Java

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Jython

Exploiting Concurrency with Dynamic Languages

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Exploiting concurrency with dynamic languages

- Background
- The languages
- The benefits of these languages
- Example
- Summary

Background

What Java brought to the table

- Built in, simple support for multi threaded programming
- Synchronized blocks and methods in the language
- wait() and notify()
- A good, sound memory model for concurrent situations
- Executors, Thread pools, Concurrent collection, Atomic variables, Semaphores, Mutexes, Barriers, Latches, Exchangers, Locks, fine grained timing...

Why use a language other than Java?

- More expressive - put the good stuff to better use
- Higher order constructs abstract away tedious boilerplate
- Closures

Why use a language other than Java?

- Closures provide clean ways of expressing tasks and thread entries
- Meta-programmability can encapsulate conventions
  - Operator overloading
  - Macros and function modifiers
- Capabilities for building DSLs
- Built in ways of dealing with modern problems
  - Support for concurrency best practices?

The Languages

Jython

- I'm biased
- Python is used a lot in scientific computing
  - Could benefit a lot from better concurrency offered by Jython being on the Java platform
- Highly dynamic
- Strict, explicit, but compact and readable syntax

JRuby

- It is a great language implementation
- It is a popular, highly productive language
- Highly dynamic
- Powerful syntax for closures

Scala

- Geared towards scalability in concurrency
- Interesting Actor model
  - Provide for scalability by restricting data sharing between concurrently executing code

Clojure

- Built at core for being good at concurrency
- Provides for concurrency by using persistent data structures
  - Most objects are immutable
- Objects that are mutable are mutated explicitly
  - Software transactional memory

"Why not Groovy" (or another language)

- Good and popular dynamic language for the JVM
- Can do anything that Java, Jython or JRuby can
- Not interesting - All examples would be "me too"

- Countless other languages have their specialties, including them all would be too much
  - Ioke, Kawa, Rhino, Java FX script, Kahlua, Fortress...

What these languages add

Automatic resource management - Jython

```
with synchronization_on(shared_resource):
    data = shared_resource.get_data(key)
    if data is not None:
        data.update_time = current_time()
        data.value = “The new value”
        shared_resource.set_data(key, data)
```

Closures - JRuby

```
shared_resource.synchronized do
    data = shared_resource.get_data(key)
    if data.nil?
        data.update_time = current_time()
        data.value = “The new value”
        shared_resource.set_data key, data
    end
end
```

Closures - JRuby

```
chunk_size = large_array.size/NUM_THREADS
threads(NUM_THREADS) do |i|
   start = chunk_size * i
   (start..start+chunk_size).each do |j|
      large_array[j] += 1
   end
end
```

Meta functions - Jython (“function decorators”)

```
@future # start thread, return future ref
def expensive_computation(x, y):
    z = go_do_a_lot_of_stuff(x)
    return z + y

# use the function and the future
future_value = expensive_computation(4,3)
go_do_other_stuff_until_value_needed()
value = future_value()
```

Meta functions - Jython

```
@forkjoin # fork on call, join on iter
def recursive_iteration(root):
    if root.is_leaf:
        yield computation_on(root)
    left = recursive_iteration(root.left)
    right= recursive_iteration(root.right)
    for node in left:  yield node
    for node in right: yield node
for node in recursive_iteration(tree):...
```

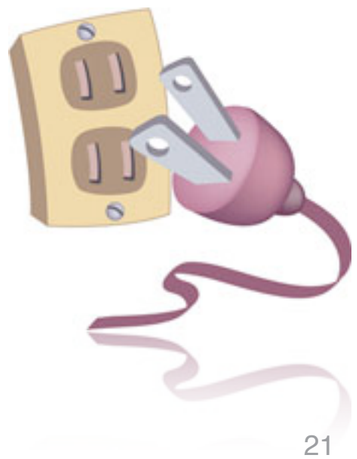
Built in Software Transactional Memory - Clojure

```
(defn transfer [amount from to]
  (dosync ; isolated, atomic transaction
   (if (>= (ensure from) amount)
       (do (alter from - amount)
           (alter to + amount))
       (throw (new
               java.lang.RuntimeException
               "Insufficient funds")))))

(transfer 1000 your-account my-account)
```

Transactions as a managed resource - Jython

```
import neo4j
neo = neo4j.NeoService("/var/neodb")
persons = neo.index("person")
with neo.transaction:
    tobias = neo.node(name="Tobias")
    persons[tobias['name']] = tobias
    emil = neo.node(name="Emil", CEO=True)
    persons[emil['name']] = emil
    tobias.Knows(emil, how="Buddies")
```



