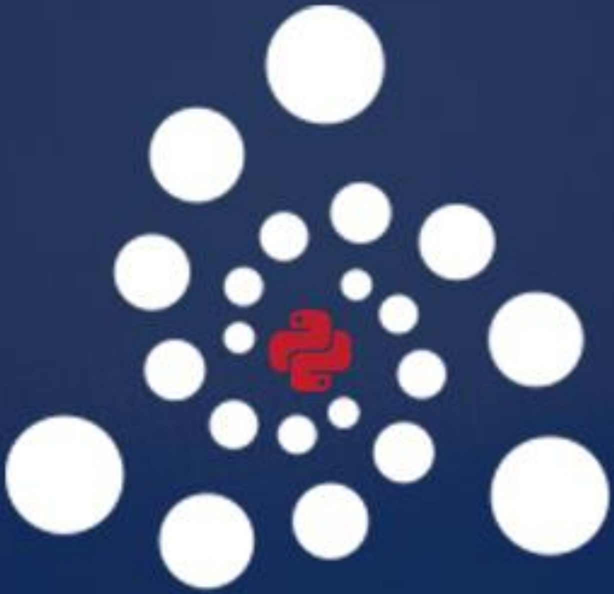

Python pyramid

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About the Tutorial

Pyramid is an open source, WSGI compliant web framework written in Python. Initially the project named as Pylons, but later released under the new name Pyramid.

Apart from Pyramid, the Pylons Project consists of different web application technologies such as Waitress (a WSGI server), SubstanceD (Pyramid-based application server), WebOb (a WSGI request/response library), and many more.

Audience

This tutorial is designed for Python developers who want to learn to build robust, scalable MVC pattern web applications using Pyramid framework.

Prerequisites

Before you proceed, make sure that you understand the basics of procedural and object-oriented programming in Python. Knowledge of REST architecture is an added advantage.

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1. Pyramid – Overview

Pyramid is an open source, WSGI compliant web framework written in Python. Initially the project named as Pylons, but later released under the new name Pyramid.

- Pyramid is a minimalistic web framework. It doesn't come packaged with any templating library or doesn't have support for any specific database packages.

- However, it can be integrated both with SQL databases via SQLAlchemy and with the Zope Object Database, as well as other NoSQL databases such as CouchDB.

- Pyramid can also be configured to work with templating libraries such as Mako, Jinja2 or Chameleon.

- Pyramid has been developed by **Chris McDonough**. The first version of Pyramid was released in January 2011. The latest version, Pyramid 2.0 has been released in March 2021.

Comparison with Other Python Frameworks

Pyramid web application framework is inspired by Zope and Django frameworks. As a result, it combines the best provisions of the two.

- Pyramid is largely based on **repose.bfg** framework. After it was merged with the Pylons project, the same was renamed as Pyramid in 2010.

- The ability to extend Pyramid application is borrowed from Zope library. Without modifying the application code, the application can be reused, modified or extended. The features such as declarative security layer and traversal of routes is inherited from Zope.

- As is the case of Pylons 1.0, Pyramid doesn't enforce any policy. It also lets the user choose any database or templating system The URL dispatch approach is also inspired by Pylons.

- The concept of **views** is based on similar approach of Django. Extensive documentation is also a Django features adapted by Pyramid.

- Although the definition doesn't fit exactly, Pyramid can be said to follow MVC (Model-View-Controller) approach.

2. Pyramid – Environment Setup

It is recommended that the Pyramid package be installed on a system having Python 3.6 or above version installed. Pyramid can be installed on Linux, MacOS as well as Windows platform. Simplest way of installing it is by using PIP installer, preferably under a Python virtual environment.

```
pip3 install pyramid
```

Although a Pyramid web application can be run using the built-in WSGI development server that is a part of the **wsgiref** module, it is not recommended for use in production environment. Hence, we also install Waitress, a production-quality pure-Python WSGI server (also a part of Pylons project)

```
pip3 install waitress
```

This will install Pyramid (ver 2.0), Waitress (ver 2.1.2) in addition to other dependencies from Pylon project such that WebOb, PasteDeploy, and others. To check what gets installed, run pip freeze command.

```
pip3 freeze

hupper==1.10.3

PasteDeploy==2.1.1

plaster==1.0

plaster-pastedeploy==0.7

pyramid==2.0

translationstring==1.4

venusian==3.0.0

waitress==2.1.2

WebOb==1.8.7

zope.deprecation==4.4.0

zope.interface==5.4.0
```

3. Pyramid – Hello World

To check whether Pyramid along with its dependencies are properly installed, enter the following code and save it as **hello.py**, using any Python-aware editor.

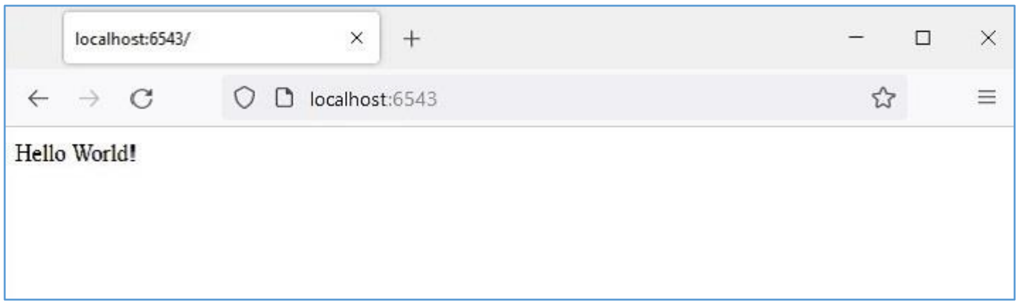
```
from wsgiref.simple_server import make_server
from pyramid.config import Configurator
from pyramid.response import Response

def hello_world(request):
    return Response('Hello World!')

if __name__ == '__main__':
    with Configurator() as config:
        config.add_route('hello', '/')
        config.add_view(hello_world, route_name='hello')
        app = config.make_wsgi_app()
    server = make_server('0.0.0.0', 6543, app)
    server.serve_forever()
```

The **Configurator** object is required to define the URL route and bind a view function to it. The WSGI application object is obtained from this config object is an argument to the **make_server()** function along with the IP address and port of localhost. The server object enters a listening loop when **serve_forever()** method is called.

Run this program from the command terminal as

```
Python hello.py
```

The WSGI server starts running. Open the browser and enter http://loccalhost:6543/ in the address bar. When the request is accepted, the **hello_world()** view function gets executed. It returns the Hello world message. The Hello world message will be seen in the browser window.



Hello World!

As mentioned earlier, the development server created by make_server() function in the **wsgiref** module is not suited for production environment. Instead, we shall use Waitress server. Modify the hello.py as per the following code:

```
from pyramid.config import Configurator
from pyramid.response import Response
from waitress import serve

def hello_world(request):
    return Response('Hello World!')

if __name__ == '__main__':
    with Configurator() as config:
        config.add_route('hello', '/')
        config.add_view(hello_world, route_name='hello')
        app = config.make_wsgi_app()
        serve(app, host='0.0.0.0', port=6543)
```

All other functionality is same, except we use **serve()** function of **waitress** module to start the WSGI server. On visiting the '/' route in the browser after running the program, the Hello world message is displayed as before.

Instead of a function, a callable class can also be used as a view. A callable class is the one which overrides the **__call__()** method.

```
from pyramid.response import Response


class MyView(object):
    def __init__(self, request):
        self.request = request

    def __call__(self):
        return Response('hello world')
```

4. Pyramid – Application Configuration

The Pyramid application object has an application registry that stores mappings of view functions to routes, and other application-specific component registrations. The Configurator class is used to build the application registry.

The Configurator life cycle is managed by a context manager that returns an application object.

```
with Configurator(settings=settings) as config:

    #configuration methods

    app = config.make_wsgi_app()
```

The Configurator class defines the following important methods to customize the application:

add_route()

This method registers a route for URL dispatch. Following arguments are used:

- **name**: the first required positional argument must be a unique name for the route. The name is used to identify the route when registering views or generating URLs.

- **pattern**: The second required positional argument is a string representing the URL path optionally containing variable placeholders for parsing the variable data from the URL. The placeholders are surrounded by curly brackets. For example, "/students/{id}".

- **request_method**: The value can be one of "GET", "POST", "HEAD", "DELETE", "PUT". Requests only of this type will be matched against the route.

add_view()

This method adds a view configuration to the application registry. It binds a view function to the **route_name** present in the configuration. The arguments required are:

- **view**: The name of a view function.

- **route_name**: A string that must match the name of a route configuration declaration.

- **request_method**: Either a string (such as "GET", "POST", "PUT", "DELETE", "HEAD" or "OPTIONS") representing an HTTP REQUEST_METHOD, or a tuple containing one or more of these strings.

add_static_view()

This method adds a **view** used to render static assets such as images and CSS files, and uses the following arguments:

- **name**: This argument is a string representing an application-relative local URL prefix, or a full URL.

- **Path**: This argument represents the path on disk where the static files reside. Its value can be an absolute or a package-relative path.

This method in turn calls the **add_route()** method of Configurator object.

add_notfound_view()

This method adds a view to be executed when a matching view cannot be found for the current request. The following code shows an example:

```
from pyramid.config import Configurator

from pyramid.response import Response


def notfound(request):

    return Response('Not Found', status='404 Not Found')


config.add_notfound_view(notfound)
```

add_forbidden_view()

Configures the application registry so as to define a view to be executed when there is HTTPForbidden exception raised. The argument list contains a reference to a function that returns a 403 status response. If no argument is provided, the registry adds **default_exceptionresponse_view()**.

add_exception_view()

This method causes addition of an exception view function to the configuration, for the specified exception.

make_wsgi_app()

This method returns a Pyramid WSGI application object.

scan()

This is a wrapper for registering views. It imports all application modules looking for @view_config decorators.

For each one, it calls config.add_view(view) with the same keyword arguments. A call to scan() function performs the scan of the package and all the subpackages for all the decorations.

A typical sequence of statements that performs configuration of application registry is as in the following code snippet:

```
from pyramid.config import Configurator


with Configurator() as config:
    config.add_route('hello', '/')
    config.add_view(hello_world, route_name='hello')
    app = config.make_wsgi_app()
```

This approach towards configuration of the application is called imperative configuration. Pyramid provides another approach towards configuration, called as decorative configuration.

Declarative Configuration

Sometimes, it becomes difficult to do the configuration by imperative code, especially when the application code is spread across many files. The declarative configuration is a convenient approach. The **pyramid.view** model defines **view_config** – a function, class or method decorator - that allows the view registrations very close to the definition of view function itself.

Two important arguments are provided to **@view_config()** decorator. They are **route_name** and **request_method**. They bear same explanation as in **add_route()** method of Configurator class. The function just below it is decorated so that it is bound to the route added to the registry of the application object.

Give below is the example of declarative configuration of **hello_world()** view function:

```
from pyramid.response import Response
from pyramid.view import view_config


@view_config(route_name='hello', request_method='GET')
def hello_world(request):
    return Response('Hello World!')
```

The view_config decorator adds an attribute to the hello_world() function, making it available for a scan to find it later.

The combination of configuration decoration and the invocation of a scan is collectively known as declarative configuration. Following code configures the application registry with declarative approach.

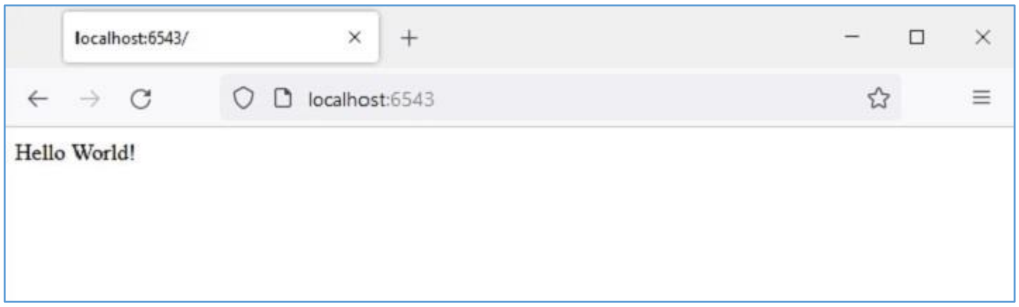
The scan() function discovers the routes and their mapped views, so that there is the need to add imperative configuration statements.

```
from wsgiref.simple_server import make_server
from pyramid.config import Configurator
from pyramid.response import Response
from pyramid.view import view_config


@view_config(route_name='hello', request_method='GET')
def hello_world(request):
    return Response('Hello World!')


if __name__ == '__main__':
    with Configurator() as config:
        config.add_route('hello', '/')
        config.scan()
        app = config.make_wsgi_app()
    server = make_server('0.0.0.0', 6543, app)
    server.serve_forever()
```

The scanner translates the arguments to view_config into a call to the pyramid.config.Configurator.add_view() method, so that the action is equivalent to the following statement:

```
config.add_view(hello_world, route_name='hello',
request_method='GET')
```

After the above program is run, the WSGI server starts. When the browser visits the link http://localhost:6543/, the "Hello World" message is rendered as before.

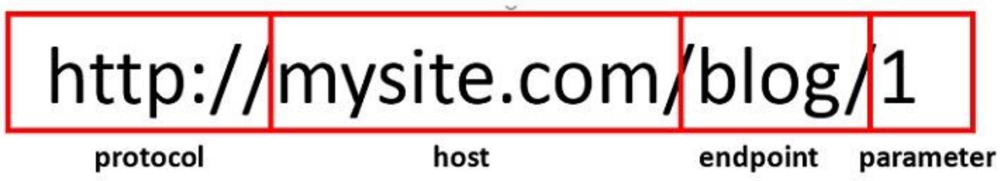


Hello World!

5. Pyramid – URL Routing

Before the advent of MVC architecture, web applications used the mechanism of mapping the URL entered by the user in the browser, to a program file whose output was rendered as HTML to as a response back to the browser. Pyramid framework uses a routing mechanism where the endpoint of the URL is matched with different URL patterns registered in the application's registry, invokes its mapped view and renders the response.

A typical URL comprises of three parts: The protocol (such as http:// or https://) followed by the IP address or hostname. The remaining part of the URL after first / after the hostname is called as the path or endpoint.



The endpoint followed by one or more variable parts forms the route. The variable part identifiers are surrounded by curly brackets. For example, for the above URL, the route is **/blog/{id}**

The WSGI application acts as a router. It checks the incoming request against the URL patterns present in the route map. If a match is found, its associated view callable is executed and the response is returned.

Route Configuration

A new route is added to the application by invoking add_route() method of the Configurator object. A route has a name, which acts as an identifier to be used for URL generation and a pattern that is meant to match against the PATH_INFO portion of a URL (the portion following the scheme and port, e.g., /blog/1 in the URL http://example.com/blog/1).

As mentioned earlier, the pattern parameter of add_route() method can have one or more placeholder identifiers surrounded by curly brackets and separated by /. Following statement assigns 'index' as the name of route given to '/{name}/{age}' pattern.

```
config.add_route('index', '/{name}/{age}')
```

To associate a view callable to this route, we use add_view() function as follows:

```
config.add_view(index, route_name='index')
```

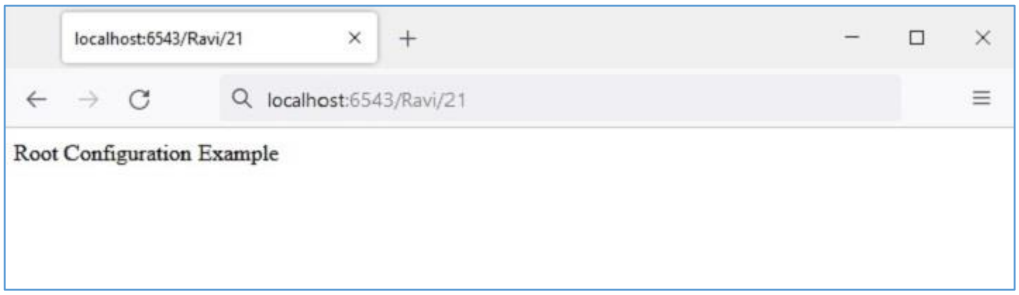
The index() function should be available for the route to be matched to it.

```
def index(request):
    return Response('Root Configuration Example')
```

We put these statements in the program below:

```
from wsgiref.simple_server import make_server
from pyramid.config import Configurator
from pyramid.response import Response


def index(request):
    return Response('Root Configuration Example')


if __name__ == '__main__':
    with Configurator() as config:
        config.add_route('index', '/{name}/{age}')
        config.add_view(index, route_name='index')
        app = config.make_wsgi_app()
    server = make_server('0.0.0.0', 6543, app)
    server.serve_forever()
```

Run the above code and visit http://localhost:6543/Ravi/21 in the browser. As the URL's PATH_INFO matches with the index route, the following output is displayed:



Root Configuration Example

The pattern used in route configuration usually starts with a forward slash (/) character. A pattern segment (an individual item between / characters in the pattern) may either be a literal string, or it may be a placeholder marker (e.g., {name}), or a certain combination of both. A replacement marker does not need to be preceded by a / character.

Here are some examples of route patterns

```
/student/{name}/{marks}

/{id}/student/{name}/{marks}

/customer/{id}/item/{itemno}

/{name}/{age}
```

The place holder identifier must be a valid Python identifier. Hence, it must begin with an uppercase or lowercase ASCII letter or an underscore, and it can only have uppercase or lowercase ASCII letters, underscores, and numbers.

Route Matching

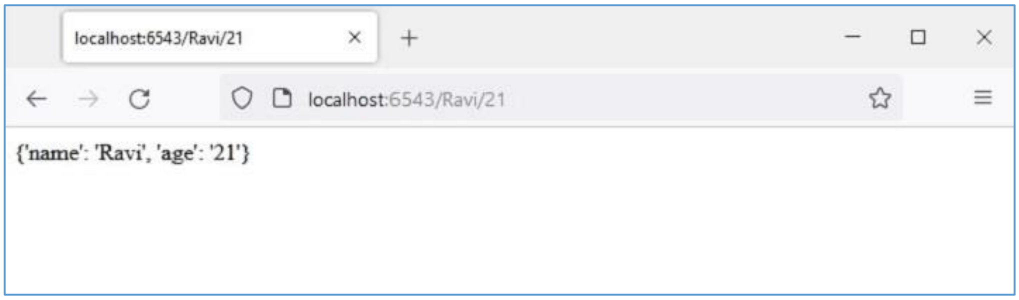
When the incoming request matches with the URL pattern associated with a particular route configuration, a dictionary object named **matchdict** is added as an attribute of the request object.

The **request.matchdict** contains the values that match replacement patterns in the pattern element. The keys in a **matchdict** are strings, while their values are Unicode objects.

In the previous example, change the index() view function to following:

```
def index(request):

    return Response(str(request.matchdict))
```

The browser displays the path parameters in the form of a **dict** object.



```
{'name': 'Ravi', 'age': '21'}
```

When the request matches a route pattern, the request object passed to the view function also includes a **matched_route** attribute. The name of the matched route can be obtained from its name property.

In the following example, we have two view functions student_view() and book_view() defined with the help of @view.config() decorator.

The application's registry is configured to have two corresponding routes – 'student' mapped to **'/student/{name}/{age}'** pattern and 'book' mapped to **'/book/{title}/{price}'** pattern. We call the scan() method of **configurator** object to add the views.

```
from wsgiref.simple_server import make_server

from pyramid.config import Configurator

from pyramid.response import Response

from pyramid.view import view_config


@view_config(route_name='student')

def student_view(request):

    return Response(str(request.matchdict))

@view_config(route_name='book')

def book_view(request):

    title=request.matchdict['title']

    price=request.matchdict['price']

    return Response('Title: {}, Price: 
{}'.format(title,price))
```

```
if __name__ == '__main__':
    with Configurator() as config:
        config.add_route('student', '/student/{name}/{age}')
        config.add_route('book', '/book/{title}/{price}')
        config.scan()
        app = config.make_wsgi_app()
    server = make_server('0.0.0.0', 6543, app)
    server.serve_forever()
```

When the browser is given http://localhost:6543/student/Ravi/21 URL, the output is

```
{'name': 'Ravi', 'age': '21'}
```

If the URL entered is http://localhost:6543/book/Python/300, the output is

```
Title: Python, Price: 300
```

6. Pyramid – View Configuration

The term "View Configuration" refers to the mechanism of associating a view callable (a function, method or a class) with the information of route configuration. Pyramid finds the best callable for the given URL pattern.

There are three ways to configure a **view**:

- Using add_view() method
- Using @view_config() decorator
- Using @view_defaults () class decorator

Using add_view() Method

This is the simplest method of configuring a view imperatively by calling the **add_view()** method of the **Configurator** object.

This method uses the following arguments:

- **name**: The view name required to match this view callable. If name is not supplied, the empty string is used (implying the default view).

- **context**: This resource must be an object of a Python class in order for this view to be found and called. If context is not supplied, the value None, which matches any resource, is used.

- **route_name**: This value must match the name of a route configuration declaration that must match before this view will be called. If **route_name** is supplied, the view callable will be invoked only when the named route has matched.

- **request_type**: an interface that the request must provide in order for this view to be found and called.

