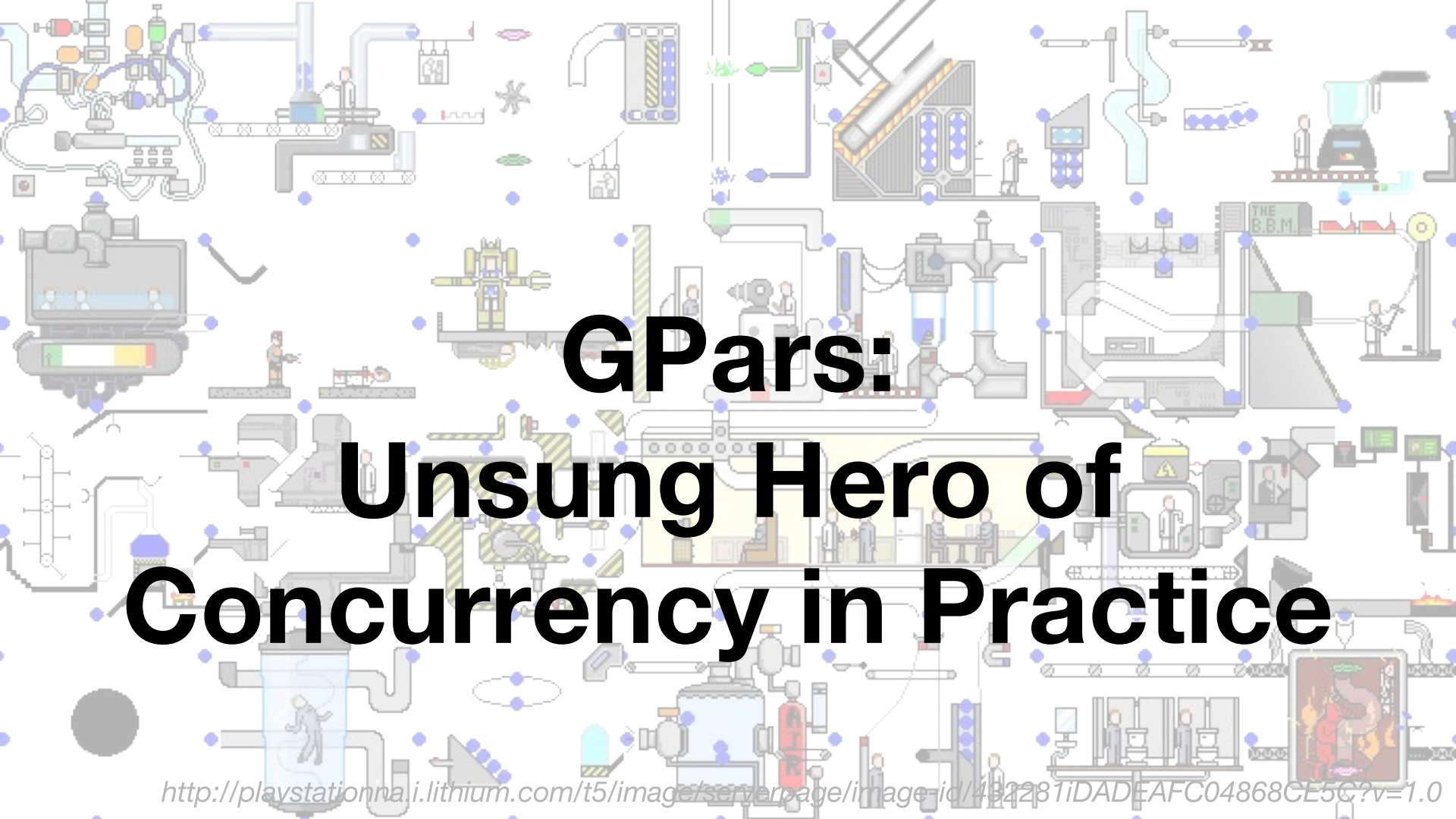


GPars: Unsung Hero of Concurrency in Practice

http://playstationna.i.lithium.com/t5/image/serverpage/image-id/432281iDADEAFC04868CE5C?v=1.0

Focus for this talk

When it comes to **concurrency and parallelism**,

first things to appear in someone's mind may be "Java Concurrency in Practice" by Brian Göetz, **threads, java.util.concurrent, Fork-Join, parallel streams, reactive, Akka or MapReduce**.

When it comes to Groovy, first things to appear in someone's mind may be Gradle, Grails, Spock, DSLs or scripting.

http://www.theverge.com/2015/4/22/8381963/rube-goldberg-machine-contest-history-ideas

Focus for this talk

Great injustice is that you rarely meet **GPars** in both these lists.

Framework that provides **high-level APIs and DSLs for writing concurrent and parallel code** both in Java and Groovy

and support for concepts of **map/reduce, fork/join, asynchronous code, actors, agents, dataflows (not all mentioned)** deserves a little more attention, isn't it?

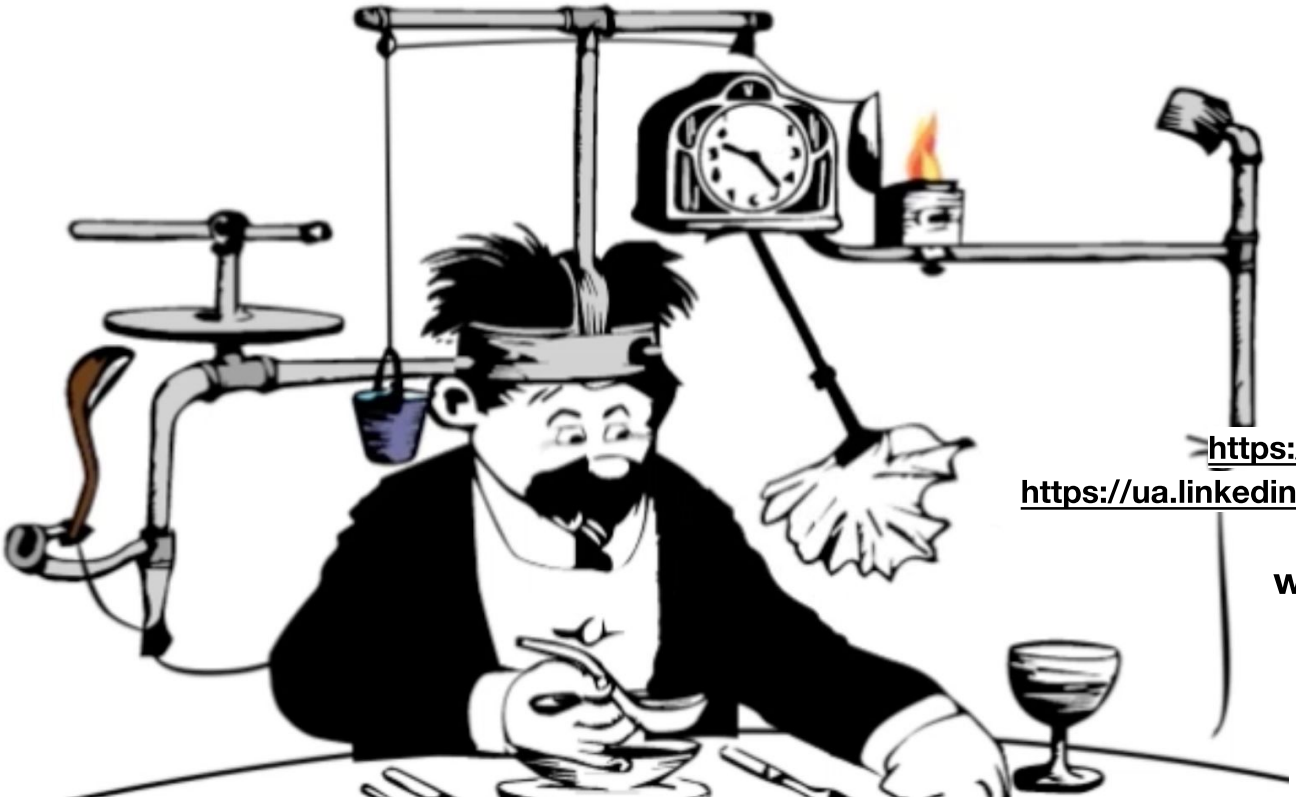
http://www.theverge.com/2015/4/22/8381963/rube-goldberg-machine-contest-history-ideas

Focus for this talk

In this talk we will try to fix it. One by one, **we will explore various use cases of GPars** with all its pragmatism and conciseness.

Not forgetting neither plain Java nor Groovy adepts, we will use Groovy to empower our solutions and ensure that everything works from Java the same way.

http://www.theverge.com/2015/4/22/8381963/rube-goldberg-machine-contest-history-ideas



Yaroslav Yermilov

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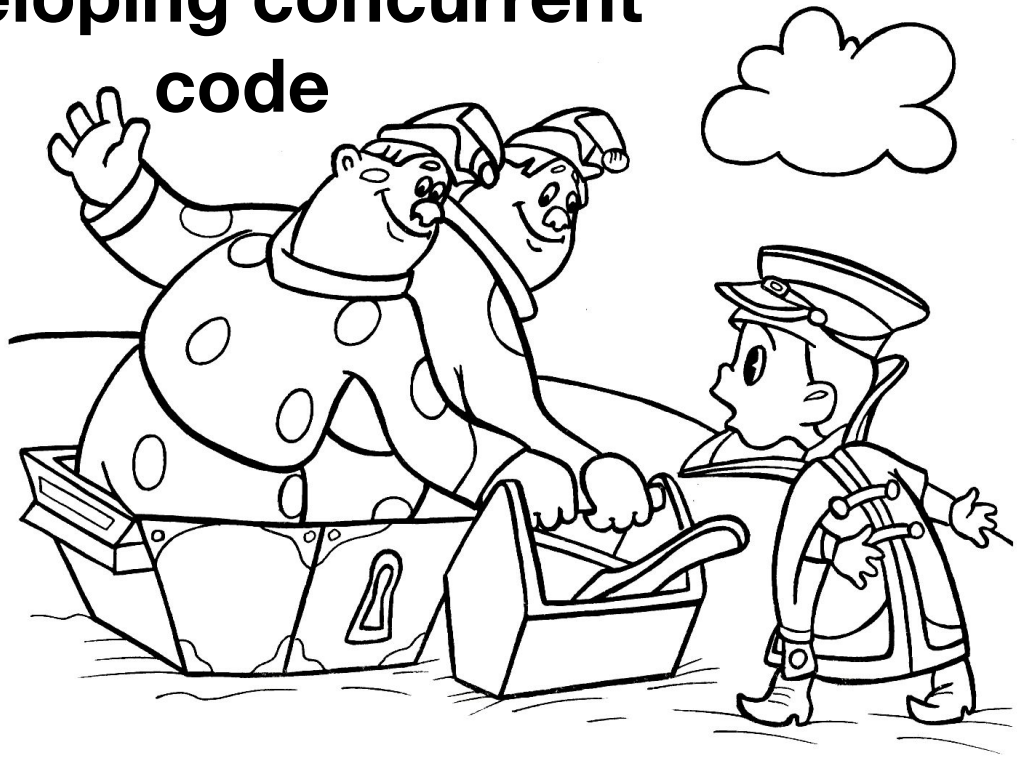
https://ua.linkedin.com/pub/yaroslav-yermilov/58/682/506

work for EPAM Systems since 2011
distributed systems,
Big Data and automated testing

out of office - Groovy

https://motherboard.vice.com/en_us/article/inside-rube-goldberg-machine-youtube-video-artist-joseph-herschers-bedroom-workshop

two guidelines for developing concurrent code



guideline #2 for developing concurrent code

MURPHY'S LAW:

Anything that can go wrong will go wrong.

```
public class Holder {
    private int n;

    public Holder(int n) { this.n = n; }

    public void assertSanity() {
        if (n != n) {
            throw new AssertionError("Even it can go wrong!");
        }
    }
}

public class Initializer {

    public Holder holder;

    public void init() { holder = new Holder(42); }
}
```

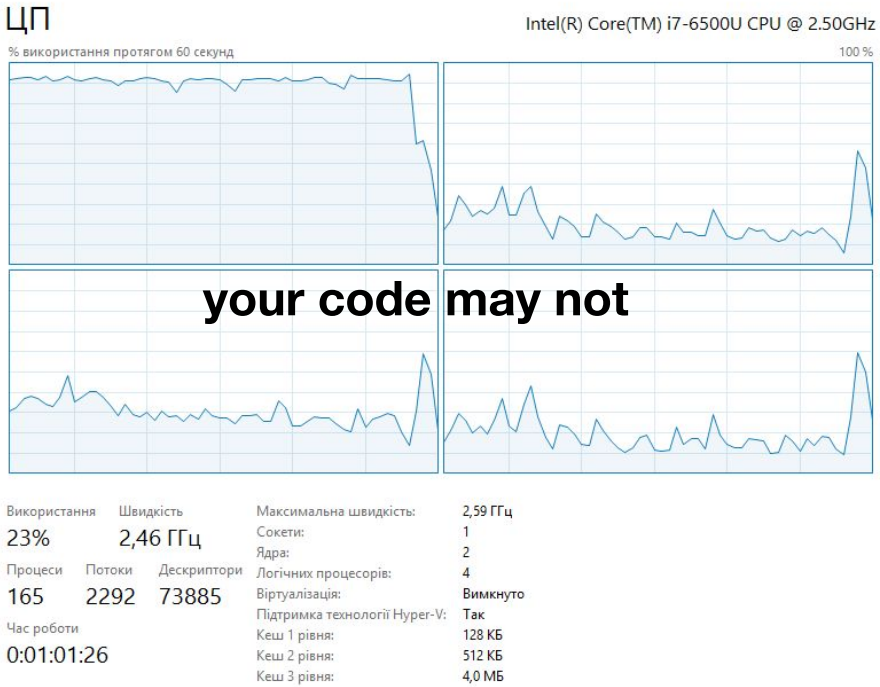
Holder was not properly published!

http://www.systemcomic.com/2009/04/27/the-system-197

guideline #1 for developing concurrent code

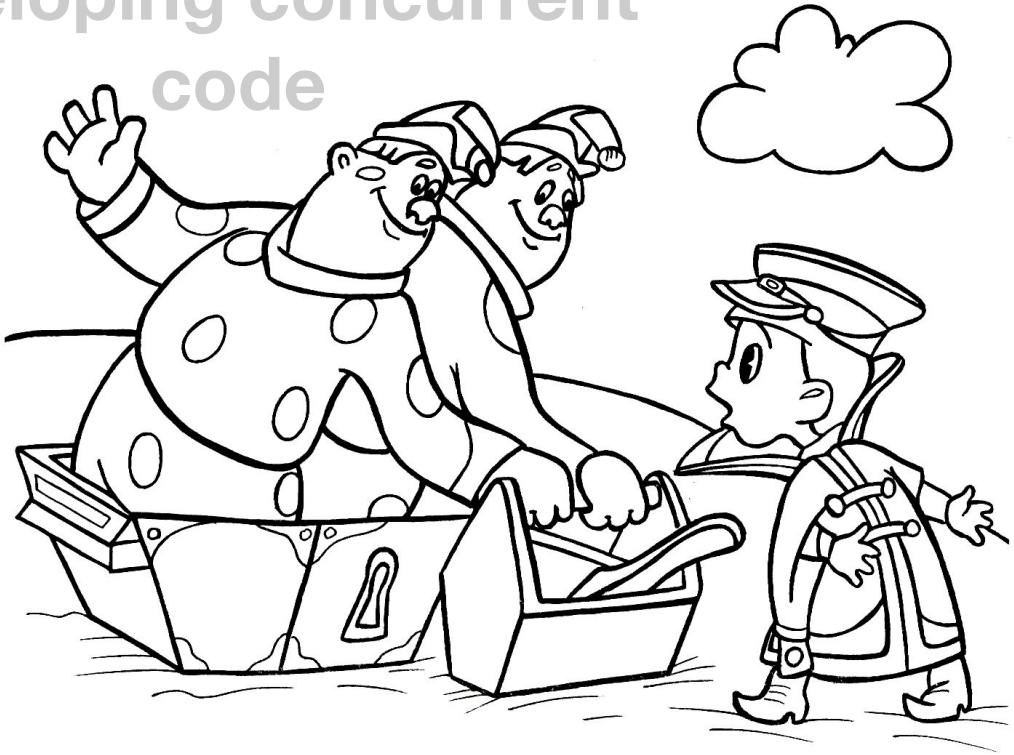
MOORE'S LAW:

Computers will get exponentially faster.



http://www.systemcomic.com/2009/04/27/the-system-197

two guidelines for developing concurrent code



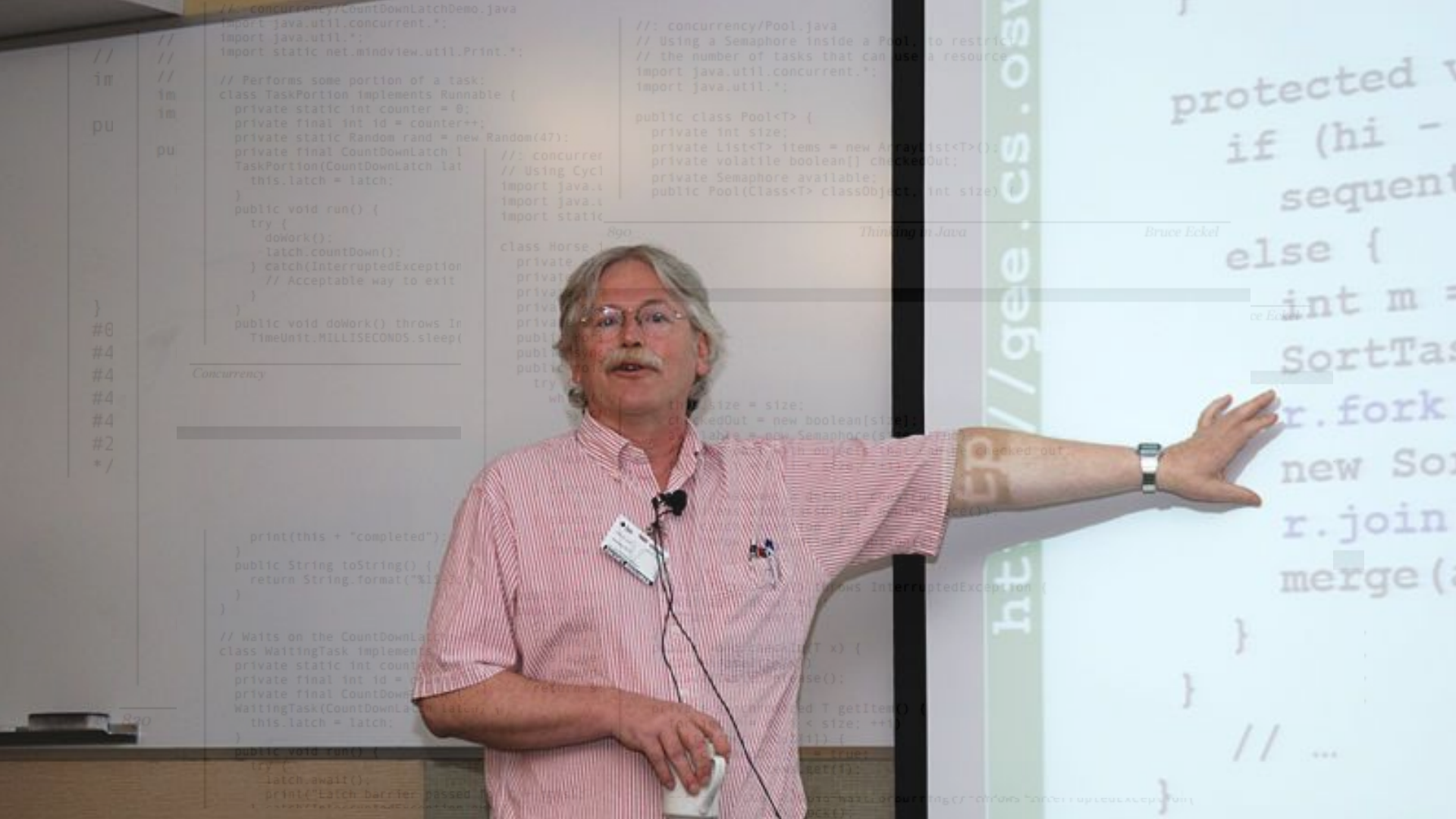
Java toolbox

The **Thread** class

The traditional way to turn a **Runnable** object into a working task is to hand it to a **Thread** constructor. This example shows how to drive a **Liftoff** object using a **Thread:**

```
//: concurrency/BasicThreads.java
// The most basic use of the Thread class.

public class BasicThreads {
  public static void main(String[] args) {
    Thread t = new Thread(new LiftOff());
    t.start();
    System.out.println("Waiting for LiftOff");
  }
} /* Output: (90% match)
Waiting for LiftOff
#0(9), #0(8), #0(7), #0(6), #0(5), #0(4), #0(3), #0(2), #0(1),
#0(Liftoff!),
*///:~
```


Concurrency
Thinking in Java
Bruce Eckel
http://gee.cs.oswego.edu

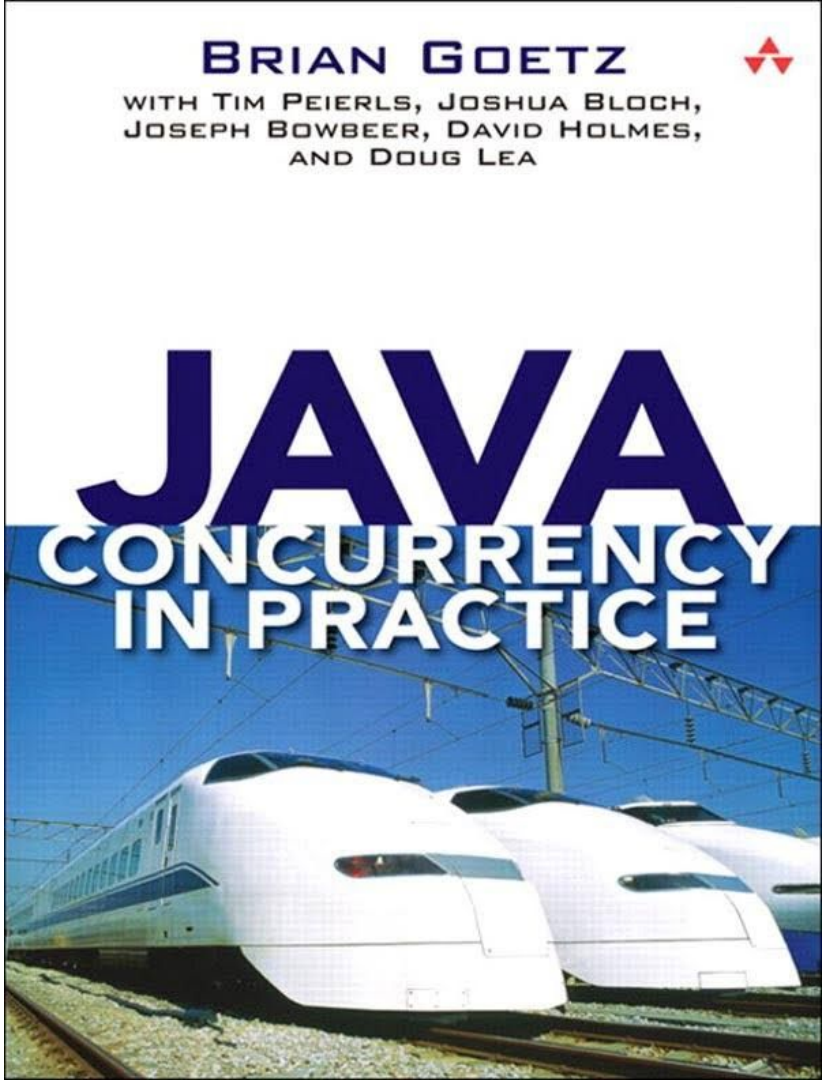
two guidelines for developing concurrent code

developer

Java toolbox

If multiple threads access the same mutable state variable without appropriate synchronization, your program is broken.

