

Improve Load Balancing Performance and  
Efficiency Using Equally Spread Current  
Execution Algorithm working with response  
time clustering in Microservices

MSc Research Project  
MSc Cloud Computing

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# Improve Load Balancing Performance and Efficiency Using Equally Spread Current Execution Algorithm working with response time clustering in Microservices

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## 1 Introduction

The purpose of this document is to provide information and operating procedures required to run the code provided as a part of "Msc Research Project" submission. The entire code has been written in Python programming language.

## 2 Prerequisite

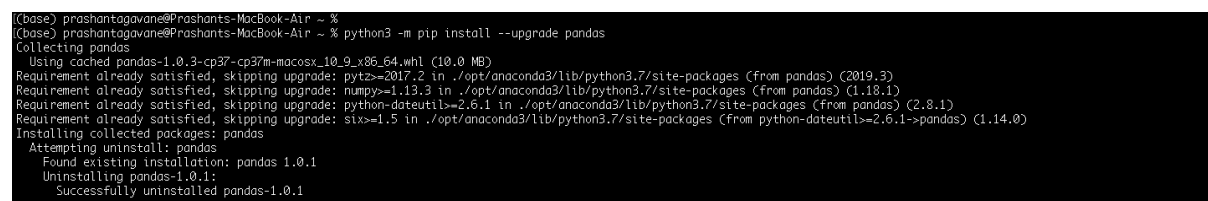
The user of this document requires to have basic python programming knowledge and python3(I would recommend latest stable python3 version '3.7.\*' which can be downloaded from python official website) installed on his system in order to run this code.

## 3 Additional python packages/libraries

The user requires to install additional python packages (update them in case they are already installed on their system). Following commands would be helpful for installing/updating additional required python packages.

### 3.1 pandas

```
python3 -m pip install --upgrade pandas
```



```
(base) prashantagavane@Prashants-MacBook-Air ~ %  
(base) prashantagavane@Prashants-MacBook-Air ~ % python3 -m pip install --upgrade pandas  
Collecting pandas  
Using cached pandas-1.0.3-cp37-cp37m-macosx_10_9_x86_64.whl (10.0 MB)  
Requirement already satisfied, skipping upgrade: pytz>=2017.2 in ./opt/anaconda3/lib/python3.7/site-packages (from pandas) (2019.3)  
Requirement already satisfied, skipping upgrade: numpy>=1.13.3 in ./opt/anaconda3/lib/python3.7/site-packages (from pandas) (1.18.1)  
Requirement already satisfied, skipping upgrade: python-dateutil>=2.6.1 in ./opt/anaconda3/lib/python3.7/site-packages (from pandas) (2.8.1)  
Requirement already satisfied, skipping upgrade: six>=1.5 in ./opt/anaconda3/lib/python3.7/site-packages (from python-dateutil>=2.6.1->pandas) (1.14.0)  
Installing collected packages: pandas  
Attempting uninstall: pandas  
Found existing installation: pandas 1.0.1  
Uninstalling pandas-1.0.1:  
Successfully uninstalled pandas-1.0.1
```

Figure 1: Install Panda

### 3.2 sklearn

```
python3 -m pip install --upgrade sklearn
```

```
(base) prashantagavane@Prashants-MacBook-Air ~ % python3 -m pip install --upgrade sklearn
Collecting sklearn
  Using cached sklearn-0.0.tar.gz (1.1 kB)
Requirement already satisfied, skipping upgrade: scikit-learn in /opt/anaconda3/lib/python3.7/site-packages (from sklearn) (0.22.1)
Requirement already satisfied, skipping upgrade: scipy<=0.17.0 in /opt/anaconda3/lib/python3.7/site-packages (from scikit-learn->sklearn) (1.4.1)
Requirement already satisfied, skipping upgrade: joblib<=0.11 in /opt/anaconda3/lib/python3.7/site-packages (from scikit-learn->sklearn) (0.14.1)
Requirement already satisfied, skipping upgrade: numpy<=1.11.0 in /opt/anaconda3/lib/python3.7/site-packages (from scikit-learn->sklearn) (1.18.1)
Building wheels for collected packages: sklearn
  Building wheel for sklearn (setup.py) ... done
  Created wheel for sklearn: filename=sklearn-0.0-py2.py3-none-any.whl size=1315 sha256=010e2acbc00d798c31ee22af6ba5031514781d9f4974d2ae9a705ad2fbc79c6b
  Stored in directory: /Users/prashantagavane/Library/Caches/pip/wheels/46/ef/c3/157e41f5ee1372d1be90b09f74f82b10e391eaacca8f22d33e
Successfully built sklearn
Installing collected packages: sklearn
Successfully installed sklearn-0.0
(base) prashantagavane@Prashants-MacBook-Air ~ %
```

