

Lab Assignment 9: Module Dependency and Cohesion Analysis

INTRODUCTION, SETUP, AND TOOLS

Introduction

In modern software development, ensuring that the codebase is well-structured and maintainable is crucial for long-term success. Software design flaws, such as poor modularization and low cohesion, can lead to difficult-to-maintain code and increased risk of bugs. This lab focuses on analyzing two critical aspects of software design: **module dependency** and **class cohesion**.

Setup

Operating System: You can perform this lab on **Windows**, **Linux**, or **MacOS**.

Programming Languages:

Python: Version 3.7 or above. If you're using Python, ensure that you have Python installed along with the necessary dependencies.

Java: Version 11 or later. You will need to have Java installed for running the **LCOM** tool on your Java project.

Required Tools:

pydeps (for Python): This tool is used to generate dependency graphs for Python projects. You can install **pydeps** using pip.

LCOM.jar (for Java): This tool measures the Lack of Cohesion of Methods (LCOM) for Java classes. You will run this tool using the Java runtime environment.

METHODOLOGY AND EXECUTION WITH RESULT AND ANALYSIS

Define Selection Criteria:

Code Lines: Minimum 500,

And selected repository as first preference. the following image shows the process and output.

The screenshot shows a search interface for GitHub repositories. The top navigation bar includes links for Activities, Google Chrome, GitHub Search, seart-ghs.siusi.ch, Statistics, Publication, and About. The main search area has a "General" tab selected, with a search input field containing "python". Other tabs include "License", "Has topic", "Python", and "Uses Label". The interface is divided into several sections: "History and Activity" (Number of Commits, Issues, Branches), "Date-based Filters" (Created Between, Last Commit Between), "Popularity Filters" (Number of Stars, Watchers, Forks), "Size of codebase" (Non Blank Lines, Code Lines, Comment Lines), and "Additional Filters" (Sorting by Name or Ascending, Repository Characteristics like Exclude Forks, Has License, Has Open Issues, Has Wiki, Has Pull Requests). The bottom section displays search results for repositories like @01studio-lab/micropython_examples and @022ev/python_scripts, showing commit counts, issue counts, pull request counts, star counts, branch counts, release counts, last push dates, file sizes, and last commit dates.

Results: 8,902

@01studio-lab/micropython_examples

- Commits: 46
- Issues: 0
- Open Issues: 0
- Created: 2020-03-14
- Code Lines: 15,119
- Last Commit SHA: f@6a1bee398674ceafedbed2aaac88d8413cc8abad
- Watchers: 8
- Total Pull Reqs: 0
- Open Pull Reqs: 0
- Updated: 2021-10-26
- Comment Lines: 8,139
- Stars: 64
- Branches: 1
- Releases: 0
- Last Push: 2021-10-26
- Blank Lines: 5,294
- Forks: 43
- Contributors: 1
- Size: 69.26 KB
- Last Commit: 2021-10-26

Show More

@022ev/python_scripts

- Commits: 141
- Issues: 0
- Open Issues: 0
- Created: 2021-10-02
- Code Lines: 3,781
- Last Commit SHA: 7@ed7df97c9287b966b4139f585ed3a17802f2d29
- Watchers: 1
- Total Pull Reqs: 57
- Open Pull Reqs: 5
- Updated: 2021-10-31
- Comment Lines: 392
- Stars: 13
- Branches: 1
- Releases: 0
- Last Push: 2021-10-31
- Blank Lines: 1,127
- Forks: 45
- Contributors: 35
- Size: 7.78 KB
- Last Commit: 2021-10-31

Show More

@03strich/python-pandora

Activities Google Chrome GitHub Search seart-ghs.usi.ch Mar 27 9:17 AM

phomus@python-comwechatrobot-HTTP

Commits: 37	Watchers: 2	Stars: 10	Forks: 7
Issues: 0	Total Pull Reqs: 3	Branches: 1	Contributors: 4
Open Issues: 0	Open Pull Reqs: 0	Releases: 1	Size: 31 B
+ Created: 2022-09-22	✓ Updated: 2023-07-01	↑ Last Push: 2023-12-09	Last Commit: 2023-12-09
Code Lines: 728	Comment Lines: 45	Blank Lines: 179	

Last Commit SHA: a26ff0713812469e499f09ca2369e6c97864d46a

Show More

zerpc/zeropcp-python

Commits: 261	Watchers: 124	Stars: 3186	Forks: 383
Issues: 173	Total Pull Reqs: 90	Branches: 1	Contributors: 26
Open Issues: 50	Open Pull Reqs: 4	Releases: 0	Size: 389 B
+ Created: 2012-02-24	✓ Updated: 2025-02-08	↑ Last Push: 2025-02-08	Last Commit: 2025-02-08
Code Lines: 4,255	Comment Lines: 938	Blank Lines: 1,246	

Last Commit SHA: 668af5b55c01e983cfab6c58b1c1db664460133a9

Show More

0x00wolf/PATHBYTER-Hybrid-Encryption-Ransomware-with-Multiprocessing-in-Python

Commits: 123	Watchers: 1	Stars: 12	Forks: 1
Issues: 0	Total Pull Reqs: 9	Branches: 1	Contributors: 1
Open Issues: 0	Open Pull Reqs: 0	Releases: 0	Size: 350 B
+ Created: 2023-09-04	✓ Updated: 2023-10-08	↑ Last Push: 2023-09-25	Last Commit: 2023-09-25
Code Lines: 1,287	Comment Lines: 126	Blank Lines: 436	

