CS15-319 / 15-619 Cloud Computing

Recitation 3

January 27 & 29, 2015

Overview

- **Setup your instance for the demo**
  - Information in the handout
- **Administrative Issues**
  - TA hours, guidelines on Piazza posts
- **Last Week's Reflection**
  - Project 1.1, OLI Unit 1, Quiz1
- **This Week's Schedule**
  - Deadlines for OLI Unit 2, Module 3 and 4, Project 1.2
- **Demo**
- **Questions**

Administrative

- TA office hours are posted on Piazza and Google calendar.
- Suggestions for using Piazza
  - Discussion forum, contribute questions and answers
  - Read the Piazza Post Guidelines (@20) before asking
  - Read Piazza questions & answers carefully to avoid duplicate ones
  - Don’t ask a public question about a quiz question
  - Try to ask a public question if possible

Platforms

- Open Learning Initiative (OLI)
  - Access through Blackboard
  - Contains Units and Quizzes
- Amazon Web Services (AWS) Account
  - Create AWS account (@8)
  - Complete Account Linking Form
  - Receive email request and **click link to confirm!**
- http://theproject.zone
  - Project write up, submissions and scoreboard
  - Registration Link in Email
- Piazza
  - Discussion forum
- If you do not have access to all of these platforms, please contact us immediately!

Last Week Reflection

- Reading:
  - Unit 1: Introduction to Cloud Computing
    - Module 2 : Cloud Building Blocks
  - Quiz 1: Introduction to Cloud Computing
- Project:
  - Project 1.1:
    - Wikipedia Dataset
    - Filtering one hour’s worth of data

FAQ this week, 1

- Q: Service level agreement is for example what a SAAS like Netflix signs with AWS, right? (@165)
- A: An SLA is the entire agreement that specifies
  - what service is to be provided, how it is supported,
  - times, locations, costs, performance,
  - and responsibilities of the parties involved.
- You accepted the an SLA when you created the AWS Account.
- Q: I still don't understand what a service level objective (SLO) is. (@165)
- A: SLOs are specific measurable characteristics of the SLA such as availability, throughput, frequency, response time, or quality.
  - Eg: An SLO might be acceptable downtime of 10 minutes per month
  - This translates into 99.xxxx% uptime requirement
  - AWS guarantees is 99.95% uptime for EC2 instances

FAQ this week, 2

- Q: Does AWS actively monitor and remove malware hosted by it's users? Are they legally allowed to look inside AMIs? (@165)
- A: It Depends!
  - Amazon can monitor traffic in and out of your resources to detect anomalies (DDoS, Spamming etc.)
  - Your use is governed by Amazon Terms of Service
    - They will contact you in case of a Government Order or Subpoena
    - They could investigate further or delete files if you don't respond
    - Eg: USA PATRIOT ACT and DMCA
- Join the Discussion on Piazza.

Quiz 1 Clarifications, 1

- Docker and it's relation to cloud services. (@162)
- The question is specifically asks what kind of service is used to run a Docker app.
- Check out AWS's Docker Container service: https://aws.amazon.com/ecs/

Quiz 1 Clarifications, 2

- Private and Public Clouds (@170)
- How can private clouds help save money?
- They enable sharing of resources within the organization.
  - Eg: Operations, Finance, Billing, Inventory can share the same pool of computers if they use a private cloud.
- AWS started as a private cloud

