Perl 6 Signatures: The Full Story

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.WHO

Perl 6 Hacker

Rakudo core developer

Focus on the object model, type system, multiple dispatch and signature handling

Traveller

I love to travel. Especially to Perl events. ☺

Beer Drinker

Beer is tasty.

I drink it.

\☺/

Plan for today's talk

The basics

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The not so basics

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The slightly mind-bending

Perl 6 Signatures: The Full Story

The basics

The not so basics

The slightly mind-bending

The “OMG awesome!”

Some Basic Examples

Some Basic Examples

(From Perl 5 => Perl 6)

Positional Parameters

```
sub get_coordinates {
    my ($city, $country) = @_;
    …
}
```

```
sub get_coordinates($city, $country) {
    …
}
```

Named Parameters

```
sub get_capital {
    my %params = @_;
    my $country = $params{'country'};
    …
}
```

```
sub get_capital(:$country) {
    …
}
```

Slurpy Positionals

```
sub sort_west_to_east {
    return sort {
        $a->latitude <=> $b->latitude
    }, @_;
}
```

```
sub sort_west_to_east(*@places) {
    return @places.sort({
        $^a.latitude <=> $^b.latitude
    });
}
```

By the way…

```
sub sort_west_to_east(*@places) {
    return @places.sort({
        $^a.latitude <=> $^b.latitude
    });
}
```

…can also be written in Perl 6 as…

```
sub sort_west_to_east(*@places) {
    return @places.sort({ .latitude });
}
```

(like sorting on the mapped values)

And even prettier…

```
sub sort_west_to_east(*@places) {
    return @places.sort({ .latitude });
}
```

…can also be written in Perl 6 as…

```
sub sort_west_to_east(*@places) {
    return @places.sort(*.latitude);
}
```

(because `*.foo` generates a closure like `{ $_.foo }`)

Slurpy Nameds

```
sub sum_distances {
    my %place_distances = @_;
    my $total = 0;
    $total += $_ for values %place_distances;
    return $total;
}
```

```
sub sum_distances(*%place_distances) {
    return [+] %place_distances.values
}
```

Arity Checking

The Perl 6 runtime checks that you passed enough parameters.

If you pass too few or too many, an exception is thrown.

```
sub book_train($from, $to, $date, $time) {
    …
}
book_train('Lund', 'Paris', '2010-10-09');
```

```
Not enough positional parameters passed; got 3 but expected 4
  in 'book_train' at line 1
  in main program body at line 4
```

Optional Parameters

```
sub book_train {
    my ($from, $to, $date, $time) = @_;
    …
}
```

```
sub book_train($from, $to, $date, $time?) {
    …
}
```

Defaults

```
sub biggest_city {
    my $country = shift;
    my $rank    = shift || 1;
    …
}
```

```
sub biggest_city($country, $rank = 1) {
    …
}
```

Required Named Parameters

While positional parameters are required by default, named parameters are optional by default.

To require one be passed, use !

```
sub book_train(:$from!, :$to!,
               :$date!, :$time) {
    …
}
```

Parameter Binding

In Perl 6, parameters are bound. This means that (by default) you get a read-only alias to the original value.

Read-only Alias

In Perl 6, this code will fail:

```
sub convert_currency($amount, $rate) {
    $amount = $amount * $rate;
    return $amount;
}

my $price = 99;
$price = convert_currency($price, 11.1);
say $price;
```

```
Cannot assign to readonly value
  in 'convert_currency' at line 2:test.p6
  in main program body at line 6:test.p6
```

is copy

To give the sub its own copy of the value to work with, use is copy.

```
sub convert_currency($amount is copy, $rate) {
    $amount = $amount * $rate;
    return $amount;
}

my $price = 99;
$price = convert_currency($price, 11.1);
say $price;
```

```
1098.9
```

is rw

Can also modify the original without having to pass a reference

```
sub convert_currency($amount is rw, $rate) {
    $amount = $amount * $rate;
}

my $price = 99;
convert_currency($price, 11.1);
say $price;
```

```
1098.9
```

Passing Arrays / Hashes

In Perl 6, passing an array or hash works like passing a reference.

```
sub example(@array, %hash) {
    say @array.elems;
    say %hash.keys.join(', ');
}

my @numbers = 1,2,3,4;
my %ages = Jnthn => 25, Noah => 120;
example(@numbers, %ages);
```

```
4
Noah, Jnthn
```

Types

What are types?

