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Debugging Hung Python Processes With GDB

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Who Am I?

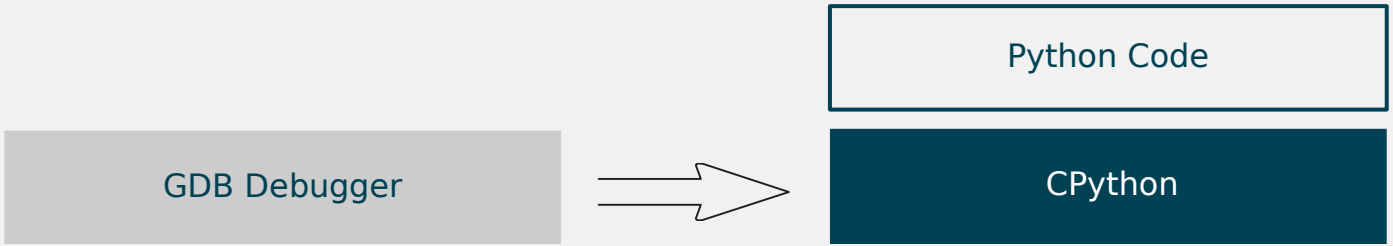
- Python user since 2005
- Senior Software Engineer with Red Hat since 2015
- Work on Pulp [0]
- Contribute to several Open Source projects
- Love Puzzles
- PhD Candidate in Computer Science @ NCSU
- Married and live in Raleigh, NC

[0]: http://www.pulpproject.org/

Why use GDB to debug Python software?

- Production application where pdb can't go
- Remote applications where rpdb isn't available
- Rarely occurring issues
- Deadlocking applications

Conceptual Model



example.py

```
import os
import time

def bar():
    time.sleep(30)

def foo():
    print 'pid is %s' % os.getpid()
    bar()

foo()
```

GDB Basics

- Connect to a running process: `gdb /path/to/program/ 1234`
- Connect to a running process by pid: `gdb -p <pid>`
- `c` to continue
- `Ctrl + C` to stop execution again
- `Ctrl + D` to detach (which continues)

Demo of basics + `bt`

A function call in CPython

```
#8  0x00007ff43137e666 in fast_function (nk=<optimized out>,
na=0, n=0, pp_stack=0x7ffd25b961a0, func=<function at remote
0x7ff43172d6e0>)
    at /usr/src/debug/Python-2.7.10/Python/ceval.c:4198
#9  call_function (oparg=<optimized out>,
pp_stack=0x7ffd25b961a0) at /usr/src/debug/Python-
2.7.10/Python/ceval.c:4133
#10 PyEval_EvalFrameEx (f=f@entry=Frame 0x7ff43185fc20, for
file example.py, line 14, in <module> (),
throwflag=throwflag@entry=0)
    at /usr/src/debug/Python-2.7.10/Python/ceval.c:2755
```

Calling into the kernel

```
#0  0x00007ff4306add43 in __select_nocancel () from
/lib64/libc.so.6
#1  0x00007ff42fe2ffc0 in floatsleep (secs=<optimized out>) at
/usr/src/debug/Python-2.7.10/Modules/timemodule.c:948
#2  time_sleep (self=<optimized out>, args=<optimized out>)
at /usr/src/debug/Python-2.7.10/Modules/timemodule.c:206
#3  0x00007ff43137e8be in call_function (oparg=<optimized
out>, pp_stack=0x7ffd25b95f40) at /usr/src/debug/Python-
2.7.10/Python/ceval.c:4112
#4  PyEval_EvalFrameEx (f=f@entry=Frame 0x7ff431738050, for
file example.py, line 6, in bar (), throwflag=throwflag@entry=0)
    at /usr/src/debug/Python-2.7.10/Python/ceval.c:2755
```

Python extensions for GDB

Python extensions for GDB

- py-list Python source (if any) in current thread and Frame
- py-bt Print a Python stack trace from the GDB stack
- py-locals Print all Python locals from current thread
- py-print Print something from python namespace
- py-up and py-down Move up and down the Python stack

`py-list` output of example.py

```
(gdb) py-list
   1    import os
   2    import time
   3
   4
   5    def bar():
  >6        time.sleep(30)
   7
   8
   9    def foo():
  10        print 'pid is %s' % os.getpid()
  11        bar()
```

`py-bt` output of example.py

```
(gdb) py-bt
#4 Frame 0x7f12850d0050, for file example.py, line 6, in bar ()
    time.sleep(30)
#7 Frame 0x7f12851f7dd0, for file example.py, line 11, in foo ()
    bar()
#10 Frame 0x7f12851f7c20, for file example.py, line 14, in
<module> ()
    foo()
```

GDB and threads

- `info threads` Shows you information about threads in process
- Current thread is marked with *
- `thread <id>` Switches the current thread to <id>
- `thread apply all <COMMAND>` applies command to all threads
  - `thread apply all py-bt`
  - `thread apply all py-list`

Working with Core Dumps

- Generate a coredump with `gcore <pid>`
- Connect to a coredump with `gdb /path/to/program <core_file>`

Consider using `strace`

- trace system calls and signals
- An example call:

```
open("/dev/null", O_RDONLY) = 3
```

- An example error:

```
open("/foo/bar", O_RDONLY) = -1 ENOENT (No such file or directory)
```

strace demo

`strace python example.py`

Better Demo

Gotchas

- You need debuginfo libraries installed
  - GDB will tell you what you need
  - Your packages need to be the same as the ones gdb wants
- Optimized out Python code removes GDB's ability to see it
- Root is required to connect other user's processes

Trigger rpdb.set_trace() with a signal

- Add a signal handler which triggers rpdb.set_trace()
- Make it yourself or let rpdb do it. Recent versions have it build in.
- set_trace() can be triggered at any time by using the TRAP signal handler

```
import rpdb
rpdb.handle_trap()

# As with set_trace, you can optionally specify addr and port
rpdb.handle_trap("0.0.0.0", 54321)
```

References

- https://wiki.python.org/moin/DebuggingWithGdb
- https://fedoraproject.org/wiki/Features/EasierPythonDebugging
- https://sourceware.org/gdb/current/onlinedocs/gdb/Threads.html
- https://github.com/tamentis/rpdb#trigger-rpdb-with-signal

Contact Info

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