Pugs

an implementation of

Perl 6

Audrey Tang

def

Pugs...

Pugs...

$\stackrel{\text{def}}{=}$ **Perl 6 Compiler**

Pugs...

$\stackrel{\text{def}}{=}$ **Perl 6 Compiler**

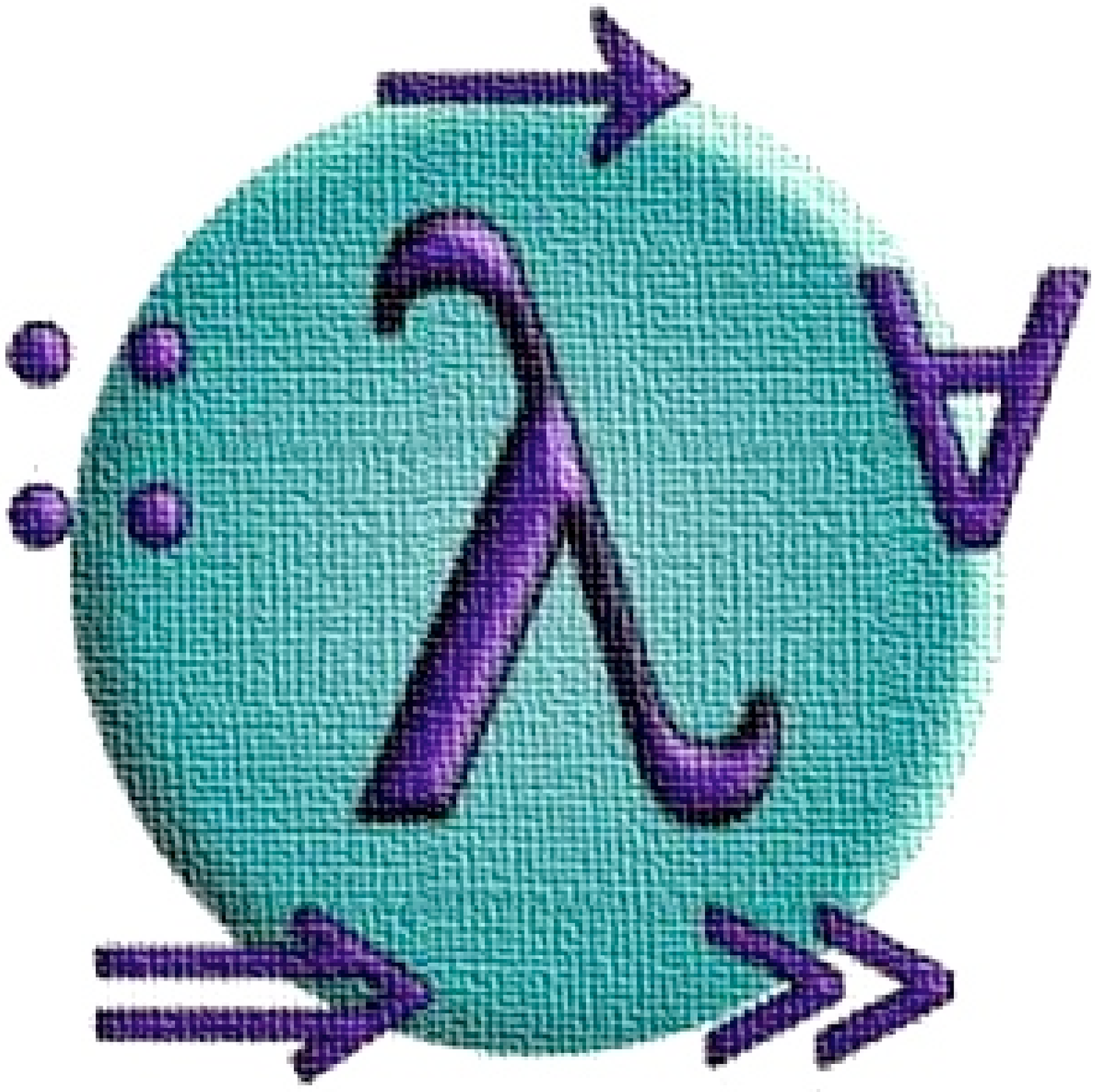
$\stackrel{\text{def}}{=}$ **Perl 6 Runtime**

Pugs...

≡ def **Perl 6 Compiler**

≡ def **Perl 6 Runtime**

≡ def **Perl 6 Test Suite**




PROGRAMMING REPUBLIC OF
PERL
JSAN
Java


PROGRAMMING REPUBLIC OF
JSAN
Java


AN

Perl 6 Code

Perl 6 Code

- ✓ 120+ Modules

Perl 6 Code

- ✓ 120+ Modules
- ✓ 160+ Examples

Perl 6 Code

- ✓ 120+ Modules
- ✓ 160+ Examples
- ✓ 18,000+ Unit Tests

“Official Perl 6”

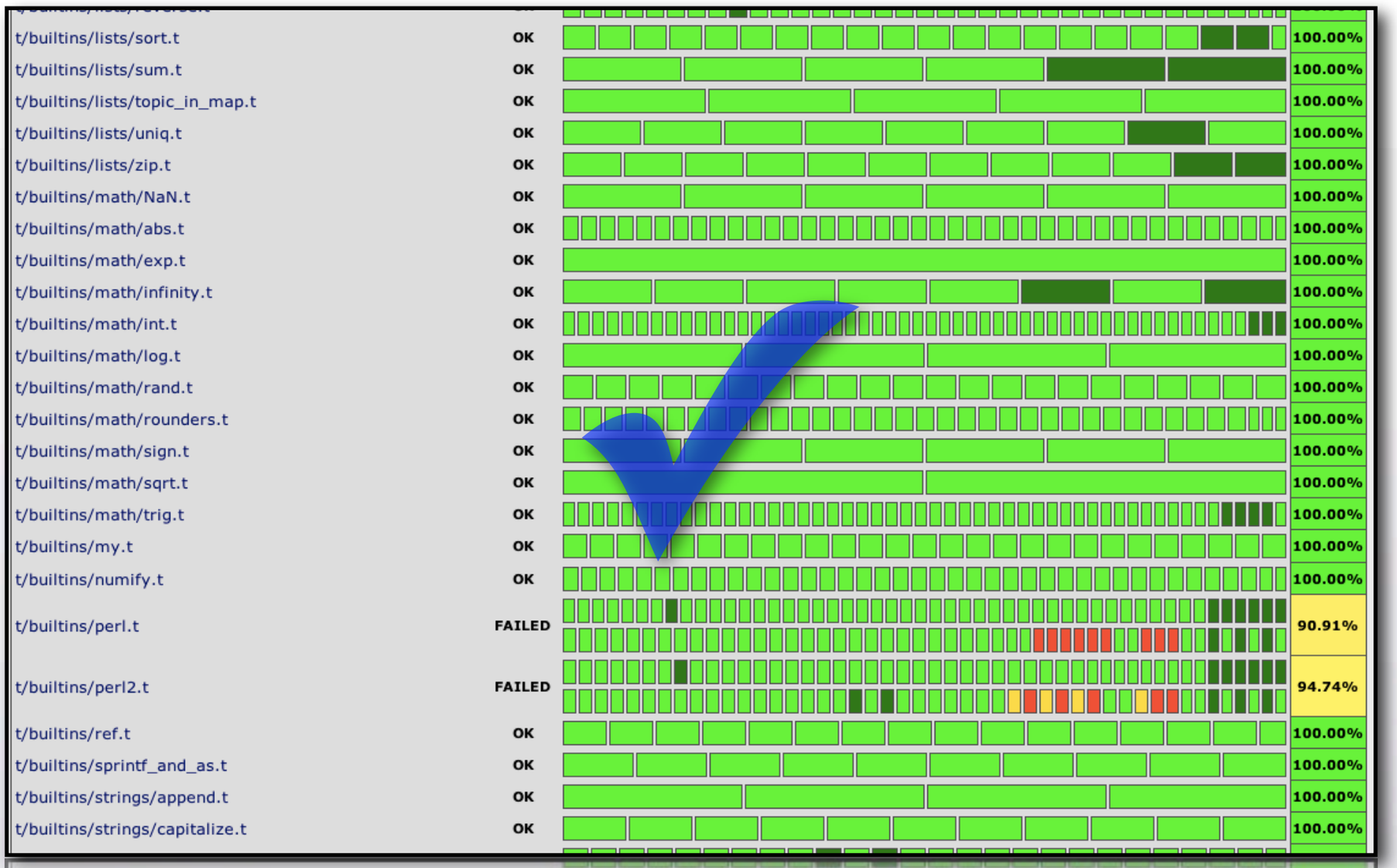
“Official Perl 6”

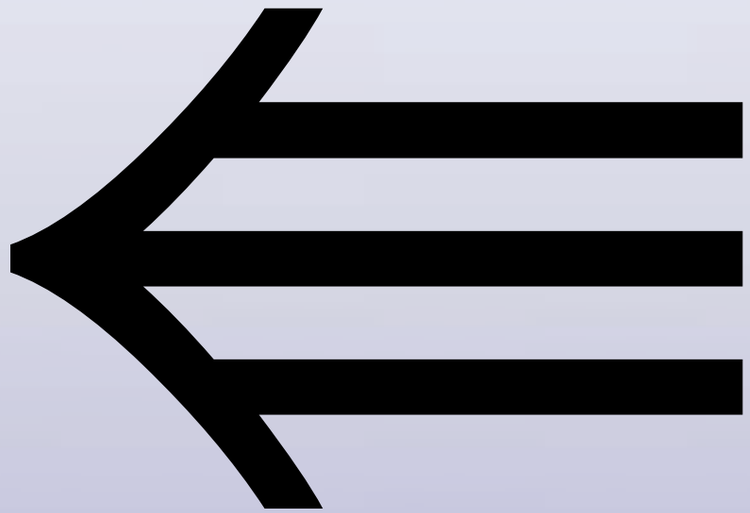
- ✓ Anything that passes the official test suite

“Official Perl 6”

- ✓ Anything that passes the official test suite
- ✓ Defined by semantics, not by accidents of history

Test ⇔ Spec


t/builtins/lists/sort.t OK 100.00%
t/builtins/lists/sum.t OK 100.00%
t/builtins/lists/topic_in_map.t OK 100.00%
t/builtins/lists/uniq.t OK 100.00%
t/builtins/lists/zip.t OK 100.00%
t/builtins/math/NaN.t OK 100.00%
t/builtins/math/abs.t OK 100.00%
t/builtins/math/exp.t OK 100.00%
t/builtins/math/infinity.t OK 100.00%
t/builtins/math/int.t OK 100.00%
t/builtins/math/log.t OK 100.00%
t/builtins/math/rand.t OK 100.00%
t/builtins/math/rounders.t OK 100.00%
t/builtins/math/sign.t OK 100.00%
t/builtins/math/sqrt.t OK 100.00%
t/builtins/math/trig.t OK 100.00%
t/builtins/my.t OK 100.00%
t/builtins/numify.t OK 100.00%
t/builtins/perl.t FAILED 90.91%
t/builtins/perl2.t FAILED 94.74%
t/builtins/ref.t OK 100.00%
t/builtins/sprintf_and_as.t OK 100.00%
t/builtins/strings/append.t OK 100.00%
t/builtins/strings/capitalize.t OK 100.00%



Perl, circa 1995

Perl, circa 1995

- `use 5.000;`

Perl, circa 1995

```
use 5.000;
require 'fastcwd.pl';
```

Perl, circa 1995

```
use 5.000;
require 'fastcwd.pl';
require 'newgetopt.pl';
```

Perl, circa 1995

```
use 5.000;
require 'fastcwd.pl';
require 'newgetopt.pl';
require 'exceptions.pl';
```

Perl, circa 2005

Perl, circa 2005

```
use v6-alpha;
```

Perl, circa 2005

```
use v6-alpha;
use perl5:DBI;
```

Perl, circa 2005

```
use v6-alpha;
use perl5:DBI;
use perl5:Encode <encode decode>;
```

Perl, circa 2005

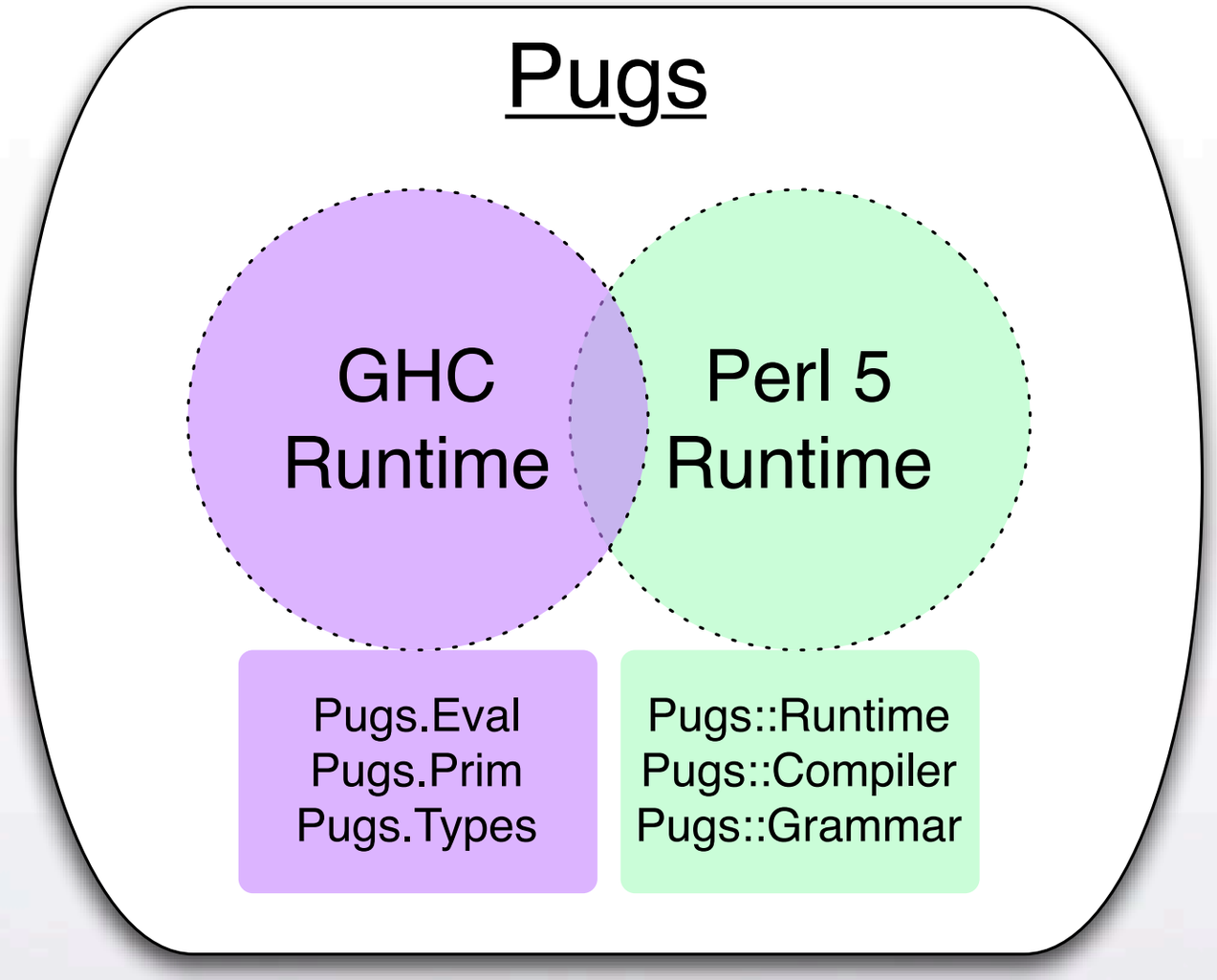
```
use v6-alpha;
use perl5:DBI;
use perl5:Encode <encode decode>;
use perl5:Template;
```

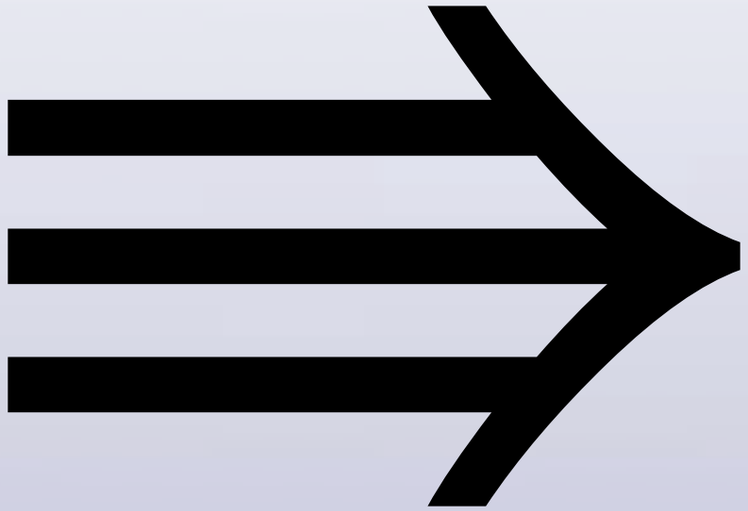
Perl, circa 2005

```
use v6-alpha;
use perl5:DBI;
use perl5:Encode <encode decode>;
use perl5:Template;
```

```
# Implementation of "fork"
eval "fork()" :lang<perl5>;
```

Dual Core


Pugs
GHC
Runtime
Perl 5
Runtime
Pugs.Eval
Pugs.Prim
Pugs.Types
Pugs::Runtime
Pugs::Compiler
Pugs::Grammar