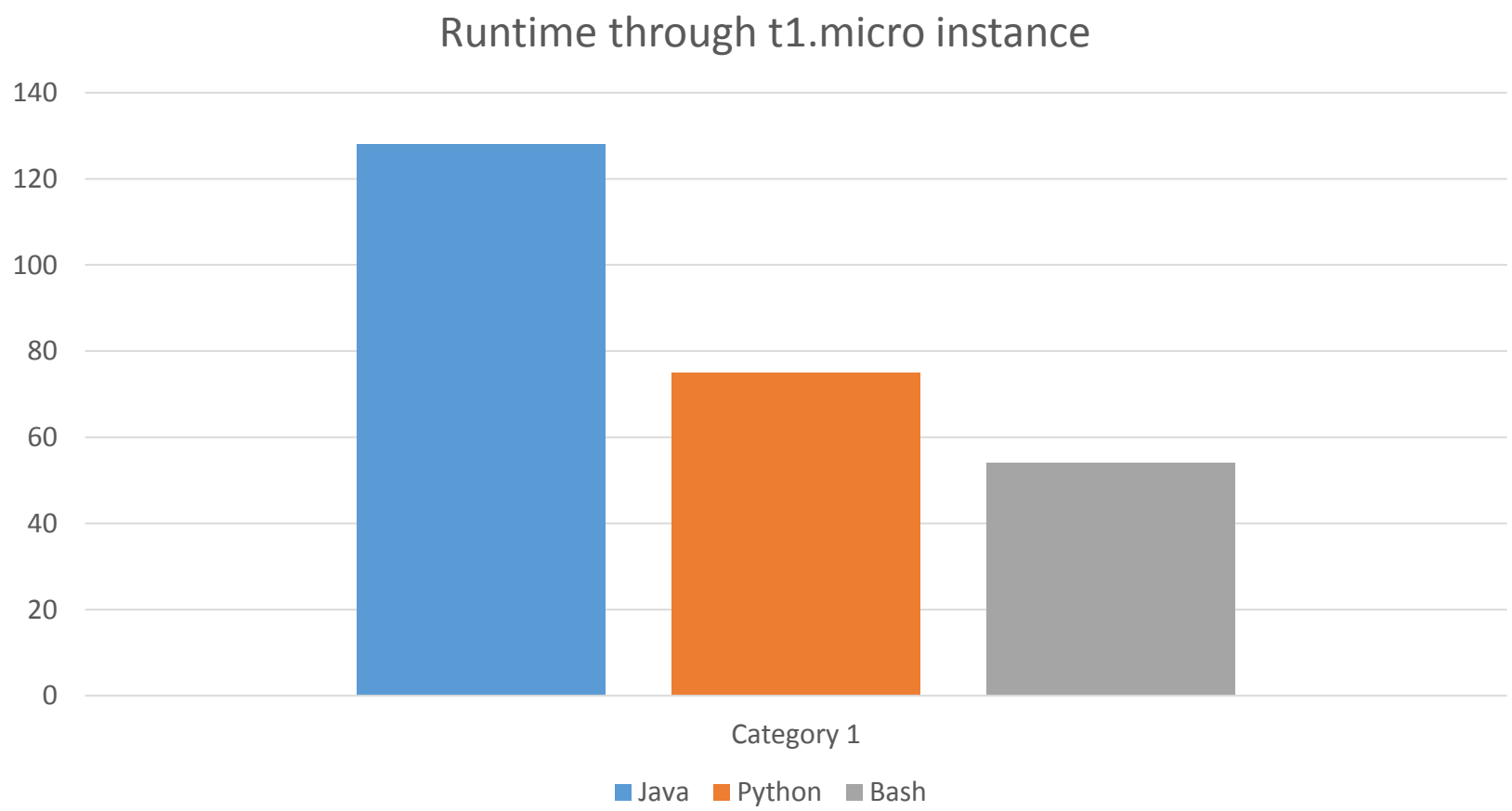
Looking back at Project 1.1

- Loading all the data to memory to filter and process is a bad idea!
  - Recurring theme in the course projects
  - You will see this in 15619 Team Project (ETL)
- Better Approach: Work from disk, build a processing pipeline
  - Write programs that process line by line
  - Unix pipes typically great to achieve this
  - cat | grep |awk

Time to compare!

- Java v.s. Python v.s. Bash v.s. others
- Dataset size: ~70 MB
- Filtering
  - Filtering Complexity : O(N)
- Sort
  - Time and space complexities vary
  - Unix sort: MergeSort
  - Java collections sort: Merge/QuickSort
  - Python default sort: TimSort
- Other Aspects
  - Effect of the Garbage Collectors

How did the various approaches do?



Join the Discussion on Piazza

- Big Question: What is the optimal set of scripts to answer the questions in P1.1? (@91)
- Share your approach and thoughts.
- The insight may help you considerably for the rest of the Projects in the course

This Week's Schedule

- Complete Unit 2 (Modules 3 & 4)
  - Complete activities on each page
    - In-module activities are not graded
  - If you encounter a bug in the OLI write-up
    - Provide feedback at the end of each OLI page
- **Complete Project 1.2 (Using Elastic MapReduce)**
  - Submission Deadline, Sunday, Feb 1, 11:59pm ET

TPZ Scoreboard

THEPROJECTZONE

Home | Primer | Project 1 | Project 2 | Project 3 | Project 4 | Profile | Log Out | suhailr

1.2 Using Amazon's Elastic MapReduce

Writeup | Submissions | ScoreBoard

Column headers: **click** to **sort**.

Search:

NickName	Q0(20)	Q1(25)	Q2(5)	Q3(15)	Q4(15)	Q5(20)	Q6(20)	Q7(20)	Q8(20)	Q9(20)	Q10(20)	Total	Attempts	TimeStamp
JeevesSobs	0	25	5	15	15	0	0	0	0	0	0	60	2	2015-01-27 06:28:15.203
PinkyPiggy	0	25	0	15	15	0	0	20	0	20	0	95	2	2015-01-27 07:25:36.716

Showing 1 to 2 of 2 entries

Why Study Data Centers ?

