15-319 / 15-619 Cloud Computing

Recitation 2

January 22 & 24, 2019

Accessing the Course

- Open Learning Initiative (OLI) Course
  - Access via canvas.cmu.edu
- http://theproject.zone (access through canvas)
  - choose CMU as the identity provider
  - AWS Account Setup
  - Azure Account Setup
  - GCP Account Setup
  - Update your TPZ profile with AWS, Azure & GCP info
  - Complete the Primers on AWS, Azure and GCP
- Piazza

Amazon Web Services (AWS) Account

- === ONLY IF YOU HAVEN'T DONE SO ALREADY ===
- Log on to https://theproject.zone through Canvas and make sure you follow the instructions in the Account Setup Primer
- Use an AWS standard account instead of an AWS Educate starter account
- Wait to receive Consolidated Billing Request email from Amazon
    - Manual process, waiting time varies
- When you receive the linking email, click the link to verify the linked billing
    - Many students have not clicked on the link yet!
        - Check your **SPAM** folder
    - You won’t be able to complete the projects.

Azure Account

- === ONLY IF YOU HAVEN'T DONE SO ALREADY ===
- Do **not** use your @andrew.cmu.edu or other CMU issued email address.
- Update your TPZ Profile

Google Cloud Platform (GCP) Account

- === ONLY IF YOU HAVEN'T DONE SO ALREADY ===
- Please contact us if you have trouble creating your GCP account.
- Follow the instructions in the primer.
- Receive a $50 coupon on https://theproject.zone
- Redeem the coupon as per instructions on https://theproject.zone
- If you cannot view your GCP coupon in your TPZ profile (https://theproject.zone/profile) post on Piazza privately and share your Andrew ID so we can make that available for you.

Piazza

- Suggestions for using Piazza
  - Discussion forum, contribute questions and answers
  - Read the Piazza Post Guidelines (@6) before asking
- When you have a (project-specific) problem, follow the order below!
  - Try to solve the problem by yourself (Search, Stack Overflow)
  - Read Piazza questions & answers carefully to avoid duplicates
    - Visit TA OHs: TA office hours are posted on Piazza and Google calendar
    - Create a piazza post
- Please note:
  - **Show the effort you have done first**
  - **Give us fullest context (AndrewId, error message in text, etc.)**
  - Don’t ask a public question about a quiz question
  - Try to ask a public question if possible

Reflecting on Last Week

- AWS, Azure and GCP
  - Create accounts
  - Use web consoles or APIs to launch VMs on AWS, Azure and GCP
  - (AWS) Spot instances and S3
- In P0, run a web server, test to access the server over a browser
  - Launch, connect to and terminate VMs
  - Install & run software on a VM
  - Vertical scaling
- Basic SSH skills
- Terraform primer
  - Read it if you have not done so

Skill Building in This Course

- Important skill to develop
    - willingness and courage to
        - recognize, explore and solve problems **on your own with suitable tools**
        - ask technical question properly instead of simply asking for solutions
        - learn the basics of new tools quickly and make use of them in a limited time (e.g. 1 week)

Make Sure to Complete the Primers!

- Complete the Primers
    - Understanding AWS/Azure/GCP
        - provisioning resources, connecting to VMs, playing around, …
    - Linux warmup
    - Git
    - Maven and Checkstyle
    - Jupyter Notebook
        - Command Line
        - Data analysis in Bash
        - Data analysis in Python (pandas)
    - Infrastructure as Code (Terraform)

Programming Experience Expected

- **Strong proficiency** in at least one of the following, with some fair comprehension of the others:
  - **Java 8**
  - **Python 3**
  - **Bash**
- **Java and Python are required** to complete parts of Projects.
- Use the time now to brush up
- Please read Maven primer!
- Do not fear bash/python scripting, it will make your life easier!

Completing Projects in this Course

- Provision AWS, Azure or GCP Resources
  - Use the AMIs/VHDs/OS Images we provide for the project
  - Tag all instances!
- Monitor your cost
  - Calculate costs before you provision!
- Complete tasks for each project module
  - Each project module has several sections unlocked by AssessMe
- Submit your work
  - Pledge of integrity
  - Results in scoreboard
- Terminate all resources when you have verified your score and kept a copy of your work (e.g., git **private** repo)

Tagging

- Tag *all* tag-able resources on AWS
  - Before you make a resource request, read the docs/specifications to find out if tagging is supported
  - We will specify which resources are required to be tagged in each project
  - Apply the tags during resource provisioning
  - We need tags to track usage, a grade penalty will be applied automatically if you do not tag!
  - Spot instances
    - Tags of spot request do not propagate to the VMs!
    - AWS EC2 Fleet is the remedy
- Tagging Format
  - `Key: Project`
  - Value: 0, 1.1, 1.2….etc.