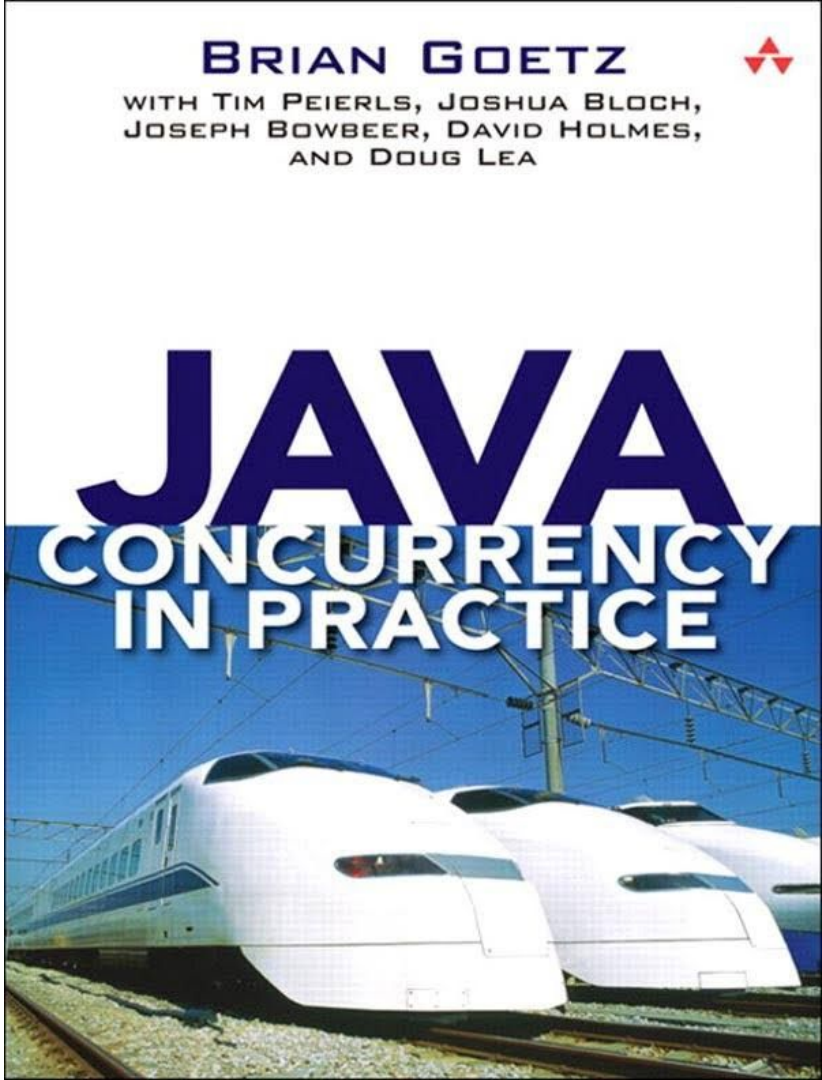
There are three ways to fix it:



If multiple threads access the same mutable state variable without appropriate synchronization, your program is broken.

There are three ways to fix it:

Don’t share the state variable across threads



If multiple threads access **the same mutable state variable** without appropriate synchronization, your program is broken.

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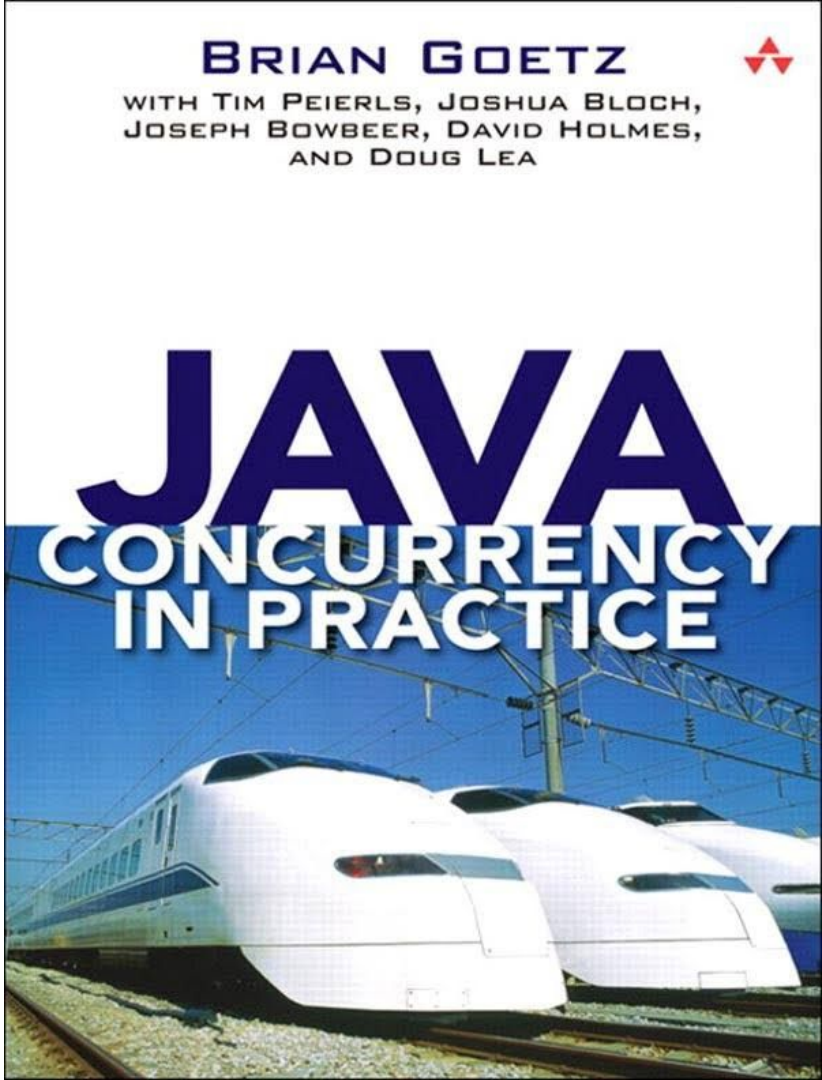
Don’t share the state variable across threads

Make the state variable immutable



If multiple threads access the same mutable state variable **without appropriate synchronization**, your program is broken.

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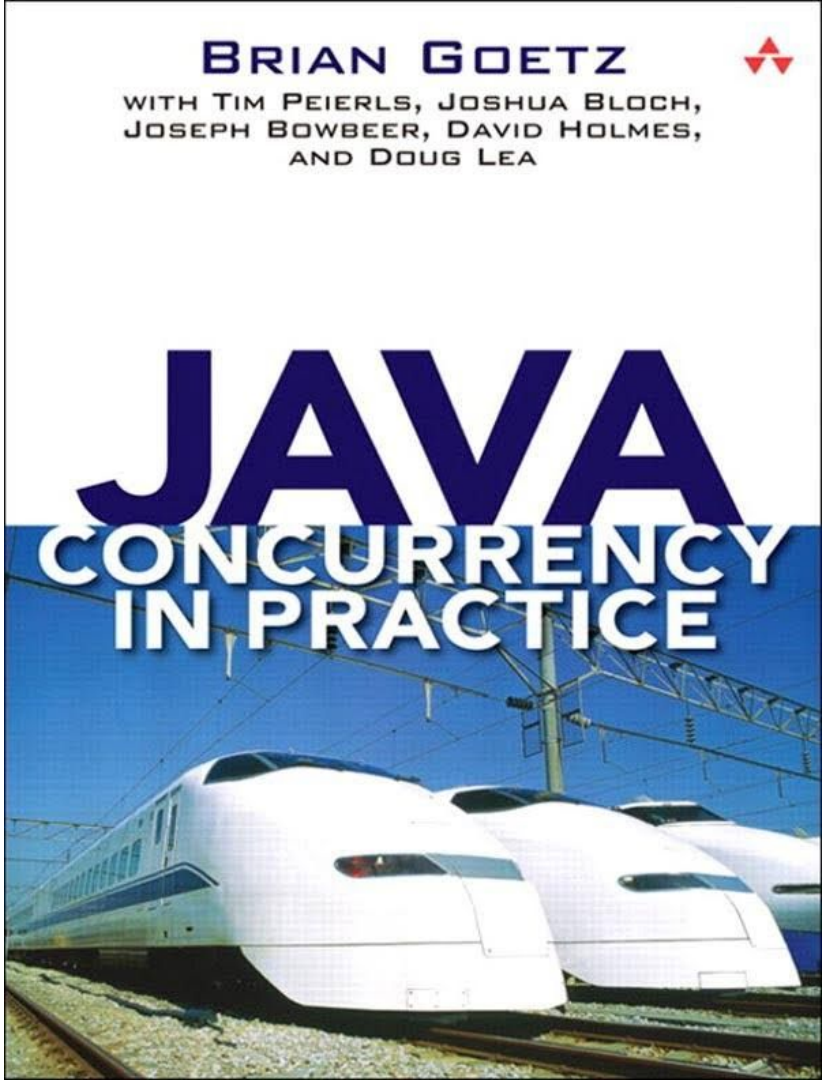
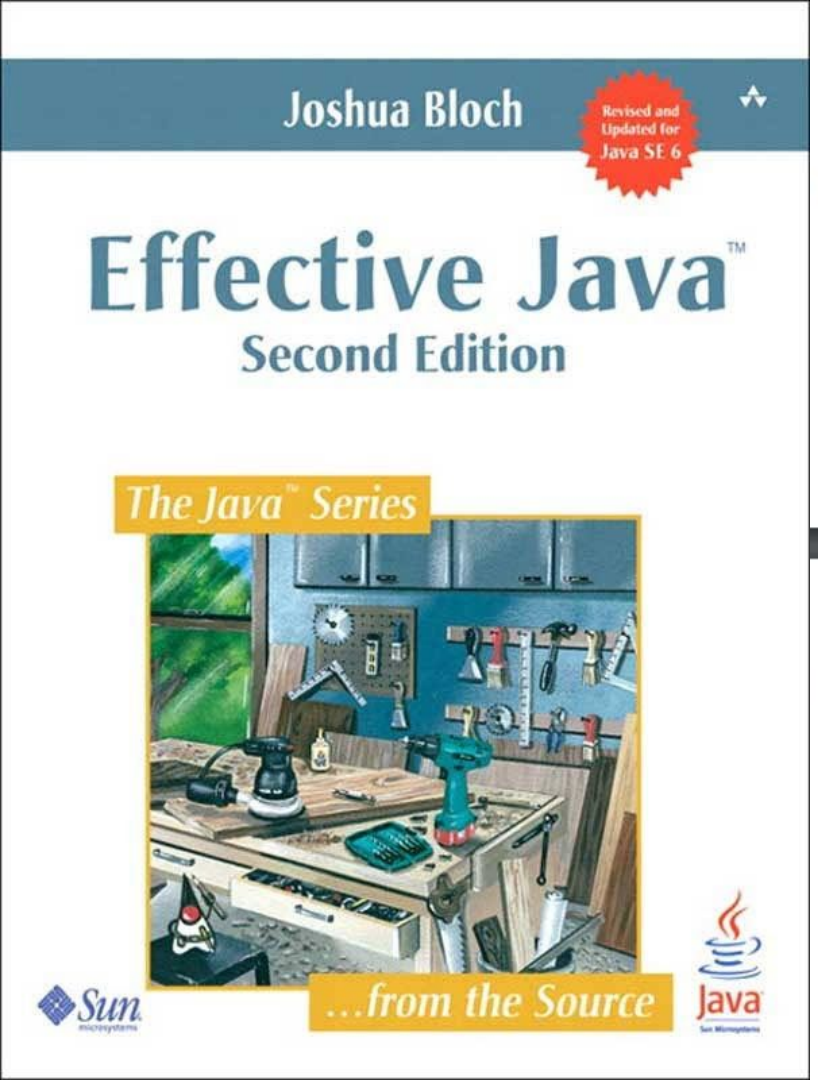
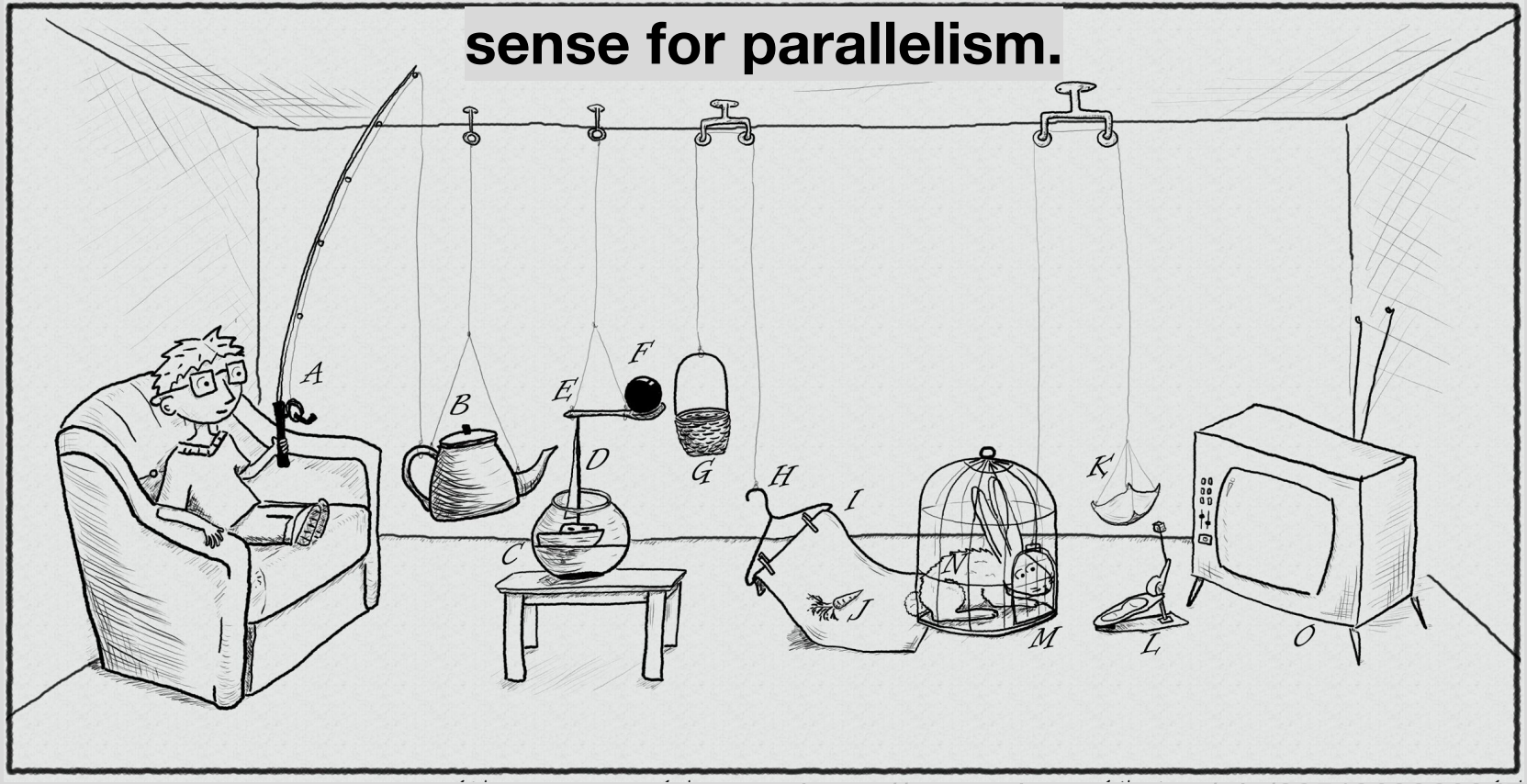
Make the state variable immutable

Use synchronization whenever accessing the state variable





The traditional thread-based concurrency model built into Java doesn't match well with the natural human sense for parallelism.



https://www.pinterest.com/pin/395190936024778319/

```
public class MergeSortTask<T extends Comparable<T>> extends RecursiveTask<List<T>> {
   @Override
   protected List<T> compute() {
       if (list.size() < 2) { return list; }
       if (list.size() == 2) {
           if (list.get(0).compareTo(list.get(1)) != 1) {
               return list;
           } else {
               return asList(list.get(1), list.get(0));
           }
       }

       MergeSortTask<T> leftTask = new MergeSortTask<>(list.subList(0, list.size() / 2));
       MergeSortTask<T> rightTask = new MergeSortTask<>(list.subList(list.size() / 2,
list.size()));

       leftTask.fork(); rightTask.fork();

       List<T> left = leftTask.join();
       List<T> right = rightTask.join();

       return merge(left, right);
   }
```

http://blog.takipi.com/forkjoin-framework-vs-parallel-streams-vs-executorservice-the-ultimate-benchmark/

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   }
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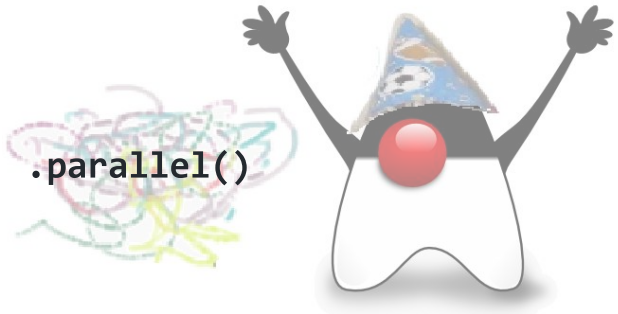
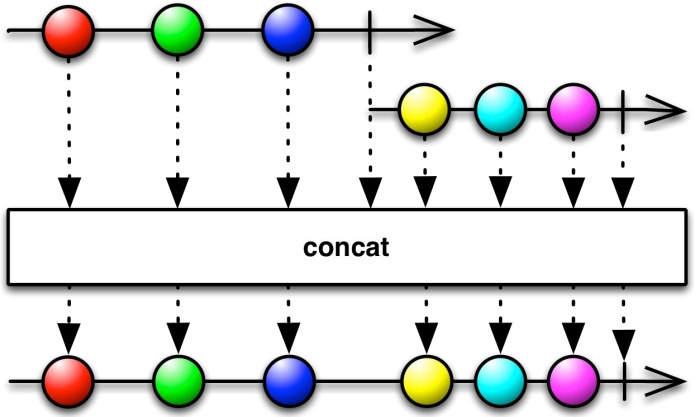
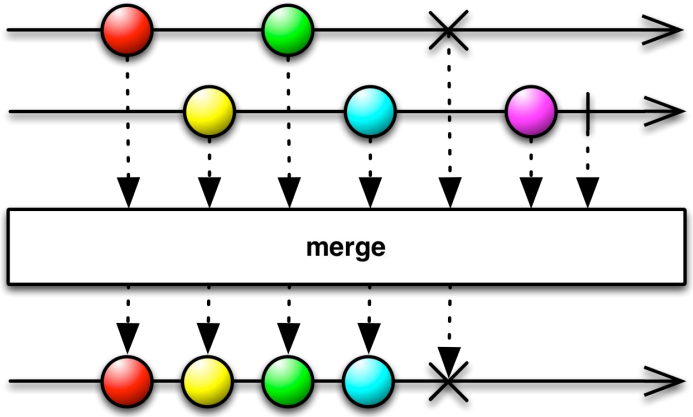
http://blog.takipi.com/forkjoin-framework-vs-parallel-streams-vs-executorservice-the-ultimate-benchmark/

