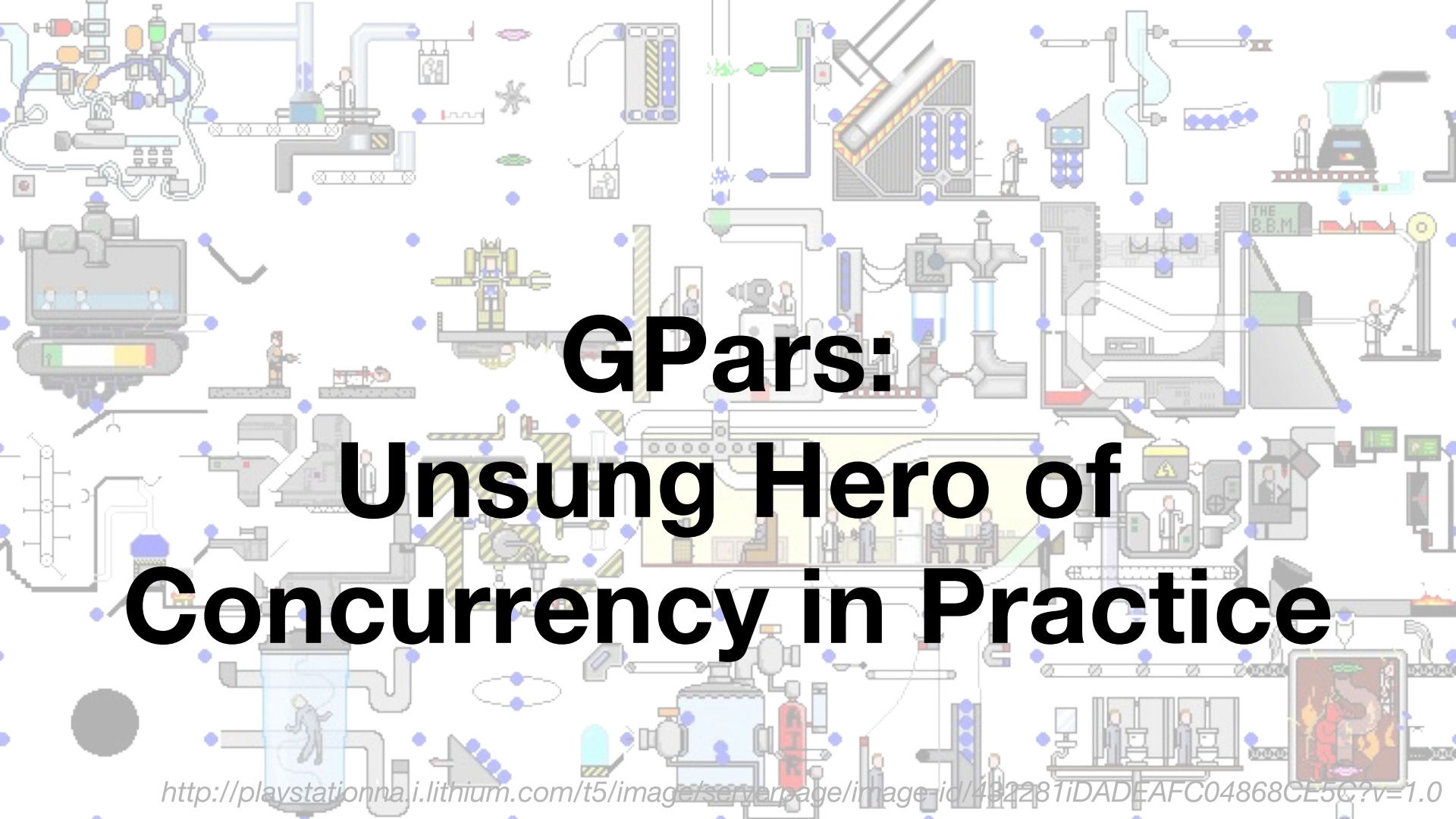


GPars: Unsung Hero of Concurrency in Practice

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?

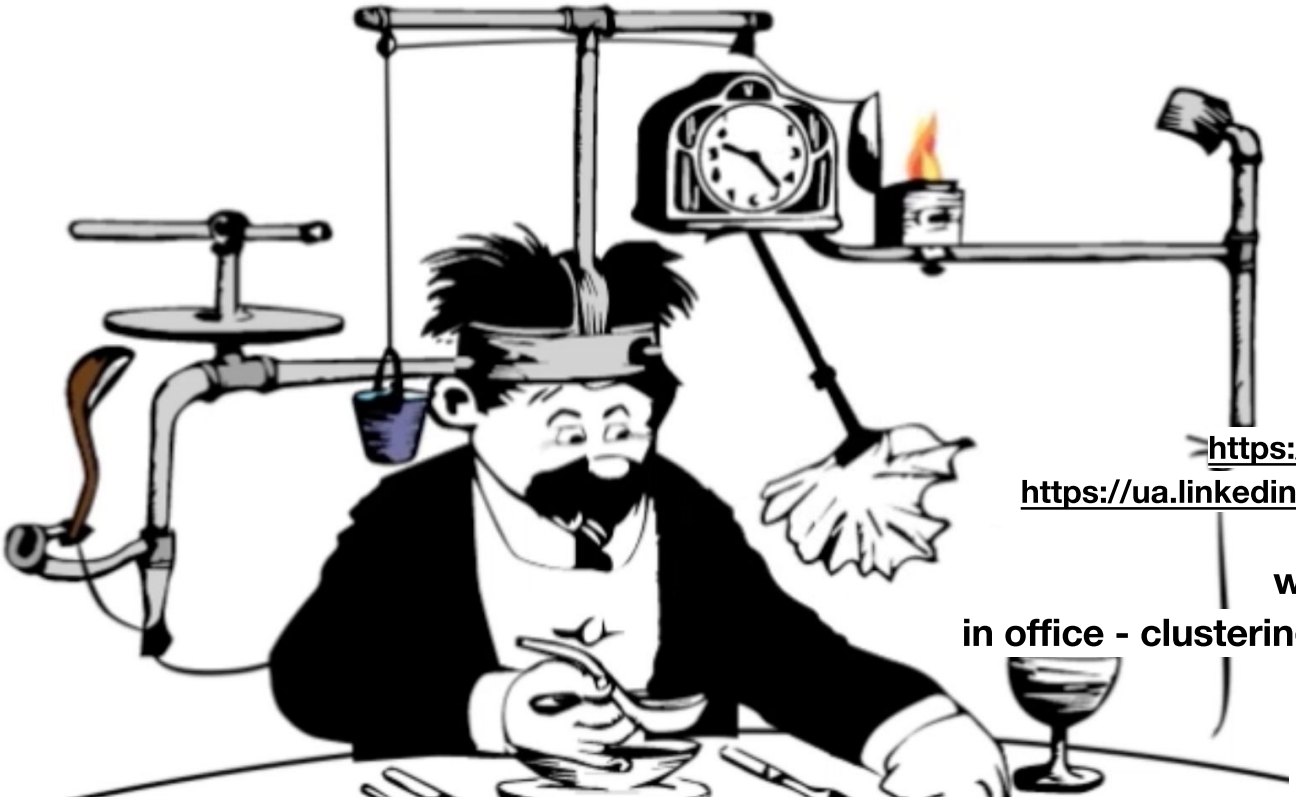
http://www.theverge.com/2015/4/22/8381963/rube-goldberg-machine-contest-history-ideas

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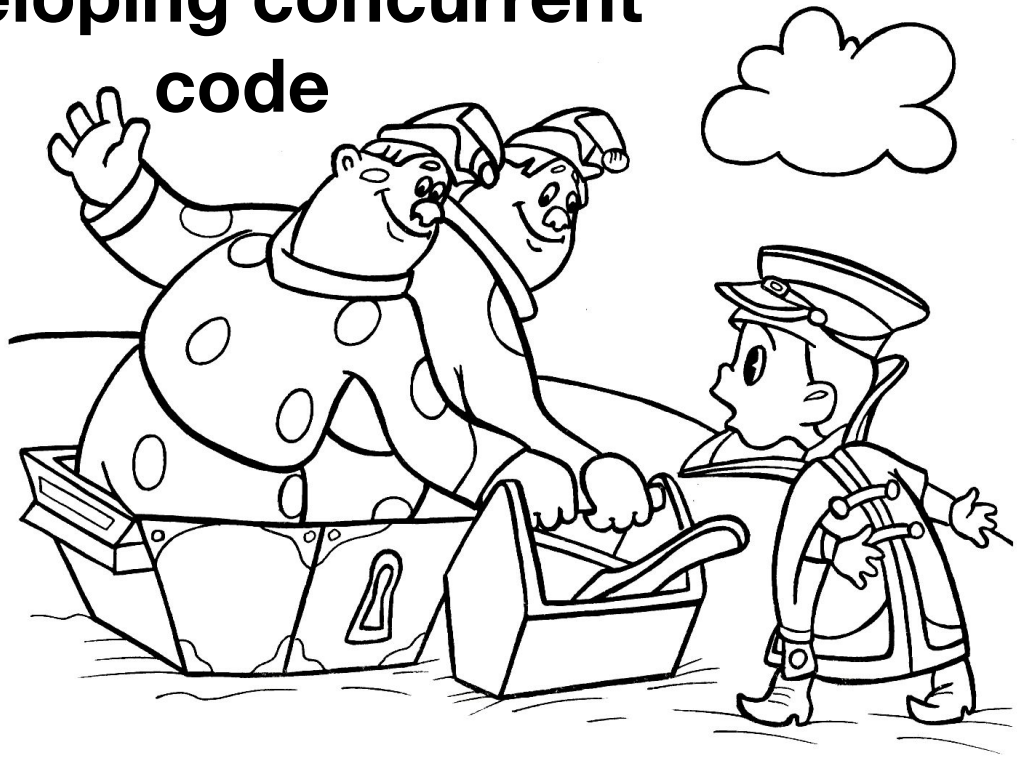
https://www.facebook.com/yaroslav.yermilov
https://ua.linkedin.com/pub/yaroslav-yermilov/58/682/506

