

# Understanding Roles, Constraints And Classes



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# Understanding Roles, Constraints And Classes

## The Perl 6 Object Model

- The Perl 6 object model attempts to improve on the Perl 5 one
  - Nicer, more declarative syntax
  - One way to do things, rather than the many that appeared in Perl 5 (but you can still do other stuff if you like)
  - Roles – the Big New Thing
  - Before roles, something familiar...

# Classes

# Understanding Roles, Constraints And Classes

## What Are Classes Used For?

- Instance Management
  - Classes “create” objects
  - Alternatively, you can view a class as a kind of blueprint for how to create an object
  - Classes define both the state and behaviour that an object has, and relate them

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## What Are Classes Used For?

- Code re-use
  - We often try to design classes to do one particular thing
  - That means that, ideally, they can be re-used to do that thing multiple times, potentially in multiple programs

# Understanding Roles, Constraints And Classes

## What Are Classes Used For?

- Providing a route to polymorphism
  - This means that the same code can safely operate on values of different types
- Inheritance relationships state that one class can be used in place of another
- Essentially, enables more re-use

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## Classes In Perl 6

- Introduce a class using the `class` keyword
- With a block:

```
class Puppy {  
    ...  
}
```

- Or without to declare that the rest of the file describes the class.

```
class Puppy;
```





**They called me  
WHAT?!**



They called me  
**WHAT?!**

**white**



They called me  
**WHAT?!**

**white**

**4 paws**



They called me  
**WHAT?!**

**white**

**4 paws**

**tail**

# Understanding Roles, Constraints And Classes

## Attributes

- Introduced using the **has** keyword

```
class Puppy {  
    has $name;  
    has $colour;  
    has @paws;  
    has $tail;  
}
```

- All attributes in Perl 6 are stored in an opaque data type
- Hidden to code outside of the class

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## Accessor Methods

- We want to allow outside access to some of the attributes
- Writing accessor methods is boring!
- `$ .` means it is automatically generated

```
class Puppy {  
  has $.name;  
  has $.colour;  
  has @paws;  
  has $tail;  
}
```

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## Mutator Methods

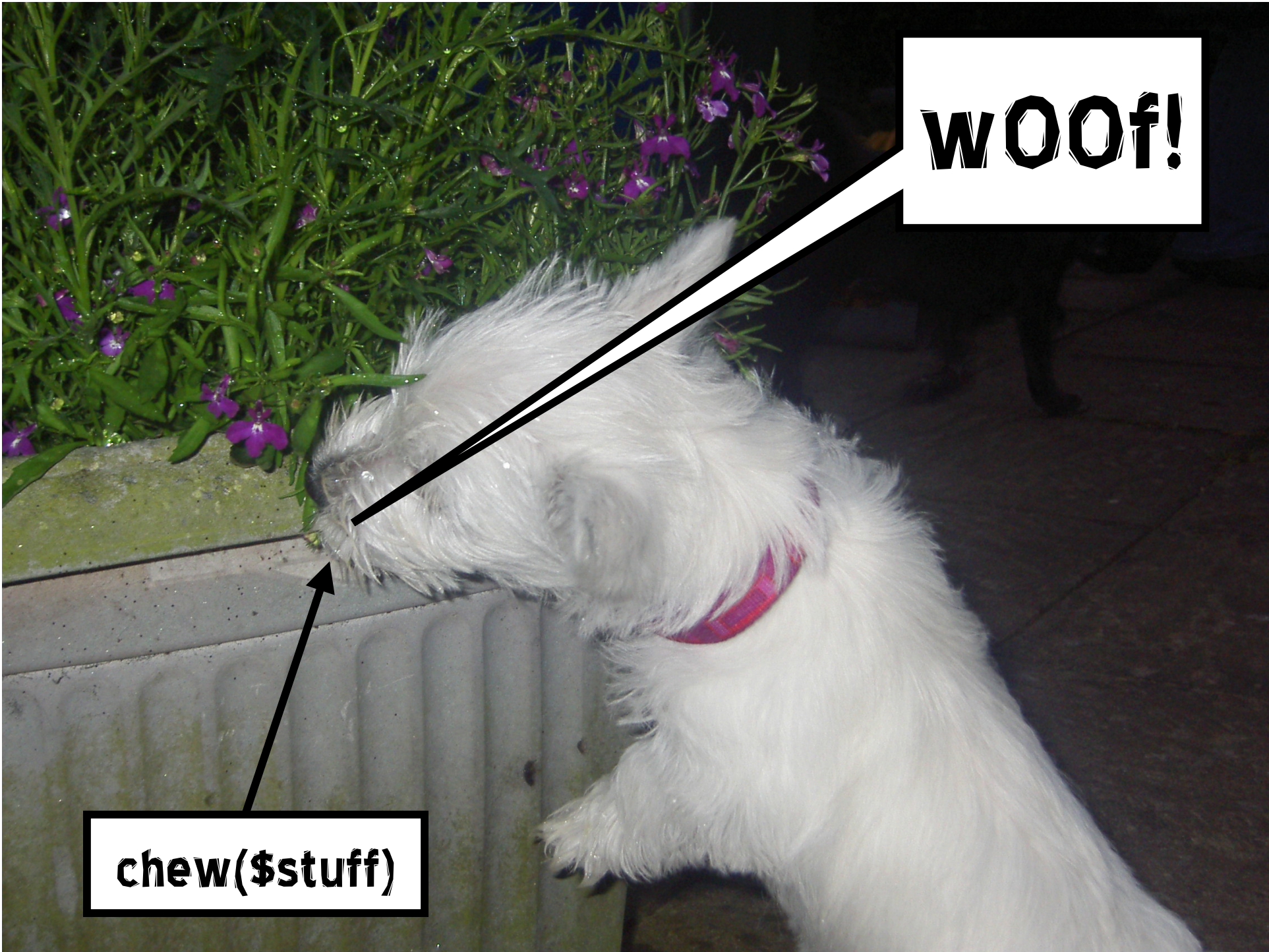
- We should be able to change some of the attributes
- Use `is rw` to generate a mutator method too

```
class Puppy {  
  has $.name is rw;  
  has $.colour;  
  has @paws;  
  has $tail;  
}
```





**woof!**



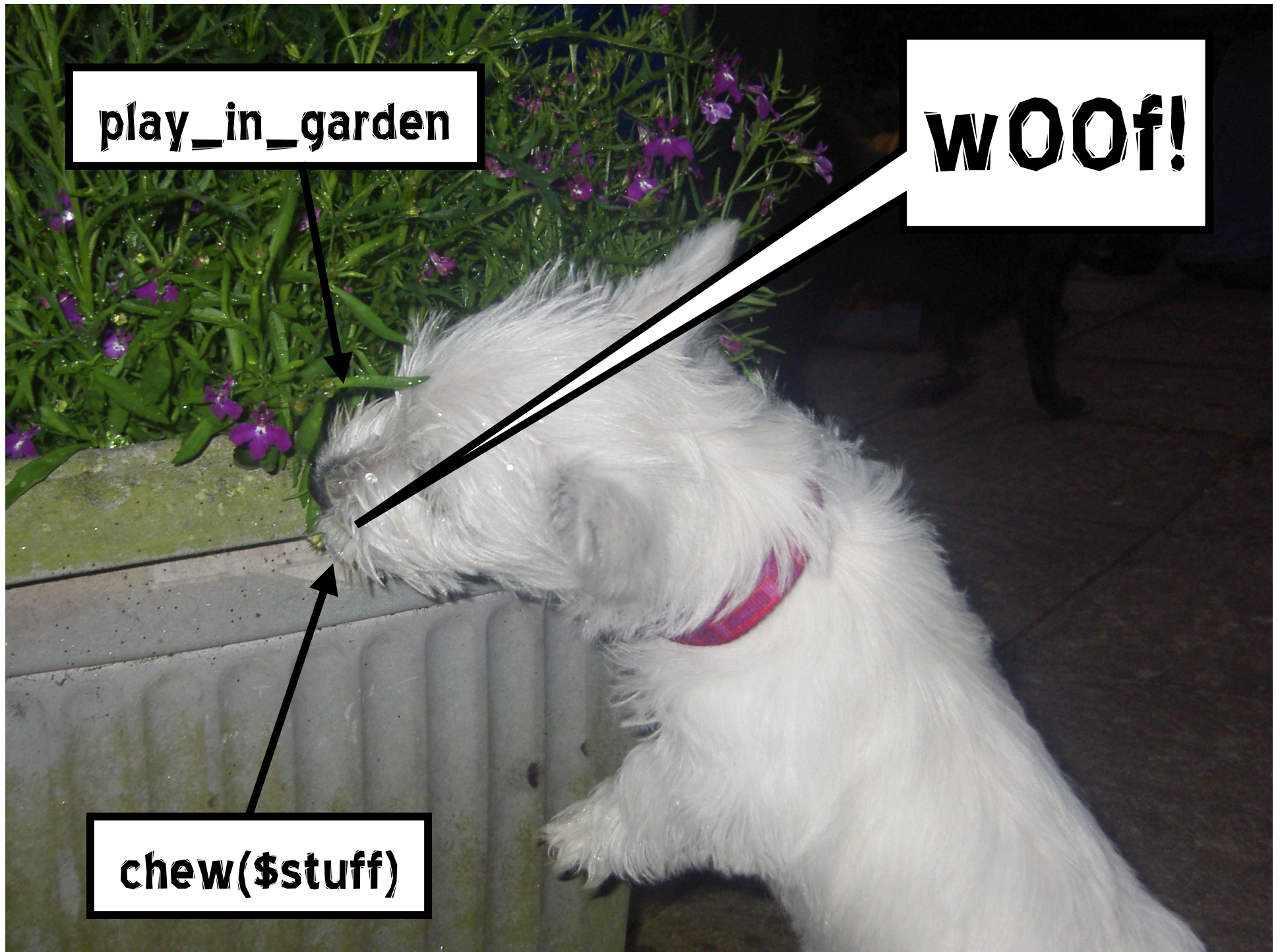
**woof!**

**chew(\$stuff)**

**play\_in\_garden**

**wOOf!**

**chew(\$stuff)**

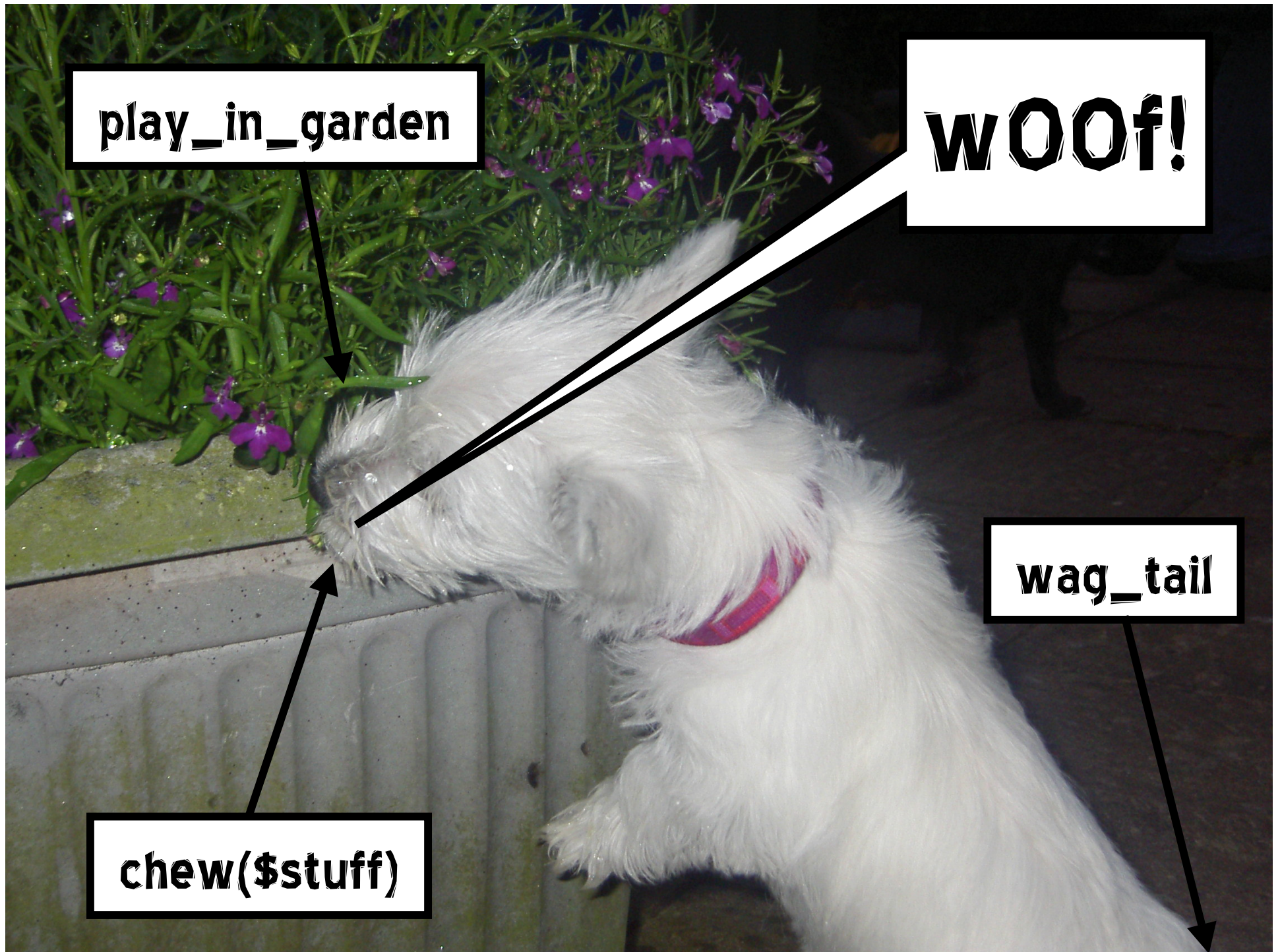


**play\_in\_garden**

**w00f!**

**wag\_tail**

**chew(\$stuff)**



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## Methods

- The new **method** keyword is used to introduce a method

```
method bark() {  
    say "w00f!";  
}
```

- Parameters go in a parameter list; the invocant is optional!

```
method chew($item) {  
    $item.damage++;  
}
```

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## Attributes In Methods

- Attributes can be accessed with the `$.` syntax, via their accessor

```
method play_in_garden() {  
    $.colour = 'black';  
}
```

- To get at the actual storage location, `$colour` can be used

```
method play_in_garden() {  
    $colour = 'black';  
}
```

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## Attributes In Methods

- If there is a conflict with a lexical variable, you can use `$!colour`

```
method play_in_garden() {  
