More Modules

Inheritance, Exporting, documentation, testing

Inheritance

- Inheritance is the concept that a class can be a "subclass" of another class.
- subclasses ("children") inherit all the methods of their superclasses ("parents")
- In most languages, classes can have at most one parent.
  - single inheritance
- In Perl, classes are allowed to inherit from as many parents as you like
  - multiple inheritance
- Just because this is allowed, doesn't necessarily mean this is a good idea.

Inheriting

- Inheritance is accomplished by specifying a class's parent(s) within that class's package **`@ISA`** array:

-
  ```
  package Student;
  use strict;
  use Person;
  our @ISA = ('Person');
  ```
  - "Student is a Person"
  - compile time: **`use base 'Person';`**
- Whenever a method is called on an object of Student, if that method is not found, Perl searches the Person package for the method.
  - If the method isn't found there, Perl searches Person's parent class(es), etc
  - If multiple inheritance is used anywhere, Perl searches Depth-first through the parent classes.

An example

```
• package Person;
  #. . .
  sub show{
    my $self = shift;
    print "$self->{name} ($self->{SSN})";
  }
• package Student;
  use Person;
  our @ISA = ('Person');
  # or   use base 'Person';
  #. . .
• #!/usr/bin/env perl
  use Student;
  my $stu = Student->new('Paul', 123);
  $stu->show();
```

Method overriding

- What if Student did declare a show method? Which one would be called?
- The answer is Student's would be called on Student objects, and Person's would be called on Person objects
- A subclass's method will always override its parent's method of the same name. The parent's method does not get called at all.
- This leads to the (possibly surprising) conclusion that a subclass's constructor does not implicitly call its parent's constructor.

Creating a new object

```
• package Person;
  sub new {
    my $class = shift;
    my $self = {name=>$_[0], SSN=>$_[1]};
    bless $self, $class;
  }
• package Student;
  sub new {
    my $class = shift;
    my ($name, $ssn, $id) = @_;
•   my $self = Person->new($name, $ssn);
    $self->{id} = $id;
•   bless $self, $class;
  }
```

Eliminate Hardcoding

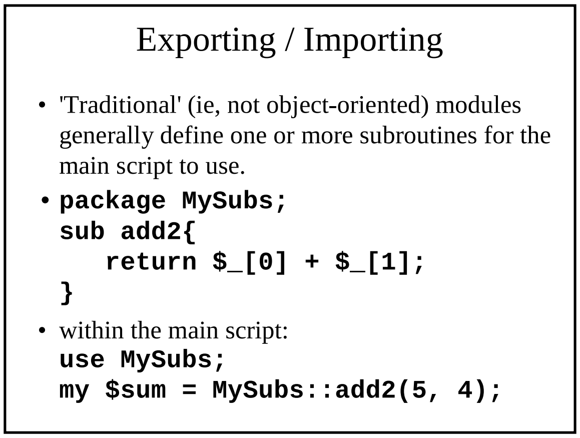
- It's almost never a good idea to hardcode the name of the superclass, any more than you want to hardcode the name of the current class.
- Instead of explicitly saying "Person", you want to say "the superclass of this class"
- **`my $self = $class->SUPER::new();`**
- This tells perl to start looking in the classes from **`@ISA`** for the **`new()`** method.
- This is also how you'd bypass any other method in the current class, if you wanted a method of the same name from the parent class.

Best Practice

- When creating an inherited class, the first thing you should do is the "empty class test"
-
```
package Child;
use Parent;
our @ISA = ('Parent');
1;
```
- you should now be able to create an instance of Child, and use it as though it was a Parent, without any other changes.