In Perl 6, every value knows its type.

```
say 42.WHAT;
say "camel".WHAT;
say [1, 2, 3].WHAT;
say (sub ($n) { $n * 2 }).WHAT;
```

```
Int()
Str()
Array()
Sub()
```

A type name in Perl 6 represents all possible values of that type.

Typed Parameters

Can restrict a parameter to only accept arguments of a certain type.

```
sub show_dist(Str $from, Str $to, Int $kms) {
    say "From $from to $to is $kms km.";
}
show_dist('Kiev', 'Lviv', 469);
show_dist(469, 'Kiev', 'Lviv');
```

```
From Kiev to Lviv is 469 km.
Nominal type check failed for parameter '$from'; expected Str
but got Int instead
  in 'show_dist' at line 1:test.p6
  in main program body at line 5:test.p6
```

Type Coercions

Sometimes, you want to accept any type, but then transform it into another type before binding to the parameter

```
sub show_dist($from, $to, $kms as Int) {
    say "From $from to $to is $kms km.";
}
show_dist('Kiev', 'Lviv', '469');
show_dist('Kiev', 'Lviv', 469.35);
```

```
From Kiev to Lviv is 469 km.
From Kiev to Lviv is 469 km.
```

Constraints

Sometimes, you need to do some more powerful validation on arguments.

```
sub discount($price, $percent
             where (1 <= $percent <= 100)) {
    say "You get $percent% off! Pay EUR " ~
        $price - ($price * $percent / 100);
}
discount(100, 20);
discount(100, 200);
```

```
You get 20% off! Pay EUR 80
Constraint type check failed for parameter '$percent'
  in 'discount' at line 2:test.p6
  in main program body at line 7:test.p6
```

Multiple Dispatch

Perl 6 Signatures: The Full Story

In Perl 6, you can write many subs with the same name but different signatures.

When you call the sub, the runtime will look at the types of the arguments and pick the best match.

Dispatch By Arity

Example (from Test.pm): dispatch by different number of parameters

```
multi sub todo($reason, $count) is export {
    $todo_upto_test_num = $num_of_tests_run + $count;
    $todo_reason = '# TODO ' ~ $reason;
}

multi sub todo($reason) is export {
    $todo_upto_test_num = $num_of_tests_run + 1;
    $todo_reason = '# TODO ' ~ $reason;
}
```

Dispatch By Type

Example: part of a JSON emitter

```
multi to-json(Array $a) {
    return '[ ' ~
        $a.values.map({ to-json($_) }).join(', ') ~
        ' ]';
}
multi to-json(Hash $h) {
    return '{ ' ~
        $h.pairs.map({
            to-json(.key) ~ ': ' ~ to-json(.value)
        }).join(', ') ~
        ' }';
}
```

Dispatch By Constraint

Can use multiple dispatch with constraints to do a lot of "write what you know" style solutions

Factorial:

Factorial:

fact(0) = 1

Factorial:

fact(0) = 1

fact(n) = n * fact(n - 1)

Factorial:

fact(0) = 1

fact(n) = n * fact(n - 1)

```
multi fact(0)  { 1 }
multi fact($n) { $n * fact($n - 1) }
```

Factorial:

fact(0) = 1

fact(n) = n * fact(n - 1)

```
multi fact(0)  { 1 }
multi fact($n) { $n * fact($n - 1) }
```

```
(Int $ where 0)
```

Fibonacci Sequence:

$$fib(0) = 0$$

$$fib(1) = 1$$

$$fib(n) = fib(n - 1) + fib(n - 2)$$

Fibonacci Sequence:

$$fib(0) = 0$$

$$fib(1) = 1$$

$$fib(n) = fib(n - 1) + fib(n - 2)$$

```
multi fib(0)  { 0 }
multi fib(1)  { 1 }
multi fib($n) { fib($n - 1) + fib($n - 2) }
```

Nested Signatures

Captures

A set of parameters form a signature.
A set of arguments form a capture.

Signature

```
sub greet($name, :$greeting = 'Hi') {
    say "$greeting, $name!";
}
greet("Mr L. O'lcat", greeting => 'OH HAI');
```

Capture

Coercing To Captures

It is possible to coerce arrays, hashes and other objects into captures.