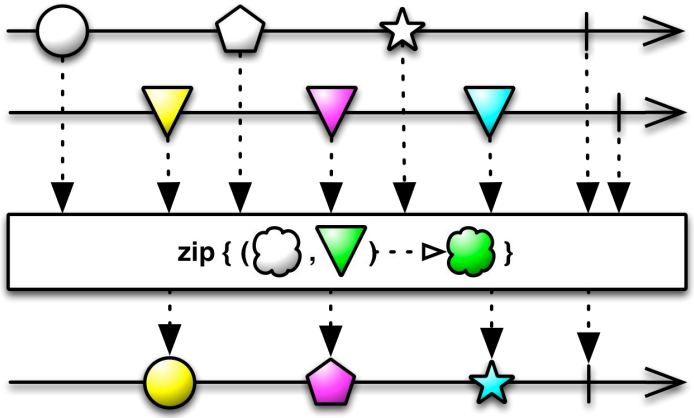
```
Optional<Status> mostPopularTweet = tweets.stream()
```

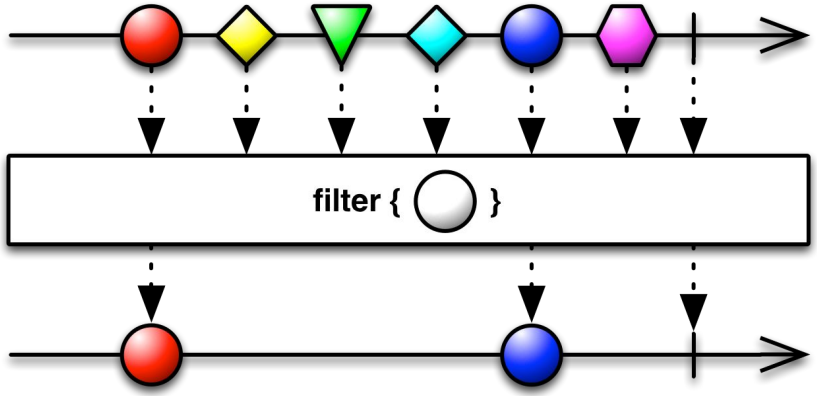


```
        .parallel()
        .filter(tweet -> tweet.getText().toLowerCase().contains(topic.toLowerCase()))
        .filter(tweet -> !tweet.isRetweet())
        .max(comparingInt(tweet -> tweet.getFavoriteCount() + tweet.getRetweetCount()));
```









http://reactivex.io/RxJava/2.x/javadoc/io/reactivex/Flowable.html

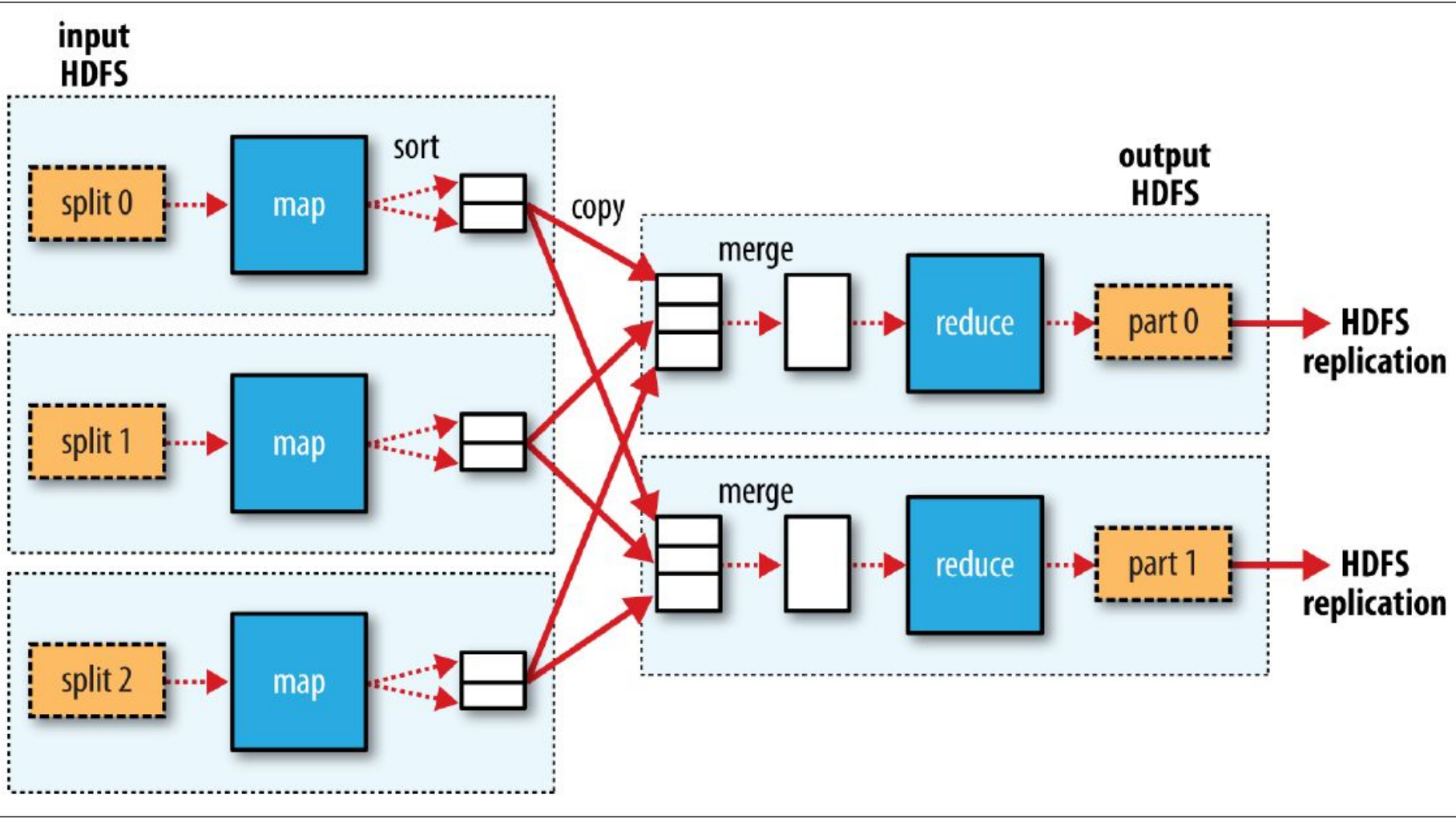
Next you create the resource controller that will serve these greetings.

Create a resource controller

In Spring's approach to building RESTful web services, HTTP requests are handled by a controller. These components are easily identified by the `@RestController` annotation, and the `GreetingController` below handles `GET` requests for `/greeting` by returning a new instance of the `Greeting` class:

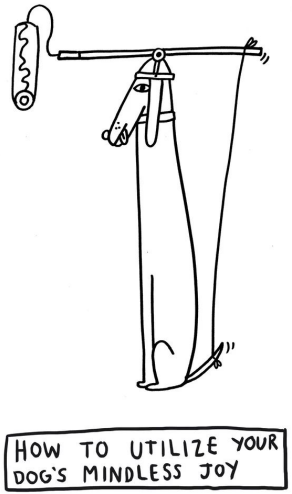
`src/main/java/hello/GreetingController.java`

```
@RestController
public class GreetingController {

  private static final String template = "Hello, %s!";
  private final AtomicLong counter = new AtomicLong();

  @RequestMapping("/greeting")
  public Greeting greeting(@RequestParam(value="name", defaultValue="World") String name) {
      return new Greeting(counter.incrementAndGet(), String.format(template, name));
  }
}
```


input
HDFS
split 0
map
sort
split 1
map
split 2
map
copy
merge
reduce
part 0
output
HDFS
HDFS
replication
merge
reduce
part 1
HDFS
replication


akka

GPars



data parallelism

map/reduce

fork/join

asynchronous execution

actors

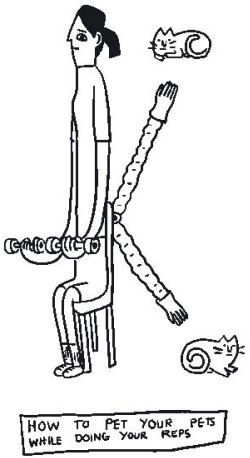
agents

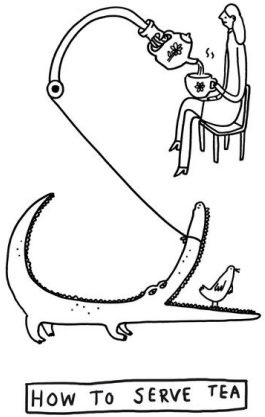
dataflows

remote execution

Communicating Sequential Processes

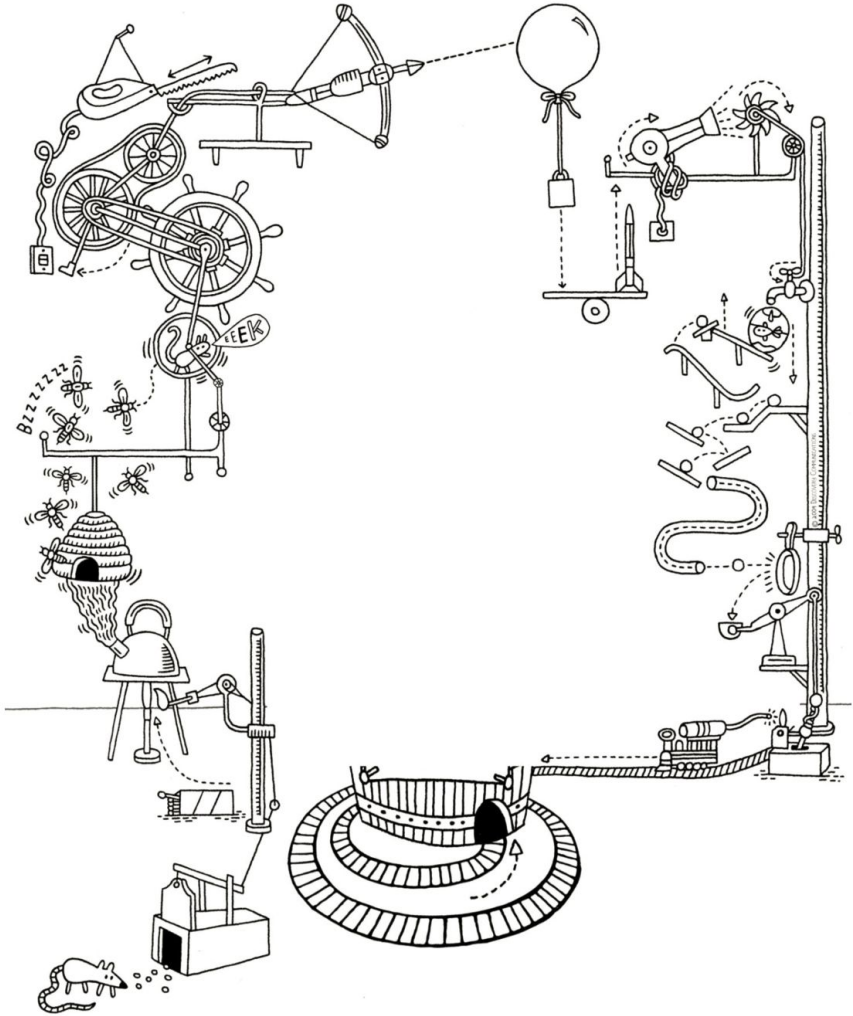
Software Transactional Memory





http://www.theverge.com/2015/4/22/8381963/rube-goldberg-machine-contest-history-ideas

JAVA
OR
GROOVY?



http://forevercuriousmuseum.org/events/rube-goldberg-machine-summer-camp-july-28-29-30-2015/

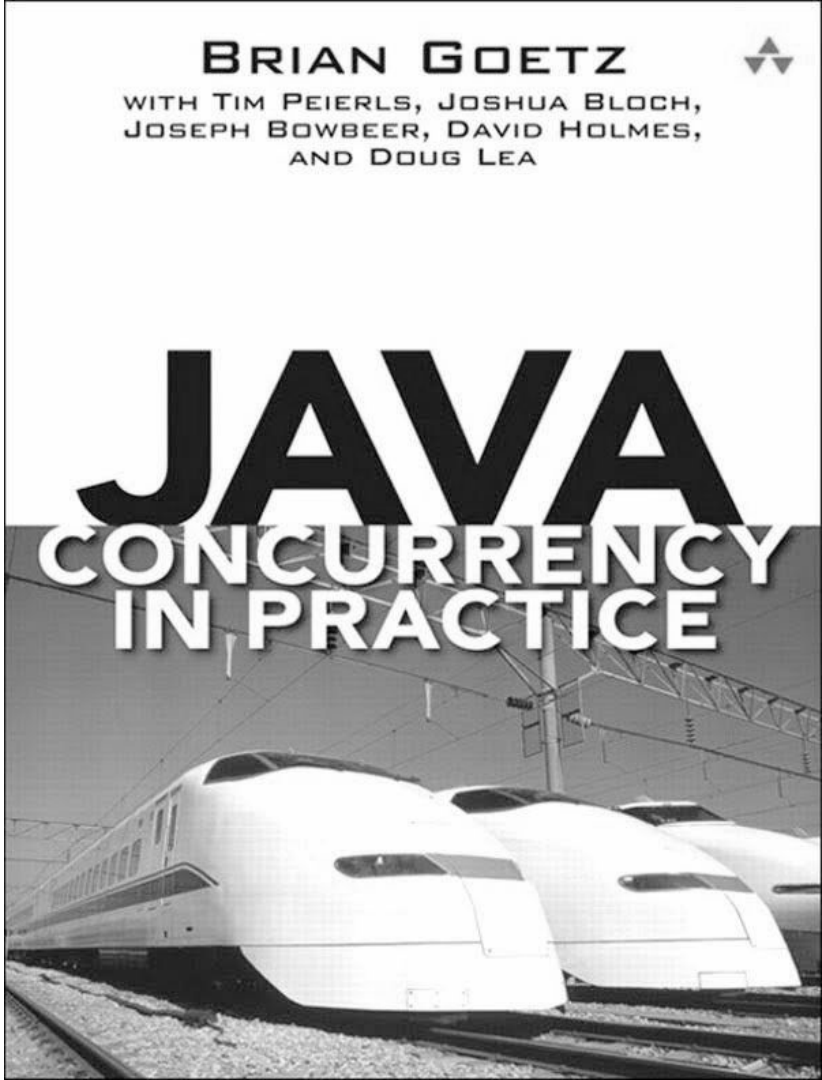
If multiple threads access the same mutable state variable without appropriate synchronization, your program is broken.

There are three ways to fix it:

Don’t share the state variable across threads

Make the state variable immutable

Use synchronization whenever accessing the state variable

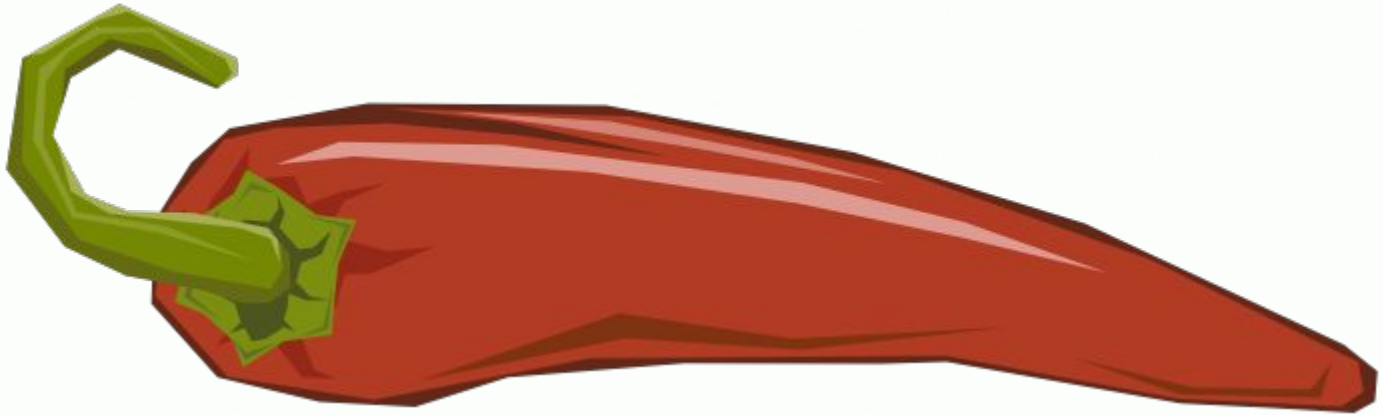


```java
public final class ImmutableJavaPerson {

    private final String name;

    private final Collection<String> tweets;

    public ImmutableJavaPerson(String name, Collection<String> tweets) {
        this.name = name;
        this.tweets = new ArrayList<>(tweets);
    }

    public String getName() {
        return name;
    }

    public Collection<String> getTweets() {
        return unmodifiableCollection(tweets);
    }

    @Override
    public boolean equals(Object o) {
        if (this == o) return true;
        if (o == null || getClass() != o.getClass()) return false;
```

```
    @Override
    public boolean equals(Object o) {
        if (this == o) return true;
        if (o == null || getClass() != o.getClass()) return false;

        ImmutableJavaPerson that = (ImmutableJavaPerson) o;

        if (name != null ? !name.equals(that.name) : that.name != null) return false;
        return tweets != null ? tweets.equals(that.tweets) : that.tweets == null;
    }

    @Override
    public int hashCode() {
        int result = name != null ? name.hashCode() : 0;
        result = 31 * result + (tweets != null ? tweets.hashCode() : 0);
        return result;
    }
}
```

```groovy
@Immutable class ImmutableGroovyPerson {

   String name
   Collection<String> tweets
}
```

```groovy
@Immutable class ImmutableGroovyPerson {

   String name
   Collection<String> tweets
}
```



```
class SynchronizedCounter {

    int atomicCounter
    int counter

    @Synchronized
    int incrementAndGet() {
        atomicCounter = atomicCounter + 1
        return atomicCounter
    }

    @WithReadLock
    int value() {
        counter
    }

    @WithWriteLock
    void increment() {
        counter = counter + 1
    }
}
```

```
def thread1 = Thread.start {
   println "Hello from ${Thread.currentThread().name}"
}


def thread2 = Thread.startDaemon {
   println "Hello from ${Thread.currentThread().name}"
}


[ thread1, thread2 ]*.join()
```

```
def process = (['git', 'status']).execute([], new File('.'))
def processOutput = new StringWriter()
process.consumeProcessOutput processOutput, processOutput
process.waitFor()
println processOutput.toString().trim()
```

```
def config = new CompilerConfiguration()
config.addCompilationCustomizers(new ASTTransformationCustomizer(ThreadInterrupt))
def binding = new Binding(i:0)
def shell = new GroovyShell(binding,config)
def t = Thread.start {
   shell.evaluate(userCode)
}
t.join(1000)
if (t.alive) {
   t.interrupt()
}
```

```
@TimedInterrupt(value=1, unit=TimeUnit.SECONDS)
class FibCalculator {

   def fib(int n) {
       n < 2 ? n : fib(n - 1) + fib(n - 2)
   }
}
```

```
@ConditionalInterrupt({ Quotas.disallow('user') })
class UserService {

   void longRunningRequest() { ... }
}
```

```
"Hello from ${Thread.currentThread().name}"
```

```
'''Multi-line
strings'''
```

```
def numbers = [ 1, 2, 3 ]
def colors = [ red: '#ff0000', green: '#00ff00', blue: '#0000ff' ]
```

```
carNames = car*.name
```

```
Clousure sum = { a, b -> a + b }
Clouse increment = sum.curry(1)
```

```
name = user?.name
displayName = user.name ?: 'unknown'
```

```
assert new String('text') == new String('text')
assert (2 <=> 5) == -1
```

```
Object str1 = 'text'
def str2 = str1
assert str1.length() == str2.length()
```

```
def sneakyThrow() { throw new IOException("i don't care") }
```

```
@IgnoreIf({ os.linux || jdk.version == 8 })
```

```groovy
def rows = Sql.newInstance(url, user, password, driver).rows "SELECT * FROM table"
```

```groovy
(0..<5).collect { it % 2 == 0 }
println list.find { it > 7 }
if (4 in nums) println 'yes'
println persons.max({ person -> person.age })
5.times { println 'hello!' }
println list[0..2]
```

```groovy
def json = new JsonSlurper().parseText(jsonText)
json.clients[3].location.country.code
```

```groovy
def xml = new XmlSlurper().parseText(xmlText)
xml.clients[3].location.country.@code
xmlBuilder.root(attribute: 28) {
 elem1('hello')
 elem2('xml')
}
```

```groovy
new File('poem.txt').eachLine { line ->
  println line
}
```

```groovy
def increment(int number, int delta = 0) { ... }
def connectJdbc(Map params) { ... }
connectJdbc(url: 'jdbc://', driver: 'generic', username: 'admin', password: 'admin')
```

```
@Grab(group='org.springframework', module='spring-orm', version='4.3.8.RELEASE')
import org.springframework.jdbc.core.JdbcTemplate
```

```
@TypeChecked
@CompileStatic
```

```
class MetaProgramming {
 def methodMissing(String methodName, def methodArgs) { ... }
}
Number.metaClass.doubleIt = { -> delegate * 2 }
ReturnStatement returnStatement = macro { return "42" }
```