Last Commit SHA: 39ba7e994dc1232d2b610786e9f11fc9b56ba08e

Show More

Activities Google Chrome GitHub Search GitHub - zeropcp/zeropcp Python Mar 27 8:55 AM

github.com/zeropcp/zeropcp

bombela Merge pull request #252 from chombourger/issue-251 668af5b - last month 261 Commits

bin	Keepy flake8 happy.	9 years ago
doc	docs: Fix a few typos	3 years ago
tests	Merge pull request #247 from kloczek/master	4 years ago
zeropcp	Merge pull request #252 from chombourger/issue-251	last month
ignore	Fixed depreciation warnings:	12 years ago
travis.yml	Move from deprecated nose to pytest (solves #243)	4 years ago
LICENSE	(c) change.	10 years ago
README.rst	Bump version to 0.6.3.	6 years ago
setup.py	Move from deprecated nose to pytest (solves #243)	4 years ago
tox.ini	Move from deprecated nose to pytest (solves #243)	4 years ago

zeropcp for python

<http://www.zeropcp.io>

Readme View license Activity Custom properties 3.2k stars 123 watching 384 forks Report repository

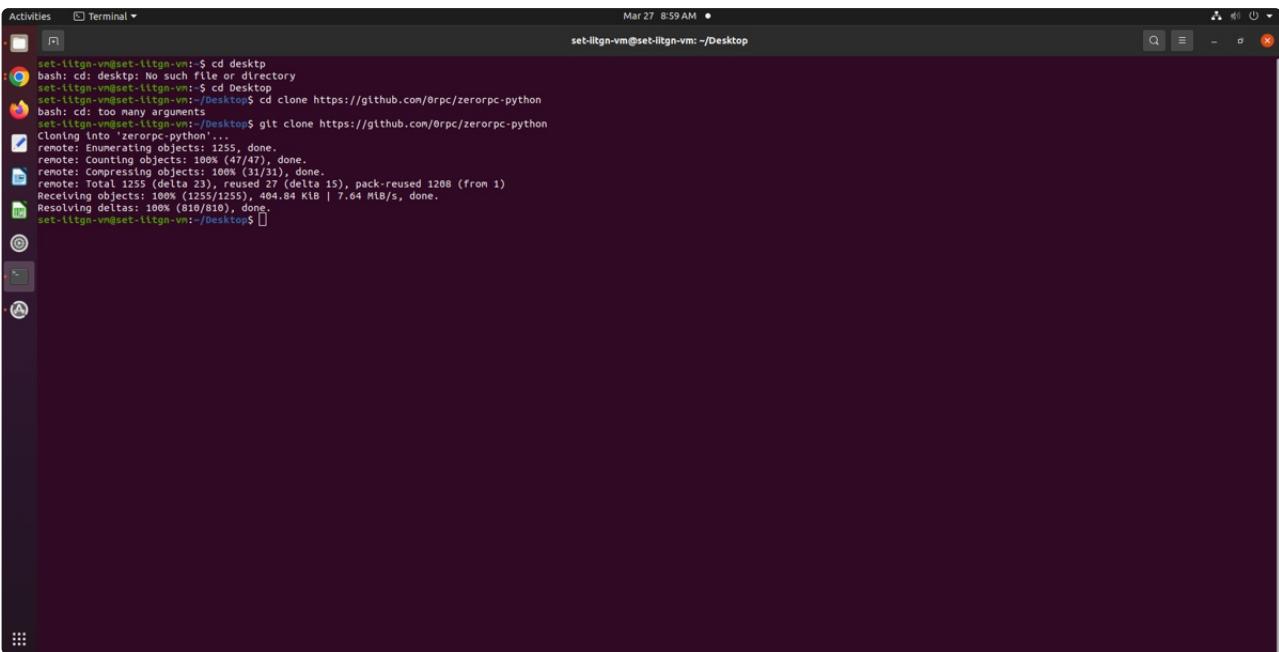
Releases 18 tags

Packages No packages published

Contributors 30 + 16 contributors

Languages Python 100.0%

git clone

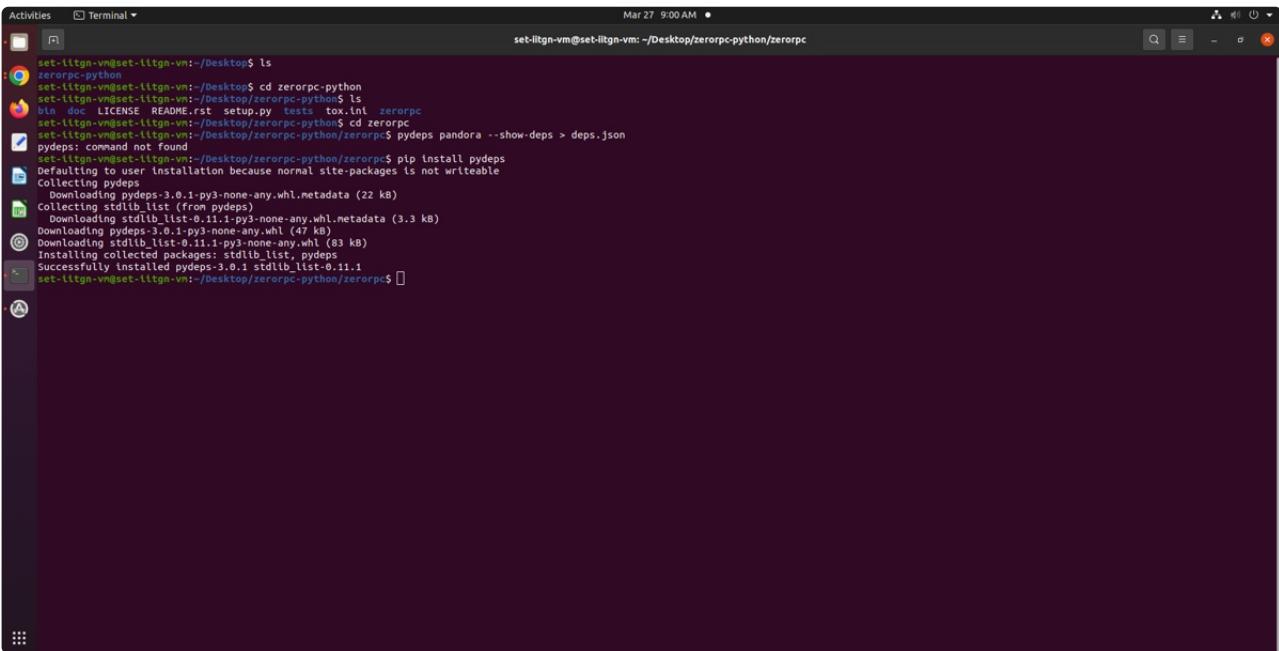


```
set-litgn-vm@set-litgn-vm: ~$ cd desktop
bash: cd: desktop: No such file or directory
set-litgn-vm@set-litgn-vm: ~$ cd Desktop
set-litgn-vm@set-litgn-vm: ~/Desktop$ cd clone https://github.com/0rpc/zerorpc-python
bash: cd: too many arguments
set-litgn-vm@set-litgn-vm: ~/Desktop$ git clone https://github.com/0rpc/zerorpc-python