Pugs Intermediate Language

Backends

Backends

⇛ Perl 5

Backends

⟹ Perl 5

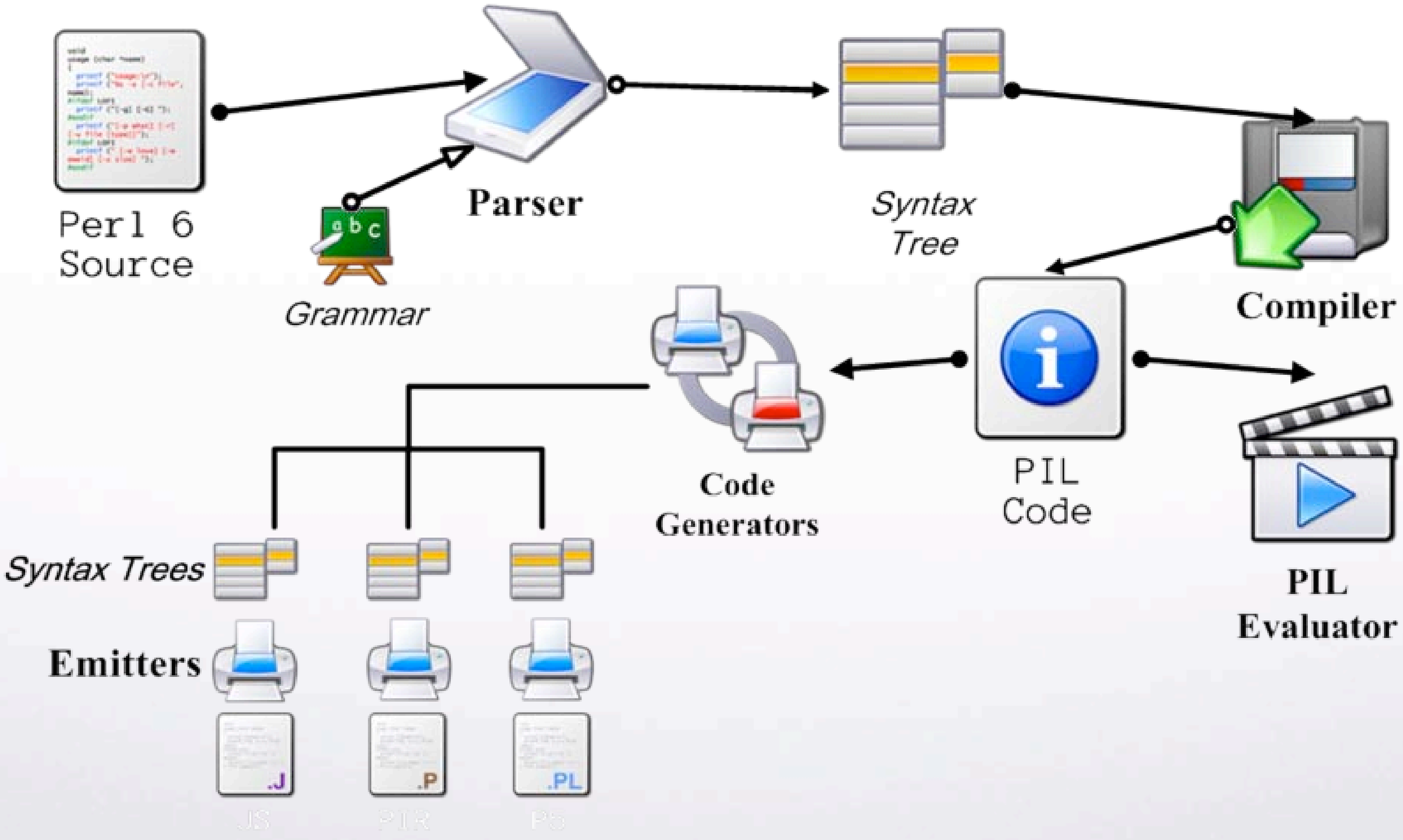
⟹ Parrot

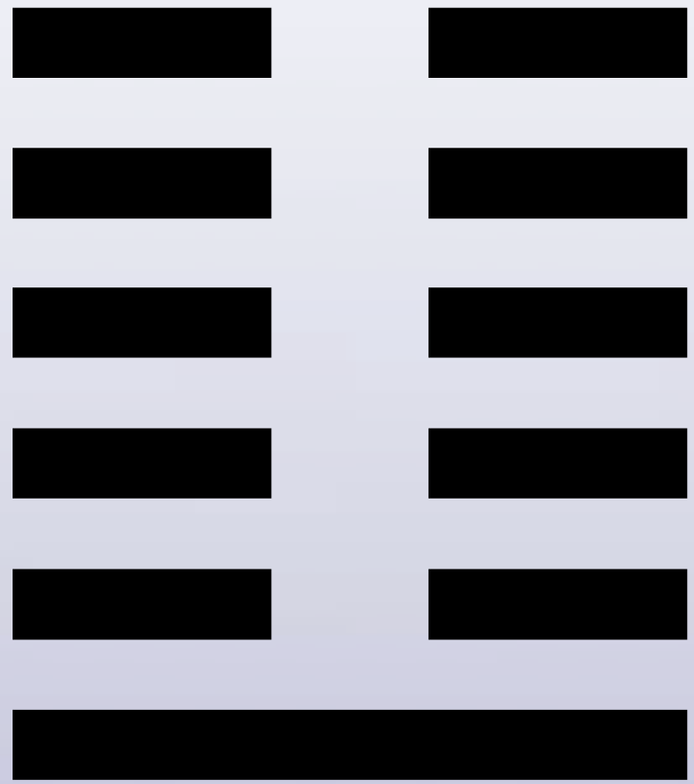
Backends

⟹ Perl 5

⟹ Parrot

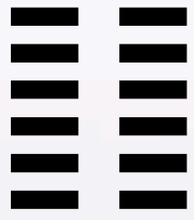
⟹ JavaScript


Perl 6
Source
Grammar
Parser
Syntax
Tree
Compiler
Code
Generators
PIL
Code
PIL
Evaluator
Syntax Trees
Emitters
.J
.P
.PL
JS
PIR
PS



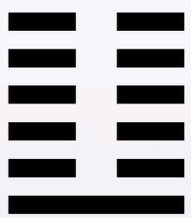
6.0

Primitives



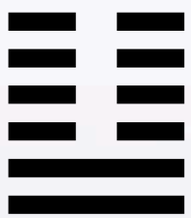
6.2

Functions



6.28

Objects



6.283

Grammars

䷗

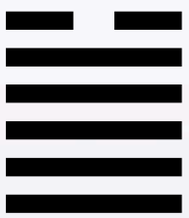
6.2831

Types

䷀

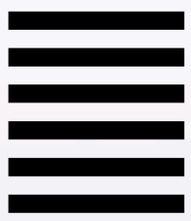
6.28318

Macros



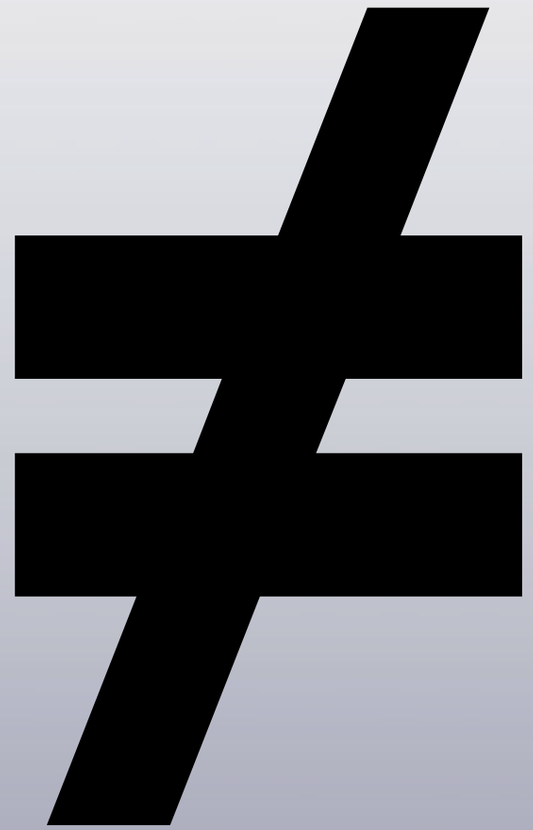
6.283185

Self Hosting



2π

Perl 6!



“Frivolous Toy interpreter”

(as seen on Slashdot)

“Frivolous Toy interpreter”

“~~Frivolous~~

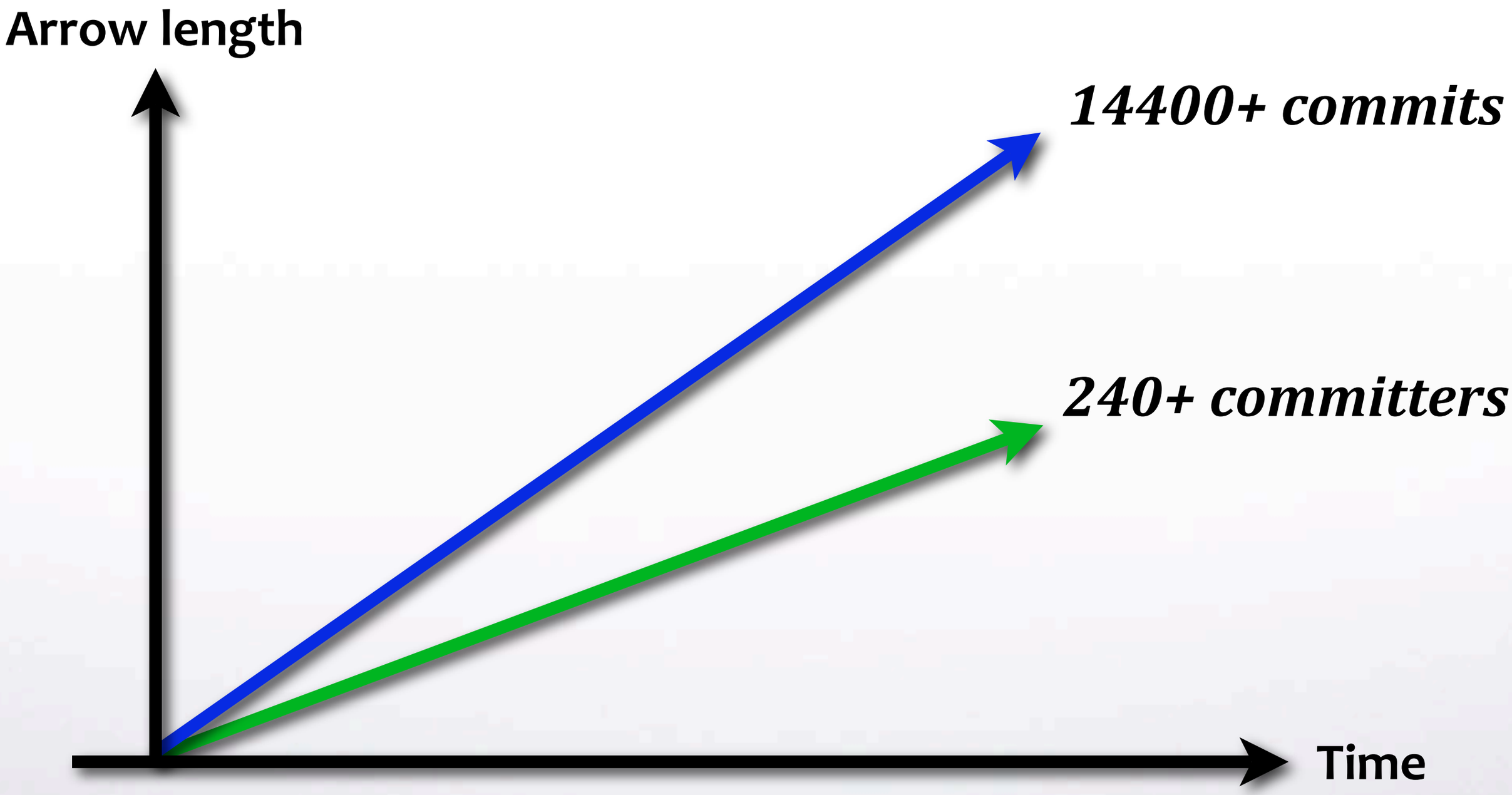
Toy interpreter”

“Toy interpreter”

“Toy ~~interpreter~~”

“Toy”

-O*fun*


Arrow length
14400+ commits
240+ committers
Time

Test Driven

Test Driven

☺ Bug report ➠ Test

Test Driven

☺ Bug report ➟ Test

☺ Smoke Server

Test Driven

☺ Bug report ➟ Test

☺ Smoke Server

☺ `:todo<unspecced>`

Anarchistic

Anarchistic

☺ 10+ languages

Anarchistic

☺ 10+ languages

☺ 30+ sub-projects

Anarchistic

☺ 10+ languages

☺ 30+ sub-projects

☺ Fast feedback loop

Patches Welcome?

Commits Welcome!

```
16:19  @audreyt  A commit bit is in your inbox now...
16:19  @audreyt  Don't forget to add your name to the AUTHORS file;
16:19  @audreyt  Welcome aboard!
```

irc.freenode.net

#perl6

λ Camels

λ Camels

200+ People

λ Camels

200+ People

20+ Regulars

λ Camels

- ✆ 200+ People
- ✆ 20+ Regulars
- ✆ TimToady++

svnbot6

```
13:26 < svnbot6> r10754 | audreyt++ | * reduce-metaop.t - unTODO one surprisingly
13:26 < svnbot6> r10754 | audreyt++ |   succeeding test involving [=].
13:26 < svnbot6> r10754 | audreyt++ |   That's all for tonight...
14:35 < svnbot6> r10755 | audreyt++ | * INSTALL: Bump our parrot requirement to
14:35 < svnbot6> r10755 | audreyt++ |   0.4.5 for the shiny regex/token/rule
14:35 < svnbot6> r10755 | audreyt++ |   :ratchet/:sigspace support.
15:50 < svnbot6> r10756 | fglock++ | Pugs::Grammar::Perl6 - added @{exp}, exp[], s///,
15:50 < svnbot6> r10756 | fglock++ |   - added modules Pugs::Compiler::Perl6,
15:50 < svnbot6> r10756 | fglock++ |     Pugs::Emitter::Perl6::Perl5,
15:50 < svnbot6> r10756 | fglock++ |     Pugs::Runtime::Perl6
15:50 < svnbot6> r10756 | fglock++ |   - added stub module: v6-pugs
15:50 < svnbot6> r10756 | fglock++ | Pugs::Compiler::Precedence
15:50 < svnbot6> r10756 | fglock++ |   - fixed postcircumfix to allow an empty list
15:53 < svnbot6> r10757 | fglock++ | renamed Pugs-Grammar-Perl6 to Pugs-Compiler-Perl6
15:56 < svnbot6> r10758 | fglock++ | Pugs-Compiler-Perl6 - fixed test.pl
```

evalbot6

```
16:25 < audreyt> ?eval [+] 1..100
16:26 < evalbot_10746> 5050
16:26 < audreyt> ?eval { $_ ?? $_ * &?BLOCK($_-1) !! 1 }.(10)
16:26 < evalbot_10746> 3628800
```

lambdabot

```
16:30 < audreyt> @pl f h = hGetContents h >>= \x -> return (lines x)
16:30 < lambdabot> f = (lines `fmap`) . hGetContents
16:32 < audreyt> @djinn (a -> b) -> (c -> b) -> Either a c -> b
16:32 < lambdabot> f a b c =
16:32 < lambdabot>   case c of
16:32 < lambdabot>   Left d -> a d
16:30 < lambdabot>   Right e -> b e
```

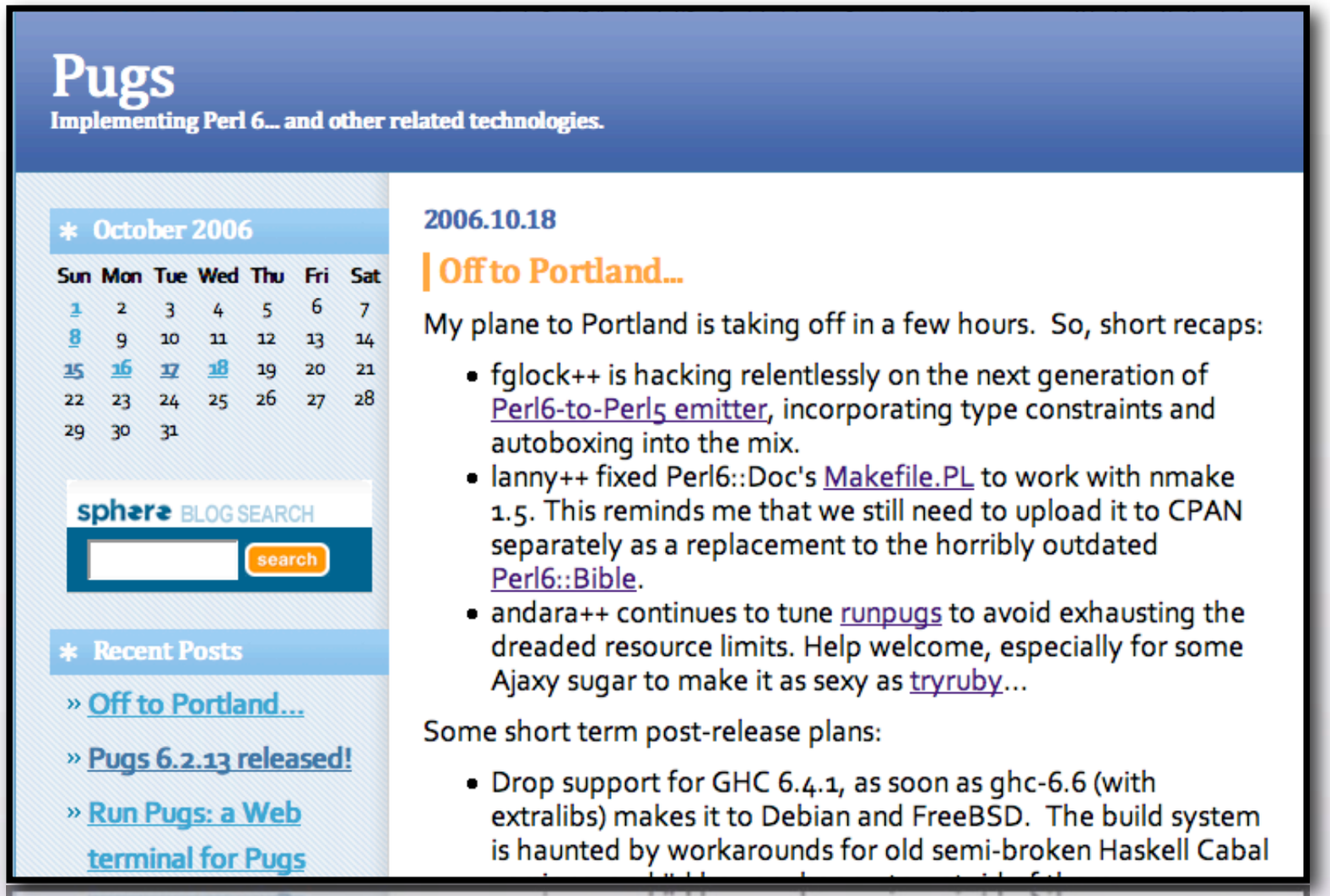
IRC.pugscode.org

perl6 2006-10-18,Wed

Logs Channels Help Search ←Prev date (Last day)

Who	
Alias_	Well, it would be nice from a PR point of view to have it formalised and wrapped up in a candy-shell And might actually finally mean I don't have to listen to the Duke Nukem jokes any more :)
avar	ascii art of the duke in the installer?:)
Alias_	That would be hilarious :)
[particle]	i think duke nukem is under misc/ somewhere in the repo... ;)
Alias_	A camel with a shotgun and strippers
avar	heh
TimToady	I think when people start playing with 6.2.13 they'll realize it's really getting rather solid already.
	Alias_ nods
Alias_	I was just thinking in more symbolic terms
TimToady	and I really don't mind the anonymonks proving themselves to be idiots in front of everyone. well, o
---	buetow joined perl6
TreyHarris	TimToady: which anonymonks are you referring to? not names, just what comprehension results in
TimToady	it seems a little odd to use the word "comprehension" on that particular subset
---	dakrone joined perl6 hexmode joined perl6 weinig joined perl6
TimToady	Parents' Back To School Night &

Blog.pugscode.org



Run.pugscode.org

Run Perl 6 now -- in your browser!

This live web terminal runs the latest development snapshot of the pugs interpreter for Perl 6. For more details, read the info page.