Budgets and Penalties

- No proper tags → 10% grade penalty
- Provision resources in regions other than us-east-1 → 10% grade penalty
- Budget
  - For P1.1, each student’s budget is **$1**
  - Exceeding Budget → 10% project penalty
  - Exceeding Budget x 2 → 100% project penalty (no score)
  - You can see Cost and Penalties in TPZ.
- No exceptions.
- We will enforce these penalties automatically starting from Project 1.1

How to Work on a Budget

- P1.1 Budget $\longrightarrow$ \$1
- You are only allowed to use t2.micro
  - \$0.0116 per hour (on demand)
- Other costs to consider:
  - EBS is \$0.1 per GB/month
  - Instances using our AMI gets 30 GB EBS by default.
  - Data transfer costs (minimal)

Total time:

\$1 / (\$0.0116 + 30 * \$0.1 / 30 / 24) = 63 hours

- **Note**: Free Tier does not apply to linked accounts!

Academic Integrity Violation

- Cheating → the lowest penalty is a 200% penalty & potential dismissal
  - Other students, previous students, Internet (e.g. Stackoverflow)
  - Do not work on code together
  - This is about you struggling with something and learning
  - Penalty for cheating is SEVERE – don’t do it!
  - Ask us if you are unsure

Compromised Accounts

- If you put any of your credentials in files on
  - Github, Dropbox, Google Drive, Box, etc.
  - You are vulnerable to getting your account compromised.
  - Going over 2x the project budget ⇒ 100% penalty!
- People are scanning publicly available files for cloud credentials.
  - They compromise your account and launch resources in other regions.

DO NOT SAVE YOUR CLOUD CREDENTIALS IN FILES!

Deadlines!

- **Hard** Deadlines
  - No late days, no extensions
  - Start early!
  - Plan your activities, interviews and other commitments around the deadlines.
  - **No exceptions!**
- Project modules are due on Sundays at 23:59 ET
- Quizzes are typically due on Fridays
  - There is one exception this semester the Thursday before Spring Break

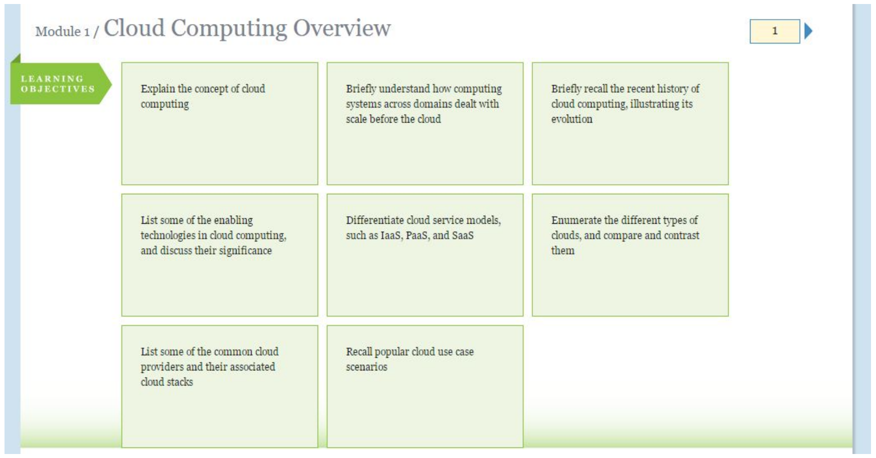
Deadlines!

- **Project deadlines**
  - **On TheProject.Zone**

- **Quiz deadlines**
  - **On OLI**

Quiz 1 Preparation

- Tests your understanding in Modules 1 and 2
  - Cloud computing fundamentals, service models, economics, SLAs, security
  - Use the activities in each page for practice.
  - You will be tested on you ability to perform the stated learning objectives on OLI:

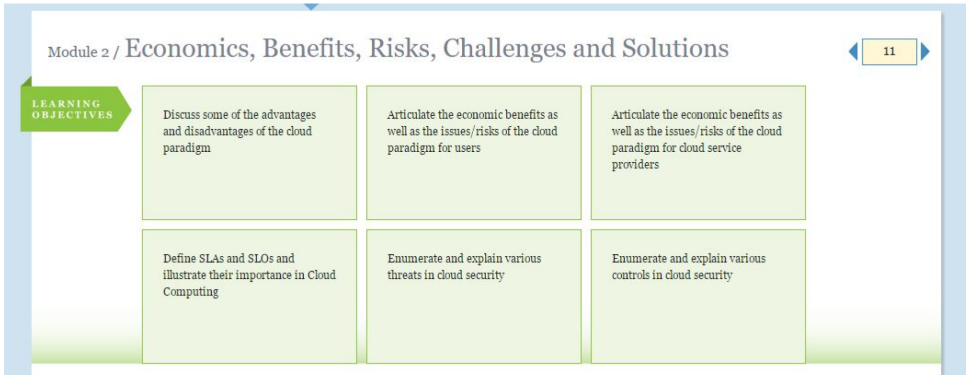


Module 1 / Cloud Computing Overview

1

LEARNING OBJECTIVES

- Explain the concept of cloud computing
- Briefly understand how computing systems across domains dealt with scale before the cloud
- Briefly recall the recent history of cloud computing, illustrating its evolution
- List some of the enabling technologies in cloud computing, and discuss their significance
- Differentiate cloud service models, such as IaaS, PaaS, and SaaS
- Enumerate the different types of clouds, and compare and contrast them
- List some of the common cloud providers and their associated cloud stacks
- Recall popular cloud use case scenarios



