Map Reduce Discussion Notes

kuang chen (kuangc@eecs.berkeley.edu)

Problem

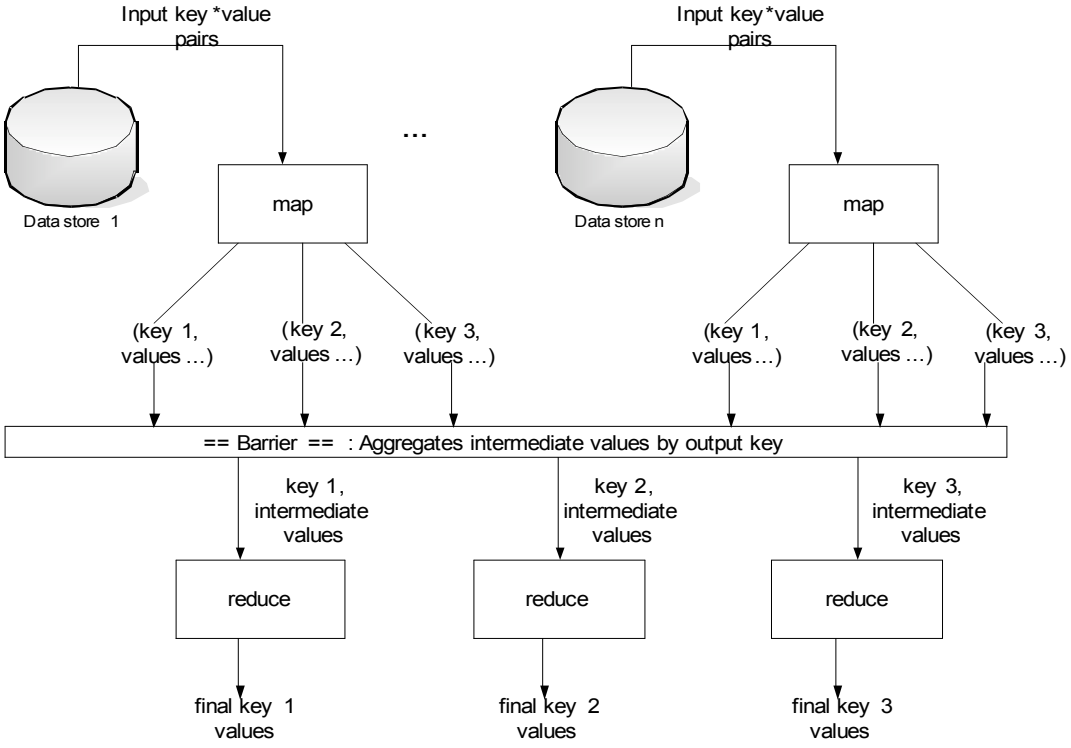
want to process lots of data - TBs
want to parallelize across datacenter
want to make it easy for lots of programmers

Existing work

use of a restricted programming model - "parallel prefix computation"
higher level abstractions to simplify parallel programming -
Bulk Synchronous Programming and some MPI primitives
locality optimizations - "active disks"
running backup tasks - "eager scheduling"

Google's Approach

programming model borrows from functional programming
map (in_key, in_value) -> (out_key, intermediate_value) list
records from data source fed in as (key,value) pairs
map produces one or more intermediate values with an output key
reduce (out_key, intermediate value list) -> out_value list
after the map phase is finished, all intermediate values for a output key
are combined into a list
reduce combines intermediate values into one or more final values
per output key



MapReduce implementation

takes care of the dirty work
designed for google datacenters
key features - (see pg 3 figure 1)
automatic parallelization, distribution
1 master : n workers
master divides work into M pieces (~64MB),
assigns to workers user-defined map task; map results fall into R pieces
workers reports map tasks are done; intermediate data is sorted
master assigns R reduce tasks
* reduce cannot start until map finishes
fault-tolerance
master pings workers periodically

- re-execute completed and in-progress map tasks
- re-execute in-progress, but straggling reduce tasks
- skips bad records

status and monitoring

simple, clean abstraction for programmers

locality

- master assigns work according to location of data - same machine, rack...

Performance

sort experiment - beat the TeraSort benchmark - so is fast

high utilization

data input rate is quite high due to locality optimization

running eager backup tasks shortened runtime by 44%

10%+ simultaneous failure of computing nodes resulted in only 5% increase in execution time

Conclusion

MapReduce is a success at google - it's used a lot (see pg 10, table 1)

- Good a simplifying large-scale computation for programmers
- Functional programming paradigm can be used for large-scale apps
- A large variety of problems can expressed as MapReduce computations
- Implementation scales to datacenter

But... specifically for Google problems, layered on Google infrastructure

- It is a restricted programming model - what type of problems cannot run on it?