Scripting the cloud with Skywriting

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A universal model?

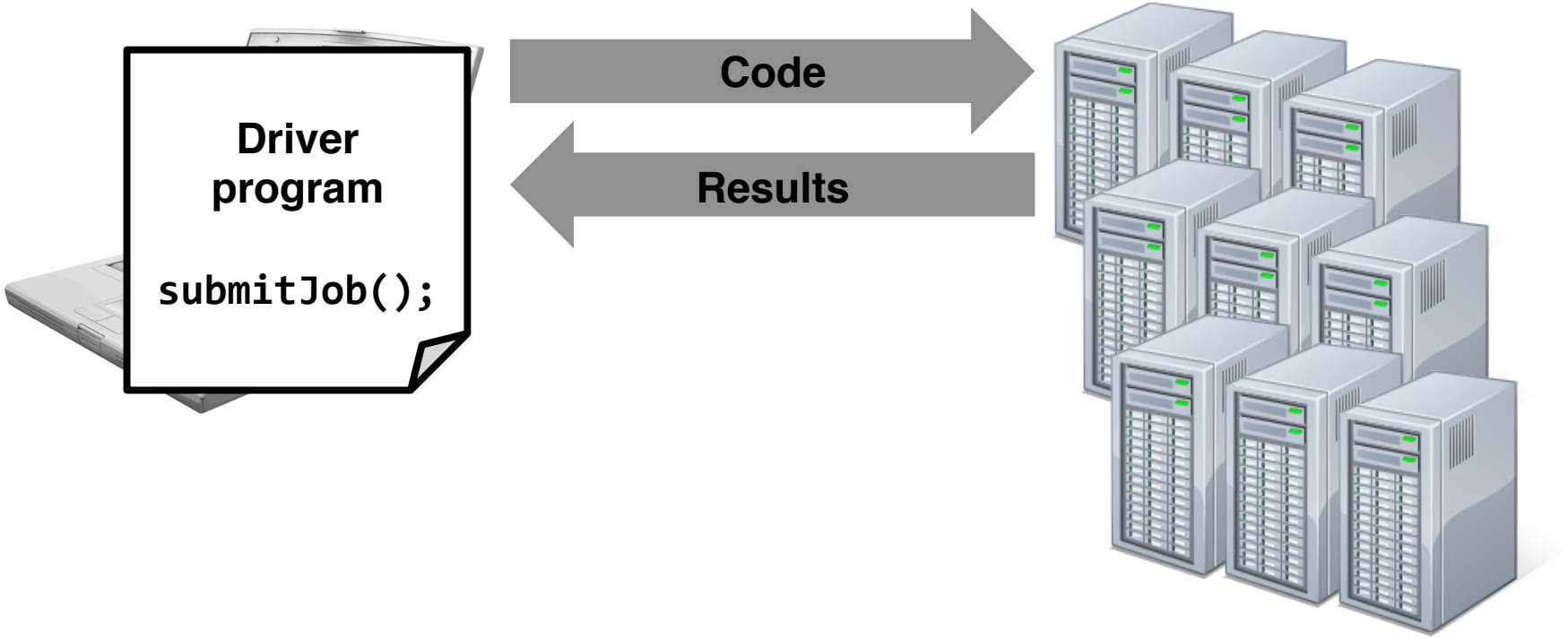
MapReduce

A universal model?

