Introductory Perl

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What is Perl?

- General purpose scripting language developed by Larry Wall in 1987.
- Has many of the characteristics of C, the various Unix shells, as well as text processing utilities like sed and awk

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A very basic Perl script

Start up your favorite text editor and call this 'hello' and enter in the following two lines.

```
#!/usr/bin/perl
print "Hello world!\n";
```

After saving this file, exit the editor and do the following:

```
>chmod u+x hello
```

• Perl programs or 'scripts' are not compiled, but interpreted.

• In Unix, the u+x permission must be set to run the script.

• In Windows, perl scripts have a **.pl** as the file extension so you would call this script **hello.pl** and the chmod command would not be needed.

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We run this script simply by typing:

```
>hello
```

If '.' (current directory) is not in your path, then you must invoke the program as follows:

```
>./hello
```

Assuming no mistakes you should get:

```
Hello world!
```

In Windows, one could also just double click on **hello.pl** (which won't work as expected) or issue the command

```
>hello.pl
```

from within a command shell.

So what's going on?

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```
#!/usr/bin/perl
```

tells Unix that the script which follows is to be processed with the program /usr/bin/perl

- Common mechanism used by Unix scripting languages, utilities and shells
- It may be **/usr/bin/perl** or **/usr/local/bin/perl** depending on your system
- script is run after its syntax is checked first
- In Windows, the **#** isn't needed, but the script is still checked for correctness first.

```
print "Hello world!\n";   # produces output on screen
```

- **\n** is the newline character which puts the cursor at the start of next line
- A semi-colon is needed at the end of (almost) every line in a Perl script.
- Comments can be put on any line, and must start with a **#** character.

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Let's modify our hello script top make it interactive.

```
#!/usr/bin/perl
print "What is your name? ";
$name=<STDIN>;
chomp($name);
print "Hello there $name.\n";
```

If we run this, we get

```
>hello  ( or ./hello if your shell is misconfigured)

What is your name?  Tim

Hello there Tim.
>
```

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So what's happening here?

First we prompt the user for their name,

```
print "What is your name? ";
```

and then take input from the keyboard:

```
$name=<STDIN>;
```

This takes a line of **standard input** and assign it to the variable **`$name`**

(We'll discuss variable nomenclature in the next section.)

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Since the line of standard input includes a **`\n`** at the end (when we hit **ENTER**) this gets removed or '**chomped**' by the command

```
chomp($name);
```

(This 'chomping' is something you should get used to seeing and using in any perl script which takes input.)

Finally, we say hello

```
print "Hello there $name.\n";
```

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Perl Variables and Operators

In Perl, there are three basic data types:

- Scalars
- Arrays
- Associative arrays (also called hashes)

Unlike C or C++, for example, there is no need to specify names or types of variables at the beginning of a program.

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Scalars

Scalars consist of integer or floating point numbers or text strings.

Scalar variables begin with a **$** followed by their name which can consist of either letters (upper or lower case) or **_** or numbers, with some exceptions which we'll discuss.

Ex:

```
$x = 3.5;
$name = "Tim";
$A_very_long_and_silly_looking_variable_name = 2;
```

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All numbers in Perl are double precision floating point numbers (integers too!)

Ex:

```
$x=3;
$y=-5.5;
$z=6.0E23;    # exponential notation for 6 x 10^23
```

One can also work in Octal (base 8) or Hexadecimal (base 16) as well.

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As for strings, the only two types are single and double quoted.

Ex:

```
$x = "Hello\n";     # Hello followed by newline
$y = 'Hello\n';     # literally Hello\n
```

Within double quotes, special characters like **\n**, are interpreted properly.

Ex:

\n	newline
\t	tab
\"	literally "
****	literally \

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So if we have

```
print "Left\tMiddle\tRight\n";
```

we get

```
Left  Middle      Right
```

For single quoted strings, however, what's in quotes gets printed as is.

```
print
'Left\tMiddle\tRight\n';
```

yields

```
Left\tMiddle\tRight\n
```

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Also, if you wish to embed variables inside strings and have the value substituted in properly, you must use double quotes.

Ex:

```
$name="Tim";
print "Hello $name\n";
```

will produce

```
Hello Tim
```

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The typical operators for numerical values are present:

```
+,-,*,/
```

There is also an exponentiation operator,

```
2**3;      # 8 since 2^3 = 8
```

as well as a 'modulus' operator for taking remainders

```
5 % 2;     # 1, since 5 divided by 2 leaves remainder 1
```

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Additionally, there are the autoincrement **++** and autodecrement **--** operators as in C.

