Mining Software Repositories: OpenStack Nova Project.

Goal

The goal of this tool and analysis is to help in capturing insights from the commits on a project repo, in this case: the openstack nova project repo. This will help in understanding the project as well as provide guidiance to contributors and maintainers.

Objectives

The following questions will be answered:

- Find the most actively modified module?
- How many commits occured during the studied period?
- How much churn occurred during the studied period? Churn is defined as the sum of added and removed lines by all commits.

NB: This workflow is responsible for the pre-processing, analysis, and generation of insight from the collected data. It is assumed that the automated collection of the data via the script accessible in thesame folder with this notebook has been completed. The collected data will be loaded here before the other process in the workflow executes.

Required imports:

In [1]:
```
# Built-in libraries
import json
import os

# The normal data science ecosystem libraries
# pandas for data wrangling
import pandas as pd

# Plotting modules and libraries required
import matplotlib as mpl
import matplotlib.pyplot as plt
```

Required settings:

In [2]:
```
# Settings:
# 1. Command needed to make plots appear in the Jupyter Notebook
%matplotlib inline

# 2. Command needed to make plots bigger in the Jupyter Notebook
plt.rcParams['figure.figsize']= (12, 10)

# 3. Command needed to make 'ggplot' styled plots- professional and yet good looking theme.
plt.style.use('ggplot')

# 4. This will make the plot zoomable
# mpld3.enable_notebook()
```

Other utility functions for data manipulation

In [3]:
```
# Utility data manipulation functions

# 1. Extract path parameters from filename
def path_parameters(dframe):
     filename = os.path.basename(dframe["filename"])
     filetype = os.path.splitext(dframe["filename"])[1]
     directory = os.path.dirname(dframe["filename"])

     return directory, filename, filetype
```

1. Loading the data

In [4]:
```
# Open and load json file
with open('data.json', encoding="utf8") as file:
    data = json.load(file)
    print("data loaded successfully")
```

```
data loaded successfully
```

Data normalization

The collected commit data is a semi-structured json which has nested data similar to the image below. Files is a list of file objects. The loaded data will be normalized into a flat table using pandas.json_normalize.


```
{⊟
  "sha":"232f8275ec00767d1f100cacae4823e6f77e04ef",
  "node_id":"C_kwDOAAwOD9oAKDIzMmY4Mjc1ZWMwMDc2N2QxZjEwMGNhY2F1NDgyM2U2Zjc3ZTA0ZWY",
  "commit":{⊞},
  "url":"https://api.github.com/repos/openstack/nova/commits/232f8275ec00767d1f100cacae4823e6f77e04ef",
  "html_url":"https://github.com/openstack/nova/commit/232f8275ec00767d1f100cacae4823e6f77e04ef",
  "comments_url":"https://api.github.com/repos/openstack/nova/commits/232f8275ec00767d1f100cacae4823e6f77e04ef/comments",
  "author":null,
  "committer":{⊞},
  "parents":[⊞],
  "stats":{⊞},
  "files":[⊟
    {⊞},
    {⊞},
    {⊞},
    {⊞},
    {⊞},
    {⊞},
    {⊞},
    {⊞},
    {⊞}
  ]
}
```


In [5]:
```
df = pd.json_normalize(data, "files", ["commit_node_id", "commit_sha", "commit_html_url", "commit_date" ])
```

2. Displaying current state of the data

In [6]:
```
# The first 5 rows
df.head()
```

Out[6]:

	sha	filename	status	additions	deletions	changes	
0	08006e2b92a44b709b3ef6171cfb9a95519c8f5e	nova/compute/api.py	modified	18	4	22	https://githu
1	79a62da21a6d4e768b48f8be3c44e39b9bcd3a83	nova/tests/unit/compute/test_api.py	modified	30	0	30	https://githu
2	ef5582543a2ac953179e5dbc3e493e69c9bc84bf	releasenotes/notes/bug-1960401-504eb255253d966...	added	8	0	8	https://githu
3	b3f461cca42b3bc413767649e7284db3c7332f42	nova/api/openstack/compute/deferred_delete.py	modified	1	1	2	https://gith
4	59b9c384df60d670f526f91ffb10fa09d12ab7ba	nova/api/openstack/compute/migrate_server.py	modified	1	1	2	https://gith

