ass2q1

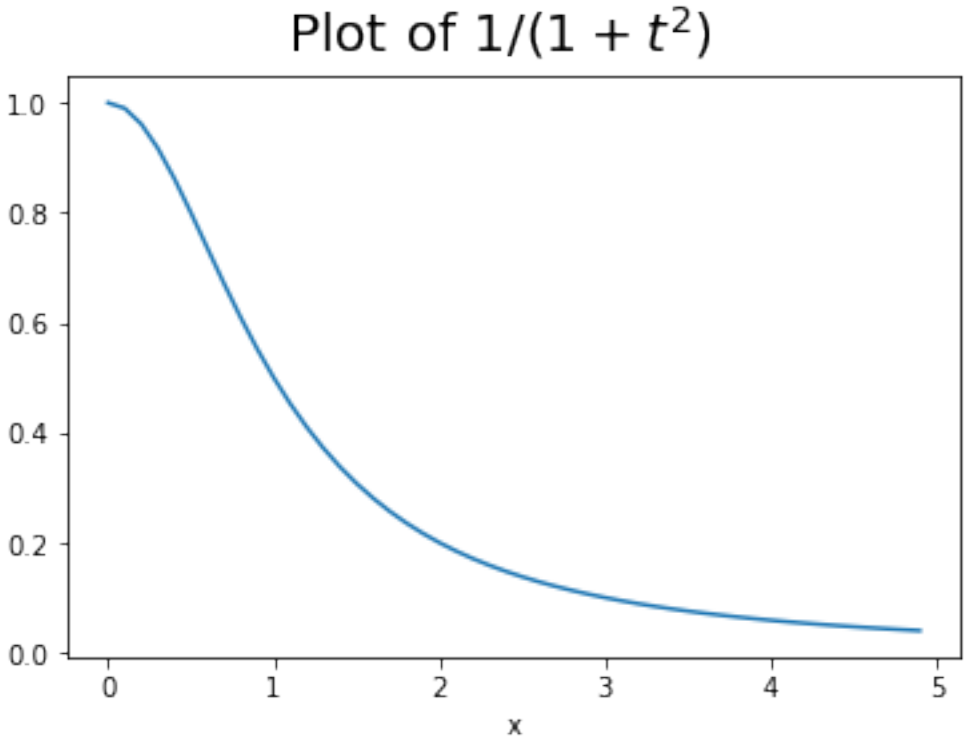
January 31, 2018

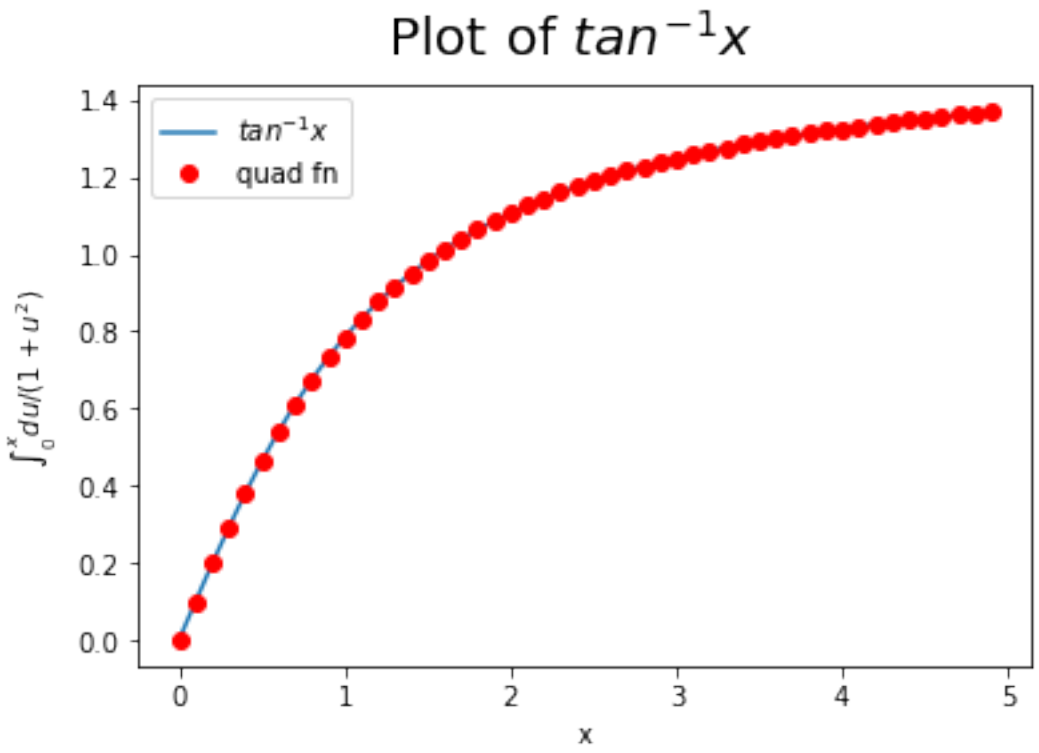
In [57]:
```
from pylab import *
from scipy.integrate import quad
from math import pi

def f(x):
    return 1.0/(1+np.square(x))

def tan_inv(x):  #f is 1/(1+t^2) and a is upper limit

    ans = np.zeros(len(x))
    err = np.zeros(len(x))
    for i in range(len(x)):
        ans[i],err[i] = quad(f,0,x[i])
    return ans,err

x = arange(0,5,0.1)
y = f(x)

fig1 = figure()
plot(x,y)
fig1.suptitle(r"Plot of $1/(1+t^{2})$", fontsize=20)
xlabel("x")
fig1.savefig('1.jpg')

tanInv = np.arctan(x)
fig2 = figure()
plot(x,tanInv)
Ix,err = tan_inv(x)

print("arctan(x) | Integral values(x)")
for i in range(len(Ix)):
    print " %.5f  :  %.5f" %(tanInv[i],Ix[i])              #printing the list with pr
#     print " %f  :  %f" %(tanInv[i],Ix[i])               #printing the list with prec


plot(x,Ix,'ro')
legend( (r"$tan^{-1}x$","quad fn"))
```

