Problem 4.1

Compile a table to compare public clouds and private clouds in each of the following four aspects. Also identify their differences, advantages, and shortcomings in terms of design technologies and application flexibility. Give several example platforms that you know of under each cloud class.

a. Technology leveraging and IT resource ownership
b. Provisioning methods of resources including data and VMs, and their management
c. Workload distribution methods and loading policies
d. Security precautions and data privacy enforcement

	Public Clouds	Private Clouds
a	Built over the internet, Owned by Service Providers and accessible through a subscription.	Built with in the domain of an intranet owned by a single organization. It is Client owned and managed. Access is limited to owning clients and their partners.
b	Offers publicly accessible remote interface for creating and managing VM instances.	Distribute data and VM resources.
c	Handles workload dynamically. Should be designed to handle workload without communication dependencies	Handles workload dynamically. Balance workload more efficiently.
b	Data Privacy is a challenge	Can enforce data privacy more effectively.

Please Read – 4.1.2.4, 4.1.1.2 and 4.1.1.3 for above.

Problem 4.2

Describe the following techniques or terminologies used in cloud computing and cloud services. Use a concrete example cloud or case study to explain the addressed technology.

a. Virtualized data center

The major advantage of public clouds lies in the avoidance of capital expenses by users in IT investments in hardware, software, and personnel.

Most companies start with virtualization of their computing machines to lower the operating costs. Companies such as Microsoft, Oracle, and SAP may want to establish policy-driven management of their computing resources, mainly to improve QoS to their employees and customers. By integrating virtualized data centers and company IT resources, they offer *IT as a service* to improve the agility of their company operations. This approach avoids replacement of a large number of servers every 18 months. As a result, these companies can upgrade their IT efficiency significantly.

b. Green information technology

IT power consumption in the United States has more than doubled to 3 percent of the total energy consumed in the country. The large number of data centers in the country has

contributed to this energy crisis to a great extent. More than half of the companies in the Fortune 500 are actively implementing new corporate energy policies. Recent surveys from both IDC and Gartner confirm the fact that virtualization had a great impact on cost reduction from reduced power consumption in physical computing systems. This alarming situation has made the IT industry become more energy-aware. With little evolution of alternate energy resources, there is an imminent need to conserve power in all computers. Virtualization and server consolidation have already proven handy in this aspect. Green data centers and benefits of storage virtualization are considered to further strengthen the synergy of green computing.

Ref 4.3.3.3

c. Multitenant technique

SaaS for distributing software to a large number of users for their simultaneous use and resource sharing if so desired.
Ref – 4.3.1.2

Problem 4.5

Consider two cloud service systems: Google File System and Amazon S3. Explain how they achieve their design goals to secure data integrity and to maintain data consistency while facing the problems of hardware failure, especially concurrent hardware failures

The design goal to secure data integrity and to maintain data consistency is achieved by the redundant hardware and redundant data. The redundand virtual machines are kept in the inactive state. If any VM fails, the snapshot of the failed machine is taken and saved to another inactive VM. The same is done for the data. The various copies of the data are maintained in the cluster. In case of a failure, the data is recovered from one of the copy of the data. The concurrent hardware failures can also be covered up by the extra inactive VM available.

Problem 4.10

Explain the differences in the following two machine recovery schemes. Comment on their implementation requirements, advantages and shortcomings, and application potential.

a. Recovery of a physical machine failure by another physical machine

Configure hardware ->Install OS -> Configure OS -> Install Backup Agent -> Startup single step automatic recovery.

As per the above steps to recover a physical machine from a physical machine is slow, complex and expensive. Total recovery time is attributed to the hardware configuration, installing and configuring the OS, installing the backup agents, and the long time to restart the physical machine.

b. Recovery of a VM failure by another VM

Restore VM Configuration -> Start Data Recovery

To recover a VM platform, the installation and configuration times for the OS and backup agents are eliminated. Therefore, we end up with a much shorter disaster recovery time, about 40 percent of that to recover the physical machines. Virtualization aids in fast disaster recovery by VM encapsulation.

The cloning of VMs offers an effective solution. The idea is to make a clone VM on a remote server for every running VM on a local server. Among all the clone VMs, only one needs to be active. The remote VM should be in a suspended mode. A cloud control center should be able to activate this clone VM in case of failure of the original VM, taking a snapshot of the VM to enable live migration in a minimal amount of time. The migrated VM can run on a shared Internet connection. Only updated data and modified states are sent to the suspended VM to update its state. The Recovery Property Objective (RPO) and Recovery Time Objective (RTO) are affected by the number of snapshots taken. Security of the VMs should be enforced during live migration of VMs

