10 modern programming concepts which your favourite programming language is missing[1]

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[1] unless your favorite language is …

Callback hell ☹

```
getData(function(a) {
  getMoreData(a, function(b) {
    getYetMoreData(b, function(c) {
      getMoreFoo(c, function(d) {
        ...
      });
    });
  });
});
```

Callback hell ☹

```
getData(function(a) {
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    getYetMoreData(b, function(c) {
      getMoreFoo(c, function(d) {
        ...
      });
    });
  });
});
```

And this is even without error handling!

Overloaded semicolon ☺

```
do a <- getData
   b <- getMoreData     a
   c <- getYetMoreData b
   d <- getMoreFoo      c
```

Simple & easy. You can pretend that you're using blocking I/O.

Overloaded semicolon ☺

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do a <- getData
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   d <- getMoreFoo      c
```

Simple & easy. You can pretend that you're using blocking I/O.

NB: This is called "monads". There are also monads for non-determinism, parsing, …


OH
HELL YEAH!!!
quickmeme.com

QuickCheck

```
is(sqrt(4),  2, "sqrt(4) is working");
is(sqrt(16), 4, "sqrt(16) is working");
# ...
```

This does not scale! Property-checking is a useful addition:

```
> quickCheck $ \x -> sqrt(x*x) == x
*** Failed! Falsifiable (after 2 tests):
-0.269864
> quickCheck $ \x -> sqrt(x*x) == abs x
+++ OK, passend 100 tests.
```

Automatic test case generation and counterexample simplification.

Quiz time! Spot the error.

```c
#include <stdlib.h>
int main(int argc, char *argv[]) {
   ...;
   user_input = ...;
   if(abs(user_input) > ...) {
       exit(1);
   }
   ...;
}
```

Quiz time! Spot the error.

```c
#include <stdlib.h>
int main(int argc, char *argv[]) {
  ...;
  user_input = ...;
  if(abs(user_input) > ...) {
      exit(1);
  }
  ...;
}
```

Also: Billion Dollar Mistake by Tony Hoare.
`http://lambda-the-ultimate.org/node/3186`

Solution: Option types.

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A value of type `Maybe Int` is

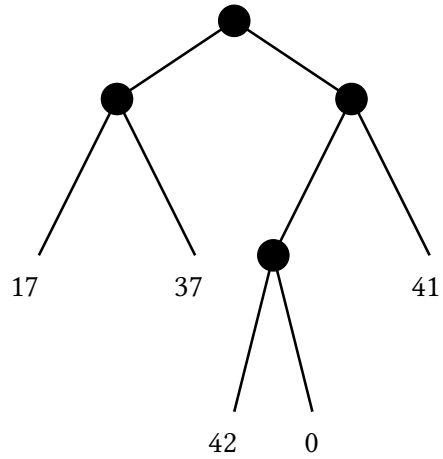
1. either `Nothing`
2. or a value of the form `Just x`, where `x` is an `Int`.

Type signature of `abs`: `Int -> Maybe Int`

Use option types when you cannot return a meaningful result and don't want to raise a proper exception, when you have optional arguments, or when you have optional entries in data structures.


HEY GIRL. I JUST MET
YOU, AND THIS IS CRAZY.
BUT I WANT (JUST YOU).
SO CALL ME, MAYBE?
imgflip.com

Pattern matching




```
data Tree = Leaf Int | Fork Tree Tree

ex = Fork
    (Fork (Leaf 17) (Leaf 37))
    (Fork (Fork (Leaf 42) (Leaf 0)) (Leaf 41))

inorder :: Tree -> [Int]
inorder (Leaf x)   = [x]
inorder (Fork l r) = inorder l ++ inorder r
```

Typing

```
BufferedReader in =
    new BufferedReader(
        new InputStreamReader(System.in)
    );
```

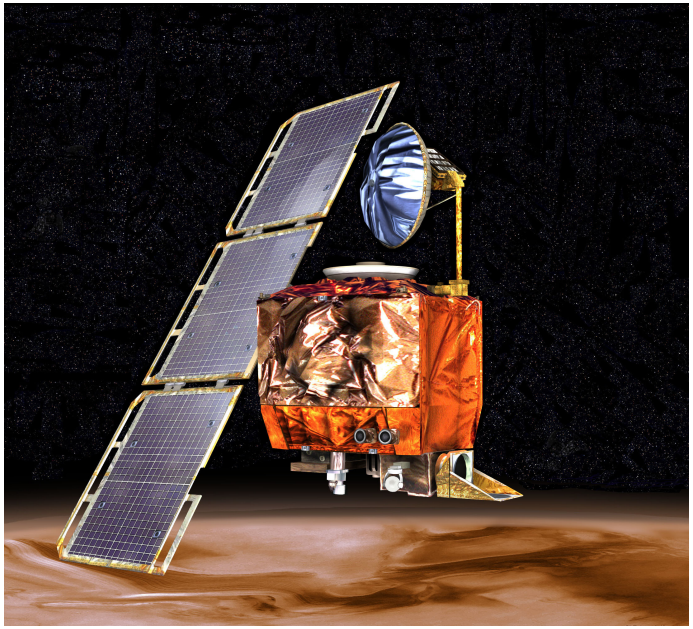
Types ☺

A good type system provides:

- inference: you don't have to type those types!
- safety: no NullPointerException
- "algebraic data types" and function types
- parametricity: generics on steroids
- higher-kinded types

Great for prototyping and refactoring!


UGUUBEARSCAVE.STORENVY.COM
WOW



Mars Climate Orbiter (1998)

Cost of the mission:
$327 million

Failed due to a unit error
(newton-secs vs. pound-secs)

Units of Measure Types ☺

```
[<measure>] type N = (kg * m) / sec^2

fireThrusters (x:float<N * sec>) = ...

let duration = 2<sec>
let force = 1000<N>
fireThrusters (duration * force)

let diag (x:float<'u>) (y:float<'u>)
      = sqrt (x*x + y*y) // Pythagoras
```


NEW CUYAMA
Population 562
Ft. above sea level 2150
Established 1951
TOTAL 4663
CAFE

Time-traveling debugger

Dependent types