~~MapReduce~~

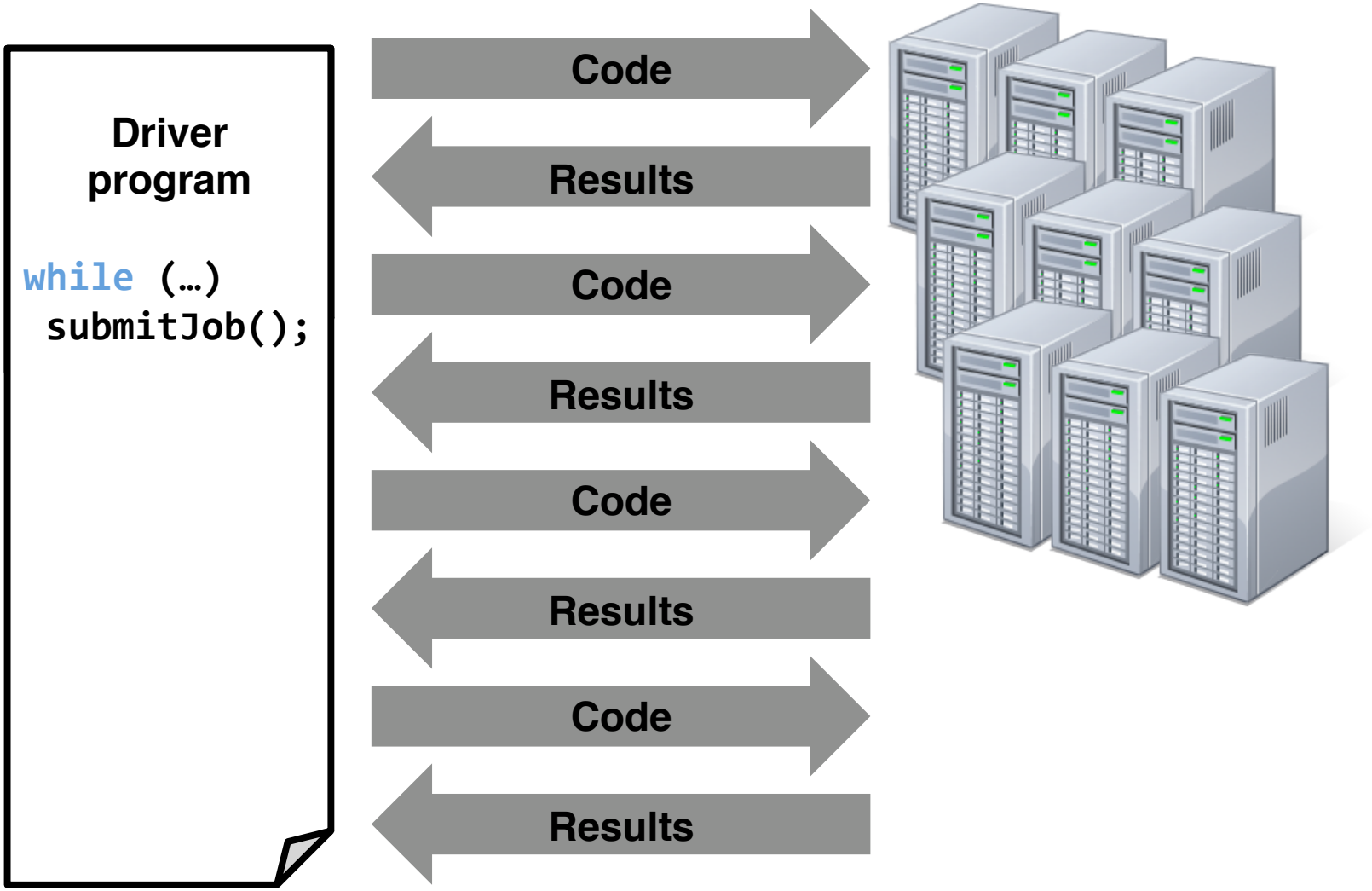
A universal model!

