Miles or Kilometers?

Why Your Data Schema Should Include Units

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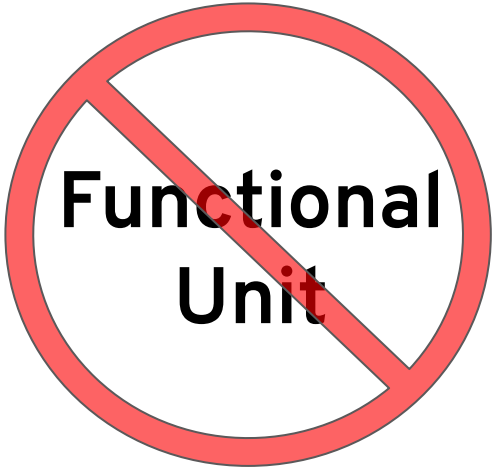
“Unit” is Overloaded



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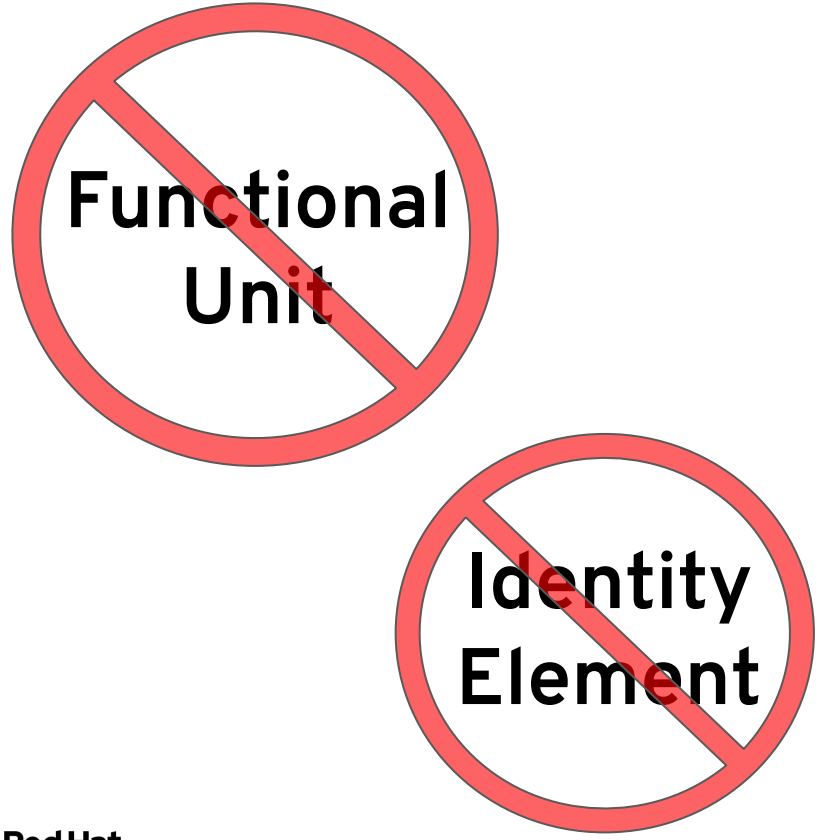

