Perl 6

&

The Zen of Erlang

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booking.com
The Perl Conference, 2016

Context

Context

Not a "I’ve done this thing in production" talk

Context

Not a "I’ve done this thing in production" talk

(…yet! :D)

Context

Not a "I’ve done this thing in production" talk

(…yet! :D)

Casing the joint

Context

Not a "I've done this thing in production" talk

(...yet! :D)

Casing the joint

Signal boosting

Context

Not a "I've done this thing in production" talk

(...yet! :D)

Casing the joint

Signal boosting

Let's chat about this!

Overview

Overview

unified theory of (un)reliability

Overview

unified theory of (un)reliability

juggling raptors

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unified theory of (un)reliability

juggling raptors

mecha-concurrency

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juggling raptors

mecha-concurrency

the power of power cycling

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Theory of (un)reliability

Theory of (un)reliability

1) don’t write bugs

Theory of (un)reliability

1) don’t write bugs

OR

Theory of (un)reliability

1) don’t write bugs

OR

2a) write *fewer* bugs

Theory of (un)reliability

1) don't write bugs

OR

2a) write *fewer* bugs

2b) limit bug impact

Theory of (un)reliability

1) don't write bugs

OR

2a) write *fewer* bugs <— do this

2b) limit bug impact

Theory of (un)reliability

1) don’t write bugs

OR

2a) write *fewer* bugs <— do this

2b) limit bug impact <— and this

a fever dream

a fever dream

"the sync script is broken"

a fever dream

"the sync script is broken"

`/usr/local/bin/sync.pl`

a fever dream

"the sync script is broken"

`/usr/local/bin/sync.pl`

```
$ less sync.pl
```

a fever dream

a fever dream

no shebang

a fever dream

no shebang

no strict

a fever dream

no shebang

no strict

```
`ssh $ENV{REMOTE} perl /usr/local/bin/sync.pl`
```

a fever dream

no shebang

no strict

```
`ssh $ENV{REMOTE} perl /usr/local/bin/sync.pl`
```

no subs

a fever dream

no shebang

no strict

```
`ssh $ENV{REMOTE} perl /usr/local/bin/sync.pl`
```

no subs

```
$host =~ s/[a-z]{5}//; # TODO substr??
```

a fever dream

no shebang

no strict

```
`ssh $ENV{REMOTE} perl /usr/local/bin/sync.pl`
```

no subs

```
$host =~ s/[a-z]{5}//; # TODO substr??
```

~1200 lines

talk about your feelings

Why?

Why?

epic baby perl?

Why?

epic baby perl?

unmaintainable?

Why?

epic baby perl?

unmaintainable?

unreliable?

IT WORKS

SHIP IT

coupling -> reliability

coupling -> reliability

'the right amount'

coupling -> reliability

'the right amount'

abstraction

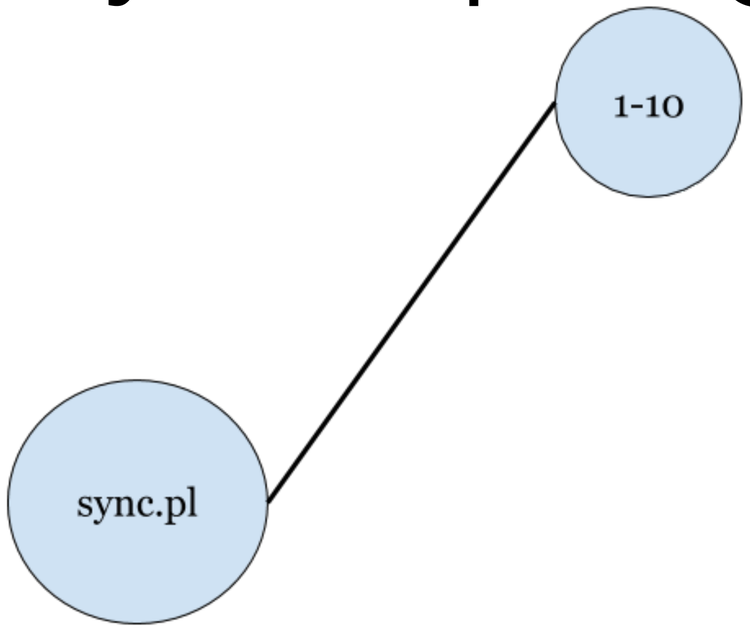
coupling -> reliability

'the right amount'

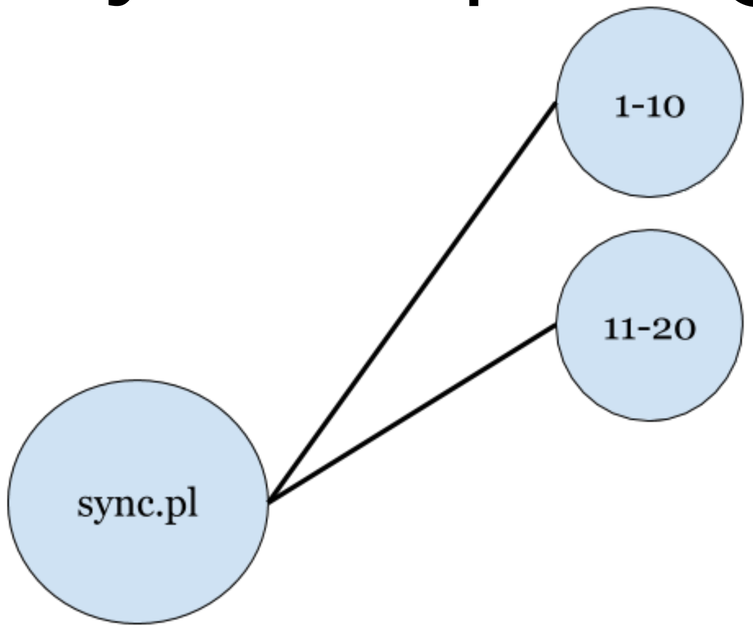
abstraction

scope

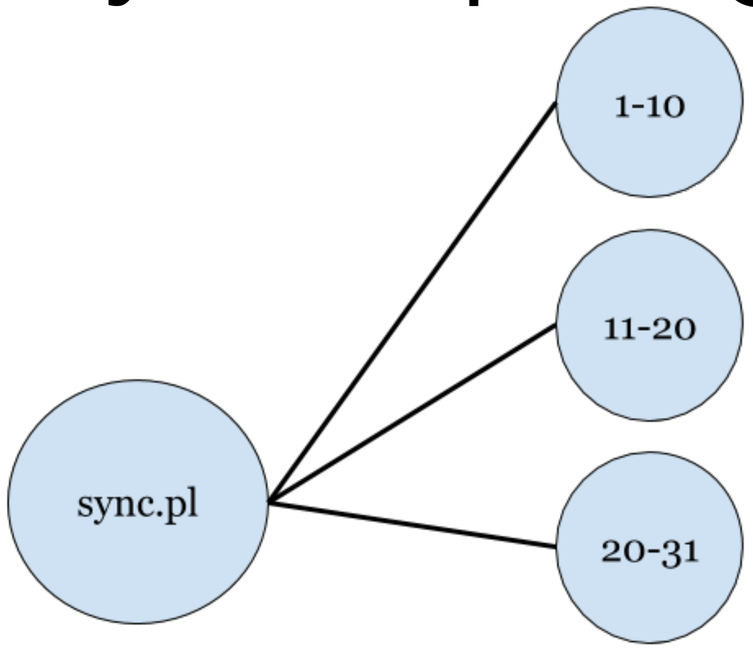
reliability scope: global



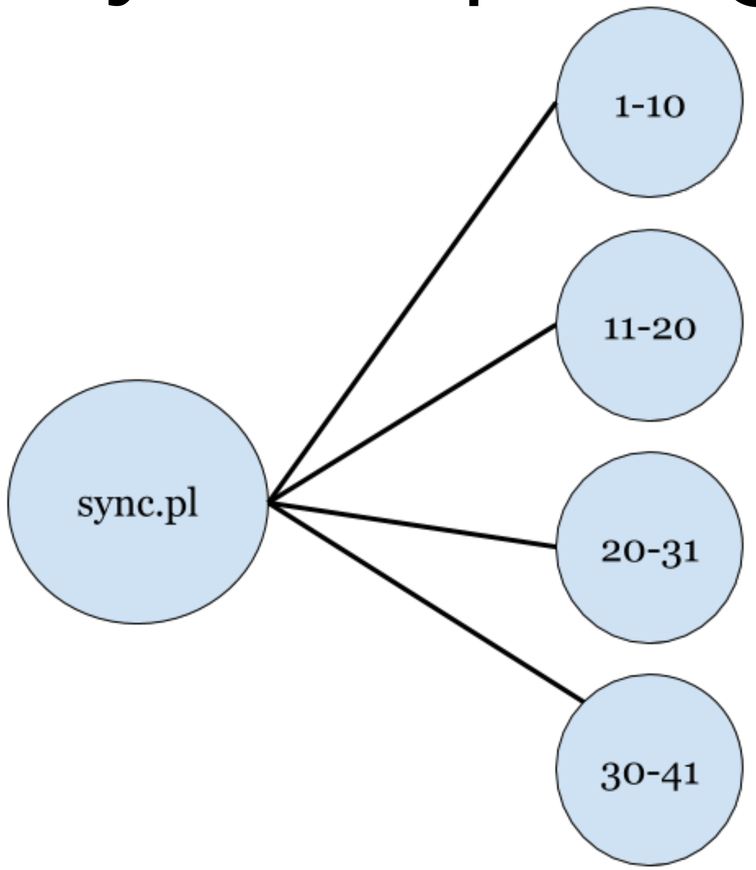
reliability scope: global



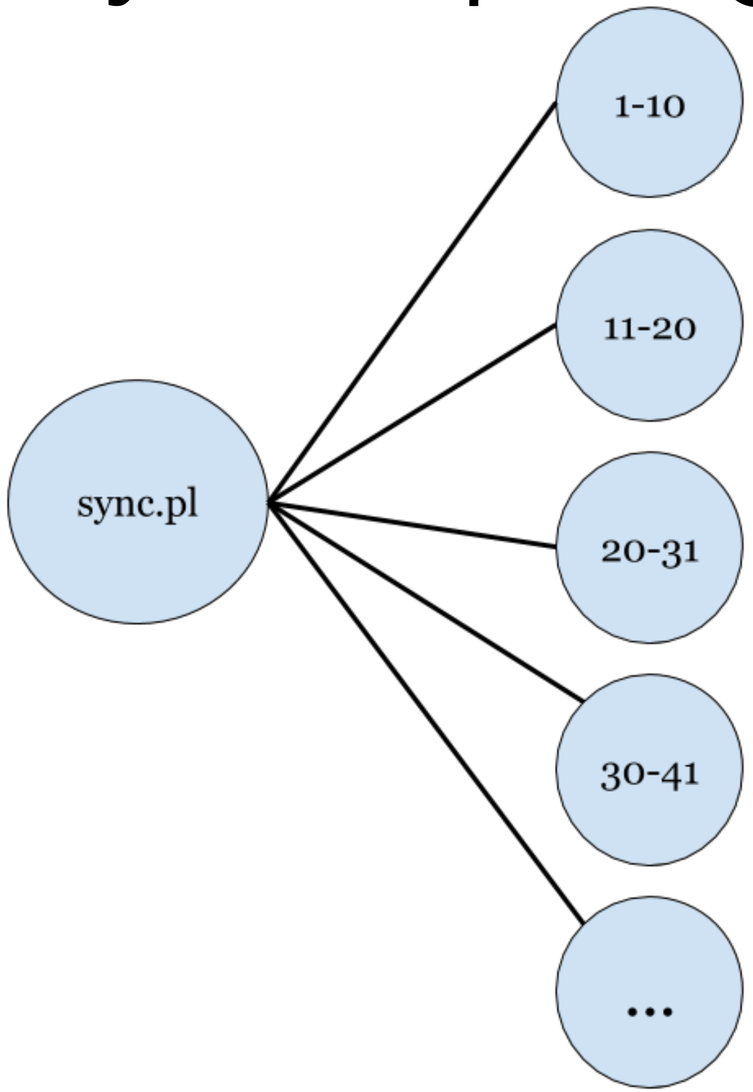
reliability scope: global



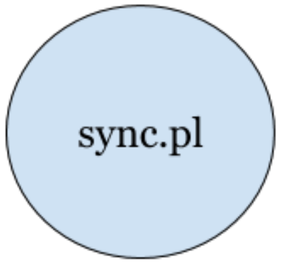
reliability scope: global



reliability scope: global



reliability scope: local



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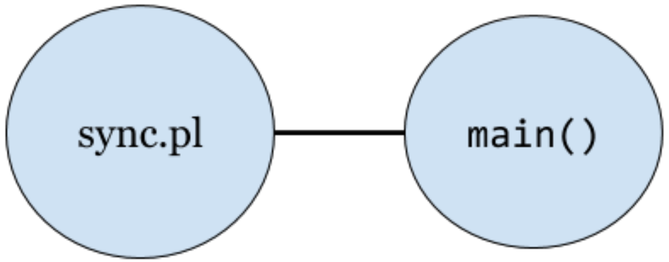