Problem 4.13

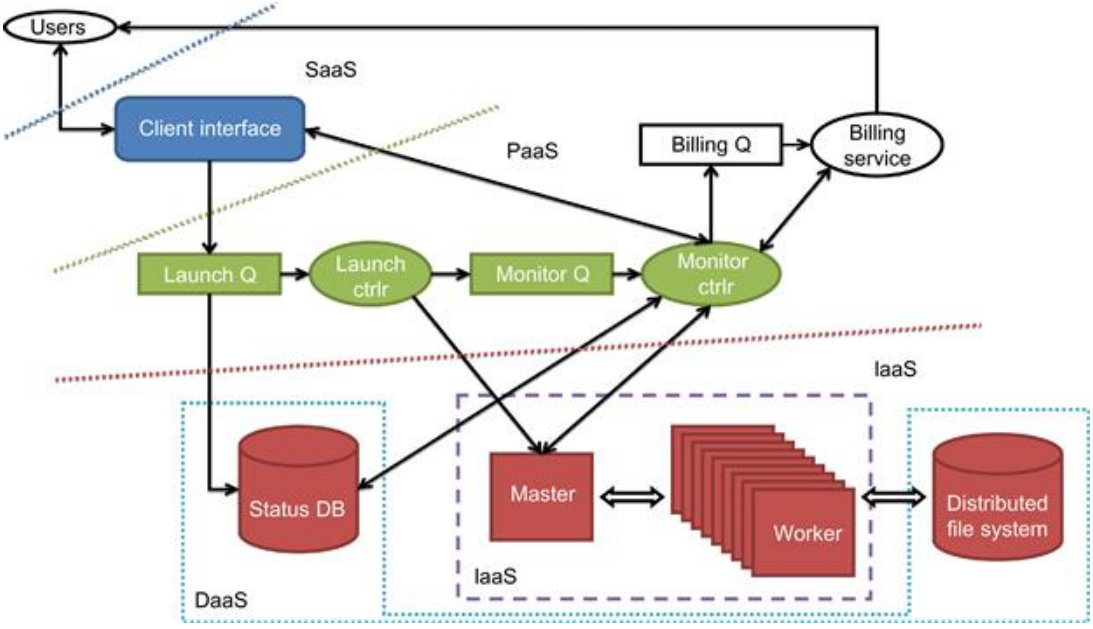
Map the following 14 names or abbreviated terms on the left column with the best-match definitions or descriptions on the right column. Just enter the description label (a, b, c, ….) in the blank spaces in front of the terms being matched to. This is a 1-to-1 correspondence.

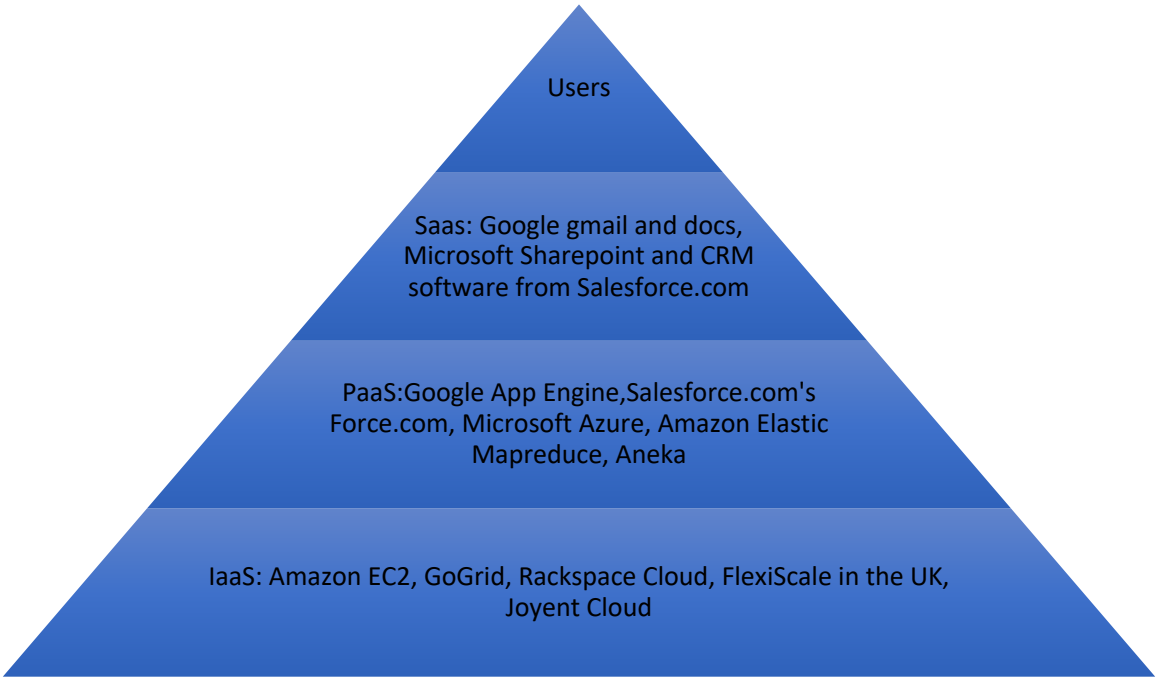
Term	**Description to Be Mapped with the Terms on the Left Column**
__c___ GAE	**a**) The agreement signed between users and providers in cloud computing
__g__ CRM	**b**) A public cloud that must run from Windows 7 based host
__d___ AWS	**c**) A public cloud used mainly for PaaS applications
__a___ SLA	**d**) A public compute cloud used in scalable business computing application
__b__ Azure	**e**) A cloud platform built by SalesForce.com
__h___ EC2	**f**) A commercial cloud OS for transforming a data center to a cloud platform
__i___ S3	**g**) One of the most frequently used SaaS applications used in the business world
__e___ Force.com	**h**) A cloud platform built mainly for IaaS applications
__f___ vSphere/4	**i**) A storage cloud service for distributed storage applications