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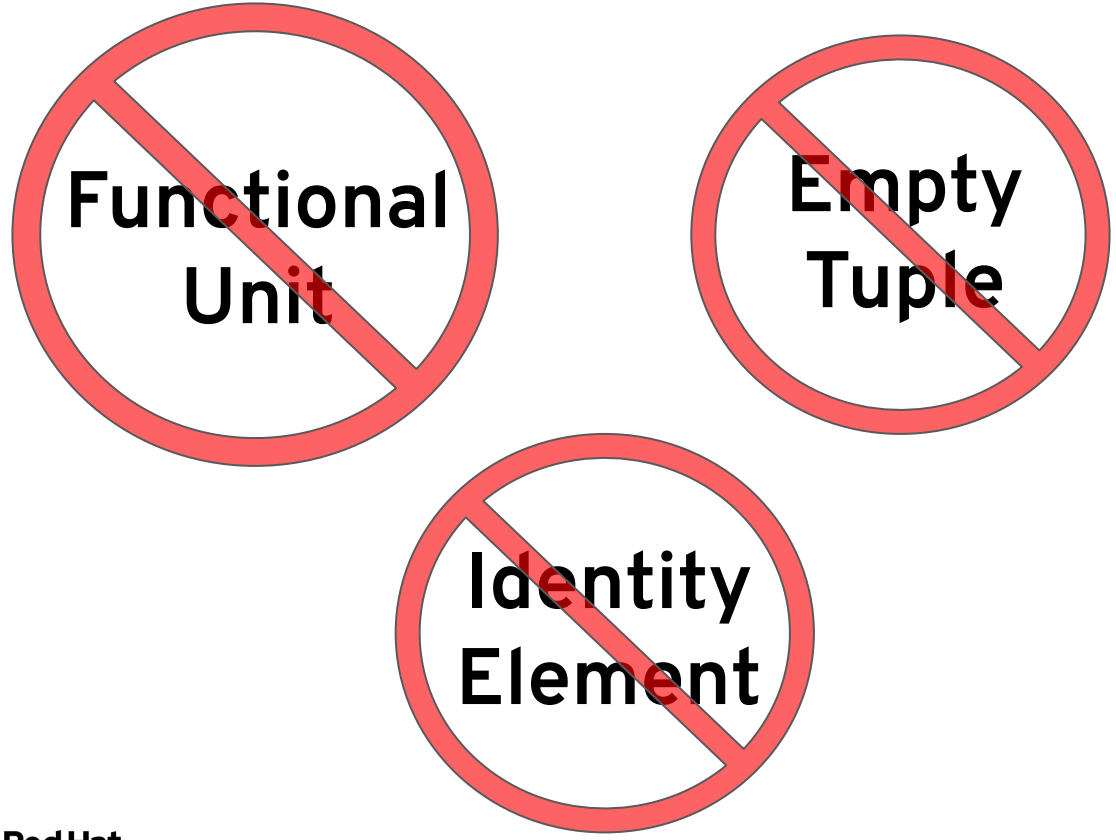

“Unit” is Overloaded

Functional Unit

Empty Tuple

Identity Element

in awe at the size of this lad.
absolute unit.

Units of Measure

Units of Measure

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Units from Software

latency: seconds, milliseconds

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memory limit: megabytes, gigabits, tebibytes

