The PyPy Project and You

OSDC 2008

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What you're in for in the next 20 mins

- Quick intro and motivation
- Quick overview of architecture and current status
- Introduction to features unique to PyPy, including the JIT, with the odd demo
- A little talk about what the future holds

What is PyPy?

- PyPy is:
  - An implementation of Python in Python
  - A very flexible compiler framework (with some features that are especially useful for implementing interpreters)
  - An open source project (MIT license)
  - A lot of fun!

What was PyPy?

- PyPy *was* a Structured Targeted REsearch Proposal (STREP), part funded by the EU
- The funding period ended at the end of March 2007
- In May we had our final technical review, and

  "[PyPy] fully achieved its objectives and tech goals and has even exceeded expectations"

What we've got

- We can produce a binary that looks very much like CPython to the user
- Most, but not all, extension modules supported – enough to run Twisted, Django, Pylons

  (Google's Open Source office sponsored some of the work on running "real" software on PyPy)

What we've got

- Have "semi-advanced" garbage collection options (generational, semispace, compacting mark&sweep, Boehm-Demers-Weiser)
- Can produce binary for CLR/.NET (watch out IronPython! :-) and JVM (ditto Jython…)
- Can also produce binaries with more features (stackless, JIT, …)

Motivation

- PyPy grew out of a desire to modify/extend the *implementation* of Python, for example to:
  - Increase performance (psyco-style JIT compilation, better garbage collectors)
  - Add expressiveness (stackless-style coroutines, logic programming)
  - Ease porting (to new platforms like the JVM or CLI or to low memory situations)

