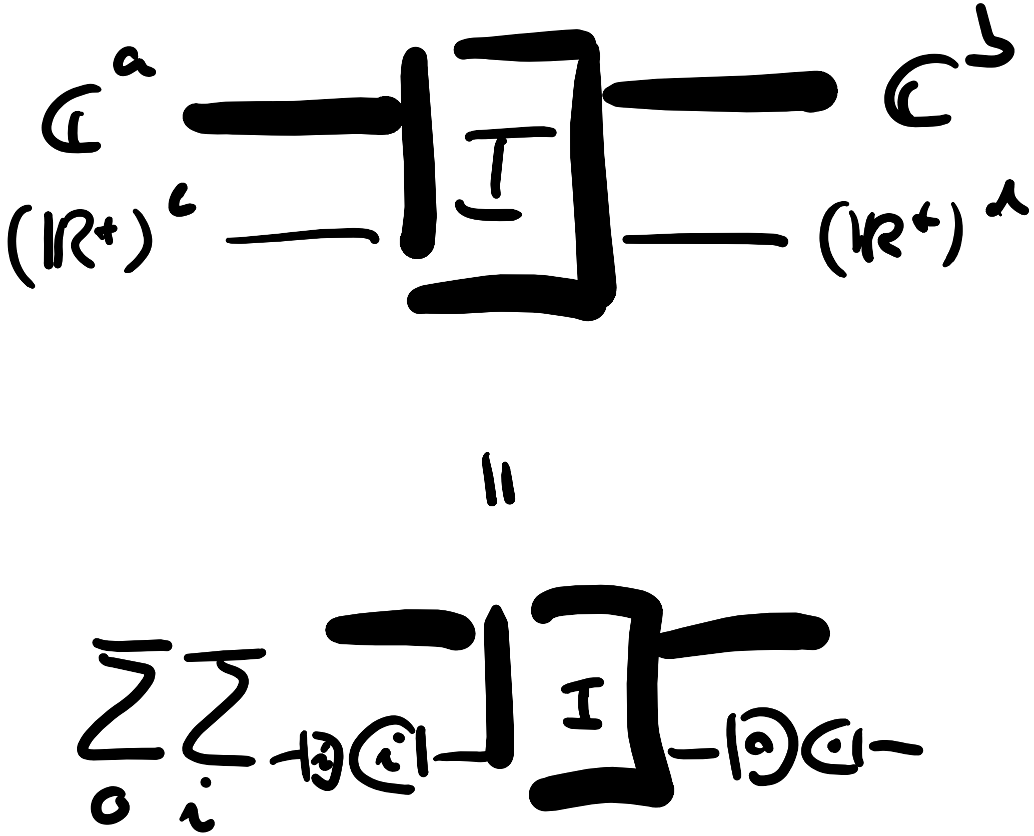
Quantum in Pictures Lecture Series

Lecturer: Stefano Gogioso

Thu 29 June 2023 – Afternoon Lecture

INDIANA UNIVERSITY BLOOMINGTON


$\mathbb{C}^a$
$(\mathbb{R}^+)^c$
I
$\mathbb{C}^b$
$(\mathbb{R}^+)^d$
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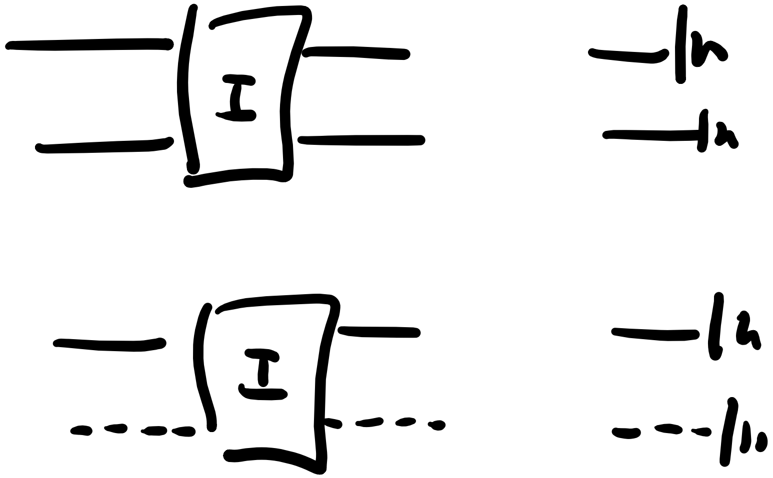
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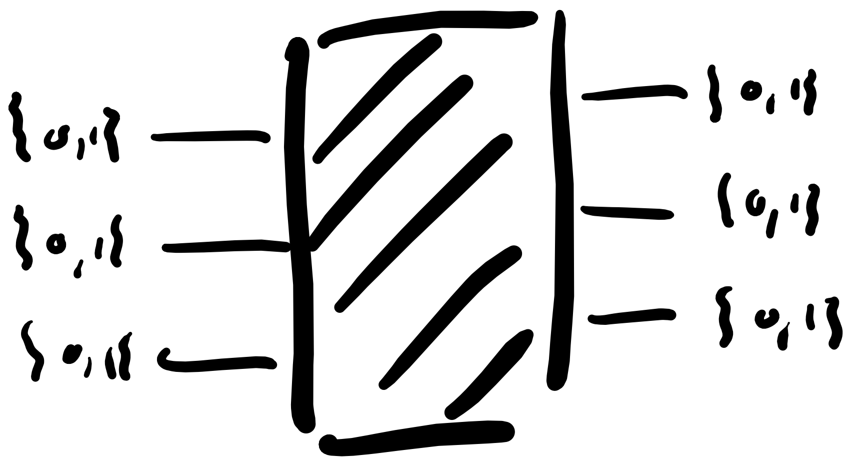
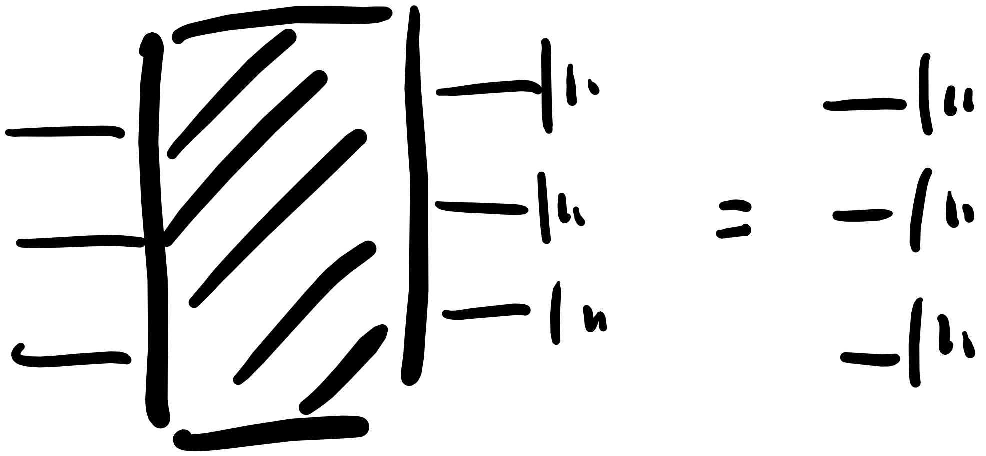


$\in \mathbb{R}_+^{8 \times 8}$

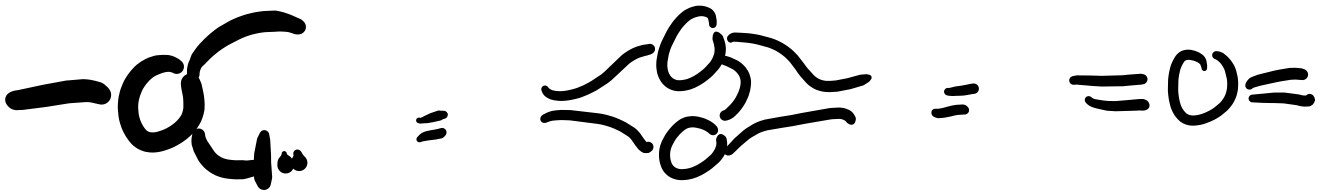


$\Rightarrow$ matrix is stochastic

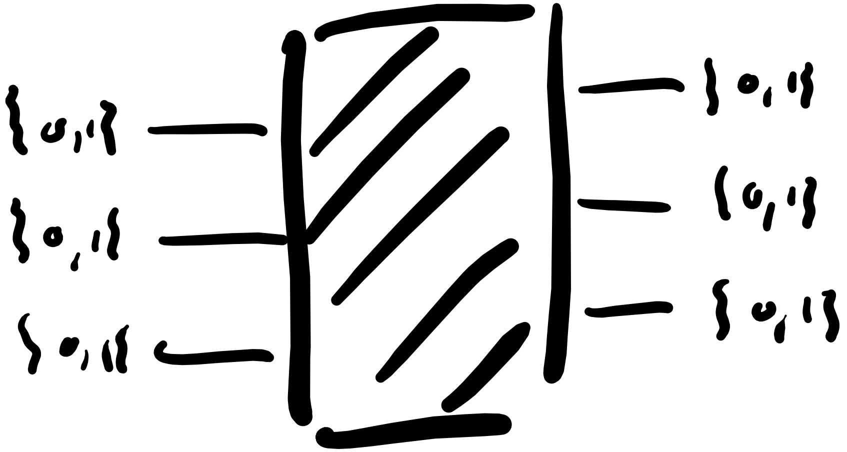
(conditional prob. dist)

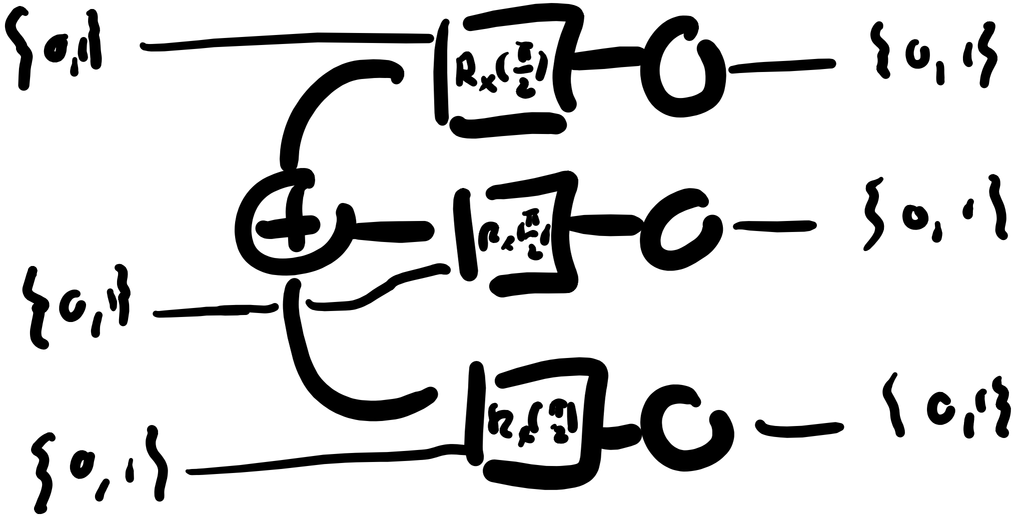
Demolition Measurement

Non-demolition measurement



Decoherence

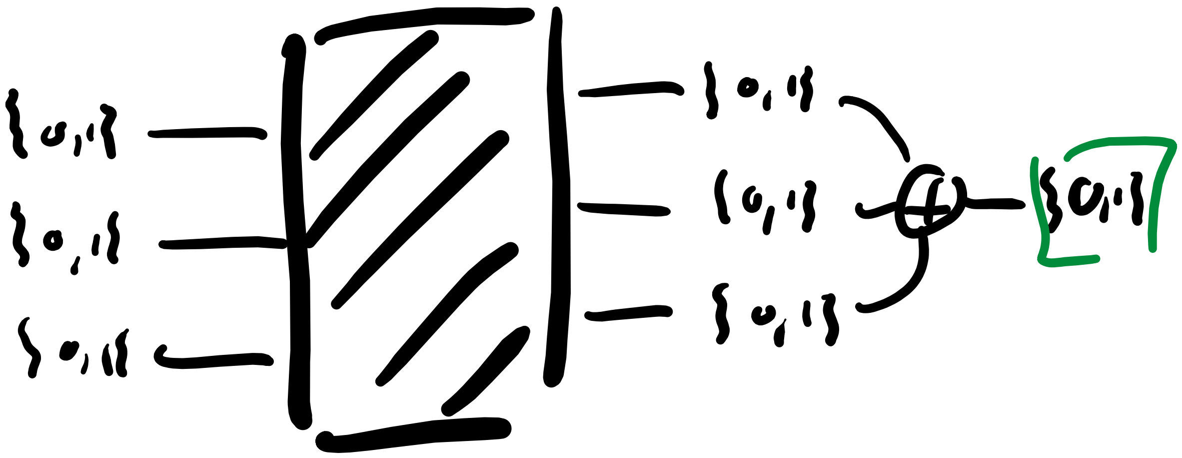


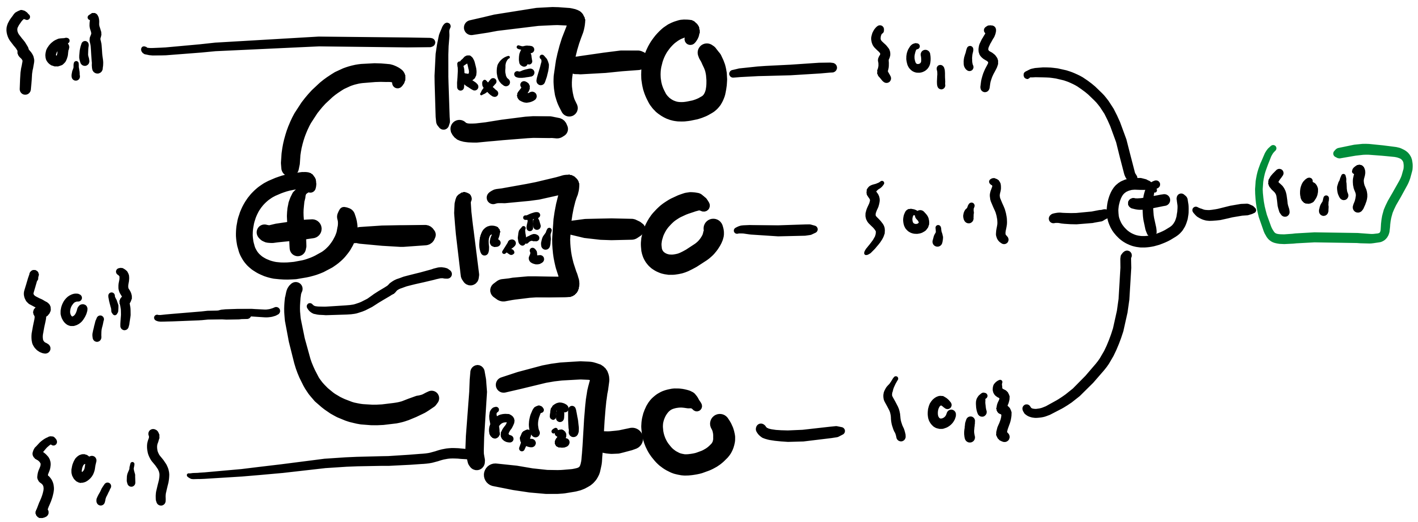


in ↓ / out →	000	001	010	011	100	101	110	111
000	1/4	0	0	1/4	0	1/4	1/4	0
~~001~~								
~~010~~								
011	0	1/4	1/4	0	1/4	0	0	1/4
~~100~~								
101	0	1/4	1/4	0	1/4	0	0	1/4
110	0	1/4	1/4	0	1/4	0	0	1/4
~~111~~								

↑

(either no-one, or exactly two parties rotated by $\pi/2$)

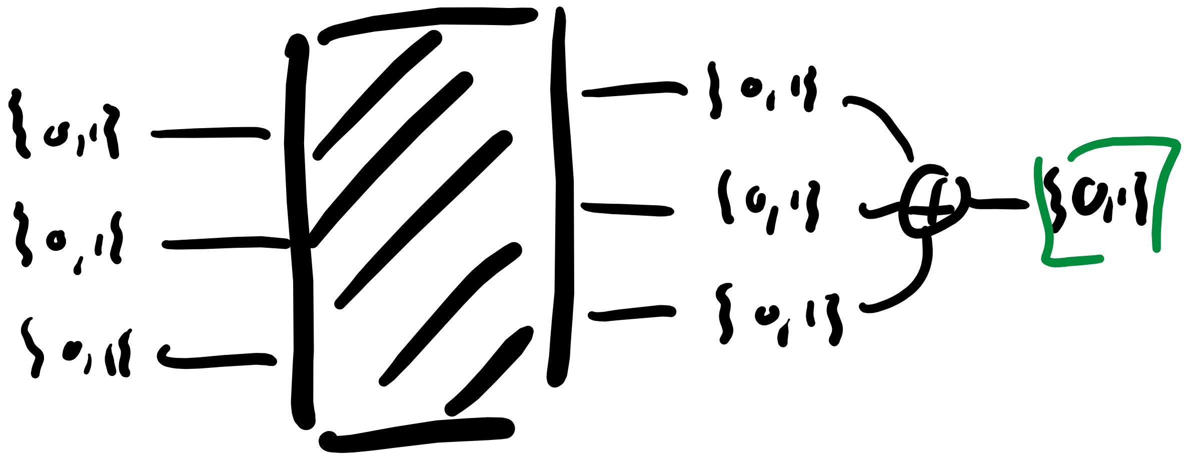




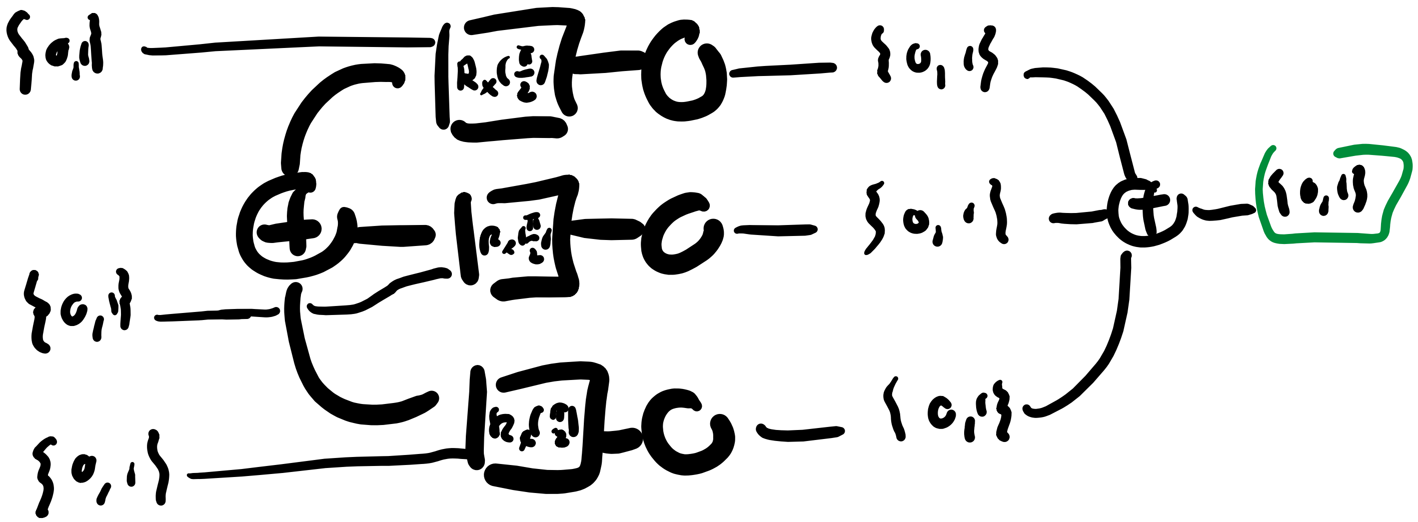
in ↓ / out →	000	001	010	011	100	101	110	111
xor	0	1	1	0	0	1	1	0
000	1/4	0	0	1/4	0	1/4	1/4	0
~~001~~								
~~010~~								
011	0	1/4	1/4	0	1/4	0	0	1/4
~~100~~								
101	0	1/4	1/4	0	1/4	0	0	1/4
110	0	1/4	1/4	0	1/4	0	0	1/4
~~111~~								

↑

(either no-one, or exactly two parties rotated by $\pi/2$)



in ↓ / the out →	0	1
000	1	0
~~001~~		
~~010~~		
011	0	1
~~100~~		
101	0	1
110	0	1
~~111~~		



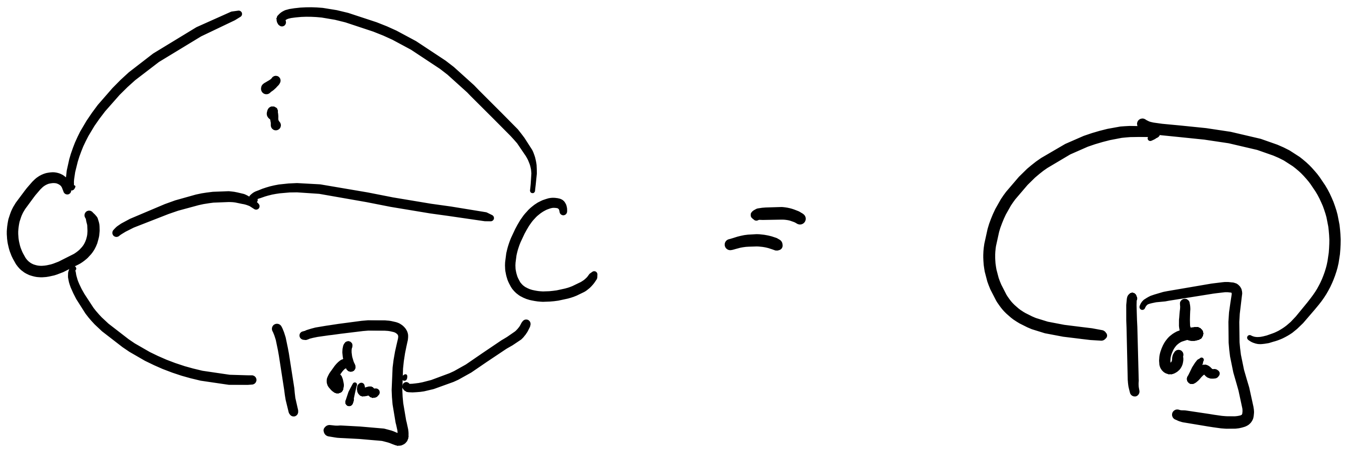
(either no-one, or exactly two gates rotated by $\pi/2$)

Local Hidden Variable Model

outcomes for A, B, C: $\quad x_0^A, x_1^A, x_0^B, x_1^B, x_0^C, x_1^C \in \{0,1\}$

$$
\begin{array}{ccccccc}
\cancel{x_0^A} & \oplus & \cancel{x_0^B} & \oplus & \cancel{x_0^C} & = & 0 \\
\oplus & & \oplus & & \oplus & & \oplus \\
\cancel{x_0^A} & \oplus & \cancel{x_1^B} & \oplus & \cancel{x_1^C} & = & 1 \\
\oplus & & \oplus & & \oplus & & \oplus \\
\cancel{x_1^A} & \oplus & \cancel{x_1^B} & \oplus & \cancel{x_0^C} & = & 1 \\
\oplus & & \oplus & & \oplus & & \oplus \\
\cancel{x_1^A} & \oplus & \cancel{x_0^B} & \oplus & \cancel{x_1^C} & = & 1 \\
\shortparallel & & \shortparallel & & \shortparallel & & \shortparallel \\
0 & \oplus & 0 & \oplus & 0 & \neq & 1
\end{array}
$$

$$\frac{1}{3} \sum_{\mu = x,y,z} \sum_{i=1,2} \left(\langle \psi | \sigma_{\mu_i} | \psi \rangle \right)^2 = 1$$



$\mathbb{C}^4$ ———

$\mathbb{C}^2$ ——— $\mathcal{H}_2$