The Perl 6 Express

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About This Talk

- A look at some of the changes and new features in Perl 6, the next version of the Perl programming language that is currently in development
- Tries to cover the stuff you most need to know
- Sticks to code that you can run on a Perl 6 implementation today (Rakudo)

A Little Background

What is Perl 6?

- Perl 6 is a ground-up re-design and re-implementation of the language
- Not backward compatible with Perl 5
  - Opportunity to add, update and fix many things
  - There will be a code translator and you will be able to use many Perl 5 modules from Perl 6

Language vs. Implementation

- In Perl 5, there was only one implementation of the language
- Other languages have many choices
- Perl 6 is the name of the language, but not of any particular implementation (just like C)
- Various implementation efforts underway

Rakudo

- An implementation of Perl 6 on the Parrot Virtual Machine
  - VM aiming to run many dynamic languages and allow interoperability between them
- Implemented partly in NQP (a subset of Perl 6), partly in Perl 6 (some built-ins), partly in Parrot Intermediate Language and a little bit of C

Why "Rakudo"?

- Suggested by Damian Conway
- Some years ago, Con Wei Sensei introduced a new martial art in Japan named "The Way Of The Camel"
- In Japanese, this is "Rakuda-do"
- The name quickly became abbreviated to "Rakudo", which also happens to mean "paradise" in Japanese

How To Build Rakudo

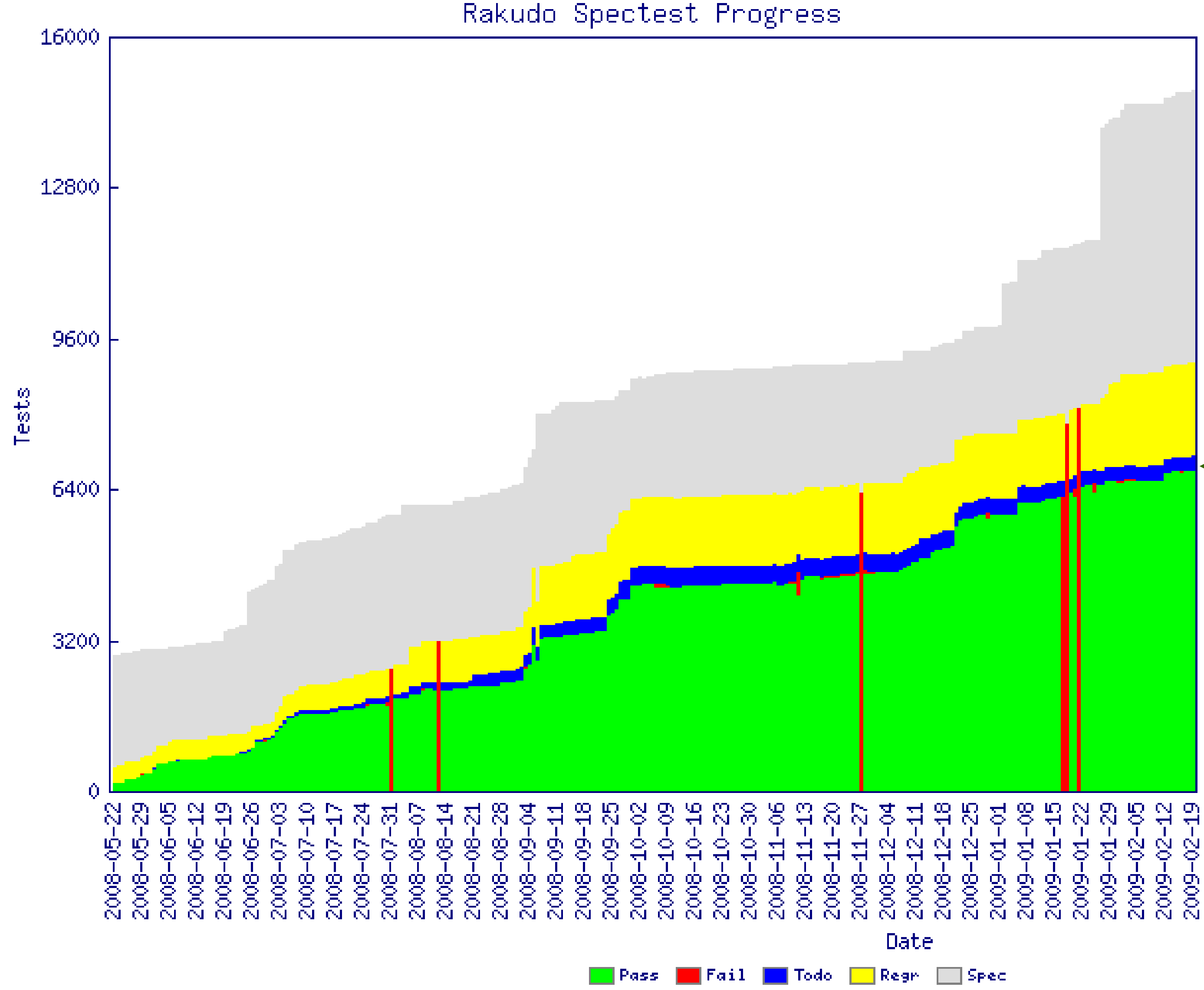
- Clone the source from GIT git://github.com/rakudo/rakudo.git
- Build it (builds Parrot for you):

```
perl Configure.pl --gen-parrot
make perl6
```