- Data centers are your new computers!
- The cloud is the data center!
- Make sure to read and understand the content of Unit 2
  - Equipment in a data center
  - Power, cooling, networking
  - How to design data centers
  - What could break
    - All software layers are on top of physical resources

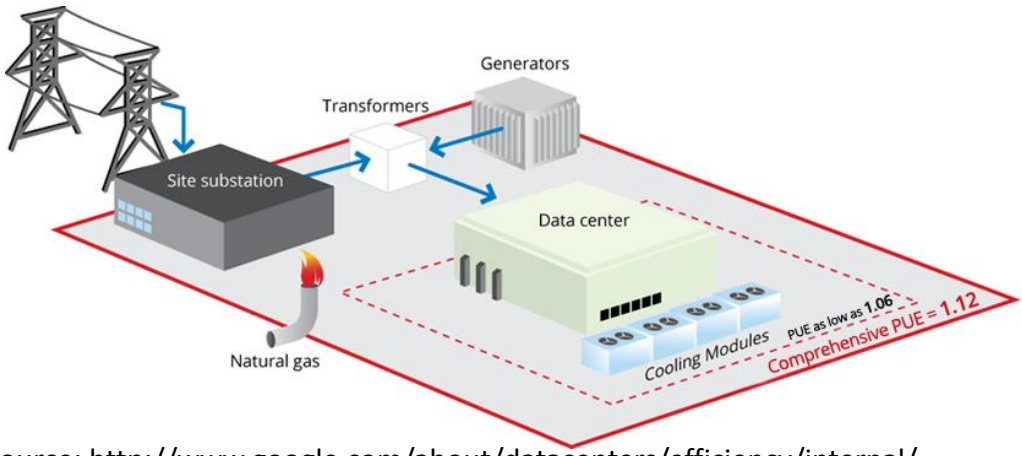
Module 3: Data Center Trends

- Definition & Origins
  - Infrastructure dedicated to housing computer and networking equipment, including power, cooling, and networking.
- Growth
  - Size (No. of racks and cabinets)
  - Density
- Efficiency
  - Servers
  - Server Components
  - Power
  - Cooling

Facebook data center

Module 4: Data Center Components

- IT Equipment
  - Anything that is mounted in a stack
  - Servers : rack-mounted
    - Motherboard
    - Expansion cards
  - Type of Storage
    - Direct attached storage (DAS)
    - Storage area network (SAN)
    - Network attached storage (NAS)
  - Networking
    - Ethernet, protocols, etc.
- Facilities
  - Server room
  - Power (distribution)
  - Cooling
  - Safety



Source: http://www.google.com/about/datacenters/efficiency/internal/

Project 1.2

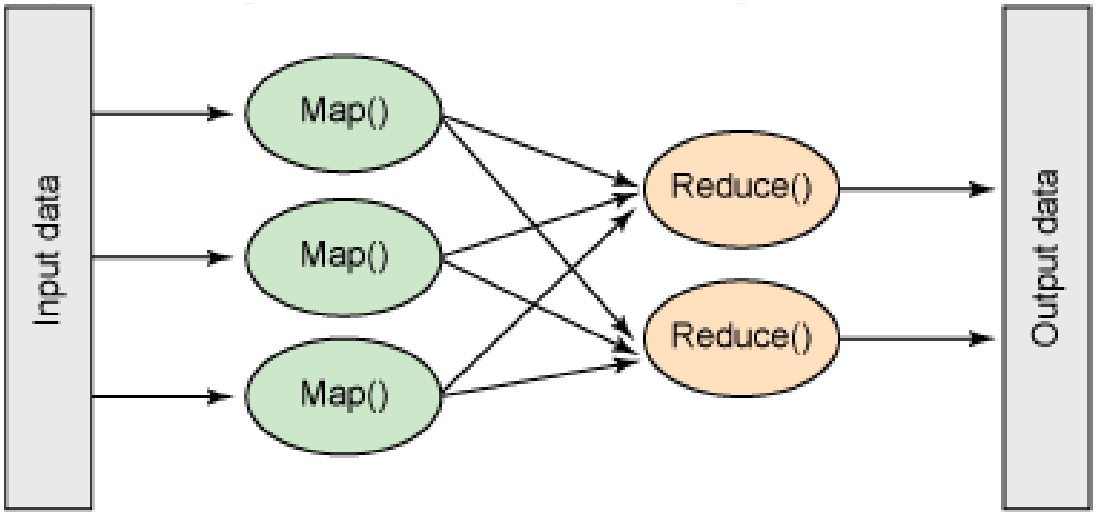
- In Project 1.1, we processed 1 hour of data
  - Slow, took time to process
  - Many minutes to run on a single file
  - How do you filter and sort the data for one month?
    - 720 files total (**~ 70 GB compressed, 250 GB uncompressed**)
- Parallel & Distributed Processing
  - How about Pthreads/MPI/…?
  - How simple are these frameworks?
  - Need to design many elements from scratch:
    - File Handling
    - Task Management
    - Orchestration
  - Painful. Take 15440/15618 for a taste ☺

