COMS 4113 Homeworks

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Agenda

- Overview of homeworks (deadlines, grading, related topics, difficulty)
- Introduction to Go

Homeworks

8 Homeworks in total (excluded HW0).

Homework	**Submission Deadline**	**Weights**
HW0	M 01/24 (2 days!)	0 (but required)
HW1	Tu 02/01 (1 week)	10%
HW2a	Tu 02/15 (2 weeks)	10%
HW2b	Tu 02/22 (1 week)	10%
HW3a	Tu 03/08 (2 weeks)	10%
HW3b	Tu 03/22 (1 week)	10%
HW4a	Tu 04/05 (2 weeks)	10%
HW4b	F 04/15 (1 week + 3 days)	10%
Quiz	F 04/22 (1 week)	20%
HW5	Tu 05/10 (2 weeks + 2 days)	10%

Related Topics

Homework	Project	Related Topics
HW1	MapReduce	MapReduce, RPC
HW2	Primary/Backup Server	Fault Tolerant
HW3	Paxos and KV Database	Consensus, Paxos, Availability
HW4	Sharded KV Database	Scalability, Paxos, Atomic commitment
HW5	Model Checking Paxos	Testing & Model Checking

Difficulty

- HW1 < HW2 < HW3 < HW4 ≈ HW5
- Part a < Part b

Tips

- Read papers and understand the protocol before coding.
- Frequently print your results when debugging a distributed system.
- Start your part b before the deadline of part a.
- Get familiar with Go when working on HW1.
- Reference: 5 - 15 hours a week (coding & debugging).

Grading

- Unit tests are used to grade your assignments.
- Unit tests in the same homework have the same scores (if 10 unit tests, then each contribute to 1.25%).
- Each unit tests will be run 50 times. Every time a unit test fails, the score of this unit test will be multiplied by 0.9.
- Grading machines are run in Linux with Go version of 1.13.

#fails	0	1	2	3	4	5	6	7	8	25
score	100%	90%	81%	73%	66%	59%	53%	48%	43%	7%

How to test your code

- Run unit tests at least 50 times, maybe on different machines
- The result is not deterministic (especially for HW2-4), due to goroutine/thread scheduling
- Passing tests 50 times does not mean your code is correct, and you code may still fail on our grading machine!
- We’ll not add hidden unit tests!

Go

- Statically typed
- Garbage collection
- CSP-style concurrency

- More and more popular: Docker, etcd, ...

- Do not panic; Go is much simpler than C/C++, when you get familiar with the Go’s syntax.

MapReduce

1. Split the file in M chunks.

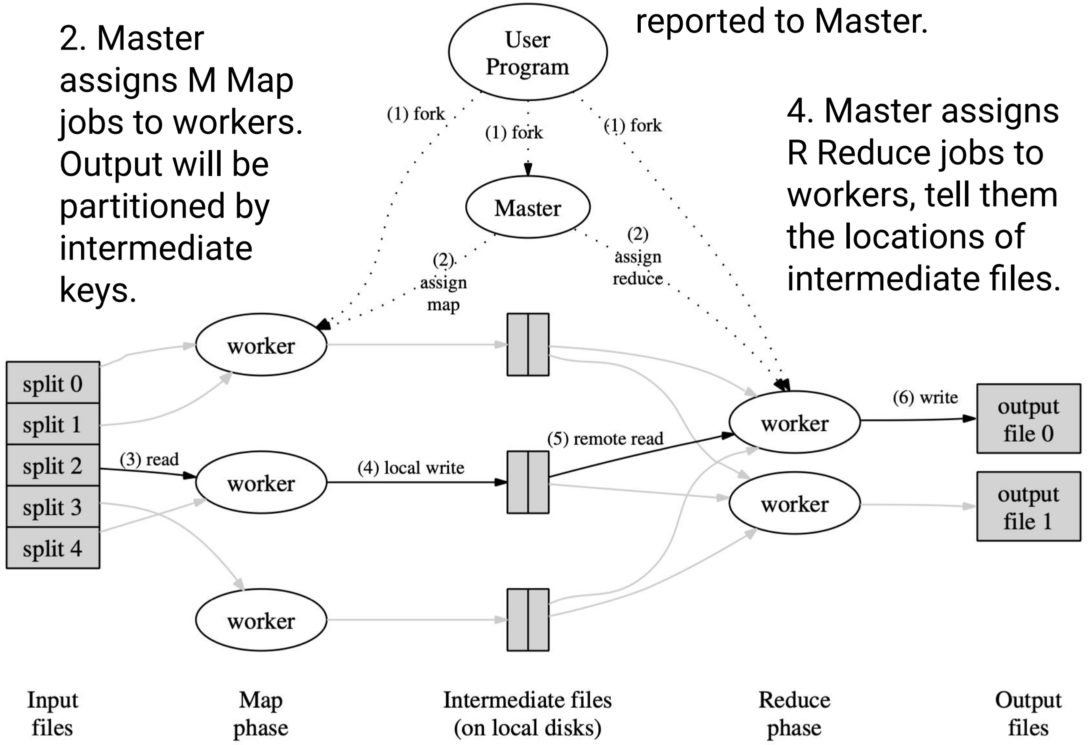
Define Map and Reduce Functions.

