

Area Under Graph

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Table of Contents

1 Problem

2 Solution

3 Codes

Problem Statement

Area lying in the first quadrant and bounded by the circle $x^2 + y^2 = 4$ and the lines $x = 0$ and $x = 2$ is?

Solution

FUNCTION	FORMULA
$g(x)$	$\mathbf{x}^T \mathbf{V} \mathbf{x} + 2\mathbf{u}^T \mathbf{x} + f = 0$
The points of intersection of the line L with the conic section as above are given by $\mathbf{x}_i = \mathbf{h} + \kappa_i \mathbf{m}$	$L : \mathbf{x} = \mathbf{h} + \kappa \mathbf{m}, \kappa \in \mathbb{R}$ $\kappa_i = \frac{1}{\mathbf{m}^T \mathbf{V} \mathbf{m}} \left(-\mathbf{m}^T (\mathbf{V} \mathbf{h} + \mathbf{u}) \pm \sqrt{[\mathbf{m}^T (\mathbf{V} \mathbf{h} + \mathbf{u})]^2 - g(\mathbf{h}) (\mathbf{m}^T \mathbf{V} \mathbf{m})} \right)$

Table: Variables Used

Solution

On comparing $g(x)$ and $x^2 + y^2 - 4 = 0$ the parameters of the circle are

$$\mathbf{v} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \quad (3.1)$$

$$\mathbf{u} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \quad (3.2)$$

$$f = -4 \quad (3.3)$$

The area bounded by $x = 0$, $x = 2$ and the circle in the first quadrant is

$$\int_0^2 \sqrt{4 - x^2} dx \quad (3.4)$$

for indefinite integration of above form we get

$$\int \sqrt{4 - x^2} dx = 2 \sin^{-1} \frac{x}{2} + x \sqrt{4 - x^2} + c \quad (3.5)$$

$$\int_0^2 \sqrt{4 - x^2} dx = \pi \quad (3.6)$$

Hence the enclosed area is π square units

C Code for Calculating Area

```
#include <stdio.h>
#include <math.h>
double area(double lower_limit, double upper_limit){
    double sum=0 ;
    for ( double i = lower_limit; i<=upper_limit; i+=1e-7 ){
        sum += sqrt(4-i*i)*1e-7;
    }
    return sum ;
}
```

Python Code using shared library

```
import ctypes
lib = ctypes.CDLL('./integration.so')
lib.area.argtypes = [ctypes.c_double, ctypes.c_double]
lib.area.restype = ctypes.c_double
print("Area_enclosed",lib.area(0,2))
```

Python Code for Plotting

```
import sys
sys.path.insert(0, '/home/nithink/matgeo/codes/CoordGeo')
import numpy as np
import matplotlib.pyplot as plt
from numpy import linalg as LA
```

```
# local imports
```

```
from line.funcs import *
from triangle.funcs import *
from conics.funcs import *
```

```
r = 2
```

```
V = np.eye(2)
```

```
u = np.array([0, 0]).reshape(-1, 1) # Reshaping u as a column  
vector
```

```
f = -4
```


Python Code for Plotting

```
# Generating circle
```

```
x_circ = circ_gen(-u, r)
```

```
n1 = np.array([1, 0]).reshape(-1,1)
```

```
c1 = 0
```

```
n2 = np.array([1, 0]).reshape(-1,1)
```

```
c2 = 2
```

```
k1 = -4
```

```
k2 = 4
```

```
#Generating Lines
```

```
x_A = line_norm(n1,c1,k1,k2)
```

```
x_B = line_norm(n2,c2,k1,k2)
```

Python Code for Plotting

```
# Plotting all lines and circles  
plt.plot(x_circ[0, :], x_circ[1, :], label='$Circle$')  
plt.plot(x_A[0,:],x_A[1,:],label='$x_{\_0}$')  
plt.plot(x_B[0,:],x_B[1,:],label='$x_{\_2}$')
```

```
# Adjusting axis spines  
ax = plt.gca()  
ax.spines['top'].set_color('none')  
ax.spines['left'].set_position('zero')  
ax.spines['right'].set_color('none')  
ax.spines['bottom'].set_position('zero')
```

```
# Define the space  
x = np.linspace(0,2,100)  
y_circle = np.sqrt(4-x**2)
```

Python Code for Plotting

```
# Fill the area between the lines and the circle  
plt.fill_between(x,0, y_circle, color='red', alpha=0.5, label='Shaded_  
Region')
```

```
# Labels and title  
plt.xlabel('x')  
plt.ylabel('y')
```

```
# Final plot settings  
plt.legend(loc='upper_right')  
plt.axis('equal')
```

```
#Display the Plot  
plt.show()
```

Diagram

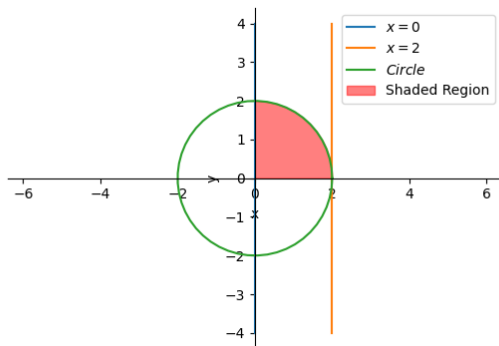


Figure: Enclosed Area