Exploration de la boucle d'événements asyncio

Pycon 2014, Lyon

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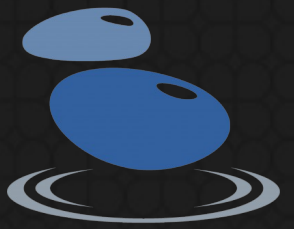

- Core developer Python depuis 2010
- Contributeur à asyncio (code, doc)
- Auteur de Trollius, portage d'asyncio sur Python 2.6
- Libriste convaincu : publie sur github et bitbucket
- Travaille pour eNovance sur OpenStack

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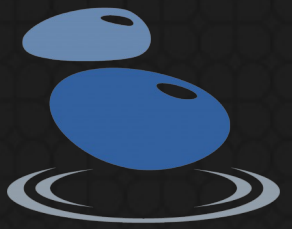
Mise en garde



- Code simplifié, API proche d'asyncio, mais différente
- Pas de gestion d'erreur ni d'optimisation
- Code écrit pour Python 3

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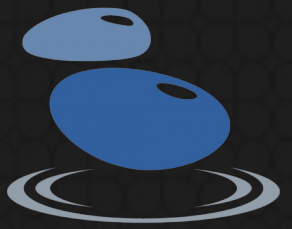
Fonctions de rappel



```
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()
```

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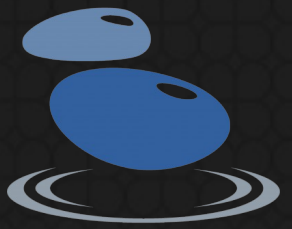
Fonctions de rappel



Code

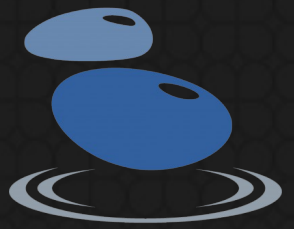
```
loop.call_soon(hello_world)
```

Callbacks

```
hello_world()
```

Output

Fonctions de rappel



Code

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

Callbacks

```
hello_world()
```

Output

```
Hello World!
```

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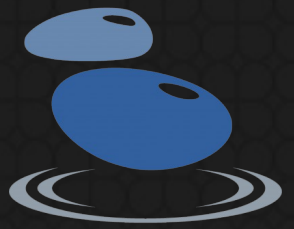
Fonctions de rappel



Code

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

Callbacks

Output

```
Hello World!
```

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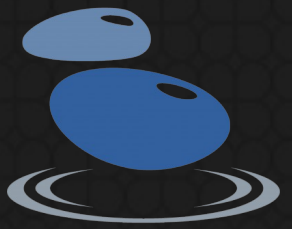

```
class TimerEventLoop(CallbackEventLoop):

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

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

    ...
```

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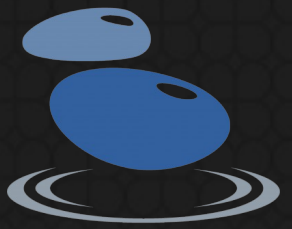
Minuteurs



```
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()
```

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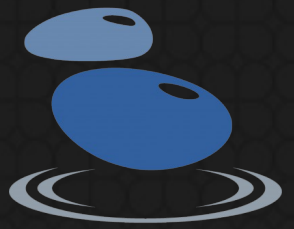
Minuteurs



Code

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

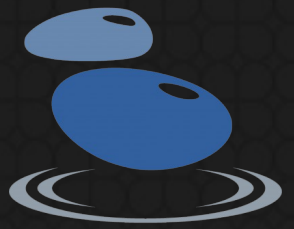
Timers

```
(1, hello_world)
```

Output

Callbacks

Minuteurs



Code

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

Timers

```
(1, hello_world)
(5, exit)
```

Output

Callbacks

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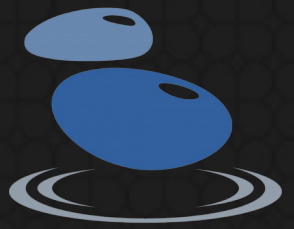
Minuteurs



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

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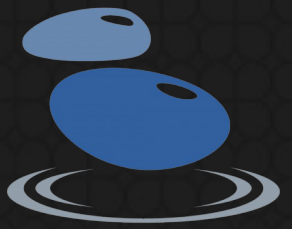

Code

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

Timers

(1, hello_world)

(5, exit)

(2, good_bye)

Output

Callbacks

hello_world()

good_bye()