Term	Description to Be Mapped with the Terms on the Left Column
__l___ EBS	**j**) An open-source hypervisor developed at Cambridge University
__m___ SQL	**k**) The distributed file system used in Google search engines and in App Engine
__n___ Chubby	**l**) An Amazon block lock interface for saving and restoring the VM instances
__j___ XEN	**m**) An Azure service module for users to visit and use of relational database
__k___ GFS	**n**) A distributed block lock service module in Google App Engine

Problem 4.19

Draw a layered diagram to relate the construction of IaaS, PaaS, and SaaS clouds from bare machine hardware to the users applications. Briefly list the representative cloud service offerings at each cloud layer from the major cloud providers that you know of.





Cloud computing delivers infrastructure, platform, and software (application) as services, which are made available as subscription-based services in a pay-as-you-go model to consumers. The services provided over the cloud can be generally categorized into three different service models: namely IaaS, Platform as a Service (PaaS), and Software as a Service (SaaS). These form the three pillars on top of which cloud computing solutions are delivered to end users. All three models allow users to access services over the Internet, relying entirely on the infrastructures of cloud service provider

Problem 9.6

The IoT differs from the traditional Internet in many ways. Identify their differences and describe their distictions in connecting entities, infrastructure and networking, and application domains.

- IoT and Traditional Internet differs in many ways like in IoT content is created by machine whereas in traditional internet the content is created by Human. In IoT Content is consumed by pushing information and triggering actions but in traditional internet content is consumed by request. IoT can be used to determine the action and get the timely information, but traditional internet is used to answer questions. So far, for IoT mainly content is created, whereas in traditional internet content creation and consumption is done.
- In IoT each device is connected to every other device in the network whereas in traditional internet, the internet connection is required to connect the two devices.
- IoT can be seen in application domain like industry and economy, environmental and natural resources, society and daily life. The examples of these domains are energy, financial sector, energy.

- IoT infrastructure is divided in four stages.
  - ✓ Data Sensors
  - ✓ Data Aggregation and Data Conversion
  - ✓ Data Preprocessing
  - ✓ Data Analysis and Management.

Problem 9.7

Distinguish the following pairs of terminologies:

a. Open source versus proprietary operating systems

Operating System for which the original source code is made freely available and may be redistributed and modified.

Operating System software that is not open source or freely licensed is called proprietary operating system.

b. Internet of Things versus cyber-physical systems

The IoT refers to the networked interconnection of everyday objects, tools, devices, or computers. One can view the IoT as a wireless network of sensors that interconnect all things in our daily life. These things can be large or small and they vary with respect to time and place. The idea is to tag every object using RFID or a related sensor or electronic technology such as GPS.

Computers have become pervasive and ubiquitous. Computing devices appear in TV remote controls, smartphones iPods, elevators, escalators, windshield wipers, thermostats in offices/homes, and traffic lights at intersections. These devices are so common in our daily lives that we do not even think of them as computers. Technical people refer to these devices embedded systems that perform one or more dedicated functions. With the advent of smartphones, GPS navigators, and tablet computers, embedded systems are turning into a new class of intelligent systems, known as cyber-physical systems.

A cyber-physical system (CPS) is an embedded system which integrates the computing process with the physical world as an interactive and intelligent system.

c. Social networks versus professional networks

A social network is a structure representing the social relationships of individuals. In a social network, nodes represent the individuals, and the ties between the nodes represent the relationships such as friendship, kinship, and colleagueship.

A professional network service (or, in an Internet context, simply professional network) is a type of social network service that is focused solely on interactions and relationships of a business nature rather than including personal, nonbusiness interactions

Problem 9.14

Match the following 20 names or abbreviated terms in the left column with the best-match definitions or descriptions in the right column.

Term	Description to Be Mapped with the Terms on the Left Column
__p___MySpace	**a**) The world's largest social network in terms of registered users today
_____Cloudlet	**b**) A social network mainly used for video strip forwarding applications
__m___Bluetooth	**c**) A natural extension of the Internet involving humans in the loop of control
__h___IoT	**d**) A social network for microblogging and news alert applications
__k___WiMAX	**e**) A radio tagging technology used in Internet of Things construction
__e___RFID	**f**) An infrastructure that supports remote cloud access by mobile devices
__j___ZigBee	**g**) A private cloud built by IBM for internal use in R&D applications
__l___GPS	**h**) An Internet extension for interconnecting all objects, people, animals, and products
__a___Facebook	**i**) An Internet access technology used mainly for its speed and flexibility
__b___YouTube	**j**) The most scalable wireless sensor network
__d___Twitter	**k**) A fixed wireless technology for broadband Internet access
__q___Nebula	**l**) A satellite technology for location-sensitive applications
__c___CPS	**m**) A wireless technology used to replace cables in short-range applications
__g___RC2	**n**) One of the most frequently used SaaS applications in the business world
__o___LinkedIn	**o**) A social network mainly used in professional networking over the Internet
__i___WiFi	**p**) A social network web site specialized in customized social services
__n___CRM	**q**) A large private cloud used initially for aerospace and weather forecasting applications
__f___Cloudlet	**r**) A public cloud used in IaaS applications under a pay-as-you-go billing system

MPI Versus MapReduce from Internet

MPI is best suited for problems that require a lot of interprocess communication.