Cloning into 'zerorpc-python'...
remote: Enumerating objects: 1255, done.
remote: Counting objects: 1086 (47/47), done.
remote: Compressing objects: 100% (31/31), done.
remote: Total 1255 (delta 23), reused 27 (delta 15), pack-reused 1208 (from 1)
Receiving objects: 100% (1255/1255), 404.84 KiB | 7.64 MiB/s, done.
Resolving deltas: 100% (810/810), done.
set-litgn-vm@set-litgn-vm: ~/Desktop$
```

Software Tool Setup:

Download, install, and configure bandit using command given on [Pydeps](#) [1]

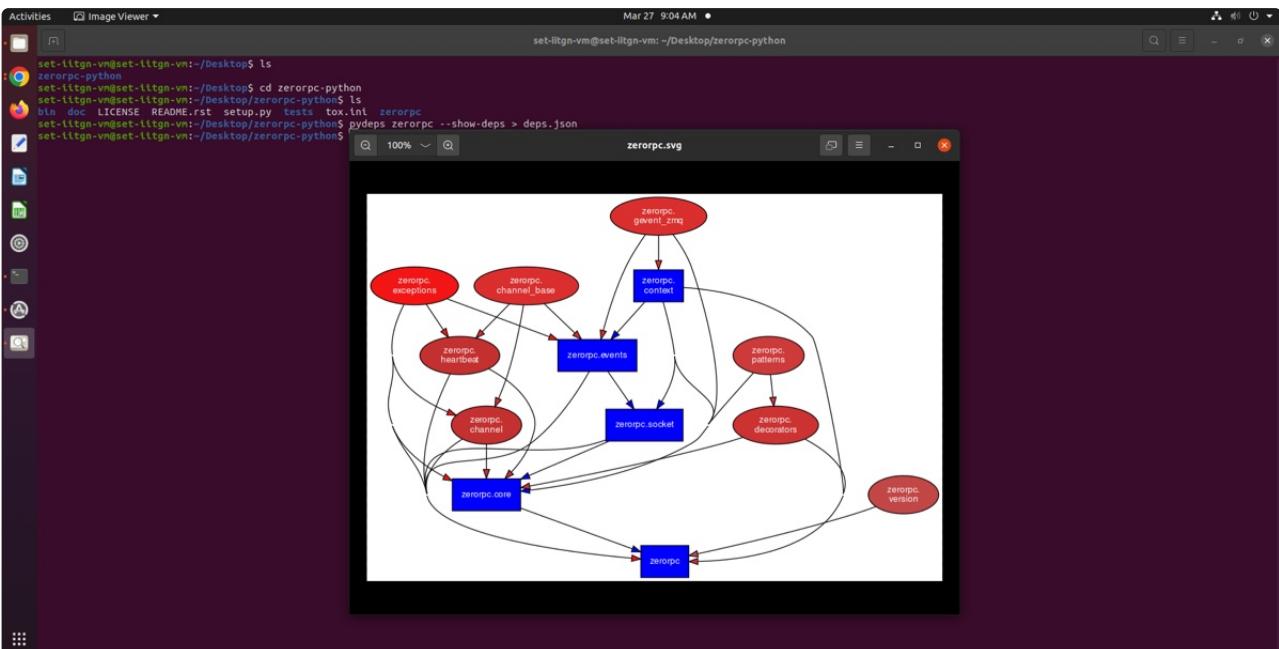
```
pip install pydeps
```



```
set-litgn-vm@set-litgn-vm: ~$ ls
zerorpc-python
set-litgn-vm@set-litgn-vm: ~$ cd zerorpc-python
set-litgn-vm@set-litgn-vm: ~/zerorpc-python$ ls
bin doc LICENSE README.rst setup.py tests tox.ini zerorpc
set-litgn-vm@set-litgn-vm: ~/zerorpc-python$ cd zerorpc
set-litgn-vm@set-litgn-vm: ~/zerorpc$ pydeps pandora --show-deps > deps.json
pydeps: command not found
set-litgn-vm@set-litgn-vm: ~/zerorpc$ pip install pydeps
Defaulting to user installation because normal site-packages is not writeable
Collecting pydeps
  Downloading pydeps-3.0.1-py3-none-any.whl.metadata (22 kB)
Collecting stdlib_list (from pydeps)
  Downloading stdlib_list-0.11.1-py3-none-any.whl.metadata (3.3 kB)
  Downloading pydeps-3.0.1-py3-none-any.whl (47 kB)
  Downloading stdlib_list-0.11.1-py3-none-any.whl (83 kB)
Installing collected packages: stdlib_list, pydeps
Successfully installed pydeps-3.0.1 stdlib_list-0.11.1
set-litgn-vm@set-litgn-vm: ~/zerorpc$
```