Actor Execution - Scala

- Concurrent processes communicating through messages
- Receive and act upon messages
  - Send message
  - Create new actors
  - Terminate
  - Wait for new message
- Message objects are immutable

Actor Execution - Scala

```
case class IncredibleProblem(d:String)
class SimpleSolution(d:String)
object RichardDeanAnderson extends Actor{
  def act = {
    loop {
      react {
      case IncredibleProblem(d) =>
        reply(SimpleSolution(d))
      }}}}
```

Example

Adding two numbers

```
# Jython
def adder(a,b):
    return a+b
```

```
# JRuby
def adder(a,b)
    a+b
end
```

Counting the number of additions - Jython

```
from threading import Lock
count = 0
lock = Lock()
def adder(a,b):
    global count
    with lock:
        count += 1
    return a+b
```

Counting the number of additions - JRuby

```
class Counting
    def adder(a,b)
        @mutex.synchronize {
            @count = @count + 1
        }
        a + b
    end
end
```

Adding two numbers - Clojure

```
(defn adder [a b]
   (+ a b))

(let [count (ref 0)]
  (defn counting-adder [a b]
    (dosync (alter count + 1))
    (+ a b))
  (defn get-count [] (deref count)))
```

Actors Adding numbers - Scala

```
class Adder {
  def add(a:Int,b:Int) = a+b
}
```

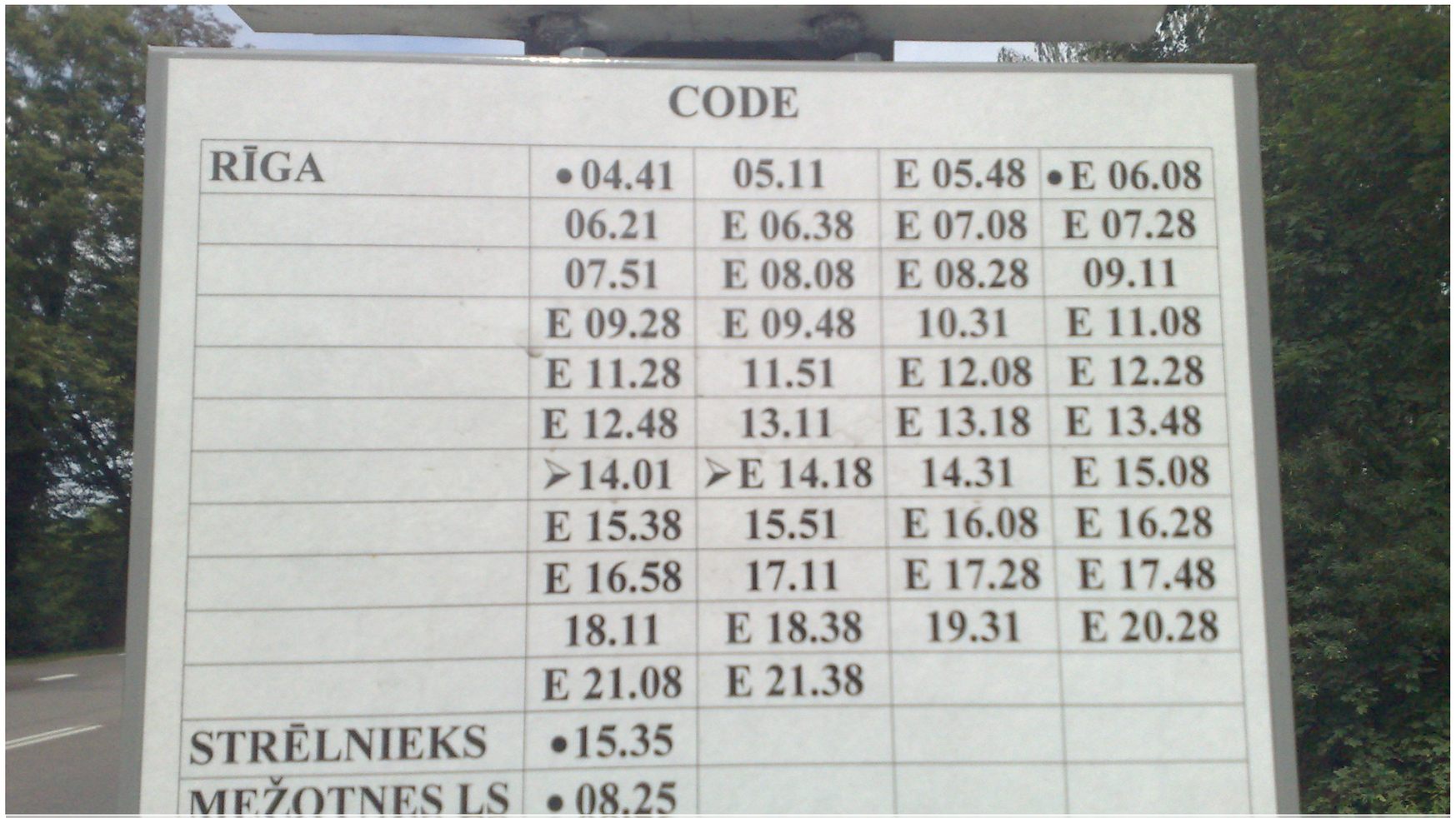
Actors Adding numbers - Scala

```
class Cntr(var count:Int) extends Actor {
  def act = {
    loop {
      react {
      case Inc => count = count + 1
      case GetCount => reply(count); exit
      }
    }
} }
```