```
$a=2;
++$a; # $a now equals 3
--$a; # $a now equals 2 again
```

Note, these also can be applied to character values as well.

Ex:

```
$x="A";
++$x;   # $x now equals B
```

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For strings, there is a concatenation operator for combining two (or more) strings

It is given by **.** (a period)

Ex:

```
$x="Hello";

$y="There";

$z=$x.$y;   # $z is now "HelloThere"
```

Note, if you want a space in between, you can do this

```
$z=$x." ".$y;     # $z is now "Hello There"
```

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We saw earlier the **chomp()** function removes a trailing newline character if one is present.

Ex:

```
$a="Hello There\n";
chomp($a);  # $a now equals "Hello There"


$b="Hi There";
chomp($b);  # $b still equals "Hi There"
```

There is also the function, **chop()**,which removes the last character in a string, whether it is a newline or not, but this is deprecated.

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Making Comparisons

If we wish to compare two scalars then we **must** choose the appropriate comparison operator.

Comparison	Number	String
equal	`==`	`eq`
not equal	`!=`	`neq`
less than	`<`	`lt`
greater than	`>`	`gt`
less than or equal	`<=`	`le`
greater than or equal	`>=`	`ge`

Ex: `"023" < "23"` is false, but
`"023" lt "23"` is true

so be aware of the data you are working with when making comparisons.

We'll use these later, in the section on control structures.

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Arrays

In Perl, arrays are lists of scalar values, either strings, or numbers.

Array variables, as a whole, are prefixed with the `@` sign followed by the array name which can consist of either letters, numbers, or `_` characters.

They can be created and modified in a variety of ways, the simplest is to just list the elements in the array.

Ex:

```
@X=(5,11,-6,12);

@People=("Tom","Dick","Harry");

@DaysOfWeek=("Mon","Tue","Wed","Thu","Fri","Sat","Sun");

@stuff=("Hi",3.1415,6,"Bye\n"); # mix and match!
```

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Array elements are indexed starting from **0** and are accessed as follows:

Ex:

```
@X=(5,11,-6,12);
print "$X[2]\n";
```

yields

```
-6
```

That is, if the array is named **@X** then the i^{th} element is **$X[i]**

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Adding elements to an array can be done in several ways.

Ex:

```
@People=("Tom","Dick");
@People=(@People,"Harry")
```

So now,

```
@People=("Tom","Dick","Harry");
```

Note, if one instead did

```
@People=("Harry", @People);
```

then

```
@People=("Harry","Tom","Dick");
```

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One can also add an element by means of the array index.

Ex:

```
@X=(3,8,-2);
$X[3]=5;
```

So now

```
@X=(3,8,-2,5);
```

That is, we have added a **fourth** element to the array. (at array index **3**)

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One can also copy arrays in a very simple manner.

```
@Names=("Tom","Dick","Harry");
@CopyOfNames=@Names;
```

So now,

```
@CopyOfNames=("Tom","Dick","Harry");
```

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One can also take a 'slice' of an array.

Ex:

```
@Planets=("Mercury","Venus","Earth","Mars",
          "Jupiter","Saturn","Uranus",
          "Neptune","Pluto");

@InnerPlanets=@Planets[0..3];
```

So now, `@InnerPlanets=("Mercury","Venus","Earth","Mars");`

Also, one may include other ranges, e.g.

`@SomePlanets=@Planets[0..1,7..8];`

thus `@SomePlanets=("Mercury","Venus","Neptune","Pluto");`

(Keep in mind, element **0** is the first element in the array.)

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Combining two arrays is also very easy:

Ex:

```
@People=("Tom","Dick","Harry");

@MorePeople=("John","Jim");

@Combined=(@People,@MorePeople);
```

So now,

```
@Combined=("Tom","Dick","Harry","John","Jim");
```

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There is a built-in **`sort()`** function for sorting the elements of an array.

Ex:

```
@People=("Tom","Dick","Harry");
@People=sort(@People);
```

`@People` now equals **`("Dick","Harry","Tom");`**

• By default, the sorting is based on the ASCII (i.e. dictionary) value of the strings.

• There is also a way to sort arrays in numerical order.

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Associative Arrays

An associative array is a structure consisting of pairs of scalars, a key and a value, such that each value is associated to a key.

Associative array variables, as a whole, are prefixed with `%` followed by the name which can consist of either letters or numbers or **_** characters.

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As with regular arrays, individual elements are accessed with a **$**.

Typically, associative arrays are created and augmented on the fly, just by giving key and value pairs.

Ex:

```
$Grade{"Tom"}="A";

$Grade{"Dick"}="B";
```

note {} instead of **[]** for associative arrays

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That is, **%Grade** is an associative array with (right now) two key and value pairs, which were given by the two assignment statements.

We could have also done this with the following statement:

```
%Grade = ("Tom" => "A","Dick" => "B");
```

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A very useful function to apply to an associative array is **`keys()`**

As the name suggests, this returns all the keys in a given associative array, in ordinary array form.

Ex:

```
%Grade=("Tom"=>"A","Dick"=>"B","Harry"=>"C");

