Part 1a:

2^{12} = 2^12 = 4096

4^5 = 4^5 = 1024

4^5 = 2^(2*5) = 1024

1221 MOD 12 (MOD is the modulo operator, a.k.a. the remainder)
Ans: Remainder is 9

61 MOD 13
Ans: Remainder is 9

43 MOD 7
Ans: Remainder is 1

Part 1b:

V1 = (2, 1, 3) and V2 = (1, 1, 2) and a 3x3 matrix M = [(1, 1, 1), (2, 1, 3), (1, 0, 2)]

V1 + V2 (vector addition)
Ans: (3, 2, 5)

V1 – V2 (vector subtraction)
Ans: (1, 0, 1)

|V1| (vector length)
Ans: $\sqrt{2^2 + 1^2 + 3^2} = \sqrt{14} = 3.7416573867739413$
(Python Version: np.sqrt((v1**2).sum()) = 3.7416573867739413)

|V2| (vector length)
Ans: $\sqrt{1^2 + 1^2 + 2^2} = \sqrt{6} = 2.4494897427831779$
(Python Version: np.sqrt((v2**2).sum()) = 2.4494897427831779)

M * V1 (matrix times vector)
Ans: M * Transpose (V1) = Matrix (3x3) * V1.T (3x1) = Matrix (3x1) =

```
([[ 6],
  [14],
  [ 8]])
```

Python Version:

```
In [13]: ##M * V1 (matrix times vector)
         M * v1.T

Out[13]: matrix([[ 6],
                 [14],
                 [ 8]])
```

M * M (or M^2)

Ans: M * M = Matrix (3x3) * Matrix (3x3) = Matrix (3x3) =
```
([[ 4,  2,  6],
 [ 7,  3, 11],
 [ 3,  1,  5]])
```

Python Version:

```
In [15]: ##M * M (or M^2)
         M**2

Out[15]: matrix([[ 4,  2,  6],
                 [ 7,  3, 11],
                 [ 3,  1,  5]])
```

M^4

Ans: M * M * M * M= Matrix (3x3) * Matrix (3x3) * Matrix (3x3) * Matrix (3x3)
= Matrix (3x3) =
```
([[ 4,  2,  6],
 [ 48,  20,  76],
 [ 82,  34, 130],
 [ 34,  14,  54]])
```

Python Version:

```
In [16]: ##M^4
         M**4

Out[16]: matrix([[ 48,  20,  76],
                 [ 82,  34, 130],
                 [ 34,  14,  54]])
```

Part 1c: Pro(H)=0.6 And Pro(T)=0.4

HHT

Ans: Probability(HHT) = Pro(H) * Pro(H) * Pro(T) = 0.6 *0.6 * 0.4 = 0.144

THHT

Ans: Probability(THHT) = Pro(T)* Pro(H)* Pro(H)* Pro(T) = 0.4 *0.6 * 0.6 * 0.4 = 0.0576

Exactly 2 Heads out of a sequence of 3 coin flips.

Ans: Probability of Exactly 2 Heads out of a sequence of 3 coin flips. The followings are 8 possible events

1)HHH
2)HHT
3)HTH
4)THH
5)HTT
6)THT
7)TTH
8)TTT

Ans: $C_2^3 * 0.6^2 * 0.4^1 = 0.432$

Exactly 1 Tail out of sequence of 3 coin flips.
Ans: Probability of Exactly 1 Tail out of a sequence of 3 coin flips. The followings are 8 possible events
1)HHH
2)HHT
3)HTH
4)THH
5)HTT
6)THT
7)TTH
8)TTT

Ans: $C_1^3 * 0.4^1 * 0.6^2 = 0.432$ #Same as the above case with Exactly 2 heads in 3 coin flips.

Part 1d:
Table1: Employee(ID, Name, Address, Position)
Table2: Certificates(EID, CertName, Date1)

i. Find all employees first name is "Jane" (assume that Name is the full name of employee and that there is no FirstName column)
Ans:

```
--Assume the Name = "FirstName LastName" :
Select Name
from Employee
where upper(name) LIKE 'JANE%';
```

ii. Find out how many different certifications (CertName) are stored in the database (you should not count the same CertName twice).
Ans:

```
Select count(unique(CertName)) As No_type_Cert
from Certificates;
```

iii. Find all employees that have fewer than 4 certifications (note that this should include **0** to be correct)
Ans:

```
Select id, name, address, position, count(Certificates.CERTNAME) AS No_Cert
from Employee left outer join Certificates
on Employee.ID = Certificates.EID
group by id,name,address,position
having count(Certificates.CERTNAME)<4;
```

Part 1e:

Mining of Massive Datasets, Exercise 1.3.3 : Suppose hash-keys are drawn from the population of all nonnegative integers that are multiples of some constant c, and hash function h(x) is x mod 15. For what **values** of c will h be a suitable hash function, i.e., a large random choice of hash-keys will be divided roughly equally into buckets?

