Glitch: a programming model for Live Programming

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Live Feedback: Archer Analogy

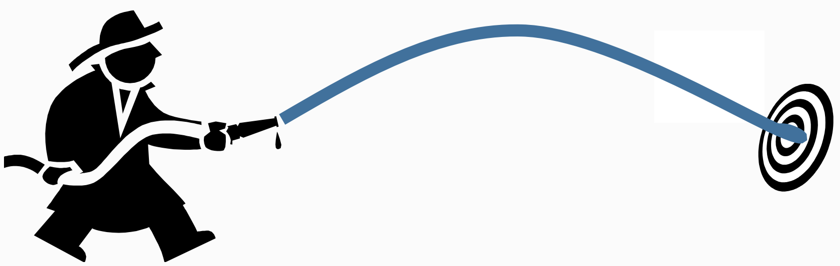
[Hancock, 2003]

Archer:

aim	➡	shoot	➡	see	➡	repeat
edit	➡	run	➡	debug	➡	repeat

Hose:

aim	⬌	see
edit	⬌	debug




Yin
Yang

Can we make this real?

(beyond small demos)

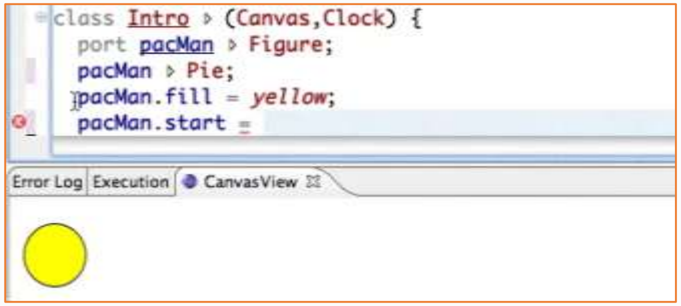
Challenges

Infrastructure (lots of change!)

- Incremental compiler
- Editor
- Execution engine

Living it up with a Live Programming Language

[McDirmid, 2007]



Superglue (my thesis)

- FRP-like language with signals
- Handling code changes "fit" into its programming model
- Cool toy demos

What about real code!?

All infrastructure for this demo was written with something else!

Living it up with a Live Programming Language

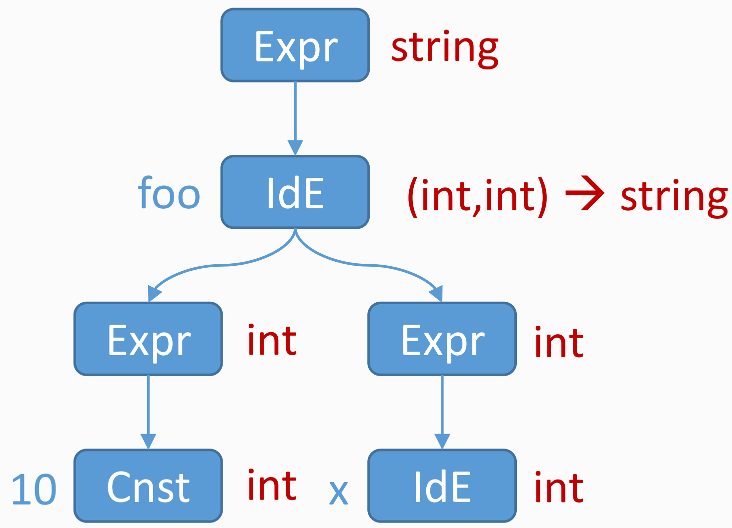
[McDirmid, 2007]

