Writing a Telegram Antispam Bot in Python:

An introduction to async programming

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Speaker Introduction

- Marc-André Lemburg
  - Python since 1994
  - Studied Mathematics
  - CEO eGenix.com GmbH
  - Consulting CTO, Senior Solutions Architect and Coach
  - EuroPython Society Fellow and former Chair
  - Python Software Foundation Fellow
  - Python Core Developer
  - Based in Düsseldorf, Germany

  - More and for connecting: http://malemburg.com

Motivation: Writing a Telegram Antispam Bot

- Our Python Meeting Düsseldorf user group has been getting lots of signup spam since early last year
  - No longer possible to handle those manually
- Issues
  - Link Spam
  - Crypto Spam
  - Shady Offers
  - Scraping of contact infos

Solution: Write a low resource, scalable TG bot

- Use a scalable Python library for writing Telegram Bots:

  pyrogram

  - Fairly new library, actively maintained
  - Fully asynchronous
  - Uses the Telegram API directly (without proxy)
  - Open Source: LGPL 3

But what's this "asynchronous programming" ?

Let's have a look at
different execution models…

- Synchronous execution
- Threaded execution
- Asynchronous execution

Terminology: Synchronous / Threaded / Asynchronous

- Synchronous
  - All instructions are executed one after another
  - I/O and similar external resources cause execution to wait
  - Timing is not a problem. Everything is deterministic.
  - Problem: Waiting is not an efficient use of resources :-)

Terminology: Synchronous / Threaded / Asynchronous

- Threaded
  - Several synchronous parts of the program run in parallel, using OS threads
  - Execution is controlled by the OS, not the application
  - Threads are often assigned to different CPU cores

  - Problem: Sequence of execution is not necessarily deterministic
  - Problem: Unexpected delays can happen
  - Problem: Sharing data is hard – requires locks
  - Problem: OS overhead

  - Advantage: Efficient use of resources

Terminology: Synchronous / Threaded / Asynchronous

- Asynchronous
  - While some parts of the program wait for e.g. I/O, other parts can continue to run
  - Execution is controlled by the application, not the OS
  - This is not the same as “running in parallel“ (threading)

  - Problem: Sequence of execution is not necessarily deterministic
  - Problem: Unexpected delays can happen
  - Problem: Scope limited to a single core
  - Problem: All parts of the code have to collaborate

  - Advantage: Efficient use of resources

Python: Global Interpreter Lock (GIL)

- The GIL makes sure that only one thread runs Python byte code at any point in time
  - Only released for I/O or other long running tasks...
  - … and then only if no Python code can be run

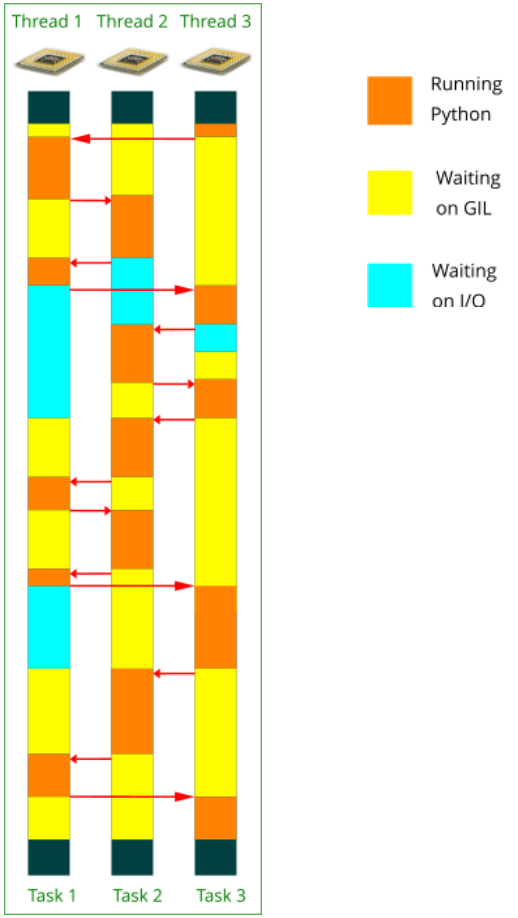
```
204  /* Take the GIL.
205
206     The function saves errno at entry and restores its value at exit.
207
208     tstate must be non-NULL. */
209  static void
210  take_gil(PyThreadState *tstate)
211  {
212      int err = errno;
```