- **request_method**: a string (such as "GET", "POST", "PUT", "DELETE", "HEAD", or "OPTIONS") representing an HTTP REQUEST_METHOD or a tuple containing one or more of these strings. The **view** will be called only when the method attribute of the request matches a supplied value.

- **request_param**: This argument can be any string or a sequence of strings. The view will only be called when the **request.params** dictionary has a key which matches the supplied value.

In the following example, two functions **getview()** and **postview()** are defined and associated with two routes of the same name. These functions just return the name of the HTTP method by which they are called.

The getview() function is called when the URL **/get** is requested using GET method. Similarly, the postview() function is executed when **/post** path id requested by POST method.

```
from wsgiref.simple_server import make_server
from pyramid.config import Configurator
from pyramid.response import Response
def getview(request):
    ret=request.method
    return Response('Method: {}'.format(ret))
def postview(request):
    ret=request.method
    return Response('Method: {}'.format(ret))

if __name__ == '__main__':
    with Configurator() as config:
        config.add_route('getview', '/get')
        config.add_route('postview', '/post')
        config.add_view(getview,
route_name='getview',request_method='GET')
        config.add_view(postview,route_name='postview',
request_method='POST')
        app = config.make_wsgi_app()
    server = make_server('0.0.0.0', 6543, app)
    server.serve_forever()
```

While the GET request can be sent by using the web browser as HTTP client, it is not possible to use it for POST request. Hence, we use the CURL command line utility.

```
C:\Users\Acer>curl localhost:6543/get
Method: GET
C:\Users\Acer>curl -d "param1=value1" -H "Content-Type:
application/json" -X POST http://localhost:6543/post
Method: POST
```

As mentioned earlier, the **request_method** parameter can be a list of one or more HTTP methods. Let us modify the above program and define a single **oneview()** function that identifies the HTTP method that causes its execution.

```
def oneview(request):
    ret=request.method
    return Response('Method: {}'.format(ret))
```

This function is registered in the application's configuration for all the HTTP methods.

```
config.add_route('oneview', '/view')
config.add_view(oneview, route_name='oneview',
                      request_method=['GET','POST', 'PUT', 'DELETE'])
```

The CURL output is shown as below:

```
C:\Users\Acer>curl localhost:6543/view
Method: GET
C:\Users\Acer>curl -d "param1=value1" -H "Content-Type:
application/json" -X POST http://localhost:6543/view
Method: POST
C:\Users\Acer>curl -d "param1=value1" -H "Content-Type:
application/json" -X PUT http://localhost:6543/view
Method: PUT
C:\Users\Acer>curl -X DELETE http://localhost:6543/view
```

```
Method: DELETE
```

Using @view_config() Decorator

Instead of adding views imperatively, the @view_config decorator can be used to associate the configured routes with a function, a method or even a callable class.

As described in the Declarative Configuration section, a registered route can be associated with a function as in the following example:

```
from wsgiref.simple_server import make_server
from pyramid.config import Configurator
from pyramid.response import Response
from pyramid.view import view_config
@view_config(route_name='hello')
def hello_world(request):
    return Response('Hello World!')
if __name__ == '__main__':
    with Configurator() as config:
        config.add_route('hello', '/')
        config.scan()
        app = config.make_wsgi_app()
    server = make_server('0.0.0.0', 6543, app)
    server.serve_forever()
```

Note that the views are added into the application configuration only after calling the scan() method. While removes the need for imperatively adding the views, the performance may be slightly slower.

The view_config() decorator can also be given same arguments as that of add_view() method. All arguments may be omitted.

```
@view_config()
```

```
def hello_world(request):
    return Response('Hello World!')
```

In such a case, the function will be registered with any route name, any request method or parameters.

The view_config decorator is placed just before the definition of callable view function, as in the above example. It can also be put on top of a class if it is to be used as the view callable. Such a class must have a **__call__()** method.

In the following Pyramid application code, the **MyView** class is used as a callable and is decorated by the **@view_config** decorator.

```
from wsgiref.simple_server import make_server
from pyramid.config import Configurator
from pyramid.response import Response
from pyramid.view import view_config


@view_config(route_name='hello')
class MyView(object):
    def __init__(self, request):
        self.request = request


    def __call__(self):
        return Response('hello World')


if __name__ == '__main__':
    with Configurator() as config:
        config.add_route('hello', '/')
        #config.add_view(MyView, route_name='hello')
        config.scan()
        app = config.make_wsgi_app()
    server = make_server('0.0.0.0', 6543, app)
    server.serve_forever()
```

Note that instead of scanning for view configurations, we can add views by explicitly calling the add_view() method.

If the methods in a class have to be associated with different routes, separate @view_config() should be used on top of each one of them, as done in the following example. Here, we have two methods bound to two separate routes.

```
from wsgiref.simple_server import make_server
from pyramid.config import Configurator
from pyramid.response import Response
from pyramid.view import view_config


class MyView(object):
    def __init__(self, request):
        self.request = request


    @view_config(route_name='getview', request_method='GET')
    def getview(self):
        return Response('hello GET')
    @view_config(route_name='postview', request_method='POST')
    def postview(self):
        return Response('hello POST')


if __name__ == '__main__':
    with Configurator() as config:
        config.add_route('getview', '/get')
        config.add_route('postview', '/post')
        config.scan()
        app = config.make_wsgi_app()
    server = make_server('0.0.0.0', 6543, app)
    server.serve_forever()
```

Here's the output of CURL commands:

```
C:\Users\Acer>curl localhost:6543/get
hello GET
C:\Users\Acer>curl -d "param1=value1" -H "Content-Type:
application/json" -X POST http://localhost:6543/post
hello POST
```

Using @view_defaults() Decorator

view_defaults() is a class decorator. If you have to add the methods in a class as view with some common parameters and some specific parameters, the common parameters can be specified in the **view_defaults()** decorator on top of the class, performing configuration of each method by a separate **view_config()** before each one of them.

In the following code, we have different methods responding to the same route but with different **request_method**. Hence we define the rout name as default, and specify the **request_method** in each view configuration.

```
from wsgiref.simple_server import make_server
from pyramid.config import Configurator
from pyramid.response import Response
from pyramid.view import view_config
from pyramid.view import view_defaults


@view_defaults(route_name='myview')
class MyView(object):
    def __init__(self, request):
        self.request = request


    @view_config( request_method='GET')
    def getview(self):
        return Response('hello GET')
    @view_config(request_method='POST')
    def postview(self):
        return Response('hello POST')
    @view_config(request_method='PUT')
    def putview(self):
        return Response('hello PUT')
    @view_config(request_method='DELETE')
    def delview(self):
        return Response('hello DELETE')

if __name__ == '__main__':
    with Configurator() as config:
        config.add_route('myview', '/view')
        config.scan()
        app = config.make_wsgi_app()
    server = make_server('0.0.0.0', 6543, app)
    server.serve_forever()
```

The CURL commands with different HTTP requests to the server are as follows:

```
C:\Users\Acer>curl localhost:6543/view
hello GET
C:\Users\Acer>curl -d "param1=value1" -H "Content-Type:
application/json" -X POST http://localhost:6543/view
hello POST
C:\Users\Acer>curl -d "param1=value1" -H "Content-Type:
application/json" -X PUT http://localhost:6543/view
hello PUT
C:\Users\Acer>curl -X DELETE http://localhost:6543/view
```

```
hello DELETE
```

7. Pyramid – Route Prefix

Many times, similar URL patterns are registered with different routes in more than one Python code modules. For example, we have a **student_routes.py** where /list and /add URL patterns are registered with 'list' and 'add' routes. The view functions associated with these routes are **list()** and **add()**, respectively.

```
#student_routes.py
from pyramid.config import Configurator
from pyramid.response import Response
from pyramid.view import view_config


@view_config( route_name='add')
def add(request):
    return Response('add student')
@view_config(route_name='list')
def list(request):
    return Response('Student list')


def students(config):
    config.add_route('list', '/list')
    config.add_route('add', '/add')
    config.scan()
```

These routes will eventually be registered when the **students()** function is called.

At the same time, there is book_routes.py, in which the same URLs **/list** and **/add** are registered to 'show' and 'new' routes. Their associated views are list() and add() respectively. The module has **books()** function which adds the routes.

```
#book_routes.py
from pyramid.config import Configurator
from pyramid.response import Response
from pyramid.view import view_config

@view_config( route_name='new')
def add(request):
    return Response('add book')
@view_config(route_name='show')
def list(request):
    return Response('Book list')

def books(config):
    config.add_route('show', '/list')
    config.add_route('new', '/add')
    config.scan()
```

Obviously, there is a conflict between URL patterns as '/list' and '/add' point to two routes each and this conflict must be resolved. This is done by using the **route_prefix** parameter of the **config.include()** method.

The first parameter to config.include() is the function which adds the routes, and the second is the route_prefix string which will be prepended to the URL pattern used in the included function.

Hence, the statement

```
config.include(students, route_prefix='/student')
```

will result in the '/list' URL pattern changed to '/student/list' and '/add' becomes 'student/add'. Similarly, we can add prefix to these URL patterns in the books() function.

```
config.include(books, route_prefix='/books')
```

The code that starts the server is as below:

```
from wsgiref.simple_server import make_server
from pyramid.config import Configurator
from pyramid.response import Response
from student_routes import students
from book_routes import books

if __name__ == '__main__':
    with Configurator() as config:
        config.include(students, route_prefix='/student')
        config.include(books, route_prefix='/book')
        app = config.make_wsgi_app()
    server = make_server('0.0.0.0', 6543, app)
    server.serve_forever()
```

Let us run the above code and test the routes by following CURL commands.

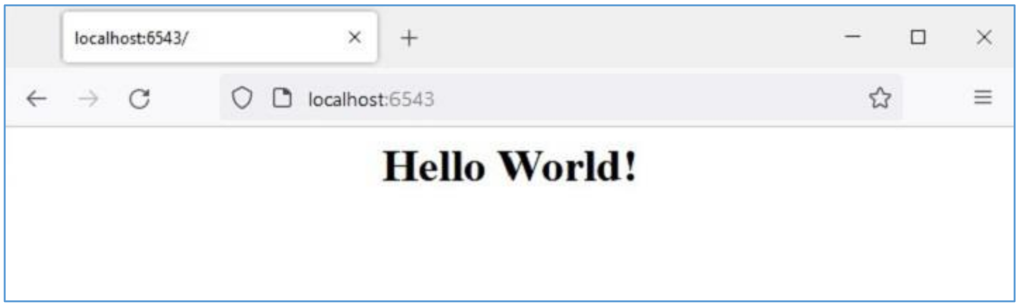
```
C:\Users\Acer>curl localhost:6543/student/list
Student list
C:\Users\Acer>curl localhost:6543/student/add
add student
C:\Users\Acer>curl localhost:6543/book/add
add book
C:\Users\Acer>curl localhost:6543/book/list
Book list
```

8. Pyramid – Templates

By default, the content-type of the response of a view function is in plain text. In order to render HTML, the text of the response body may include HTML tags, as in the following example:

```
from wsgiref.simple_server import make_server
from pyramid.config import Configurator
from pyramid.response import Response


def hello_world(request):
    return Response('<h1 style="text-align:center;">Hello World!</h1>')


if __name__ == '__main__':
    with Configurator() as config:
        config.add_route('hello', '/')
        config.add_view(hello_world, route_name='hello')
        app = config.make_wsgi_app()
    server = make_server('0.0.0.0', 6543, app)
    server.serve_forever()
```

After starting the server (by running the above code), visit to http://localhost:6543/, the browser renders following output:



Hello World!

However, this method of rendering HTML, especially if it is likely to contain certain variable data, is extremely cumbersome. For this purpose, web frameworks use templating libraries. A template library merges the variable data with the otherwise static HTML code to generate and render web pages dynamically.

Template Bindings

Pyramid provides templating support with the help of bindings to popular template libraries such as jinja2, Mako and Chameleon.

Template Language	Pyramid Bindings	Default Extensions
Chameleon	pyramid_chameleon	.pt, .txt
Jinja2	pyramid_jinja2	.jinja2
Mako	pyramid_mako	.mak, .mako

First of all, we need to install the corresponding Python library for using the required template library. For example, to use jinja2 template, install **pyramid_jinja2** using PIP installer.

```
pip3 install pyramid_jinja2
```

Then we need to include it in the application configuration.

```
config.include('pyramid_jinja2')
```

The pyramid.renderers module defines render_to_response() function. It is used with following parameters:

```
render_to_response(renderer_name, value, request)
```

The **renderer_name** is the template web page, usually saved in the templates subfolder of the application directory, the value parameter is a dictionary passed as a context to the template, and the request object obtained from WSGI environment.

Save the following HTML script as **hello.jinja2** in the **templates** folder.

```
<html>
  <body>
    <h1>Hello, {{ name }}!</h1>
  </body>
</html>
```

Jinja2 Template Library

Here, 'name' is a jinja2 template variable. The jinja2 template language inserts variables and programming constructs in the HTML scripts using following syntax:

Expressions

- {{ ... }} for Expressions to print to the template output
- {% ... %} for Statements
- {# ... #} for Comments not included in the template output

Conditionals

- {% if expr %}
- {% else %}
- {% endif %}

Loop

- {% for var in iterable %}
- {% endfor %}

In hello.jinja2 {{ name }}, the value of 'name' context variable is dynamically rendered in the view response.

Rendering Template

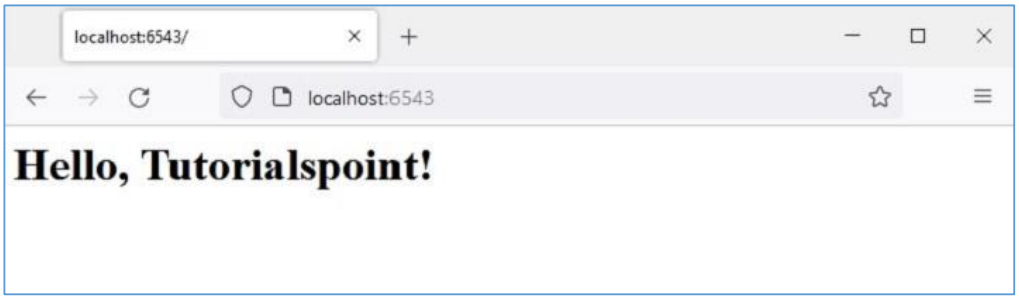
The **hello_world()** view function directly renders this template by calling **render_to_response()** function. It also sends a context value to the template.

```
from pyramid.renderers import render_to_response


def hello_world(request):
    return render_to_response('templates/hello.jinja2',
                              {'name':'Tutorialspoint'},
                              request=request)
```

As usual, this view is added to the hello route, pointing to / URL. The complete application code is as follows:

```
from wsgiref.simple_server import make_server
from pyramid.config import Configurator
from pyramid.response import Response
from pyramid.renderers import render_to_response


def hello_world(request):
    return render_to_response('templates/hello.jinja2',
                              {'name':'Tutorialspoint'},
                              request=request)


if __name__ == '__main__':
    with Configurator() as config:
        config.add_route('hello', '/')
        config.include('pyramid_jinja2')
        config.add_view(hello_world, route_name='hello')
        app = config.make_wsgi_app()
    server = make_server('0.0.0.0', 6543, app)
    server.serve_forever()
```

Run the server and visit http://localhost:6543/. The browser shows following result:



Hello, Tutorialspoint!

Every view must return a response object. The **render_to_response()** function is a shortcut function that actually returns a response object. This allows the **hello_world** view above to simply return the result of its call to **render_to_response()** directly.

On the other hand, **pyramid.renderers.render()** function renders a template to a string. We can manufacture a response object directly, and use that string as the body of the response.

Let us change the **hello_world()** view function as follows:

```
from pyramid.renderers import render


def hello_world(request):
    retval =  render('templates/hello.jinja2',
    {'name':'Tutorialspoint'}, request=request)
    return Response(retval)
```

Remaining code being same, the browser also shows the same output as above.

Rendering via Configuration

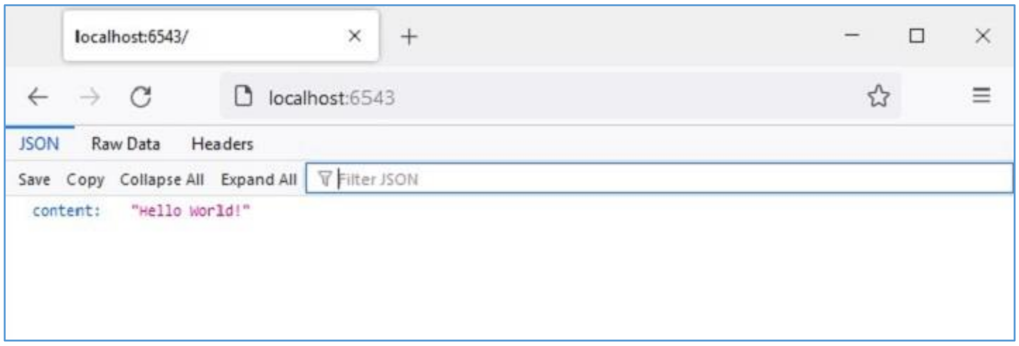
As mentioned earlier, the content_type of HTTP response returned by Pyramid's view callable id text/plain. However, it can be altered to string, JSON or JSONP if the renderer parameter of the @view_config decorator is assigned with any of these values. Pyramid thus have following built-in renderers:

- JSON
- String
- JSONP

In the following example, the hello_world() view function is configured to render JSON response.

```
from pyramid.view import view_config


@view_config(route_name='hello',renderer='json')
def hello_world(request):
    return {'content':'Hello World!'}
```

The setting of renderer type to JSON also sets the **content_type** header of the HTTP response to **application/json**. The browser displays the JSON response as in the following figure:



```
content:    "Hello World!"
```

The renderer parameter of the @view_config() decorator can be set to a template web page (which must be present in the templates folder). The prerequisite conditions are that the appropriate Python binding of the template library must be installed, and the application configuration must include the binding.

We have already installed python_jinja2 package, so that we can use jinja2 template to be rendered by the hello_world() view function, decorated by @view_config() with renderer parameter.

The hello.jinja2 template HTML code is as follows:

```
<html>
  <body>
    <h1>Hello, {{ name }}!</h1>
  </body>
</html>
```

The decorated hello_world() function is written as:

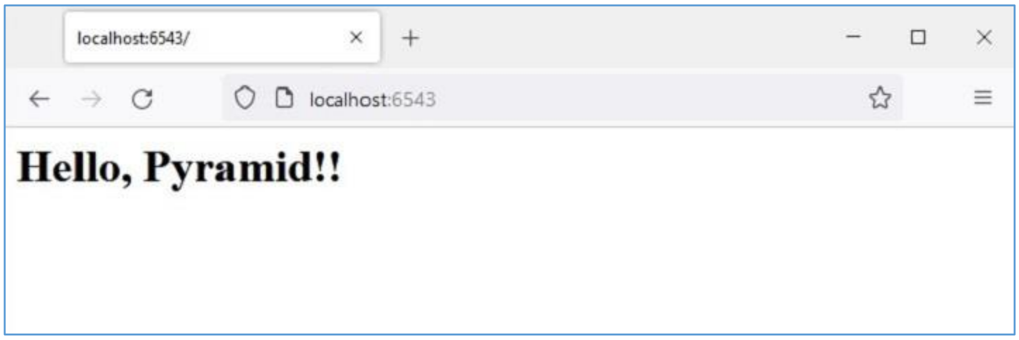
```
from pyramid.view import view_config


@view_config(route_name='hello', renderer='templates/hello.jinja2')
def hello_world(request):
    return {'name':'Pyramid!'}
```

In this case, the view function returns a dictionary object. It is made available to the template as the context data, that can be inserted in the HTML text with the help of template language syntax elements.

The complete code to render a jinja2 template is as follows:

```
from wsgiref.simple_server import make_server
from pyramid.config import Configurator
from pyramid.response import Response
from pyramid.view import view_config


@view_config(route_name='hello',
renderer='templates/hello.jinja2')
def hello_world(request):
    return {'name':'Pyramid!'}


if __name__ == '__main__':
    with Configurator() as config:
        config.include('pyramid_jinja2')
        config.add_route('hello', '/')
        config.scan()
        app = config.make_wsgi_app()
    server = make_server('0.0.0.0', 6543, app)
    server.serve_forever()
```

The template webpage with variable data supplied by the **view** function looks as below:



Hello, Pyramid!!

Add/Change Renderer

Templates are nothing but web pages interspersed with template language syntax. Even though Pyramid uses the default extension of a jinja2 template as ".jinja2", the established practice is to use the ".html" extension of web pages.

We can change the application configuration to let the .html extension be used in addition to ".jinja2". This is done by the **add_jinja2_renderer**.

```
config.add_jinja2_renderer(".html")
```

The **hello.jinja2** template is now renamed as hello.html. To be able to use this template, let us change the view function definition to the following code:

```
from pyramid.view import view_config


@view_config(route_name='hello',
renderer='templates/hello.html')
def hello_world(request):
    return {'name':'Pyramid!'}
```

Simultaneously, we modify the Configurator object's properties by adding the ".html" renderer.

```
if __name__ == '__main__':
    with Configurator() as config:
        config.include('pyramid_jinja2')
        config.add_jinja2_renderer(".html")
        config.add_route(hello, '/')
        config.scan()
        app = config.make_wsgi_app()
    server = make_server('0.0.0.0', 6543, app)
    server.serve_forever()
```

Template Context from matchdict

As explained earlier, if the URL pattern in the route configuration consists of one or more placeholder parameters, their values from the request URL are passed along with the request as a **matchdict** object, which in turn can be passed as context data to the template to be rendered.