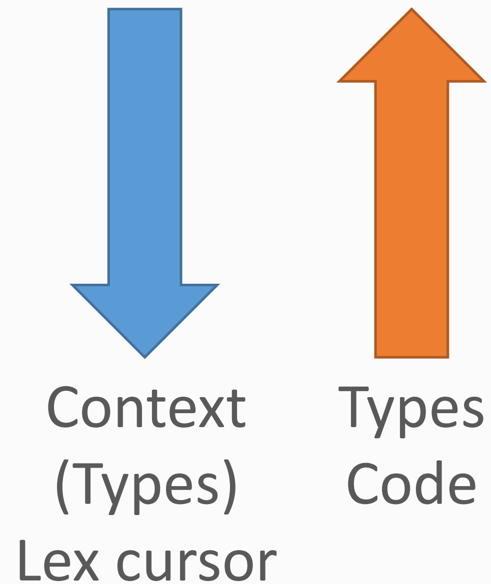
Incremental Compilation Framework

- Damage/repair of memoized tree nodes
- Originally for Scala in Scala

Incremental Compilation

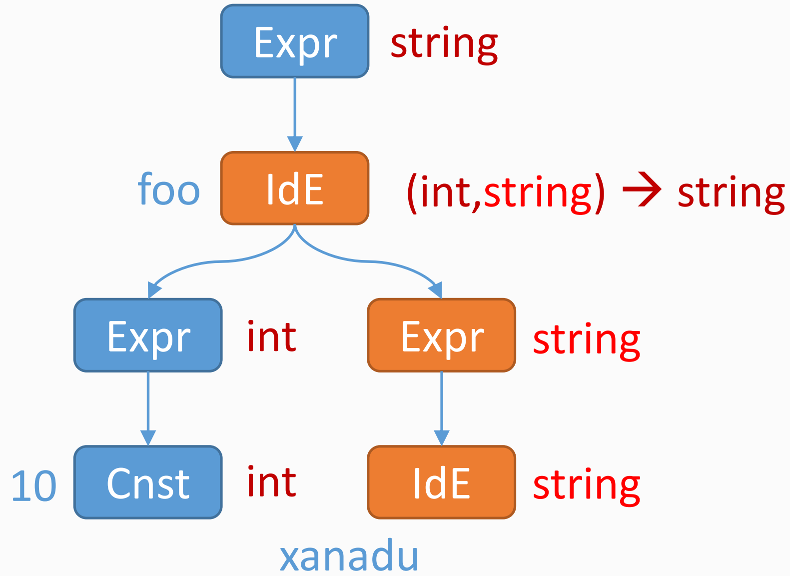
foo(10, x)

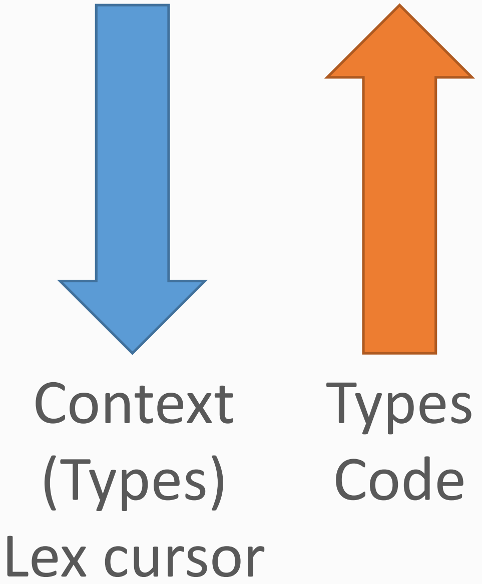




Incremental Compilation

foo(10, xanadu)





