Live a little: `unsafePerformIO` it!

Victor Miraldo

Channable

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This is but one technique to cope with `IO`

Today

1. Question Monad-transformer design pattern
2. Explore `unsafePerformIO` as a reasonable alternative

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solver <- forkIO (exec "z3")
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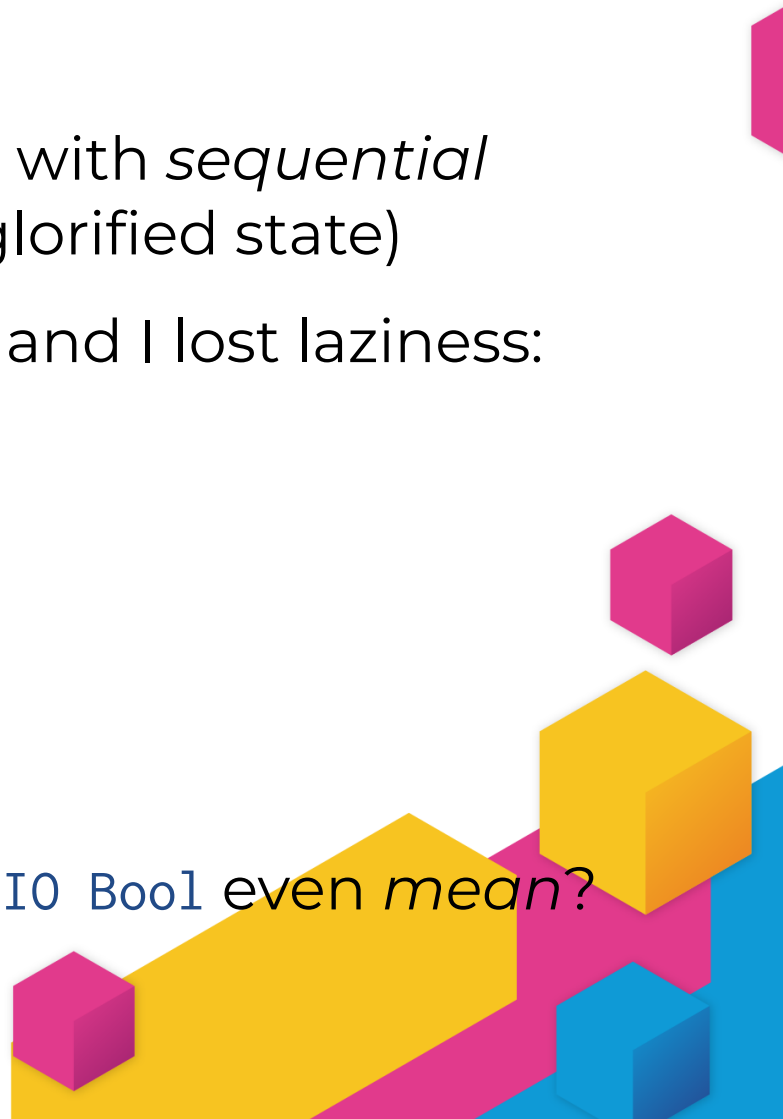
Even worse... What does `solve x :: IO Bool` even *mean*?



Stuck in `IO`

Open challenge 1

Open problem: the IO monad has become Haskell's sin-bin. (Whenever we don't understand something, we toss it in the IO monad.)

Festering sore:

```
unsafePerformIO :: IO a -> a
```

Dangerous, indeed type-unsafe, but occasionally indispensable.

War

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Wearing the hair shirt: a retrospective on Haskell (2003)

Simon Peyton Jones
January 2003
invited talk at POPL 2003

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What did I want?

I wanted (in pseudo-Agda):

