

# Discover asyncio event loop



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# Victor Stinner

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- Python core developer since 2010
- [github.com/haypo/](https://github.com/haypo/)
- [bitbucket.org/haypo/](https://bitbucket.org/haypo/)
- Working for **eNovance** on OpenStack

# Disclaimer

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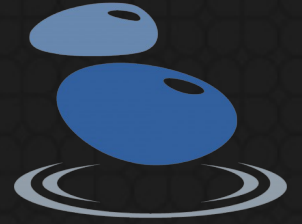


- Simplified code snippets close to asyncio, but different
- No error handling nor optimization
- (asyncio handles errors and is optimized)
- Code written for Python 3



# Agenda

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1. Callbacks
2. Timers
3. Selectors
4. Generator
5. Coroutine and BaseTask
6. Future and Task

# Callbacks

---



```
class CallbackEventLoop:
    def __init__(self):
        self.callbacks = []

    def call_soon(self, func):
        self.callbacks.append(func)

    def execute_callbacks(self):
        callbacks = self.callbacks
        self.callbacks = []
        for cb in callbacks:
            cb()
```

# Callbacks

---



Code

```
loop.call_soon(hello_world)
```

Callbacks

```
hello_world()
```

Output



# Callbacks

---



## Code

```
loop.call_soon(hello_world)  
loop.execute_callbacks()
```

## Callbacks

```
hello_world()
```

## Output

Hello World!

# Callbacks

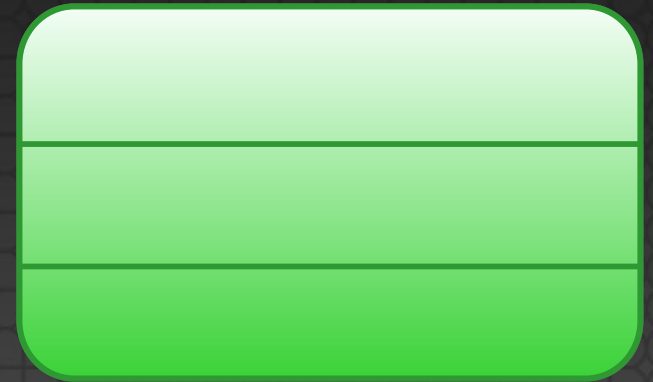
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## Code

```
loop.call_soon(hello_world)  
loop.execute_callbacks()
```

## Callbacks



## Output

Hello World!



# Timers

---



```
class TimerEventLoop(CallbackEventLoop):
```

```
    def __init__(self):  
        super().__init__()  
        self.timers = []
```

```
    def call_at(self, when, func):  
        timer = (when, func)  
        self.timers.append(timer)
```

```
    ...
```

# Timers

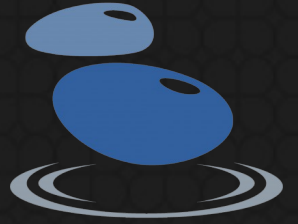
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```
class TimerEventLoop(CallbackEventLoop):  
    ...  
    def execute_timers(self):  
        now = time.time()  
        new_timers = []  
        for when, func in self.timers:  
            if when <= now:  
                self.call_soon(func)  
            else:  
                new_timers.append((when, func))  
        self.timers = new_timers  
        self.execute_callbacks()
```

# Timers

---



Code

```
loop.call_at(1, hello_world)
```

Timers

```
(1, hello_world)
```

Output

Callbacks



# Timers

---



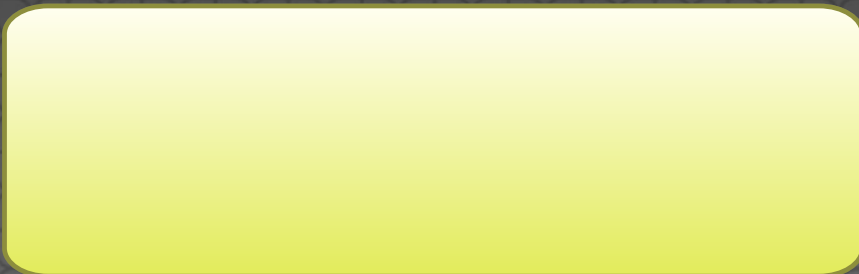
## Code