Processing Large Files

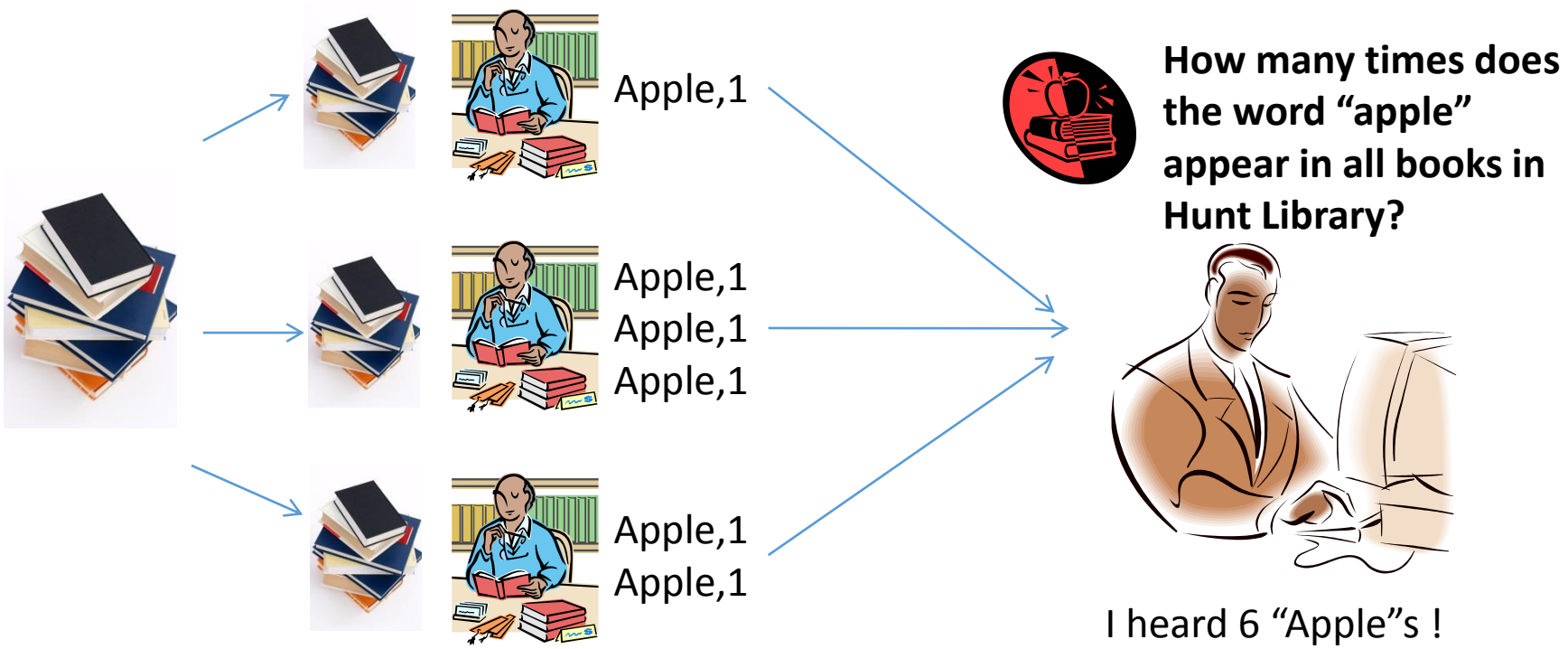
- When the input is 200MB
  - In memory data structures can be used to process on a single machine
  - HashMaps, Trees, ArrayLists etc.
- When the file size is 200 GB or TB
  - Large–scale data processing
  - Out of memory
  - Slow
  - How would you deal with it?
    - Partition the input?
    - Distribute the work?
    - Coordinate the effort?
    - Aggregate the results?

Introduction to MapReduce

- **Definition**: Programming model for processing large data sets with a parallel, distributed algorithm on a cluster
- **Map**: Extract something you care about
- **Group by key**: Sort and Shuffle
- **Reduce**: Aggregate, summarize, filter or transform
- **Output** the result

