Promise Land

Proving Correctness with Strongly Typed Javascript-Style Promises

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Introduction

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  - Haskell library for Promises
    - can use Promises from Haskell code

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  - model for asynchronous code
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  - Haskell library for Promises
    - can use Promises from Haskell code
    - correctness checks JS doesn’t have

Background

Promises

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use `then` and `next` to attach handlers to a Promise

- handlers run after a Promise has succeeded or failed
- result is a new Promise
- the computations are said to be *chained* together

States of a Promise

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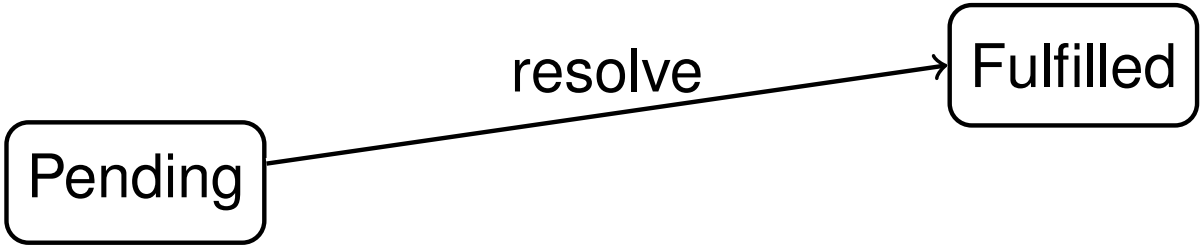

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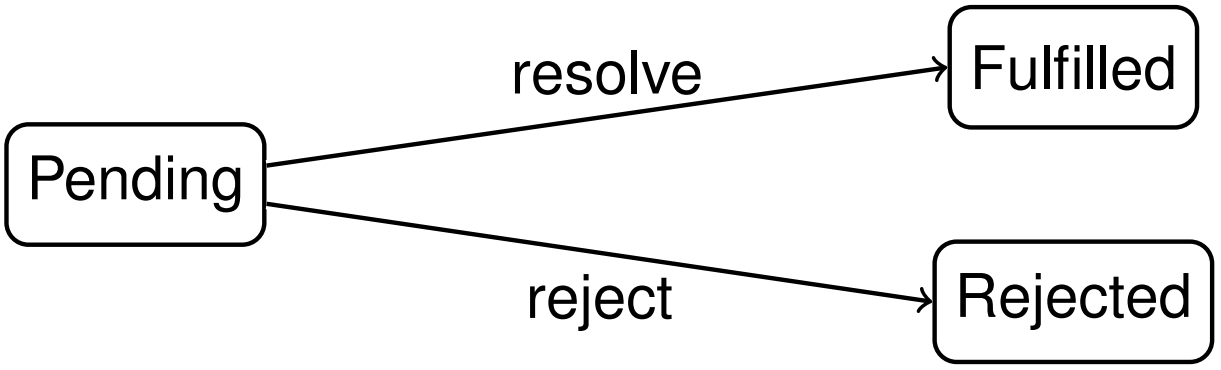