Interactive Pugs Session

```
 _____
/\  __ \
\ \ \/\ \ __  __  _____  _____      (P)erl6
 \ \  __//\ \/\ \/\  __ \/\  __\     (U)ser's
  \ \ \/ \ \ \_\ \ \ \/\ \ \___  \    (G)olfing
   \ \__\  \ \____/\ \____ \/\_____\  (S)ystem
    \/__/   \/___/  \/___/\ \/_____/
                       /\____/      Version: 6.2.13 (r14415)
                       \/___/    Copyright 2005-2006, The Pugs Contributors
------------------------------------------------------------------------
 Web: http://pugscode.org/           Email: perl6-compiler@perl.org

Welcome to Pugs -- Perl6 User's Golfing System
Type :h for help.

Loading Prelude... done.
pugs>
```

Smoke.pugscode.org

repository snapshot / linux

Pugs 6.2.13 r14410	18 Oct 2006 03:51 Wed	233.02 min	100.00 % ok	17954: 17954,	0, 4638,	747,	0 » » SYN
Pugs 6.2.13 r14403	17 Oct 2006 15:26 Tue	30.08 min	100.00 % ok	17954: 17954,	0, 4638,	747,	0 » » SYN
Pugs 6.2.13 r14402	17 Oct 2006 14:44 Tue	34.87 min	99.69 % ok	17956: 17900,	56, 1182,	6956,	0 » » SYN
Pugs 6.2.13 r14383	17 Oct 2006 05:11 Tue	29.93 min	100.00 % ok	17954: 17954,	0, 4638,	747,	0 » » SYN
Pugs 6.2.13 r14375	17 Oct 2006 00:38 Tue	28.28 min	100.00 % ok	17954: 17954,	0, 4638,	747,	0 » » SYN
Pugs 6.2.12 r14350	15 Oct 2006 06:36 Sun	29.82 min	100.00 % ok	17954: 17954,	0, 4638,	747,	0 » » SYN
Pugs 6.2.12 r14342	15 Oct 2006 03:27 Sun	31.53 min	100.00 % ok	17954: 17954,	0, 4639,	747,	0 » » SYN
Pugs 6.2.12 r14339	14 Oct 2006 20:00 Sat	32.58 min	100.00 % ok	17954: 17954,	0, 4639,	747,	0 » » SYN
Pugs 6.2.12 r14334	14 Oct 2006 10:00 Sat	51.47 min	99.99 % ok	17954: 17952,	2, 4644,	747,	6 » » SYN
Pugs 6.2.12 r14331	13 Oct 2006 19:56 Fri	29.97 min	99.99 % ok	17954: 17953,	1, 4644,	747,	6 » » SYN

repository snapshot / MSWin32

Pugs 6.2.13 r14413	18 Oct 2006 13:36 Wed	58.77 min	99.99 % ok	17918: 17917,	1, 4637,	782,	0 » » SYN
Pugs 6.2.13 r14413	18 Oct 2006 07:57 Wed	31.05 min	99.99 % ok	17954: 17953,	1, 4638,	782,	0 » » SYN
Pugs 6.2.13 r14413	18 Oct 2006 04:42 Wed	17.83 min	99.99 % ok	17954: 17953,	1, 4638,	782,	0 » » SYN
Pugs 6.2.13 r14410	17 Oct 2006 21:40 Tue	17.78 min	99.99 % ok	17954: 17952,	2, 4638,	782,	0 » » SYN

Spec.pugscode.org

Whitespace and Comments

- Single-line comments work as in Perl 5, starting with a `#` character and ending at the subsequent newline. They count as whitespace equivalent to newline for purposes of separation. Unlike in Perl 5, `#` may not be used as the delimiter in quoting constructs.

  - Show the snippet from t/syntax/comments.t (line 117 ~ line 128 — 4 √, 0 ×) -

- Multiline comments are provided by extending the syntax of POD to nest `=begin comment`/`=end comment` correctly without the need for `=cut`. The format name does not have to be `comment` -- any unrecognized format name will do to make it a comment. (However, bare `=begin` and `=end` probably aren't good enough, because all comments in them will show up in the formatted output.)

  - Show the snippet from t/syntax/comments.t (line 129 ~ line 162 — 2 √, 0 ×) -

  We have single paragraph comments with `=for comment` as well. That lets `=for` keep its meaning as the equivalent of a `=begin` and `=end` combined. As with `=begin` and `=end`, a comment started in code reverts to code afterwards.

  - Show the snippet from t/syntax/comments.t (line 163 ~ line 185 — 2 √, 0 ×) -

  Since there is a newline before the first `=`, the POD form of comment counts as whitespace equivalent to a newline.

Mailing Lists

Mailing Lists

perl6-users

Mailing Lists

perl6-users

perl6-language

Mailing Lists

perl6-users

perl6-language

perl6-compiler

Repositories

Repositories

http://svn.openfoundry.org/pugs/

Repositories

http://svn.openfoundry.org/pugs/

http://perlcabal.org/~audreyt/darcs/pugs/

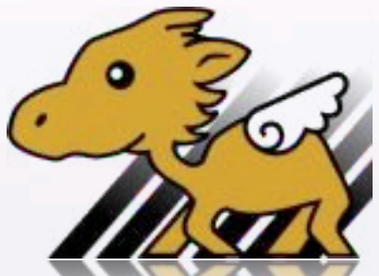
Repositories

SUBVERSION

http://svn.openfoundry.org/pugs/

darcs

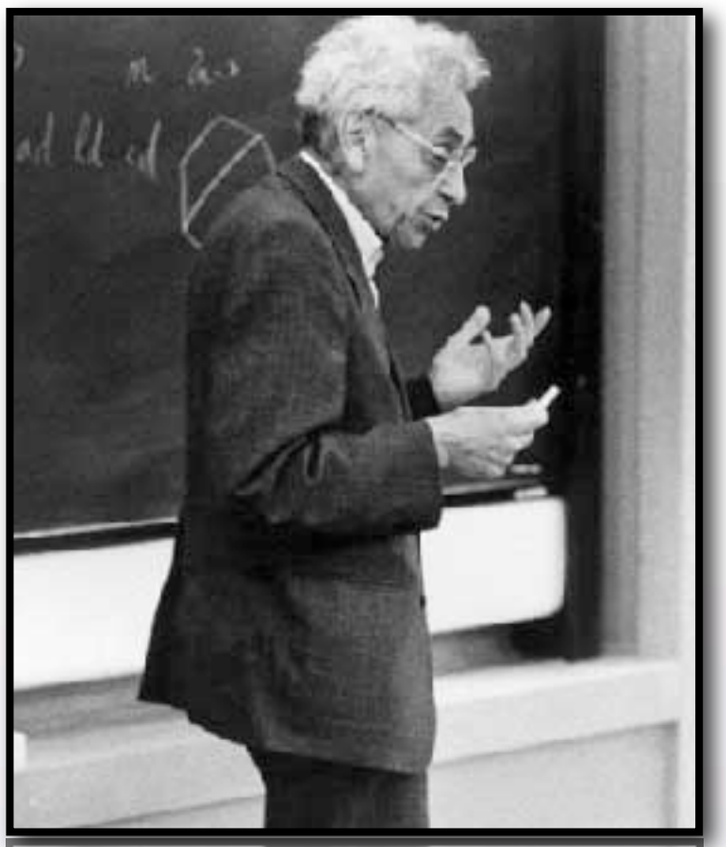
http://perlcabal.org/~audreyt/darcs/pugs/



SVK

Erdösing

Erdösing



2006..*

Hackathons

Hackathons

- Taipei

Hackathons

- Taipei
- Vienna

Hackathons

- Taipei
- Vienna
- Toronto

Hackathons

- Taipei
- Vienna
- Toronto
- Amsterdam

Hackathons

- Taipei
- Vienna
- Toronto
- Amsterdam
- Echt

Hackathons

- Taipei
- Vienna
- Toronto
- Amsterdam
- Echt
- Lismore

Hackathons

- Taipei
- Vienna
- Toronto
- Amsterdam
- Echt
- Lismore
- Mt. Arbel

Hackathons

- Taipei
- Vienna
- Toronto
- Amsterdam
- Echt
- Lismore
- Mt. Arbel
- Vienna²

Hackathons

- Taipei
- Vienna
- Toronto
- Amsterdam
- Echt
- Lismore
- Mt. Arbel
- Vienna²
- Tokyo

Hackathons

- Taipei
- Vienna
- Toronto
- Amsterdam
- Echt
- Lismore
- Mt. Arbel
- Vienna²
- Tokyo
- Redmond

Hackathons

- Taipei
- Vienna
- Toronto
- Amsterdam
- Echt
- Lismore
- Mt. Arbel
- Vienna²
- Tokyo
- Redmond
- Chicago

Hackathons

- Taipei
- Vienna
- Toronto
- Amsterdam
- Echt
- Lismore
- Mt. Arbel
- Vienna²
- Tokyo
- Redmond
- Chicago
- Boston

Hackathons

- Taipei
- Vienna
- Toronto
- Amsterdam
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- Lismore
- Mt. Arbel
- Vienna²
- Tokyo
- Redmond
- Chicago
- Boston
- Portland

Hackathons

- Taipei
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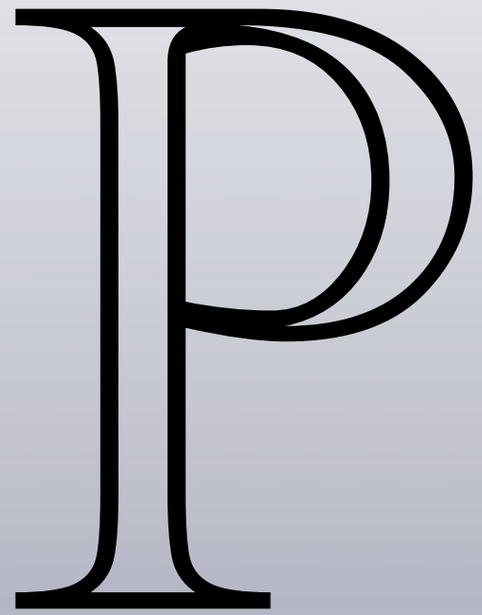
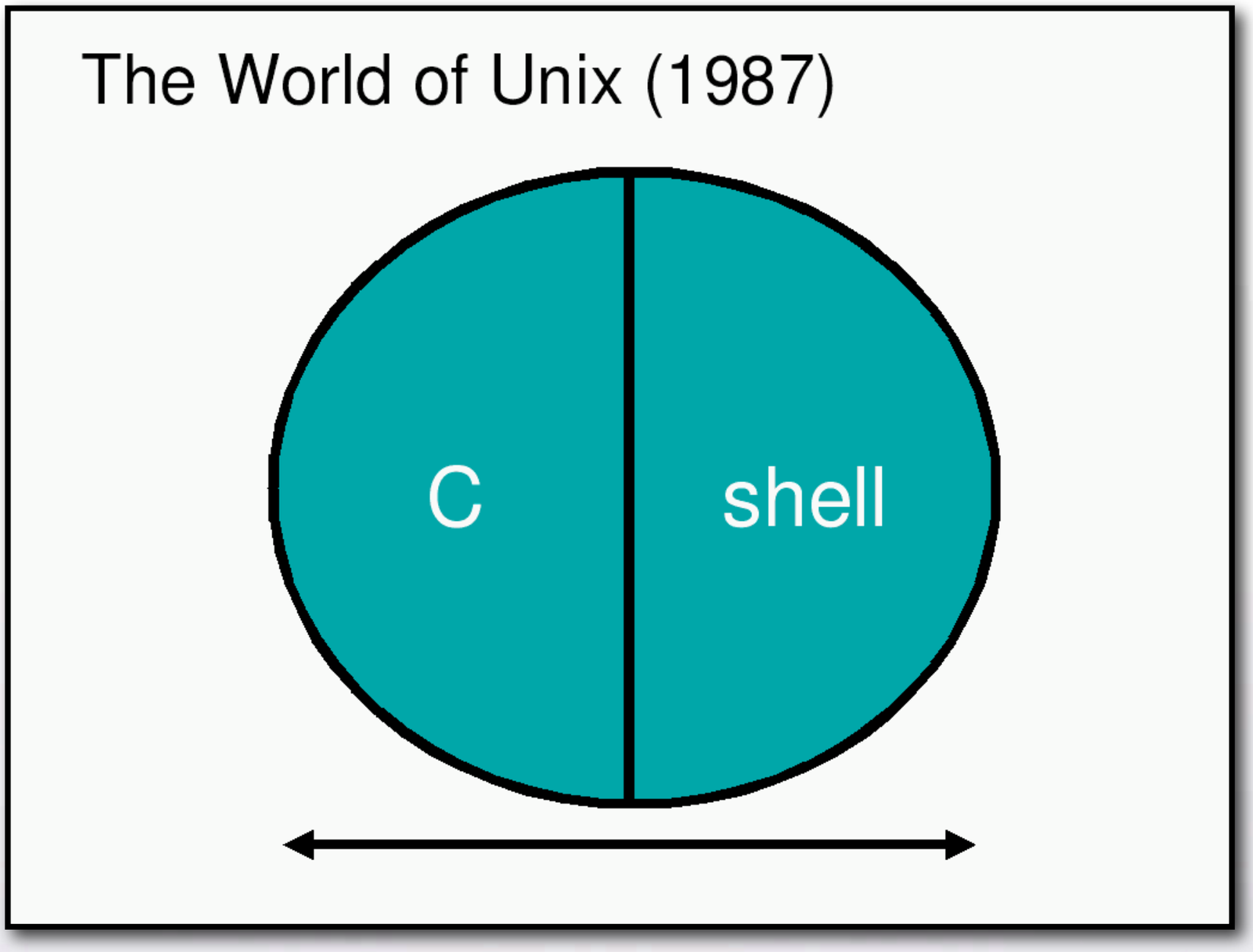
- Mt. Arbel
- Vienna²
- Tokyo
- Redmond
- Chicago
- Boston
- Portland
- Sao Paulo

Hackathons

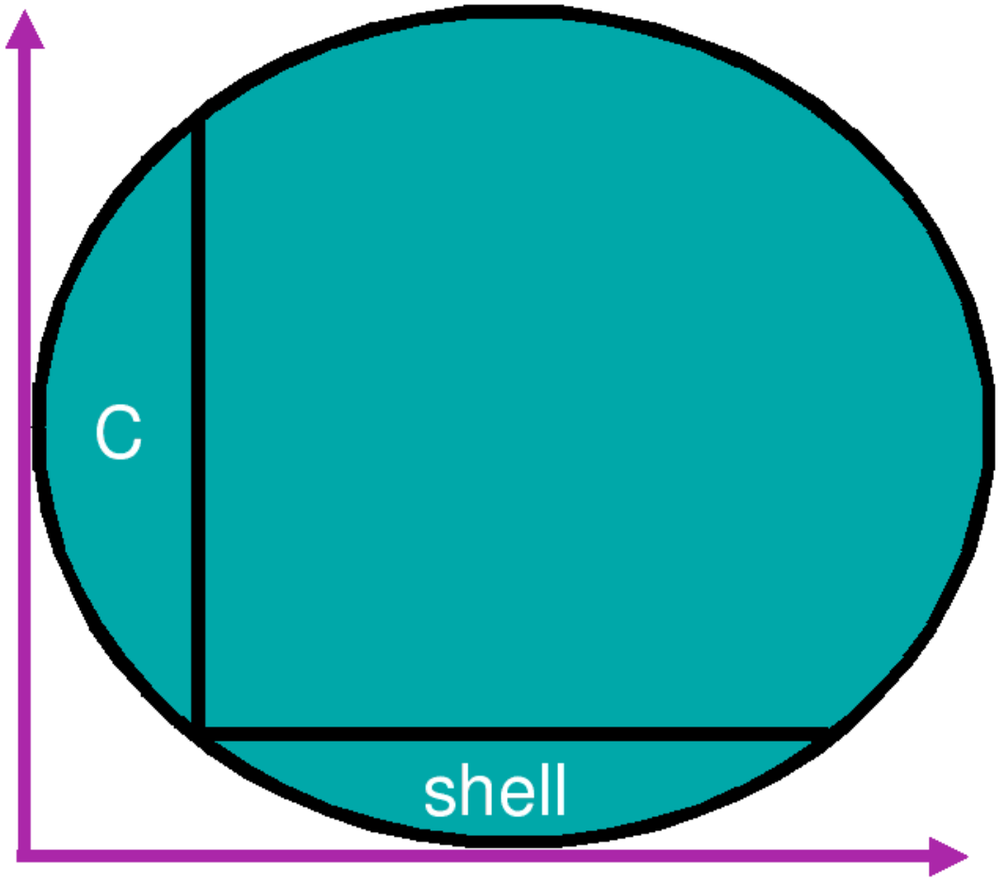
- Taipei
- Vienna
- Toronto
- Amsterdam
- Echt
- Lismore
- Mt. Arbel
- Vienna²
- Tokyo
- Redmond
- Chicago
- Boston
- Portland
- Sao Paulo
- *…and more!*

