Agenda

- Online vs offline systems
  raw vs derived data
- Intro to MapReduce
- Example: inverted index from forward index

Online Systems or Services

KV stores, web servers, databases, caches

wait for requests from clients, & try to handle them quickly.

Low Latency & Availability

Offline Systems or Batch processing Systems

MapReduce — Process LOTS of data
High throughput often priority

Streaming Systems
Hybrid of offline & online
Jamie Brandon

Different Representations of data

Raw data - Authoritative version
The format new data goes into

Derived data - Result of taking existing data & processing it somehow

MapReduce is a tool for computing derived data

Inverted Index

Inversion of forward index.

Forward Index

Doc	word
Doc1	the, quick, brown, fox
Doc2	the, dog, growls

Inverted Index

word	Doc
the	Doc1, Doc2
quick	Doc1
dog	Doc2

Converting Forward Index to Inverted Index.

for each document D:

```
for each word w in D:
    emit <w, D>
```

then,

combine Ds in a list for each unique word w

why can't we use above pseudocode in real life?

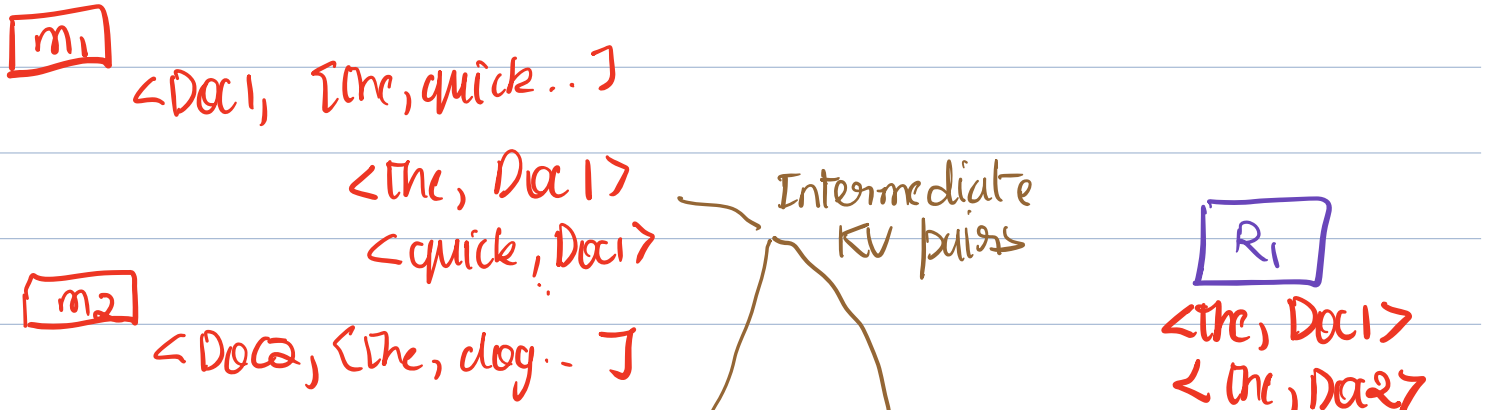
At scale, this become a distributed systems problem, & needs to deal with things like partitioning, availability, etc.

MapReduce is a framework to enable solving these problems by hiding the complexity of distributed systems.

```
for each document D:
    for each word w in D:
        emit <w, D>
```

This can be done in parallel!

This can be done locally on a machine for a doc



<the, Doc2>
<dog, Doc2>

m3

<Doc3, [i, love, my ...]>

<i, Doc3>

<love, Doc3>

<dog, Doc2>
<dog, Doc3>

R2

<quick, Doc1>

<love, Doc3>

<the [Doc1, Doc2]>

How would you aggregate intermediate KV pairs

Ensure all same keys end up on same machine.

Implementing using HASHING

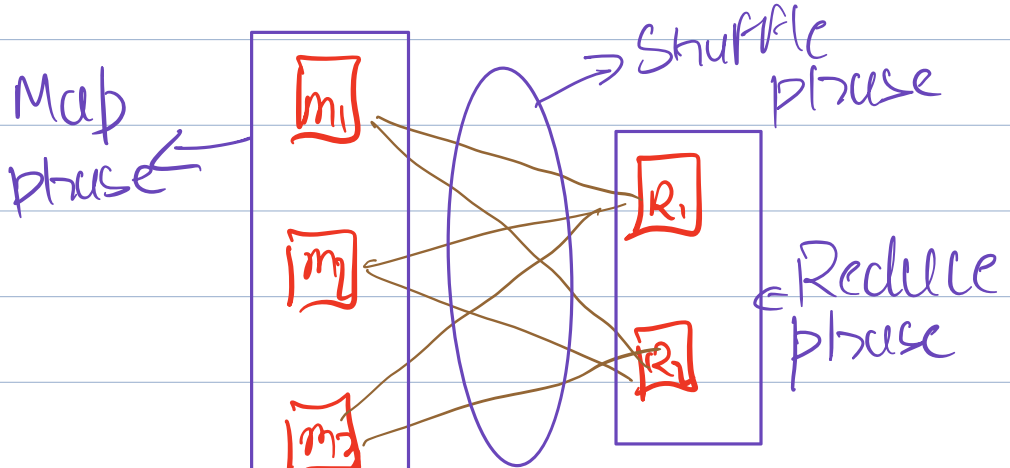
hash(key) % 2

↓

No. of 'reduce' machines

How does 'Reduce' worker read the data?

In general, every machine needs to read data from all 'map' nodes.



This communication pattern is called shuffle

Examples of tasks for MapReduce

- inverted index
- grep
- distributed sorting
- distributed word count

Combiners

Run the 'reduce' logic locally on the map workers & store intermediate data.