work for EPAM Systems since 2011
in office - clustering, 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); }
}
```

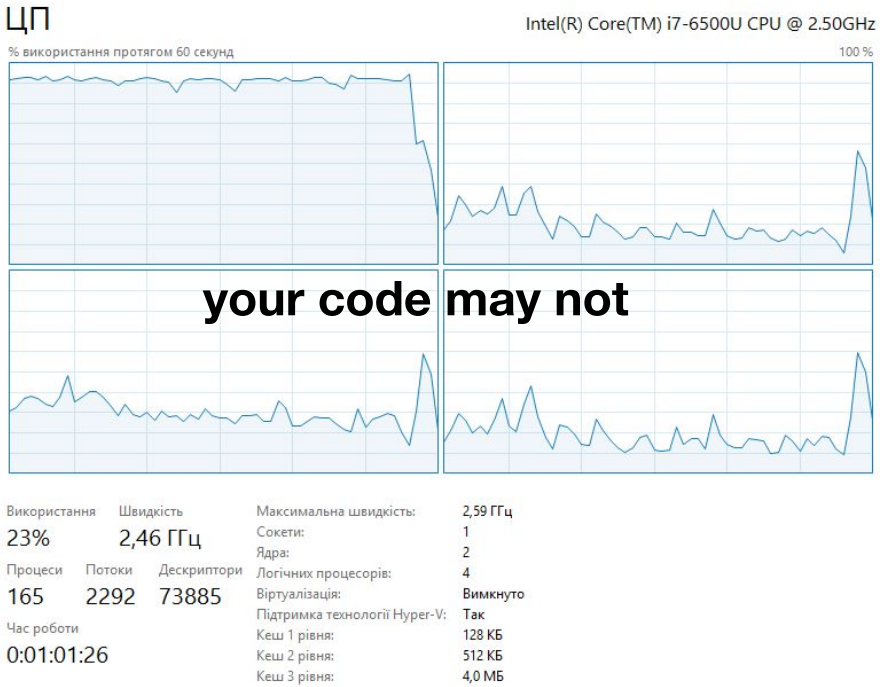
Holder was not properly published!

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

guideline #1 for developing concurrent code

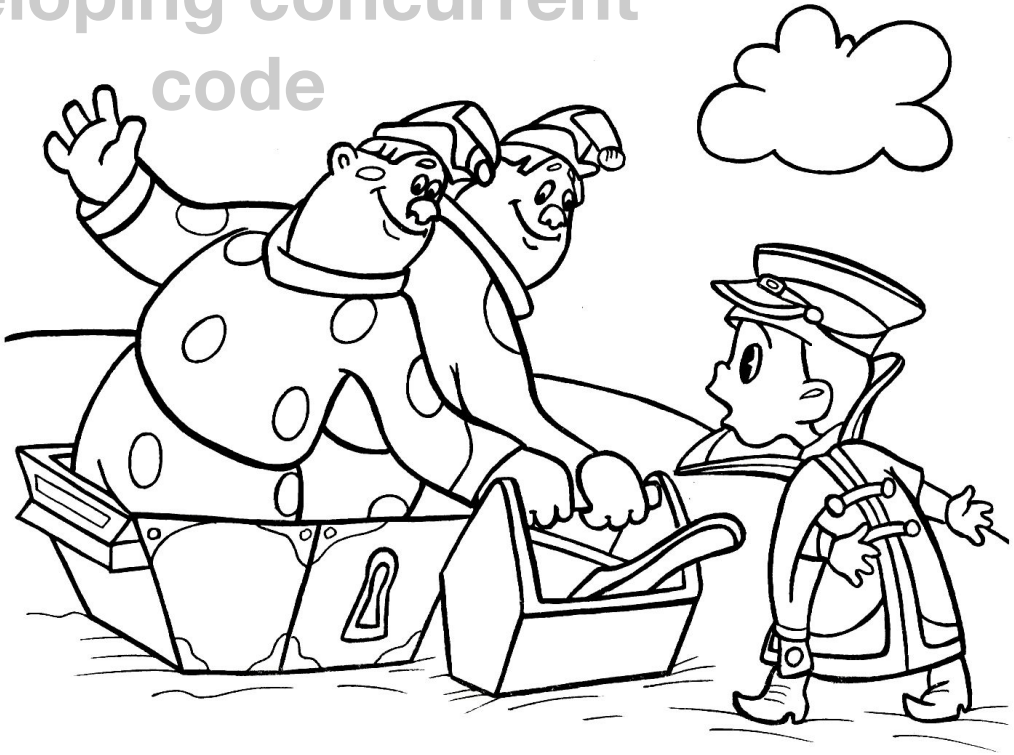
MOORE'S LAW:

Computers will get exponentially faster.



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

two guidelines for developing concurrent code



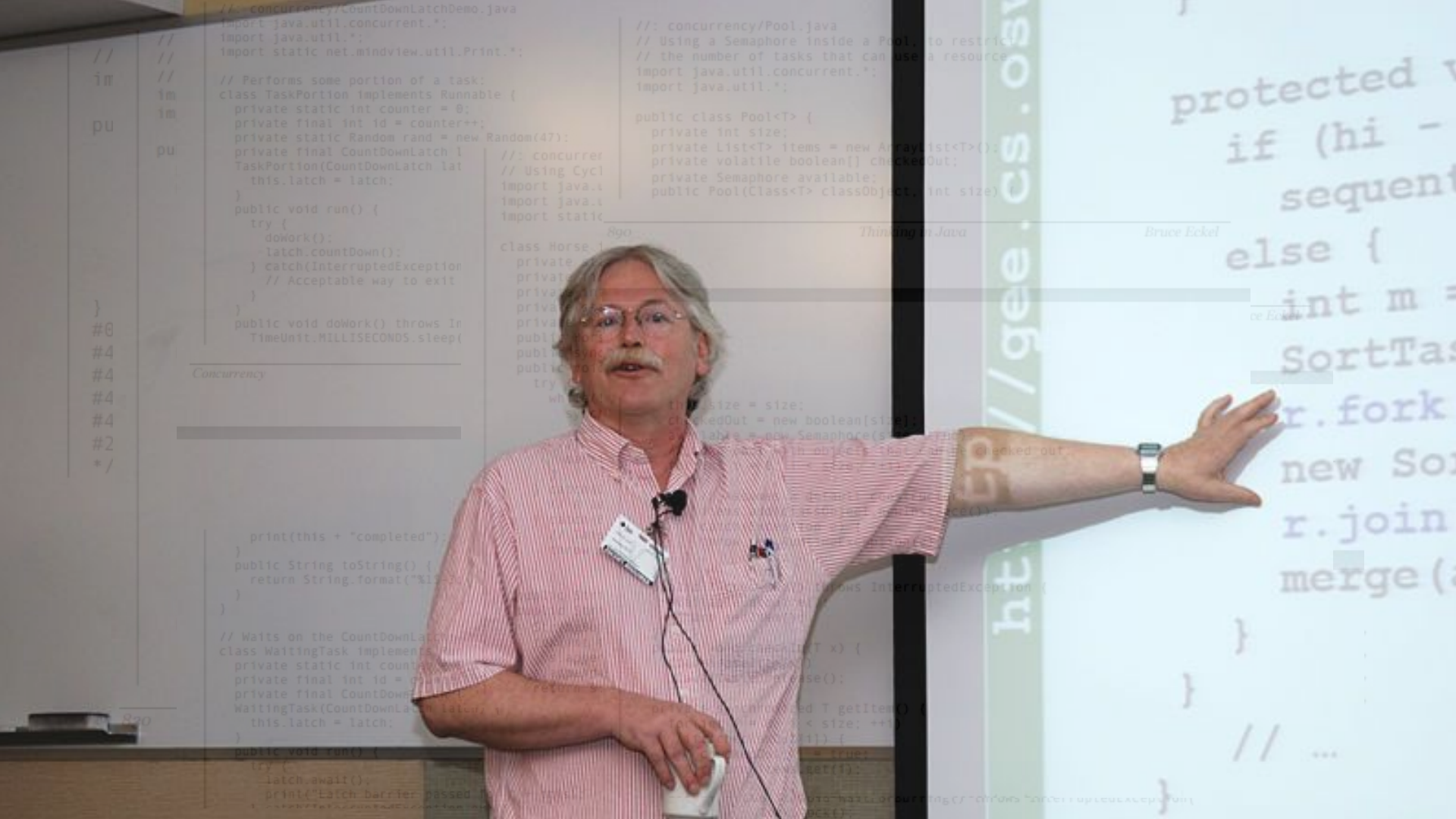
Java toolbox

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

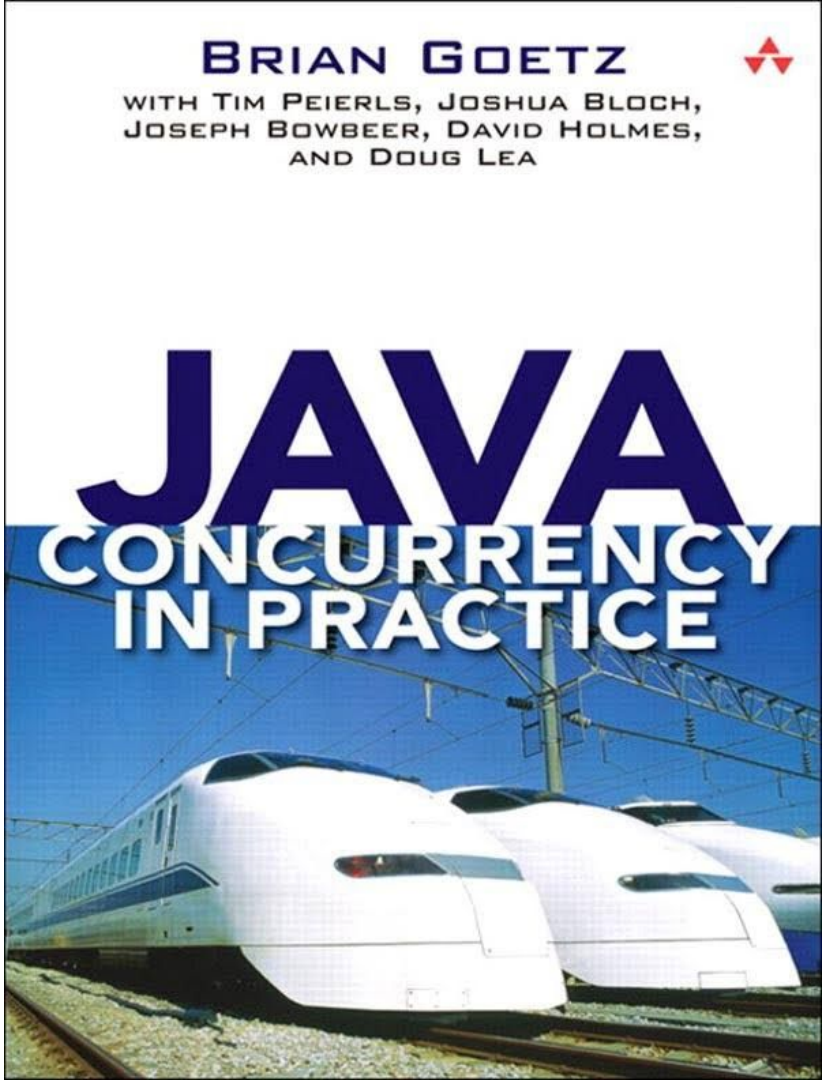
If multiple threads access the same mutable state variable without appropriate synchronization, your program is broken.

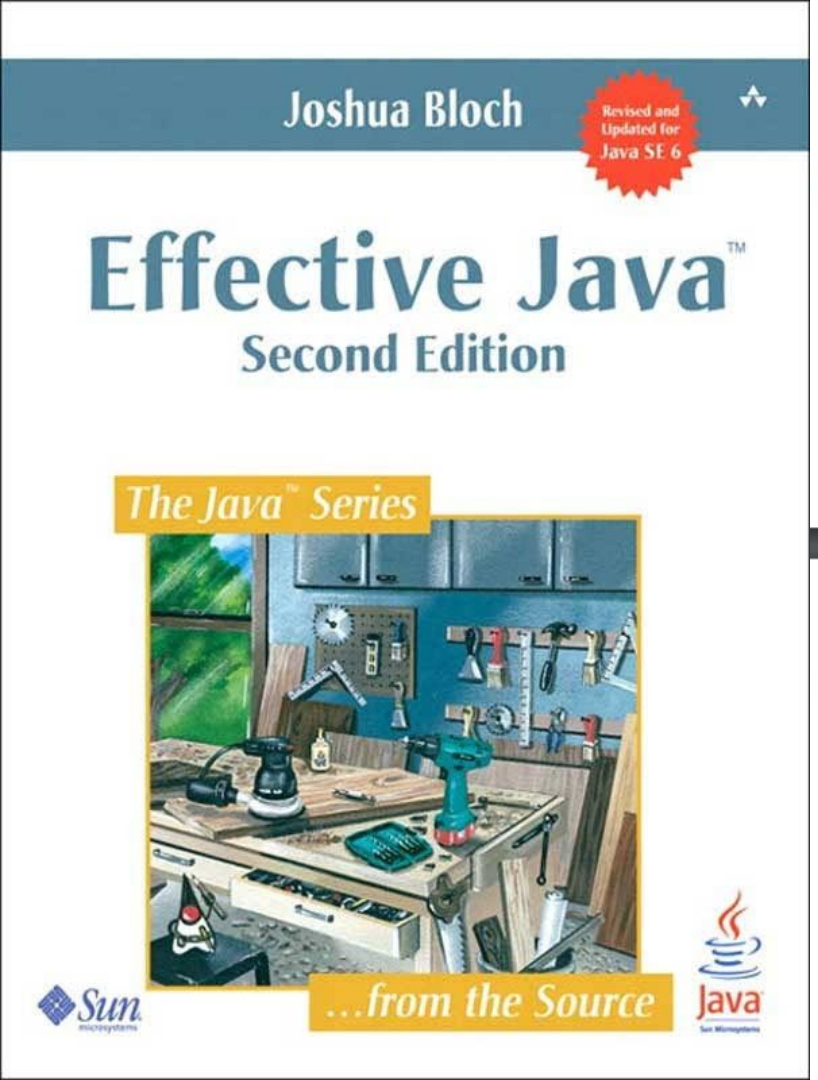
There are three ways to fix it:

Don’t share the state variable across threads

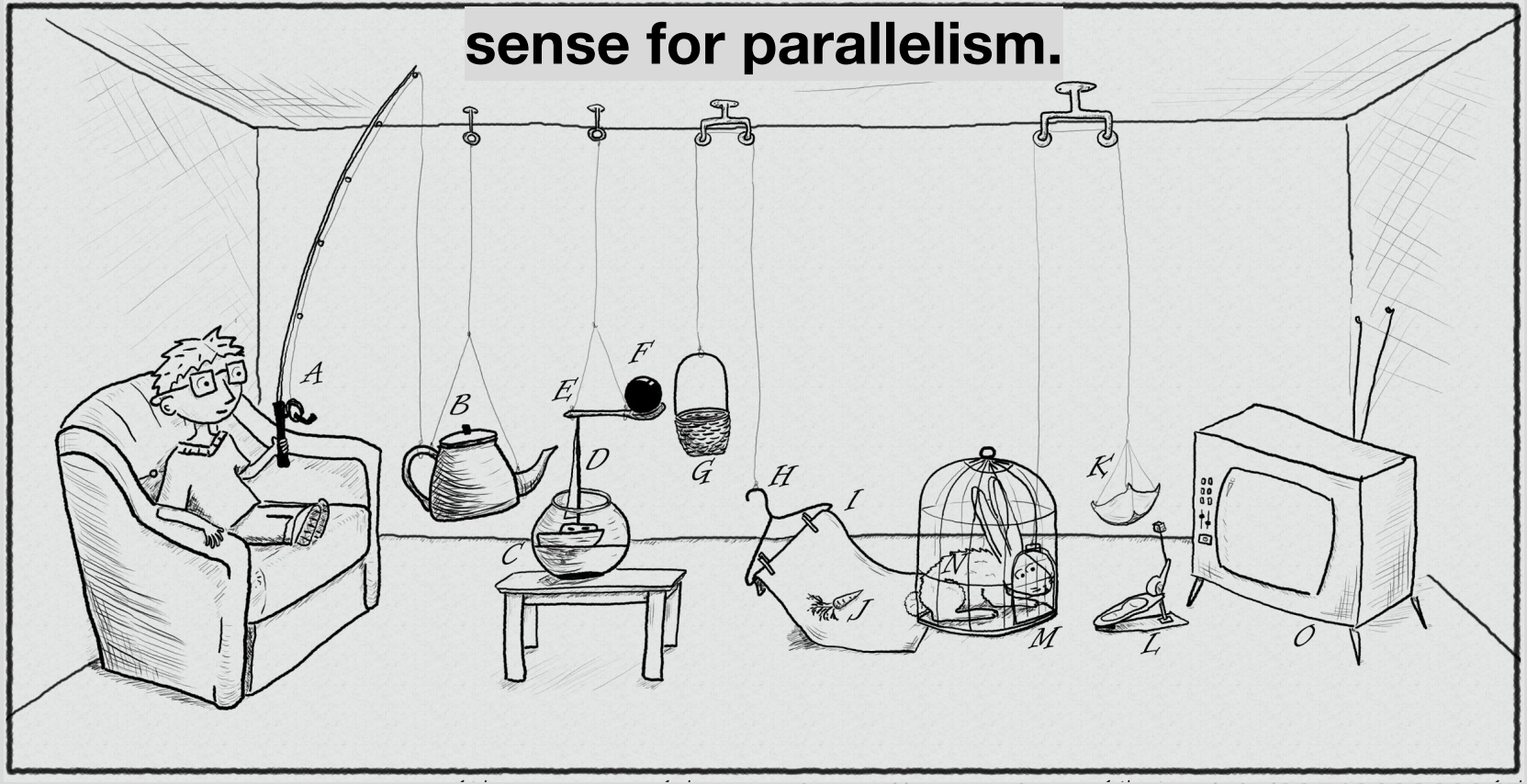
Make the state variable immutable

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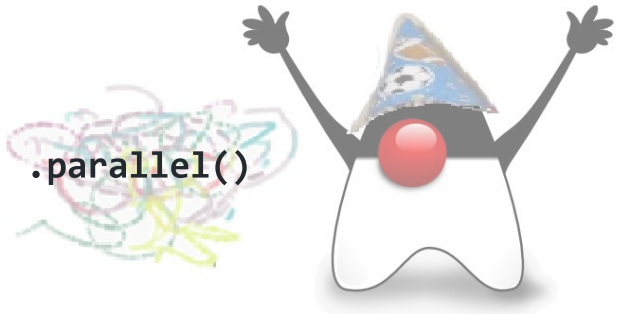
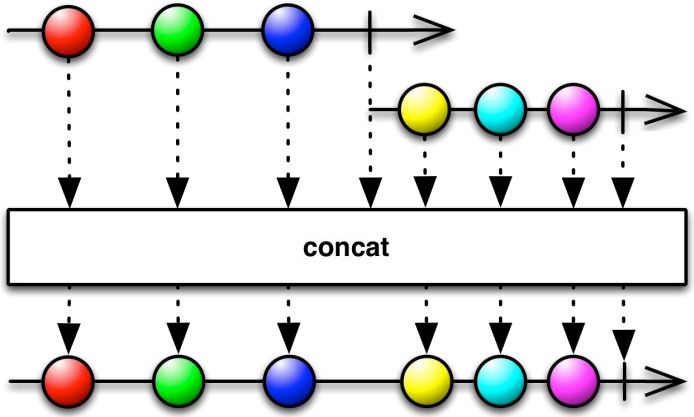
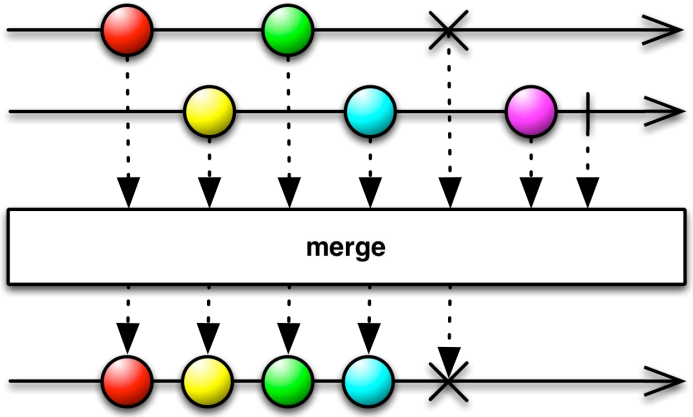
http://blog.takipi.com/forkjoin-framework-vs-parallel-streams-vs-executorservice-the-ultimate-benchmark/

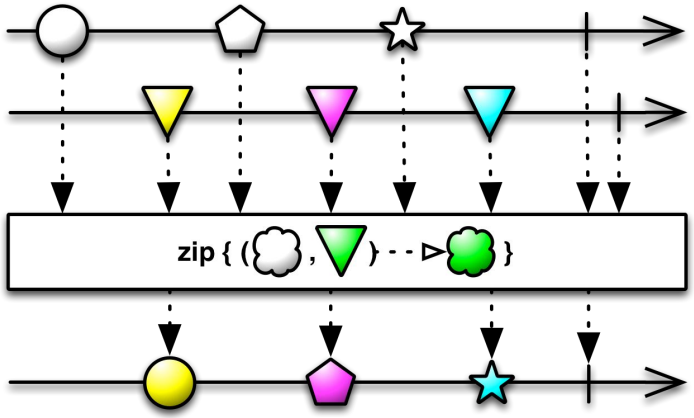
```
Optional<Status> mostPopularTweet = tweets.stream()
```

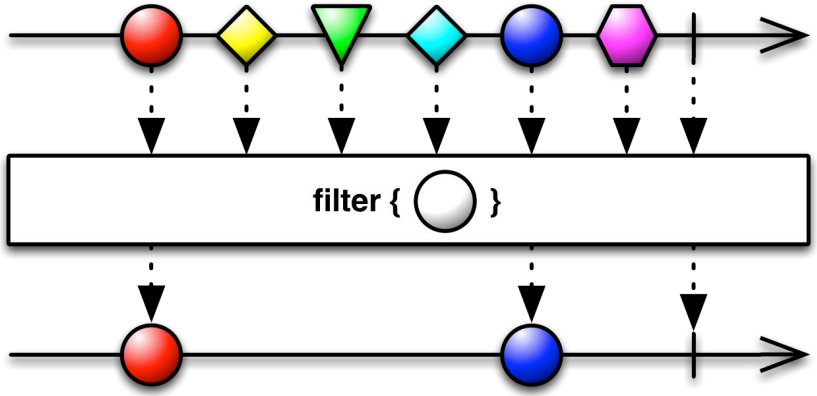