Array elements => positional arguments

Hash pairs => named arguments

Object attributes => named arguments

Unpacking Arrays

Can extract elements from within an array, to do FP-style list processing

```
sub head([$head, *@tail]) {
    return $head;
}
sub tail([$head, *@tail]) {
    return @tail;
}
my @example = 1,2,3,4;
say head(@example);
say tail(@example);
```

```
1
234
```

Unpacking Hashes

Can extract values by key

```
sub show_place((:$name, :$lat, :$long, *%rest)) {
    say "$name lies at $lat,$long.";
    say "Other facts:";
    for %rest.kv -> $title, $data {
        say "    $title.ucfirst(): $data";
    }
}
my %info = name => 'Paris', lat => 48.51,
           long => 2.21, population => 2193031;
show_place(%info);
```

```
Paris lies at 48.51,2.21.
Other facts:
    Population: 2193031
```

Unpacking Objects

Can extract values by attribute (only those that are declared with accessors)

```
sub nd($r as Rat (:$numerator, :$denominator)) {
    say "$r = $numerator/$denominator";
}
nd(4.2);
nd(3/9);
```

```
4.2 = 21/5
0.333333333333333 = 1/3
```

Unpacking + Multiple Dispatch

When using multiple dispatch, "unpackability" works like a constraint.

Therefore we can do multiple dispatch based upon the shape and values inside of complex data structures.

Example: Quicksort

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```
# Empty list sorts to the empty list
multi quicksort([]) { () }
```

Example: Quicksort

```
# Empty list sorts to the empty list
multi quicksort([]) { () }

# Otherwise, extract first item as pivot...
multi quicksort([$pivot, *@rest]) {
    ...
}
```

Example: Quicksort

```
# Empty list sorts to the empty list
multi quicksort([]) { () }

# Otherwise, extract first item as pivot...
multi quicksort([$pivot, *@rest]) {
    # Partition.
    my @before = @rest.grep(* < $pivot);
    my @after  = @rest.grep(* >= $pivot);
    …
}
```

Example: Quicksort

```
# Empty list sorts to the empty list
multi quicksort([]) { () }

# Otherwise, extract first item as pivot...
multi quicksort([$pivot, *@rest]) {
    # Partition.
    my @before = @rest.grep(* < $pivot);
    my @after  = @rest.grep(* >= $pivot);

    # Sort the partitions.
    (quicksort(@before), $pivot, quicksort(@after))
}
```

Introspection

Introspection

We can take a Signature object and get information about the parameters

```
sub show_dist(Str $from, Str $to, Int $kms) {
    ...
}

for &show_dist.signature.params -> $p {
    say "$p.name() of type $p.type.perl()";
}
```

```
$from of type Str
$to of type Str
$kms of type Int
```

Zavolaj

A native calling interface that uses signature introspection to know how to marshall parameters into C types

```
use NativeCall;
sub mysql_real_connect(
    OpaquePointer $mysql_client, Str $host,
    Str $user, Str $password, Str $database,
    Int $port, Str $socket, Int $flag)
    returns OpaquePointer
    is native('libmysqlclient')
    { ... }
```

Other uses for Captures and Signature objects

Unpacking Return Values

You can bind the return value(s) from a sub or method call against a signature

```
my (:$name, :$score) := $db.get-highest-scorer();
print "$name has the highest score of $score";
```

Tree-matching

Can use signatures as a tree matching language, including in given/when

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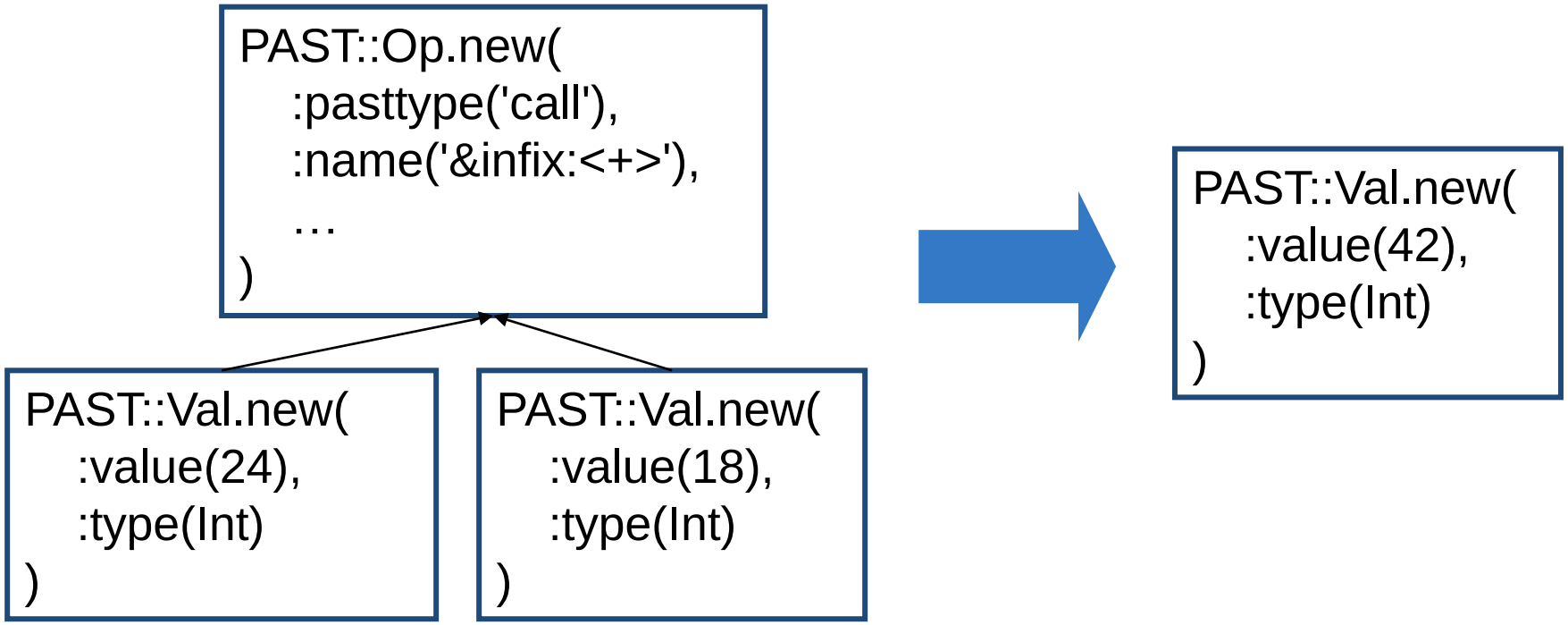
```
say 24 + 18
```