Module 2 / Economics, Benefits, Risks, Challenges and Solutions

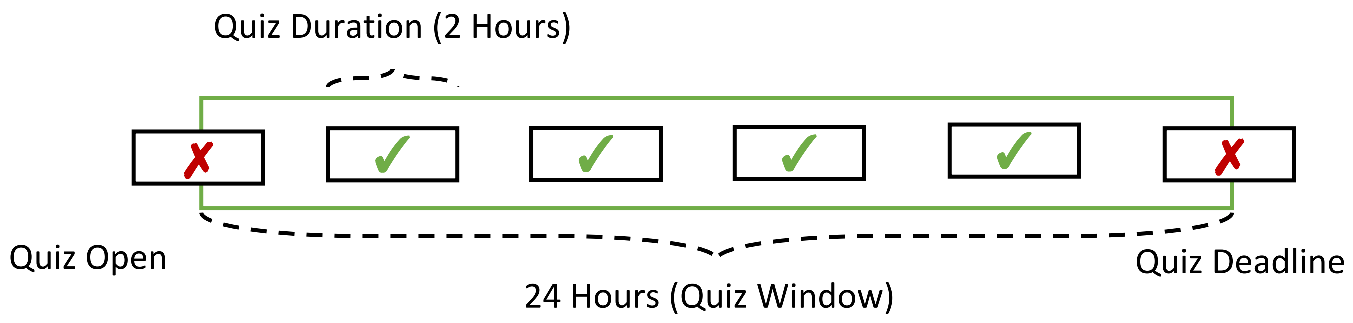
11

LEARNING OBJECTIVES

- Discuss some of the advantages and disadvantages of the cloud paradigm
- Articulate the economic benefits as well as the issues/risks of the cloud paradigm for users
- Articulate the economic benefits as well as the issues/risks of the cloud paradigm for cloud service providers
- Define SLAs and SLOs and illustrate their importance in Cloud Computing
- Enumerate and explain various threats in cloud security
- Enumerate and explain various controls in cloud security

Quiz 1 Logistics

- Quiz 1 will be open for 24 hours, Friday, Jan 26
  - Quiz 1 becomes available on **Jan 25, 00:01 AM ET.**
  - Deadline for submission is **Jan 25, 11:59 PM ET.**
  - Once open, you have **120 min** to complete the quiz.
  - You may not start the quiz after the deadline has passed.
  - Every 15 minutes you will be prompted to save.
  - **Maintain your own timer from when you start the quiz.**
  - **Click submit before deadline passes. No Exceptions!**



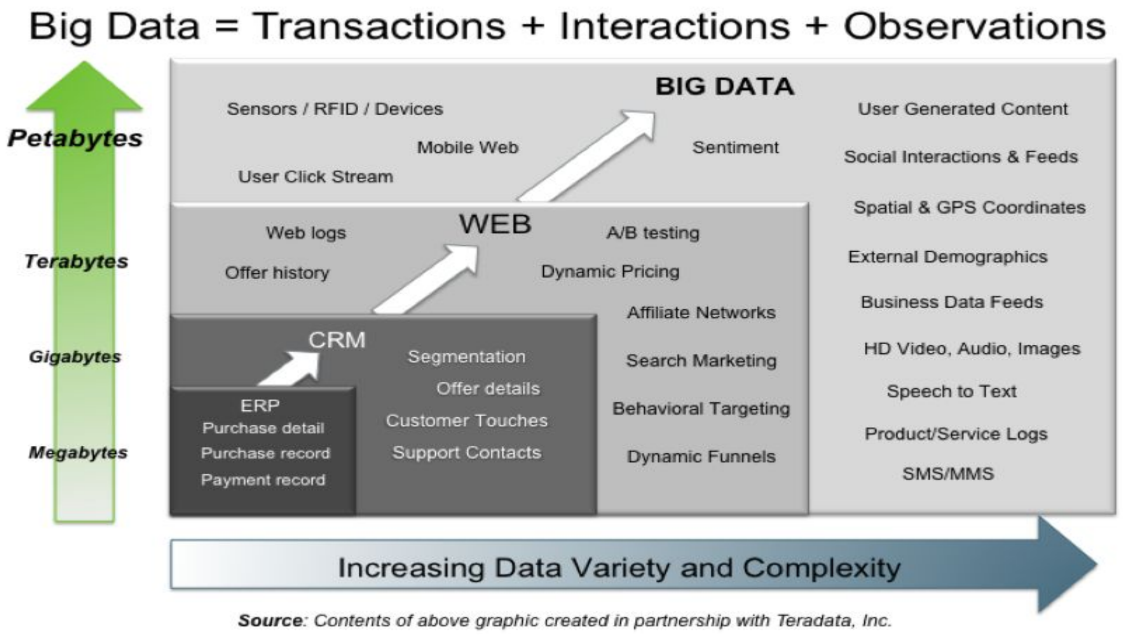
Submit Before Deadline

- When you start the Quiz, you cannot stop the clock.
  - You have 120 minutes to click on submit.
  - You have to keep track of the time yourself.
  - If you don’t click on submit you will not receive a grade.

YOU MUST SUBMIT
WITHIN 120 MINUTES
AND
BEFORE THE DEADLINE

Project 1 Motivation: Big Data

- What is Big Data?
  - It is high volume, high velocity, and/or high variety information assets.
  - There is a lot of value in the analysis of big data for organizations

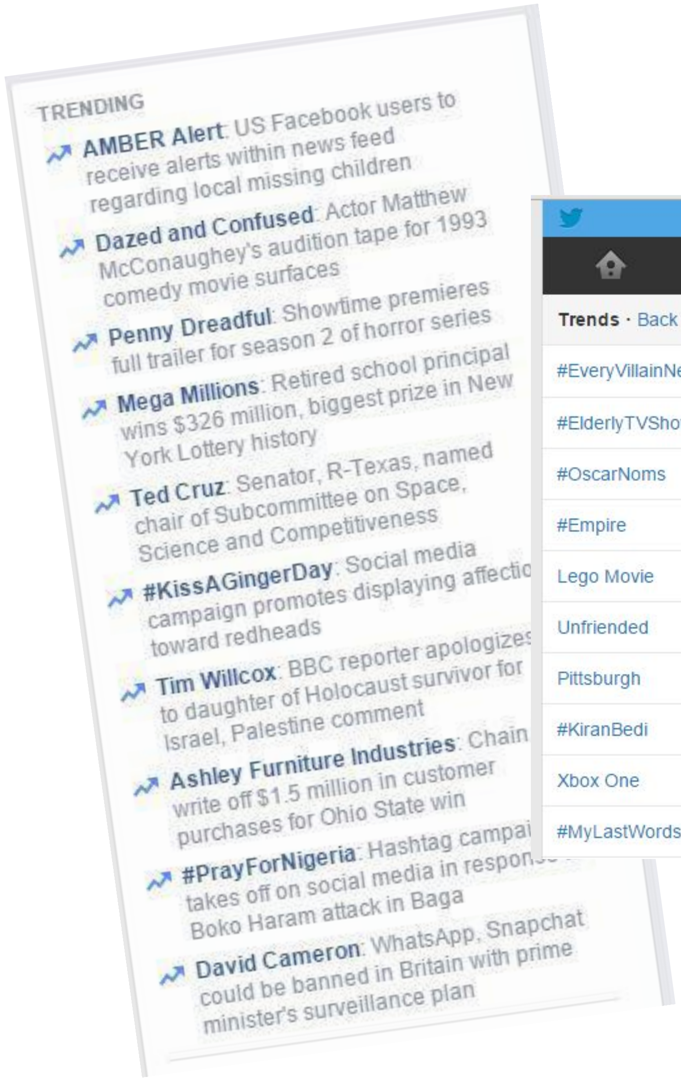


Use Cases: Big Data Analysis

- Online retailers are analyzing consumer spending habits to learn trends and offer personalized recommendations and offers to individual customers.

- Companies such as Time Warner, Comcast etc. are using big data to track media consumption habits of their subscribers and trends to provide value-added information to advertisers and customers.

Trending Topics are Everywhere!



TRENDING

AMBER Alert: US Facebook users to receive alerts within news feed regarding local missing children

Dazed and Confused: Actor Matthew McConaughey's audition tape for 1993 comedy movie surfaces

Penny Dreadful: Showtime premieres full trailer for season 2 of horror series

Mega Millions: Retired school principal wins $326 million, biggest prize in New York Lottery history

Ted Cruz: Senator, R-Texas, named chair of Subcommittee on Space, Science and Competitiveness

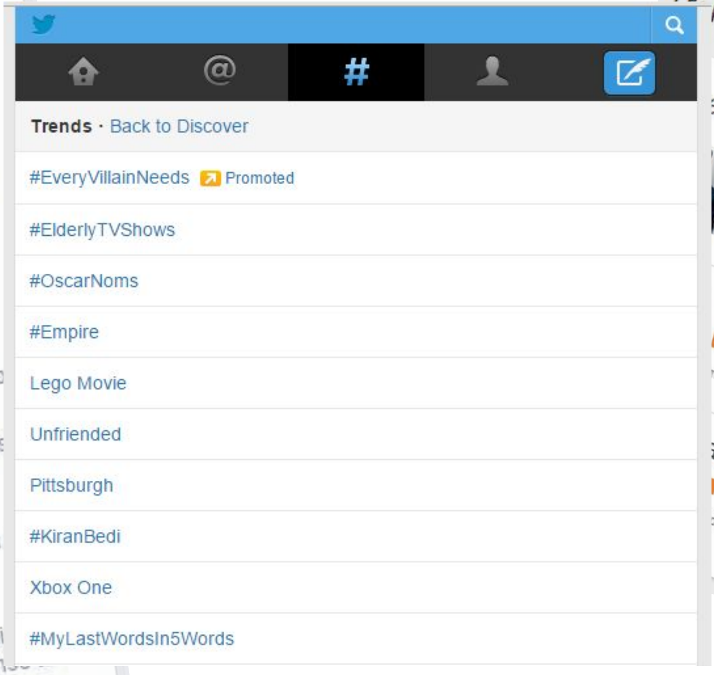
#KissAGingerDay: Social media campaign promotes displaying affectio toward redheads