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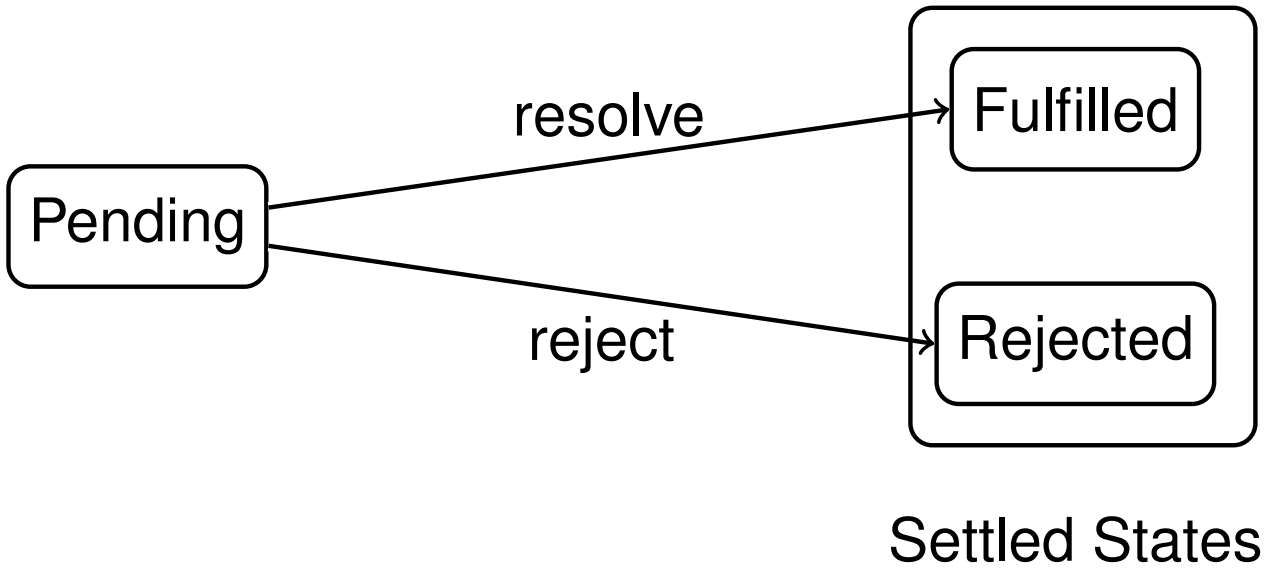
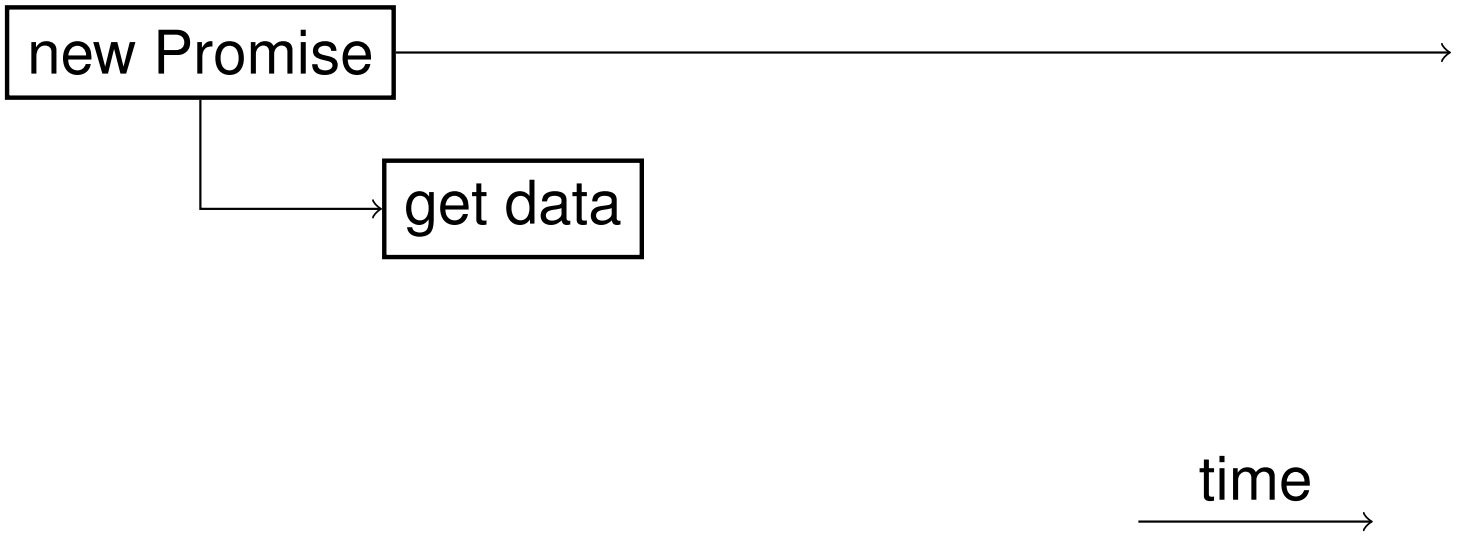