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Units from Software

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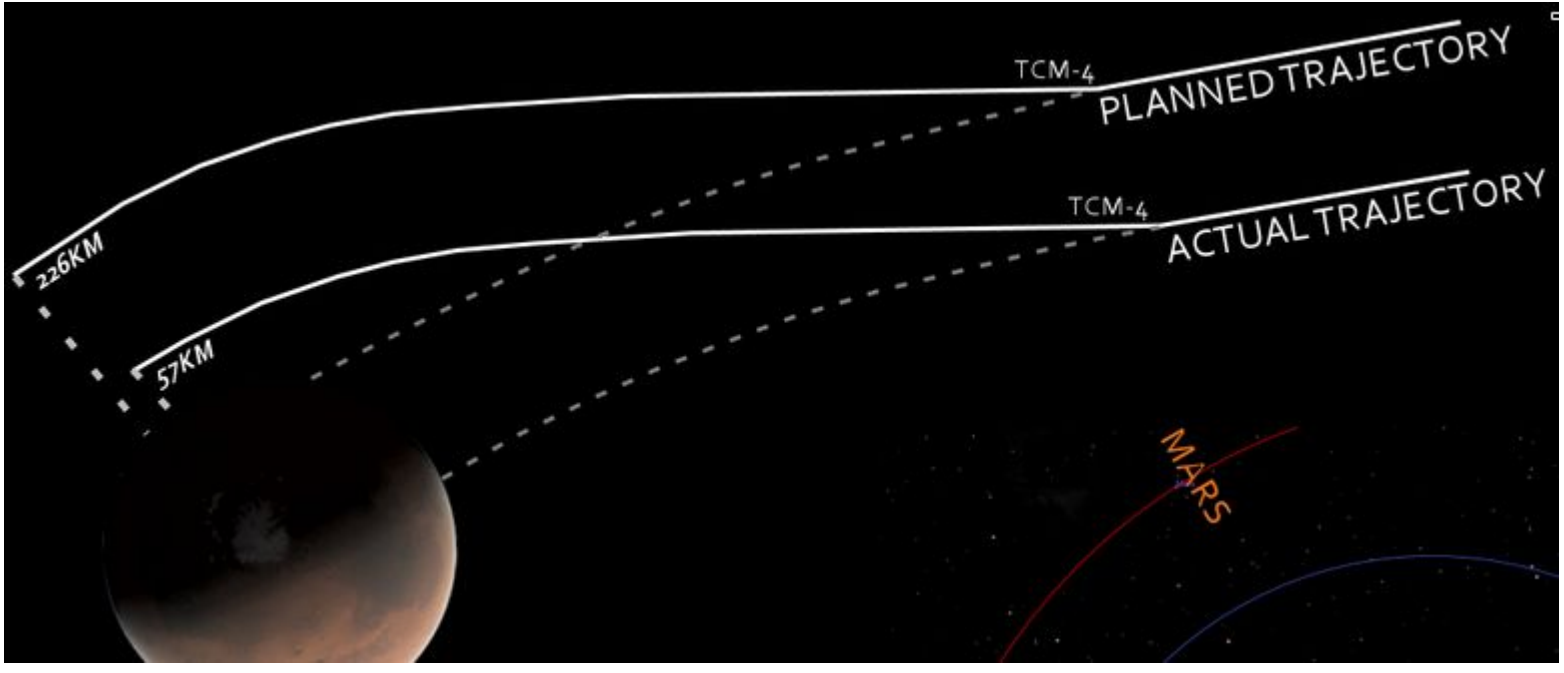
memory limit:	megabytes, gigabits, tebibytes
bandwidth:	megabytes / second, gigabits / second
throughput:	queries / second, inferences / second
cluster measures:	nodes, pods / second, VCs

Unit Mistake: $327 million



Mars Climate Orbiter: lbf·s instead of N·s

“M” (1000^2) or “Mi” (1024^2) ?

```
.withAmount(s"${driverMemoryMb}M")
.withAmount(s"${driverMemoryMiB}Mi")
```

https://github.com/apache-spark-on-k8s/spark/pull/470

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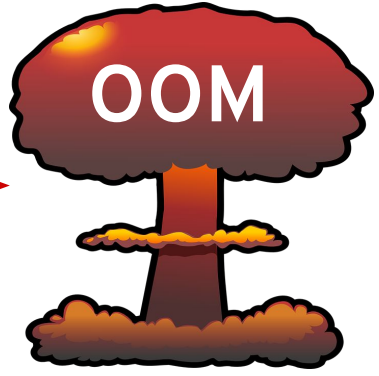

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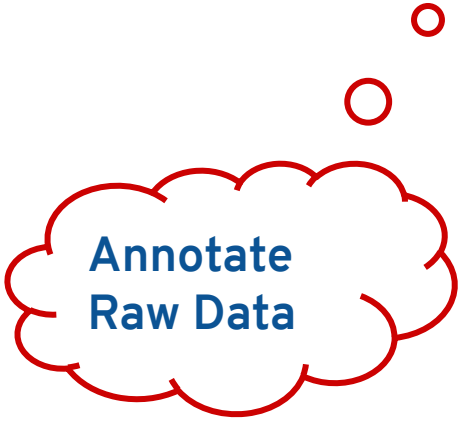
What Role Do Units Play?

100 milliseconds

2048 megabytes

10 gigabits / second



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Define Legal Operations

Annotate Raw Data

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100 milliseconds

2048 megabytes

10 gigabits / second

Define Legal Operations

Annotate Raw Data

Forbid Illegal Operations

Legal

conversion

10 minutes = 600 seconds

1 gigabit / second = 7500 megabytes / minute

Legal

conversion

10 minutes = 600 seconds
1 gigabit / second = 7500 megabytes / minute

algebra

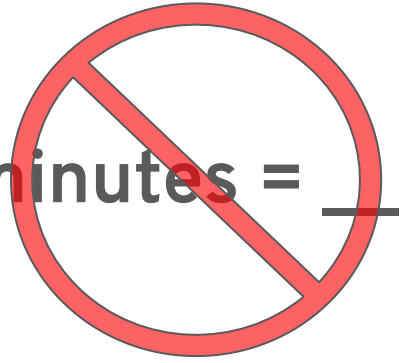
10 seconds + 1 minute = 70 seconds
(10 gigabits / second)(60 seconds) = 600 gigabits

Illegal!

conversion 10 minutes = __ bytes

Illegal!

conversion 10 minutes = __ bytes



Illegal!

