Beyond Bash

Shell scripting in a typed, OO language

Scala by the Bay, 15 August 2015

Slides: http://tinyurl.com/beyondbash

0.1 Who am i

Li Haoyi

Paid $ to work on ~~dev tools @ Dropbox~~

Not paid $ to work on ~~Scala.js~~

Using Scala professionally since… never

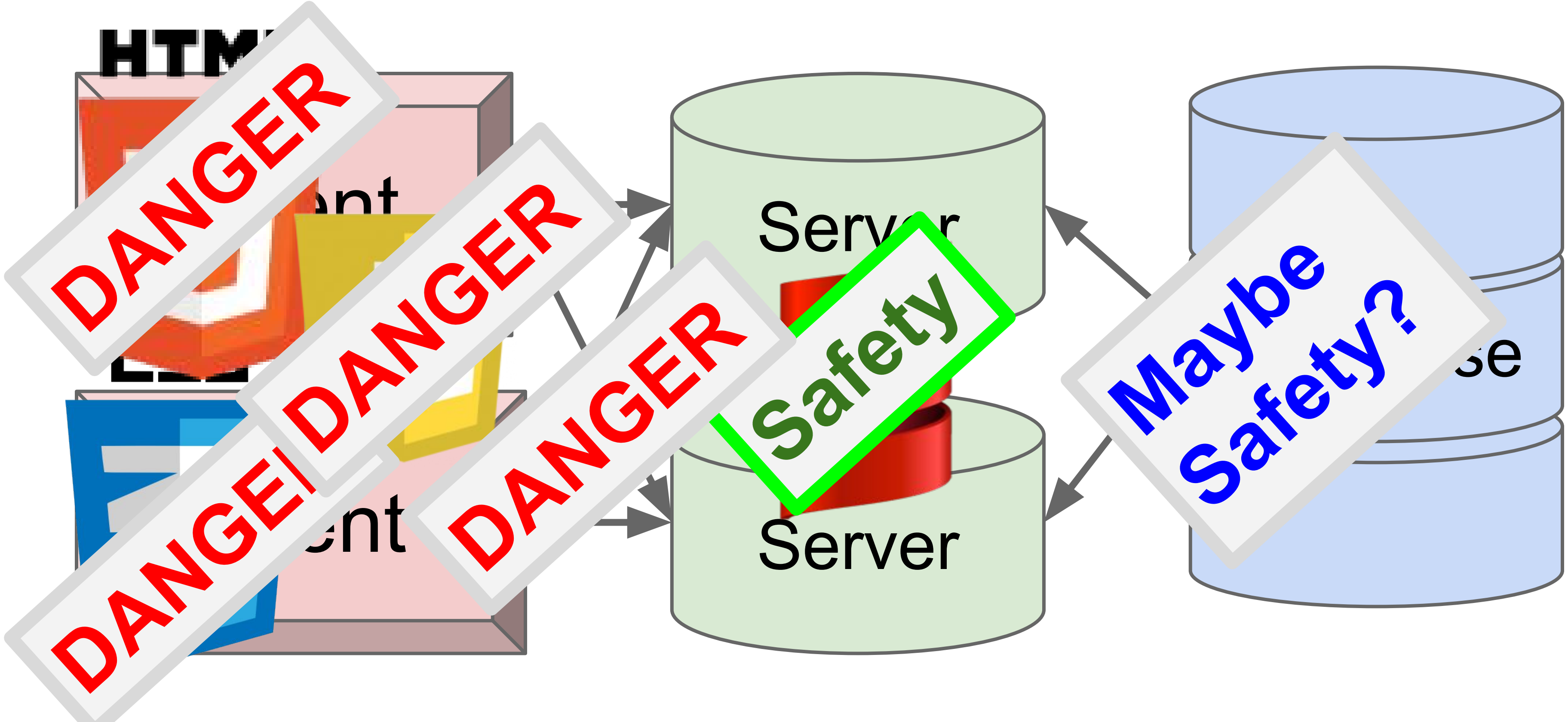
0.2 Agenda

- 0.x: Agenda
- 1.x: Bash
- 2.x: Ammonite-Ops
- 3.x: Ammonite-REPL
- 4.x: Conclusion
- 5.x: Q&A