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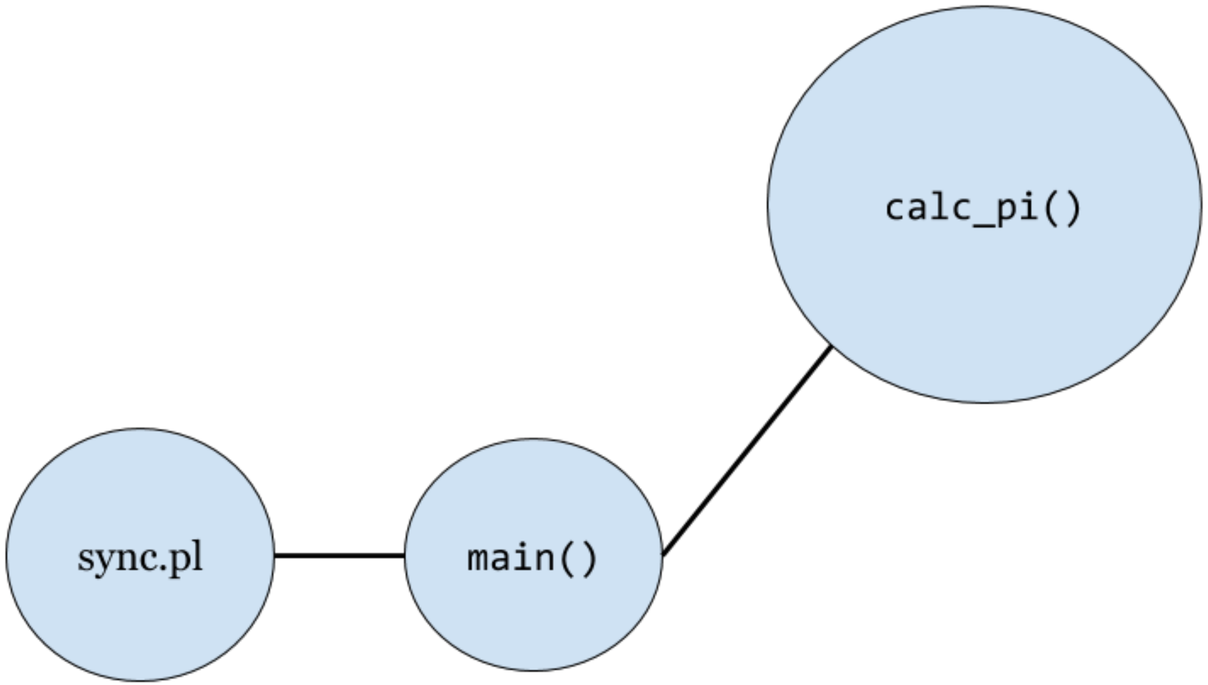
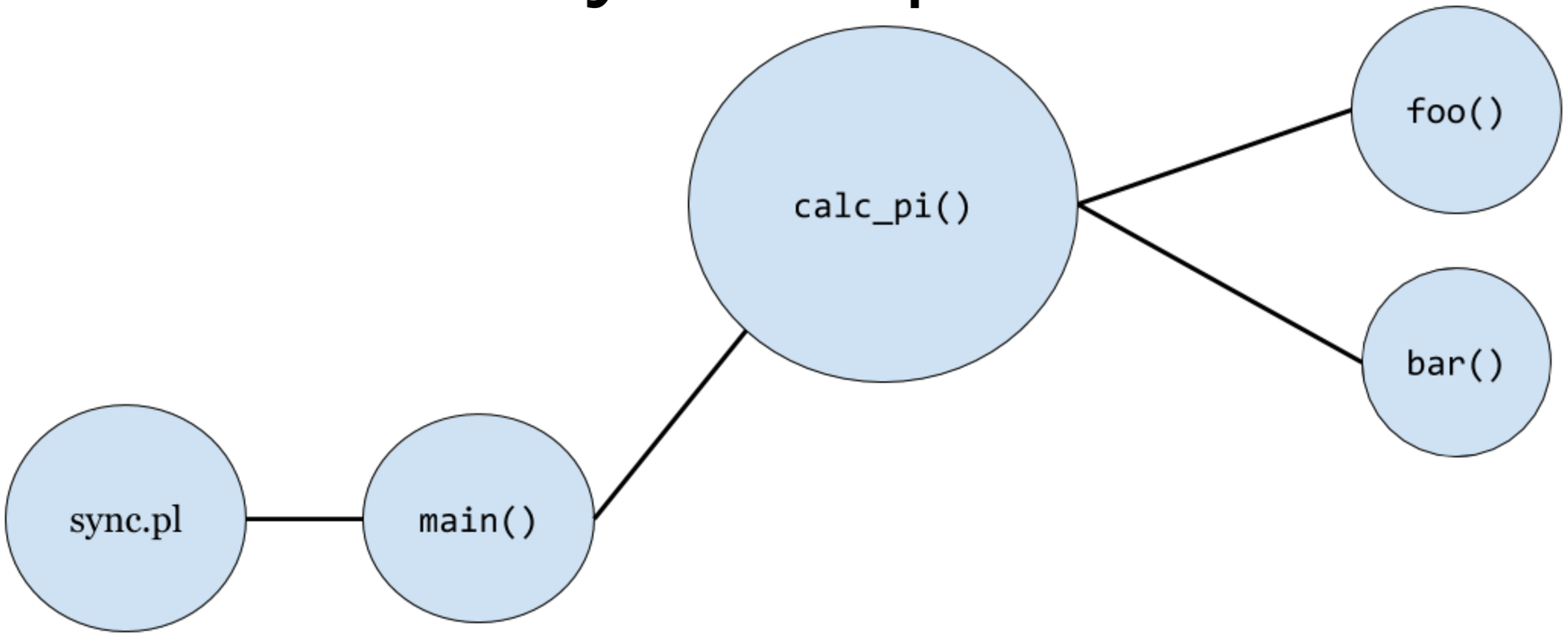


reliability scope: local



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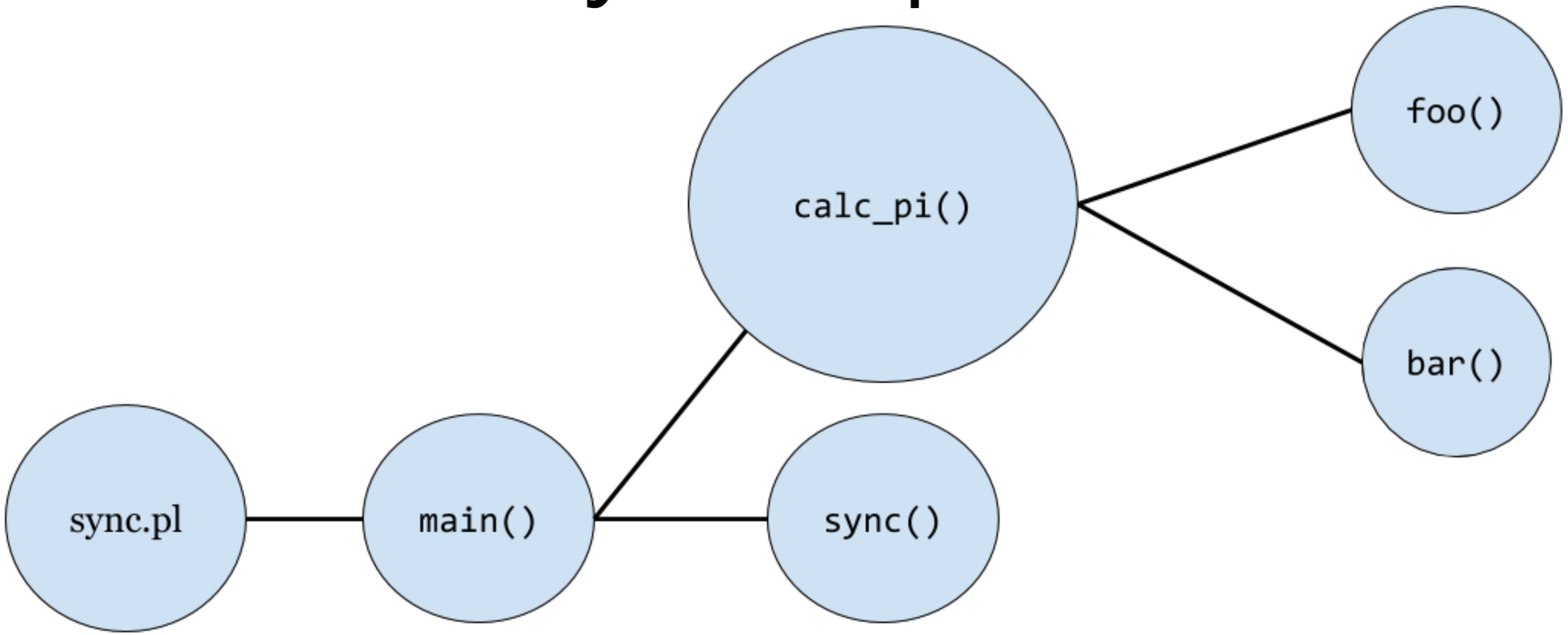

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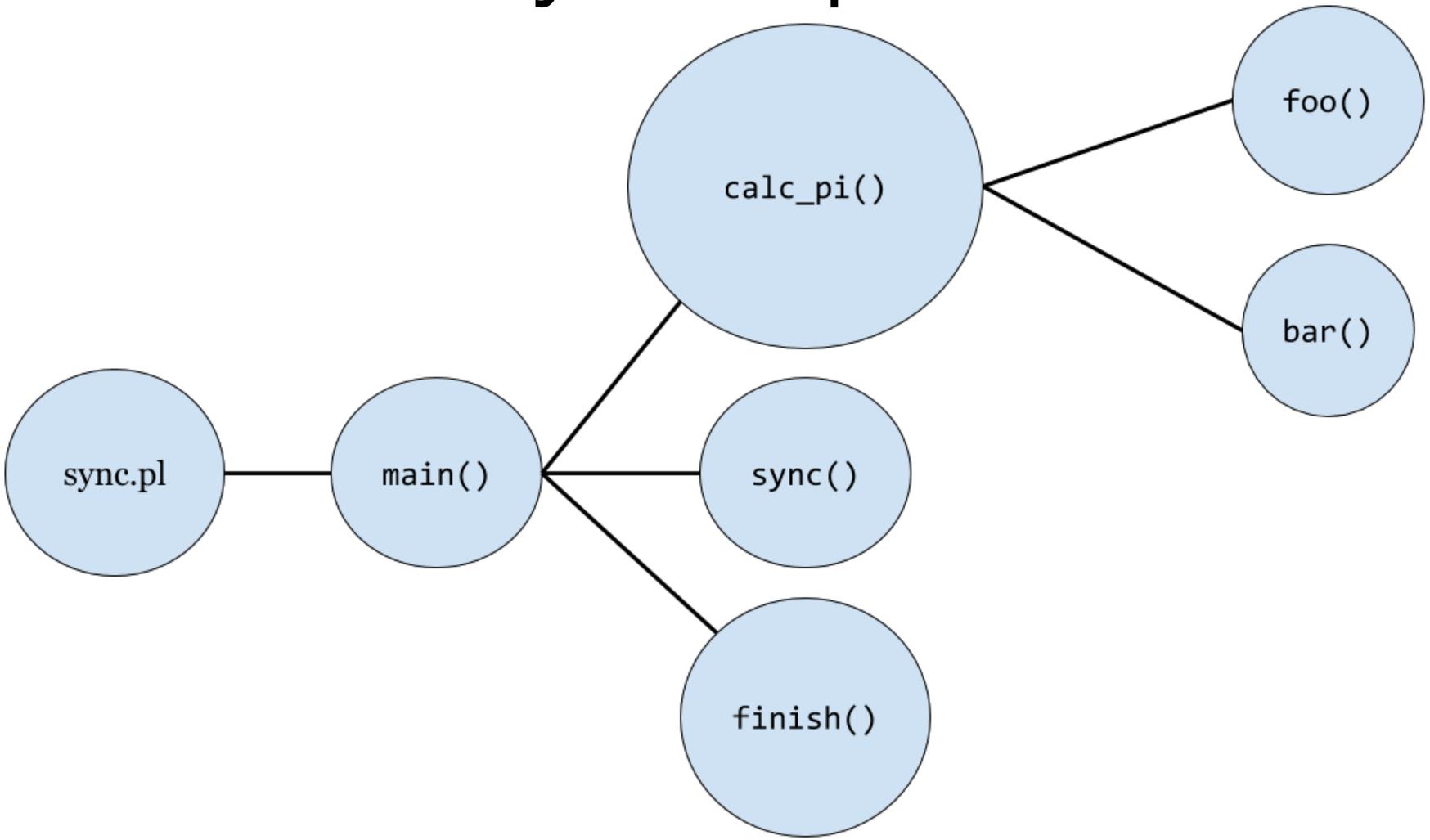
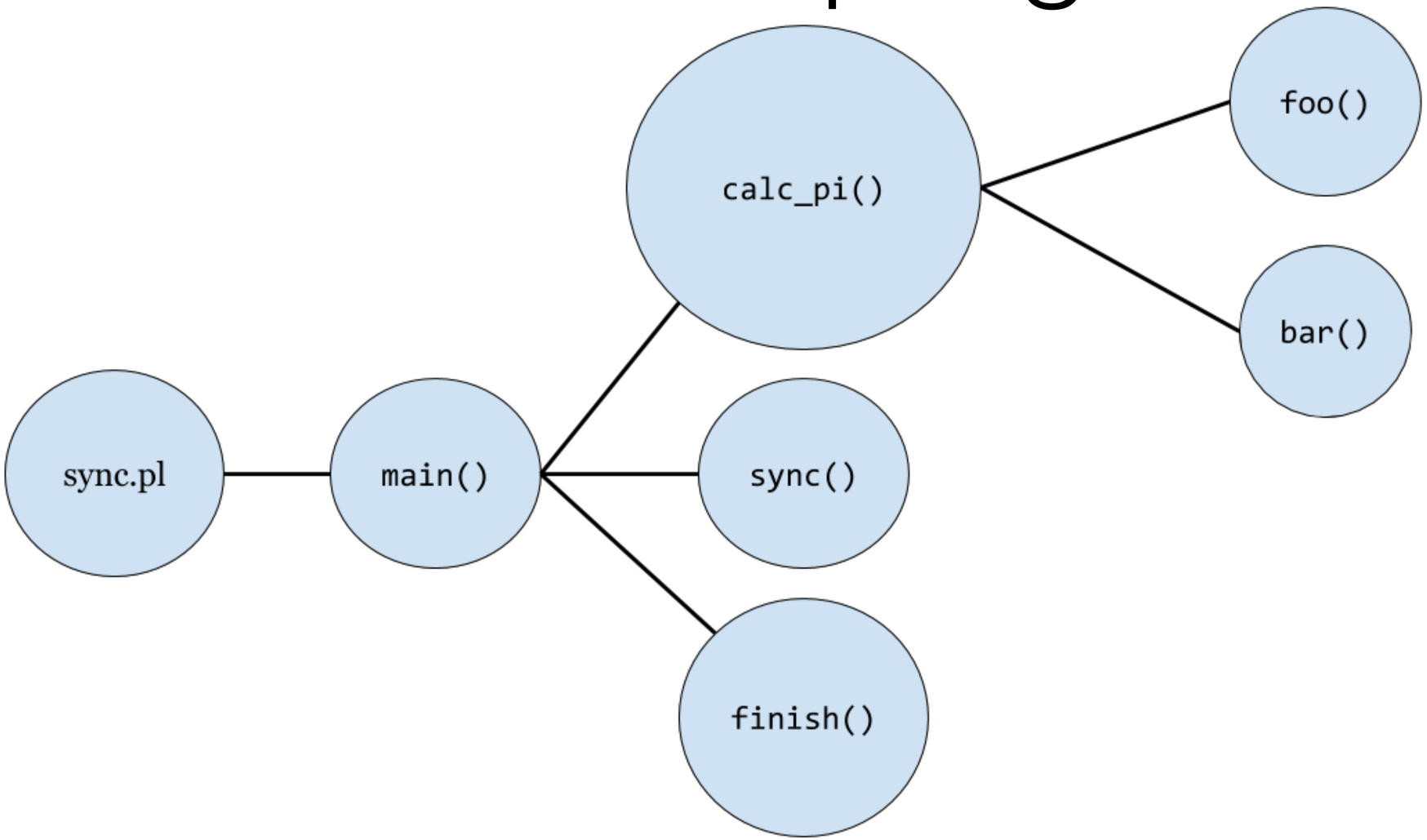


secret coupling?