For our next example, the **hello.html** – the jinja2 template remains the same.

```
<html>
  <body>
    <h1>Hello, {{ name }}!</h1>
  </body>
</html>
```

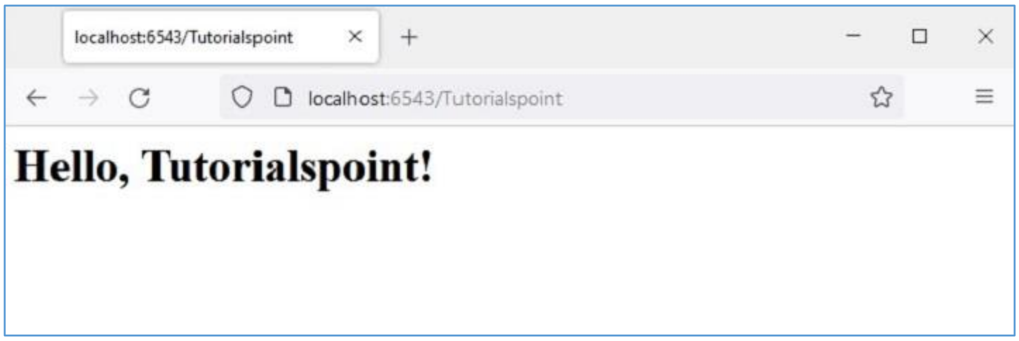
We know that the value for the context variable 'name' is passed by the view function. However, instead of passing a hardcoded value (as in the previous example), its value is fetched from the **matchict** object. This object is populated by the path parameters in the URL string.

```
from pyramid.view import view_config


@view_config(route_name='index', renderer='templates/hello.html')
def index(request):
    return {'name':request.matchdict['name']}
```

The modified application code is given below:

```
from wsgiref.simple_server import make_server
from pyramid.config import Configurator
from pyramid.response import Response
from pyramid.view import view_config

@view_config(route_name='index', renderer='templates/hello.html')
def index(request):
    return {'name':request.matchdict['name']}
if __name__ == '__main__':
    with Configurator() as config:
        config.include('pyramid_jinja2')
        config.add_jinja2_renderer(".html")
        config.add_route('index', '/{name}')
        config.scan()
        app = config.make_wsgi_app()
    server = make_server('0.0.0.0', 6543, app)
    server.serve_forever()
```

Start the server, open the browser and enter the URL http://localhost:6543/Tutorialspoint. The tailing string becomes the value of 'name' key in the **matchdict**. It is utilized by the jinja2 template and following output is rendered.



Hello, Tutorialspoint!

Conditionals and Loops in Template

The jinja2 template language allows conditional statements and looping constructs to be included in the HTML script. The jinja2 syntax for these programming elements is as follows:

Conditionals

```
{% if expr %}

HTML

{% else %}

HTML

{% endif %}
```

Loop

```
{% for var in iterable %}

HTML

{% endfor %}
```

It can be seen that the jinja2 syntax is very much similar to Python's if and for statements. Except that, jinja2 doesn't use the indentations to mark the blocks. Instead, for each if there has to be an endif statement. Similarly, for each for statement, there has to be a endfor statement.

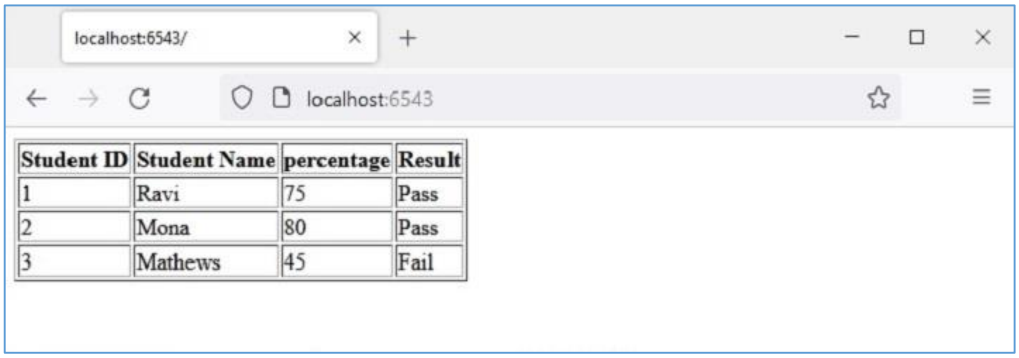
Following example demonstrates the use of template conditional and loop statements. First, the Pyramid code uses a students as a list of dictionary objects, each dictionary having id, name and percentage of a student. This list object is passed as a context to the marklist.html template

```
from wsgiref.simple_server import make_server

from pyramid.config import Configurator

from pyramid.response import Response

from pyramid.view import view_config


students = [

    {"id": 1, "name": "Ravi", "percent": 75},
    {"id": 2, "name": "Mona", "percent": 80},
    {"id": 3, "name": "Mathews", "percent": 45},
]


@view_config(route_name='index',
renderer='templates/marklist.html')
def index(request):
    return {'students':students}


if __name__ == '__main__':
    with Configurator() as config:
        config.include('pyramid_jinja2')
        config.add_jinja2_renderer(".html")
        config.add_route('index', '/')
        config.scan()
        app = config.make_wsgi_app()
    server = make_server('0.0.0.0', 6543, app)
    server.serve_forever()
```

Save this program as marklist.py. Now, the following HTML script has to be save as marklist.html. It traverses the students list object received from the view function, and renders the student data in the form of a HTML table. The fourth column shows pass/fail result, using the jinja2 if statement syntax.

```
<html>
<body>
<table border=1>
    <thead>  <tr>
        <th>Student ID</th>  <th>Student Name</th>
        <th>percentage</th>
        <th>Result</th>
    </tr>   </thead>
    <tbody>
{% for Student in students %}
    <tr> <td>{{ Student.id }}</td> <td>{{ Student.name }}</td>
        <td>{{ Student.percent }}</td>
        <td>
            {% if Student.percent>=50 %}
                        Pass
                  {% else %}
                        Fail
                  {% endif %}
        </td>  </tr>
{% endfor %}
    </tbody>
</table>
 </body>
</html>
```

Run the **marklist.py** code. The http://localhost:6543/ link renders the following tabular result:



Student ID	Student Name	percentage	Result
1	Ravi	75	Pass
2	Mona	80	Pass
3	Mathews	45	Fail

9. Pyramid – HTML Form Template

In this chapter, we shall see how Pyramid reads the data from HTML form. Let us save the following HTML script as **myform.html**. We shall use it for obtaining Template object and render it.

```
<html>
<body>
<form method="POST" action="http://localhost:6543/students">
<p>Student Id: <input type="text" name="id"/>  </p>
<p>student Name: <input type="text" name="name"/>  </p>
<p>Percentage: <input type="text" name="percent"/>  </p>
<p><input type="submit" value="Submit"> </p>
</body>
</html>
```

An "index" route added in Pyramid object's configuration is mapped to the following index() function, which renders the above HTML form:

```
@view_config(route_name='index',
renderer='templates/myform.html')
def index(request):
    return {}
```

As we can see, the data entered by user is passed to /students URL by POST request. So, we shall add a 'students' route to match the /students pattern, and associate it with add() view function as follows:

```
@view_config(route_name='students',
renderer='templates/marklist.html')
def add(request):
    student={'id':request.params['id'],
'name':request.params['name'],

'percent':int(request.params['percent'])}
```

```
     students.append(student)
     return {'students':students}
```

The data sent by POST request is available in the HTTP request object in the form of **request.params** object. It is a dictionary of HTML form attributes and their values as entered by the user. This data is parsed and appended to students list of dictionary objects. The updated students object is passed to the marklist.html template as a context data.

The **marklist.html** web template as the same as used in the previous example. It displays a table of student data along with the computed result column.

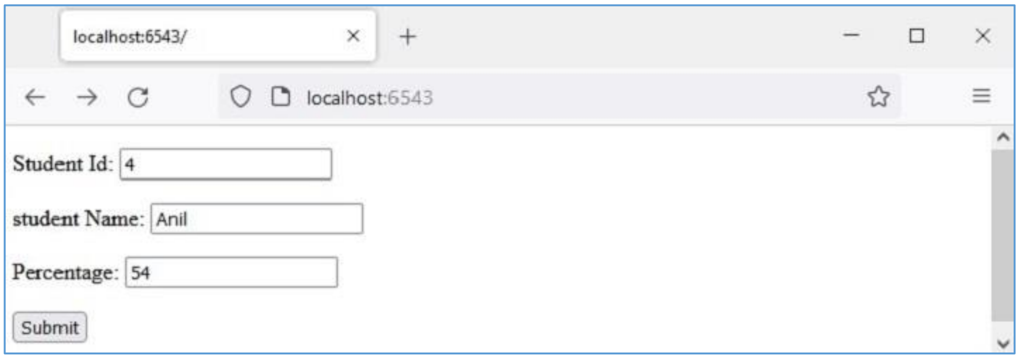
```
<html>
<body>
<table border=1>
    <thead>  <tr>
        <th>Student ID</th>  <th>Student Name</th>
        <th>percentage</th>
        <th>Result</th>
    </tr>   </thead>
    <tbody>
{% for Student in students %}
    <tr> <td>{{ Student.id }}</td> <td>{{ Student.name }}</td>
        <td>{{ Student.percent }}</td>
        <td>
            {% if Student.percent>=50 %}
                        Pass
                 {% else %}
                        Fail
                 {% endif %}
        </td>  </tr>
{% endfor %}
    </tbody>
```

```
</table>
</body>
</html>
```

The complete code containing views for rendering the HTML form, parsing the form data and generating a page showing the students marklist table is given below:

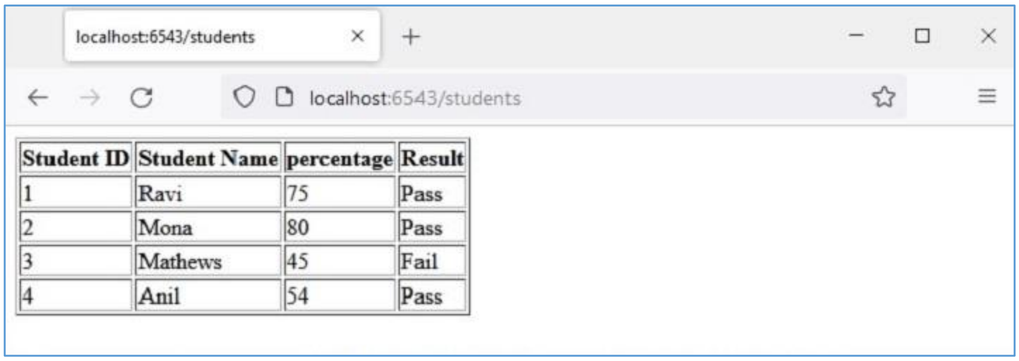
```
from wsgiref.simple_server import make_server
from pyramid.config import Configurator
from pyramid.response import Response
from pyramid.view import view_config


students = [
    {"id": 1, "name": "Ravi", "percent": 75},
    {"id": 2, "name": "Mona", "percent": 80},
    {"id": 3, "name": "Mathews", "percent": 45},
]


@view_config(route_name='index',
renderer='templates/myform.html')
def index(request):
    return {}
@view_config(route_name='students',
renderer='templates/marklist.html')
def add(request):
    student={'id':request.params['id'],
'name':request.params['name'],

'percent':int(request.params['percent'])}


    students.append(student)
    return {'students':students}


if __name__ == '__main__':
    with Configurator() as config:
        config.include('pyramid_jinja2')
        config.add_jinja2_renderer(".html")
        config.add_route('index', '/')
        config.add_route('students','/students')
        config.scan()
        app = config.make_wsgi_app()
    server = make_server('0.0.0.0', 6543, app)
    server.serve_forever()
```

To start the server, run the above Python code from command line. In your browser, visit http://localhost:6543/ to get the form as shown below:



Student Id:	4
student Name:	Anil
Percentage:	54

Enter a sample data as shown and press submit button. The browser is directed to /students URL, which in turn invokes the **add()** view. The result is a table of marklist showing the newly entered data of a new student.



Student ID	Student Name	percentage	Result
1	Ravi	75	Pass
2	Mona	80	Pass
3	Mathews	45	Fail
4	Anil	54	Pass

10. Pyramid – Static Assets

Often it is required to include in the template response some resources that remain unchanged even if there is a certain dynamic data. Such resources are called static assets. Media files (.png, .jpg etc), JavaScript files to be used for executing some front end code, or stylesheets for formatting HTML (.css files) are the examples of static files.

Pyramid serves these static assets from a designated directory in the server's filesystem to the client's browser. The **add_static_view()** method of the Configurator object defines the name of the route and path for the folder containing the static files such as images, JavaScript, and CSS files.

As a convention, the 'static' directory is used to store the static assets and the add_static_view() is used as follows:

```
config.add_static_view(name='static', path='static')
```

Once the static route is defined, the path of static assets while using in HTML script can be obtained by **request.static_url()** method

Static Image

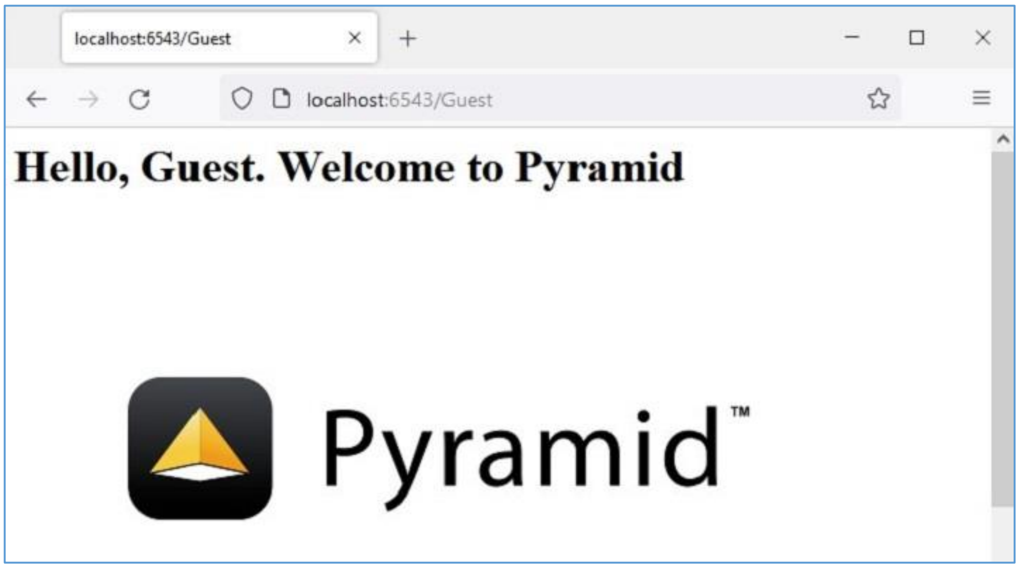
In the following example, Pyramid logo is to be rendered in the logo.html template. Hence, "pyramid.png" file is first placed in static folder. It is now available for using as src attribute of <img> tag in HTML code.

```
<html>

<body>

<h1>Hello, {{ name }}. Welcome to Pyramid</h1>

<img src="{{request.static_url('app:static/pyramid.png')}}">

</body>

</html>
```

The application code updates the configurator with **add_static_view()**, and defines **index()** view renders the above template.

```
from wsgiref.simple_server import make_server
from pyramid.config import Configurator
from pyramid.response import Response
from pyramid.view import view_config

@view_config(route_name='index', renderer='templates/logo.html')

def index(request):
    return {'name':request.matchdict['name']}

if __name__ == '__main__':
    with Configurator() as config:
        config.include('pyramid_jinja2')
        config.add_jinja2_renderer(".html")
        config.add_route('index', '/{name}')
        config.add_static_view(name='static', path='app:static')
        config.scan()
        app = config.make_wsgi_app()
    server = make_server('0.0.0.0', 6543, app)
    server.serve_forever()
```

Run the above code to start the server. Use http://localhost:6543/Guest as the URL in your browser. Here 'Guest' is the path parameter picked up by the view function in **matchdict** object and passed to the logo.html template as the context. The browser displays the Pyramid logo now.



Hello, Guest. Welcome to Pyramid

Javascript as Static Asset

Here is another example of static file. A JavaScript code **hello.js** contains a definition of **myfunction()** to be executed on the **onload** event in following HTML script (templates\hello.html)

```
<html>
    <head>
     <script
src="{{request.static_url('app:static/hello.js')}}"></script>
    </head>
<body onload="myFunction()">
     <div id="time" style="text-align:right; width="100%"></div>
     <h1><div id="ttl">{{ name }}</div></h1>
    </body>
</html>
```

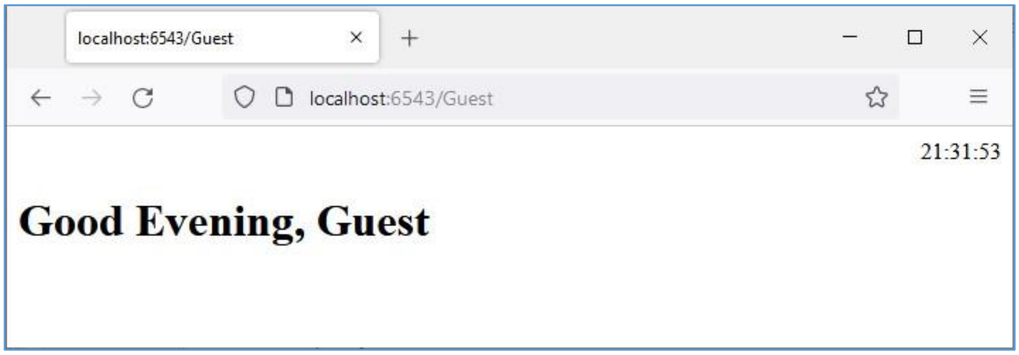
The **hello.js** code saved in static folder is as follows:

```
function myFunction() {
  var today = new Date();
  var h = today.getHours();
```

```
    var m = today.getMinutes();
    var s = today.getSeconds();
    var msg="";
    if (h<12)
    {
         msg="Good Morning, ";
    }
    if (h>=12 && h<18)
    {
         msg="Good Afternoon, ";
    }
     if (h>=18)
    {
         msg="Good Evening, ";
    }
    var x=document.getElementById('ttl').innerHTML;
    document.getElementById('ttl').innerHTML =  msg+x;
    document.getElementById('time').innerHTML =  h + ":" + m + ":" + s;
  }
```

The function detects the value of current time and assigns appropriate value to **msg** variable (good morning, good afternoon or good evening) depending on the time of the day.

Save **hello.js** in **static** folder, **hello.html** in **templates** folder and restart the server. The browser should show the current time and corresponding message below it.



21:31:53

Good Evening, Guest

11. Pyramid – Request Object

The functionality of a view callable involves obtaining the request data from the WSGI environment and returning a certain HTTP response back to the client after processing. The view function receives the Request object as the argument.

Normally this object is not instantiated by the user. Instead, it encapsulates the WSGI environ dictionary. This **request** object represents "pyramid.request.Request class." It possesses a number of attributes and methods, using which the request data is processed by the view function.

Here are some of the **attributes**:

- **request.method**: The HTTP request method used by the client to send the data, e.g., GET, POST
- **request.GET**: This attribute is a multidict with all the variables in the query string.
- **request.POST**: This attribute is available only if the request was a POST and it is a form submission. It is a multidict with all the variables in the request body.
- **request.params**: A combined multidict of everything in request.GET and request.POST.
- **request.body**: This attribute contains the entire request body as a string. This is useful when the request is a POST that is not a form submission, or a request like a PUT.
- **request.cookies**: Contains all the cookies.
- **request.headers**: A case-insensitive dictionary of all the HTTP headers.

In addition to the above HTTP specific environment attributes, Pyramid also adds certain special attributes.

- **request.url**: Returns the full request URL with query string, e.g., http://localhost:6543/app?name=Ravi
- **request.host**: The host information in the URL, e.g., localhost

- **request.host_url**: This attribute returns the URL with the host, e.g., http://localhost:6543/

- **request.application_url**: The URL of the application (without PATH_INFO), e.g., http://localhost:6543/app

- **request.path_url**: Contains the URL of the application including the PATH_INFO, e.g., http://localhost:66543/app

- **request.path**: Returns The URL including PATH_INFO without the host , e.g., "/app"

- **request.path_qs**: the query string in the URL including PATH_INFO, e.g., "/app?name=Ravi"

- **request.query_string**: Only the query string in the URL, e.g., "name=Ravi"

12. Pyramid – Response Object

The Response class is defined in pyramid.response module. An object of this class is returned by the view callable.

```
from pyramid.response import Response

def hell(request):

     return Response("Hello World")
```

The response object contains a status code (default is 200 OK), a list of response headers and the response body. Most HTTP response headers are available as properties. Following attributes are available for the Response object:

- **response.content_type**: The content type is a string such as – **`response.content_type = 'text/html'`**.