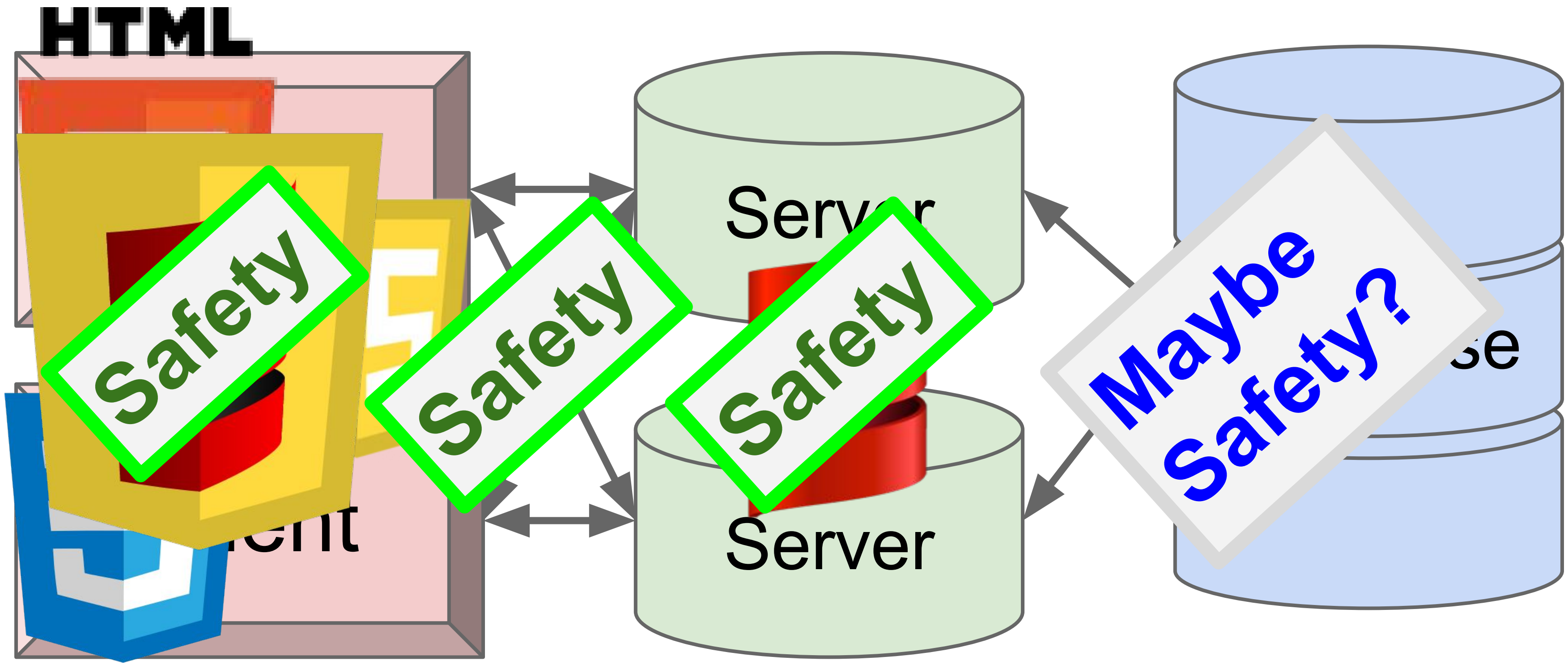
0.3 Problem Statement

“How can we stop using the worst languages in the world to build our most important infrastructure?

1.1 Application Architecture



1.2 Application Architecture



1.3 Scala.js!

Javascript: Problem solved

Scala.js works

Check it out if you haven't

http://www.scala-js.org/

1.3 Scala.js!

- Casting is great

```
elem.asInstanceOf[html.Input]
```

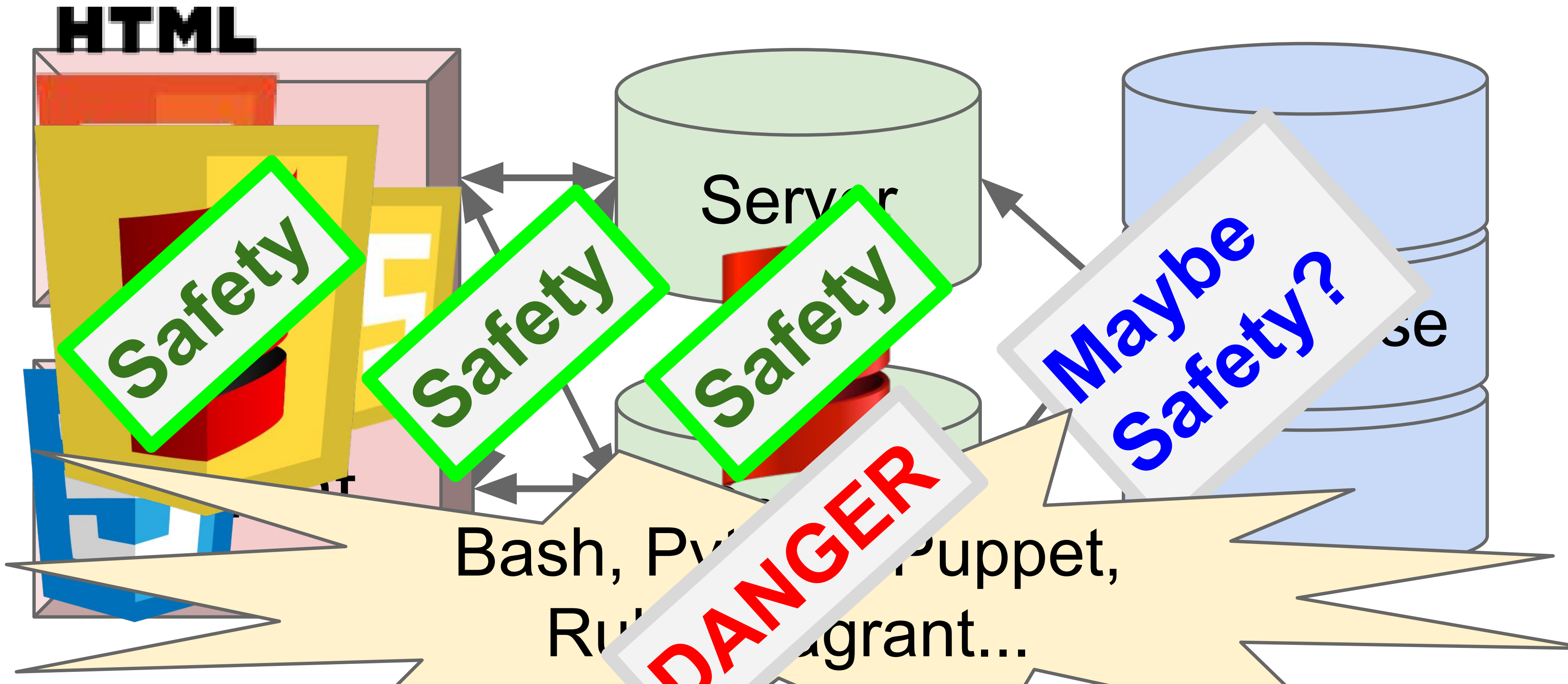
  - In Javascript, *every expression is a cast!*

- Weird, unsound behavior is fine
  - As long as it's less weird/unsound than Javascript

- Best-effort error-handling is outstanding
  - Javascript doesn't put in effort at all

Bad when better than worse is excellent

1.4 Application Architecture



1.5 Danger Below!

High-performance, type-safe application code

High-performance, type-safe web front-end

Underpinned by a mix of Bash, Python, Ruby, Puppet, Vagrant, ...

