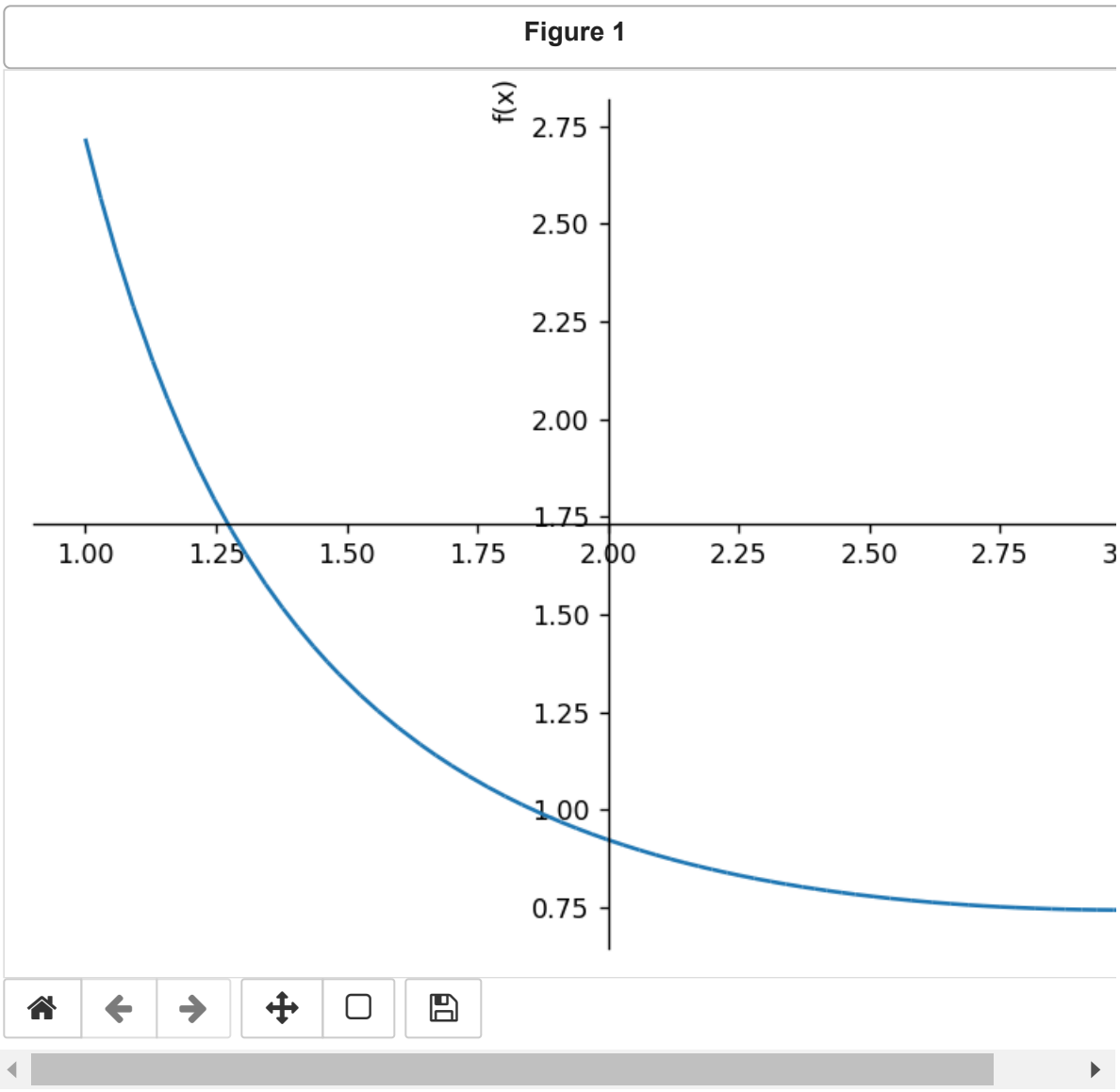
Double-click to insert team members' names here: Martin William Schramm, Harold Wu, Yida Zou