Ans:

Given: h(x) = x mod 15 which values of x is multiple of c

In order to send all the non-negative integers are sent to each of the 15 buckets which are 0,1,2,3,4,5,6,7,8,9,10,11,12,13,14. I would suggest that the values of c would be 1,2,7,11,13,17 and these random drawn numbers with the above multiples would be sent to EACH of the 15 buckets. Please check the following tables to support this assumed result. Also, I have skipped to state the some constant values, e.g. 4,8, because they have factors of 2 and 4. Actually, the constant values of c could be more the above 6 values and those values are all highly possible prime numbers except the value of 1. Please refer to the follow tables refer to the values of c and the buckets.

Multiple values	c	value of x	B	Bucket
0	1	0	15	0
15	1	15		0
1	1	1		1
16	1	16		1
2	1	2		2
17	1	17		2
3	1	3		3
18	1	18		3
4	1	4		4
19	1	19		4
5	1	5		5
20	1	20		5
6	1	6		6
21	1	21		6
7	1	7		7
22	1	22		7
8	1	8		8
23	1	23		8
9	1	9		9
10	1	10		10
11	1	11		11
12	1	12		12
13	1	13		13
14	1	14		14

Multiple values	c	value of x	B	Bucket
0	2	0	15	0
15	2	30		0
8	2	16		1
23	2	46		1
1	2	2		2
16	2	32		2
9	2	18		3
2	2	4		4
17	2	34		4
10	2	20		5
3	2	6		6
18	2	36		6
11	2	22		7
4	2	8		8
19	2	38		8
12	2	24		9
5	2	10		10
20	2	40		10
13	2	26		11
6	2	12		12
21	2	42		12
14	2	28		13
7	2	14		14
22	2	44		14

Multiple values	c	value of x	B	Bucket
0	7	0	15	0
15	7	105		0
13	7	91		1
11	7	77		2
9	7	63		3
7	7	49		4
22	7	154		4
5	7	35		5
20	7	140		5
3	7	21		6
18	7	126		6
1	7	7		7
16	7	112		7
14	7	98		8
12	7	84		9
10	7	70		10
8	7	56		11
23	7	161		11
6	7	42		12
21	7	147		12
4	7	28		13
19	7	133		13
2	7	14		14
17	7	119		14

Multiple values	c	value of x	B	Bucket
0	11	0	15	0
15	11	165		0
11	11	121		1
7	11	77		2
22	11	242		2
3	11	33		3
18	11	198		3
14	11	154		4
10	11	110		5
6	11	66		6
21	11	231		6
2	11	22		7
17	11	187		7
13	11	143		8
9	11	99		9
5	11	55		10
20	11	220		10
1	11	11		11
16	11	176		11
12	11	132		12
8	11	88		13
23	11	253		13
4	11	44		14
19	11	209		14

Multiple values	c	value of x	B	Bucket
0	13	0	15	0
15	13	195		0
11	13	143		8
7	13	91		1
22	13	286		1
3	13	39		9
18	13	234		9
14	13	182		2
10	13	130		10
6	13	78		3
21	13	273		3
2	13	26		11
17	13	221		11
13	13	169		4
9	13	117		12
5	13	65		5
20	13	260		5
1	13	13		13
16	13	208		13
12	13	156		6
8	13	104		14
23	13	299		14
4	13	52		7
19	13	247		7

Multiple values	c	value of x	B	Bucket
0	17	0	15	0
15	17	255		0
8	17	136		1
23	17	391		1
1	17	17		2
16	17	272		2
9	17	153		3
2	17	34		4
17	17	289		4
10	17	170		5
3	17	51		6
18	17	306		6
11	17	187		7
4	17	68		8
19	17	323		8
12	17	204		9
5	17	85		10
20	17	340		10
13	17	221		11
6	17	102		12
21	17	357		12
14	17	238		13
7	17	119		14
22	17	374		14

Part 1f:

Generally speaking, The Mapper part is the code to read through the blocks of data, and then every word/key give value of 1
The Reducer phase is actually to use the function to aggregate Key-Value pair. The user would be in the role to decide what function to be applied. Avg, sum, std, count, min,max etc in this phase.

i. Find the smallest number in the input file.