In [7]:
```
# The last five rows
df.tail()
```

Out[7]:

	sha	filename	status	additions	deletions	changes	
2209	6b397f5f5cfd4d06687dac0928b33a11a51e860a	doc/source/reference/index.rst	modified	3	0	3	https://github.com/opens
2210	c84ab26337f5de23e6bc55eac0988063bb83a13b	doc/source/reference/upgrade-checks.rst	modified	96	90	186	https://github.com/opens
2211	6da9ae060628f408e3188403e9d861946dfa0b54	doc/source/user/index.rst	modified	0	3	3	https://github.com/opens
2212	ef65b8940d24cea8060a3a1756553c29b89c801f	doc/test/redirect-tests.txt	modified	2	1	3	https://github.com/opens
2213	c71e899fd4872cb3b1680ea2a95d6a5ea6f91568	api-guide/source/accelerator-support.rst	modified	54	0	54	https://github.com/opens

In [8]:
```
# Summary of the dataframe
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2214 entries, 0 to 2213
Data columns (total 15 columns):
 #   Column             Non-Null Count  Dtype
---  ------             --------------  -----
 0   sha                2214 non-null   object
 1   filename           2214 non-null   object
 2   status             2214 non-null   object
 3   additions          2214 non-null   int64
 4   deletions          2214 non-null   int64
 5   changes            2214 non-null   int64
 6   blob_url           2214 non-null   object
 7   raw_url            2214 non-null   object
 8   contents_url       2214 non-null   object
 9   patch              2174 non-null   object
 10  previous_filename  40 non-null     object
 11  commit_node_id     2214 non-null   object
 12  commit_sha         2214 non-null   object
 13  commit_html_url    2214 non-null   object
 14  commit_date        2214 non-null   object
dtypes: int64(3), object(12)
memory usage: 259.6+ KB
```

3. Data cleaning

In [9]:
```
# Removing columns not needed for the analysis
columns = ['previous_filename', 'patch', 'contents_url', 'raw_url', 'previous_filename', 'commit_node_id']
df.drop(columns, inplace=True, axis=1)
```

In [10]:
```
# Generating and adding extra columns
df[["directory", "file_name", "file_type"]] = df.apply(lambda x: path_parameters(x), axis=1, result_type="expan
```

In [11]:
```
# Delete the previous filename column as it is no longer required
df.drop("filename", inplace=True, axis=1)
```

In [12]:
```
# Rename columns
df.rename(columns={"sha": "file_sha", "status": "file_status", "additions":"no_of_additions", "deletions": "no_
```

In [13]:
```
# Optimising the data frame by correcting the data types.
# This will also make more operations possible on the data frame

df = df.astype({'file_sha': 'str', 'file_status': 'category', 'no_of_additions':'int', 'no_of_deletions':'int',
```

In [14]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2214 entries, 0 to 2213
Data columns (total 12 columns):
 #   Column           Non-Null Count  Dtype
---  ------           --------------  -----
 0   file_sha         2214 non-null   object
 1   file_status      2214 non-null   category
 2   no_of_additions  2214 non-null   int32
 3   no_of_deletions  2214 non-null   int32
 4   changes          2214 non-null   int32
 5   blob_url         2214 non-null   object
 6   commit_sha       2214 non-null   object
 7   commit_html_url  2214 non-null   object
 8   commit_date      2214 non-null   object
 9   directory        2214 non-null   object
 10  file_name        2214 non-null   object
 11  file_type        2214 non-null   category
dtypes: category(2), int32(3), object(7)
memory usage: 152.3+ KB
```

Basic Analysis and Visualization

1. Total number of commits that occured during the studied period.

In [15]:
```
# value_counts returns a series object counting all unique values with the 1st value being the most frequently
df["commit_sha"].value_counts()
```

Out[15]:
```
0d1dd103d1431400b04f5f3edcb0d48453a79151    164
f3d48000b139ec38d92da274a34a8387f76cbc89     83
0e0196d979cf1b8e63b9656358116a36f1f09ede     83
3ac73ada33e5d4ae7fc264cb13b46788ae706244     54
ccef1940bf92da7441beb6b88fa9f998b1e9b2b2     36
                                           ...
fa35cfa9983e098455d9dfc1daa87f8be4cf57d4      1
0d0de2e448ebfe0485eb1714b1f9d81b807c7128      1
6e1b22581f3c4c0b3017b189a174c659905bbc3a      1
c98f1f8943af0b2e21c910591ee99d7ec3a023c1      1
2226ec4e3b9ecbd070f1545e40063ede1f1aa44a      1
Name: commit_sha, Length: 470, dtype: int64
```

In [16]:
```
print("The total no. of processed commits is: {commits_total}".format(commits_total = len(df["commit_sha"].valu
```

```
The total no. of processed commits is: 470
```

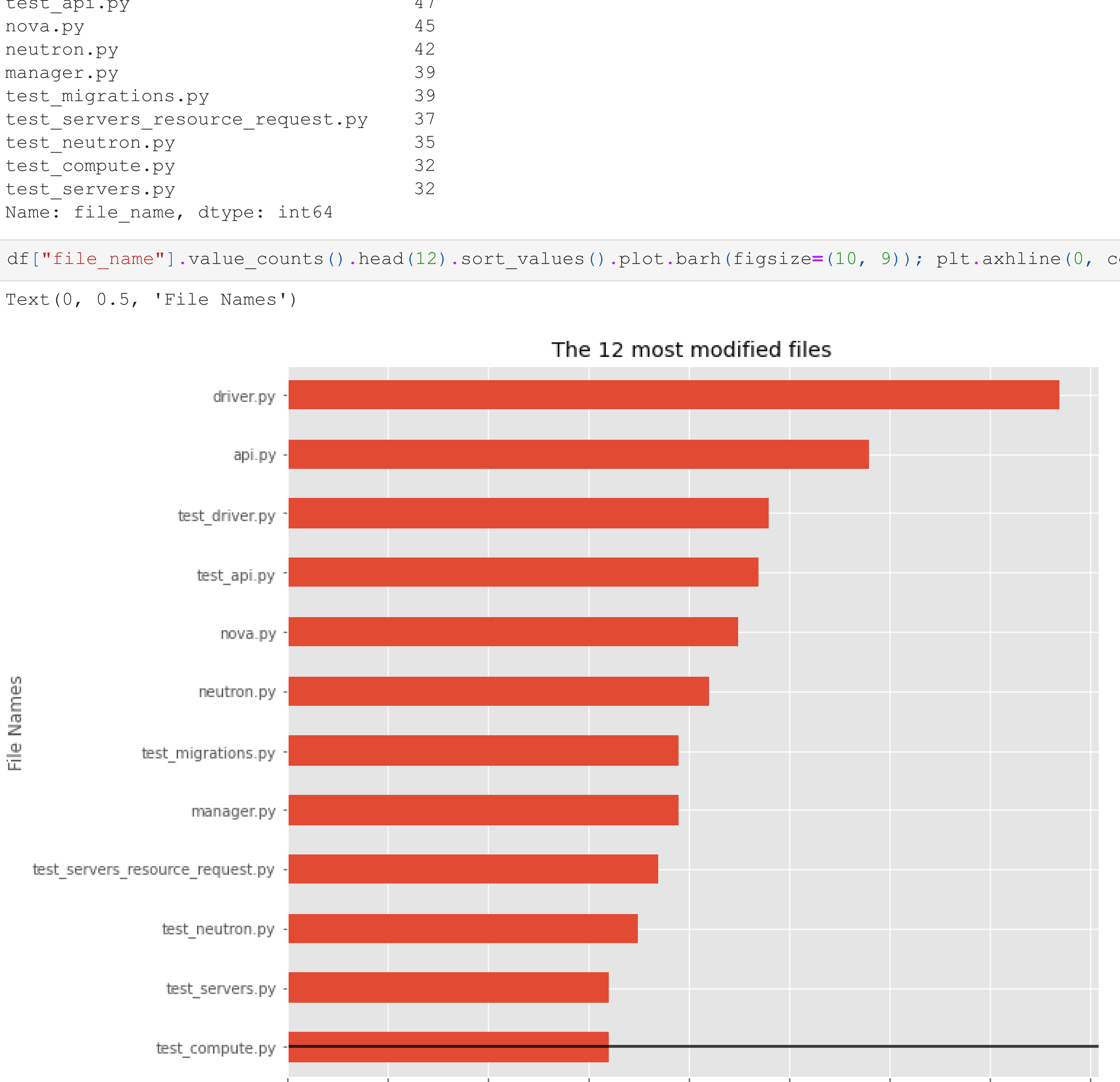
2. The 12 most modified files

In [17]:
```
df["file_name"].value_counts().head(12)
```

Out[17]:
```
driver.py                              77
api.py                                 58
test_driver.py                         48
test_api.py                            47
nova.py                                45
neutron.py                             42
manager.py                             39
test_migrations.py                     39
test_servers_resource_request.py       37
test_neutron.py                        35
test_compute.py                        32
test_servers.py                        32
Name: file_name, dtype: int64
```