```
        .parallel()
        .filter(tweet -> tweet.getText().toLowerCase().contains(topic.toLowerCase()))
        .filter(tweet -> !tweet.isRetweet())
        .max(comparingInt(tweet -> tweet.getFavoriteCount() + tweet.getRetweetCount()));
```









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

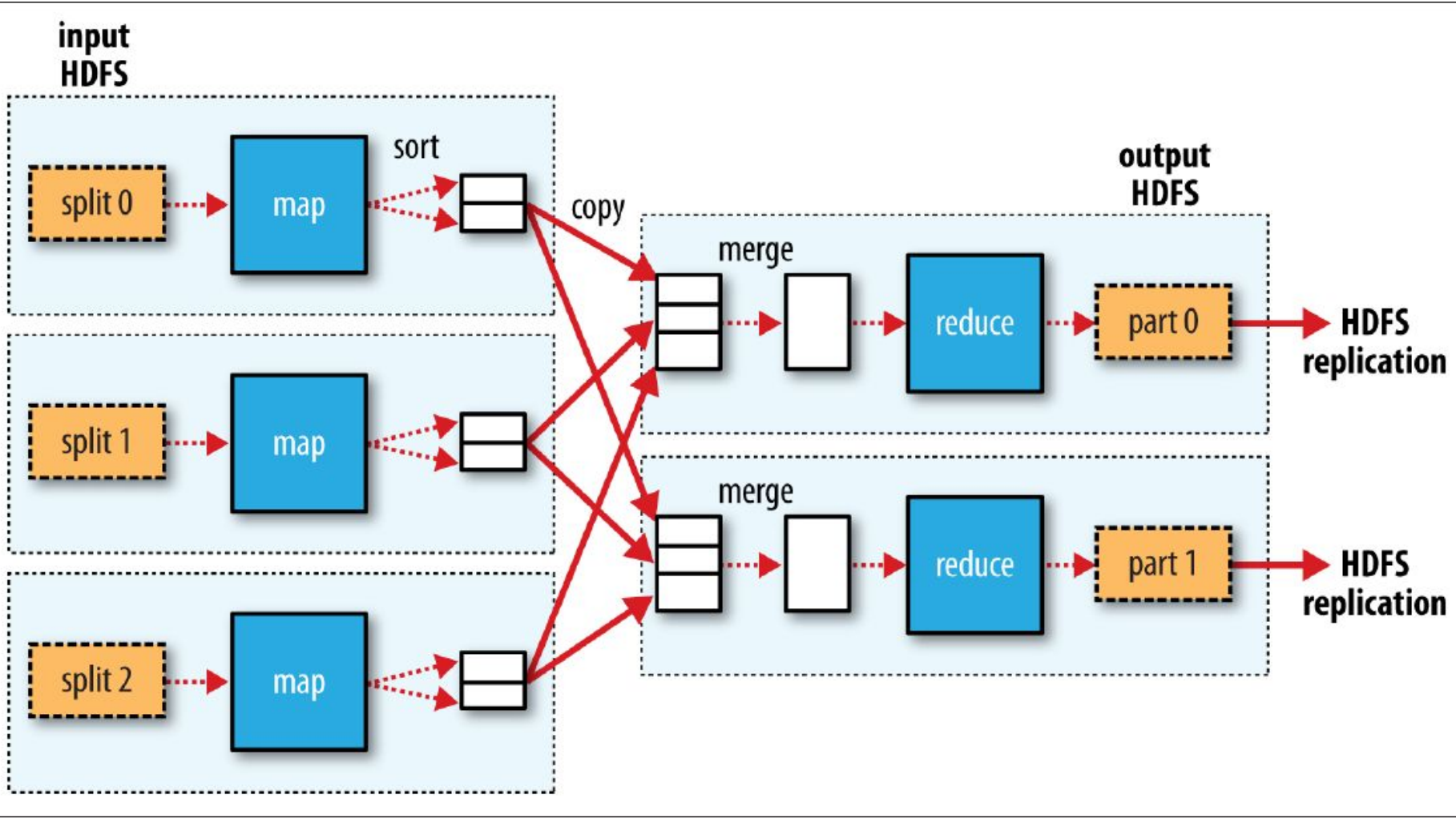
Next you create the resource controller that will serve these greetings.

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:

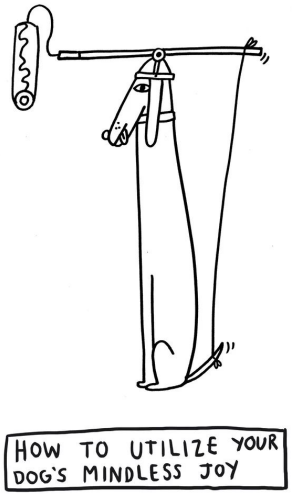
`src/main/java/hello/GreetingController.java`

