

PyPy: current status and GIL-less future

Antonio Cuni, Maciej Fijałkowski, Armin Rigo

EuroPython 2012

July 2 2012



PyPy at EuroPython

```
fijal:~/extradoc/talk$ cd ep20  
ep2004-pypy/ ep2006/ ep2008/ ep2010/  
ep2005/ ep2007/ ep2009/ ep2011/  
ep2012/
```

- for those who missed previous EPs, PyPy is a Python interpreter with a JIT.

PyPy at EuroPython

```
fijal:~/extradoc/talk$ cd ep20  
ep2004-pypy/ ep2006/ ep2008/ ep2010/  
ep2005/ ep2007/ ep2009/ ep2011/  
ep2012/
```

- for those who missed previous EPs, PyPy is a Python interpreter with a JIT.

Software archeology

“single functions doing integer arithmetic get great speed-ups; about anything else will be a bit slower with the JIT than without. We are working on this - you can even expect quick progress, because it is mostly a matter of adding a few careful hints in the source code of the Python interpreter of PyPy.”

(status of the JIT of PyPy as of March 2007)

Software archeology

- Around since 2003
- (advertised as) production ready since December 2010
 - ▶ release 1.4
- Funding
 - ▶ EU FP6 programme
 - ▶ Eurostars programme
 - ▶ donations
 - ▶ ...

PyPy 1.9: current status

- Faster
 - ▶ **1.7x** than 1.5 (a year ago)
 - ▶ **2.2x** than 1.4
 - ▶ **5.5x** than CPython
- Implements Python 2.7.2
- Many more “PyPy-friendly” programs
- Packaging
 - ▶ Debian, Ubuntu, Fedora, Homebrew, Gentoo, ArchLinux, ...
 - ▶ Windows (32bit only), OS X
- C extension compatibility
 - ▶ runs (big part of) **PyOpenSSL** and **lxml**

PyPy organization

- Part of Software Freedom Conservancy
 - ▶ Bradley successfully fighting U.S. bureaucracy
 - ▶ we are happy about it
- Funding model
 - ▶ py3k, numpy, STM
 - ▶ more than 100'000\$ in donations
 - ▶ from individuals, large companies and the PSF
 - ▶ **thank to all**

Let's talk about Python

- Rapid prototyping
 - ▶ run your web server in 3 seconds
 - ▶ run your script in 0.1s
- Glue language
 - ▶ integrating with C is “easy”

Let's talk about PyPy

- JIT warmup time
 - ▶ significant
 - ▶ rapid prototyping is harder
- no good way to call C from PyPy (yet)

JIT warmup times

- JIT-ted code: very fast
 - Everything else: slow
 - JIT-ting one piece at a time
 - “takes a while”
 - **Cannot** cache JIT-ted code between runs
-
- We did not spend much time on this
 - **PyPy JIT Under the hood**
 - ▶ July 4 2012

JIT warmup times

- JIT-ted code: very fast
- Everything else: slow
- JIT-ting one piece at a time
- “takes a while”
- **Cannot** cache JIT-ted code between runs
- We did not spend much time on this
- **PyPy JIT Under the hood**
 - ▶ July 4 2012

- `py3k` branch in mercurial
 - developed in parallel
- Focus on correctness
- Dropped some interpreter optimizations for now
- Work in progress

Py3k status

- Directly from the “What’s new in Python 3.x”:
 - ▶ string vs unicode, int/long unification
 - ▶ syntactic changes (`print()`, `except`, ...)
 - ▶ set, oct, binary, bytes literals
 - ▶ view and iterators instead of lists
 - ▶ function annotations, keyword only arguments
 - ▶ `nonlocal`
 - ▶ extended iterable unpacking
 - ▶ dictionary comprehensions
 - ▶ `raise ... from ...`, lexical exception handling
 - ▶ `__pycache__`
- Most features are already there
 - ▶ major exception: unicode identifiers

Py3k: what's left?

- First 90% done, remaining 90% not done
- Tons of small issues
- Extension modules / stdlib
- In January:
 - ▶ PyPy “own” tests: 1621 failures
 - ▶ CPython tests: N/A (did not compile)
- Now:
 - ▶ PyPy “own” tests: 83 failures
 - ▶ CPython tests: “lots”
- Most are shallow failures

- progress going slowly
- multi dimensional arrays, broadcasting, fancy indexing
- all dtypes, except complex, strings and objects
- tons of functions missing
- you can help!