https://github.com/python/cpython/blob/master/Python/ceval_gil.h

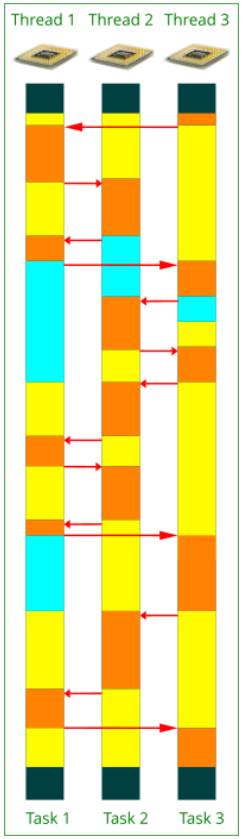
- Threads can only share the Python Interpreter, not use it simultaneously
  - Result: Even if you have multiple cores in the CPUs, only one thread can run Python byte code
  - All other threads which want to run Python code have to wait

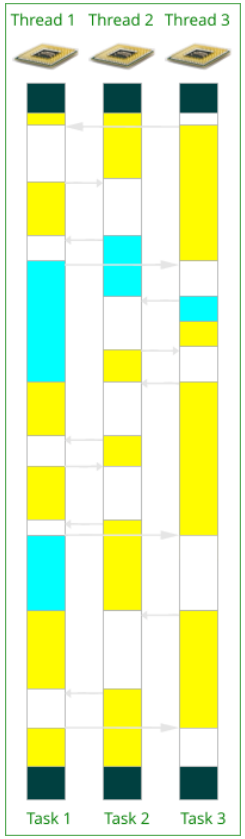
Python: Threaded code on multiple cores/threads

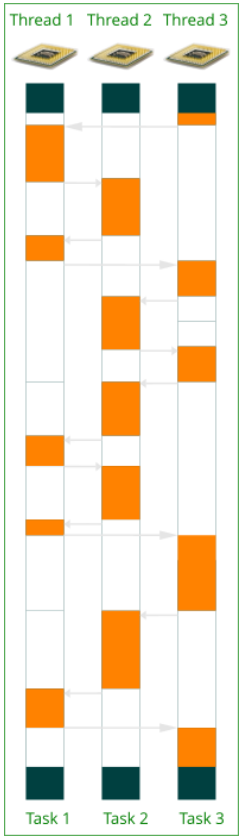
- Threaded + multiple cores/threads:
  A lot of waiting
  - Threads need to wait for the GIL
    Delays due to I/O
  - Not much parallel work
    (mostly only while doing I/O)

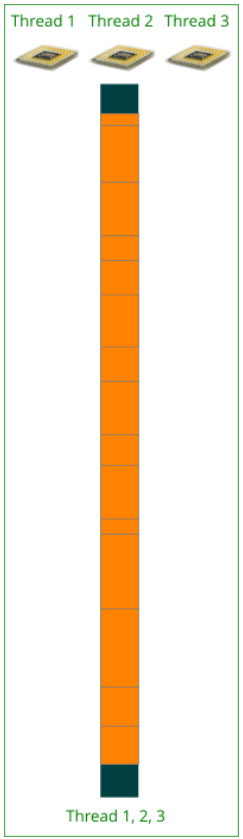


Python: Threaded code – a closer look



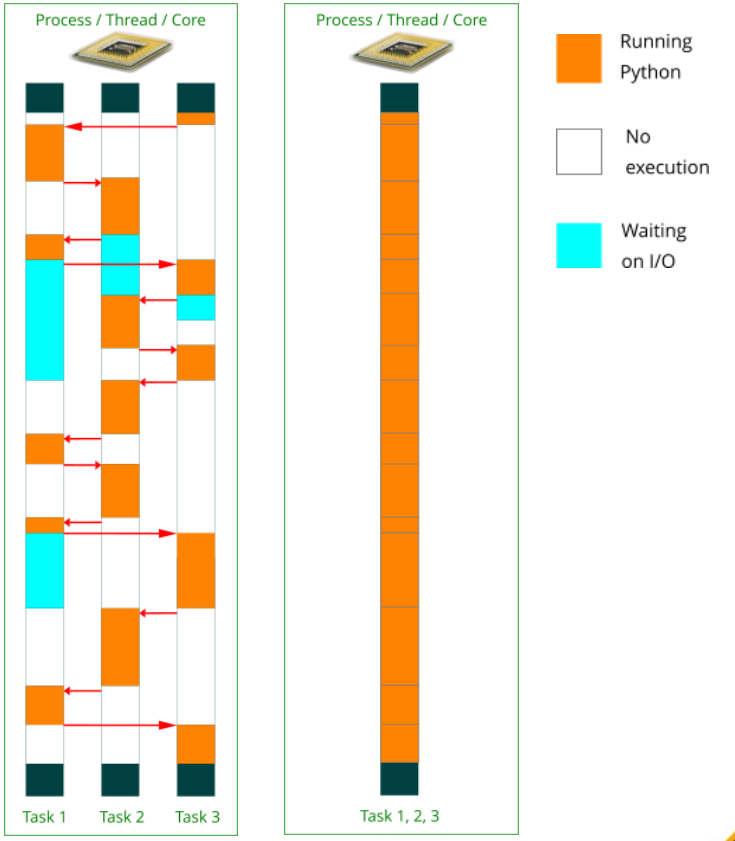






Python: Asynchronous to saturate a single core/thread

- Asynchronous with one thread/process: Less waiting
  - All application parts have to participate
  - Active passing of control (cooperative)
  - Less overhead compared to threads
  - No parallel work, only simulated
  - More efficient use of a single core



Asynchronous programming in Python

- Coroutines
  - Like “subroutines”, but routine can internally give up control to the calling function where needed
  - Created by calling an async function in Python
- New keywords in Python 3.5+
  - Make working with coroutines a lot easier
  - async def task() - defines a coroutine
  - await an_io_call() - gives up control, until an_io_call() responds
- Package asyncio
  - Provides the event loop to run coroutines
  - Many other helpers to run coroutines

async + await: Example

Synchronous

```
1   import asyncio
2   import time
3
4   # Synchron
5   def task_sync(x):
6       print (f'Task sync: {x} working')
7       time.sleep(2)
8       print (f'Task sync: {x} done')
9
10  task_sync('Example 1')
11
12  print ('-'*72)
```

Asynchronous

```
14  # Asynchron
15  async def task_async(x):
16      print (f'Task async: {x} working')
17      await asyncio.sleep(2)
18      print (f'Task async: {x} done')
19
20  # Call task
21  tasks = (task_async('Example 2'),
22           task_async('Example 3'),
23           )
24  async def main():
25      await asyncio.gather(*tasks)
26  asyncio.run(main())
```

async + await: Blocking calls / Giving up control

Synchronous

```python
import asyncio
import time

# Synchron
def task_sync(x):
    print (f'Task sync: {x} working')
    time.sleep(2)
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task_sync('Example 1')

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Asynchronous

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# Call task
tasks = (task_async('Example 2'),
         task_async('Example 3'),
         )
async def main():
    await asyncio.gather(*tasks)
asyncio.run(main())
```

async + await: Running sync / async functions

Synchronous

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```

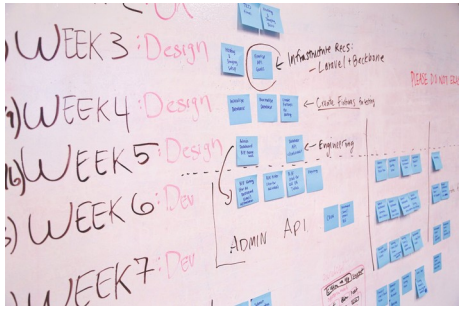
The asyncio module: a closer look

- Management functions for coroutines
  - asyncio.run() – runs a coroutine immediately (in a new event loop)
  - asyncio.gather() – runs multiple coroutines (as tasks) in parallel and waits for completion of all of them
  - asyncio.sleep() – sleep for coroutines (let's other coroutines run)

- Waiting on coroutines
  - asyncio.wait_for() – wait for a coroutine (with timeout)
  - asyncio.wait() – wait for a set of tasks/coroutines (with timeout)

The asyncio module: a closer look

- Task objects
  - Represents a scheduled coroutine call
  - Run by the event loop
  - asyncio.Task – task object type (*don't create directly*)
  - Task.cancel() – cancels a Task object
  - Task.done() – returns True, iff the coroutine has been called
  - etc.



- Scheduling tasks / coroutines
  - asyncio.create_task() – create and schedule a Task object
  - asyncio.current_task() – returns the currently running task object
  - asyncio.all_task() – returns all task objects

Running async: the Event Loop

- Task objects are run by an event loop
  - Tasks run until the next await is hit
    Processing then goes back to the event loop
  - There can only be one event loop per thread
  - asyncio.get_running_loop() returns the loop object

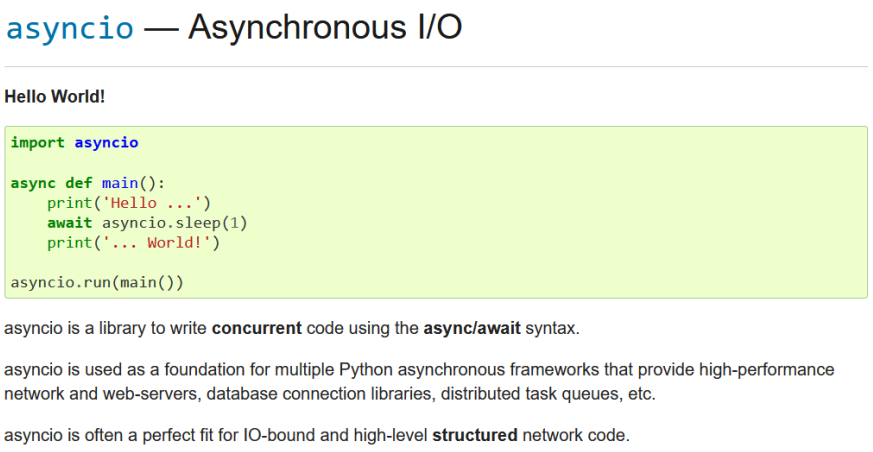
- Blocking code
  - Examples: loading data with non-async code, long running calculation
  - It is possible to run blocking code in a separate thread
    to not have it block the event loop:

    loop.run_in_executor()

    asyncio.to_thread() (Python 3.9+)

And so much more ...

- There are lots of other features and tools available in the asyncio world:
  - Subprocesses
  - Exceptions
  - Servers
  - Timers
  - Signal handlers
  - Sockets with async support
  - File descriptors with async support
  - Different event loop types
  - etc.



`asyncio` — Asynchronous I/O

Hello World!

```
import asyncio

async def main():
    print('Hello ...')
    await asyncio.sleep(1)
    print('... World!')

asyncio.run(main())
```

asyncio is a library to write **concurrent** code using the **async/await** syntax.

asyncio is used as a foundation for multiple Python asynchronous frameworks that provide high-performance network and web-servers, database connection libraries, distributed task queues, etc.

asyncio is often a perfect fit for IO-bound and high-level **structured** network code.

Async eco system: Lowest level

- Python Standard Lib
  - asyncio

- Event Loops
  - Event loop implementations often come with integrations for sockets, streams, files, pipes, DNS, network connections, etc.
  - asyncio.loop – Standard event loop
  - uvloop – Faster loop variant for asyncio using libuv
- Alternative stacks
  - Trio – Alternative async library, making things a bit easier / more concise
  - AnyIO – Abstraction for asyncio and trio

Async eco system: Low level

- AIO Libs
  - Collection of many async packages for Python's asyncio
  - https://github.com/aio-libs

- Examples
  - aiohttp – HTTP client / server
  - aiopg – PostgreSQL interface
  - aiomysql – MySQL interface
  - aioredis – Redis interface
  - aiodns – DNS client
  - *(lots more)*

Warning:
The database packages often don't support transactions !

Async eco system: High level

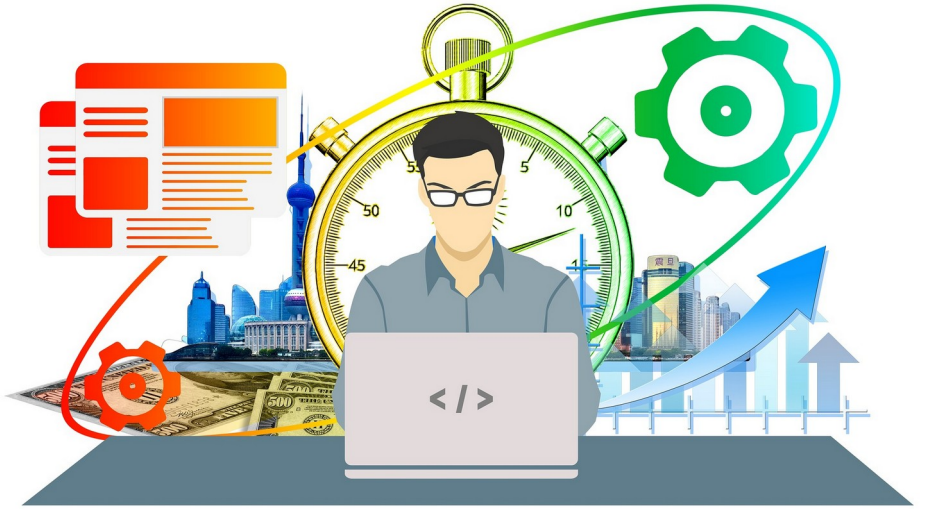
- Web
  - ASGI – Async variant of WSGI
  - Tornado – Web framework
  - Starlette – New ASGI web framework
  - Quart – Async web framework similar to Flask
  - Django 3.0 – Django is starting to support ASGI as well
  - Uvicorn – ASGI server (similar to gunicorn for WSGI)
- APIs
  - FastAPI – REST API server
  - Tartiflette – GraphQL server
  - Strawberry – GraphQL server

Let's apply this new knowledge...

… in the Telegram Antispam Bot:

https://github.com/egenix/egenix-telegram-antispam-bot

or search for "egenix telegram"



Implementation of the Bot

- Subclassing of pyrogram's Client
- Configuration via a Python config.py
  - Use os.environ for overrides
- Delivered as a Python package
  - Easy to install
  - Provide __main__.py, to make *python -m package* work
- Observability
  - Use logging for simple debugging
  - Send admin messages to an admin Telegram group for easy monitoring

```python
### Bot class

class AntispamBot(Client):

    # Dictionary of new members signing up to the group.
    #
    # The dict maps member IDs to the initial new member message.
    new_members = None

    # Flag to keep the .idle_loop() alive
    keep_running = False

    # Bot user id. Set in .start()
    bot_id = 0

    # Set of Challenge class names to use
    challenges = CHALLENGES
```

Don’t use Bot commands – process all messages

- Use the catch all handler
- Delegate tasks to other methods
- Where I/O happens, use async

```
# Handlers

async def all_messages(self, client, message):

    """ Handler which receives all messages sent to the chat.

        This delegates the handling to other methods.
    """
    if _debug:
        self.log('New message:', message)
    if not self.check_access(message):
        return

    # Ignore messages without a .from_user attribute
    if not message.from_user:
        return
    member_id = message.from_user.id

    # Ignore messages sent by the bot itself
    if member_id == self.bot_id:
        return

    # Delegate some messages to other handlers:
    if message.new_chat_members:
        # Process new chat members message
        return await self.new_chat_members(client, message)
```

Async works almost like sync code ...

… with just a few *await* added, meaning: "wait for an answer"

```
async def welcome_new_member(self, message):

    """ Accept and welcome the user as a new member to the group.

        This concludes the conversation and removes the member from
        the .new_members dict.

        message needs to point to the user's signup message.
    """
    chat_id = message.chat.id
    new_member = message.new_member
    await self.remove_conversation(message)
    await self.send_message(
        chat_id,
        f'Thank you for answering the welcome question, '
        f'{new_member.first_name}. '
        f'You are now a member of the chat. '
        f'Please introduce yourself to the group in a line or two.')
    self.new_members.pop(new_member.id)
    await self.log_admin(
        f'Accepted application by '
        f'["{new_member.first_name}" '
        f'(username={new_member.username}, id={new_member.id})]'
        f'(tg://user?id={new_member.id})'
        )
```

Antispam Bot: Results

- Since end of April 2022, the bot banned 780+ spam signups until today
  - Saved more than around 26 hours of admin work
  - Break even reached
- Saved us from an unknown number of spam messages
- Mission accomplished

Main takeaway: Async is great – give it a try !

Thank you for your attention !

Time for discussion

Contact

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References

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