```
@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

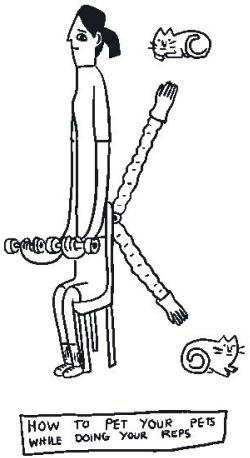
agents

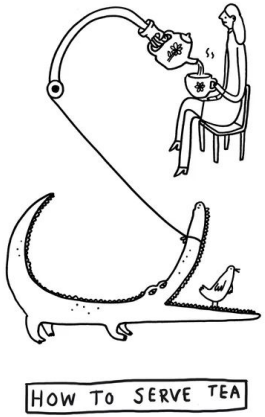
dataflows

remote execution

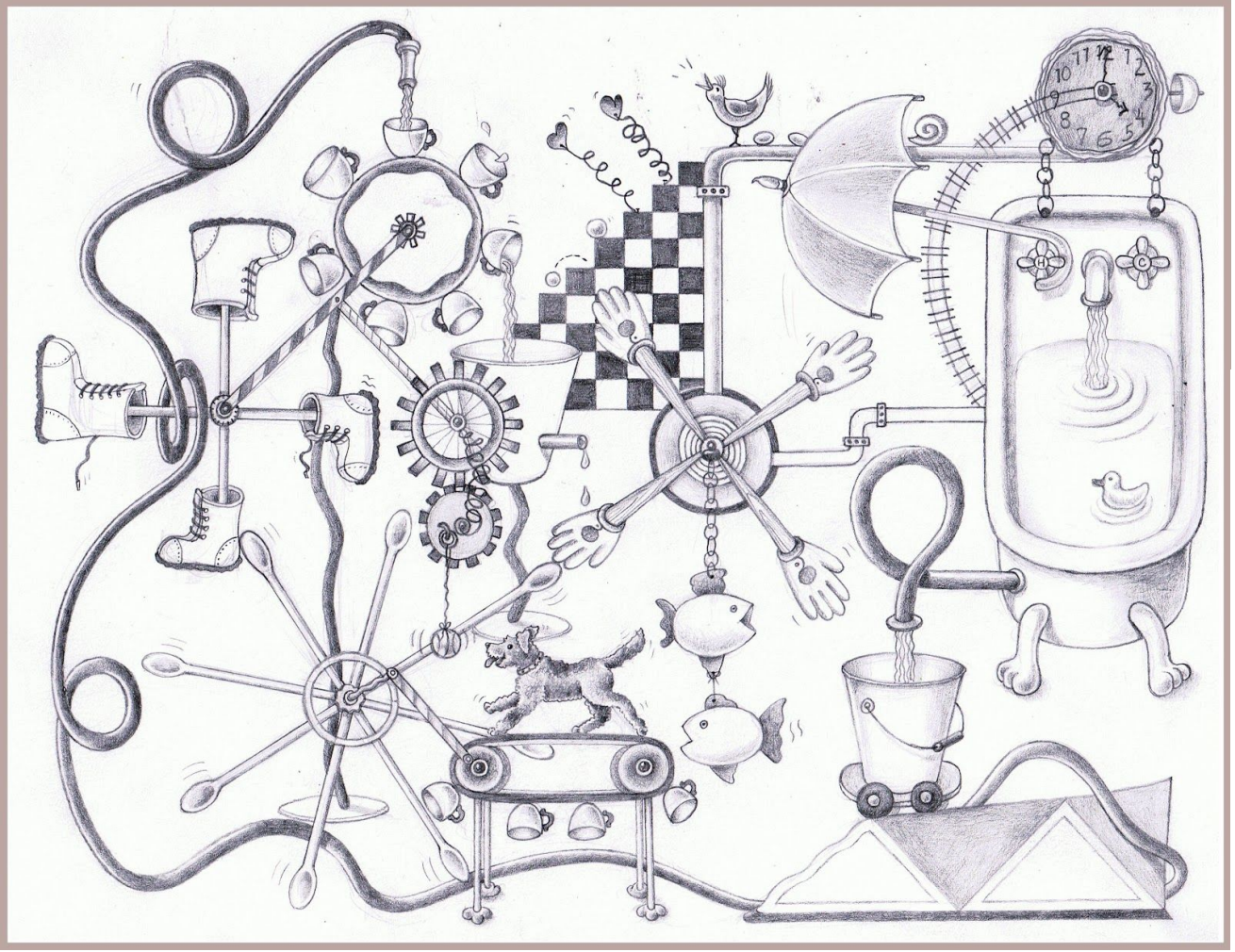
Communicating Sequential Processes

Software Transactional Memory





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

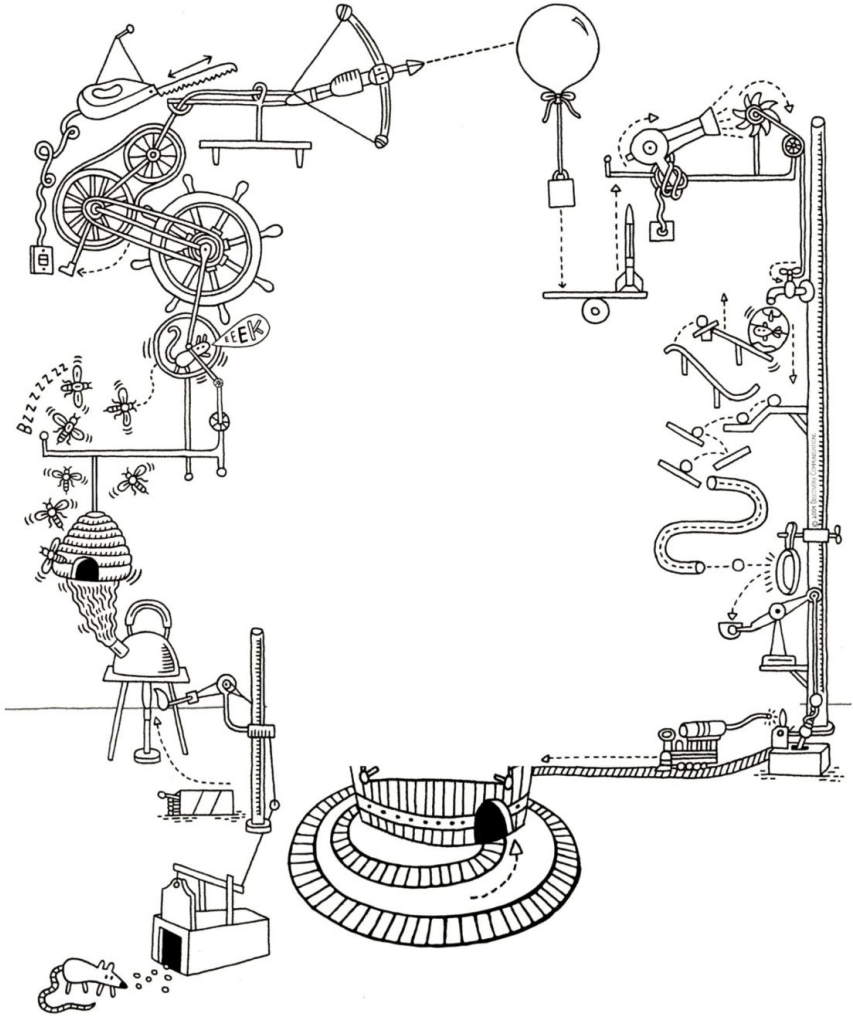


DEMO

goo.gl/PZNNGY

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

JAVA
OR
GROOVY?



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

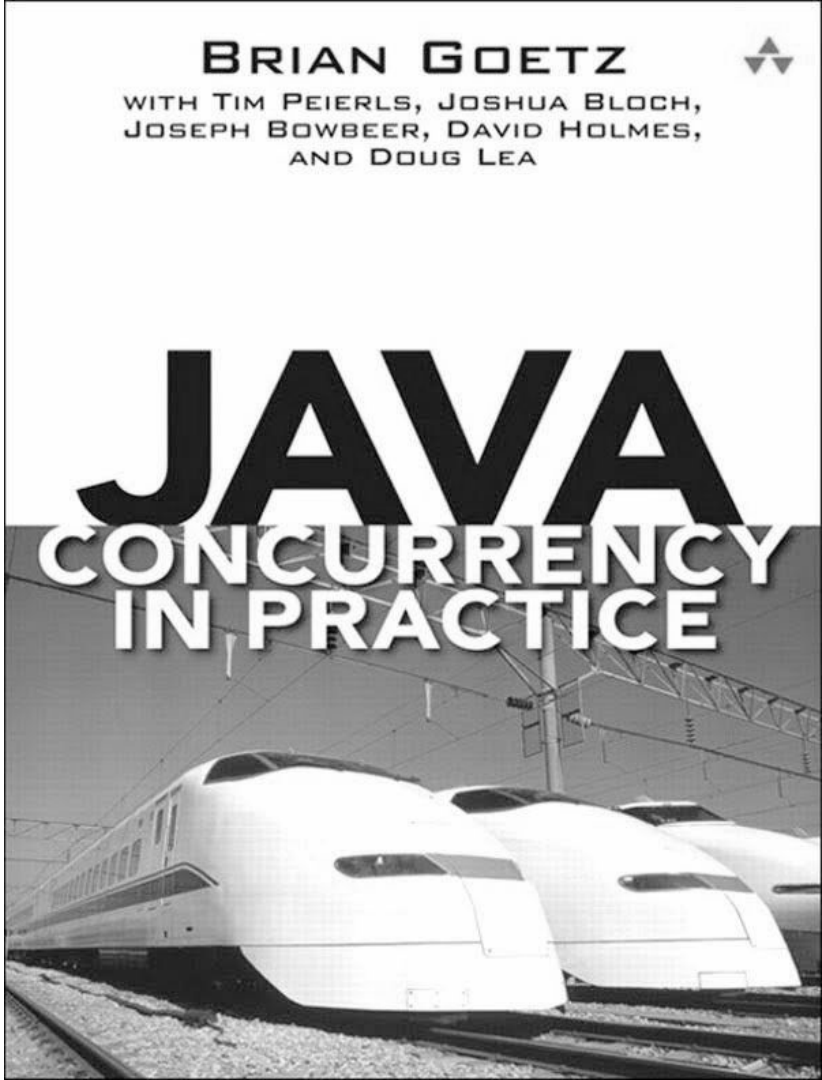
If multiple threads access the same mutable state variable without appropriate synchronization, your program is broken.

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



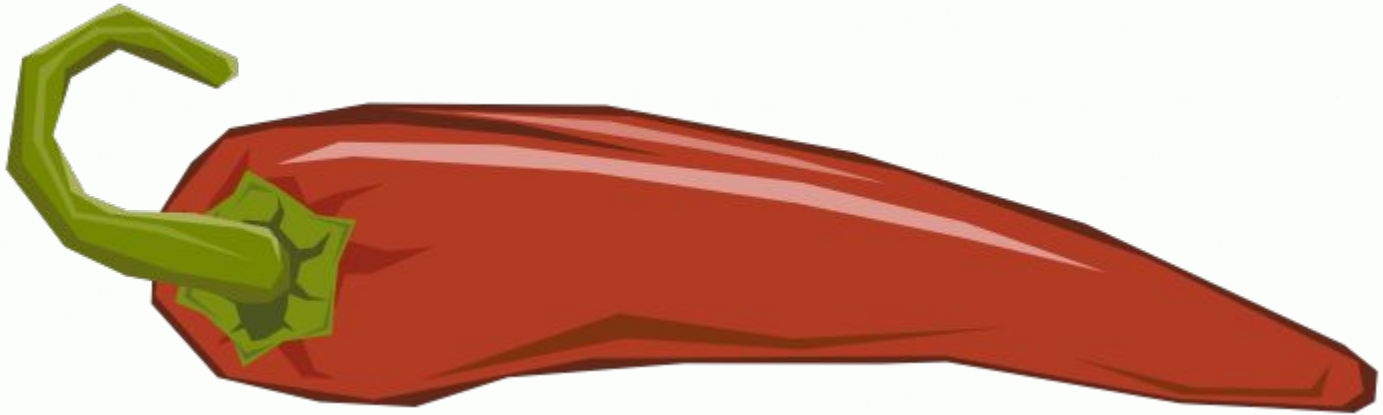
```java
public final class ImmutableJavaPerson {

    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
    }

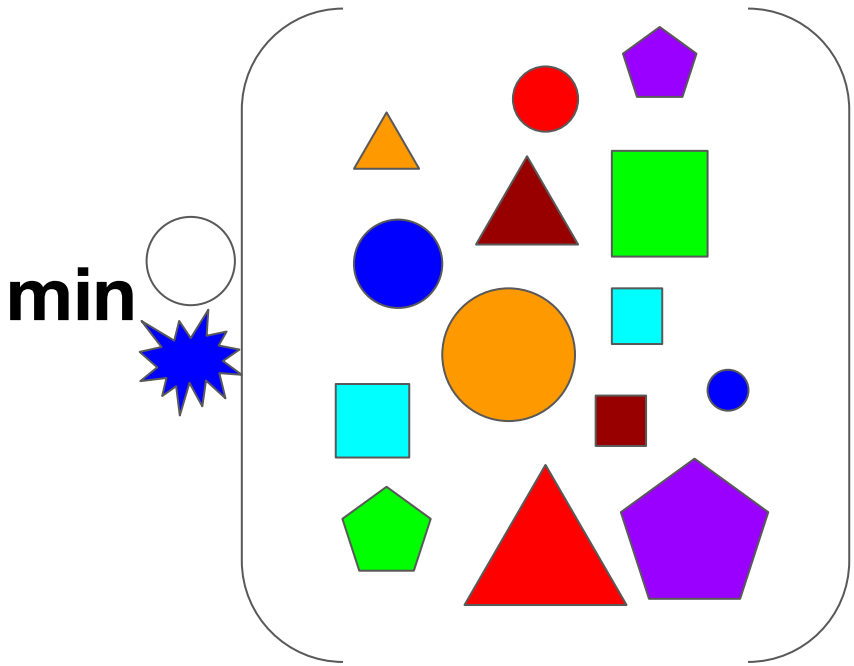
    @WithWriteLock
    void increment() {
        counter = counter + 1
    }
}
```

