Assignment 2– COEN 241 (Cloud Computing)

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Your Own Serverless Infrastructure

Report

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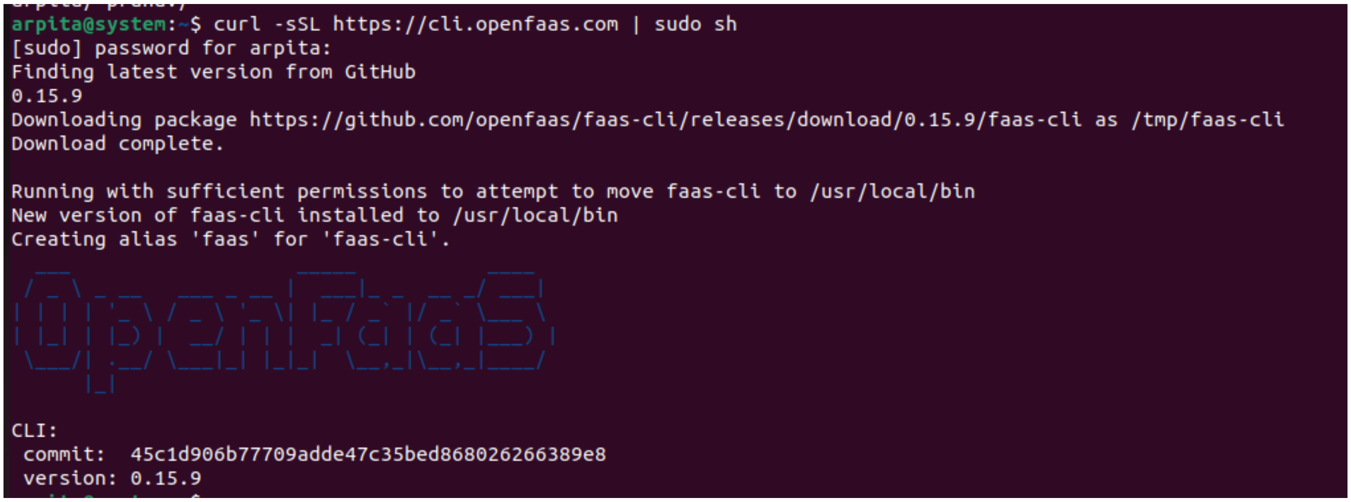
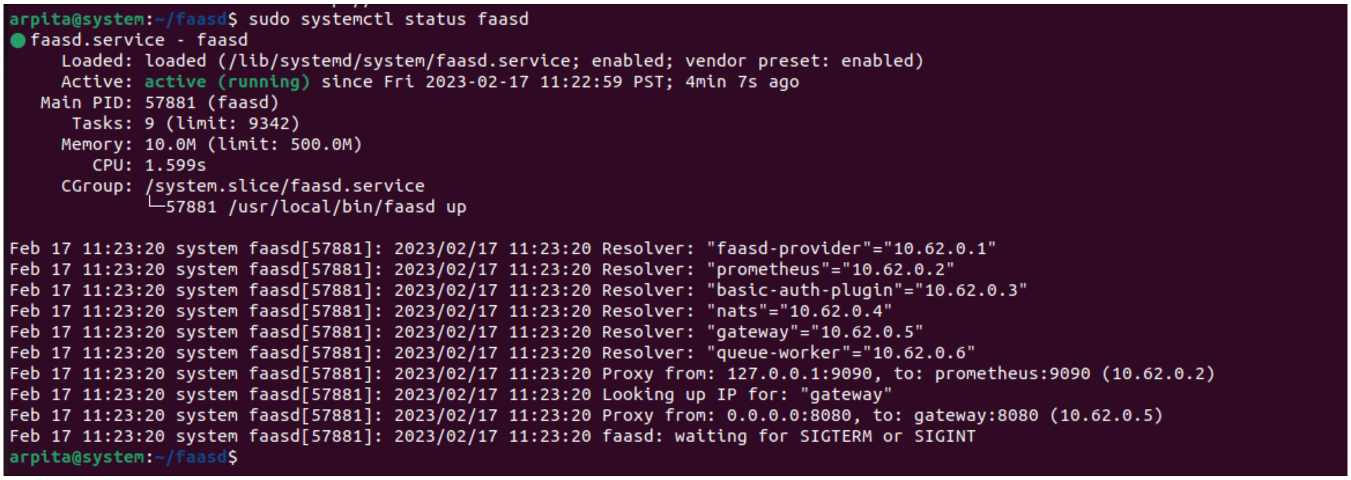
Install OpenFaaS CLI



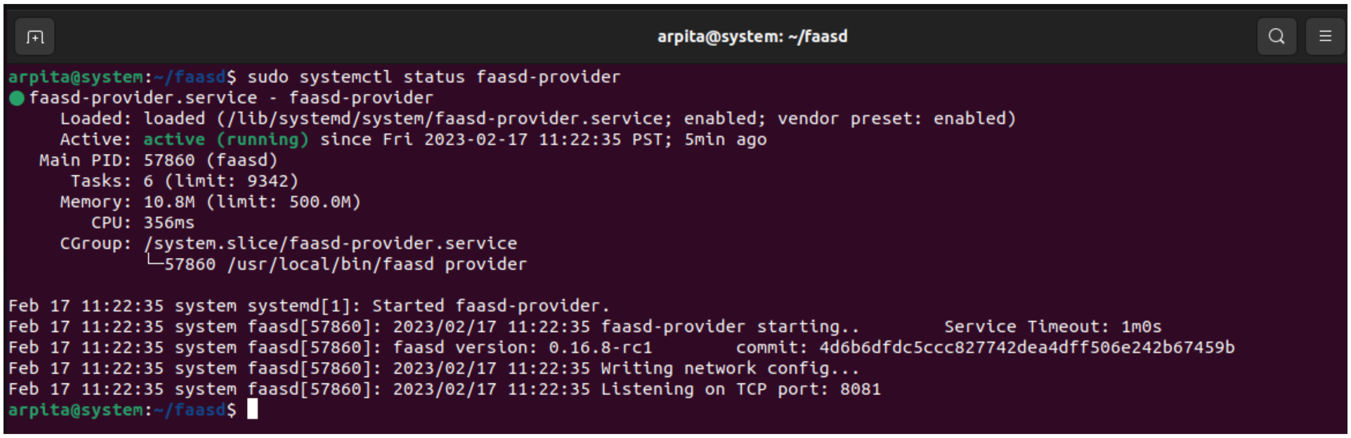
```
arpita@system:~$ curl -sSL https://cli.openfaas.com | sudo sh
[sudo] password for arpita:
Finding latest version from GitHub
0.15.9
Downloading package https://github.com/openfaas/faas-cli/releases/download/0.15.9/faas-cli as /tmp/faas-cli
Download complete.

Running with sufficient permissions to attempt to move faas-cli to /usr/local/bin
New version of faas-cli installed to /usr/local/bin
Creating alias 'faas' for 'faas-cli'.
  ___                   _____           ____
 / _ \ _ __   ___ _ __ |  ___|_ _  __ _/ ___|
| | | | '_ \ / _ \ '_ \| |_ / _` |/ _` \___ \
| |_| | |_) |  __/ | | |  _| (_| | (_| |___) |
 \___/| .__/ \___|_| |_|_|  \__,_|\__,_|____/
      |_|


CLI:
 commit:  45c1d906b77709adde47c35bed868026266389e8
 version: 0.15.9
```