- Run it on the command line, with a script or in interactive mode

```
perl6 -e "say 'Hello, world!'"
perl6 script.p6
perl6
```

Rakudo Progress



← **7000+**
passing specification tests

Variables

Declaring Variables

- As in Perl 5, declare lexical variables with **`my`**

```
my $answer = 42;
my $city = 'Sofia';
my $very_approx_pi = 3.14;
```

- Unlike in Perl 5, by default you must declare your variables (it's like having **`use strict`** on by default)
- You can also use **`our`** for package variables, just like in Perl 5

Sigils

- All variables have a sigil
- Unlike in Perl 5, the sigil is just part of the name (**`$a[42]`** is now **`@a[42]`**).
- The sigil defines a kind of "interface contract" – promises about what you can do with this variable
    - Anything with @ sigil can be indexed into positionally, using […]

Arrays

- Hold zero or more elements and allow you to index into them with an integer

```
# Declare an array.
my @scores;

# Or initialize with some initial values.
my @scores = 52,95,78;
my @scores = <52 95 78>; # The same

# Get and set individual elements.
say @a[1]; # 95
@a[0] = 100;
say @a[0]; # 100
```

Hashes

- Hold zero or more elements, with keys of any type

```
# Declare a hash.
my %ages;

# Set values.
%ages<Fred> = 19;    # Constant keys
my $name = 'Harry';
%ages{$name} = 23;   # More complex ones

# Get an individual element.
say %ages<Harry>;    # 23
```

Iteration

The `for` Loop To Iterate

- In Perl 6, the **`for`** loop is used to iterate over anything that provides an iterator
- By default, puts the variable into **`$_`**
- The following example will print all of the elements in the **`@scores`** array

```
my @scores = <52 95 78>;
for @scores {
    say $_;
}
```

The `for` Loop To Iterate

- Anything between **`{ … }`** is just a block
- In Perl 6, a block can take parameters, specified using the **->** syntax

```
my @scores = <52 95 78>;
for @scores -> $score {
    say $score;
}
```

- Here, we are naming the parameter to the block that will hold the iteration variable

The `for` Loop To Iterate

- .kv method of a hash returns keys and values in a list
- A block can take multiple parameters, so we can iterate over the keys and values together

```
my %ages = (Fred => 45, Bob => 33);
for %ages.kv -> $name, $age {
    say "$name is $age years old";
}
```

```
Fred is 45 years old
Bob is 33 years old
```