Run the Software Tool on Selected Repositories:

```
pydeps zerorpc --show-deps > deps.json
```



zerorpc.svg
Image File
18.0 KB



deps.json
JSON File
6.0 KB

Module	Fan-in	Fan-out
main	0	14
zerorpc	5	9
zerorpc.core	2	9
zerorpc.events	3	5
zerorpc.context	5	2
zerorpc.exceptions	6	0
zerorpc.channel	3	2
zerorpc.heartbeat	3	2
zerorpc.socket	3	2
zerorpc.channel_base	4	0
zerorpc.decorators	3	1
zerorpc.gevent_zmq	4	0
zerorpc.patterns	3	0
zerorpc.cli	1	1

<code>zerorpc.version</code>	2	0
------------------------------	---	---

Analyze the generated dependency graph

Identify Highly coupled modules:

- `zerorpc.core`
 - **Imports:** zerorpc, channel, context, decorators, exceptions, gevent_zmq, heartbeat, patterns, socket
 - **Imported by:** __main__, zerorpc
- `zerorpc.context`
 - **Imports:** zerorpc, gevent_zmq
 - **Imported by:** __main__, zerorpc, core, events, socket
- `zerorpc.events`
 - **Imports:** zerorpc, channel_base, context, exceptions, gevent_zmq
 - **Imported by:** __main__, zerorpc, socket
- `zerorpc`
 - Central module that re-exports/aggregates many submodules.

Detect cyclic dependencies and explain how they affect maintainability.

- **Cycle Example:**
 - `zerorpc.core` → `zerorpc.context` → `zerorpc` → `zerorpc.core`
 - Also, `zerorpc.context` → `zerorpc` → `zerorpc.core` → `zerorpc.context`

These form **cyclic dependencies**, mainly due to the `zerorpc` root module re-importing its submodules.

Impact on maintainability:

- Difficult to isolate modules for testing.
- Increases load-time dependency complexity.
- Can cause circular import errors in Python under some conditions.

Check for unused and disconnected modules.

- `zerorpc.cli` (only used by `__main__`)
- `zerorpc.version` (used by `__main__` and `zerorpc`)
- `zerorpc.decorators` (used only in `core` and `zerorpc`)

Assess the depth of dependencies.

- `zerorpc.channel_base` : imported by 4 modules → forms a **base layer**
- `zerorpc.core` : depends on many mid- and low-level modules → **deep and central**

- `zerorpc.socket`: depends on context and events → moderately deep

Perform a dependency impact assessment:

How would changes in the core module1 affect the rest of the system?

`zerorpc.core` is a **central orchestrator** in the system.

It has:

- **Fan-in:** 2 (modules that import/use it: `zerorpc`, `__main__`)
- **Fan-out:** 9 (modules it imports: `zerorpc.channel`, `zerorpc.channel_base`, `zerorpc.context`, `zerorpc.decorators`, `zerorpc.events`, `zerorpc.exceptions`, `zerorpc.gevent_zmq`, `zerorpc.heartbeat`, `zerorpc.socket`)

Observations:

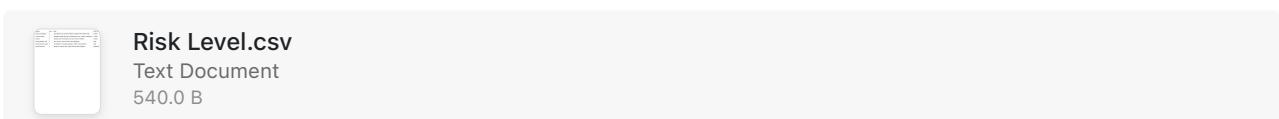
- While only 2 modules directly import `zerorpc.core`, one of them is the `zerorpc` module, which acts as the **gateway** for almost all other modules in the system.
- Therefore, **any change in `zerorpc.core` cascades** indirectly to a **large portion of the codebase**.