Deploy OpenFaaS



```
arpita@system:~/faasd$ sudo systemctl status faasd
● faasd.service - faasd
     Loaded: loaded (/lib/systemd/system/faasd.service; enabled; vendor preset: enabled)
     Active: active (running) since Fri 2023-02-17 11:22:59 PST; 4min 7s ago
   Main PID: 57881 (faasd)
      Tasks: 9 (limit: 9342)
     Memory: 10.0M (limit: 500.0M)
        CPU: 1.599s
     CGroup: /system.slice/faasd.service
             └─57881 /usr/local/bin/faasd up

Feb 17 11:23:20 system faasd[57881]: 2023/02/17 11:23:20 Resolver: "faasd-provider"="10.62.0.1"
Feb 17 11:23:20 system faasd[57881]: 2023/02/17 11:23:20 Resolver: "prometheus"="10.62.0.2"
Feb 17 11:23:20 system faasd[57881]: 2023/02/17 11:23:20 Resolver: "basic-auth-plugin"="10.62.0.3"
Feb 17 11:23:20 system faasd[57881]: 2023/02/17 11:23:20 Resolver: "nats"="10.62.0.4"
Feb 17 11:23:20 system faasd[57881]: 2023/02/17 11:23:20 Resolver: "gateway"="10.62.0.5"
Feb 17 11:23:20 system faasd[57881]: 2023/02/17 11:23:20 Resolver: "queue-worker"="10.62.0.6"
Feb 17 11:23:20 system faasd[57881]: 2023/02/17 11:23:20 Proxy from: 127.0.0.1:9090, to: prometheus:9090 (10.62.0.2)
Feb 17 11:23:20 system faasd[57881]: 2023/02/17 11:23:20 Looking up IP for: "gateway"
Feb 17 11:23:20 system faasd[57881]: 2023/02/17 11:23:20 Proxy from: 0.0.0.0:8080, to: gateway:8080 (10.62.0.5)
Feb 17 11:23:20 system faasd[57881]: 2023/02/17 11:23:20 faasd: waiting for SIGTERM or SIGINT
arpita@system:~/faasd$
```

Verify OpenFaaS Installation

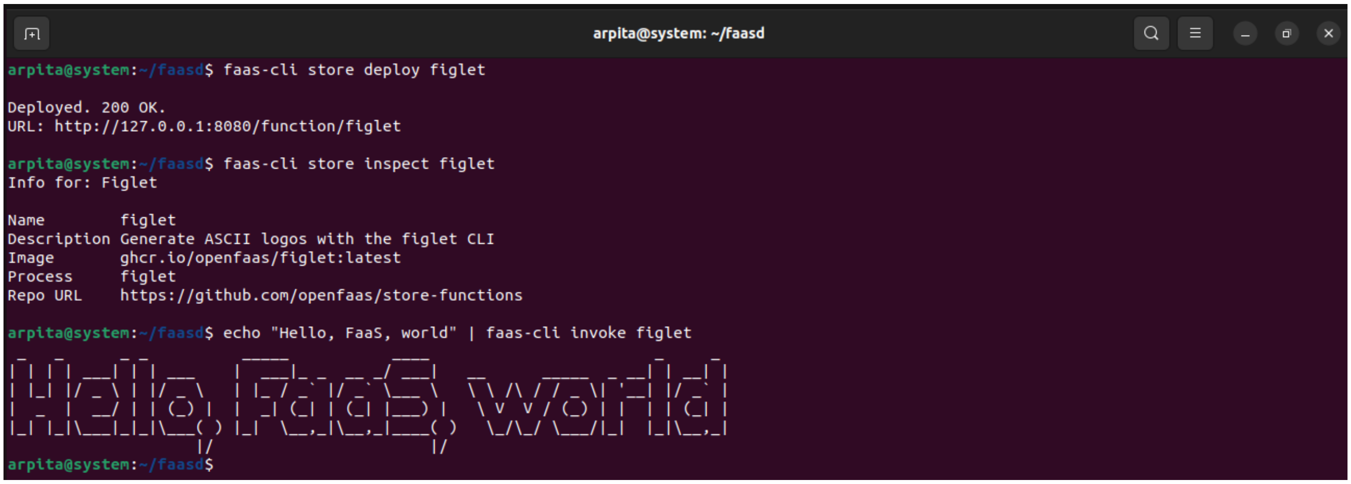


```
arpita@system:~/faasd$ sudo systemctl status faasd-provider
● faasd-provider.service - faasd-provider
     Loaded: loaded (/lib/systemd/system/faasd-provider.service; enabled; vendor preset: enabled)
     Active: active (running) since Fri 2023-02-17 11:22:35 PST; 5min ago
   Main PID: 57860 (faasd)
      Tasks: 6 (limit: 9342)
     Memory: 10.8M (limit: 500.0M)
        CPU: 356ms
     CGroup: /system.slice/faasd-provider.service
             └─57860 /usr/local/bin/faasd provider

Feb 17 11:22:35 system systemd[1]: Started faasd-provider.
Feb 17 11:22:35 system faasd[57860]: 2023/02/17 11:22:35 faasd-provider starting..        Service Timeout: 1m0s
Feb 17 11:22:35 system faasd[57860]: faasd version: 0.16.8-rc1        commit: 4d6b6dfdc5ccc827742dea4dff506e242b67459b
Feb 17 11:22:35 system faasd[57860]: 2023/02/17 11:22:35 Writing network config...
Feb 17 11:22:35 system faasd[57860]: 2023/02/17 11:22:35 Listening on TCP port: 8081
arpita@system:~/faasd$ 
```

Trying out a Function from the Store

Figlet Function Invocation from command line -

Figlet Function is a function that is already deployed and present in faas-cli store that can be invoked through faas-cli or curl command or using gateway UI through browser. The function generates ascii valued figures of given string input. For example, in the below screenshot the function takes input string - "Hello, FaaS, world" and generates the figure as shown in the screenshot:



```
arpita@system:~/faasd$ faas-cli store deploy figlet

Deployed. 200 OK.
URL: http://127.0.0.1:8080/function/figlet

arpita@system:~/faasd$ faas-cli store inspect figlet
Info for: Figlet

Name        figlet
Description Generate ASCII logos with the figlet CLI
Image       ghcr.io/openfaas/figlet:latest
Process     figlet
Repo URL    https://github.com/openfaas/store-functions

arpita@system:~/faasd$ echo "Hello, FaaS, world" | faas-cli invoke figlet
 _   _      _ _          _____           ____                       _     _ 
| | | | ___| | | ___    |  ___|_ _  __ _/ ___|    __      _____  _ __| | __| |
| |_| |/ _ \ | |/ _ \   | |_ / _` |/ _` \___ \    \ \ /\ / / _ \| '__| |/ _` |
|  _  |  __/ | | (_) |  |  _| (_| | (_| |___) |    \ V  V / (_) | |  | | (_| |
|_| |_|\___|_|_|\___( ) |_|  \__,_|\__,_|____( )    \_/\_/ \___/|_|  |_|\__,_|
                    |/                       |/                               
arpita@system:~/faasd$
```

Complete slack-request/handler.py -

Complete slack-request can be found in this folder - https://github.com/arpitav03/Cloud-Computing-Course-2023/tree/main/homeworks/hw-2/slack-request