The `loop` Loop

- The **`for`** loop is only for iteration now; for C-style for loops, use the **`loop`** keyword

```
loop (my $i = 1; $i <= 42; $i++) {
    say $i;
}
```

- Bare **`loop`** block is an infinite loop

```
loop {
    my $cur_pos = get_position();
    update_trajectory($target, $cur_pos);
}
```

Conditionals

The `if` Statement

- You can use the if…elsif…else style construct in Perl 6, as in Perl 5

```
if $foo == 42 {
    say "The answer!";
} elsif $foo == 0 {
    say "Nothing";
} else {
    say "Who knows what";
}
```

- However, you can now omit the parentheses around the condition

Chained Conditionals

- Perl 6 supports "chaining" of conditionals, so instead of writing:

```
if $roll >= 1 && $roll <= 6 {
    say "Valid dice roll"
}
```

You can just write:

```
if 1 <= $roll <= 6 {
    say "Valid dice roll"
}
```

Chained Conditionals

- You are not limited to chaining just two conditionals

```
if 1 <= $roll1 == $roll2 <= 6 {
    say "Doubles!"
}
```

- Here we check that both roles of the dice gave the same value, and that both of them are squeezed between 1 and 6, inclusive

Subroutines

Parameters

- You can write a signature on a sub
- Specifies the parameters that it expects to receive
- Unpacks them into variables for you

```
sub order_beer($type, $how_many) {
    say "$how_many pints of $type, please";
}
order_beer('Leffe', 5);
```

```
5 pints of Leffe, please
```

Auto-Referencing

- Arrays and hashes can be passed without having to take references to prevent them from flattening

```
sub both_elems(@a, @b) {
    say @a.elems;
    say @b.elems;
}
my @x = 1,2,3;
my @y = 4,5;
both_elems(@x, @y);
```

```
3
2
```

Optional Parameters

- Parameters can be optional
- Write a ? after the name of the parameter to make it so

```
sub speak($phrase, $how_loud?) { ... }
```

- Alternatively, give it a default value

```
sub greet($name, $greeting = 'Ahoj') {
    say "$greeting, $name";
}
greet('Zuzka');          # Ahoj, Zuzka
greet('Anna', 'Hallo');  # Hallo, Anna
```

Named Parameters

- Named parameters are also available

```
sub catch_train(:$number!, :$car, :$place) {
    my $platform = find_platform($number);
    walk_to($platform);
    find_place($car, $place);
}
catch_train(
    number => '005',
    place => 23
    car => 5,
);
```

- Optional by default; use ! to require

Slurpy Parameters

- For subs taking a variable number of arguments, use slurpy parameters

```
sub say_double(*@numbers) {
    for @numbers {
        say 2 * $_;
    }
}
say_double();               # No output
say_double(21);             # 42\n
say_double(5,7,9);          # 10\n14\n18\n
```

- Use *%named for named parameters

Object Orientation

Everything Is An Object

- You can treat pretty much everything as an object if you want
- For example, arrays have an **`elems`** method to get the number of elements

```
my @scores = <52 95 78>;
say @scores.elems; # 3
```

- Can also do push, pop, etc. as methods

```
@scores.push(88);
say @scores.shift; # 52
```

Classes

- Basic class definitions in Perl 6 are not so unlike many other languages
  - Attributes specifying state
  - Methods specifying behaviour

```
class Dog {
    has $.name;
    has @!paws;
    method bark() {
        say "w00f";
    }
}
```

Attributes

- All attributes are named **`$!foo`** (or **`@!foo`**, **`%!foo`**, etc)
- Declaring an attribute as **`$.foo`** generates an accessor method
- Adding **`is rw`** makes it a mutator method too

```
has $!brain;         # Private
has $.color;         # Accessor only
has $.name is rw;    # Accessor and mutator
```

Inheritance

- Done using the **`is`** keyword

```
class Puppy is Dog {
    method bark() {       # an override
        say "yap";
    }
    method chew($item) {  # a new method
        $item.damage;
    }
}
```