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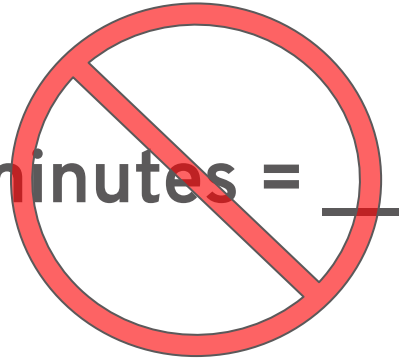

algebra 10 pods + 5 nodes

Illegal!

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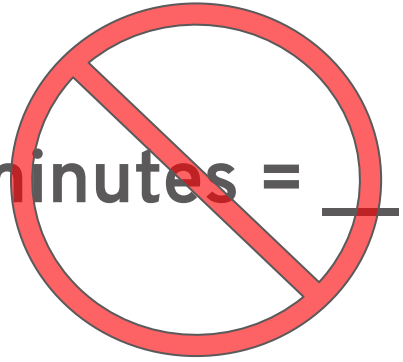

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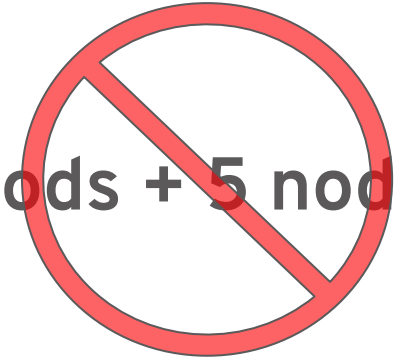

Data Types!

```
true & false

“eje” + “@redhat.com”

10 - 5
```

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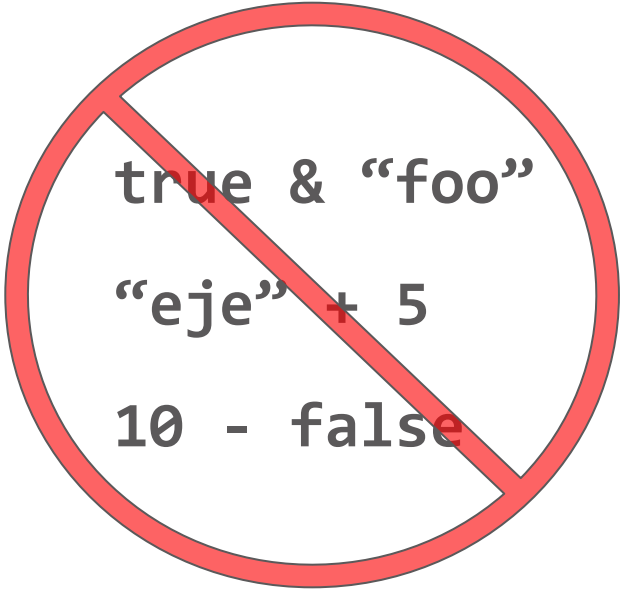
```



What If...

