Debugging Hung Python Processes With GDB

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May 2, 2016
(Based on work by Brian Bouterse and David Malcolm, Red Hat)
Why are we here?

There are (roughly) 3 type of programs to debug:
1. “Program doesn't do what I want!”
   • Debug with prints/pdb...
2. “Program crashed!”
   • Inspect traceback, goto 1.
3. “My program seems stuck and I don't know what it's doing!”
   • ???
What will we learn?

- Tools to help you know **what** the program is doing?
- Won't teach you **how** to debug
- Still need to think about the **why**
Who Am I?

- Python user since 2008
- Working at Red Hat since 2014
- Before that – Intelligence Core, IDF
- Contributes for OpenStack (Neutron)
- Coding Enthusiastic
- Problem Solver (race conditions, deadlocks...)
pdb

- Allows for easy, gdb-like interface with code

- Requirement: put a breakpoint & restart program
  - Cannot attach!

```
import pdb; pdb.set_trace()
```

- This is also a problem
pdb commands

• list    Print surrounding source code

• bt      Print program's backtrace

• print   Print variable or function’s return value

• up, down  Move up and down the stack

• Can also run code!
rpdb (as in “remote pdb”)  

- Same interface as pdb, installable with pip  

- Requirement: put a breakpoint & restart program:  

```python
import rpdb
rpdb.Rpdb(port=1337).set_trace()
```

- Connect with ‘telnet’
Trigger `rpdb.set_trace()` with SIGTRAP

```python
# Trigger rpdb.set_trace() on SIGTRAP with
# specified IP/port
rpdb.handle_trap("0.0.0.0", 1337)
```

- Recent versions already have it build in
- Problem?
strace (syscall tracer)

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

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

- Blocking
  
  ```
  select(1, [0], NULL, NULL, NULL
  ```
Conceptual Model

GDB Debugger → Python Code

CPython
Why use GDB for Python?

- Production application where pdb can't go
- Remote applications where rpdb isn't available
- “My program *seems stuck* and *I don't know* what it's doing!”
  - Solution: use GDB!
GDB Basics

- Connect to a running process: `gdb -p <pid>`
- `c` to continue
- Ctrl+C to stop execution again
- Ctrl+D to detach (which continues)
GDB Commands

- list  Print surrounding source code
- bt    Print program's backtrace
- print Print variable or function's return value
- up, down Move up and down the stack
- Problem?
GDB commands

- list  Print surrounding source code
- bt    Print program’s backtrace
- print Print variable or function’s return value
- up, down Move up and down the stack
- Problem?
import os
import time

def foobar(amount):
    time.sleep(amount)

def main():
    print "Hello, World! My pid is %d" % os.getpid()
    foobar(amount=1337)
    print "Bye, World!"

if __name__ == '__main__':
    main()
A function call in CPython

#8  0x000007ff43137e666 in fast_function (nk=<optimized out>, na=0, n=0, pp_stack=0x7ffd25b961a0, afunc=<function at remote 0x7ff43172d6e0>)
at /usr/src/debug/Python-2.7.10/Python/ceval.c:4196

#9  call_function (oparg=<optimized out>, pp_stack=0x7ffd25b961a0)
at /usr/src/debug/Python-2.7.10/Python/ceval.c:4131

#10  PyEval_EvalFrameEx (f=f@entry=Frame 0x7ff43185fc20
for file example1.py, line 10, in <module> (),
throwflag=throwflag@entry=0)
at /usr/src/debug/Python-2.7.10/Python/ceval.c:2753
Calling into the kernel

#0  0x00007ff4306add43 in __select_nocancel ()
from /lib64/libc.so.6
#1  0x00007ff42fe2ffc0 in floatsleep (secs=<optimizedout>) at/usr/src/debug/Python2.7.10/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:4110
#4  PyEval_EvalFrameEx (f=f@entry=Frame 0x7ff431738050, for file example1.py, line 6, in bar (), throwflag=throwflag@entry=0)
at /usr/src/debug/Python-2.7.10/Python/ceval.c:2753
Python extensions for GDB
Python extensions for GDB

- **py-list**: Print surrounding *python* source code
- **py-bt**: Print *python* stack trace
- **py-print**: Print *python* variables
- **py-up, py-down**: Move up and down the *python* stack
- **py-locals**: Print all *python* locals
`py-list` output of example1.py

```
(gdb) py-list

1    #!/usr/bin/env python
2    import os
3    import time
4
5    def foobar(amount):
>6        time.sleep(amount)
7
8    def main():
9        print "Hello, World! My pid is %d" % os.getpid()
10       foobar(amount=1337)
11       print "Bye, World!"
```
`py-bt` output of example1.py

(gdb) py-bt

#4 Frame 0x7f547357d3c0, for file ./example1.py, line 6, in foobar (amount=1337)
    time.sleep(amount)

#8 Frame 0x7f547357d050, for file ./example1.py, line 10, in main ()
    foobar(amount=1337)

#11 Frame 0x7f54735bedd0, for file ./example1.py, line 14, in <module> ()
    main()
Demo
GDB and threads

- `info threads`
  - Current thread is marked with *

- Switch:`thread <id>`

- `thread apply all <COMMAND>`
  - `thread apply all py-bt`
  - `thread apply all py-list`
Working with Core Dumps

- Also works with core dumps.
- Generate coredump: `gcore <pid>`
- `gdb /path/to/program <core_file>`
Gotchas

- You need debuginfo libraries installed
  - GDB will tell you what you need

- Optimized out Python code = bad GDB

- Root is required for GDB's attach
What’s next?

- A lot

- Example: `py-print` can’t traverse namespaces
- Example: `py-print` can’t call functions
- Example: run `pdb.set_trace()` from GDB?

- Code in Python’s HG, please contribute!
References

- https://wiki.python.org/moin/DebuggingWithGdb
- https://fedoraproject.org/wiki/Features/EasierPythonDebugging
- https://sourceware.org/gdb/current/onlinedocs/gdb/Threads.html
- https://hg.python.org/cpython/rev/6de3de3ab71f/
Questions?
TALKED AT PYCON IL

EVERYONE CLAPPED
Thank You

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