During the Map phase, the input file is split into different blocks. In the block, the Mapper function maps the data in the <key , value> format. The Mapper won't count or search for duplicates, so that the output from mapper would be some like <100, 1>, <200, 1> , <100,1>format.

And then the reducer takes the key-value pair from the Map phase, the reducer function aggregates the key and its value to a format <key, value>, e.g. <100, 2>, <200,10> which the values show the occurrence of the key within the block. After that the code should find out the smallest number (key) among all the numbers within the block.

ii. Find all unique numbers that greater than 100 but less than 1000.

That Map phase is very similar to part i. During the Map phase, the input file is split into different blocks. In the block, the Mapper function maps the data in the <key , value> format. The Mapper won't count or search for duplicates, so that the output from mapper would be some like <100, 1>, <200, 1> , <3000,1>format.

And then the reducer takes the key-value pair from the Map phase, the reducer function aggregates the key and its value to a format <key, value>, e.g. <100, 2>, <200,10> which the values show the occurrence of the key within the block. After that the code should find out the number between 100 and 1000 (i.e. Python: if key <1000 and key>100) among all the number (key) within the block.

iii. For a data file that contains records (ID, First, Last, Grade) for each student, find how many students with repeating names there are for each name entry.

In the Map phase, we need to map out all the keys which is First, Last from the student records. The query / aggregate SQL would be as the following

Map phase:
Select First, Last, ?
from student
group by First, Last

In the reduce phase, the reducer function will aggregate the keys (First, Last) from the map phase. The reducer function would be count(ID) refer to the ? on the Map phase Query.

iv. For a data file that contains records (ID, First, Last, Grade) for each student, find the GPA of each student.

Assuming the Grade is in 4.0 Scale.

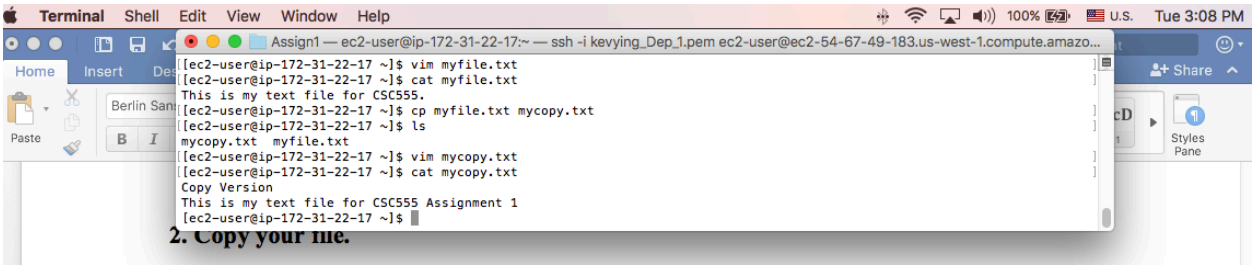
In the Map phase, the map function would map out the Keys <ID,First,Last> and Values <Grade> from the student record. The key-value pair format would be as <ID,First,Last, Grade>. The query/aggregate SQL would be as the following:

Map phase:
Select ID,First,Last, ?
From Student
Group by ID,First,Last

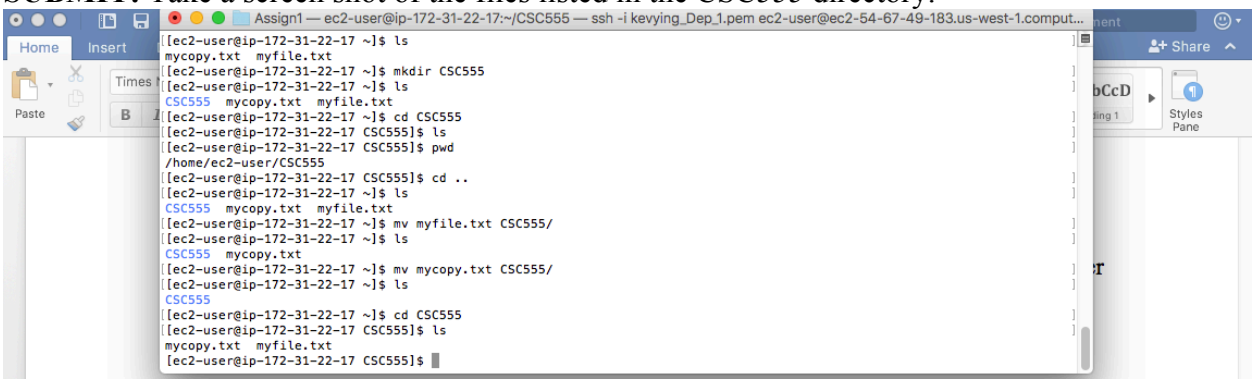
In the reduce phase, the reducer function will take the output from Map phase and compute the GPA for each Key < ID,First,Last > by using the function AVG(Grade) which refer to the ? in the Map phase Query.