When Data becomes large (petabytes, anyone?), and there is little interprocess communication, MPI becomes a pain. This is so because the processes will spend all the time sending data to each other (bandwidth becomes a limiting factor) and your CPUs will remain idle. Perhaps an even bigger problem is reading all that data.

This is the fundamental reason behind having something like Hadoop. The Data also has to be distributed - Hadoop Distributed File System!

To say all this in short, **MPI is good for task parallelism and Hadoop is good for Data Parallelism**

Normally, MPI (message passing interface) supports more flexible communication method than MapReduce. (Asynchronous vs Synchronous)

But MPI moves the data itselt during the communication. On the contrary, MapReduce uses the concept of "data locality" which means the streaming between CPU and disk is possible. However, MPI cannot because it requires "will-be-processed" data must fit in the memory. (in-core processing).

With above example, two programs have many counter-concepts such as fault-tolerancy, data locality, in-core vs out-of-core processing model, batch processing and so on.

Therefore, even though MPI supports somewhat more flexible manner compared to MapReduce, it is not always the best shot

What is the difference between parallel computing, MapReduce and Message Passing Interface(MPI)

You're really talking three completely different concepts. "What is the difference between Goodyear, Ford, and the Interstate Highway System". Let me try to indicate the relations.

The term "parallel computing" covers a bunch of different types of computing. Here are just some examples.

Your smart phone does parallel computing because it has multiple cores, and in fact multiple specialized computing chips, so that's already two types right in your pocket. Another popular type of parallel computing is done with GPUs, and it is a form of multi-threading but with the threads executing largely the same code. This type of parallel computing is sometimes called "data parallel" because it is the case of many data points all being treated the same way. That makes sense in graphics, right? If you have a

multicore chip, you can try to take computing-intensive tasks and split them up over the cores. That's another type of parallel computing.

So "parallel computing" covers many different types of activities.

MPI is a library for a particular type of parallelism: distributed memory, which is what you have in a "cluster". In its simplest form, think of a bunch of PCs hooked together with ethernet cable. (Of course in a real cluster the network will be much more sophisticated.) MPI allows programs on one node to send data to another, or conversely receive. This sending/receiving is necessary because, unlike in the previous types of parallelism, the processing elements do not all see the same memory: each cluster node has its own memory and can not directly access the memory of another node. MPI is very general.

Hadoop is an implementation of the abstract idea called "map-reduce". That is, it is a programming model for a certain type of calculation that consists of a parallel "map" step, followed by some form data gathering: "reduce". Certain problems can be elegantly formulated in map-reduce, others not. Thus, you would use hadoop only if it fits your problem. Other problems need to be coded in another framework, for instance MPI. Since hadoop is often applied to large amounts of data, it is often done in a distributed memory context, and in fact you could implement hadoop on top of MPI.

FAULT Tolerance MPI:

In the scope of Open MPI, we typically define "fault tolerance" to mean the ability to recover from one or more component failures in a well defined manner with either a transparent or application-directed mechanism. Component failures may exhibit themselves as a corrupted transmission over a faulty network interface or the failure of one or more serial or parallel processes due to a processor or node failure. Open MPI strives to provide the application with a consistent system view while still providing a production quality, high performance implementation.

Yes, that's pretty much as all-inclusive as possible -- intentionally so! Remember that in addition to being a production-quality MPI implementation, Open MPI is also a vehicle for research. So while some forms of "fault tolerance" are more widely accepted and used, others are certainly of valid academic interest.

Open MPI plans on supporting the following fault tolerance techniques:

- Coordinated and uncoordinated process checkpoint and restart. Similar to those implemented in LAM/MPI and MPICH-V, respectively.
- Message logging techniques. Similar to those implemented in MPICH-V
- Data Reliability and network fault tolerance. Similar to those implemented in LA-MPI
- User directed, and communicator driven fault tolerance. Similar to those implemented in FT-MPI.

The Open MPI team will not limit their fault tolerance techniques to those mentioned above, but intend on extending beyond them in the future

1. MPI is good for task parallelism: TRUE

2. Efficiency -- When we consider the overall efficiency rather than time taken to execute a particular task, we can see that MapReduce gives greater efficiency since MPI involves communication between the processes and due to the latency in communication involved it can take longer. TRUE

false, because for many compute-intensive applications such as scientific simulations the lowered efficiency of disk I/O outweighs the lowered efficiency of network I/O.

3. Appropriate application – Applications that are batch process-able are more suited for Map Reduce (BLAST, K-means Clustering) whereas for MPI processes, computing smaller data is more preferable since it is less fault tolerant. TRUE

4. MapReduce is an implementation of Google's. It has 2 functions: Map and Reduce. Parallelization is made easier for the programmers because all the internal details are hidden from them. The MapReduce library takes care of everything, like fault tolerance and error handling, whereas with MPI the user needs to program everything.