- Multiple inheritance also possible

```
class Puppy is Dog is Pet { … }
```

Delegation

- The **`handles`** keyword specifies that an attribute handles certain methods

```
has $!brain handles 'think';
has $!mouth handles <bite eat drink>;
```

- You can use pairs to rename them

```
has $!brain handles :think('use_brain')
```

- Really all the compiler is doing is generating some "forwarder" methods for you

Proto-objects

- When you declare a class, it installs a prototype object in the namespace
- Somewhat like an "empty" instance of the object
- You can call methods on it which don't depend on the state; for example, the new method to create a new instance:

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

Instantiation

- When you instantiate an object you can also specify initial attribute values

```
my $pet = Puppy.new(
    name => 'Rosey',
    color => 'White'
);
```

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    color => 'White'
);
```

Metaclasses

- There is no Class class
- A proto-object points to the metaclass, making it available through the .HOW (Higher Order Workings) macro
- This allows for introspection (getting a list of its methods, attributes, parents, roles that it does and so forth – all of which can be further introspected)

Basic I/O

File Handle Objects

- I/O is now much more OO
- The **`open`** function will now return an IO object, which you call methods on to do input/output
- **`open`** takes a named parameter to specify the mode

```
my $fh = open("foo.txt", :r);  # read
my $fh = open("foo.txt", :w);  # write
my $fh = open("foo.txt", :rw); # read/write
my $fh = open("foo.txt", :a);  # append
```

Iterating Over A File

- Use the **`for`** loop to iterate over the file handle, and the prefix **=** operator to get an iterator from the file handle

```
my $fh = open("README", :r);
for =$fh -> $line {
    say $line;
}
$fh.close();
```

- Note that this auto-chomps: new line characters are removed from $line

Writing To A File

- To write to a file, just call the **`print`** and **`say`** methods on the file handle object

```
my $fh = open("example.txt", :w);
for 1..10 -> $i {
    $fh.say($i);
}
$fh.close();
```

Standard Handles

- STDIN is available as the global $*IN, STDOUT as $*OUT and STDERR as $*ERR
- They are just file handle objects, so it's possible to call methods on them to read/write with them

```
print "Your name is: ";
my $name = $*IN.readline;
say "Hi, $name!";
```

A Couple Of Handy Functions

- The slurp function lets you read an entire file into a scalar

```
my $content = slurp("data.txt");
```

- The prompt function prints the given message, then takes input from STDIN

```
my $name = prompt "Your name is: ";
say "OH HAI, { $name.uc }!";
```

Types

Types

- In Perl 6, values know what kind of thing they are

```
say 42.WHAT;              # Int
say "beer".WHAT;          # Str
sub answer { return 42 }
say &answer.WHAT;         # Sub
```

- Including your own classes

```
class Dog { … }
my $fido = Dog.new();
say $fido.WHAT;           # Pes
```

Typed Variables

- We can refer to types in our code by name
- For example we can declare a variable can only hold certain types of thing

```
my Int $x = 42;         # OK, 42 isa Int
$x = 100;               # OK, 100 isa Int
$x = "CHEEZBURGER";     # Error
```

- Again, this works with types you have defined in your own code too

Typed Parameters

- Types can also be written in signatures to constrain what types of parameters can be passed

```
sub hate(Str $thing) {
    say "$name, you REALLY suck!";
}
hate("black hole"); # OK
hate(42);           # Type check failure
```

Introducing Subtypes

- In Perl 6, you can take an existing type and "refine" it

```
subset PositveInt of Int where { $_ > 0 }
```

- Pretty much any condition is fine
- The condition will then be enforced per assignment to the variable

```
my PositiveInt $x = 5; # OK
$x = -10;              # Type check failure
```

Introducing Subtypes

- Like other types, you can use them on subroutine parameters
- You can also write an anonymous refinement on a sub parameter

