Homotopy Physics and Avatars

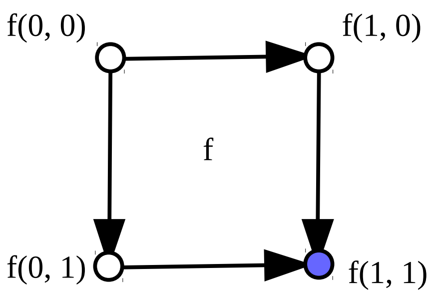
by Sven Nilsen, 2021

In this paper I show why avatars occur in Homotopy Physics.

Assume some homotopy map of the following type in Homotopy Physics[1]:

$$f : I^2 \to \mathbb{C}$$

This homotopy map is continuous everywhere except at one corner `f(1, 1)` (the blue dot):



In Homotopy Physics, this 2D function surface `f` is physical.
Counter intuitively, a particle is not a point that travels along a single path over the surface.
Instead, in this model, particles are made up of many such homotopy maps at small scales.

At first sight, this might seem like an oversimplification.
However, by modeling physical systems using this technique at high resolution,
it yields accurate predictions and provides grounding of common sense of physical phenomena.

Seen from the perspective of the surface `f`, the corner `f(1, 1)` is indeterminate.
However, seen from the perspective of `f(1, 1)` as a point, it can be treated as another homotopy map:

$$f(1, 1) := (f(\to 1, 1), f(1, \to 1))$$

$$f(1, 1) : I^0 \to \mathbb{C}^2$$

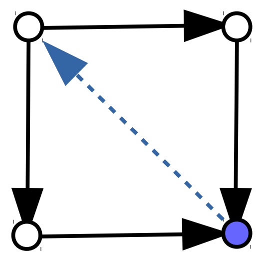
It takes the two values by approaching the indeterminate point from two directions.
These two directions are determined by the edge of the function surface.

Every part of the model consists of homotopy maps of type `$I^N \to \mathbb{C}^M$`,
where `N` and `M` are natural numbers.

A node which has no incoming arrows, but has at least one outgoing arrow, is called a *source node*.
A node which has no outcoming arrows, but has at least one incoming arrow, is called a *target node*.

A target node with `M` incoming arrows have `M` complex numbers.
This property is what makes it possible for quantum circuits to create avatars[2] of itself.

Consider the following quantum circuit where the source node leads back to the target node:



When the quantum circuit starts running, the source node has 1 complex number.
After one iteration, the source node has 2 complex numbers.
After two iterations, the source node has 4 complex numbers.
etc.
These paths, where a node tunnels to other nodes, satisfy the Core Axiom of Path Semantics[3].

The type of the 2D function surface `f` changes with the number of iterations in the quantum circuit:

$f_0 : I^2 \rightarrow \mathbb{C}$	start
$f_1 : I^2 \rightarrow \mathbb{C}^2$	1 iteration
$f_2 : I^2 \rightarrow \mathbb{C}^4$	2 iterations
$f_3 : I^2 \rightarrow \mathbb{C}^8$	3 iterations
$f_X : I^2 \rightarrow \mathbb{C}^{(2\wedge X)}$	`X` iterations

Each iteration produces two copies of the initial quantum circuit.
A copy of the initial quantum circuit is called an *avatar*.
Avatars can also be used to describe complex quantum circuits that produce copies of simpler circuits.

The rule for introducing avatars through a quantum circuit is that the map from the target node to the source node must be continuous. This implies that there exists some function `g` that generates new quantum circuits based on previous iterations:

$$g : \mathbb{C}^X \rightarrow I^2 \rightarrow \mathbb{C}^X$$

The function `g` is called the *generator* on `f`.

In general, a generator has the type:

$$(I^{N0} \rightarrow \mathbb{C}^{M0}) \rightarrow (I^{N1} \rightarrow \mathbb{C}^{M1})$$

Where `N0, M0, N1, M1` are natural numbers.

Using the Path Integral Formulation[4] of quantum mechanics, one can derive rules for generators based on the setup of the experiment. The calculations of probabilities in Homotopy Physics are the same as in the Path Integral Formulation. The difference is conceptual and in the creativity of these models. Whole physical systems might be treated as quantum circuits that produces self similar quantum circuits. Homotopy Physics provides intuition for physical self reproduction through space-time.

References:

[1] "Homotopy Physics"
AdvancedResearch – Reading sequence on Homotopy Physics
https://github.com/advancedresearch/path_semantics/blob/master/sequences.md#homotopy-physics

[2] "Avatar Extensions"
AdvancedResearch – Summary page on Avatar Extensions
https://advancedresearch.github.io/avatar-extensions/summary.html

[3] "Path Semantics"
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https://github.com/advancedresearch/path_semantics/blob/master/papers-wip/path-semantics.pdf

[4] "Path integral formulation"
Wikipedia
https://en.wikipedia.org/wiki/Path_integral_formulation