Quantum measurement

Predict a distribution, sample it and understand what measurement changes.

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By the end, you'll be able to

- Distinguish exact probabilities from finite-shot counts.
- Explain state change under a projective measurement.
- Use sampling uncertainty without treating it as hardware noise.

One shot gives one outcome

A computational-basis measurement of $\alpha|0\rangle + \beta|1\rangle$ produces 0 or 1 according to the squared amplitudes. After an ideal projective measurement, the qubit is in the corresponding basis state.

Measurement does not always change a state. A qubit already in $|0\rangle$ stays there after a Z-basis measurement. The important point is that arbitrary inspection without disturbance is unavailable.

Fresh preparations matter

If you measure $|+\rangle$ once and get 0, immediately measuring that same qubit in Z again gives 0. To estimate the original 50/50 distribution, repeat the **preparation and experiment**, not just the final measurement on the collapsed state.

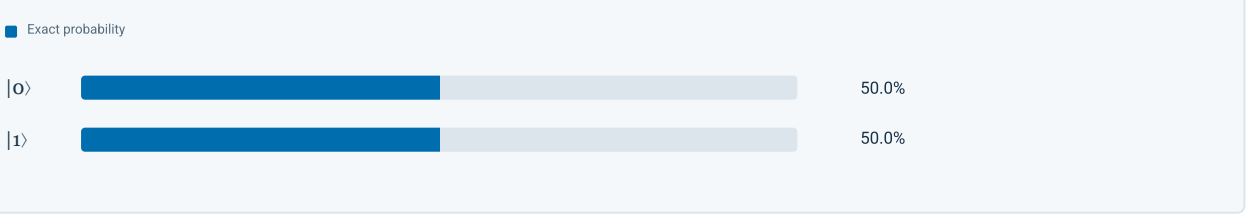
The lab's shots are independent preparations. Its "exact" bars come from the mathematical statevector. Hardware does not supply those amplitudes directly.

L15 · INTERACTIVE LAB

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Shots & statistical uncertainty

Exact probabilities are predictions. A finite sample fluctuates. The Wilson interval describes sampling uncertainty for the probability of 1 under independent repeated preparations.



MODEL · Ideal pure-state vector, complex double precision ORDER · q0 is the leftmost bit

Prediction: Will exactly half of 100 shots be 1? What should happen to the uncertainty interval at 10,000 shots? Challenge: Keep the state fixed and change only the seed. Explain why different counts need not indicate a different quantum state. Open the live experiment studio.

Interpret the interval

For 100 independent fair shots, the expected count of 1 is 50, but 47 or 54 would be ordinary fluctuations. A 95% Wilson interval estimates a range for the underlying probability from the observed count, assuming independent identically prepared trials. It is not a guarantee about an individual outcome or a complete model of hardware error.

A different basis

To measure a qubit in X using a Z-readout device, apply H first. This turns $|+\rangle$ into $|0\rangle$ and $|-\rangle$ into $|1\rangle$. Always name the basis when interpreting results.

Try it: change only the seed, then change only the shot count. Which changes alter the state? Neither. Explain why counts and interval widths still change.

Reference: IBM Quantum — Quantum mechanics basics.