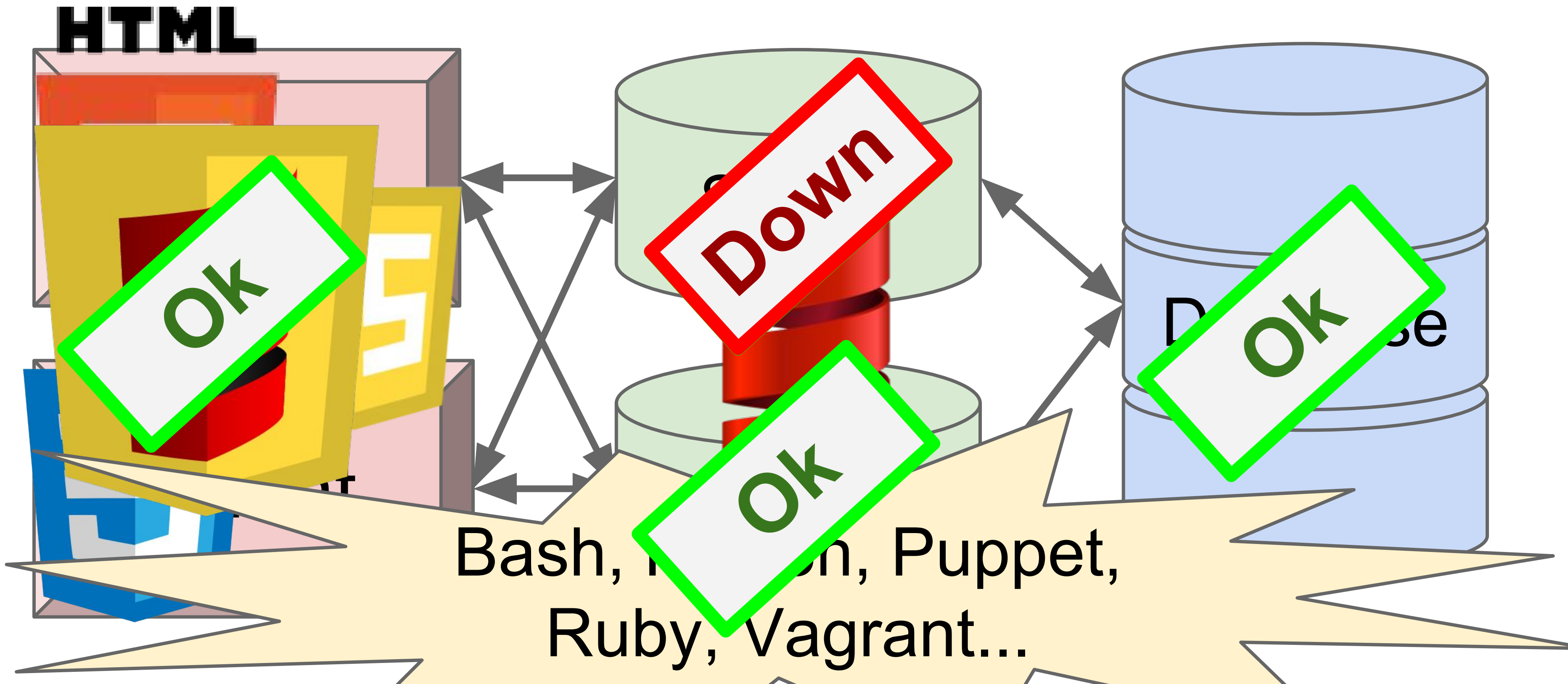
1.5 Danger Below!

Hard to test!

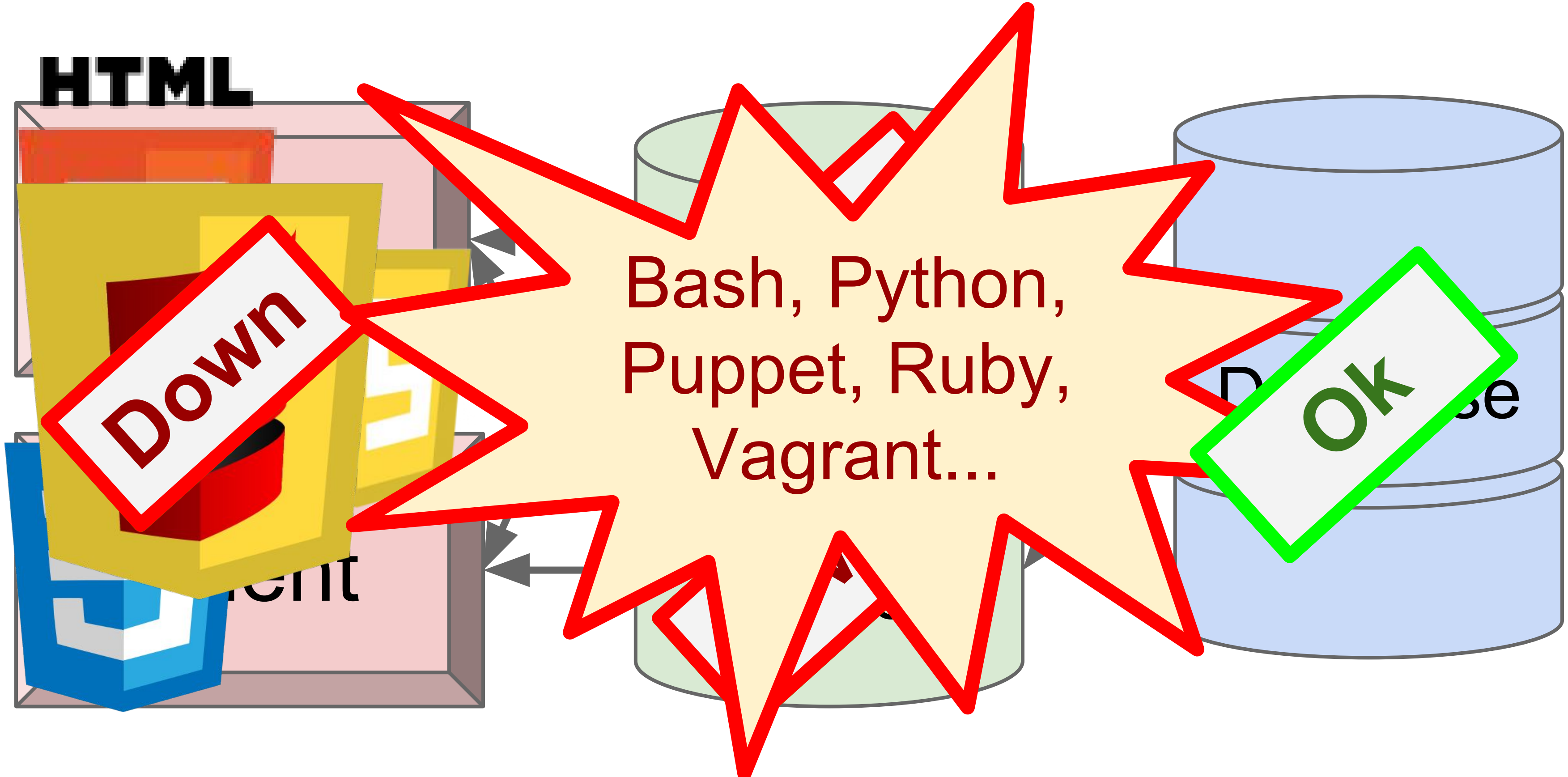
Not typechecked!