Automatic conversions

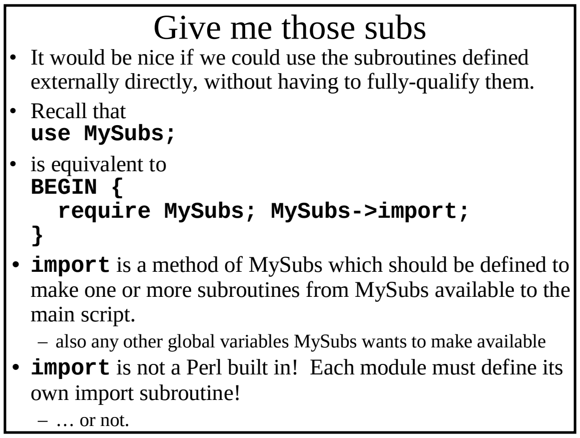
- Recall that a class method of the form:
  `my $person = Person->new();`
- is translated by Perl to:
  `my $person = Person::new('Person');`
- If Student is a subclass of Person, Perl attempts to resolve
  `my $student = Student->new();`
  as: **`my $student = Student::new('Student');`**
- However, if the Student package doesn't define a new() method, Perl looks in Student's parent classes, and instead calls:
  `my $student = Person::new('Student');`
- This is why constructors should bless into the class passed in, rather than just into the current package.



Exporting / Importing

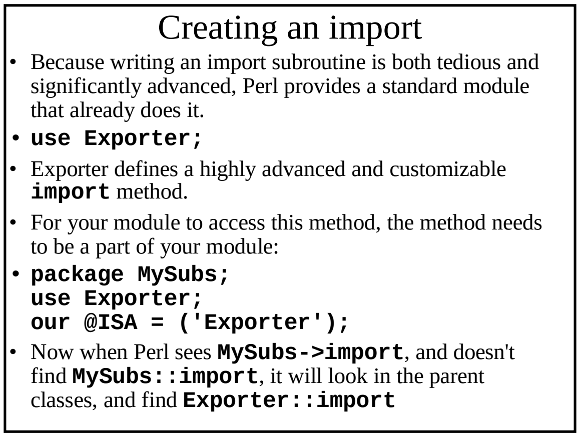
- 'Traditional' (ie, not object-oriented) modules generally define one or more subroutines for the main script to use.

-
  ```
  package MySubs;
  sub add2{
     return $_[0] + $_[1];
  }
  ```
- within the main script:
  ```
  use MySubs;
  my $sum = MySubs::add2(5, 4);
  ```



Give me those subs

- It would be nice if we could use the subroutines defined externally directly, without having to fully-qualify them.
- Recall that
  ```
  use MySubs;
  ```
- is equivalent to
  ```
  BEGIN {
    require MySubs; MySubs->import;
  }
  ```
- **`import`** is a method of MySubs which should be defined to make one or more subroutines from MySubs available to the main script.
  - also any other global variables MySubs wants to make available
- **`import`** is not a Perl built in! Each module must define its own import subroutine!
  - … or not.



Creating an import

- Because writing an import subroutine is both tedious and significantly advanced, Perl provides a standard module that already does it.

-
  ```
  use Exporter;
  ```
- Exporter defines a highly advanced and customizable **`import`** method.
- For your module to access this method, the method needs to be a part of your module:

-
  ```
  package MySubs;
  use Exporter;
  our @ISA = ('Exporter');
  ```
- Now when Perl sees **`MySubs->import`**, and doesn't find **`MySubs::import`**, it will look in the parent classes, and find **`Exporter::import`**

What and how to Export

- `Exporter::import` looks for three ***package*** variables which define what to export
- `@EXPORT` defines items that are imported by default
- `@EXPORT_OK` defines items that can be imported upon request
- `%EXPORT_TAGS` defines groups of items that can be imported together
- Any module that inherits from Exporter should define these three ***package*** variables.