    $!colour = 'black';  
}
```

- This is because all (private) attributes inside the class really have the ! In their name; can use it to emphasize privateness.

```
has $!tail;
```

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## Consuming A Class

- A default **new** method is generated for you that sets attributes
- Also note that **->** has become **.**

```
my $puppy = Puppy.new(  
  name => 'Rosey',  
  colour => 'white'  
);  
$puppy.bark();           # w00f!  
say $puppy.colour;       # white  
$puppy.play_in_garden();  
say $puppy.colour;       # black
```

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## A Note On Instantiation

- Another common way to write the instantiation code is this

```
my Puppy $puppy .= new(  
  name => 'Rosey',  
  colour => 'white'  
);
```

- The `.=` method means “call a method on myself and assign the result to me”
- `$puppy` is undefined, but we know its class, so can call the `new` method

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## Delegation

- Sometimes, one of the attributes contains a method that we want to expose in the current class; we could write a method like this:

```
method wag() {  
    $tail.wag();  
}
```

- Use delegation instead; modify the declaration of `$tail`

```
has $tail handles 'wag';
```

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## Inheritance

- A puppy is really a dog, so we want to implement a Dog class and have Puppy inherit from it
- Inheritance is achieved using the **is** keyword

```
class Dog {  
    ...  
}  
class Puppy is Dog {  
    ...  
}
```

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## Multiple Inheritance

- Multiple inheritance is possible too; use multiple `is` statements

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

# Roles

# Understanding Roles, Constraints And Classes

## In Search Of Greater Re-use

- In Perl 6, roles take on the task of re-use, leaving classes to deal with instance management
- We need to implement a **walk** method for our **Dog** class
- However, we want to re-use that in the **Cat** and **Pony** classes too
- What are our options?