Incremental Compilation

Type checkers need symbol tables

- Indirection, key names depend on input, non-local

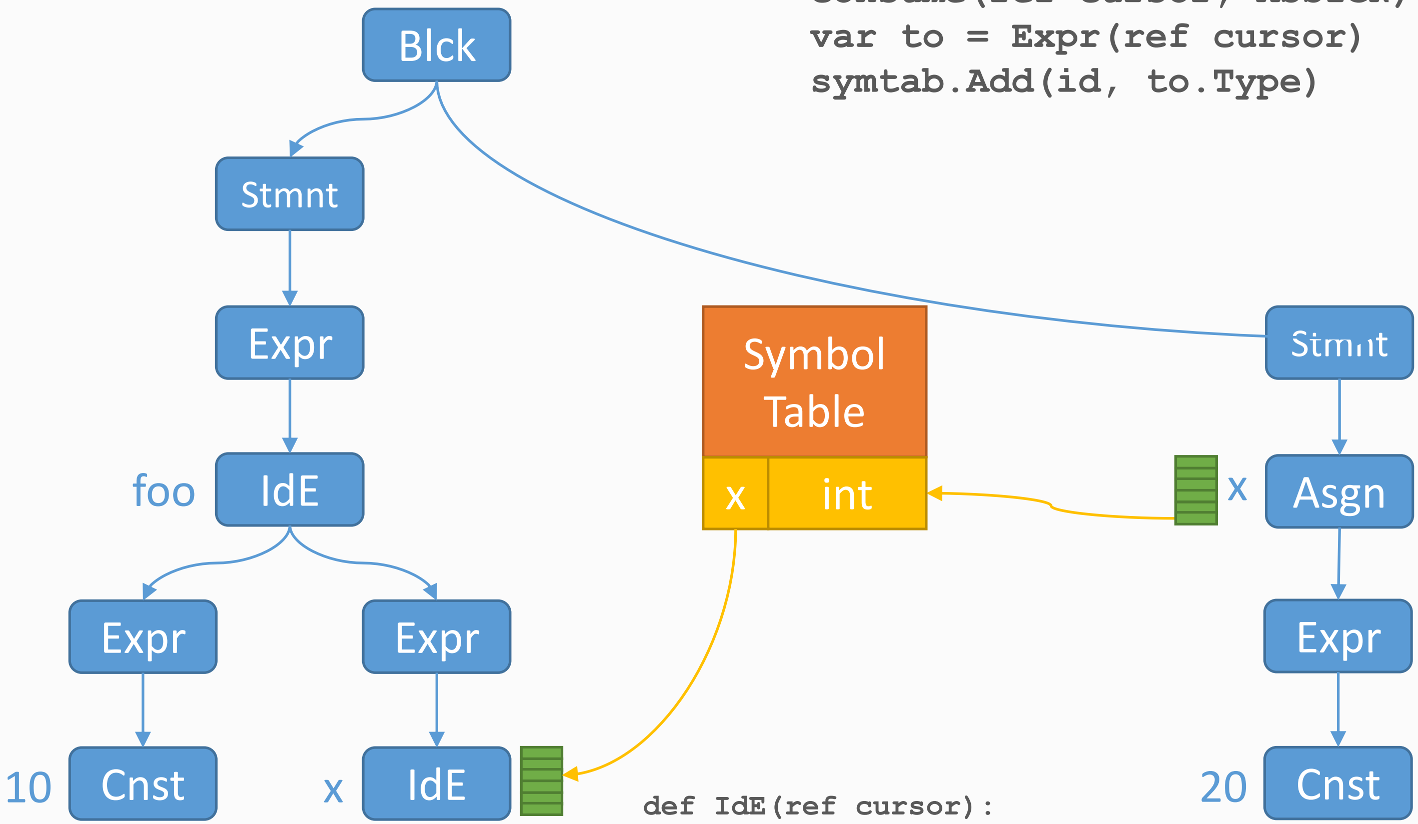
Go beyond plain memoization

- Trace non-local dependencies
- Log, undo symbol table entries per tree

Incremental Compilation

foo(10, x)
x = 20

```
def Assign(ref cursor):
 var id = consume(ref cursor, ID)
 consume(ref cursor, ASSIGN)
 var to = Expr(ref cursor)
 symtab.Add(id, to.Type)
```

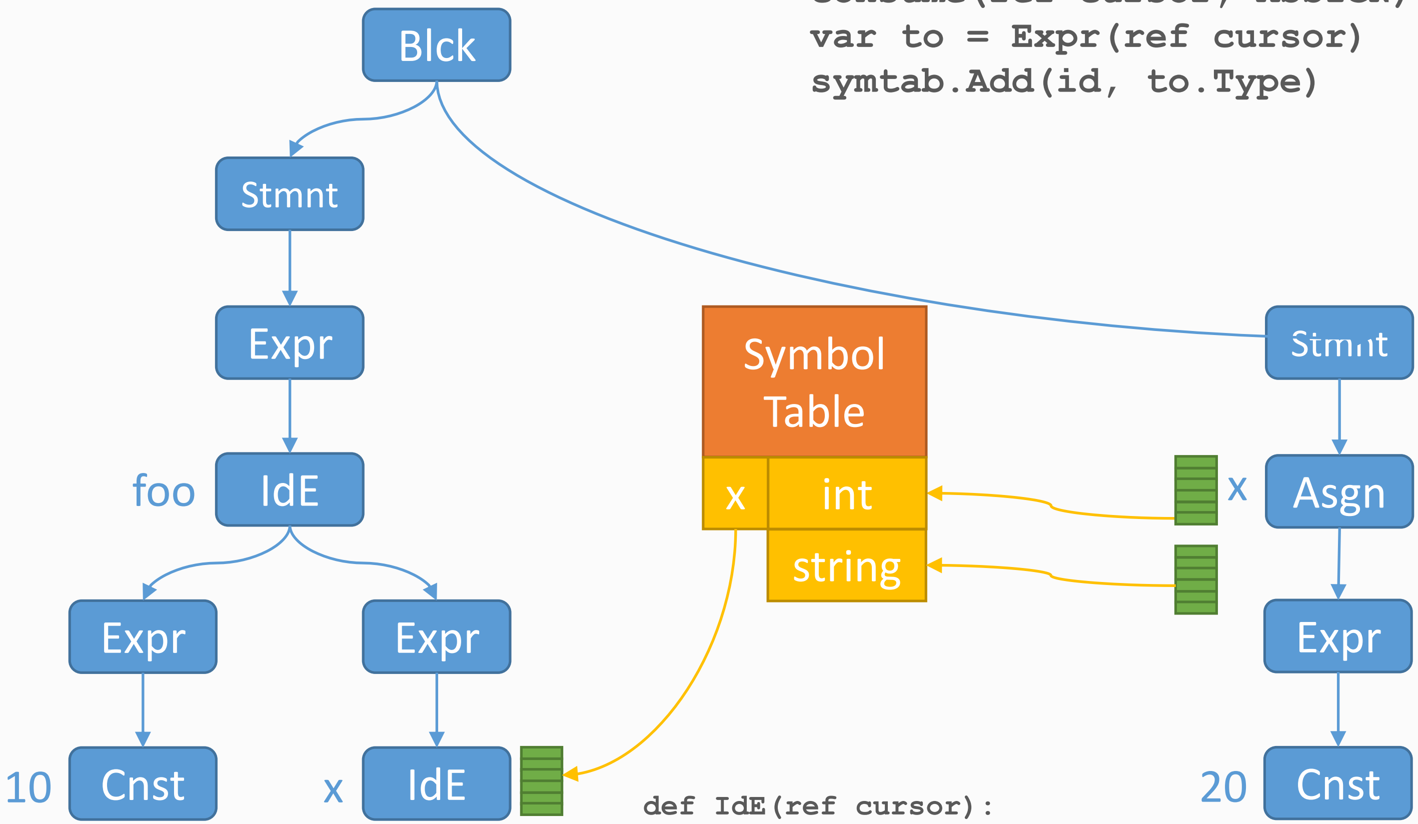



```
def IdE(ref cursor):
 var id = consume(ref cursor, ID)
 return symtab[id]
```