Calling C

HOW STANDARDS PROLIFERATE:
(SEE: A/C CHARGERS, CHARACTER ENCODINGS, INSTANT MESSAGING, ETC)



Calling C landscape

- CPython C extensions
- SWIG, SIP, wrapper generators
- ctypes
- Cython
- CFFI (our new thing)

Example

```
>>> from cffi import FFI
>>> ffi = FFI()
>>> ffi.cdef("""
...     int printf(const char *format, ...);
... """)
>>> C = ffi.dlopen(None)
>>> arg = ffi.new("char[]", "world")
>>> C.printf("hi there, %s!\n", arg)
hi there, world!
```

- Many more examples
- Including macro calls and most subtleties of C
- `http://cffi.readthedocs.org`

- Software Transactional Memory
- “Remove the GIL”

Problem

- One Python program == one core
- Even with threads

Does it matter?

- “My script runs anyway in 0.1 seconds”
- Python getting exponentially slower?

Does it matter?

- “My script runs anyway in 0.1 seconds”
- Python getting exponentially slower?

Does it matter?

- “I can have several processes exchanging data”
- A special-case solution only

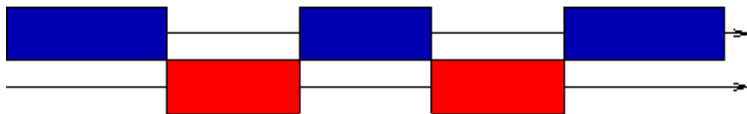
Does it matter?

- “I can have several processes exchanging data”
- A special-case solution only

- A Python without the GIL
- not the first one:
 - ▶ Python 1.4 patch (Greg Stein, 1996)
 - ▶ Jython
 - ▶ IronPython
- Demo

Transactions, similar to database transactions

- GIL

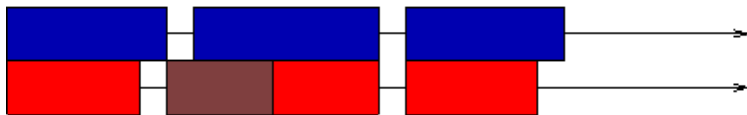


- STM



Conflicts

Occasional conflict:



- Hardware support: Intel Haswell, 2013
- “CPython-htm”?
- Removing the GIL: suddenly around the corner

The catch

You have to use threads

The catch

You have to use threads

Threads

- Messy
- Hard to debug, non-reproducible
- Parallel with Explicit Memory Management:
 - ▶ messy, hard to debug rare leaks or corruptions
 - ▶ automatic GC solves it
 - ▶ (like in Python)

This talk is really about...

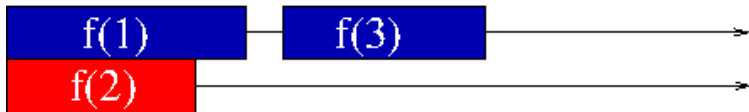
- Multicore usage **without using threads**
- Demo with the “transaction” module

How?

- Longer, controlled transactions
- GIL



- STM



Results

- Same results in both cases
- i.e. can pretend it is one-core

The opposite catch

- Always gives correct results...
- But maybe too many conflicts
 - ▶ up to: systematic conflicts
- This still approaches the issue from “the right side”

The opposite catch

- Always gives correct results...
- But maybe too many conflicts
 - ▶ up to: systematic conflicts
- This still approaches the issue from “the right side”

About CPython

- Long transactions: HTM too limited
- At least for the next 10-15 years
- On CPython we are stuck with threads
 - ▶ for the next 10-15 years

Summary

- STM fine with PyPy, but HTM required for CPython
- HTM too limited for long transactions
- Long transactions give a better programming model
- For years to come, only in PyPy
 - ▶ Unless major effort from CPython devs

Conclusion

- The GIL will be removed soon
- But for the foreseeable future, Python programmers stuck with using threads

Conclusion

- ...while other langs get the better programming model
 - ▶ My own point of view only
 - ▶ Or maybe everybody will switch to PyPy

Conclusion

- ...while other langs get the better programming model
 - ▶ My own point of view only
 - ▶ Or maybe everybody will switch to PyPy

Thank you

- `http://pypy.org/`
- You can hire Antonio (`http://antocuni.eu`)
- Questions?
- PyPy help desk on Thursday morning