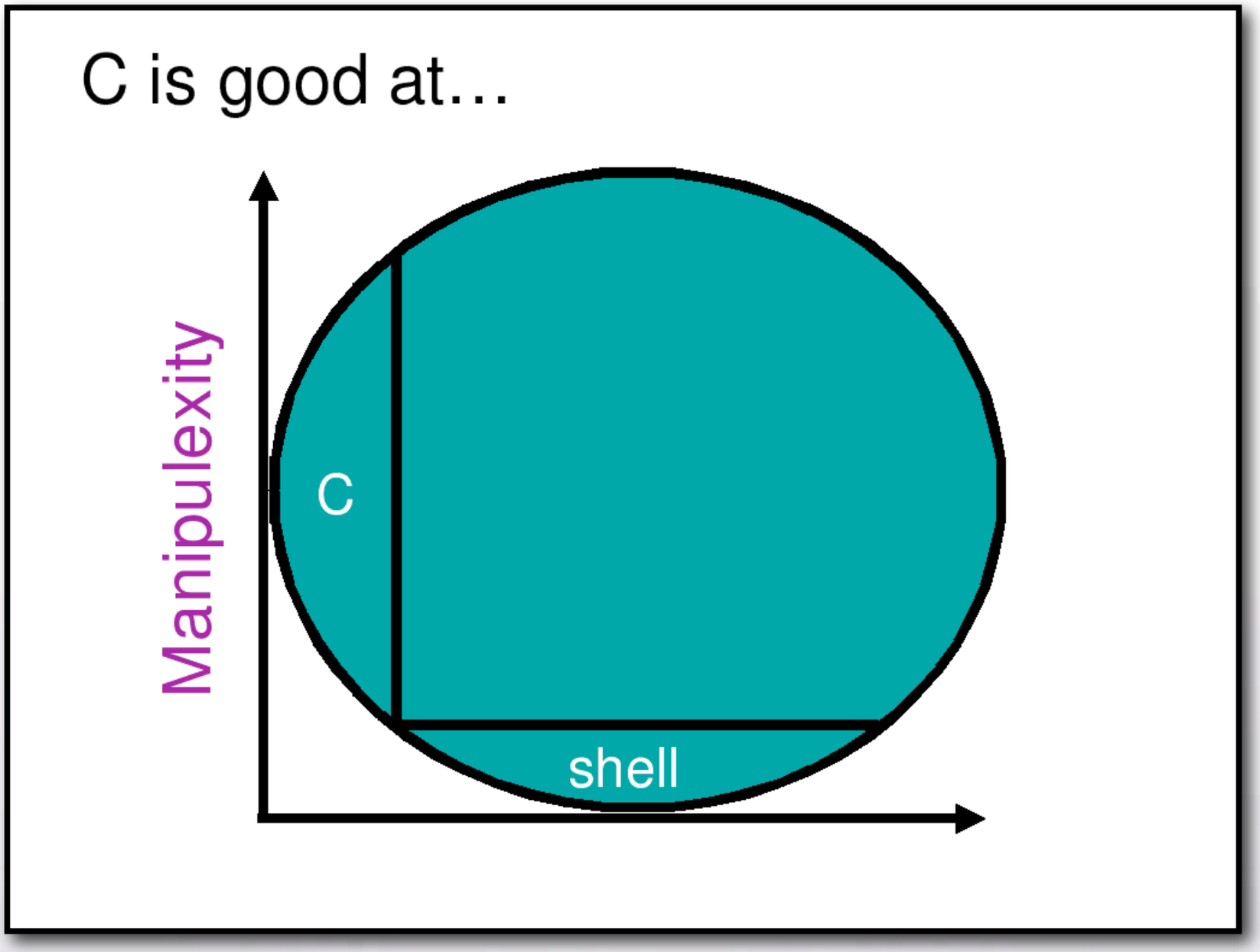


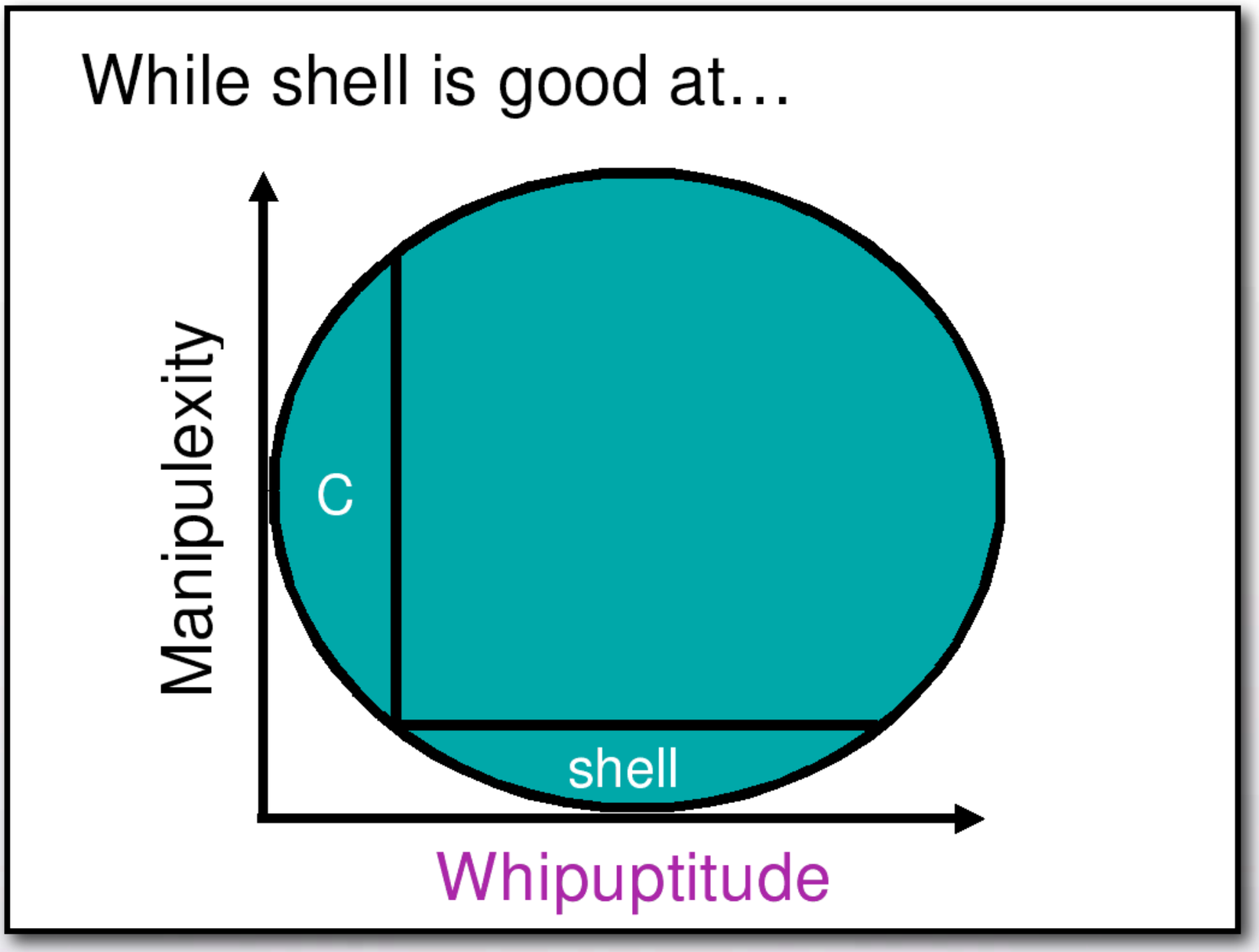
Practical

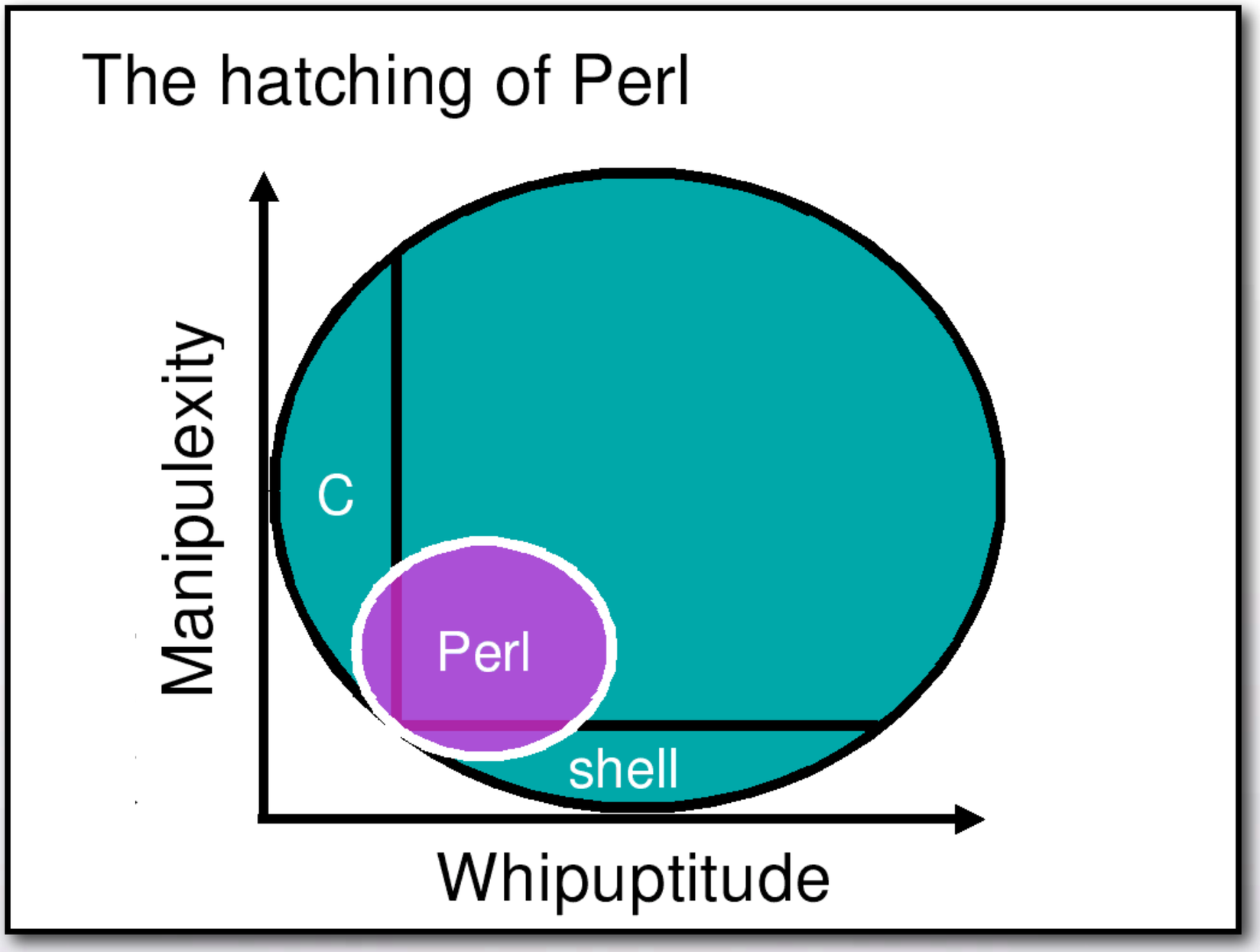

The World of Unix (1987)
C
shell

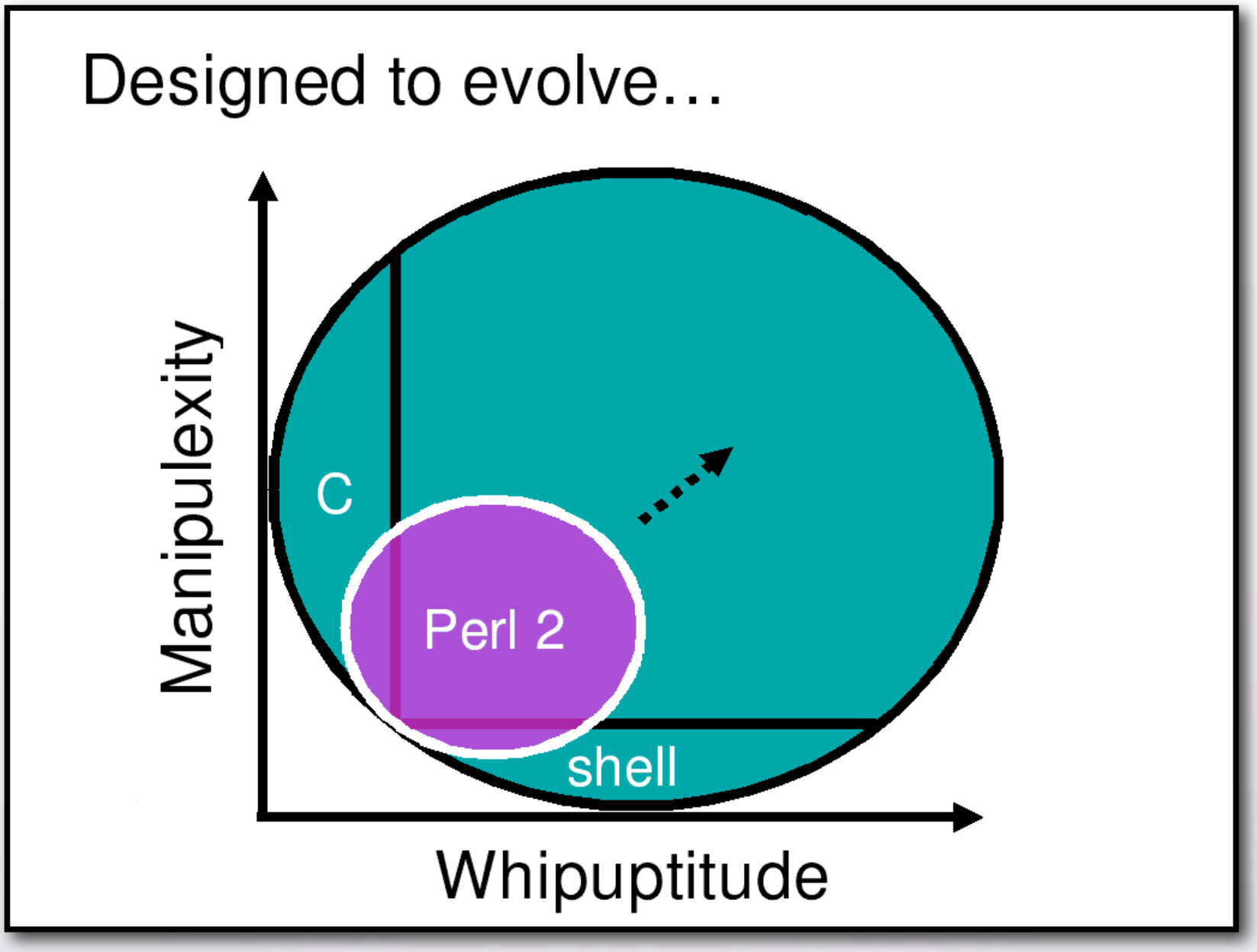
A new dimension

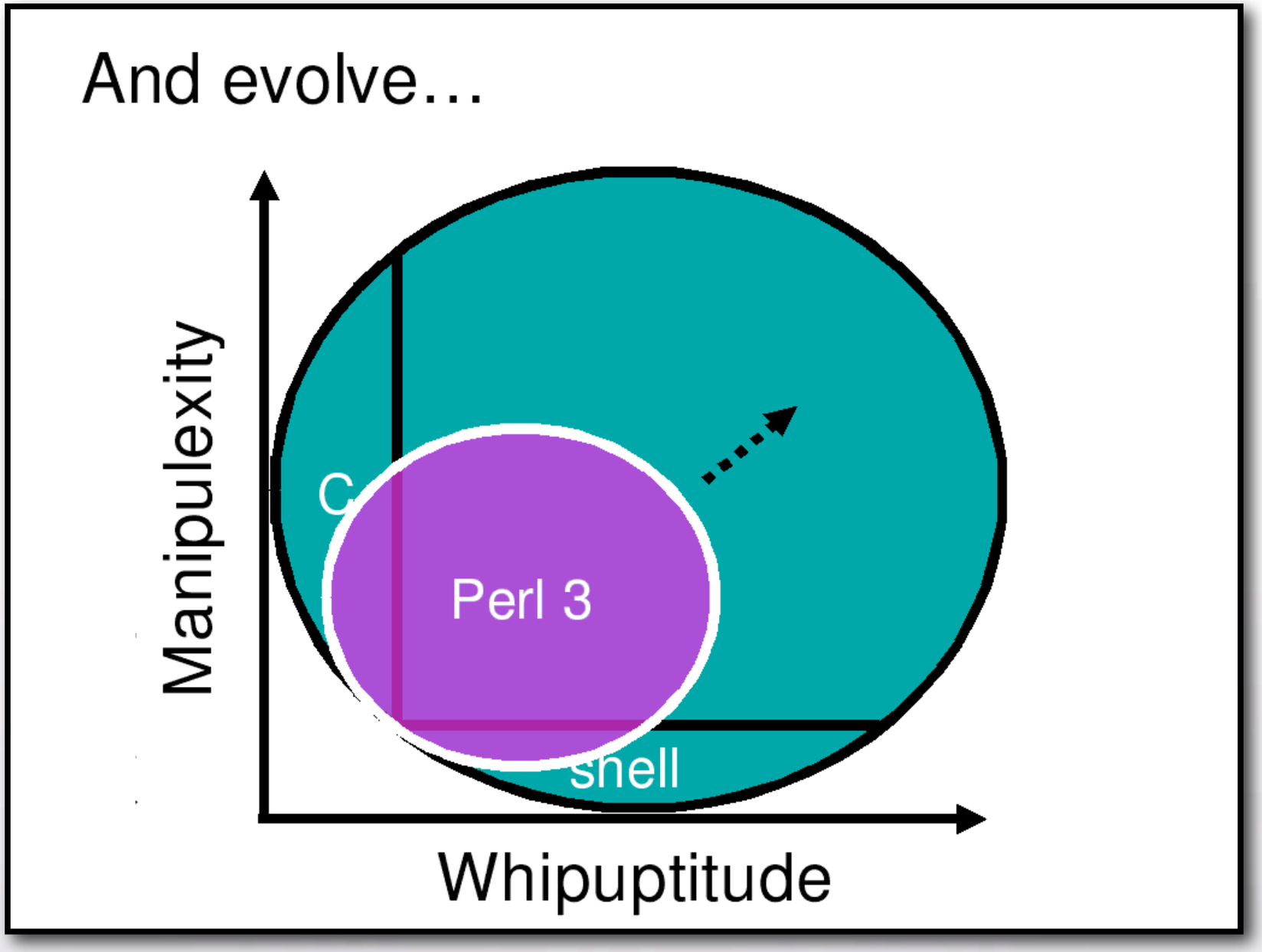


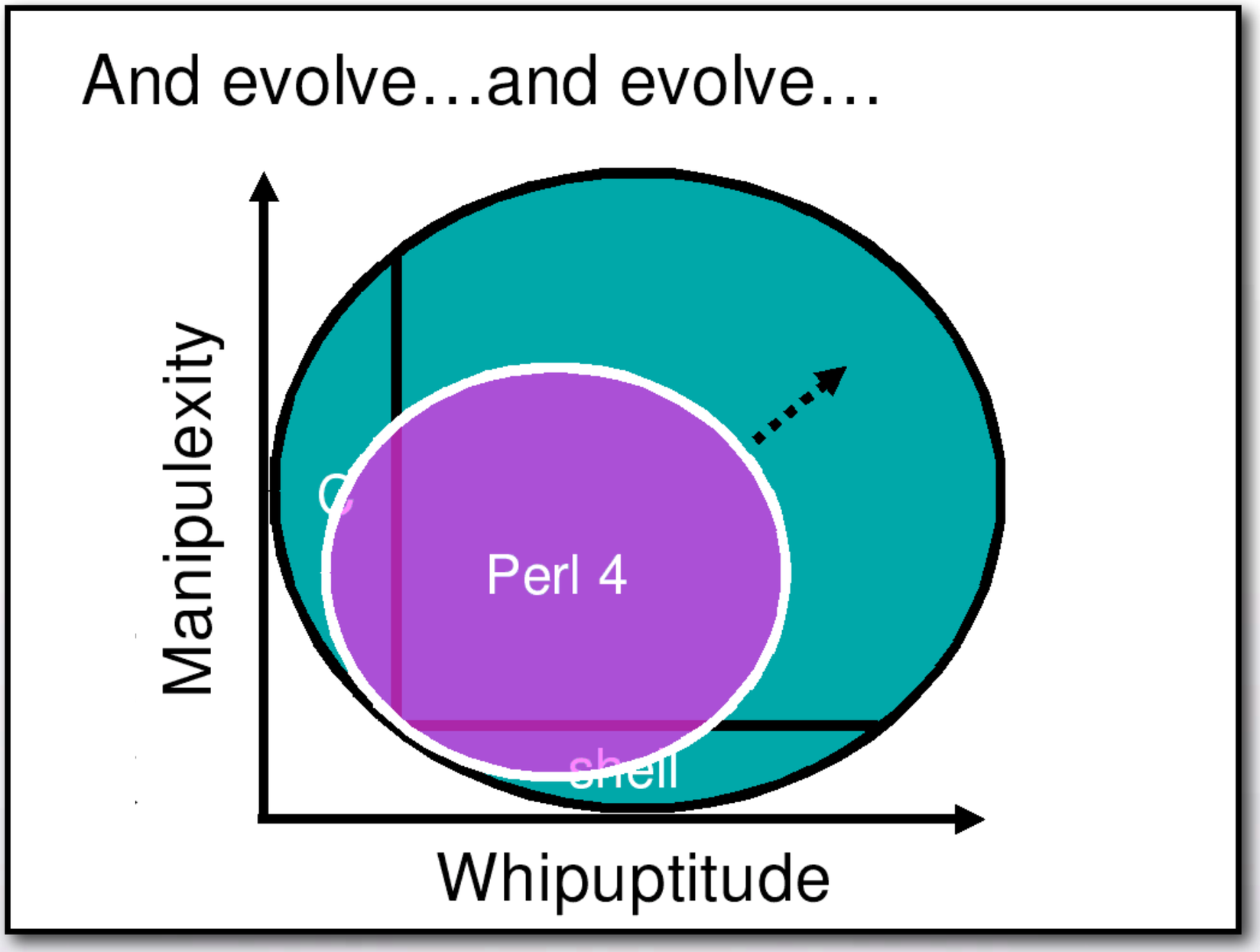

C is good at...
Manipulexity
C
shell


While shell is good at…
Manipulexity
C
shell
Whipuptitude

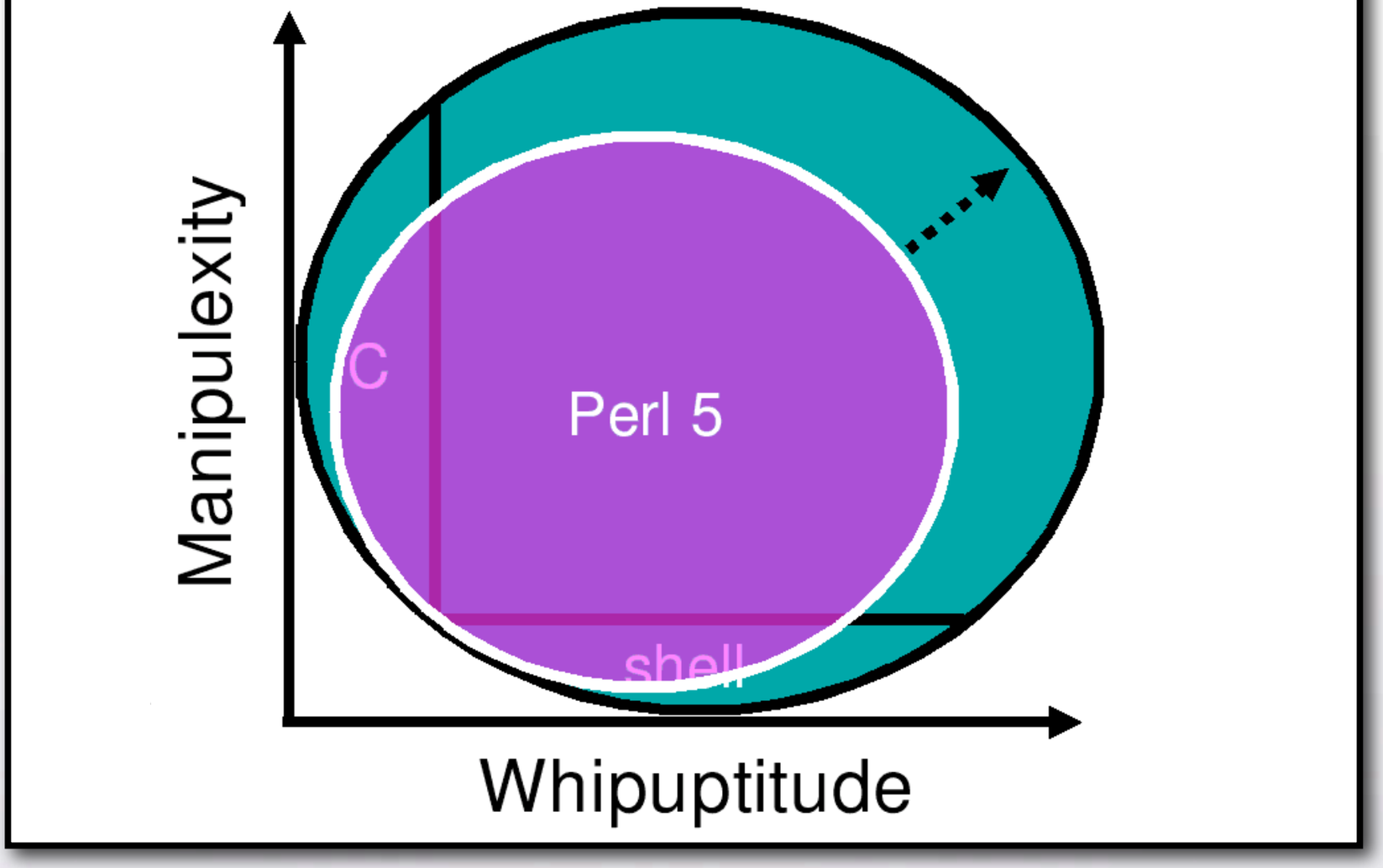

The hatching of Perl
Manipulexity
C
Perl
shell
Whipuptitude


Designed to evolve…
Manipulexity
C
Perl 2
shell
Whipuptitude


And evolve…
Manipulexity
C
Perl 3
shell
Whipuptitude


And evolve…and evolve…
Manipulexity
Perl 4
shell
Whipuptitude

All your programs are belong to us…



A

Abstractions

↪ *Sexy*

Closures

```
sub make_counter {
    my $start = shift;
    return sub { ++$start };
}
```

```
my $from_ten = make_counter(10);
my $from_three = make_counter(3);

print $from_three->(); # 4
print $from_three->(); # 5
print $from_ten->();   # 11
```

Tie

```
use Tie::Google;
tie my %search => 'Tie::Google';

for (@{ $search{'Perl Pugs'} }) {
    print "* $_->{title} - $_->{URL}\n";
}
```

Abstractions^{++}

Abstractions^{++}

- ∀ bless()

Abstractions^{++}

- ∀ bless()
- ∀ IO Layers

Abstractions++

- bless()
- IO Layers
- BEGIN {...}

Shorthands

↪ *Natural*

DeCSS

```
s''$/=\2048;while(<>){G=29;R=142;if((@a=unqT="C*",_)[20]&48){D=89;_=unqb24,qT,@
b=map{ord qB8,unqb8,qT,_^$a[--D]}@INC;s/...$/1$&/;Q=unqV,qb25,_;H=73;O=$b[4]<<9
|256|$b[3];Q=Q>>8^(P=(E=255)&(Q>>12^Q>>4^Q/8^Q))<<17,O=O>>8^(E&(F=(S=O>>14&7^O)
^S*8^S<<6))<<9,_=(map{U=_%16orE^=R^=110&(S=(unqT,"\xb\ntd\xbz\x14d")[_/16%8]);E
^=(72,@z=(64,72,G^=12*(U-2?0:S&17)),H^=_%64?12:0,@z)[_%8]}(16..271))[_]^((D>>=8
)+=P+(~F&E))for@a[128..$#a]}print+qT,@a}';s/[D-HO-U_]/\$$&/g;s/q/pack+/g;eval
```

Shorthands^{++}

Shorthands++

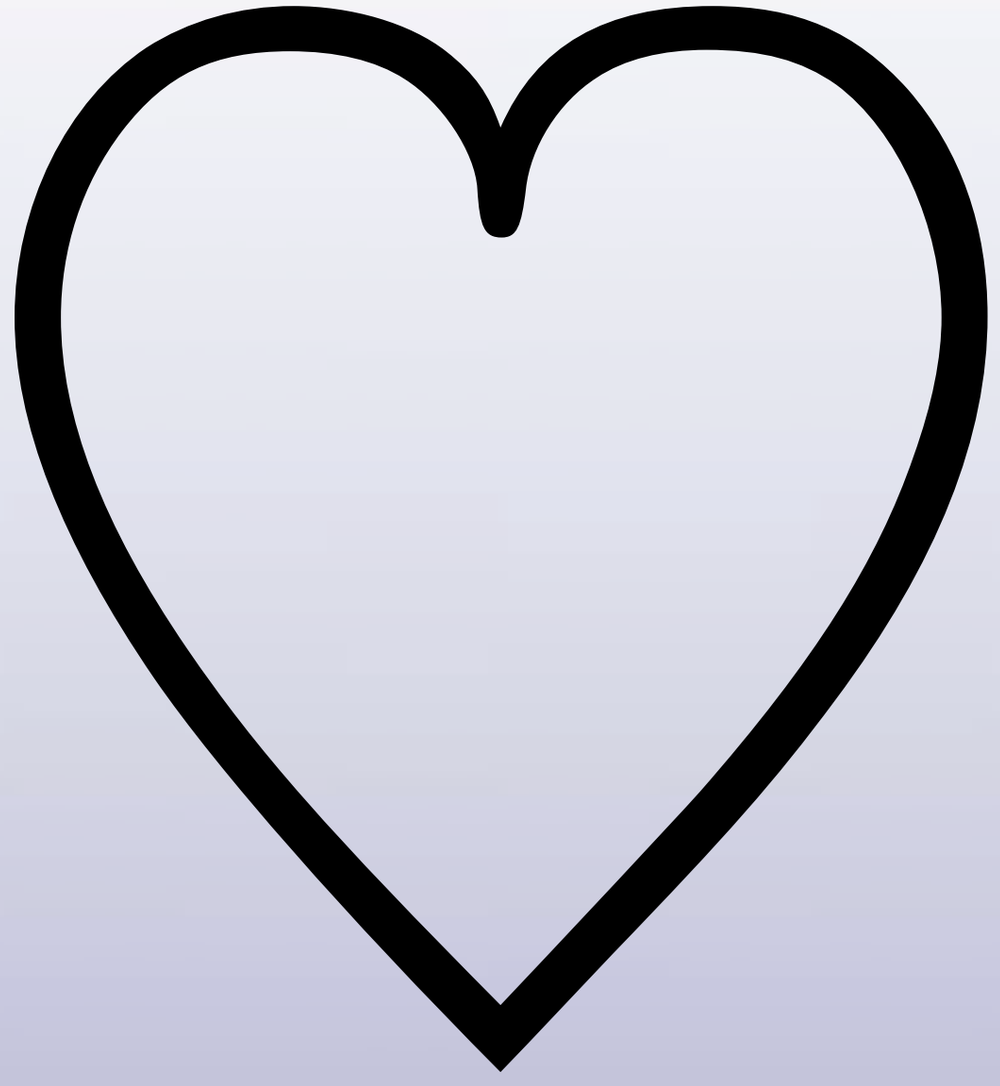
- Regex

Shorthands++

- Regex
- Context

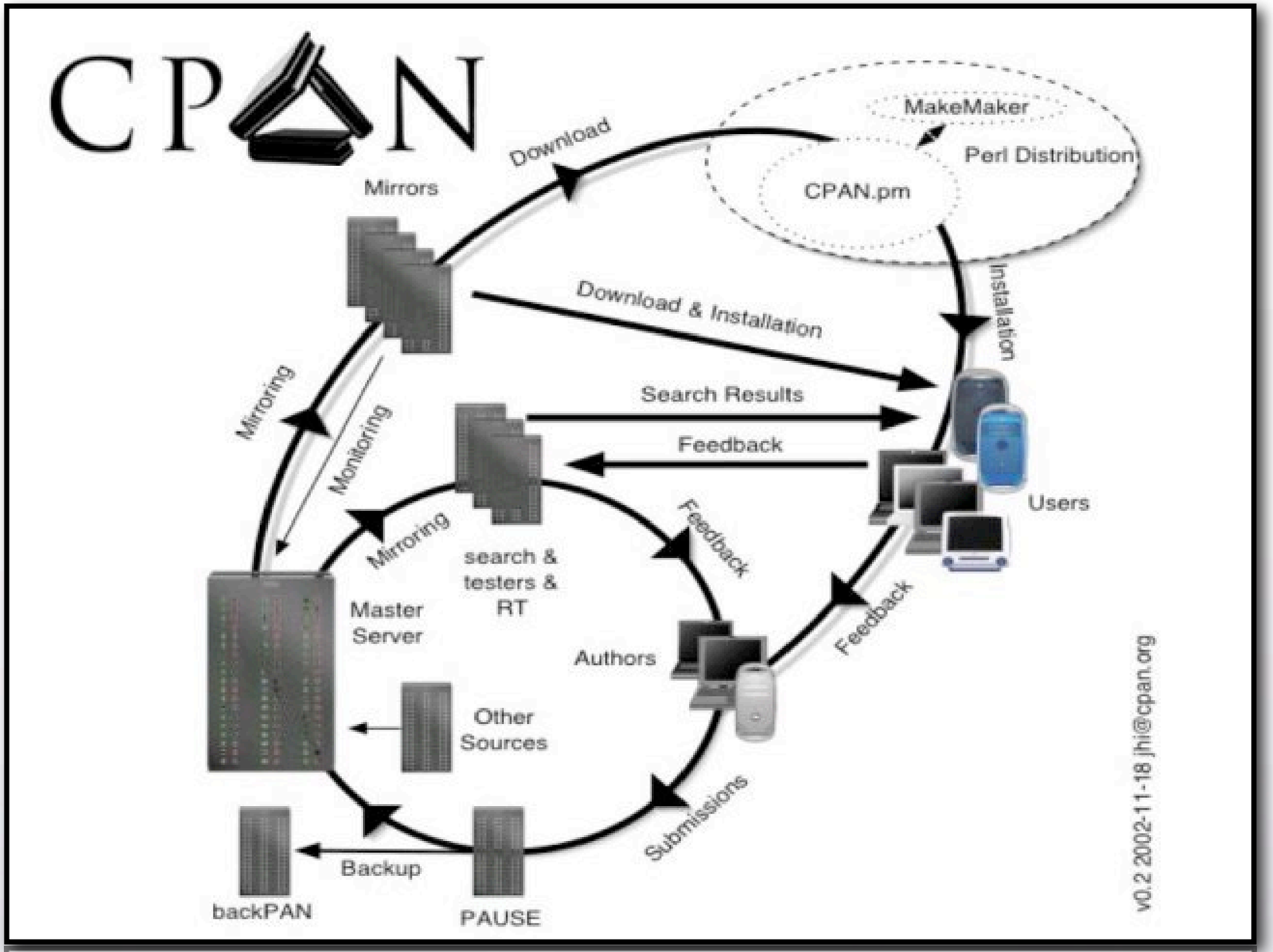
Shorthands++

- Regex
- Context
- Topical $_



Best coding

↪ *No coding*


CPAN
Download
Mirrors
