

Exercises 1: DIY FRP

Henrik Nilsson

The objective of these exercises is to implement your own Classic FRP variant along the lines of *FRP from first principles* by Wan and Hudak. The file `DIYFRP.hs`, available via the course WWW page:

<http://www.cs.nott.ac.uk/~nhn/ITU-FRP2010>

provides a code skeleton and some useful definitions to get you started. For further details, consult the lecture slides and the aforementioned paper. However, it is advisable to attempt to solve the exercises before looking at the code provided in the paper.

1. Implement the the basic behaviors and combinators `time`, `$*`, `lift0`, `lift1`, `lift2`.

Hint: `time` can be defined in a very simple way, so a good start. Also, try to define `lift1` using `$*` and `lift0`, and then `lift2` following the same pattern.

Test your definitions using `reactimateB`. The utility function `ppTrace` can help making the output more legible.

2. Make behaviors an instance of the classes `Num`, `Fractional`, `Floating`, and also define comparison operators, logical operators etc. on behaviors as indicated. (Haskell's type classes are not defined in a sufficiently general way to make it possible to overload the latter operators.)
3. Implement `never`, `now`, `after`, `repeatedly`. Note that the occurrence of the `after` event should be w.r.t. the start time of the event. As to `repeatedly`, what should happen if the specified events period is short compared with the sampling interval?
4. Implement the switch combinator `until`.
5. Consider the following FRP program:

```
let
  c = hold 0 (count (repeatedly 0.5))
in
  c 'until' after 5 ==> c * 2
```

What kind of behavior do you expect? Try it. What happens with the counter at the time of the switch? Why? Is there another behavior that would be useful? How could that be achieved?

6. Implement `integral`, approximating it using the Riemann sum. Try to make the value of the integral at time t only depend on the values of the integrated behavior **strictly before** t .
7. Define the behavior e^t by exploiting the identity:

$$e^x = 1 + \int_0^x e^y dy$$

Try to compute e^t for $t \in [0, 10]$ using smaller and smaller steps. Do you notice anything as the steps get smaller?

8. Repeat the experiment, but now compute $f(t)$ defined by:

$$f(x) = 1 + \int_0^x f(y)f(y) dy$$

What happens? Why?