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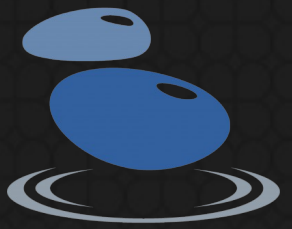

Code

```
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()
```

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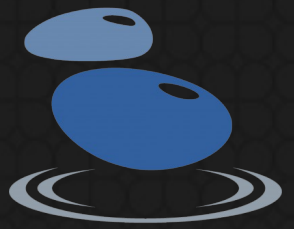
Minuteurs



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

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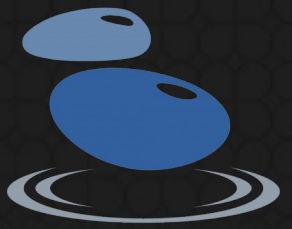
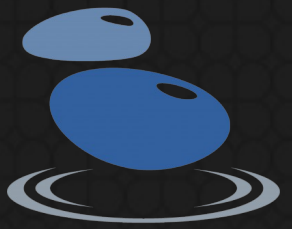
Multiplexeur E/S



- Sockets : réseau, TCP, UDP et UNIX
- Pipes : processus, signaux
- Module **select** : **`select()`** Windows, `poll()`, `epoll()` Linux, `kqueue()` BSD et Mac OS X, `devpoll()` Solaris
- Module **selectors** de Python 3.4

Multiplexeur E/S



```
from selectors import DefaultSelector

class SelectorEventLoop(TimerEventLoop):

    def __init__(self):
        super().__init__()
        self.selector = DefaultSelector()

    def add_reader(self, sock, func):
        self.selector.register(sock,
                               selectors.EVENT_READ,
                               data=func)

    ...
```

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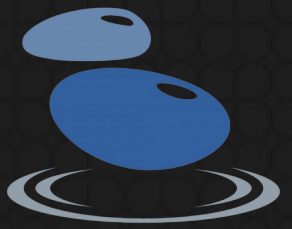
Multiplexeur E/S



```
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()
```

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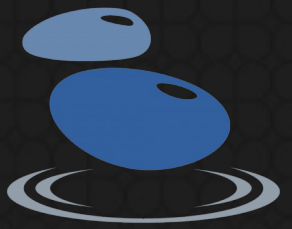
Multiplexeur E/S



```
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
```

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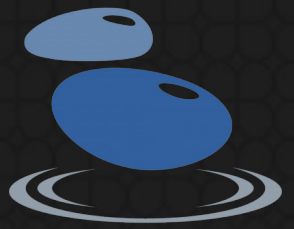
Multiplexeur E/S



Code

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

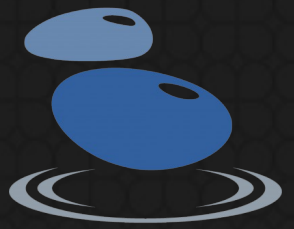
Selector

s: idle

Callbacks

Output

Multiplexeur E/S



Code

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

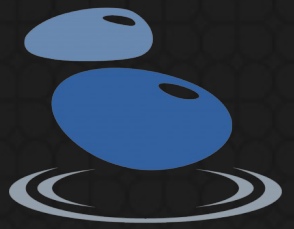
Selector

s: read event

Callbacks

Output

Multiplexeur E/S



Code

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

Selector

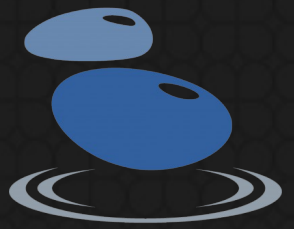
s: read event

Callbacks

reader()