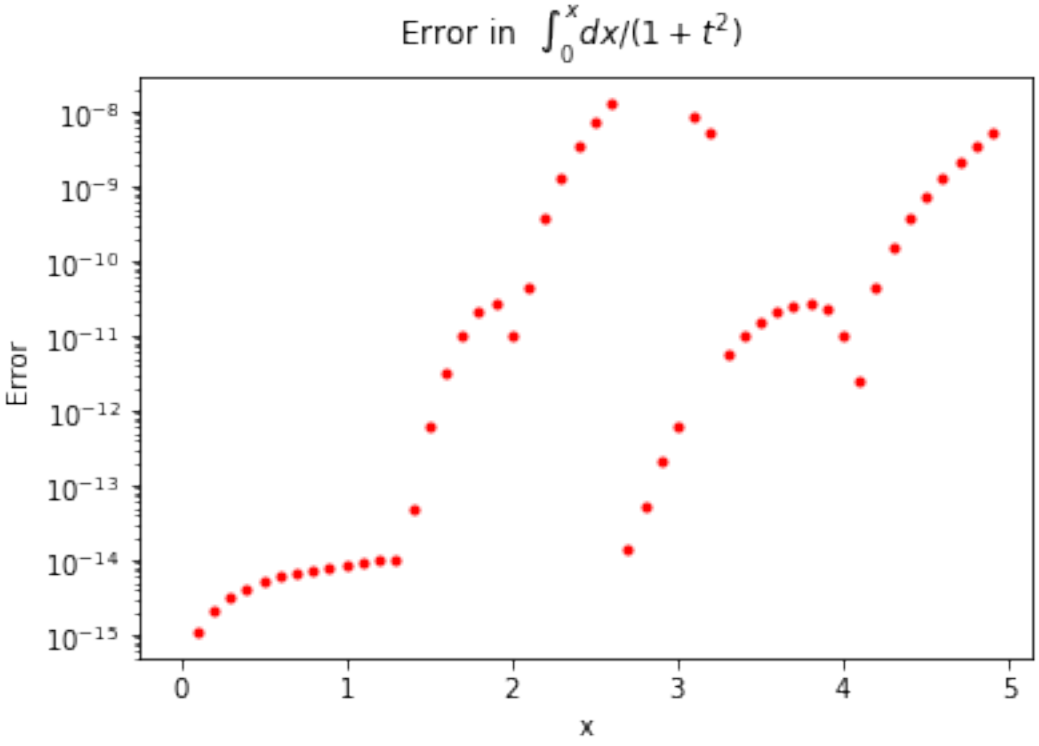
```
fig2.suptitle(r"Plot of $tan^{-1}x$", fontsize=20)
xlabel("x")
ylabel("$\int_{0}^{x} du/(1+u^{2})$")
fig2.savefig('2.jpg')

fig3 = figure()
semilogy(x,err,'r.')
fig3.suptitle(r"Error in  $\int_{0}^{x} dx/(1+t^{2}) $", fontsize=12)
xlabel("x")
ylabel("Error")
fig3.savefig('3.jpg')

show()
```

```
arctan(x) | Integral values(x)
 0.00000  :  0.00000
 0.09967  :  0.09967
 0.19740  :  0.19740
 0.29146  :  0.29146
 0.38051  :  0.38051
 0.46365  :  0.46365
 0.54042  :  0.54042
 0.61073  :  0.61073
 0.67474  :  0.67474
 0.73282  :  0.73282
 0.78540  :  0.78540
 0.83298  :  0.83298
 0.87606  :  0.87606
 0.91510  :  0.91510
 0.95055  :  0.95055
 0.98279  :  0.98279
 1.01220  :  1.01220
 1.03907  :  1.03907
 1.06370  :  1.06370
 1.08632  :  1.08632
 1.10715  :  1.10715
 1.12638  :  1.12638
 1.14417  :  1.14417
 1.16067  :  1.16067
 1.17601  :  1.17601
 1.19029  :  1.19029
 1.20362  :  1.20362
 1.21609  :  1.21609
 1.22777  :  1.22777
 1.23874  :  1.23874
 1.24905  :  1.24905
```