Move computation to the data

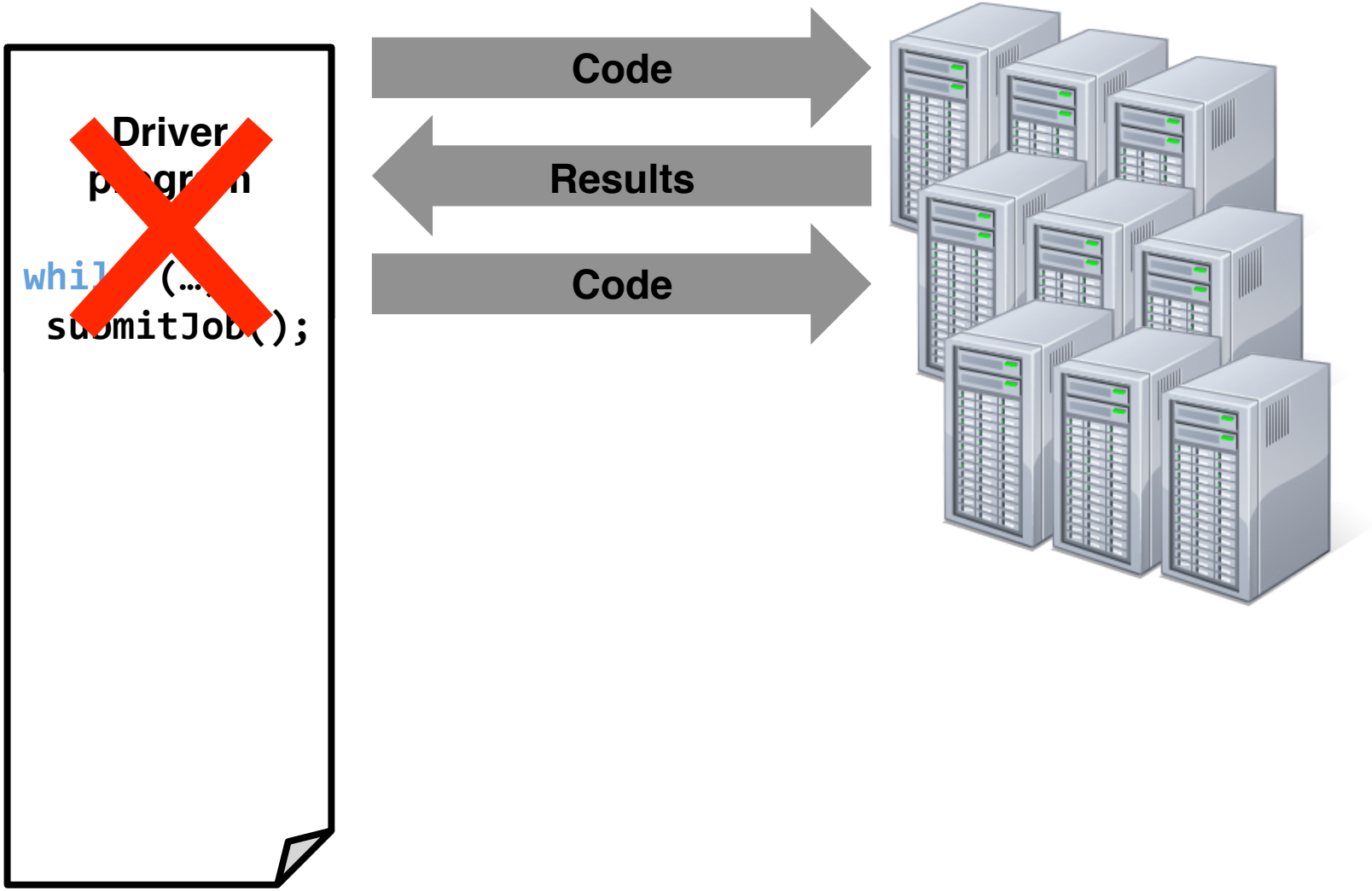


```
while (!converged)
    do work in parallel;
```