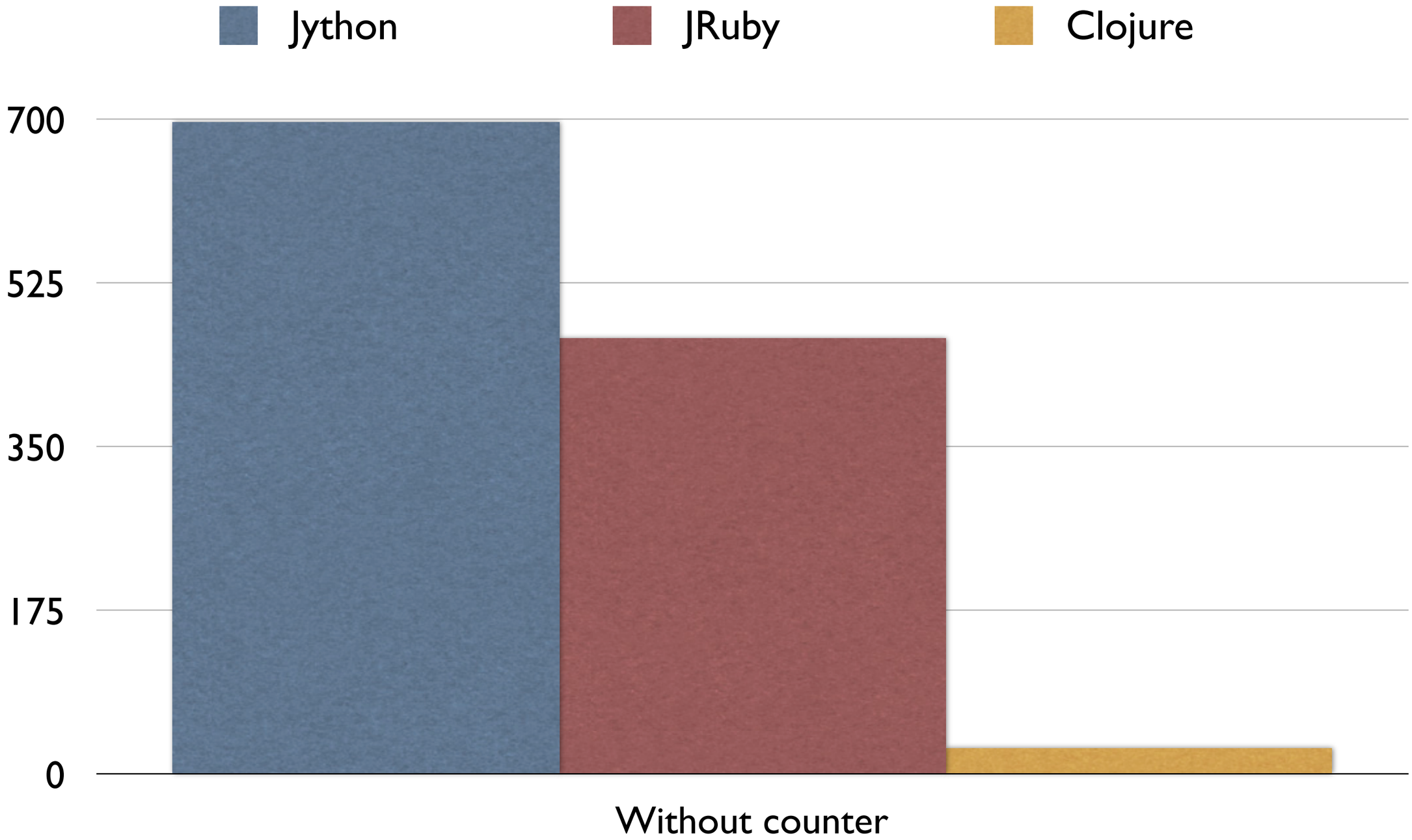
Actors Adding numbers - Scala

```
class CountingAdder(times:Int,adder:Adder,counter:Cntr) extends Actor {
  def act = {
    loop {
      react {
      case Add(a,b) => {
        val start = nanoTime()
      for (i <- 0 until times) {
        counter ! Inc
        adder.add(a,b)
      }
      val time = nanoTime() - start
      react {
        case GetTime => reply(time / 1000000.0)
      }
    }
    case Done => exit
    } } } }
```