```
sub divide(Num $a,
           Num $b where { $^n != 0 }) {
    return $a / $b;
}
say divide(126, 3); # 42
say divide(100, 0); # Type check failure
```

Multiple Dispatch

Multiple Dispatch

- Earlier we saw that routines in Perl 6 can now have signatures
- In Perl 6, you can write multiple routines with the same name, but different signatures
- We let the runtime engine analyse the parameters that we are passing and call the best routine (known as the best candidate).

Dispatch By Arity

- Arity = number of arguments that a routine takes
- Choose by number of parameters

```
multi sub greet($name) {
    say "Ahoj, $name!";
}
multi sub greet($name, $greeting) {
    say "$greeting, $name!";
}
greet('Anna');            # Ahoj Anna
greet('Лена', 'Привет '); # Привет, Лена"
```

Dispatch By Arity

- Arity = number of arguments that a routine takes
- Choose by number of parameters

```
multi sub greet($name) {
    say "Ahoj, $name!";
}
multi sub greet($name, $greeting) {
    say "$greeting, $name!";
}
greet('Anna');              # Ahoj Anna
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```

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Dispatch By Arity

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- Choose by number of parameters

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    say "Ahoj, $name!";
}
multi sub greet($name, $greeting) {
    say "$greeting, $name!";
}
greet('Anna');                # Ahoj Anna
greet('Лена', 'Привет '); # Привет, Лена"
```

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Type-Based Dispatch

- We can also use the types of parameters to help decide which candidate to call

```
multi sub double(Num $x) {
    return 2 * $x;
}
multi sub double(Str $x) {
    return "$x $x";
}
say double(21);      # 42
say double("hej");   # hej hej
```

Type-Based Dispatch

- Paper/Scissor/Stone is easy now

```
class Paper   { }
class Scissor { }
class Stone   { }
multi win(Paper $a,   Stone $b)   { 1 }
multi win(Scissor $a, Paper $b)   { 1 }
multi win(Stone $a,   Scissor $b) { 1 }
multi win(Any $a,     Any $b)     { 0 }

say win(Paper.new, Scissor.new);  # 0
say win(Stone.new, Stone.new);    # 0
say win(Paper.new, Stone.new);    # 1
```

Subtypes In Multiple Dispatch

- In multiple dispatch, subtypes act as "tie-breakers"
  - First, we narrow down the possible candidates based upon the role or class they expect the parameter to inherit from or do
  - Then, if we have multiple candidates left, we use the subtypes to try and pick a winner

Subtypes In Multiple Dispatch

- Here is an example of using subtypes to distinguish between two candidates

```
multi say_short(Str $x) {
    say $x;
}
multi say_short(Str $x
               where { .chars >= 12 }) {
    say substr($x, 0, 10) ~ '...';
}
say_short("Beer!");         # Beer!
say_short("BeerBeerBeer!"); # BeerBeerBe...
```

Dispatch Failures

- Multiple dispatch can fail in a couple of ways
    - When all candidates have been considered, and none of them accept the parameters we have passed
    - When we have two or more candidates that accept the parameters and have no way to decide which one is better

No Applicable Candidates

- The following program will give an error saying that there are no applicable candidates

```
multi sub double(Num $x) {
    return 2 * $x;
}
multi sub double(Str $x) {
    return "$x $x";
}
double(1..10); # 1..10 is a Range object
```

Ambiguous Candidates

- This one fails due to ambiguity

```
multi sub say_sum(Num $x, Int $y) {
    say $x + $y;
}
multi sub say_sum(Int $x, Num $y) {
    say $x + $y;
}
say_sum(15, 27);
```

- But helpfully tells you what conflicted

```
Ambiguous dispatch to multi 'say_sum'.
Ambiguous candidates had signatures:
:(Num $x, Int $y)
:(Int $x, Num $y)
```

Exceptions

CATCH

- Can write a CATCH block within any other block (not just try; like Perl 5's eval block, it catches all exceptions)
- Catches exceptions that occur inside that block