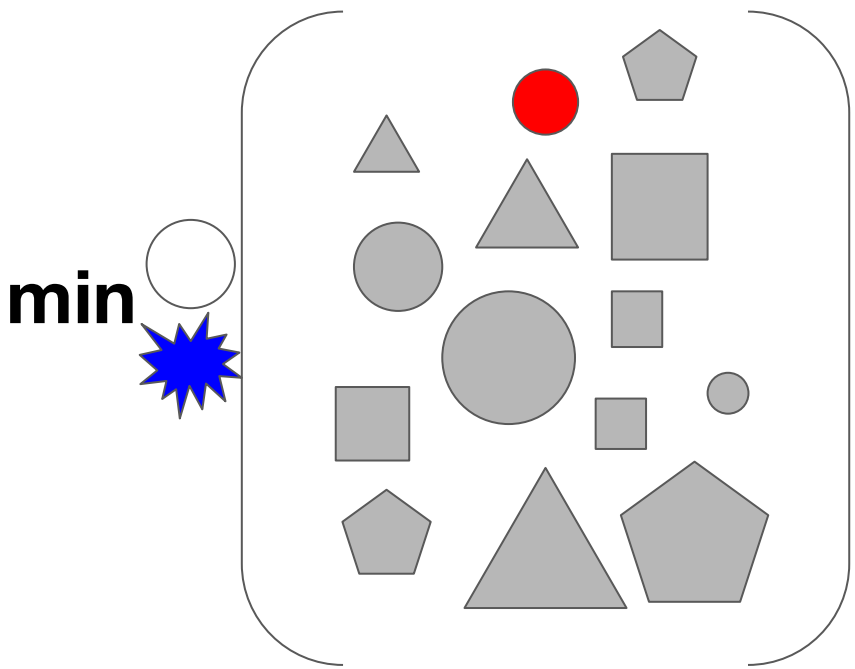
```
def thread1 = Thread.start {
   println "Hello from ${Thread.currentThread().name}"
}


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()
```


min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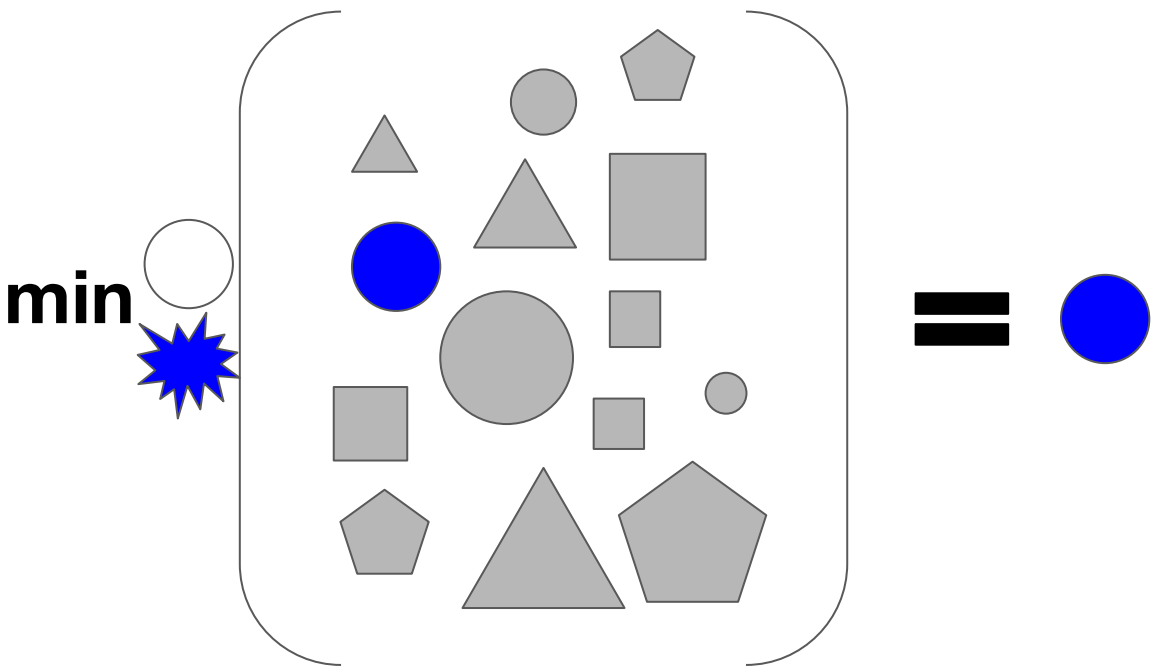
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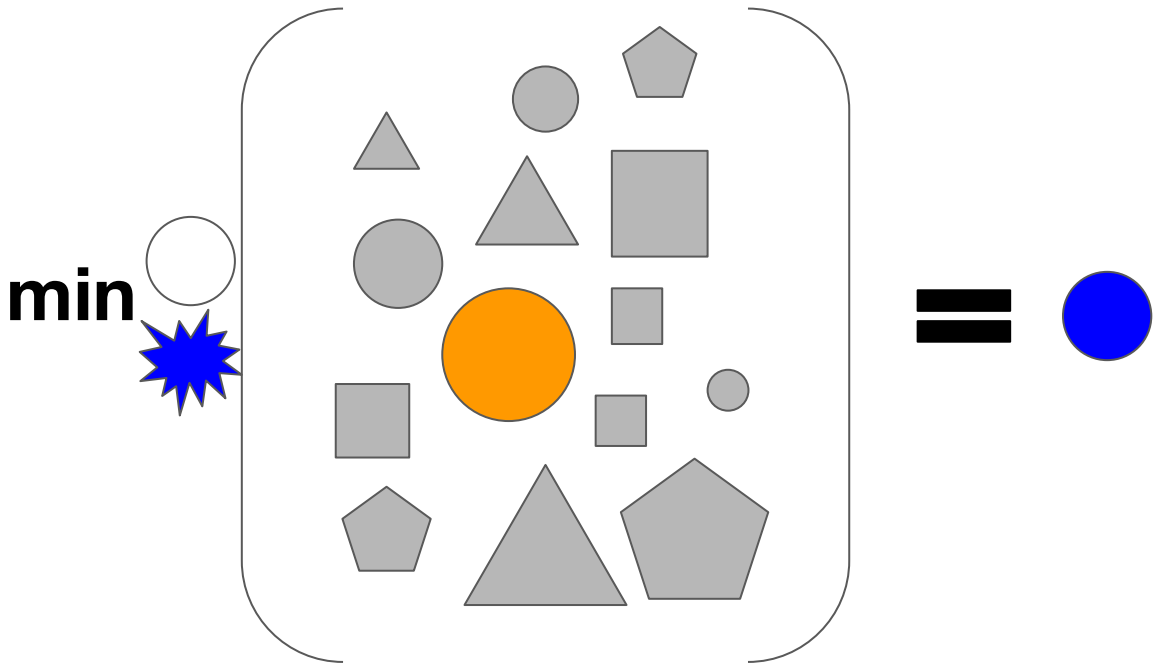
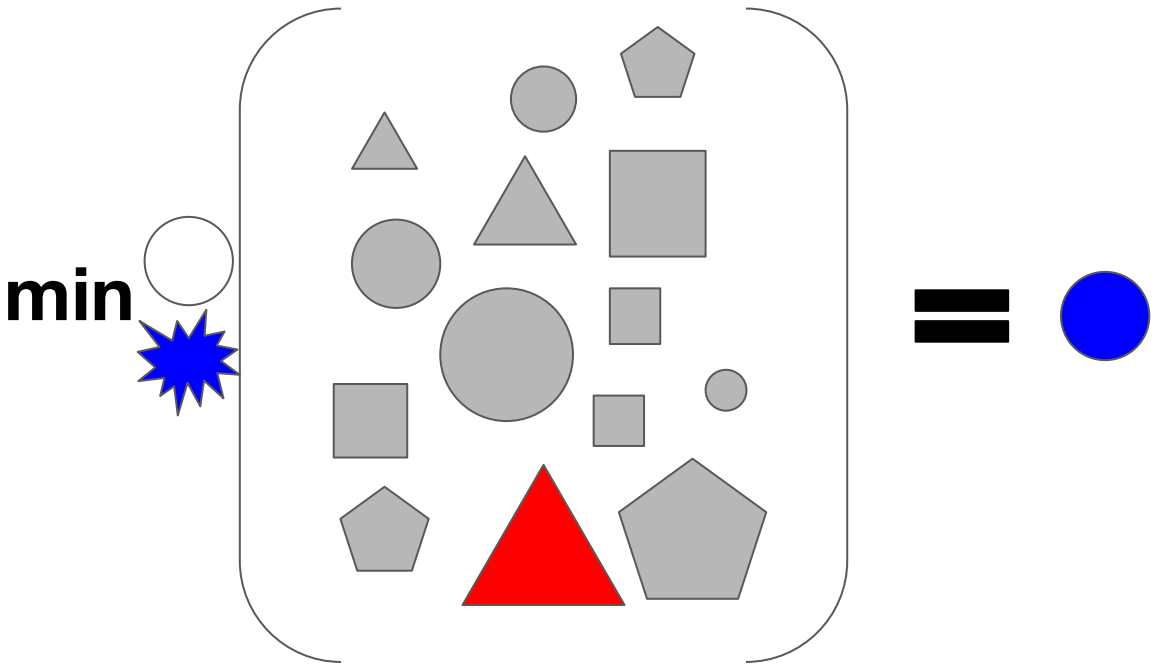

min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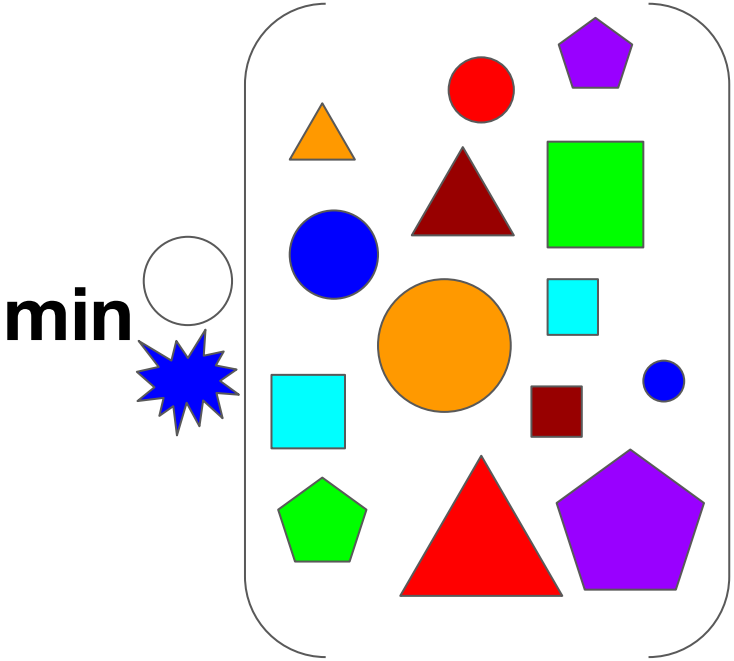
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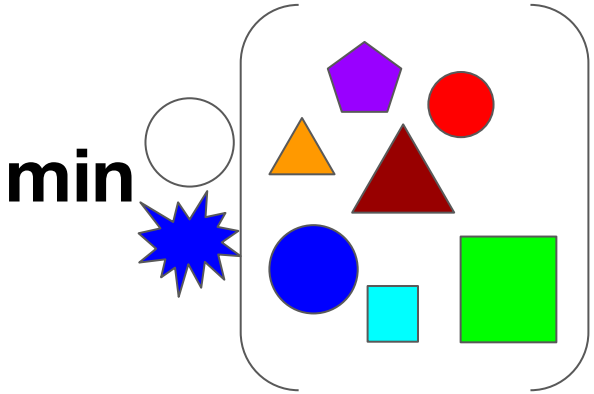
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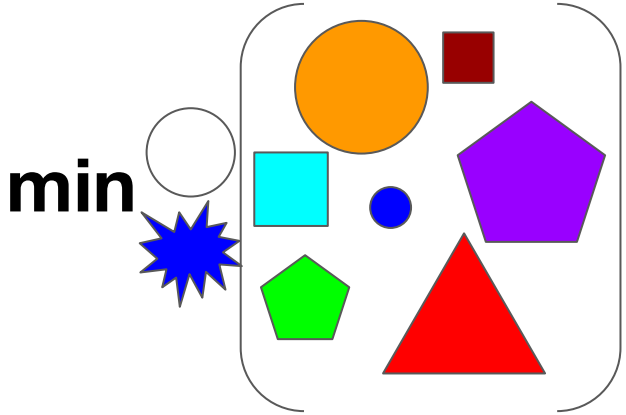
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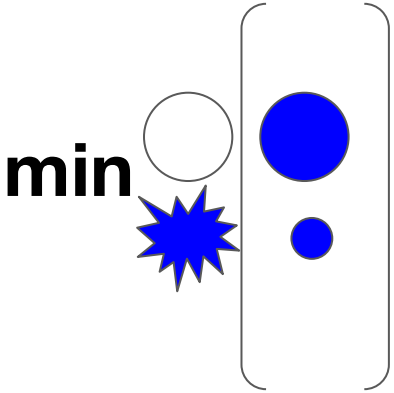
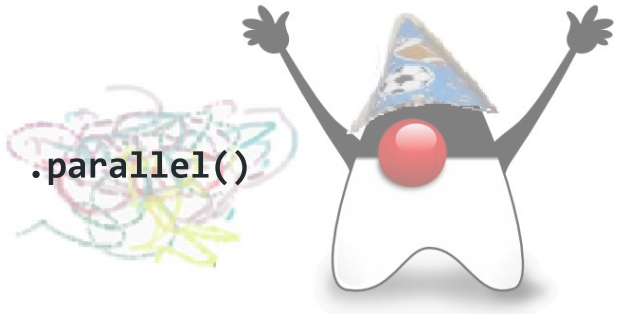
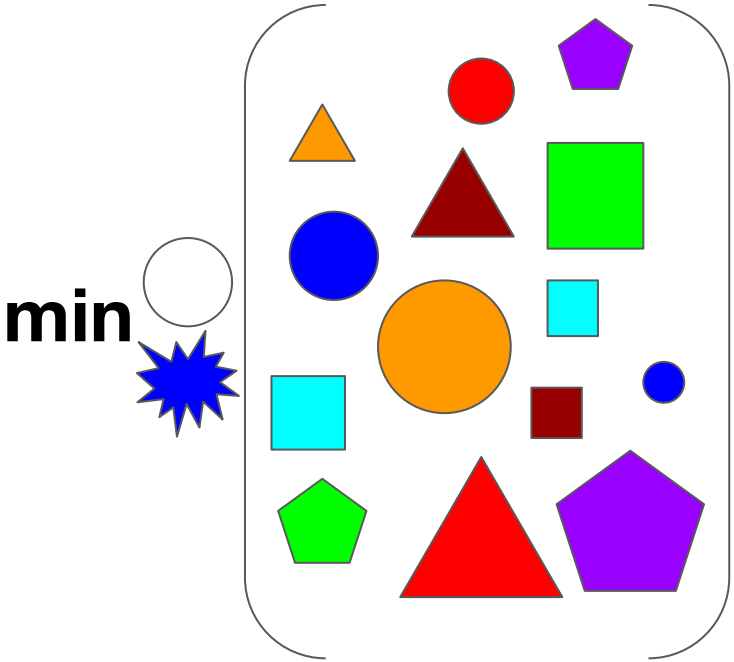