Exporting Example

-
  ```
  package MySubs;
  use Exporter;
  our @ISA=('Exporter');
  ```

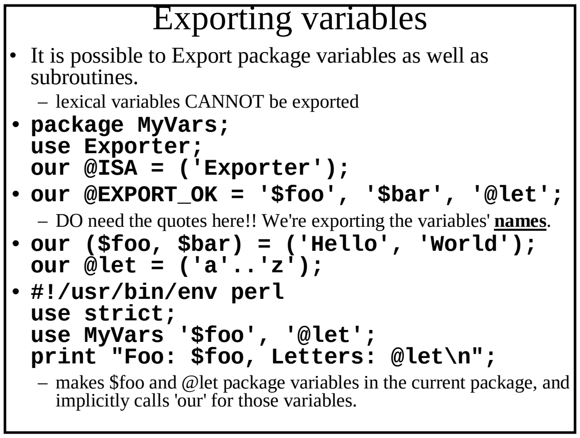
-
  ```
  our @EXPORT = qw/add2/;
  our @EXPORT_OK = qw /add3 add4/;
  our %EXPORT_TAGS = (
    all => [qw/add2 add3 add4/]
  );
  ```

-
  ```
  sub add2 { … }
  sub add3 { … }
  sub add4 { … }
  ```

-
  ```
  1;
  ```

Importing Examples

- **`use MySubs;`**
  - &add2 now available for direct use.
- **`use MySubs ('add2', 'add3');`**
  - &add2 and &add3 imported
  - items in @EXPORT can be requested, just like @EXPORT_OK
- **`use MySubs ();`**
  - nothing imported, not even from @EXPORT
- **`use MySubs (':all');`**
  - everything in **`@{$EXPORT_TAGS{all}}`** imported
- **`use MySubs ('add4');`**
  - JUST &add4, nothing from @EXPORT
- **`use MySubs (':DEFAULT', 'add4');`**
  - Everything from @EXPORT, plus &add4



Exporting variables

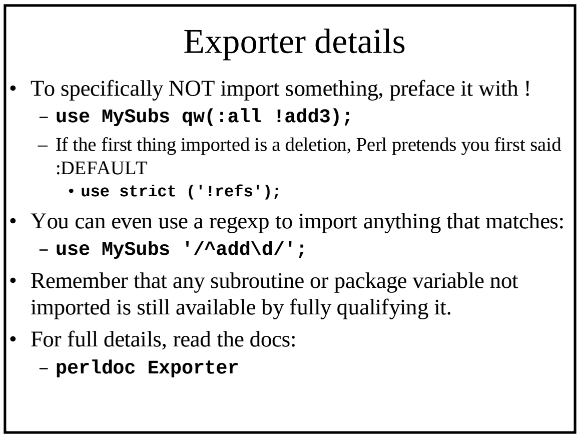
- It is possible to Export package variables as well as subroutines.
  - lexical variables CANNOT be exported

-
  ```
  package MyVars;
  use Exporter;
  our @ISA = ('Exporter');
  ```

-
  ```
  our @EXPORT_OK = '$foo', '$bar', '@let';
  ```
  - DO need the quotes here!! We're exporting the variables' **names**.

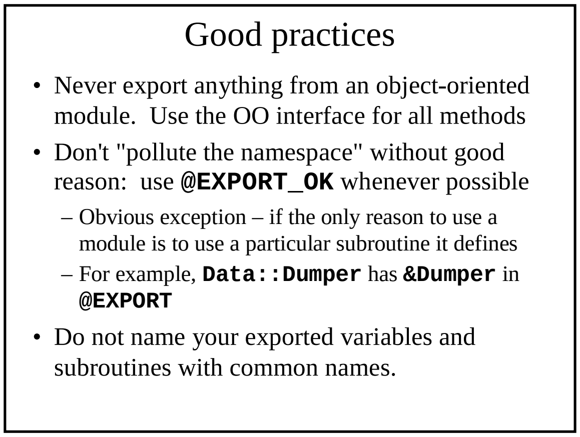
-
  ```
  our ($foo, $bar) = ('Hello', 'World');
  our @let = ('a'..'z');
  ```

-
  ```
  #!/usr/bin/env perl
  use strict;
  use MyVars '$foo', '@let';
  print "Foo: $foo, Letters: @let\n";
  ```
  - makes $foo and @let package variables in the current package, and implicitly calls 'our' for those variables.