5. MapReduce is used for data intensive applications whereas MPI is used for computationally intensive applications. TRUE

6. MapReduce is used for batch processing. MPI is used for shorter tasks that require responses for individual queries. TRUE

7. MapReduce is good for data parallelism whereas MPI is good for task parallelism. TRUE

8. MPI is used in small data sets which require less fault tolerance while MapReduce is applied to larger ones that require greater fault tolerance. TRUE

9. MPI is a message passing protocol that uses the concept of shared memory. TRUE

10. MapReduce is easy for programmers. They only need to implement Map and Reduce code. But MPI programmers need to think about the computation and communication at every step. T

11. MapReduce provides dynamic scheduling to load balancing tasks. MPI doesn't have this internal mechanism. T

12. MapReduce is a framework for distributed computing on very large data sets; MPI is an API specification or communication protocol for parallel computing. MPI gives much more control over how exactly different nodes in the cluster will communicate. T

13. In MapReduce the reducer is idle for a certain amount of time until the mapper generates the key sets, which is not the case in MPI. T

14. MPI is single process multiple data – (SPMD) whereas MapReduce can be SIMD/MIMD/MPMD T

15. MPI supports multiple MapReduce and is portable. MapReduce is portable on systems which can install Java. T

The authors proposed "a hybrid framework of iterative MapReduce and MPI for molecular dynamics applications". I think they meant "iterative MapReduce using MPI". Graph is another example of iterative computation. Some researchers solve large graph problems using MapReduce, others using MPI. One may also use hybrid approaches. In theory, one can use MPI to create a MapReduce framework, or use MapReduce disc based communication to implement MPI APIs. To understand whether it is a good idea, one needs to explain what it is optimized for.

Questions about Iterative MapReduce

Yes, MapReduce is a programming model for large-scale data processing. Hadoop is a software framework that implements the MapReduce concept using Java. Iterative MapReduce is a programming model that extends MapReduce to support iterative computations (e.g. machine learning and graph).

Dataflow is an interesting concept from Google's Cloud Dataflow. There you will see data-centric processing models related to databases. For example pipelines of data transformation (or filters). These engines integrate features of workflow with batch, micro-batch, streaming systems. There are distinctions though between query (e.g. data management) operations and data analysis (e.g. machine learning), because the algorithms are different. Parallel Computation Model is needed when the data analysis becomes complex and difficult to scale.

Reference

Idiosyncratic terminology - What does "*multiple MapReduce*" mean? It is not terminology that has been discussed in this class. We have discussed "*iterative MapReduce,*" though. Are the terms supposed to be synonymous?

* **Correct principles undermined by flawed examples** - *Applications that are batch process-able are more suited for Map Reduce (BLAST, K-means Clustering) whereas for MPI processes, computing smaller data is more preferable since it is less fault tolerant.*" It is true that MapReduce works well for batch processes and MPI works well for compute-intensive tasks that do not have petabyte datasets. In that sense, the statement is true. However, BLAST is not particularly well-suited to a classic MapReduce implementation because it requires iteration, and k-means clustering likewise is a compute-intensive task. So the examples provided in the statement are ambiguous at best.

* **Overgeneralizations** - "*MapReduce programming is easy*" - It is easier than MPI programming, for sure. But in my 23 years of professional development, I have undertaken many programming tasks that are far easier than MapReduce programming.

The statement that *something* is *easy* only makes sense if you are comparing the *something* to *some other things*. The absolute form of the statement makes it basically impossible to analyze, other than to observe that it can be interpreted in a variety of ways, depending on what other programming tasks you are comparing it to.

* **Statements can be true sometimes and false at other times** - This statement...

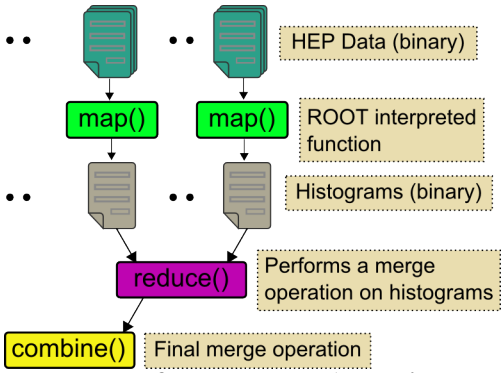
"*When we consider the overall efficiency rather than time taken to execute a particular task, we can see that MapReduce gives greater efficiency since MPI involves communication between the processes and due to the latency in communication involved it can take longer.*"

This statement would be true for certain kinds of tasks -- e.g., calculating TF-IDF scores over a petabyte-scale text corpus. However, if you were performing matrix multiplication tasks, you would probably find MPI to be more efficient, since the file I/O is far less efficient than network I/O.

Search Engine Question:

Analytics Questions:

High Energy Physics(HEP) Data Analysis



MapReduce for HEP Data Analysis

Performance of Twister (CGL-MapReduce) and Hadoop in HEP Data Analysis

As part of an effort funded by the DoE we are working with the High Energy Physics group at Caltech with their particle physics data analy tools. The data analysis framework used by these tools is ROOT, and the analysis functions are written using an interpreted language of RC named CINT.

