Recitation 15: MapReduce

MIT - 6.033

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Plan

* Setting
* Design
* MapReduce it?
* Failures

Logistics

* Schedule your proj presentation!
* Design project updates released

What did you notice about this paper?

Notes on terminology:

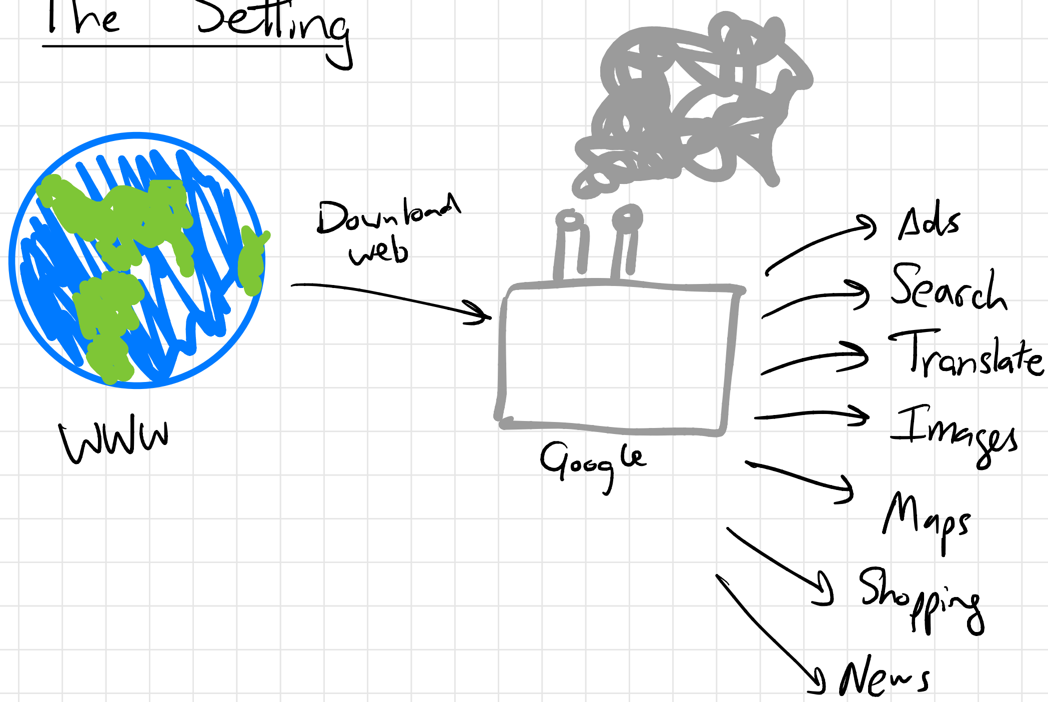
MapReduce paper uses "master" for server that coordinates workers

↳ We will use "main" instead

(Katrina prefers "coordinator")

↳ Most open-source projects & companies have deprecated use of "master" and we will follow that convention.

The Setting



* Vast quantities of data $\approx 2^{60}$ bytes
* Thousands of machines
* Used for lots of things.
  ↳ Always new applications.

Problem: When your new employee shows up, how can you give them access to this data set?

⇒ When you have 2^{60} bytes of data, even simple tasks are difficult.

Idea: Give programmer a simple way to interact with the data.

The simple API is really the deverves in this paper (IMO).

It's just this:

map(key1, val1) → [(key2, val2), ...]

reduce(key2, [val2, ...]) → val2

In MR paper, this is a list of values

User (application developer) doesn't worry about:

* where code runs in data center
* fault tolerance
* storing intermediate results
* stragglers
* locality
* resource consumption???

Example: Page popularity

→ For each URL u, how many pages link to u?

↳ Used in first versions of Google search

```
cat.com
dog.com
veg.com
dog.com
```

→ [(cat.com, 1), (dog.com, 1), (veg.com, 1)]

```
dog.com
```

→ [(dog.com, 1)]

map(page_name, page_html) → [(URL1, 1), (URL2, 1), ...]

↳ For each page, output URLs of all outgoing links on that page.

reduce(URL, (1, 1, 2, ..., 1)) → 134

↳ Sum up the # of incoming links.

(dog.com, (1, 1, 2, ..., 1)) → 134

Poll: MapReduce it?

* You have a copy of 2^{50} web pages. You want to find all pages written in Spanish.

  ↳ Yes, definitely makes sense.

* You have 2^{20} images of dogs and you need to resize them all to 50%.

  ↳ Data probably too small. Might as well run on your laptop.

* You have 2^{50} labeled images of dogs & want to train an ML classifier on them.

  ↳ Probably depends on your model!
  ↳ Most don't parallelize super well.

* You have a map of all roads in the U.S. and you want to find the shortest path from every city to every other city.

  ↳ Seems messy?... problem: global computation
  But if data is big...