Worst consequences for errors

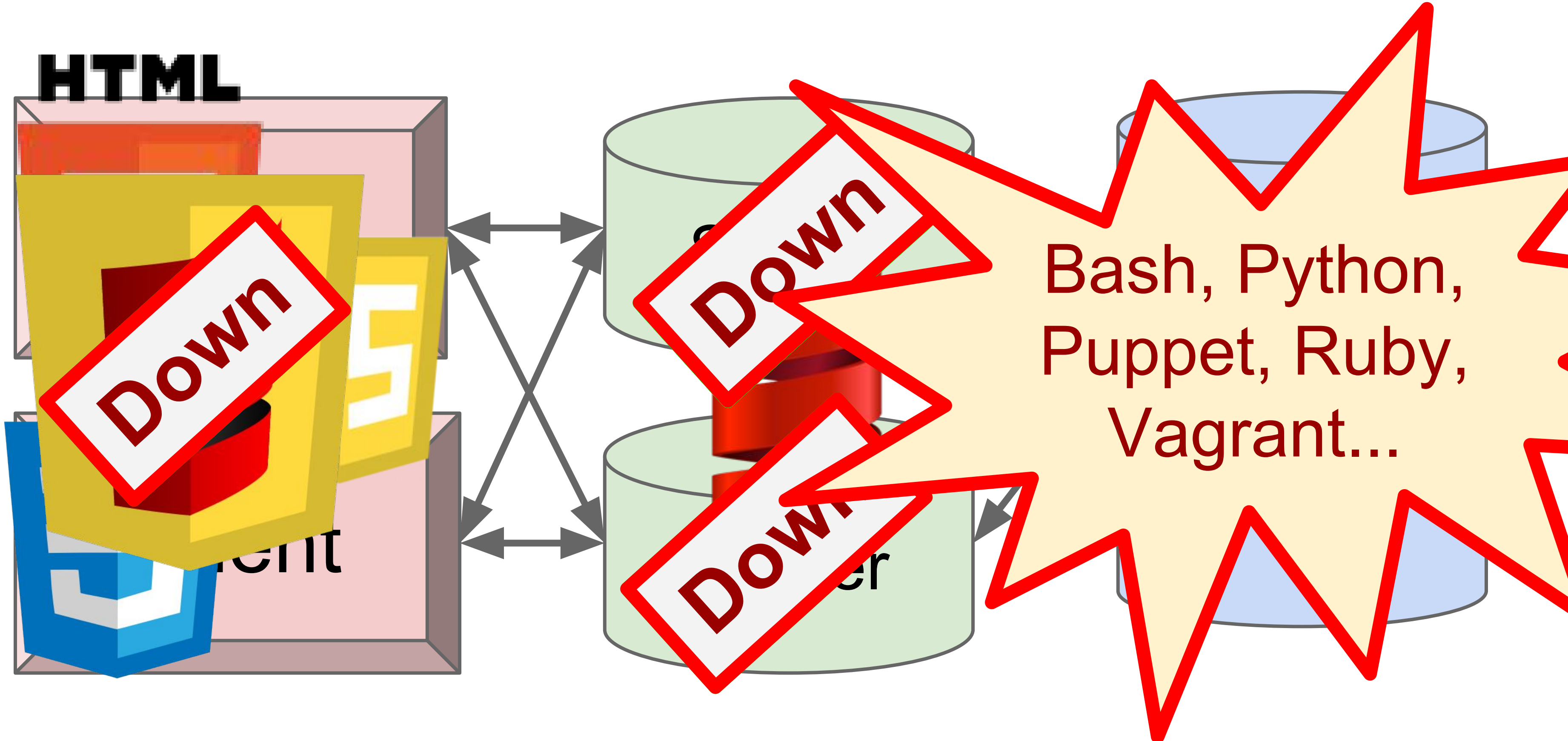
1.5 Danger Below!



1.5 Danger Below!



1.5 Danger Below!



bash$

1.6 What's wrong with Bash?

- Obscure syntax ~~`if [[$? -eq 0 ]]`~~ `if [[ $? -eq 0 ]]`
  - Even though you use it every day for 10 yrs
- Everything is global
  - Everything is spooky!
- Everything is a String
- Even basic math/logic is incredibly difficult

1.7 What's wrong with Bash?

```
# Run a script on all files with some extension

find . -name '*.ext' | while IFS=$'\n' read -r FILE; do
  process "$(readlink -f "$FILE")" || echo "error processing: $FILE"
done
```

Incorrect

??? ???

```
find . -name '*.ext' \( -exec ./some_other_script "$PWD"/{} \; -o -print \)
```

Good Solution

???

```
find . -name '*.ext' -exec ./some_other_script "$PWD"/{} \;
```

It seems to work

http://stackoverflow.com/questions/4410412/bash-processing-recursively-through-all-files-in-a-directory

“It seems to work”

Such a high degree of confidence!

Why do people use Bash

Can we use something else?

Sample use case

- List the things in my current folder
- Look at my current git
- Make a folder with a file inside
- Delete the folder

Why do people use Bash

Can we use something else?

No

Bash is Better

1.9 Bash vs Scala

```
rm -rf folder/inner_dir
```

1 line 24 chars

12 lines 279 chars

```scala
def removeAll(path: String) = {
  def rec(f: File): Seq[File] =
    f.listFiles
     .filter(_.isDirectory)
     .flatMap(rec)
     .++(f.listFiles)
  for(f <- rec(new File(path))){
    if (!f.delete())
      throw new RuntimeException()
  }
}
removeAll("folder/inner_dir")
```

1.10 Bash vs Python

```
rm -rf folder/inner_dir
```

↑ 1 line 24 chars

```
import shutil
shutil.rmtree('folder/my_file.jpg')
```

↑ 2 lines 50 chars

1.11 Bash vs Python: Round 2

```bash
git status
```

1 line 10 chars

```python
import subprocess
subprocess.check_call(["git", "status"])
```

2 lines 60 chars

🟩 Important Bits

🟥 Dumb Noise

1.12 Bash is Better

Less syntactic ceremony

```
cp fileB fileB
```

Common operations are short

```
ls
```

Fewer keystrokes overall

Very Important!

Commands do what you want

```
rm -rf folder
```

Ammonite-Ops

Rock-solid filesystem ops in Scala

```
"com.lihaoyi" %% "ammonite-ops" % "0.4.5"
```

2.1 Ammonite-Ops

- Goals:
  - No more than 2x as verbose as Bash
  - Safer than working with Python or java.{io, nio}

- Non-Goals!
  - Monadic pure dependent-typed safety
  - Reactive manifesto accreditation
  - 50-year enterprise maintainability

2.2 Ammonite-Ops

```
git status
```

1 line 10 chars

```
%git 'status
```

1 line 12 chars

```
rm folder/my_file.jpg
```

1 line 21 chars

```
rm! 'folder/"my_file.jpg"
```

1 line 25 chars

2.3 A Taste of Ammonite

```
import ammonite.ops._
// Delete a file or folder
rm! cwd/'folder

// Make a folder named "folder"
mkdir! cwd/'folder

// Copy a file or folder
cp(cwd/'folder, cwd/'folder1)

// List the current directory
val listed = ls! cwd
```

Short commands that mirror Bash

That do what you want!

No ambiguity in parsing arguments

2.4 A Taste of Ammonite

```
// List the current directory
val listed: Seq[Path] = ls! cwd

// Commands return normal values
// you can process normally
for(path <- listed){
  println(path)
  // paths are proper data-structures
  // with attributes, methods, etc.
  if (path.ext == "tmp") rm! path
}
```

Values are typed, structured data

No string munging trying to do simple tasks!

2.5 Piping

```
things |  f      ->    things map f
things || f      ->    things flatMap f
things |? f      ->    things filter f       Traversable
things |& f      ->    things reduce f
things |! f      ->    things foreach f
things |> f      ->    f(things)             Any
f! thing         ->    f(thing)              T => V
```

2.6 Putting it Together

- Concise filesystem operations
    - `ls! cwd`
- Structured, concise path operations
    - `ls! cwd/'src/'main`
- Pipes as aliases for collection methods
    - `ls! cwd/'src/'main |? (_.ext == "scala") | (_.size) sum`

2.7 Putting it Together

```
# Recursive line count of Javascript files
find ./dir -name '*.js' | xargs wc -l
```

38 chars

```
ls.rec! cwd/'dir |? (_.ext == "js") | read.lines | (_.size) sum
```

64 chars

2.8 Putting it Together

```
# List dot-files *only*
ls -a | grep "^\."
```

19 chars

```
ls! cwd |? (_.last(0) == '.')
```

30 chars

2.9 Putting it Together

```
# Largest 7 files in the current directory
find . -ls | sort -nrk 7 | head -7
```

35 chars

```
ls.rec! cwd | (x => x.size -> x) sortBy (-_._1) take 7
```

55 chars

2.10 Ammonite-Ops

- Easy, convenient filesystem ops in Scala!
- (Almost) as concise as Bash

```
ls! cwd
```

    - Definitely less typing than java.io/nio
- Clean, structured data-model
    - Paths. Are. Not. Strings!

```
cwd/'src/'main/"file.txt"
```

    - Results from commands aren’t strings either

2.11 This begs the question...

Can we use Ammonite-Ops + Scala-REPL as our default shell?

Let’s try contributing some changes to https://github.com/lihaoyi/demo

No

2.12 No

- Echo-ed output is unreadable
- Ctrl-C kills everything; bye bye work!
- Can’t subprocess out w/o borking JLine
- http://lihaoyi.github.io/Ammonite/#OtherFixes

Ammonite-REPL

Re-inventing the Scala REPL

3.1 Ammonite-REPL

- Goal
  - *You should not need to exit the REPL*

- How often do you need to restart Bash?

3.2 Using the Ammonite REPL

```
# Standalone Executable
curl -L -o amm https://git.io/v3E3V; chmod +x amm; ./amm
// SBT project
libraryDependencies += (
  "com.lihaoyi" % "ammonite-repl" % "0.4.5" % "test"
  cross CrossVersion.full
)
initialCommands in (Test, console) :=
  """ammonite.repl.Repl.run("")""" // sbt test/console
```

Live Demo

Whee!

3.3 Fun Features

- Great pretty-printing
- Syntax-highlighted everything!
- Ctrl-C Interruptible
- Live-loading modules from maven central
- Multi-line editing!

3.4 Ammonite-REPL

- A strictly-better Scala REPL
- Usable in any SBT project
- Or standalone

3.5 This begs the question...

Can we use Ammonite-Ops + Ammonite-REPL as our default shell?

Let’s try contributing some changes to https://github.com/lihaoyi/wootjs

3.6 Ammonite-REPL

- Scala-REPL is not a plausible systems shell
- Ammonite-REPL is!
- (Possibly)
- You can do real work in it

3.7 Work In Progress

- Extensible Autocomplete
  - *Already* autocomplete properties, names in scope
  - *Need* to autocomplete filesystem paths
  - *Nice to have* autocomplete for ivy coordinates, etc.

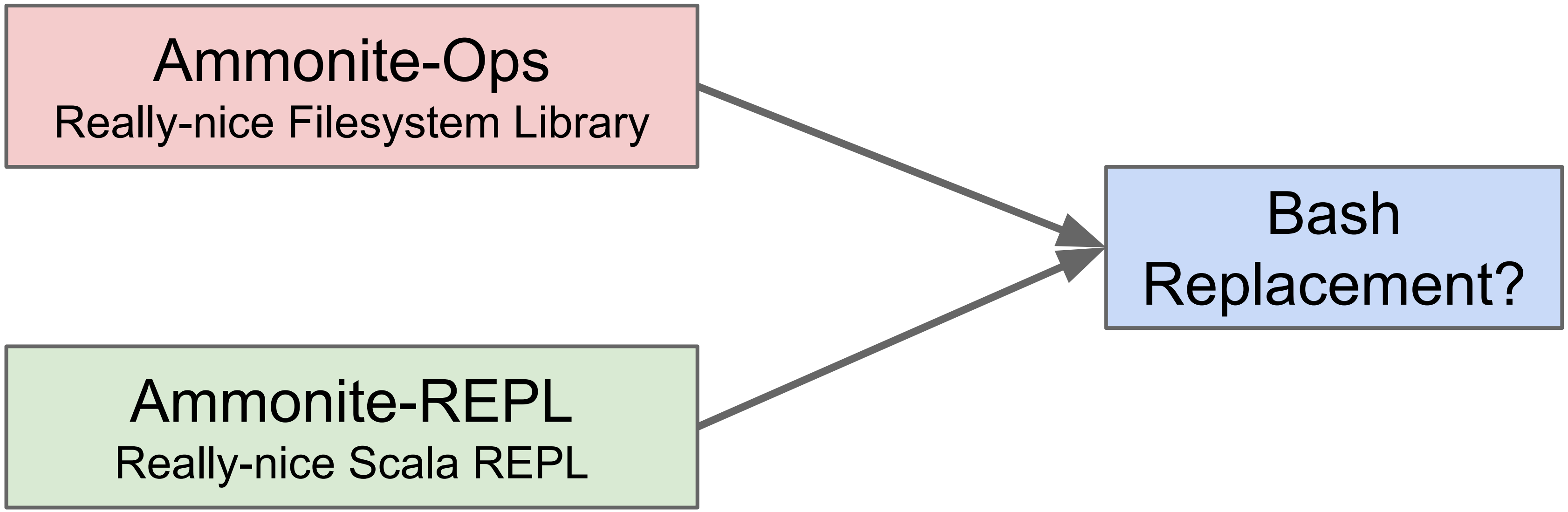
- Fetch scaladoc, source to show in-terminal