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safePerformIO : (f : IO a) -> ProofOfSafety f -> a
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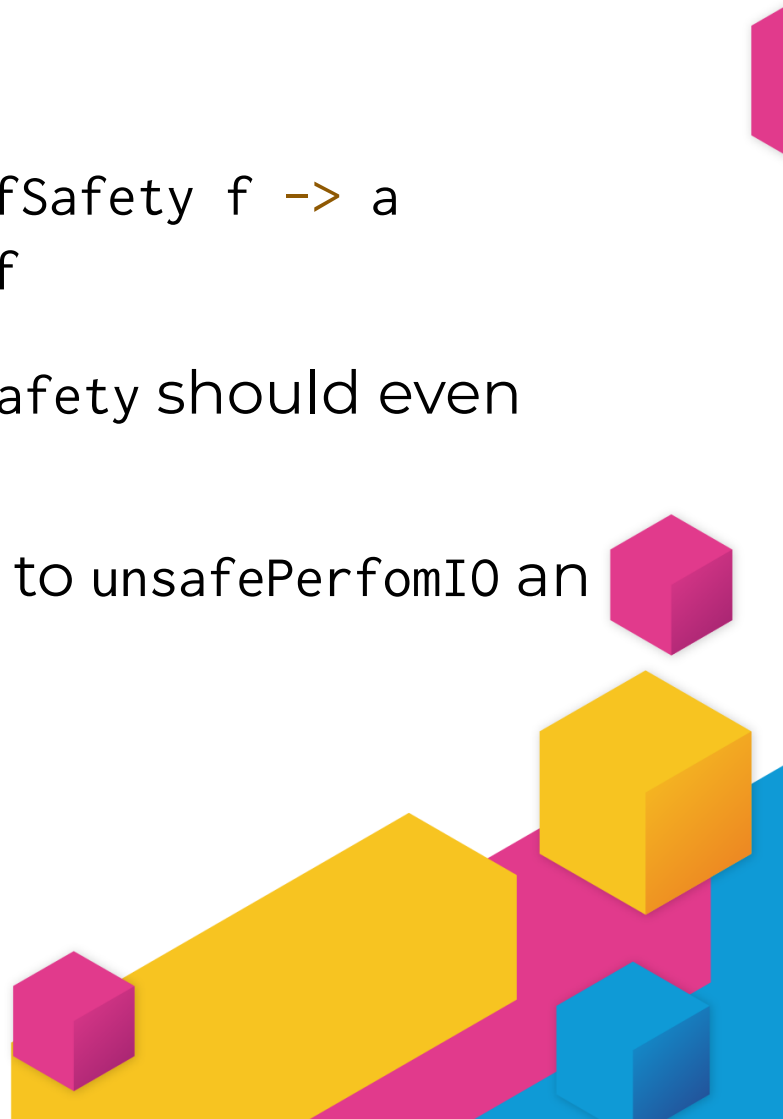
That is: how do we conclude it is ok to `unsafePerfomIO` an `IO` block?



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For more, check A History of Haskell, section 7.

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TL;DR:

Order is an illusion. You must not care about (or defend against!) the order in which your `unsafePerformIO`s are ran, whether they're ran at all (sequentially or concurrently).

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TL;DR:

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Good necessary rule of thumb:

```
let x = unsafePerformIO f in (x , x)
  <=>
(unsafePerformIO f , unsafePerformIO f)
```

For some domain-specific definition of <=>.

RTFM!

Which was already written in the docs, anyway...

> *If the I/O computation wrapped in* `unsafePerformIO` *performs side effects, then the relative order in which those side effects take place (relative to the main I/O trunk, or other calls to unsafePerformIO) is* ***indeterminate****. Furthermore, when using* `unsafePerformIO` *to cause side-effects, you should take the [...] precautions to ensure the side effects are performed as many times as you expect them to be. [...]*

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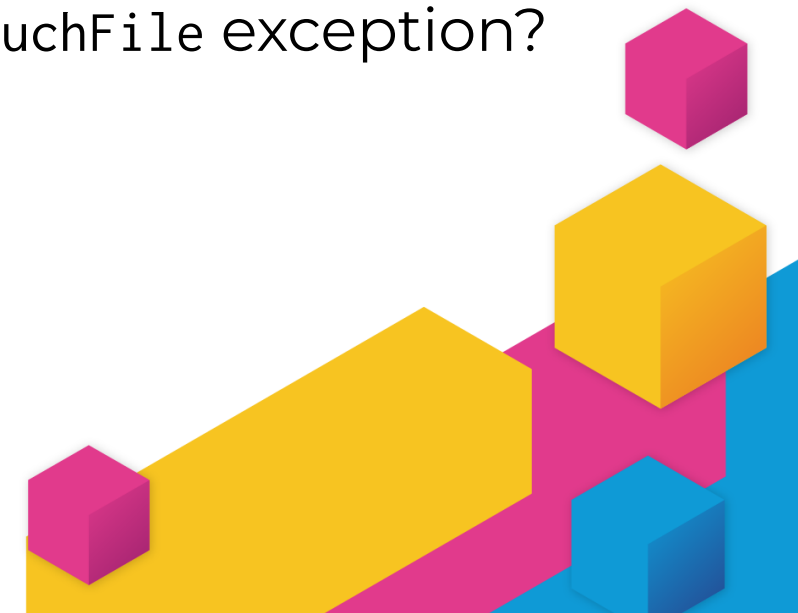
What is so much worse about a `NoSuchFile` exception?