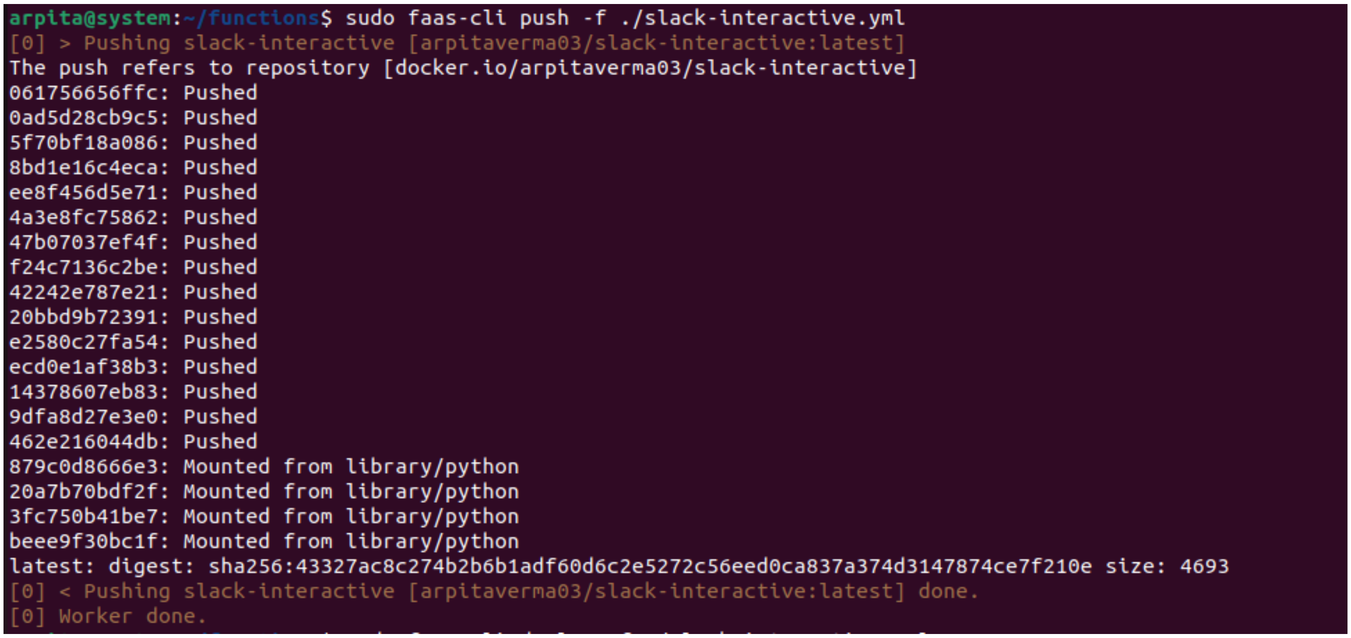
Complete slack-interactive/handler.py -

Complete slack-interactive can be found in this folder - https://github.com/arpitav03/Cloud-Computing-Course-2023/tree/main/homeworks/hw-2/slack-interactive

Slack Interactive

Build

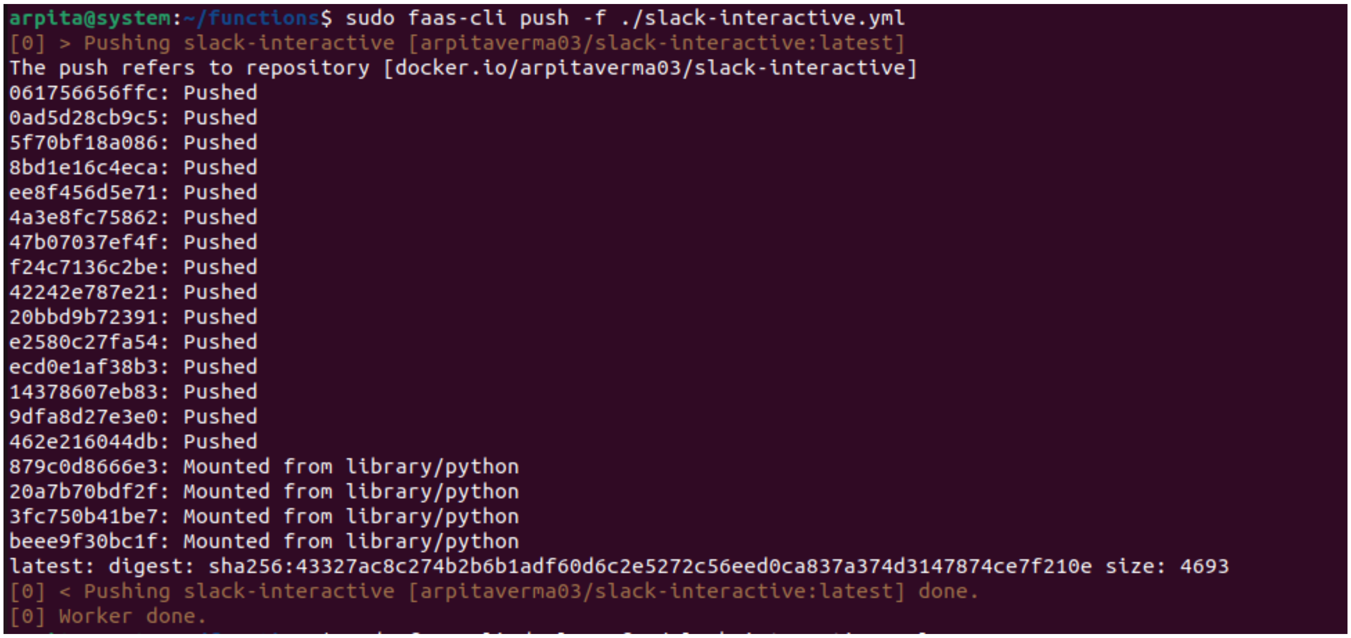
The slack build command builds a docker image for the function and its dependencies which is used for creating and running a container. Below screenshot shows the functionality of ‘faas-cli push -f ./slack-interactive.yml’ command -



```
arpita@system:~/functions$ sudo faas-cli push -f ./slack-interactive.yml
[0] > Pushing slack-interactive [arpitaverma03/slack-interactive:latest]
The push refers to repository [docker.io/arpitaverma03/slack-interactive]
061756656ffc: Pushed
0ad5d28cb9c5: Pushed
5f70bf18a086: Pushed
8bd1e16c4eca: Pushed
ee8f456d5e71: Pushed
4a3e8fc75862: Pushed
47b07037ef4f: Pushed
f24c7136c2be: Pushed
42242e787e21: Pushed
20bbd9b72391: Pushed
e2580c27fa54: Pushed
ecd0e1af38b3: Pushed
14378607eb83: Pushed
9dfa8d27e3e0: Pushed
462e216044db: Pushed
879c0d8666e3: Mounted from library/python
20a7b70bdf2f: Mounted from library/python
3fc750b41be7: Mounted from library/python
beee9f30bc1f: Mounted from library/python
latest: digest: sha256:43327ac8c274b2b6b1adf60d6c2e5272c56eed0ca837a374d3147874ce7f210e size: 4693
[0] < Pushing slack-interactive [arpitaverma03/slack-interactive:latest] done.
[0] Worker done.
```