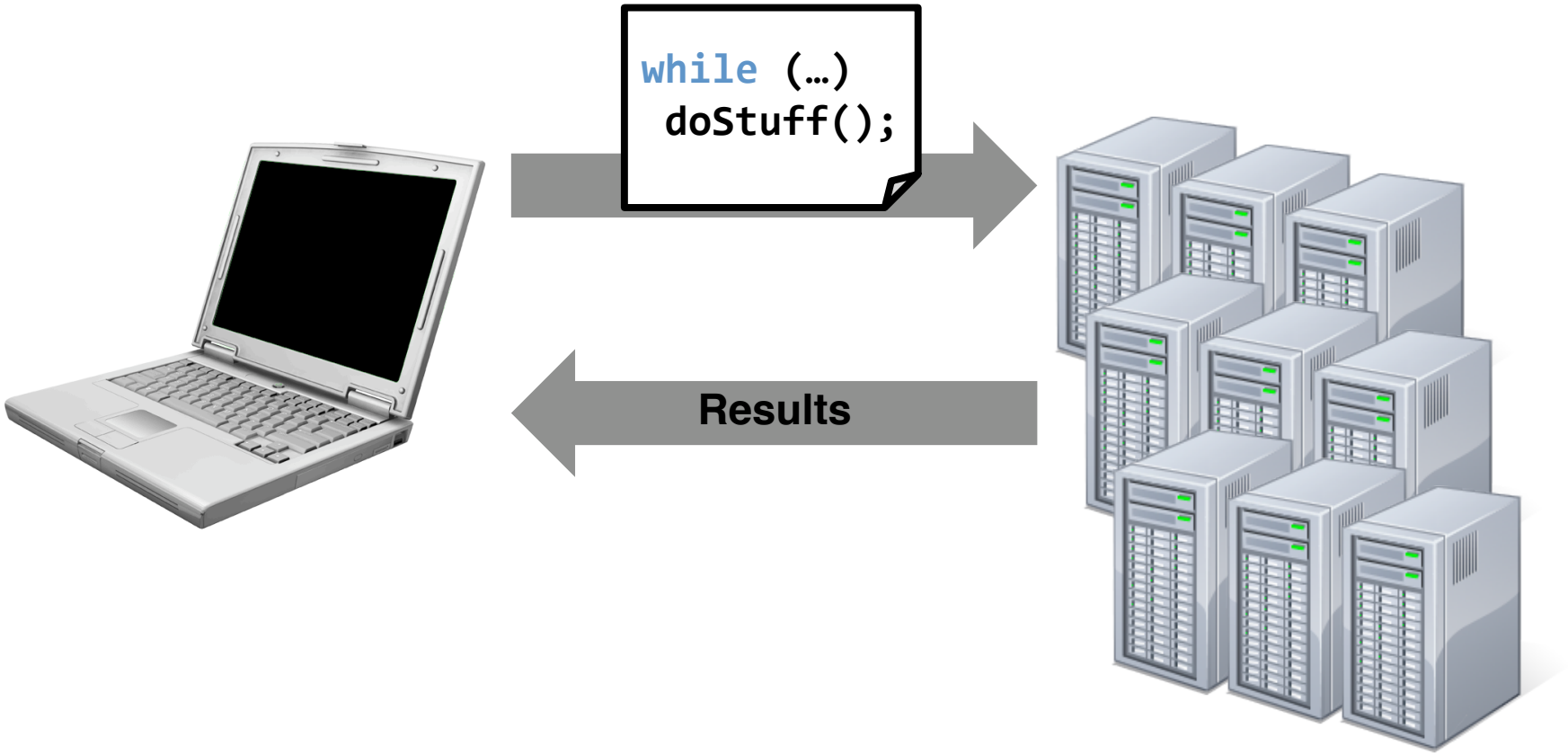
Iterative algorithm



Iterative algorithm



Skywriting



Skywriting

- JavaScript-like job specification language
  - Supports functional programming
  - Data-dependent control flow
- Distributed execution engine
  - Locality-based scheduling
  - Fault tolerance
  - Thread migration

Spawning a task

```
function f(x) { return x + 1; }


res1 = spawn(f, [42]);
```

Task dependencies

```
function f(x) { return x + 1; }
function g(y) { … }

res1 = spawn(f, [42]);
res2 = spawn(g, [res1]);
```

`res1` and `res2` are *future references*

Logistic regression

```
points = […]; // List of partitions
w = …;        // Random initial value
for (i in range(0, ITERATIONS)) {
  w_old = w;
  results = [];
  for (part in points) {
    results += spawn(log_reg, [part, w_old]);
  }
  w = spawn(update, [w_old, results]);
}
```

Logistic regression

```
points = […]; // List of partitions
w = …;        // Random initial value
do {
  w_old = w;
  results = [];
  for (part in points) {
    results += spawn(log_reg, [part, w_old]);
  }
  w = spawn(update, [w_old, results]);
  done = spawn(converged, [w_old, w]);
} while (!*done);
```

Logistic regression

```
points = […]; // List of partitions
w = …;        // Random initial value
do {
  w_old = w;
  results = [];
  for (part in points) {
    results += spawn(log_reg, [part, w_old]);
  }
```