Lies everywhere!

There are a number of impure operations we accept as pure:

1. Memory allocation
2. Function calling (can create stack frames and jumps)

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Depending on the context, more valuable than hiding `IO` inside monad transformers.

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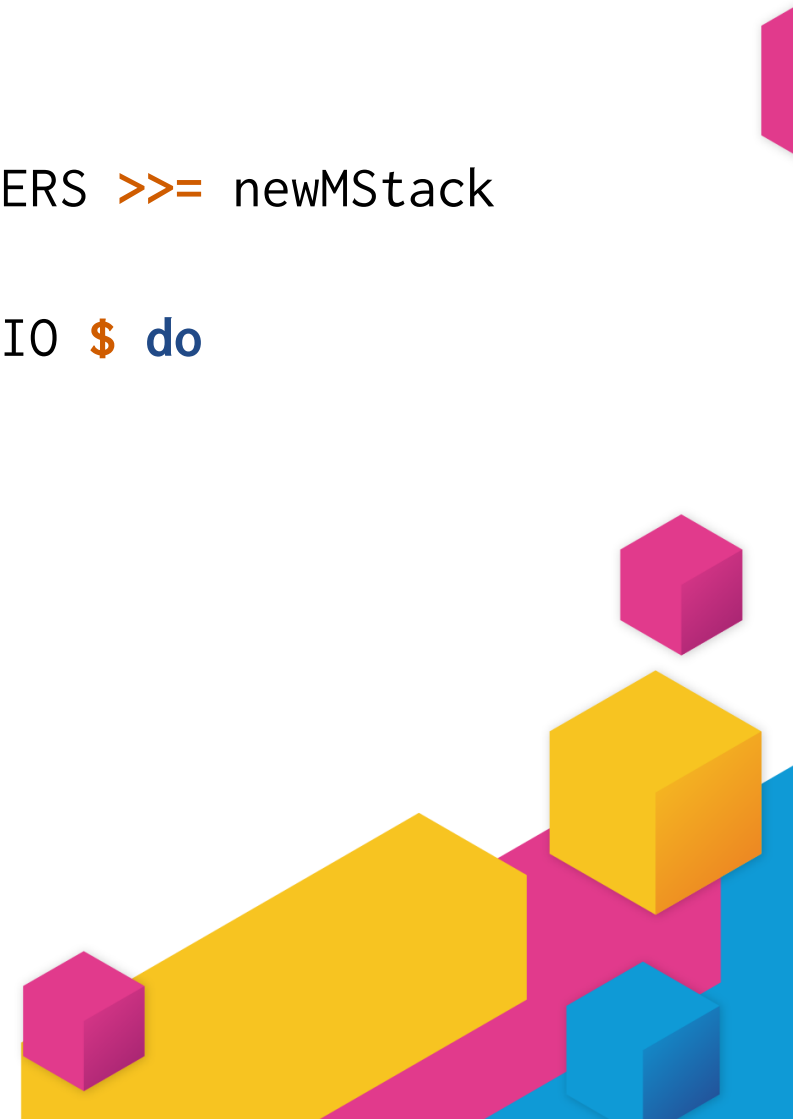
```
solve :: Problem -> Bool
solve = unsafePerformIO $ do
  allProcs <- launchSolvers nUM_SOLVERS >>= newMStack

  return $ \problem -> unsafePerformIO $ do
    ms <- popMStack allProcs
    r <- withMVar ms $ \solver -> do
      solveProblem problem solver
    pushMStack ms allProcs
    return r
```



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Just like registers, stack frames and jumps are an implementation trick to run our software in the current hardware,

Think of `unsafePerformIO` as an implementation trick: How do we implement our software over the current user-interation API?

Should we pollute every user *and every use* of our code with the weight of monads?

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Semantics!