```
loop.call_at(1, hello_world)  
loop.call_at(5, exit)
```

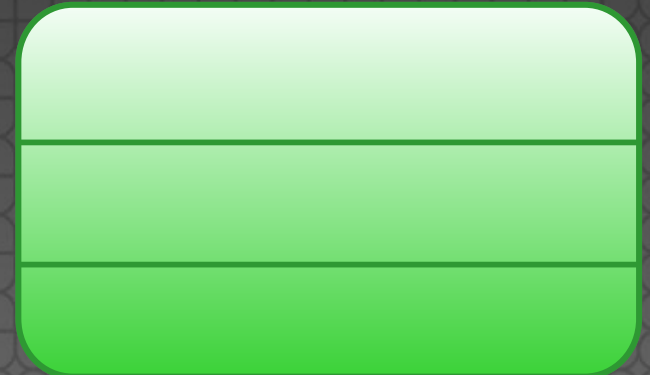
## Timers

(1, hello_world)
(5, exit)

## Output



## Callbacks



# Timers

---



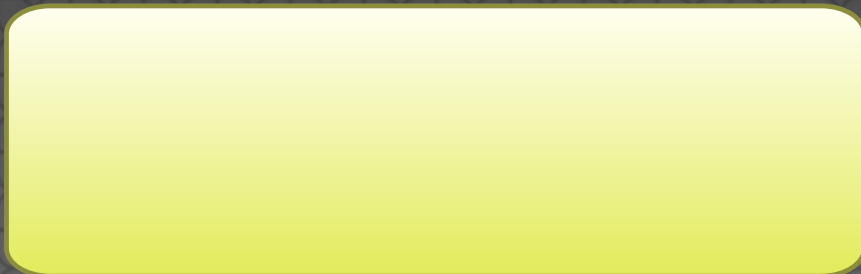
## Code

```
loop.call_at(1, hello_world)  
loop.call_at(5, exit)  
loop.call_at(2, good_bye)
```

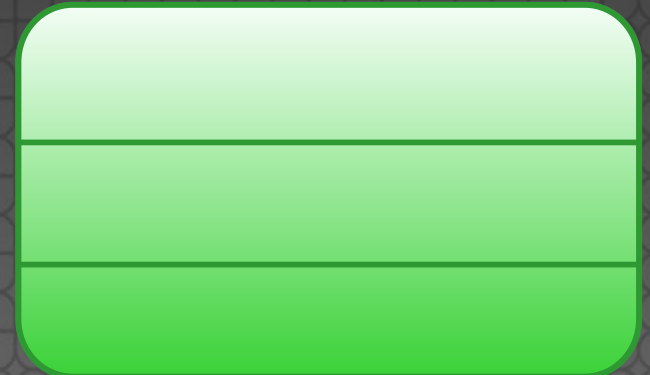
## Timers

(1, hello_world)
(5, exit)
(2, good_bye)

## Output



## Callbacks



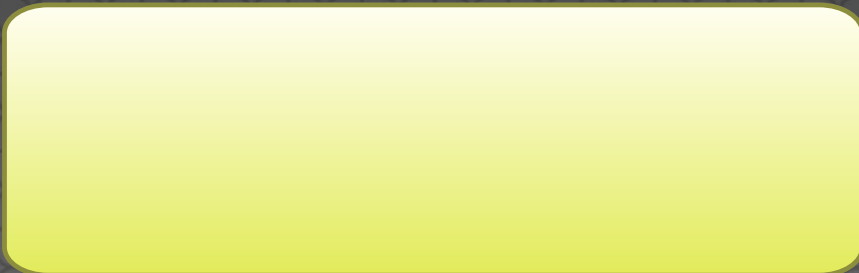
# Timers



## Code