Potential Impact:

- **Structural or logical changes** in `zerorpc.core` may:
 - Break the **functionality of `zerorpc`**, which in turn affects 13+ modules.
 - Introduce **inconsistencies** if underlying modules it depends on (via fan-out) are changed in parallel.
 - Affect **event handling, socket behavior, context sharing**, and **error propagation** due to its deep integration with foundational modules.

Which modules are at risk of breaking the system if modified?

Module	Fan-in	Risk Level
<code>zerorpc.exceptions</code>	6	Critical
<code>zerorpc.context</code>	5	Critical
<code>zerorpc</code>	5	Critical



- These modules form the **spine of the RPC mechanism**, including **communication, context propagation, and error reporting**.
- Modifying any of them could introduce:
 - API incompatibilities

- Runtime failures
 - Subtle bugs in downstream consumers

Measuring Java Class Cohesion using LCOM:

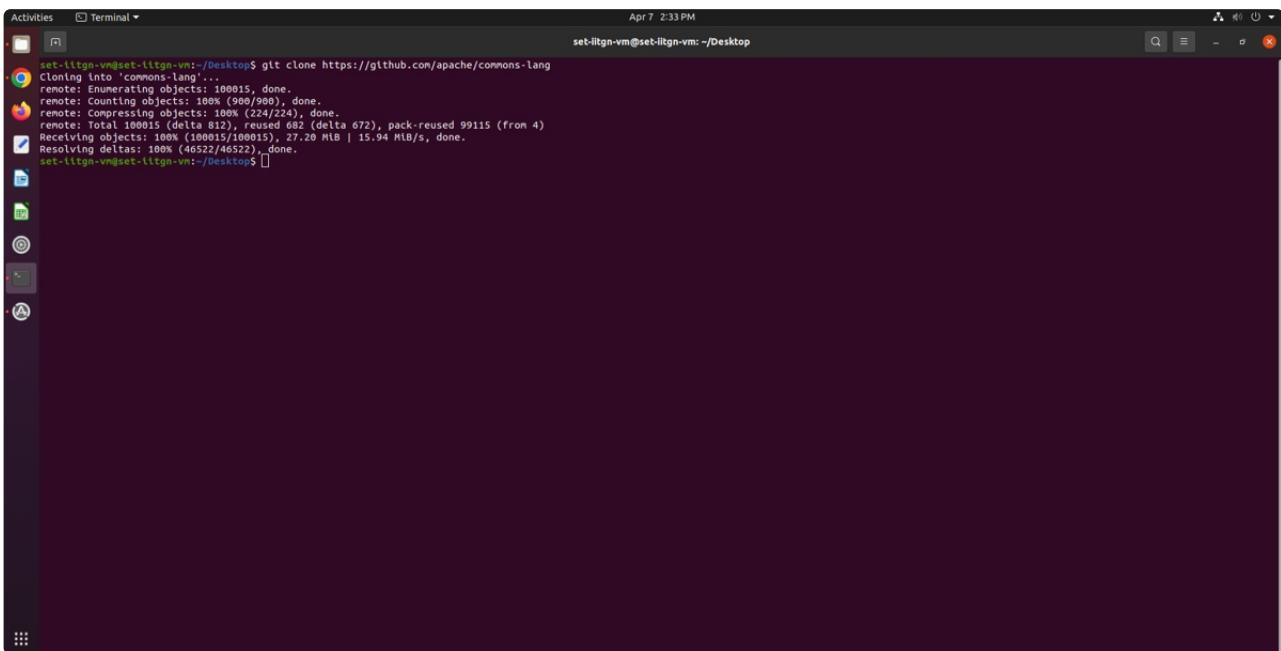
```
sudo apt update  
sudo apt install openjdk-11-jdk -y
```

```
git clone https://github.com/tushartushar/LCOM.git  
cd LCOM  
mvn clean package
```

```
Activities Terminal April 7 2:03 PM set-litgn-vm@set-litgn-vm: ~/Desktop/LCOM

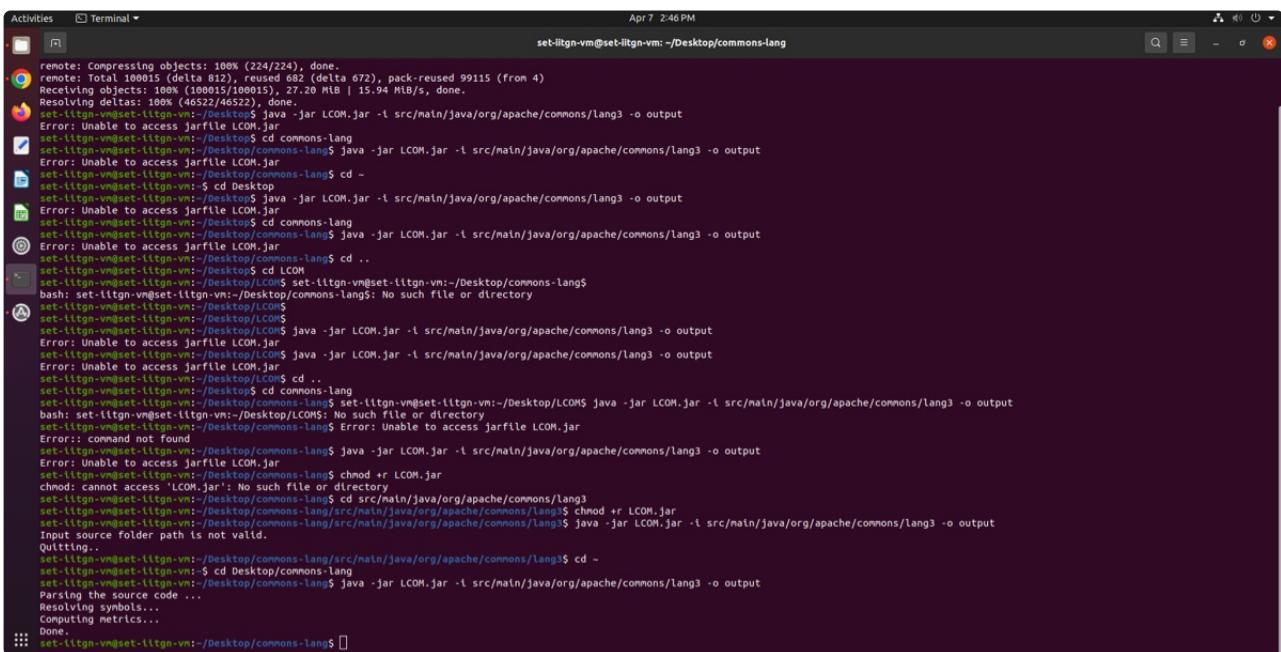
git clone https://github.com/tushartushar/LCOM.git
Cloning into 'LCOM'.
remote: Compressing objects: 100% (17/17), done.
remote: Total 2064 (delta 2), reused 16 (delta 1), pack-reused 2043 (from 1)
Receiving objects: 100% (2064/2064), 2.38 MB | 4.92 MiB/s, done.
Resolving deltas: 100% (1123/1123), done.
set-litgn-vm@set-litgn-vm: ~/Desktop$ cd LCOM
set-litgn-vm@set-litgn-vm: ~/Desktop/LCOM$ mvn clean package
[INFO] Scanning for projects...
[INFO]
[INFO] ----- LCOM:LCOM -----
[INFO] Building LCOM 1.0.0
[INFO] [ Jar ]
[INFO] Downloading from central: https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-clean-plugin/2.5/maven-clean-plugin-2.5.pom
Downloaded from central: https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-clean-plugin/2.5/maven-clean-plugin-2.5.pom (3.9 kB at 12 kB/s)
[INFO] Downloading from central: https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-plugins/22/maven-plugins-22.pom
Downloaded from central: https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-plugins/22/maven-plugins-22.pom (13 kB at 362 kB/s)
[INFO] Downloading from central: https://repo.maven.apache.org/maven2/org/apache/maven/maven-parent/21/maven-parent-21.pom
Downloaded from central: https://repo.maven.apache.org/maven2/org/apache/maven/maven-parent/21/maven-parent-21.pom (26 kB at 659 kB/s)
[INFO] Downloading from central: https://repo.maven.apache.org/maven2/org/apache/apache/apache/10/apache-10.pom
Downloaded from central: https://repo.maven.apache.org/maven2/org/apache/apache/apache/10/apache-10.pom (15 kB at 462 kB/s)
[INFO] Downloading from central: https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-clean-plugin/2.5/maven-clean-plugin-2.5.jar
Downloaded from central: https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-clean-plugin/2.5/maven-clean-plugin-2.5.jar (25 kB at 684 kB/s)
[INFO] Downloading from central: https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-resources-plugin/2.6/maven-resources-plugin-2.6.pom
Downloaded from central: https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-resources-plugin/2.6/maven-resources-plugin-2.6.pom (8.1 kB at 246 kB/s)
[INFO] Downloading from central: https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-plugins/23/maven-plugins-23.pom