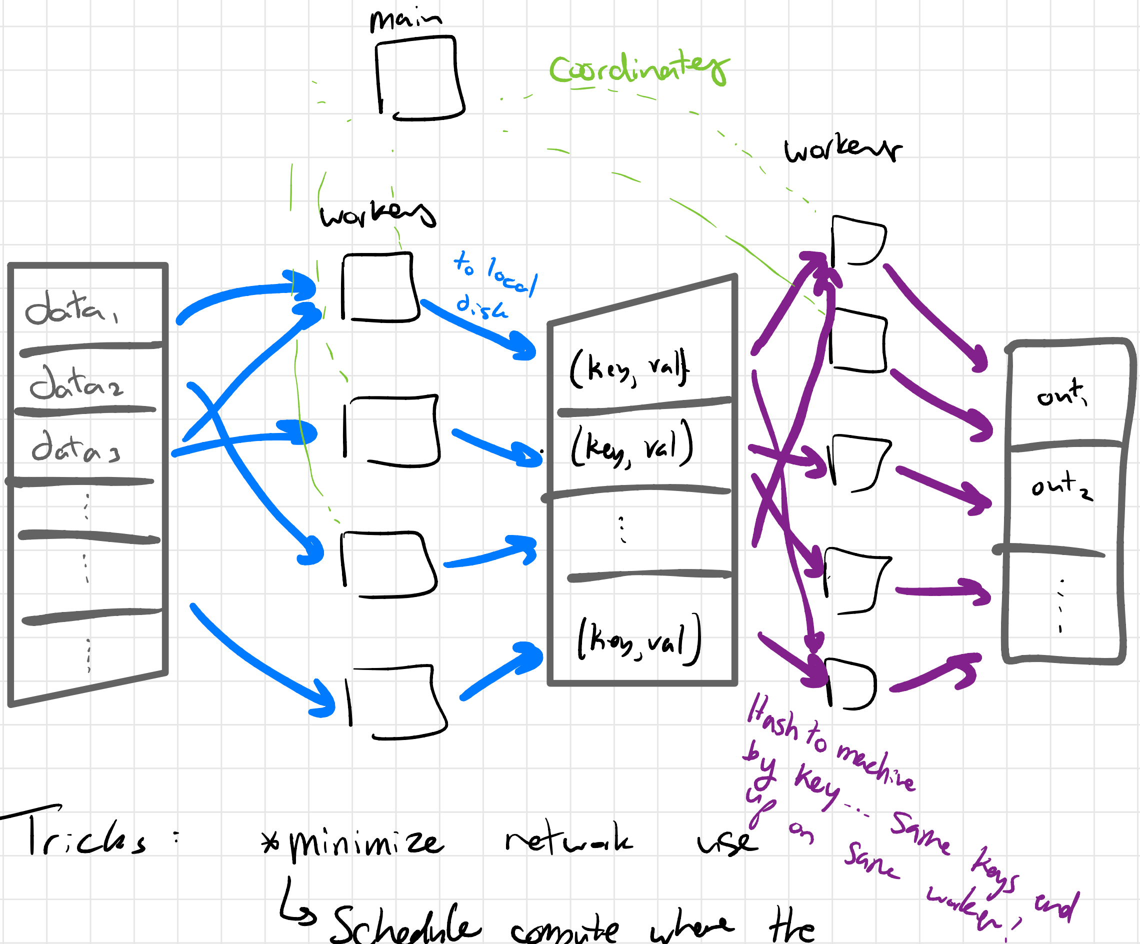
* Run the web server that hosts nytimes.com.

  ↳ Really only good for batch jobs

→ Manipulating state is also problematic (e.g. Amazon warehouse)

How to implement MapReduce?

- As in GFS, a single main server



Tricks: * minimize network use

↳ Schedule compute where the data is.

Failures

"fail stop"

What happens if worker disappears?
↳ Rerun! Only lose a chunk of work
↳ Same trick can handle slow workers

What happens if a worker gives corrupt output?

¯_(ツ)_/¯ You're on your own...

What happens if main server fails?
↳ Didn't cover this in eval.
⟹ Example failure in room ... everyone picks a tt
↳ one main versus everyone

Useful life fact

$Pr[\text{main fails}] = f$

$Pr[\text{at least 1 server fails out of } n] = 1 - (1 - f)^n \simeq 1 - e^{-nf}$

[Assume independent failures...]

Probability of a failure goes up exponentially with the # of servers!
↳ Failures are the common case.
↳ Good life lesson ☺

Closing thought:

- Central challenge of systems is exposing the POWER of computer to the application programmer (e.g. UNIX)
- Choosing the right interface is key
  - ↳ Ease of use
  - ↳ Flexibility in implementation
  - ↳ Generality

↳ MapReduce hits a really nice sweet spot in the design space.