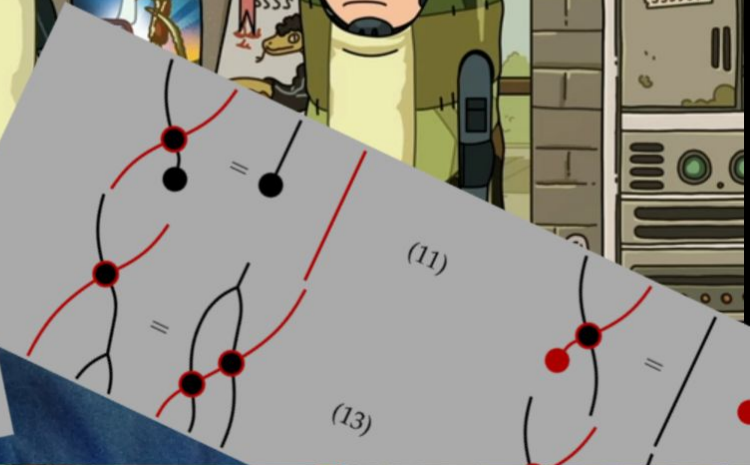
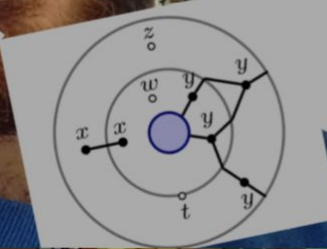
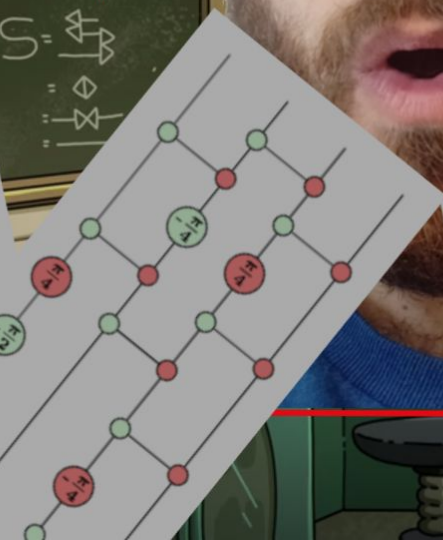
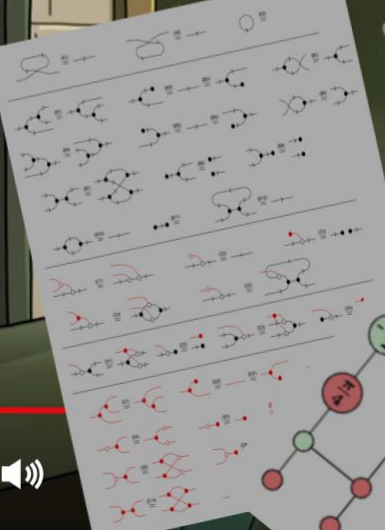
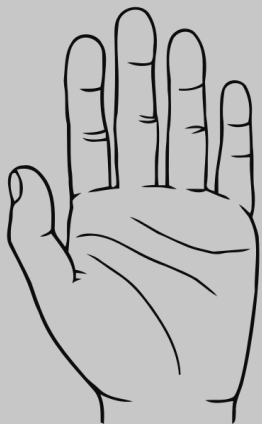


$$S \left\{ \begin{array}{l} S \\ S \end{array} \right. \frac{S}{S} \frac{\Delta}{\Delta} = - \frac{\Delta}{\Delta} \frac{\Delta}{\Delta} \left[\begin{array}{l} \Delta \\ \Delta \end{array} \right]$$
$$S = \frac{\Delta}{\Delta} \frac{\Delta}{\Delta}$$
$$= \frac{\Delta}{\Delta} \frac{\Delta}{\Delta}$$



Abstraction





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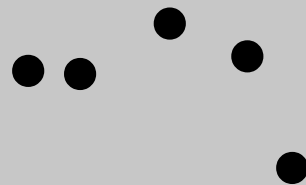
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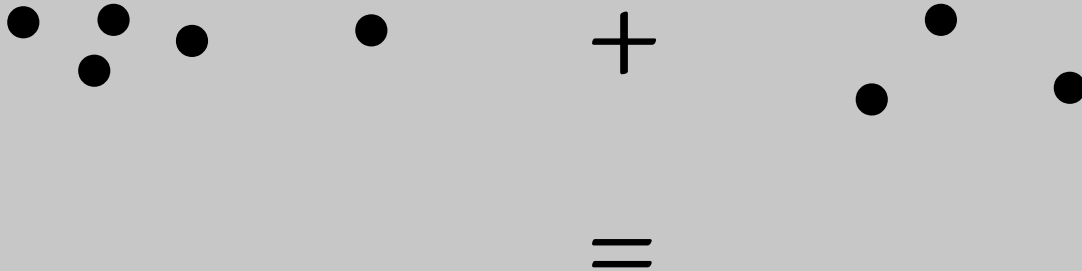
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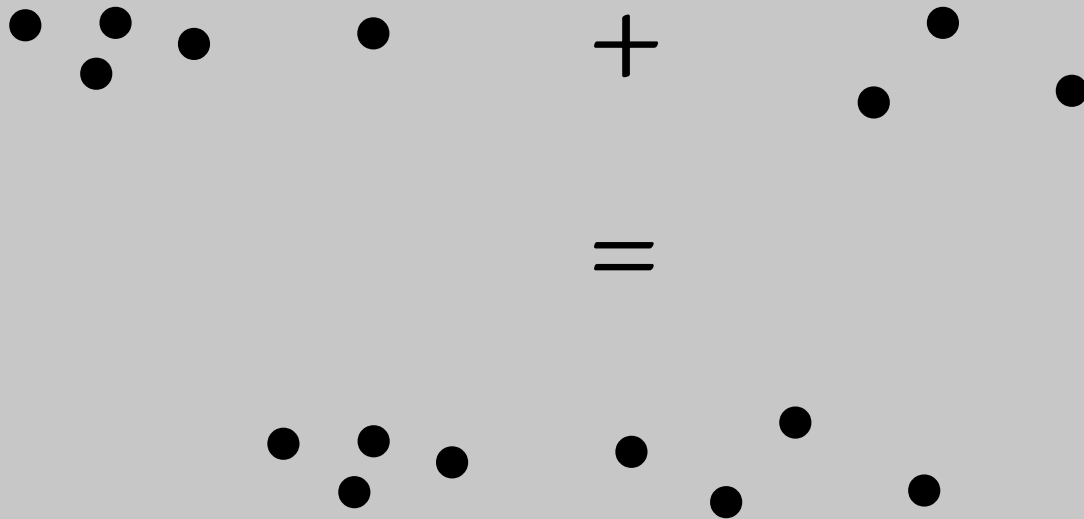