The goal of the analysis is to execute a set of analysis functions on a collection of data files produced by high-energy physics experiments. processing each data file, the analysis produces a histogram of identified features. These histograms are then combined to produce the final result of the overall analysis. This data analysis task is both data and compute intensive and fits very well for MapReduce computation mod First figure shows the program flow of this analysis once it is converted to a MapReduce implementation and the second figure compares th performance of Twister and Hadoop for this data analysis. More details of this analysis can be found in this paper.

Questions about Iterative MapReduce

Key Features	MapReduce	Iterative Mapreduce
• Parallel Computation Model	Yes , Hadoop	Yes ,Hadoop
• Data/Control flow	Dynamic	Static
• Task Execution Unit	Processor	Thread
• Data caching	No	Yes ,by Memory
• Communication	Broadcast to	Pub/Sub messaging infrastructure
• Fault-tolerance	Strong	Weak
• Language and Implementation	Java	Java
• Suitable Application	High Energy Physics Histograms , Distributed Search	K Means Clustering PageRank Linear algebra

Projects

Hadoop WordCount, PageRank and Blast

Map Function

1. Use **getWordFreq()** to get a frequency map, i.e. **word → count** map
2. For each entry in the map, output the **word** and the **count**

Reduce Function

1. Sum **count** values for the given **word**
2. Write the **word** as rowkey and **count** as value

Hint: Check what's needed to create an **ImmutableBytesWritable**

Quizzes

B649/E599 Quiz 2

February 10, 2017
(Total1 point; Duration 10 minutes)

B649/E599 has a focus on system topics of Cloud Computing. While there're many cloud systems, technologies and applications, it's important to understand some fundamental issues about Cloud. Here are a few questions to highlight topics in this area. The question will be graded on clarity of algorithm and completeness of efficiency discussion.

a) **(0.2 point) There are two implementations of MapReduce: Google MapReduce and Apache Hadoop. What are their common features and difference?**

- Hadoop is open source but Google is not an open source.
- Hadoop and Google uses different file systems to store the data sets. Google uses Google File system and Hadoop uses Hadoop File System.
- Google Big Query Webservice and Hadoop with Hive works in a similar way. A user can compose a query and can get the results
- HDFS follows WORM – Write Once and Read Many times whereas Google File System follows Multiple writer , multiple reader model.

b) **(0.8 point) Please pick out incorrect statements from the below list and explain why they're wrong.**

1) MapReduce is a framework for distributed computing on very large data sets.

2) MapReduce can performance efficiently when run Pagerank applications.

3) MapReduce is an implementation by Google. It has 2 functions Map and Reduce. Parallelization is made easier for the programmers because all the internal details are hidden from them.

False. The internal details of Map and Reduce can be modified and changed by the user. The developer has to understand the existing code of map and reduce and then he needs to add it to the code. This means that there are no hidden internal details.

4) MapReduce library takes care of everything like parallelism and fault tolerance.

5) MapReduce is used for static batch processing.

False. Map Reduce is not used for static batch processing. Mapreduce is used for large data sets where the problem can be solved in a parallel way.

6) MapReduce is good for data parallelism.

2 is false - MapReduce uses disk-based communications so it is not efficient for iterative computation like Kmeans.

5 is false - MapReduce uses dynamic batch scheduling for high throughput. The Map tasks are scheduled whenever empty slots/cores become available. This is in contrast to the static scheduling when all map tasks are run simulanously. The rest are true

B649/E599 Quiz 3

(Duration 10 minutes; Total 1 point)

Problem 1 (0.3 point) We list two cloud platforms (OpenStack, AWS). You can choose a data-intensive application such as a large-scale search or data processing application. Discuss the major advantages and disadvantages in the following areas:

a. Run the service on the OpenStack platform

Advantage

- Low Cost
- Supports mixed hypervisor and bare metal server environments

Disadvantage

- The list of services is less compared to AWS.

b. Run the service on the AWS platform

Advantage

- Lot of services available.

Disadvantage

- High Cost

c. Explain why are virtual machines and virtual clusters suggested in cloud computing systems?

Few points why virtual machines and virtual clusters suggested in cloud computing.

- Maximize the efficiency of the physical infrastructure by supporting multi-tenant environments.
- Enables Fast deployment and Effective Scheduling
- Gets High-Performance Virtual Storage.

B649/E599 Quiz 4

(Duration 10 minutes; Total 1 point)

Problem 1 (0.5 point) List the key search engine technologies in project 6 that scale to internet scale web pages and web accessible documents. For each technology, briefly explain its function in one sentence.

- **Indexing** - The purpose of storing an index is to optimize speed and performance in finding relevant documents for a search query. Without an index, the search engine would scan every document in the corpus, which would require considerable time and computing power. For example, while an index of 10,000 documents can be queried within milliseconds, a sequential scan of every word in 10,000 large documents could take hours. The additional computer storage required to store the index, as well as the considerable increase in the time required for an update to take place, are traded off for the time saved during information retrieval.

- **Inverted Index** – Stores a list of occurrences of each atomic search criterion, typically in the form of a hash table or binary tree.

- **Page Rank** – PageRank works by counting the number and quality of links to a page to determine a rough estimate of how important the website is. The underlying assumption is that more important websites are likely to receive more links from other websites.
  PageRank is a link analysis algorithm and it assigns a numerical weighting to each element of a hyperlinked set of documents, such as the World Wide Web, with the purpose of "measuring" its relative importance within the set. The algorithm may be applied to any collection of entities with reciprocal quotations and references

- **Flow of Project 6** - The inverted index of the searched key word is retrieved. All the URI are assigned the document id. These inverted indices help to get the document id's. The document ids based on the PageRank are returned.