Incremental Compilation

foo(10, x)
x = "hello"

```
def Assign(ref cursor):
  var id = consume(ref cursor, ID)
  consume(ref cursor, ASSIGN)
  var to = Expr(ref cursor)
  symtab.Add(id, to.Type)
```

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```

Incremental Compilation

foo(10, x)
x = “hello”

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def Assign(ref cursor):
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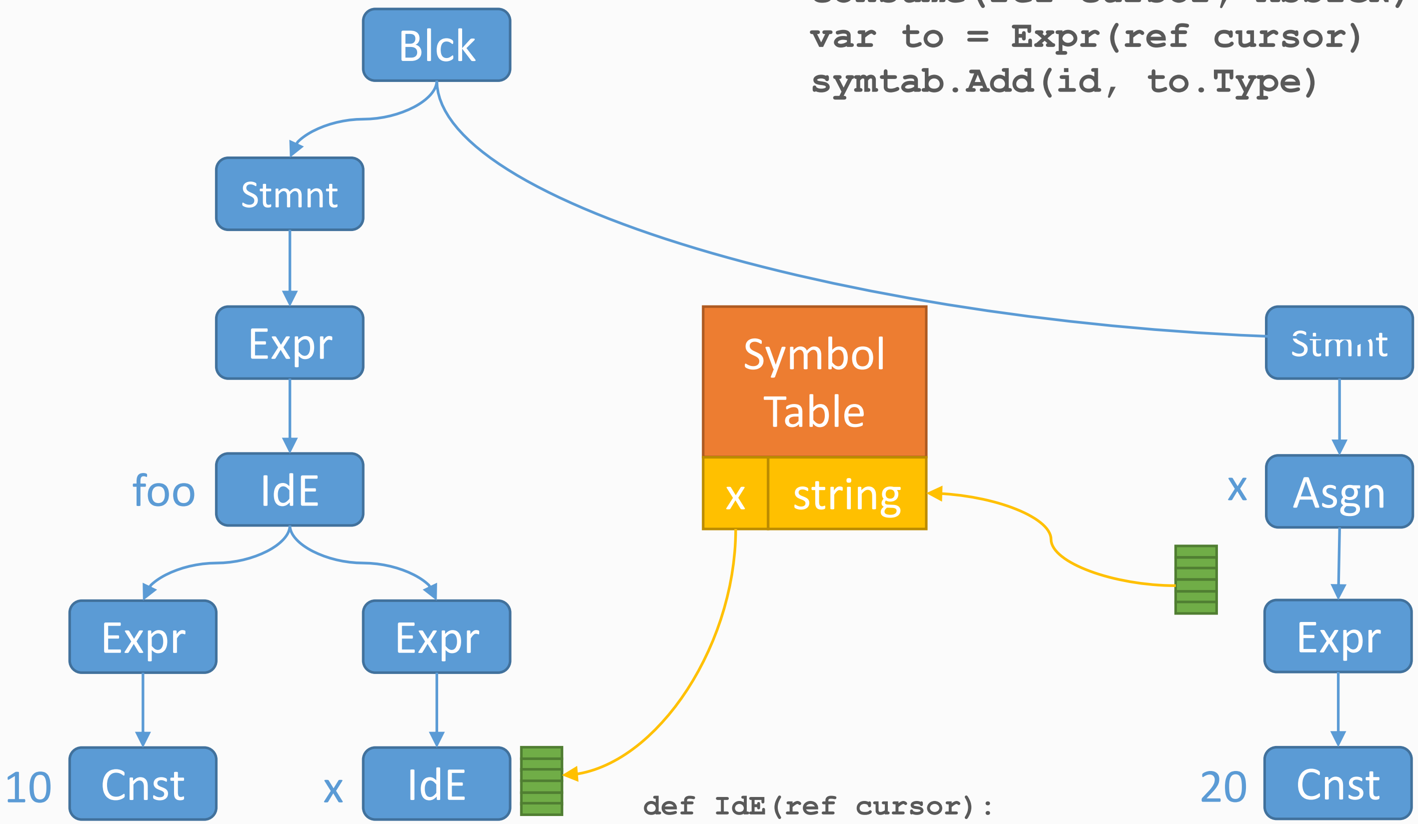
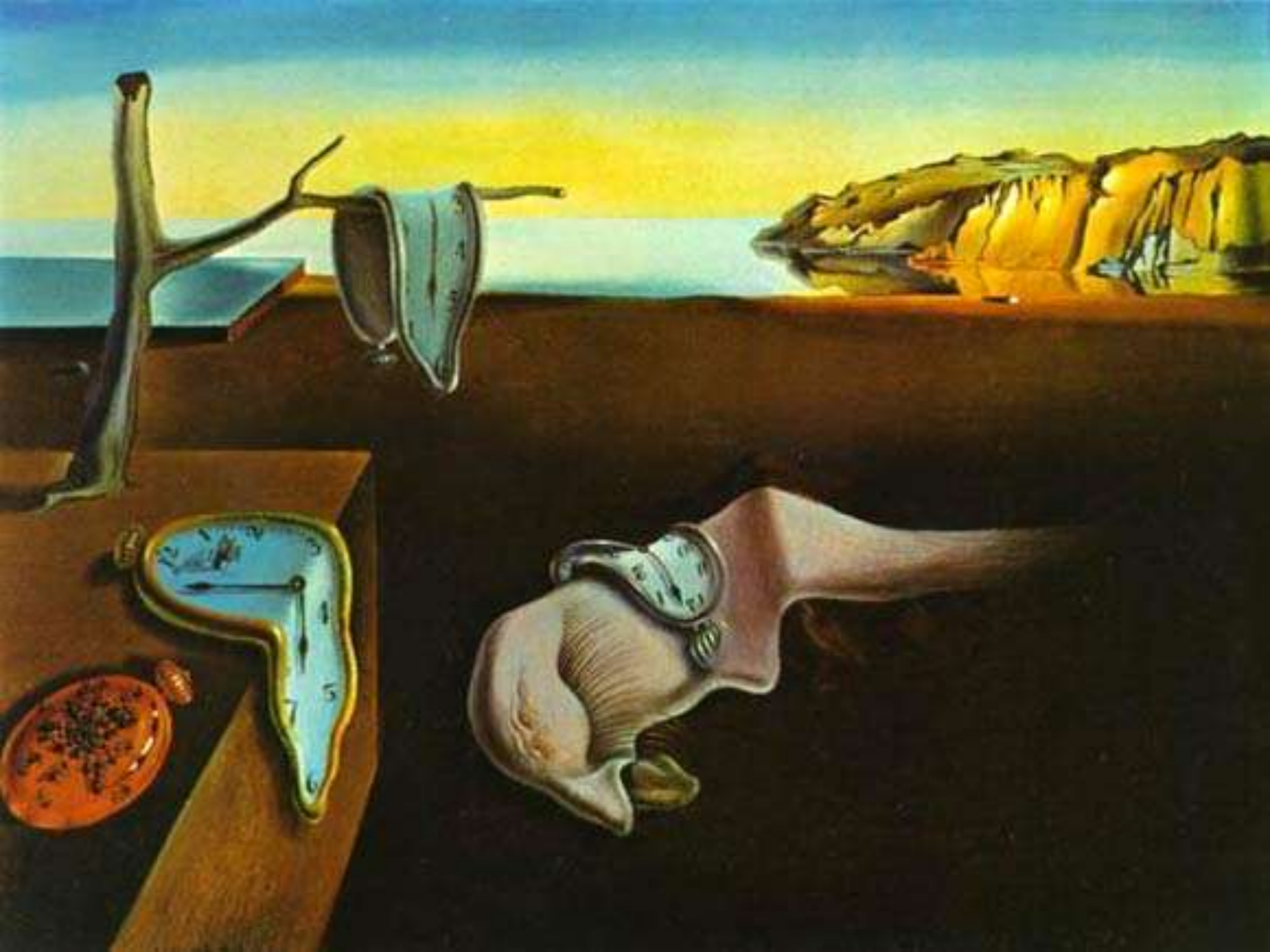



```
def IdE(ref cursor):
 var id = consume(ref cursor, ID)
 return symtab[id]
```