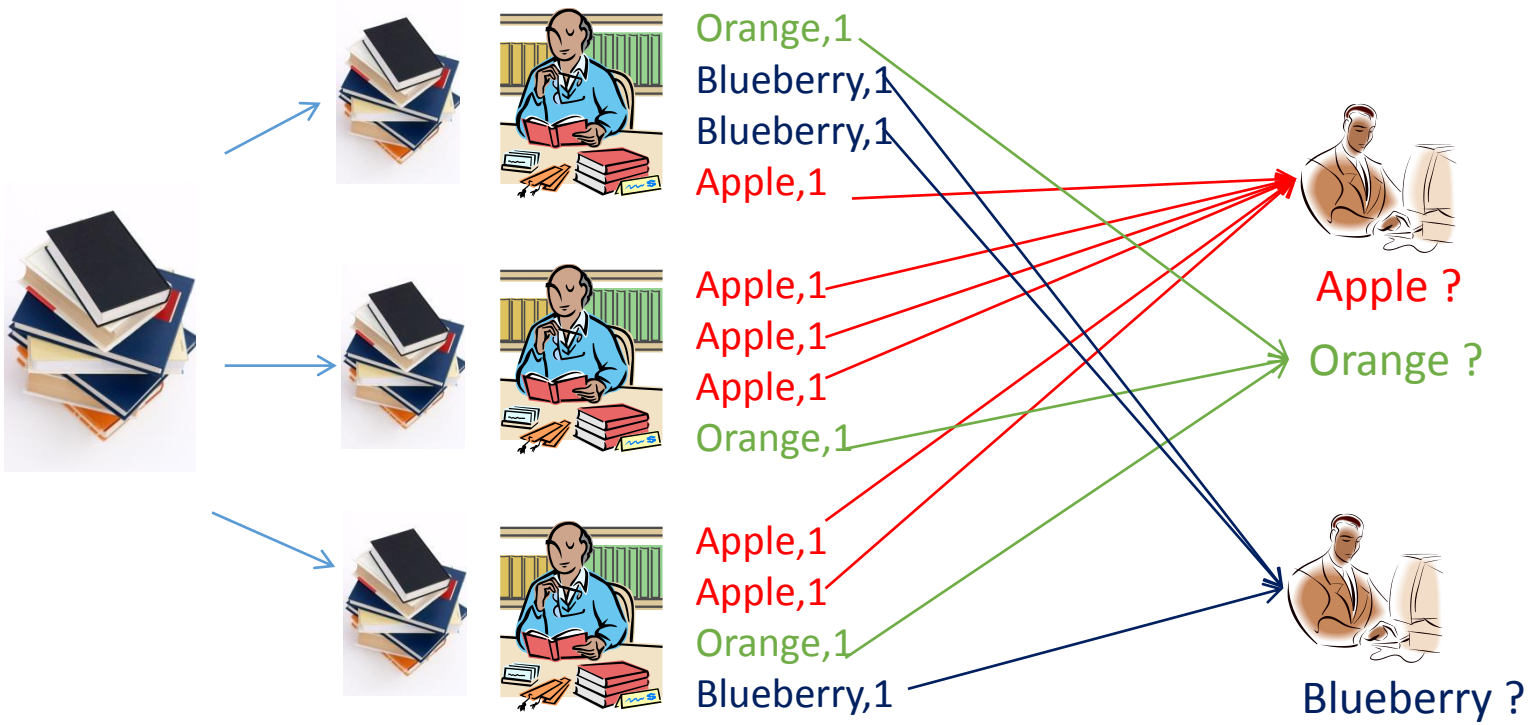


MapReduce Example



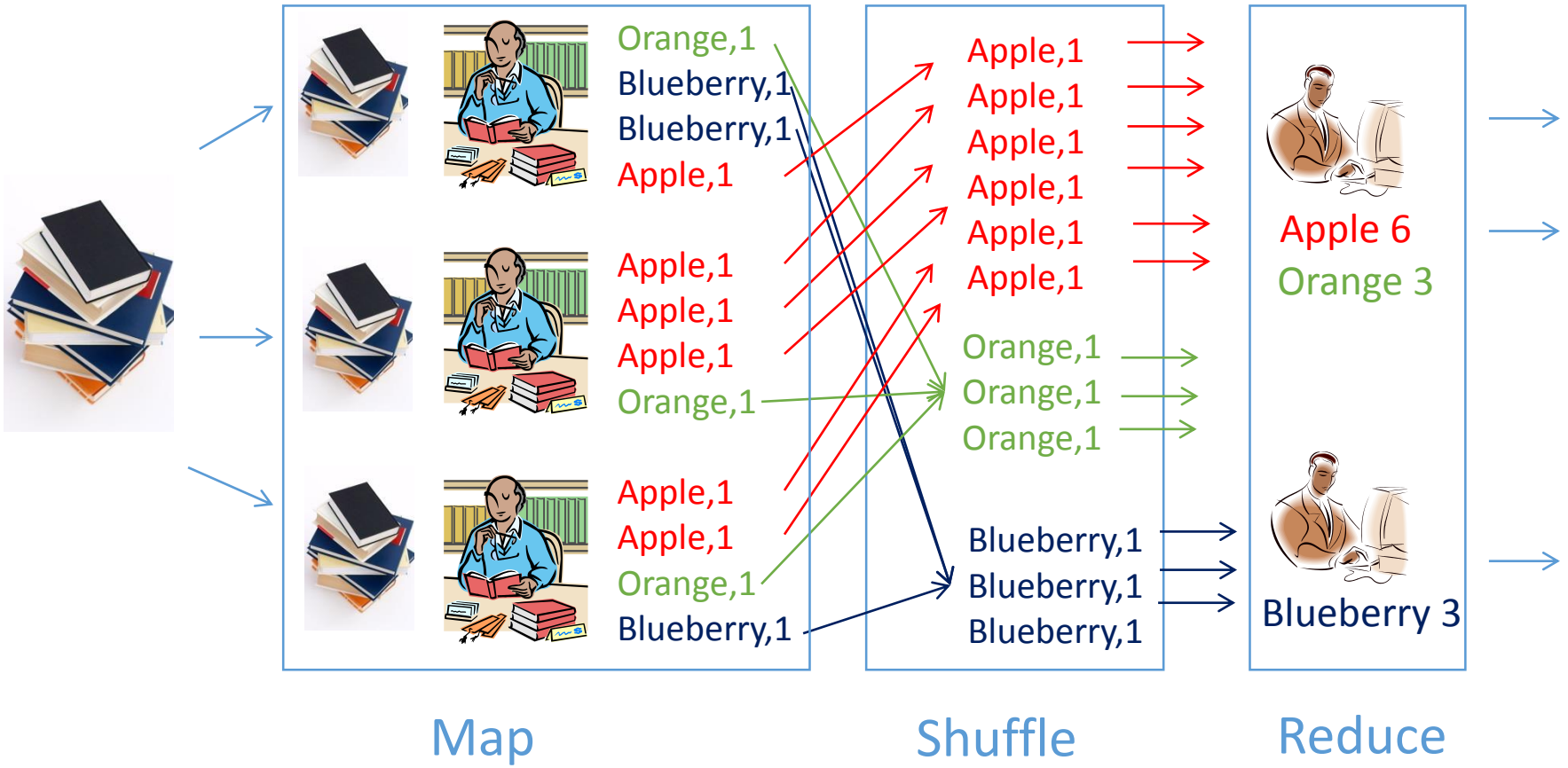
MapReduce Example

What if we want to count the number of times all fruits appeared in these books?