Push

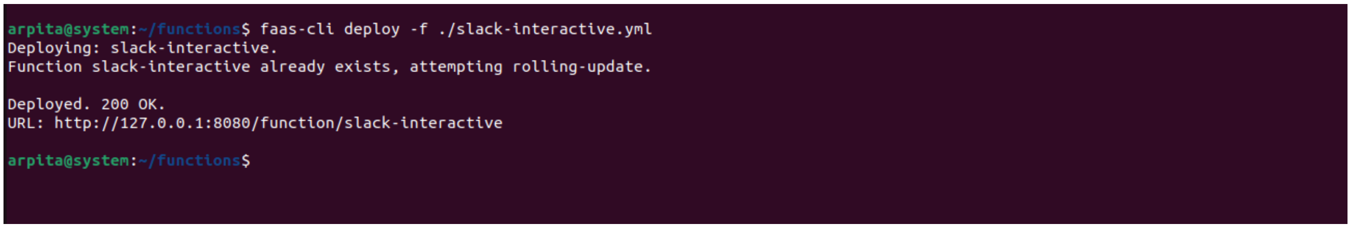
Slack Push command uploads the image of the functions with its runtime libraries and dependencies to the docker hub. Below screenshot shows the functionality of ‘faas-cli push -f ./slack-interactive.yml’ command –



```
arpita@system:~/functions$ sudo faas-cli push -f ./slack-interactive.yml
[0] > Pushing slack-interactive [arpitaverma03/slack-interactive:latest]
The push refers to repository [docker.io/arpitaverma03/slack-interactive]
061756656ffc: Pushed
0ad5d28cb9c5: Pushed
5f70bf18a086: Pushed
8bd1e16c4eca: Pushed
ee8f456d5e71: Pushed
4a3e8fc75862: Pushed
47b07037ef4f: Pushed
f24c7136c2be: Pushed
42242e787e21: Pushed
20bbd9b72391: Pushed
e2580c27fa54: Pushed
ecd0e1af38b3: Pushed
14378607eb83: Pushed
9dfa8d27e3e0: Pushed
462e216044db: Pushed
879c0d8666e3: Mounted from library/python
20a7b70bdf2f: Mounted from library/python
3fc750b41be7: Mounted from library/python
beee9f30bc1f: Mounted from library/python
latest: digest: sha256:43327ac8c274b2b6b1adf60d6c2e5272c56eed0ca837a374d3147874ce7f210e size: 4693
[0] < Pushing slack-interactive [arpitaverma03/slack-interactive:latest] done.
[0] Worker done.
```

Deploy

Slack Push command takes the image from docker hub and runs a container/s for the provided function. Below screenshot shows the functionality of ‘faas-cli deploy -f ./slack-interactive.yml’ command -

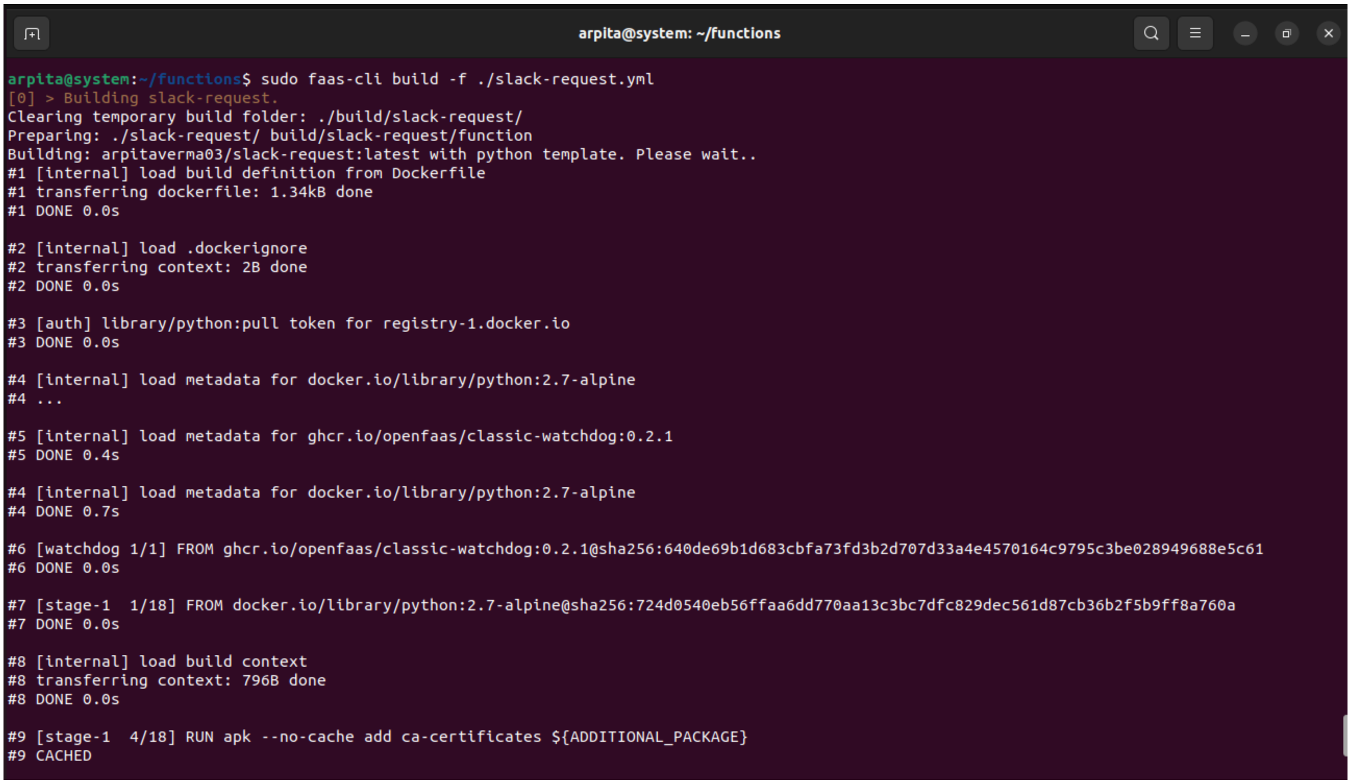


```
arpita@system:~/functions$ faas-cli deploy -f ./slack-interactive.yml
Deploying: slack-interactive.
Function slack-interactive already exists, attempting rolling-update.

Deployed. 200 OK.
URL: http://127.0.0.1:8080/function/slack-interactive

arpita@system:~/functions$
```