min

```
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()));
```

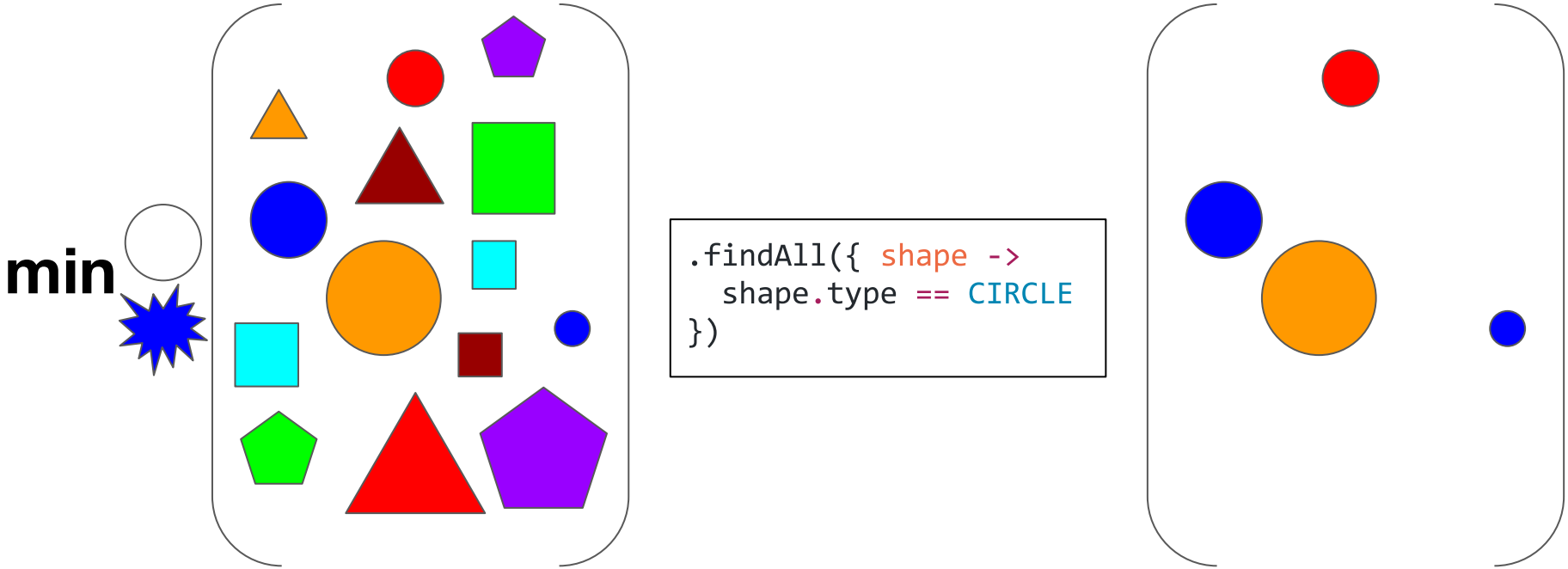
```
Optional<Shape> minBlueCircle = shapes.stream()
                    .parallel()
                    .filter(shape -> shape.getType() == CIRCLE)
                    .filter(shape -> shape.getColor() == BLUE)
                    .min(comparingInt(shape -> shape.getSize()));
```



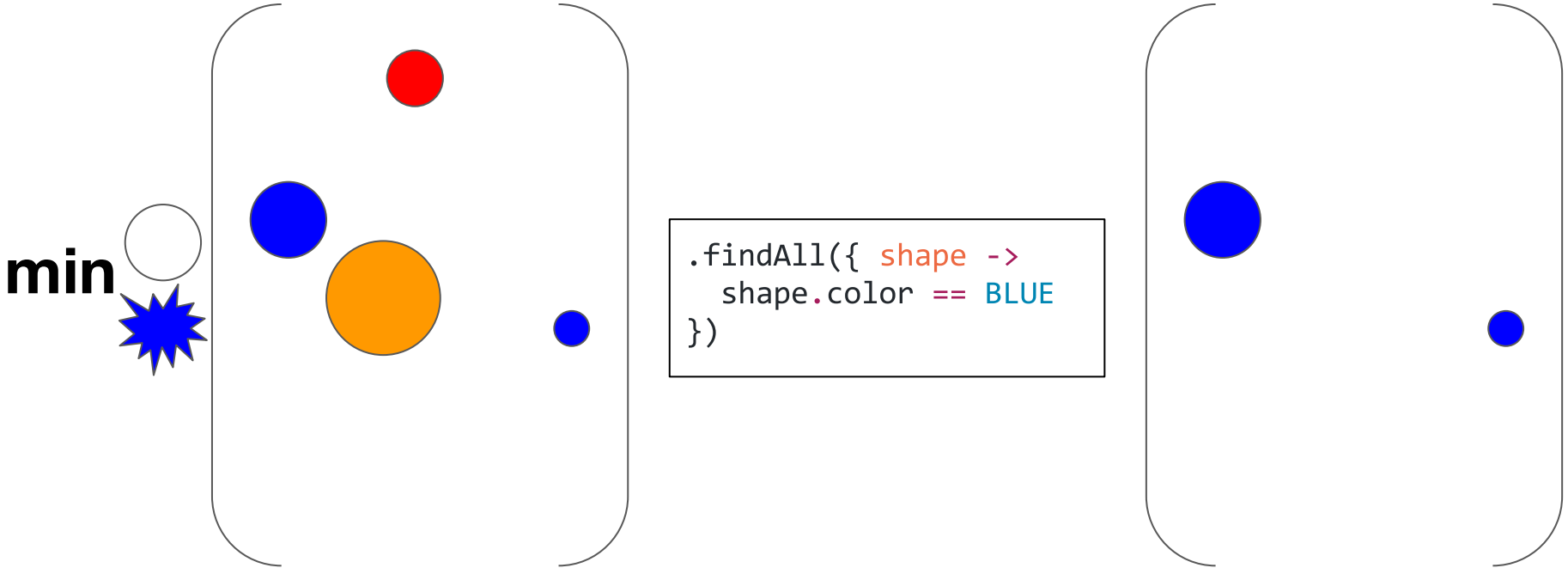

```
.filter(shape -> shape.getType() == CIRCLE)
.filter(shape -> shape.getColor() == BLUE)
.min(comparingInt(shape -> shape.getSize()));
```

```
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 })
```