```
try {
    die "omg!";
    CATCH {
        say "wtf?"
    }
}
```

$!

- As in Perl 5, $! is still related to error handling
- Is a kind of exception object, though can stringify it

```
try {
    die "omg";
    CATCH {
        say $! ~ "wtfbbq" # omgwtfbbq
    }
}
```

Junctions

Junctions

- How often do you find yourself writing things like:

```
if $drink eq 'wine' || $drink eq 'beer' {
    say "Don't get drunk on it!";
}
```

- With junctions we can write this as:

```
if $drink eq 'wine' | 'beer' {
    say "Don't get drunk on it!";
}
```

- **`"wine" | "beer"`** is a junction

What are junctions?

- A junction can be used anywhere that you would use a single value
- You store it in a scalar
- But, it holds and can act as many values at the same time
- Different types of junctions have different relationships between the values

Constructing Junctions From Arrays

- You can construct junctions from arrays

```
if all(@scores) > $pass_mark {
    say "Everybody passed!";
}
if any(@scores) > $pass_mark {
    say "Somebody passed";
}
if one(@scores) > $pass_mark {
    say "Just one person passed";
}
if none(@scores) > $pass_mark {
    say "EPIC FAIL";
}
```

Junction Auto-Threading

- If you pass a junction as a parameter then by default it will auto-thread
- That is, we will do the call once per item in the junction

```
sub example($x) {
    say "called with $x";
}
example(1|2|3);
```

```
called with 1
called with 2
called with 3
```

Junction Auto-Threading

- The default parameter type is Any
- However, this is not the "top" type – that is Object
- Junction inherits from Object, not Any

Junction Auto-Threading

- The default parameter type is Any
- However, this is not the "top" type – that is Object
- Junction inherits from Object, not Any

```
sub example(Junction $x) {
    say "called with " ~ $x.perl;
}
example(1|2|3);
example(42);
```

```
called with any(1, 2, 3)
Parameter type check failed for $x in call to example
```

Junction Auto-Threading

- The default parameter type is Any
- However, this is not the "top" type – that is Object
- Junction inherits from Object, not Any

```
sub example(Object $x) {
    say "called with " ~ $x.perl;
}
example(1|2|3);
example(42);
```

```
called with any(1, 2, 3)
called with 42
```

Junction Auto-Threading

- The return value that you get maintains the junction structure

```
sub double($x) {
    return $x * 2;
}
my $x = double(1 | 2 & 3);
say $x.perl;
```

```
any(2, all(4, 6))
```

- We thread the leftmost all or none junction first, then leftmost any or one

Meta-Operators

Reduction Operators

- Takes an operator and an array
- Acts as if you have written that operator between all elements of the array

```
# Add up all values in the array.
my $sum = [+] @values;

# Compute 10 factorial (1 * 2 * 3 * … * 10)
my $fact = [*] 1..10;

# Check a list is sorted numerically.
if [<=] @values { … }
```

Hyper Operators

- Takes an operator and does it for each element in an array, producing a new array.

```
my @a = 1,2,3;
my @b = 4,5,6;
my @c = @a >>+<< @b; # 5 7 9
my @d = @a >>*<< @b; # 4 10 18
```

- Point "sharp end" outwards to replicate last element if needed

```
my @e = @a >>+>> 1;  # 2 3 4
```

Cross Operators

- Alone, produces all possible permutations of two or more lists

```
my @a = 1,2;
my @b = 'a', 'b';
say (@a X @b).perl; # ["1", "a", "1", "b",
                    #  "2", "a", "2", "b"]
```

- Can also take an operator and use it to combine the elements together in some way, e.g. string concatenation