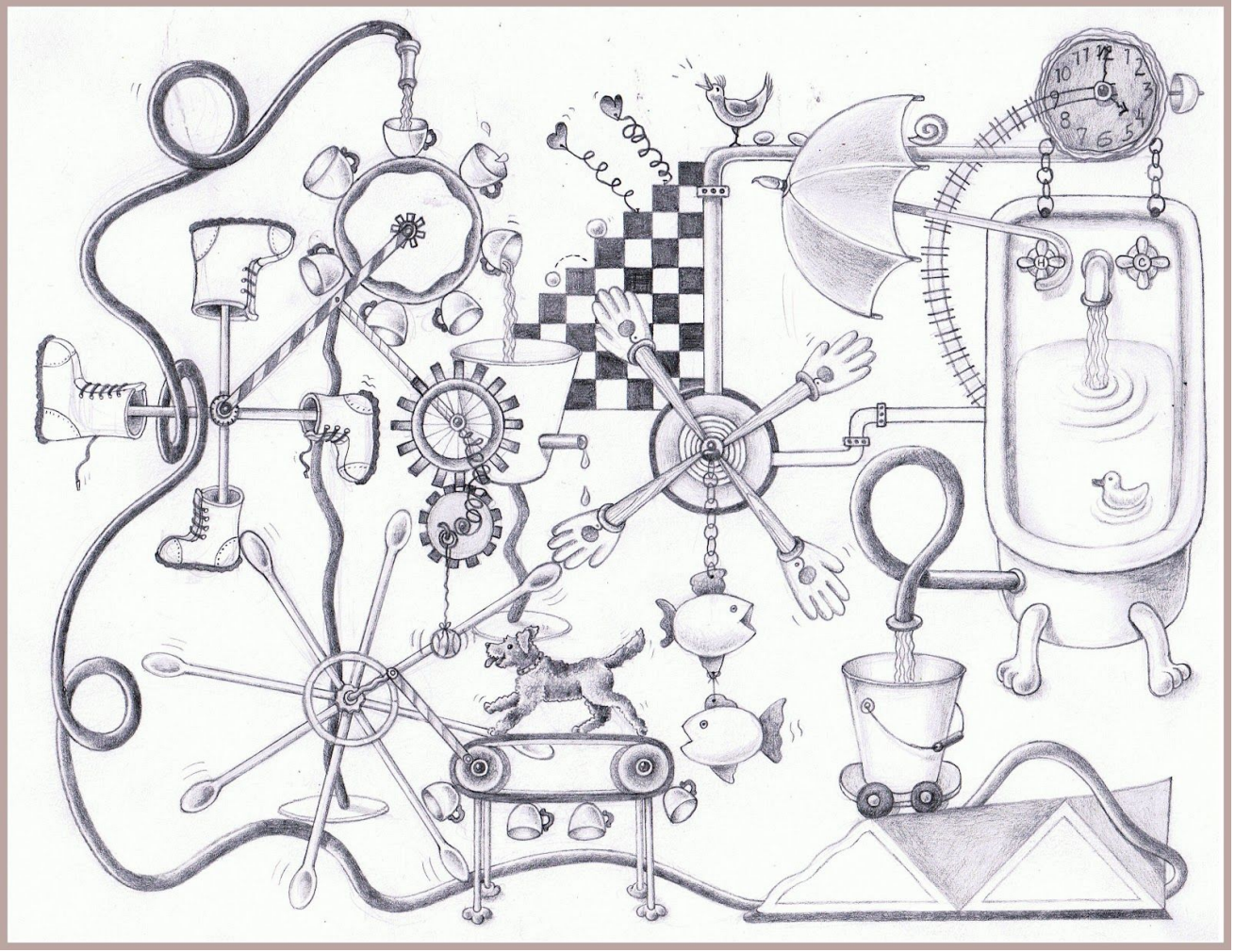
```
@Canonical
@InheritConstructors
@Lazy
@Sortable
@Builder
@Delegate
@Memoized
@Singleton
@Log
```

```
class MyNumber {
 MyNumber plus(MyNumber other) { ... }
}
```

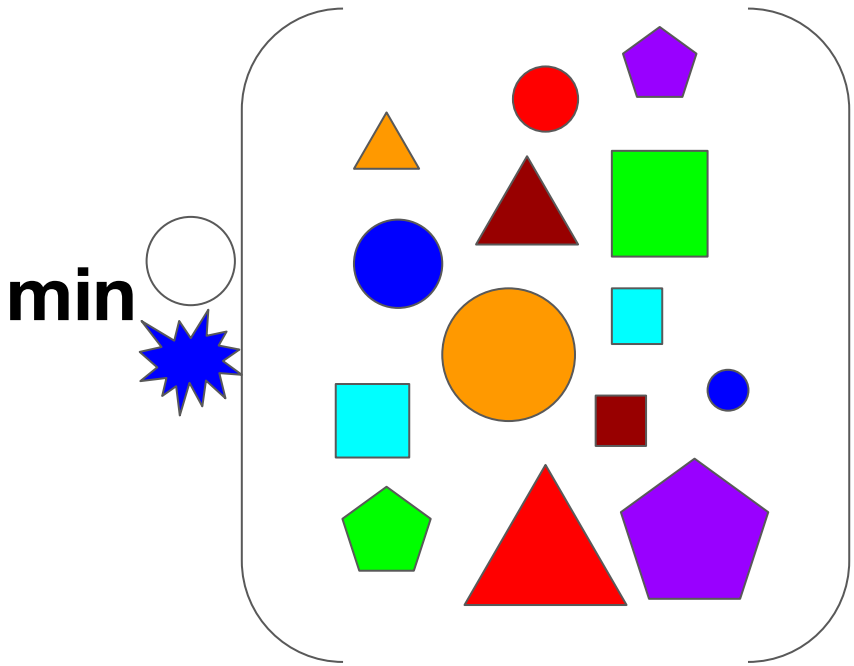
```
trait DatabaseTest { ... }
```

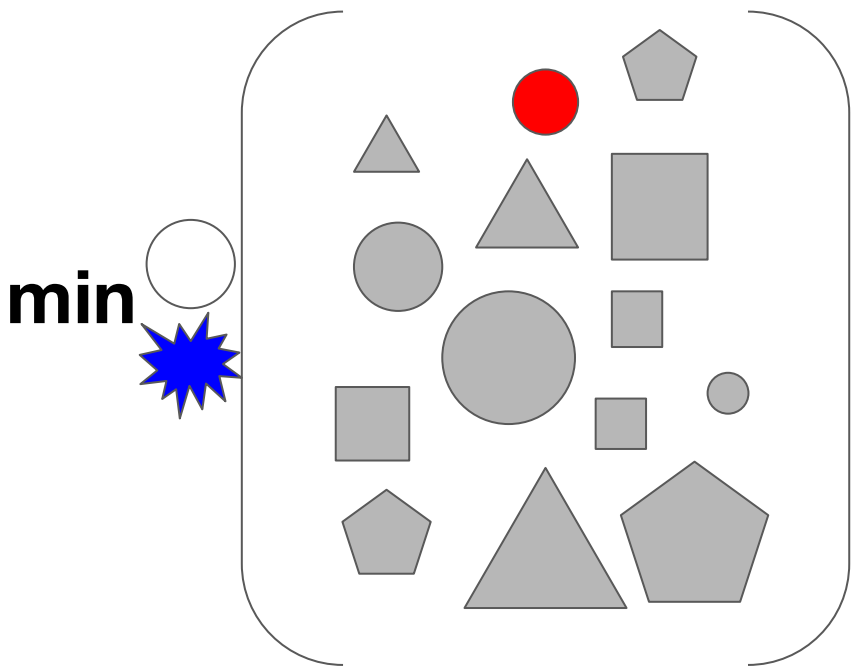
```
please show the square_root of 100
```

```
new GroovyShell(variables).evaluate 'println persons.sort { person -> person.name }'
```



https://www.pinterest.com/pin/527554543837493577/


min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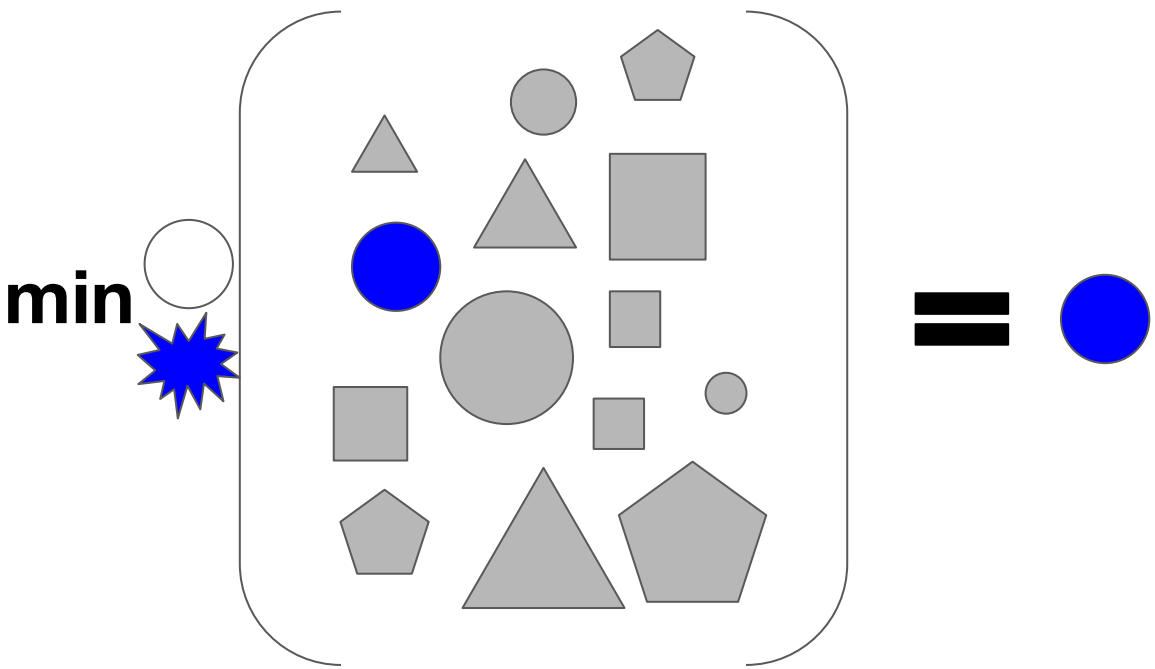
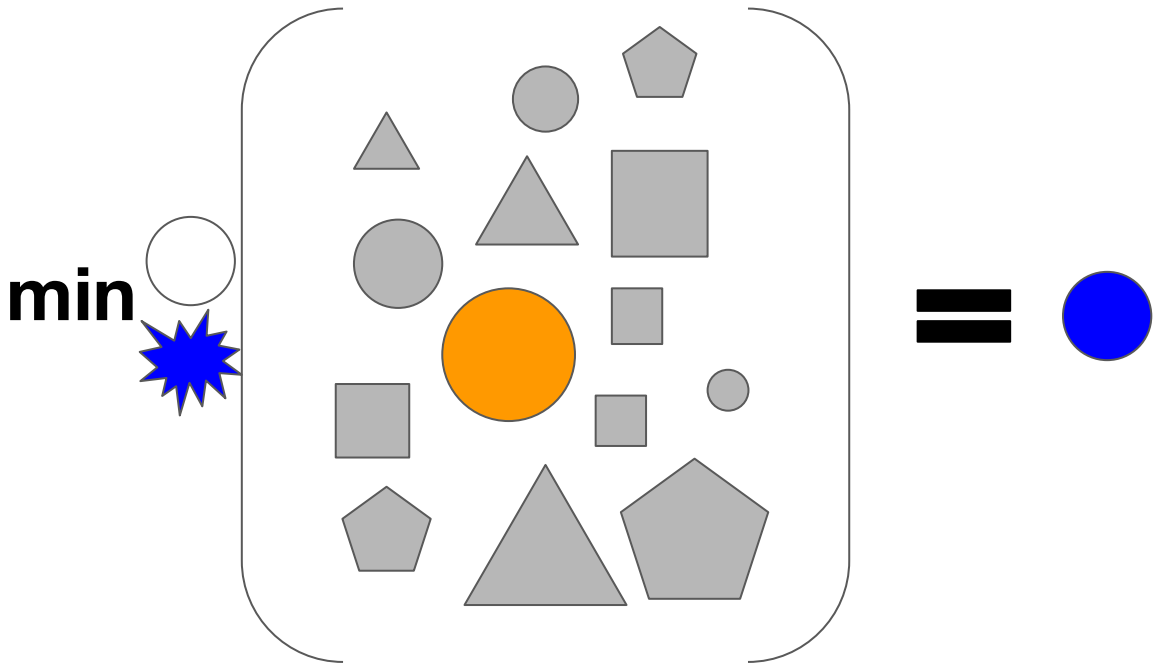
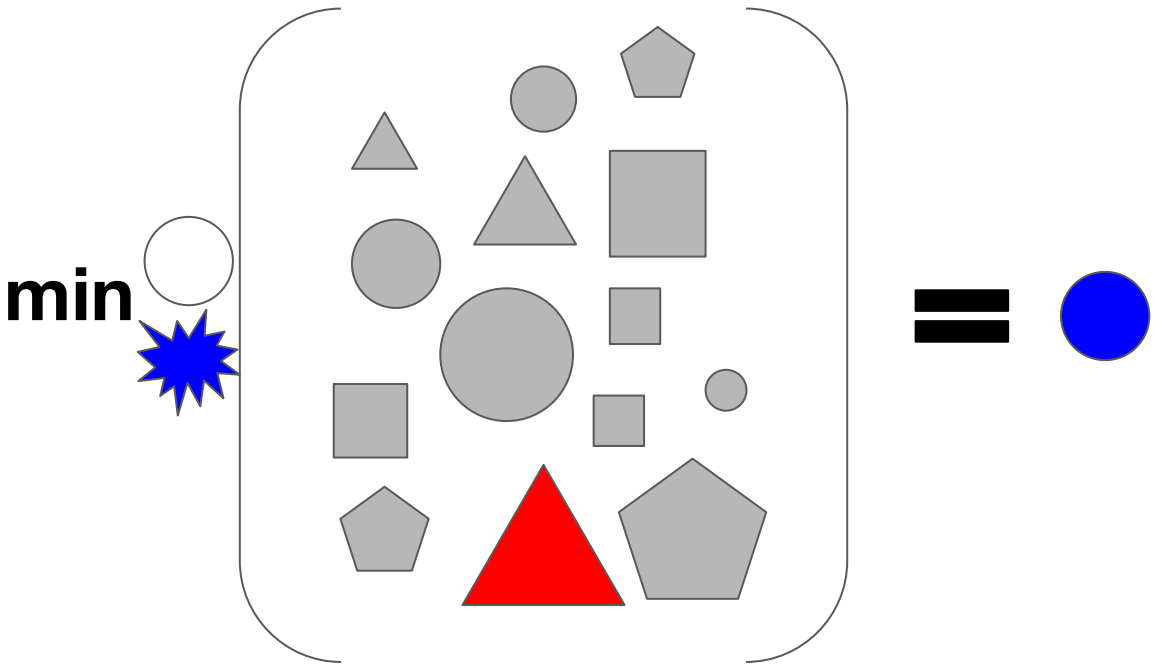
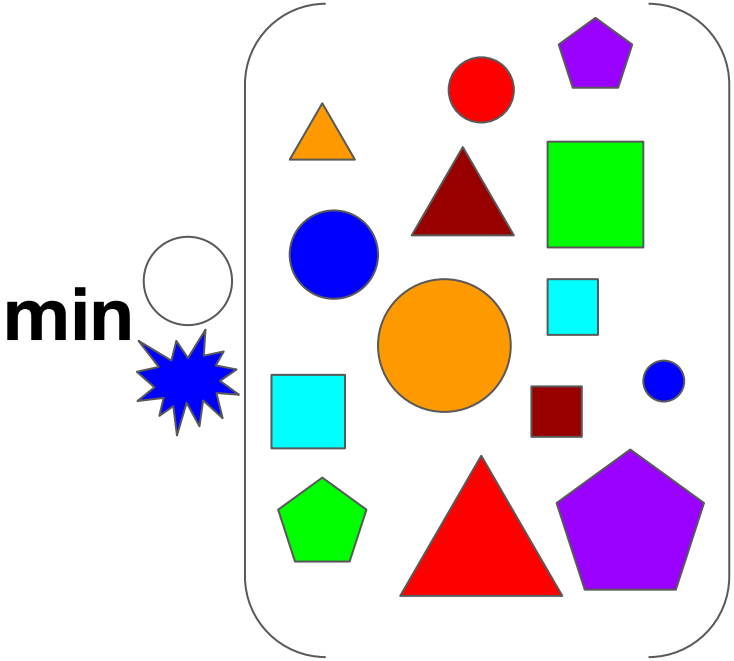
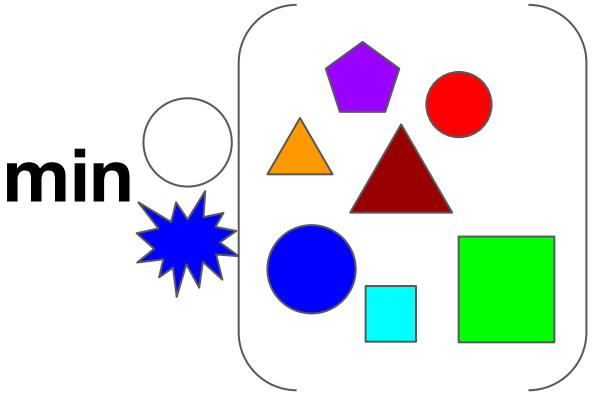
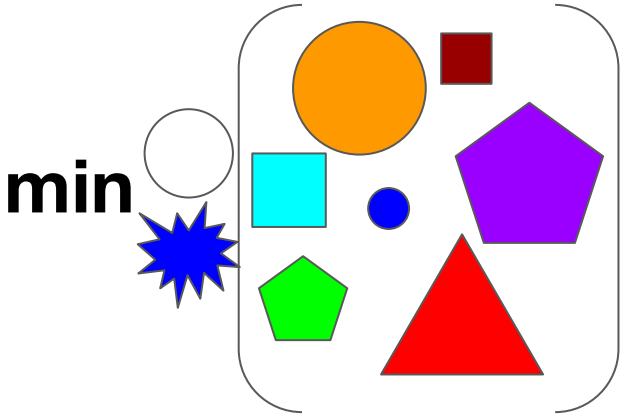

min

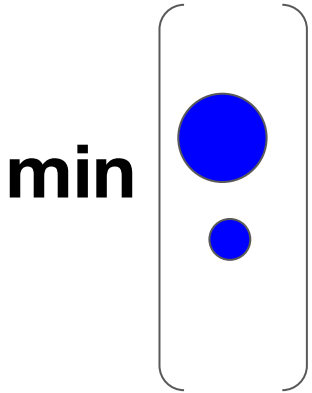

min


min

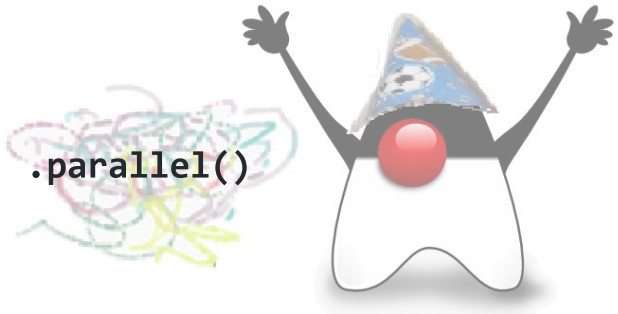

min


min


min


min

```
Optional<Status> mostPopularTweet = tweets.stream()
```



```
        .parallel()
        .filter(tweet -> tweet.getText().toLowerCase().contains(topic.toLowerCase()))
        .filter(tweet -> !tweet.isRetweet())
        .max(comparingInt(tweet -> tweet.getFavoriteCount() + tweet.getRetweetCount()));
```