Exporter details

- To specifically NOT import something, preface it with !
  - `use MySubs qw(:all !add3);`
  - If the first thing imported is a deletion, Perl pretends you first said :DEFAULT
    - `use strict ('!refs');`
- You can even use a regexp to import anything that matches:
  - `use MySubs '/^add\d/';`
- Remember that any subroutine or package variable not imported is still available by fully qualifying it.
- For full details, read the docs:
  - `perldoc Exporter`



Good practices

- Never export anything from an object-oriented module. Use the OO interface for all methods
- Don't "pollute the namespace" without good reason: use **`@EXPORT_OK`** whenever possible
  - Obvious exception – if the only reason to use a module is to use a particular subroutine it defines
  - For example, **`Data::Dumper`** has **`&Dumper`** in **`@EXPORT`**
- Do not name your exported variables and subroutines with common names.

Documentation

- Documenting your modules is always a good idea.
- Comments are decent, but creating an actual document that explains your module is better
  - You wouldn't want to have to view the source of Data::Dumper to see how to use it.
- Perl allows you to write the documentation for your modules within the modules themselves
- Users can then do **`perldoc MyMod`** to view the documentation.
- The sublanguage for this documentation is POD
  - Plain Old Documentation
  - **`perldoc perlpod`** for a full description

POD your modules

- You should type your POD right into your Perl module file
- the Perl parser knows to look for POD text, and skip over it
- The POD parser knows to skip over sections that are not POD.

POD

- Three kinds of paragraphs, delimited by blank lines both above and below
- 'Normal' paragraph – normal text, just type it as you would any other document
- Preformatted paragraph – start a paragraph with a tab or a space, and the paragraph will not be formatted in any way
  - use this for blocks of code in your documentation
- Command paragraph – start with a = character, to specially format the following text

POD commands

- =head1, =head2, =head3, =head4
  - The text in this paragraph is a heading
  - `=head1 MySubs: Utility functions`
- =over 5, =item *, =back
  - a list of items. '5' will be the number of characters to indent. '*' is the bullet to use for this list item. Any paragraphs between the =item and =back are the text for this list item. =back means the end of the list
- =pod
  - POD begins here. POD actually begins with any command, so use this only to start a 'normal' or preformatted POD paragraph.
- =cut
  - POD ends here. What follows until the next POD line is actual Perl code

Formatting

- Within a normal paragraph, or a list heading, you can format the text
- I<italics text>
- B<bold text>
- C<code text> (fixed-width, unformatted)
- S<non-breaking spaces>
- (see perldoc perlpod for more)

POD Good Practices

- All modules should define standard sections (delimited with one of the =head commands)
  - Name: Name and brief summary of your module
  - Description: Description, common uses
  - Synopsis: Example of how your module is to be used
  - Subroutines/Methods: name, define, and demonstrate each subroutine created
  - See Also: Pointers to any relevant data
  - Copyright: Who created it, when, how to contact you
- Any other sections you think would be useful
- Look at the source of any standard module for examples

Testing

- When creating your modules, you should have a test plan in mind.
- You want to write tests that will insure your module does what it's supposed to.
- Often a good idea to build the tests first, before defining the implementation of your module. Then as you write the module, run the tests to see if you are coding correctly.
- Perl provides several different Test suites to help you out with these
- Two examples: **`Test::Simple`**, **`Test::More`**

Test::Simple

- Exports exactly one subroutine: **`ok()`**
- **`ok()`** takes two values. The first is an expression to evaluate. The second is the name or description of the test.
- If the expression is true, the test succeeded.
-
  ```
  use MyVars qw/$foo @let/;
  use Test::Simple tests=>2;
  ok($foo eq 'Hello', '$foo is correct');
  ok(@let == 26, '@let has 26 letters');
  ```
- Will either print out "ok" or "not ok", followed by the test name.
- At the end, it will tell you how many tests you failed