Promise Timing



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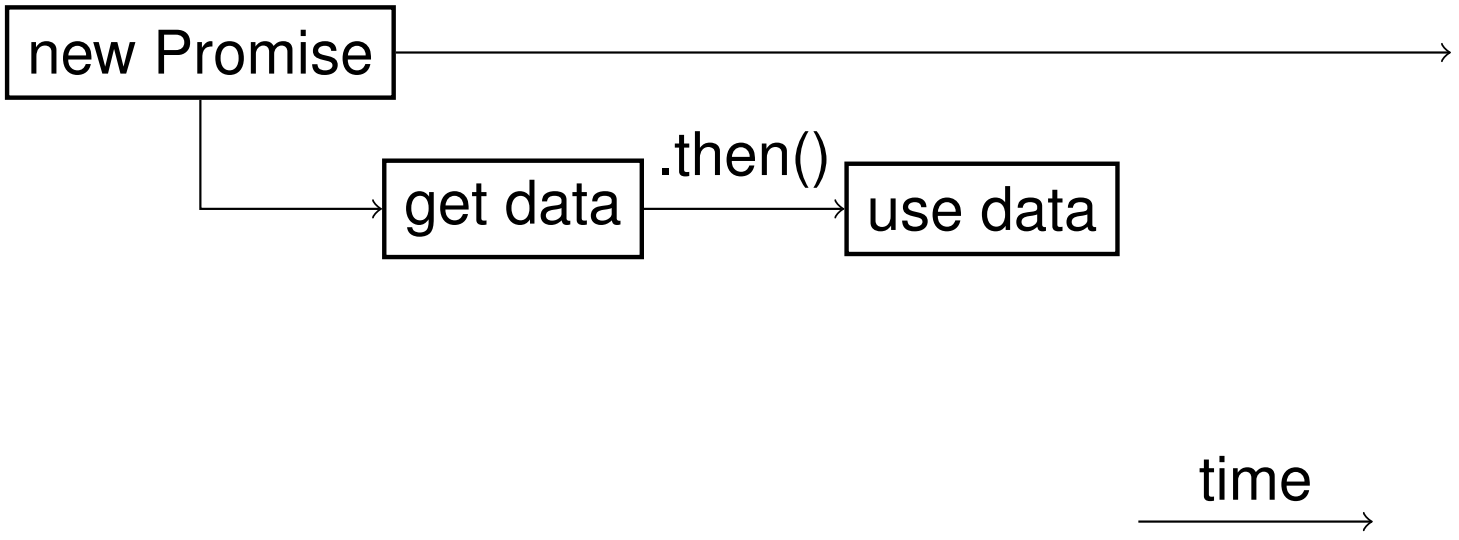

