

1.5.18

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Question

Find the coordinates of a point **A** where **AB** is the diameter of the circle whose center is $\begin{pmatrix} 2 \\ -3 \end{pmatrix}$ and **B** is the point $\begin{pmatrix} 1 \\ 4 \end{pmatrix}$.

Theoretical Solution

Let the vector **A** be required vector to be found

Given,

Circle with Center (say) **P** and Diameter **AB**

$$\mathbf{B} = \begin{pmatrix} 1 \\ 4 \end{pmatrix} \quad \mathbf{P} = \begin{pmatrix} 2 \\ -3 \end{pmatrix} \quad (1)$$

Center of a circle is the mid point of the diameter. For a circle with center P and ends of diameters represented by vectors A and B

$$\mathbf{P} = \frac{\mathbf{A} + \mathbf{B}}{2} \quad (2)$$

$$\mathbf{A} = 2\mathbf{P} - \mathbf{B} \quad (3)$$

Theoretical Solution

To find vector **A** , we know that **P** divides diameter **AB** in ratio 1: 1

$$\therefore \mathbf{P} = \frac{\mathbf{A} + \begin{pmatrix} 1 \\ 4 \end{pmatrix}}{2} \quad (4)$$

$$\begin{pmatrix} 2 \\ -3 \end{pmatrix} = \frac{\mathbf{A} + \begin{pmatrix} 1 \\ 4 \end{pmatrix}}{2} \quad (5)$$

Theoretical Solution

Rearranging the terms , we get

$$\mathbf{A} = \begin{pmatrix} 4 & -1 \\ -6 & -4 \end{pmatrix} \quad (6)$$

Hence ,

$$\mathbf{A} = \begin{pmatrix} 3 \\ -10 \end{pmatrix} \quad (7)$$

C Code (1) - Function to find A matrix

```
#include <stdio.h>
#include <math.h>
void func(double *P, double *B, double *A , int m )
{
    for ( int i = 0 ; i < m ; i++ )
    {
        A[i] = 2*P[i] - B[i] ;
    }
}
```

C Code (1) - Function to Find Radius

```
double radius(double *P , double *B , int m )
{
    double sum = 0.0;
    for ( int i = 0 ; i < m ; i++ )
    {
        sum += pow(P[i]-B[i] , 2 );
    }
    return sqrt(sum) ;
}
```


C Code (2) - Function to Generate Points on Circle

```
#include <math.h>

void circle_gen(double *X , double *Y , double *P, int n , double
    r)
{
    // n is no. of points to generates. x stores x coor , y stores y
    coor
    for (int i = 0 ; i < n ; i++ )
    {
        double theta = 2.0 * M_PI * i / n ;
        X[i] = P[0] + r * cos(theta);
        Y[i] = P[1] + r * sin (theta);
    }
}
```

C Code (2) - Function to Generate Points on Line

```
void line_gen (double *X, double *Y , double *A , double *B , int
               n , int m )
{
    double temp[m] ;
    for (int i = 0 ; i < m ; i++)
    {
        temp [ i ] = (B[i]- A[i]) /(double) n ;
    }
    for (int i = 0 ; i <= n ; i++ )
    {
        X[i] = A[0] + temp[0] * i ;
        Y[i] = A[1] + temp[1] * i ;
    }
}
```

Python Code - Using Shared Object

```
import ctypes
import numpy as np
import matplotlib.pyplot as plt

handc1 = ctypes.CDLL("./functions.so")

handc1.func.argtypes = [
    ctypes.POINTER(ctypes.c_double),
    ctypes.POINTER(ctypes.c_double),
    ctypes.POINTER(ctypes.c_double),
    ctypes.c_int
]

handc1.func.restype = None # void function
```

Python Code - Using Shared Object

```
m = 2

P = np.array([[2],[-3]], dtype=np.float64)
B = np.array([[1],[4]], dtype=np.float64)
A = np.zeros(m, dtype=np.float64)

handc1.func(
    P.ctypes.data_as(ctypes.POINTER(ctypes.c_double)),
    B.ctypes.data_as(ctypes.POINTER(ctypes.c_double)),
    A.ctypes.data_as(ctypes.POINTER(ctypes.c_double)),
    m #len(P) alternate
)
```

Python Code - Using Shared Object

```
handc1.radius.argtypes = [  
    ctypes.POINTER(ctypes.c_double),  
    ctypes.POINTER(ctypes.c_double),  
    ctypes.c_int  
]  
  
handc1.radius.restype = ctypes.c_double #return double  
  
radius = handc1.radius(  
    P.ctypes.data_as(ctypes.POINTER(ctypes.c_double)),  
    B.ctypes.data_as(ctypes.POINTER(ctypes.c_double)),  
    m  
)
```

Python Code - Using Shared Object

```
handc2 = ctypes.CDLL("./circle_line.so")
handc2.line_gen.argtypes = [
    ctypes.POINTER(ctypes.c_double),
    ctypes.POINTER(ctypes.c_double),
    ctypes.POINTER(ctypes.c_double),
    ctypes.POINTER(ctypes.c_double),
    ctypes.c_int,
    ctypes.c_int
]
handc2.line_gen.restype = None
n = 20, m = 2
X_l = np.zeros(n, dtype=np.float64)
Y_l = np.zeros(n, dtype=np.float64)
```