Slack Request

Build

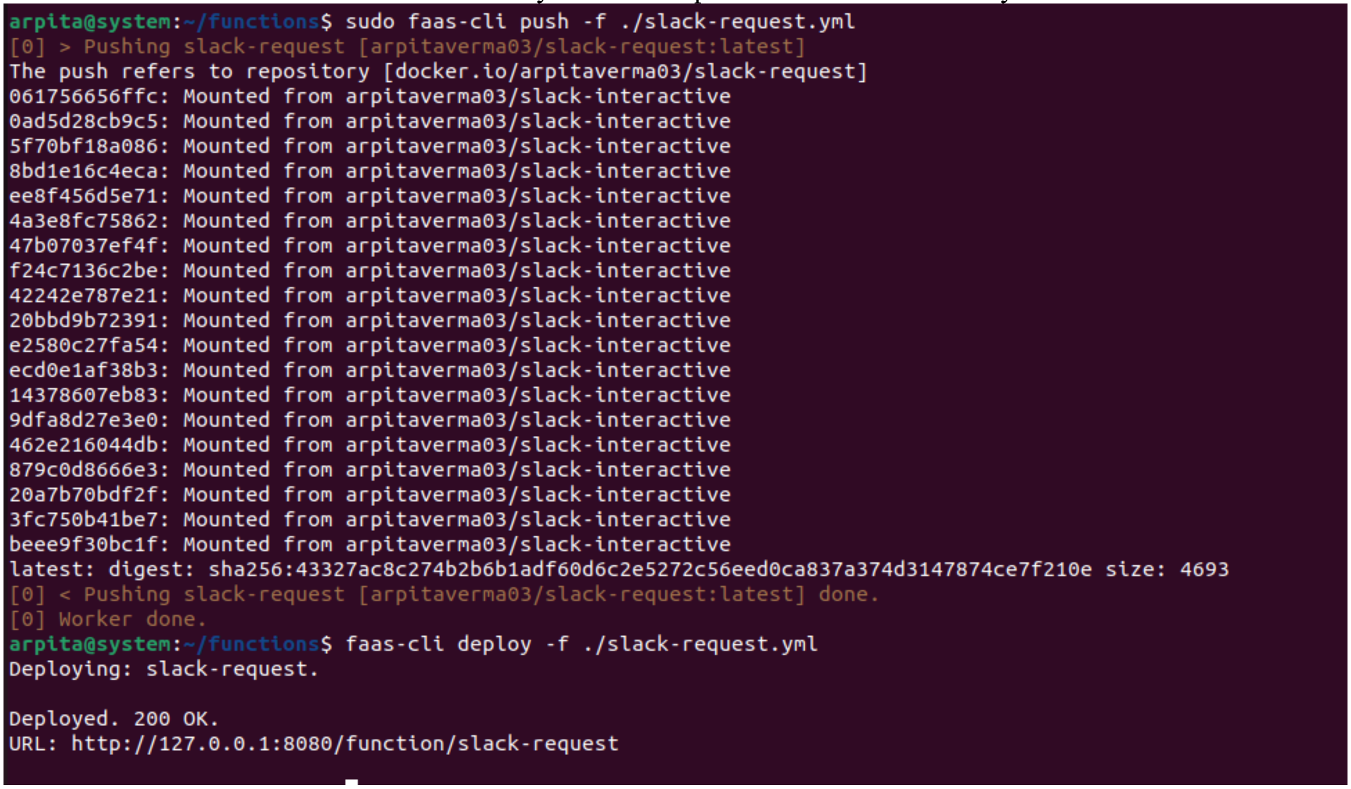
The slack build command builds a docker image for the function and its dependencies which is used for creating and running a container. Below screenshot shows the functionality of ‘faas-cli push -f ./slack-request.yml’ command -



```
arpita@system:~/functions$ sudo faas-cli build -f ./slack-request.yml
[0] > Building slack-request.
Clearing temporary build folder: ./build/slack-request/
Preparing: ./slack-request/ build/slack-request/function
Building: arpitaverma03/slack-request:latest with python template. Please wait..
#1 [internal] load build definition from Dockerfile
#1 transferring dockerfile: 1.34kB done
#1 DONE 0.0s

#2 [internal] load .dockerignore
#2 transferring context: 2B done
#2 DONE 0.0s

#3 [auth] library/python:pull token for registry-1.docker.io
#3 DONE 0.0s

#4 [internal] load metadata for docker.io/library/python:2.7-alpine
#4 ...

#5 [internal] load metadata for ghcr.io/openfaas/classic-watchdog:0.2.1
#5 DONE 0.4s

#4 [internal] load metadata for docker.io/library/python:2.7-alpine
#4 DONE 0.7s

#6 [watchdog 1/1] FROM ghcr.io/openfaas/classic-watchdog:0.2.1@sha256:640de69b1d683cbfa73fd3b2d707d33a4e4570164c9795c3be028949688e5c61
#6 DONE 0.0s

#7 [stage-1  1/18] FROM docker.io/library/python:2.7-alpine@sha256:724d0540eb56ffaa6dd770aa13c3bc7dfc829dec561d87cb36b2f5b9ff8a760a
#7 DONE 0.0s

#8 [internal] load build context
#8 transferring context: 796B done
#8 DONE 0.0s

#9 [stage-1  4/18] RUN apk --no-cache add ca-certificates ${ADDITIONAL_PACKAGE}
#9 CACHED
```

Push

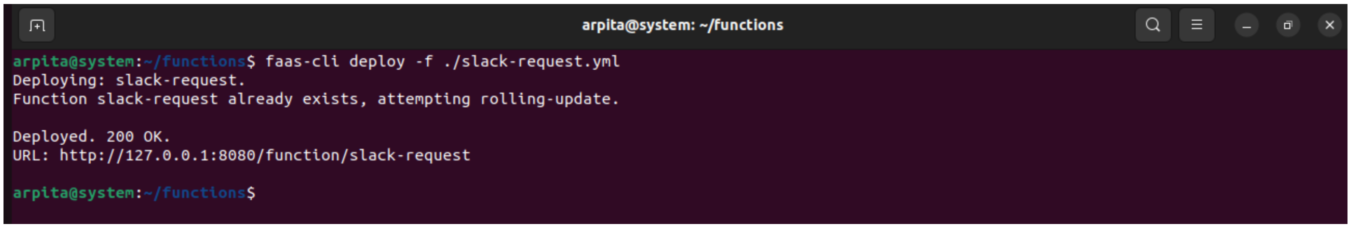
Slack Push command uploads the image of the functions with its runtime libraries and dependencies to the docker hub. Below screenshot shows the functionality of ‘faas-cli push -f ./slack-interactive.yml’ command -



```
arpita@system:~/functions$ sudo faas-cli push -f ./slack-request.yml
[0] > Pushing slack-request [arpitaverma03/slack-request:latest]
The push refers to repository [docker.io/arpitaverma03/slack-request]
061756656ffc: Mounted from arpitaverma03/slack-interactive
0ad5d28cb9c5: Mounted from arpitaverma03/slack-interactive
5f70bf18a086: Mounted from arpitaverma03/slack-interactive
8bd1e16c4eca: Mounted from arpitaverma03/slack-interactive
ee8f456d5e71: Mounted from arpitaverma03/slack-interactive
4a3e8fc75862: Mounted from arpitaverma03/slack-interactive
47b07037ef4f: Mounted from arpitaverma03/slack-interactive
f24c7136c2be: Mounted from arpitaverma03/slack-interactive
42242e787e21: Mounted from arpitaverma03/slack-interactive
20bbd9b72391: Mounted from arpitaverma03/slack-interactive
e2580c27fa54: Mounted from arpitaverma03/slack-interactive
ecd0e1af38b3: Mounted from arpitaverma03/slack-interactive
14378607eb83: Mounted from arpitaverma03/slack-interactive
9dfa8d27e3e0: Mounted from arpitaverma03/slack-interactive
462e216044db: Mounted from arpitaverma03/slack-interactive
879c0d8666e3: Mounted from arpitaverma03/slack-interactive
20a7b70bdf2f: Mounted from arpitaverma03/slack-interactive
3fc750b41be7: Mounted from arpitaverma03/slack-interactive
beee9f30bc1f: Mounted from arpitaverma03/slack-interactive
latest: digest: sha256:43327ac8c274b2b6b1adf60d6c2e5272c56eed0ca837a374d3147874ce7f210e size: 4693
[0] < Pushing slack-request [arpitaverma03/slack-request:latest] done.
[0] Worker done.
arpita@system:~/functions$ faas-cli deploy -f ./slack-request.yml
Deploying: slack-request.

Deployed. 200 OK.
URL: http://127.0.0.1:8080/function/slack-request
```

Deploy

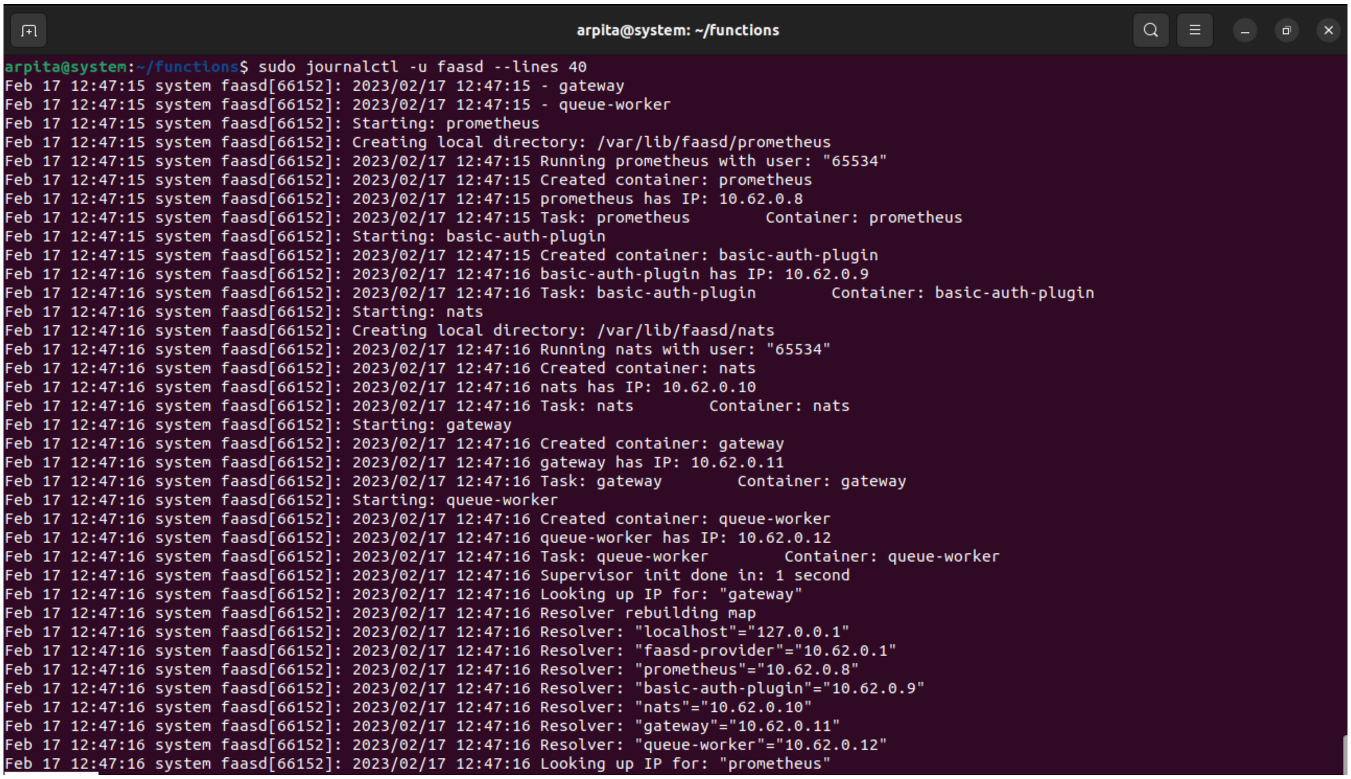
Slack Push command takes the image from docker hub and runs a container/s for the provided function. Below screenshot shows the functionality of ‘faas-cli deploy -f ./slack-request.yml’ command –



```
arpita@system:~/functions$ faas-cli deploy -f ./slack-request.yml
Deploying: slack-request.
Function slack-request already exists, attempting rolling-update.

Deployed. 200 OK.
URL: http://127.0.0.1:8080/function/slack-request

arpita@system:~/functions$
```

sudo journalctl -u faasd --lines 40

Journalctl command utility helps to collect the kernel space and user space logs of different processes. Above command is used to display the 40 lines of logs of faasd.service. Below is the screenshot of output of above command -

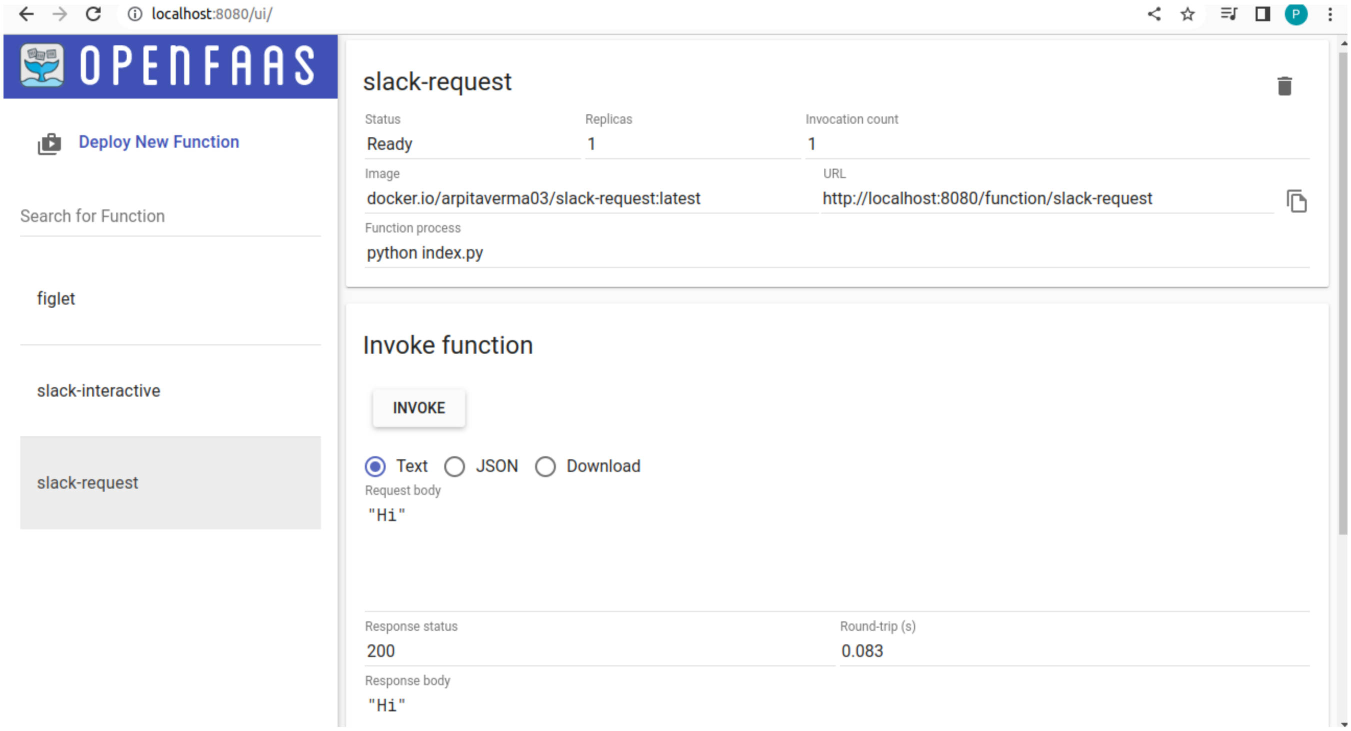


```
arpita@system:~/functions$ sudo journalctl -u faasd --lines 40
Feb 17 12:47:15 system faasd[66152]: 2023/02/17 12:47:15 - gateway
Feb 17 12:47:15 system faasd[66152]: 2023/02/17 12:47:15 - queue-worker
Feb 17 12:47:15 system faasd[66152]: Starting: prometheus
Feb 17 12:47:15 system faasd[66152]: Creating local directory: /var/lib/faasd/prometheus
Feb 17 12:47:15 system faasd[66152]: 2023/02/17 12:47:15 Running prometheus with user: "65534"
Feb 17 12:47:15 system faasd[66152]: 2023/02/17 12:47:15 Created container: prometheus
Feb 17 12:47:15 system faasd[66152]: 2023/02/17 12:47:15 prometheus has IP: 10.62.0.8
Feb 17 12:47:15 system faasd[66152]: 2023/02/17 12:47:15 Task: prometheus        Container: prometheus
Feb 17 12:47:15 system faasd[66152]: Starting: basic-auth-plugin
Feb 17 12:47:15 system faasd[66152]: 2023/02/17 12:47:15 Created container: basic-auth-plugin
Feb 17 12:47:16 system faasd[66152]: 2023/02/17 12:47:16 basic-auth-plugin has IP: 10.62.0.9
Feb 17 12:47:16 system faasd[66152]: 2023/02/17 12:47:16 Task: basic-auth-plugin        Container: basic-auth-plugin
Feb 17 12:47:16 system faasd[66152]: Starting: nats
Feb 17 12:47:16 system faasd[66152]: Creating local directory: /var/lib/faasd/nats
Feb 17 12:47:16 system faasd[66152]: 2023/02/17 12:47:16 Running nats with user: "65534"
Feb 17 12:47:16 system faasd[66152]: 2023/02/17 12:47:16 Created container: nats
Feb 17 12:47:16 system faasd[66152]: 2023/02/17 12:47:16 nats has IP: 10.62.0.10
Feb 17 12:47:16 system faasd[66152]: 2023/02/17 12:47:16 Task: nats        Container: nats
Feb 17 12:47:16 system faasd[66152]: Starting: gateway
Feb 17 12:47:16 system faasd[66152]: 2023/02/17 12:47:16 Created container: gateway
Feb 17 12:47:16 system faasd[66152]: 2023/02/17 12:47:16 gateway has IP: 10.62.0.11
Feb 17 12:47:16 system faasd[66152]: 2023/02/17 12:47:16 Task: gateway        Container: gateway
Feb 17 12:47:16 system faasd[66152]: Starting: queue-worker
Feb 17 12:47:16 system faasd[66152]: 2023/02/17 12:47:16 Created container: queue-worker
Feb 17 12:47:16 system faasd[66152]: 2023/02/17 12:47:16 queue-worker has IP: 10.62.0.12
Feb 17 12:47:16 system faasd[66152]: 2023/02/17 12:47:16 Task: queue-worker        Container: queue-worker
Feb 17 12:47:16 system faasd[66152]: 2023/02/17 12:47:16 Supervisor init done in: 1 second
Feb 17 12:47:16 system faasd[66152]: 2023/02/17 12:47:16 Looking up IP for: "gateway"
Feb 17 12:47:16 system faasd[66152]: 2023/02/17 12:47:16 Resolver rebuilding map
Feb 17 12:47:16 system faasd[66152]: 2023/02/17 12:47:16 Resolver: "localhost"="127.0.0.1"
Feb 17 12:47:16 system faasd[66152]: 2023/02/17 12:47:16 Resolver: "faasd-provider"="10.62.0.1"
Feb 17 12:47:16 system faasd[66152]: 2023/02/17 12:47:16 Resolver: "prometheus"="10.62.0.8"
Feb 17 12:47:16 system faasd[66152]: 2023/02/17 12:47:16 Resolver: "basic-auth-plugin"="10.62.0.9"
Feb 17 12:47:16 system faasd[66152]: 2023/02/17 12:47:16 Resolver: "nats"="10.62.0.10"
Feb 17 12:47:16 system faasd[66152]: 2023/02/17 12:47:16 Resolver: "gateway"="10.62.0.11"
Feb 17 12:47:16 system faasd[66152]: 2023/02/17 12:47:16 Resolver: "queue-worker"="10.62.0.12"
Feb 17 12:47:16 system faasd[66152]: 2023/02/17 12:47:16 Looking up IP for: "prometheus"
```

OpenFaaS Gateway Screenshots

OpenFaaS Gateway is the API gateway that accepts and processes the commands from faas-cli, REST APIs or programs and passes it over to other components like Prometheus, NATFS, Containerd, Kubernetes etc. to perform their tasks. OpenFaaS gateway UI can be launched at http://127.0.0.1:8080/ui/ to check the list of functions that are deployed. Using UI, we can also invoke functions that are deployed.

1. All Function Display



slack-request

Status: Ready
Replicas: 1
Invocation count: 1
Image: docker.io/arpitaverma03/slack-request:latest
URL: http://localhost:8080/function/slack-request
Function process: python index.py

Invoke function

INVOKE

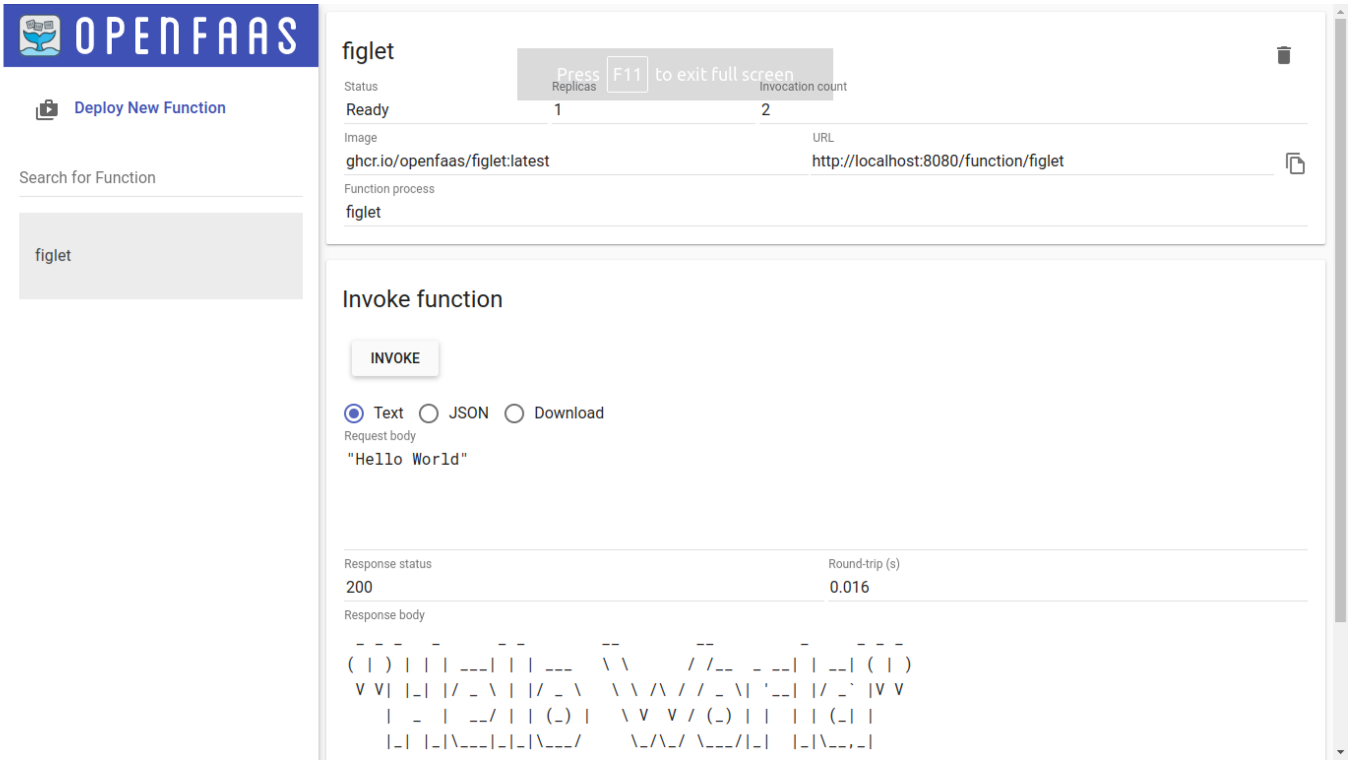
● Text ○ JSON ○ Download

Request body
"Hi"

Response status: 200
Round-trip (s): 0.083

Response body
"Hi"