2. Master assigns M Map jobs to workers. Output will be partitioned by intermediate keys.

3. There are MxR intermediate results from Map phases. Their location are reported to Master.

4. Master assigns R Reduce jobs to workers, tell them the locations of intermediate files.

5. Reduce jobs output R final outputs.



From the MapReduce paper (link)

MapReduce Example: word count

Split file: input-1.txt, input-2.txt, ..., input-m.txt

Map Phase: "..., a dog, a cat ..." => {"a": ["1", "1"], "dog": ["1"], "cat": ["1"], ...}

Intermediate files: file-1-1.txt {"a": ["1", "1"], "cat": ["1"], ...}, file-1-2.txt {"dog": ["1"]}

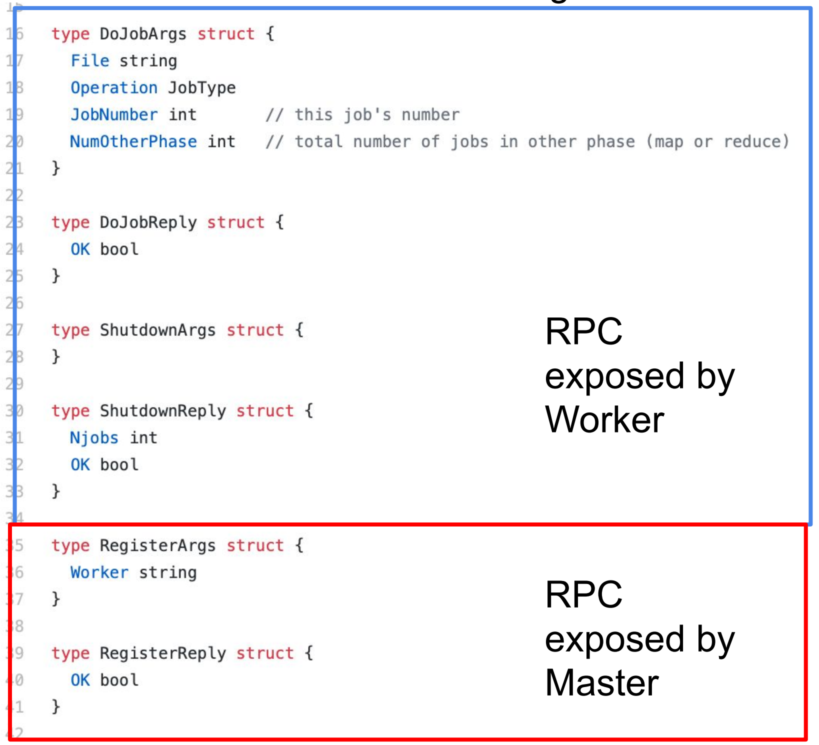
Reduce Phase: {"a": ["1", "1"], "cat": ["1"], ...}, {"a": ["1", "1", "1"], "apple": ["1", "1"]} =>

{"a": "5"}, {"apple": "2"}, {"cat": "1"}, ...

Output: output-1.txt, output-2.txt, ..., output-r.txt

How to start?

1. Start with common.go.
Get familiar with the RPC signature.

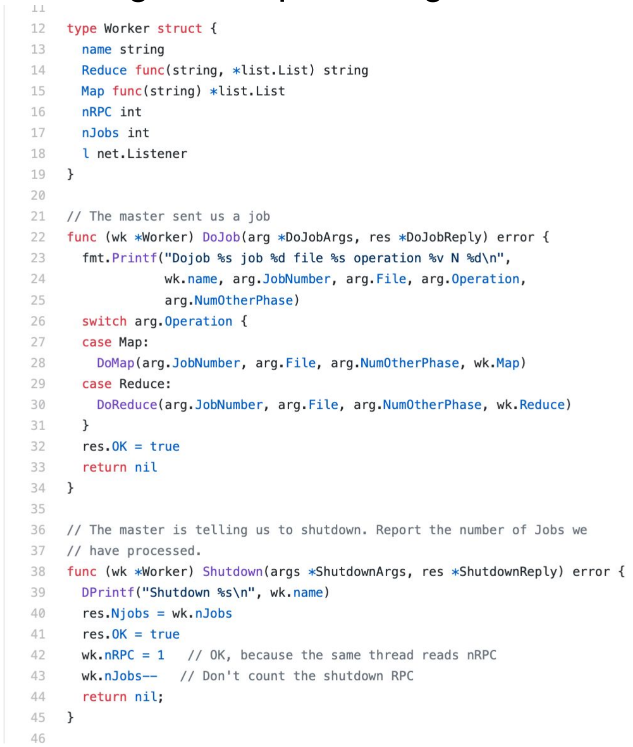


```go
type DoJobArgs struct {
  File string
  Operation JobType
  JobNumber int       // this job's number
  NumOtherPhase int   // total number of jobs in other phase (map or reduce)
}

type DoJobReply struct {
  OK bool
}

type ShutdownArgs struct {
}

type ShutdownReply struct {
  Njobs int
  OK bool
}

type RegisterArgs struct {
  Worker string
}

type RegisterReply struct {
  OK bool
}
```