Addition

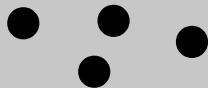


A visual representation of the addition $4 + 3 = 7$. The equation is shown using black dots and mathematical symbols on a light gray background. On the left, there are four dots arranged in a horizontal line. To their right is a plus sign $+$. Further right are three dots arranged in a triangular pattern. To their right is an equals sign $=$. Finally, on the far right, there are seven dots arranged in a horizontal line.

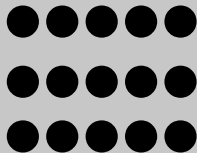
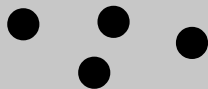
Addition



Multiplication



Multiplication



Rhymes

Rhymes

C'est l'histoire de Loulou Lapierre
Une p'tite mère ben ordinaire
Qui travaille à temps partiel
Comme femme de chambre dans un hôtel

A
A
B
B

Joyeux calvaire! - Les Cowboys Fringants

Rhymes

C'est l'histoire de Loulou Lapierre Une p'tite mère ben ordinaire Qui travaille à temps partiel Comme femme de chambre dans un hôtel	A A B B	
Joyeux calvaire! - Les Cowboys Fringants		
ولا في بهالجب مصاري ولا ممكن فيه ليرات ولا ممكن في اراضي ولا فيه مجوهرات	A B A B	
Ziad Rahbani - بلا ولا شي		

Rhymes

C'est l'histoire de Loulou Lapierre Une p'tite mère ben ordinaire Qui travaille à temps partiel Comme femme de chambre dans un hôtel	A A B B	
Joyeux calvaire! - Les Cowboys Fringants		
ولا في بهالجب مصاري ولا ممكن فيه ليرات ولا ممكن في اراضي ولا فيه مجوهرات	A B A B	
Ziad Rahbani - بلا ولا شي		
There's something in this sound that takes me far It's like a special song Can move my mood along But I cannot say you'll hear through my guitar	A B B A	
It Runs Through Me - Tom Misch		

Rhymes

C'est l'histoire de Loulou Lapierre Une p'tite mère ben ordinaire Qui travaille à temps partiel Comme femme de chambre dans un hôtel	A A B B	
Joyeux calvaire! - Les Cowboys Fringants		
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Ziad Rahbani - بلا ولا شي		
There's something in this sound that takes me far It's like a special song Can move my mood along But I cannot say you'll hear through my guitar	A B B A	
It Runs Through Me - Tom Misch		

Story time

TW: category theory!

Theorem: A distributive law between two monads induces a composite monad structure.

Theorem: A distributive law between two monads induces a composite monad structure.

$$(\hat{\mu} \diamond \mu) \circ \hat{M}\lambda M \circ \overline{M}(\hat{\eta} \diamond \eta) = \mathbb{1}_{\overline{M}}$$