```
say 42
```

Tree-matching

Can use signatures as a tree matching language, including in given/when



Tree-matching

Can use signatures as a tree matching language, including in given/when

```
given $node {
    # Is this a math operation we can constant fold?
    when :(PAST::Val (:$type where Numeric, *%),
           PAST::Val (:$type where Numeric, *%),
           :$pasttype where 'call',
           :$name where /'&infix:<' <[+-*%]> '>'/,
           *%) {
        $node = fold_constants($node);
    }
    ...
}
```

Test::Mock

A simple Perl 6 mock object testing framework that I hacked up

Example of how captures and signatures being first class objects can be really powerful

http://github.com/jnthn/test-mock/

Test::Mock Example: Setup

```
class Pub {
    method order_beer($pints) { }
    method throw($what) { }
}
class Glass { }
class Party { }

# Create mock object and use it (normally we'd pass
# it into the code we wanted to test.)
my $p = mocked(Pub);
$p.throw(Party.new);
$p.order_beer(2);
$p.order_beer(1);
```

Test::Mock Example: Usage

```
check-mock($p,
    …
);
```

Test::Mock Example: Usage

```
check-mock($p,
  # Just check if we called it, with no checks on
  # the supplied arguments.
  *.called('order_beer', times => 2)
);
```

Test::Mock Example: Usage

```
check-mock($p,
  # Check using a capture (does equivalence check)
  *.called('order_beer', times => 1, with => \(1)),
  *.called('order_beer', times => 1, with => \(2)),
  *.never-called('order_beer', with => \(10)),
);
```

Test::Mock Example: Usage

```
check-mock($p,
  # Check using a signature (would the arguments
  # passed in the call bind against it)

  # Check type of argument passed
  *.called('throw', with => :(Party)),
  *.never-called('throw', with => :(Glass)),

  # Or get fancier with constraints
  *.called('order_beer', times => 2,
      with => :($ where { $^n < 10 })),
  *.never-called('order_beer',
      with => :($ where { $^n >= 10 }))
);
```

Test::Mock Implementation

```
method called($name, :$times, :$with) {
    # Extract calls of the matching name.
    my @calls = @!log.grep({ .<name> eq $name });

    # If we've an argument filter, apply it; we eqv
    # captures and smart-match everything else
    if defined($with) {
        if $with ~~ Capture {
            @calls .= grep({ .<capture> eqv $with });
        }
        else {
            @calls .= grep({ .<capture> ~~ $with });
        }
    }
    …
}
```

Conclusions

Not Just Replacing @_

Perl 6 signatures provide you with a neater way to handle arguments passed to subs and methods than working with @_.

However, they are also useful away from subs and methods, e.g. for tree matching.

"When?"

All of the examples shown today are already working in Rakudo Perl 6.

Signature handling and multiple dispatch are amongst the most mature and stable parts of Rakudo.

Merci beaucoup!

Questions?