Downloaded from central: https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-plugins/23/maven-plugins-23.pom (9.2 kB at 317 kB/s)
[INFO] Downloading from central: https://repo.maven.apache.org/maven2/org/apache/maven/maven-parent/22/maven-parent-22.pom
Downloaded from central: https://repo.maven.apache.org/maven2/org/apache/maven/maven-parent/22/maven-parent-22.pom (30 kB at 692 kB/s)
[INFO] Downloading from central: https://repo.maven.apache.org/maven2/org/apache/apache/apache/11/apache-11.pom
Downloaded from central: https://repo.maven.apache.org/maven2/org/apache/apache/11/apache-11.pom (15 kB at 463 kB/s)
[INFO] Downloading from central: https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-resources-plugin/2.6/maven-resources-plugin-2.6.jar
Downloaded from central: https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-resources-plugin/2.6/maven-resources-plugin-2.6.jar (30 kB at 922 kB/s)
[INFO] Downloading from central: https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-compiler-plugin/3.1/maven-compiler-plugin-3.1.pom
Downloaded from central: https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-compiler-plugin/3.1/maven-compiler-plugin-3.1.pom (10 kB at 329 kB/s)
[INFO] Downloading from central: https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-plugins/24/maven-plugins-24.pom
Downloaded from central: https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-plugins/24/maven-plugins-24.pom (11 kB at 349 kB/s)
[INFO] Downloading from central: https://repo.maven.apache.org/maven2/org/apache/maven/maven-parent/23/maven-parent-23.pom
Downloaded from central: https://repo.maven.apache.org/maven2/org/apache/maven/maven-parent/23/maven-parent-23.pom (33 kB at 905 kB/s)
[INFO] Downloading from central: https://repo.maven.apache.org/maven2/org/apache/apache/13/apache-13.pom
Downloaded from central: https://repo.maven.apache.org/maven2/org/apache/apache/13/apache-13.pom (14 kB at 451 kB/s)
[INFO] Downloading from central: https://repo.maven.apache.org/maven/plugins/maven-compiler-plugin/3.1/maven-compiler-plugin-3.1.jar
Downloaded from central: https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-compiler-plugin/3.1/maven-compiler-plugin-3.1.jar (43 kB at 1.2 MB/s)
[INFO] Downloading from central: https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-surefire-plugin/2.12.4/maven-surefire-plugin-2.12.4.pom
Downloaded from central: https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-surefire-plugin/2.12.4/maven-surefire-plugin-2.12.4.pom (10 kB at 317 kB/s)
[INFO] Downloading from central: https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-surefire-plugin/2.12.4/maven-surefire-plugin-2.12.4.pom
Downloaded from central: https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-surefire-plugin/2.12.4/maven-surefire-plugin-2.12.4.pom (44 kB at 431 kB/s)
[INFO] Downloading from central: https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-surefire-reporter/2.12.4/maven-surefire-reporter-2.12.4.pom
Downloaded from central: https://repo.maven.apache.org/maven2/org/apache/maven/plugins/maven-surefire-reporter/2.12.4/maven-surefire-reporter-2.12.4.pom (14 kB at 451 kB/s)
```

```
git clone https://github.com/apache/commons-lang
```



```
set-litgn-vm@set-litgn-vm:~/Desktop$ git clone https://github.com/apache/commons-lang
Cloning into 'commons-lang'...
remote: Enumerating objects: 100015, done.
remote: Counting objects: 100% (900/900), done.
remote: Compressing objects: 100% (224/224), done.
remote: Total 100015 (delta 672), pack-reused 99115 (from 4)
Receiving objects: 100% (100015/100015), 27.20 MiB | 15.94 MiB/s, done.