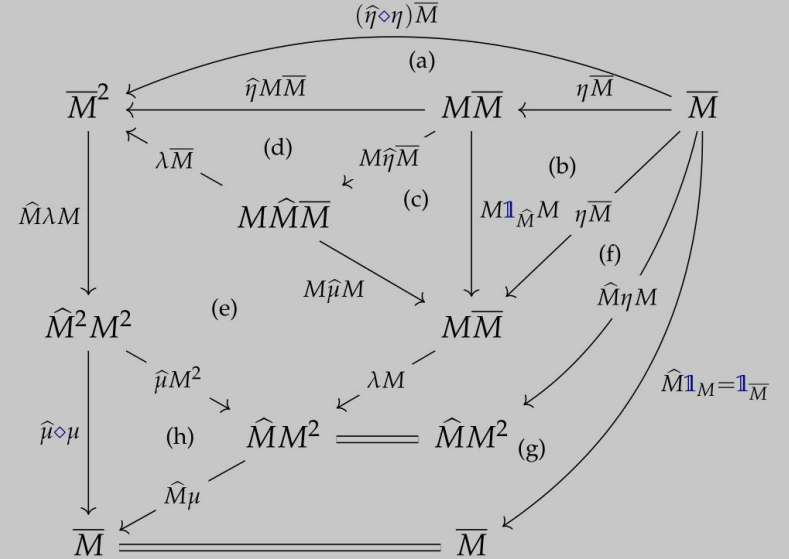
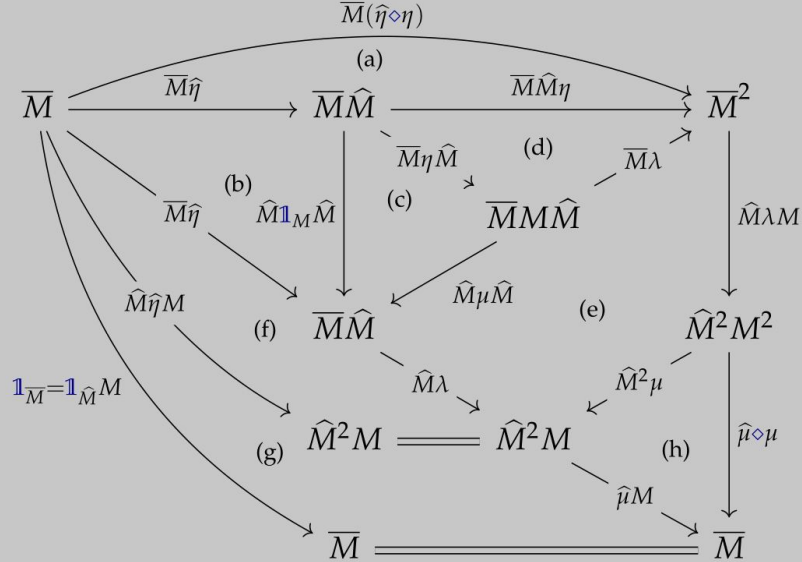
$$(\hat{\mu} \diamond \mu) \circ \hat{M}\lambda M \circ (\hat{\eta} \diamond \eta)\overline{M} = \mathbb{1}_{\overline{M}}$$

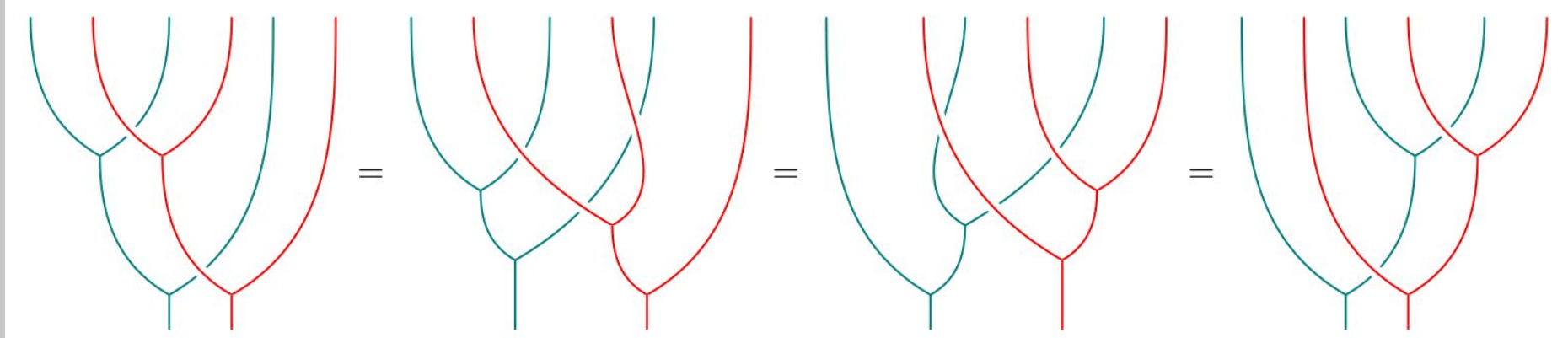
$$(\hat{\mu} \diamond \mu) \circ \hat{M}\lambda M \circ (\hat{\mu} \diamond \mu)\overline{M} \circ \hat{M}\lambda M\overline{M} = (\hat{\mu} \diamond \mu) \circ \hat{M}\lambda M \circ \overline{M}(\hat{\mu} \diamond \mu) \circ \overline{M}\hat{M}\lambda M$$