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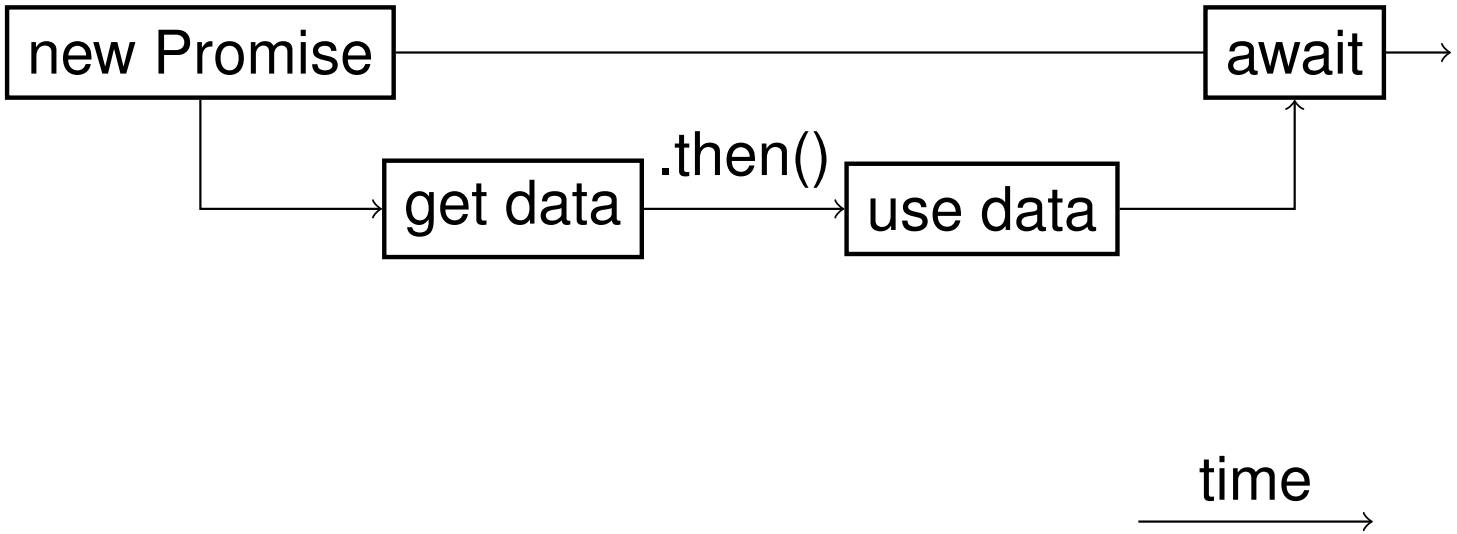

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- abstract over any type
- ex: `[a]` is a list whose elements have type `a`
- ex: `Either a b`
  - can be a `Left a` or `Right b`
  - often used as result of a computation that could fail

Monads

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typeclass grouping types with similar behavior

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```
return
    :: a -> m a
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```
:: m a -> (a -> m b) -> m b
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ex: `Either a`

```
return = Right
(Right x) >>= f = f x
(Left y)  >>= f = (Left y)
```

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results in a value of type `a`

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newEmptyMVar :: IO (MVar a)
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newEmptyMVar :: IO (MVar a)
putMVar :: MVar a -> a -> IO ()
takeMVar :: MVar a -> IO a
```

Implementation

Making Promises

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store an `MVar (Either f p)`

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```
data Promise :: * -> * -> * where
     Pending :: MVar (Either f p) -> Promise f p
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JS version accepts an *executor* function

two callbacks: for success and failure

use: `newPromise (λ s f -> if error then f("Failed!")`
`else s(value))`

newPromise

Type:

```
executor ->  (Promise f p)
```

newPromise

Type:

```
executor -> IO (Promise f p)
```

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Type:

```
(successFun -> failFun -> ?)  -> IO (Promise f p)
```

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```
((p -> IO ()) -> (f -> IO ()) -> IO ()) -> IO (Promise f p)
```

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Code:

```
newPromise k = do
    state <- newEmptyMVar
    forkIO $ k (putMVar state .  Right)
               (putMVar state .  Left)
    return (Pending state)
```

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```
pThen :: Promise f p
      -> (p -> IO (Promise f p'))
      -> IO (Promise f p')
```

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```
pRace ::  [Promise f p] -> IO (Promise f p)
```

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- looks a lot like `pThen`
- but `pThen` results in an `IO (Promise f b)`
- extra Promise constructor storing the callback
  - uses `pThen` when we run the Promise

Results

Would the system detect real bugs?

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Madsen et al. (2017) case study

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21 Stack Overflow questions about JS Promises

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6: unintentional `undefined`

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catch these by updating the type of `newPromise`

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((p -> IO Token) -> (f -> IO Token) -> IO Token)
    -> IO (Promise f p)
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6: unintentional `undefined` ✓

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executor never calls either callback
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Thank You