In [18]:
```
df["file_name"].value_counts().head(12).sort_values().plot.barh(figsize=(10, 9)); plt.axhline(0, color='k'); pl
```

Out[18]:
```
Text(0, 0.5, 'File Names')
```

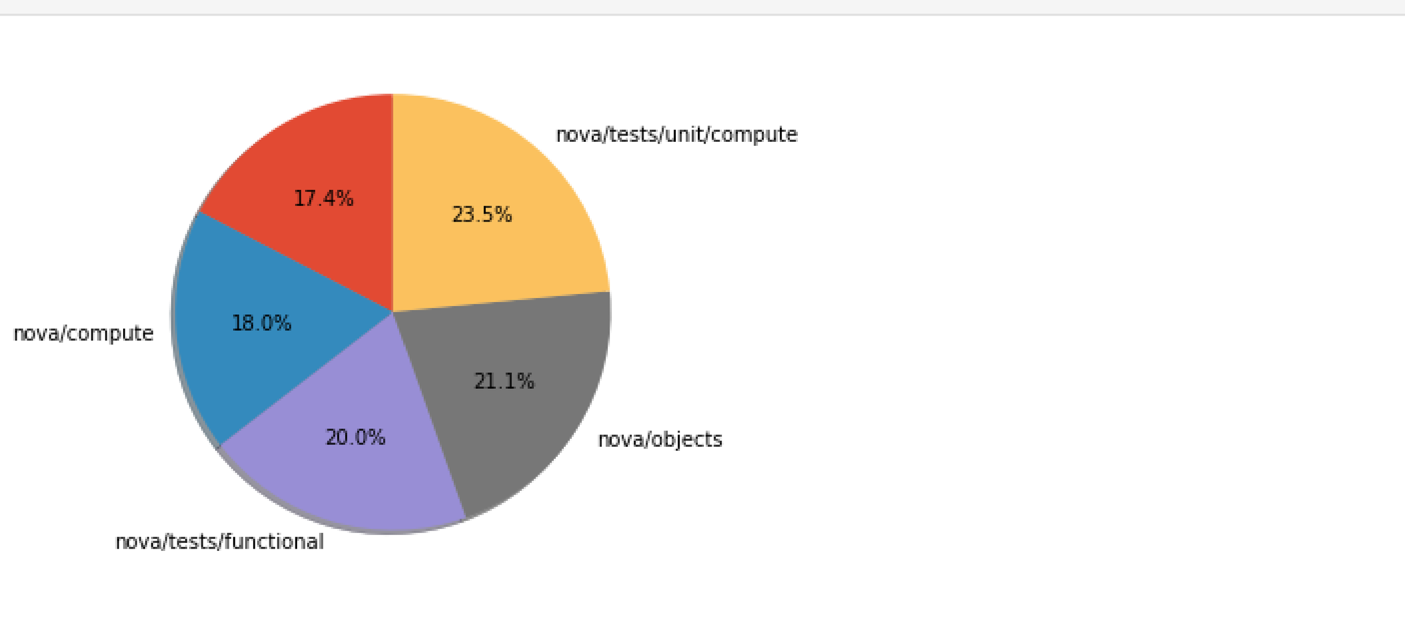


3. The 5 most modified directories

In [19]:
```
df["directory"].value_counts().head(5)
```

Out[19]:
```
nova/tests/unit/compute    108
nova/objects                97
nova/tests/functional       92
nova/compute                83
                            80
Name: directory, dtype: int64
```

In [20]:
```
df["directory"].value_counts().head(5).sort_values().plot.pie(autopct='%1.1f%%', figsize=(10,5),
        shadow=True, startangle=90, ylabel="");
```



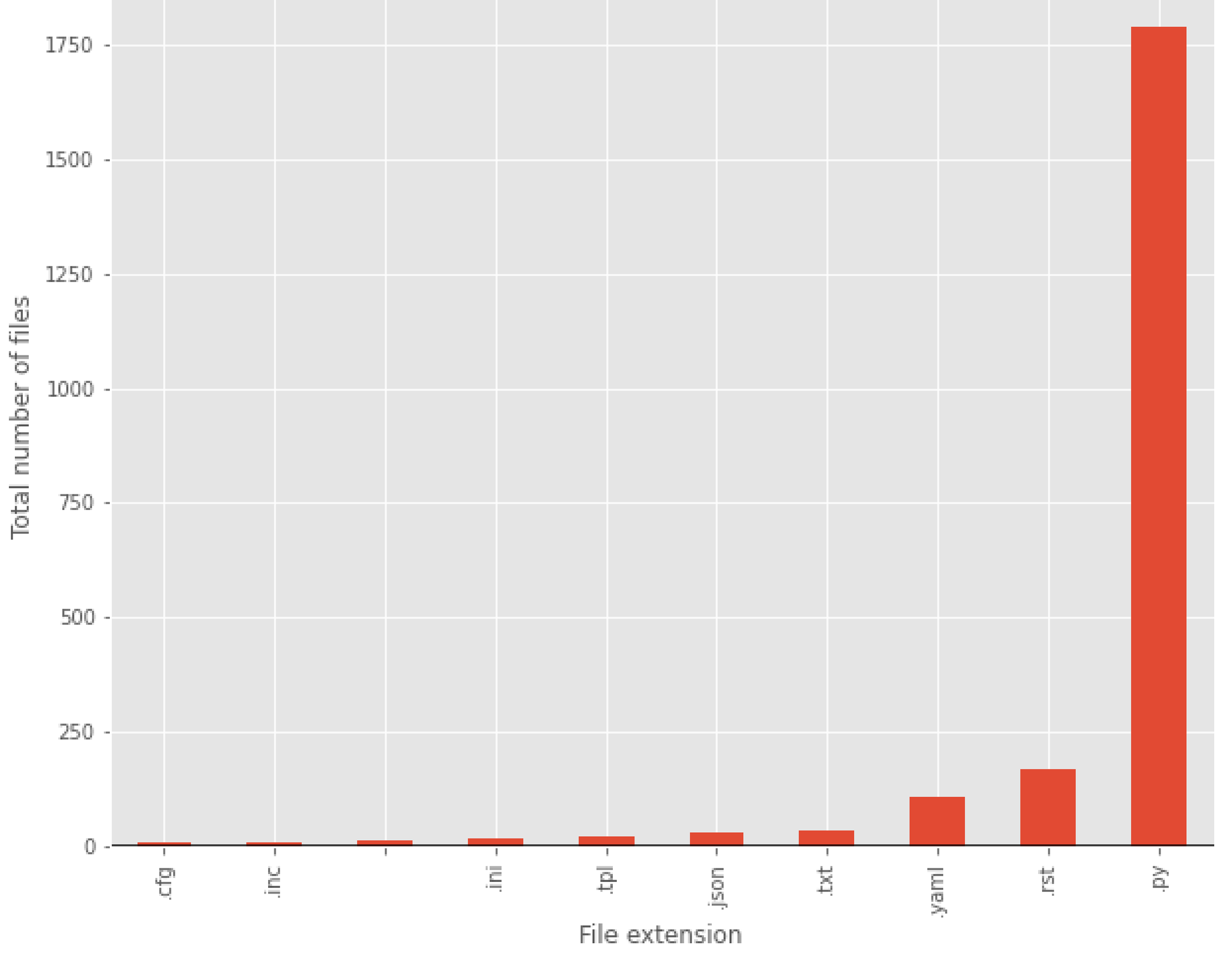
4. The most used file type

In [21]:
```
df["file_type"].value_counts()
```

Out[21]:
```
.py      1789
.rst      170
.yaml     110
.txt       34
.json      31
.tpl       21
.ini       19
           14
.inc        8
.cfg        7
.mako       4
.sh         4
.conf       3
Name: file_type, dtype: int64
```

In [22]:
```
df["file_type"].value_counts().head(10).sort_values().plot.bar(figsize=(10, 8)); plt.axhline(0, color='k'); plt
```

Out[22]:
```
Text(0, 0.5, 'Total number of files')
```



5. Churn

In [23]:
```
# sum of all changes that occured during the period
df["changes"].sum()
```

Out[23]:
```
94432
```

Findings

The key technology in use in the project is python and lots of efforts are geared towards testing both unit and functional test.