Incremental Compilation

- Able to weave this into scalac
  - Could mostly handle the way scalac was implemented
  - Actually this was a requirement…
- No need to lose imperative programming
  - But then scalac also was not very imperative…
- Adapted quickly for SuperGlue



Usable Live Programming

[McDirmid, 2013]

Live programming in 2013 is cool again!

Time to dust off my old tricks

This time…generalize

Infrastructure/language based on same programming model

“symbol table add” → any imperative operation?

Glitch as the simplest model that could possibly work

Glitch

Divide program execution up into **nodes**

Trace dependencies

Log side-effecting operations (imperatives)

Re-execute node on dependency change

Reap after re-exec: undo **dead** imperatives

Compare old and new log; recursively undo dead nodes

Glitch

Imperatives must be undoable

Nodes can re-execute in any order:

Imperatives must be commutative w.r.t. order!

Supported imperatives:

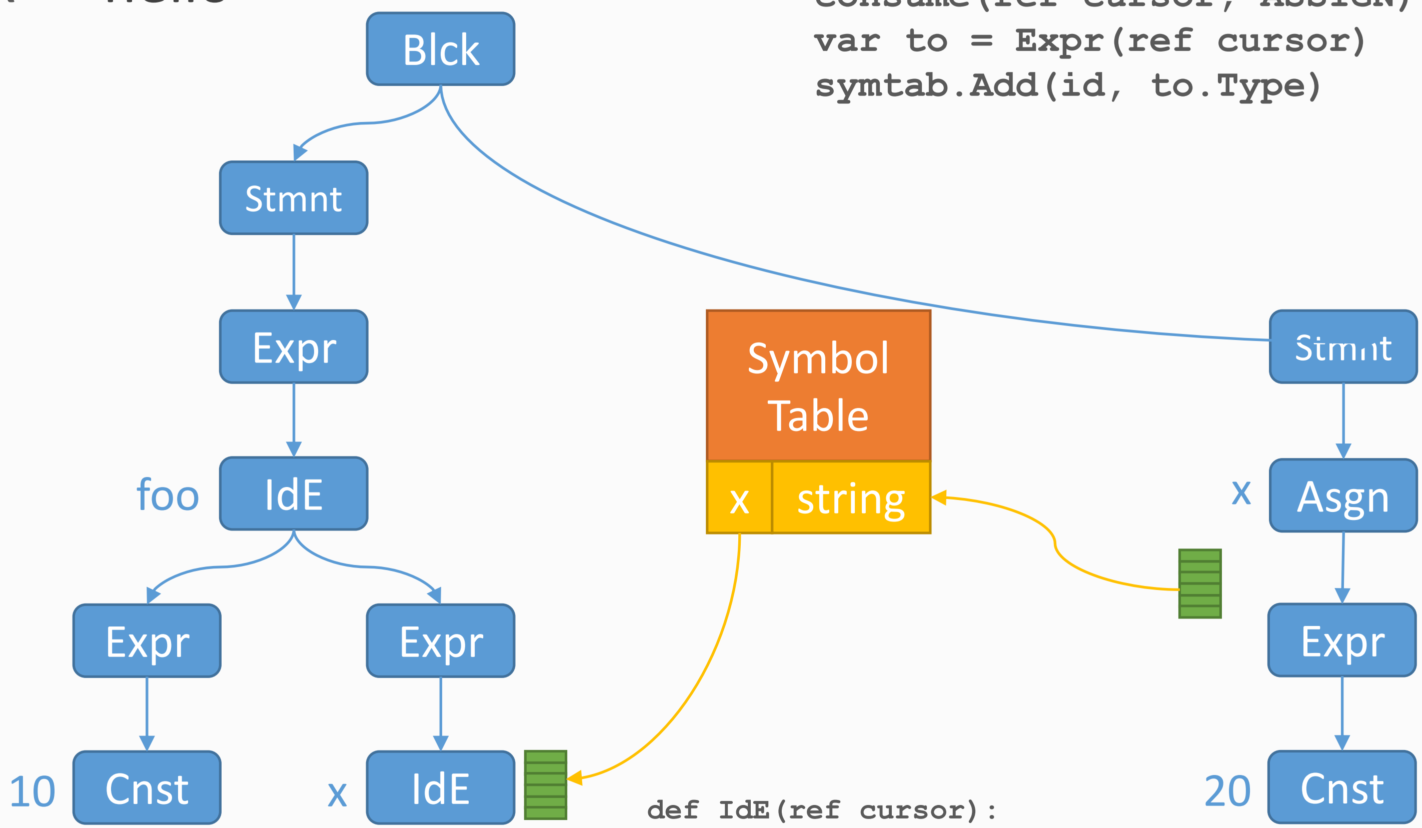
- Set Add, Aggregation (trivial)
- Assignment (dynamic single assignment restriction)
- Dictionary Set (like assignment)
- List.Append (provide ordered execution address)

Glitch

foo(10, x)

x = “hello”

```
def Assign(ref cursor):
 var id = consume(ref cursor, ID)
 consume(ref cursor, ASSIGN)
 var to = Expr(ref cursor)
 symtab.Add(id, to.Type)
```