Test::More

- Drop-in replacement for Test::Simple
- Once you are comfortable using Test::Simple, you should replace it. You can simply change the use statement, and your current test script will continue to work fine.
- Test::More defines additional testing subroutines, with better diagnostics

Test::More testing

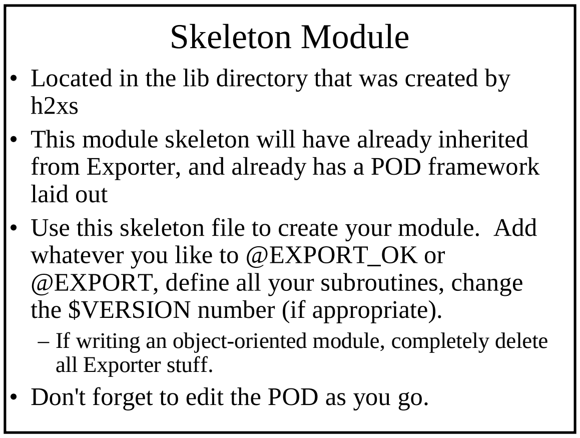
- `is($foo, 'Hello', '$foo set');`
  - Compares $foo to 'Hello' using eq
  - If failed, tells what it got ($foo), and what it was expecting ('Hello')
- `like($bar, qr/world/i, '$bar match');`
  - Checks if $bar =~ /world/i
- `cmp_ok(@stuff, '==', 26,'26 letters');`
  - Compares 1st & 3rd args, using 2nd arg
- `is_deeply(\@foo, \@bar, '@foo==@bar');`
  - Tests all elements of @foo and @bar, deeply and recursively, to see if they are exactly equivalent
- Find more in perldoc **`Test::More`**

Letting Perl do the work

- At this point, you may be getting overwhelmed at the amount of things you have to (or should) do when creating a module
- Fortunately, Perl comes with a tool that sets everything up for you.
- h2xs
  - Legacy name – original main purpose was to translate C header files into XS code
- Now also simply used to get prepared to write a module

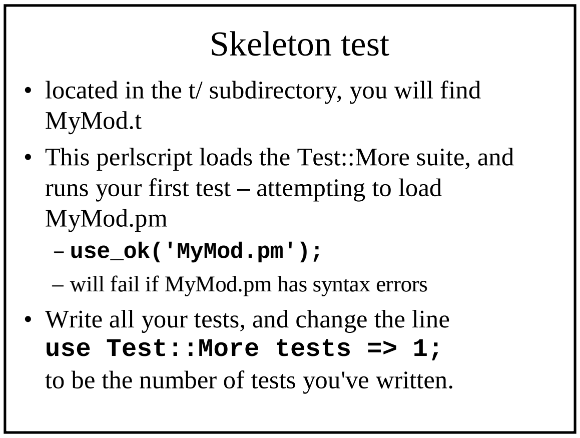
h2xs

- Before you create any files, before you write any tests, run the following program:
  `h2xs –AX –n MyMod`
  - (replace 'MyMod' with the name of your module)
- Several files are created for you.
- Most notably – a skeleton MyMod.pm and a skeleton MyMod.t (for testing)



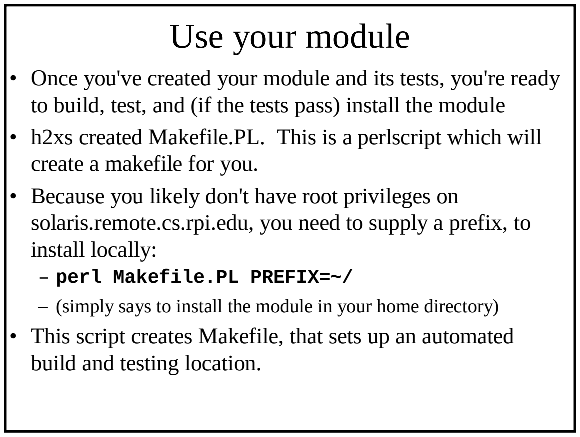
Skeleton Module

- Located in the lib directory that was created by h2xs
- This module skeleton will have already inherited from Exporter, and already has a POD framework laid out
- Use this skeleton file to create your module. Add whatever you like to @EXPORT_OK or @EXPORT, define all your subroutines, change the $VERSION number (if appropriate).
  - If writing an object-oriented module, completely delete all Exporter stuff.
- Don't forget to edit the POD as you go.