Tim Willcox: BBC reporter apologizes to daughter of Holocaust survivor for Israel, Palestine comment

Ashley Furniture Industries: Chain write off $1.5 million in customer purchases for Ohio State win

#PrayForNigeria: Hashtag campai takes off on social media in respons Boko Haram attack in Baga

David Cameron: WhatsApp, Snapchat could be banned in Britain with prime minister's surveillance plan



Trends · Back to Discover

#EveryVillainNeeds Promoted

#ElderlyTVShows

#OscarNoms

#Empire

Lego Movie

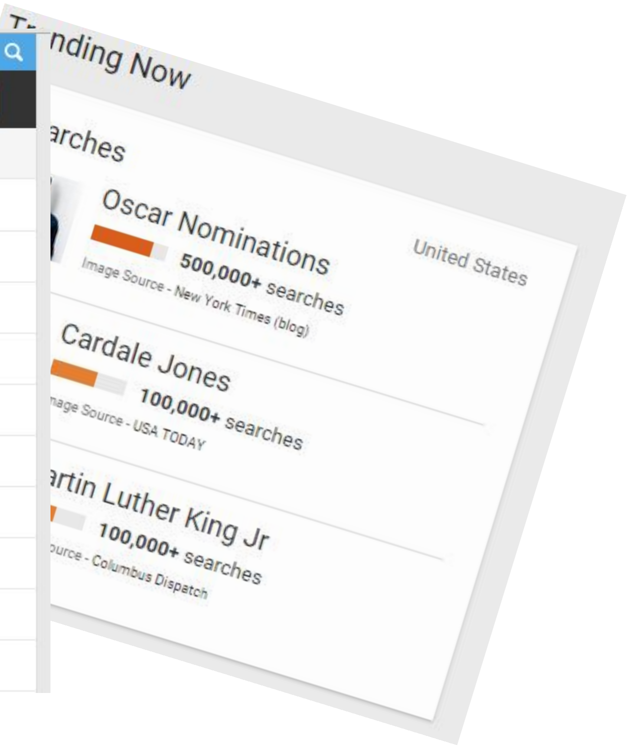
Unfriended

Pittsburgh

#KiranBedi

Xbox One

#MyLastWordsIn5Words



T nding Now

arches

United States

Oscar Nominations
500,000+ searches
Image Source - New York Times (blog)

Cardale Jones
100,000+ searches
age Source - USA TODAY

rtin Luther King Jr
100,000+ searches
ource - Columbus Dispatch

Why Trending Topics?

- Identify trends and viral content
- Maximize advertisement placement opportunities
- Search Engine Optimization (SEO)
- And more....

Project 1

- Identify Trending Topics on Wikipedia
  - Use the hourly pageviews dataset.
- <u>Project 1.1</u>: (This Week)
  - Find trends from a single hour of data.
- <u>Project 1.2</u>: (Next Week)
  - Find trends with the 30-day dataset using MapReduce.
    - Data from March 8 to April 6 in 2018

The Dataset

- Data set
  - Wikimedia page views dataset
  - One File Per Hour
- Format:

```
<domain code> <page title> <number of accesses> <total data returned>
```

<Language>.<ProjectName>
en = English Wikipedia (Desktop)
en.b = English Wikibooks
fr.v = French Wikiversity

Project 1.1 Tasks

- Task 1: Sequential data pre-processing
  - Implement sequential data filter in Java
  - Practice test-driven development (TDD) with JUnit
  - Achieve 100% code coverage for the DataFilter class
- Task 2: Data analysis
  - Search a file with grep
  - Filter or process data with awk
  - Data Analysis with Jupyter Notebook and Pandas library
  - Identify the limitations of the sequential programming

Data Pre-processing is Important

- Impossible: Raw Dataset →Data analysis
- Raw Dataset →Data pre-processing →Data analysis

raw data:

after data pre-processing

reference: Nishant Neeraj

Task 1: Data Pre-processing

- We are only interested in English Wikipedia desktop/mobile pages (**`<domain code>:`** en, en.m)
- This dataset is raw, real-world
  - Never assume that the dataset is perfectly clean and well formed
- Use the filtering rules specified in the writeup
- If there are records from both desktop and mobile sites for the same page title, sum the accesses into one record
- Sort the pages by number of pageviews, break ties by ascending lexicographical order
- Output: **`<page title> <number of accesses>`**

Bad Coding Practices!

No modularity in code, hard to debug:

```
public static void main(final String[] args) {
    read the records from the input
    for record in records:
        if it violates the rule A: (20 lines)
            continue
        if it violates the rule B: (20 lines)
            continue
        … 5 other rules (100 lines)
        put record into a map <title, pageview>
    sort the map
    print output
}
```

Good Coding Practice: Test-Driven Development (TDD)

What is TDD?

- divide the problem into a series of small steps
- start by writing test cases
- then refactor the code to pass the test
- and repeat
  - Test case ⇒ code ⇒ pass ⇒ another test case ⇒ ...

TDD emphasizes writing unit tests ahead of writing the code.

TDD lets you treat failures as a norm instead of an exception.