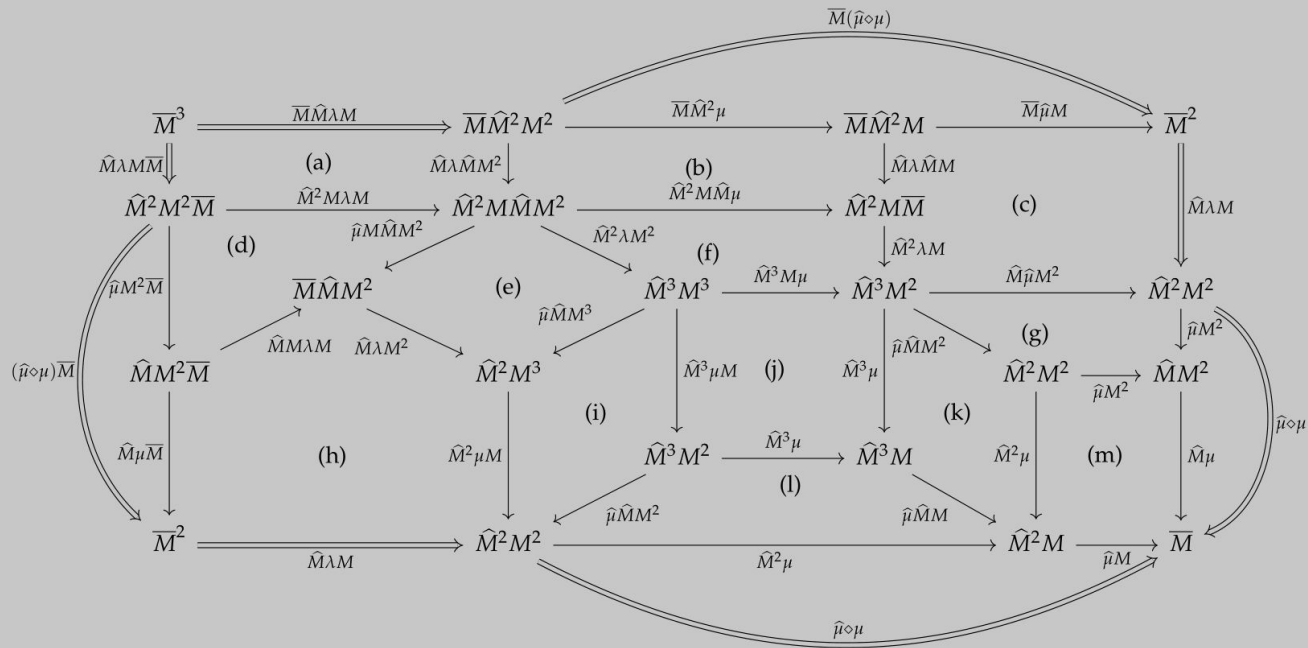
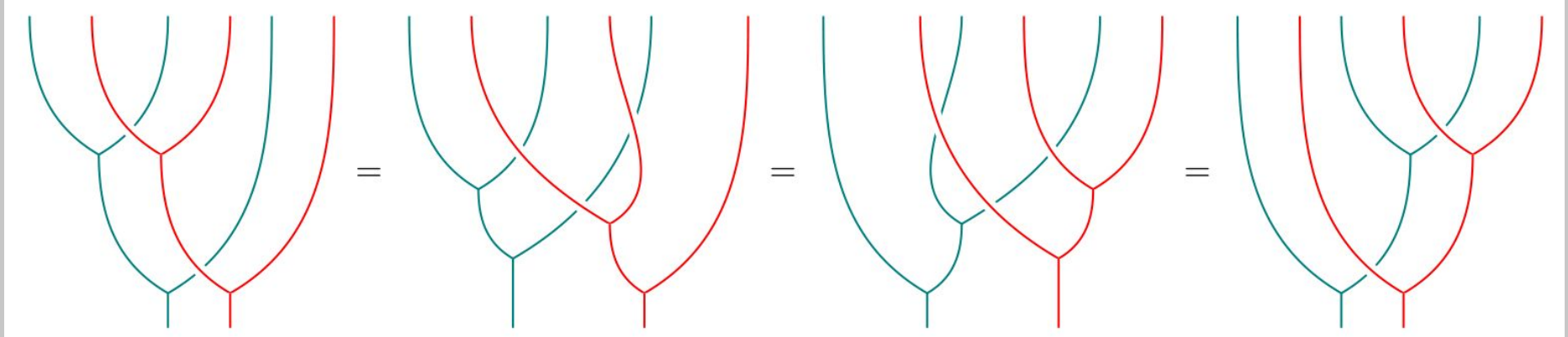
Theorem: A distributive law between two monads induces a composite monad structure.

$$(\hat{\mu} \diamond \mu) \circ \hat{M}\lambda M \circ \overline{M}(\hat{\eta} \diamond \eta) = \mathbb{1}_{\overline{M}}$$

$$(\hat{\mu} \diamond \mu) \circ \hat{M}\lambda M \circ (\hat{\eta} \diamond \eta)\overline{M} = \mathbb{1}_{\overline{M}}$$



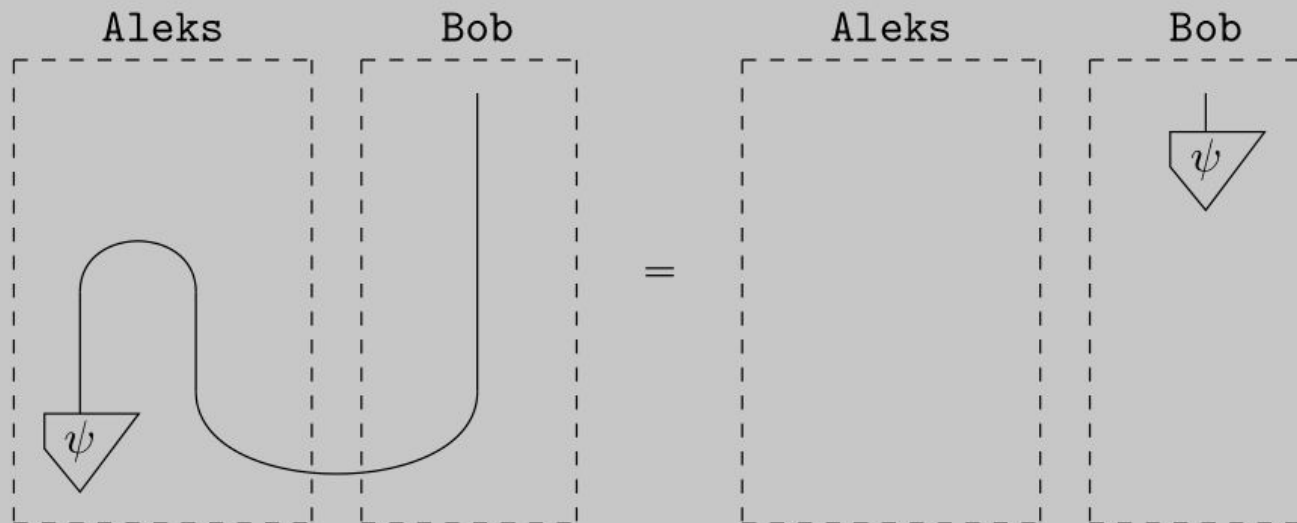
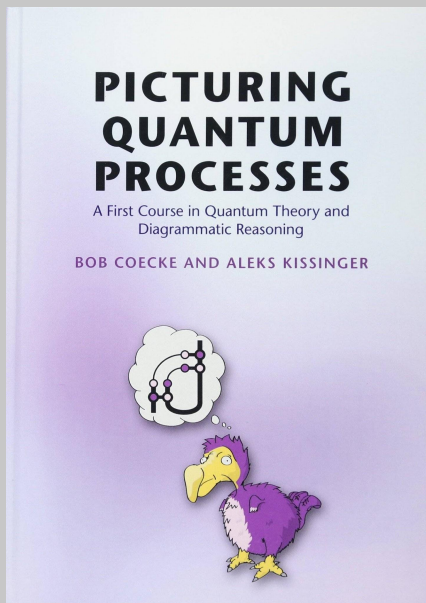