- **response.charset**: It also informs encoding in **response.text**.

- **response.set_cookie**: This attribute is used to set a cookie. The arguments needed to be given are name, value, and max_age.

- **response.delete_cookie**: Delete a cookie from the client. Effectively it sets max_age to 0 and the cookie value to ''.

The **pyramid.httpexceptions** module defines classes to handle error responses such as 404 Not Found.

These classes are in fact subclasses of the **Response** class. One such class is "pyramid.httpexceptions.HTTPNotFound". Its typical use is as follows:

```
from pyramid.httpexceptions import HTTPNotFound

from pyramid.config import view_config

@view_config(route='Hello')

def hello(request):

     response = HTTPNotFound("There is no such route defined")

     return response
```

We can use location property of Response class to redirect the client to another route. For example:

```
view_config(route_name='add', request_method='POST')

def add(request):

    #add a new object

    return HTTPFound(location='http://localhost:6543/')
```

13. Pyramid – Sessions

A session is a time interval between client logs into a server and it logs out of it. Session object is also a dictionary object containing key-value pairs of session variables and associated values. In Pyramid, it is available as an attribute of request object.

In order to handle session mechanism, the Pyramid Application object must be configured with a session factory that returns the session object. Pyramid core provides a basic session factory, which uses cookies to store session information.

Default Session Factory

The **pyramid.session** module defines **SignedCookieSessionFactory** class. Its object needs a secret key for digitally signing the session cookie information.

```
from pyramid.session import SignedCookieSessionFactory
my_session_factory = SignedCookieSessionFactory('abcQWE123!@#')
```

The **set_session_factory()** method of the Configurator class uses this factory object to set up the session.

```
config.set_session_factory(my_session_factory)
```

Once this is done, the session object is now available for implementation as **request.session** attribute. To add a session variable, use:

```
request.session['user'] = 'Admin'
```

To retrieve a session variable, use:

```
user=request.session['user']
```

To remove a session variable, use the **pop()** method.

```
request.session.pop('user')
```

Session Example

Described below is the usage of session variable in a Pyramid application. First, the login route (associated with login() view function) brings up a login form on the browser.

```
@view_config(route_name='login')
def login(request):
    html="""
<html>
<body>
<form action='/add'>
Enter User name :
<input type='text' name='user'>
<input type='submit' value='submit'>
</form>
</body>
</html>
"""
     return Response(html)
```

The add() function reads the 'user' form attribute and uses its value to add a session variable.

```
@view_config(route_name='addsession')
def add(request):
    request.session['user']=request.params['user']
    return Response("<h2>Session object added.</h2><br><h3><a
href='/read'>click here</a></h3>")
```

The read() view reads back the session variable data and displays a welcome message.

```
@view_config(route_name='readsession')
def read(request):
    user=request.session['user']
    response="<h2>Welcome {} </h2>".format(user)+"<br><h3><a
href='/logout'>Logout</a></h3>"
    return Response(response)
```

These views along with the session factory are added in the application configuration.

```
config.set_session_factory(my_session_factory)
config.add_route('login','/')
config.add_route('logout','/logout')
config.add_route('addsession', '/add')
config.add_route('readsession', '/read')
config.scan('session')
```

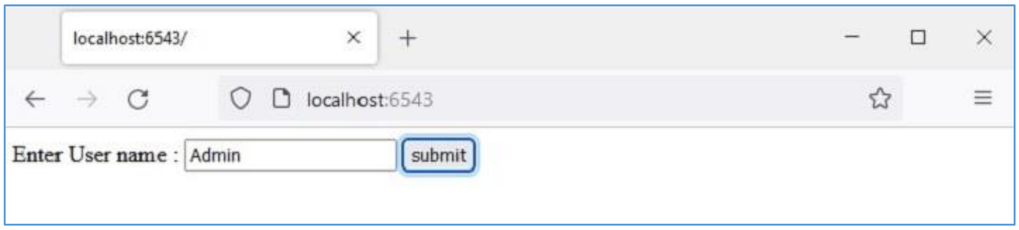
The complete code is given below:

```
from wsgiref.simple_server import make_server
from pyramid.config import Configurator
from pyramid.response import Response
from pyramid.view import view_config
from pyramid.session import SignedCookieSessionFactory
my_session_factory = SignedCookieSessionFactory('abcQWE123!@#')


@view_config(route_name='login')
def login(request):
    html="""
<html>
<body>
<form action='/add'>
Enter User name :
<input type='text' name='user'>
```

```
<input type='submit' value='submit'>
</form>
</body>
</html>
"""
    return Response(html)


@view_config(route_name='addsession')
def add(request):
    request.session['user']=request.params['user']
    return Response("<h2>Session object added.</h2><br><h3><a
href='/read'>click here</a></h3>")


@view_config(route_name='readsession')
def read(request):
    user=request.session['user']
    response="<h2>Welcome {} </h2>".format(user)+"<br><h3><a
href='/logout'>Logout</a></h3>"
    return Response(response)


@view_config(route_name='logout')
def logout(request):
    request.session.pop('user')
    response="<h2>You have been logged out </h2><br><h3><a
href='/'>Login</a></h3>"
    return Response(response)


if __name__ == '__main__':
    with Configurator() as config:
        config.set_session_factory(my_session_factory)
        config.add_route('login','/')
        config.add_route('logout','/logout')
        config.add_route('addsession', '/add')
        config.add_route('readsession', '/read')
        config.scan('session')
        app = config.make_wsgi_app()
    server = make_server('0.0.0.0', 6543, app)
    server.serve_forever()
```

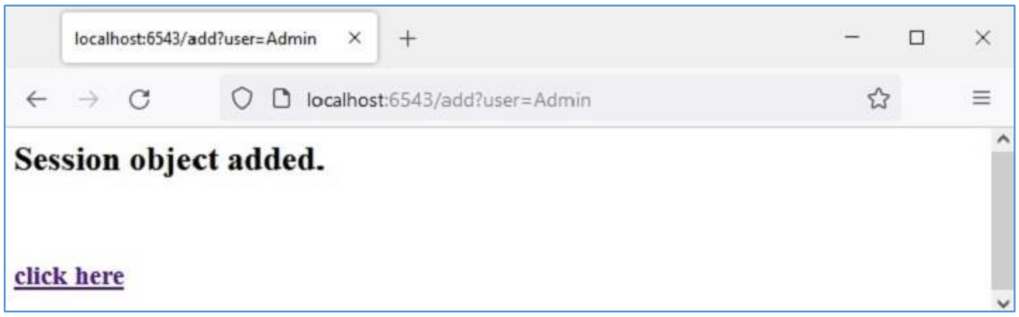
Save this script as main.py in a subfolder (called 'session') within the Pyramid virtual environment folder. Note that this subfolder must have an empty **__init__.py** file for it to be treated as a package.

Run main.py and enter http://localhost:6543/ to open up the login form in the browser.



Enter User name : Admin submit

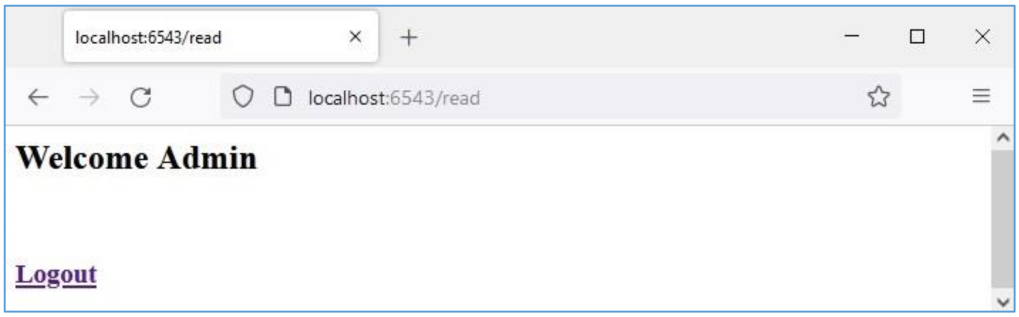
Enter the user name and press the "submit" button. The given name is saved as a 'user' session variable.



Session object added.

click here

The 'click here' link reads back the **session** variable and displays welcome message.



Welcome Admin

Logout

The logout link pops the **session** variable and takes the browser back to the login page.

14. Pyramid – Events

A Pyramid application emits various events during the course of its lifetime. Although these events need not be used up normally, slightly advanced operations can be performed by properly handling these events.

An event broadcast by the Pyramid framework becomes usable only when you register it with a **subscriber** function. The emitted event must be used as the argument of the subscriber function.

```
def mysubscriber(event):
    print("new request")
```

However, a subscriber function becomes operational only when it is added to the application's configuration with the help of **add_subscriber()** method as shown below:

In the following snippet, the application is configured so that the subscriber function is invoked when it emits **NewRequest** object.

```
from pyramid.events import NewRequest
config.add_subscriber(mysubscriber, NewRequest)
```

There is also a @subscriber() decorator for configuring the event.

```
from pyramid.events import NewRequest
from pyramid.events import subscriber

@subscriber(NewRequest)
def mysubscriber(event):
    print ("new request")
```

As with the decortive view configuration, here also the config.scan() must be performed for the decorator to be effective.

As mentioned earlier, the Pyramid application emits a variety of event types. These event classes are available in **pyramid.event** module. They are listed below:

- **ApplicationCreated**: This event is transmitted just when the config.make_wsgi_app() method of the Configurator class is called to return the WSGI application object.

- **NewRequest**: An object of this event class is emitted every time the Pyramid application starts processing an incoming request. This object has a request attribute which is the request object as supplied by WSGI environ dictionary.

- **ContextFound**: The application's router traverses all the routes and finds an appropriate match with the URL pattern. This is when the object of ContextFound class is instantiated.

- **BeforeTraversal**: An instance of this class is emitted as an event after the Pyramid router has attempted to find a route object but before any traversal or view code is executed.

- **NewResponse**: As the name suggests, this event is raised whenever any Pyramid view callable returns a response. This object has request and response attributes.

- **BeforeRender**: An object of this type is transmitted as an event just before a renderer is invoked. The subscriber function to this event has access to the application's global data (which is in the form of a dict object) and can modify value of one or more keys.

15. Pyramid – Message Flashing

The mechanism of message flashing is used by web application frameworks to provide certain feedback to the user about his interaction with the application. The flashed messages are held in a queue by the session object.

Flash messaging mechanism makes it possible to create a message in one view and render it in a view function called next. As in the previous section, we must enable the session factory first to be able to handle the session. To add a message in the message queue, use **flash()** method of the session object.

```
request.session.flash('Hello World')
```

The session has **pop_flash()** and **peek_flash()** methods. The pop_flash() method removes the last added message from the queue. The peek_flash() method returns true if the queue has a message, false if it is empty.

Both these methods are used in a template web page to fetch one or messages from the queue and render it as a part of the response.

Message Flashing Example

The mechanism of message flashing is demonstrated by the example below. Here, the login() view code checks if it has been invoked by POST or GET method. If the method is GET, it renders the login form with username and password fields. The submitted form is submitted with POST method to the same URL.

When the POST method is detected, the view further checks the validity of the inputs and flashes appropriate messages to the session queue. These error flash messages are extracted by the login template itself, whereas after the success flash message is flashed, the client is redirected to the index() view to render the index template.

The two views in the application code are:

```
@view_config(route_name='login', renderer='templates/login.html')
def login(request):
    if request.method == 'POST':
        if request.POST['password']=='' or request.POST['username']=='':
            request.session.flash('User name and password is 
required')
            return HTTPFound(location=request.route_url('login'))
        if len(request.POST['password'])in range(1,9):
            request.session.flash('Weak password!')
        if request.POST['username']not in ['admin', 'manager', 
'supervisor']:
            request.session.flash('successfully logged in!')
            return HTTPFound(location=request.route_url('index'))
        else:
            request.session.flash('Reserved user ID Forbidden!')
            return HTTPFound(location=request.route_url('login'))
    return {}


@view_config(route_name='index', renderer='templates/index.html')
def index(request):
    return {}
```

The login.html template has the following code:

```
<!doctype html>
<html>
<head>
<style>
p {background-color:grey; font-size: 150%}
</style>
</head>
<body>
<h1>Pyramid Message Flashing Example</h1>
{% if request.session.peek_flash()%}
  <div id="flash">
    {% for message in request.session.pop_flash() %}
     <p>{{ message }}</p>
```

```
      {% endfor %}

   </div>
   {% endif %}
 <h3>Login Form</h3>
 <form action="" method="POST">
 <dl>
 <dt>Username:
 <dd><input type="text" name="username">
 <dt>Password:
 <dd><input type="password" name="password">
 </dl>
 <input type="submit" value="Login">
 </form>
 </body>
 </html>
```

Before the login form is displayed, the jinja2 template code traverses through the message queue, pops each message in the **<div id='flash'>** section.

Following is the script for **index.html** that flashes the success messages inserted by the login() view:

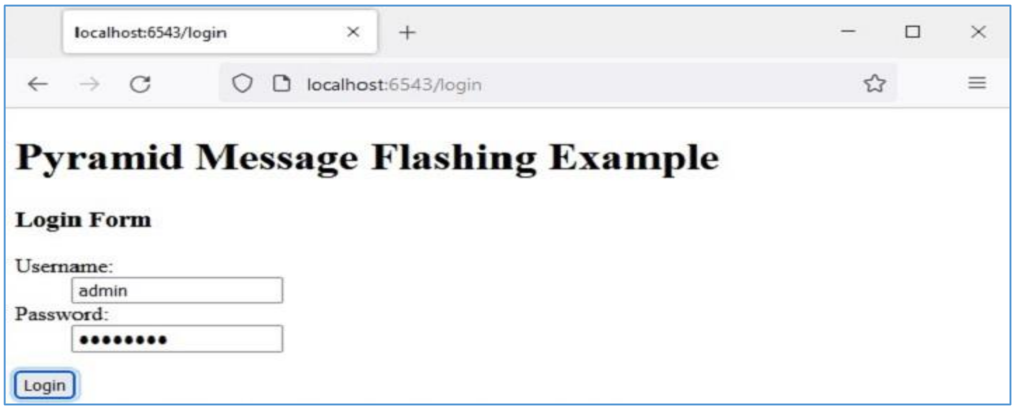
```
<!doctype html>
<html>
<head>
<style>
p {background-color:grey; font-size: 150%}
</style>
</head>
   <body>
{% if request.session.peek_flash()%}
  <div id="flash">
    {% for message in request.session.pop_flash() %}
      <p>{{ message }}</p>
     {% endfor %}
     {% endif %}
      <h1>Pyramid Message Flashing Example</h1>
      <h3>Do you want to <a href = "/login">
         <b>log in?</b></a></h3>
   </body>
</html>
```

The application code for this example is **main.py**

```
from wsgiref.simple_server import make_server
from pyramid.config import Configurator
from pyramid.response import Response
from pyramid.view import view_config
from pyramid.session import SignedCookieSessionFactory
from pyramid.httpexceptions import HTTPFound


my_session_factory = SignedCookieSessionFactory(' abcQWE123!@#')


@view_config(route_name='login', renderer='templates/login.html')
def login(request):
    if request.method == 'POST':
        if request.POST['password']=='' or request.POST['username']=='':
            request.session.flash('User name and password is required')
            return HTTPFound(location=request.route_url('login'))
        if len(request.POST['password'])in range(1,9):
            request.session.flash('Weak password!')
        if request.POST['username']not in ['admin', 'manager',
'supervisor']:
            request.session.flash('successfully logged in!')
            return HTTPFound(location=request.route_url('index'))
        else:
            request.session.flash('Reserved user ID Forbidden!')
            return HTTPFound(location=request.route_url('login'))
    return {}

@view_config(route_name='index', renderer='templates/index.html')
def index(request):
    return {}

if __name__ == '__main__':
    with Configurator() as config:
        config.set_session_factory(my_session_factory)
        config.include('pyramid_jinja2')
        config.add_jinja2_renderer(".html")
        config.add_route('login','/login')
        config.add_route('index','/')
        config.scan('flash')
        app = config.make_wsgi_app()
    server = make_server('0.0.0.0', 6543, app)
    server.serve_forever()
```

Save this program code as **app.py** in a flash subfolder in the virtual environment for Pyramid, putting a blank **__init__.py** in it. Store the two templates ("index.html" and "login.html") in **flush\templates** folder.

Run the **main.py** and open the login form in the browser by clicking the http://localhost:6543/login link.



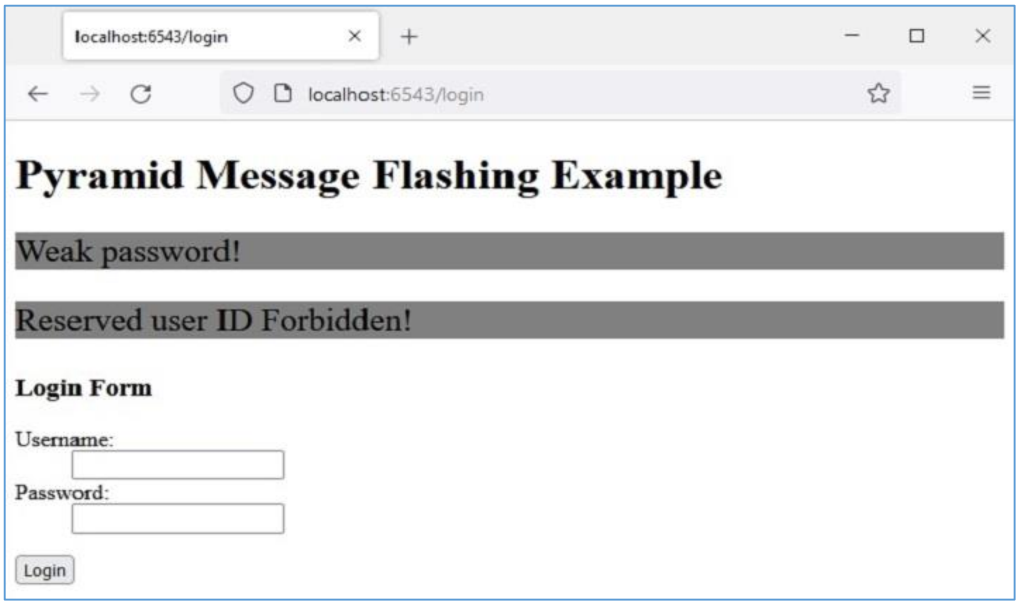
Pyramid Message Flashing Example

Login Form

Username: admin

Password: ••••••••

Try entering one of the reserved usernames 'admin', 'manager', or 'supervisor'. The error message will be flashed as shown below:



Pyramid Message Flashing Example

Weak password!

Reserved user ID Forbidden!

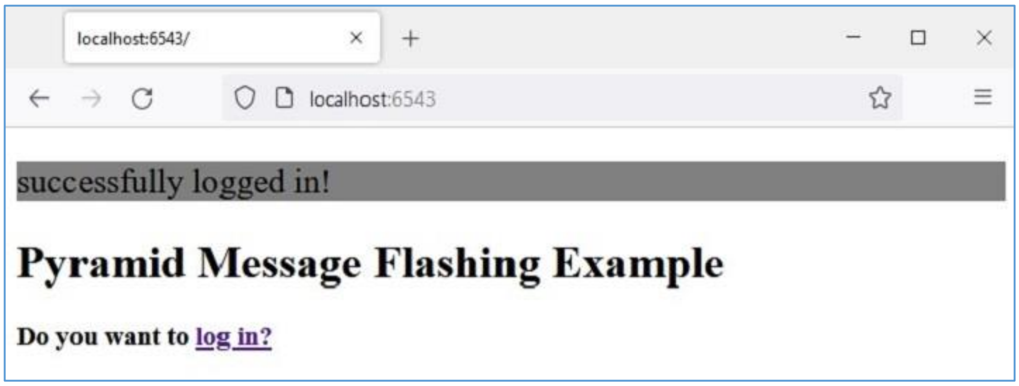
Login Form

Username:

Password:

Login

This time, enter acceptable credentials and see the result:



successfully logged in!

Pyramid Message Flashing Example

Do you want to log in?

16. Pyramid – Using SQLAlchemy

In this chapter, we shall learn how to use a relational database as a backend with the Pyramid web application. Python can interact with almost every relational database using corresponding DB-API compatible connector modules or drivers. However, we shall use **SQLAlchemy** library as an interface between Python code and a database (we are going to use SQLite database as Python has in-built support for it). SQLAlchemy is a popular SQL toolkit and Object Relational Mapper.

Object Relational Mapping is a programming technique for converting data between incompatible type systems in object-oriented programming languages. Usually, the type system used in an Object Oriented language like Python contains non-scalar types. However, data types in most of the database products such as Oracle, MySQL, etc., are of primitive types such as integers and strings.

In an ORM system, each class maps to a table in the underlying database. Instead of writing tedious database interfacing code yourself, an ORM takes care of these issues for you while you can focus on programming the logics of the system.