Python Code - Using Shared Object

```
handc2.line_gen(  
    X_1.ctypes.data_as(ctypes.POINTER(ctypes.c_double)),  
    Y_1.ctypes.data_as(ctypes.POINTER(ctypes.c_double)),  
    A.ctypes.data_as(ctypes.POINTER(ctypes.c_double)),  
    B.ctypes.data_as(ctypes.POINTER(ctypes.c_double)),  
    n,m)  
  
plt.figure()  
  
#plotting line  
plt.plot([X_1[0],X_1[-1]], [Y_1[0],Y_1[-1]], "g--", label="Diameter"  
    )  
plt.scatter(A[0],A[1],color = "red",s=50)  
plt.scatter(B[0],B[1],color = "red",s=50)  
plt.scatter(P[0],P[1],color = "red",s=50,label = "Center of  
    Circle")
```

Python Code - Using Shared Object

```
handc2.circle_gen.argtypes = [  
    ctypes.POINTER(ctypes.c_double),  
    ctypes.POINTER(ctypes.c_double),  
    ctypes.POINTER(ctypes.c_double),  
    ctypes.c_int,  
    ctypes.c_double]  
  
handc2.circle_gen.restypes = None  
  
n = 200  
#r = radius  
  
X_c = np.zeros(n, dtype=np.float64)  
Y_c = np.zeros(n, dtype=np.float64)
```


Python Code - Using Shared Object

```
handc2.circle_gen(  
  
    X_c.ctypes.data_as(ctypes.POINTER(ctypes.c_double)),  
    Y_c.ctypes.data_as(ctypes.POINTER(ctypes.c_double)),  
    P.ctypes.data_as(ctypes.POINTER(ctypes.c_double)),  
    n , radius  
)  
  
#plotting circle  
plt.plot(X_c,Y_c , "b-")  
  
plt.annotate(f"A({A[0]},{A[1]})", (A[0], A[1]), textcoords="  
offset points", xytext=(0,5), ha='right')  
plt.annotate("B", (B[0], B[1]), textcoords="offset points",  
    xytext=(0,5), ha='left')  
plt.annotate("P", (P[0], P[1]), textcoords="offset points",  
    xytext=(0,5), ha='left')
```

Python Code - Using Shared Object

```
# Equal scaling for axes (important for circles!)
plt.gca().set_aspect("equal", adjustable="box")

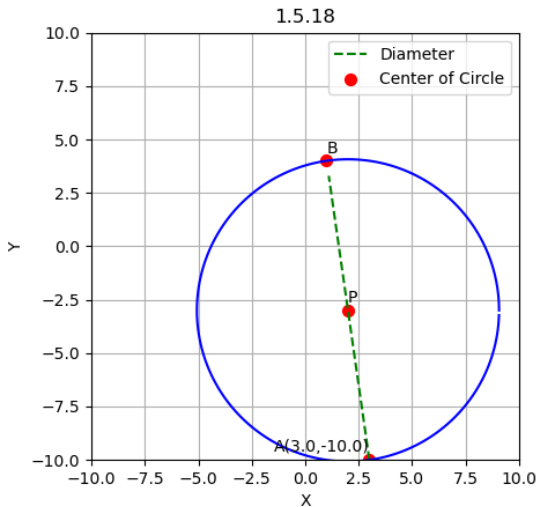
plt.xlim([-10,10])
plt.ylim([-10,10])

# Labels and title
plt.xlabel("X")
plt.ylabel("Y")
plt.title("1.5.18")

plt.legend(loc = 'upper right')
plt.grid(True)

plt.savefig('figs/circle_graph.png')
subprocess.run(shlex.split("termux-open figs/circle_graph.png"))
```

Plot-Using Both C and Python



Python Code

```
import math
import sys
import numpy as np
import numpy.linalg as LA
import matplotlib.pyplot as plt
import matplotlib.image as mpimg

#local imports
from libs.line.funcs import *
from libs.triangle.funcs import *
from libs.conics.funcs import circ_gen

#if using termux
import subprocess
import shlex
```

Python Code

```
def func(P, B):  
    # NumPy automatically applies operations to each element in  
    the array  
    return 2*P -B  
  
def func_radius(P,B) :  
    return LA.norm(P-B)  
  
P = np.array([2,-3]).reshape(-1,1)  
B = np.array([1,4]).reshape(-1,1)  
  
A = func(P,B).reshape(-1,1)  
  
x_AB = line_gen_num(A,B,20)  
radius = func_radius(P,B)
```

```
x_circ = circ_gen(P,radius)
plt.plot(x_circ[0,:],x_circ[1:], "red",label="Circle")
plt.plot(x_AB[0,:],x_AB[1:], "g--",label="Diameter")

tri_coords = np.block([[A,B,P]])
plt.scatter(tri_coords[0,:], tri_coords[1,:])
vert_labels = ['A', 'B', 'P']
for i , txt in enumerate(vert_labels):
    plt.annotate(txt,(tri_coords[0,i],tri_coords[1,i]),textcoords
        ="offset points", xytext=(0,10),ha='center')
```

```
plt.xlabel('$x$')
plt.ylabel('$y$')
plt.legend(loc='best')
plt.grid() # minor
plt.axis('equal')
#plt.savefig("../figs/circle_graph2.png")
#plt.show()

plt.savefig('/figs/circle_graph2.png')
subprocess.run(shlex.split("termux-open figs/circle_graph2.png"))
```

Plot-Using only Python