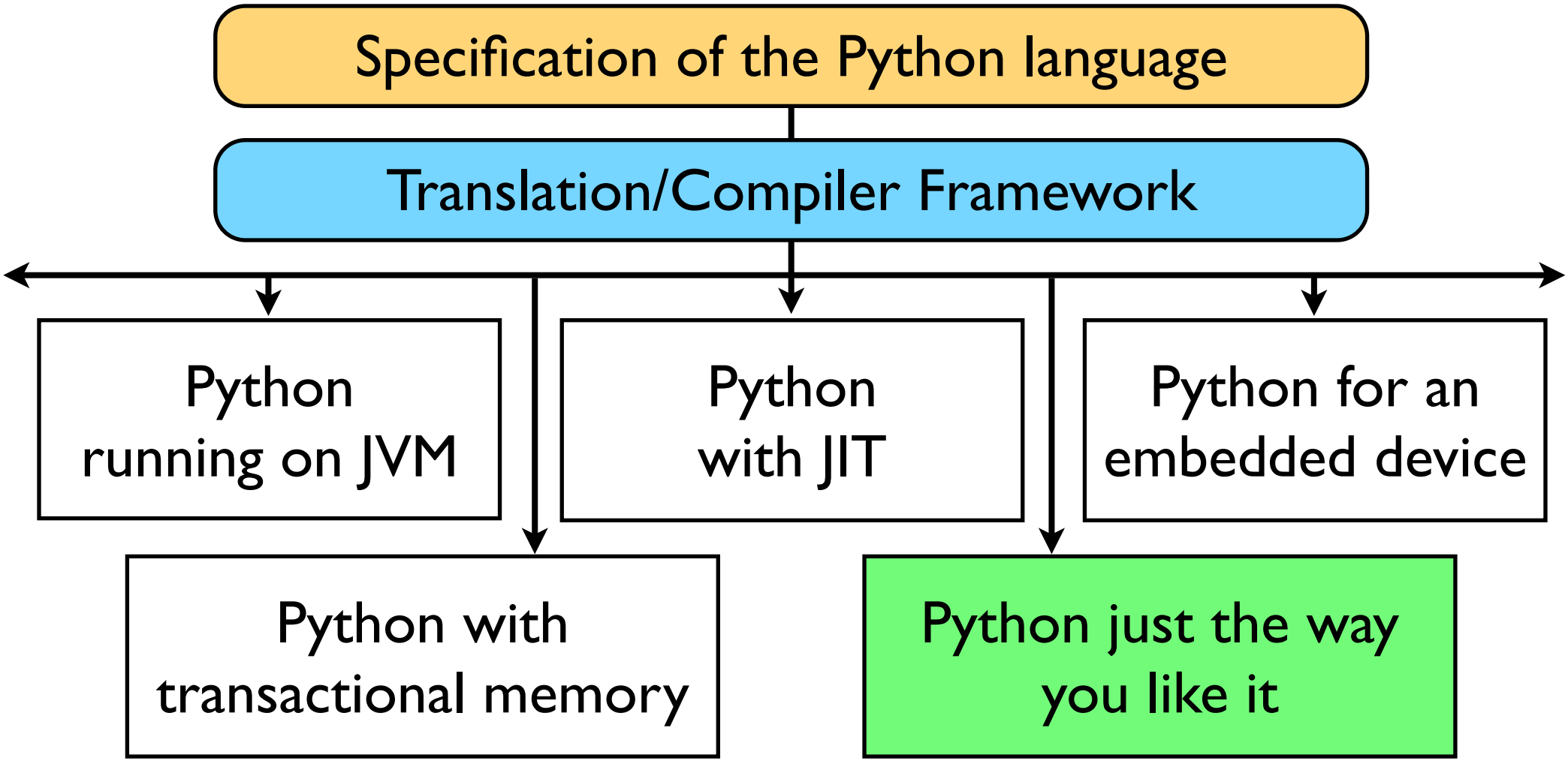
Problems with CPython

- CPython is a fine implementation of Python but:
  - It's written in C, which makes porting to, for example, the CLI hard
  - While psyco and stackless exist, they are very hard to maintain as Python evolves
  - Some implementation decisions are very hard to change (e.g. refcounting)

PyPy's Big Idea

- Take a *description* of the Python programming language
- Analyze this description:
  - Decide whether to include stackless- or psyco-like features
  - Decide which GC to use
  - Decide the target platform
- Translate to a lower-level, efficient form

The PyPy platform



How do you specify the Python language?

- The way we did it was to write an interpreter for Python in *RPython* – a subset of Python that is amenable to analysis
- This allowed us to write unit tests for our specification/implementation that run on top of CPython
- Can also test entire specification/ implementation in same way

The Translation/ Compiler Framework

- The compiler framework takes as input live Python objects (as opposed to source code)
- It *abstractly interprets* the bytecode of functions to produce flow graphs
- Further layers of abstract interpretation perform more analysis and gradually reduce the level of abstraction
- Finally C or other source code is generated

If you have a hammer…

- We'd written this compiler framework, with only one expected non-trivial input (our Python interpreter)
- We realized that it would be suitable for implementations of other dynamically-typed programming languages
- Now have implementations of Prolog, JavaScript and Scheme (to varying extents)

The *L*×*O*×*P* problem

This leads to one of PyPy's meta-goals, ameliorating the so-called *L*×*O*×*P* problem: given

- *L* dynamic languages
- *O* target platforms
- *P* implementation decisions

we don't want to have to write *L*×*O*×*P* different interpreters by hand.

The *L*×*O*×*P* problem

- PyPy aims to reduce this to an *L*+*O*+*P* problem:
  - Implement *L* language front-ends
  - Write backends for *O* platforms
  - Take *P* implementation decisions
- Then let the *magic of PyPy*™ tie it all together :-)

Status – Interpreter

- PyPy's Python interpreter supports 2.5.2 by default
- 2.6 should be easy enough
- No Py3K yet :-) (will be work, but not too instanely hard)
- The "__pypy__" module includes a variety of mysterious and exciting things, depending on options supplied

Status – compiled interpreter

- When compiled to (standalone) C with all the optimizations turned on, our interpreter varies from a little faster to about twice as slow than CPython
- The prototype JIT compiler ran programs 60 times faster than CPython!
- Can also build interpreters with threading and with stackless features

Status – backends

- We currently have three complete backends:
  - C/POSIX (like CPython)
  - CLI (like IronPython)
  - JVM (like Jython)
- Also a collection of half-finished or un-maintained backends (LLVM, Common Lisp, Squeak, …)

Things that make PyPy unique

- The Just-In-Time compiler (and the way it is being made)
- Sandboxed Executable
- Transparent Proxies
- JavaScript backend

About the project

- Open source, of course (MIT license)
- Sprint driven development – focused week long coding sessions
- Extreme Programming practices: pair programming, test-driven development

Future Hopes

- At least in my opinion, the work so far on PyPy has mostly been preparatory – the real fun is yet to come.
- Likely future work includes:
  - More work on the JIT
  - Reducing code duplication
  - Improved C gluing, better GIL handling

Future Dreams

- Higher performance GC (steal ideas or even code from Jikes RVM?)
- Implementations of other dynamic languages such as JavaScript, Prolog (already started), Ruby (?), Perl (??) (which will get a JIT essentially for free)
- The ability to have dynamically loaded extension modules

Join the fun!

- Project relies more than ever on getting the community involved
- Read documentation:

  http://codespeak.net/pypy/

- Come hang out in `#pypy` on freenode, post to pypy-dev
- Probably will be easier to keep up now…

Thanks for listening!

Any Questions?