Skeleton test

- located in the t/ subdirectory, you will find MyMod.t
- This perlscript loads the Test::More suite, and runs your first test – attempting to load MyMod.pm
  - **`use_ok('MyMod.pm');`**
  - will fail if MyMod.pm has syntax errors
- Write all your tests, and change the line **`use Test::More tests => 1;`** to be the number of tests you've written.



Use your module

- Once you've created your module and its tests, you're ready to build, test, and (if the tests pass) install the module
- h2xs created Makefile.PL. This is a perlscript which will create a makefile for you.
- Because you likely don't have root privileges on solaris.remote.cs.rpi.edu, you need to supply a prefix, to install locally:
  - **`perl Makefile.PL PREFIX=~/`**
  - (simply says to install the module in your home directory)
- This script creates Makefile, that sets up an automated build and testing location.

make

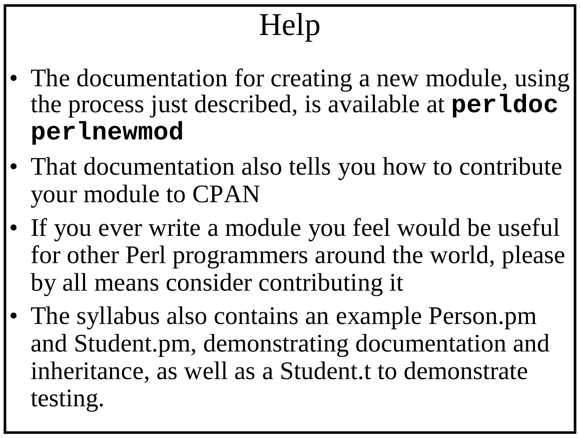
- Once you've created your Makefile, run three commands:
- **`make`**
  - copies your module from the development directory to a build directory (blib/lib)
- **`make test`**
  - Runs all .t files in the t/ directory, and checks for the "ok" messages. Reports total number of passes and failures.
  - By default, only shows results of tests that failed. To get full output, run
    `make test TEST_VERBOSE=1`
- **`make install`**
  - If all tests passed, run this to install your module into your library, so main scripts can use it.

Where'd it go?

- On solaris.remote, your module will be installed in **`~/lib/perl5/site_perl/5.8.5`**
- Within any Perl script you write that uses your module, make sure you first tell Perl where the module is located:
-
```
use lib
"$ENV{HOME}/lib/perl5/site_perl/5.8.5";
use MyMod;
```
- If your scripts all work with your module, success!

What to submit

- For homework 4, you will be writing two modules.
- I expect everyone to be using the h2xs method just described to create each installation package
- Please name your modules with your RCS Id
  - ex: **`h2xs –AX –n Lallip::MyMod`**
- When you have finished testing and are ready to submit, for each module, run:
  `make dist`
- this will create a "tarball", a tarred and gzipped file containing all of the files that h2xs created and you modified.
  - Lallip-MyMod-0.01.tar.gz
- These tarballs are what you will submit for your homework.



Help

- The documentation for creating a new module, using the process just described, is available at **`perldoc perlnewmod`**
- That documentation also tells you how to contribute your module to CPAN
- If you ever write a module you feel would be useful for other Perl programmers around the world, please by all means consider contributing it
- The syllabus also contains an example Person.pm and Student.pm, demonstrating documentation and inheritance, as well as a Student.t to demonstrate testing.