@Students=keys(%Grade);
```

`@Students` now equals **`("Tom","Dick","Harry")`**

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undefined values

If a scalar value is referred to, but has not been assigned a value, Perl gives it the default value of **undef** which literally means undefined.

So, for example, if **`$a`** has not been defined, then

```
print "$a";
```

will produce no output, but will not generate an error either.

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Likewise

```
@X=(3,7,9,2);
print "$X[10]";
```

will produce no output.

The point being that any array element not yet defined has the value **undef**.

And if

```
%Grade=("Tom" => "A","Dick"=>"B");
```

then **`$Grade{"Harry"}`** is **undef** since we have not given it a value.

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Perl Control Structures

In Perl, there are a variety of familiar loop structures and conditionals. Some of the syntax is similar to C.

All of these are built around what's known as a statement block which is simply a sequence of statements, surrounded by **`{`** and **`}`**

Conditionals

Ex:

```
$entry=<STDIN>;
chomp($entry);
if($entry eq "Thank You"){
    print "You are Welcome!\n";
}
```

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The conditional itself

```
$entry eq "Thank You"
```

is within parentheses and the value returned is either true or false.

If true, then the block within `{` and `}` is executed.

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Before going further, here is a basic guide as to what is true or false in Perl:

- `"0"` and `""` (the empty string) and **undef** are false.
- all else is true*

What Perl does, is to first convert any scalar to string, then apply the above rules.

* Note, "0.0" evaluates to true since, as a string, "0.0" is not "0"

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Why should we care that **"0"** and **undef** are false?

Ex:

```
if($go){
      print "Time to go!\n";
}
```

This print statement won't be invoked if the variable **$go** has not been set. e.g the value of this variable is based upon some input from the user.

This can be useful as we will see in subsequent tutorials.

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In addition to **if,** one also has an **else** construction.

```
print "What\'s the password? ";
$entry=<STDIN>;
chomp($entry);
if($entry eq "FOOBAR"){
      print "Access Granted\n";
}else{
      print "Incorrect Password!\n";
}
```

If the conditional is true, **($entry eq "FOOBAR")** then the print statement inside the first set of **{** and **}** is executed,

otherwise the **"Incorrect Password!"** message gets printed.

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Also, one can combine conditionals using

`&&`	logical and
`||`	logical or

```
if(($day eq "Monday") && ($time eq "7AM")){
      print "Time to get up!\n";
}
```

Logical **not** is given via `!`

```
if(!($password eq ”FOOBAR")){
      print "Access Denied\n";
}
```

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loops

One has many of the familiar loop constructions.

Consider the following examples.

Ex:

```
$n=1;
$sum=0;
while($n<=10){
      $sum = $sum + $n;
      $n++;
}
print "The sum of the numbers from 1 to 10 is $sum\n";
```

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A useful example of a while loop is one which takes multiple lines of standard input and process each line in some fashion. For example:

```
#!/usr/bin/perl
while($line=<STDIN>){
       chomp($line);
       print "[$line]\n";
}
```

This keeps repeating as long as there is input to be read in.

If we call this script 'bracket' then we can take input from a Unix pipe and surround each line with `[]` for example

```
> ls –al | bracket
```

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There is also a **`for`** statement.

Ex:

```
$sum=0;
for($n=1;$n<=10;$n++){
       $sum = $sum + $n;
}
print "The sum is $sum\n";
```

The general syntax is:

```
for(initial_expression;test_expression;increment_expression){
       statement block
}
```

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There is a nice generalization of **`for()`** used to loop over the elements of an array.

Ex:

```
@People=("Tom","Dick”,"Harry");
foreach $person (@People){
      print "$person\n";
}
```

yields (as you might expect)

```
Tom
Dick
Harry
```

Note, this works regardless of the size of the array.

Also, one does not need to keep track of the array index.

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One can use the **`foreach()`** function together with the **`keys()`** function to examine the contents of an associative array.

Ex:

```
%Grade=("Tom"=>"A",
        "Dick"=>"B",
        "Harry"=>"C"
        );
@People=keys(%Grade);
foreach $person (@People){
      print "$person received a $Grade{$person} \n";
}
```

i.e.

`keys(%Grade)` is the array **`("Tom","Dick","Harry")`**
extracted from the associative array **`%Grade`**;

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Regular Expressions (a.k.a. 'regexps')

- one of the most powerful features of Perl
- process text using what are known as regular expressions
- regular expressions are a means of doing pattern matching on strings.

The general syntax for a pattern is

```
/pattern/
```

where **pattern** is the text pattern we are trying to describe.

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The general syntax to see if a string matches a certain pattern is:

```
$x =~ /pattern/
```

pattern matching operator

For example, to see if **$x** contains the word **hello** we might write:

```
if($x =~ /hello/){
      #do something
}
```

i.e. If the pattern matches, then the conditional has value true.

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By default, pattern matching is case sensitive, so the following strings would match:

```
$x="hello there"
$x="I just called to say hello"
$x="Othello by William Shakespeare"
```

yes! this is a match

but something like

```
$x="Hello to you!"
```

would not (the capital H makes a difference)

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Note, to ignore the distinction between upper and lower case one can do the following:

```
if($x =~ /hello/i){
      #do something
}
```

The **i** after the **/** means *ignore* case.

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One way to make the pattern more flexible is to use alternation.

Ex:

```
$x =~ /th(is|at)/
```

is true if **$x** matches either

this or that

The **(|)** allows us to choose one or more possibilities.
For example, we could do:

```
$x =~ /th(is|at|en)/
```

to look for '**this**' '**that**' or '**then**'

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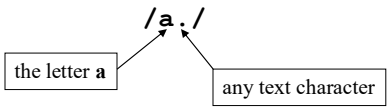
Regular expressions allow us to be quite general about the patterns we look for.

Ex: Match all strings which have the letter **a** followed by *at least one* text character. (i.e. something other than \n)



So these would match

```
"apple"
"this and that"
```

but not

```
"a"
"a\n"
```

} no text characters after the **a**

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For more variability, we can also match on multiples of characters.

multipliers.

`*`	**zero or more** occurrences of the *previous* entity
`+`	**at least one** of the *previous* entity
`?`	**0** or **1** instances of the *previous* entity
`{n}`	**n** instances of the *previous* entity
`{m,n}`	between **m** and **n** instances of the *previous* entity

Ex:

```
/be*t/
```

would match **"bet"** and **"beet"** or even **"bt"**

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If we change ***** to **+** then

```
/be+t/
```

matches **"bet"** and **"beet"** but not **"bt"**
since the **e+** means at least one instance of the letter **e**

If we change this to say

```
/b.+t/
```

then this would match **"boot", "belt", "bet", "bat", "b t"** etc.
since **.+** means match one or more of any character

Again, the pattern just has to exist somewhere in the string in order to match.

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classes

Say we wish to see if there is a vowel somewhere in a given string.

We could do this as follows.

```
if($x=~/[aeiou]/){
      print "Found a vowel!\n";
}
```

The `[ ]` indicates a specific **class** of characters which we want to match.

In this case, one of the five vowels.

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If we wish to match any lower case letter, then we can use

```
/[a-z]/     # i.e. all the letter from a to z
```

to include upper case letters we use

```
/[a-zA-Z]/ # all letter from a to z and A to Z
```

Likewise, we can also match digits.

```
/[0-9]/
```

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There are also a number of pre-defined classes one can use which have abbreviations.

description	class	abbreviation
digits	**[0-9]**	**\d**
words	**[a-zA-Z_]**	**\w**
space	**[\n\r\t\f]**	**\s**

literally a space

These classes are useful particularly when constructing complicated patterns.

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To negate a class, use **[^]**

ex. **[^x]** everything <u>but</u> the letter x

\W	non-word characters	**[^a-zA-Z_]**
\S	non-space characters	**[^ \r\n\t\f]**
\D	non-digit characters	**[^0-9]**

One can combine pre-defined classes to make larger classes.

Ex:

```
$x=~/[\w\d]/
```

matches words **and** digits

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anchoring patterns

Suppose we wish to specify where in a string a given pattern is matched.

For example, say we wish to see if a given string starts with a capital letter.

```
$sentence =~ /^[A-Z]/
```

The **^** is to test if the pattern is matched at the beginning of the string.

Note, due to an unfortunate reuse of symbols, this is *not* the same as class negation seen earlier.

i.e. **`/[^A-Z]/`** means match everything *but* A-Z !!

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Likewise, we could test if a certain pattern is matched at the end of a string.

i.e. Say we wish to check if a certain string ends with the letter **e**

We could use the following:

```
$x =~ /e$/;
```

So this would match if

```
$x = "the"
```

but not if

```
$x = "the rest"
```

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One can also anchor a pattern at a **word boundary** using the directive **\b**

Such a boundary occurs at the beginning of a string (or end) or at a transition from a **\w** to a **\W** or vice versa.

Ex:

```
$x =~ /the\b/;
```

matches if

$x="the"** or **$x="the end"

but not

$x="then"

Matching somewhere that is **not** a word boundary can be done with **\B**

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References for further information on Perl

Books

- Learning Perl by Randal L. Schwartz & Tom Christiansen (O'Reilly)
- Programming Perl by Larry Wall, Tom Christiansen and Jon Orwant (O' Reilly)
- Perl in a Nutshell by Ellen Siever, Stephen Spainhour, and Nathan Patwardhan (O' Reilly)

Web

http://www.perl.com

http://math.bu.edu/people/tkohl/perl ← My Perl Page!

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