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## The Java, C# Answer

- There's only single inheritance
- You can write an interface, which specifies that a class must implement a **walk** method
- Write a separate class that implements the **walk** method
- You can use delegation (hand coded)
- Sucks

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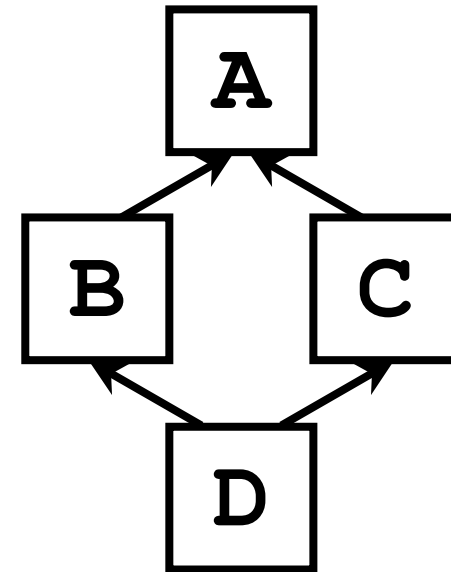
## The Multiple Inheritance Answer

- Write a separate class that implements the `walk` method
- Inherit from it to get the method
- Feels wrong linguistically
  - “A dog is a walk” – err, no
  - “A dog does walk” – what we want
- Multiple inheritance has issues...

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## Multiple Inheritance Issues

- The diamond inheritance problem
  - Do we get two copies of A's state?
  - If B and C both have a **walk** method, which do we choose?
- Implementing multiple inheritance is tricky too



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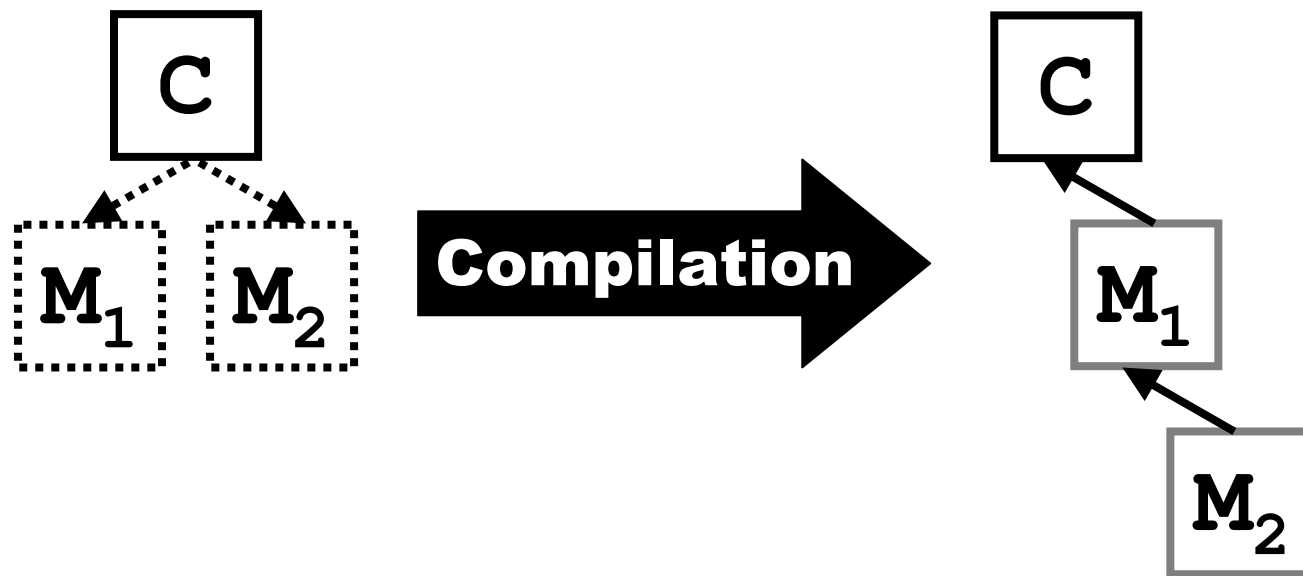
## Mix-ins

- A mix-in is a group of one or more methods that can not be instantiated on their own
- We take a class and “mix them in” to it
- Essentially, these methods are added to the methods of that class
- Write a **Walk** mixin with the **walk** method, mix it in.