Test-Driven Development (TDD)

Why TDD?

- Helps to structure your code in a way that easily facilitates testing
- Separates the concerns and makes your code clean, easy-to-read and robust
- Ensures that your changes won’t break existing functionality
- Achieves safer refactoring, increasing returns and effective collaborations
- TDD is an industry best practice!!!

TDD w/ JUnit 5: Start by signature

```
public class Filter {

    public static boolean containsCloud(final String record) {
        // it is okay to start with an incorrect solution
        // the method signature is what matters
        return false;
    }
}
```

TDD w/ JUnit 5: Create test cases

```
import org.junit.jupiter.api.Test;

import static org.junit.jupiter.api.Assertions.*;

class FilterTest {
    @Test
    void testContainsCloud() {
        // positive
        assertTrue(Filter.containsCloud("cloud computing"));
        // negative
        assertFalse(Filter.containsCloud("mapreduce"));
    }
}
```

TDD w/ JUnit 5: Run the test

```
[INFO] Running FilterTest
[ERROR] Tests run: 1, Failures: 1, Errors: 0, Skipped: 0, Time elapsed: 0.021 s <<<
FAILURE! - in FilterTest
[ERROR] testContainsCloud  Time elapsed: 0.017 s  <<< FAILURE!
org.opentest4j.AssertionFailedError: expected: <true> but was: <false>
        at FilterTest.testContainsCloud(FilterTest.java:9)
[INFO] Results:
[ERROR] Failures:
[ERROR]   FilterTest.testContainsCloud:9 expected: <true> but was: <false>
[ERROR] Tests run: 1, Failures: 1, Errors: 0, Skipped: 0
[INFO]
[INFO] ------------------------------------------------------------------------
[INFO] BUILD FAILURE
[INFO] ------------------------------------------------------------------------
```

TDD w/ JUnit 5: Implement

```
public class Filter {
    public static boolean containsCloud(final String record) {
        return record.contains("cloud");
    }
}
```

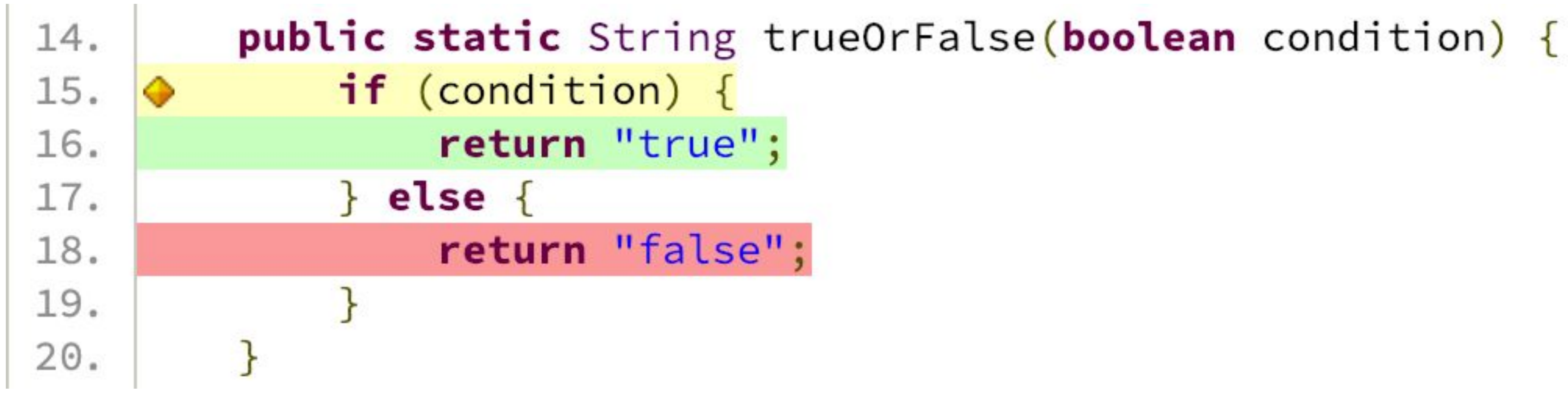
TDD w/ JUnit 5: Rerun the test

```
[INFO]  T E S T S
[INFO] -------------------------------------------------------
[INFO] Running FilterTest
[INFO] Tests run: 1, Failures: 0, Errors: 0, Skipped: 0, Time elapsed: 0.012 s
- in FilterTest
[INFO]
[INFO] Results:
[INFO]
[INFO] Tests run: 1, Failures: 0, Errors: 0, Skipped: 0
[INFO]
[INFO]
------------------------------------------------------------------------
[INFO] BUILD SUCCESS
[INFO]
------------------------------------------------------------------------
```

Java Code Coverage Tool (JaCoCo)