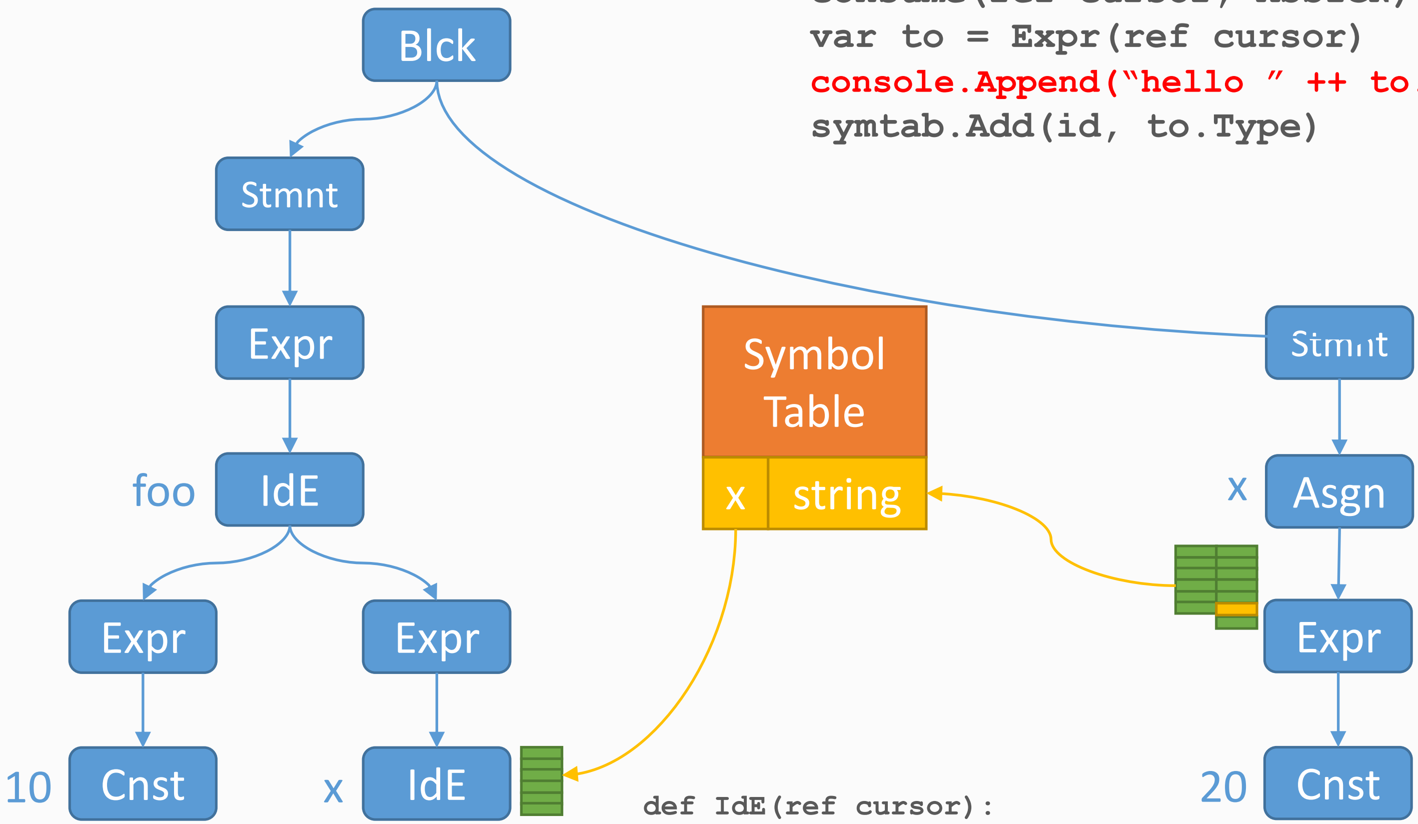



```
def IdE(ref cursor):
 var id = consume(ref cursor, ID)
 return symtab[id]
```

Glitch

foo(10, x)
x = “hello”

```
def Assign(ref cursor):
 var id = consume(ref cursor, ID)
 consume(ref cursor, ASSIGN)
 var to = Expr(ref cursor)
 console.Append("hello " ++ to.Tp)
 symtab.Add(id, to.Type)
```




```
def IdE(ref cursor):
 var id = consume(ref cursor, ID)
 return symtab[id]
```

Why “Glitch”?

Consistency is eventual

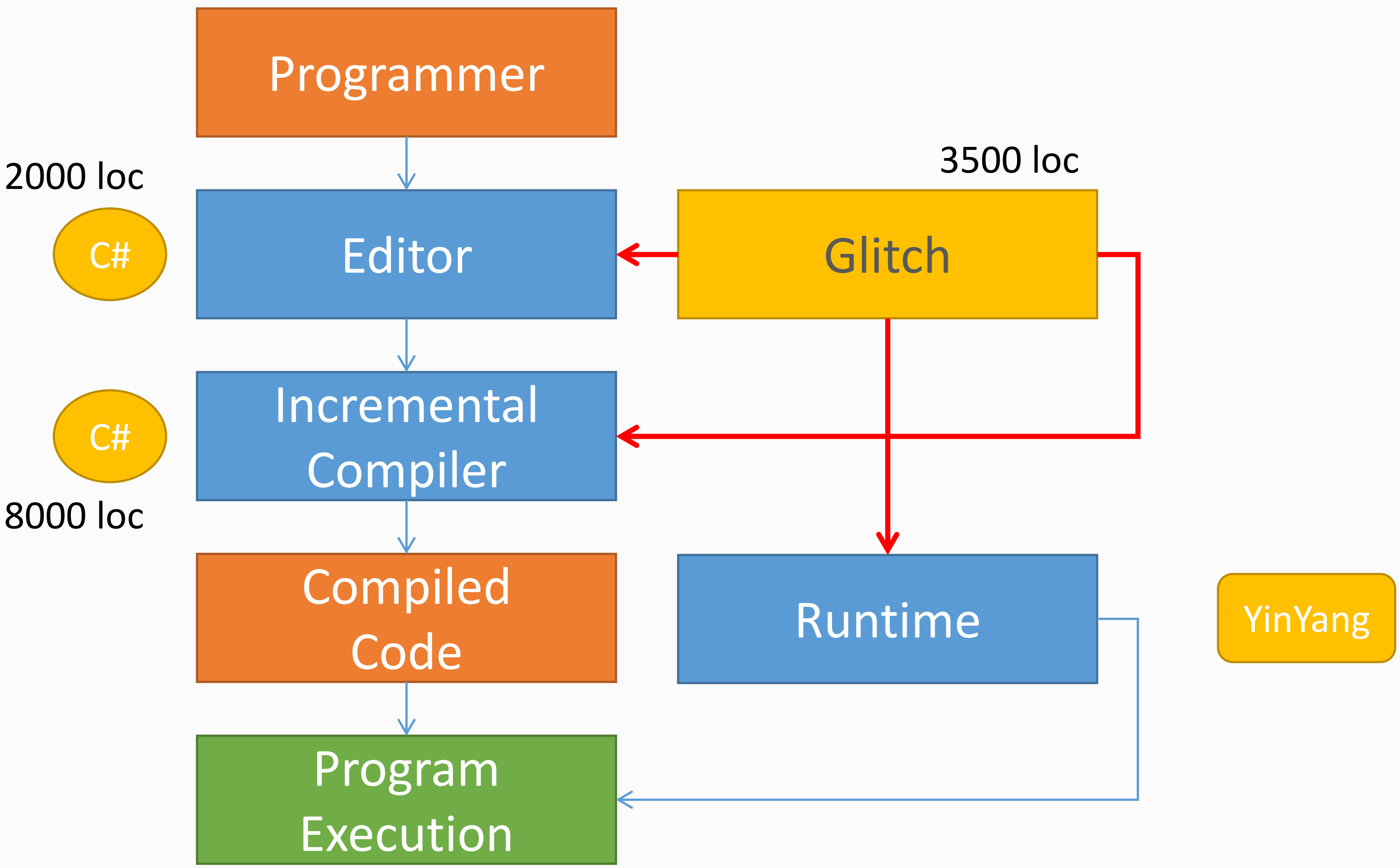
No attempt is made to find an “optimal” re-execution order

