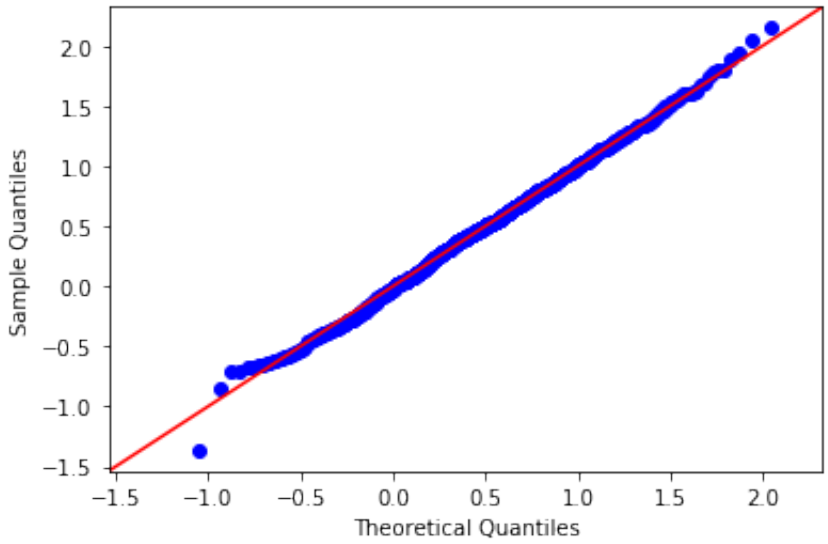


In [36]:
```
### kernel density estimate
nbins = 10  # number of bins
b = 3       # right end (from looking at histogram)
a = -2     # left end (from looking at histogram)
dx = (b-a)/nbins  # bin width
bin_edges = np.linspace(a,b,nbins+1) # nbins+1 points for nbins bins
print(bin_edges)
# counts in each bin
counts, bin_edges = np.histogram(random_x,bins=bin_edges)
print(counts)
# find bin centers and kernel density
bin_centers = (bin_edges[1:] + bin_edges[:-1])/2
print(bin_centers)
kernel_density = counts/(M*dx)
print(kernel_density)
# plot of kernel density estimate and exact prob density
plt.plot(bin_centers,kernel_density,'b.')
xfine = np.linspace(a,b) # fine array in x for plotting exact curve
plt.plot(xfine,sp.norm.pdf(xfine,sca,sca),'r-')
#plt.ylim((0,1))
plt.xlabel('x')
plt.ylabel('prob density')
plt.show()
```

```
[-2.  -1.5 -1.  -0.5  0.   0.5  1.   1.5  2.   2.5  3. ]
[  0   1  24 140 335 339 138  21   2   0]
[-1.75 -1.25 -0.75 -0.25  0.25  0.75  1.25  1.75  2.25  2.75]
[0.    0.002 0.048 0.28  0.67  0.678 0.276 0.042 0.004 0.   ]
```



In [37]:
```
# quantile-quantile plot (qqplot)
import statsmodels.api as sm # statsmodels needed for qq plot
#sm.qqplot(random_x, dist=sp.norm(1,2), line = '45') <- OLD VERSION
sm.qqplot(random_x, dist=sp.norm, loc=sca, scale=sca, line = '45')
plt.show()
```



In [ ]:
```
```