Performance figures



Execution times (ms for 400000 additions)



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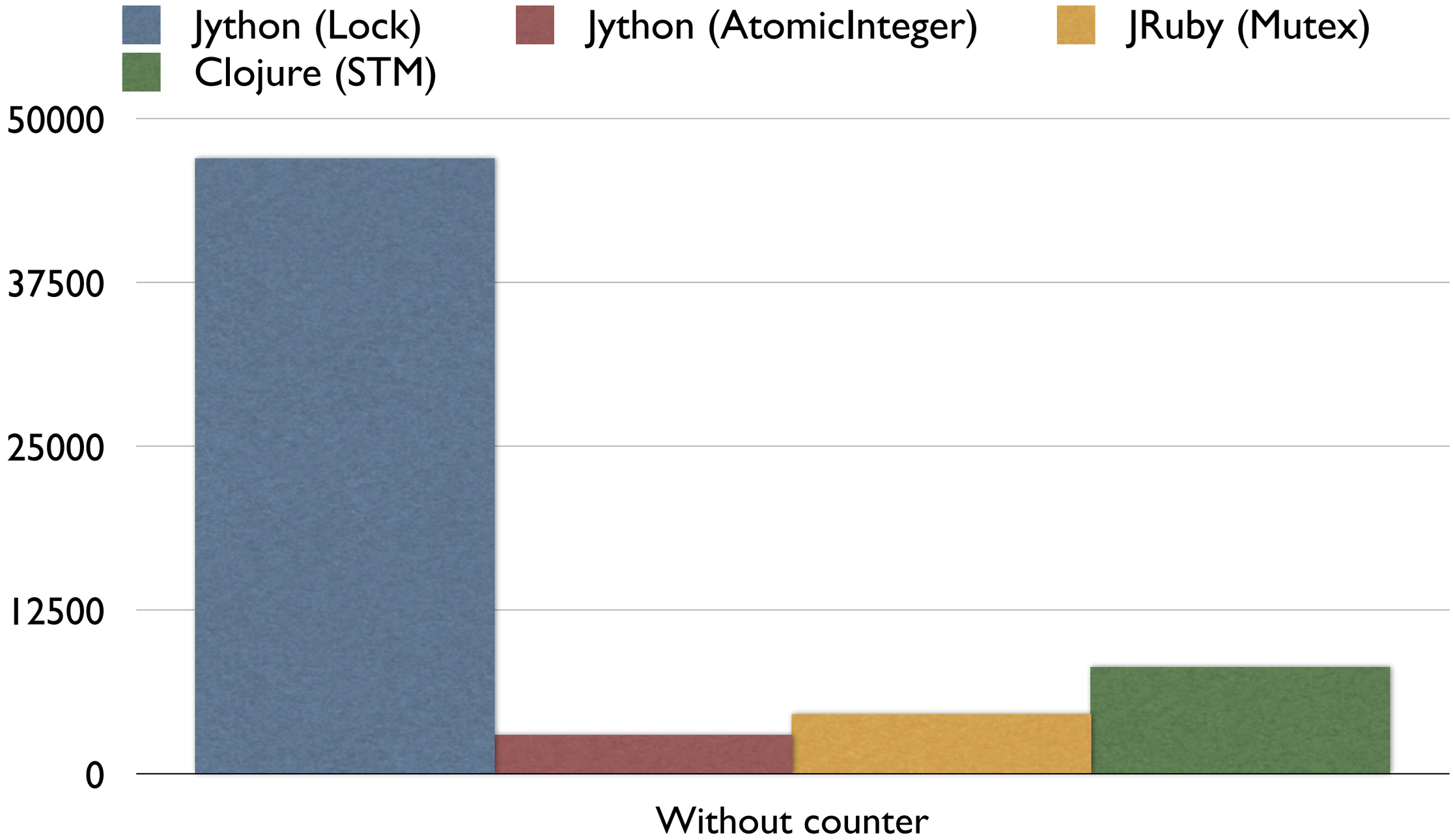