Output

Multiplexeur E/S



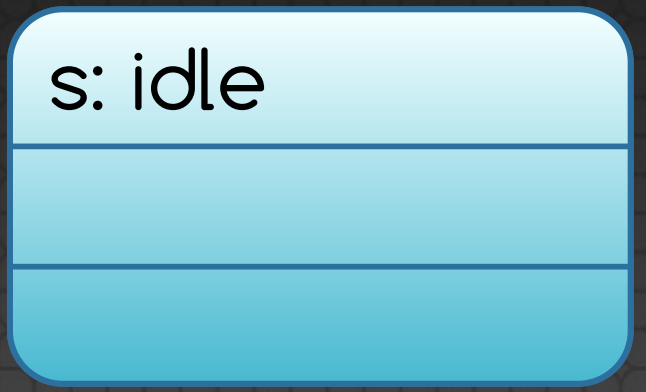
Code

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

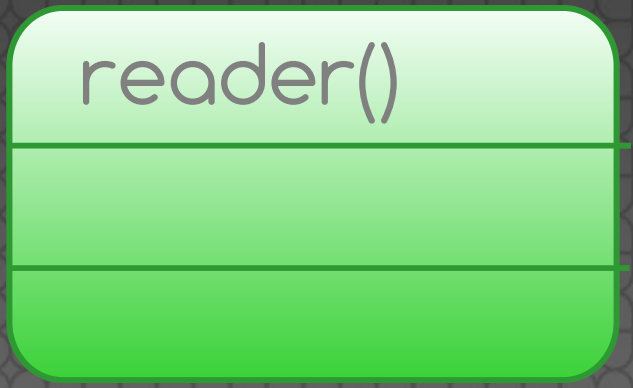
Output

```
Received: b'abc'
```

Selector



Callbacks



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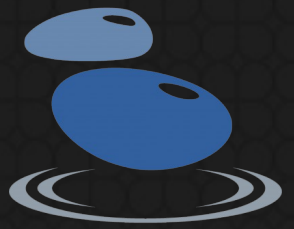
Multiplexeur E/S



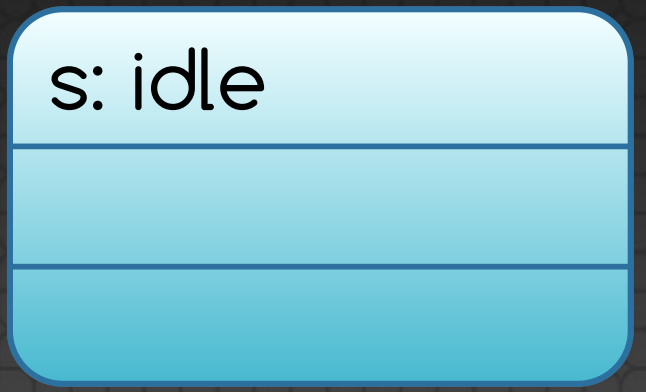
Code

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

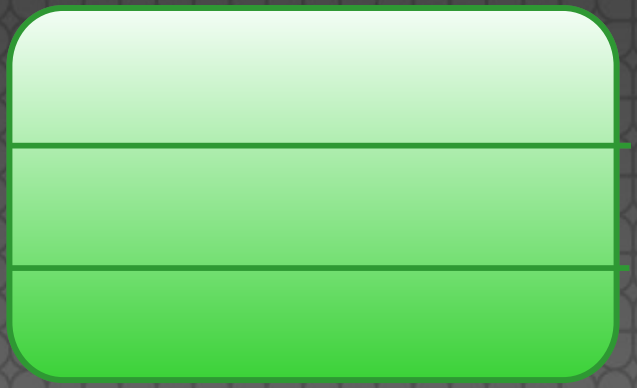
Output

```
Received: b'abc'
```

Selector



Callbacks



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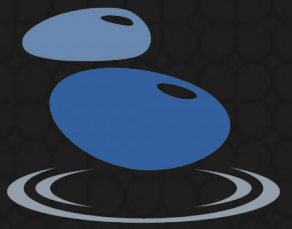
Générateur



- Fonction qui peut être mise en pause
- Mot clé **`yield`**

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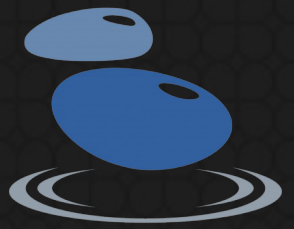
Générateur



Code

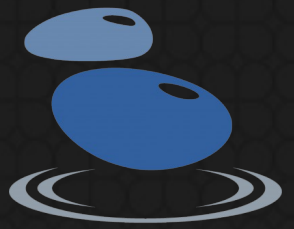
```
gen = producer()
```

producer() generator

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

Output

Générateur



Code

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

producer() generator

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

Output

```
start
```

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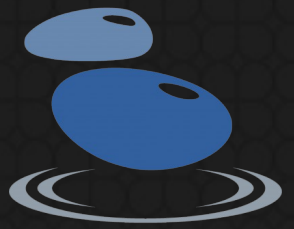
Générateur



Code

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

producer() generator

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

Output

```
start
stop
```

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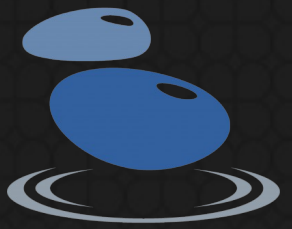
Coroutine



- Coroutine : générateur utilisant uniquement `yield from` (pas `yield`)
- Python 3.3 apporte `yield from` et `return` aux générateurs
- `yield from` : chaîne l'exécution avec un autre générateur ou attend un Future

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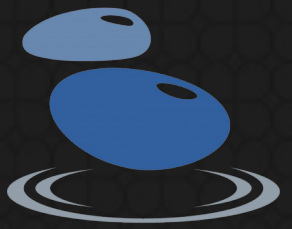
Tâche simple



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

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

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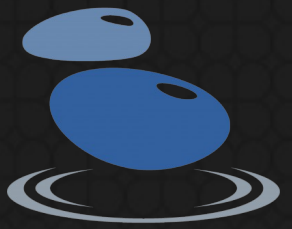
Tâche simple



Code

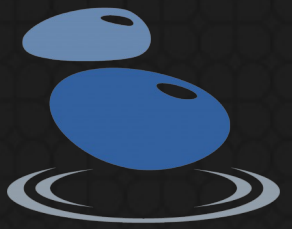
```
coro = test_coro()
task = BaseTask(coro)
```

test_coro() coroutine

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

Output

Tâche simple



Code

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

test_coro() coroutine

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

Output

```
begin
```

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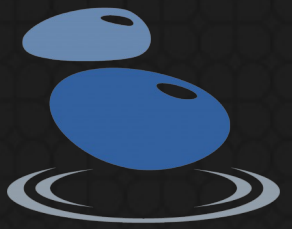
Tâche simple



Code

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

test_coro() coroutine

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

Output

```
begin
end
```

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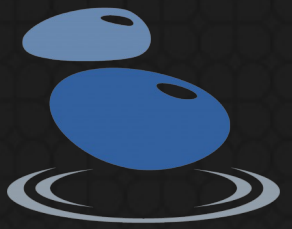
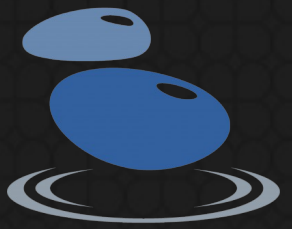
Future et tâche



- **Future** sert à stocker un résultat futur
- **Future** permet de déclarer le flot d'exécution
- **Task** exécute une coroutine dans la boucle d'événements

Future



```
class Future:

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

    def result(self):
        return self._result

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

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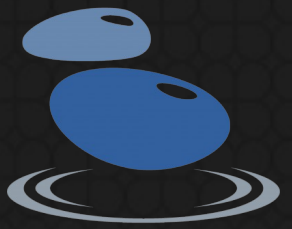
Future



```
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
```

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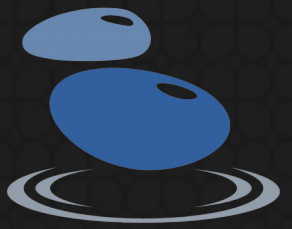
Tâche



```
class Task:

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

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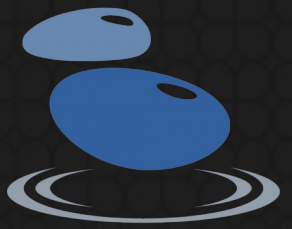
Tâche



```
class Task:
    ...
    def step(self):
        try:
            result = next(self.coro)
        except StopIteration:
            return

        if isinstance(result, Future):
            result.add_done_callback(self.step)
```

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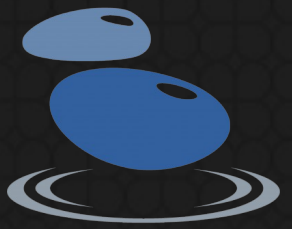
Pause



```
def sleep(delay, loop):
    fut = Future(loop)
    cb = functools.partial(fut.set_result,
                           None)
    loop.call_later(delay, cb)
    yield from fut

def slow_print(loop):
    print("Hello")
    yield from sleep(1.0)
    print("World")
```

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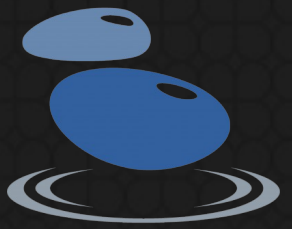
Pause



slow_print() coroutine

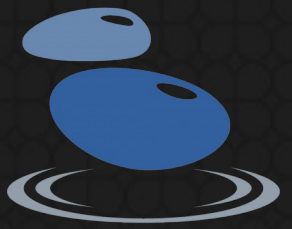
```
print("Hello")
yield from sleep(1.0, loop)
print("World")
```