Sandbox during development, commit when nothing is damaged in production

No fancy analyses; just logging

Kind of **boring** from a technical perspective, but it works!

Glitch in the stack



Glitch payoffs

Expressive semi-imperative code

Automatic repair management

Simple implementation

Completely dynamic (also a cost...)

But wait, there's more!

- Iterative computing
  - No restriction on what writes can be seen
  - Parsing and type checking together in same pass
- Optimistic speculative parallelism
- Distributed computing
- …

Asynchronous Execution

```
// synchronous - old/blocking/determinstic
var dataA = fileA.read()
process(dataA)
var dataB = fileB.read()
process(dataB)
```

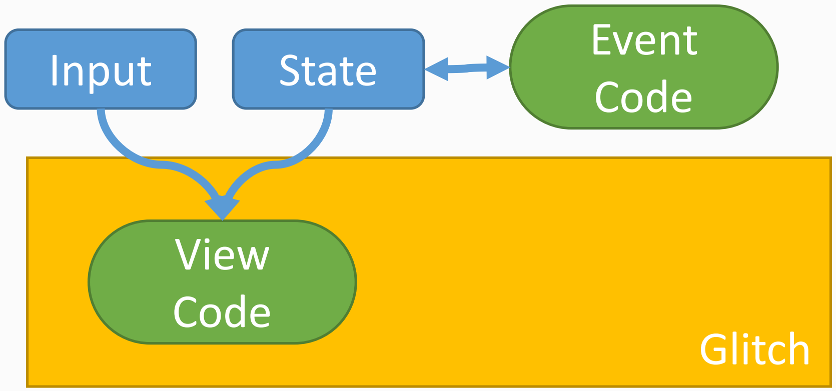
```
// asynchronous - new/non-blocking/non-determinstic
fileA.readAsync(dataA => process(dataA))
fileB.readAsync(dataB => process(dataB))
```

```
// Glitch - retro/non-blocking/determinstic
var dataA = fileA.read()
process(dataA)
var dataB = fileB.read()
process(dataB)
```

Time as major future work

Cannot abstract over time, events, and interactivity

...so no debugging of time-stepped computations (yet)



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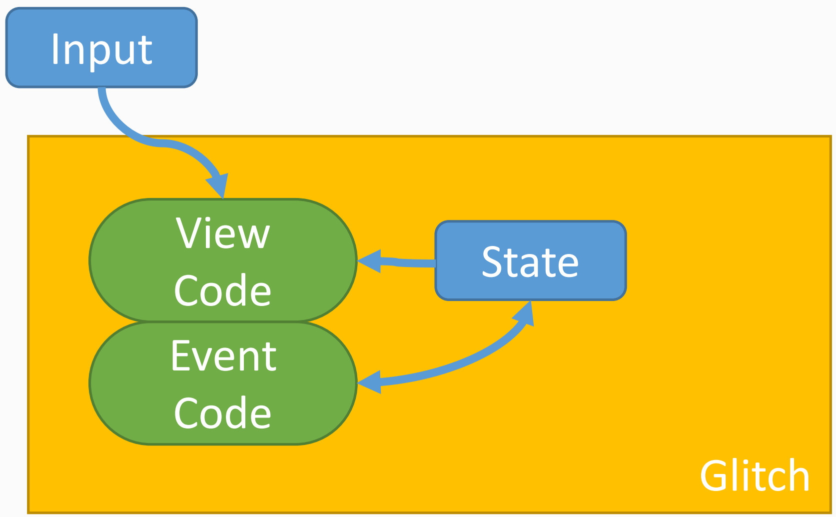

Drawbacks

Tracing logging have costs (performance)

Only semi-imperative (expressiveness)

Eventual consistency makes pulling triggers harder

Not complete until time is included

Conclusion

Why not manage change like garbage collection manages memory?