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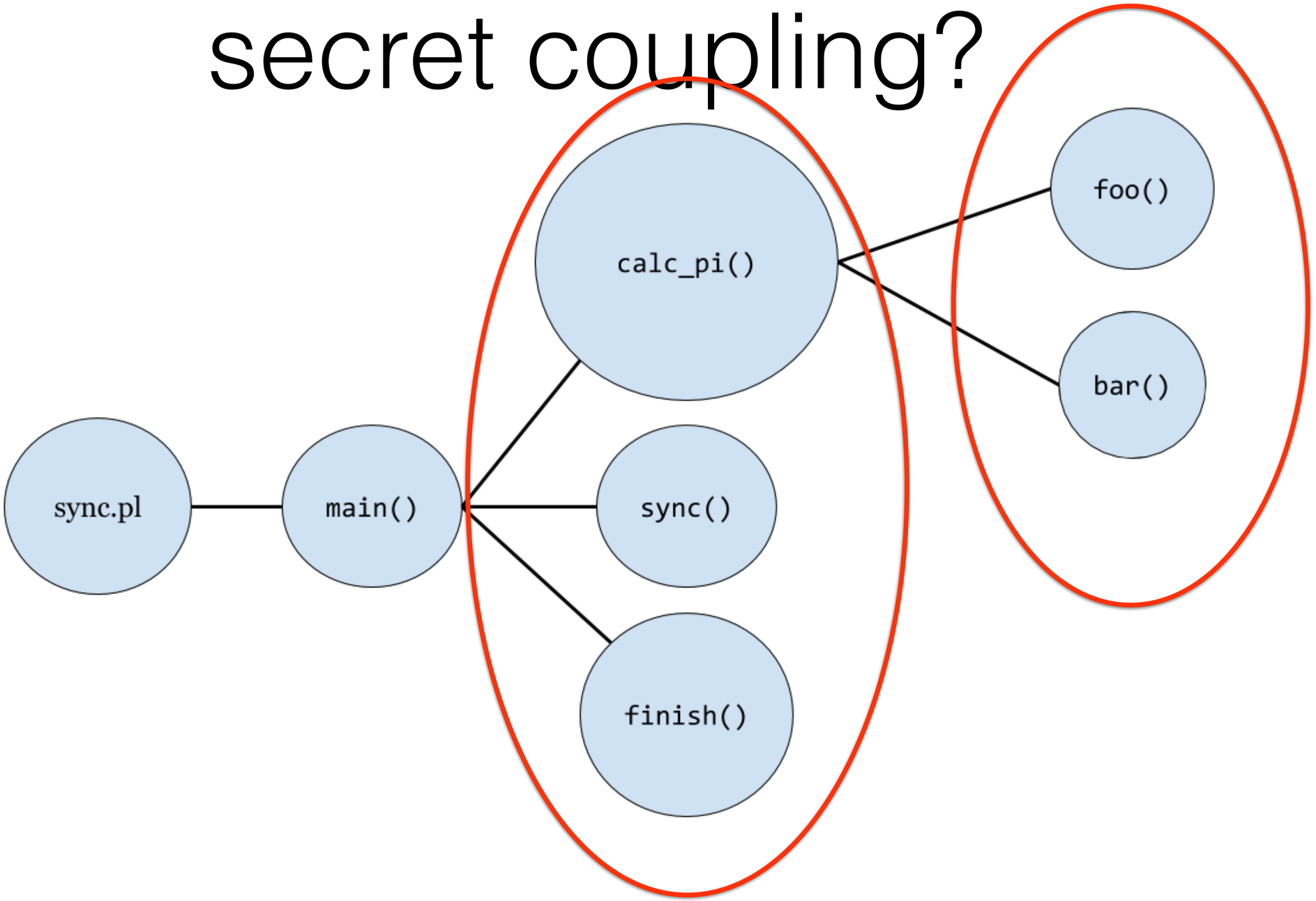

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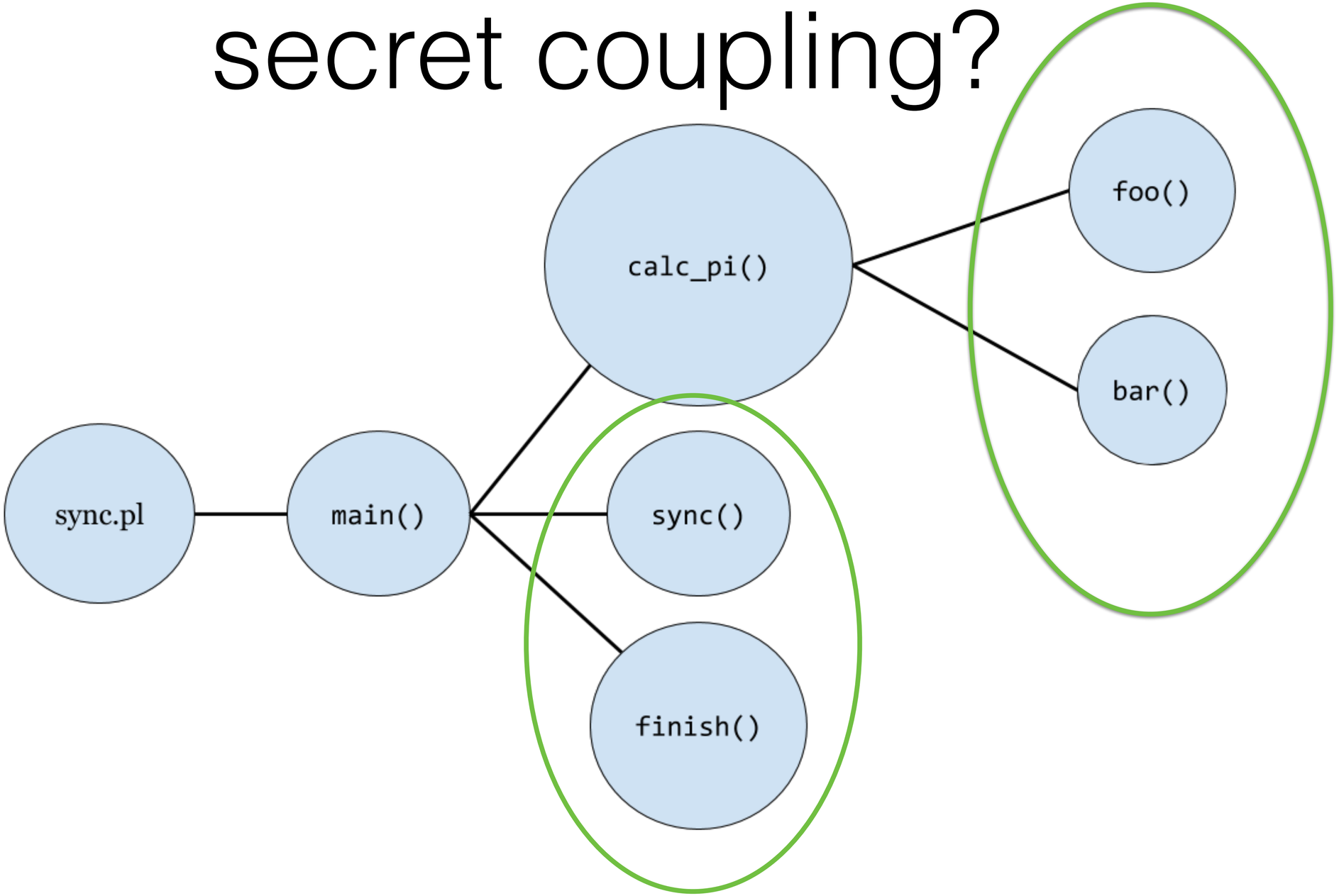
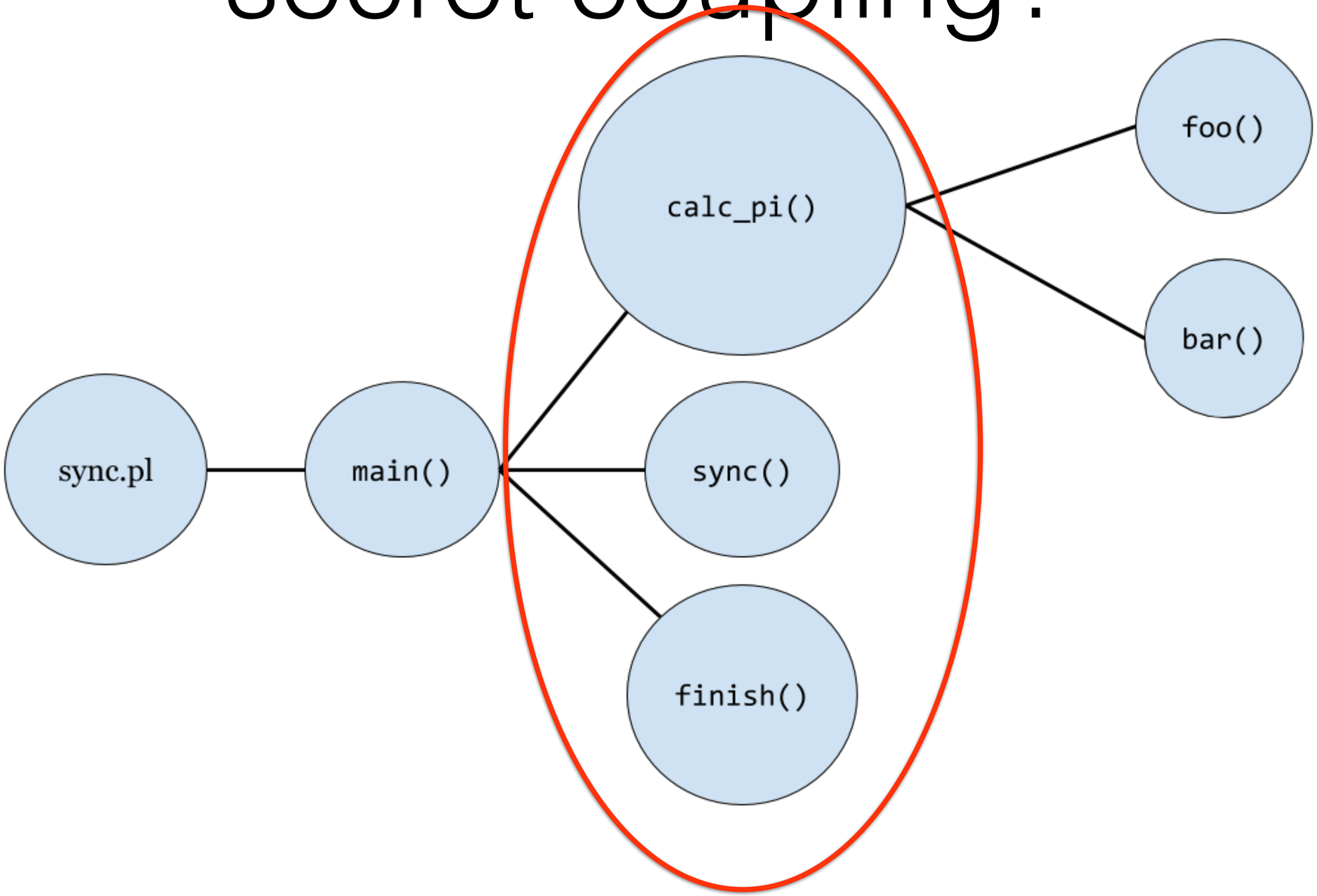
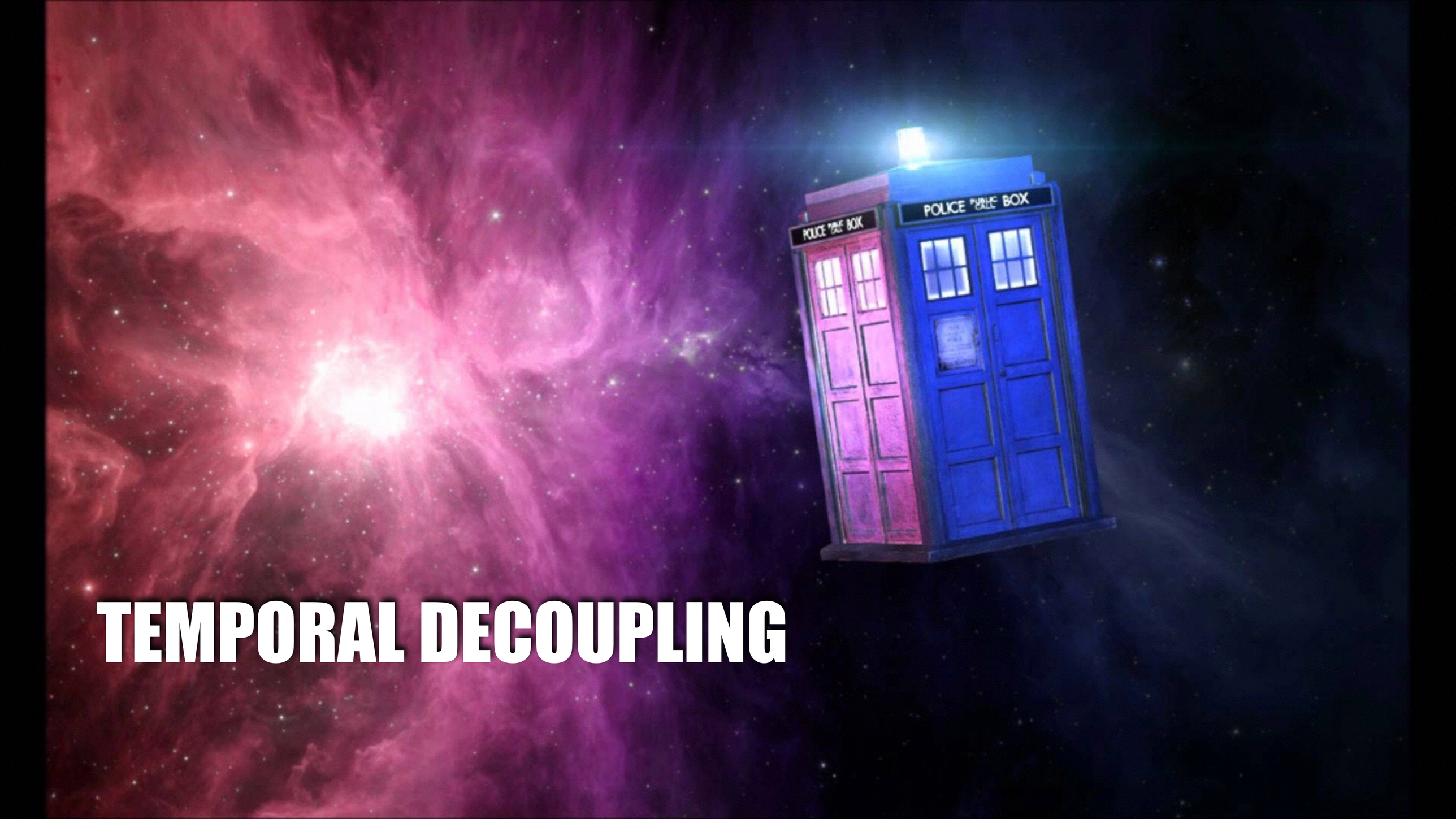


secret coupling?





TEMPORAL DECOUPLING

Temporal Decoupling - why?

Temporal Decoupling - why?

component simplicity

Temporal Decoupling - why?

component simplicity

enforce interface between components

Temporal Decoupling - why?

component simplicity

enforce interface between components

fault tolerance/reliability

Temporal Decoupling - how?

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sounds a lot like...concurrency

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"I don’t care what order it runs in"

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sounds a lot like...concurrency

"I don’t care what order it runs in"

concurrency + Perl 5 == event loops

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sounds a lot like...concurrency

"I don’t care what order it runs in"

concurrency + Perl 5 == event loops

POE, AnyEvent, Mojo::IOLoop, IO::Async, etc.

Temporal Decoupling - how?

sounds a lot like...concurrency

"I don’t care what order it runs in"

concurrency + Perl 5 == event loops

POE, AnyEvent, Mojo::IOLoop, IO::Async, etc.

let’s write one!

