NOKIA Bell Labs

Verifying state machine transitions with Scala types

Lambda Days

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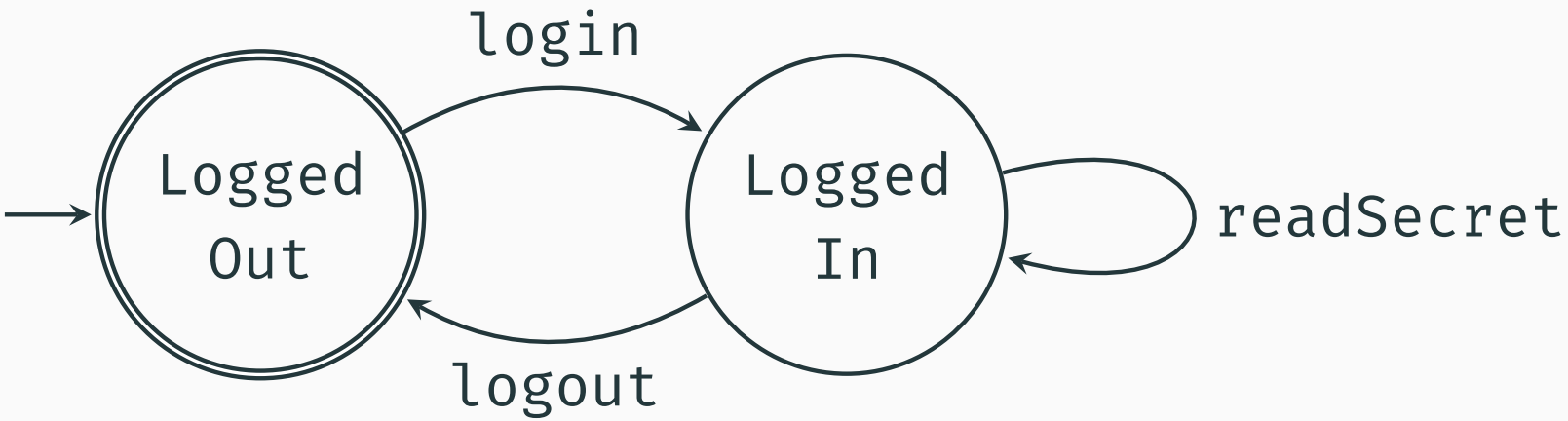
36A8 2002 483A 4CBF A5F8
DF6F 48B2 9573 BF19 7B13

API example

- Simple API for handling users:*



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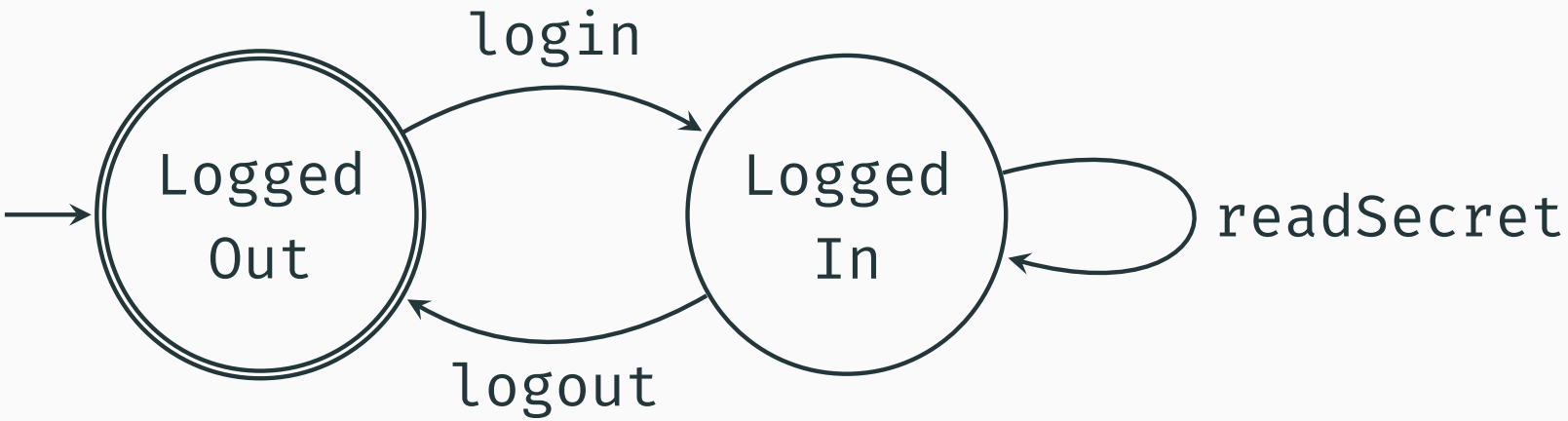