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```
conc :: A -> B -> ... -> IO Result
conc x y ... = uglyIOcode
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versus

```
abstr :: A -> B -> ... -> Result
abstr x y ... = unsafePerformIO $ conc x y ...
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versus

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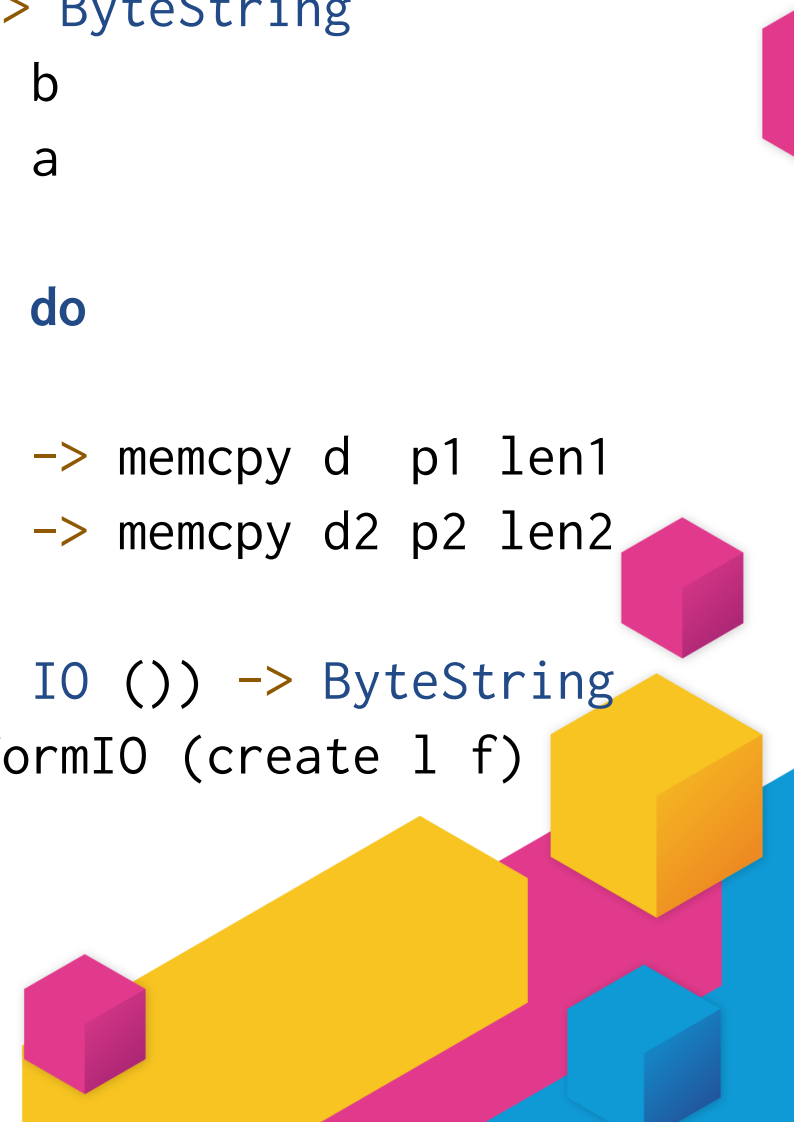
abstr x y ... = unsafePerformIO $ conc x y ...
```

`conc` is just one possible implementation for what `abstr` is *supposed to be*.

Example: bytestring

```
append :: ByteString -> ByteString -> ByteString
append (BS _   0)    b                 = b
append a             (BS _   0)        = a
append (BS fp1 len1) (BS fp2 len2) =
    unsafeCreate (len1+len2) $ \d -> do
      let d2 = d `plusPtr` len1
      unsafeWithForeignPtr fp1 $ \p1 -> memcpy d  p1 len1
      unsafeWithForeignPtr fp2 $ \p2 -> memcpy d2 p2 len2

unsafeCreate :: Int -> (Ptr Word8 -> IO ()) -> ByteString
unsafeCreate l f = unsafeDupablePerformIO (create l f)
```



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Different implementations must satisfy *the same laws*

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1. `unsafePerformIO` shouldn't be immediately dismissed as some sort of boogeyman;
2. Thinking in terms of meanings is more important than in terms of implementations;
3. Out of the 50 most used libraries on Hackage, 35 use `unsafePerformIO`;
4. Purity is really difficult, if not impossible, to define: heavily contextual