Examples

Quantum Processes

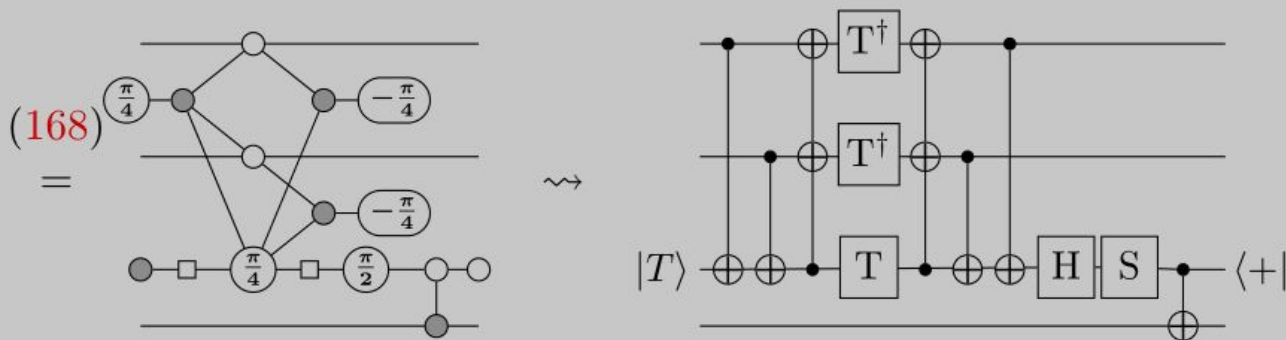
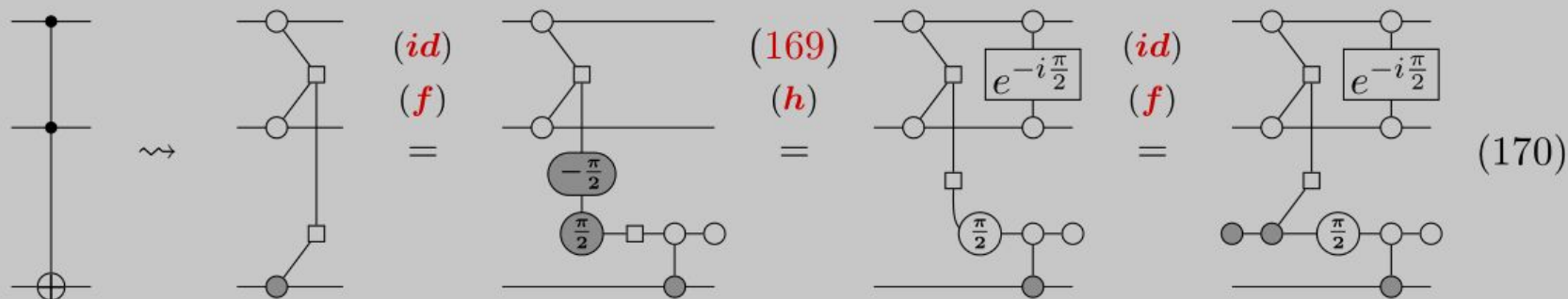
Quantum Teleportation



Links: [paper](#), [book](#), [quantum NLP](#), [graphical linear algebra](#)