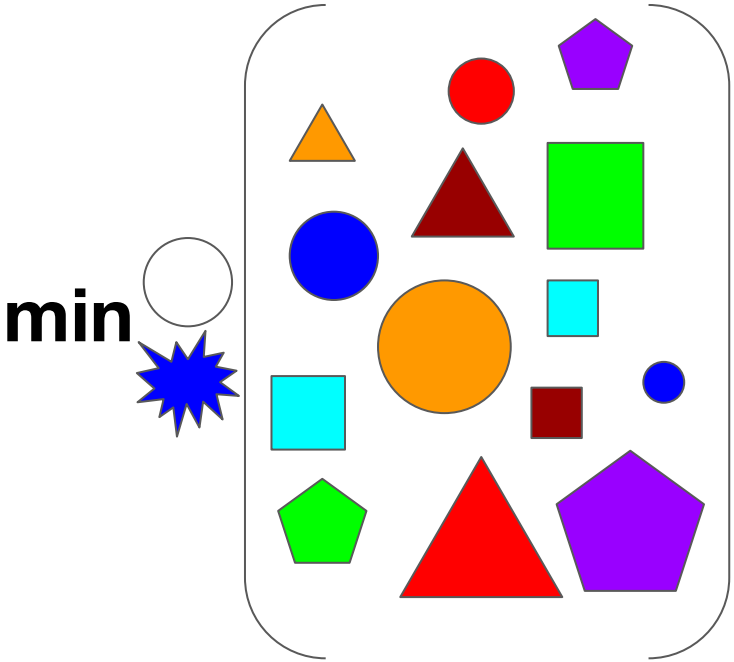
```
shapes.stream()
```

```
Optional<Shape> minBlueCircle = shapes.stream()

                .filter(shape -> shape.getType() == CIRCLE)
```

```
Optional<Shape> minBlueCircle = shapes.stream()

                .filter(shape -> shape.getType() == CIRCLE)
                .filter(shape -> shape.getColor() == BLUE)
```

```
Optional<Shape> minBlueCircle = shapes.stream()

                    .filter(shape -> shape.getType() == CIRCLE)
                    .filter(shape -> shape.getColor() == BLUE)
                    .min(comparingInt(shape -> shape.getSize()));
```

```
Optional<Shape> minBlueCircle = shapes.stream()
                    .parallel()
                    .filter(shape -> shape.getType() == CIRCLE)
                    .filter(shape -> shape.getColor() == BLUE)
                    .min(comparingInt(shape -> shape.getSize()));
```




```
.filter(shape -> shape.getType() == CIRCLE)
.filter(shape -> shape.getColor() == BLUE)
.min(comparingInt(shape -> shape.getSize()));
```

shapes

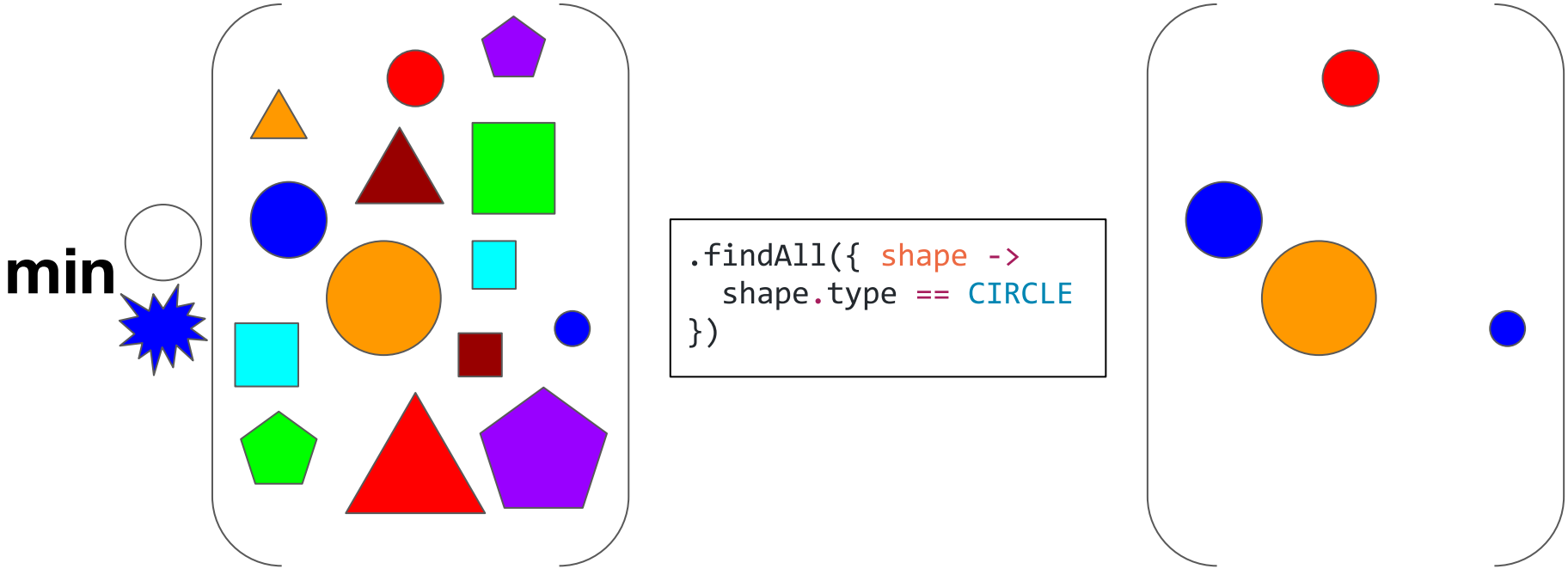
```
Shape minBlueCircle = shapes
        .findAll({ shape -> shape.type == CIRCLE })
```

```
Shape minBlueCircle = shapes
        .findAll({ shape -> shape.type == CIRCLE })
        .findAll({ shape -> shape.color == BLUE })
```

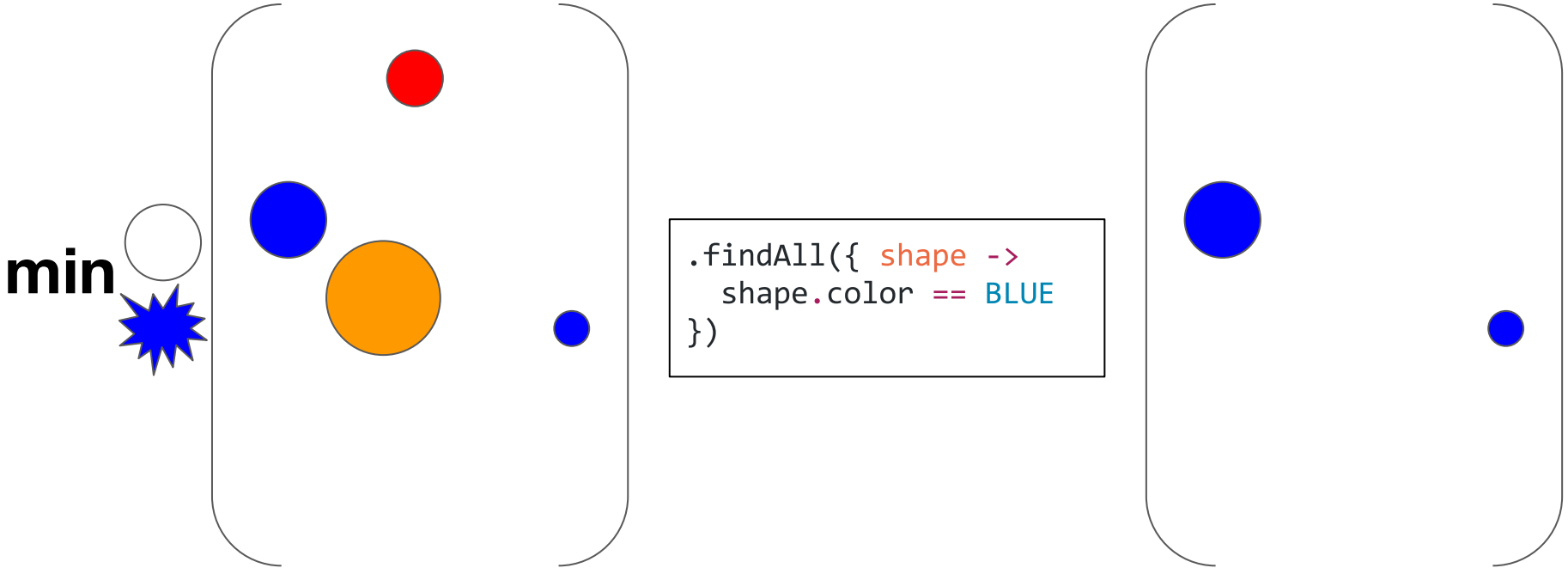
```
Shape minBlueCircle = shapes
        .findAll({ shape -> shape.type == CIRCLE })
        .findAll({ shape -> shape.color == BLUE })
        .min({ shape -> shape.size })
```

```
ParallelEnhancer.enhanceInstance shapes
Shape minBlueCircle = shapes
       .findAllParallel({ shape -> shape.type == CIRCLE })
       .findAllParallel({ shape -> shape.color == BLUE })
       .minParallel({ shape -> shape.size })
```

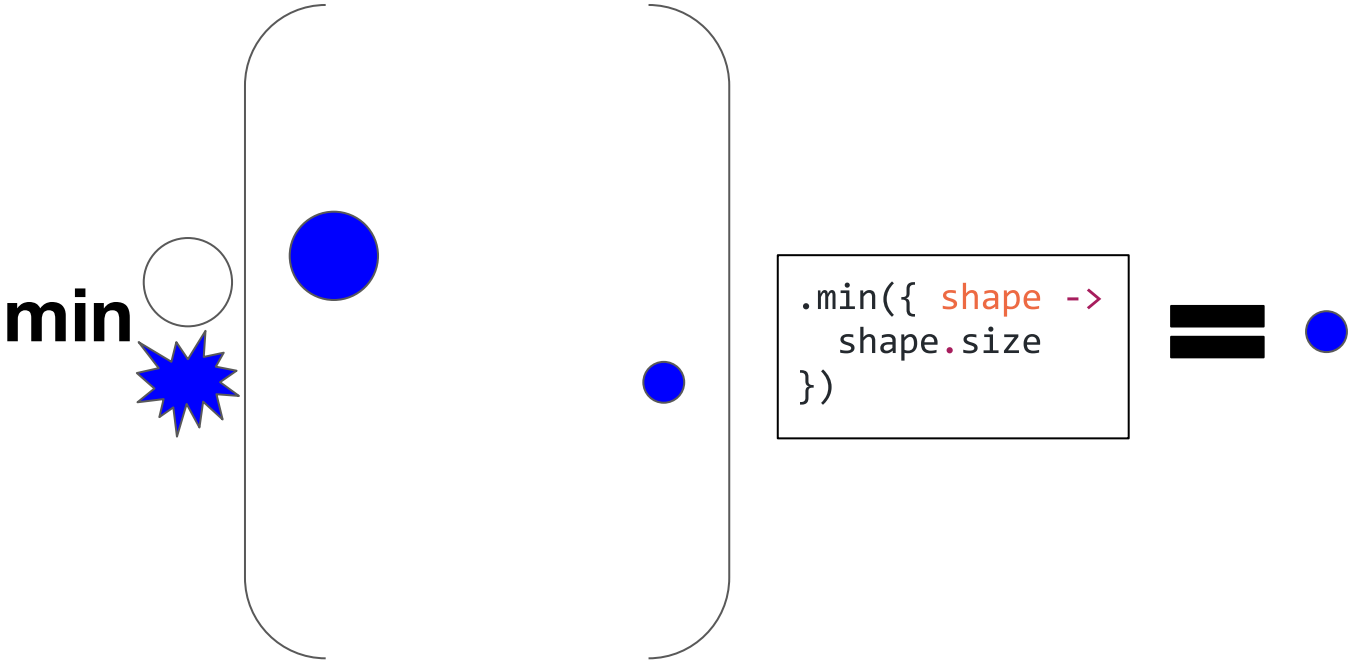
```
ParallelEnhancer.enhanceInstance shapes
shapes.makeConcurrent()
Shape minBlueCircle = shapes
        .findAll({ shape -> shape.type == CIRCLE })
        .findAll({ shape -> shape.color == BLUE })
        .min({ shape -> shape.size })
```



```
ParallelEnhancer.enhanceInstance shapes
shapes.makeConcurrent()
Shape minBlueCircle = shapes
        .findAll({ shape -> shape.type == CIRCLE })
        .findAll({ shape -> shape.color == BLUE })
        .min({ shape -> shape.size })
```

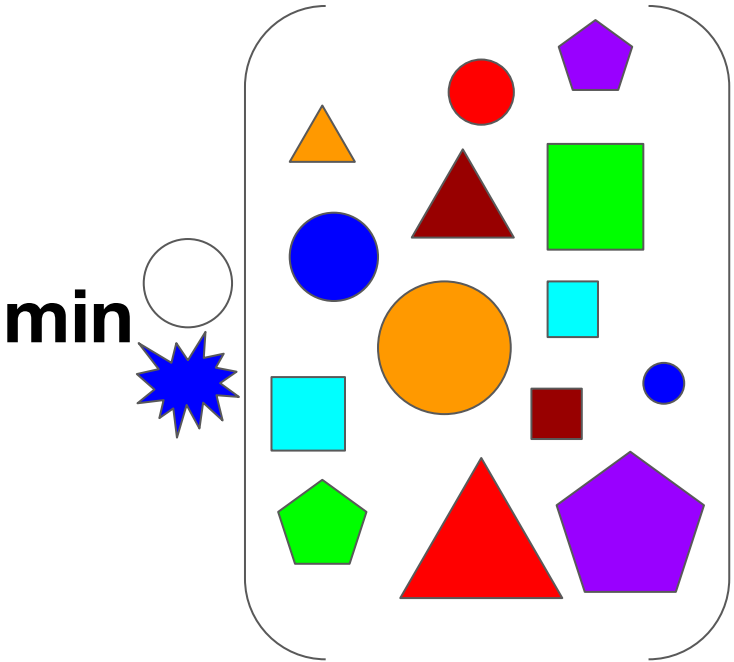


```
ParallelEnhancer.enhanceInstance shapes
shapes.makeConcurrent()
Shape minBlueCircle = shapes
        .findAll({ shape -> shape.type == CIRCLE })
        .findAll({ shape -> shape.color == BLUE })
        .min({ shape -> shape.size })
```



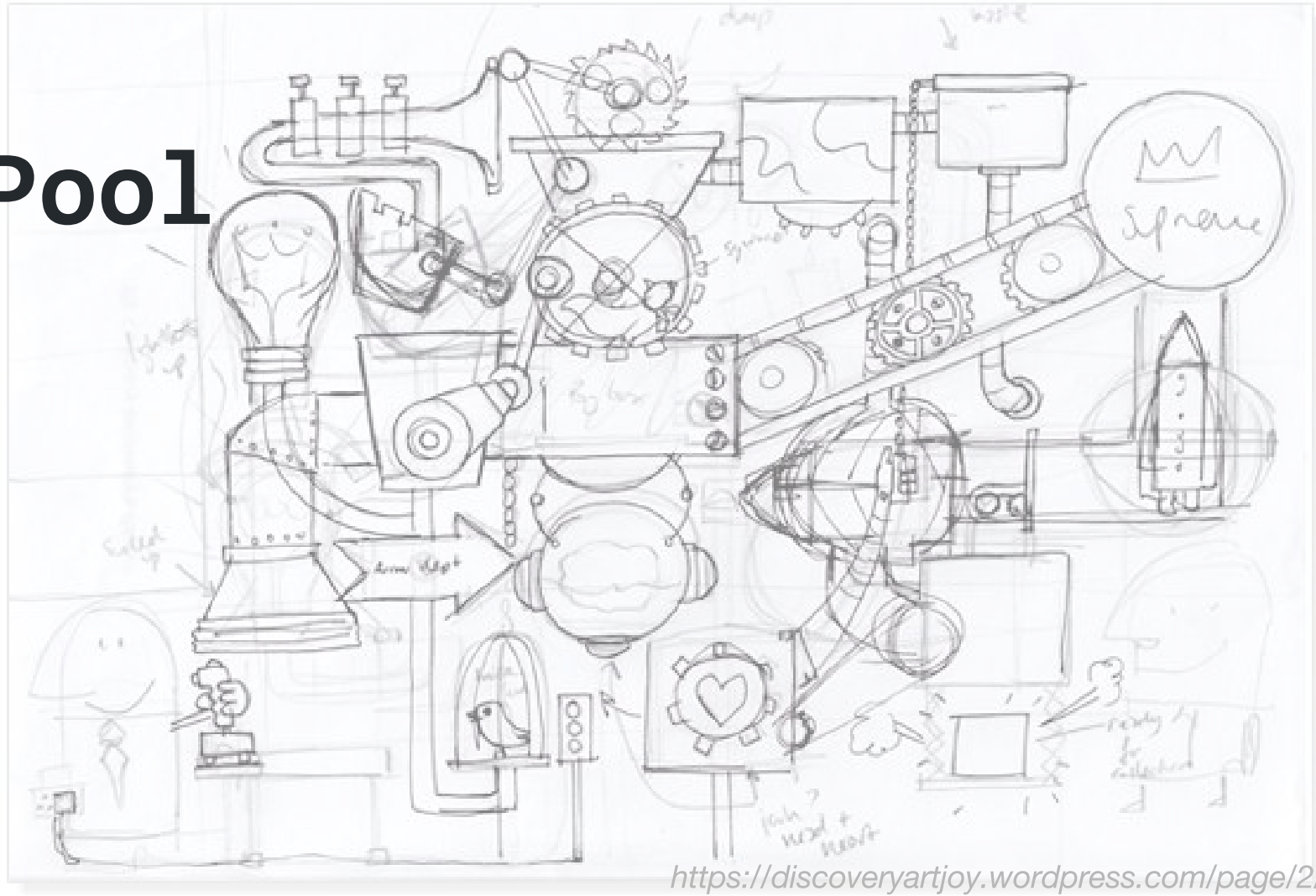
```
Shape minBlueCircle = shapes
        .findAll({ shape -> shape.type == CIRCLE })
        .findAll({ shape -> shape.color == BLUE })
        .min({ shape -> shape.size })
```

```
withPool {
    Shape minBlueCircle = shapes.parallel
            .filter({ shape -> shape.type == CIRCLE })
            .filter({ shape -> shape.color == BLUE })
            .min({ shape -> shape.size })
}
```




```
.filter({ shape -> shape.type == CIRCLE })
.filter({ shape -> shape.color == BLUE })
.min({ shape -> shape.size })
```

withPool



https://discoveryartjoy.wordpress.com/page/2/

```
withPool {




}
```

```
GParsPool.withPool {









}
```

```
GParsPool.withPool { ForkJoinPool pool ->









}
```

```
GParsPool.withExistingPool(pool) {




}
```

```
GParsExecutorsPool.withPool { ExecutorService executor ->




}
```

```
GParsPool.withPool { ForkJoinPool pool ->









}
```

```
GParsPool.withPool(numberOfThreads, exceptionHandler) { ForkJoinPool pool ->
```

```
    Runtime.getRuntime().availableProcessors() + 1
```

```
}
```

```
withPool {
        Shape minBlueCircle = shapes
                .findAllParallel({ shape -> shape.type == CIRCLE })
                .findAllParallel({ shape -> shape.color == BLUE })
                .minParallel({ shape -> shape.size })


        shapes.makeConcurrent()
        Shape minBlueCircle = shapes
                .findAll({ shape -> shape.type == CIRCLE })
                .findAll({ shape -> shape.color == BLUE })
                .min({ shape -> shape.size })


        Shape minBlueCircle = shapes.parallel
                .filter({ shape -> shape.type == CIRCLE })
                .filter({ shape -> shape.color == BLUE })
                .min({ shape -> shape.size })
}
```

```
withPool {




}
```

```
withPool {

    List latestTweets = twitter.fetchLatestTweets()

    println 'Done:'
    println latestTweets









}
```

```
withPool {

    Future latestTweets = executeAsync({ twitter.fetchLatestTweets() })

    println 'Loading...'
    println latestTweets.get()









}
```

```
withPool {

    Future latestTweets = twitter.&fetchLatestTweets.callAsync()

    println 'Loading...'
    println latestTweets.get()









}
```

```
withPool {

    Closure fetchLatestTweetsAsync = twitter.&fetchLatestTweets.async()
    Future latestTweets = fetchLatestTweetsAsync()

    println 'Loading...'
    println latestTweets.get()









}
```

```
withPool {

    Closure fetchLatestTweetsAsync = twitter.&fetchLatestTweets.async()
    Future latestTweets = fetchLatestTweetsAsync()

    Closure extractKeywordsAsync = keywords.&extractKeywords.async()

    println 'Loading tweets...'
    Future keywords = extractKeywordsAsync(latestTweets.get())

    println 'Extracting keywords...'
    println keywords.get()




}
```

```
withPool {

    Closure fetchLatestTweetsAsync = twitter.&fetchLatestTweets.asyncFun()
    Promise latestTweets = fetchLatestTweetsAsync()

    Closure extractKeywordsAsync = keywords.&extractKeywords.asyncFun()
    Promise keywords = extractKeywordsAsync(latestTweets)

    println 'Loading tweets and extracting keywords...'
    println keywords.get()









}
```

```
withPool {

    Closure fetchLatestTweetsAsync = twitter.&fetchLatestTweets.asyncFun()
    Promise latestTweets = fetchLatestTweetsAsync()

    Closure extractKeywordsAsync = keywords.&extractKeywords.asyncFun()
    Promise keywords = extractKeywordsAsync(latestTweets)

    keywords.whenBound {
       println it
    }

    println 'Loading tweets and extracting keywords...'




}
```

```
withPool {

    Closure fetchAsync = twitter.&fetchLatestTweets.asyncFun()

    Closure watsonsExtractKeywords = watsons.&extractKeywords.curry(fetchAsync())
    Closure googleExtractKeywords = google.&extractKeywords.curry(fetchAsync())

    List keywords =             watsonsExtractKeywords()

    println keywords









}
```

```
withPool {

    Closure fetchAsync = twitter.&fetchLatestTweets.asyncFun()

    Closure watsonsExtractKeywords = watsons.&extractKeywords.curry(fetchAsync())
    Closure googleExtractKeywords = google.&extractKeywords.curry(fetchAsync())

    List keywords =                                          googleExtractKeywords()

    println keywords




}
```