MakeMaker
Perl Distribution
CPAN.pm
Installation
Download & Installation
Search Results
Feedback
Users
Mirroring
Monitoring
Mirroring
search &
testers &
RT
Feedback
Master
Server
Authors
Feedback
Other
Sources
Submissions
Backup
backPAN
PAUSE
v0.2 2002-11-18 jhi@cpan.org

CPAN

CPAN

♡ 11 years

CPAN

♡ 11 years

♡ 5000+ authors

CPAN

♡ 11 years

♡ 5000+ authors

♡ 10000+ modules

Services

Services

- ♡ Package Management

Services

- ♡ Package Management
- ♡ Rating & Discussion

Services

- ♡ Package Management
- ♡ Rating & Discussion
- ♡ Smoke Testing

Services

- ♡ Package Management
- ♡ Rating & Discussion
- ♡ Smoke Testing
- ♡ Issue Tracking

Vocabulary

$\geqq$ Syntax

“The Best thing happened to **Perl**”

But...

Perl 5

is not the best thing

for **CPAN**

Syntax

Redundancy

```
use v5;
```

```
use v5;
sub render {
```

```
use v5;
sub render {
    my $self = shift;
```

```
use v5;
sub render {
    my $self = shift;
    my %opts = (x => 1, y => 1, z => 0, %{$_[0]});
```

```
use v5;
sub render {
    my $self = shift;
    my %opts = (x => 1, y => 1, z => 0, %{$_[0]});
    for my $item ( $self->filter(@{ $self->{items} }) ) {
```

```
use v5;
sub render {
    my $self = shift;
    my %opts = (x => 1, y => 1, z => 0, %{$_[0]});
    for my $item ( $self->filter(@{ $self->{items} }) ) {
        print $item->draw({
        x => $opts{x},
        y => $opts{y},
        z => $opts{z},
}), "\n";
```

```
use v5;
sub render {
    my $self = shift;
    my %opts = (x => 1, y => 1, z => 0, %{$_[0]});
    for my $item ( $self->filter(@{ $self->{items} }) ) {
        print $item->draw({
            x => $opts{x},
            y => $opts{y},
            z => $opts{z},
        }), "\n";
    }
}
```

```
use v6-alpha;
```

```
use v6-alpha;
method render ($x = 1, $y = 1, $z = 0) {
```

```
use v6-alpha;
method render ($x = 1, $y = 1, $z = 0) {
    for @.filter(@.items) {
```

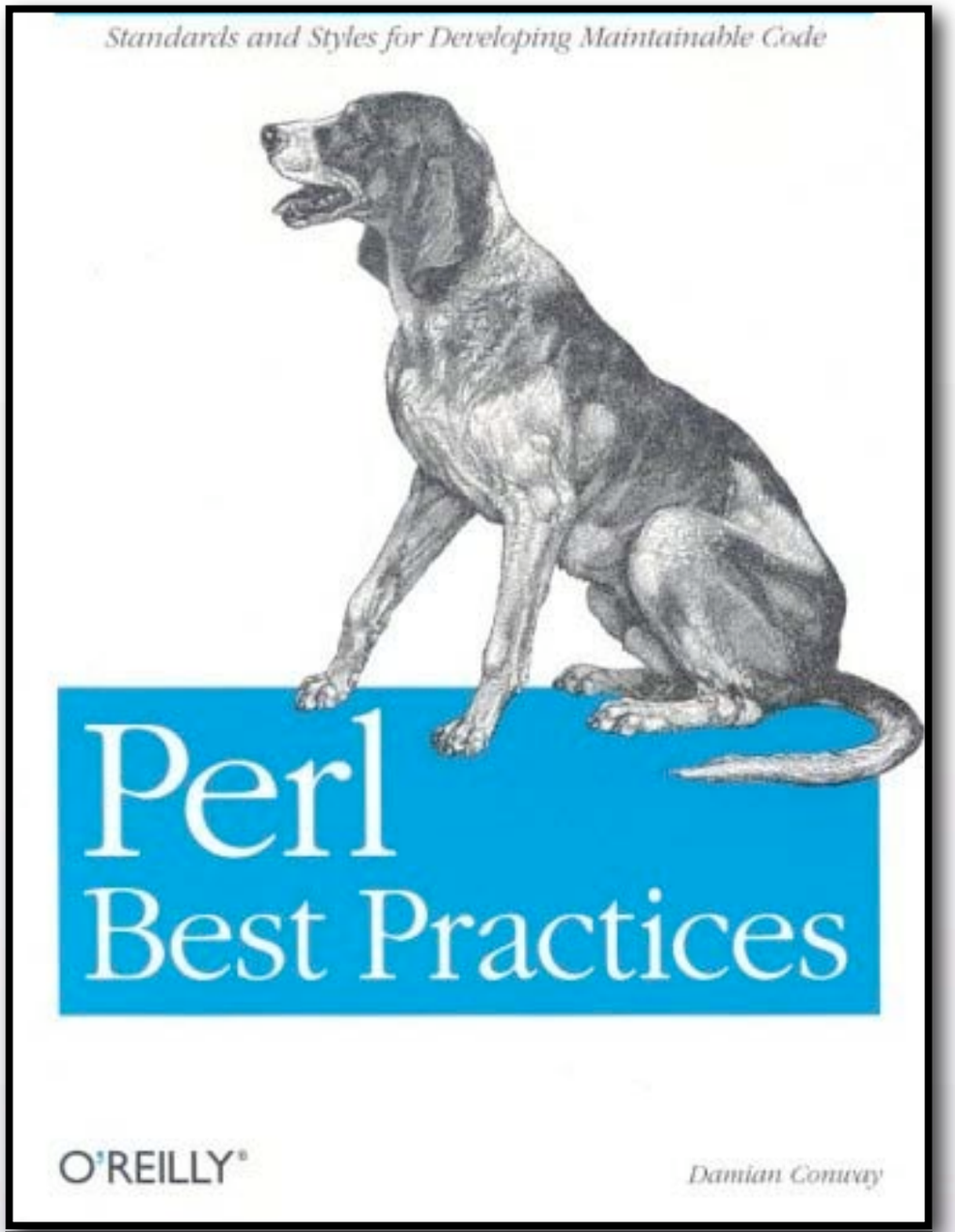
```
use v6-alpha;
method render ($x = 1, $y = 1, $z = 0) {
    for @.filter(@.items) {
        say .draw(:$x, :$y, :$z);
    }
}
```