```
“eje” + 5
        ^ Error! Type Mismatch
```

What If...

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```

```
10 seconds + 5 bytes
```

What If...

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10 seconds + 5 bytes
             ^ Error! Type Mismatch
```

Find the Unit Types

```
.withAmount(s"${driverMemoryMb}M")
.withAmount(s"${driverMemoryMiB}Mi")
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Encoded in Variable Name

Find the Unit Types

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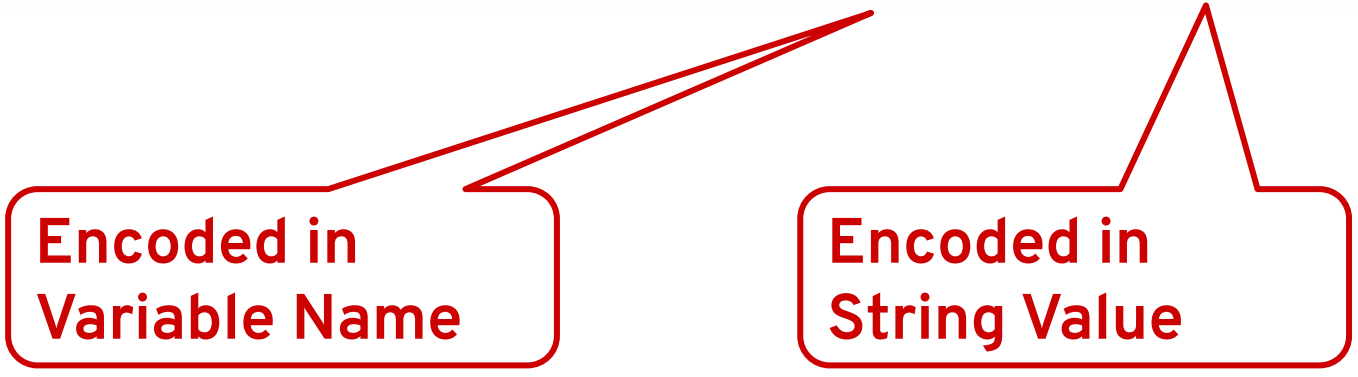

Units as Data Types

```
val mass = Quantity[Float, Kilogram](100.0)
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val mass = Quantity[Float, Kilogram](100.0)

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```
val mass = Quantity[Float, Kilogram](100.0)

val duration = 30.withUnit[Second]

val g = (9.8).withUnit[Meter %/ (Second %^ 2)]
```

Units as Data Types

```
val mass = Quantity[Float, Kilogram](100.0)

val duration = 30.withUnit[Second]

val g = (9.8).withUnit[Meter %/ (Second %^ 2)]

val ohms = (0.01).withUnit[
(Kilogram %* (Meter %^ 2)) %/ ((Second %^ 3) %*
(Ampere %^ 2))
]
```

Programming With Unit Types

```
def callKubeAPI(memLimit: Quantity[Int, Mega %* Byte]) =
    memLimit.show
```

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def callKubeAPI(memLimit: Quantity[Int, Mega %* Byte]) =
    memLimit.show

// ....

val memRequest = 1000.withUnit[Mebi %* Byte]
```

Programming With Unit Types

```
def callKubeAPI(memLimit: Quantity[Int, Mega %* Byte]) =
    memLimit.show

// ....

val memRequest = 1000.withUnit[Mebi %* Byte]

// ....

scala> callKubeAPI(memRequest)
res0: String = 1024 MB
```

Compile-Time Checking

```
val timeout = 100.withUnit[Milli %* Second]
```

Compile-Time Checking

```
val timeout = 100.withUnit[Milli %* Second]

// ....

scala> callKubeAPI(timeout)
    error: type mismatch;
   found   : Quantity[Int,Milli %* Second]
   required: Quantity[Int,Mega %* Byte]
```

Unit Types for Configuration

```
val confTS = ConfigFactory.parseString("""
        "log-retention-time" = "24 hour"
        "log-segment-size" = "1 megabyte"
        "log-flush-interval" = "10 second"
        "log-bandwidth" = "10 megabyte / second"
      """)
```

Unit Aware Configuration

```
def sysCall(ms: Quantity[Int, Milli %* Second]) =
    ms.showFull
```

Unit Aware Configuration

```
def sysCall(ms: Quantity[Int, Milli %* Second]) =
    ms.showFull

val logRetentionTime =
    conf.getQuantity[Int, Second]("log-retention-time")
```

Unit Aware Configuration

```
def sysCall(ms: Quantity[Int, Milli %* Second]) =
    ms.showFull

val logRetentionTime =
    conf.getQuantity[Int, Second]("log-retention-time")

scala> sysCall(logRetentionTime.get)
res0: String = 86400000 millisecond
```