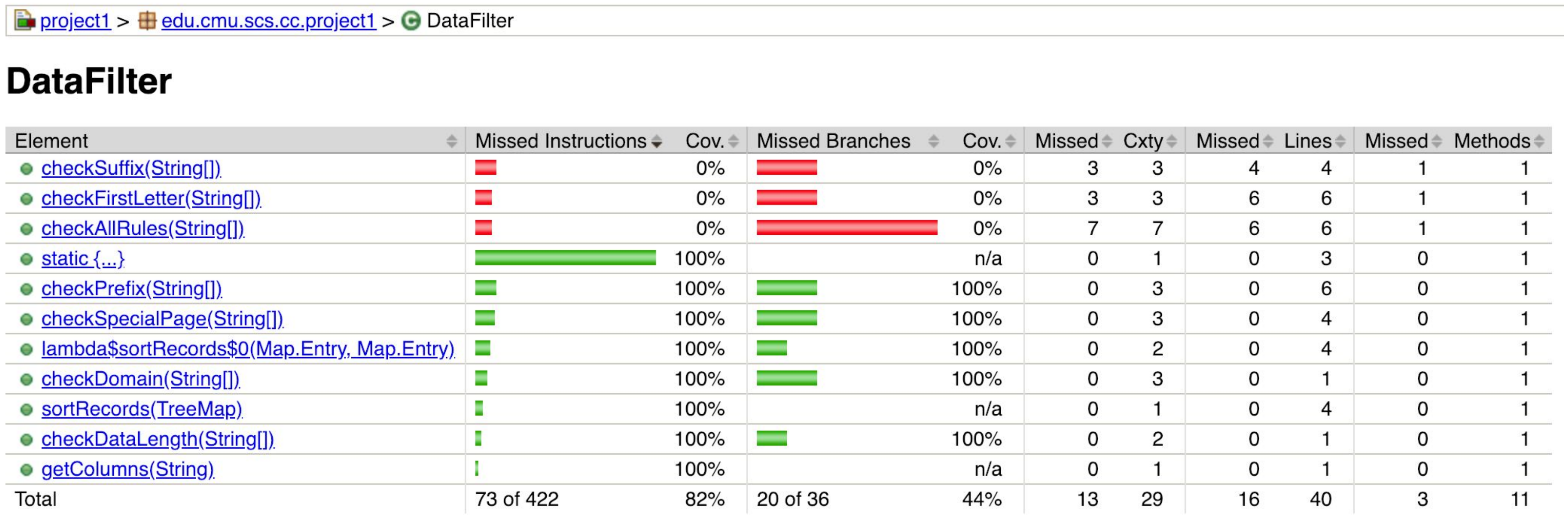
Jacoco analyzes Java byte code and maps the collected information back to source code to visualize the code coverage at line-level granularity.

- Instructions (C0 Coverage)
- Branches (C1 Coverage)



```
    public static String trueOrFalse(boolean condition) {
        if (condition) {
            return "true";
        } else {
            return "false";
        }
    }
```

Your JaCoCo Task



project1 > edu.cmu.scs.cc.project1 > DataFilter

DataFilter

Element	Missed Instructions	Cov.	Missed Branches	Cov.	Missed	Cxty	Missed	Lines	Missed	Methods
checkSuffix(String[])	🟥	0%	🟥	0%	3	3	4	4	1	1
checkFirstLetter(String[])	🟥	0%	🟥	0%	3	3	6	6	1	1
checkAllRules(String[])	🟥	0%	🟥	0%	7	7	6	6	1	1
static {...}	🟩	100%		n/a	0	1	0	3	0	1
checkPrefix(String[])	🟩	100%	🟩	100%	0	3	0	6	0	1
checkSpecialPage(String[])	🟩	100%	🟩	100%	0	3	0	4	0	1
lambda$sortRecords$0(Map.Entry, Map.Entry)	🟩	100%	🟩	100%	0	2	0	4	0	1
checkDomain(String[])	🟩	100%	🟩	100%	0	3	0	1	0	1
sortRecords(TreeMap)	🟩	100%		n/a	0	1	0	4	0	1
checkDataLength(String[])	🟩	100%	🟩	100%	0	2	0	1	0	1
getColumns(String)	🟩	100%		n/a	0	1	0	1	0	1
Total	73 of 422	82%	20 of 36	44%	13	29	16	40	3	11

Your task is to create the test cases to achieve 100% instructions and branches coverage.

P1.1 Task 1: Data Pre-processing Code Template

- In this task, we provide a code template:
  - Merges both desktop and mobile sites for the same page title if any
  - Sorts the output in descending numerical order of the number of accesses and break ties by ascending lexicographical order
  - Outputs the results into a file named as exactly “output”
- It also defines a set of filter methods that you need to implement
- We provide a set of test cases for the first several filter methods
- Your task is to:
  - add the test cases for the rest of the required methods
    - achieve 100% code coverage
  - implement the methods and pass the test
  - make the program encoding aware

Develop Robust Code that Can Execute Correctly on Multiple Environments

- “My submitted code does not produce the same results as the one on my EC2 instance...”
- If your code behaves well in your development environment, it does **not** guarantee that your code will work perfectly in other environments.
- If you run into this, read the writeup carefully, check and adopt best practices before you create posts on Piazza.
- Be cautious about implicit reliance on your environment
  - Locale
  - Encoding-aware I/O
  - Newline(EOL)
  - Versions & Compatibility
  - Absolute/Relative Paths

Develop Robust Code that Can Execute Correctly on Multiple Environments(cont.)

