

TASK 1: BORN RULE - MEASUREMENT PROBABILITIES

Aim: To calculate and visualize the measurement probabilities of quantum states using the Born Rule in Quantum Mechanics.

Algorithm:

1. Start the program.
2. Import necessary libraries:
3. numpy for numerical and complex vector operations.
4. matplotlib.pyplot for visualization.
5. Define the function `born_rule_probabilities(psi)`:
6. Compute the absolute square of each amplitude in the state vector $\psi \rightarrow |\psi|^2$.
7. Normalize the probabilities by dividing each by the sum of all probabilities.
8. Return the normalized probability distribution.
9. Create quantum superposition states.
10. Calculate measurement probabilities.
11. Create two subplots using matplotlib.
12. Display them.

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

print("\n" + "="*50)
print("TASK 1: BORN RULE - MEASUREMENT PROBABILITIES")
print("="*50)

def born_rule_probabilities(psi):
    """Calculate measurement probabilities using Born rule:  $P = |\langle \text{basis} | \psi \rangle|^2$ """
    probabilities = np.abs(psi)**2
    return probabilities / np.sum(probabilities) # Normalize

# Create superposition states
psi_1 = np.array([1/np.sqrt(2), 1/np.sqrt(2)]) # |+> state
psi_2 = np.array([1/np.sqrt(3), np.sqrt(2/3)]) # Custom superposition

print("Superposition state 1:  $|\psi_1\rangle =$ ", psi_1)
print("Measurement probabilities:", born_rule_probabilities(psi_1))

print("Superposition state 2:  $|\psi_2\rangle =$ ", psi_2)
print("Measurement probabilities:", born_rule_probabilities(psi_2))
```

```

# Visualization
states = ['|0>', '|1>']
probs_1 = born_rule_probabilities(psi_1)
probs_2 = born_rule_probabilities(psi_2)

plt.figure(figsize=(10, 4))

plt.subplot(1, 2, 1)
plt.bar(states, probs_1, color='blue', alpha=0.7)
plt.title('State  $|\psi_1\rangle$  Probabilities')
plt.ylabel('Probability')

plt.subplot(1, 2, 2)
plt.bar(states, probs_2, color='red', alpha=0.7)
plt.title('State  $|\psi_2\rangle$  Probabilities')
plt.ylabel('Probability')

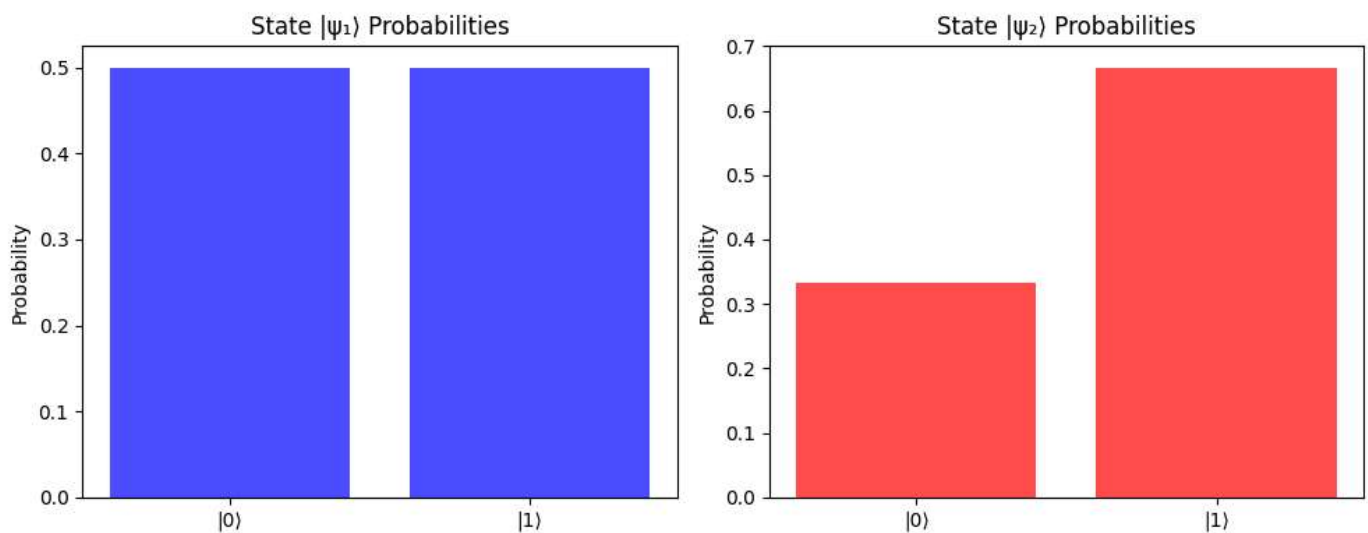
plt.tight_layout()
plt.show()

```

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Superposition state 1:  $|\psi_1\rangle = [0.70710678 \ 0.70710678]$ 
Measurement probabilities:  $[0.5 \ 0.5]$ 
Superposition state 2:  $|\psi_2\rangle = [0.57735027 \ 0.81649658]$ 
Measurement probabilities:  $[0.33333333 \ 0.66666667]$ 

```



Result: Measurement probabilities for different quantum states were calculated and visualized successfully.