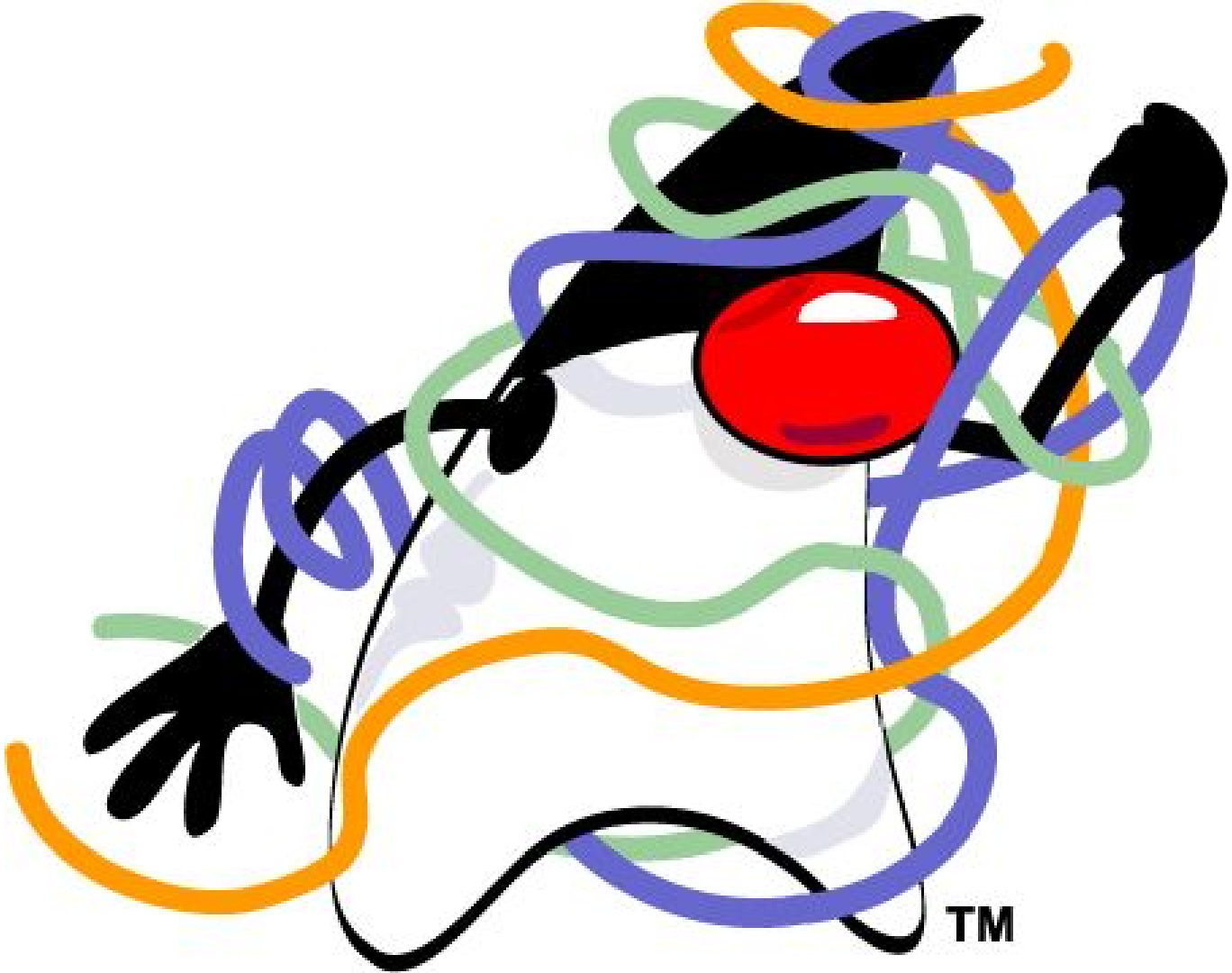
```
withPool {

    Closure fetchAsync = twitter.&fetchLatestTweets.asyncFun()

    Closure watsonsExtractKeywords = watsons.&extractKeywords.curry(fetchAsync())
    Closure googleExtractKeywords = google.&extractKeywords.curry(fetchAsync())

    List keywords = speculate( watsonsExtractKeywords(), googleExtractKeywords() )

    println keywords




}
```

```
withPool {

    Closure fetchAsync = twitter.&fetchLatestTweets.asyncFun()

    Closure watsonsExtractKeywords = watsons.&extractKeywords.curry(fetchAsync())
    Closure googleExtractKeywords = google.&extractKeywords.curry(fetchAsync())

    List keywords = speculate( watsonsExtractKeywords(), googleExtractKeywords() )

    println keywords









}
```

```
withPool {

    List latestTweets = twitter.fetchLatestTweets()

    Closure watsonsExtractKeywords = watsons.&extractKeywords.curry(latestTweets)
    Closure googleExtractKeywords = google.&extractKeywords.curry(latestTweets)

    List keywords = speculate( watsonsExtractKeywords(), googleExtractKeywords() )

    println keywords









}
```

```
withPool {

    Closure fetchWithCache = twitter.&fetchLatestTweets.gmemoize()

    Closure watsonsExtractKeywords = watsons.&extractKeywords.curry(fetchWithCache())
    Closure googleExtractKeywords = google.&extractKeywords.curry(fetchWithCache())

    List keywords = speculate( watsonsExtractKeywords(), googleExtractKeywords() )

    println keywords









}
```

```
withPool {
    runForkJoin(list) { list ->
      if (list.size() < 2) { return list }
      if (list.size() == 2) {
          if (list[0] <= list[1]) {
              return list
          } else {
              return list[-1..0]
          }
      }

      int middleIndex = list.size() / 2

      forkOffChild list[0..<middleIndex]
      forkOffChild list[middleIndex..<list.size()]

      return merge(*childrenResults)
  }
}
```


TM

```
withPool(lambdaToClosure(() -> {









}));
```

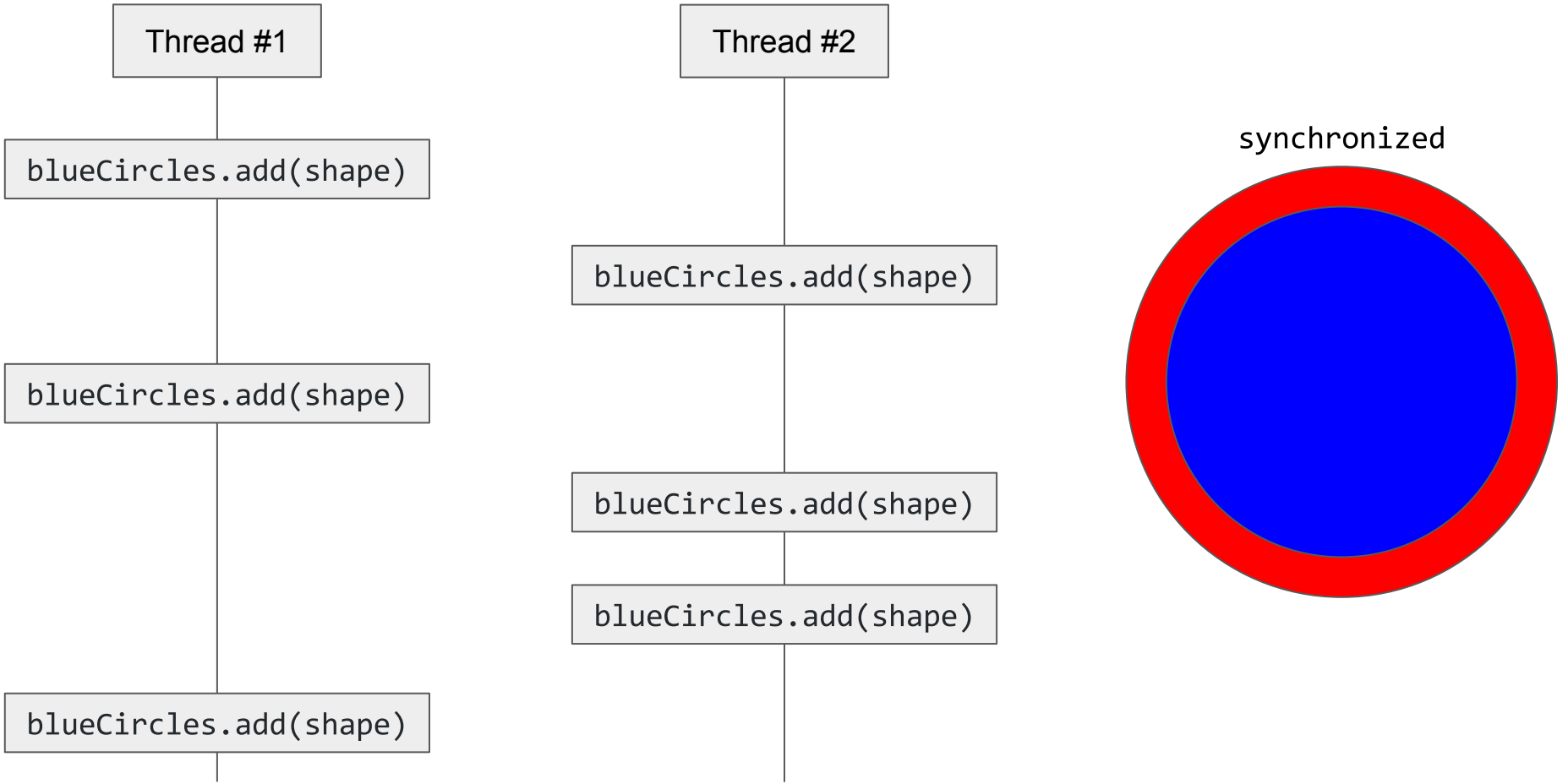
```
withPool(lambdaToClosure(() -> {

    Future result = executeAsync (
        lambdaToClosure(() -> { return twitter.fetchLatestTweets(); })
    ).get(0);

    final List tweets = (List) result.get();

    List keywords = speculate (
        lambdaToClosure(() -> { return watsons.extractKeywords(tweets); }),
        lambdaToClosure(() -> { return google.extractKeywords(tweets); })
    );

    return keywords;



}));
```

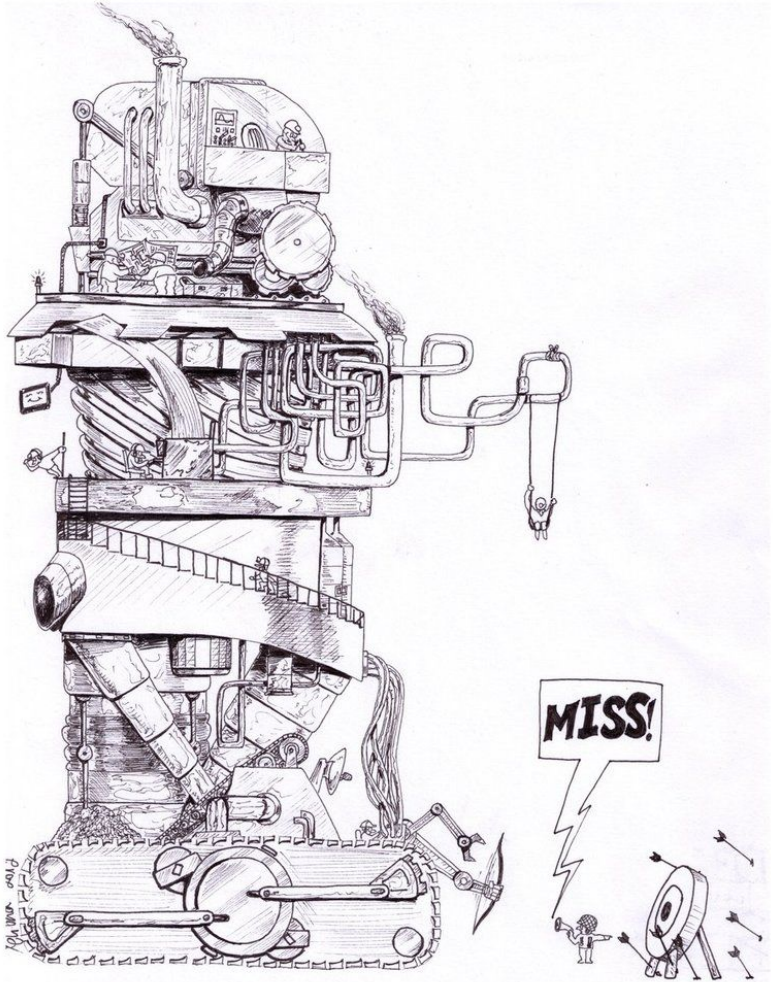
```
withPool(lambdaToClosure(() -> {

    Future result = executeAsync (
        lambdaToClosure(() -> { return twitter.fetchLatestTweets(); })
    ).get(0);

    final List tweets = (List) result.get();

    List keywords = speculate (
        lambdaToClosure(() -> { return watsons.extractKeywords(tweets); }),
        lambdaToClosure(() -> { return google.extractKeywords(tweets); })
    );

    return keywords;



}));
```

```
withPool {

    Shape minBlueCircle = shapes
       .findAllParallel({ shape -> shape.type == CIRCLE })
       .findAllParallel({ shape -> shape.color == BLUE })
       .minParallel({ shape -> shape.size })









}
```

```
withPool {

    List<Shape> blueCircles = []

    shapes.findAllParallel({ shape -> shape.type == CIRCLE })
          .findAllParallel({ shape -> shape.color == BLUE })
          .eachParallel({ shape -> blueCircles.add(shape) })

}
```

If multiple threads access the same mutable state variable without appropriate synchronization, **your program is broken**.

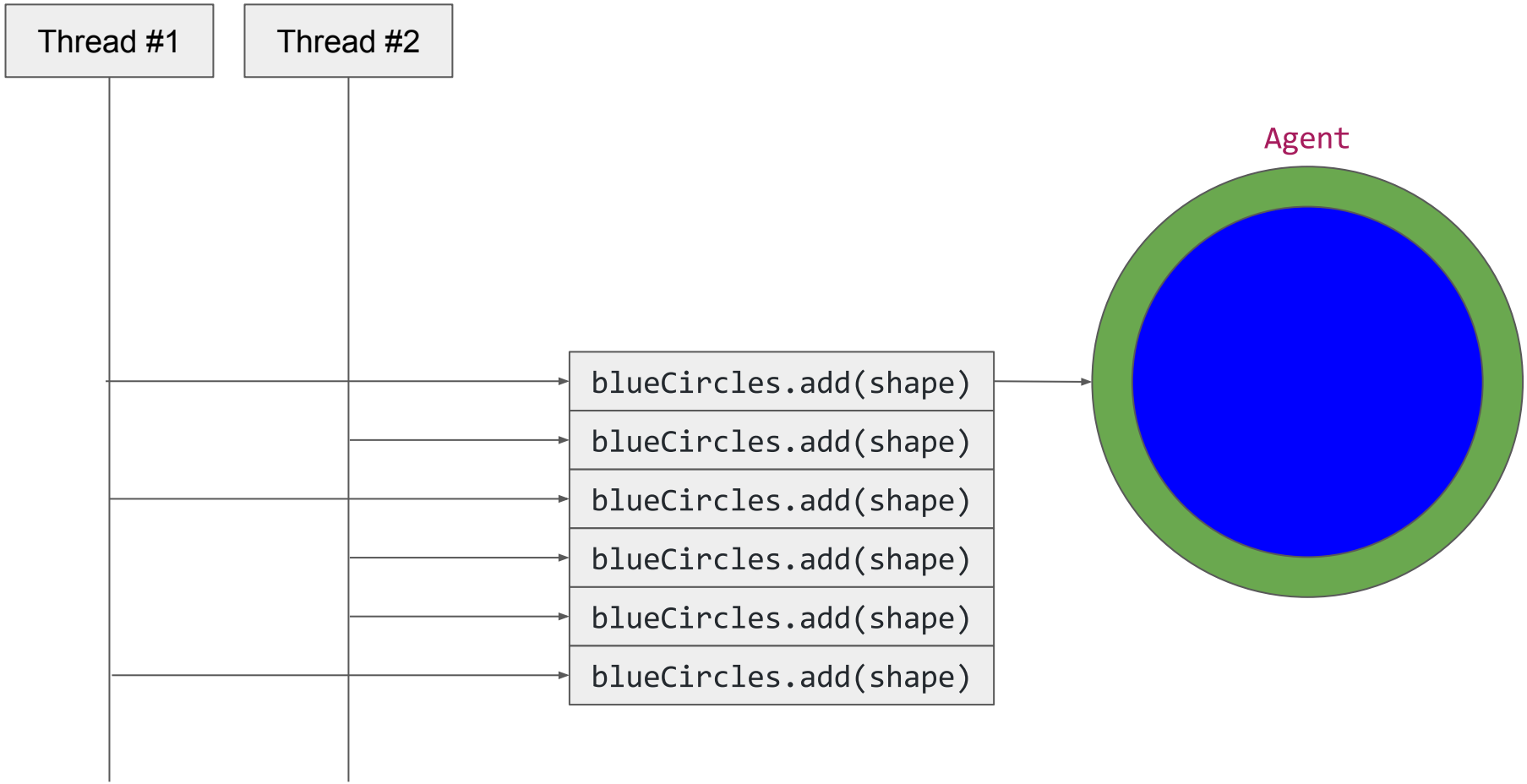

Thread #1
blueCircles.add(shape)
blueCircles.add(shape)
blueCircles.add(shape)
Thread #2
blueCircles.add(shape)
blueCircles.add(shape)
blueCircles.add(shape)
synchronized



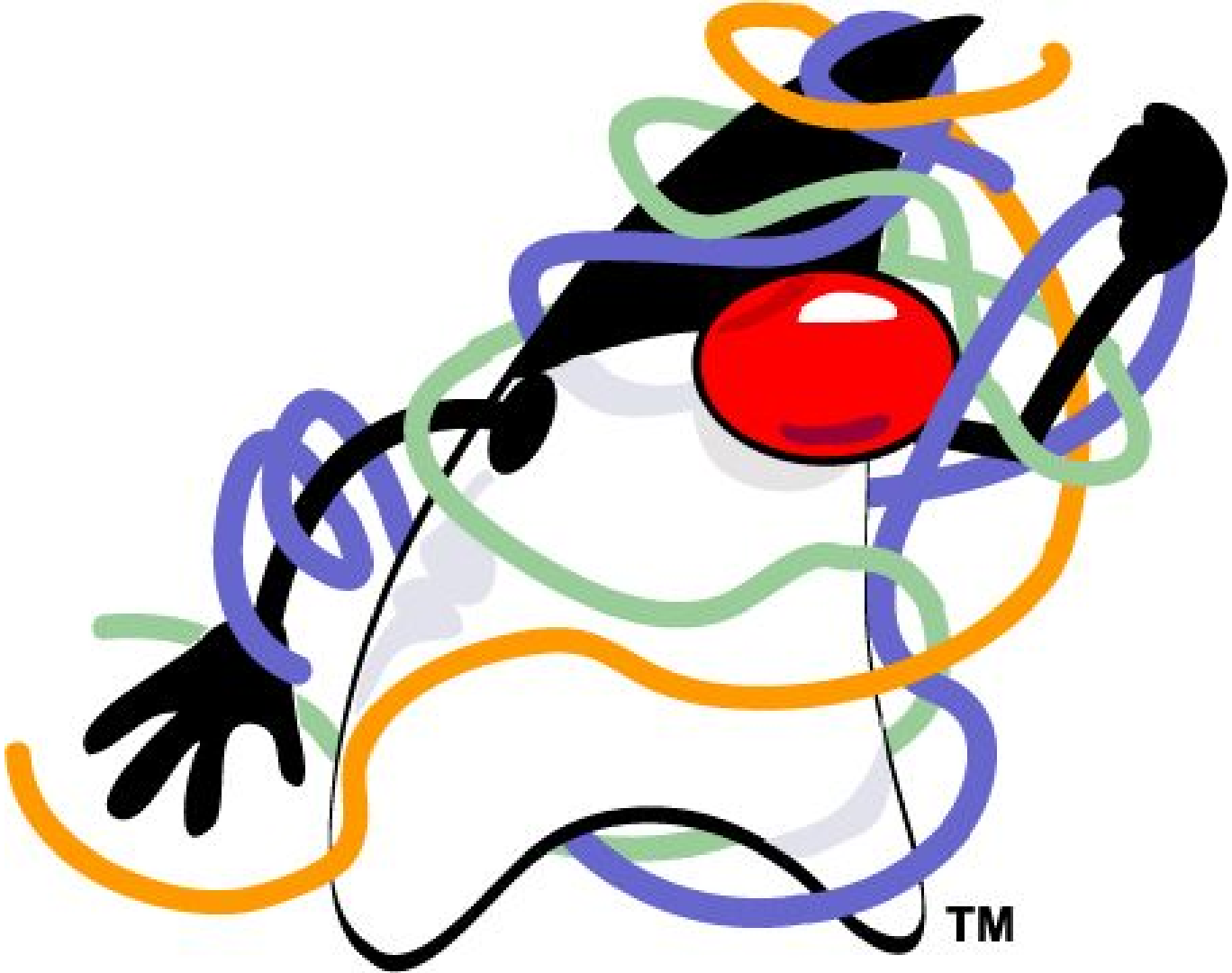
AGENTS

http://www.keywordsuggests.com/DT5zG9YMrnEK707aqUa2IhkNs5vUwu3mV6WrrLHR0soHddyR42EFvbEkYg9kaqswD%7CyremGnEFLO%7CzJXdp0SMQ/

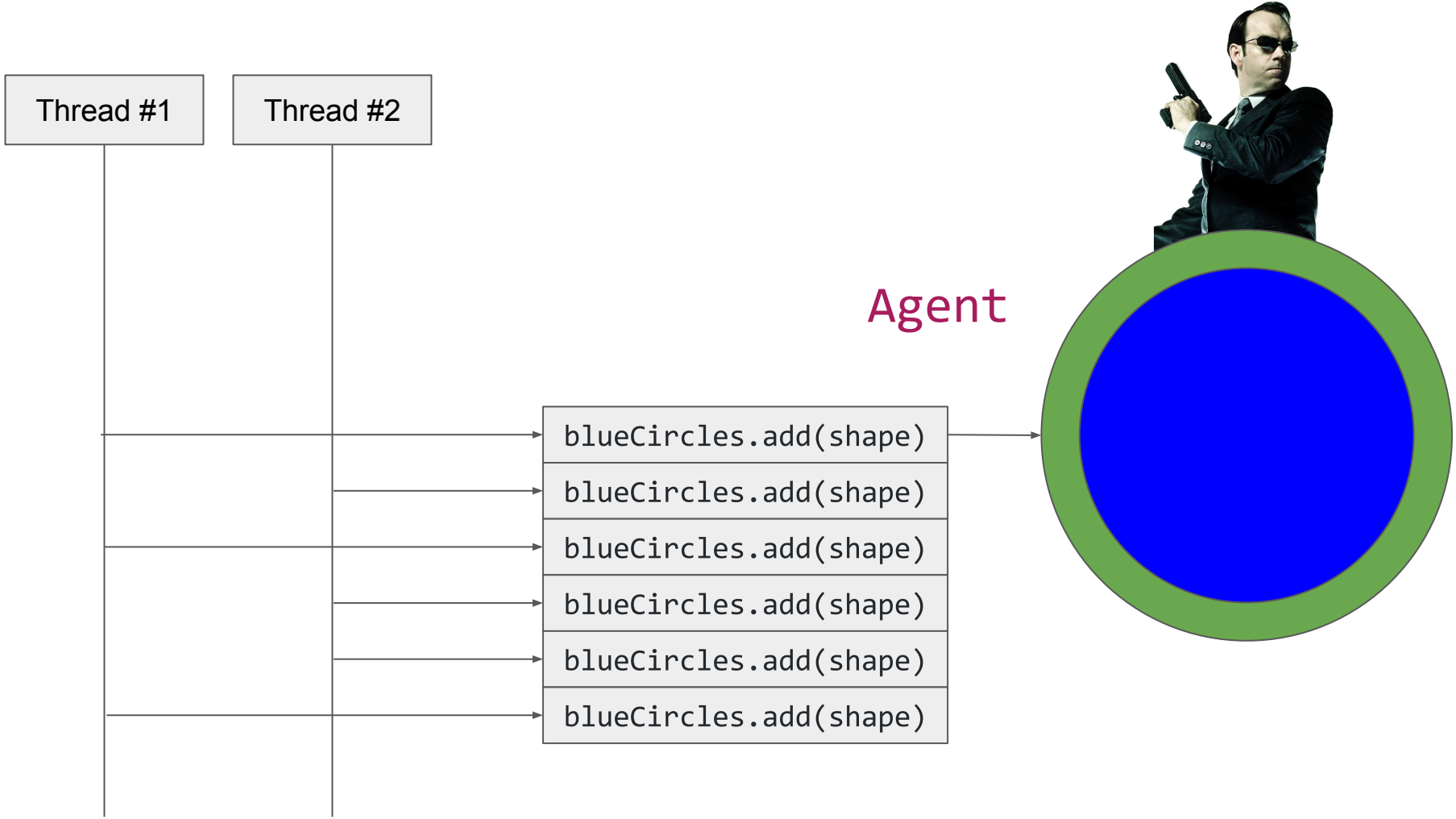
```
withPool {

    def blueShapesGuard = new Agent<List<Shape>>()
    blueShapesGuard { updateValue [] }

    shapes.findAllParallel({ shape -> shape.type == CIRCLE })
          .findAllParallel({ shape -> shape.color == BLUE })
          .eachParallel({ shape -> blueShapesGuard { it.add(shape) } })









}
```