- Example of how *locale* will change default behavior

	LC_ALL=en_US.UTF-8	**LC_ALL=C**
sort	**aAbB**	**ABab**
encoding	**ьмопяёя**	**??????????????**
...	**...**	**...**

Develop Robust Code that Can Execute Correctly on Multiple Environments(cont.)

- newlines, Windows versus Linux
  - \n
  - \r\n
- Versions & compatibility
  - python2 python3 over python
  - pip2 pip3 over pip
- Absolute versus relative paths
  - use relative ones!

Progressively Solve Data Science Problems with Jupyter Notebook

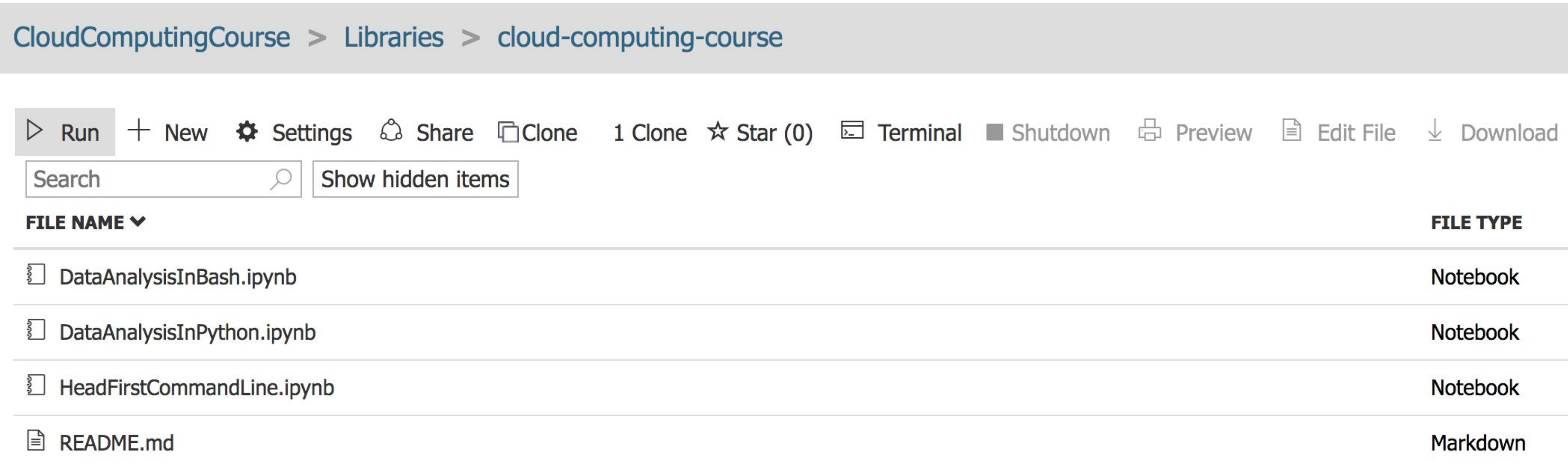
Why Jupyter Notebook?

- Interactive Computing
  - "save" your progress at the latest checkpoint

- Persisted Output and Reproducible Analysis
  - write data analysis reports and share with others

Your Data Science Task with Jupyter Notebook

- Finish the Jupyter Notebook primer
- Visit the Azure Notebooks library 15-319/15-619: Cloud Computing Course



FILE NAME	FILE TYPE
DataAnalysisInBash.ipynb	Notebook
DataAnalysisInPython.ipynb	Notebook
HeadFirstCommandLine.ipynb	Notebook
README.md	Markdown

Project 1.1 Workflow

- Launch EC2 instance with a special AMI
  - Experiment using Terraform with prepared worked examples
- Download the required dataset
- Implement the Data Filter program
  - Achieve 100% code coverage
- Complete Data Analysis Task
  - Answer the awk/grep questions inside runner.sh
  - Answer the Python questions inside data_analysis.ipynb
  - Answer q10 which will be manual graded
- Submit your code for grading
  - Complete the `references` file in JSON format
  - Execute `submitter` to submit your code
- Finish Project Reflection (graded) before the deadline

- Finish Project Reflection Feedback for 3 students
  - Within 7 days **after** the project deadline

Grading of Your Projects

- Code submissions are auto-graded
- Scores will be made available on http://theproject.zone
  - it may take several minutes for your score to show
  - the submissions table is updated with every submission
- We will grade all the code (both auto and manually graded)
- **Hard to read code** of poor quality will lead to a loss of points during manual grading.
- Lack of **comments**, especially in complicated code, will lead to a loss of points during manual grading.
- Poor **indentation** will lead to a loss of points during manual grading
  - Preface each function with a header that describes what it does
    - Use descriptive variable and function names
    - Use Checkstyle, PEP8, or other tools to check your coding style
- The idea is also NOT to comment every line of code

Reminder: Deadlines

- This Friday at 23:59 ET
  - Quiz 1
- This Sunday at 23:59 ET
  - Project 1.1 (including Project Reflection)
- Next Sunday at 23:59 ET
  - Project 1.1 Reflection Feedback
- ASAP, at the latest 1/28/2019 at 23:59 ET
  - Academic Integrity Course Quiz