RPC exposed by Worker

RPC exposed by Master

2. Understand the code in worker.go and logic in mapreduce.go.

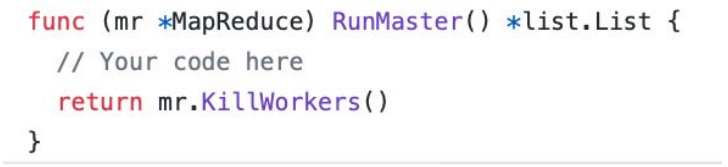


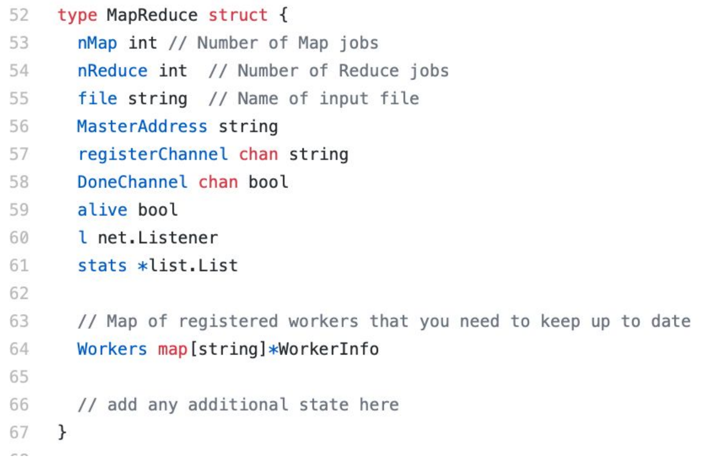
```go
type Worker struct {
  name string
  Reduce func(string, *list.List) string
  Map func(string) *list.List
  nRPC int
  nJobs int
  l net.Listener
}

// The master sent us a job
func (wk *Worker) DoJob(arg *DoJobArgs, res *DoJobReply) error {
  fmt.Printf("Dojob %s job %d file %s operation %v N %d\n",
             wk.name, arg.JobNumber, arg.File, arg.Operation,
             arg.NumOtherPhase)
  switch arg.Operation {
  case Map:
    DoMap(arg.JobNumber, arg.File, arg.NumOtherPhase, wk.Map)
  case Reduce:
    DoReduce(arg.JobNumber, arg.File, arg.NumOtherPhase, wk.Reduce)
  }
  res.OK = true
  return nil
}

// The master is telling us to shutdown. Report the number of Jobs we
// have processed.
func (wk *Worker) Shutdown(args *ShutdownArgs, res *ShutdownReply) error {
  DPrintf("Shutdown %s\n", wk.name)
  res.Njobs = wk.nJobs
  res.OK = true
  wk.nRPC = 1   // OK, because the same thread reads nRPC
  wk.nJobs--   // Don't count the shutdown RPC
  return nil;
}
```

How to start?

3. Implement the Master following the protocol from the paper. You need to write in both master.go and mapreduce.go

4. Finally, run each test cases 50 times to make sure your code is correct.


```go
func (mr *MapReduce) RunMaster() *list.List {
  // Your code here
  return mr.KillWorkers()
}
```


```go
type MapReduce struct {
  nMap int // Number of Map jobs
  nReduce int  // Number of Reduce jobs
  file string  // Name of input file
  MasterAddress string
  registerChannel chan string
  DoneChannel chan bool
  alive bool
  l net.Listener
  stats *list.List

  // Map of registered workers that you need to keep up to date
  Workers map[string]*WorkerInfo

  // add any additional state here
}
```

Go Tutorial

By Jay Karp

https://courseworks2.columbia.edu/courses/146117/files/folder/Go%20Introduction?

HW0 FAQ

We’ve got 115 responses via the confirmation form, and if you cannot create your assignment repository, you can post a private question in ED to tell us.

- My GitHub account is linked to my personal email account.

  No problem; do not worry!

- Will making repo private affect CAs’ visibility?

  We can see your private repos. Please keep your repo private!

Thank you for listening

If you haven’t got your assignment repository created, do it soon!

Feel free to post questions in ED, and we’ll help you!