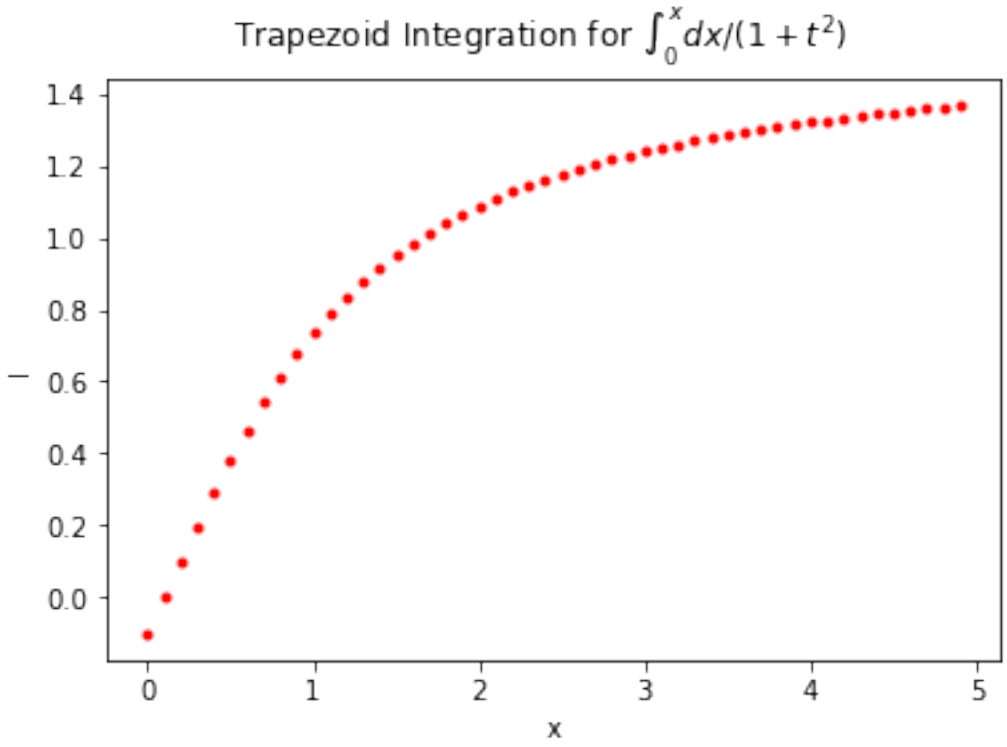
```
1.25875  :  1.25875
1.26791  :  1.26791
1.27656  :  1.27656
1.28474  :  1.28474
1.29250  :  1.29250
1.29985  :  1.29985
1.30683  :  1.30683
1.31347  :  1.31347
1.31979  :  1.31979
1.32582  :  1.32582
1.33156  :  1.33156
1.33705  :  1.33705
1.34230  :  1.34230
1.34732  :  1.34732
1.35213  :  1.35213
1.35674  :  1.35674
1.36116  :  1.36116
1.36540  :  1.36540
1.36948  :  1.36948
```