Unit Aware Configuration

```
def sysCall(ms: Quantity[Int, Milli %* Second]) =
    ms.showFull

val logRetentionTime =
    conf.getQuantity[Int, Second]("log-retention-time")

scala> sysCall(logRetentionTime.get)
res0: String = 86400000 millisecond

scala> conf.getQuantity[Int, Byte]("log-retention-time")
ToolBoxError: reflective compilation has failed:
```

Unit Aware Avro Schema

```
{
"type": "record",
"name": "smol",
"fields": [
    { "name": "latency", "type": "double", "unit": "second" },
    { "name": "bandwidth", "type": "double", "unit": "gigabyte / second" }
]}
```

Unit Aware Avro Schema

```
rec.putQuantity(qp)(
    "latency", 100.withUnit[Milli %* Second])

rec.putQuantity(qp)(
    "bandwidth", 1.withUnit[Tera %* Bit %/ Minute])
```

Unit Aware Avro Schema

```
rec.putQuantity(qp)(
    "latency", 100.withUnit[Milli %* Second])

rec.putQuantity(qp)(
    "bandwidth", 1.withUnit[Tera %* Bit %/ Minute])

scala> rec
res0: Record = {"latency": 0.1, "bandwidth": 2.083333}
```

Unit Aware Avro Schema

```
scala> rec.getQuantity[Double, Micro %* Second](qp)("latency").show
res0: String = 100000.0 µs

scala> rec.getQuantity[Double, Giga %* Bit %/ Minute](qp)("bandwidth").show
res1: String = 1000.0 Gb/min
```

Unit Aware Avro Schema

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scala> rec.getQuantity[Double, Micro %* Second](qp)("latency").show
res0: String = 100000.0 µs

scala> rec.getQuantity[Double, Giga %* Bit %/ Minute](qp)("bandwidth").show
res1: String = 1000.0 Gb/min

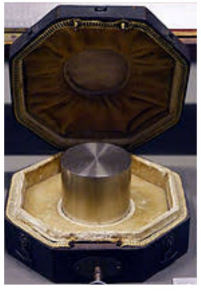
scala> rec.getQuantity[Double, Byte](qp)("latency")
Exception: unit metadata "second" incompatible with "Byte"
```

More and Better Units

```
implicit val defineUnitPod = BaseUnit[Pod](abbv = “pod”)
```

```
implicit val defineUnitNode = BaseUnit[Node](abbv = “node”)
```

Review



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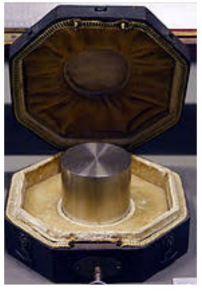

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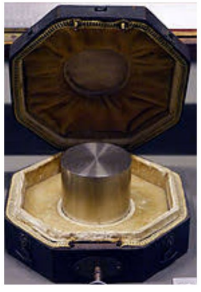

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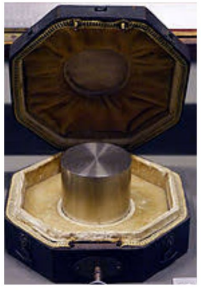

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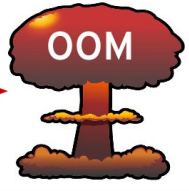
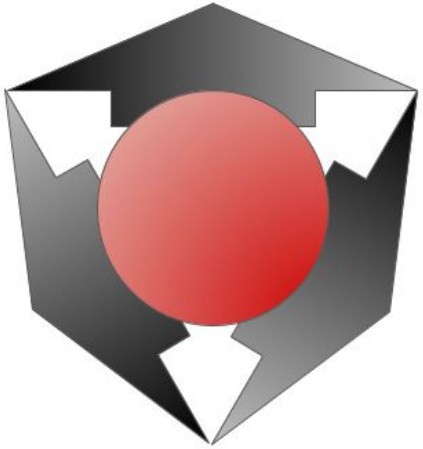
< JVM (in Mi) → OOM



Explore



coulomb

Unit analysis for Scala

https://github.com/erikerlandson/coulomb#documentation

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