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ParallelEnhancer.enhanceInstance shapes
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        .findAll({ shape -> shape.type == CIRCLE })
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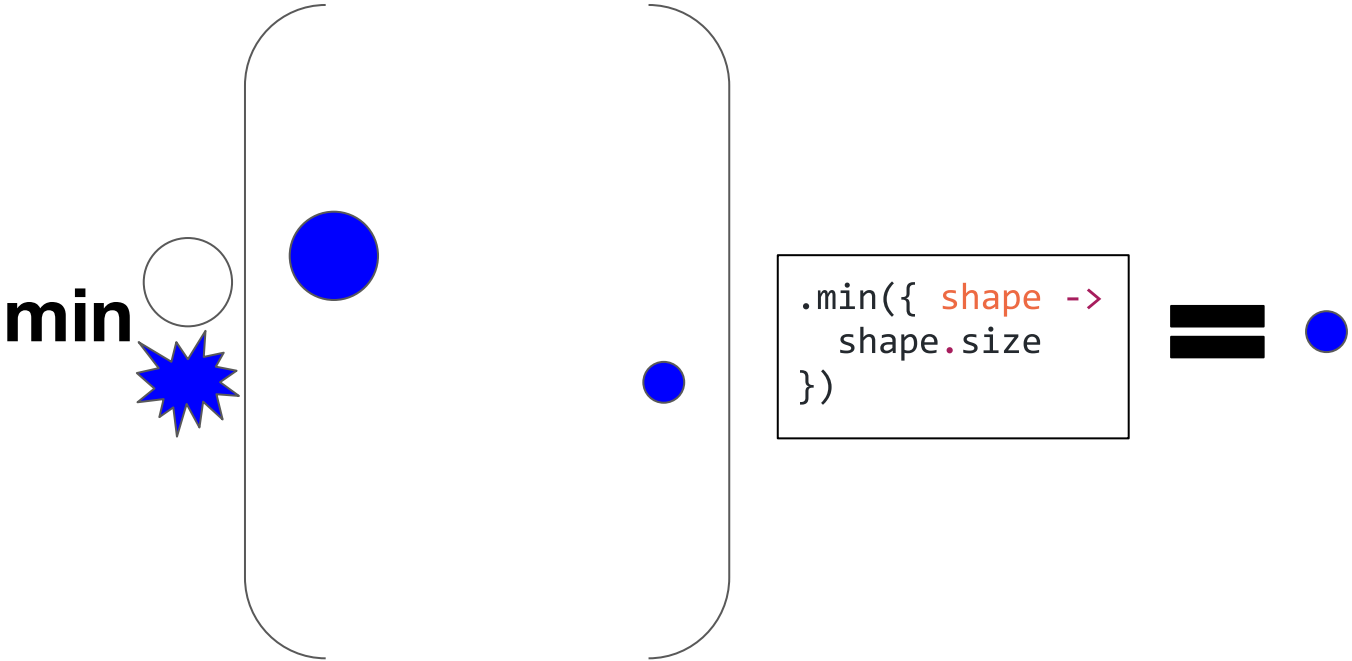
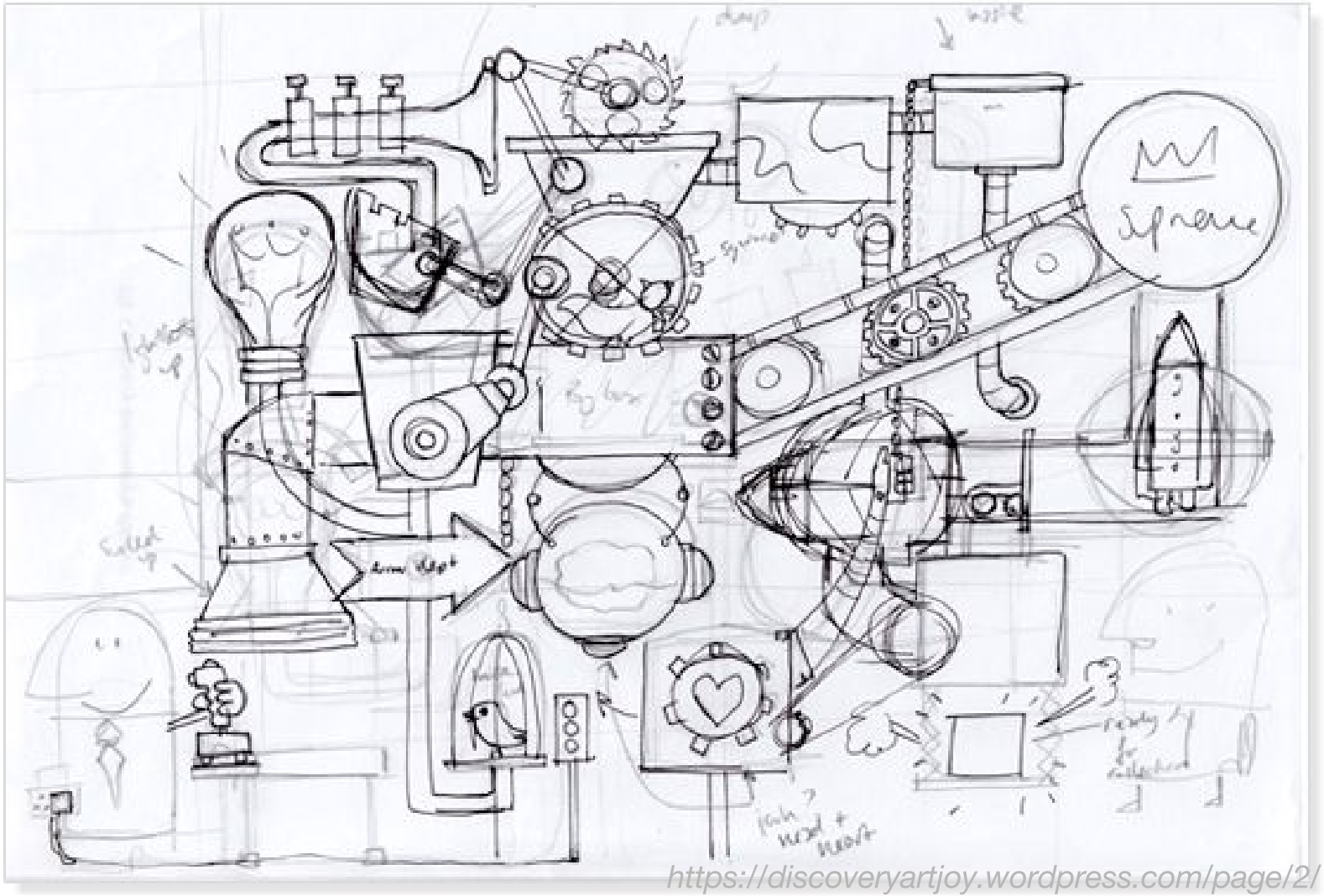
        .min({ shape -> shape.size })
```



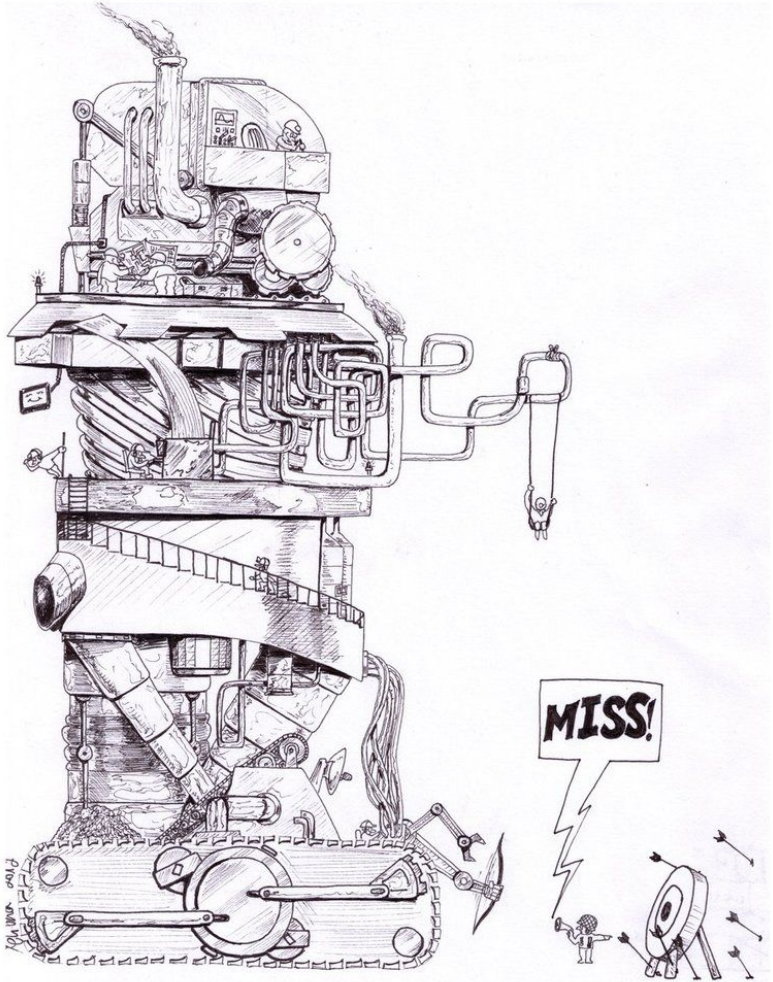
```groovy
def findMostPopularTweet = { Map params ->
    String topic = params.about
    Collection tweets = params.from

    withPool {
        tweets.parallel.filter({ Status tweet ->
            tweet.text.toLowerCase().contains(topic.toLowerCase())
        }).filter({ Status tweet ->
            !tweet.retweet
        }).map({ Status tweet ->
            [
                user: tweet.user.screenName,
                text: tweet.text,
                favourited: tweet.favoriteCount,
                retweeted: tweet.retweetCount
            ]
        }).max({
            it.favourited + it.retweeted
        })
    }
}

def result = findMostPopularTweet about: 'gpars', from: jeeconfTweets
```

WITH POOL



```
withPool {

    Closure fetchLatestTweets = twitter.&fetchLatestTweets.asyncFun()
    Closure determineTopic = topics.&determineTopic.asyncFun()
    Closure aggregateTopics = topics.&aggregateTopics.asyncFun()
    Closure fetchNewsAbout = news.&fetchNewsAbout.asyncFun()
    Closure filterMostImportant = news.&filterMostImportant.asyncFun()


    Promise topics = determineTopic(fetchLatestTweets)


    Promise aggregatedTopics = topics.get().inject({ t1, t2 -> aggregateTopics(t1, t2) })


    aggregatedTopics.then {
        fetchNewsAbout(it)
    }.then {
        filterMostImportant(it)
    }.then {
        println it
    }.join()
}
```

```
withPool {

    Closure fetchLatestTweets = twitter.&fetchLatestTweets.asyncFun()
    Closure determineTopic = topics.&determineTopic.asyncFun()
    Closure aggregateTopics = topics.&aggregateTopics.gmemoize()
    Closure fetchNewsAbout = news.&fetchNewsAbout.asyncFun()
    Closure filterMostImportant = news.&filterMostImportant.asyncFun()


    Promise topics = determineTopic(fetchLatestTweets)


    Promise aggregatedTopics = topics.get().inject({ t1, t2 -> aggregateTopics(t1, t2) })


    aggregatedTopics.then {
        fetchNewsAbout(it)
    }.then {
        filterMostImportant(it)
    }.then {
        println it
    }.join()
}
```



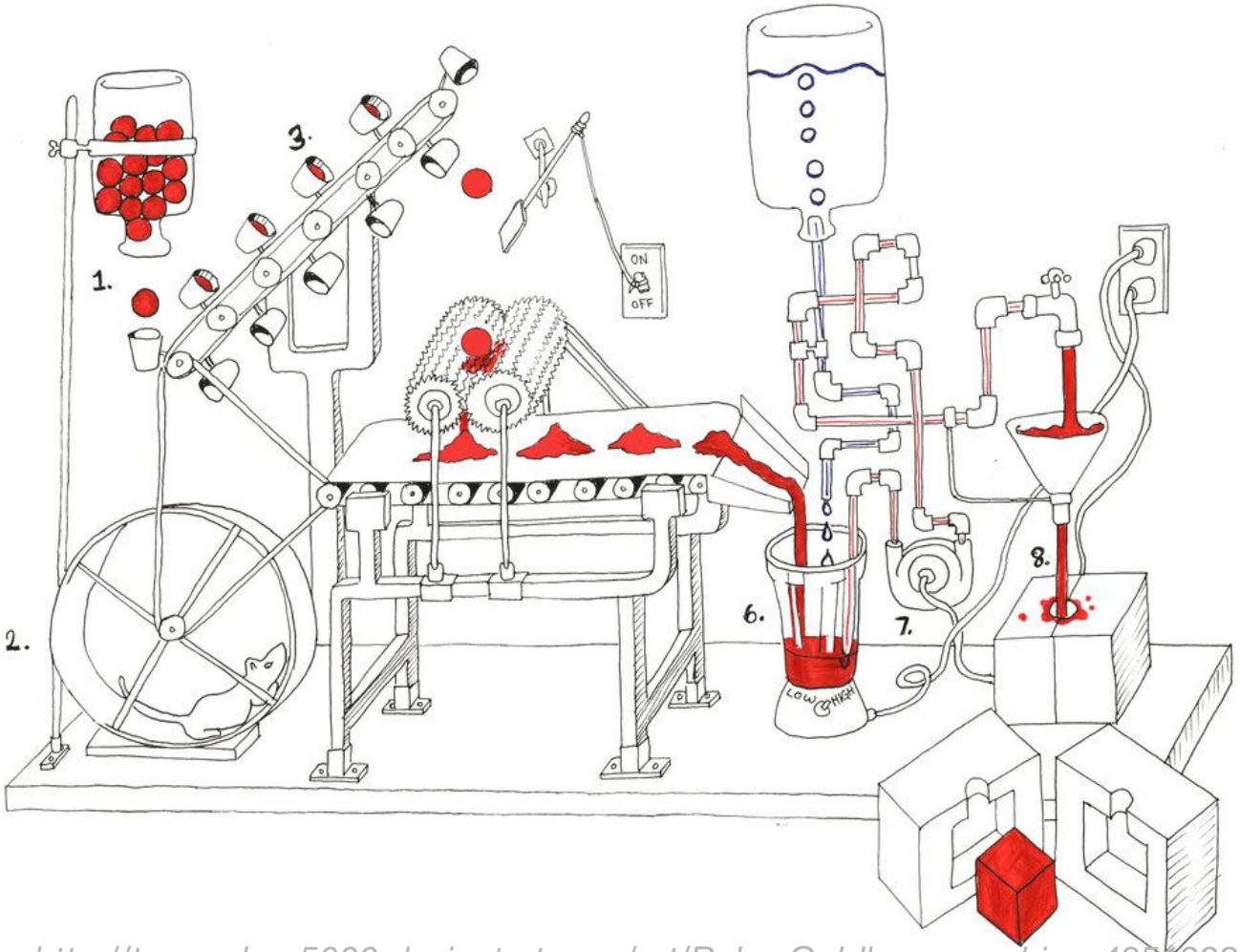
AGENTS

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

```
def stringGuard = new Agent<String>()
28.times {
    Thread.start {
        stringGuard { updateValue(it + '|' + Thread.currentThread().name) }
    }
}
println stringGuard.val

def listGuard = new Agent<List<String>>()
43.times {
    Thread.start {
        listGuard { it.add(Thread.currentThread().name) }
    }
}
listGuard.valAsync {
    println it
}
```

```
final Agent<String> stringGuard = new Agent<>();
stringGuard.send(new MessagingRunnable<String>() {
    @Override
    protected void doRun(String value) {
        stringGuard.updateValue(value + '|' + Thread.currentThread().getName());
    }
});
System.out.println(stringGuard.getVal());

final Agent<List<String>> listGuard = new Agent<>();
listGuard.send(new ArrayList<>());
listGuard.send(new MessagingRunnable<List<String>>() {
    @Override
    protected void doRun(List<String> value) {
        value.add(Thread.currentThread().getName());
    }
});
listGuard.valAsync(new MessagingRunnable<List<String>>() {
    @Override
    protected void doRun(List<String> value) {
        System.out.println(value);
    }
});
```

ACTORS

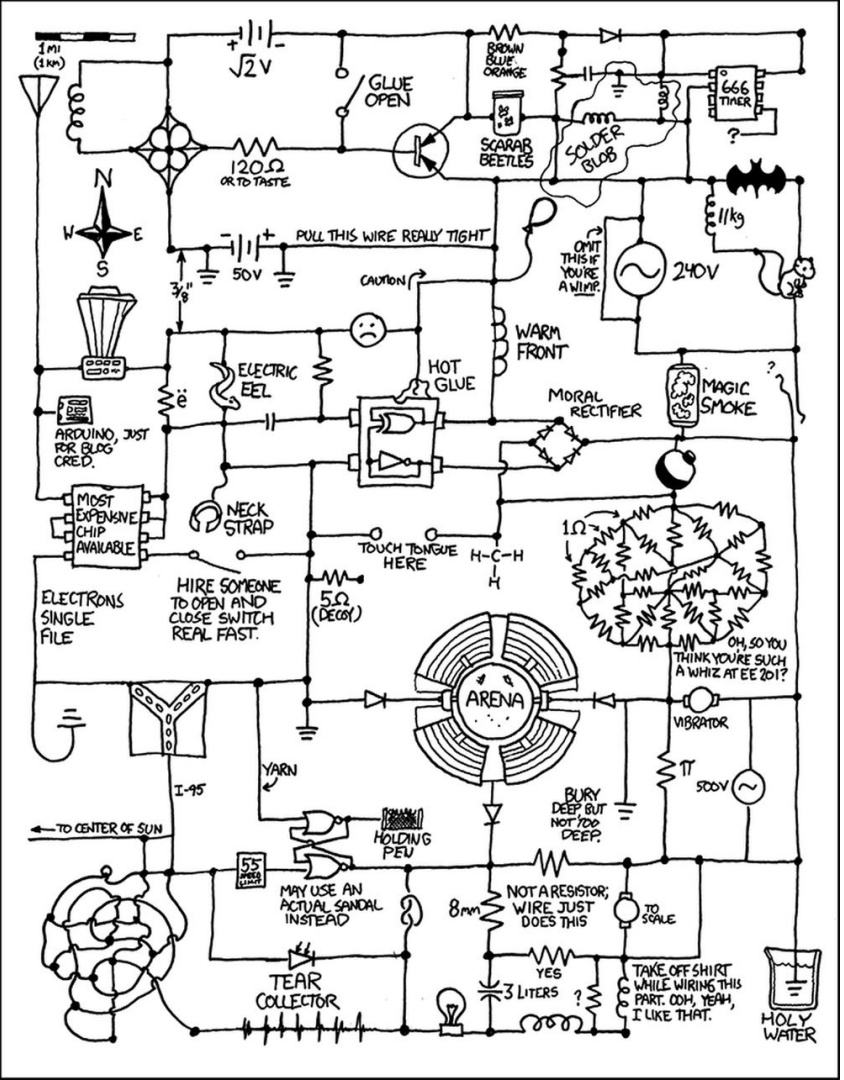


http://tommyboy5000.deviantart.com/art/Rube-Goldberg-machine-485199926