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## How Mix-ins Work

- Defined in terms of single inheritance



- **C** with **M<sub>1</sub>** and **M<sub>2</sub>** mixed in is, essentially, an anonymous subclass

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## Issues With Mix-ins

- If  $M_1$  and  $M_2$  both have methods of the same name, which one is chosen is dependent on the order that we mix in
  - Fragile class hierarchies again
- Further, mix-ins end up overriding a method of that name in the class, so you can't decide which mix-in's method to actually call in the class itself

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## The Heart Of The Problem

- The common theme in our problems is the inheritance mechanism
- Need something else in addition
- We want
  - To let the class be able to override any methods coming from elsewhere
  - Explicit detection and resolution of conflicting methods

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## Flattening Composition

- A role, like a mix-in, is a group of methods
- If a class **does** a role, then it will have the methods from that role, however:
  - If two roles provide the same method, it's an error, unless the class provides a method of that name
  - Class methods override role methods

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## Creating Roles

- Roles are declared using the **role** keyword
- Methods declared just as in classes

```
role Walk {  
  method walk($num_steps) {  
    for 1..$num_steps {  
      .step for @paws;  
    }  
  }  
}
```

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## Composing Roles Into A Class

- Roles are composed into a class using the **does** keyword

```
class Dog does Walk {  
    ...  
}
```

- Can compose as many roles into a class as you want
- Conflict checking done at compile time
- Works? Not quite...

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## Composing Roles Into A Class

- Notice this line in the `walk` method:

```
.step for @paws;
```

- Can state that a role “shares” an attribute with the class it is composed into using `has` without `.` or `!`

```
has @paws;
```

- Note: to use this currently in Pugs, you must use:

```
.step for @!paws;
```

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## Additional Safety

- We want to be sure that when we compose our role, the items in `@paws` will have the `step` method.
- Assuming the `Paw` class has the `step` method, we can add a type annotation to the `has` declaration in both the role and the class, stating that elements of the array must be of the class `Paw`.

```
has Paw @paws;
```

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## Parametric Polymorphism

- Polymorphism = code can work with values of different types
- Parametric = a type takes a parameter; we pass a type variable whenever we use the type
- What is the type of the invocant (self) for a method in a role?
  - That of the class we compose it into

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## Parametric Polymorphism

- The types of roles are therefore parametric
- They are parameterised on the type of the class that we compose the role into
  - Compose Walk into class Dog, the invocant has type Dog
  - Compose Walk into class Cat, the invocant has type Cat

# **Constraints**

## Refinement Types

- A type classifies a value
  - For example, 42 is an integer
- Therefore for each type there is a (possibly infinite) set of values that could be classified as that type
- Constraints are refinement types
  - Take an existing type
  - Restrict the values in it further

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## EvenInt

- An EvenInt will be a refinement of the Int type that can only hold even values
- Declare it using the **subset** keyword

```
subset EvenInt of Int
  where { $^n % 2 == 0 };
```

- Variables with the secondary sigil  $\wedge$  hold parameters that the block has been passed; the lexicographically first name gets the first parameter, etc.

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## Making Walk More General

- We may want to use the **Walk** role for humans too
- Humans have feet, not paws
- We'd like **@paws** to contain something that has the **step** method, but in reality it may contain **Foot** or **Paw** objects

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## Making Walk More General

- Define a refinement type that requires the **step** method (Any = any type)

```
my subset Walkable of Any  
  where { .can('step') };
```

- Use this in the **has** declaration in the class and the role

```
has Walkable @paws;
```

