From classical to good quantum LDPC codes.

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Today.

- Brif Review of Coding.

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- Quantum Error Correction Codes.

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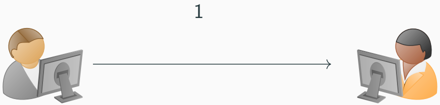
- Good Classical Locally Testabile Codes and Good Qauntum LDPC.

Classical Vs Quantum Encoding.

Classical:



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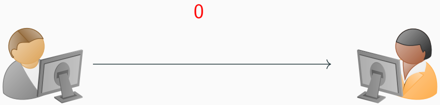

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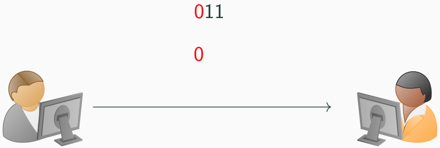

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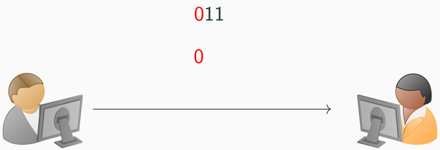

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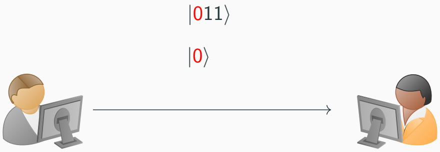

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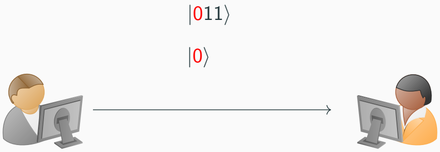
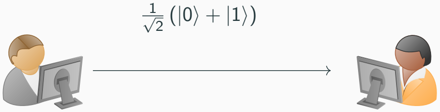


Quantum:



Classical Vs Quantum Encoding.

Classical:

$|011\rangle$

$|0\rangle$

Quantum:

$\frac{1}{\sqrt{2}}\left(|0\rangle - |1\rangle\right)$

Classical Vs Quantum Encoding.

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The C.S Questions.

In the asymptotic regime, can we encode quantum states in codes robust against many errors, as our original massage grows? And in what costs?

Good Classical LDPC Code.

Definition

Let $n \in \mathbb{N}$ and $\rho, \delta \in (0,1)$. We say that C is a **binary linear code** with parameters $[n, \rho n, \delta n]$. If C is a subspace of $\mathbb{F}_2^n$, and the dimension of C is at least ρn and any pair of distinct elements in C differ in at least δn coordinates. We call to the vectors belong to C *codewords*, to ρn the dimension of the code, and to δn the distance of the code.

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A **family of codes** is an infinite series of codes..

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Definition

We will say that a family of codes is a **good code** if its parameters converge into positive values.

Good Classical LDPC Code.

C

ode C is a linear subspace $\rightarrow$ There is a matrix H such:

$$x \in C \Leftrightarrow Hx = 0$$

We will call H the parity check matrix.

Definition

A codes family will be called LDPC code if weight of any row (col) in H is $O(1)$.

Good Classical LDPC Code.

Good Classical LDPC Code.

Quantum Encoding.

Quantum Encoding.

Quantum Encoding.

Idea I - (Uncertainty) Clouds as States.

CSS Code.

'Idea II' - Tanner Checks are 'Too Much' Interdependence.

'Idea III' - Impossibility of Both C_X, C_Z being Good.

Quantum Tanner Code Construction.

Proving Strategy.