Segmented Time

by Sven Nilsen, 2021

In this paper I present a theoretical framework for reasoning about segmented time.

Assume there is a black box which can be programmed with sequences of bits, but which only gives a natural number in response. The type of the black box is:

```
black_box : [bool] → nat
```

The black box can be copied and all copies behave deterministically, but not in the sense of a pure function[1]. The black box has an internal state, so when it is given a sequence of bits, it can change the output next time. However, since the black box can be copied, one can use a copy to predict the output.

This simple model provides a sufficient theoretical framework for reasoning about segmented time.

The mechanism for segmented time is counter-intuitive. One can think about it as the black box having *intrinsic* knowledge about the pause between inputs, e.g. from how the black box is constructed.
Any system which receives a continuous stream of bits is **not** isomorphism to segmented time.

The trick is that the output can only be produced for a *sequence of bits*, which might be thought of as a way to split a stream of bits into segments. Each bit represents one unit of time, hence segmented time consists of multiple units of time glued together continuously, with a pause between each segment.

The black box can depend on the segmentation of time, in addition to the content of the transferred bits. Translated into a stream of bits, there is a pause symbol that separates segments.

Segmented time is important for understanding deterministic systems that depend on previous states. Specially, the communication between such systems and how they relate to Category Theory[2]:

1. All morphisms have the “pause” side-effect
2. An identity morphism is an empty sequence of bits
3. Composition concatenates two segments, removing the “pause” in-between

Composition holds only for inputs. How it relates to output classifies the direction of time:

- Directional time
- Non-directional time

A directional segmented time system has the following property (normal path[3] with side-effects):

```
concat[black_box₀ × black_box₀ → black_box₁] <=> snd
```

Here, `black_box$_0$` and `black_box$_1$` are two copies of the same black box. Side-effects are left to right. Non-directional time means that the asymmetric normal path above has at least one exception.

References:

[1] “Pure function”
Wikipedia
https://en.wikipedia.org/wiki/Pure_function

[2] “Category theory”
Wikipedia
https://en.wikipedia.org/wiki/Category_theory

[3] “Normal Paths”
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https://github.com/advancedresearch/path_semantics/blob/master/papers-wip/normal-paths.pdf