Jenga Internals

Bug-for-bug compatibility

Best Practice

takes **discipline**


Standards and Styles for Developing Maintainable Code
Perl
Best Practices
O'REILLY®
Damian Conway

Best Practice

should be **Natural!**


6

2000

RFCs

2001

Parrot

2002

Apocalypses

2003

Ponie

(*late, as in **the late Arthur Dent***)

2004

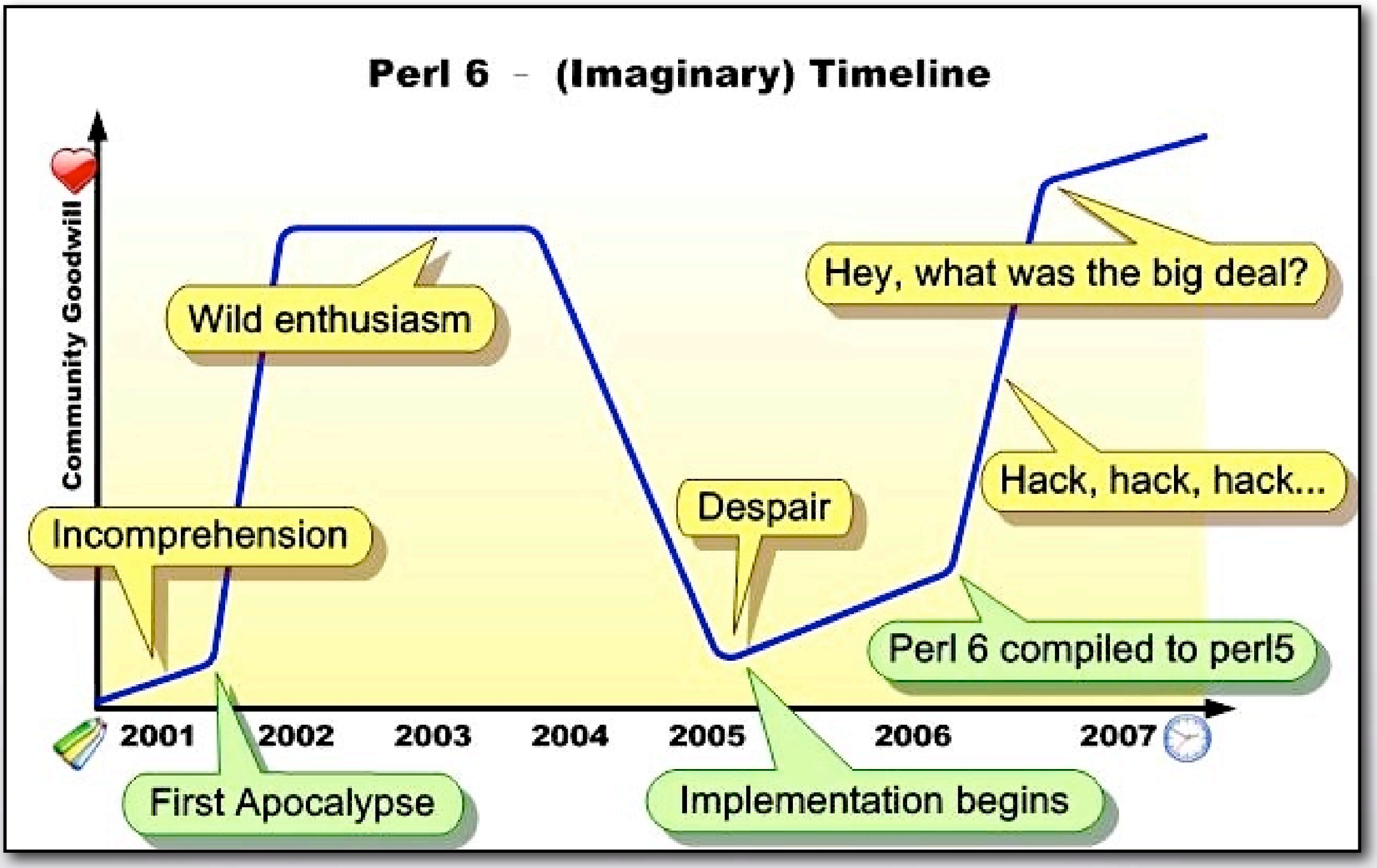
Synopses

2005

Pugs

2006

v6-alpha


Perl 6 – (Imaginary) Timeline
Community Goodwill
Wild enthusiasm
Incomprehension
First Apocalypse
Despair
Implementation begins
Hey, what was the big deal?
Hack, hack, hack...
Perl 6 compiled to perl5
2001
2002
2003
2004
2005
2006
2007

Reconcile the **Irreconcilable**

Static

vs

Dynamic

Types

Typing

```
use v5;
sub f {
    sqrt($_[0] ** 2 + $_[1] ** 2)
}
my $five = f( 3, 4 );
```

```
use v6-alpha;
sub f {
    sqrt(@_[0] ** 2 + @_[1] ** 2)
}
my $five = f( 3, 4 );
```

Gradual Typing with **Annotations**

```
sub f (Num $x, Num $y) {
    sqrt($x ** 2 + $y ** 2);
}
my Num $five = f( 3, 4 );
```

```
subset Positive of Num where { $_ > 0 }
```

```
subset Positive of Num where { $_ > 0 }

sub f (
    Positive $x, Positive $y
    --> Positive where { $_ >= ($x & $y) }
) {
```

```
subset Positive of Num where { $_ > 0 }

sub f (
    Positive $x, Positive $y
    --> Positive where { $_ >= ($x & $y) }
) {
    sqrt($x ** 2 + $y ** 2);
}
```

```raku
subset Positive of Num where { $_ > 0 }

sub f (
    Positive $x, Positive $y
    --> Positive where { $_ >= ($x & $y) }
) {
    sqrt($x ** 2 + $y ** 2);
}

my $five := f(3, 4); # inferred as Positive
```

Compiler

vs

Runtime

BEGIN {...}

BEGIN {...}

- Compiler *is* a REPL

BEGIN {...}

- Compiler *is* a REPL
- Expose the entire compiler

BEGIN {...}

- Compiler *is* a REPL
- Expose the entire compiler
- All parts are swappable

BEGIN {...}

- Compiler *is* a REPL
- Expose the entire compiler
- All parts are swappable
- Even the lexer!

```
macro circumfix:</* */> ($x)
    is parsed /.*?/
    { '' }

/* This is a C-style comment */
```

```raku
sub postfix:<!> ($x) {
    [*] 1..$x
}

say 10!; # 3628800
```

```
macro GREETING () {
    # A late-bound macro
    q:code(:COMPILING){ "Hello, $s" };
}

my $s = "world";
say GREETING; # Hello, world
```

Lazy

vs

Eager

```
# "cat"
for =<> { .say }
```

```
# "cat"
for =<> { .say }

# "cat", annotated with line numbers
for each(1..*; =<>) {
    say "Line $^num: $^text";
}
```

```
# Lists are lazy streams!
my @fib = (
```

```
# Lists are lazy streams!
my @fib = (
    0, 1,
```

```
# Lists are lazy streams!
my @fib = (
    0, 1,
    each(@fib; @fib[1..*]).map(&infix:<+>)
);
```

```
# Lists are lazy streams!
my @fib = (
     0, 1,
     each(@fib; @fib[1..*]).map(&infix:<+>)
);

say "The first ten numbers are: @fib[^10]";
```

```
# Items are eager values. However...
```

```
# Items are eager values. However...
my $ignored = lazy { 9 ** 9 ** 9 };
```

```
# Items are eager values. However...
my $ignored = lazy { 9 ** 9 ** 9 };
my $unused = lazy { say [1..$ignored] };
```

```
# Items are eager values. However...
my $ignored = lazy { 9 ** 9 ** 9 };
my $unused = lazy { say [1..$ignored] };
```

```
say "Hello, world!";
```

Classes

vs

Prototypes

```
class Dog is Mammal does Pet {
```

```
class Dog is Mammal does Pet {

    my $.count where 0..100;
```

```
class Dog is Mammal does Pet {

    my $.count where 0..100;

    has $!brain;
```

```
class Dog is Mammal does Pet {

    my $.count where 0..100;

    has $!brain;

    has &.vocalize = &say;
    has $.name is rw = "fido";
```

```
class Dog is Mammal does Pet {

    my $.count where 0..100;

    has $!brain;

    has &.vocalize = &say;
    has $.name is rw = "fido";

    has $.fur  handles Groomable;
    has $.tail handles <wag hang>;
```

```
class Dog is Mammal does Pet {

    my $.count where 0..100;

    has $!brain;

    has &.vocalize = &say;
    has $.name is rw = "fido";

    has $.fur  handles Groomable;
    has $.tail handles <wag hang>;

    method owner () handles s/^owner_// { ... }

}
```

```
my Dog $fido .= new;
```

```
my Dog $fido .= new;

$fido.HOW;    # the meta object for Dog
```

```
my Dog $fido .= new;

$fido.HOW;    # the meta object for Dog
$fido.WHAT;   # the Dog prototype object
```

```raku
my Dog $fido .= new;

$fido.HOW;    # the meta object for Dog
$fido.WHAT;   # the Dog prototype object
$fido.WHICH; # $fido's Object ID
```

```
my Dog $fido .= new;

$fido.HOW;    # the meta object for Dog
$fido.WHAT;   # the Dog prototype object
$fido.WHICH; # $fido's Object ID

Dog.isa(Dog); $fido.isa(Dog);
```

```
$fido.HOW.add_method(
    'bark',
    method () { $.vocalize('Woof!') }
);
```

```
$fido.HOW.add_method(
    'bark',
    method () { $.vocalize('Woof!') }
);

Dog.can('bark'); $fido.can('bark');
```

Parallelism

vs

Sanity

```
# Hyper Operator (SSE/GPU friendly)
[1, 1, 2, 3, 5] »+« [1, 2, 3, 5, 8];
```

```
# Hyper Operator (SSE/GPU friendly)
[1, 1, 2, 3, 5] »+« [1, 2, 3, 5, 8];
# === [2, 3, 5, 8, 13]
```

```
# Recursive Visits
-« [[1, 2], 3];
```

```
# Recursive Visits
-« [[1, 2], 3];
# === [[-1, -2], -3]
```

```
# Hyper Methods
[1, 4, 9, 16]».sqrt;
```

```raku
# Hyper Methods
[1, 4, 9, 16]».sqrt;
# === [1, 2, 3, 4]
```

```
% time                    pugs -e '(1..100000)>>.sqrt'
real 9.387s
user 9.219s
```

```
% time                          pugs -e '(1..100000)>>.sqrt'
real 9.387s
user 9.219s
```

```
% time env GHCRTS=-N2 pugs -e '(1..100000)>>.sqrt'
real 5.807s
user 6.959s
```

```
# Junctions
sub is_prime (Int $n --> Bool) {
    $n % all(2 .. $n.sqrt+1);
}
```

```
# Junctions
sub is_prime (Int $n --> Bool) {
    $n % all(2 .. $n.sqrt+1);
}

sub has_twin_prime (Int $n --> Bool) {
    is_prime($n & ($n ± 2));
}
```

```
# Junctions
sub is_prime (Int $n --> Bool) {
    $n % all(2 .. $n.sqrt+1);
}

sub has_twin_prime (Int $n --> Bool) {
    is_prime($n & ($n ± 2));
}

sub infix:<±> ($x, $y) {
    ($x + $y) | ($x - $y);
}
```

```
# Junctions
sub is_prime (Int $n --> Bool) {
    $n % all(2 .. $n.sqrt+1);
}

sub has_twin_prime (Int $n --> Bool) {
    is_prime($n & ($n ± 2));
}

sub infix:<±> ($x, $y) {
    ($x + $y) | ($x - $y);
}
```

Concurrency

Locking

```
async {
    $x.withdraw(3);
    $y.deposit(3);
}
```

```
async {
    $x.withdraw(3);
```

☣ **Race Condition** ☣

```
    $y.deposit(3);
}
```

```
async {
    $x.lock;
    $y.lock;
```

```
async {
    $x.lock;
    $y.lock;
    $x.withdraw(3);
    $y.deposit(3);
}
```

```
async {
    $x.lock;
    $y.lock;
    $x.withdraw(3);
    $y.deposit(3);
}
```

```
async {
    $y.lock;
    $x.lock;
}
```

☣ Deadlock ☣

```
async {
    $x.lock;
    $y.lock;
    $x.withdraw(3);
    $y.deposit(3);
}
```

```
async {
    $y.lock;
    $x.lock;
}
```

Software Transactional Memory

```
# No locks, no races!
contend {
    $x.withdraw(3);
    $y.deposit(3);
}
```

```
# Retry with "defer"
method withdraw ($n) {
    defer if $.balance < $n;
    $.balance -= $n;
}
```

```
# Retry with "defer"
method withdraw ($n) {
    defer if $.balance < $n;
    $.balance -= $n;
}

# Choice with "maybe"
sub transfer ($x1, $x2, $y) {
    maybe { $x1.withdraw(3) }
    maybe { $x2.withdraw(3) }
    $y.deposit(3);
}
```

```
# Retry with "defer"
method withdraw ($n) {
    defer if $.balance < $n;
    $.balance -= $n;
}

# Choice with "maybe"
sub transfer ($x1, $x2, $y) {
    maybe { $x1.withdraw(3) }
    maybe { $x2.withdraw(3) }
    $y.deposit(3);
}

# Composable with nested "maybe"
contend {
    maybe { transfer($x1, $x2, $y) }
    maybe { transfer($x3, $x4, $y) }
}
```

My Language

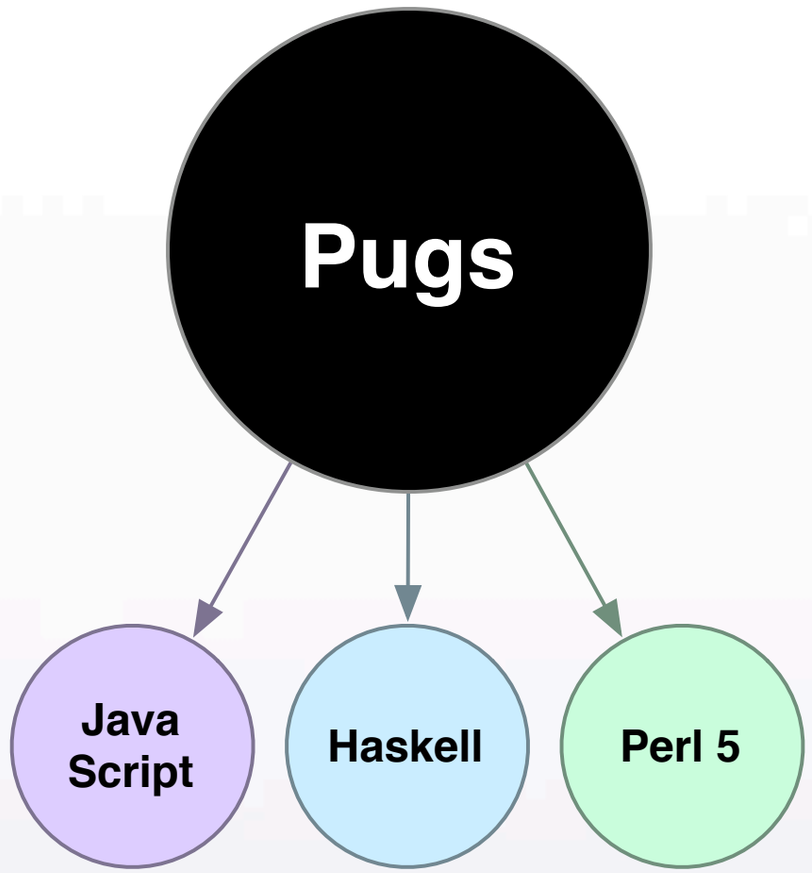
vs

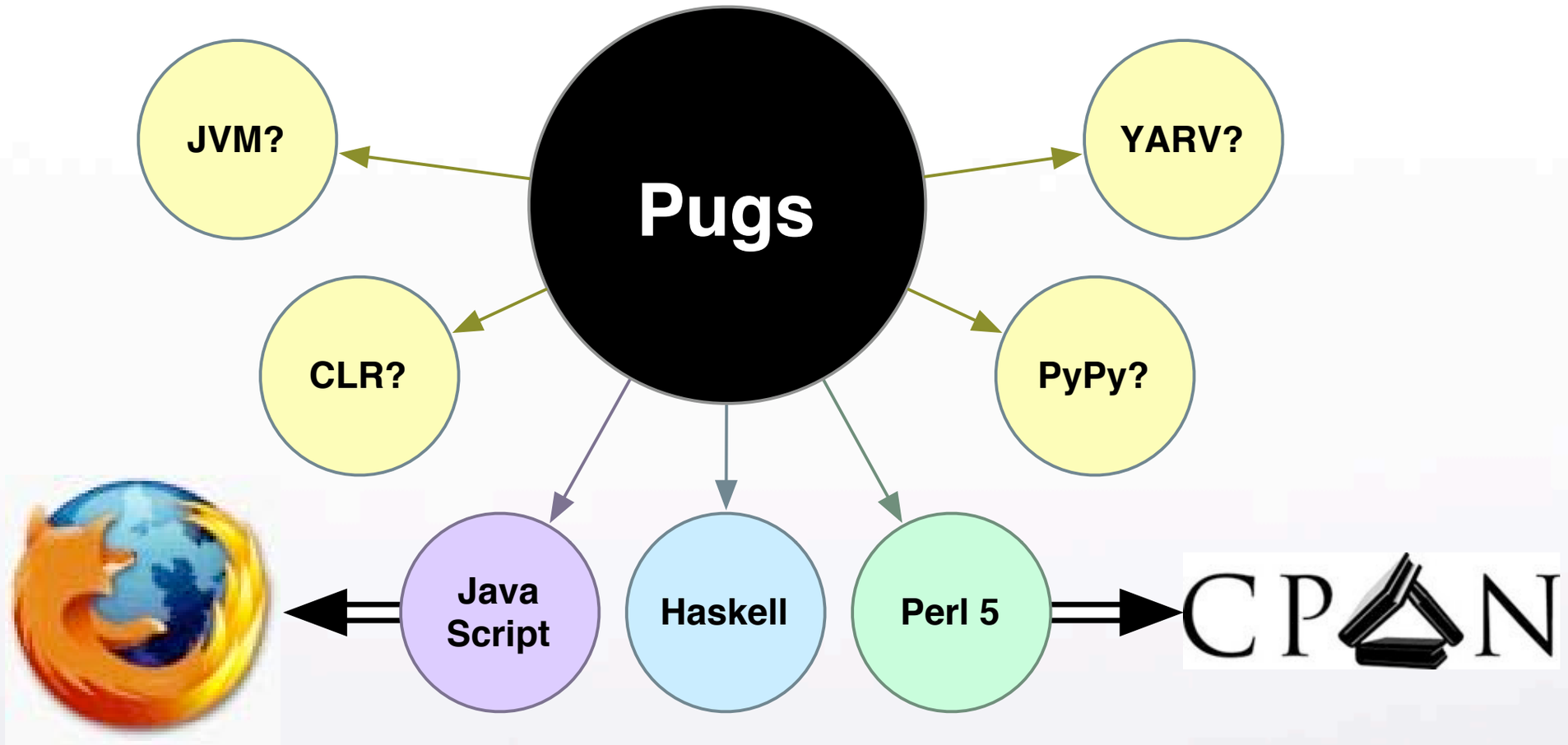
Your Language

```
use jsan:DOM;
```

```
use jsan:DOM;
use perl5:DBI;
```

```
use jsan:DOM;
use perl5:DBI;
use haskell:Numeric;
```


Pugs
Java Script
Haskell
Perl 5


Pugs
JVM?
YARV?
CLR?
PyPy?
Java Script
Haskell
Perl 5
CPAN

يد

Popular

Target Language

Generating JS

Generating JS

- Java: Google Web Toolkit

Generating JS

- Java: Google Web Toolkit
- Perl: Jifty

Generating JS

- Java: Google Web Toolkit
- Perl: Jifty
- Ruby: Rails/JS

Generating JS

- Java: Google Web Toolkit
- Perl: Jifty
- Ruby: Rails/JS
- Python: Pyjamas

Generating JS

- Java: Google Web Toolkit
- Perl: Jifty
- Ruby: Rails/JS
- Python: Pyjamas
- C#: Script#

Same language for both sides

✓

Client-side

just a **tiny subset**

✗

Compiling to JS

Compiling to JS

- HOP/Scheme2JS

Compiling to JS

- HOP/Scheme2JS
- Links

Compiling to JS

- HOP/Scheme2JS
- Links
- HaXe

Compiling to JS

- HOP/Scheme2JS
- Links
- HaXe
- Pugs!

