Categorical Semantics for Feynman Diagrams

Razin A. Shaikh, Quantinuum
razin.shaikh@cambridgequantum.com

Stefano Gogioso, Hashberg
quantum@hashberg.io

below we compose the categorical versions of

Sequential composition of two categorical Feynman diagrams results in the superposition of all possible graph-theoretic combinations of the individual diagrams

Ingredients
1. Creation and annihilation operators
2. Feynman propagator
3. Split and merge maps

Rules
1. Isometry
2. Sliding rule (split)
3. Sliding rule (merge)

Categorical Feynman Diagrams
For a given Feynman diagram, we consider its corresponding term in Wick’s expansion. We translate that term into a string diagram, obtaining a linearized version of the Feynman diagram as a process in our \( \mathsf{fHilb} \) category.

We rewrite the string diagram using the given rules to obtain the categorical Feynman diagram.