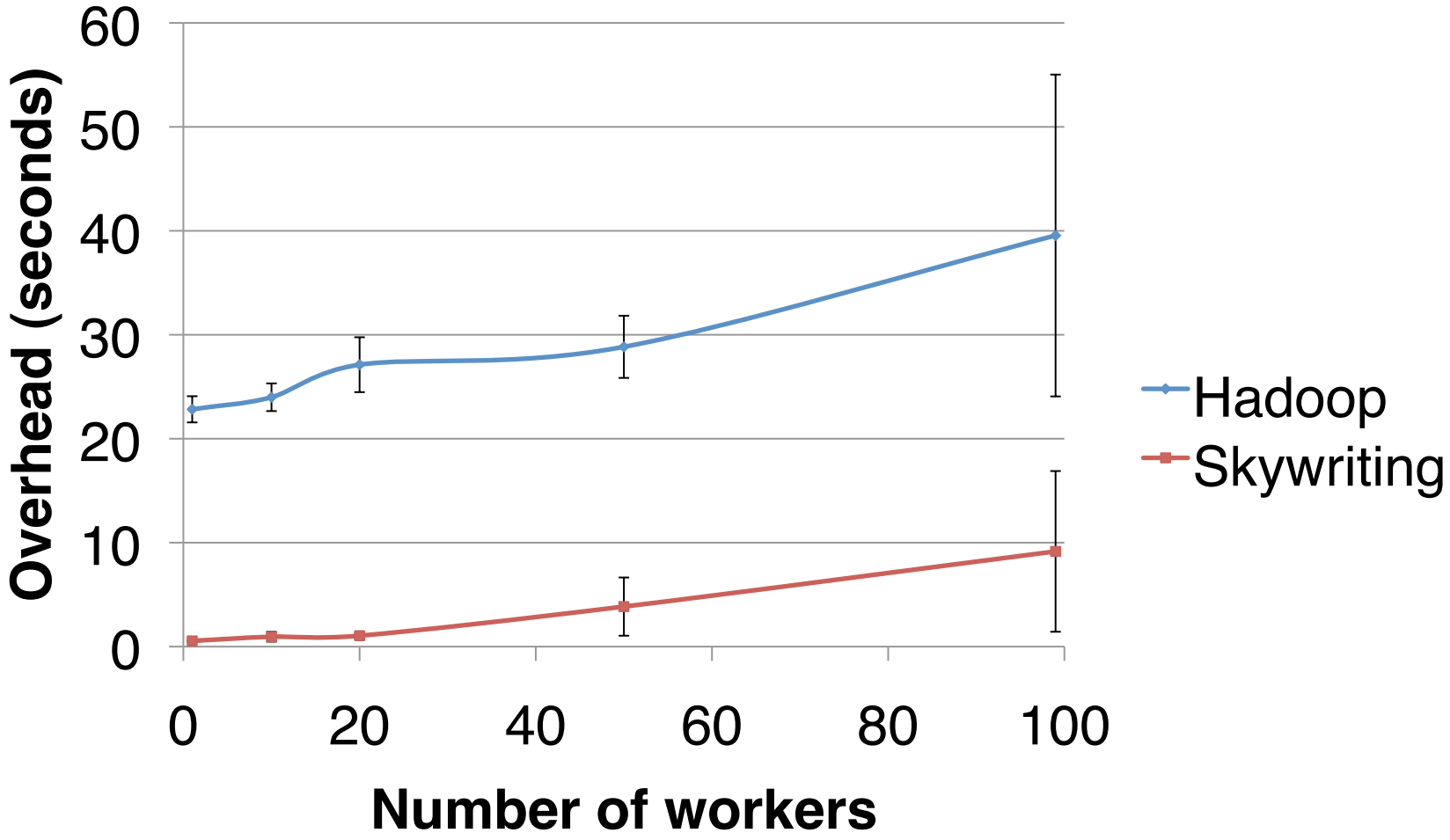
*-operator dereferences (forces) a future

```
} while (!*done);
```

Implementation status

- Implemented in 4000 lines of Python
  - Also: Java, C and .NET bindings
- Many additional features
  - Native code execution
  - Introspection
  - Conditional synchronisation
- Available as open-source
  - http://github.com/mrry/skywriting

Job creation overhead



Future directions

- Multiple-scale parallel computing
  - Multiple cores, machines and clouds
- Streaming computations
  - Piping high-bandwidth data between tasks
- Better language integration
  - Hosted Skywriting on CLR or JVM

Conclusions

- Turing-complete programming language for distributed computation
- Runs real jobs with low overhead
- Lots more still to do!

Questions?

- Email
  - Derek.Murray@cl.cam.ac.uk
- Project website
  - http://www.cl.cam.ac.uk/netos/skywriting/