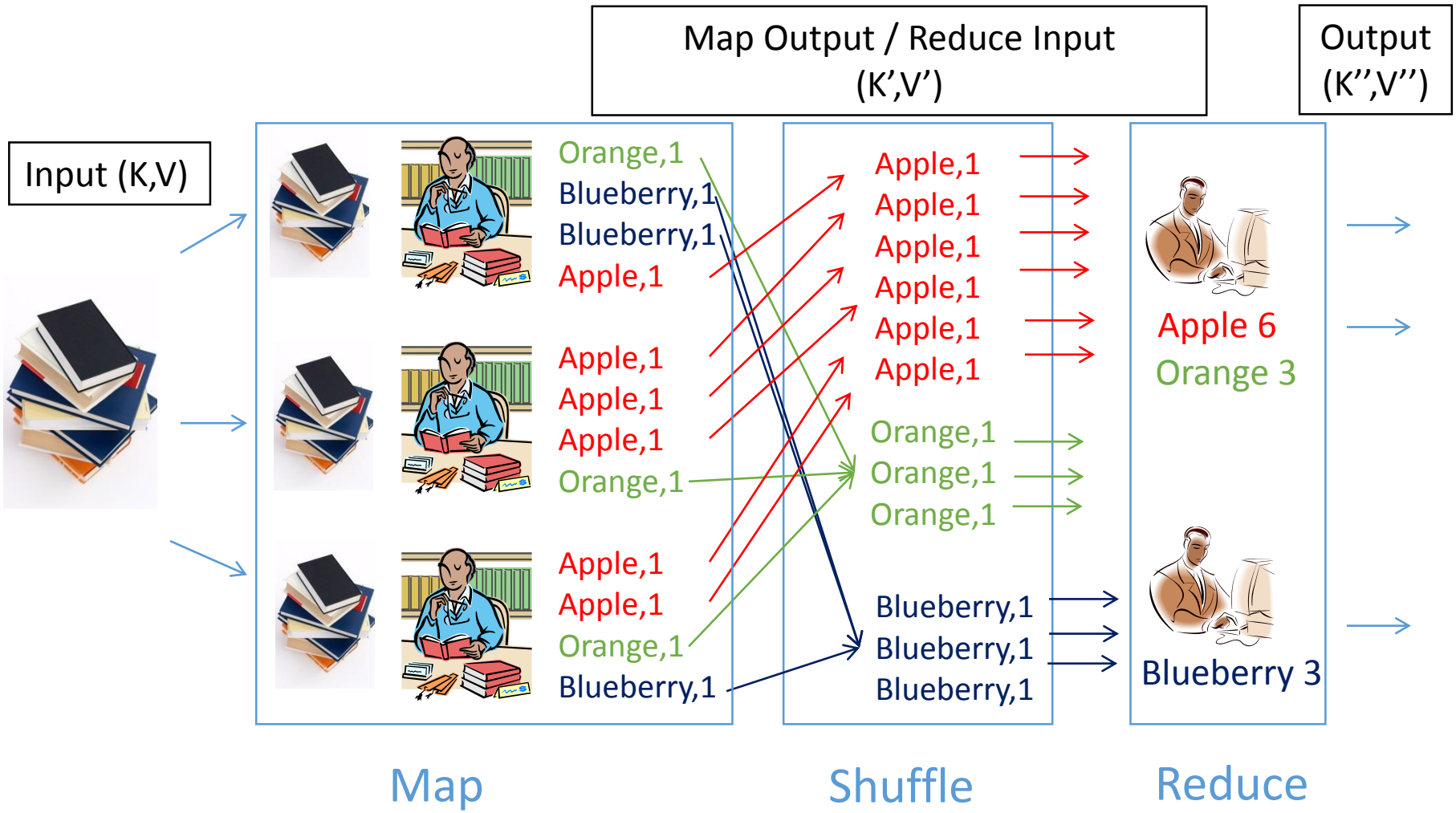


You can have multiple aggregators, each one working on a distinct set of “fruits”.

MapReduce Example



MapReduce Example



Steps of MapReduce

- Map
- Shuffle
- Reduce
- Produce final output

Steps of MapReduce

- Map
  - Prepare input for mappers
    - Split input into parts and assign them to mappers
  - Map Tasks
    - Each mapper will work on its portion of the data
    - Output: **key-value pairs**
      - Keys are used in Shuffling and Merge to find the Reducer that handles it
      - Values are messages sent from mapper to reducer
      - e.g. (Apple, 1)

Steps of MapReduce

- Shuffle
  - Group by key: sort the output of mapper by key
    - Split keys and assign them to reducers (based on hashing)
    - Each key will be assigned to exactly one reducer
- Reduce
  - Each reducer will work on one or more keys
  - Input: mapper's output (key-value pairs)
  - Output: the result needed
    - Different aggregation logic may apply
- Produce final output
  - Collect all output from reducers
  - Sort them by key

Mapreduce: Framework

- MapReduce framework takes care of:
  - Partitioning the input data
  - Scheduling the program's execution across a set of machines
  - Perform the Group by key (sort & shuffle) step
    - In practice, this is the bottleneck
  - Handling machine failures
  - Manage required inter-machine communication

Parallelism in MapReduce

- Mappers run in parallel, creating different intermediate values from input data
- Reducers also run in parallel, each working on different keys
- However, reducers cannot start until all mappers finish