Overview

unified theory of (un)reliability

juggling raptors

mecha-concurrency

the power of power cycling

The Zen of Erlang

Perl 6

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Event Loop

Event Loop

```
while (1) {

}
```

Event Loop

```
while (1) {
  for my $sock ($select->can_read(1)) {









  }
  if (my @writable = $select->can_write(1)) {

  }
}
```

Event Loop

```
while (1) {
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Event Loop

```
while (1) {
  for my $sock ($select->can_read(1)) {









  }
  if (my @writable = $select->can_write(1)) {

  }
}
```

Event Loop

```
while (1) {
  for my $sock ($select->can_read(1)) {
  }
  if (my @writable = $select->can_write(1)) {
                                  for @writable;
  }
}
```

Event Loop

```
while (1) {
  for my $sock ($select->can_read(1)) {
  }
  if (my @writable = $select->can_write(1)) {
      $_->print("hi there!\n") for @writable;
  }
}
```

Event Loop

```
while (1) {
  for my $sock ($select->can_read(1)) {
  }
  if (my @writable = $select->can_write(1)) {
      $_->print("hi there!\n") for @writable;
  }
}
```

Event Loop

```
while (1) {
  for my $sock ($select->can_read(1)) {
      if ($sock == $listen) {


      } else {









      }
  }
  if (my @writable = $select->can_write(1)) {
      $_->print("hi there!\n") for @writable;
  }
}
```

Event Loop

```
while (1) {
  for my $sock ($select->can_read(1)) {
      if ($sock == $listen) {


      } else {









      }
  }
  if (my @writable = $select->can_write(1)) {
      $_->print("hi there!\n") for @writable;
  }
}
```

Event Loop

```
while (1) {
  for my $sock ($select->can_read(1)) {
      if ($sock == $listen) {
          my $new = $listen->accept;

      } else {









      }
  }
  if (my @writable = $select->can_write(1)) {
      $_->print("hi there!\n") for @writable;
  }
}
```

Event Loop

```
while (1) {
  for my $sock ($select->can_read(1)) {
      if ($sock == $listen) {
          my $new = $listen->accept;
          $select->add($new);
      } else {
      }
  }
  if (my @writable = $select->can_write(1)) {
      $_->print("hi there!\n") for @writable;
  }
}
```

Event Loop

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while (1) {
  for my $sock ($select->can_read(1)) {
      if ($sock == $listen) {
          my $new = $listen->accept;
          $select->add($new);
      } else {
          }
  }
  if (my @writable = $select->can_write(1)) {
      $_->print("hi there!\n") for @writable;
  }
}
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Event Loop

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while (1) {
  for my $sock ($select->can_read(1)) {
      if ($sock == $listen) {
          my $new = $listen->accept;
          $select->add($new);
      } else {
          if ($sock->sysread(                    )) {

          } else {

          }
      }
  }
  if (my @writable = $select->can_write(1)) {
      $_->print("hi there!\n") for @writable;
  }
}
```

Event Loop

```
while (1) {
  for my $sock ($select->can_read(1)) {
      if ($sock == $listen) {
          my $new = $listen->accept;
          $select->add($new);
      } else {
          if ($sock->sysread(my $buffer, 4096, 0)) {

          } else {

          }
      }
  }
  if (my @writable = $select->can_write(1)) {
      $_->print("hi there!\n") for @writable;
  }
}
```

Event Loop

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while (1) {
  for my $sock ($select->can_read(1)) {
      if ($sock == $listen) {
          my $new = $listen->accept;
          $select->add($new);
      } else {
          if ($sock->sysread(my $buffer, 4096, 0)) {
              printf "%s data: %s", $sock->fileno, $buffer;
          } else {

          }
      }
  }
  if (my @writable = $select->can_write(1)) {
      $_->print("hi there!\n") for @writable;
  }
}
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Event Loop

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while (1) {
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      if ($sock == $listen) {
          my $new = $listen->accept;
          $select->add($new);
      } else {
          if ($sock->sysread(my $buffer, 4096, 0)) {
              printf "%s data: %s", $sock->fileno, $buffer;
          } else {

          }
      }
  }
  if (my @writable = $select->can_write(1)) {
      $_->print("hi there!\n") for @writable;
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```

Event Loop

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while (1) {
  for my $sock ($select->can_read(1)) {
      if ($sock == $listen) {
          my $new = $listen->accept;
          $select->add($new);
      } else {
          if ($sock->sysread(my $buffer, 4096, 0)) {
              printf "%s data: %s", $sock->fileno, $buffer;
          } else {
              $select->remove($sock) and $sock->close;
          }
      }
  }
  if (my @writable = $select->can_write(1)) {
      $_->print("hi there!\n") for @writable;
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Event Loop

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          $select->add($new);
      } else {
          if ($sock->sysread(my $buffer, 4096, 0)) {
              printf "%s data: %s", $sock->fileno, $buffer;
          } else {
              $select->remove($sock) and $sock->close;
          }
      }
  }
  if (my @writable = $select->can_write(1)) {
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      if ($sock == $listen) {
          my $new = $listen->accept;
          $select->add($new);
      } else {
          if ($sock->sysread(my $buffer, 4096, 0)) {
              # this would be an 'on_read' callback
          } else {
              $select->remove($sock) and $sock->close;
          }
      }
  }
  if (my @writable = $select->can_write(1)) {
      $_->print("hi there!\n") for @writable;
  }
}
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Event Loop

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          $select->add($new);
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          } else {
              # this would be an 'on_close' callback
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Event Loop

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          $select->add($new);
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          if ($sock->sysread(my $buffer, 4096, 0)) {
              # this would be an 'on_read' callback
          } else {
              # this would be an 'on_close' callback
          }
      }
  }
  if (my @writable = $select->can_write(1)) {
      # on_writable callback
  }
}
```

Event Loop

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while (1) {
  for my $sock ($select->can_read(1)) {
      if ($sock == $listen) {
          my $new = $listen->accept;
          $select->add($new);
      } else {
          if ($sock->sysread(my $buffer, 4096, 0)) {
              # this would be an 'on_read' callback
          } else {
              # this would be an 'on_close' callback
          }
      }
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  if (my @writable = $select->can_write(1)) {
      # on_writable callback
  }
}
```

Event Loop

```
while (1) {
  for my $sock ($select->can_read(1)) {
      if ($sock == $listen) {
          my $new = $listen->accept;
          $select->add($new);
      } else {
          if ($sock->sysread(my $buffer, 4096, 0)) {
              sleep(5);
          } else {
              # this would be an 'on_close' callback
          }
      }
  }
  if (my @writable = $select->can_write(1)) {
      # on_writable callback
  }
}
```

Event Loop

```
while (1) {
  for my $sock ($select->can_read(1)) {
      if ($sock == $listen) {
          my $new = $listen->accept;
          $select->add($new);
      } else {
          if ($sock->sysread(my $buffer, 4096, 0)) {
              sleep(5); # or DBI fetch
          } else {
              # this would be an 'on_close' callback
          }
      }
  }
  if (my @writable = $select->can_write(1)) {
      # on_writable callback
  }
}
```

Event Loop … Poll

Event Loop … Poll

simpler

Event Loop … Poll

simpler

faster

Event Loop … Poll

simpler

faster

more reliable

Event Loop … Poll

simpler

faster

more reliable

more scalable

Event Loops & Decoupling

Event Loops & Decoupling

minimal decoupling

Event Loops & Decoupling

minimal decoupling

a leaky abstraction

Event Loops & Decoupling

minimal decoupling

a leaky abstraction

even with nicer APIs (promises, futures, etc.)

Event Loops & Decoupling

minimal decoupling

a leaky abstraction

even with nicer APIs (promises, futures, etc.)

why?

Overview

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a shrewdness of schedulers

cooperative and preemptive

a shrewdness of schedulers

cooperative

a shrewdness of schedulers

cooperative

event loops

a shrewdness of schedulers

cooperative

event loops

coroutines - Coro, Python generators, Lua

a shrewdness of schedulers

cooperative

event loops

coroutines - Coro, Python generators, Lua

programmer must explicitly 'yield'

a shrewdness of schedulers

cooperative

event loops

coroutines - Coro, Python generators, Lua

programmer must explicitly 'yield'

(call a callback, `->promise` a promise, `->done` a future)

a shrewdness of schedulers

cooperative

event loops

coroutines - Coro, Python generators, Lua

programmer must explicitly 'yield'

(call a callback, `->promise` a promise, `->done` a future)

bad actor can wreck the system

a shrewdness of schedulers

preemptive

a shrewdness of schedulers

preemptive

operating system processes

a shrewdness of schedulers

preemptive

operating system processes

(except Windows before 95, Mac before OS X)

a shrewdness of schedulers

preemptive

operating system processes

(except Windows before 95, Mac before OS X)

threads

a shrewdness of schedulers

preemptive

operating system processes

(except Windows before 95, Mac before OS X)

threads

user code has no say in the matter

a shrewdness of schedulers

preemptive

operating system processes

(except Windows before 95, Mac before OS X)

threads

user code has no say in the matter

scheduler is the boss

a shrewdness of schedulers

cooperative vs. preemptive

a shrewdness of schedulers

cooperative

malloc/free

vs.

preemptive

a shrewdness of schedulers

cooperative

malloc/free

vs.

preemptive

garbage collection

a shrewdness of schedulers

cooperative

malloc/free

vs.

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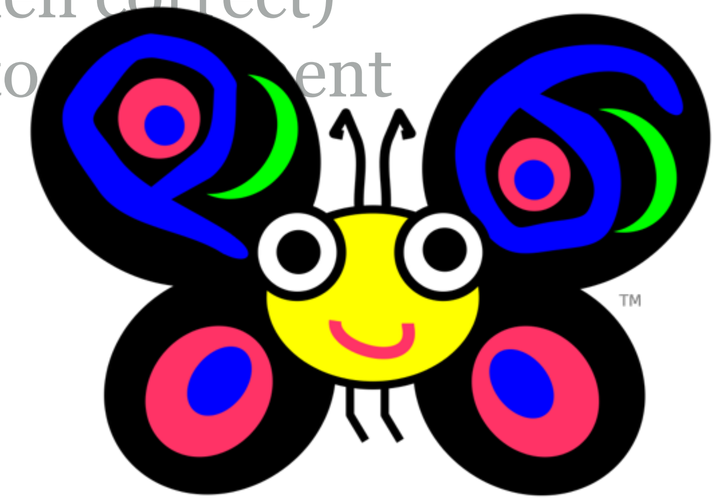
a shrewdness of schedulers

cooperative vs. preemptive

malloc/free vs. garbage collection

- fast (when correct)
- simple to [illegible]ent
- fragile



- slower
- complex implementation
- resilient to programmer error

great! thread me up!

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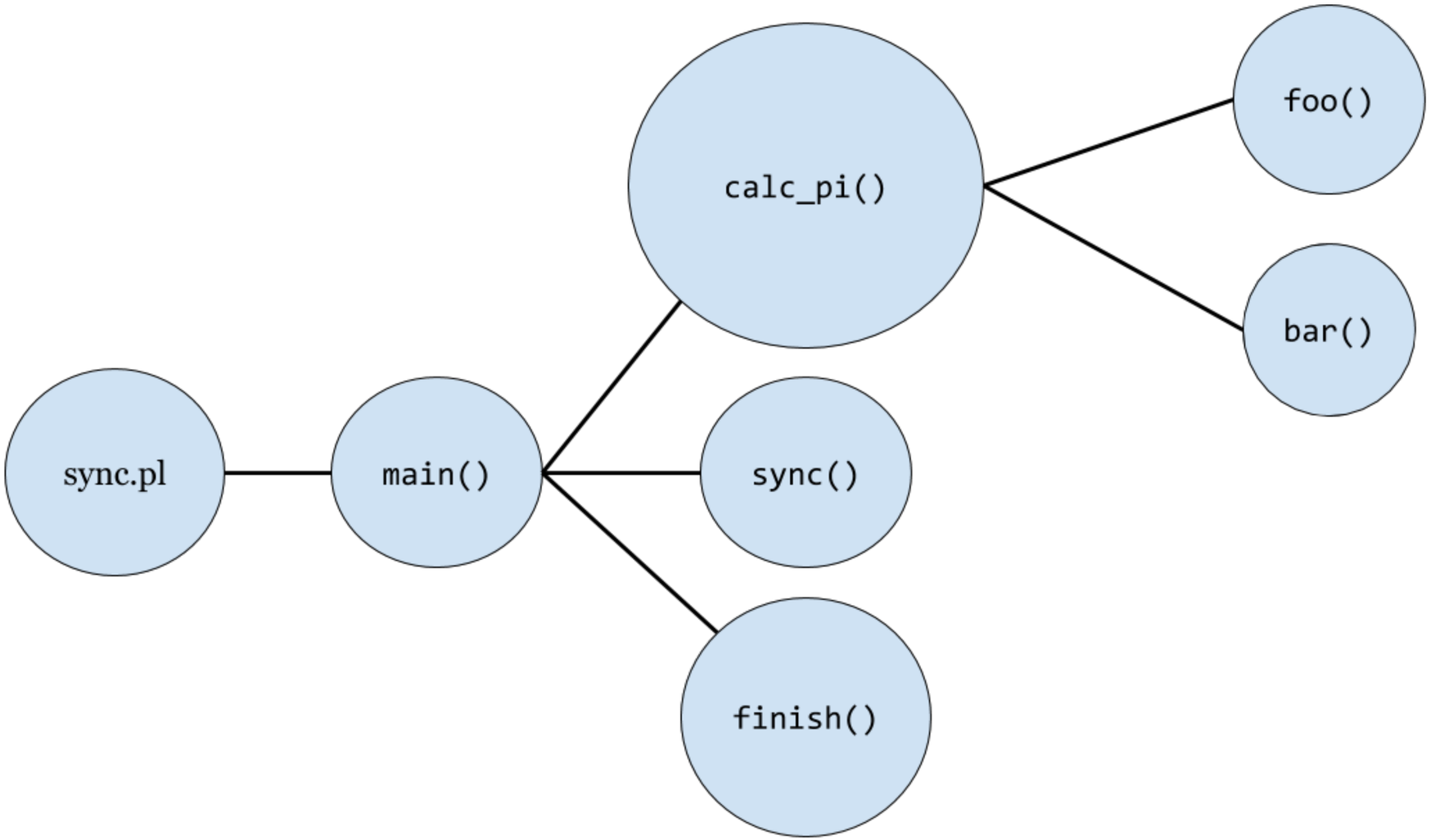

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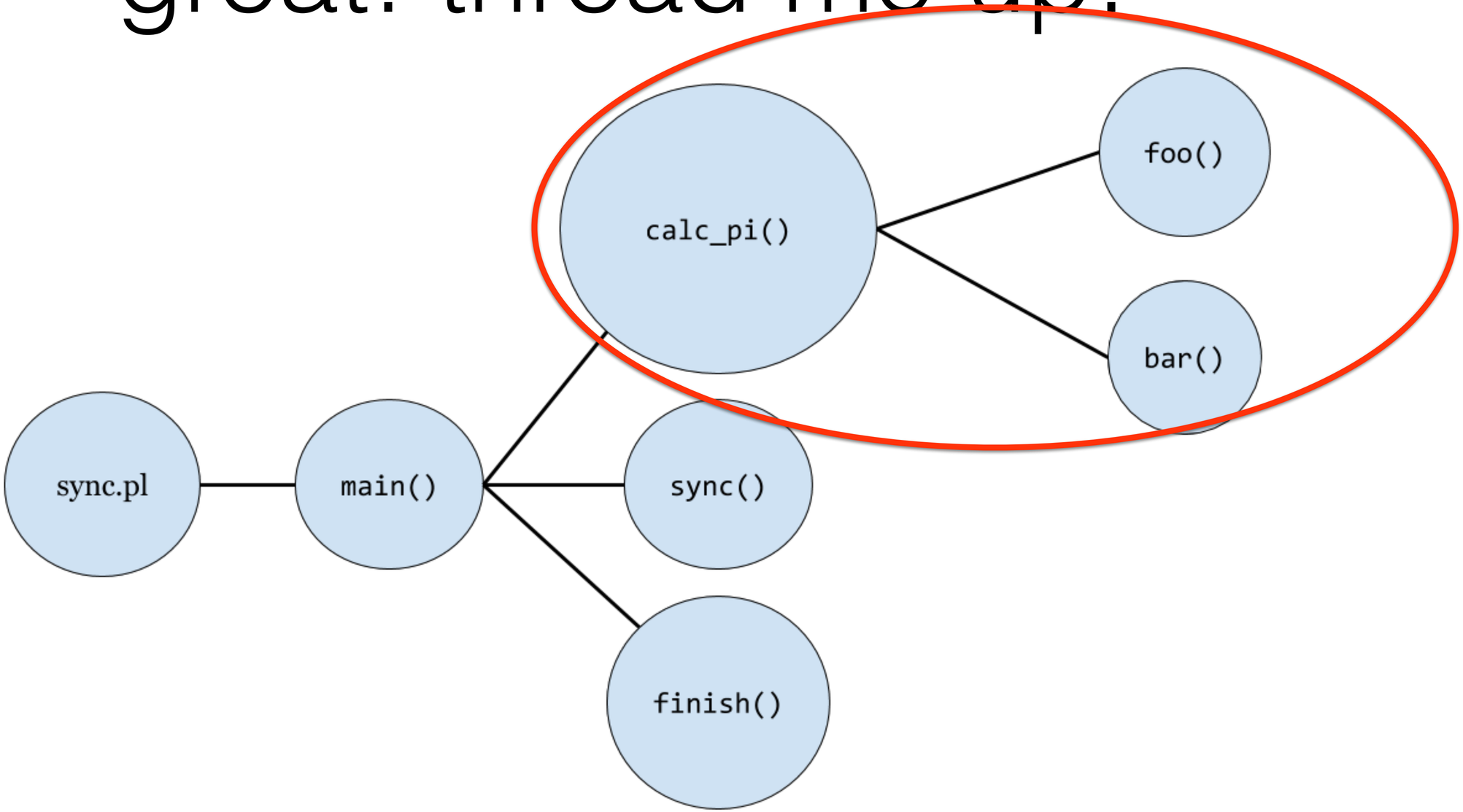

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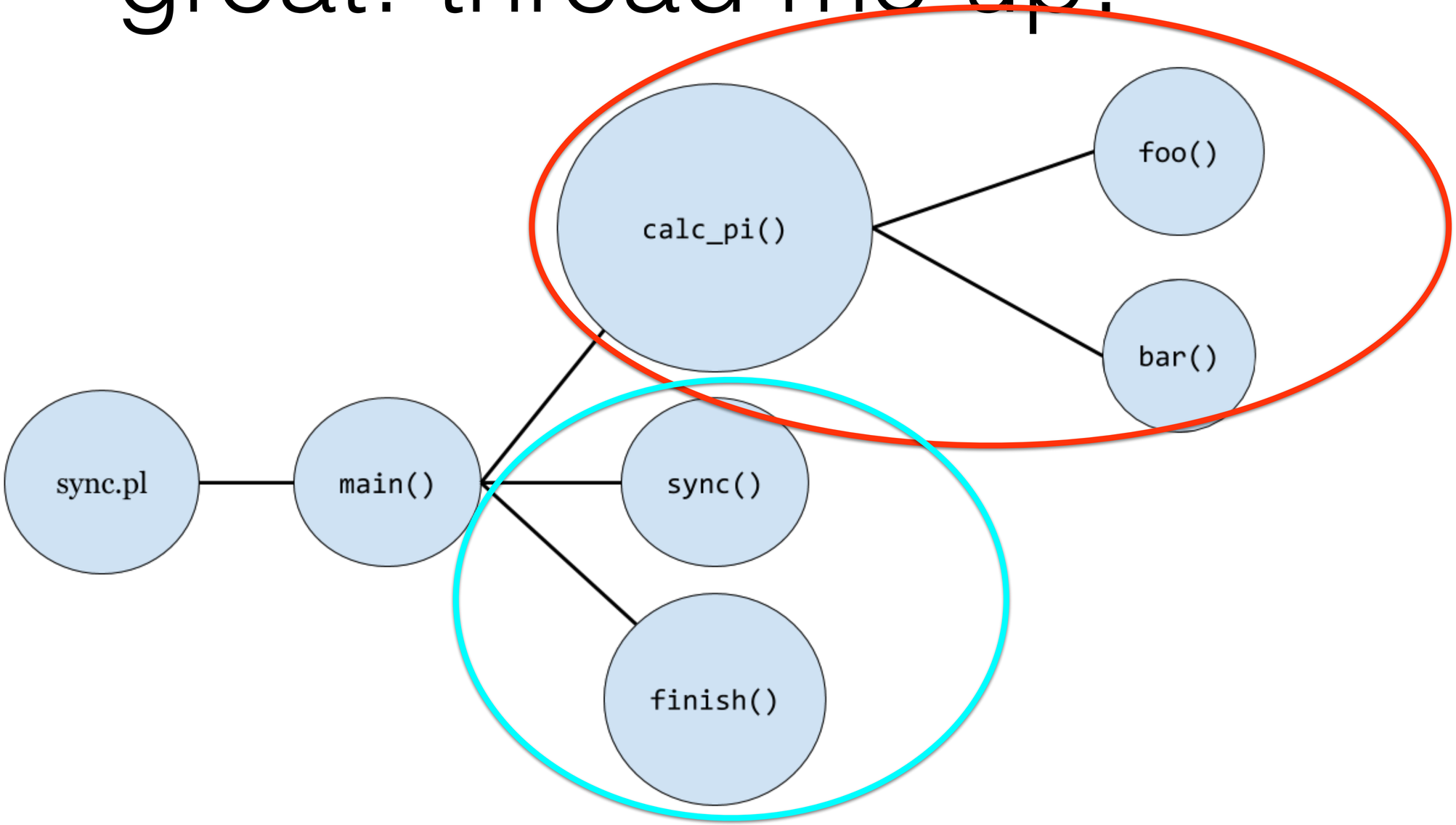

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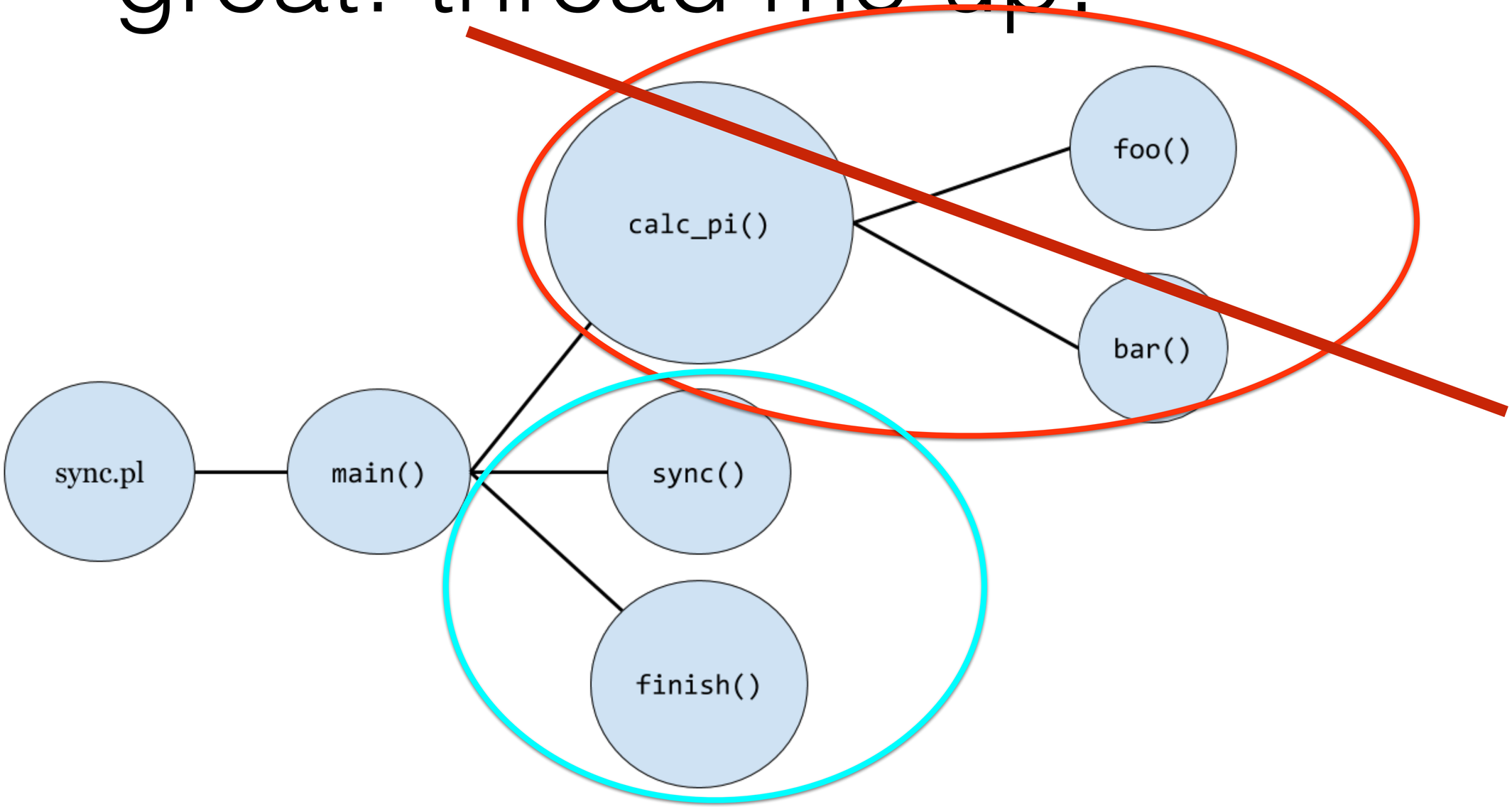


THREADS FOR RELIABILITY?
YOUR OPTIMISM IS ADORABLE

The trouble with threads

The trouble with threads

goal: 'temporally decouple' parts of our program

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for component simplicity

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for enforcement of interfaces

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for component simplicity

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for reliability

The trouble with threads: limits

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/proc/sys/kernel/threads-max (since Linux 2.3.11)
       This file specifies the system-wide limit on the number of
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The trouble with threads: limits

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       This file specifies the system-wide limit on the number of
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```

```
$ cat /proc/sys/kernel/threads-max
7744
```

"you are allowed to have 7744 objects, and no more!"

The trouble with threads: coupling

do they help?

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simplicity? locks, atomics, thread-safe queues…

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interfaces? same memory space

The trouble with threads: coupling

do they help?

simplicity? locks, atomics, thread-safe queues…

interfaces? same memory space

reliability? unsafe termination/restart

Termination/restart?

Overview

unified theory of (un)reliability - ✓

juggling raptors - ✓

mecha-concurrency

the power of power cycling

The Zen of Erlang

Perl 6

Overview

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Turning it off and back on again

the magic words in software reliability

Why is restarting *so good?*

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some bugs happen every time some code runs (*bohrbugs*)

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(but you should have caught it in dev, it happens every time!)

heisenbugs happen almost never, so restarting does the trick!

(and 'almost never' at 10000 requests/second -> every minute)

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reliable systems do not need to run error-free!

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can we use this?

Why is restarting *so good?*

reliable systems do not need to run error-free!

can we use this?

(we do, all the time: operating systems)

Operating systems are the bomb

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preemptively scheduled no-shared-state isolated safe-to-kill safe-to-restart units of concurrency

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tree of reliability: init or supervisord above things that do actual work (uwsgi, starman, etc.)

Operating systems are the bomb

preemptively scheduled no-shared-state isolated safe-to-kill safe-to-restart units of concurrency

(aka "processes")

tree of reliability: init or supervisord above things that do actual work (uwsgi, starman, etc.)

it’s ok if the web worker crashes, less so if init goes down

Operating systems are the bomb

wouldn’t it be nice to use this at a finer granularity? like a single function?

Overview

unified theory of (un)reliability - ✓

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Overview

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The Zen of Erlang

Perl 6

Erlang (the blurb)

"... a general-purpose, concurrent, functional programming language"

Erlang (the hype)

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(probably) runs your telephone!

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many nines!

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millions of sockets on a single system!

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built-in cross-server coordination!

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many nines!

millions of sockets on a single system!

built-in cross-server coordination!

as mature as Perl!

Erlang (the insight)

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a hierarchy of coupled-ness
(from most to least)

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a hierarchy of coupled-ness
(from most to least)

lines of code

Erlang (the insight)

a hierarchy of coupled-ness
(from most to least)

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functions/classes

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lines of code
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threads

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lines of code
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(true) concurrency and reliability are two sides of the same coin.

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operating systems get this.

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Erlang takes this

Erlang (the insight)

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... and applies it here

Erlang takes this

Erlang (the OS)

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"processes"

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'green processes' - not OS processes!

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preemptively scheduled

Erlang (the OS)

"processes"

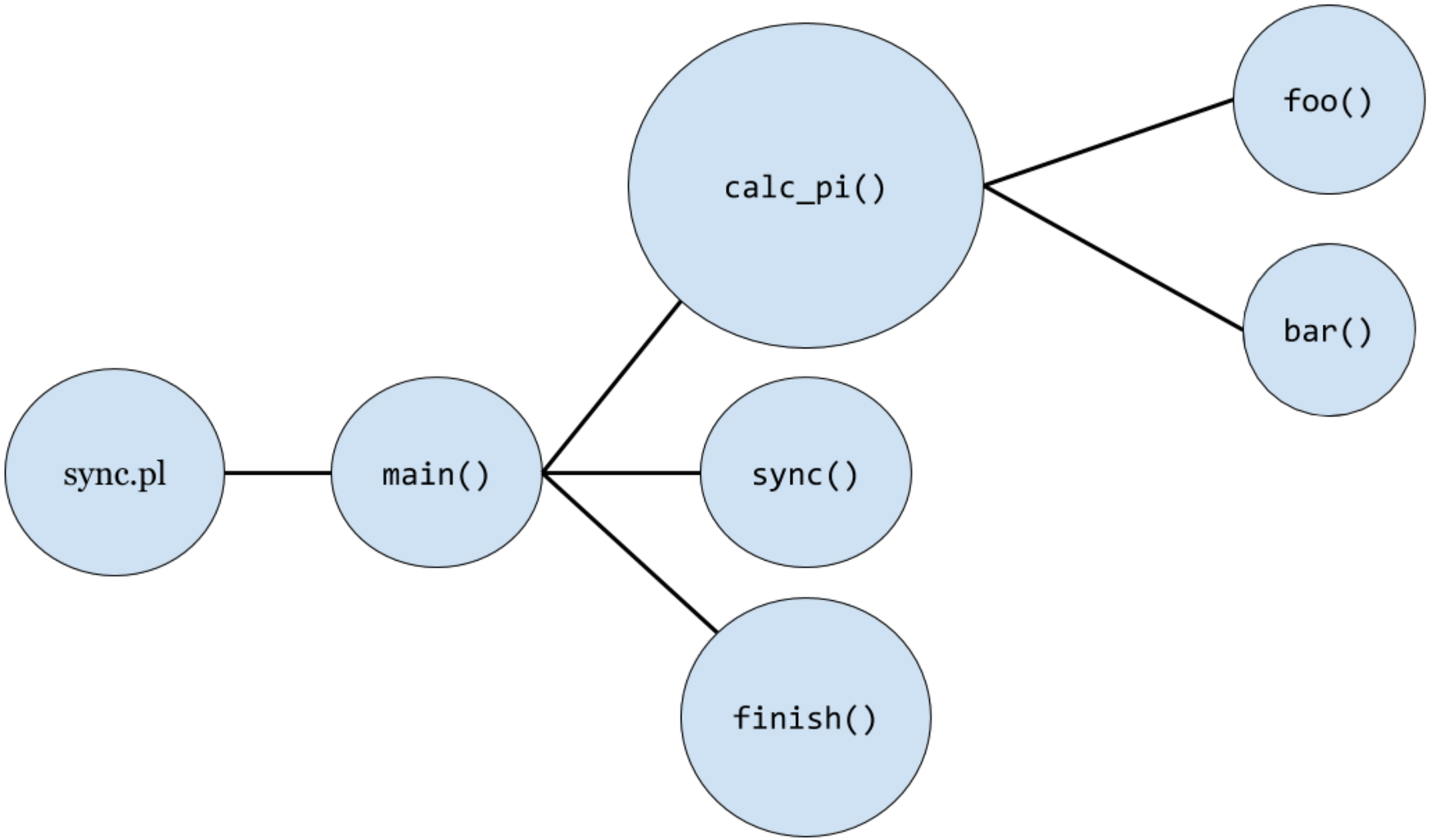
'green processes' - not OS processes!