Resolving deltas: 100% (4652/4652), done.
set-litgn-vm@set-litgn-vm:~/Desktop$
```

```
java -jar LCOM.jar -i src/main/java/org/apache/commons/lang3 -o output
```



```
set-litgn-vm@set-litgn-vm:~/Desktop/commons-lang$ Apr 7 2:46PM
set-litgn-vm@set-litgn-vm:~/Desktop/commons-lang$ remote: Compressing objects: 100% (224/224), done.
remote: Total 100015 (delta 672), pack-reused 99115 (from 4)
Receiving objects: 100% (100015/100015), 27.20 MiB | 15.94 MiB/s, done.
Resolving deltas: 100% (4652/4652), done.
set-litgn-vm@set-litgn-vm:~/Desktop$ java -jar LCOM.jar -i src/main/java/org/apache/commons/lang3 -o output
Error: Unable to access jarfile LCOM.jar
set-litgn-vm@set-litgn-vm:~/Desktop/commons-lang$ set-litgn-vm@set-litgn-vm:~/Desktop/commons-lang$ java -jar LCOM.jar -i src/main/java/org/apache/commons/lang3 -o output
Error: Unable to access jarfile LCOM.jar
set-litgn-vm@set-litgn-vm:~/Desktop/commons-lang$ cd ~
set-litgn-vm@set-litgn-vm:~$ cd Desktop
set-litgn-vm@set-litgn-vm:~/Desktop$ java -jar LCOM.jar -i src/main/java/org/apache/commons/lang3 -o output
Error: Unable to access jarfile LCOM.jar
set-litgn-vm@set-litgn-vm:~/Desktop$ cd commons-lang
set-litgn-vm@set-litgn-vm:~/Desktop/commons-lang$ java -jar LCOM.jar -i src/main/java/org/apache/commons/lang3 -o output
Error: Unable to access jarfile LCOM.jar
set-litgn-vm@set-litgn-vm:~/Desktop/commons-lang$ set-litgn-vm@set-litgn-vm:~/Desktop/commons-lang$ cd ..
set-litgn-vm@set-litgn-vm:~/Desktop$ cd LCOM
set-litgn-vm@set-litgn-vm:~/Desktop/LCOM$ set-litgn-vm@set-litgn-vm:~/Desktop/commons-lang$ cd ..
set-litgn-vm@set-litgn-vm:~/Desktop$ cd LCOM
set-litgn-vm@set-litgn-vm:~/Desktop/LCOM$ bash: set-litgn-vm@set-litgn-vm:~/Desktop/commons-lang: No such file or directory
set-litgn-vm@set-litgn-vm:~/Desktop/LCOM$ set-litgn-vm@set-litgn-vm:~/Desktop$ java -jar LCOM.jar -i src/main/java/org/apache/commons/lang3 -o output
Error: Unable to access jarfile LCOM.jar
set-litgn-vm@set-litgn-vm:~/Desktop/LCOM$ java -jar LCOM.jar -i src/main/java/org/apache/commons/lang3 -o output
Error: Unable to access jarfile LCOM.jar
set-litgn-vm@set-litgn-vm:~/Desktop/LCOM$ cd ..
set-litgn-vm@set-litgn-vm:~/Desktop$ cd commons-lang
set-litgn-vm@set-litgn-vm:~/Desktop/commons-lang$ set-litgn-vm@set-litgn-vm:~/Desktop/LCOM$ java -jar LCOM.jar -i src/main/java/org/apache/commons/lang3 -o output
bash: set-litgn-vm@set-litgn-vm:~/Desktop/commons-lang: No such file or directory
set-litgn-vm@set-litgn-vm:~/Desktop/commons-lang$ Error: Unable to access jarfile LCOM.jar
Error:: command not found
set-litgn-vm@set-litgn-vm:~/Desktop/commons-lang$ java -jar LCOM.jar -i src/main/java/org/apache/commons/lang3 -o output
Error: Unable to access jarfile LCOM.jar
set-litgn-vm@set-litgn-vm:~/Desktop/commons-lang$ chmod +r LCOM.jar
chmod: cannot access 'LCOM.jar': No such file or directory
set-litgn-vm@set-litgn-vm:~/Desktop/commons-lang$ cd src/main/java/org/apache/commons/lang3
set-litgn-vm@set-litgn-vm:~/Desktop/commons-lang$ chmod +r LCOM.jar
set-litgn-vm@set-litgn-vm:~/Desktop/commons-lang$ java -jar LCOM.jar -i src/main/java/org/apache/commons/lang3 -o output
Input source folder path is not valid.
Quitting..
set-litgn-vm@set-litgn-vm:~/Desktop/commons-lang$ cd ~
set-litgn-vm@set-litgn-vm:~$ cd Desktop/commons-lang
set-litgn-vm@set-litgn-vm:~/Desktop/commons-lang$ java -jar LCOM.jar -i src/main/java/org/apache/commons/lang3 -o output
Parses the source code ...
Resolving symbols...
Computing metrics...
Done.
set-litgn-vm@set-litgn-vm:~/Desktop/commons-lang$
```