In [25]:
```
from numpy import *
import sympy as sp
```

#1a Plot function

In [26]:
```
matplotlib notebook
```

In [27]:
```
x=sp.symbols('x')
F=sp.exp(x)/x**3
Fdef=sp.integrate(F,(x,1,3))
sp.plot(F,(x,1,3))
```



Out[27]: <sympy.plotting.plot.Plot at 0x24cd7f00160>

#1b Left Endpoint Approximation

In [28]:
```
x=sp.symbols('x')
d_x=(3-1)/100
x_i=arange(1,3,d_x)
y_i=exp(x_i)/x_i**3
LI=sum(y_i)*d_x
print("The approximation with 100 left endpoint rectangles is",LI)
```

```
The approximation with 100 left endpoint rectangles is 2.294111486034061
```

#2 Right Endpoint Approximation

In [29]:
```
x=sp.symbols('x')
d_x=(3-1)/100
x_i=arange(1+d_x,3+d_x,d_x)
y_i=exp(x_i)/x_i**3
RI=sum(y_i)*d_x
print("The approximation with 100 right endpoint rectangles is",RI)
```

```
The approximation with 100 right endpoint rectangles is 2.254624024963537
```

#3 Midpoint Approximation

In [30]:
```
x=sp.symbols('x')
dx=(3-1)/100
x_i=arange(1+dx/2,3-dx/2,dx)
y_i=exp(x_i)/x_i**3
midSum100 = sum(y_i)*dx
print("The approximation with 100 midpoint rectangles is",midSum100)

#PART B
avg = (LI+RI)/2
print("The average of the left and right endpoint approximations is",avg)
print("This is approximately equal to the midpoint approximation")
```

```
The approximation with 100 midpoint rectangles is 2.2740959634770928
The average of the left and right endpoint approximations is 2.274367755498
7993
This is approximately equal to the midpoint approximation
```

#4ab Trapezoid Approximation

In [31]:

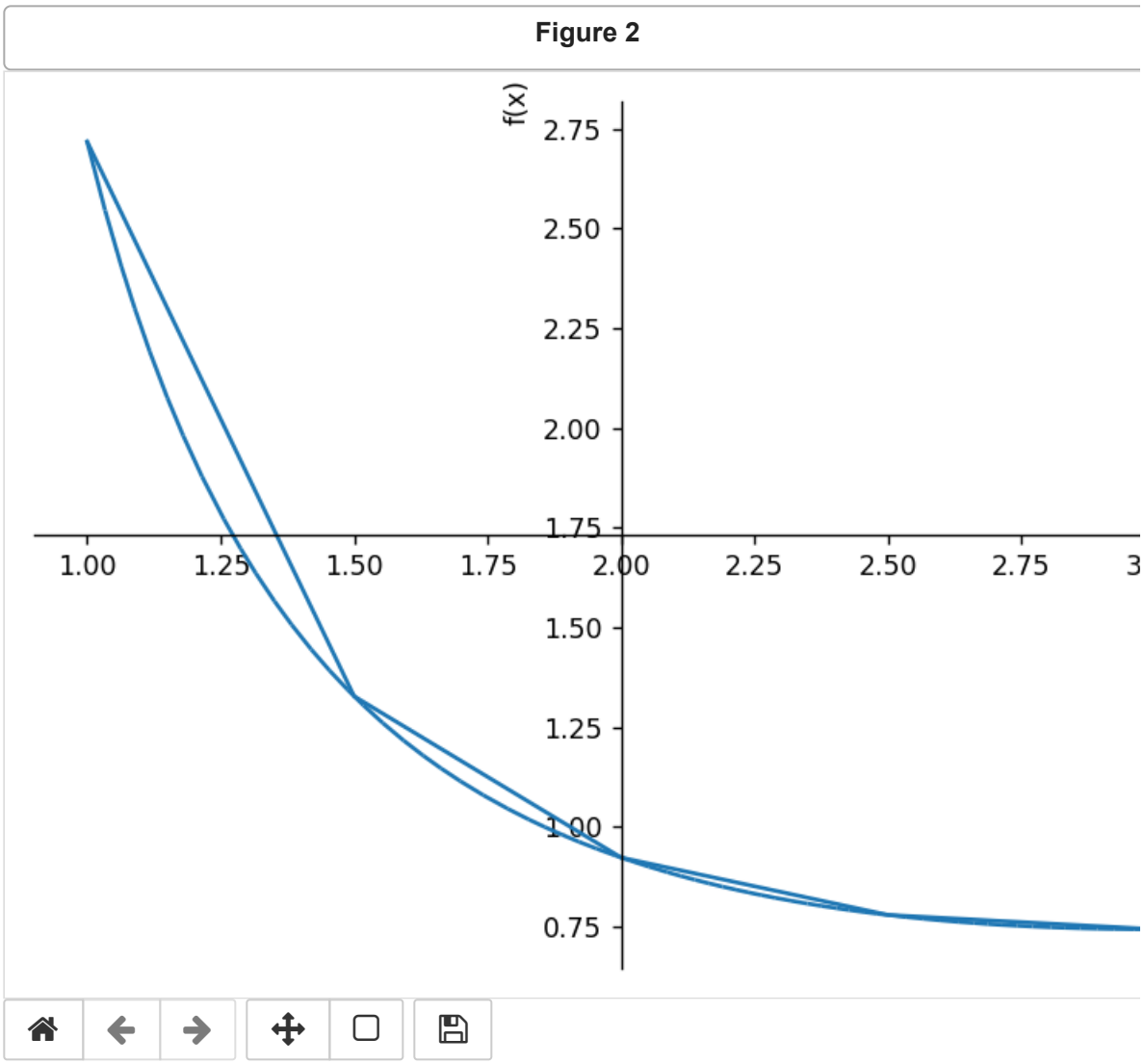
```
from scipy.integrate import trapz
x=sp.symbols('x')
dx=(3-1)/100
x_i=arange(1,3+dx,dx)
y_i=exp(x_i)/x_i**3
trapSum100 = sum(y_i)*dx
print("The approximation with 100 trapezoid rectangles is",trapSum100)
#PART B
avg = (LI+RI)/2
print("The average of the left and right endpoint approximations is",avg)
print("This is not as equal to the trapezoid approximations")
```

```
The approximation with 100 trapezoid rectangles is 2.3089896615327183
The average of the left and right endpoint approximations is 2.274367755498
7993
This is not as equal to the trapezoid approximations
```

#4c Illustrate Trapezoid Approximation

In [32]:

```
x=sp.symbols('x')
f=sp.exp(x)/x**3
sp.plot(f,(x,1,3))
xp=[1,1.5,2,2.5,3]
yp=[f.subs({x:i}) for i in xp]
import matplotlib.pyplot as plt
plt.plot(xp,yp)
```



Out[32]: [<matplotlib.lines.Line2D at 0x24cd95d4850>]

#5a Simpsons Rule

In [33]:
```
from scipy.integrate import simps
dx = (3-1)/100
xi = arange(1, 3+dx, dx)
yi = exp(x_i)/x_i**3
simpsum = simps(yi, xi)
print("The Simpson method approximation is "+str(simpsum)+".")
```

```
The Simpson method approximation is 2.274186633030346.
```

#5b Errors in Approximations

In [34]:
```
a = 2.27418655599653 #actual
print("Left Approximation:",fabs(a-LI))
print("Right Approximation:",fabs(a-RI))
print("Midpoint Approximation:",fabs(midSum100-LI))
print("Trapezoid Approximation:",fabs(trapSum100-LI))
print("Simpsons Approximation:",fabs(simpsum-LI))
```

```
Left Approximation: 0.01992493003753104
Right Approximation: 0.01956253103299277
Midpoint Approximation: 0.020015522556968257
Trapezoid Approximation: 0.014878175498657331
Simpsons Approximation: 0.019924853003714826
```