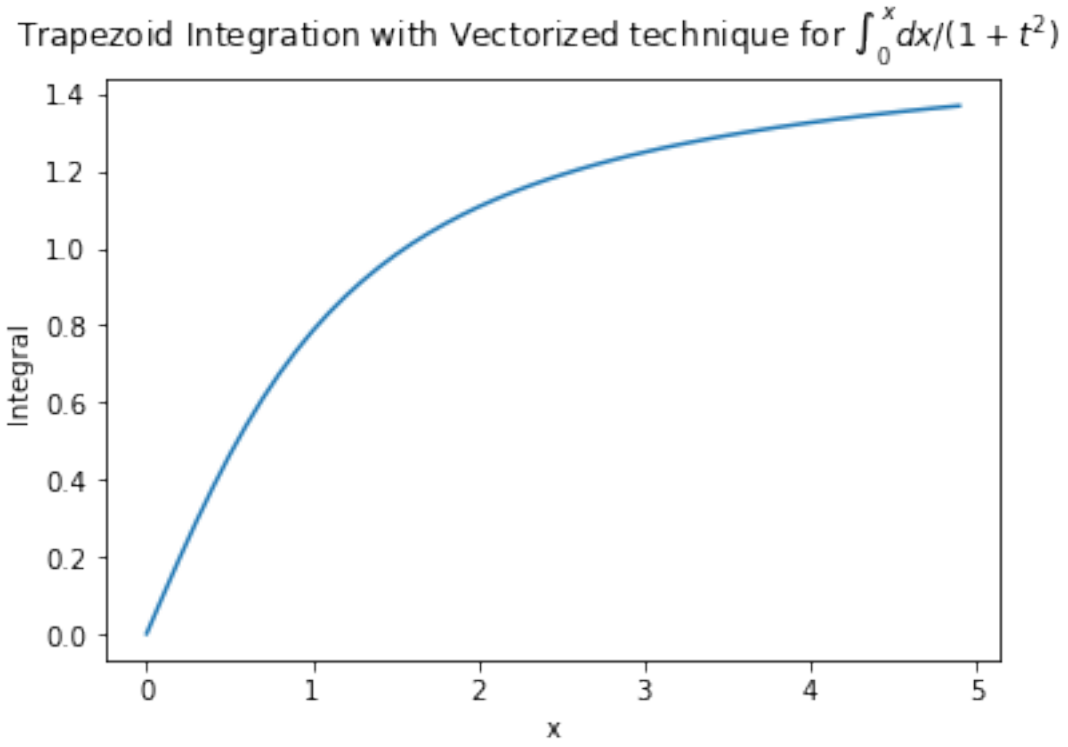

Plot of $tan^{-1}x$
$tan^{-1}x$
quad fn
$\int_0^x du/(1+u^2)$
x


Error in $\int_0^x dx/(1+t^2)$
Error
x

```
In [54]: def trapez(x,i,h):
             Ii = h*((cumsumlike(x,i))-0.5*(f(x[0])+f(x[i])))
             return Ii

         def cumsumlike(x,i):
             temp=0
             for k in range(i):
                 temp+=f(x[k])
             return temp

         I = []
         h=0.1
         x=arange(0,5,h)
         for k in range(len(x)):
             I.append(trapez(x,k,h))

         fig4 = figure()
         plot(x,I,'r.')
         fig4.suptitle(r"Trapezoid Integration for $\int_{0}^{x} dx/(1+t^{2}) $", fontsize=12)
         xlabel("x")
         ylabel("I")
         fig4.savefig('4.jpg')
         show()
```