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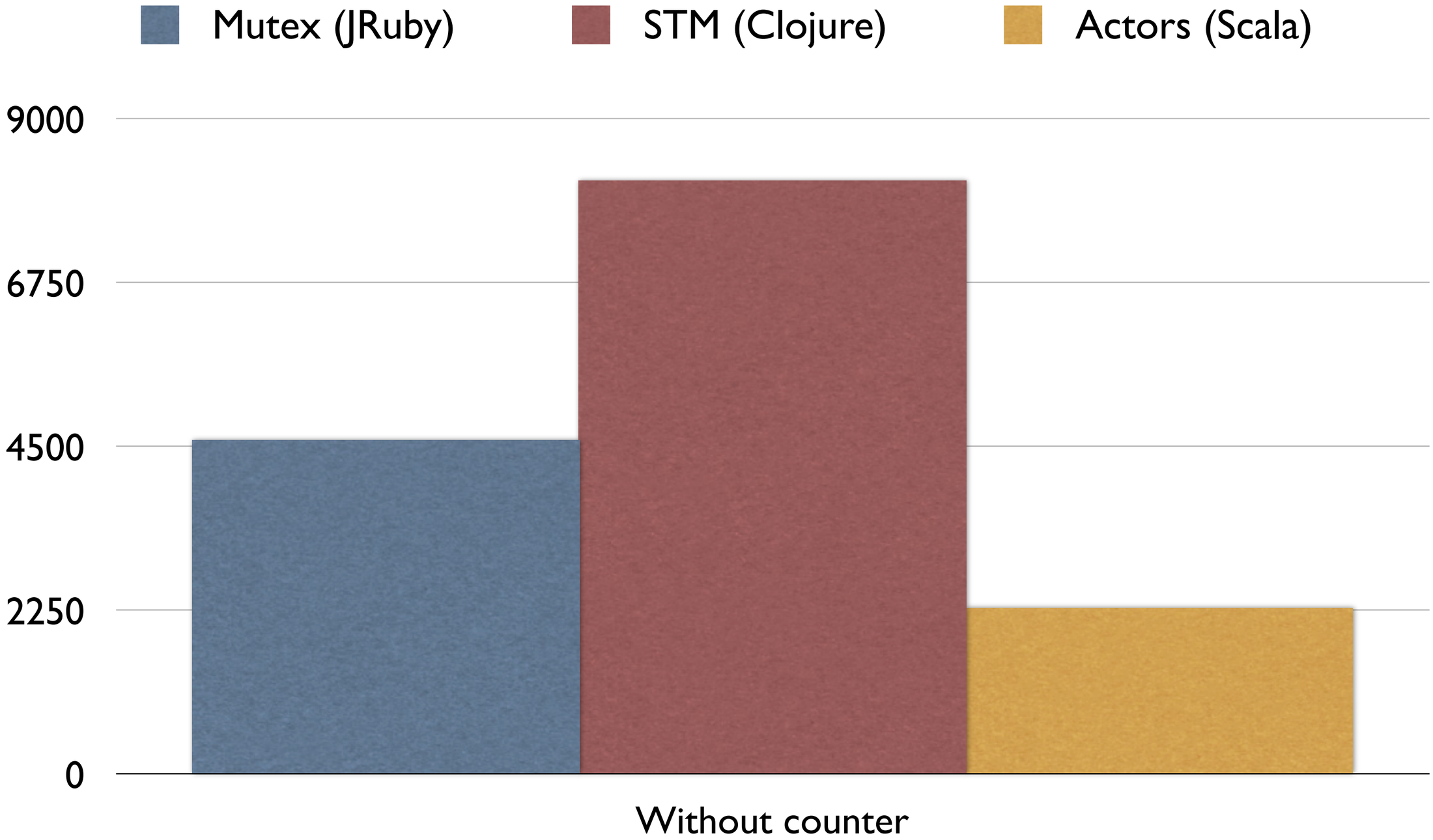

Summary

Jython

- Nice resource management syntax
- Implementation has a few things left to work out
- Suffer from high mutability in core datastructures

JRuby

- Closures help a lot
- Great implementation
- Suffer from high mutability in core datastructures

Scala

- Actors have good characteristics
  - Decouple work tasks with no shared state
  - Asynchronous communication is great
- Syntax is more on the verbosity level of Java

Clojure

- Immutability frees you from thinking about synchronization
- Transactions for mutation enforces thinking about state
- The combination enforces best practices, but in a way much different from “plain old Java”

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Thank You

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