```
say (@a X~ @b).perl; # ["1a", "1b",
                     #  "2a", "2b"]
```

Regexes And Grammars

What's Staying The Same

- You can still write regexes between slashes
- The ?, + and * quantifiers
- ??, +? and *? lazy quantifiers
- (…) is still used for capturing
- Character class shortcuts: \d, \w, \s
- | for alternations (but semantics are different; use || for the Perl 5 ones)

Change: Literals And Syntax

- Anything that is a number, a letter or the underscore is a literal

```
/foo_123/     # All literals
```

- Anything else is syntax
- You use a backslash (\) to make literals syntax and to make syntax literals

```
/\<\w+\>/     # \< and \> are literals
              # \w is syntax
```

Change: Whitespace

- Now what was the x modifier in Perl 5 is the default
- This means that spaces don't match anything – they are syntax

```
/abc/       # matches abc
/a b c/     # the same
```

Change: Quoting

- Single quotes interpret all inside them as a literal (aside from \')
- Can re-write:

```
/\<\w+\>/
```

As the slightly neater:

```
/'<' \w+ '>'/
```

- Spaces are literal in quotes too:

```
/'a b c'/  # requires the spaces
```

Change: Grouping

- A non-capturing group is now written as […] (rather than (?:…) in Perl 5)

```
/[foo|bar|baz]+/
```

- Character classes are now <[…]>; they are negated with -, combined with + or - and ranges are expressed with ..

```
/<[A..Z]>/             # uppercase letter...
/<[A..Z] - [AEIOU]>/   # ...but not a vowel
/<[\w + [-]]>          # anything in \w or a -
```

Change: s and m

- The **`s`** and **`m`** modifiers are gone
- `.` now always matches anything, including a new line character
- Use **`\N`** for anything but a new line
- **`^`** and **`$`** always mean start and end of the string
- **`^^`** and **`$$`** always mean start and end of a line

Matching

- To match against a pattern, use ~~

```
if $event ~~ /\d**4/ { ... }
```

- Negated form is !~~

```
if $event !~~ /\d**4/ { fail "no year"; }
```

- $/ holds the match object; when used as a string, it is the matched text

```
my $event = "Bulgarian Perl Workshop 2009";
if $event ~~ /\d**4/ {
    say "Held in $/"; # Held in 2009
}
```

Named Regexes

- You can now declare a regex with a name, just like a sub or method

```
regex Year { \d**4 }; # 4 digits
```

- Then name it to match against it:

```
if $event ~~ /<Year>/ { ... }
```

Calling Other Regexes

- You can "call" one regex from another, making it easier to build up complex patterns and re-use regexes

```
regex Year { \d**4 };
regex Place { Bulgarian | Ukrainian };
regex Workshop {
    <Place> \s Perl \s Workshop \s <Year>
};
regex YAPC {
    'YAPC::' ['EU'|'NA'|'Asia'] \s <Year>
};
regex Event { <Workshop> | <YAPC> };
```

The Match Object

- Can extract the year from a list of event names like this:

```
for @events -> $ev {
    if $ev ~~ /<Event>/ {
        if $/<Event><YAPC> {
             say $/<Event><YAPC><Year>;
        } else {
             say $/<Event><Workshop><Year>;
        }
    } else {
        say "$ev was not a Perl event.";
    }
}
```

`rule` and `token`

- By default, regexes backtrack
- Not very efficient for building parsers
- If you use **`token`** or **`rule`** instead or **`regex`**, it will not backtrack
- Additionally, **`rule`** will replace any literal spaces in the regex with a call to ws (**`<.ws>`**), which you can customize for the thing you are parsing

Learning More

Where To Learn More

- The Rakudo Perl 6 implementation has a site at http://www.rakudo.org/
- The Parrot Website http://www.parrot.org/
- The Parrot Blog recently had an 8-part PCT tutorial posted http://www.parrotblog.org/

Get Involved!

- Join the Parrot and/or Perl 6 compiler mailing list
- Pop onto the IRC channel
- Get the source and start hacking
  - Partial implementations of many languages – come and help us get your favorite one running on Parrot
  - Or if you like C, lots of VM guts work

Thank you!

Questions?