TypeMetrics.csv

Text Document

30.0 KB

LcomLog07042025_1444.txt

TXT Document

6.0 B

The analysis generated a TypeMetrics.csv, containing metrics such as **Project Name**, **Package Name**, **Type Name**, **LCOM1**, **LCOM2**, **LCOM3**, **LCOM4**, **LCOM5**, and **YALCOM** for each class in the project.

Identify classes with high LCOM values and analyze:

Type Name	Package Name	LCOM1
ObjectUtils	org.apache.commons.lang3	1378
Range	org.apache.commons.lang3	192
RandomStringUtils	org.apache.commons.lang3	191
NumberUtils	org.apache.commons.lang3	151
StringUtils	org.apache.commons.lang3	127

| What does a high LCOM value suggest?

- High LCOM indicates **low cohesion**, meaning methods in a class operate on **different subsets** of data fields.
- This is a sign of **poor class design**, suggesting that the class may be **doing too many unrelated tasks**.

| Is there a chance for functional decomposition?

- Absolutely. For example:
 - ObjectUtils and StringUtils might contain utility methods that can be split into smaller, **more focused helper classes**.
 - Range might benefit from splitting into specialized subclasses based on range types.

Visualizing Cohesion in Classes:

| Create a table of LCOM values for the selected classes.

Type Name	LCOM1	LCOM2	LCOM3	LCOM4	LCOM5	YALCOM
ObjectUtils	1378	0	53	39	0.98	0.74
Range	192	6	6	2	0.77	0.07
StringUtils	127	0	43	29	1.08	0.63
NumberUtils	151	0	42	27	1.08	0.6
RandomStringUtils	191	0	12	7	1.4	0.15

| Compare them side-by-side in the format below:

- **ObjectUtils** has the highest LCOM1 and LCOM3 values, suggesting it contains many unrelated methods. This class likely needs **major decomposition**.
- **RandomStringUtils** has the **highest LCOM5 (1.40)**, showing a strong case of low cohesion per method interactions — again pointing toward **low internal focus**.
- **Range**, despite its high LCOM1 (192), has a **very low YALCOM (0.07)** — indicating **a possible anomaly** or that it's well-focused in another cohesion aspect.
- **StringUtils** and **NumberUtils** show similar patterns — moderately high LCOM1 and LCOM3 values, with balanced YALCOM, suggesting **some cohesion** but still possible room for modularization.

APPENDIX

I would like to express my sincere gratitude to my course instructor, Prof. [**Shouwick Mondal**](#), for his invaluable guidance and support throughout this lab. I also appreciate the assistance from All TAs, whose help with me with troubleshooting.

Additionally, I am grateful for the resources provided, including Which I have sited down which helped me resolve issues efficiently. Finally, I'd like to thank my peers for contributing to a collaborative and supportive learning environment.

CITATION

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