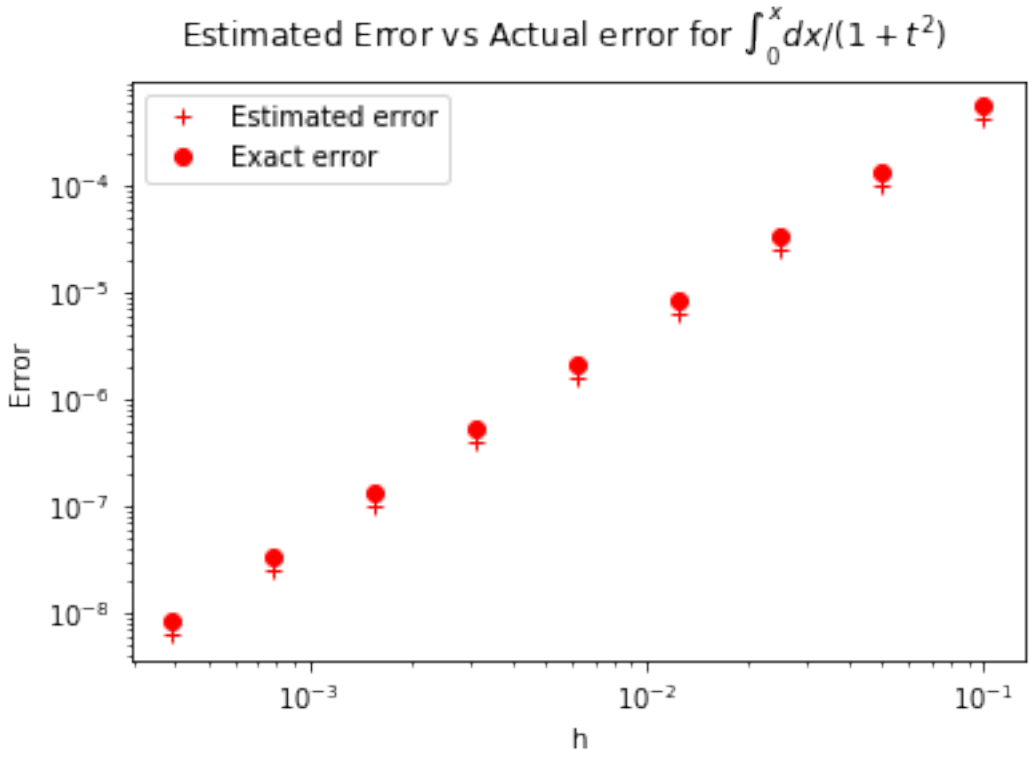

```
In [55]: I1 = h*(cumsum(f(x))-0.5*(f(x[0])+f(x)))

         fig5 = figure()
         plot(x,I1)
         fig5.suptitle(r"Trapezoid Integration with Vectorized technique for $\int_{0}^{x} dx/(1
         xlabel("x")
         ylabel("Integral")
         fig5.savefig('5.jpg')
         show()
```




```
In [56]: h = 0.1+np.zeros(10)
         tol = 10**-8
         est_err = 1 + np.zeros(10)
         act_err = 1 + np.zeros(10)
         i=0
         ans = np.zeros(10)

         while(est_err[i]>tol):

             est_err_temp = []
             h[i+1]=h[i]/2.0
             x=arange(0,5,h[i])
             x_next = arange(0,5,h[i+1])

             I = h[i]*(cumsum(f(x))-0.5*(f(x[0])+f(x)))
             I_next = h[i+1]*(cumsum(f(x_next))-0.5*(f(x_next[0])+f(x_next)))

             x_com = np.intersect1d(x,x_next)

             for k in range(len(x_com)):
                 est_err_temp.append(I_next[2*k]-I[k])

             arg_max_err = argmax(absolute(est_err_temp))
```

```
            act_err[i] = arctan(x_com[arg_max_err])-I[arg_max_err]
            est_err[i] = est_err_temp[arg_max_err]

            print h[i],est_err[i],act_err[i]
            if(est_err[i]>tol):
                i+=1

        fig6 = figure()
        loglog(h[:-1],est_err[:-1],'r+')
        loglog(h[:-1],act_err[:-1],'ro')
        legend(("Estimated error","Exact error"))
        fig6.suptitle(r"Estimated Error vs Actual error for $\int_{0}^{x} dx/(1+t^{2}) $", font
        xlabel("h")
        ylabel("Error")
        fig6.savefig('6.jpg')
        show()
```

```
0.1 0.000405843684336 0.000541031426507
0.05 0.000101395190693 0.000135187742171
0.025 2.53730205509e-05 3.38302944043e-05
0.0125 6.34297412416e-06 8.45727385335e-06
0.00625 1.58572596742e-06 2.11429972918e-06
0.003125 3.96434796102e-07 5.2857963162e-07
0.0015625 9.91086310798e-08 1.32144835518e-07
0.00078125 2.47771875239e-08 3.30362490697e-08
0.000390625 6.1942947438e-09 8.25906154578e-09
```


Estimated Error vs Actual error for $\int_0^x dx/(1+t^2)$
Estimated error
Exact error
Error
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-3}
10^{-2}
10^{-1}
h

In [ ]: