Simulation of indivisible channels in collision models

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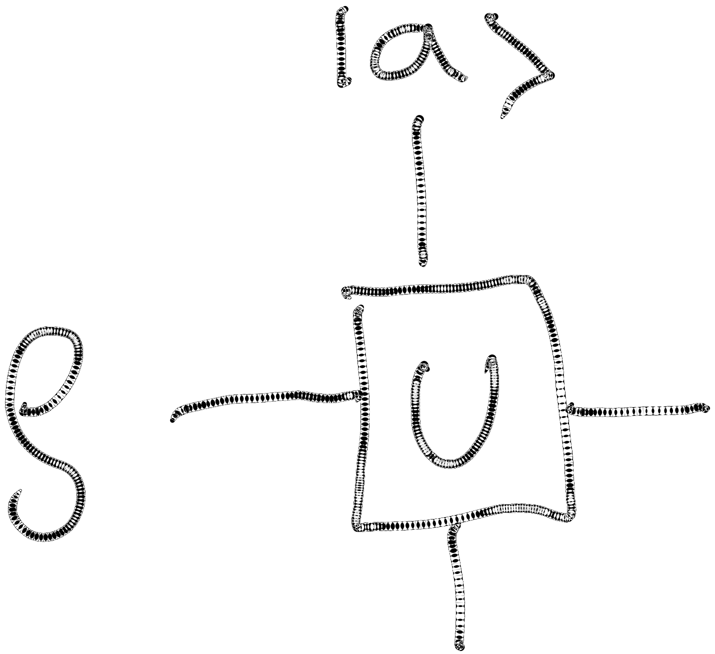
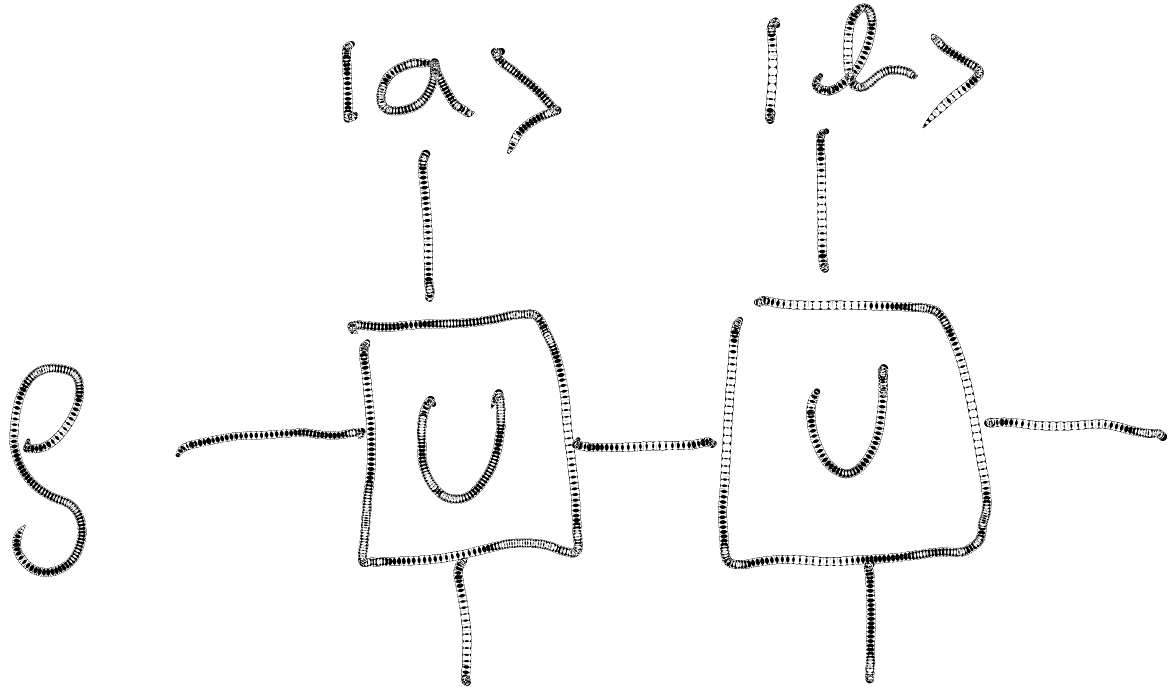
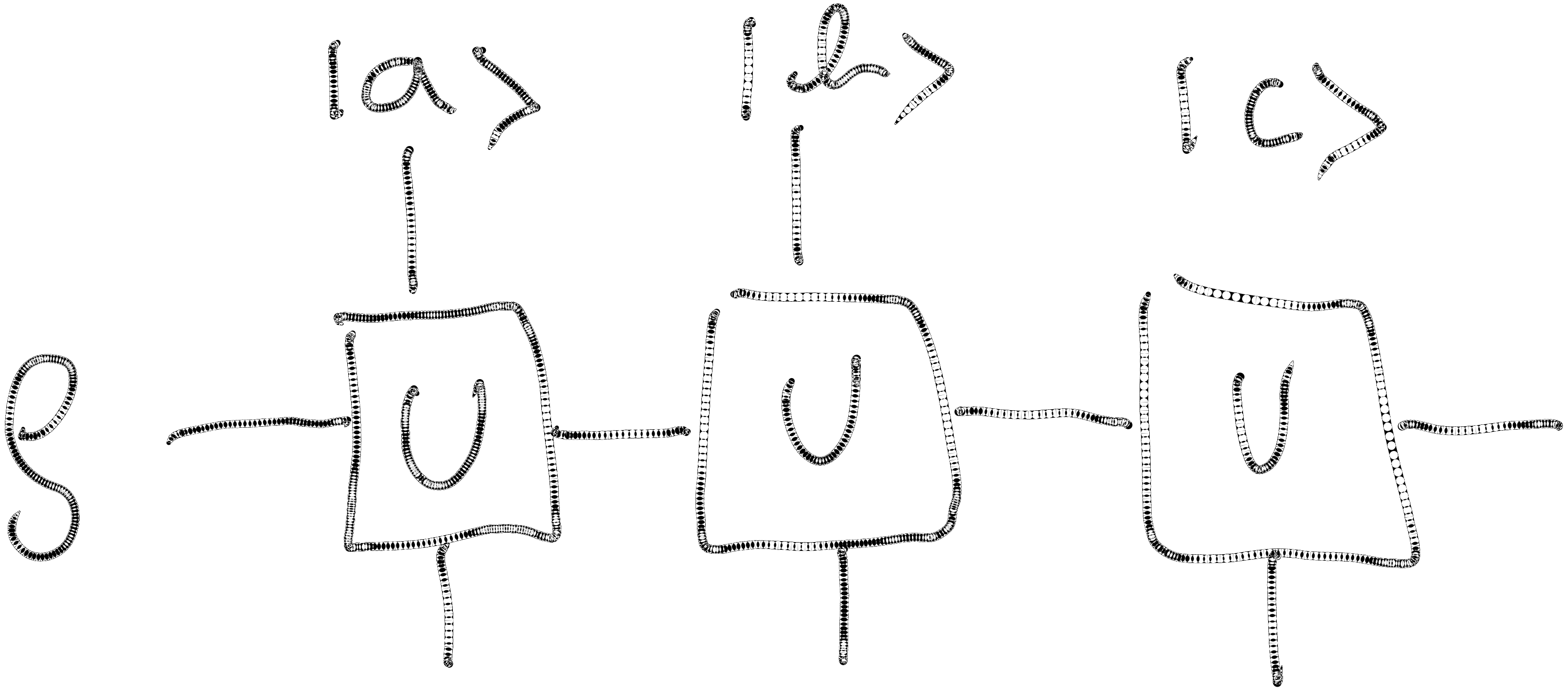
Collision model



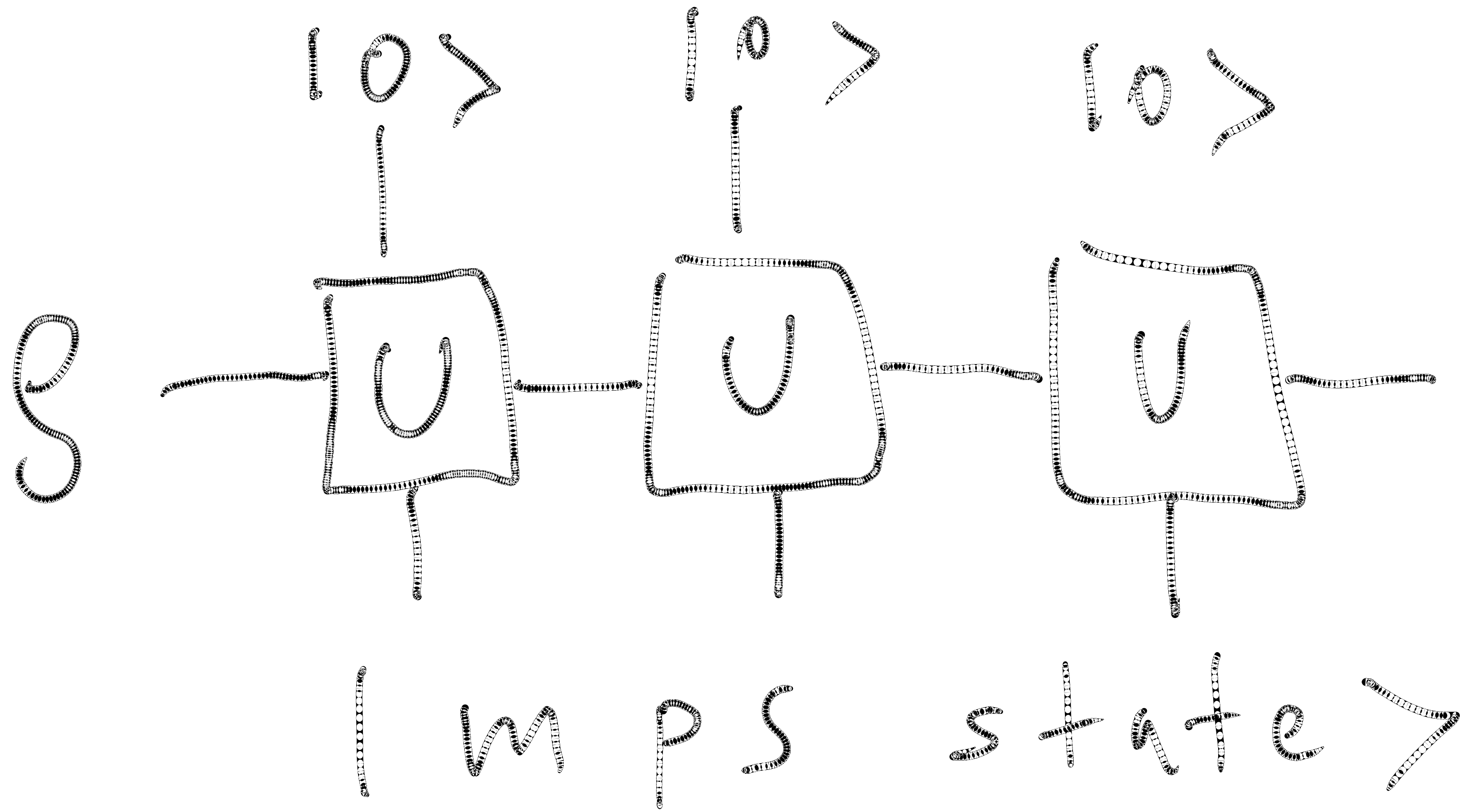
Collision model



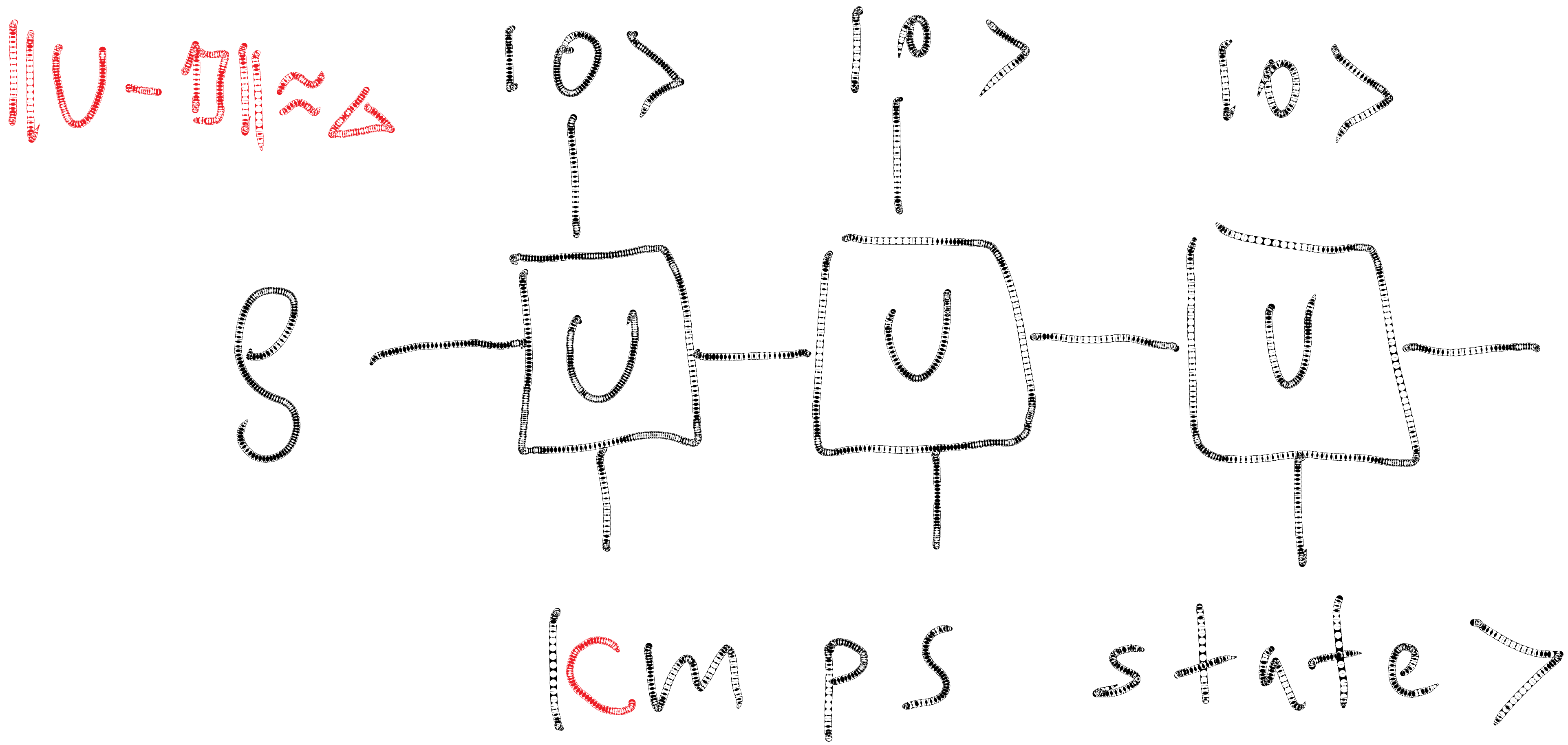
Collision model



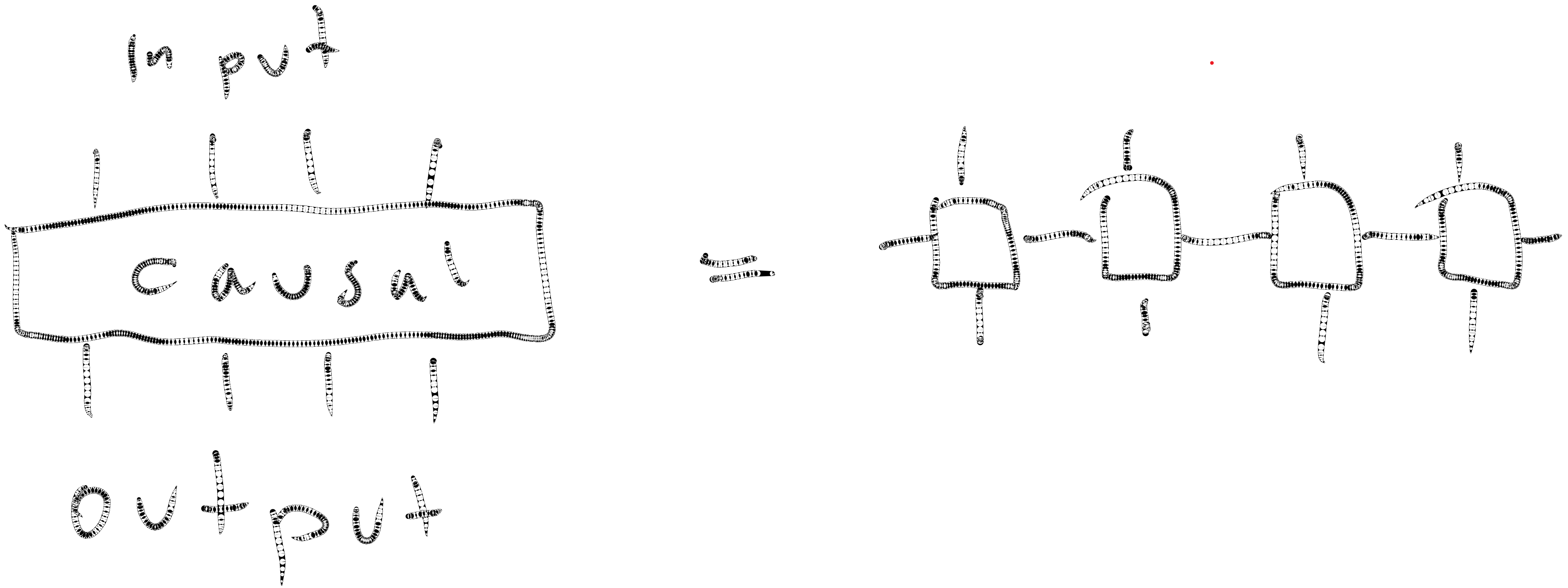
Collision model



Collision model



Collision model

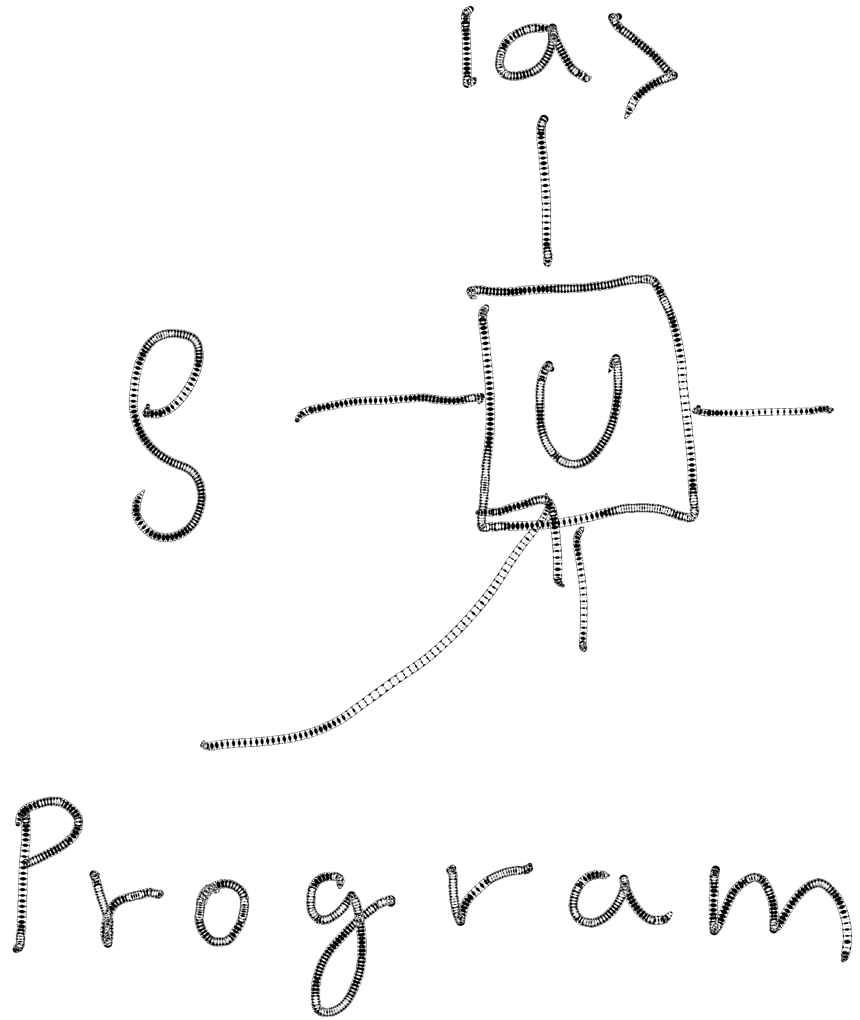


Collision model

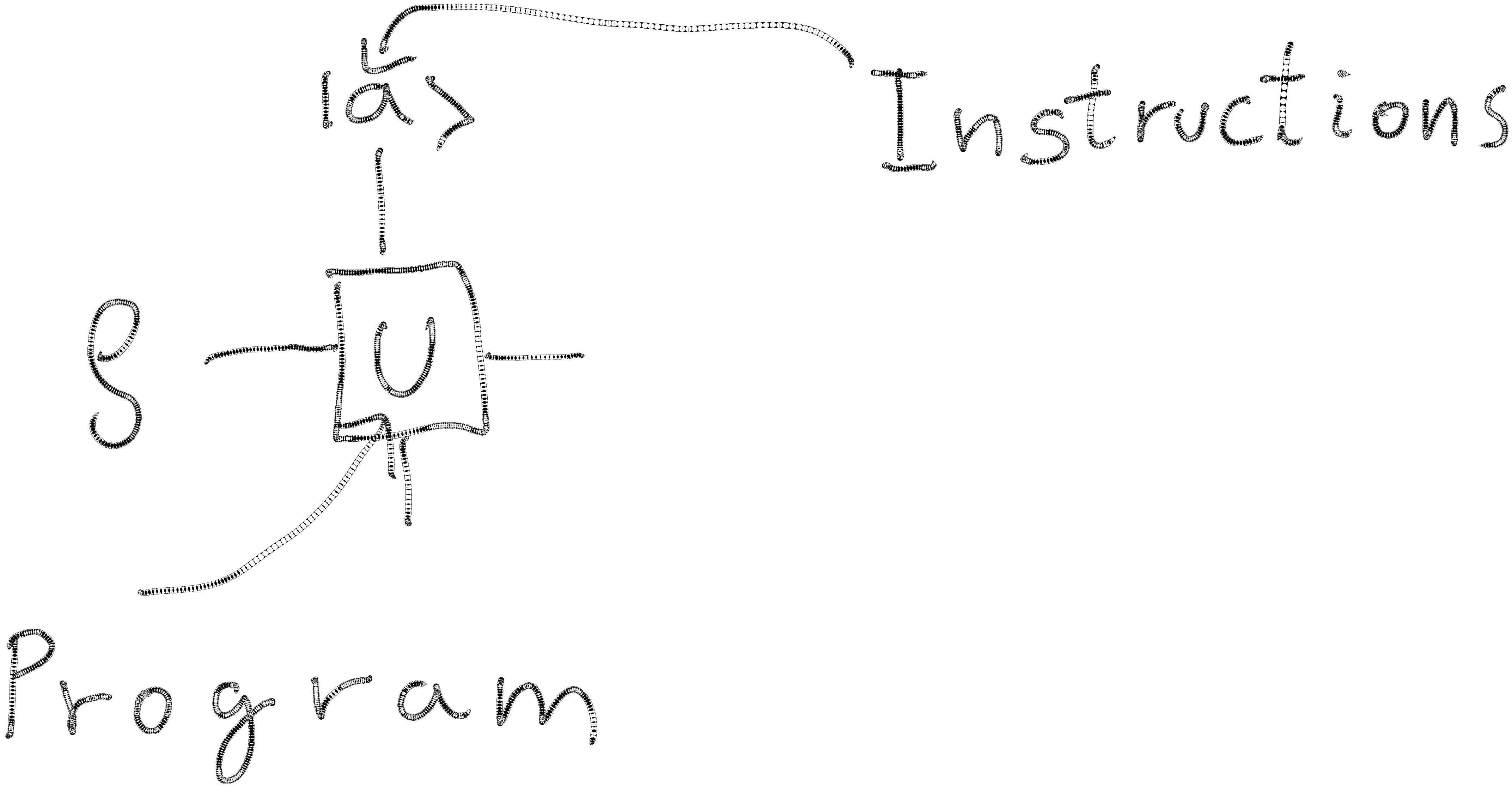
=

interesting structure

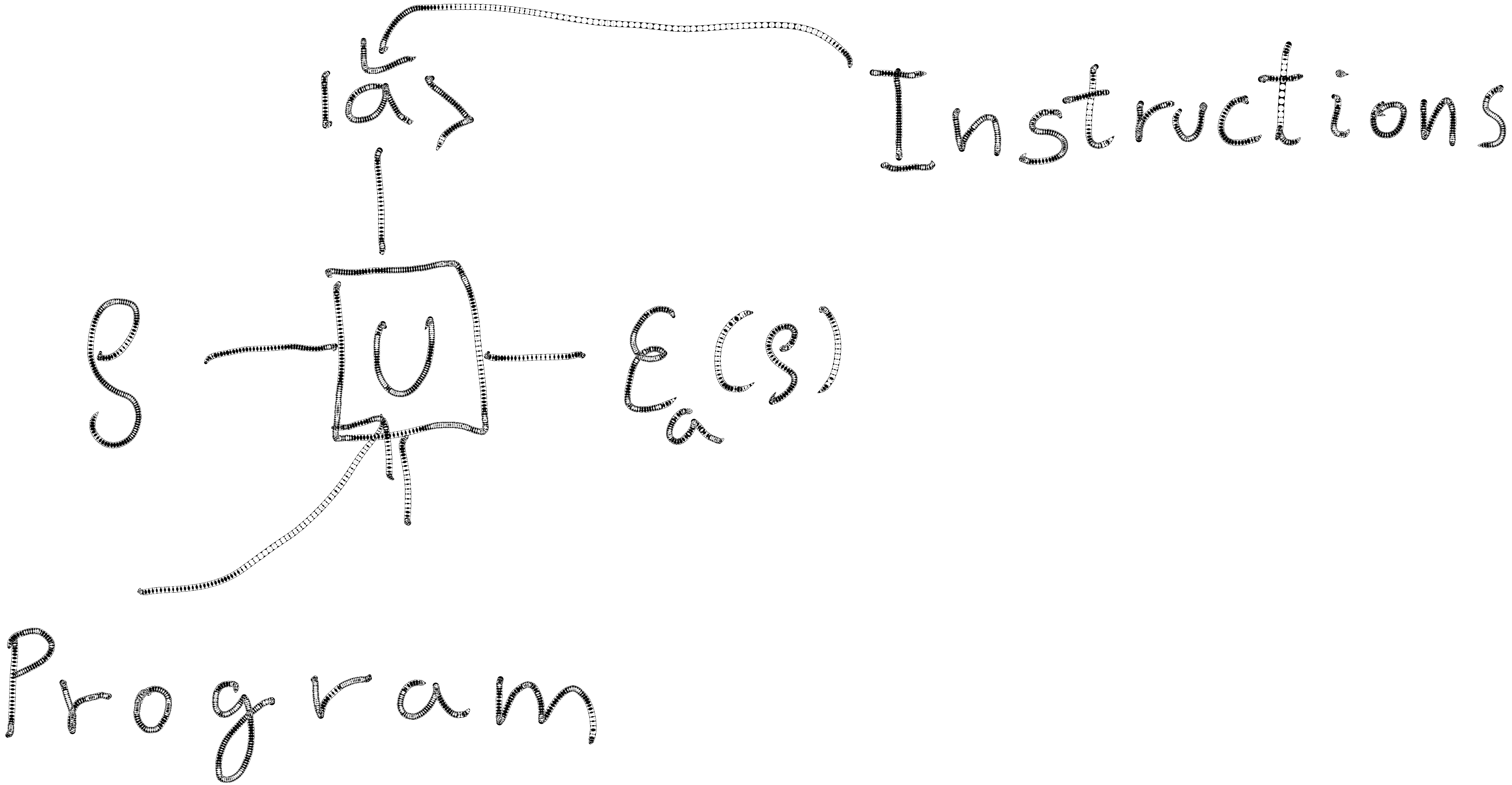
Simulation



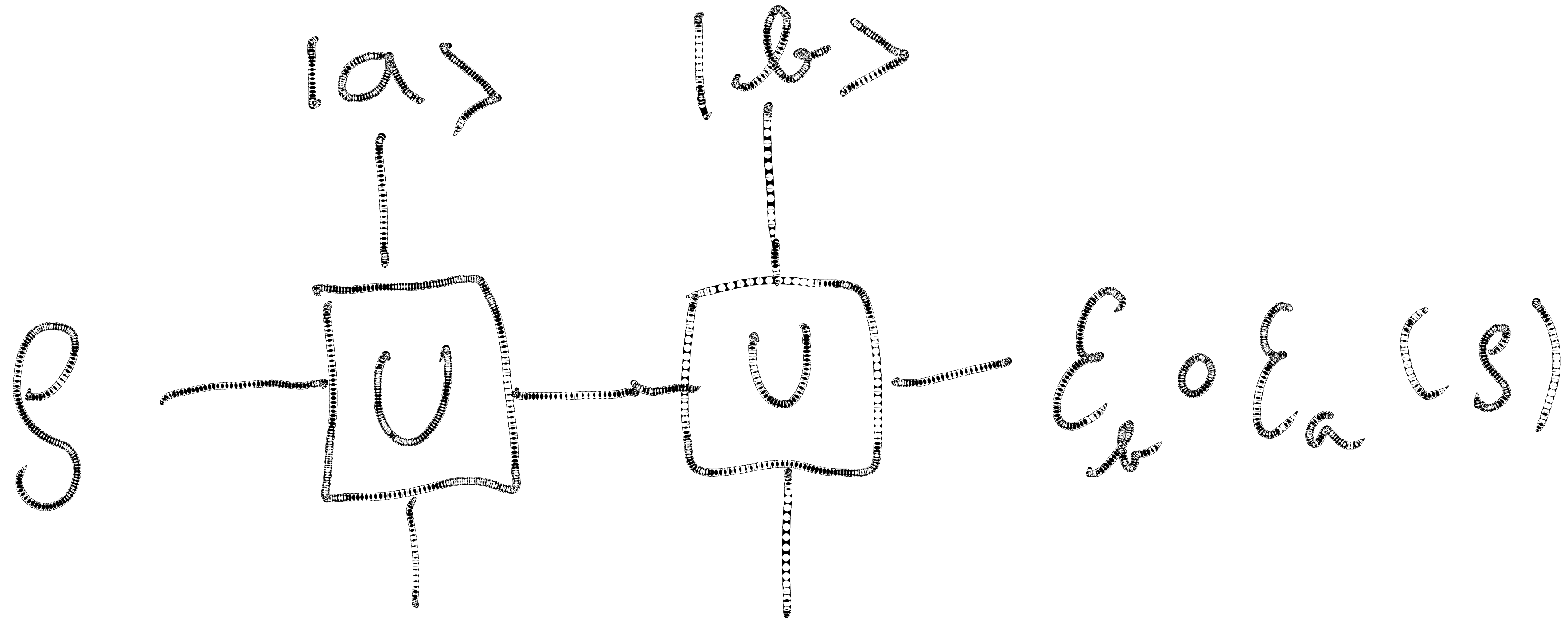
Simulation



Simulation



Simulation



Simulation

$$|a\rangle = |b\rangle = \dots = |0\rangle$$

$$\rho(n) = \underbrace{\mathcal{E}_0 \circ \dots \circ \mathcal{E}_0}_{n}(\rho)$$

cmps limit

$$\rho(t) = \mathcal{E}_t(S) = e^{\mathcal{L}t}(S)$$

Markovian evolution

Divisibility

Non-Unitary Channels

$$\mathcal{E} = \mathcal{E}_\alpha \circ \mathcal{E}_\beta$$

Divisible channel

Wolf, Cirac,
Communications in Mathematical Physics
April 2008, Volume 279, Issue 1, pp 147-168

Divisibility

$$\mathcal{E}_t = e^{\mathcal{L}t}$$

Infinitely ↑

Divisible channel

(Markovian)

InDivisibility

$$\mathcal{E}(\rho) = q_x \sigma_x \rho \sigma_x + q_y \sigma_y \rho \sigma_y + q_z \sigma_z \rho \sigma_z$$

$$q_x q_y q_z > 0 \qquad \sum_i q_i = 1$$

InDivisibility

$$\mathcal{E}(\rho) = q_x \sigma_x \rho \sigma_x + q_y \sigma_y \rho \sigma_y + q_z \sigma_z \rho \sigma_z$$

$$q_x \; q_y \; q_z > 0 \qquad \sum_i q_i = 1$$

Can we simulate those!

Simulating random unitary channels

$$\mathcal{E}(\rho) = \sum_i p_i W_i \rho W_i^\dagger$$

$$W_i = \exp(iH_i)$$

$$U_\Delta = \sum_i |i\rangle\langle i| \otimes \exp(i\Delta H_i)$$

$$\Delta = \frac{1}{N}$$

$$|in\rangle_N = \sum_i \sqrt{p_i}\ |i, \ldots i\rangle$$

Simulating random unitary channels

$$\mathcal{E}_t(\rho) = \sum_i p_i \, e^{itH_i} \rho \, e^{-itH_i}$$

$$= \mathrm{Tr}_E \left[U_t \left(|\psi\rangle\langle\psi| \otimes \rho \right) U_t^\dagger \right]$$

$$|\psi\rangle = \sum_i \sqrt{p_i} \, |i\rangle$$

$$U_t = e^{itH}$$

$$H = \sum_i |i\rangle\langle i| \otimes H_i$$

Simulating subsystem evolutions

Can one?

$$\mathcal{E}_t(\rho) = \mathrm{Tr}_E\left[U_t\left(|\psi\rangle\langle\psi| \otimes \rho\right)U_t^\dagger\right]$$

$|\psi\rangle$ = arbitrary

$U_t = e^{itH}$

H = arbitrary

I have a video