- Windows support for Ammonite-REPL
  - Ammonite-Ops already works

Conclusion

WTF did we just do?

4.1 Ammonite...


Ammonite-Ops
Really-nice Filesystem Library
Ammonite-REPL
Really-nice Scala REPL
Bash
Replacement?

4.2 Ammonite...

- Re-implemented much of Bash’s functionality in Scala
- Twisted Scala’s syntax into a weird, bash-like form
- Re-implemented the Scala REPL to make this work

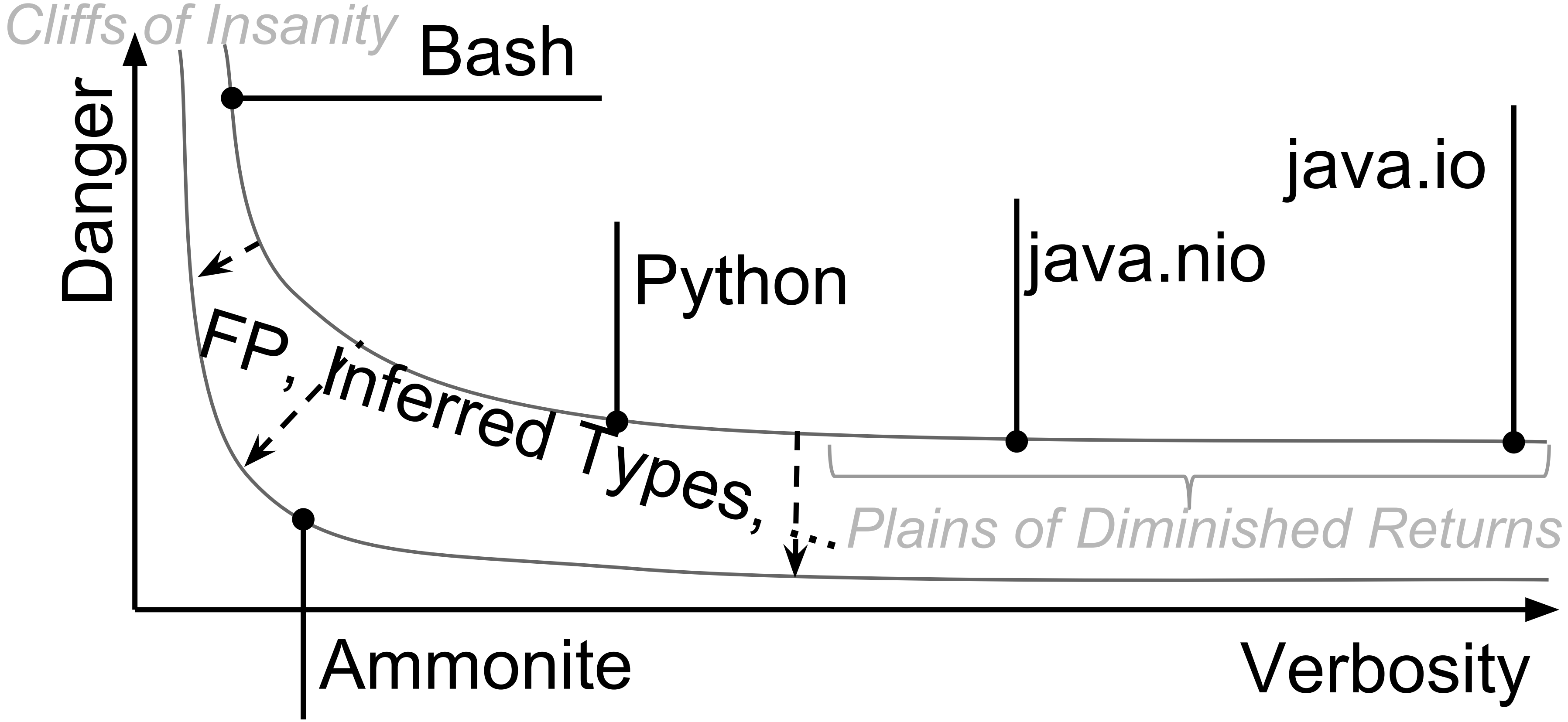
Why?

Did we need to do so many things?

4.3 Why Not...

- Make Bash less unsafe?
- Make Python less verbose?
- Improve on java.io or java.nio?