Figure 2: Install Sklearn

### 3.3 numpy

`python3 -m pip install --upgrade numpy`

```
(base) prashantagavane@Prashants-MacBook-Air ~ % python3 -m pip install --upgrade numpy
Collecting numpy
  Downloading numpy-1.18.3-cp37-cp37m-macosx_10_9_x86_64.whl (15.1 MB)
    |#####| 15.1 MB 714 kB/s
Installing collected packages: numpy
  Attempting uninstall: numpy
    Found existing installation: numpy 1.18.1
    Uninstalling numpy-1.18.1:
      Successfully uninstalled numpy-1.18.1
  Successfully installed numpy-1.18.3
(base) prashantagavane@Prashants-MacBook-Air ~ %
```

Figure 3: Install Numpy

### 3.4 matplotlib

`python3 -m pip install --upgrade matplotlib`

```
(base) prashantagavane@Prashants-MacBook-Air ~ % python3 -m pip install --upgrade matplotlib
Requirement already up-to-date: matplotlib in /opt/anaconda3/lib/python3.7/site-packages (3.2.1)
Requirement already satisfied, skipping upgrade: kiwisolver<=1.0.1 in /opt/anaconda3/lib/python3.7/site-packages (from matplotlib) (1.1.0)
Requirement already satisfied, skipping upgrade: cycler<=0.10 in /opt/anaconda3/lib/python3.7/site-packages (from matplotlib) (0.10.0)
Requirement already satisfied, skipping upgrade: pyparsing<=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in /opt/anaconda3/lib/python3.7/site-packages (from matplotlib) (2.4.6)
Requirement already satisfied, skipping upgrade: numpy<=1.11 in /opt/anaconda3/lib/python3.7/site-packages (from matplotlib) (1.18.3)
Requirement already satisfied, skipping upgrade: python-dateutil<=2.1 in /opt/anaconda3/lib/python3.7/site-packages (from matplotlib) (2.8.1)
Requirement already satisfied, skipping upgrade: setuptools in /opt/anaconda3/lib/python3.7/site-packages (from kiwisolver=>1.0.1->matplotlib) (46.0.0.post20200309)
Requirement already satisfied, skipping upgrade: six in /opt/anaconda3/lib/python3.7/site-packages (from cycler=>0.10->matplotlib) (1.14.0)
(base) prashantagavane@Prashants-MacBook-Air ~ %
```

Figure 4: Install Matplotlib

## 4 Comparative Analysis

The implementation of this research project is entirely based on comparative analysis between two load-balancing algorithms/techniques(detailed information has been provided in submitted report). The user needs to carry out comparative analysis on two plots produced by execution of each python script step by step in given order. The order of execution should be as following :-

- 1)python3 main\_without\_cluster.py
- 2)python3 main\_with\_cluster.py

## 4.1 Round Robin

In order to test the functionality of this project, first, we need to find out the response time of each microservice working with the RoundRobin algorithm. The execution of a given script will plot recorded response times against tasks allocated and load balanced to each microservice by the RoundRobin algorithm.