```
loop.call_at(1, hello_world)
loop.call_at(5, exit)
loop.call_at(2, good_bye)
loop.execute_timers()
```

## Output



## Timers

(1, hello\_world)

(5, exit)

(2, good\_bye)

## Callbacks

hello\_world()

good\_bye()



# Timers

---



## Code

```
loop.call_at(1, hello_world)
loop.call_at(5, exit)
loop.call_at(2, good_bye)
loop.execute_timers()
```

## Output

Hello World!  
Good bye.

## Timers

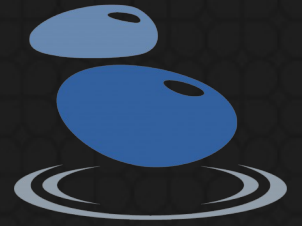
(5, exit)

## Callbacks

hello\_world()  
good\_bye()

# Timers

---



## Code

```
loop.call_at(1, hello_world)
loop.call_at(5, exit)
loop.call_at(2, good_bye)
loop.execute_timers()
```

## Output

Hello World!  
Good bye.

## Timers

(5, exit)

## Callbacks

# Selector

---



```
class SelectorEventLoop(TimerEventLoop):  
  
    def __init__(self):  
        super().__init__()  
        self.selector = selectors.Selector()  
  
    def add_reader(self, sock, func):  
        self.selector.register(sock,  
                               selectors.EVENT_READ,  
                               data=func)  
  
    ...
```



# Selector

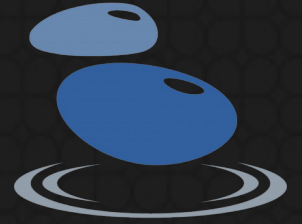
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```
class SelectorEventLoop(TimerEventLoop):  
    ...  
    def select(self):  
        timeout = self.compute_timeout()  
  
        events = self.selector.select(timeout)  
        for key, mask in events:  
            func = key.data  
            self.call_soon(func)  
  
        self.execute_timers()
```

# Selector

---



```
class SelectorEventLoop(TimerEventLoop):  
    ...  
    def compute_timeout(self):  
        if self.callbacks:  
            # already something to do  
            return 0  
        elif self.timers:  
            next_timer = min(self.timers)[0]  
            timeout = next_timer - time.time()  
            return max(timeout, 0.0)  
        else:  
            # blocking call  
            return None
```

# Selector

---



## Code

```
s, c = socket.socketpair()  
loop.add_reader(s, reader)
```

## Selector

s: idle

## Callbacks

## Output



# Selector



## Code

```
s, c = socket.socketpair()  
loop.add_reader(s, reader)  
c.send(b'abc')
```

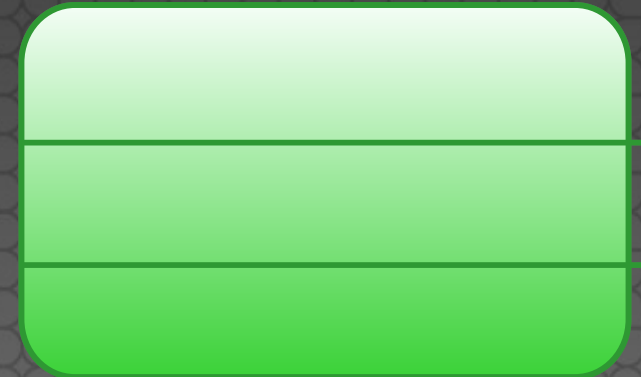
## Output



## Selector

s: read event

## Callbacks



# Selector



## Code

```
s, c = socket.socketpair()  
loop.add_reader(s, reader)  
c.send(b'abc')  
loop.select()
```

## Output



## Selector

s: read event

## Callbacks

reader()

# Selector



## Code

```
s, c = socket.socketpair()  
loop.add_reader(s, reader)  
c.send(b'abc')  
loop.select()
```

## Output

Received: b'abc'

## Selector

s: idle

## Callbacks

reader()

# Selector



## Code

```
s, c = socket.socketpair()  
loop.add_reader(s, reader)  
c.send(b'abc')  
loop.select()
```

## Output

Received: b'abc'

## Selector

s: idle

## Callbacks



# Generator



Code

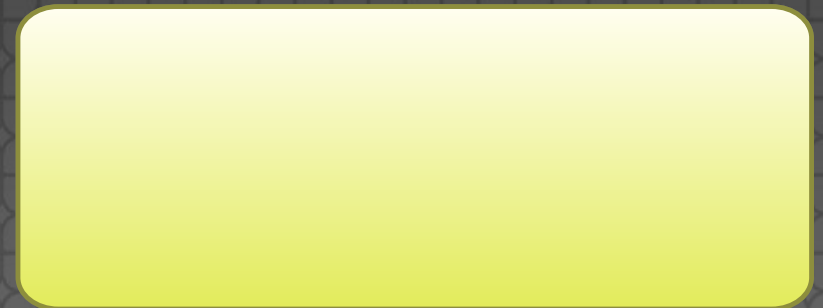
```
gen = producer()
```

producer() generator



```
yield "start"  
return "stop"
```

Output



# Generator



Code

```
gen = producer()  
print(next(gen))
```

producer() generator



```
yield "start"  
return "stop"
```

Output

start


# Generator



Code

```
gen = producer()
print(next(gen))
try:
    gen.next()
except StopIteration as e:
    print(e.value)
```

producer() generator



```
yield "start"
return "stop"
```

Output

```
start
stop
```

# Coroutine

---



```
@asyncio.coroutine
def my_coroutine(future):
    res = yield from future
    return res
```



# BaseTask

---



```
class BaseTask:
    def __init__(self, coro):
        self.coro = coro

    def step(self):
        try:
            next(self.coro)
        except StopIteration:
            pass
```

# BaseTask



Code

```
coro = test_coro()  
task = BaseTask(coro)
```

test\_coro() coroutine



```
print("begin")  
yield from ["hack"]  
print("end")
```

Output




# BaseTask



Code

```
coro = test_coro()  
task = BaseTask(coro)  
task.step()
```

test\_coro() coroutine



```
print("begin")  
yield from ["hack"]  
print("end")
```

Output

```
begin
```

# BaseTask



## Code

```
coro = test_coro()  
task = BaseTask(coro)  
task.step()  
task.step()
```

## test\_coro() coroutine

```
print("begin")  
yield from ["hack"]  
print("end")
```



## Output

```
begin  
end
```



# Future

---



```
class Future:
```

```
    def __init__(self, loop):  
        self.loop = loop  
        self.callbacks = []  
        self._result = None
```

```
    def add_done_callback(self, func):  
        self.callbacks.append(func)
```

```
    def result(self):  
        return self._result
```

```
    ...
```

# Future

---



```
class Future:
    ...
    def set_result(self, result):
        self._result = result

        for func in self.callbacks:
            self.loop.call_soon(func)

    def __iter__(self):
        # used by "yield from future"
        yield self
```

# Task

---



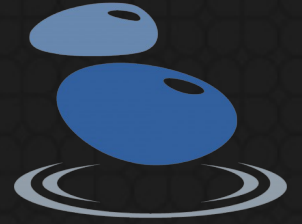
```
class Task:

    def __init__(self, coro, loop):
        self.coro = coro
        loop.call_soon(self.step)
    ...
```



# Task

---



```
class Task:
    ...
    def step(self):
        try:
            result = next(self.coro)
        except StopIteration:
            pass
        else:
            if isinstance(result, Future):
                result.add_done_callback(
                    self.step)
```

# Questions?

<http://docs.python.org/dev/library/asyncio.html>

<http://github.com/haypo/>  
<http://bitbucket.org/haypo/>

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Thanks David Malcom  
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<http://dmalcolm.livejournal.com/>