Thread #1
Thread #2
Agent
blueCircles.add(shape)
blueCircles.add(shape)
blueCircles.add(shape)
blueCircles.add(shape)
blueCircles.add(shape)
blueCircles.add(shape)

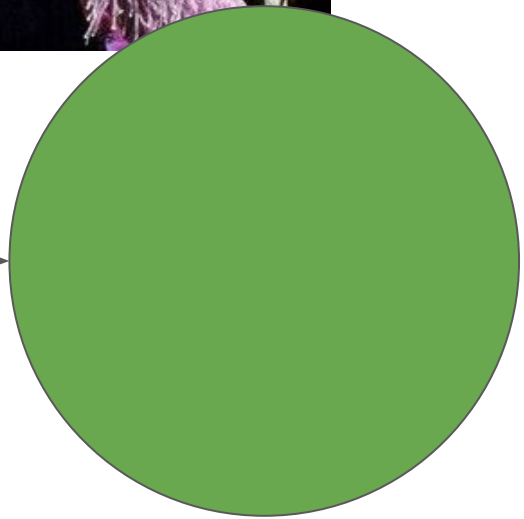
```
withPool {

    def blueShapesGuard = new Agent<Shape>()
    blueShapesGuard { updateValue [] }

    blueShapesGuard.addListener { oldValue, newValue -> … }

    blueShapesGuard.addValidator { oldValue, newValue -> … }

    shapes.findAllParallel({ shape -> shape.type == CIRCLE })
          .findAllParallel({ shape -> shape.color == BLUE })
          .eachParallel({ shape -> blueShapesGuard { it.add(shape) } })

    println blueShapesGuard.val

    blueShapesGuard.valAsync { println it }


}
```


TM

```
final Agent<List<Shape>> blueShapesGuard = new Agent<>();
blueShapesGuard.send(new ArrayList<>());
blueShapesGuard.send(new MessagingRunnable<List<Shape>>() {
    @Override
    protected void doRun(List<Shape> value) {
        value.add(shape);
    }
});

blueShapesGuard.valAsync(new MessagingRunnable<List<Shape>>() {
    @Override
    protected void doRun(List<Shape> value) {
        System.out.println(value);
    }
});
```


Thread #1
Thread #2
blueCircles.add(shape)
blueCircles.add(shape)
blueCircles.add(shape)
blueCircles.add(shape)
blueCircles.add(shape)
blueCircles.add(shape)
Agent

Actor



Thread #1

Thread #2

message

message

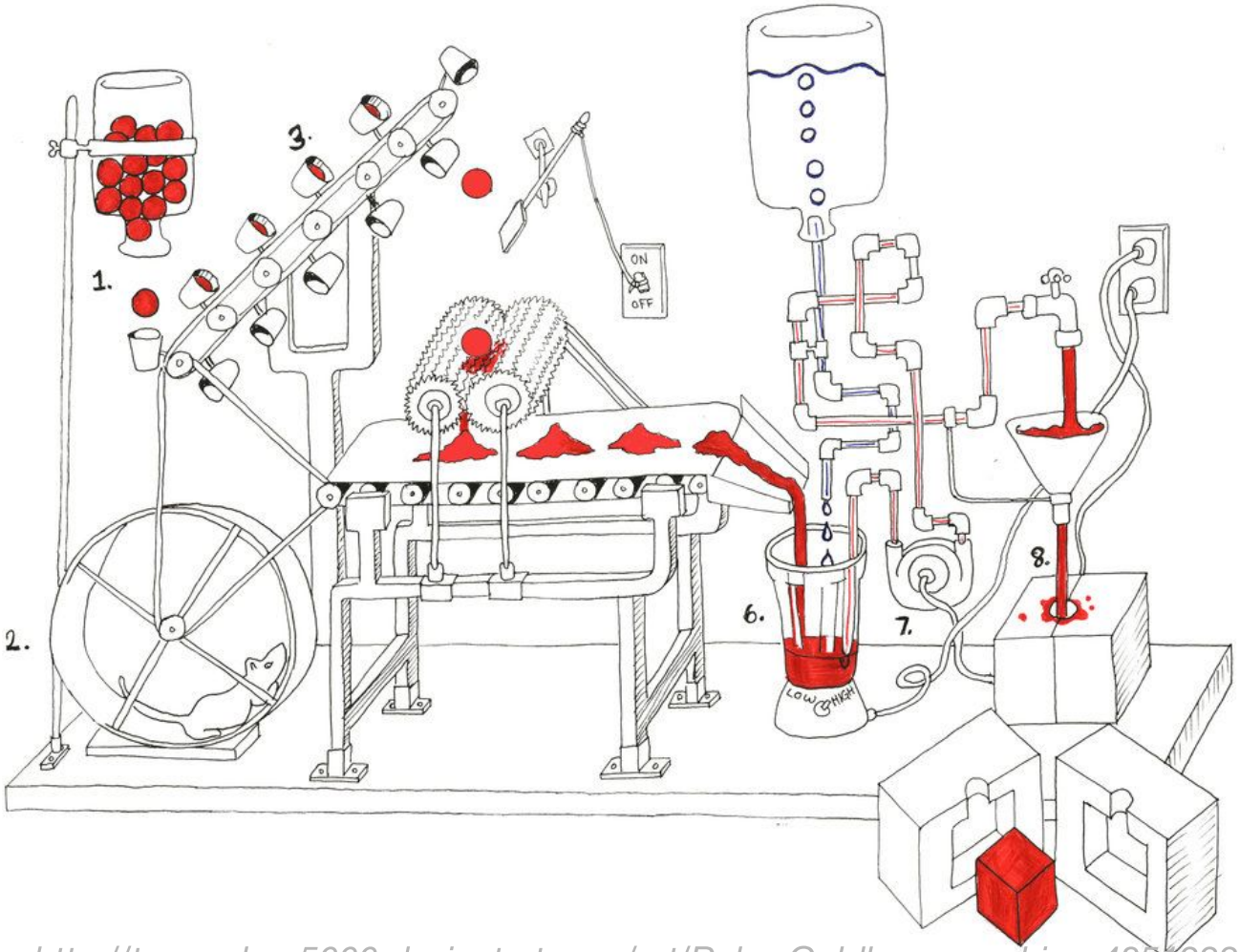
message

message

message

message

ACTORS



http://tommyboy5000.deviantart.com/art/Rube-Goldberg-machine-485199926

```
class ShapesGuardActor extends DefaultActor {
    List<Shape> shapes

    void afterStart() {
        shapes = []
    }

    void act() {
        loop {
            react { def shape -> shapes.add shape }
        }
    }
}
```

```
class ShapesGuardActor extends DefaultActor {
    List<Shape> shapes

    void afterStart() {
        shapes = []
    }

    void act() {
        loop {
            react { def shape -> shapes.add shape }
        }
    }
}
```

executed for received message

message

```
class ShapesGuardActor extends DefaultActor {
   List<Shape> shapes

   void afterStart() {
       shapes = []
   }

   void act() {
       loop { ⟵ continuously receive messages, one thread at most
           react { def shape -> shapes.add shape }
       }
   }
}
```

```
class KeywordStoreActor extends DefaultActor {
    KeywordsRepository keywordsRepository



    void act() {
        loop {
            react { def keyword -> keywordsRepository.store keyword }
        }
    }
}
```

```
def keywordStoreActor = actor {
    loop {
        react { def keyword ->
            keywordsRepository.store keyword
        }
    }
}
```

```
def keywordStoreActor = actor {
    loop {
        react { def keyword ->
            keywordsRepository.store id, keyword
        }
    }
}
```

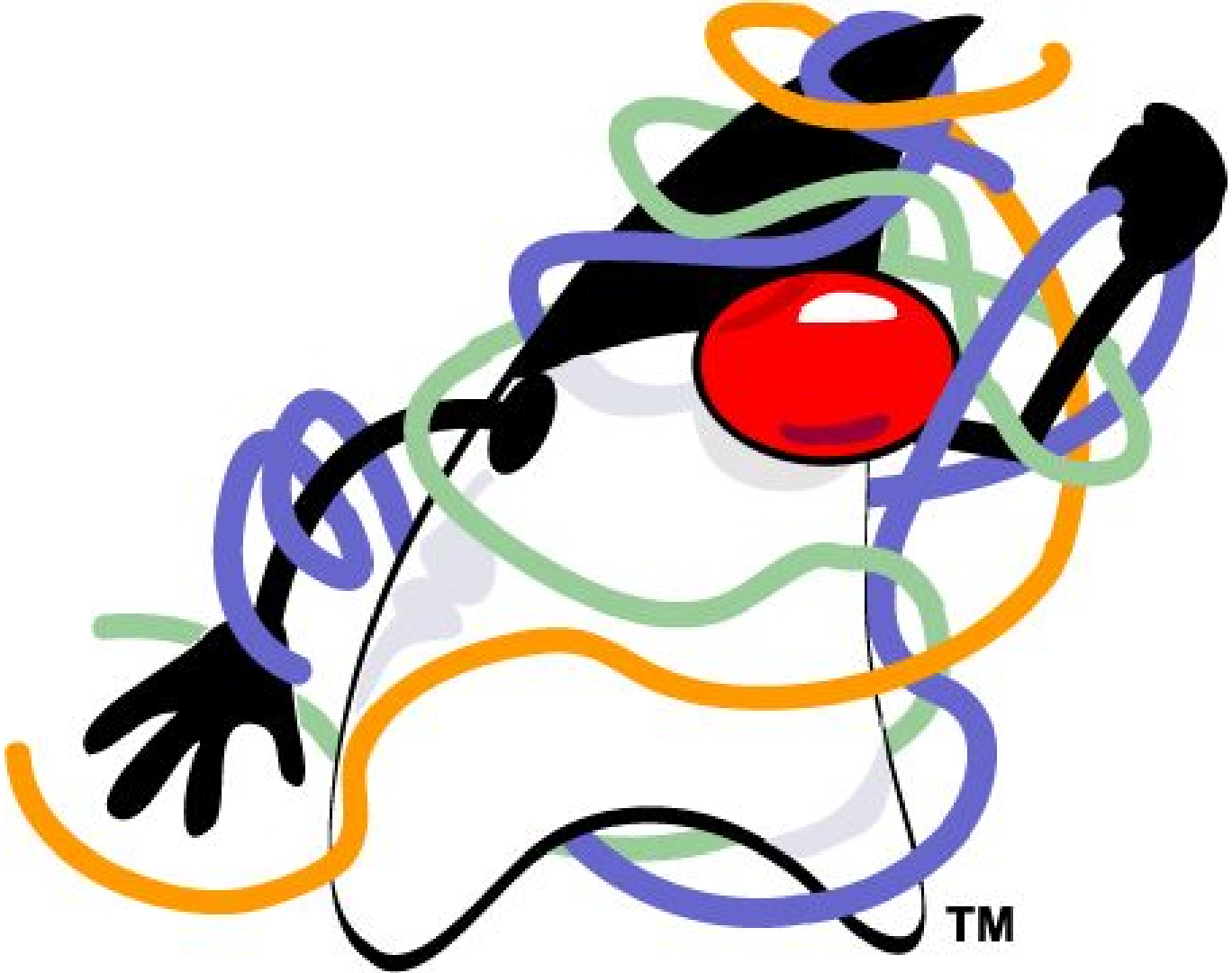
```
def keywordStoreActor = actor {
    loop {
        react { def keyword ->
            idGenerator << keyword
            react { Id id ->
                keywordsRepository.store id, keyword
            }
        }
    }
}

def idGenerator = actor {
    loop {
        react { def keyword ->
            Id id = ...
            keyword.reply id
        }
    }
}
```

send message

process answer

reply to sender

```
def keywordStoreActor = actor {
    loop {
        react { def keyword ->
            idGenerator << keyword
            react { Id id ->
                keywordsRepository.store id, keyword
            }
        }
    }
}

def idGenerator = reactor { def keyword ->
    Id id = ...
    keyword.reply id
}
```


TM

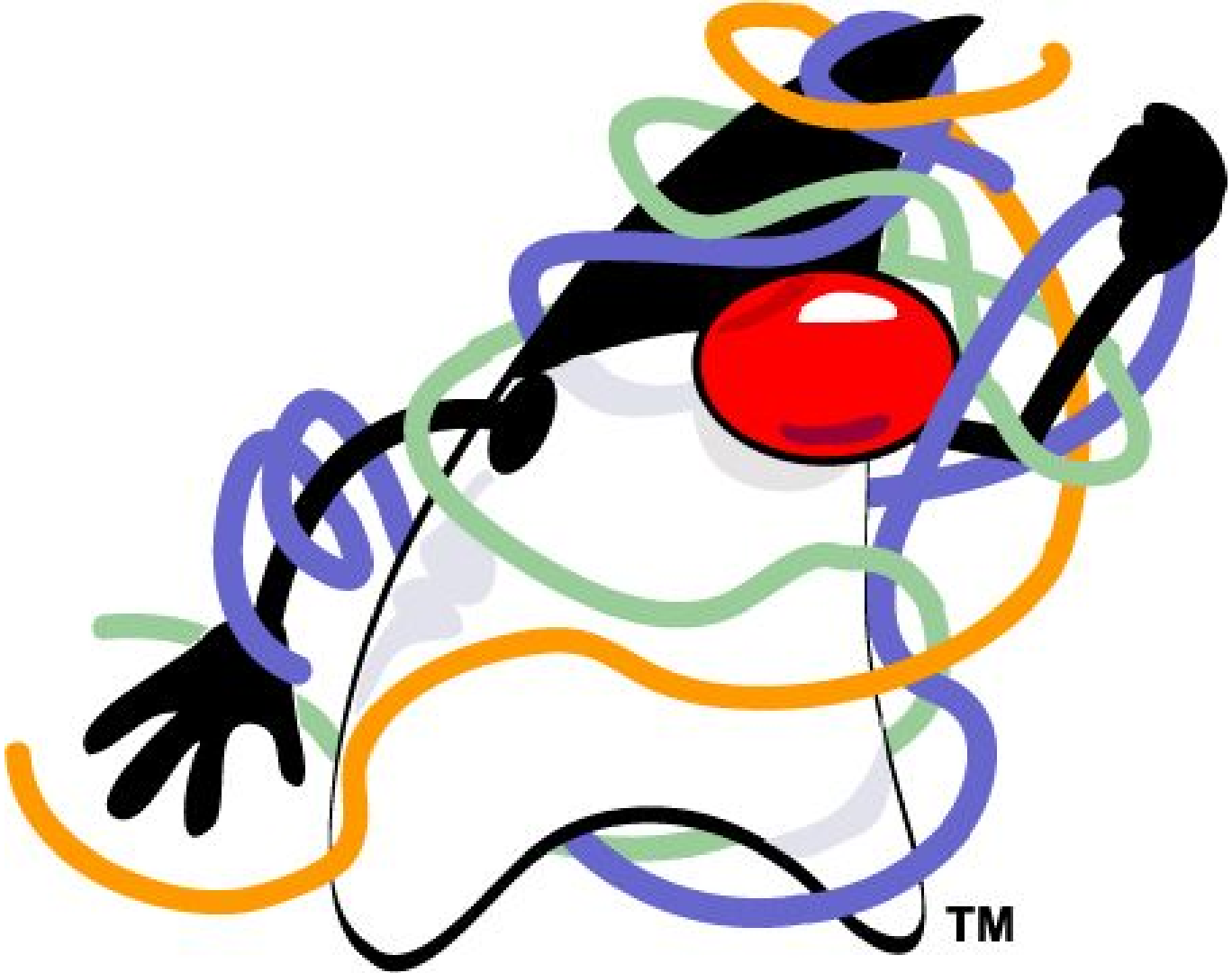
```
Closure keywordStoreHandler = new ReactorMessagingRunnable<Keyword, Object>() {
   @Override protected Object doRun(final Keyword keyword) {
      idGenerator.sendAndContinue(keyword, new MessagingRunnable<Id>() {
          @Override protected void doRun(final Id id) {
              keywordsRepository.store(id, keyword);
          }
      });
      return null;
   }
};
Actor keywordStoreActor = new ReactiveActor(keywordStoreHandler);

Closure idGeneratorHandler = new ReactorMessagingRunnable<Keyword, Id>() {
   @Override protected Id doRun(Keyword argument) {
      Id id = ...
      return id;
   }
};
Actor idGenerator = new ReactiveActor(idGeneratorHandler);
```

```
def keywordStoreActor = actor {
    loop {
        react { def keyword ->
            idGenerator << keyword
            react { Id id ->
                keywordsRepository.store id, keyword
            }
        }
    }
}

def idGenerator = reactor { def keyword ->
    Id id = ...
    keyword.reply id
}
```

```
def keywordStoreActor = actor {
    loop {
        react { def keyword ->
            idGenerator << keyword
            react { Id id ->
                keywordsRepository.store id, keyword
            }
        }
    }
}

def idGenerator = reactor { def message ->
   if (message instanceof Keyword) {
       id = ...
   }
   if (message instanceof Tweet) {
       id = ...
   }
   message.reply id
}
```

```
def keywordStoreActor = actor {
    loop {
        react { def keyword ->
            idGenerator << keyword
            react { Id id ->
                keywordsRepository.store id, keyword
            }
        }
    }
}

def idGenerator = reactor { def message ->
   if (message instanceof Keyword) {
       id = ...
   }
   if (message instanceof Tweet) {
       id = ...
   }
   if (message instanceof FacebookPost) {
       id = ...
   }
```

```
def keywordStoreActor = actor {
    loop {
        react { def keyword ->
            idGenerator << keyword
            react { Id id ->
                keywordsRepository.store id, keyword
            }
        }
    }
}

def idGenerator = messageHandler {
   when { Keyword keyword -> reply generateKeywordId(keyword) }
   when { Tweet tweet -> reply generateTweetId(tweet) }
   when { FacebookPost facebookPost -> reply generateFacebookPostId(facebookPost) }
}
```

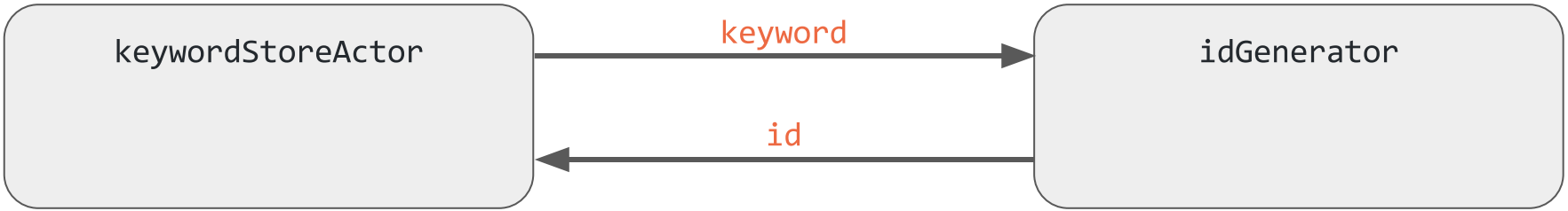

TM

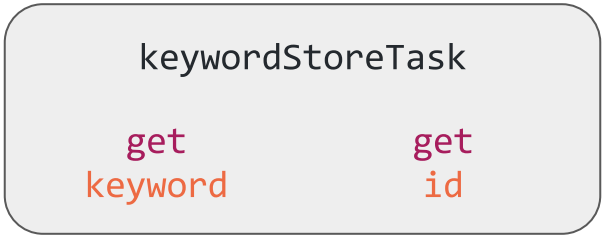
```
Closure keywordStoreHandler = new ReactorMessagingRunnable<Keyword, Object>() {
   @Override protected Object doRun(final Keyword keyword) {
      idGenerator.sendAndContinue(keyword, new MessagingRunnable<Id>() {
          @Override protected void doRun(final Id id) {
              keywordsRepository.store(id, keyword);
          }
      });
      return null;
   }
};
Actor keywordStoreActor = new ReactiveActor(keywordStoreHandler);
Actor idGenerator = new DynamicDispatchActor() {

  public void onMessage(final Keyword keyword) {
      replyIfExists(generateKeywordId(keyword));
  }

  public void onMessage(final Tweet tweet) {
      replyIfExists(generateTweetId(tweet));
  }
```