Technologies in Project 6

1. **HBase Inverted Index** – HBase Inverted index is used in the search engine.
2. **Apache Lucene –** High Performance , full featured text search library written in Java.
3. **Big Table –** Big Table to store the data.
4. **Java** – The code is written in java to build a search engine.
5. **Hadoop** - The code is executed on a Hadoop framework.

Problem 2 (0.5 point) We list two implementations of MapReduce programming model: Google MapReduce and Apache Hadoop. Complete the missing entries to show their similarities and differences in 6 technical dimensions. You do not have to explain the table entries in detail, just enter the names of languages, models, methods, mechanisms, and platform applied.

B649/E599 Quiz 5

(Duration 10 minutes; Total 1 point)

Problem 1 (0.6 point) Distinguishing the following terminologies.

Terminology	Description of the terminology
Bluetooth	A Wireless technology is used for exchanging data over short distances from fixed and mobile devices. Physical Range is 10m to 100m.
Internet of Things (IoT)	Internet of Things is a network of devices, objects, humans. These devices are smart devices with sensors where communication is possible automatically without any manual intervention.
RFID	Radio-Frequency Identification (RFID) is the use of radio waves to read and capture the information. This can be the example of a smart sensor device in Internet of things.
GPS	(Global Positioning System) GPS is a satellite based navigation system made up of at least 24 satellites
Cyber-Physical Systems (CPS)	Cyber-physical systems (CPS) are engineered systems that are built from, and depend upon, the seamless integration of computational algorithms and physical components - like medical monitoring, autonomous automobile.
WiFi	WiFi is a technology that uses radio waves to provide network connectivity. It provides the wireless connectivity to the devices by emitting frequencies between 2.4Ghz – 5GHz.

Problem 2 (0.4 point) The IoT differs from the traditional Internet in many ways. Identify their differences and describe their distinctions in connecting entities, infrastructure and networking, and application domains.

- IoT and Traditional Internet differs in many ways like in IoT content is created by machine whereas in traditional internet the content is created by Human. In IoT Content is consumed by pushing information and triggering actions but in traditional internet content is consumed by request. IoT can be used to determine the action and get the timely information, but traditional internet is used to answer questions. So far, for IoT mainly content is created, whereas in traditional internet content creation and consumption is done.
- IoT is mostly wirelessly connected as a self-configuring network of radio-frequency tags, low-cost sensors, or e-labels. It is a network of sensors or connected devices which can be uniquely identified in Cyber Physical Space.
- IoT can be seen in application domain like industry and economy, environmental and natural resources, society and daily life. The examples of these domains are energy, financial sector etc.
- IoT infrastructure is divided in four stages.
    - ✓ Data Sensors
    - ✓ Data Aggregation and Data Conversion

Sunil Exam

B649 Final Exam

May 9, 2015
(Duration 60 minutes; 30 grade points)

B649 has a focus on system topics of Cloud Computing. While there are many cloud systems, technologies and applications, it's important to understand some fundamental issues about Clouds. Here are a few questions to highlight topics in this area. Your answers are expected to uncover these issues. In the first question, you can use bullets if you like – the grade will be based on number of distinct key issues listed. In the second question, you need to select the matching term and description of listed Cloud Computing terminologies. The third question will be graded on the clarity of algorithms and completeness of discussions.

Problem 1. (a) (4 points) Compare MapReduce programming model with Iterative MapReduce. List the details of key features for each model in the following table.

Key Features	**MapReduce**	**Iterative Mapreduce**
• Parallel Computation Model	Yes , Hadoop	Yes ,Hadoop

• Data/Control flow	Dynamic	Static
• Task Execution Unit	Processor	Thread
• Data caching	No	Yes ,by Memory
• Communication	Broadcast to	Pub/Sub messaging infrastructure
• Fault-tolerance	Strong	Weak
• Language and Implementation	Java	Java
• Suitable Application	High Energy Physics Histograms , Distributed Search	K Means Clustering PageRank Linear algebra

(b) (4 points) A hypervisor is a hardware virtualization technique allowing multiple operating systems, called guests, to run on a host machine. This is also called the Virtual Machine Monitor (VMM). Explain the differences between hypervisor and para-virtualization and give one example VMM (virtual machine monitor), that was built in each of the two categories. Alternatively, you can fill out the following table.

	Xen	**KVM**	**VirtualBox**	**VMWare**
ParaVirtulization	**Y**	**Y**	**N**	**N**
Full Virtualization	N	Y	Y	Y

Problem 2 (7 points) Map the following 14 names or abbreviated terms on the left column with the best-match definitions or descriptions on the right column. Just enter the description label (a, b, c, ….) in the blank spaces in front of the terms being matched to. This is a 1-to-1 correspondence.