Callbacks

slow_print.step

Timers

Pause



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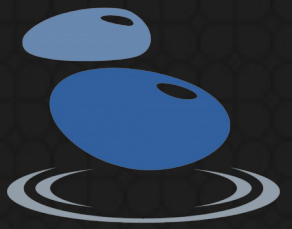

slow_print() coroutine

```
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print("World")
```

Callbacks

Timers

sleep() coroutine

```
f = Future()
loop.call_later(1.0, f.set_result)
yield from f
```

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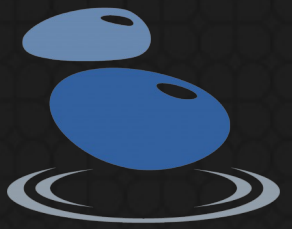
Pause



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Callbacks

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(1, f.set_result)

sleep() coroutine

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f callbacks

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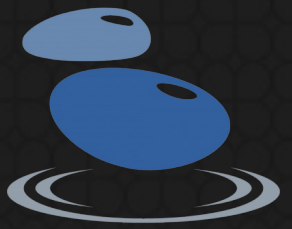
Pause



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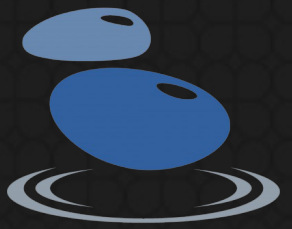

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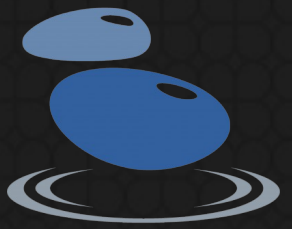

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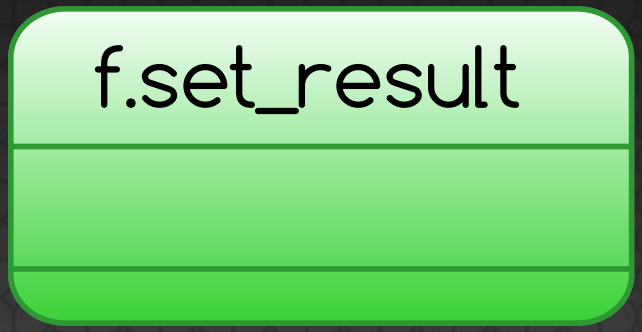
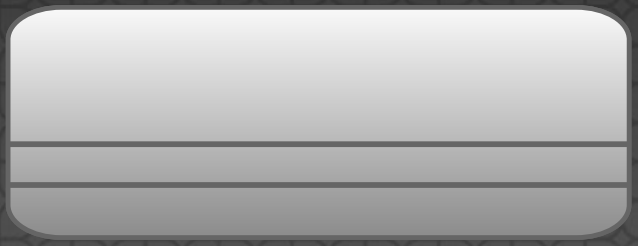


Timers



f callbacks

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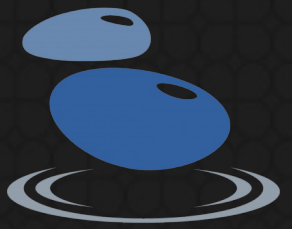
Pause



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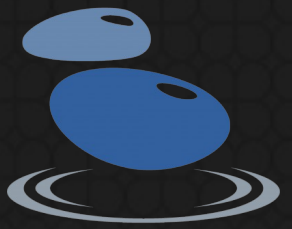

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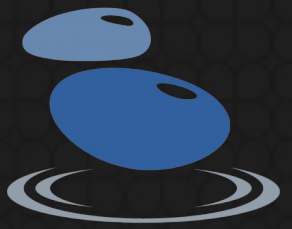

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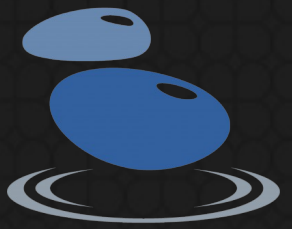

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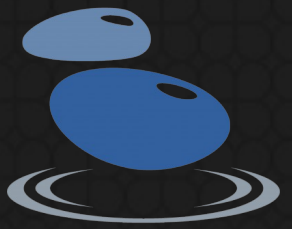

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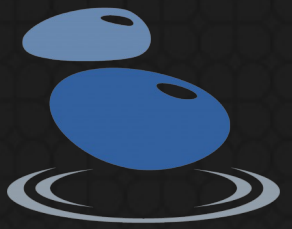
Résumé



- Fonctions de rappel, Future
- Minuteries
- Multiplexeur E/S
- Tâche, coroutine

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Questions ?

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

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

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victor.stinner@gmail.com

Merci à David Malcom pour le modèle LibreOffice

http://dmalcolm.livejournal.com/