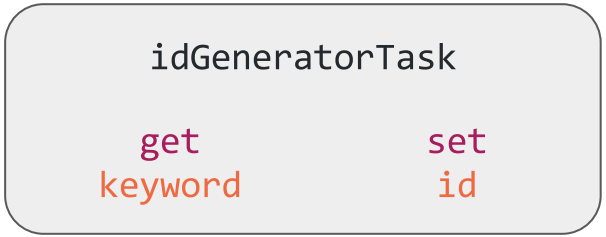
```
def keywordStoreActor = actor {
    loop {
        react { def keyword ->
            idGenerator << keyword
            react { Id id ->
                keywordsRepository.store id, keyword
            }
        }
    }
}


def idGenerator = reactor { def keyword ->
    Id id = generateId(keyword)
    keyword.reply id
}
```

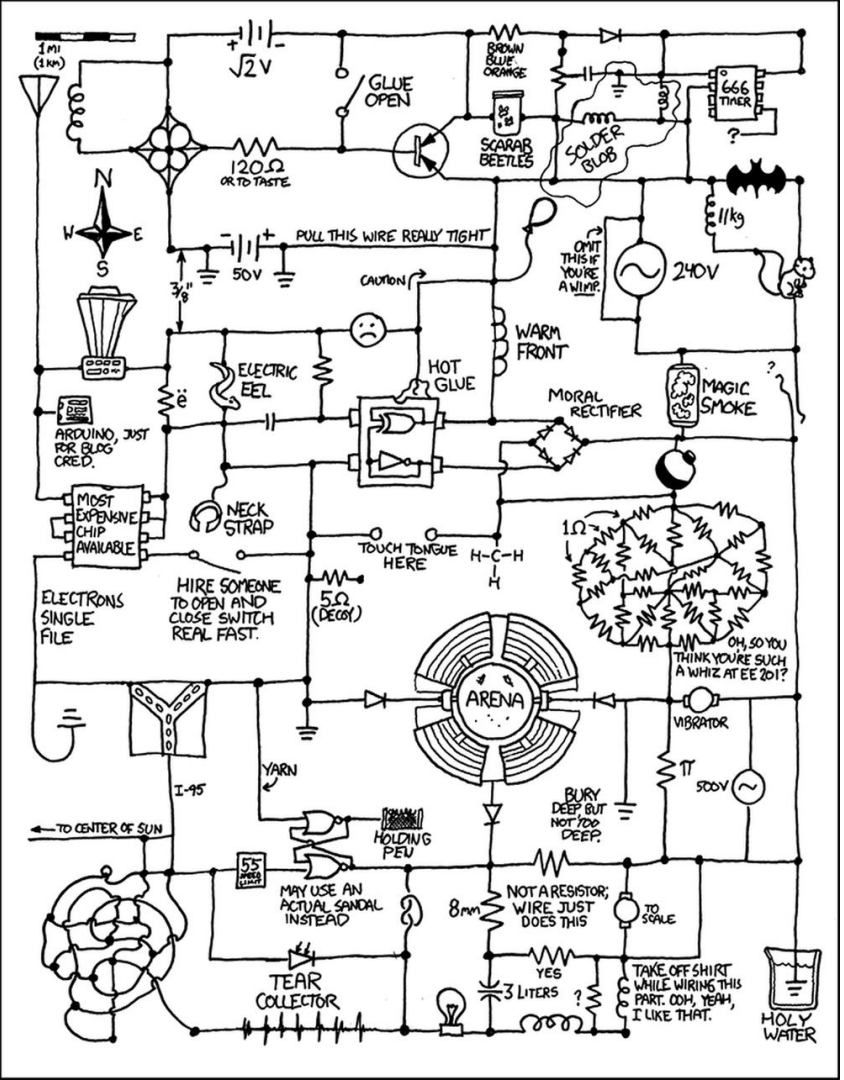
```
def keywordStoreActor = actor {
    loop {
        react { def keyword ->
            idGenerator << keyword
            react { Id id ->
                keywordsRepository.store id, keyword
            }
        }
    }
}


def idGenerator = reactor { def keyword ->
    Id id = generateId(keyword)
    keyword.reply id
}
```

```
def keywordStoreActor = actor {
    loop {
        react { def keyword ->
            idGenerator << keyword
            react { Id id ->
                keywordsRepository.store id, keyword
            }
        }
    }
}


def idGenerator = reactor { def keyword ->
    Id id = generateId(keyword)
    keyword.reply id
}
```


keywordStoreActor
keyword
id
idGenerator


keywordStoreTask
get
keyword
get
id


idGeneratorTask
get
keyword
set
id



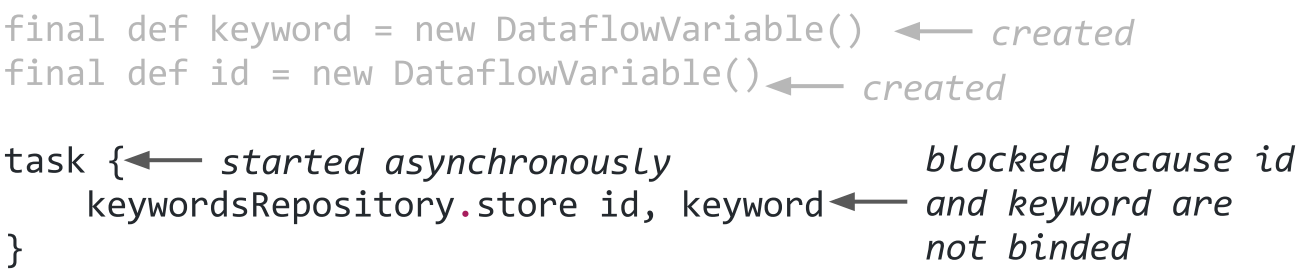
DATAFLOWS

http://www.projectroomseattle.org/programs-content/2014/6/preparing-for-the-failure-variety-show-the-rube-goldberg-confessionals

```
final def keyword = new DataflowVariable()
final def id = new DataflowVariable()
```

created

created


final def keyword = new DataflowVariable()
created
final def id = new DataflowVariable()
created
task {
started asynchronously
keywordsRepository.store id, keyword
blocked because id
and keyword are
not binded
}

```
final def keyword = new DataflowVariable()
final def id = new DataflowVariable()

task {
    keywordsRepository.store id, keyword
}

task {
    id = generateId(keyword)
}
```

created

created

blocked because id and keyword are not binded

blocked because keyword is not binded

```
final def keyword = new DataflowVariable()
final def id = new DataflowVariable()

task {
    keywordsRepository.store id, keyword
}

task {
    id = generateId(keyword)
}

task {
    List keywords = keywordsService.extractKeywords()
    keyword = orderByPriority(keywords)[0]
}
```

created

created

blocked because id and keyword are not binded

blocked because keyword is not binded

bind keyword

```
final def keyword = new DataflowVariable()
final def id = new DataflowVariable()

task {
    keywordsRepository.store id, keyword
}

task {
    id = generateId(keyword)
}

task {
    List keywords = keywordsService.extractKeywords()
    keyword = orderByPriority(keywords)[0]
}
```

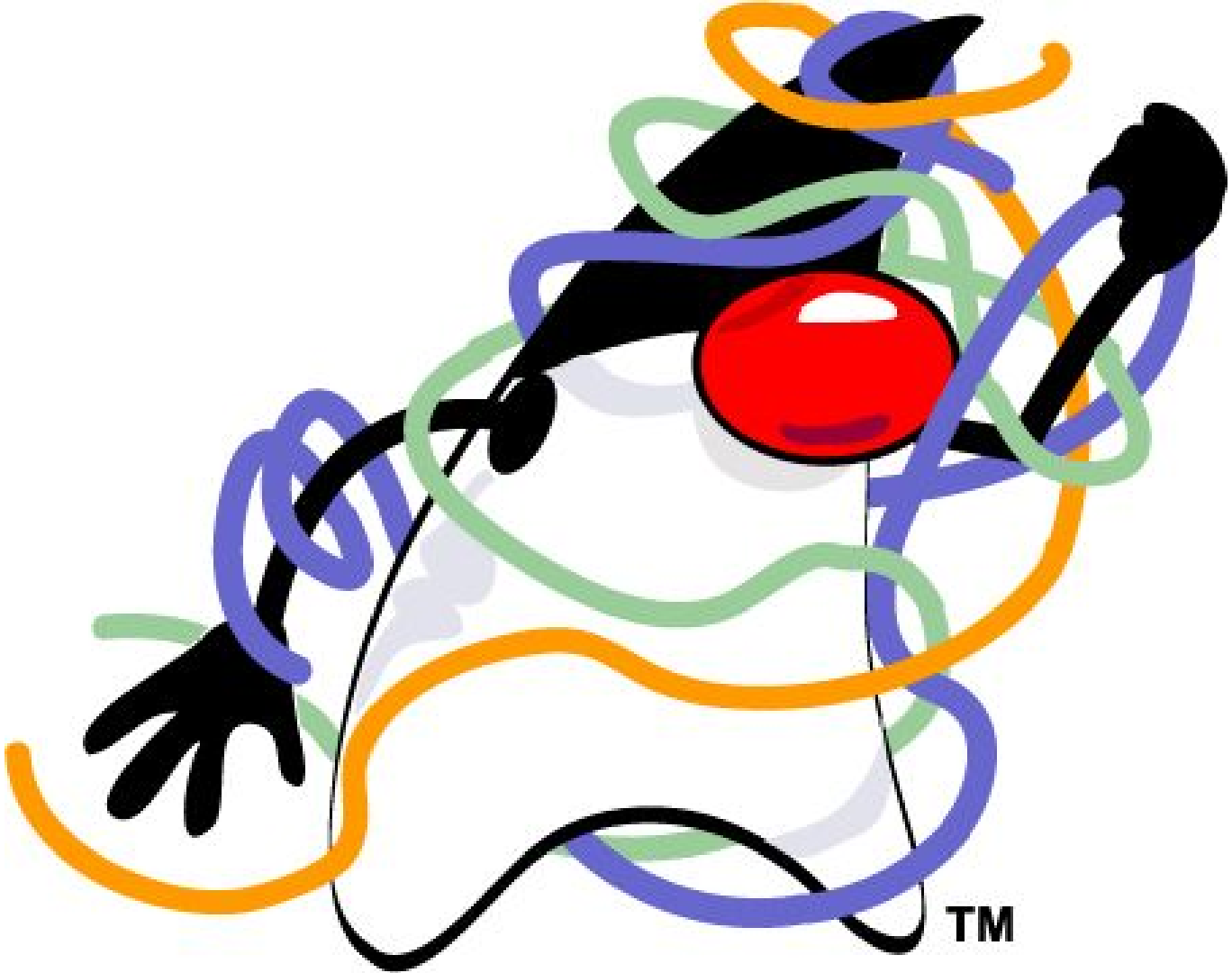
binded

created

blocked because id is not binded

bind id

```
final def keyword = new DataflowVariable()
final def id = new DataflowVariable()

task {
    keywordsRepository.store id, keyword
}

task {
    id = generateId(keyword)
}

task {
    List keywords = keywordsService.extractKeywords()
    keyword = orderByPriority(keywords)[0]
}
```


TM

```
final DataflowVariable<Keyword> keyword = new DataflowVariable<>();
final DataflowVariable<Id> id = new DataflowVariable<>();

task(lambdaToClosure(() -> {
    keywordsRepository.store(id.getVal(), keyword.getVal());
}));

task(lambdaToClosure(() -> {
    id.bind(generateId(keyword.getVal()));
}));

task(lambdaToClosure(() -> {
    List<Keyword> keywords = keywordsService.extractKeywords();
    keyword.bind(orderByPriority(keywords).get(0));
}));
```

```
final def keyword = new DataflowVariable()
final def id = new DataflowVariable()

task {
    keywordsRepository.store id, keyword
}

task {
    id = generateId(keyword)
}

task {
    List keywords = keywordsService.extractKeywords()
    keyword = orderByPriority(keywords)[0]
}
```

```
final def keyword = new DataflowVariable()
final def id = new DataflowVariable()

whenAllBound(keyword, id) {  ⟵ blocked until all mentioned variables are binded
    keywordsRepository.store id, keyword
}

task {
    id = generateId(keyword)
}

task {
    List keywords = keywordsService.extractKeywords()
    keyword = orderByPriority(keywords)[0]
}
```

```
final def keywords = new DataflowVariable()

task {
    def keyword = orderByPriority(keywords)[0]
    keywordsRepository.store keyword
}

task {
    keywords = keywordsService.extractKeywords()
}
```

```
final def keywords = new DataflowVariable()

keywords.whenBound {
    def keyword = orderByPriority(keywords)[0]
    keywordsRepository.store keyword
}

task {
    keywords = keywordsService.extractKeywords()
}
```

```
task {
    keywordsService.extractKeywords()
}.whenBound {
    def keyword = orderByPriority(keywords)[0]
    keywordsRepository.store keyword
}
```

```
task {
    keywordsService.extractKeywords()
}.whenBound {
    Promise orderedKeywords = orderByPriorityAsync(keywords)
    orderedKeywords.whenBound {
        keywordsRepository.store orderedKeywords[0]
    }
}
```

```
task {
    keywordsService.extractKeywords()
}.then orderByPriority then { it[0] } then keywordsRepository.&store
```

```
task {
    keywordsService.extractKeywords()
}.then priorityOrderActor.&sendAndPromise then { it[0] } then
repositoryStoreActor.&sendAndPromise
```

```
final def keywords = new DataflowQueue()


task {
   while (true) { keywordsRepository.store keywords.val }
}


task {
   keywordsService.extractKeywords().each { keyword ->
       keywords << keyword
   }
}
```

blocked until new value is binded

bind new value

```
final def keywords = new DataflowQueue()


task {
   while (true) { keywordsRepository.store keywords.val }
}


task {
    withPool {
        List allKeywords = keywordsService.extractKeywords()
        allKeywords.findAllParallel({!spamService.isSpam(it)}).each { keyword ->
           keywords << keyword
        }
    }
}
```

```
final def keywords = new DataflowQueue()


keywords.wheneverBound { ← started each time value is binded
   keywordsRepository.store it
}


task {
   keywordsService.extractKeywords().each { keyword ->
       keywords << keyword
   }
}
```

```
final def keywords = new DataflowQueue()



task {
   while (true) { keywordsRepository.store keywords.val }
}

task {
   keywordsService.extractKeywords().each { keyword ->
       keywords << keyword
   }
}

task {
   while (true) { logService.debug keywords.val }
}
```

```
final def keywordsBroadcast = new DataflowBroadcast()
final def keywordsRepositoryChannel = keywordsBroadcast.createReadChannel()
final def keywordsLogChannel = keywordsBroadcast.createReadChannel()

task {
   while (true) { keywordsRepository.store keywordsRepositoryChannel.val }
}

task {
   keywordsService.extractKeywords().each { keyword ->
       keywordsBroadcast << keyword
   }
}

task {
   while (true) { logService.debug keywordsLogChannel.val }
}
```

```
final def keywords = new DataflowQueue()

splitter (keywords, [ keywordsForStoring, keywordsForLogging ])

operator (inputs: [ keywordsForStoring ], outputs: []) { keywordForStoring ->
   keywordsRepository.store keywordForStoring
}

task {
   keywordsService.extractKeywords().each { keyword ->
       keywords << keyword
   }
}

operator (inputs: [ keywordsForLogging ], outputs: []) { keywordsForLogging ->
   logService.debug keywordsForLogging
}
```

```
final def keywords = new DataflowQueue()

splitter (keywords, [ keywordsForStoring, keywordsForLogging ])

operator (inputs: [ keywordsForStoring ], outputs: [], stateObject: [id: 0]) {
   keywordForStoring -> keywordsRepository.store id++, keywordForStoring
}

task {
   keywordsService.extractKeywords().each { keyword ->
       keywords << keyword
   }
}

operator (inputs: [ keywordsForLogging ], outputs: []) { keywordsForLogging ->
   logService.debug keywordsForLogging
}
```

```
final def keywords = new DataflowQueue()

splitter (keywords, [ keywordsForStoring, keywordsForLogging ])

operator (inputs: [ id, keywordsWithId ], outputs: []) { id, keywordsWithId ->
   keywordsRepository.store id, keywordForStoring
}

task {
   keywordsService.extractKeywords().each { keyword ->
       keywords << keyword
   }
}

operator (inputs: [ keywordsForId ], outputs: [ id, keywordsWithId ]) { keyword ->
   bindAllOutputValues generateId(keyword), keyword
}

operator (inputs: [ keywordsForLogging ], outputs: []) { keywordsForLogging ->
   logService.debug keywordsForLogging
}
```

```
splitter (keywords, [ keywordsForStoring, keywordsForLogging ])

operator (inputs: [ id, keywordsWithId ], outputs: []) { id, keywordsWithId ->
   keywordsRepository.store id, keywordForStoring
}

selector (inputs: [ fromWatsons, fromGoogle ], outputs: [ keyword ]) { keywords ->
   keywords.each {
       bindOutput 0, it
   }
}

operator (inputs: [ keywordsForId ], outputs: [ id, keywordsWithId ]) { keyword ->
   bindAllOutputValues generateId(keyword), keyword
}

operator (inputs: [ keywordsForLogging ], outputs: []) { keywordsForLogging ->
   logService.debug keywordsForLogging
}
```

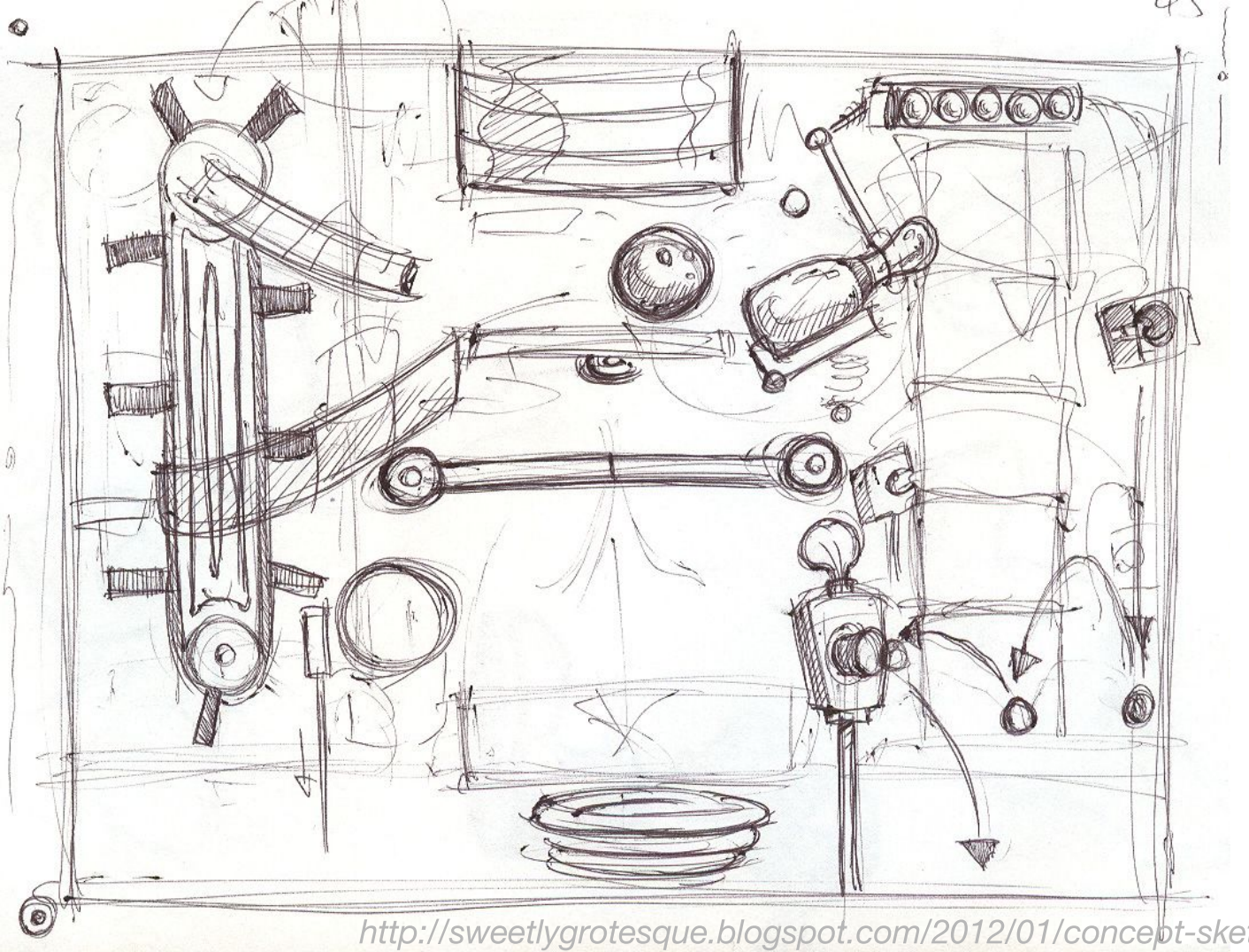
FURTHER DIVE

[Examples from slides]

[Groovy and Concurrency with GPars by Paul King]
[Gpars: Concurrency in Java & Groovy by Ken Kousen]

[Official site]
[Sources]
[Slack channel]

[The GPars User Guide]
['Concurrent Groovy with GPars' chapter from 'Groovy in Action' book]



Q/A

THANK YOU!

http://sweetlygrotesque.blogspot.com/2012/01/concept-sketches-goldberg-machine.html