Term	**Description To be mapped with the terms on the left column**
__N___ GAE	**a)** The agreement signed between users and providers in cloud computing
____ CRM	**b)** A public cloud that must run from Windows 7 based host.
___C__ AWS	**c)** A public cloud used mainly for PaaS applications
__A__ SLA	**d)** A public compute cloud used in scalable business computing application
___M__ Azure	**e)** A cloud platform built by SalesForce.com
___H__ EC2	**f)** A commercial cloud OS for transforming a datacenter to a cloud platform
___I__ S3	**g)** One of the most frequently used SaaS applications used in the business world
___E__Force.com	**h)** A cloud platform built mainly for IaaS applications
___B__ vSphere/4	**i)** A storage cloud service for distributed storage applications
___D__ EBS	**j)** An open-source hypervisor developed at Cambridge University

___G__ SQL	**k)** The distributed file system used in Google search engines and in App Engine
___L__ Chubby	**l)** An Amazon block lock inteface for saving and restoring the VM instances
____J_ XEN	**m)** An Azure service module for users to visit and use of relational database
___K___ GFS	**n)** A distributed block lock service module in Google App Engine

Problem 3 (15 points) Included are two topics and you only need to choose one to answer. (**Option 1**) You have implemented your own search engine. We have selected PageRank algorithm to rank web search results. It is based on the counts of quality links to a page. Can you provide a customized solution if the search engine is to provide a ranking of restaurants based on their popularity of web reviews?

a) (5 points) Please write your ranking algorithm (**pseudo code**)
b) (5 points) Please write a Hadoop implementation of your algorithm (**pseudo code**).
c) (5 points) Discuss the table schemas of HBase for this application.

(**Option 2**) Compare different approaches to large-scale data processing. We have selected KMeans Clustering algorithm to compare using Hadoop and Pig.

d) (5 points) Please write Kmeans algorithm (**pseudo code**)
e) (5 points) Please write Hadoop Kmeans and Pig Kmeans implementation (**pseudo code**) separately.
f) (5 points) Discuss their relative strengths and weaknesses in terms of programmability and performance.

****option 1 :

A) PageRank is a link analysis algorithm and it assigns a numerical weighting to each element of a hyperlinked set of documents, such as the World Wide Web, PageRank works by counting the number and quality of links to a page to determine a rough estimate of how important the website is. The underlying assumption is that more important websites are likely to receive more links from other websites.

Pseudo Code :

We got an AMM File to Which had Source URL and Traget URL as below :

Source URL = Traget URL

0	1
1	4 5
2	6 7

Pseudo Code :

We have to calculate Pagerank for each Source URL . To get page Rank We have to get intial page Rank for each URL

PageRank Calculation :

P = (1-d)/N + d (PR(A) / C(A))

N = No. of incoming links
PR(A) = PageRank of incoming link to 0
C(A) = No. of outgoing links from page 0
d = Dumping factor

//Broadcost Dumping factor == 0.85
d =.85
//Get the intial URLRank by each Source ULR
//Calculate the PageRank as with below formula

P = (1-d)/N + d (PR(A) / C(A))

//Out the Pagerank with Source URL .

B) As part of Page Rank Project we got AMM file
Source URL – Targert URLs

We have to write 3 MapReduce function as below :
Hadoop Map reduce :
1: Create Grap : > This job convert elements in the adjacency matrix format into (key, value) pairs.
2: PageRank algorithm –Iterative - It is a core computation that requires multiple iterations to make rank values results converge. Based on number of iterations passed, this job is repeated n times. The output of previous iteration values becomes input to the next iteration.
3: Cleanup: It removes the targetURLs list from the value passed from previous computation and generates an output file which is URL, and its pagerankValue

CreateGraph –

Map {< Input Key as offset , Value as complete line of AMM file>
// Calculate Initial PageRank by SourceURL/No. of target URLs
//Emit SourceURL , IntPageRank#targetURL
Emit (SourceURL , IntPageRank#targetURL)
}
Reduce: {
< Input SourceURL, values of initialPageranks>
//Merge all the target ULR and PageRank with Same Source URL
//Output Source URL , InPageRanks#tagetURL1#tagertURL2#
Emit < Source URL , InPageRanks#tagetURL1#tagertURL2#
}
PangRank Mapreduce – Iterative

Map{< Source URL , InPageRanks#tagetURL1#tagertURL2#>
//Calculate RankValue per page
//Output all the URL and RankPerValue#targetURL

Emit < targetURL ,RankvalueperPage Or SourceURL ,no.of targetURL>
}
Reducer <
//Calculate final PageRank by formula :

P = (1-d)/N + d (PR(A) / C(A))
Emit <URL, PageRank#TargetURL>

Cleanup Task :
Map <URL ,Pagerank#targetURL>
//Remove the target URL from the Input value
//Emit output as only Url ,PageRank
Emit <Url ,PageRank>

Reduce<URL ,PageRank>
{
//sorting and output
Emit< URL ,PageRank>
}

****C : Discuss the table schemas of HBase for this application.

HBase is an open source, distributed, column-oriented, and sorted-map datastore modeled. Data is stored in tables; each table contains multiple rows and a fixed number of column families. For every row, there can be a varied amount of qualifiers within a column family, and at the intersections of rows and qualifiers are table cells.

For PageRank ,

We should have Row –As URL , Coloum Family as PageRank as below
Hbase PagerankTable

Row	Column Family
ULR	PageRank of the URL