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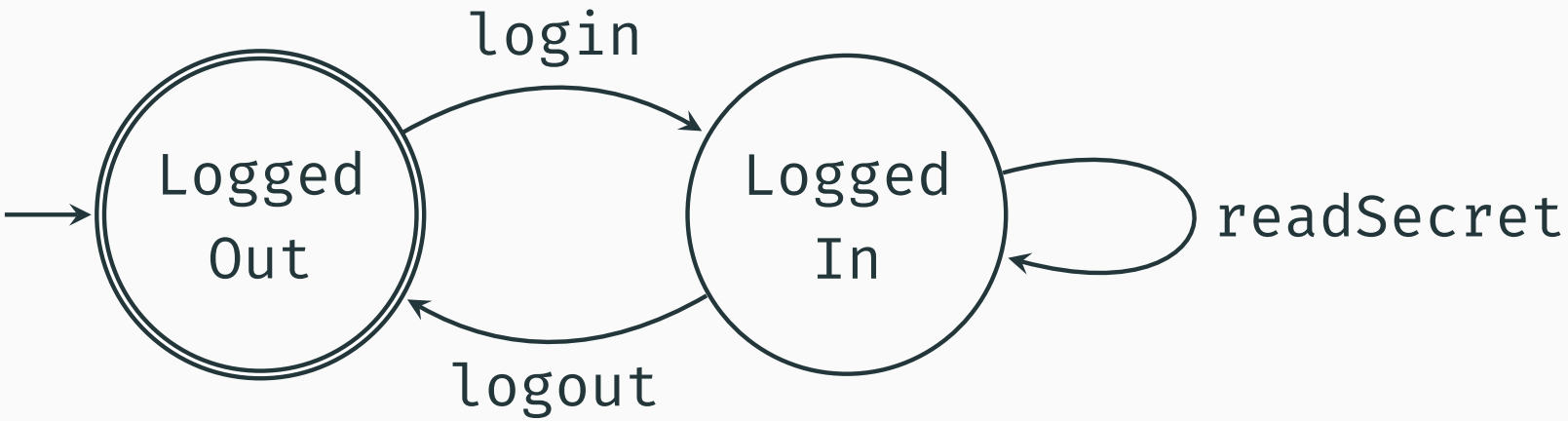