PIL2JS

pugs -C JS

pugs -C JS

- Written in Perl 5

pugs -C JS

- Written in Perl 5
- Passes 90% of tests

pugs -C JS

- Written in Perl 5
- Passes 90% of tests
- ~30k Runtime

PIL2JS Runtime

PIL2JS Runtime

- Primitives & Autoboxing

PIL2JS Runtime

- Primitives & Autoboxing
- Meta-object protocol

PIL2JS Runtime

- Primitives & Autoboxing
- Meta-object protocol
- Supports JSAN libraries

JSAN

JSAN

```
ژ   "CPAN".replace(/CP/, "JS")
```

JSAN

ژ "CPAN".replace(/CP/, "JS")

ژ Module system with Prototype.js

JSAN

- `"CPAN".replace(/CP/, "JS")`
- Module system with Prototype.js
- Test.Simple, Jemplate, *etc.*

Shortcomings

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- Calling convention too complex

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- CPS runloop is slow

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- No tail recursion nor *goto*

Shortcomings

- Calling convention too complex
- CPS runloop is slow
- No tail recursion nor *goto*
- But there's hope!

JS 2.0

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- Self hosting

JS 2.0

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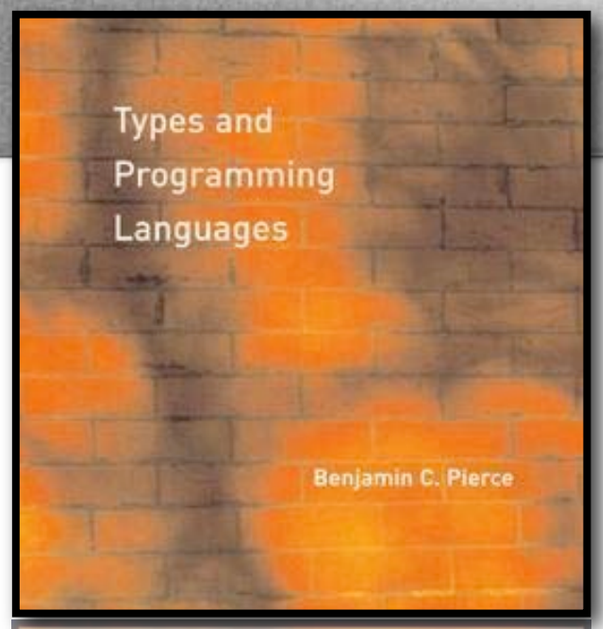
- Backtranslate to JS1

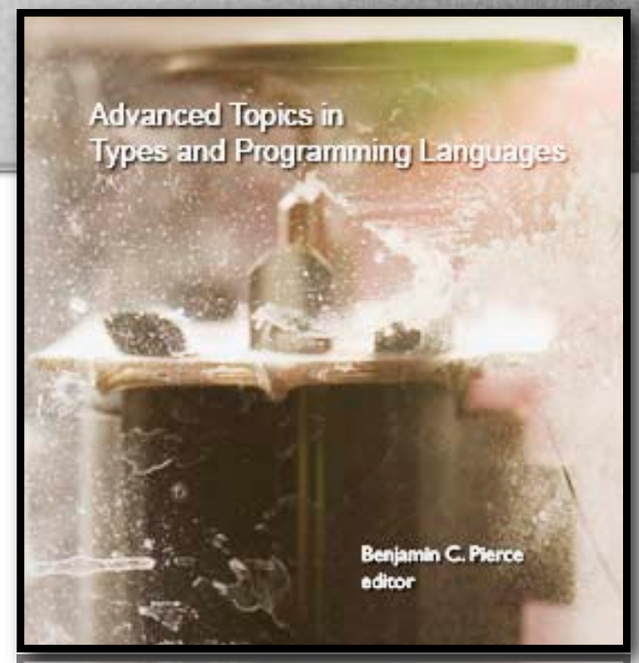
JS 2.0

- Self hosting
- Backtranslate to JS1
- Types, Modules, Continuations

JS 2.0

- Self hosting
- Backtranslate to JS1
- Types, Modules, Continuations
- Part of Firefox 3.0 (next year)





Feb 1

TaPL arrived

as an **exercise**…

Feb 6

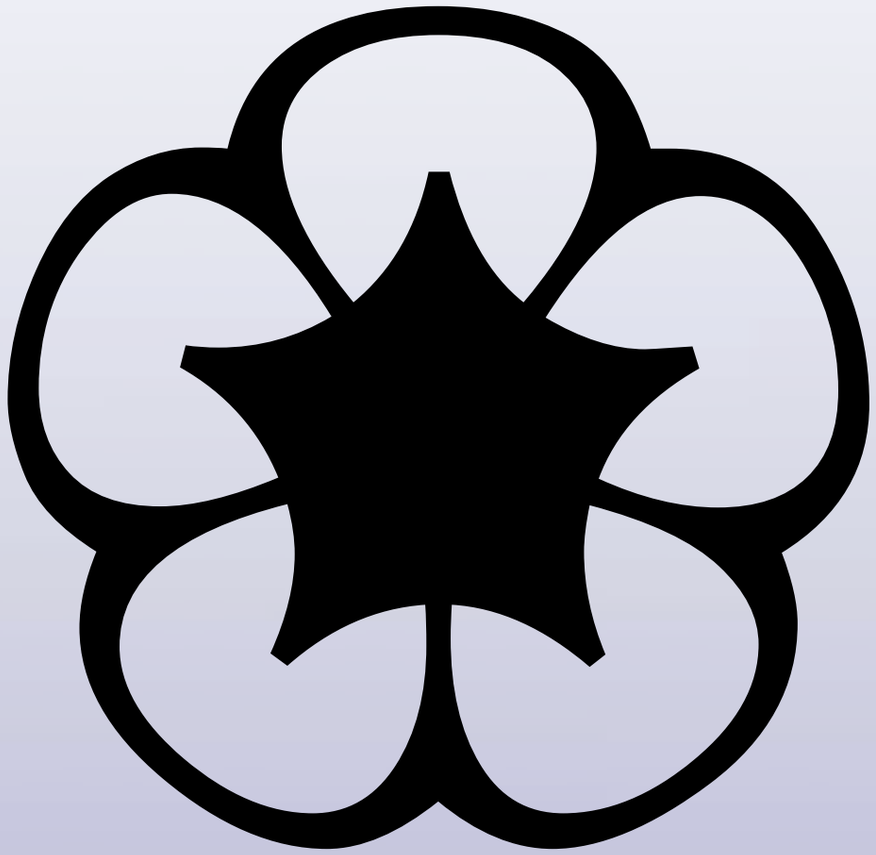
Junctions

(1|2)+(3|4) ↪ (4|5|6)

Feb 16

Input/Output

```
say "Hello, world"
```



Mar 19

PCRE Regex

s:P5:g/5/6/;

May 8

svnbot.p6

r2851 | iblech++

May 25
Prelude.pm

```
sub sprintf ($fmt, *@args)
```

May 29

Embedded Perl 5

```
use perl5:DBI;
```

Jun 2

evalbot.p6

[#perl6] ?eval 1+1

Jun 24

Perl6 → ***PIL*** → *Parrot*

`make smoke-pir`

Jul 14

PIL → Perl5

`make smoke-perl5`

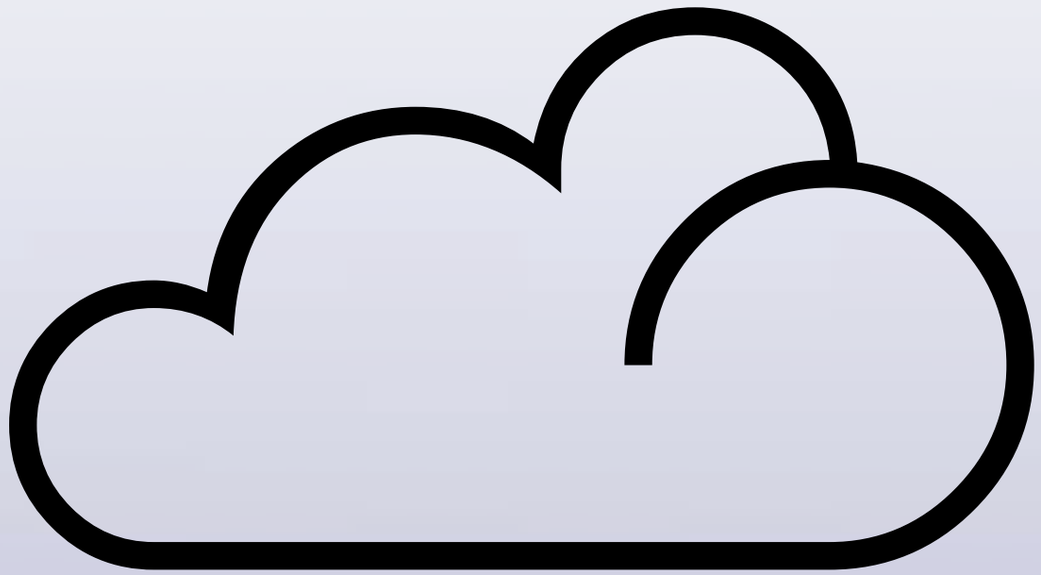
Jul 17

PIL → JavaScript

`make smoke-js`

Aug 3
Kontent Wiki

```
use perl5:Template;
```



Nov 2

Runtime API

Perl6::ObjectSpace

Nov 3

Concurrency API

```
sub f is throttled(:limit(3)) { … }
```

Nov 4

Packaging API

perl5-Foo-1.0-cpan+KANE.jib

Nov 7

Coroutines

```
coro { yield 1 }
```

Nov 23

1st commit from Larry

(still waiting for Guido ☺)

Jan 6

YAML Serialization

```
say $x.yaml;
```

Feb 3

Self-parsing Grammar

```
grammar Grammar;
```

Feb 22

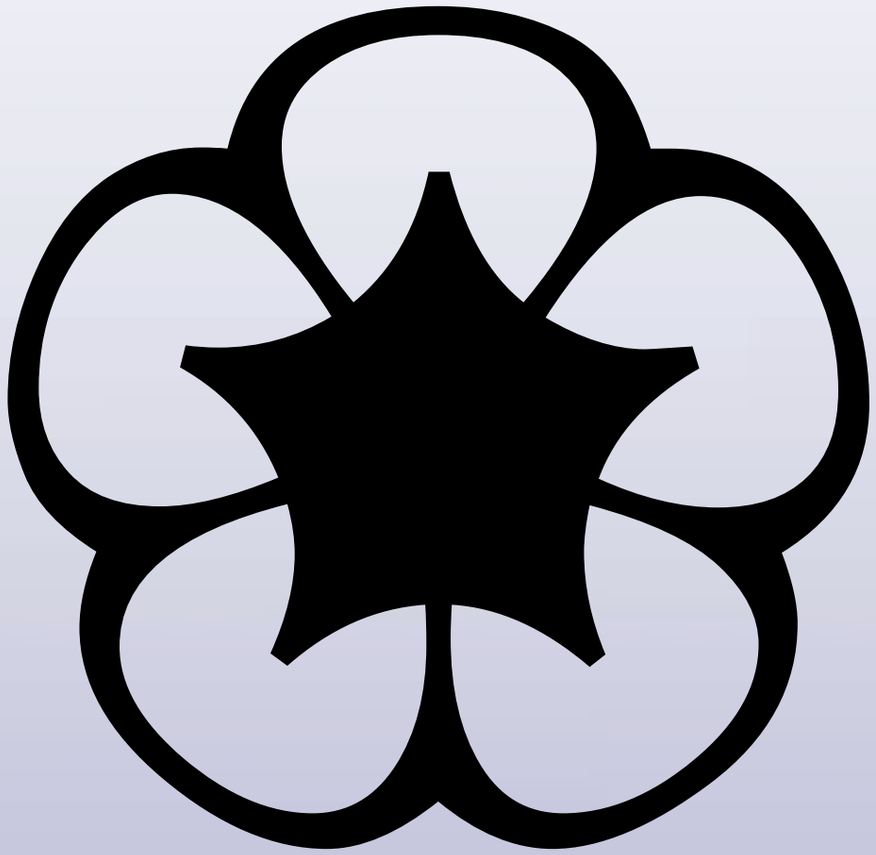
Larry joins #perl6

```
<fglock> TimToady: welcome
<Juerd> Just try to not get addicted :)
<TimToady> Juerd: too late…
```

Feb 25

Code DOM

```
$AST = q:code/ say "hi" /;
```



Mar 11

Evaluator in Perl 5

Pugs::Runtime

Mar 16

Bootstrapped on Perl 5

```
lrep.p6 lrep.p6
```

Apr 1

Calling Convention API

```
$tree = \($obj: attr => 1, $child);
```

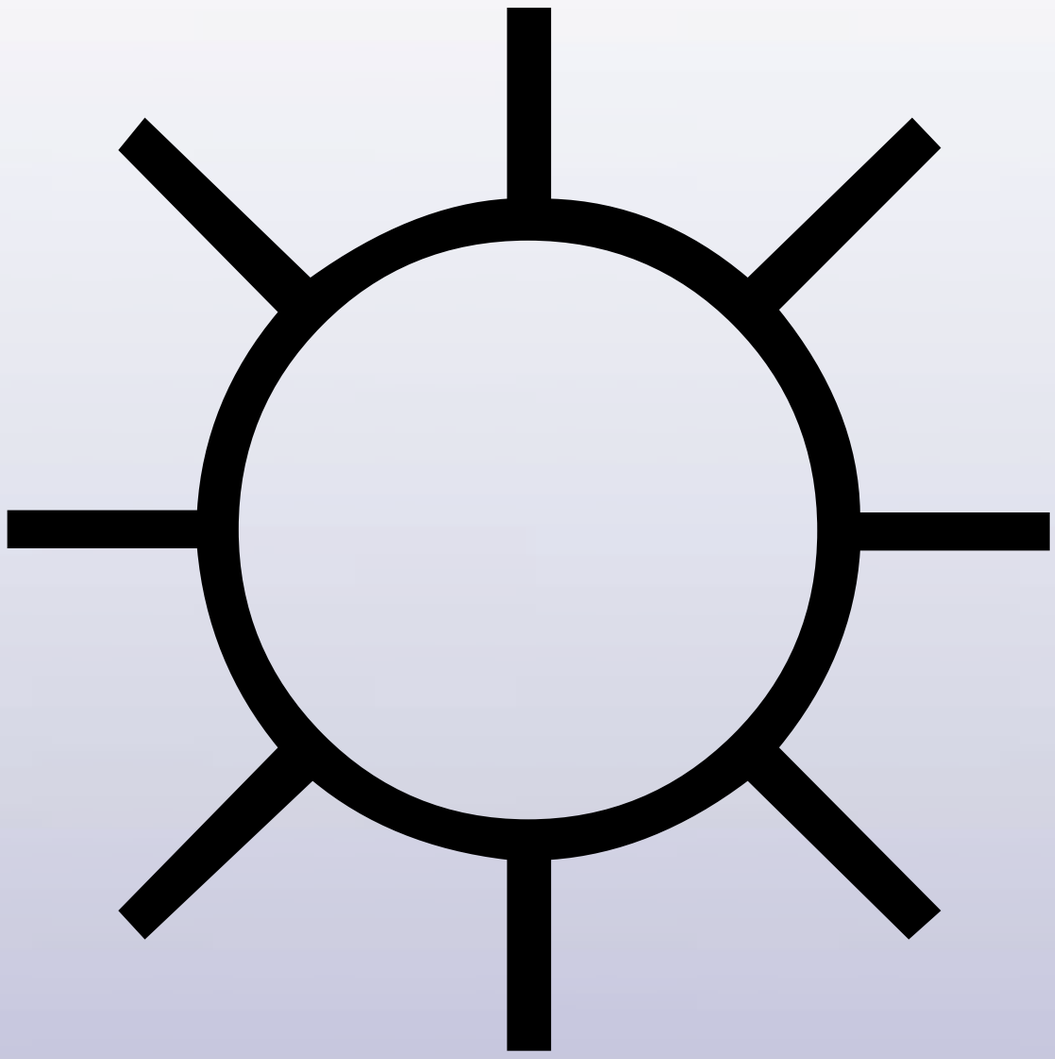
Apr 21

MIT License

May 8

Predictive Parsing

<TimToady> "do, or do not.
there is no *try*..."