Part 2:

SUBMIT: Take a screen shot of the contents of your copied file displayed on the terminal screen.

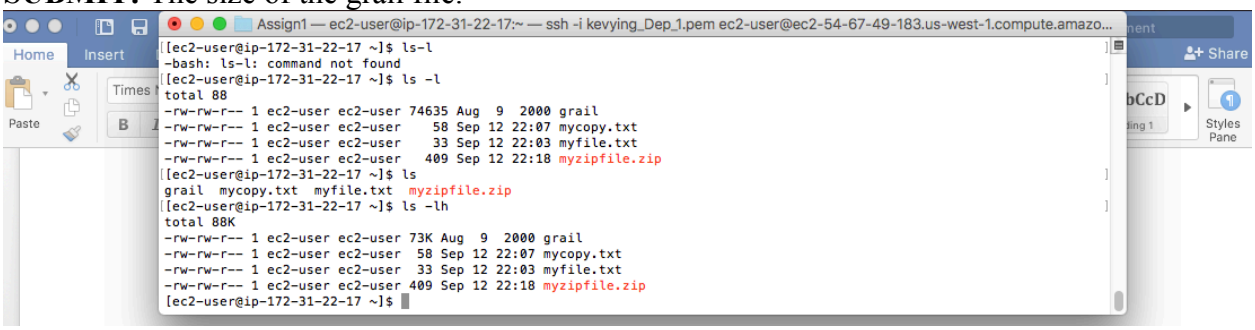


SUBMIT: Take a screen shot of the files listed in the CSC555 directory.



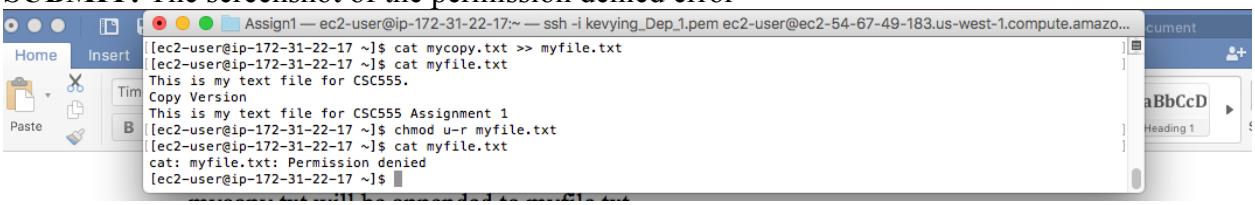
SUBMIT: Take a screen shot of the screen after this command (unzip).

SUBMIT: The size of the grail file.

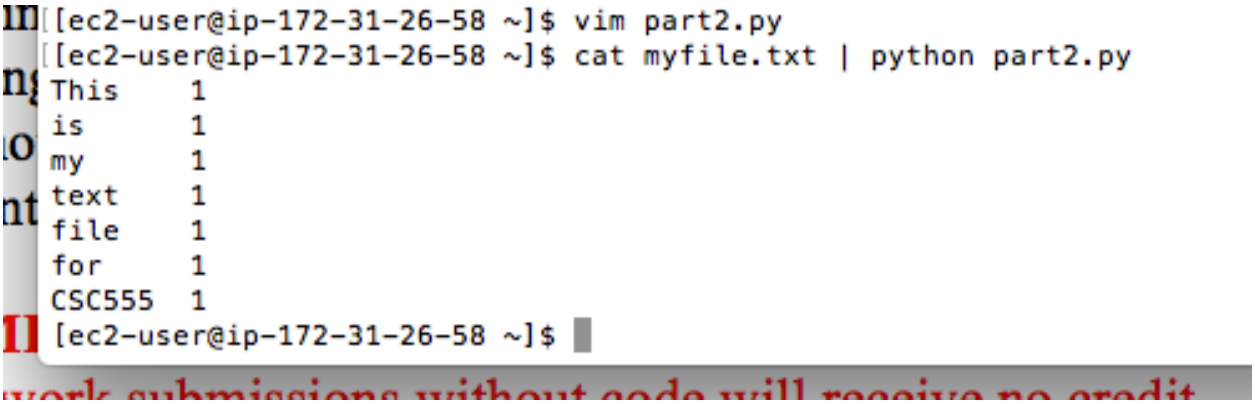


Based on the above, the size of the grail file is about 73K bytes

SUBMIT: The screenshot of the permission denied error



SUBMIT: The screen output from running your python code <u>and a copy of your python code</u>. Homework submissions without code will receive no credit.