In order to use SQLALchemy, we need to first install the library using PIP installer.

```
pip install sqlalchemy
```

SQLAlchemy is designed to operate with a DBAPI implementation built for a particular database. It uses dialect system to communicate with various types of DBAPI implementations and databases. All dialects require that an appropriate DBAPI driver is installed.

The following are the dialects included –

- Firebird
- Microsoft SQL Server
- MySQL
- Oracle
- PostgreSQL
- SQLite
- Sybase

Database Engine

Since we are going to use SQLite database, we need to create a database engine for our database called **test.db**. Import **create_engine()** function from the **sqlalchemy** module.

```
from sqlalchemy import create_engine
from sqlalchemy.dialects.sqlite import *
SQLALCHEMY_DATABASE_URL = "sqlite:///./test.db"
engine = create_engine(SQLALCHEMY_DATABASE_URL, connect_args =
{"check_same_thread": False})
```

In order to interact with the database, we need to obtain its handle. A session object is the handle to database. Session class is defined using **sessionmaker()** – a configurable session factory method which is bound to the engine object.

```
from sqlalchemy.orm import sessionmaker, Session
session = sessionmaker(autocommit=False, autoflush=False, bind=engine)
```

Next, we need a declarative base class that stores a catalog of classes and mapped tables in the Declarative system.

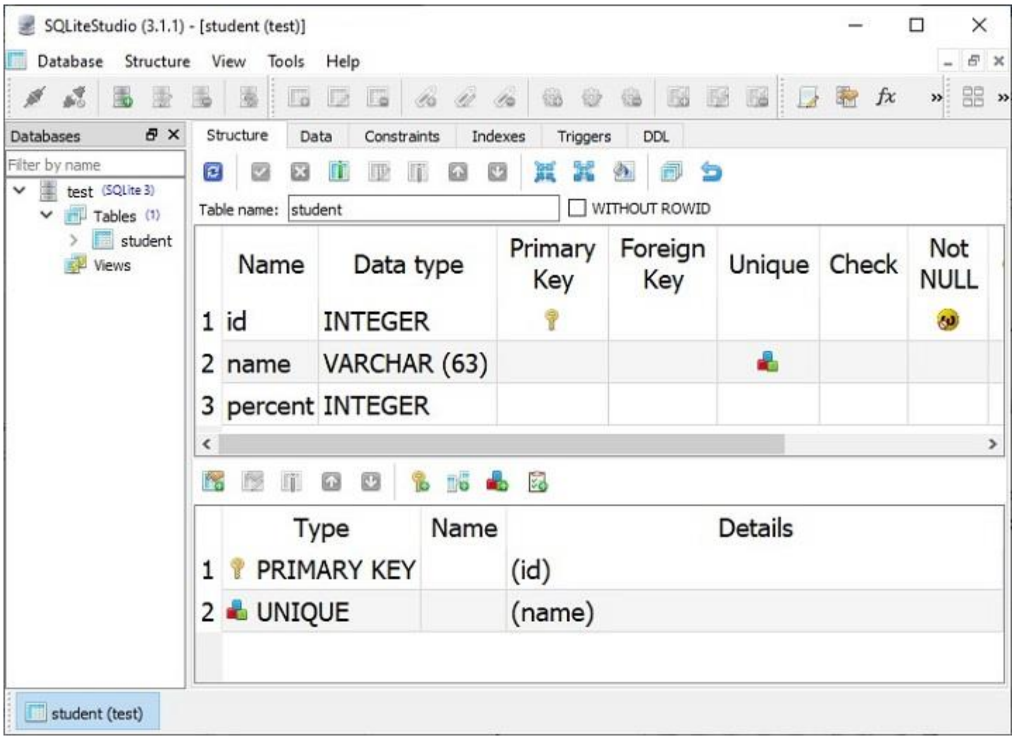
```
from sqlalchemy.ext.declarative import declarative_base
Base = declarative_base()
```

Model Class

Students, a subclass of **Base**, is mapped to a **students** table in the database. Attributes in the **Students** class correspond to the data types of the columns in the target table. Note that the id attribute corresponds to the primary key in the book table.

```
class Students(Base):
    __tablename__ = 'student'
    id = Column(Integer, primary_key=True, nullable=False)
    name = Column(String(63), unique=True)
    marks = Column(Integer)
Base.metadata.create_all(bind=engine)
```

The **create_all()** method creates the corresponding tables in the database. It can be confirmed by using a SQLite Visual tool such as **SQLiteStudio**.


SQLiteStudio (3.1.1) - [student (test)]
Database Structure View Tools Help
Databases
Filter by name
test (SQLite 3)
Tables (1)
student
Views
Structure Data Constraints Indexes Triggers DDL
Table name: student
WITHOUT ROWID
student (test)

	Name	Data type	Primary Key	Foreign Key	Unique	Check	Not NULL
1	id	INTEGER	●				●
2	name	VARCHAR (63)			●		
3	percent	INTEGER					

	Type	Name	Details
1	PRIMARY KEY		(id)
2	UNIQUE		(name)

We shall now define view functions for performing CRUD operations (i.e. add, display, modify and delete rows) on the student table in the above database.

Add a New Student Record

First, we shall create a HTML form template for the user to enter student data and define a view that renders the template. Here is the **myform.html** template

```
<html>
<body>
<form method="POST" action="http://localhost:6543/add">
<p>Student Id: <input type="text" name="id"/>  </p>
<p>student Name: <input type="text" name="name"/>  </p>
<p>Percentage: <input type="text" name="percent"/>  </p>
<p><input type="submit" value="Submit"> </p>
```

```
</body>
</html>
```

In the Pyramid application code, define the index() view function to render the above form.

```
from wsgiref.simple_server import make_server
from pyramid.config import Configurator
from pyramid.response import Response
from pyramid.view import view_config


@view_config(route_name='index', renderer='templates/myform.html')
def index(request):
    return {}
```

In the application configuration, register the route with the "/new" pattern for this view as:

```
if __name__ == '__main__':
    with Configurator() as config:
        config.include('pyramid_jinja2')
        config.add_jinja2_renderer(".html")
        config.add_route('index', '/new')
        config.scan()
        app = config.make_wsgi_app()
    server = make_server('0.0.0.0', 6543, app)
    server.serve_forever()
```

As the HTML form in the above template is submitted to **/add** URL with POST action, we need to map this URL to add route and register add() view that parses the form data into an object of Students class. This object is added to the database session and the operation is finalized by calling its commit() method.

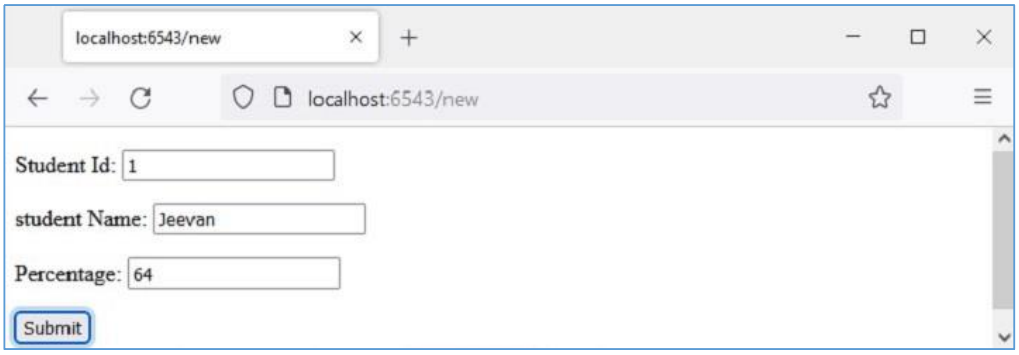
```
@view_config(route_name='add', request_method='POST')
```

```
def add(request):
    id=request.POST['id']
    name=request.POST['name']
    percent=int(request.POST['percent'])
    student=Students(id=id, name=name, percent=percent)
    session.add(student)
    session.commit()
    return HTTPFound(location='http://localhost:6543/')
```

Make sure that the add route is added in the configuration, mapped to /add URL pattern.

```
config.add_route('add','/add')
```

If we start the server and open http://localhost:6543/new in the browser, the Entry form will be displayed as follows:

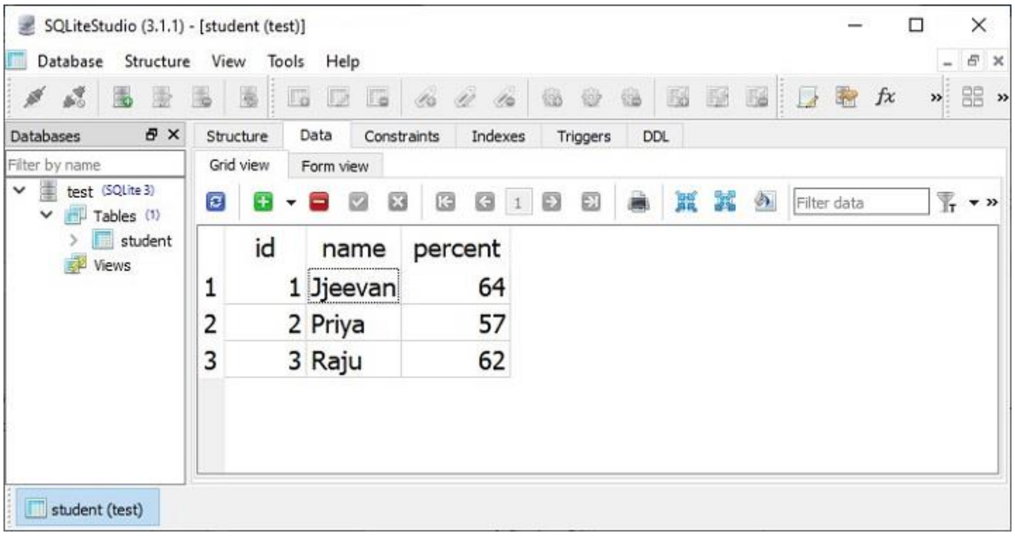


Student Id: 1

student Name: Jeevan

Percentage: 64

Fill the form and press the "submit" button. The add() view will be called and a new record will be added in the students table. Repeat the process a couple of times to add a few records. Here is a sample data:


SQLiteStudio (3.1.1) - [student (test)]
Database Structure View Tools Help
Databases
Filter by name
test (SQLite 3)
Tables (1)
student
Views
Structure Data Constraints Indexes Triggers DDL
Grid view Form view
Filter data
student (test)

	id	name	percent
1	1	Jjeevan	64
2	2	Priya	57
3	3	Raju	62

Show List of All Records

All the objects of the Students model (corresponding to row in students table) are obtained by querying the model.

```
rows = session.query(Students).all()
```

Each row is converted into a dict object, all of them are appended to a list of dict objects, and returned as a context to the list.html template to be displayed in the form of HTML template. The process is performed by the showall() view function, associated with list route.

```
@view_config(route_name='list',
renderer='templates/marklist.html')

def showall(request):

    rows = session.query(Students).all()

    students=[]

    for row in rows:

        students.append({"id":row.id, "name":row.name,
"percent":row.percent})

    return{'students':students}
```

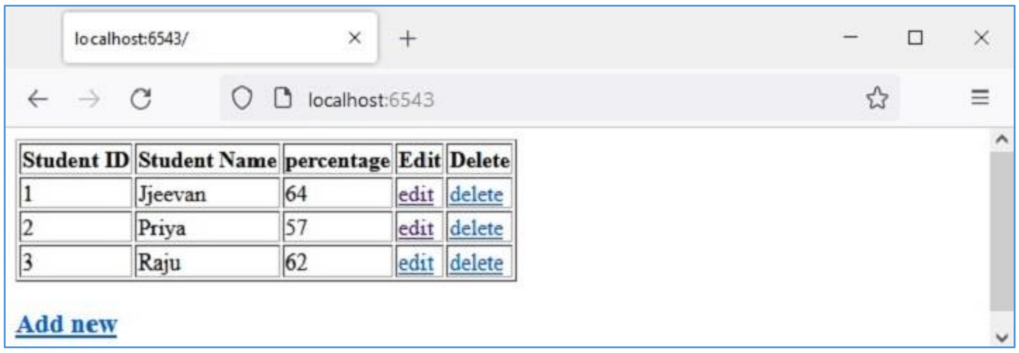
The **marklist.html** template renders the Students list as a HTML table. Its HTML/jinja2 script is as follows:

```
<html>
<body>
<table border=1>
    <thead>  <tr>
        <th>Student ID</th>
           <th>Student Name</th>
        <th>percentage</th>
        <th>Edit</th>
           <th>Delete</th>
    </tr>   </thead>
    <tbody>
{% for Student in students %}
    <tr>
     <td>{{ Student.id }}</td> <td>{{ Student.name }}</td>
    <td>{{ Student.percent }}</td>
    <td><a href="/show/{{ Student.id }}">edit</a></td>
     <td><a href="/delete/{{ Student.id }}">delete</a></td>
     </tr>
{% endfor %}
    </tbody>
</table>
<h3><a href="http://localhost:6543/new">Add new</a></h3>
 </body>
</html>
```

Add the list route in the configuration and register it with '/' URL.

```
config.add_route('list', '/')
```

Open http://localhost:6543/ in the browser after starting the server. The list of existing records in the students table will be displayed.



Student ID	Student Name	percentage	Edit	Delete
1	Jjeevan	64	edit	delete
2	Priya	57	edit	delete
3	Raju	62	edit	delete

Add new

Notice the hyperlinks in the last two columns. For example, the "edit" link before "id=1" points to http://localhost:6543/show/1. These links are intended to execute update and delete operations.

Update Existing Record

In the /show/1 URL, there is a trailing path parameter. It is mapped to 'show' route in the configuration.

```
config.add_route('show', '/show/{id}')
```

This route invokes the show() function. It fetches the record corresponding to the given id parameter, populates the HTML form with its contents and lets the user to update values of name and/or percent fields.

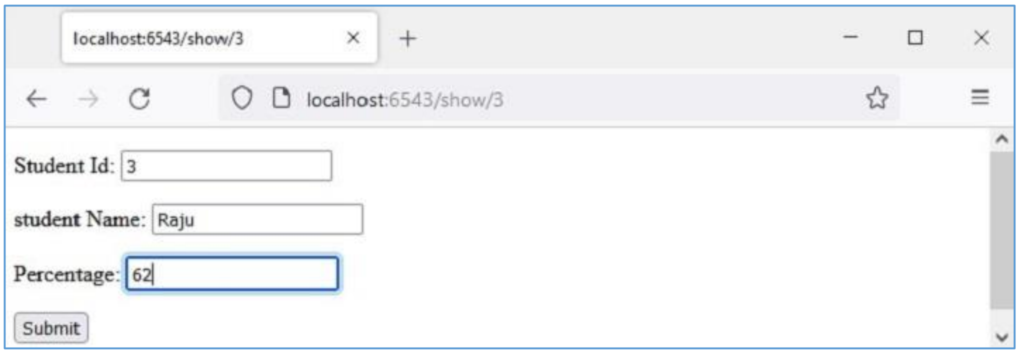
```
@view_config(route_name='show',
renderer='templates/showform.html')

def show(request):

    id=request.matchdict['id']

    row = session.query(Students).filter(Students.id ==
id).first()

    student={'id':row.id, 'name':row.name,
'percent':row.percent}

    return {'student':student}
```

The HTML/jinja2 code of showform.html template is as follows:

```
<html>
```

```
<body>
<form method="POST" action="http://localhost:6543/update">
<p>Student Id: <input type="text" name="id"
value="{{ student.id }} " readonly/>  </p>
<p>student Name: <input type="text" name="name"
value="{{ student.name }}"/>  </p>
<p>Percentage: <input type="text" name="percent"
value="{{ student.percent }}"/>  </p>
<p><input type="submit" value="Submit"> </p>
</body>
</html>
```

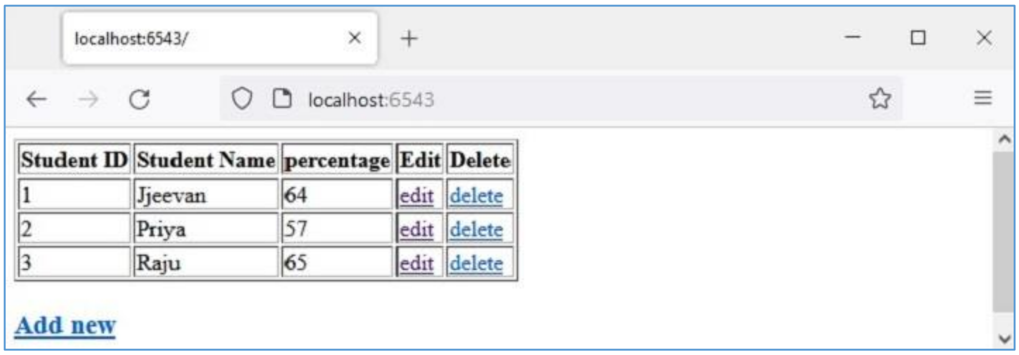
Let us update the record with id=3. Click on corresponding Edit link to navigate to http://localhost:6543/show/3



Change the value in marks text field and press submit. The form is redirected to /update URL and it invokes update() view. It fetches the submitted data and updates the corresponding object thereby the underlying row in students table is also updated.

```
@view_config(route_name='update', request_method='POST')
def update(request):
    id=int(request.POST['id'])
    student = session.query(Students).filter(Students.id ==
id).first()
    student.percent=int(request.POST['percent'])
    session.commit()
    return HTTPFound(location='http://localhost:6543/')
```

The return statement redirects the browser back to the '/' URL, which points to the list() function and shows the updated marklist.



Student ID	Student Name	percentage	Edit	Delete
1	Jjeevan	64	edit	delete
2	Priya	57	edit	delete
3	Raju	65	edit	delete

Add new

Make sure that the update route as added to the configuration before running.

```
config.add_route('update', '/update')
```

Delete a Record

To delete a record corresponding to a row in the marklist table, follow the Delete link in the last column. For example, clicking on Delete in 3rd row emits http://localhost:6543/delete/3 URL and invokes following view function:

```
@view_config(route_name='delete',
renderer='templates/deleted.html')
def delete(request):
    id=request.matchdict['id']
    row = session.query(Students).filter(Students.id == id).delete()
    return {'message':'Redcord has been deleted'}
```

The object corresponding to the path parameter parsed from the URL is deleted and the appropriate message is rendered by the following template – **deleted.html**:

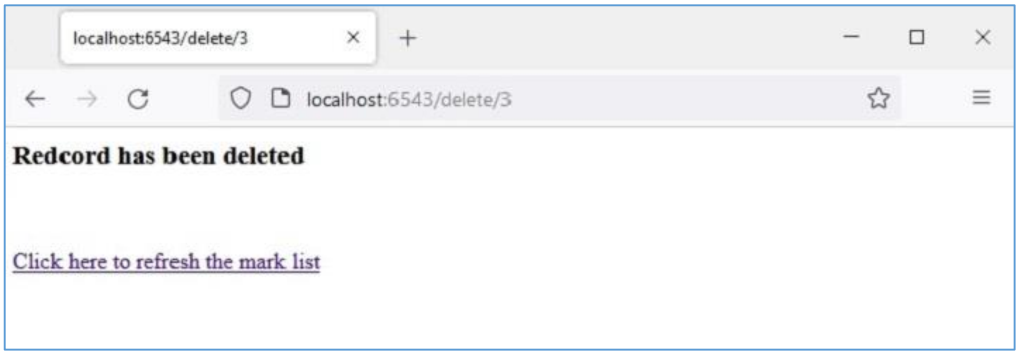
```
<html>
```

```
<body>
    <h3>{{ message}}</h3>
    <br><br>
    <a href="http://localhost:6543/">Click here to refresh
the mark list</a>
</body>
</html>
```

Obviously, the delete route has to be added in the application config registry.

```
config.add_route('delete', '/delete/{id}')
```

The result of record delete action is as shown below:



Redcord has been deleted

Click here to refresh the mark list

Take the following steps to perform the above explained activity:

1. Create a folder named as **testapp** in the Pyramid virtual environment

2. Inside **testapp**, create the **templates** folder.

3. Create a blank **__init__.py** inside **testapp** so that it becomes a package.

4. Put marklist.html, myform.html, showform.html and deleted.html files in "testapp\templates" folder. Codes of these files have been given above.