```
def main = actor {
    loop {
        fetchLatestNews.send()
        react { latestNews ->
            extractText latestNews

            react { text -> save text }
        }
    }
}

def fetchLatestNews = reactor {
    news.fetchLatest()
}

def extractText = messageHandler {
    when { Tweet tweet -> reply tweet.status }
    when { FacebookPost facebookPost -> reply facebookPost.post }
    when { BlogArticle blogArticle -> reply blogArticle.text }
}

def save = reactor { text ->
    println text
}
```

```
final Closure handler = new ReactorMessagingRunnable() {

    @Override
    protected Object doRun(Object argument) {
        return news.fetchLatest();
    }
};


final Actor actor = new ReactiveActor(handler);
actor.start();
```

```
public class MessageHandler extends DynamicDispatchActor {


    public void onMessage(final Tweet tweet) {
        replyIfExists(tweet.getStatus());
    }


    public void onMessage(final FacebookPost facebookPost) {
        replyIfExists(facebookPost.getPost());
    }


    public void onMessage(final BlogArticle blogArticle) {
        replyIfExists(blogArticle.getText());
    }
}
```



DATAFLOWS

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

```
final dataflow = new Dataflows()


task {
   dataflow.numberOfInteractions = dataflow.retweets + dataflow.facebookLikes
}


task {
   dataflow.retweets = twitter.numberOfRetweets(article)
}


task {
   dataflow.facebookLikes = facebook.numberofLikes(article)
}


println dataflow.numberOfInteractions
```

```
final DataflowVariable<Integer> numberOfInteractions = new DataflowVariable<>();
final DataflowVariable<Integer> retweets = new DataflowVariable<>();
final DataflowVariable<Integer> facebookLikes = new DataflowVariable<>();

task((Runnable) () -> {
   try {
       numberOfInteractions.bind(retweets.getVal() + facebookLikes.getVal());
   } catch (InterruptedException e) {
       throw new RuntimeException(e);
   }
});

task(() -> retweets.bind(twitter.numberOfRetweets(article)));

task(() -> facebookLikes.bind(facebook.numberofLikes(article)));

System.out.println(numberOfInteractions.getVal());
```

```
def retweets = new DataflowQueue()
def facebookLikes = new DataflowQueue()
def numberOfInteractions = new DataflowQueue()


operator(
    inputs: [ retweets, facebookLikes ],
    outputs: [ numberOfInteractions ],
    { retweetsCount, facebookLikesCount ->
        numberOfInteractions << retweetsCount + facebookLikesCount
    }
)

task {
    ALL_ARTICLES.each { article -> retweets << twitter.numberOfRetweets(article) }
}

task {
    ALL_ARTICLES.each { article -> facebookLikes << facebook.numberofLikes(article) }
}
```

```
final DataflowQueue retweets = new DataflowQueue();
final DataflowQueue facebookLikes = new DataflowQueue();
final DataflowQueue numberOfInteractions = new DataflowQueue();


operator(
 asList(retweets, facebookLikes),
 asList(numberOfInteractions),
 new DataflowMessagingRunnable(2) {

   @Override
   protected void doRun(Object... arguments) {
       getOwningProcessor().bindOutput((Integer)arguments[0] + (Integer)arguments[1]);
   }
});



task(() -> ALL_ARTICLES.forEach(a -> retweets.bind(twitter.numberOfRetweets(a))));

task(() -> ALL_ARTICLES.forEach(a -> facebookLikes.bind(facebook.numberOfLikes(a))));
```

WHY USE GPARS?

TO IMPROVE PERFORMANCE OF SEQUENTIAL CODE

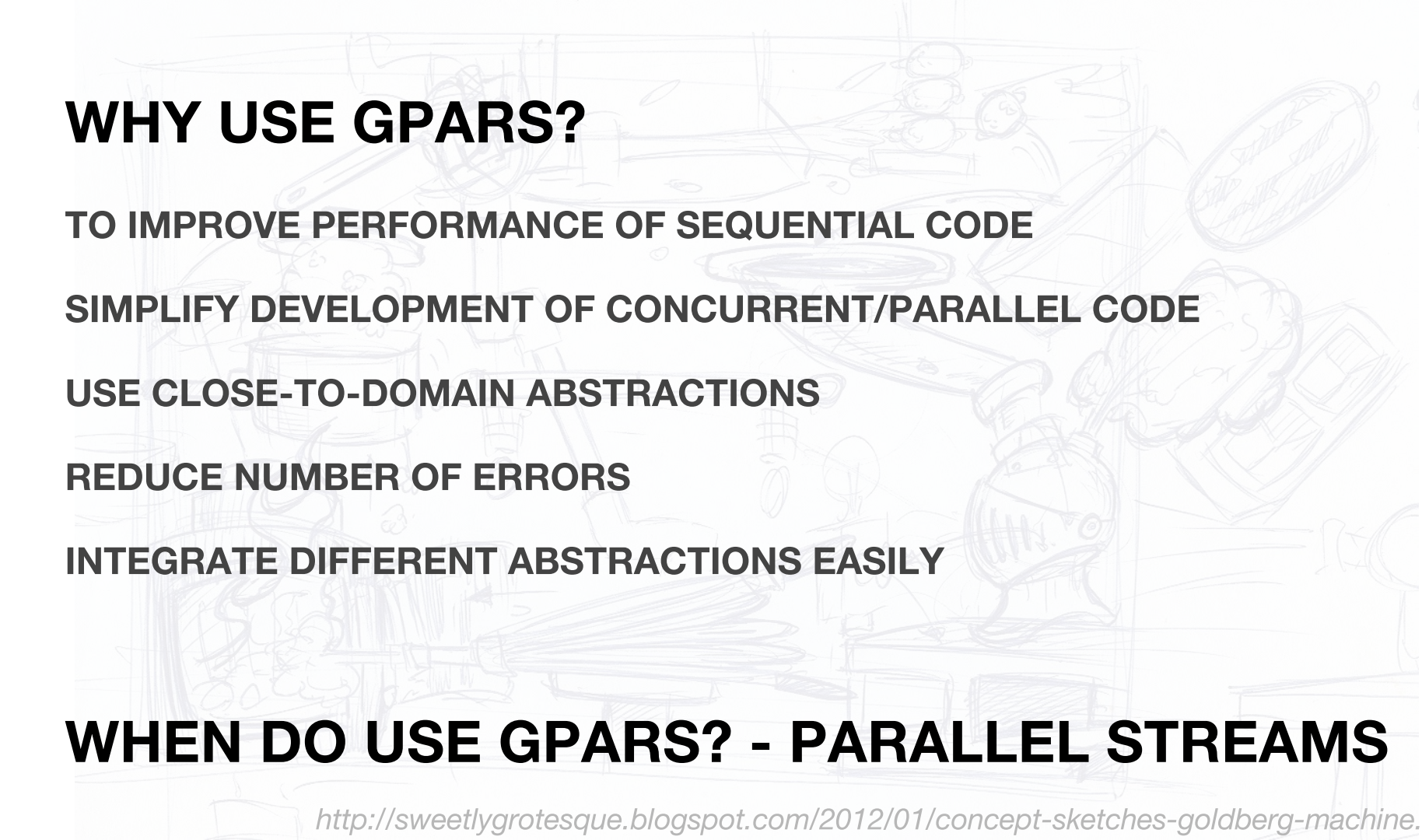
SIMPLIFY DEVELOPMENT OF CONCURRENT/PARALLEL CODE

USE CLOSE-TO-DOMAIN ABSTRACTIONS

REDUCE NUMBER OF ERRORS

INTEGRATE DIFFERENT ABSTRACTIONS EASILY

WHEN DO USE GPARS? - PARALLEL STREAMS



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

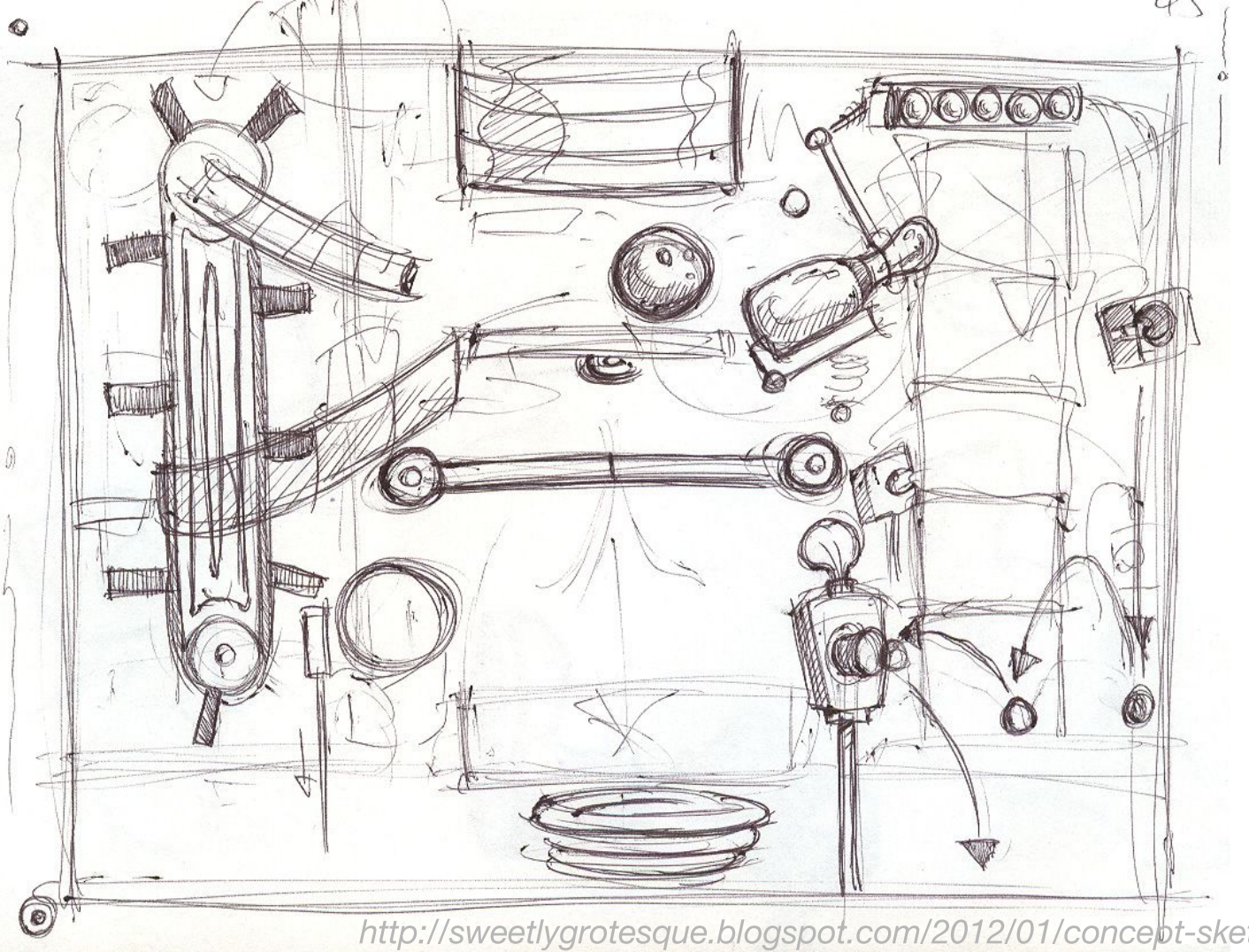
FURTHER DIVE

[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