## Understanding Roles, Constraints And Classes

**Finally...**

**~ two months  
ago, Arnhem in  
Holland was  
invaded by...**

## Understanding Roles, Constraints And Classes



# Parrot Hackers!

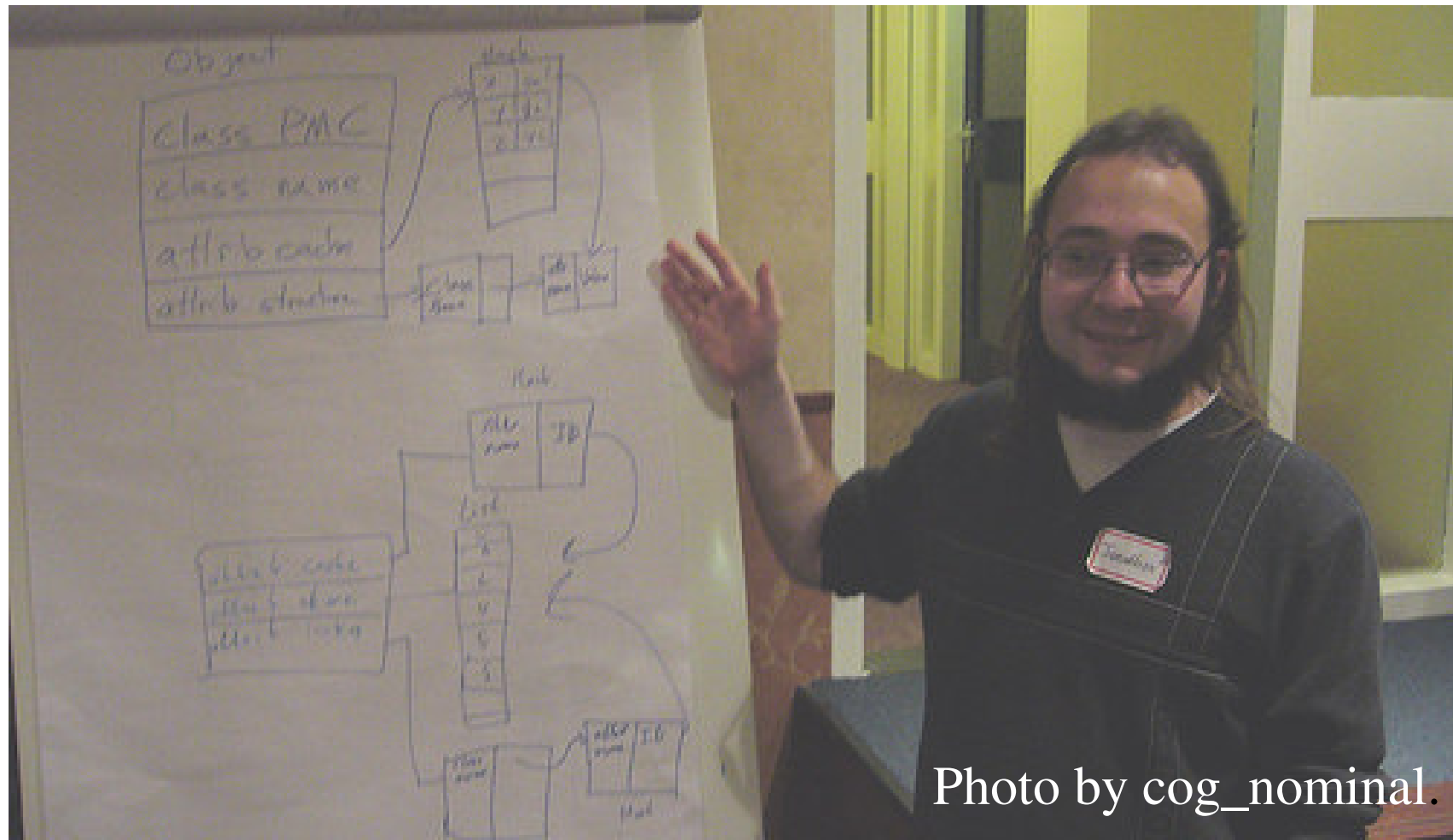
**Result: classes,  
objects and  
roles design  
overhauled**

**Overhauled**

**==**

**Actually capable  
of supporting  
Perl 6 now**

# Understanding Roles, Constraints And Classes



# Taa-daa!

**95%+ implemented  
in the latest Parrot  
release, made  
earlier this month**

**For the first time,  
Parrot supports  
roles and  
introspection.**

A small, white, scruffy-haired dog, possibly a West Highland White Terrier, is standing on a dark, wet surface at night. The dog's mouth is open, and its pink tongue is hanging out. It is looking towards a speech bubble that points to its mouth. The dog is wearing a pink collar with a silver ring. The background is dark, with some green grass visible in the foreground and a grey, textured wall on the left.

**woof!**

**Parrot  
rocks!**

**The End**

# Questions?