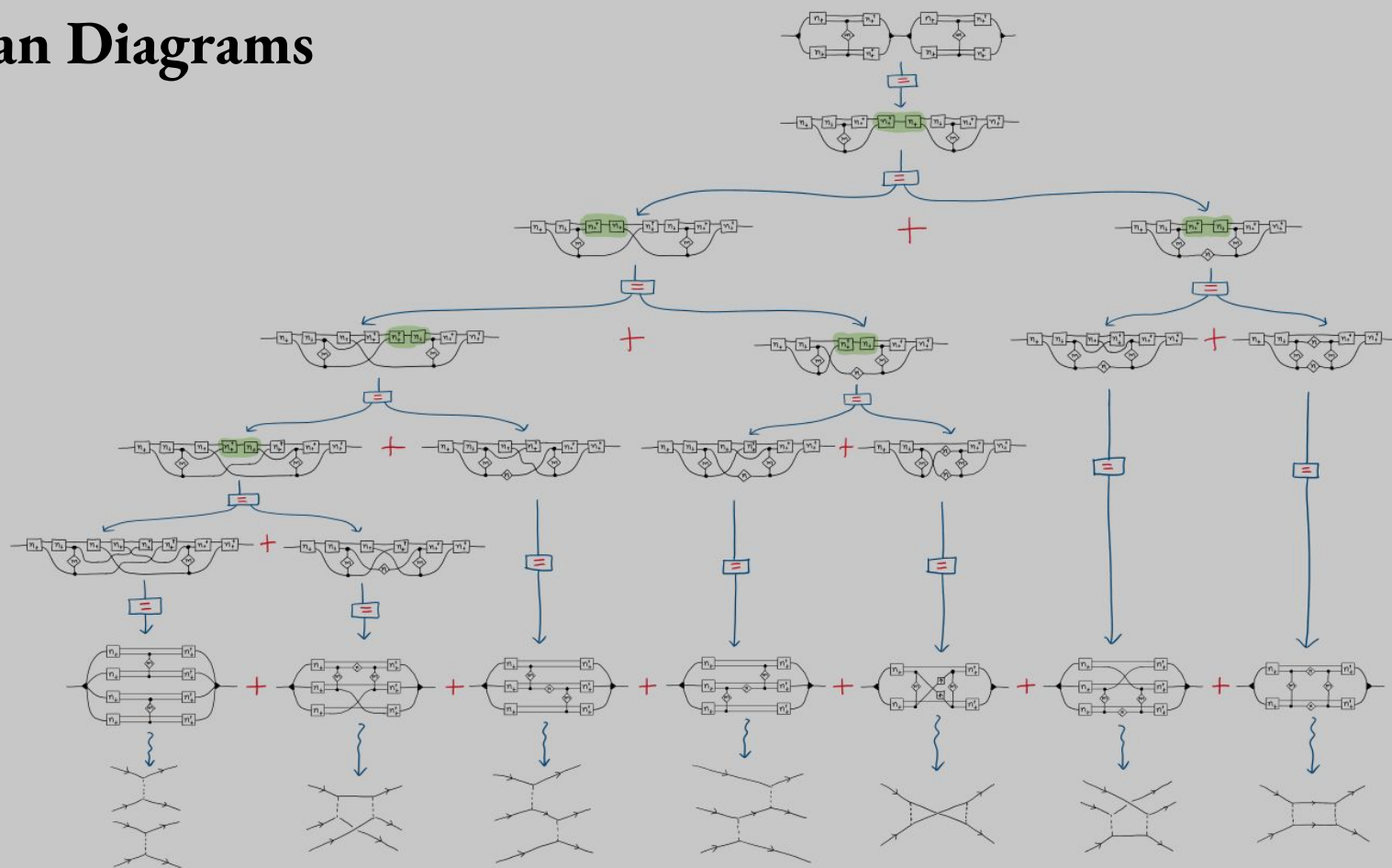
Quantum Circuits

We can now rewrite the Toffoli gate to a more efficient construction:



Links: [paper](#), [community](#), [Julia implementation](#), [Python implementation](#)

Feynman Diagrams



Links: [paper](#)

Figure 1. Composition of categorical Feynman diagrams, cf. Section 4.4.