4.4 Space of Possible Systems APIs



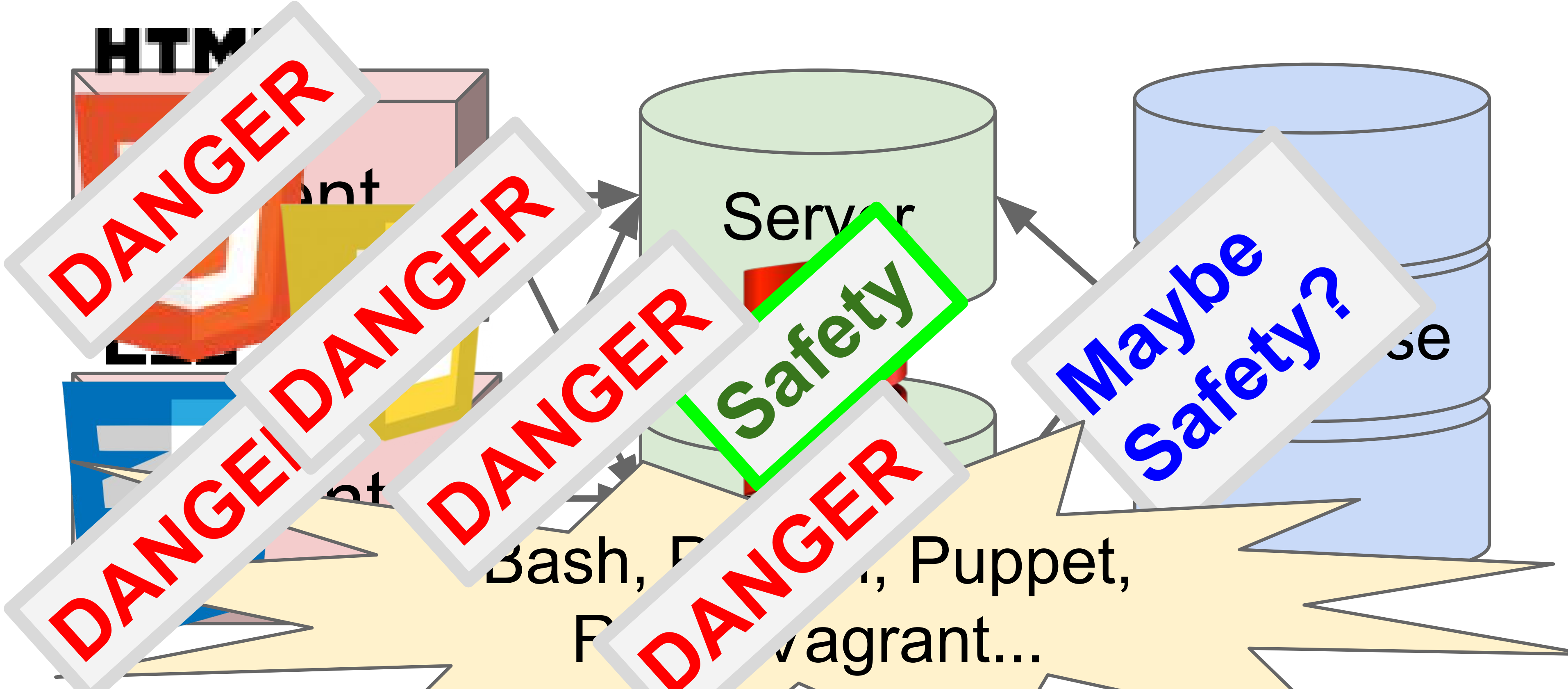
4.5 Problems w/ Scala as your Shell

- JVM takes time to boot up!
  - 3-4s startup time
  - Not just JVM boot but classloading, etc.
- 3-4s first command compile
  - 0.2-0.3s compile overhead after warmup
- Bash takes ~0.004s to boot, Python ~0.03s
- Jar is 30mb, jar + JVM is >100mb

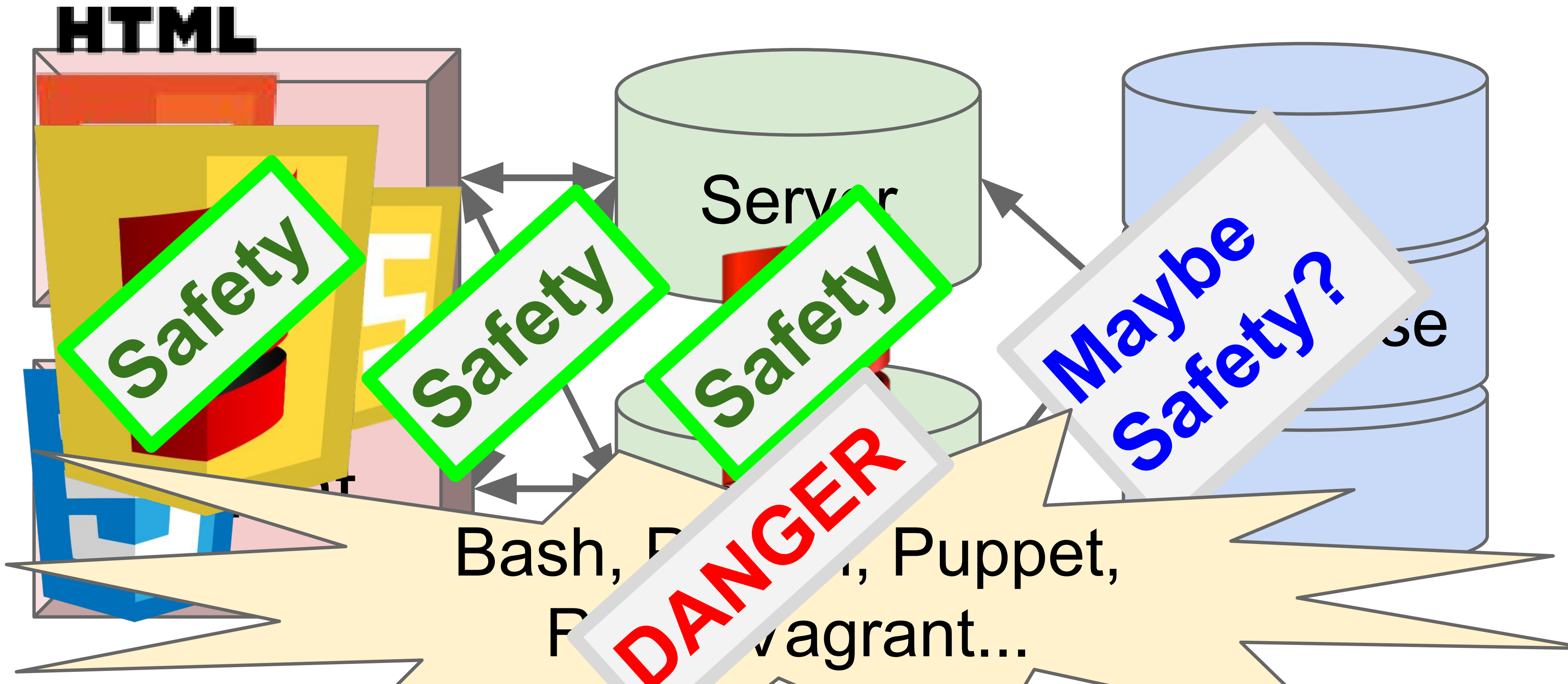
4.6 Hopefully free improvements

- Java 9 w/ modules will help JDK size/speed
  - Can bundle minimal JVM for smaller executable
  - Fewer classes to load on boot
- Dotty would (hopefully) speed compilation
  - At least it can’t get much slower, right? Right?...
- Dotty Linker would help overall
  - Should cut down the amount of stuff to load/JIT