June 1

Summer of Code

SoC: Perl.org

SoC: Perl.org

- Perl 6 DBI Module

SoC: Perl.org

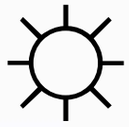
- Perl 6 DBI Module
- Perl 5 to Perl 6 Translator

SoC: Perl.org

- Perl 6 DBI Module
- Perl 5 to Perl 6 Translator
- Pugs Bootstrap From Perl 5 and Rules

SoC: Haskell.org

SoC: Haskell.org



Fast Mutable Collection Types

SoC: Haskell.org

- Fast Mutable Collection Types
- Unicode ByteString and Data.Rope

June 4

Software Transactional Memory

```
async { contend { ... } }
```

June 26

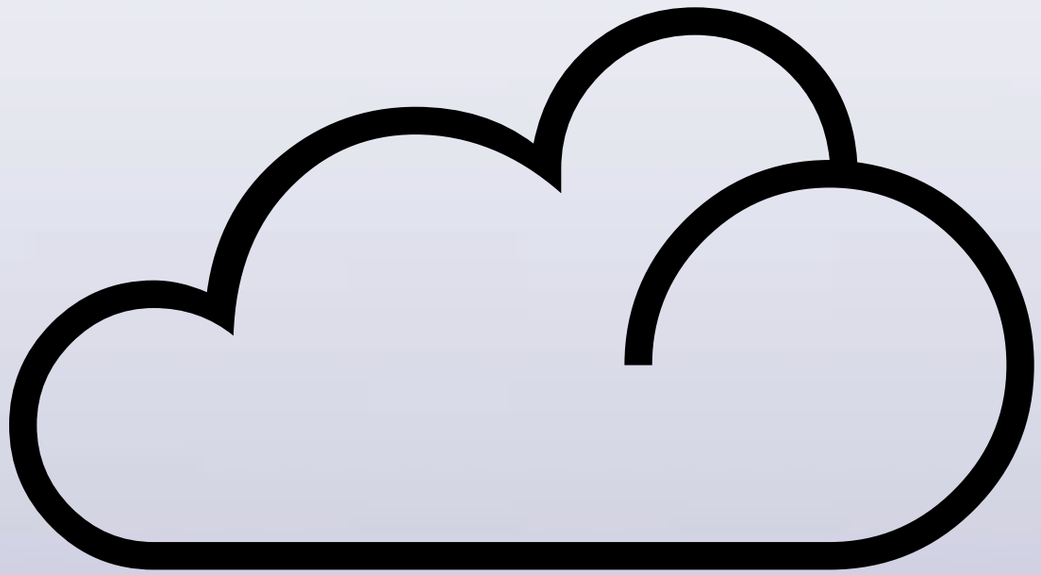
v6.pm

```
use v6-alpha;
```

August 17

Smartlinks.pl

```
# L<S02/"bidirectional mirrorings">
is q《123》, 123, "angle brackets";
```



September 16

Native Grammar Engine

via Embedded Perl5

s:g/PGE/PCR/;

October 9

Fully reentrant continuations

```
sub callcc (Code &c)
{ &c(&?CALLER_CONTINUATION) }
```

October 11

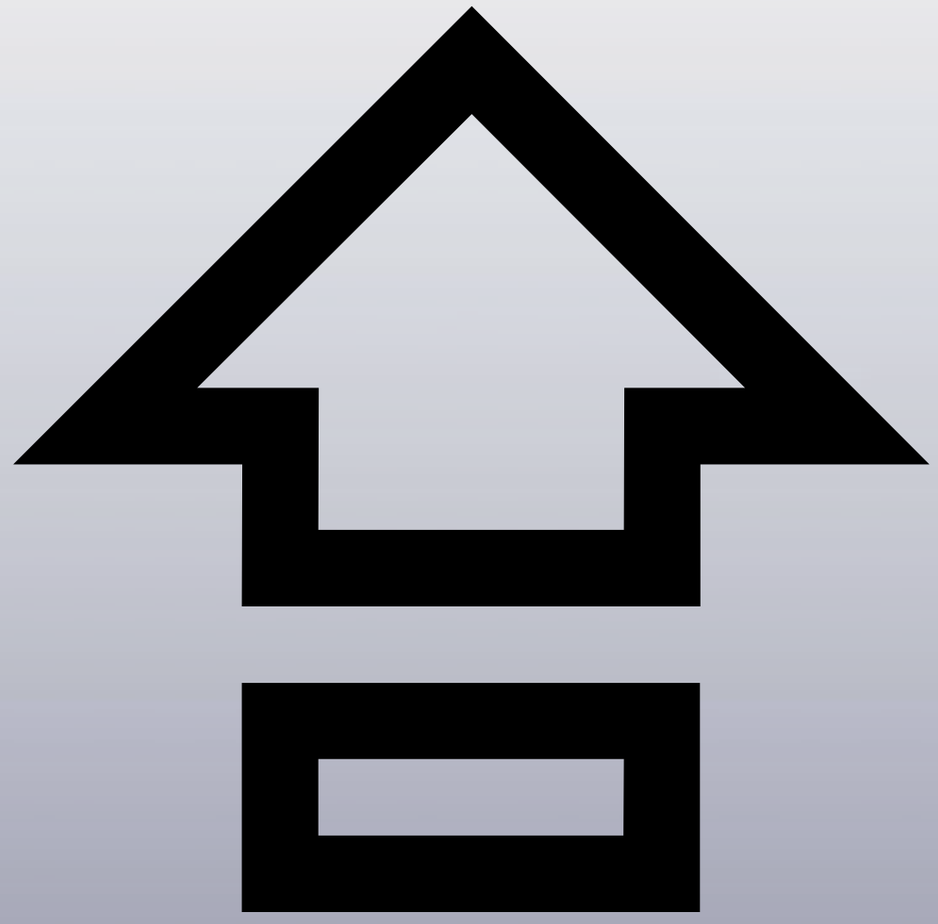
GHC 6.6

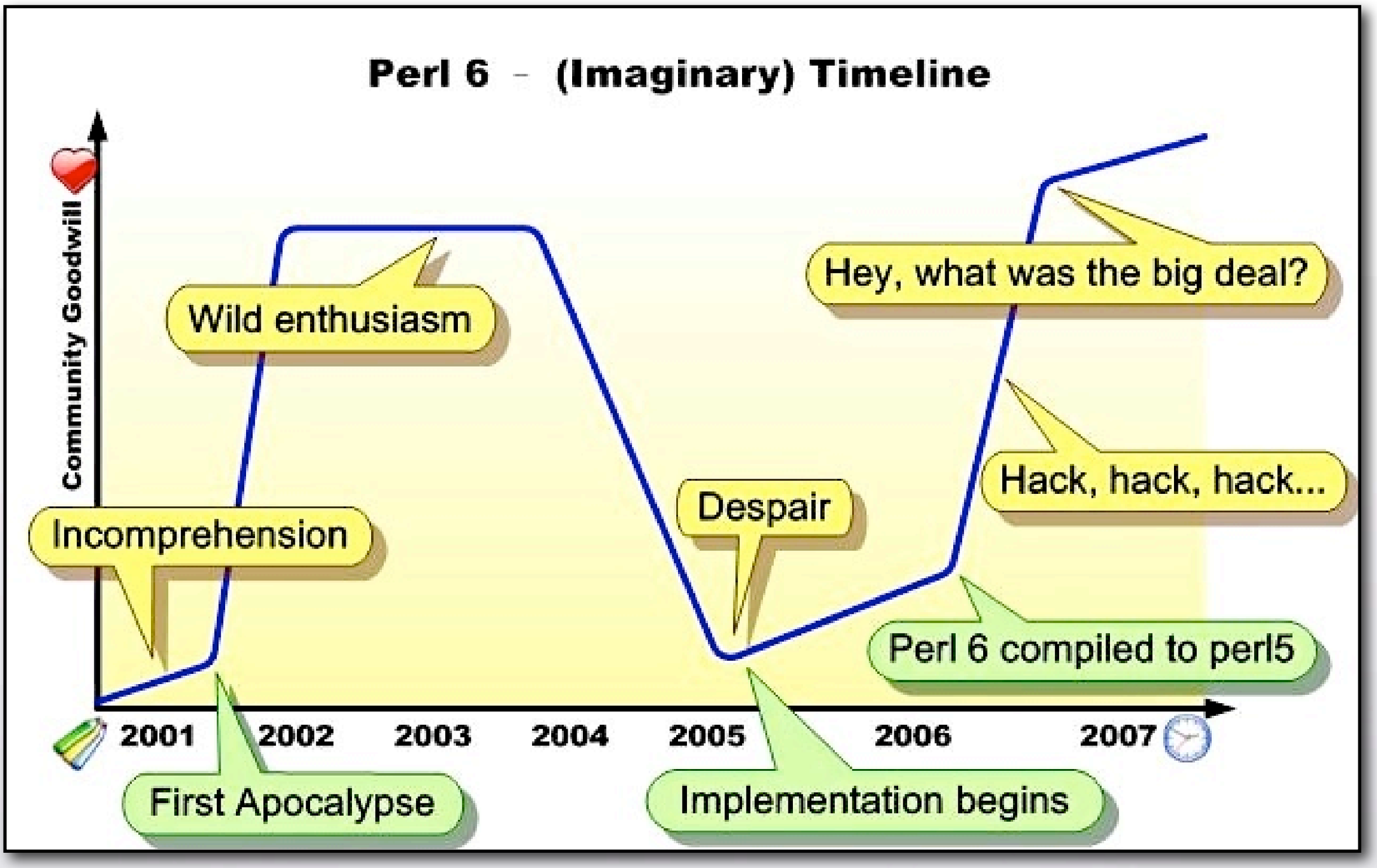
<TimToady> I upgraded and my $job program ran 60 times faster...

October 20

SMP Data Parallelism

```
[(1|2), (3|4)].>>sqrt
```




Perl 6 - (Imaginary) Timeline
Community Goodwill
Wild enthusiasm
Incomprehension
First Apocalypse
Despair
Implementation begins
Hey, what was the big deal?
Hack, hack, hack...
Perl 6 compiled to perl5
2001
2002
2003
2004
2005
2006
2007

“**CPAN** is the **language**

Perl is just **syntax**”

Production

Production

- Existing Perl 5 code base

Production

- Existing Perl 5 code base
- GHC may be unavailable

Production

- Existing Perl 5 code base
- GHC may be unavailable
- Can't rewrite from scratch

The Perl 5 VM

The Perl 5 VM

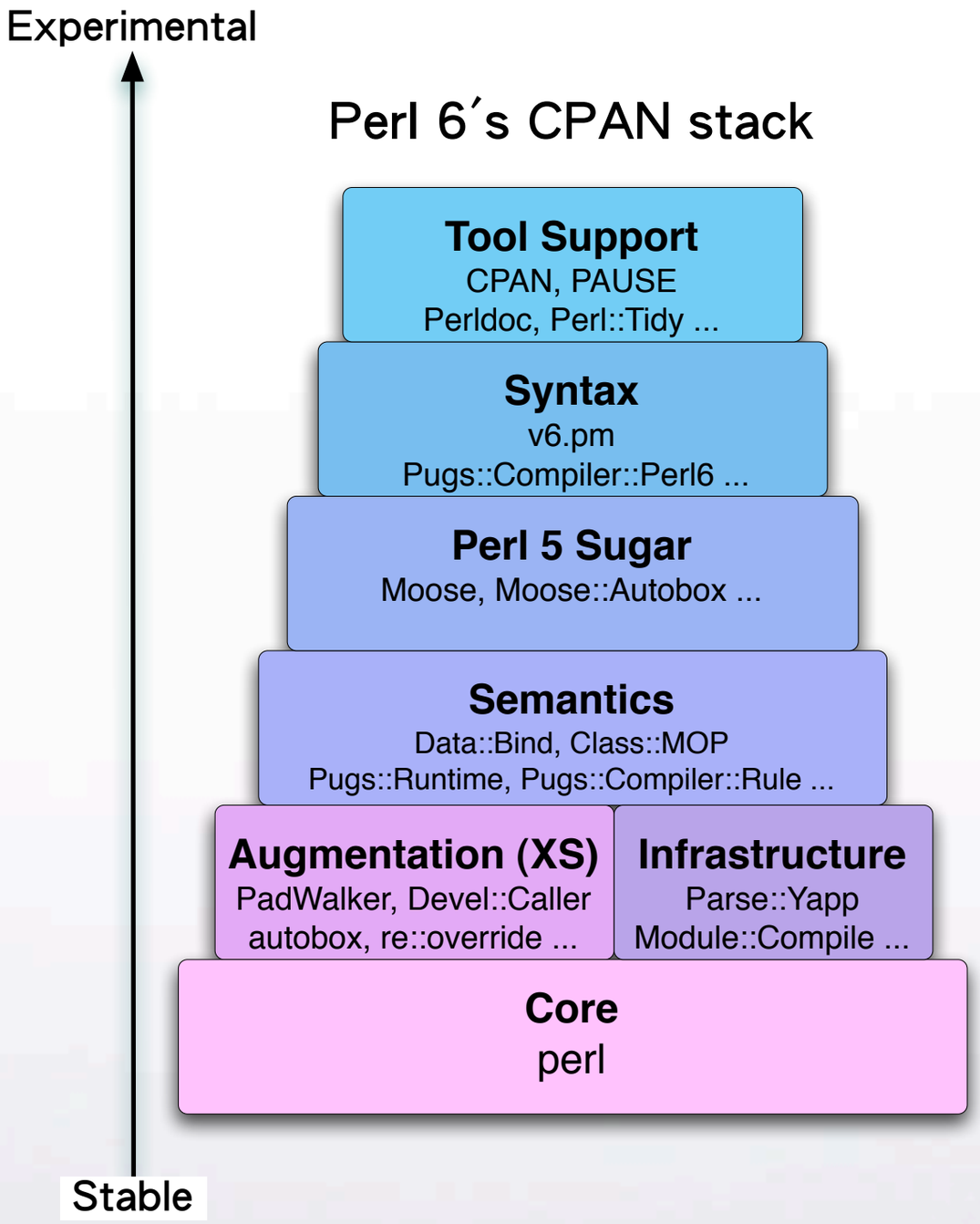
- Actively developed

The Perl 5 VM

- Actively developed
- 5.10 is much more v6ish

The Perl 5 VM

- Actively developed
- 5.10 is much more v6ish
- Unified Perl Runtime


Experimental
Perl 6´s CPAN stack
Tool Support
CPAN, PAUSE
Perldoc, Perl::Tidy ...
Syntax
v6.pm
Pugs::Compiler::Perl6 ...
Perl 5 Sugar
Moose, Moose::Autobox ...
Semantics
Data::Bind, Class::MOP
Pugs::Runtime, Pugs::Compiler::Rule ...
Augmentation (XS)
PadWalker, Devel::Caller
autobox, re::override ...
Infrastructure
Parse::Yapp
Module::Compile ...
Core
perl
Stable

Moose

Objects

with **Class**

```
use v6-alpha;
class Point;


has $.x is rw; # instance attributes
has $.y;       # default "is readonly"

method clear () {


    $.x = 0; # accessible within the class
    $.y = 0;
}
```

```
use v5;
package Point;
use Moose;

has x => (is => 'rw');
has y => (is => 'ro');

sub clear {
    my $self = shift;

    $self->{x} = 0;
    $self->y(0);
}
```

Subclassing

```
use v6-alpha;
class Point3D;


is Point;

has $.z;

method clear () {

    call;
    $.z = 0;
};
```

```
use v5;
package Point3D;
use Moose;

extends 'Point';

has z => (isa => 'Int');

override clear => sub {
    my $self = shift;
    super;
    $self->{z} = 0;
};
```

```
use v5;
package Point3D;
use Moose;

extends 'Point';

has z => (isa => 'Int');

after clear => sub {
    my $self = shift;

    $self->{z} = 0;
};
```

Subset Types

```
use v6-alpha;
class Address;
use perl5:Locale::US;
use perl5:Regexp::Common <zip $RE>;

my $STATES = Locale::US.new;
subset US_State of Str where {
    $STATES{any(<code2state state2code>)}{.uc};
};

has US_State $.state is rw;
has Str $.zip_code is rw where {
    $_ ~~ $RE<zip><<US>{'-extended' => 'allow'}
};
```

```
use v5;
package Address;
use Moose;
use Moose::Util::TypeConstraints;
use Locale::US;
use Regexp::Common 'zip';

my $STATES = Locale::US->new;
subtype USState => as Str => where {
    $STATES->{code2state}{uc($_)}
    or $STATES->{state2code}{uc($_)};
}

has state => (is => 'rw', isa => 'USState');
has zip_code => (
    is => 'rw',
    isa => subtype Str => where {
        /$RE{zip}{US}{-extended => 'allow'}/
    },
);
```

More features

More features

- Roles (Dynamic Traits)

More features

- Roles (Dynamic Traits)
- Coercion

More features

- Roles (Dynamic Traits)
- Coercion
- Meta Objects

Module::Compile

Source Filter

```
use v5;
use Filter::Simple sub {
    s{(^ sub \s+ \w+ \s+ \{ )}
     {$1\nmy $self = shift;\n}mgx;
}
```

Filter::Simple Bad

Filter::Simple Bad

※ Extra dependency

Filter::Simple Bad

- ※ Extra dependency
- ※ Slows down startup

Filter::Simple Bad

- ※ Extra dependency
- ※ Slows down startup
- ※ Breaks the debugger

Filter::Simple Bad

- ※ Extra dependency
- ※ Slows down startup
- ※ Breaks the debugger
- ※ Wrecks other Source Filters

We can **fix it!**

```
use v5;
use Filter::Simple sub {
    s{(^ sub \s+ \w+ \s+ \{ )}
     {$1\nmy $self = shift;\n}mgx;
}
```

```
use v5;
use Filter::Simple::Compile sub {
    s{(^ sub \s+ \w+ \s+ \{ )}
     {$1\nmy $self = shift;\n}mgx;
}
```

How?

Little-known **fact:**

“use Foo”

looks for **Foo.pmc**

before **Foo.pm**

```
% echo 'print "Hello\n"' > Foo.pmc
% perl -MFoo -e1
Hello
```

Save filtered results to .pmc...

…no filtering

needed next time!

Module::Compile Good

Module::Compile Good

※ Free of dependencies on user's site

Module::Compile Good

- ※ Free of dependencies on user's site
- ※ Fast startup time

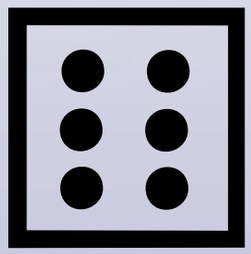
Module::Compile Good

- ※ Free of dependencies on user's site
- ※ Fast startup time
- ※ Debuggable source is all in .pmc

Module::Compile Good

- Free of dependencies on user's site
- Fast startup time
- Debuggable source is all in .pmc
- Composable precompilers

v6.pm



Source:

Rule.pm

```
use v6-alpha;

grammar Pugs::Grammar::Rule;

token ws {
      [ \s
      | \# \N*
      ]+
}
# ...more rules...
```

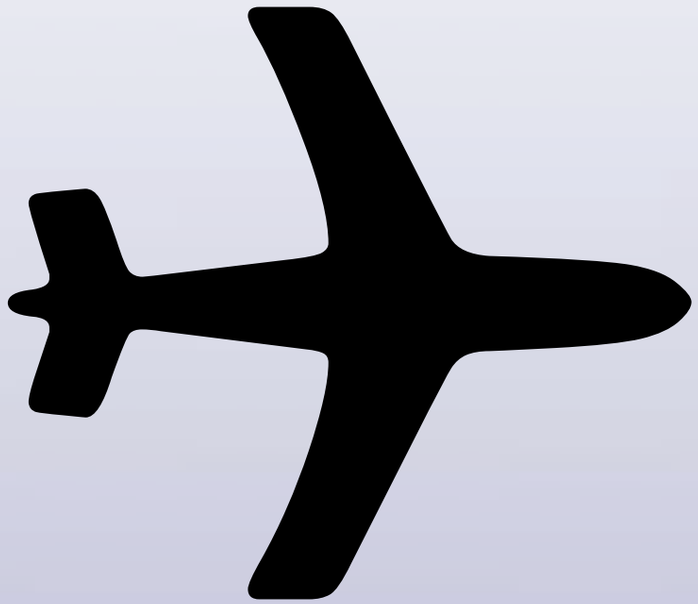
Target:

Rule.pmc

```
# Generated file - do not edit!
####################((( 32-bit Checksum Validator )))#####################
BEGIN { use 5.006; local (*F, $/); ($F = __FILE__) =~ s!c$!!; open(F)
or die "Cannot open $F: $!"; binmode(F, ':crlf'); unpack('%32N*',<F>)
== 0x1D6399E1 or die "Checksum failed for outdated .pmc file: ${F}c"}
##############################################################################
package Pugs::Grammar::Rule;
*ws = sub {
    my $grammar = shift;
    #warn "rule argument is undefined" unless defined $_[0];
    $_[0] = "" unless defined $_[0];
    my $bool = $_[0] =~ /^((?:\s|\#(?-s:.)*)+)(.*)$/sx;
    return {
        bool => $bool,
        match => $1,
        tail => $2,
        #capture => $1,
    }
};
# ...more rules...
```

Write **Perl 6**

compile to **Perl 5**



When will Perl 6 be **released?**

By ***Christmas!***

When **Perl 6** arrives, every day will be like **Christmas!**

Fin.