isolated memory

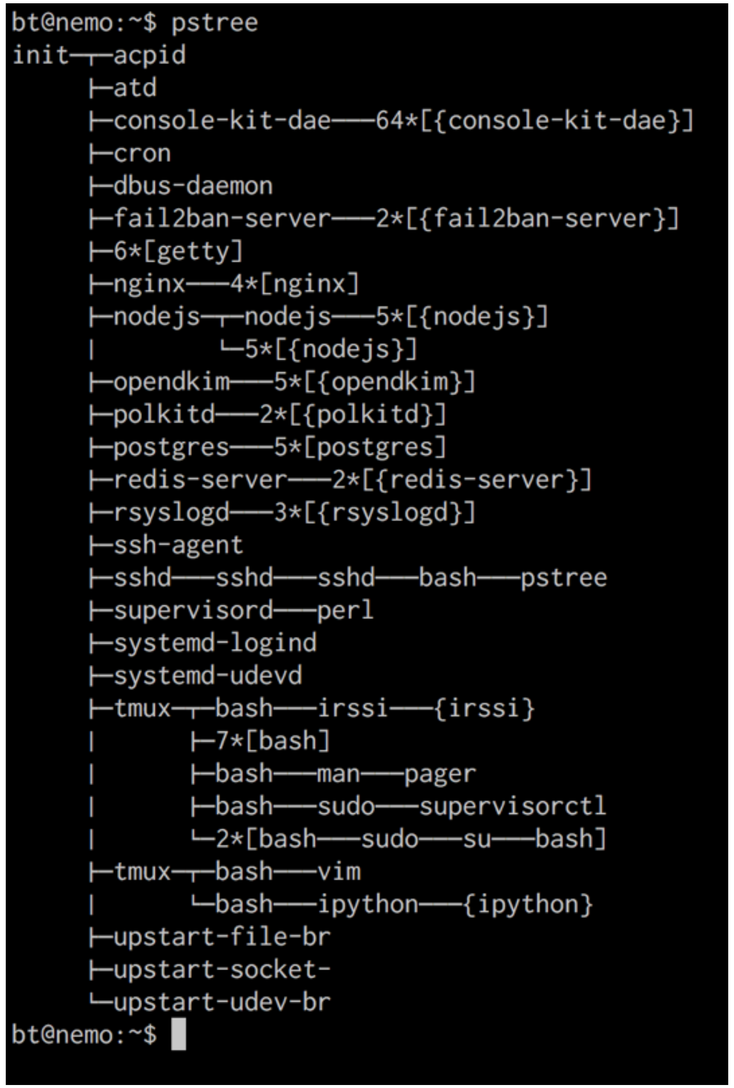
preemptively scheduled

safe to kill, safe to restart

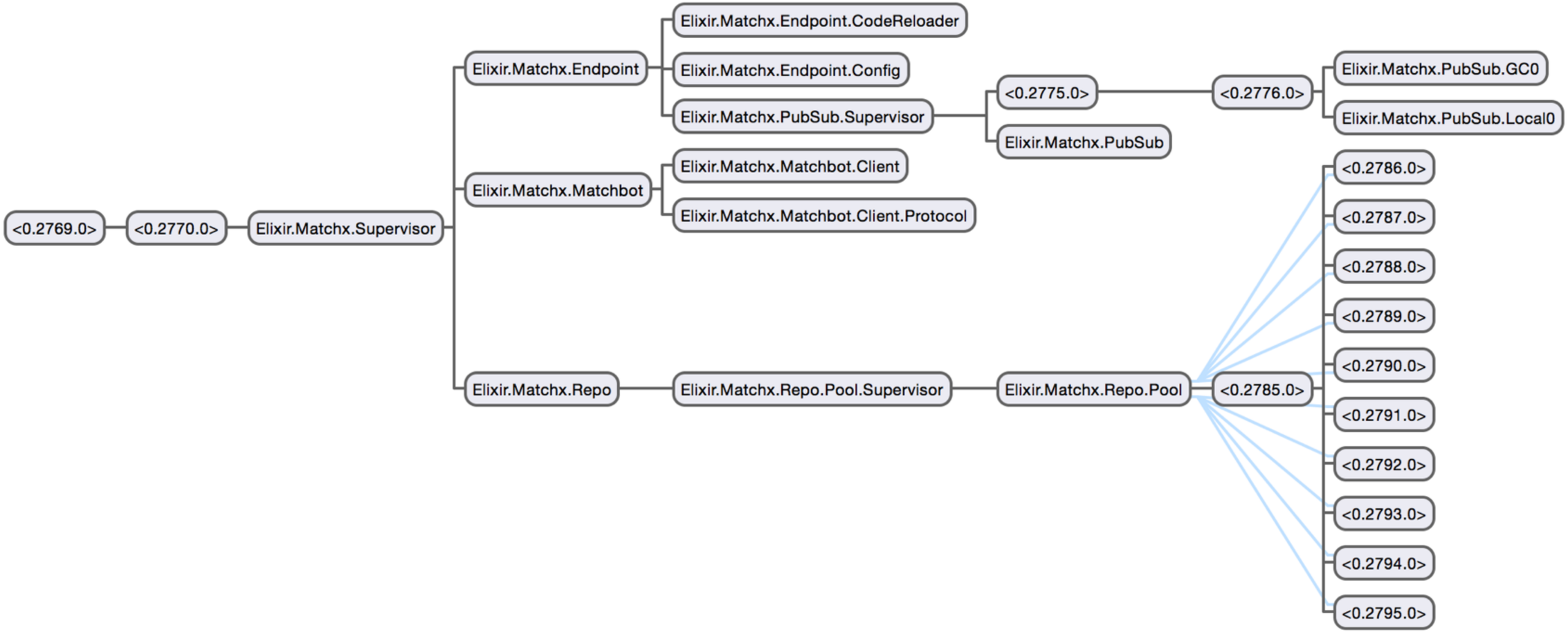
program structure



program structure



program structure



"let it crash"

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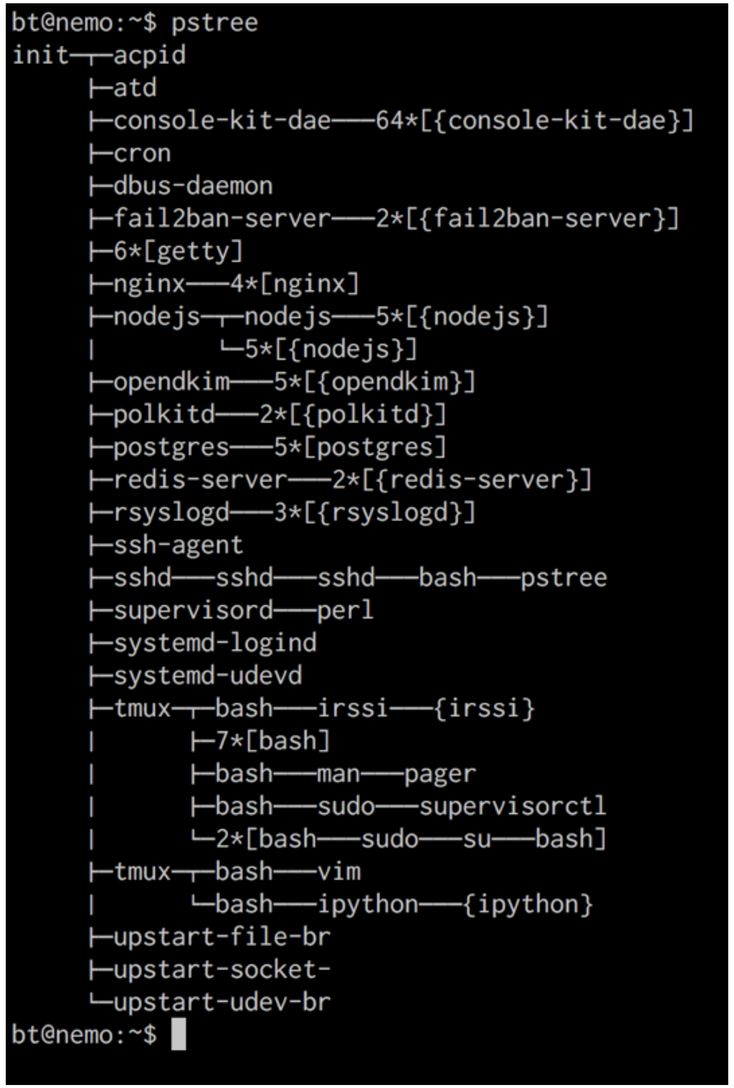
bt@nemo:~$ pstree
init─┬─acpid
├─atd
├─console-kit-dae───64*[{console-kit-dae}]
├─cron
├─dbus-daemon
├─fail2ban-server───2*[{fail2ban-server}]
├─6*[getty]
├─nginx───4*[nginx]
├─nodejs─┬─nodejs───5*[{nodejs}]
│ └─5*[{nodejs}]
├─opendkim───5*[{opendkim}]
├─polkitd───2*[{polkitd}]
├─postgres───5*[postgres]
├─redis-server───2*[{redis-server}]
├─rsyslogd───3*[{rsyslogd}]
├─ssh-agent
├─sshd───sshd───sshd───bash───pstree
├─supervisord───perl
├─systemd-logind
├─systemd-udevd
├─tmux─┬─bash───irssi───{irssi}
│ ├─7*[bash]
│ ├─bash───man───pager
│ ├─bash───sudo───supervisorctl
│ └─2*[bash───sudo───su───bash]
├─tmux─┬─bash───vim
│ └─bash───ipython───{ipython}
├─upstart-file-br
├─upstart-socket-
└─upstart-udev-br
bt@nemo:~$

"let it crash"

sshd

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init

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init

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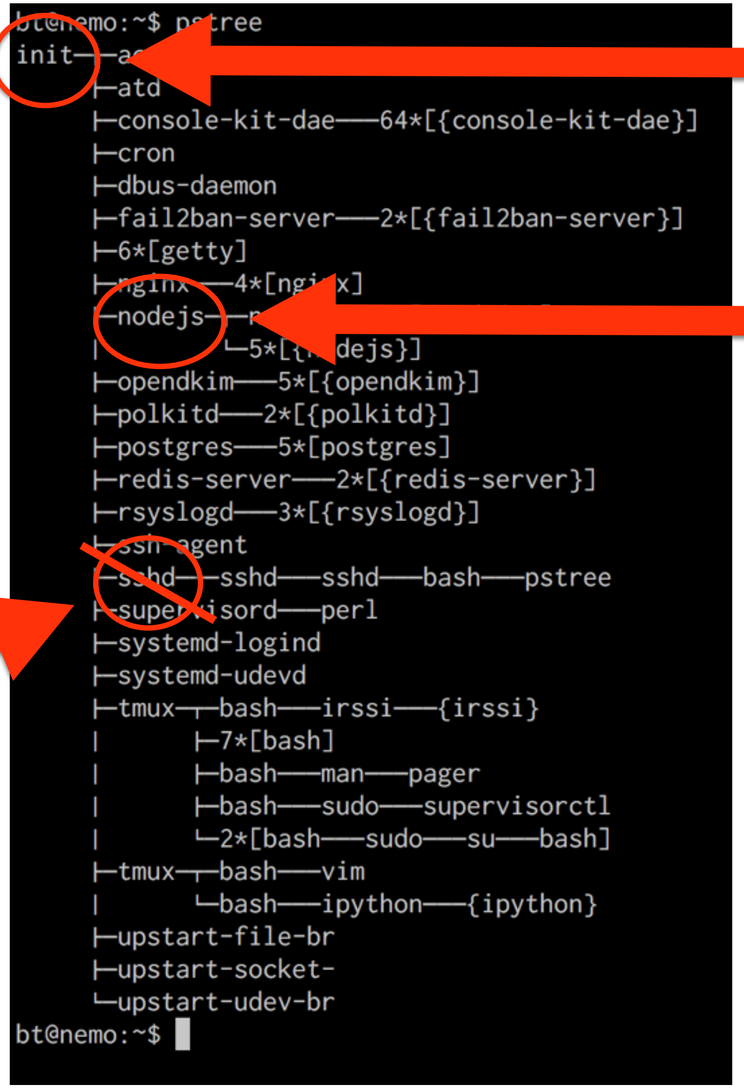
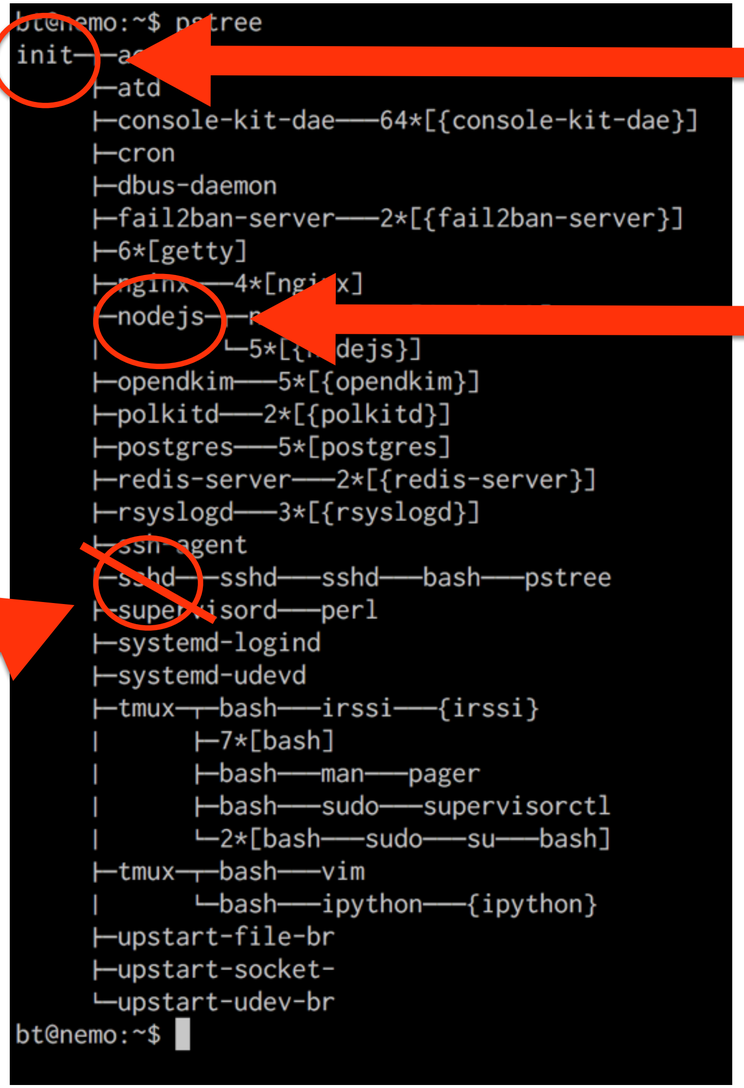


init

node.js

sshd

"let it crash"