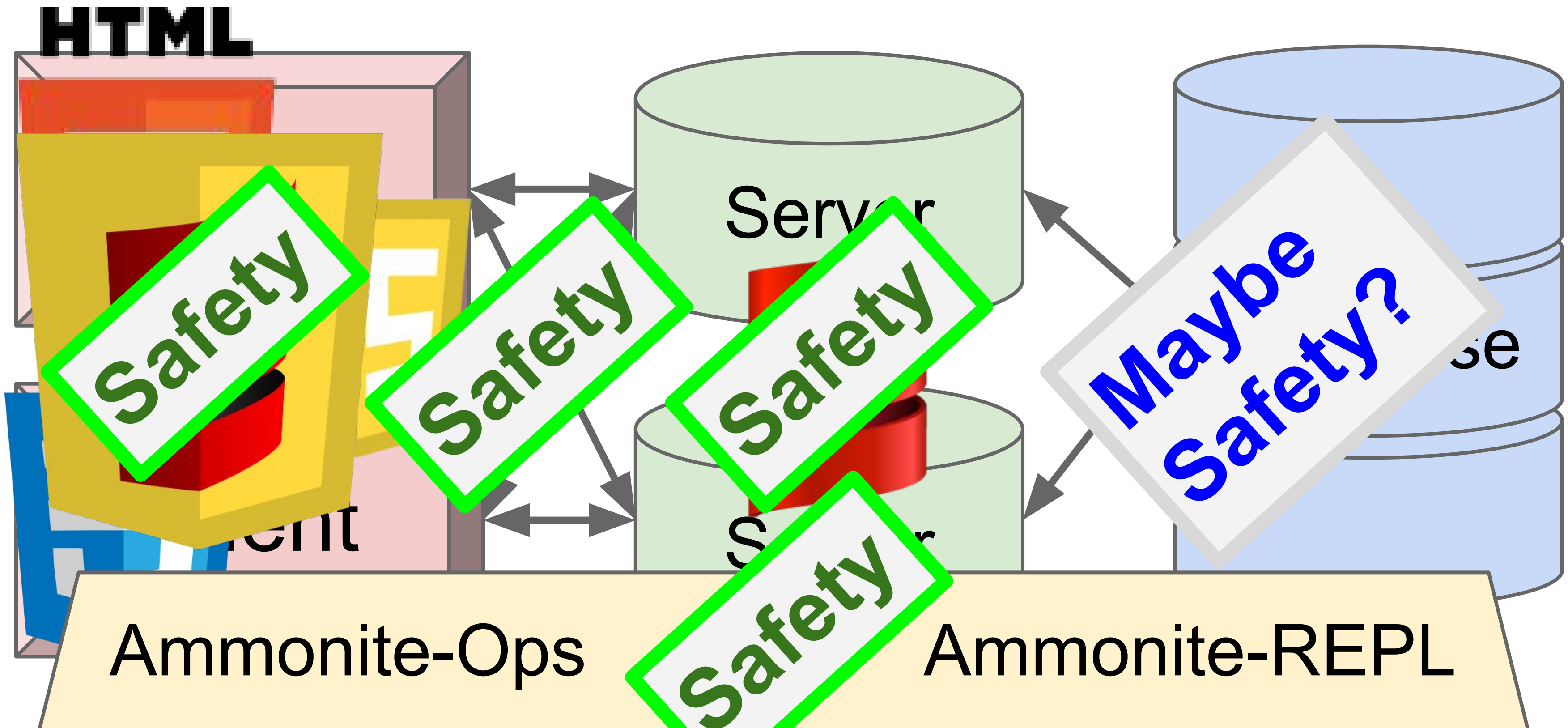
5.0 Application Architecture



5.1 Application Architecture



5.2 Application Architecture



5.3 Beyond Bash

- http://lihaoyi.github.io/Ammonite/
- `"com.lihaoyi" %% "ammonite-ops" % "0.4.5"`
- `curl -L -o amm https://git.io/v3E3V; chmod +x amm; ./amm`
- Questions?

Additional Slides

2.5 Absolute Paths & RelPaths

```
case class Path(segments: Seq[String])
```

Absolute

```
case class RelPath(segments: Seq[String], ups: Int)
```

Any ..s at the start of the path

2.6 Constructing Paths

```
> root
/

> root/'usr/'bin
/usr/bin

> 'src/'main
src/main

> up/up/'src/'main
../../src/main
```

Paths are constructed using / and...

- Segments
  - Strings
  - Symbols
- Builtins
  - root: Path
  - cwd: Path
  - up: RelPath

2.7 Combining Paths

```
> val rel = 'src/'main
src/main

> val wd = root/'Users/'lihaoyi
/Users/lihaoyi

> wd/rel
/Users/lihaoyi/src/main

> wd/rel/up
/Users/lihaoyi/src
```

Paths can be stitched together using /

Paths are normalized at every step!

not /Users/lihaoyi/src/..

2.8 Invalid Paths

```
> val rel: RelPath = 'src/'main
> val abs: Path = root/'usr/'bin

> abs/rel
/usr/bin/src/main
> rel/abs
<console>:15: error: type mismatch;
> rel/rel
src/main/src/main
> abs/abs
<console>:14: error: type mismatch;
```

Combining Paths & RelPaths improperly is a *compilation error*

2.9 Invalid Paths

```
> val rel: RelPath = 'src/'main
> val abs: Path = root/'usr/'bin


> abs/rel
/usr/bin/src/main
> rel/abs
<console>:15: error: type mismatch;
> rel/rel
src/main/src/main
> abs/abs
<console>:14: error: type mismatch;
```

```
> rel = "??[illegible]
> abs [illegible]??"


> [illegible] + "/[illegible]el
> [illegible]s + rel
> [illegible]" + abs + rel[illegible]
> [illegible] + abs + "/" + [illegible]
> r[illegible]+ abs
// co[illegible]t but annoying to [illegible]
> os.pat[illegible](abs, rel)
```