7.2.5

AI25BTECH11014 - Gooty Suhas

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Problem

Check whether the point $\mathbf{P} = \begin{pmatrix} -2 \\ 4 \end{pmatrix}$ lies on a circle of radius 6 centered at $\mathbf{C} = \begin{pmatrix} 3 \\ 5 \end{pmatrix}$.

Matrix Form

The general equation of a circle with center $\mathbf{C}$ and radius r is:

$$\|\mathbf{x} - \mathbf{C}\|^2 = r^2$$

Substituting $\mathbf{C} = \begin{pmatrix} 3 \\ 5 \end{pmatrix}$, $r = 6$:

$$\|\mathbf{x} - \begin{pmatrix} 3 \\ 5 \end{pmatrix}\|^2 = 36$$

Expanding the norm:

$$(\mathbf{x} - \begin{pmatrix} 3 \\ 5 \end{pmatrix})^T (\mathbf{x} - \begin{pmatrix} 3 \\ 5 \end{pmatrix}) = 36$$

Substitution

Let $\mathbf{x} = \mathbf{P} = \begin{pmatrix} -2 \\ 4 \end{pmatrix}$. Then:

$$\mathbf{x} - \mathbf{C} = \begin{pmatrix} -2 \\ 4 \end{pmatrix} - \begin{pmatrix} 3 \\ 5 \end{pmatrix} = \begin{pmatrix} -5 \\ -1 \end{pmatrix}$$

Now compute the squared norm:

$$\|\mathbf{x} - \mathbf{C}\|^2 = \begin{pmatrix} -5 \\ -1 \end{pmatrix}^T \begin{pmatrix} -5 \\ -1 \end{pmatrix} = (-5)^2 + (-1)^2 = 25 + 1 = 26$$

So the point yields:

$$\|\mathbf{P} - \mathbf{C}\|^2 = 26$$

Comparison

$$\text{LHS} = 26, \quad \text{RHS} = 36 \Rightarrow 26 \neq 36$$

Conclusion

The point $\mathbf{P} = \begin{pmatrix} -2 \\ 4 \end{pmatrix}$ does not satisfy the equation of the circle. Hence,

$\boxed{\mathbf{P} \text{ does not lie on the circle}}$

verify_circle.py (Part 1)

```
from sympy import Matrix, simplify

P = Matrix([[-2], [4]])
C = Matrix([[3], [5]])
r_squared = 36

diff = P - C
distance_squared = simplify(
    diff.T * diff
)[0]
```

verify_circle.py (Part 2)

```
print("Distance squared:",
      distance_squared)
print("Radius squared:",
      r_squared)

print("Point lies on circle:",
      distance_squared == r_squared)
```

verify_circle.c (Part 1)

```c
#include <math.h>

void verify_circle(float px, float py,
                   float cx, float cy,
                   float radius,
                   float* result) {
  float dx = px - cx;
  float dy = py - cy;
```

verify_circle.c (Part 2)

```
    float dist_sq = dx*dx + dy*dy;
    float r_sq = radius * radius;

    if (fabs(dist_sq - r_sq) < 1e-6)
        *result = 1.0;
    else
        *result = 0.0;
}
```

call_verify.py (Part 1)

```
import ctypes

lib = ctypes.CDLL('./libverify.so')

lib.verify_circle.argtypes = [
    ctypes.c_float, ctypes.c_float,
    ctypes.c_float, ctypes.c_float,
    ctypes.c_float,
    ctypes.POINTER(ctypes.c_float)
]
```