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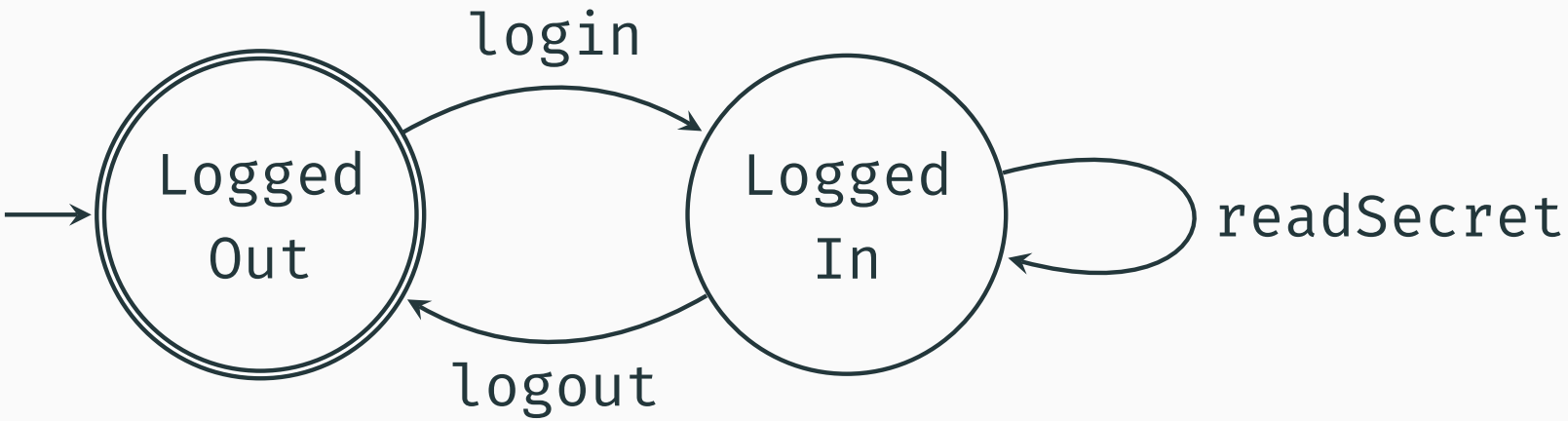

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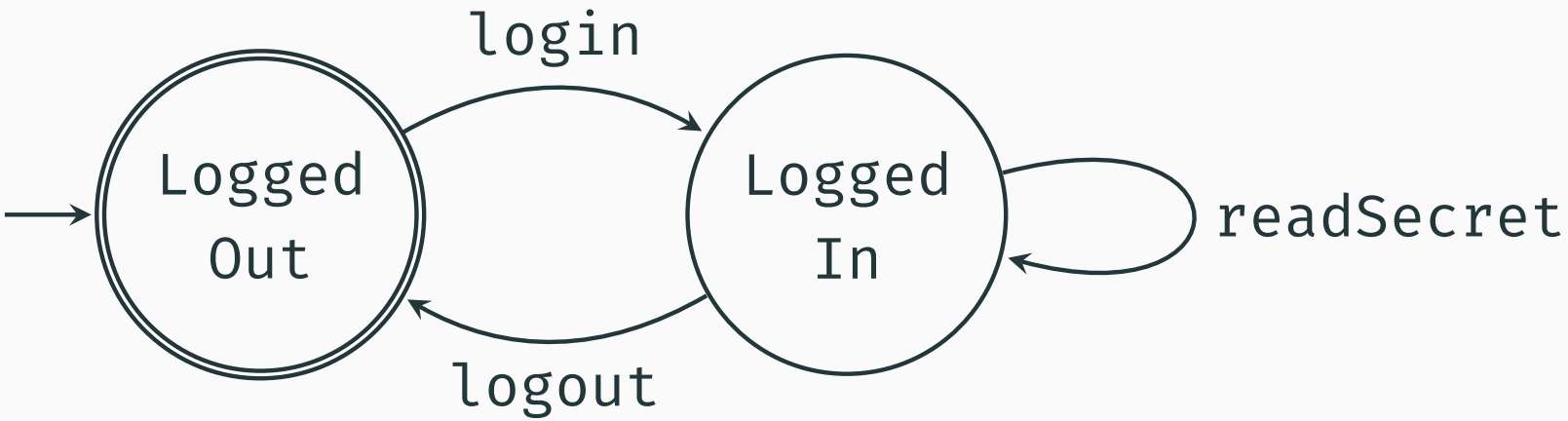