Game Theory

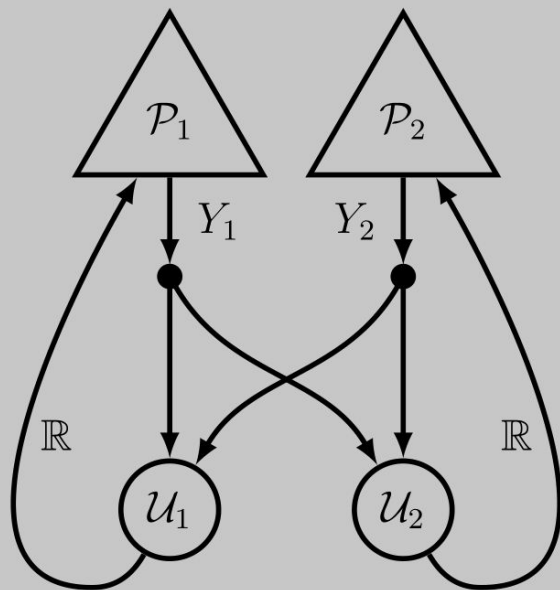


Figure 26: Bimatrix Game

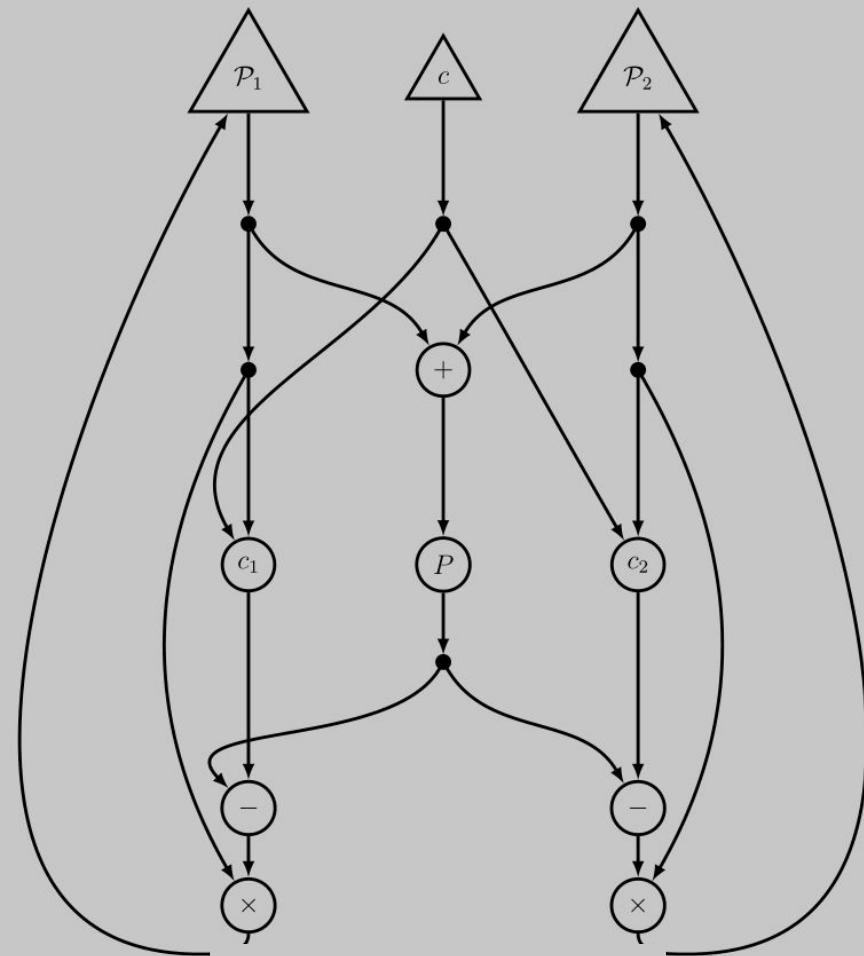


Figure 30: Cournot Duopoly

Links: [paper](#), [paper \(games on graphs\)](#)

Automata

$$\begin{aligned}
 \langle e + f \rangle &= \text{Diagram 1} \stackrel{(C4)}{=}_{KAA} \text{Diagram 2} & \langle 0 \rangle &= \text{Diagram 3} \stackrel{(C3)}{=}_{KAA} \text{Diagram 4} \\
 \langle ef \rangle &= \text{Diagram 5} \stackrel{(C1)}{=}_{KAA} \text{Diagram 6} & \langle 1 \rangle &= \text{Diagram 7} \stackrel{(C2)}{=}_{KAA} \text{Diagram 8} \\
 \langle e^* \rangle &= \text{Diagram 9} \stackrel{(C5)}{=}_{KAA} \text{Diagram 10} & \langle a \rangle &= \text{Diagram 11} =: \text{Diagram 12} \quad (8)
 \end{aligned}$$

Diagram 1: A horizontal line with a circle node. Two red boxes labeled 'e' and 'f' are connected to the circle by red lines.

Diagram 2: A horizontal line with two black nodes. Between them are two boxes labeled 'e' and 'f' stacked vertically.

Diagram 3: A horizontal line with a circle node. A red dot is connected to the circle by a red line.

Diagram 4: A horizontal line with two black nodes.

Diagram 5: A horizontal line with a circle node. Two red boxes labeled 'e' and 'f' are connected to the circle by red lines.

Diagram 6: A horizontal line with two black nodes. Between them are two boxes labeled 'e' and 'f' stacked vertically.

Diagram 7: A horizontal line with a circle node. A red circle is connected to the circle by a red line.

Diagram 8: A horizontal line with two black nodes.

Diagram 9: A horizontal line with a circle node. A red box labeled 'e' is connected to the circle by a red line.

Diagram 10: A horizontal line with two black nodes. A loop is formed by a line above and a line below, with a box labeled 'e' in the middle.

Diagram 11: A horizontal line with a circle node. A red circle labeled 'a' is connected to the circle by a red line.

Diagram 12: A horizontal line with a box labeled 'a'.

For example, $\langle ab(a + ab)^* \rangle =$

$$\text{Diagram 13} \stackrel{=}{=}_{KAA} \text{Diagram 14} \quad (9)$$

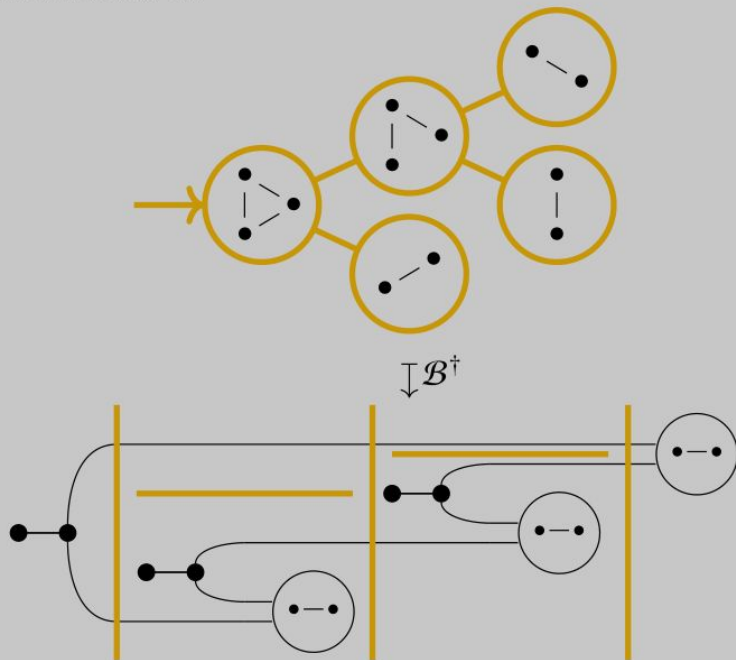
Diagram 13: A horizontal line with a circle node. Two red lines labeled 'a' and 'b' enter from the left and connect to the circle.

Diagram 14: A horizontal line with two black nodes. Between them are two boxes labeled 'a' and 'b' stacked vertically. A loop is formed by a line above and a line below, with a box labeled 'a' in the middle.

