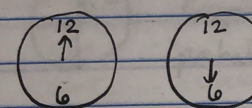
Lecture 1

Imagine a classical bit
- up/down ↑ ↓
- left/right ← →
- on/off ○ ●
- 12/6

Imagine a clock that only points at 12 & 6



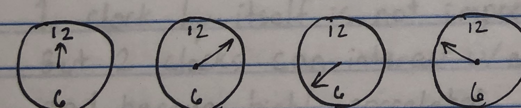
This is the same as having a classical bit {0,1}

But we are wasting so much space!

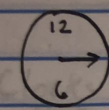
space = information

Superposition

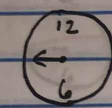
Imagine a new clock that can point anywhere on its face.



But this clock has a rule, when you tell the time you must say either 12 or 6



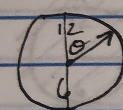
what time would you say here?



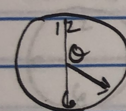
How about here?

50% of people would say 12

50% of people would say 6



People will choose 12 with probability $\cos^2(\frac{\theta}{2})$

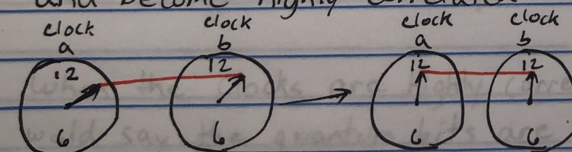


People will choose 6 with probability $\sin^2(\frac{\theta}{2})$ or $\cos^2(\frac{180-\theta}{2})$

Entanglement

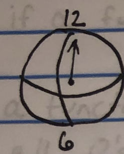
1 clock by itself is not impressive

But 2 clocks can interact w/ each other and become highly correlated



In this case clock a and b are correlated in such a way that they will always be the same value

Bloch Sphere



But the Bloch Sphere struggles w/ showing Entanglement between two qbits.

ket notation?

or

Deutsch's algorithm?

Deutsch's Problem

An algorithm capable of determining if a function f is constant or balanced

a function is <u>constant</u> if all outputs are all 0's or 1's

a function is <u>balanced</u> if half the outputs are 0's and the other half 1's

a	b	a⊕b
0	0	0
0	1	1
1	0	1
1	1	0

$f : \mathbb{Z}_2 \to \mathbb{Z}_2$

xor

$f : |x\rangle|y\rangle \to |x\rangle|f(x) \oplus y\rangle$

effectively

if $|y\rangle = |0\rangle$

then $|x\rangle|y\rangle \to |x\rangle|f(x)\rangle$

else if $|y\rangle = |1\rangle$

then $|x\rangle|y\rangle \to |x\rangle|\bar{f}(x)\rangle$ $\bar{f}(x) = \text{not } f(x)$