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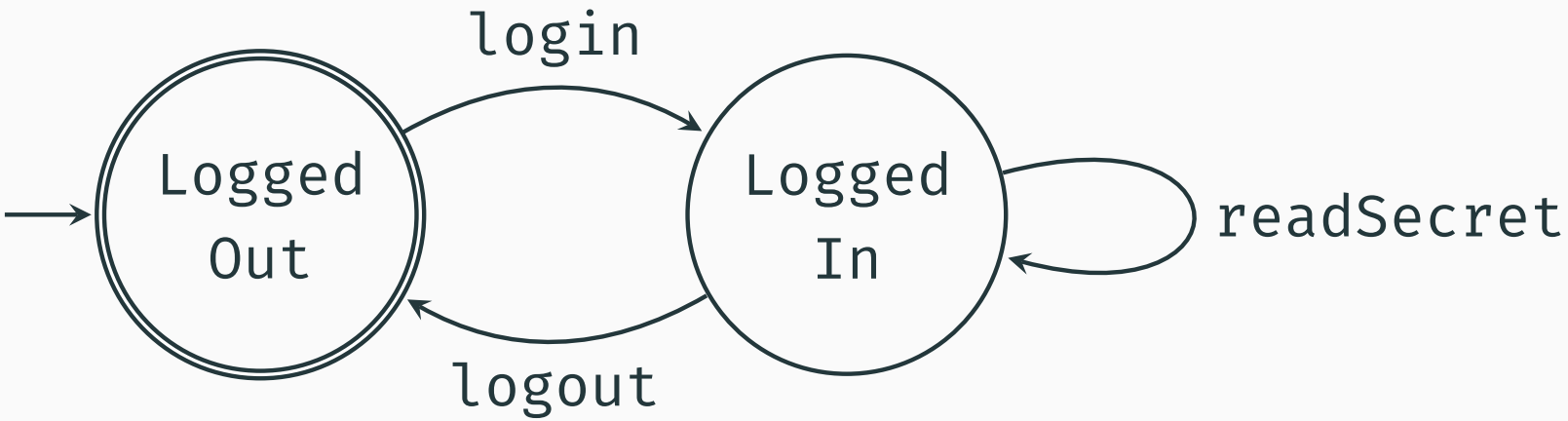

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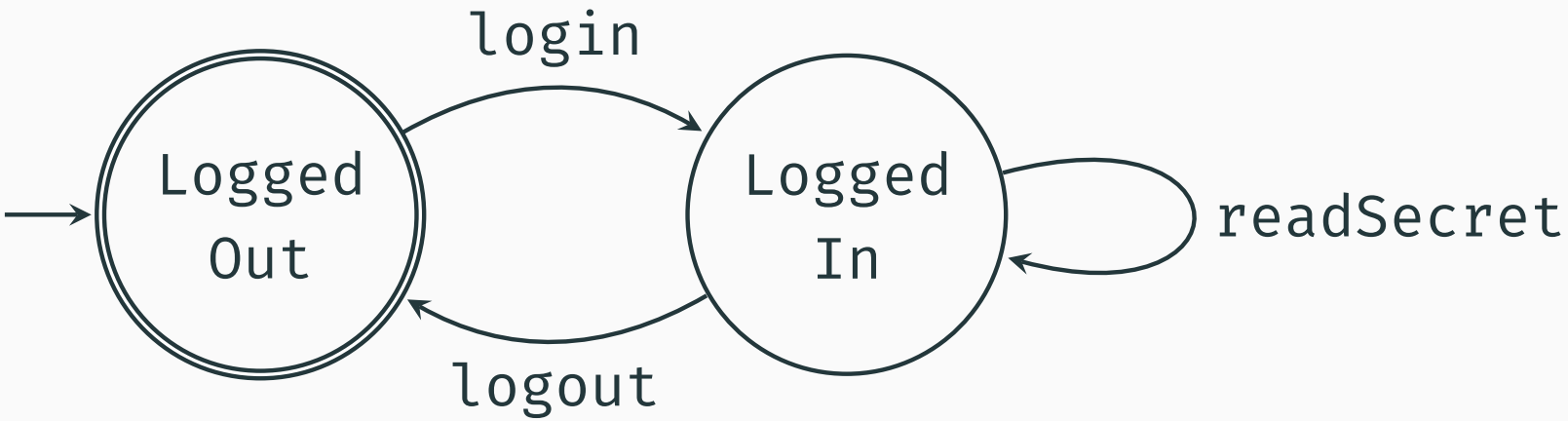