<u>Code:</u>

```
import sys

for line in sys.stdin:
    line=line.strip()
    words=line.split(' ')

    for word in words:
        print '%s\t%s' %(word,1)
```

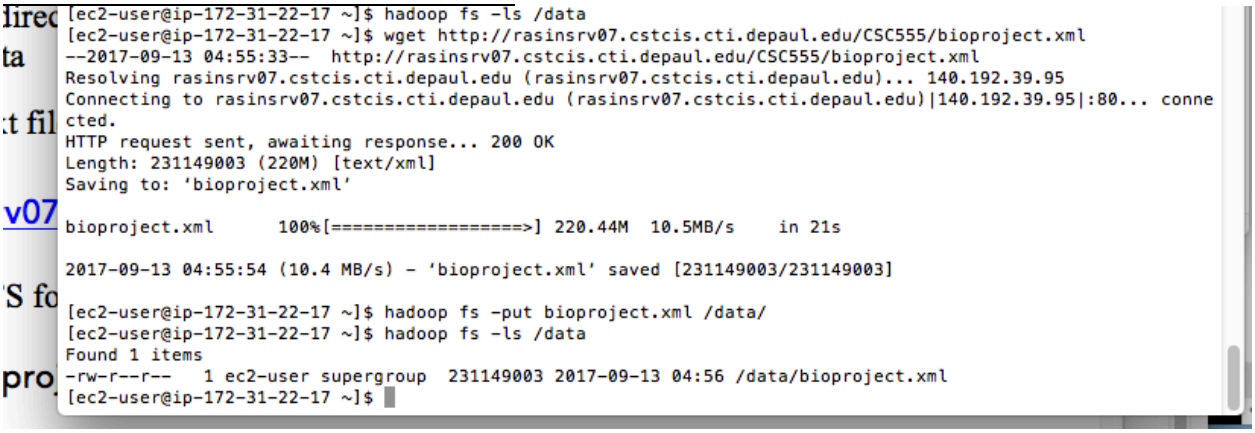
Part 3:

Copy the file to HDFS for processing

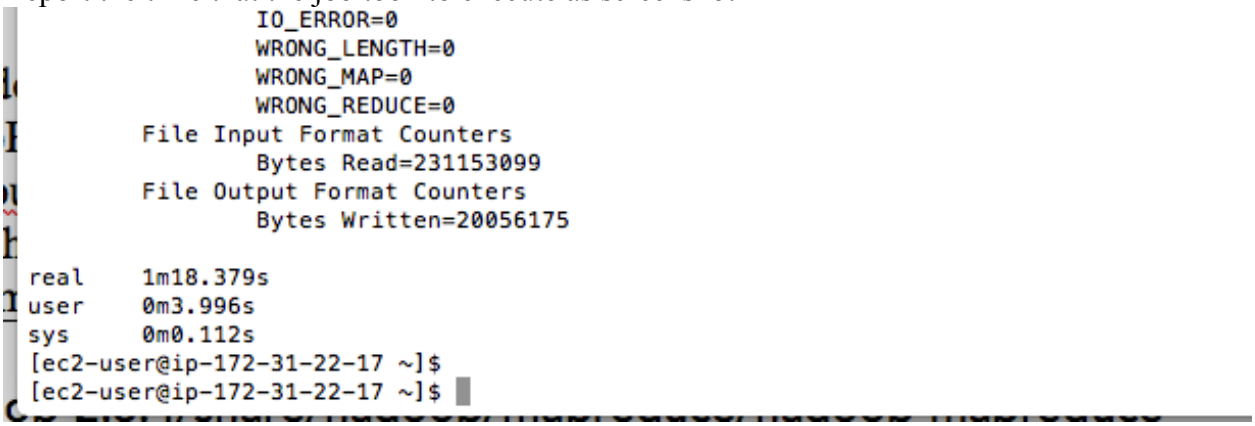
hadoop fs -put bioproject.xml /data/

(you can optimally verify that the file was uploaded to HDFS by hadoop fs -ls /data)

Submit a screenshot of this command



Report the time that the job took to execute as screenshot



WordCount: