Pubmarine Documentation

Release 0.4.3

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Contents:

Pubmarine is an implementation of the publish-subscribe pattern for asyncio. It is used for intra-process communication. “What’s that”, you ask, “Intra-process?” Yep. Intra-process. When you create a program that has multiple threads of control, you sometimes need an easy way to communicate between the various pieces. That’s where pubmarine comes in. It provides a few functions to subscribe one thread of control to a topic and then publish events to the topic from another thread.

CHAPTER 1

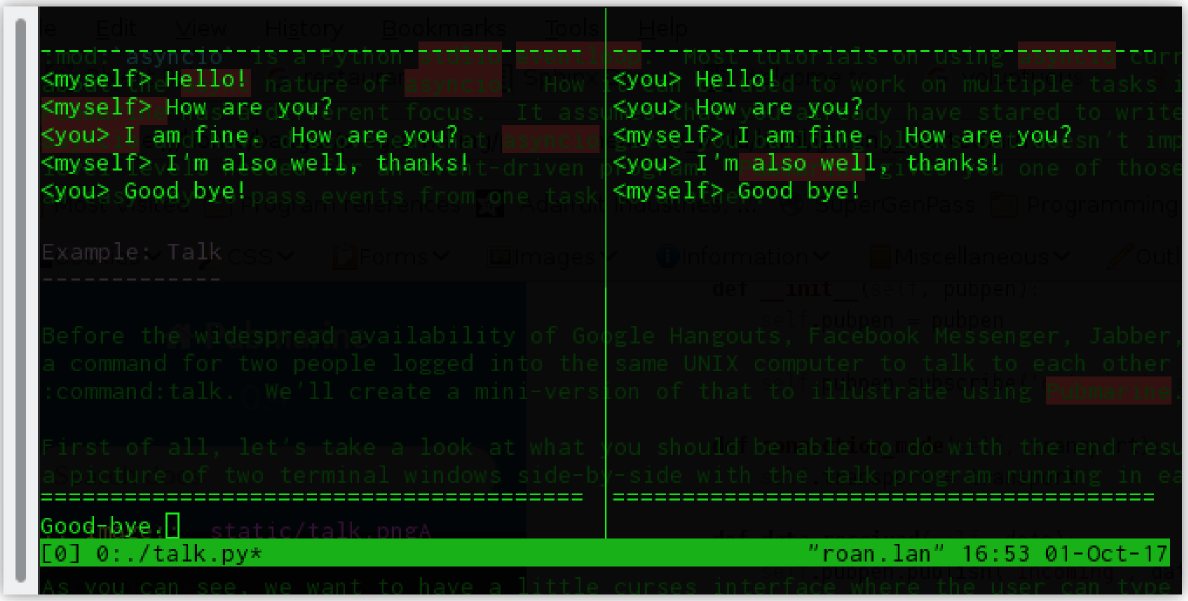
Getting Started

`asyncio` is a Python stdlib eventloop. Most tutorials on using asyncio currently talk about the async nature of asyncio. How it can be used to work on multiple tasks in parallel. Pubmarine has a different focus. It assumes that you already have stared to write a program using asyncio and have discovered that asyncio gives you building blocks but doesn't implement the higher level levels needed for an event-driven program. Pubmarine gives you one of those higher levels: an easy way to pass events from one task to another.

1.1 Example: Talk

Before the widespread availability of Google Hangouts, Facebook Messenger, Jabber, and AIM there was a command for two people logged into the same UNIX computer to talk to each other called **`talk`**. We'll create a mini-version of that to illustrate using Pubmarine.

First of all, let's take a look at what you should be able to do with the end result. Here's a picture of two terminal windows side-by-side with the talk program running in each one:



```
<myself> Hello!                                  <you> Hello!
<myself> How are you?                            <you> How are you?
<you> I am fine.  How are you?                   <myself> I am fine.  How are you?
<myself> I'm also well, thanks!                  <you> I'm also well, thanks!
<you> Good bye!                                  <myself> Good bye!







=======================================          =======================================
Good-bye.
[0] 0:./talk.py*                                              "roan.lan" 16:53 01-Oct-17
```

As you can see, we want to have a little curses interface in which each user can type short, one-line messages and have them displayed on the other user's terminal. Let's take a look at how we achieve that.

1.1.1 Ye, Olde Imports

The first thing to take a look at in our script is the imports. They're pretty small for this example program:

```python
import asyncio
import curses
from functools import partial

from pubmarine import PubPen
```

We have `asyncio`, of course, so that we can multitask between our IO operations and waiting for user input. `curses` handles drawing onto the terminal. `functools.partial()` is a handy utility function that we'll see in action in just a moment. And from pubmarine, we just need its workhorse, *`PubPen`*.

Most of the heavy lifting in this program will be done by `asyncio` and `curses`. *`pubmarine`* is a communication channel that will let those two major parts communicate with each other.

1.1.2 The Network Layer: An Asyncio Protocol

Let's start with the portion that `asyncio` will be in charge of: connecting each running instance of our talk program with all the other ones on the box. In order to handle that, we'll use a `UNIXsocket`. This will write a socket file onto the filesystem and any program which opens that file will be able to participate in the conversation. We could do this manually using he `socket` module from the Python standard library but `asyncio` provides us with a helper function that sets up the communication channel to be ready for asynchronous communications so we'll use that instead:

```python
PATH = '/var/tmp/talk.sock'

loop = asyncio.get_event_loop()
pubpen = PubPen(loop)
```

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```
try:
    # try Client first
    connection = loop.create_unix_connection(partial(TalkProtocol, pubpen), PATH)
    loop.run_until_complete(connection)
except ConnectionRefusedError:
    # server
    connection = loop.create_unix_server(partial(TalkProtocol, pubpen), PATH)
    loop.run_until_complete(connection)
```

In this short piece of code we call `asyncio.get_event_loop()` to create a vanilla loop that we're then going to use for all of our program. You also see your first use of `PubPen` here although the only thing we do is initialize it with our `event loop` and then use it to initialize the `TalkProtocol` class. As we continue to explore the code, we'll see that we hand this `PubPen` to every other class to make use of. Since it's used to aid communication between parts of the code, having it available to all of your other objects makes a lot of sense. If you're not a purist about global variables, you may want to make a single global `PubPen` instance instead of passing it around everywhere.

`asyncio.AbstractEventLoop.create_unix_connection()` is the workhorse in this piece of code. It's a utility function that sets up a client connection via a UNIX socket file. You may notice that the two blocks inside the `try:` and the `except:` are nearly identical. The `except:` block just calls `asyncio.AbstractEventLoop.create_unix_server()` instead. This is because we want our talk program to act like a peer-to-peer program. Anyone can start the talk program first. Whoever does so will become the server. The second person to connect will become a client. (Starting additional programs would start to run into corner-cases with this strategy but solving those has nothing to do with `pubmarine` so we'll leave solving those to some other demonstration ;-)

Both `create_unix_connection()` and `create_unix_server()` return a `asyncio.Future` which we have to run on the main loop. We do that via `run_until_complete()`. Although we don't need them here, after the `Future` completes it returns two objects to us: a `Transport` and a `asyncio.Protocol`. The `Transport` encapsulates getting the bytes from the socket into python in a multitasking-friendly manner. The `Protocol` encapsulates interpreting those bytes and figuring out what to do with them later. We have to write our own `Protocol` because the talk service we are implementing isn't a standard with any existing code for it.

1.1.3 The TalkProtocol class

The `TalkProtocol` isn't too complicated:

```
class TalkProtocol(asyncio.Protocol):
    def __init__(self, pubpen):
        self.pubpen = pubpen
        self.pubpen.subscribe('outgoing', self.send_message)

    def send_message(self, message):
        self.transport.write(message.encode('utf-8'))

    def connection_made(self, transport):
        self.transport = transport

    def data_received(self, data):
        self.pubpen.publish('incoming', data.decode('utf-8', errors='replace'), "<you>
↪")

    def error_received(self, exc):
        self.pubpen.publish('error', exc)

    def connection_lost(self, exc):
```

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```
        self.pubpen.publish('conn_lost', exc)
        self.pubpen.loop.stop()
```

In the class's `__init__()` we see the first real use of the *PubPen* API. We use *pubmarine.PubPen.subscribe()* to have the `TalkProtocol` watch for `outgoing` events. When one occurs, it will call the `send_message()` callback. `send_message` will use the transport layer to send the message out to the other programs listening on the socket.

subscribe() does not care about where the `outgoing` event originated. This allows widely separated parts of your program to talk to each other. They just both need to have access to the same *PubPen* instance in order to communicate.

The other methods in the `TalkProtocol` are all methods that `asyncio.Protocol` gives us the option of implementing. Each one is a callback that asyncio sends data to when certain things happen:

- `connection_made()` is called when a connection is established. Since that sends the `Transport` to us, we take the opportunity to save it for later use.
- `data_recieved()` is called when data arrives on the connection. Here we use another *PubPen* method, *publish()* to publish the `incoming` event. You can see that we're passing two parameters to the `incoming` event: a text version of the message and a string representing who is communicating. *PubPen* does not have strict checking of arguments when an event is registered. It is up to the publishers and subscribers to make sure that the events and callbacks have matching arguments.[*]_
- `error_received()` and `connection_lost()` are called when those asyncio transport-level conditions occur. In our code we use *pubmarine.PubPen.publish()* to alert other code of the events and then, if the connection is lost, we stop the main loop.

1.1.4 Giving Feedback

The talk program uses `curses` to display an interface in the terminal for the user. All of the `curses` code is inside of the `Display` class.

Initializing the Display

The Display class is defined like this:

```
class Display:
    def __init__(self, pubpen):
        self.pubpen = pubpen

        self.pubpen.subscribe('incoming', self.show_message)
        self.pubpen.subscribe('typed', self.show_typing)
        self.pubpen.subscribe('error', self.show_error)
        self.pubpen.subscribe('info', self.show_error)
        self.pubpen.subscribe('conn_lost', self.show_error)
```

As you can see, it consists entirely of subscribing various callbacks inside of the display class to events that are published elsewhere. (Except for `typed`, they are all published by the `TalkProtocol`. We'll see where `typed` comes from shortly.) Pubmarine's agnosticity towards where the event was published is good for user interfaces. A user interface has to respond to events from many sources: generated by the user, from network events, from timers, from hardware changes, etc. Using pubmarine, the user interface doesn't have to be strongly connected to those objects; instead it can receive notification that the objects have changed via the single shared *PubPen* object.

If you've ever programmed with curses before, you may be wondering where the setup of the screen and initial layout is. Usually it's in the __init__ of a class but not this time. In the example code I make Display into a context manager. That way the screen can be put into raw mode for curses when the context manager is entered and restored to cooked mode when the context manager exits:

```
   def __enter__(self):
        self.stdscr = curses.initscr()

        curses.noecho()
        curses.cbreak()
        self.stdscr.keypad(1)

        max_y, max_x = self.stdscr.getmaxyx()

        self.error_buffer = self.stdscr.derwin(1, max_x, 0, 0)

        [... Set up the rest of the screen widgets here ...]

    def __exit__(self, *args):
        curses.nocbreak()
        self.stdscr.keypad(0)
        curses.echo()
        curses.endwin()

        return False

[...]

if __name__ == '__main__':
    with Display(pubpen) as display:
        [...]
```

1.1.5 User Interaction

The majority of the methods inside of `Display` are callbacks. They update the curses display in response to the events that they are subscribed to. The one callback that is interesting to us from a Pubmarine standpoint is `Display.show_typing()`. `show_typing()` is called whenever a character is typed. How is that achieved? To find that out, we have to trace a bit of code from the toplevel all the way back into this method.

At the toplevel, our event loop has two things that it runs over. One of those is the `Transport` which `asyncio` queues to be run by the event loop inside of its own code. We saw the initialization of those earlier. The other is the routine to get user input. Let's look at that now:

```
task = loop.create_task(display.get_ch())
loop.run_forever()
```

This code schedules a co-routine from the `Display` class, `Display.get_ch()` for execution by the main loop and then runs the main loop. `get_ch()` is a short method defined like this:

```
async def get_ch(self):
    while True:
        char = chr(await self.pubpen.loop.run_in_executor(None, self.stdscr.getch))
        self.pubpen.publish('typed', char)
```

This method is an `asyncio` co-routine which means that this thread of control can be suspended while it is waiting for I/O to allow other co-routines to be processed. Since both this task and the `Transport` task are ultimately waiting on a human typist it makes sense that each of them can let the program do other things while they are waiting for that slow input. The method is a short, infinite loop which runs the blocking function, `curses.window.getch()` via `asyncio.AbstractEventLoop.run_in_executor()`. `run_in_executor()` runs a blocking function in a thread (or subprocess depending on configuration), allowing other co-routines to process while it waits for the blocking function to return.

Once the user types a character and the event loop has a chance to execute the `getch()` function the method will publish the `typed` event via *`pubmarine.PubPen.publish()`*. This is the event that `Display.show_typing()` is subscribed to:

```
self.pubpen.subscribe('typed', self.show_typing)
```

`show_typing()` itself examines the character being sent to it. If it determines that hte user hit the `[ENTER]` key and that the only thing on the line was a `.` (period) then it will exit the event loop, causing the program to terminate. Otherwise it will publish the `outgoing` event with the line that the user has entered via *`pubmarine.PubPen.publish()`*, update the chat_log window with the user's text, and then clear the user's input window:

```
def show_typing(self, char):
    if char == '\n':
        if self.input_contents == '.':
            self.pubpen.loop.stop()
        self.pubpen.publish('outgoing', self.input_contents)
        self.show_message(self.input_contents, '<myself>')
        self.clear_typing()
        return

    self.input_contents += char

    [... Curses calls to update the input window ...]
```

What happens to the `outgoing` event? If you remember when we talked about the ``TalkProtocol` `` class, the method `TalkProtocol.send_message()` receives that event and then sends the message over the socket.

1.1.6 Complete Source

The source code for the complete program can be found in the examples directory of the source tree if you want to download and run it or looked at below if you just want to see it in its entirety:

```
#!/usr/bin/python3 -tt
#
# Copyright: 2017, Toshio Kuratomi
# License: MIT

import asyncio
import curses
from functools import partial

from pubmarine import PubPen


PATH = '/var/tmp/talk.sock'

class Display:
    def __init__(self, pubpen):
        self.pubpen = pubpen
```

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```
        self.pubpen.subscribe('incoming', self.show_message)
        self.pubpen.subscribe('typed', self.show_typing)
        self.pubpen.subscribe('error', self.show_error)
        self.pubpen.subscribe('info', self.show_error)
        self.pubpen.subscribe('conn_lost', self.show_error)

    def __enter__(self):
        self.stdscr = curses.initscr()

        curses.noecho()
        curses.cbreak()
        self.stdscr.keypad(1)

        max_y, max_x = self.stdscr.getmaxyx()

        self.error_buffer = self.stdscr.derwin(1, max_x, 0, 0)

        self.separator1 = self.stdscr.derwin(1, max_x, 1, 0)
        sep_txt = b'-' * (max_x - 1)
        self.separator1.addstr(0, 0, sep_txt)

        self.chat_log = self.stdscr.derwin(max_y - 3, max_x, 2, 0)
        self.chat_max_y, self.chat_max_x = self.chat_log.getmaxyx()
        self.current_chat_line = 0

        self.separator2 = self.stdscr.derwin(1, max_x, max_y - 2, 0)
        sep_txt = b'=' * (max_x - 1)
        self.separator2.addstr(0, 0, sep_txt)

        self.input_buffer = self.stdscr.derwin(1, max_x, max_y - 1, 0)
        self.input_max_y, self.input_max_x = self.input_buffer.getmaxyx()
        self.input_current_x = 0
        self.input_contents = ''

        self.stdscr.refresh()
        return self

    def __exit__(self, *args):
        curses.nocbreak()
        self.stdscr.keypad(0)
        curses.echo()
        curses.endwin()

        return False

    async def get_ch(self):
        while True:
            char = chr(await self.pubpen.loop.run_in_executor(None, self.stdscr.
↪getch))
            self.pubpen.publish('typed', char)

    def show_message(self, message, user):
        # Instead of scrolling, simply stop the program
        if self.current_chat_line >= self.chat_max_y:
            self.pubpen.loop.stop()
            return
```

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```
        message = "%s %s" % (user, message)

        # Instead of line breaking, simply truncate the message
        if len(message) > self.chat_max_x:
            message = message[:self.chat_max_x]

        self.chat_log.addstr(self.current_chat_line, 0, message.encode('utf-8'))
        self.current_chat_line += 1
        self.chat_log.refresh()

    def show_typing(self, char):
        if char == '\n':
            if self.input_contents == '.':
                self.pubpen.loop.stop()
            self.pubpen.publish('outgoing', self.input_contents)
            self.show_message(self.input_contents, '<myself>')
            self.clear_typing()
            return

        self.input_current_x += 1
        self.input_contents += char
        self.input_buffer.addstr(0, self.input_current_x - 1, char.encode('utf-8'))
        self.input_buffer.refresh()

    def clear_typing(self):
        self.input_current_x = 0
        self.input_buffer.clear()
        self.input_contents = ''
        self.input_buffer.refresh()

    def show_error(self, exc):
        self.error_buffer.clear()
        self.error_buffer.addstr(0, 0, str(exc).encode('utf-8'))
        self.error_buffer.refresh()


class TalkProtocol(asyncio.Protocol):
    def __init__(self, pubpen):
        self.pubpen = pubpen

        self.pubpen.subscribe('outgoing', self.send_message)

    def send_message(self, message):
        self.transport.write(message.encode('utf-8'))

    def connection_made(self, transport):
        self.transport = transport

    def data_received(self, data):
        self.pubpen.publish('incoming', data.decode('utf-8', errors='replace'), "<you>
↪")

    def error_received(self, exc):
        self.pubpen.publish('error', exc)

    def connection_lost(self, exc):
        self.pubpen.publish('conn_lost', exc)
```

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```
        self.pubpen.loop.stop()


if __name__ == '__main__':
    loop = asyncio.get_event_loop()
    pubpen = PubPen(loop)

    with Display(pubpen) as display:
        try:
            # try Client first
            connection = loop.create_unix_connection(partial(TalkProtocol, pubpen),␣
↪PATH)
            loop.run_until_complete(connection)
        except ConnectionRefusedError:
            # server
            connection = loop.create_unix_server(partial(TalkProtocol, pubpen), PATH)
            loop.run_until_complete(connection)

        task = loop.create_task(display.get_ch())
        loop.run_forever()
        task.cancel()
        try:
            loop.run_until_complete(task)
        except:
            pass
```

CHAPTER 2

API Reference

PubMarine is a simple PubSub framework for Python3's asyncio.

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2.1 Exceptions

class pubmarine.**PubMarineError**
Base of all errors specific to PubMarine

class pubmarine.**EventNotFoundError**
Raised when an event is not handled by this PubPen

2.2 PubPen Context Object

class pubmarine.**PubPen**(*loop: asyncio.events.AbstractEventLoop*, *event_list: List[str] = None*)
A PubPen object coordinates subscription and publication.

Use `PubPen.subscribe()` to register callbacks to be invoked when an event is published.

Use `PubPen.publish()` to publish an event, invoking the callbacks.

Callbacks will be queued to be executed by the `asyncio` event loop that is passed into the `PubPen` when it is instantiated.

Note: Most programs should create one PubPen instance and then share it between all of the objects that wish to communicate with each other.

emit(*event: str*, **args*, ***kwargs*) → None
Publish an event

Parameters **event** – String name of an event to publish

Other args and keyword args are passed to the callback function.

Deprecated: Use publish() instead

`publish`(*event: str*, **args*, ***kwargs*) → None

Publish an event

Parameters **`event`** – String name of an event to publish

Other args and keyword args are passed to the callback function.

`subscribe`(*event: str, callback: Union[Callable[[...], Any], method]*) → int

Subscribe a callback to an event

Parameters **`event`** – String name of an event to subscribe to

Callback The function to call when the event is published. This can be any python callable.

Use `functools.partial()` to call the callback with any other arguments.

Note: The callback is registered with the event each time this method is called. The callback is called each time it has been registered when the event is published. For example:

```
>>> import asyncio
>>> import pubmarine
>>> pubpen = pubmarine.PubPen(asyncio.get_event_loop)
>>> def message():
...     print('message called')
>>> pubpen.subscribe('test', message)
>>> pubpen.subscribe('test', message)
>>> pubpen.publish('test')
message called
message called
```

If the caller wants the callback to only be called once, it is the caller's responsibility to only subscribe the callback once.

`unsubscribe`(*sub_id: int*) → None

Unsubscribe from an event.

Parameters **`sub_id`** – The subscription id returned from subscribe.

CHAPTER 3

Release Notes

3.1 0.4.3-12

3.1.1 Other Notes

- Enable mypy type checking for pubmarine. This required a small change to how we checked whether to use a WeakMethod or WeakFunction for event handlers as mypy did not understand using try-except to differentiate between the need for methods and the need for functions but it could understand an isinstance check.

3.2 0.4.3

3.2.1 Other Notes

- 0.4.2 had various bugs in building docs on readthedocs.org. Since this release is all about docs, we spun a new one with fixes.

3.3 0.4.2

3.3.1 Prelude

This update just brings documentation to the release tarball.

3.3.2 Other Notes

- Add API docs for *`pubmarine`*
- Add an example that walks through creating a simplified clone of UNIX talk using `asyncio` and *`pubmarine`*

3.4 0.4.1

3.4.1 Bug Fixes

- Fix a traceback when calling callbacks with keyword arguments. Keyword arguments to callbacks would not have worked at all prior to this.

3.5 0.4

3.5.1 Bug Fixes

- In some circumstances, callbacks which had been deallocated in the main program were not being removed from the event_handler list. This could lead to a small inefficiency as PubPen.publish() would continue to attempt to call them even though they were already removed.

3.5.2 Other Notes

- Added unittests to prevent regressions

3.6 0.3

3.6.1 New Features

- Added the ability to unsubscribe from an event. `PubPen.subscribe()` now returns a subscription_id that may be used with the new method, `PubPen.unsubscribe()` to stop getting notified about an event.

3.6.2 Deprecation Notes

- `PubPen.emit()` has been deprecated. It has been renamed to `PubPen.publish()` to better match with `PubPen.subscribe()`

CHAPTER 4

Development Docs

These docs are for developing PubMarine itself. General users do not need to look at this.

4.1 Coding Guidelines

- Make sure that tests are passing in travis
- Add new tests to exercise the code and keep coverage at 100%
- Run pylint on any new code. Currently we're at 0 pylint warnings. Let's see if we can keep it that way.
- This is a very rough guide so far. It is subject to change

4.2 Making a Release

- Make sure changes have been recorded using reno. For every new feature and bugfix:
  - `reno new [SLUG]`
  - Edit the notes file
  - git add releasenotes
  - git commit
- Update the version info in `pubmarine/__init__.py` for the release
- Regenerate release notes using reno.
  - `reno report .> NEWS`
  - Edit `NEWS` to adjust the version number for the release. Since there's no tag for the new release yet, the version has to be bumped manually in this file.
- `git push`

- Check that tests are passing in travis.
- Check that the docs built on readthedocs.org
- git tag the release
- `git push --tags`
- git clone a fresh copy
- git checkout the tag
- `python3 setup.py sdist`
- check that the dist is sane (same as what's in the repository. No extra files. No missing files)
- `python3 setup.py sdist upload --sign`

CHAPTER 5

Indices and tables

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