5. Save the following code as **models.py** in **testapp**.

```
from sqlalchemy.dialects.sqlite import *
from sqlalchemy.ext.declarative import declarative_base
from sqlalchemy import create_engine
from sqlalchemy.orm import sessionmaker
from sqlalchemy.orm import Session
from sqlalchemy import Column, Integer, String
SQLALCHEMY_DATABASE_URL = "sqlite:///./test.db"

Base = declarative_base()

class Students(Base):
    __tablename__ = 'student'
    id = Column(Integer, primary_key=True, nullable=False)
    name = Column(String(63), unique=True)
    percent = Column(Integer)

def getsession():
    engine = create_engine(
        SQLALCHEMY_DATABASE_URL,
connect_args={"check_same_thread": False}
    )

    Base.metadata.create_all(bind=engine)
    Session = sessionmaker(bind = engine)
    session = Session()
    return session
```

6. Save the following code as **views.py** in **testapp** folder.

```
from pyramid.response import Response
from pyramid.view import view_config
from pyramid.httpexceptions import HTTPFound
from models import Students
from main import session
```

```
@view_config(route_name='list',
renderer='templates/marklist.html')
def showall(request):
    rows = session.query(Students).all()
    students=[]
    for row in rows:
        students.append({"id":row.id, "name":row.name,
"percent":row.percent})
    return{'students':students}

@view_config(route_name='index', renderer='templates/myform.html')
def index(request):
    return {}

@view_config(route_name='add', request_method='POST')
def add(request):
    id=request.POST['id']
    name=request.POST['name']
    percent=int(request.POST['percent'])
    student=Students(id=id, name=name, percent=percent)
    session.add(student)
    session.commit()
    return HTTPFound(location='http://localhost:6543/')

@view_config(route_name='update', request_method='POST')
def update(request):
    id=int(request.POST['id'])
    student = session.query(Students).filter(Students.id == id).first()
    student.percent=int(request.POST['percent'])
    session.commit()
    return HTTPFound(location='http://localhost:6543/')
```

```
@view_config(route_name='show',
renderer='templates/showform.html')
def show(request):
    id=request.matchdict['id']
    row = session.query(Students).filter(Students.id == id).first()
    student={'id':row.id, 'name':row.name, 'percent':row.percent}
    return {'student':student}

@view_config(route_name='delete', renderer='templates/deleted.html')
def delete(request):
    id=request.matchdict['id']
    row = session.query(Students).filter(Students.id == id).delete()
    return {'message':'Redcord has been deleted'}
```

7. Save the following code as main.py in testapp folder.

```
from wsgiref.simple_server import make_server
from pyramid.config import Configurator
from models import getsession
session=getsession()


if __name__ == '__main__':
    with Configurator() as config:
        config.include('pyramid_jinja2')
        config.add_jinja2_renderer(".html")
        config.add_route('list', '/')
        config.add_route('index', '/new')
        config.add_route('add','/add')
        config.add_route('show', '/show/{id}')
        config.add_route('update', '/update')
        config.add_route('delete', '/delete/{id}')
        config.scan('testapp')
        app = config.make_wsgi_app()
    server = make_server('0.0.0.0', 6543, app)

    server.serve_forever()
```

8. Run **main.py** from the command prompt.

```
Python main.py
```

9. Use http://localhost:6543/ URL in the browser window. A table with only the headings and no records will be displayed.

10. Follow Add new link below the table to add records.

11. Click the "Edit" link in the table to update a record.

12. Clink the "Delete" link in the table to delete selected record.

17. Pyramid – Cookiecutter

We have so far built the Pyramid application by manually performing the route configuration, adding the views and using the templates. **Cookiecutter** offers a convenient alternative to generate a Pyramid project structure. It is a command-line utility that uses certain predefined project templates. The project can then be fine-tuned to accommodate specific requirements that the user may have.

The Python project created by Cookiecutter is a Python package. The default application logic can be further customized. The project structure so created is extremely extensible and is easy to distribute.

The Cookiecutter utility is developed by **Audrey Feldroy**. It works on Python versions >=3.7. The project templates in Python, JavaScript, Ruby, CoffeeScript, languages or RST, Markdown, CSS, HTML scripts can be used to generate a project. Github hosts a number of pre-built project templates, any of which can be used.

The project built from cookiecutter template is a cross-platform package. Cookiecutter project generation is completely automated and you don't have to write any code for it. Once the cookiecutter command is invoked, it reads the template being used and prompts the user to choose appropriate values for the settings parameters.

To begin with, install Cookiecutter with PIP installer.

```
pip install cookiecutter
```

To verify if Cookiecutter is correctly installed, run

```
>>> import cookiecutter

>>> cookiecutter.__version__

'1.7.3'
```

18. Pyramid – Creating a Project

It is assumed that a Pyramid virtual environment is up and running, and Cookiecutter is installed in it. The easiest way to create a Cookiecutter project is to use a pre-built starter template as per the following command:

```
cookiecutter gh:Pylons/pyramid-cookiecutter-starter --checkout
2.0-branch
```

The template is downloaded and the user is asked about his choice of name of the project:

```
project_name [Pyramid Scaffold]: testproj

repo_name [testproj]:
```

Then choose the template language.

Select **template_language**:

```
1 - jinja2

2 - chameleon

3 - mako

Choose from 1, 2, 3 [1]: 1
```

Since we are familiar with jinja2, give 1 as the choice. Next, use SQLALchemy as the backend.

```
Select backend:

1 - none

2 - sqlalchemy

3 - zodb

Choose from 1, 2, 3 [1]: 2
```

Inside the **testproj** folder, following file structure is created:

```
│    development.ini
│    MANIFEST.in
│    production.ini
│    pytest.ini
│    README.txt
│    setup.py
│    testing.ini
│
├──────testproj
│    │    pshell.py
│    │    routes.py
│    │    __init__.py
│    │
│    ├──────alembic
│    │    │    env.py
│    │    │    script.py.mako
│    │    │
│    │    └──────versions
│    │              README.txt
│    │
│    ├──────models
│    │         meta.py
│    │         mymodel.py
│    │         __init__.py
│    │
│    ├──────scripts
│    │         initialize_db.py
│    │         __init__.py
│    │
│    ├──────static
│    │         pyramid-16x16.png
│    │         pyramid.png
│    │         theme.css
│    │
│    ├──────templates
│    │         404.jinja2
│    │         layout.jinja2
│    │         mytemplate.jinja2
│    │
│    └──────views
│             default.py
│             notfound.py
│             __init__.py
│
└──────tests
          conftest.py
```

```
        test_functional.py
        test_views.py
        __init__.py
```

The outer **testproj** folder has an inner **testproj** package subfolder and tests package. The inner **testproj** subfolder is a package having models and scripts, subpackages, and static as well as templates folders.

Next, initialize and upgrade the database using Alembic.

```
    # Generate your first revision.
    alembic -c development.ini revision --autogenerate -m "init"
    # Upgrade to that revision.
    alembic -c development.ini upgrade head
```

Alembic is a lightweight database migration tool for usage with the SQLAlchemy Database Toolkit for Python. The outer project folder will now show a **testproj.sqlite** database.

The development.ini file provides a default data for the database. Populate the database with it by the following command.

```
initialize_testproj_db development.ini
```

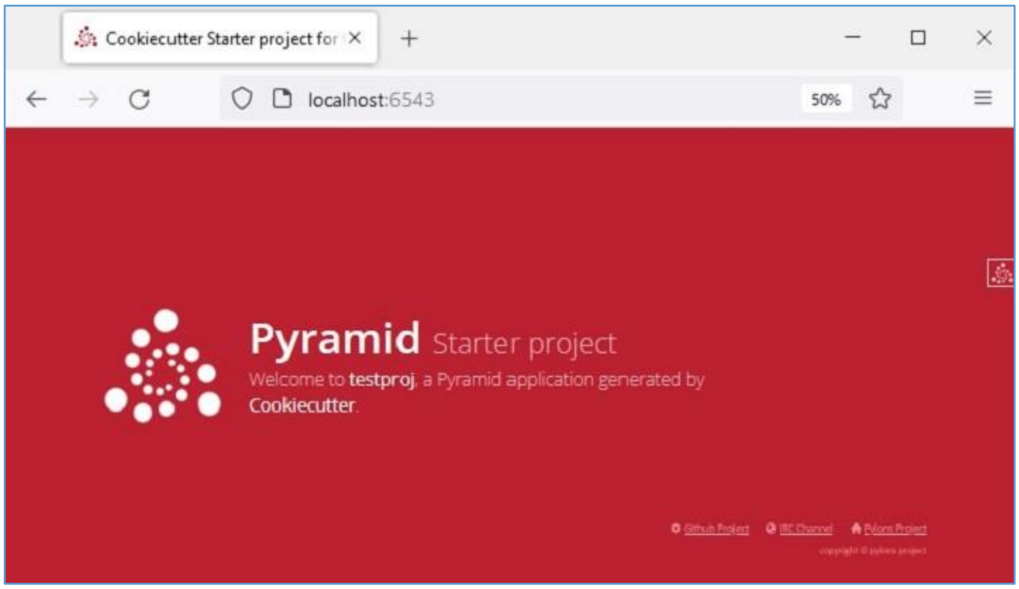
The Cookiecutter utility also generates the test suite in the tests package. They are based on **PyTest** package. Go ahead and see if the tests pass.

```
Pytest
================ test session starts ======================
platform win32 -- Python 3.10.1, pytest-7.1.2, pluggy-1.0.0
rootdir: F:\pyram-env\testproj, configfile: pytest.ini,
testpaths: testproj, tests
plugins: cov-3.0.0
collected 5 items


tests\test_functional.py ..
[ 40%]
tests\test_views.py ...
[100%]
=============== 5 passed, 20 warnings in 6.66s ===============
```

Cookiecutter uses the Waitress server. The Pyramid application is served on localhost's port 6543 by following command:

```
pserve development.ini

Starting server in PID 67700.

2022-06-19 23:43:51,308 INFO  [waitress:485][MainThread]
Serving on http://[::1]:6543

2022-06-19 23:43:51,308 INFO  [waitress:485][MainThread]
Serving on http://127.0.0.1:6543
```

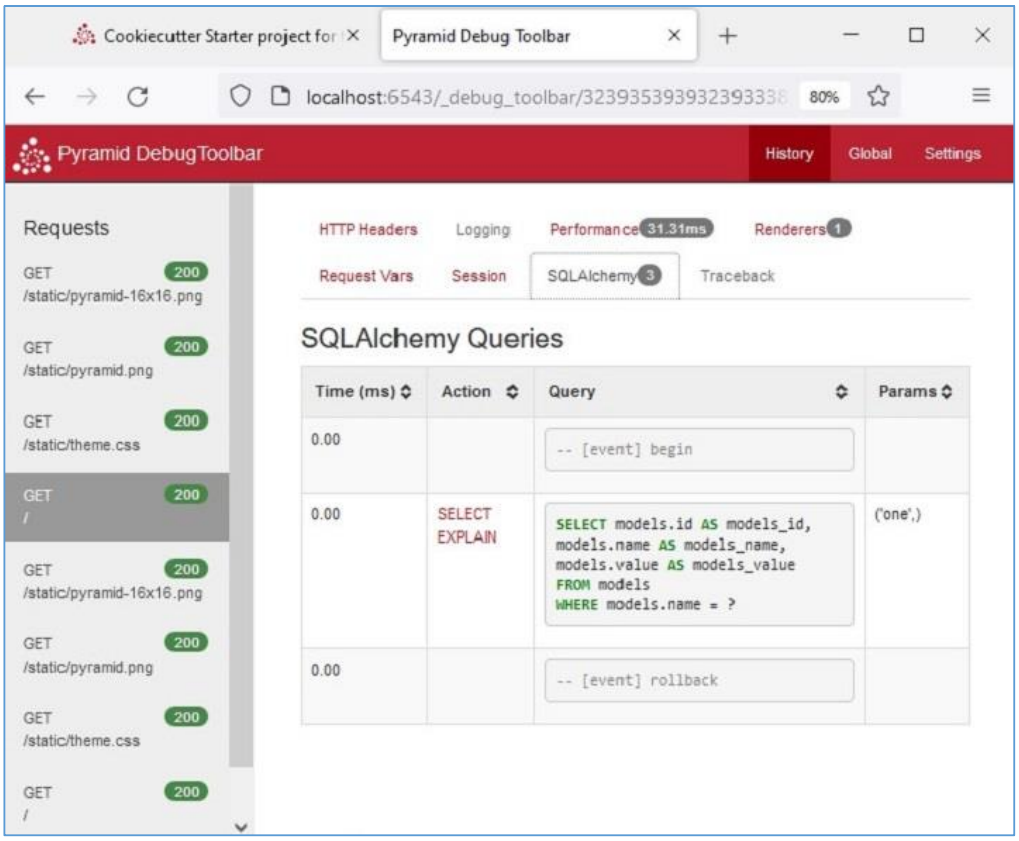
Open the browser and visit http://localhost:6543/ in it. The homepage of the newly created project will be displayed as follows:


Cookiecutter Starter project for
localhost:6543
50%
Pyramid Starter project
Welcome to testproj, a Pyramid application generated by Cookiecutter.
Github Project
IRC Channel
Pylons Project
copyright © pylons project

Debug Toolbar

You can find a smaller Pyramid logo at the top right of the homepage. Click on it to open a new tab and a debug toolbar that provides lots of useful information about the project.

For example, the SQLAlchemy tab under the history heading shows the SQLAlchemy queries showing the structure of the model created from the default data in **development.ini**.

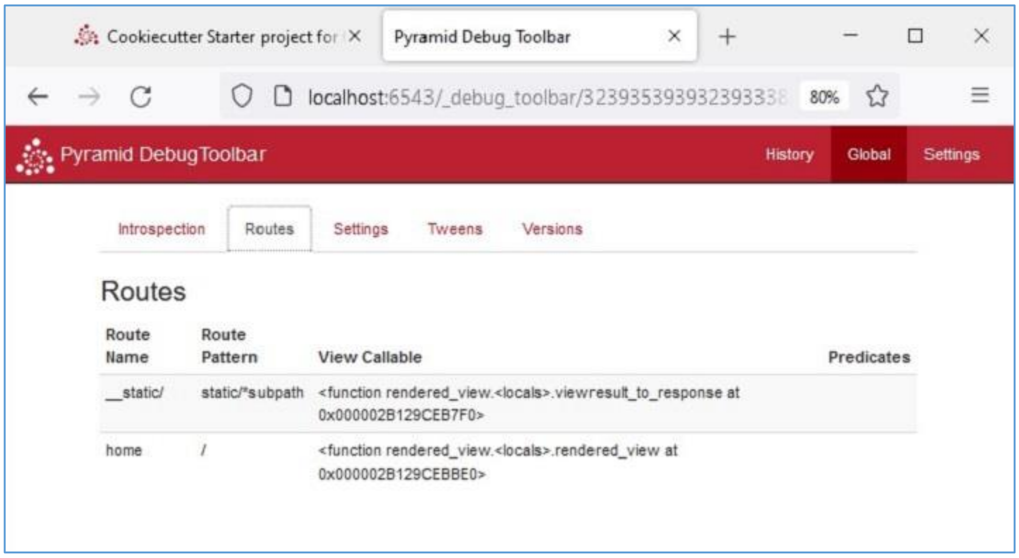


GET /static/pyramid-16x16.png 200
GET /static/pyramid.png 200
GET /static/theme.css 200
GET / 200
GET /static/pyramid-16x16.png 200
GET /static/pyramid.png 200
GET /static/theme.css 200
GET / 200

SQLAlchemy Queries

Time (ms)	Action	Query	Params
0.00		`-- [event] begin`	
0.00	SELECT EXPLAIN	`SELECT models.id AS models_id, models.name AS models_name, models.value AS models_value FROM models WHERE models.name = ?`	('one',)
0.00		`-- [event] rollback`	

The Global heading again shows tabs such as Introspection, Routes, etc. as shown below. Click the "Routes" tab to see the routes and their matching patterns defined in the application's configuration.



Routes

Route Name	Route Pattern	View Callable	Predicates
__static/	static/*subpath	<function rendered_view.<locals>.viewresult_to_response at 0x000002B129CEB7F0>	
home	/	<function rendered_view.<locals>.rendered_view at 0x000002B129CEBBE0>	

19. Pyramid – Project Structure

As mentioned earlier, the outer testproj folder contains testproj and test packages. In addition, it has other files used to describe, run, and test the application. These files are:

- **MANIFEST.in** contains list of files to be included in a source distribution of the package.

- **development.ini** is a PasteDeploy configuration file that can be used to execute your application during development.

- **production.ini** is a PasteDeploy configuration file that can be used to execute your application in a production configuration.

- **pytest.ini** is a configuration file for running tests.

- **setup.py** is the standard Setuptools setup.py file used to test and distribute the application.

- **testing.ini** is a configuration file used to execute the application's tests.

The ".ini" files are the configurations used by Cookiecutter utility to generate the Pyramid application structure. These filesuse a system called PasteDeploy, which has been developed by Ian Bicking. This library is installed automatically along with Pyramid.

Although a Pyramid application can be developed without PasteDeploy support, it gives a standardized way of starting, debugging and testing the application.

The predefined settings are read from the configuration files (with .ini extension). These files contain mainly the application configuration settings, server settings and logging settings.

development.ini

As shown earlier, the Pyramid application built with Cookiecutter is invoked by the following command:

```
pserve development.ini
```

The development.ini contains the PasteDeploy configuration specifications of the application. The configuration specifications in this file are having various sections such as [app:main], [server:main], [loggers] etc.

The most important section id [app:main]. It specifies the starting point of the application.

```
[app:main]
use = egg:testproj

pyramid.reload_templates = true
pyramid.debug_authorization = false
pyramid.debug_notfound = false
pyramid.debug_routematch = false
pyramid.default_locale_name = en
pyramid.includes =
    pyramid_debugtoolbar

sqlalchemy.url = sqlite:///%(here)s/testproj.sqlite

retry.attempts = 3
```

The very first entry "use = egg:testproj" indicates the name of the Pyramid WSGI application object main. It is declared in the **__init__.py** file of the textproj package (inside the **testproj** project folder). This section contains other startup time configuration settings.

For instance, the "pyramid.includes" setting specifies the packages to be included in the runtime. In the above example, the **debugtoolbar** package is included so that the debug panel gets activated when the Pyramid logo is clicked. We have seen its functioning in the earlier section.

We also see that the URL of the database to be used in this application has also been specified.

The [server:main] section specifies the configuration of a WSGI server which listens on TCP port 6543. It is configured to listen on localhost only (127.0.0.1).

```
[server:main]
use = egg:waitress#main
listen = localhost:6543
```

Other various logging related sections use Python's logging library. These ".ini" file sections are passed to the logging module's config file configuration engine.

production.ini

This file used to serve the application instead of the "development.ini" when the application is deployed in the production mode. Both these files are similar. However, in "production.ini", the debug toolbar is disabled, the reload options are disabled and turns off the debugging options.

Here's a stripped-down version of typical "production.ini" file:

```
[app:main]
use = egg:testproj
pyramid.reload_templates = false
pyramid.debug_authorization = false
pyramid.debug_notfound = false
pyramid.debug_routematch = false
pyramid.default_locale_name = en
sqlalchemy.url = sqlite:///%(here)s/testproj.sqlite
retry.attempts = 3
[pshell]
setup = testproj.pshell.setup
[alembic]
script_location = testproj/alembic
file_template = %%(year)d%%(month).2d%%(day).2d_%%(rev)s
[server:main]
use = egg:waitress#main
listen = *:6543
[loggers]
```

```
keys = root, testproj, sqlalchemy, alembic
[handlers]
keys = console
[formatters]
keys = generic
[logger_root]
level = WARN
handlers = console
[logger_testproj]
level = WARN
handlers =
qualname = testproj
[logger_sqlalchemy]
level = WARN
handlers =
qualname = sqlalchemy.engine
[logger_alembic]
level = WARN
handlers =
qualname = alembic
[handler_console]
class = StreamHandler
args = (sys.stderr,)
level = NOTSET
formatter = generic
[formatter_generic]
format = %(asctime)s %(levelname)-5.5s
[%(name)s:%(lineno)s][%(threadName)s] %(message)s
```

20. Pyramid – Package Structure

The Cookiecutter utility automatically creates a package folder inside the parent project folder of the same name. The package folder consists of the following files and subfolders.

__init__.py

A folder needs **__init__.py** file for it to be treated as a Python package. The **testproj** package also has this file, which essentially declares the Pyramid WSGI application project for the development.ini to use it as the entry point.

The application object is returned by the **main()** function. It configures the application registry by including the template library chosen at the time of running cookiecutter, including the **routes** module and adding the views to the configurator by scanning the existing package. Following Python code is auto generated as **__init__.py** file.

```
from pyramid.config import Configurator
def main(global_config, **settings):
    """ This function returns a Pyramid WSGI application.
    """
    with Configurator(settings=settings) as config:
        config.include('pyramid_jinja2')
        config.include('.routes')
        config.include('.models')
        config.scan()
    return config.make_wsgi_app()
```

routes.py

The Cookiecutter utility automatically generates a Python script having a function called **includeme()**. It adds a static route and a home route pointing to '/' URL pattern.

```
def includeme(config):
    config.add_static_view('static', 'static', cache_max_age=3600)
    config.add_route('home', '/')
```

These routes are added to the application configuration by the **main()** function in **__init__.py** file explained above.

Views Package

The project package (in our case **testproj** package) contains this views subpackage - a folder containing a blank **__init__.py**, a Python module called default.py that contains definition a view function named **my_view()**. It sends the name of the project as a context to a pre-built template **mytemplate.jinja2**

```
from pyramid.view import view_config
from pyramid.response import Response
from sqlalchemy.exc import SQLAlchemyError
from .. import models


@view_config(route_name='home',
renderer='testproj:templates/mytemplate.jinja2')
def my_view(request):
    try:
        query = request.dbsession.query(models.MyModel)
        one = query.filter(models.MyModel.name == 'one').one()
    except SQLAlchemyError:
        return Response(db_err_msg, content_type='text/plain',
status=500)
    return {'one': one, 'project': 'testproj'}


db_err_msg = """\
Pyramid is having a problem using your SQL database.
....
"""
```

The **default.py** scripts also imports definition of **mymodel** in models subpackage. This views package also defines a **notfound** view in notfound.py file.

```
from pyramid.view import notfound_view_config
@notfound_view_config(renderer='testproj:templates/404.jinja2')
def notfound_view(request):
    request.response.status = 404
    return {}
```

static folder

This folder under the **testproj** package folder contains Pyramid logo files and **theme.CSS** for the homepage.

templates folder

We know that the web templates need to be stored in templates folder. This subfolder contains jinja2 templates. Here we have a base template named as **layout.jinja2** and it is inherited by **mytemplate.jinja2** to be rendered by **my_view()** view function.

```
{% extends "layout.jinja2" %}


{% block content %}
<div class="content">
  <h1><span class="font-semi-bold">Pyramid</span> <span
class="smaller">Starter project</span></h1>
  <p class="lead">Welcome to <span class="font-
normal">{{project}}</span>, a&nbsp;Pyramid application
generated&nbsp;by<br><span class="font-
normal">Cookiecutter</span>.</p>
</div>
{% endblock content %}
```

models Package

This subpackage under the **tesptproj** package folder holds **mymodel.py** that has the definition of SQLAlchemy model named as **MyModel**.

```
from sqlalchemy import (
    Column,
    Index,
    Integer,
    Text,
)

from .meta import Base
class MyModel(Base):
    __tablename__ = 'models'
    id = Column(Integer, primary_key=True)
    name = Column(Text)
    value = Column(Integer)
Index('my_index', MyModel.name, unique=True, mysql_length=255)
```

The **meta.py** declares an object of Declarative Base class in SQLAlchemy.

```
from sqlalchemy.ext.declarative import declarative_base
from sqlalchemy.schema import MetaData

NAMING_CONVENTION = {
    "ix": "ix_%(column_0_label)s",
    "uq": "uq_%(table_name)s_%(column_0_name)s",
    "ck": "ck_%(table_name)s_%(constraint_name)s",
    "fk": "fk_%(table_name)s_%(column_0_name)s_%(referred_table_name)s",
    "pk": "pk_%(table_name)s"
}
metadata = MetaData(naming_convention=NAMING_CONVENTION)
Base = declarative_base(metadata=metadata)
```

21. Pyramid – Creating a Project Manually

The Cookiecutter utility uses pre-defined project templates to auto-generate the project and package structure. For complex projects, it saves a lot of manual effort in properly organizing various project components.

However, a Pyramid project can be built manually without having to use Cookiecutter. In this section, we shall see how a Pyramid project named Hello is built in following easy steps.

setup.py

Create a project directory within Pyramid virtual environment.

```
md hello
cd hello
```

and save the following script as **setup.py**

```
from setuptools import setup

requires = [
    'pyramid',
    'waitress',
]
setup(
    name='hello',
    install_requires=requires,
    entry_points={
        'paste.app_factory': [
            'main = hello:main'
        ],
    },
)
```

As mentioned earlier, this is a Setuptools setup file that defines requirements for installing dependencies for your package.

Run the following command to install the project and generate the 'egg' in the name **hello.egg-info**.

```
pip3 install -e .
```

development.ini

Pyramid uses **PasteDeploy** configuration file mainly to specify the main application object, and the server configuration. We are going to use the application object in the egg info of **hello** package, and the Waitress server, listening on port 5643 of the localhost. Hence, save the following snippet as development.ini file

```
[app:main]
use = egg:hello


[server:main]
use = egg:waitress#main
listen = localhost:6543
```

__init__.py

Finally, the application code resides in this file which is also essential for the hello folder to be recognised as a package.

The code is a basic Hello World Pyramid application code having **hello_world()** view. The **main()** function registers this view with hello route having '/' URL pattern, and returns the application object given by **make_wsgi_app()** method of Configurator.

```
from pyramid.config import Configurator
from pyramid.response import Response
def hello_world(request):
    return Response('<body><h1>Hello World!</h1></body>')
```

```
def main(global_config, **settings):
    config = Configurator(settings=settings)
    config.add_route('hello', '/')
    config.add_view(hello_world, route_name='hello')
    return config.make_wsgi_app()
```

Finally, serve the application with the help of **pserve** command.

```
pserve development.ini --reload
```

22. Pyramid – Command Line Pyramid

The Pyramid library has a **scripts** subpackage, and it contains a number of Python scripts that are made available to control and inspect a Pyramid application. These modules can be used both as an importable module as well as from command prompt. Hence, they are often called as command line scripts.

These command line scripts are:

- **pserve**: serves a web application that uses a PasteDeploy configuration file
- **pviews**: Displaying Matching Views for a Given URL
- **pshell**: The Interactive Shell
- **proutes**: Displaying All Application Routes
- **ptweens**: Displaying "Tweens"
- **prequest**: Invoking a Request
- **pdistreport**: Showing All Installed Distributions and Their Versions

All these command line scripts use the PasteDeploy configuration file (development.ini).

pserve

This is the most important script. The Pyramid application configured in the "development.ini" [app:main] section is served with the help of the chosen server (Waitress) and the mentioned host and port (localhost:6543)

Assuming that the Pyramid project (testproj) is created in the folder of the same name in the Pyramid virtual environment, the following command starts listening to incoming browser requests:

```
Env>..\scripts\pserve development.ini
```

The **pserve** module (as also the other Pyramid command-line scripts) can be run as an argument of Python interpreter in the command prompt.

```
Env>python -m pyramid.scripts.pserve development.ini
Starting server in PID 1716.
2022-06-23 14:13:51,492 INFO  [waitress:485][MainThread]
Serving on http://[::1]:6543
2022-06-23 14:13:51,492 INFO  [waitress:485][MainThread]
Serving on http://127.0.0.1:6543
```

To make **pserve** utility more flexible, the following command line parameters can be used:

- **config_uri**: The URI to the configuration file.
- **-n <name>**: Load the named application (default main)
- **-s <server_type>**: Use the named server.
- **--server-name <section_name>**: Use the named server as defined in the configuration file (default: main)
- **--reload**: Use auto-restart file monitor
- **-b**: Open a web browser to the server url.

The application is served at http://localhost:6543 in which case, the access is restricted such that only a browser running on the same machine. If you want to let the other machines on the same network, then edit the "development.ini" file, and replace the listen value in the [server:main] section as shown below:

```
[server:main]
use = egg:waitress#main
listen = *:6543
```

The setting *:6543 is equivalent to 0.0.0.0:6543 [::]:6543, as a result, the application responds to requests on all IP addresses possessed by your system, not just requests to localhost.

The --reload option in the **pserve** command line causes the application to be reloaded automatically whenever the running code is modified.

Start the application with **--reload** option.

```
pserve development.ini --reload
```

```
Starting monitor for PID 36224.

Starting server in PID 36224.

Serving on http://localhost:6543

Serving on http://localhost:6543
```

If any change to the project's .py files or .ini files is made, the server restart automatically:

```
testproj/development.ini changed; reloading ...

Gracefully killing the server.

Starting monitor for PID 36286.

Starting server in PID 36286.

Serving on http://localhost:6543

Serving on http://localhost:6543
```

pviews

The **pviews** command line script is used in the command terminal window to print a summary of matching routes and views for a given URL. The **pviews** command accepts two arguments. The first argument is the path to your application's ".ini" file and section name inside it. This should be of the format **config_file#section_name** (default value is main). The second argument is the URL to test for matching views.

Let us pviews command with the development.ini file in our testproj project built earlier with Cookiecutter.

```
Env>..\scripts\pviews development.ini /


URL = /


    context: <pyramid.traversal.DefaultRootFactory object at
0x000001DD39BF1DE0>

    view name:
```

```
    Route:
    ------
    route name: home
    route pattern: /
    route path: /
    subpath:

        View:
        -----
        testproj.views.default.my_view
```

The output shows the requested URL at the top and below which all the matching views are displayed with their view configuration details. In this example only one view matches, so there is just a single View section.

pshell

The pshell script makes it possible to interact with the Pyramid application's environment from Python prompt. This shell uses the PasteDeploy configuration file i.e. development.ini as a command line argument (like the other Pyramid scripts) and opens up Python interactive shell.

```
Env>..\scripts\pshell development.ini
Python 3.10.1 (tags/v3.10.1:2cd268a, Dec  6 2021, 19:10:37)
[MSC v.1929 64 bit (AMD64)] on win32
Type "help" for more information.

Environment:
  app          The WSGI application.
  dbsession    <sqlalchemy.orm.session.Session object at
0x0000020E9F1452D0>
  models       <module 'testproj.models' from 'f:\\pyram-
env\\testproj\\testproj\\models\\__init__.py'>
  registry     Active Pyramid registry.
  request      Active request object.

  root         Root of the default resource tree.

  root_factory Default root factory used to create `root`.

  tm           Single-thread implementation of
`~transaction.interfaces.ITransactionManager`.



>>>
```

The script reads the configuration and the objects declared in it are made available as Python objects to interact with. We can inspect their behaviour from the Python prompt.

```
>>> root

<pyramid.traversal.DefaultRootFactory object at
0x0000020E9E2507F0>

>>> registry

<Registry testproj>
```

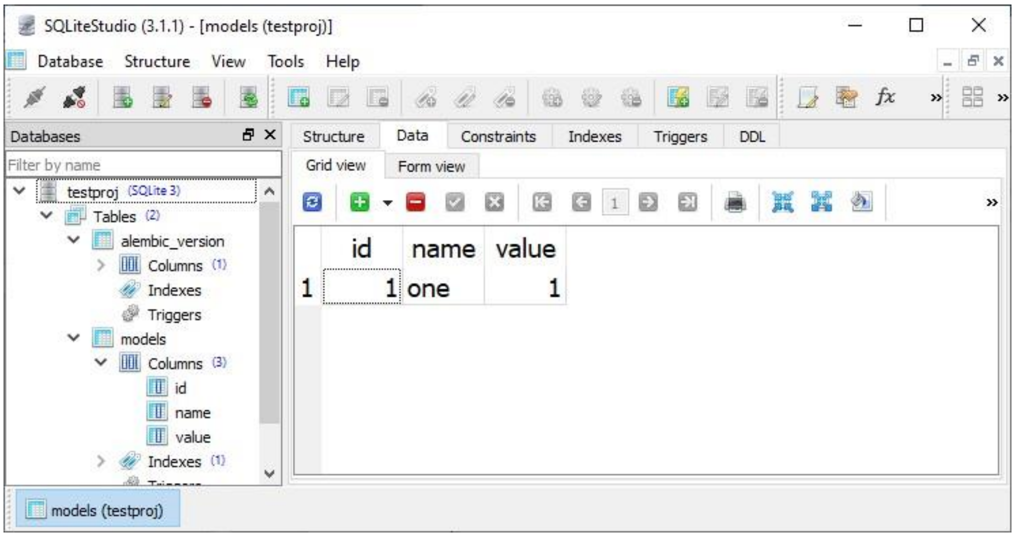
The registry settings are read from "development.ini" into a dictionary. We can traverse its contents using the for loop:

```
>>> for k,v in registry.settings.items():

...     print (k,":",v)

...

pyramid.reload_templates : True

pyramid.debug_authorization : False

pyramid.debug_notfound : False

pyramid.debug_routematch : False

pyramid.default_locale_name : en

pyramid.includes :

pyramid_debugtoolbar

sqlalchemy.url : sqlite:///…\testproj/testproj.sqlite

retry.attempts : 3
```

```
tm.manager_hook : <function explicit_manager at
0x000001D9E64E4550>
```

It is even possible to interact with the database with the help of SQLAlchemy model declared in models.py.

The application database is initialized in the beginning when we first complete the cookiecutter steps. We find a models table in the "testproj.sqlite" database with one record in it.



	id	name	value
1	1	one	1

We now access this table from the Python prompt as under:

```
>>> m=models.MyModel


>>> obj=dbsession.query(m).get(1)

>>> obj

<testproj.models.mymodel.MyModel object at 0x0000020E9FD96DA0>

>>> obj.name

'one'
```

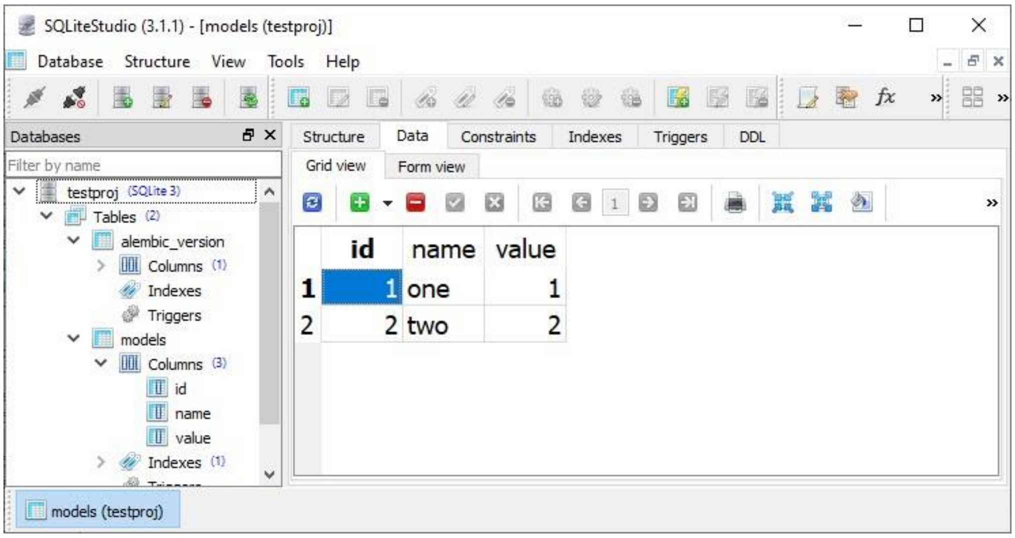
Let us adda new row in the models table. First declare an object of the MyModel class, and add it in the dbsession.

```
>>> tm.begin()
>>> obj=models.MyModel(id=2, name='two', value=2)

>>> dbsession.add(obj)

>>> tm.commit()
```

Pyramid uses a transaction manger object tm which is declared in **pyramid_tm** package. To confirm that a new record is added, retrieve it back.

```
>>> obj=dbsession.query(models.MyModel).get(2)

>>> obj.name

'two'
```

This can also be confirmed by actually looking at the models table of the database in a SQLite GUI tool.



	id	name	value
1	1	one	1
2	2	two	2

prequest

The prequest utility lets you to test the response of a URL pattern without actually starting the server. The command needs the configuration file and the URL path as the command line arguments. For example:

```
Env>prequest development.ini /
```

The command produces the raw HTML response of the Cookiecutter homepage that we have seen earlier.

There are a couple of command line switches that can be used. The -d option displays the status and headers returned by the server. To override the default GET request method, we can use -m option.

proutes

This command line Pyramid script displays all the routes added to your application's registry. It accepts just one argument i.e. the configuration file (development.ini)

Following route configuration of the testproj package is displayed by the proutes command:

```
Env>proutes development.ini
Name                        Pattern                            View

----                        -------                            ----

__static/                   /static/*subpath                   testproj:static/

home                        /
testproj.views.default.my_view

debugtoolbar                /_debug_toolbar/*subpath           <unknown>

__/_debug_toolbar/static/   /_debug_toolbar/static/*subpath
pyramid_debugtoolbar:static/
```

23. Pyramid – Testing

Writing test scripts which ensure that your code works correctly is considered as a good programming practice. Python ecosystem had a number of testing frameworks, including **unittest** which is bundled in the standard library. **Pytest** is a popular testing library. It is a preferred library for Pyramid projects.

We shall use the hello package that we developed earlier while demonstrating the use of **PasteDeploy** configuration.

First, ensure that the Pyramid environment has **PyTest** package installed.

```
pip3 install pytest
```

Open the **setup.py** file in hello package and modify it by adding the lines shown in bold.

```
from setuptools import setup


requires = [
    'pyramid',
    'waitress',
]
dev_requires = ['pytest',]
setup(
    name='hello',
    install_requires=requires,
    extras_require={
        'dev': dev_requires,
    },
    entry_points={
        'paste.app_factory': [
            'main = hello:main'
        ],
    },
)
```

Here, Pytest is added as the project dependency whenever it is installed (or reinstalled) using following command:

```
pip3 install -e ".[dev]
```

Store the following Python code as testing.py in hello package.

```
import unittest
from pyramid import testing
class HelloTests(unittest.TestCase):

    def test_hello_world(self):
        from . import hello_world
        request = testing.DummyRequest()
        response = hello_world(request)
        self.assertEqual(response.status_code, 200)
```

To run the tests, use following Pytest command. The output of the test is shown below:

```
Env\hello>pytest tests.py
========================== test session starts
==========================
platform win32 -- Python 3.10.1, pytest-7.1.2, pluggy-1.0.0
rootdir: E:\tp-pyramid\hello
collected 1 item


tests.py .
[100%]


=========================== 1 passed in 1.12s
===========================
```

To check if the test fails, induce an error in the test function and run again.

```
(tp-pyramid) E:\tp-pyramid\hello>pytest tests.py

========================== test session starts
==========================

collected 1 item


tests.py F
[100%]

=============================== FAILURES
================================

______________________ HelloTests.test_hello_world
______________________

self = <hello.tests.HelloTests testMethod=test_hello_world>

    def test_hello_world(self):

        from . import hello_world

        request = testing.DummyRequest()

        response = hello_world(request)

>       self.assertEqual(response.status_code, 404)

E       AssertionError: 200 != 404


tests.py:13: AssertionError

======================== short test summary info
========================

FAILED tests.py::HelloTests::test_hello_world -
AssertionError: 200 != 404

=========================== 1 failed in 1.53s
===========================
```

Functional Testing

Although Unit tests are popularly used in test-driven development (TDD)approach, for web applications, **WebTest** is a Python package that does functional testing. We can simulate a full HTTP request against a WSGI application, then test the information in the response.

Let us use the hello project that we had used in the earlier example. Open the setup.py and add WebTest as the project dependency.

```
from setuptools import setup


requires = [
    'pyramid',
    'waitress',
]
dev_requires = ['pytest','webtest',]
setup(
    name='hello',
    install_requires=requires,
    extras_require={
        'dev': dev_requires,
    },
    entry_points={
        'paste.app_factory': [
            'main = hello:main'
        ],
    },
)
```

Reinstall the hello package and its new dependency for development mode.

```
Env\hello>..\scripts\pip3 install -e ".[dev]"
```

Include a functional test in **tests.py** file

```
import unittest
```

```
from pyramid import testing


class HelloTests(unittest.TestCase):


    def test_hello_world(self):
        from . import hello_world


        request = testing.DummyRequest()
        response = hello_world(request)
        self.assertEqual(response.status_code, 200)


class HelloFunctionalTests(unittest.TestCase):
    def setUp(self):
        from . import main
        app = main({})
        from webtest import TestApp


        self.testapp = TestApp(app)


    def test_hello_world(self):
        res = self.testapp.get('/', status=200)
        self.assertIn(b'<h1>Hello World!</h1>', res.body)
```

Finally run Pytest as per the following command:

```
Env\hello>pytest tests.py
========================== test session starts
==========================
platform win32 -- Python 3.10.1, pytest-7.1.2, pluggy-1.0.0
rootdir: E:\tp-pyramid\hello
collected 2 items
```

```
tests.py ..
[100%]


=========================== 2 passed in 2.37s
===========================
```

Tests in Cookiecutter Project

The CookieCutter utility auto-generates the tests package containing functional tests and unit tests. We had earlier used Cookiecutter to build Pyramid project named testproj. In this project, we find tests folder.

The test_functional py contains the following test functions:

```
from testproj import models


def test_my_view_success(testapp, dbsession):
    model = models.MyModel(name='one', value=55)
    dbsession.add(model)
    dbsession.flush()
    res = testapp.get('/', status=200)
    assert res.body


def test_notfound(testapp):
    res = testapp.get('/badurl', status=404)
    assert res.status_code == 404
```

The test_views.py defines following test functions to test the views:

```
from testproj import models
from testproj.views.default import my_view
from testproj.views.notfound import notfound_view


def test_my_view_failure(app_request):
    info = my_view(app_request)
    assert info.status_int == 500

def test_my_view_success(app_request, dbsession):
    model = models.MyModel(name='one', value=55)
    dbsession.add(model)
    dbsession.flush()
    info = my_view(app_request)
    assert app_request.response.status_int == 200
    assert info['one'].name == 'one'
    assert info['project'] == 'testproj'

def test_notfound_view(app_request):
    info = notfound_view(app_request)
    assert app_request.response.status_int == 404
    assert info == {}
```

These tests are run by the following command:

```
Env\testproj>Pytest
========================== test session starts
==========================
platform win32 -- Python 3.10.1, pytest-7.1.2, pluggy-1.0.0
rootdir: Env\testproj, configfile: pytest.ini, testpaths:
testproj, tests
plugins: cov-3.0.0
collected 5 items


tests\test_functional.py ..
[ 40%]
tests\test_views.py ...
[100%]
```

```
=============== 5 passed, 20 warnings in 6.66s ===============
```

24. Pyramid – Logging

In order to collect useful information about the application, Pyramid uses the **logging** module from Python's standard library. It proves useful in development as well as production mode to detect problems if any, during the running of the application. The application log can include your own messages integrated with messages from third-party modules.