Links: [paper](#), [paper \(probabilistic automata\)](#)

Monoidal Width

Example 5.16. *The 3-clique has a branch decomposition as shown on the top. The corresponding monoidal decomposition is shown below it.*



Theorems

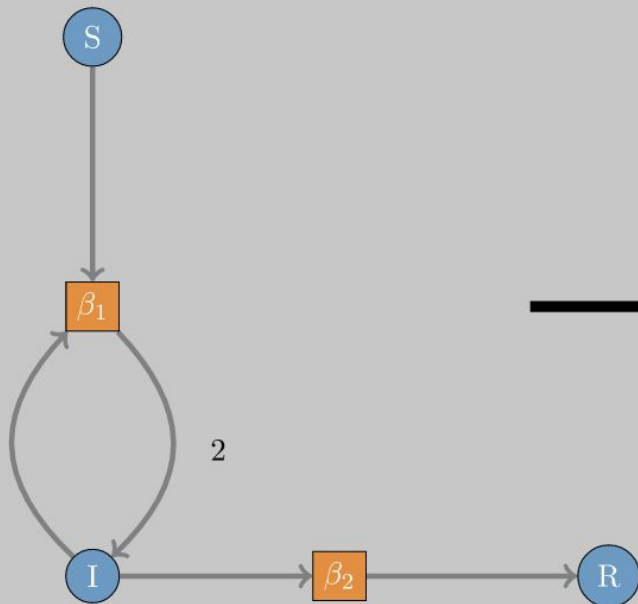
$$\begin{aligned} \text{twd}(G) &\leq \text{mtwd}(g) \leq 2 \cdot \text{twd}(G) \\ \frac{1}{2} \cdot \text{bwd}(G) &\leq \text{mwd}(g) \leq \text{bwd}(G) + 1 \\ \text{pwd}(G) &= \text{mpwd}(g) \end{aligned}$$

Links: [paper](#), [2nd paper](#)

Scientific Modelling

Petri

Dynam



F

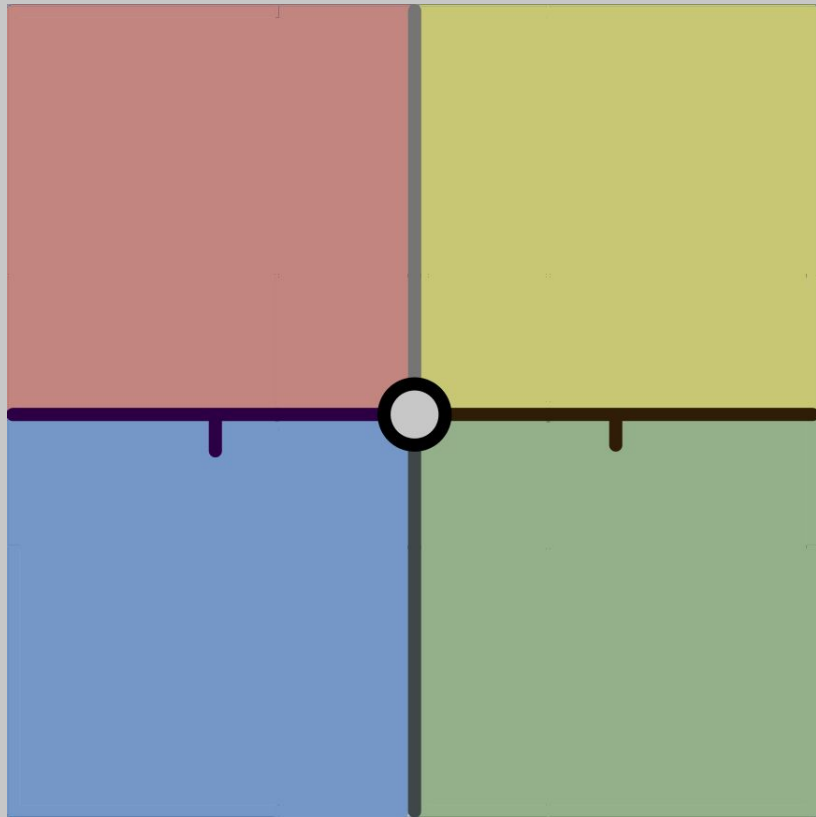
$$\dot{S} = \beta_1 SI$$

$$\dot{I} = \beta_1 SI - \beta_2 I$$

$$\dot{R} = \beta_2 I$$

Links: [paper](#), [blogpost](#), [AlgebraicJulia](#)

Logic in Color



$$\frac{a R b}{f(a) S g(b)}$$

Links: [présentation vidéo](#), [paper](#), [Christian Williams](#)

Demo !

Adding

$$\text{Diagram 1} = \text{Diagram 2} \quad (\text{Comm})$$

$$\text{Diagram 3} = \text{Diagram 4} \quad (\text{Assoc})$$

$$\text{Diagram 5} = \text{Diagram 6} \quad (\text{Unit})$$

Copying

$$\text{Diagram 7} = \text{Diagram 8} \quad (\text{CoComm})$$

$$\text{Diagram 9} = \text{Diagram 10} \quad (\text{CoAssoc})$$

$$\text{Diagram 11} = \text{Diagram 12} \quad (\text{CoUnit})$$

Adding meets Copying

$$\text{Diagram 13} = \text{Diagram 14} \quad (\text{B1})$$

$$\text{Diagram 15} = \text{Diagram 16} \quad (\text{B2})$$

$$\text{Diagram 17} = \text{Diagram 18} \quad (\text{B4})$$

$$\text{Diagram 19} = \text{Diagram 20} \quad (\text{B3})$$

Merci !