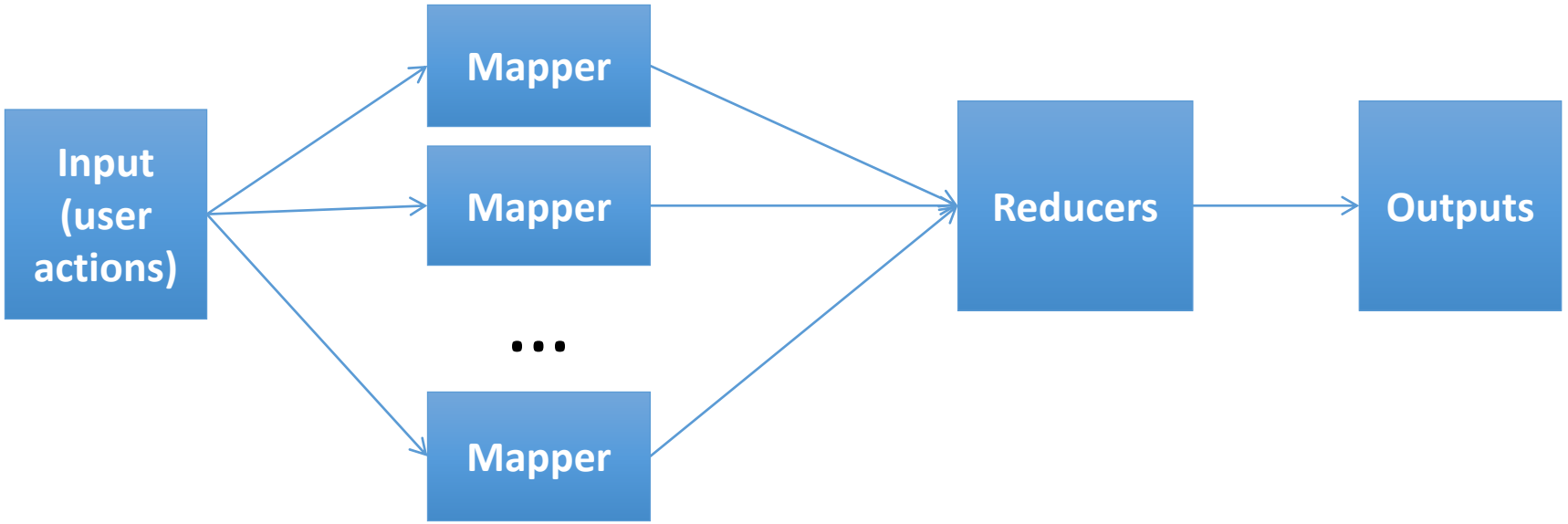
Example: Friend/Product Suggestion

- Facebook gathers information on your profile and timeline
  - e.g. contact list, messages, direct comments made, page visits, common friends, workplace/residence nearness.
  - This info is dumped into a log or a database
- Analyze this information
  - weighted matrix analysis
  - connections which are above a threshold value are chosen to be shown to the user.

Real Example: Friend/Product Suggestion

Generate key-value pairs:
Key: Friends pair
Value: Friends statistics (e.g. common friends)
e.g.
(Tom, Sara statistics)

Aggregate the statistics value for the same key and output the friends pair if it's above the threshold
e.g.
(Tom Sara)



Project 1.2 Elastic MapReduce

- Processing sequentially can be limiting, we must:
  - aggregate the view counts and
  - generate a daily timeline of page views for each article we are interested in
- Process a large dataset (~70 GB compressed)
- Setup a Streaming Elastic MapReduce job Flow in AWS
- Write simple Mapper and Reducer in the language of your choice
- You will understand some of the key aspects of Elastic MapReduce and run an Elastic MapReduce job flow
- **Note:** For this checkpoint, assign the tag with
  - Key: **Project** and Value: **1.2** for all resources

How to write the Mappers and Reducers?

- We are working with **Streaming MapReduce in EMR**
- Write individual mapper and reducer programs in the language of your choice
  - The programs must read input files through stdin
  - They have to write output through stdout
- Example Job Flow: Wordcount provided in Writeup
- Test your program on a local machine before launching a cluster!

```
cat input | mapper | sort |reducer > output
```

- Mapper, reducer and input data should be in S3
- Launch a cluster to process the data

P1.2 Grading

- P1.2 is 9% of your grade for the course!
- P1.2 code submissions are auto-graded
- Scores will be made available on http://theproject.zone after submission.
- We will grade all the code (both auto and manually)
  - Be sure to make your code readable
  - If your code is not well documented and is not readable, we will deduct points

Project 1.2 – Budgets and Penalties

- Configure EMR cluster instances in US-East-1 (N. Virginia)
- Tag all resources with Key: Project and Value: 1.2
  - Before Launching!
  - No tags ➔ 10% grade penalty
- Budget
  - For P1.2, each student's budget is $15
  - Exceeding $15 ➔ 10% project penalty
  - Exceeding $30 ➔ 100% project penalty
- Be very careful with EMR, very easy to burn through the budget!
- Plagiarism ➔ the lowest penalty is 200% & potential dismissal

How to Work on a Budget

- P1.2 Budget → $15
- You will need to create an EMR cluster
  - EMR has additional hourly cost per instance.
  - Example: 10 x m1.large = 10 x (0.175 + 0.044) = **$2.19 per hour!**
  - Total time you have: ~ 6.84 hours in this configuration
  - Use any configuration you like, all we want is the answer.
- 25 x m3.2xlarge = 25 x (0.560 + 0.140) = **$17.5 per hour!**
- **Spot Instances are your friend**:
  - Same cluster @ spot pricing = 10 x (0.0161 + 0.044) = **$0.601 per hour!**
- Test and Debug first!
  - Local Machine using Unix Pipes first
  - Then use Small Clusters with a part of the data set
- Other Costs to consider:
  - EBS is $0.1 per GB/month
  - Dataset is in S3, S3→EC2 transfers are free.

Demo

- Quick Tour of AWS
  - EMR
  - On-Demand and Spot Instances
  - Billing and Monitoring Costs
- Demo: Wordcount on EMR
- Auto-grader for P1.2
  - How to make a submission

Questions?

- Reminder: Office hours are posted on Piazza.

Upcoming Deadlines

- Quiz 2: Data Centers
  - Quiz Window Opens 02/06/2015 12:01 AM ET
  - **Due 02/06/15 11:59 PM ET**

- Project 1.2: Introduction to Big Data Analysis
  - Using Elastic MapReduce
  - **Due 01/25/15 11:59 PM ET**