The logged messages have following predefined types (in the order of decreasing severity):

- CRITICAL
- ERROR
- WARNING
- INFO
- DEBUG
- NOTSET

By default, he logging messages are redirected to sys.stderr stream. To start collecting logging messages, we need to declare a Logger object.

```
import logging

log = logging.getLogger(__name__)
```

Log messages can now be generated with logger methods corresponding to the desired logging levels. To generate a message which can prove useful for debugging the application, use **log.debug()** message with appropriate message string.

A Pyramid application based on PasteDeploy configuration makes it very easy to enable incorporate logging support. The PasteDEploy files (development.ini as well as production.ini) use the **ConfigParser** format used in the logging module's configuration parameters. The logging related sections in development.ini are passed to the logging module's configuration process when it is invoked by pserve command.

Various logger sections in the configuraton file specify the keys, formats and the logger levels for the application objects.

Following logging related sections are declared in a typical "development.ini" file:

```
# Begin logging configuration

[loggers]

keys = root, hello

[logger_hello]

level = DEBUG

handlers =

qualname = hello

[handlers]

keys = console

[formatters]

keys = generic

[logger_root]

#level = INFO

level=DEBUG

handlers = console

[handler_console]

class = StreamHandler

args = (sys.stderr,)

level = NOTSET

formatter = generic

[formatter_generic]

format = %(asctime)s %(levelname)-5.5s
[%(name)s][%(threadName)s] %(message)s

# End logging configuration
```

Let us add these sections in the **development.ini** file of our Hello application in the previous chapter.

Next, declare the Logger object and put a debug message in the **hello_world()** few function. Here's the **__init__.py** code:

```
from pyramid.config import Configurator
from pyramid.response import Response
from pyramid.view import view_config
import logging

log = logging.getLogger(__name__)

from pyramid.renderers import render_to_response

def hello_world(request):
    log.debug('In hello view')
    return render_to_response('templates/hello.html',
{'name':request.matchdict['name']},
                              request=request)

def main(global_config, **settings):
    config = Configurator(settings=settings)
    config.include('pyramid_jinja2')
    config.add_jinja2_renderer(".html")
    config.add_route('hello', '/{name}')
    config.add_view(hello_world, route_name='hello')
    return config.make_wsgi_app()
```

The hello_world() view renders the following hello.html template:

```
<html>
  <body>
    <h1>Hello, {{ name }}!</h1>
  </body>
</html>
```

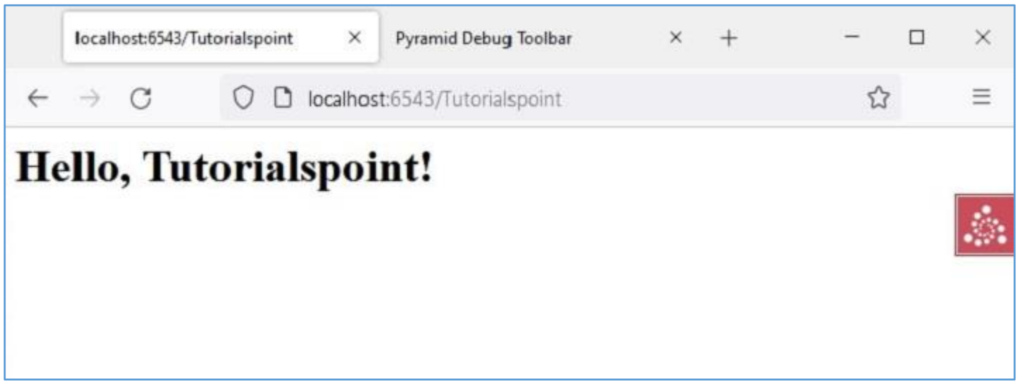
Run the application as usual:

```
pserve development.ini
```

When http://localhost:6543/Tutorialpoint URL is entered in the browser, the command window echoes following debug message:

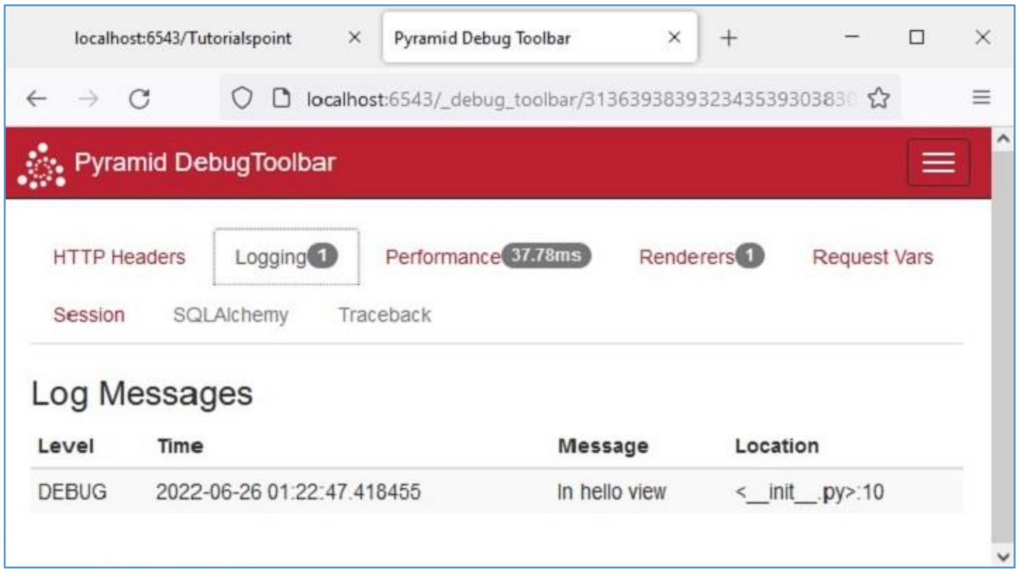
```
Starting monitor for PID 11176.
Starting server in PID 8472.
2022-06-26 01:22:47,032 INFO  [waitress][MainThread] Serving
on http://[::1]:6543
2022-06-26 01:22:47,032 INFO  [waitress][MainThread] Serving
on http://127.0.0.1:6543
2022-06-26 01:22:47,418 DEBUG [hello][waitress-1] In hello view
```

Since the debug toolbar is enabled in the configuration, it is displayed in the browser:



Hello, Tutorialspoint!

The debug message is also displayed on the logging tab of the debug toolbar as shown below:



Log Messages

Level	Time	Message	Location
DEBUG	2022-06-26 01:22:47.418455	In hello view	<__init__.py>:10

25. Pyramid – Security

Pyramid's declarative security system determines the identity of the current user and verifies if the user has access to certain resources. The security policy can prevent the user from invoking a view. Before any view is invoked, the authorization system uses the credentials in the request to determine if access will be allowed.

The security policy is defined as a class that controls the user access with the help of following methods defined in **pyramid.security** module:

- **forget(request):** This method returns header tuples suitable for 'forgetting' the set of credentials possessed by the currently authenticated user. It is generally used within the body of a view function.

- **remember(request, userid):** This method returns a sequence of header tuples on the request's response. They are suitable for 'remembering' a set of credentials such as **userid** using the current security policy. Common usage might look like so within the body of a view function.

The authenticated user's access is controlled by the objects of **Allowed** and **Denied** classes in this module.

To implement the functionality of identity, remember and forget mechanism, Pyramid provides the following **helper** classes defined in the **pyramid.authentication** module:

- **SessionAuthenticationHelper**: Store the userid in the session.

- **AuthTktCookieHelper**: Store the userid with an "auth ticket" cookie.

We can also use **extract_http_basic_credentials()** function to retrieve user credentials using HTTP Basic Auth.

To retrieve the userid from REMOTE_USER in the WSGI environment, the **request.environ.get('REMOTE_USER')** can be used.

Let us now learn how to implement the security policy with the help of following example. The "development.ini" for this example is as follows:

```
[app:main]
use = egg:tutorial
pyramid.reload_templates = true
pyramid.includes =
    pyramid_debugtoolbar
hello.secret = a12b

[server:main]
use = egg:waitress#main
listen = localhost:6543
```

We then write the security policy class in the following Python code saved as **security.py**:

```
from pyramid.authentication import AuthTktCookieHelper
USERS = {'admin': 'admin', 'manager': 'manager'}
class SecurityPolicy:
    def __init__(self, secret):
        self.authtkt = AuthTktCookieHelper(secret=secret)

    def identity(self, request):
        identity = self.authtkt.identify(request)
        if identity is not None and identity['userid'] in USERS:
            return identity

    def authenticated_userid(self, request):
        identity = self.identity(request)
        if identity is not None:
            return identity['userid']

    def remember(self, request, userid, **kw):
        return self.authtkt.remember(request, userid, **kw)


    def forget(self, request, **kw):
        return self.authtkt.forget(request, **kw)
```

The **__init__.py** file in our package folder defines following configuration. The security policy class defined above is added in the configuration with **set_security_policy()** method of Configurator class. Three routes – home, login and logout – are added to the configuration.

```
from pyramid.config import Configurator
from .security import SecurityPolicy


def main(global_config, **settings):
    config = Configurator(settings=settings)
    config.include('pyramid_chameleon')
    config.set_security_policy(
        SecurityPolicy(
            secret=settings['hello.secret'],
        ),
    )


    config.add_route('home', '/')
    config.add_route('login', '/login')
    config.add_route('logout', '/logout')
    config.scan('.views')
    return config.make_wsgi_app()
```

Three views corresponding to the above routes are defined in views.py.

```
from pyramid.httpexceptions import HTTPFound
from pyramid.security import remember, forget


from pyramid.view import view_config, view_defaults
from .security import  USERS

@view_defaults(renderer='home.pt')
class HelloViews:
    def __init__(self, request):
        self.request = request
        self.logged_in = request.authenticated_userid

    @view_config(route_name='home')
    def home(self):
        return {'name': 'Welcome'}

    @view_config(route_name='login', renderer='login.pt')
    def login(self):
        request = self.request
        login_url = request.route_url('login')
        referrer = request.url
        if referrer == login_url:
            referrer = '/'
        came_from = request.params.get('came_from', referrer)
        message = ''
        login = ''
        password = ''
        if 'form.submitted' in request.params:
            login = request.params['login']
            password = request.params['password']
            pw = USERS.get(login)
            if pw == password:
                headers = remember(request, login)
                return HTTPFound(location=came_from,
                                 headers=headers)
            message = 'Failed login'
        return dict(
            name='Login', message=message,
            url=request.application_url + '/login',
            came_from=came_from,
            login=login, password=password,)

    @view_config(route_name='logout')
    def logout(self):
        request = self.request
        headers = forget(request)
        url = request.route_url('home')
        return HTTPFound(location=url, headers=headers)
```

The login view renders the login form. When the user Id and password entered by the user are verified against the list of USERS, the details are 'remembered'. On the other hand, the logout view releases these details by 'forgetting'.

The home view renders the following chameleon template - **home.pt**

```
<!DOCTYPE html>
<html lang="en">
<body>
<div>
    <a tal:condition="view.logged_in is None"
            href="${request.application_url}/login">Log In</a>
    <a tal:condition="view.logged_in is not None"

href="${request.application_url}/logout">Logout</a>
</div>
<h1>Hello.  ${name}</h1>
</body>
</html>
```

Following is the chameleon template **login.pt** for login view.

```
<!DOCTYPE html>

<html lang="en">

<body>

<h1>Login</h1>

<span tal:replace="message"/>


<form action="${url}" method="post">

    <input type="hidden" name="came_from"
value="${came_from}"/>

    <label for="login">Username</label>

    <input type="text" id="login" name="login"
value="${login}"/><br/>

    <label for="password">Password</label>

    <input type="password" id="password" name="password"

           value="${password}"/><br/>

    <input type="submit" name="form.submitted"

           value="Log In"/>

</form>

</body>

</html>
```

The development.ini and setup.py are placed in the outer project folder, while, the **__init__.py**, **views.py**, **security.py** and the templates **home.pt** as well as **login.pt** should be saved under the package folder named hello.

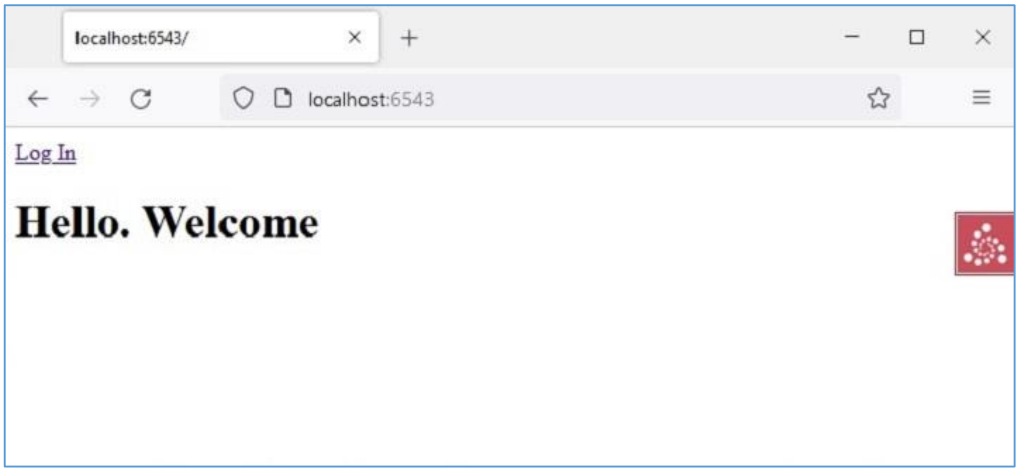
Install the package with the following command:

```
Env\hello>pip3 install -e .
```

Start the server with the **pserve** utility.

```
pserve development.ini
```

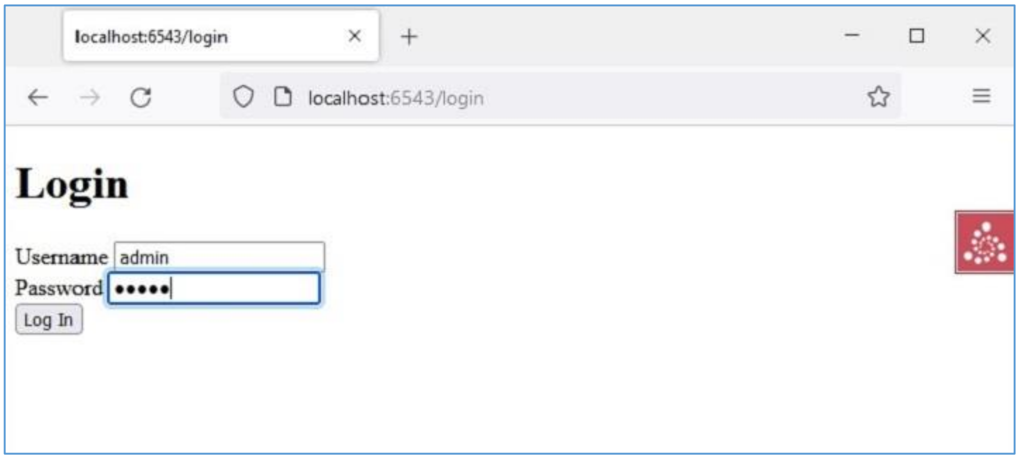
Open the browser and visit http://localhost:6543/ link.



Log In

Hello. Welcome

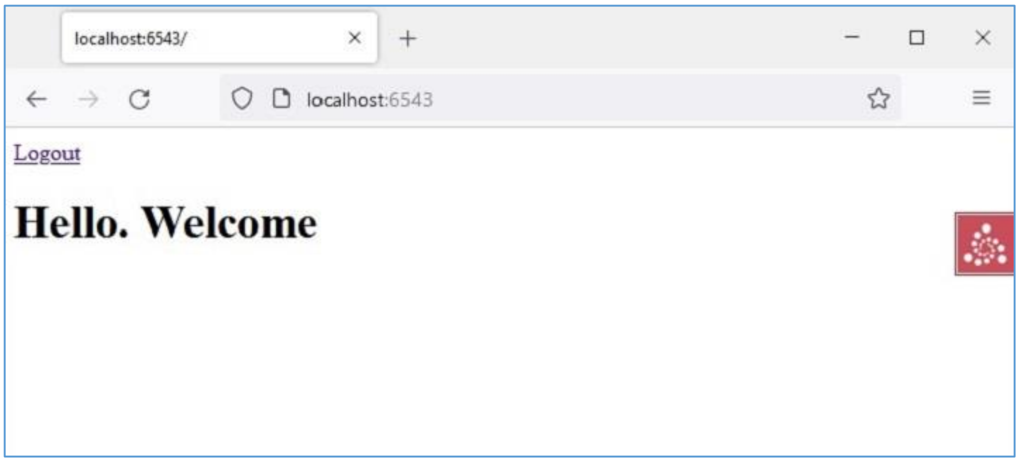
Click the "Log In" link to open the login form:



Login

Username admin
Password •••••
Log In

The home view page comes back with the link changed to logout as the credentials are remembered.



localhost:6543/

localhost:6543

Logout

Hello. Welcome

Clicking the "logout" link will result in forgetting the credentials and the default home page will be shown.

26. Pyramid – Deployment

The examples of Pyramid applications developed so far in this tutorial have been executed on the local machine. To make it accessible publicly, it must be deployed on a Production server capable of WSGI standards.

Many WSGI compatible http servers are available for this purpose. For example:

- waitress
- paste.httpserver
- CherryPy
- uWSGI
- gevent
- mod_wsgi

We have discussed how we can use Waitress server to host a Pyramid application. It can be served on ports 80 (HTTP) and 443 (HTTPS) of a machine having a public IP address.

mod_wsgi

Apache server is a popular open source HTTP server software, distributed by Apache Software Foundation. It powers most of the web servers across internet. The **mod_wsgi** (developed by **Graham Dumpleton**) is an Apache module that provides a WSGI interface for deploying Python based web applications on Apache.

In this section, the step by step procedure to deploy a Pyramid application on the Apache server is explained. Here, we'll use XAMPP, a popular open source Apache distribution. It can be downloaded from https://www.apachefriends.org/download.html.

The mod_wsgi module is installed with PIP installer. Before installing, set the MOD_WSGI_APACHE_ROOTDIR environment variable to the directory in which Apache executable is located.

```
C:\Python310\Scripts>set
MOD_WSGI_APACHE_ROOTDIR=C:/xampp/apache

C:\Python310\Scripts>pip install mod_wsgi
```

Next, run the following command in the command terminal.

```
C:\Python310\Scripts>mod_wsgi-express module-config

LoadFile "C:/Python310/python310.dll"

LoadModule wsgi_module "C:/Python310/lib/site-
packages/mod_wsgi/server/mod_wsgi.cp310-win_amd64.pyd"

WSGIPythonHome "C:/Python310"
```

These are mod_wsgi module settings to be incorporated Apache's configuration file. Open **httpd.conf** file of your XAMPP installation and copy the output of the above command line in it.

Next, create a virtual host configuration for our application. Apache stores virtual host information in **httpd-vhosts.conf** file which is found in C:\XAMPP\Apache\conf\extra\ folder. Open the file and add following lines in it:

```
<VirtualHost *>

ServerName localhost:6543

WSGIScriptAlias / e:/pyramid-env/hello/production.ini

<Directory e:/pyramid-env/hello>

        Order deny,allow

        Allow from all

        Require all granted

</Directory>

</VirtualHost>
```

Here, it is assumed that a hello Pyramid project is built using the Cookiecutter utility. The PasteDeploy configuration file to be used in production environment is used here.

This virtual host configuration needs to be incorporated in Apache's httpd.conf file. This is done by adding following lines in it:

```
# Virtual hosts

 Include conf/extra/httpd-vhosts.conf
```

We now have to save the following code as **pyramid.wsgi** file that returns the Pyramid WSGI application object.

```
from pyramid.paster import get_app, setup_logging

ini_path = 'e:/pyramid-env/hello/production.ini'

setup_logging(ini_path)

application = get_app(ini_path, 'main')
```

After performing the above mentioned procedure, restart the XAMPP server and we should be able to run the Pyramid application on the Apache server.

Deploy on Uvicorn

Uvicorn is an ASGI compatible server (ASGI stands for Asynchronous Gateway Interface). Since Pyramid is a WSGI based web framework, we need to convert the WSGI application object to ASGI object, with the help of **WsgiToAsgi**() function defined in **asgiref.wsgi** module.

```
from asgiref.wsgi import WsgiToAsgi

from pyramid.config import Configurator

from pyramid.response import Response


def hello_world(request):

    return Response("Hello")


with Configurator() as config:

    config.add_route("hello", "/")

    config.add_view(hello_world, route_name="hello")

    wsgi_app = config.make_wsgi_app()


app = WsgiToAsgi(wsgi_app)
```

Save the above code as app.py. Install Uvicorn with pip utility

```
pip3 install uvicorn
```

Run the Pyramid application in ASGI mode.

```
uvicorn app:app
```

Similarly, it can be served using **daphne** server.

```
daphne app:app
```