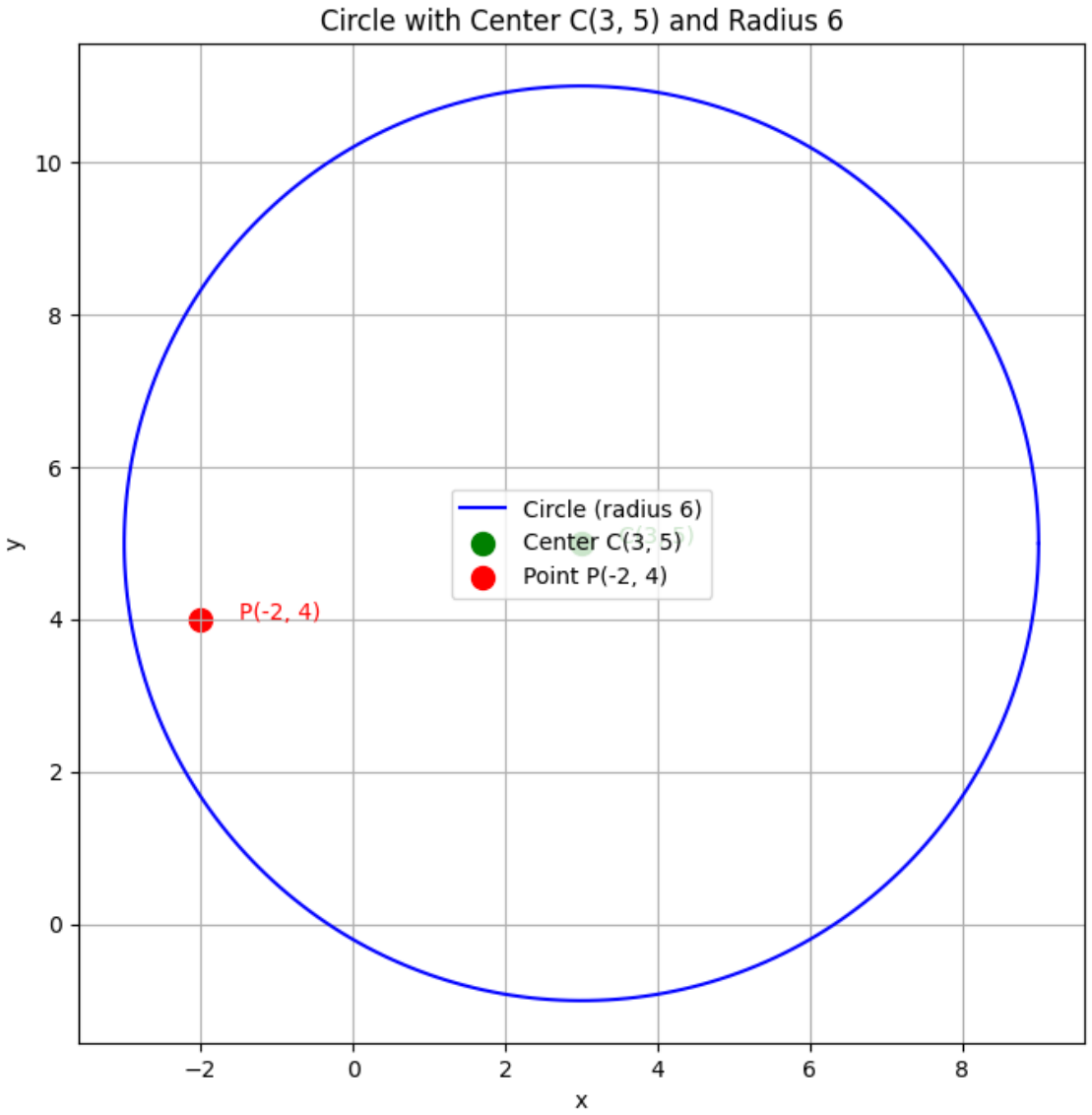
call_verify.py (Part 2)

```
lib.verify_circle.restype = None

px, py = ctypes.c_float(-2.0), ctypes.c_float(4.0)
cx, cy = ctypes.c_float(3.0), ctypes.c_float(5.0)
radius = ctypes.c_float(6.0)
result = ctypes.c_float()

lib.verify_circle(px, py, cx, cy,
                  radius, ctypes.byref(result))
```

call_verify.py (Part 3)

```
if result.value == 1.0:
    print("Verified: Point lies on the circle")
else:
    print("Verified: Point does NOT lie on the circle")
```

Diagram


Circle with Center C(3, 5) and Radius 6
Circle (radius 6)
Center C(3, 5)
Point P(-2, 4)
P(-2, 4)
x
y
−2
0
2
4
6
8
0
2
4
6
8
10