2. Figlet Function



figlet

Status: Ready

Replicas: 1

Invocation count: 2

Image: ghcr.io/openfaas/figlet:latest

URL: http://localhost:8080/function/figlet

Function process: figlet

Invoke function

● Text ○ JSON ○ Download

Request body

```
"Hello World"
```

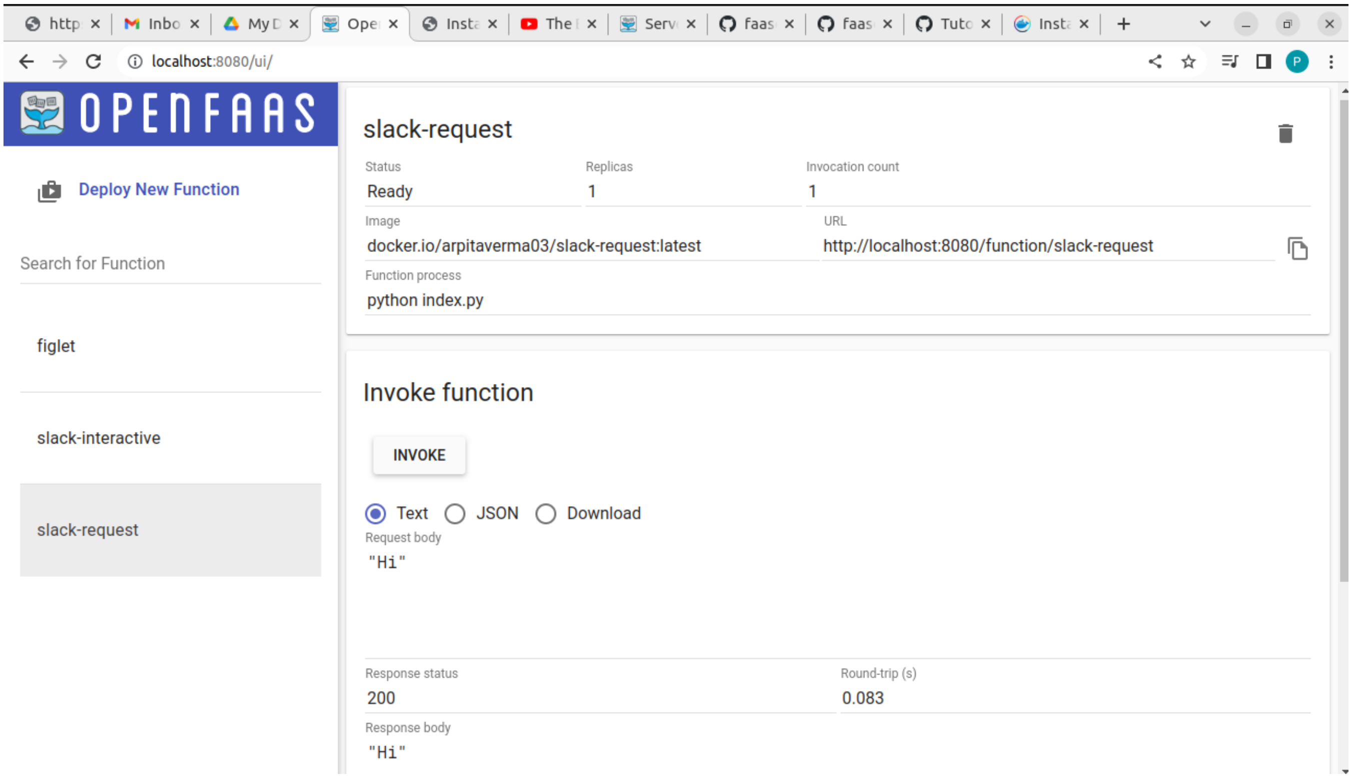
Response status: 200

Round-trip (s): 0.016

Response body

```
 _ _   _   _      _ _        __        __         _     _ _ _ 
( | ) | | | | ___| | | ___   \ \      / /__  _ __| | __| ( | )
 V V  | |_| |/ _ \ | |/ _ \   \ \ /\ / / _ \| '__| |/ _` |V V 
      |  _  |  __/ | | (_) |   \ V  V / (_) | |  | | (_| |    
      |_| |_|\___|_|_|\___/     \_/\_/ \___/|_|  |_|\__,_|    
```

3. Slack Request Function



slack-request

Status: Ready
Replicas: 1
Invocation count: 1
Image: docker.io/arpitaverma03/slack-request:latest
URL: http://localhost:8080/function/slack-request
Function process: python index.py

Invoke function

INVOKE

● Text ○ JSON ○ Download

Request body

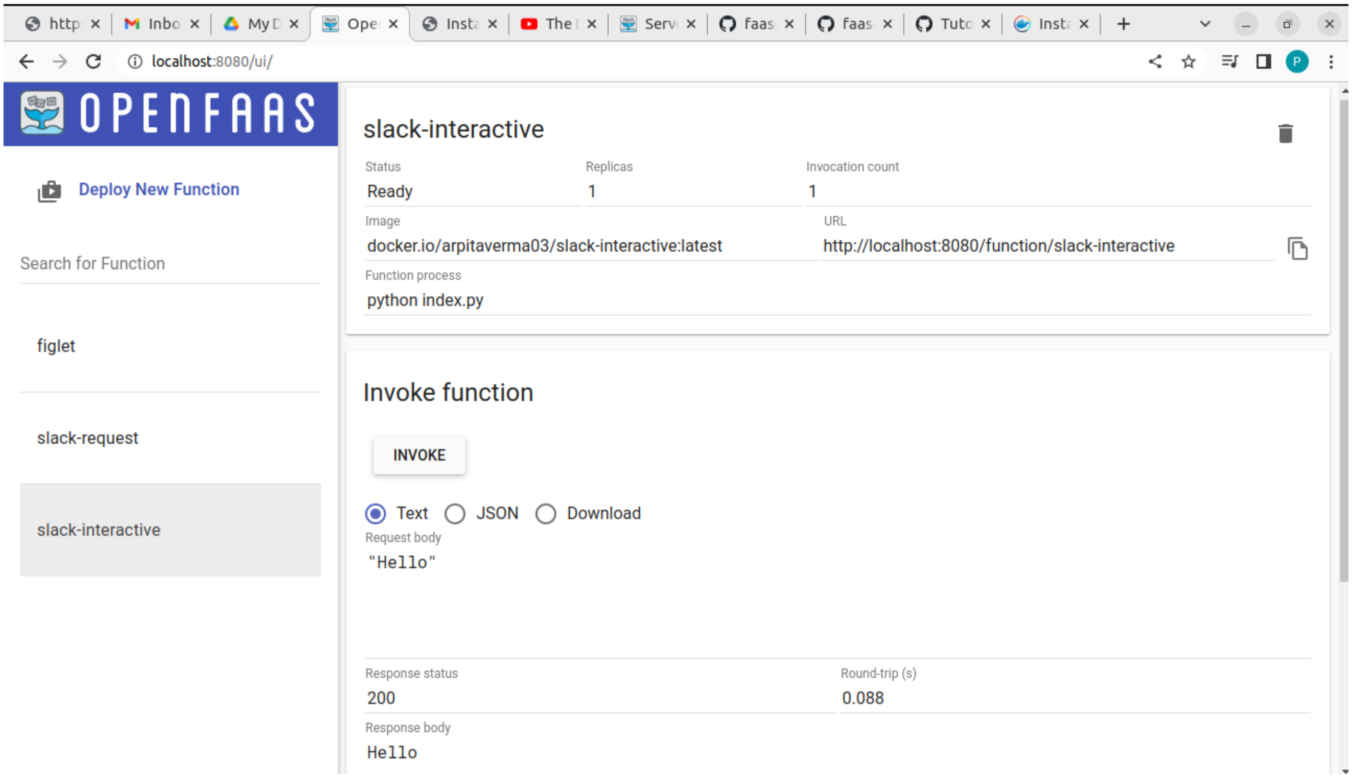
```
"Hi"
```

Response status: 200
Round-trip (s): 0.083

Response body

```
"Hi"
```

4. Slack Interactive Function



slack-interactive

Status: Ready

Replicas: 1

Invocation count: 1

Image: docker.io/arpitaverma03/slack-interactive:latest

URL: http://localhost:8080/function/slack-interactive

Function process: python index.py

Invoke function

● Text ○ JSON ○ Download

Request body
```
"Hello"
```

Response status: 200

Round-trip (s): 0.088

Response body
```
Hello
```