#flo #inclass

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1 | quantum

quantum indexing is important! it's essentially, binary indexing.

tensor products! - combination of two vector spaces, denoted as H because they are Hilbert spaces - they are finite dim! so not really proper Hilbert spaces? #question what is a Hilbert space? - for now, treat is as a finite dimensional complex vector space. it represents the state space of a qubit - and all the vectors in it have unit len! - tensor products are just to define two vector spaces to make another bigger vector space

- binary indexing because the product is preserved? that's kinda cool
  - our subscript indicing can also be used to denote which basis vector you want
  - for example,

$$e_{00} \to \begin{pmatrix} 1 \\ 0 \\ 0 \\ 0 \end{pmatrix} \text{ and } e_{11} \to \begin{pmatrix} 0 \\ 0 \\ 0 \\ 1 \end{pmatrix}$$

- **entanglement** is the tensor product of the state matrices of each qubit? or it's where you can't separate the tensor product? #question
  - no. a quantum state is the tensor product of two other vectors, then it is **separable.** otherwise, it is **entangled.**

an example of a separable state is as follows:

$$ $\begin{pmatrix} 1 \\ 0 \end{pmatrix} \otimes \begin{pmatrix} 0 \\ 1 \end{pmatrix}$ =

$\begin{pmatrix} 1 \begin{pmatrix} 0 \\ 1 \end{pmatrix} \\ 0 \begin{pmatrix} 0 \\ 1 \end{pmatrix} \end{pmatrix}$ = $\begin{pmatrix} 0 \\ 1 \\ 0 \\ 0 \end{pmatrix}$ = | ud $\rangle$$$ - the indexing is done by $a(xy)$ where $x = 01$ and $y = 10$, in binary - together, this makes 6 in binary, which we just count down from the top to get

1.1 | the matricies!

$$I = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} - - - X = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} - - - H = \frac{1}{\sqrt{2}} \begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix}$$

a matrix is **unitary** when its conjugate transpose U* is also its inverse

$$A^H = A^{-1} \to A^H A^{-1} = I$$

a matrix is **hermetian** when it's *equal* to it's conjugate transpose $A^H = \overline{A^T}$

if **U** is a unitary matrix, then $||U_a|| = ||a||$

we also define the adjoint of a matrix U, which is U^*. ie, $V[r,c] = \overline{U}[c,r]$ then we talk about, tensor products! defined, here