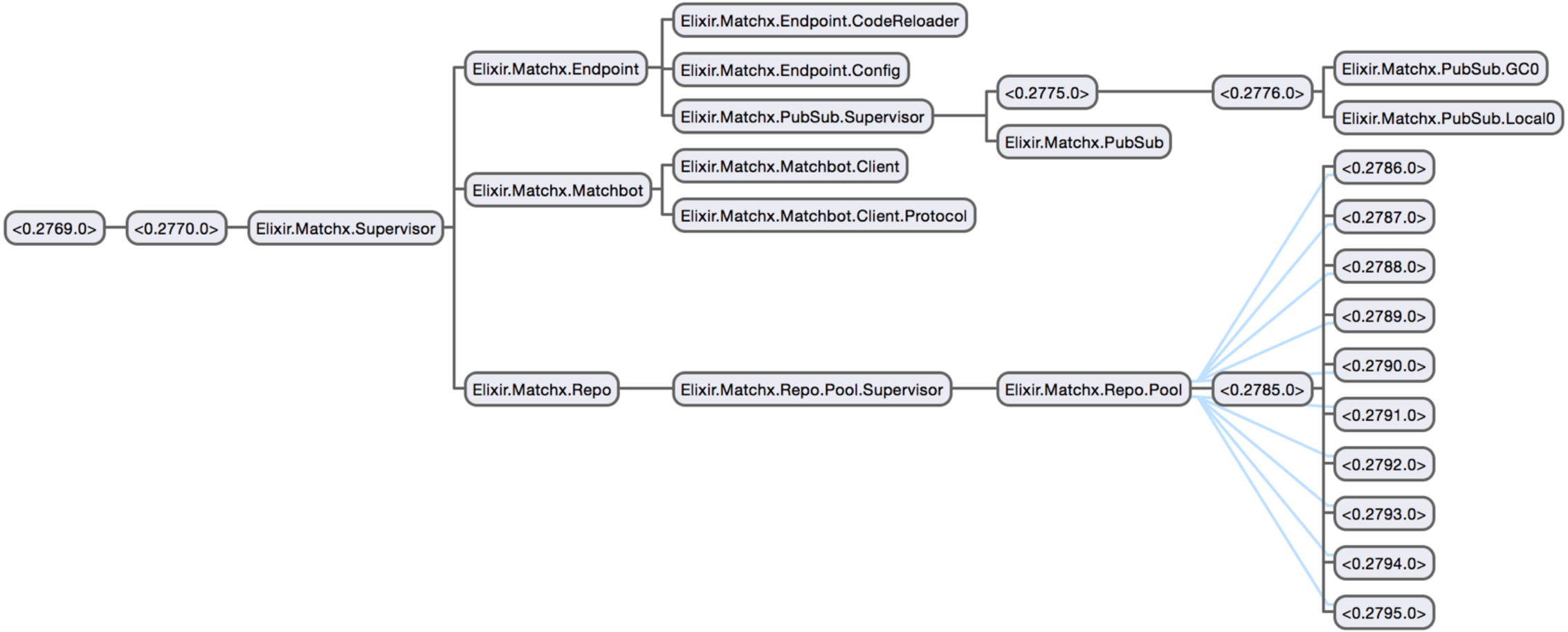
`sshd`

`init`

`node.js`

… completely ignorant of sshd's troubles

"let it crash"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Elixir.Matchx.PubSub.Supervisor
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Elixir.Matchx.Matchbot.Client
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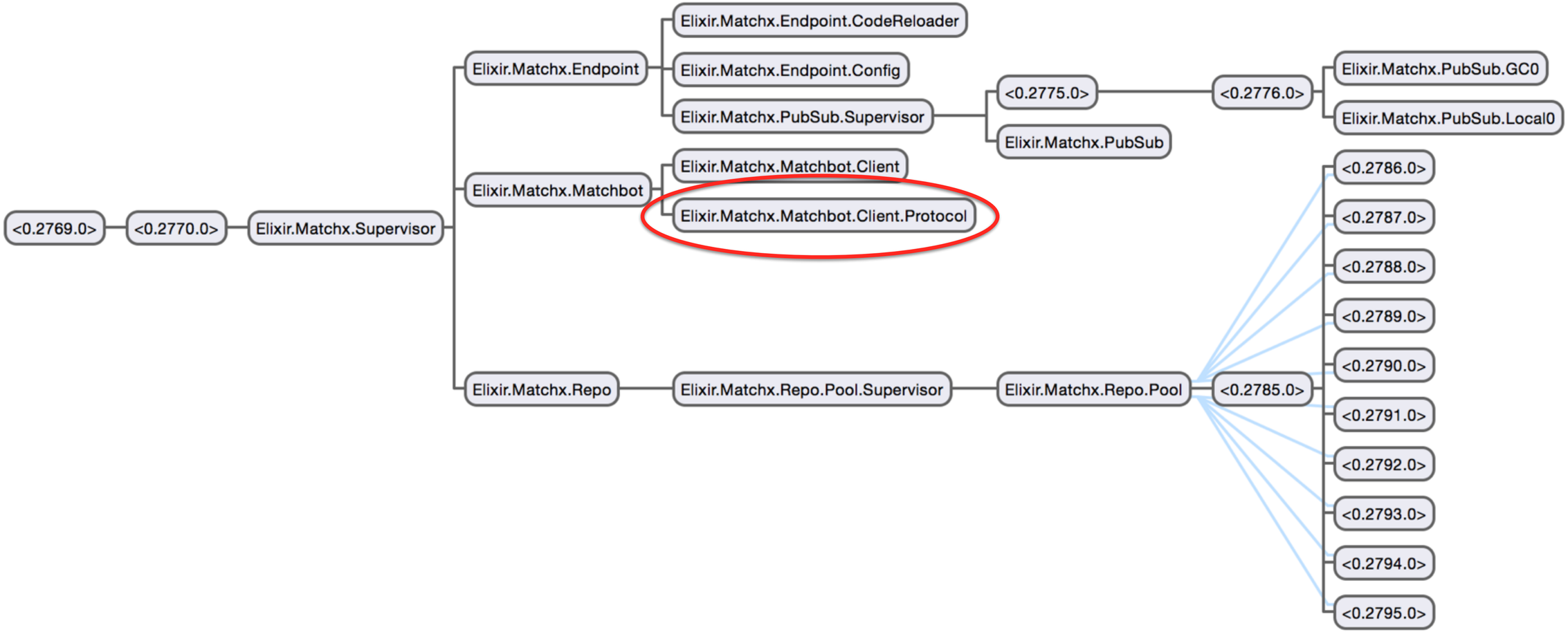
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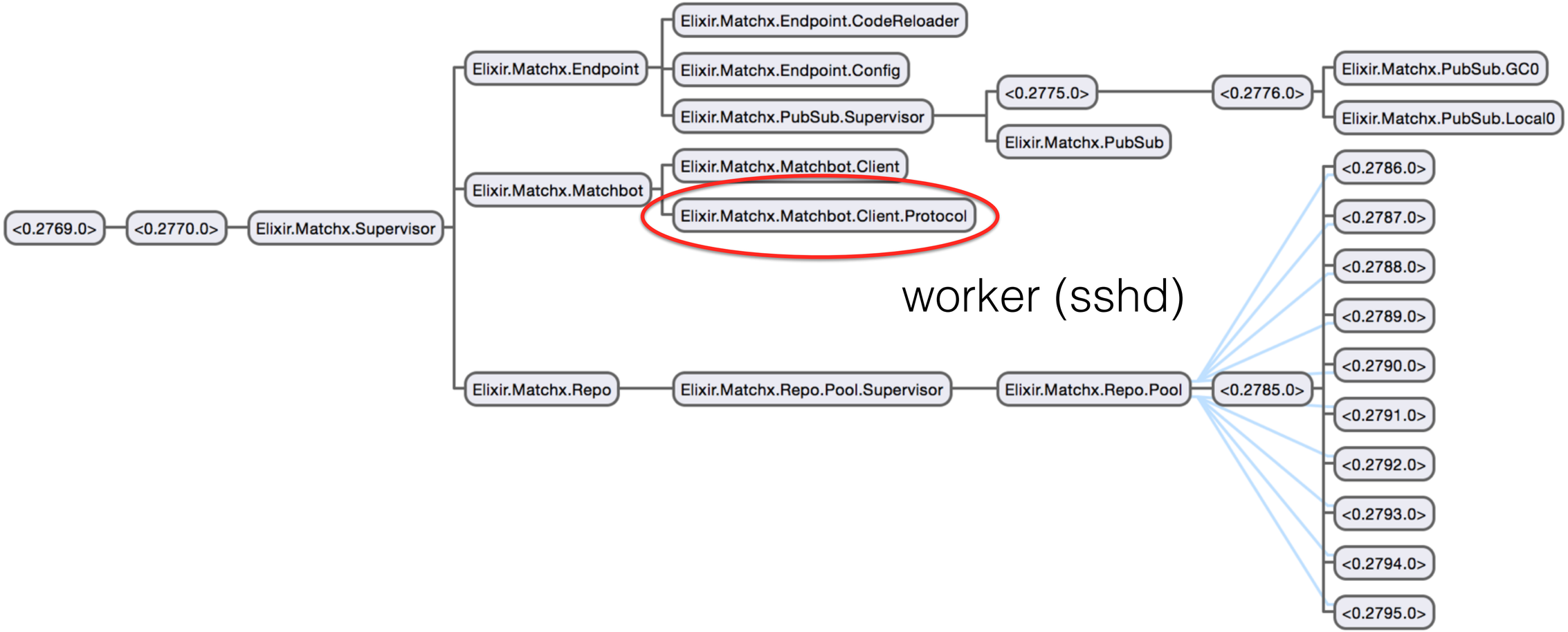
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worker (sshd)
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Elixir.Matchx.Repo.Pool
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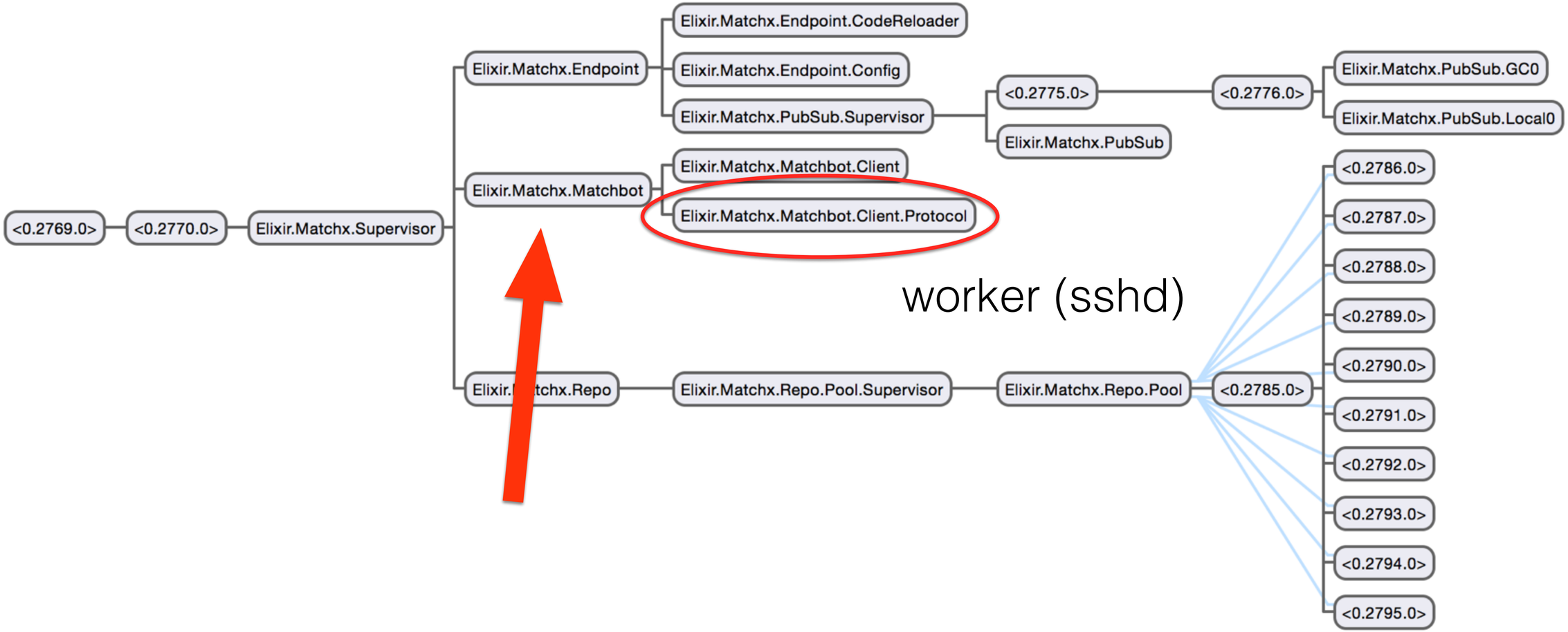
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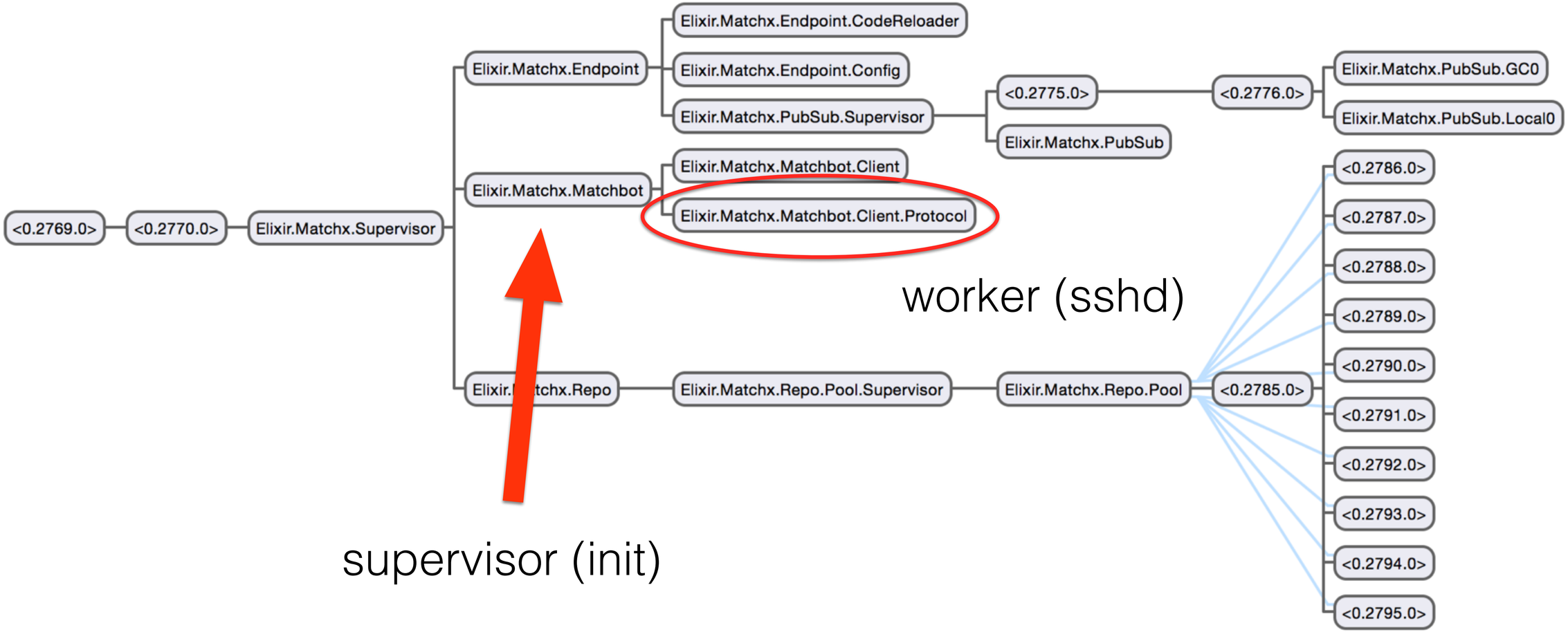
"let it crash"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Elixir.Matchx.Repo
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supervisor (init)