2)python3 main\_without\_cluster.py

```
(base) prashantgavane@Prashants-MacBook-Air: Final_artifact % python3 main_without_cluster.py
/Users/prashantgavane/opt/anaconda3/lib/python3.7/site-packages/sklearn/externals/joblib/__init__.py:15: FutureWarning: sklearn.externals.joblib is deprecated in 0.21 and will be removed in 0.23. Please import this functionality directly from joblib, which can be installed with: pip install joblib. If this warning is raised when loading pickled models, you may need to re-serialize those models with scikit-learn 0.21+.
  warnings.warn(msg, category=FutureWarning)
micro 0 starts
micro 1 starts
micro 2 starts
```

Figure 5: The Command to Execute first Experiment



Figure 6: The Round-Robin Algorithm Results

## 4.2 The proposed load balancing

In the next step, we need to find out the response time of each microservice working with the proposed load-balancing technique (Equally spread Current Execution algorithm working with response time clustering technique). The execution of a given script will plot

recorded response times against tasks allocated and load-balanced to each microservice by the proposed load balancing technique.

python3 main\_with\_cluster.py

```
(base) prashantagavane@Prashants-Macbook-Air:Final_artifact % python3 main_with_cluster.py
/Users/prashantagavane/opt/anaconda3/lib/python3.7/site-packages/sklearn/externals/joblib/__init__.py:15: FutureWarning: sklearn.externals.joblib is deprecated in 0.21 and will be removed in 0.23. Please import this functionality directly from joblib, which can be installed with: pip install joblib. If this warning is raised when loading pickled models, you may need to re-serialize those models with scikit-learn 0.21+.
  warnings.warn(msg, category=FutureWarning)
micro 0 starts
micro 1 starts
micro 2 starts
Exception in thread micro 1:
```

Figure 7: The Command to Execute Second Experiment

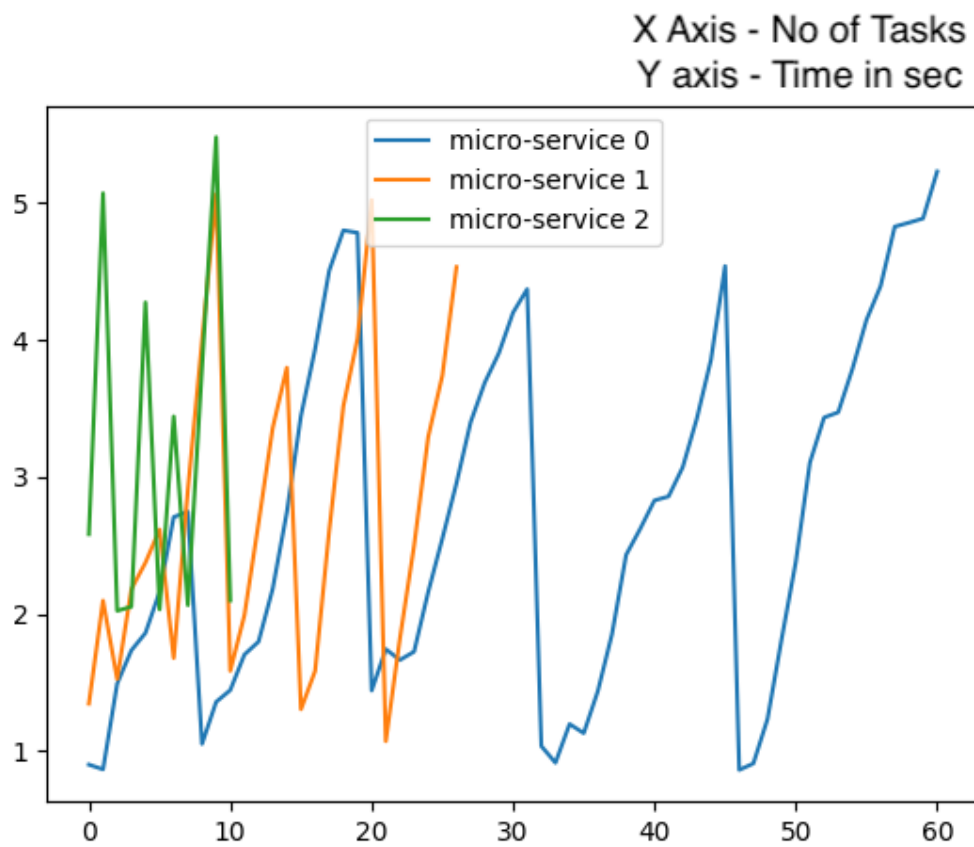


Figure 8: The Proposed Design Results