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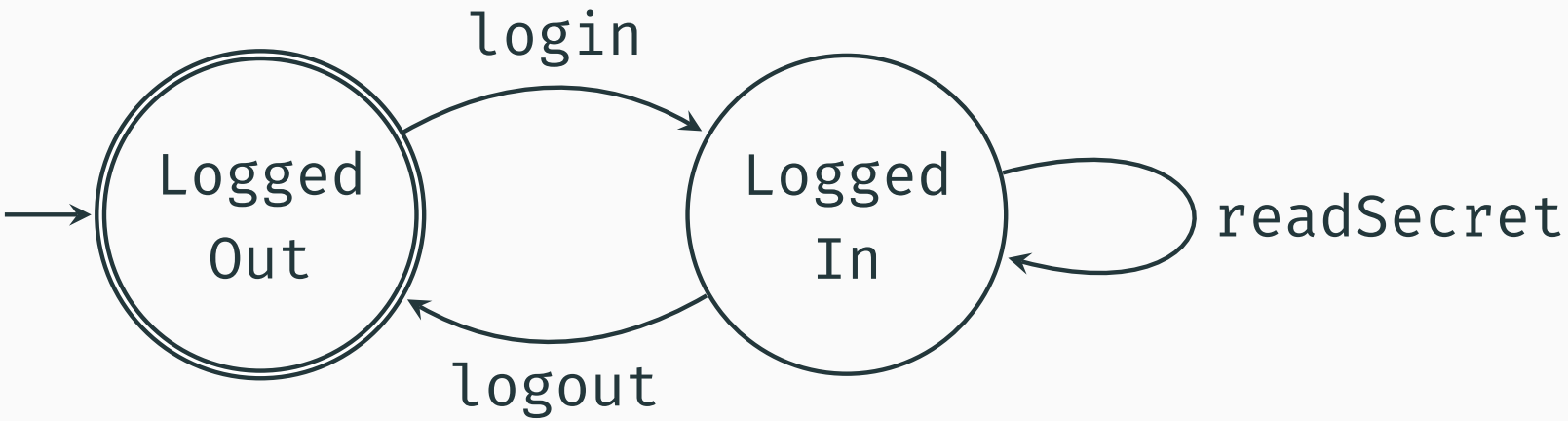

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Using a free monad

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  def login(c: Credentials): Free[UserOp, Unit]
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- We can interpret and run our bad program
  - but we'll probably get a *runtime* error
- We'd like to get a *compile-time* error for such programs

Indexed state monad

```scala
// (Simple) State monad:
case class State[S, A](run: S ⇒ (S, A))

val simpleProg: State[Int, Unit] = for {
  num ← State.get // read an Int
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val myIO: IO[String] =
  myProg.runA(new LoggedOut)
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Good and bad things

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for {
  secret ← UserApi.readSecret
  // login AFTER readSecret
  _ ← UserApi.login(myCredentials) // compile error
} yield secret
```

The good: we get a *compile-time* error if we try to log in *after* reading the secret.

```
for {
  _ ← IndexedStateT.set[IO, LoggedOut, LoggedIn](
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Further improvement: let's combine `IndexedStateT` with `Free`!

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// (Simple) Free monad:
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  - consistent *From* and *To* states
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- Further improvements:
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    - disallow incorrect state transitions
    - help with resource handling
  - When running the program:
    - disallow invalid start/end states

Summary

- Better (state machine-like) APIs:
  - DSL-like operations
  - compile-time errors for
    - incorrect state transitions
    - invalid operations
- We achieved this by:
  - using a free monad
  - which is *indexed* by the from/to states
- Further improvements:
  - When writing the interpreter:
    - disallow incorrect state transitions
    - help with resource handling
  - When running the program:
    - disallow invalid start/end states
  - These are implemented too, see the **source code** ...

Thank You!

`https://github.com/durban/scates`

- Source code, examples, slides, ...

Thank You!