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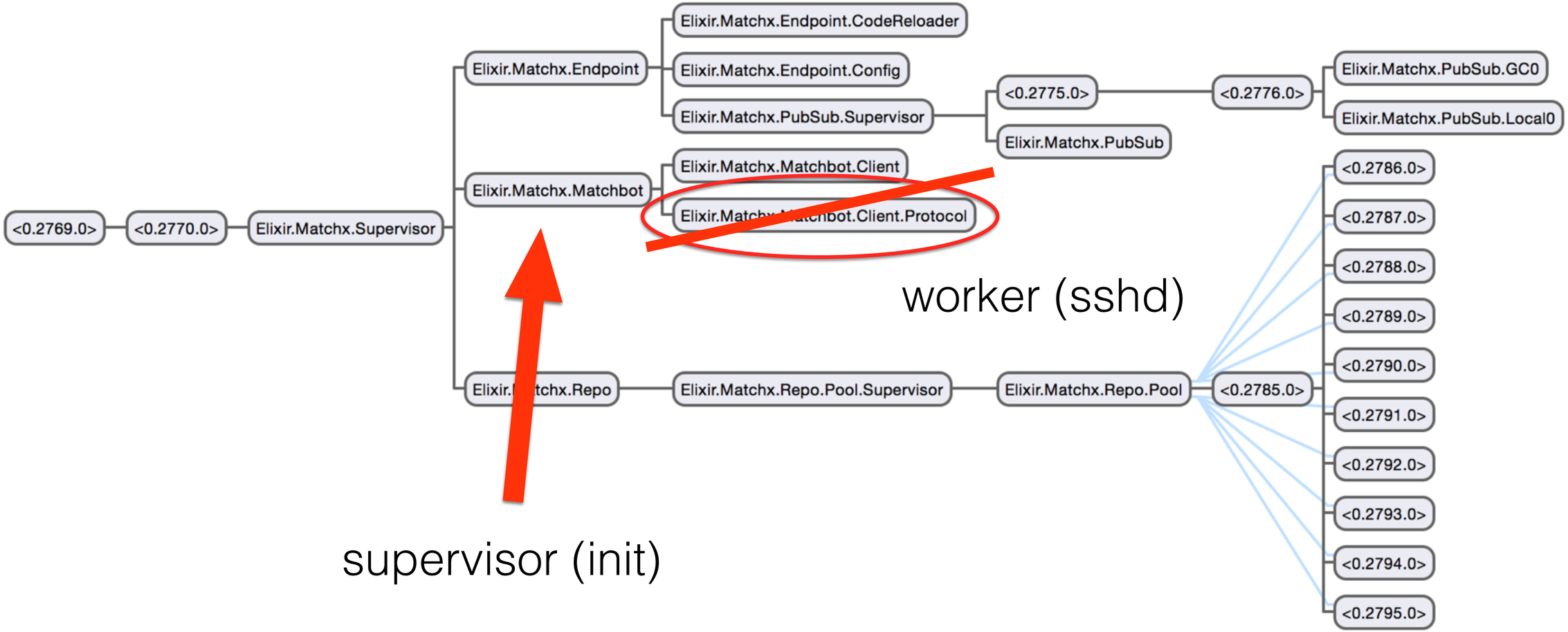
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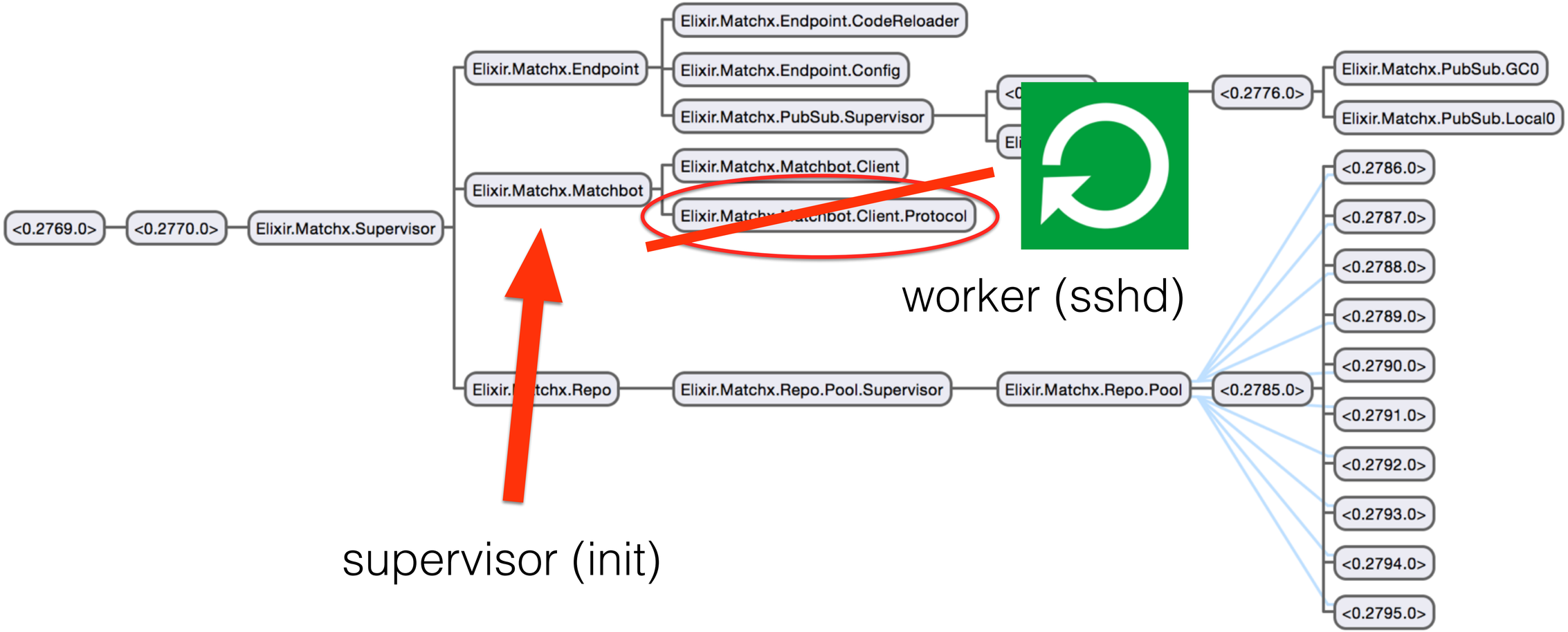
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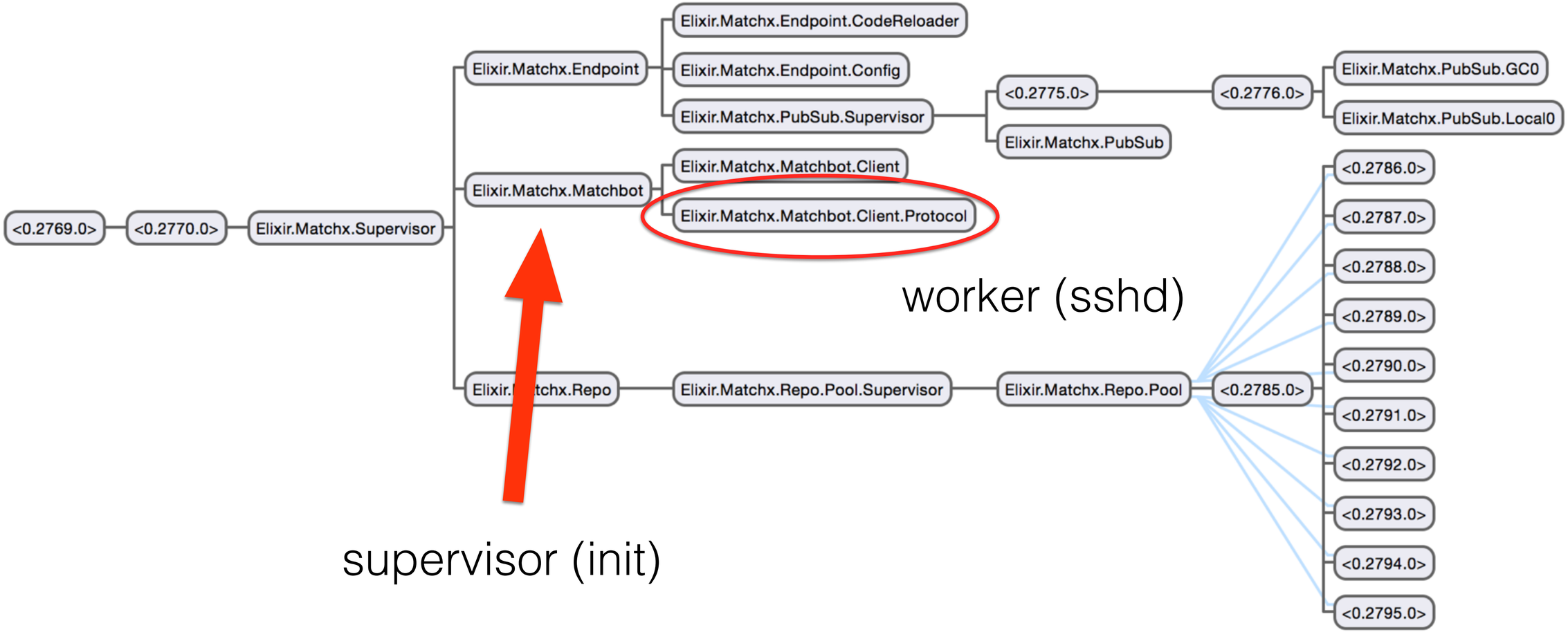
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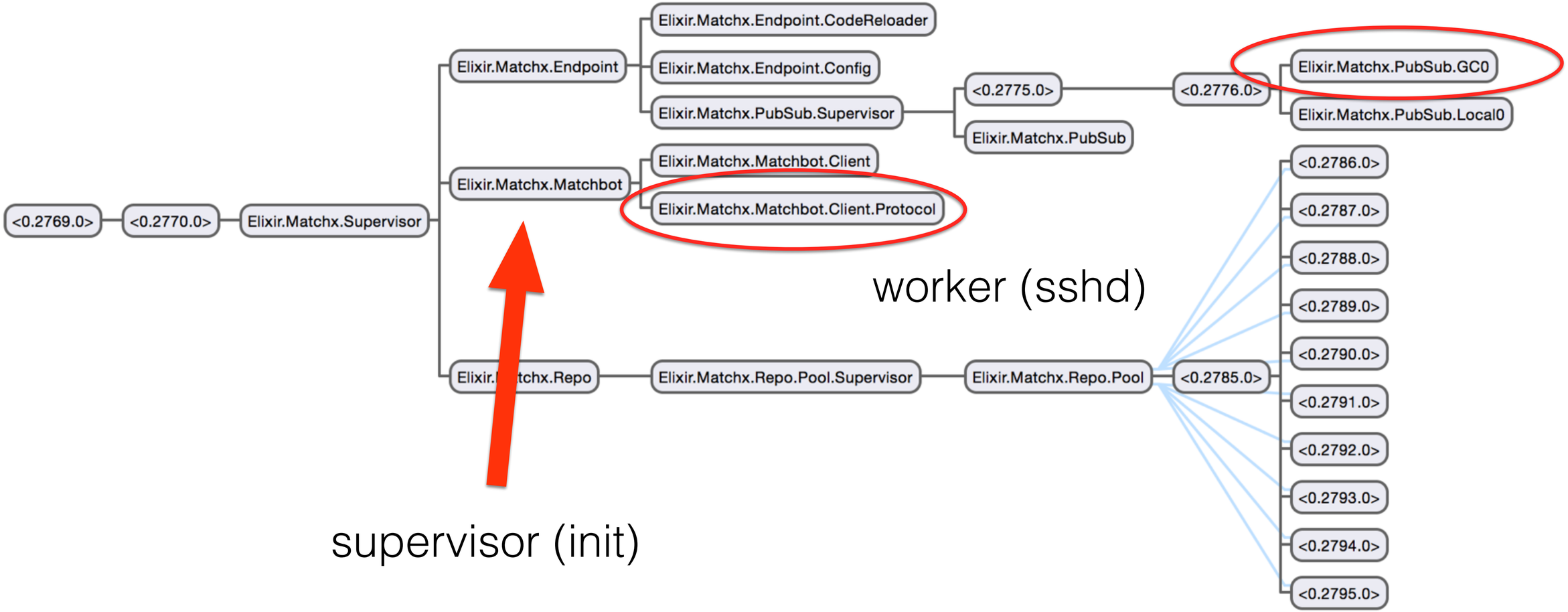
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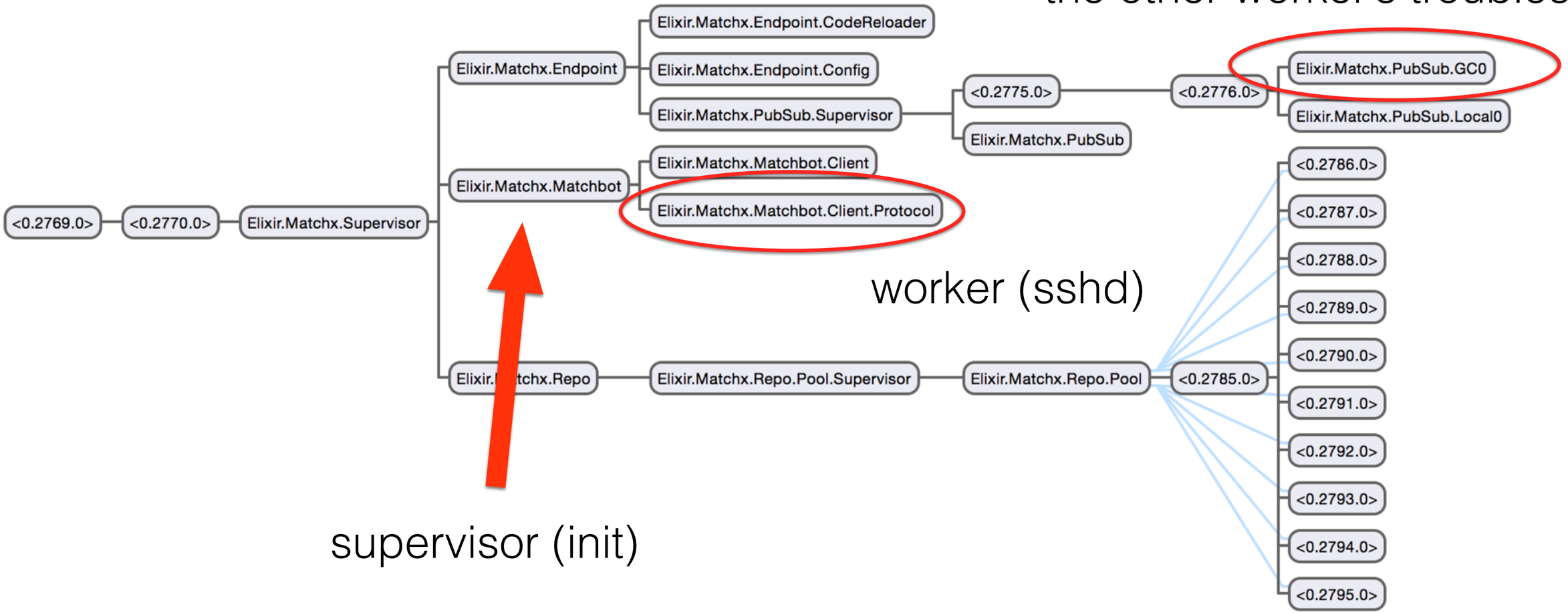
… completely ignorant of the other worker's troubles



Overview

unified theory of (un)reliability - ✓

juggling raptors - ✓

mecha-concurrency - ✓

the power of power cycling - ✓

The Zen of Erlang

Perl 6

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Perl 6

Perl 6 & Concurrency

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It has threads! Real ones!

Perl 6 & Concurrency

It has threads! Real ones!

But threads are hard to build on, so the primitives are higher-level

Perl 6 & Concurrency

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Supplies (asynchronous events)

Perl 6 & Concurrency

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Channels (thread-safe blocking queue)

Perl 6 & Concurrency

Supplies (asynchronous events)

Channels (thread-safe blocking queue)

Promises (asynchronous computation)

Perl 6 Promises

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Encapsulates some chunk of code

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Failures are isolated (part of the Promise's result)

Perl 6 Promises

Encapsulates some chunk of code

Failures are isolated (part of the Promise's result)

I can do blocking operations inside them?

Perl 6 Promises

example: concurrent sleep

Perl 6 Promises

example: concurrent sleep (but more)

Perl 6 Promises: a thread pool

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promises are cooperatively scheduled on 'return' from the function

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temporal decoupling ≈ size of your thread pool: you can block 'some'

Perl 6 Promises: a thread pool

promises are cooperatively scheduled on 'return' from the function

temporal decoupling ≈ size of your thread pool: you can block 'some'

similar caveats as threads: shared memory access, no way to know how to 'restart' (unrestricted access to shared state)

Perl 6 && Erlang

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few of the reliability ideas from Erlang/operating systems are applicable

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as long as they're closures, this situation is unlikely to change dramatically

Perl 6 && Golang?

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but consistent semantics

Perl 6 && ???

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this sounds negative

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not the talk I expected to give!

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Erlang is a much more specialised language than Perl 6

not everyone is writing network services

(although lots of us are)

Perl 6 && ???

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Perl 6's concurrency is still *great*

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a big improvement from Perl 5

Perl 6 && ???

Perl 6's concurrency is still *great*

a big improvement from Perl 5

but oriented differently from Erlang

Thanks

#perl6

Fred Herbert — http://ferd.ca/the-zen-of-erlang.html

booking.com

Questions?