Mastering Perl

by brian d foy
The Perl Review
version 1.71
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Contents

Introduction

The path to mastery 3

Modulinos

Jury rigging modules

Data Security

Profiling

Conclusion

Questions

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Introduction

About this course

- Selected topics based on *Mastering Perl*
- Mostly *not* about syntax or wizardly tricks
- Not for masters, but people who want to control Perl code
- Not necessarily the way to do it, just the way I've done it
- Create "professional", robust programs other people can use
- We'll cover

  * modulinos

  * jury rigging

  * profiling

  * security

The path to mastery

- The guild system had a progression of skills
- Apprentices were the beginners and worked with supervision
- Journeymen were competent in their trade
- Masters taught journeymen
- Journeymen studied under different masters
    - * different masters teach different tricks and methods
    - * journeyman develop their own style
- A masterpiece showed that a journeyman mastered his trade

Modulinos

Programs versus modules

- For most people, programs or scripts are our main effort in everyday work.
- However, all of the good development tools are for modules, including tools for:

  * Testing

  * Packaging

  * Distribution

  * Installation

- We can combine the two so programs get the benefits of modules.
- A *modulino* is a little module that acts like both a module and a program. It just needs to serve the application instead of the general case.

Bring back main()

- In some languages, I have to let the computer know where to start my program:

```
/* hello_world.c */

#include <stdio.h>

int main ( void ) {
 printf( "Hello C World!\n" );

 return 0;
 }
```

- A Perl program implies a `main()` loop for us as the `main::` package. Normally I write:

```
print "Hello Perl World!\n";
```

Bring back main(), continued

- I can rewrite that to bring back `main()`:

```
#!/usr/bin/perl

sub main {
 print "Hello Perl World!\n";

 # Perl still adds the exit 0 for us
 }
```

- However, the Perl program doesn’t know where to start!

Tell Perl where to start

- Since `main()` isn't special, I have to tell Perl what to run:

```
#!/usr/bin/perl

main();

sub main {
 print "Hello Perl World!\n";
 }
```

- Calling it `run()` sounds more like what I want:

```
#!/usr/bin/perl

run();

sub run {
 print "Hello Perl World!\n";
 }
```

- I'm at the same place I started, but now I can take the next step to make it a modulino.

Make it a module

- A module is really a package with some subroutines. Sometimes it’s a classical library, and other times it’s an object-oriented class.

- Modules compile code but don’t run code until we tell it too.

- With my `run()` subroutine, I almost have the same setup as a regular module.

- I add an explicit package and treat `run()` as a class method. I save it in *MyApplication.pm*.

```
#!/usr/bin/perl

package MyApplication;

__PACKAGE__->run();

sub run {
 print "Hello Perl World!\n";
 }
```

Make it a module, continued

- I’m still running code just by loading this module (assuming `.` is in `@INC`):

```
$ perl -MMyApplication -e 'dummy program'
Hello Perl World!
```

- And I can still run it as a script:

```
$ perl MyApplication.pm
Hello Perl World!
```

Who’s calling?

- `caller()` gives us information about the call stack.
- It’s usually part of a subroutine:

```
#!/usr/bin/perl

my @caller_info = caller();
print "top: @caller_info\n";
middle();

sub middle {
 my @caller_info = caller();
 print "middle: @caller_info\n";
 bottom()
 }

sub bottom {
 my @caller_info = caller();
 print "bottom: @caller_info\n";
 }
```

Who’s calling?, continued

- It returns the package, filename, and line number of the code that invoked the subroutine:

```
top:                                       # empty list for the top level
middle: main /Users/brian/Desktop/caller.pl 5
bottom: main /Users/brian/Desktop/caller.pl 10
```

caller() in a module

- In scalar context, `caller()` returns true if it is not at the top level (so, something called the current code).

- As a module, the caller is the code that loaded the modulino:

```
#!/usr/bin/perl

package MyCalledApplication;

print "Caller was true!\n" if caller();
```

- From the command line, `caller()` returns true if I load the modulino with `-M`:

```
$ perl -MMyCalledApplication -e 'dummy program'
Caller is true!
```

- As a program, `caller()` returns false because it is at the top level.

```
$ perl MyCalledApplication.pm
$
```

no output because caller is false

caller() in a module, continued

- Now I know how to tell if I am using a file as a modulino or a program: just check `caller()`:

  * true: modulino

  * false: program

Compile as a module, run as a program

- When I load *MyApplication.pm* as a module, I don’t want it to run yet.
- If it acts like a library then I can load it and use its subroutines, especially for unit testing.
- I have to delay my call to my `run()`, and I can use caller to do that.
- We don’t want to run as a program is `caller()` returns true:

```
#!/usr/bin/perl

package MyApplication;

__PACKAGE__->run() unless caller();

sub run {
 print "Hello Perl World!\n";
  }
```

Testing our program

- Most programs are hard to test because I can’t get at the pieces of them without running all of the other stuff.
- If I write my programs as modules and separate portions into subroutines, I can test it just like any other module.

```
use Test::More tests => 3;
use Test::Output;

my $class = 'MyApplication';

use_ok( $class );
can_ok( $class, 'run' );

stdout_is(
  sub{ $class->run() },
  "Hello Perl World!\n"
  );
```

can I load the module?

does it have the subroutine I need?

Adding to the program

- Now that I can test parts of it, I should separate it into as many parts as reasonably possible.
  - * There is some overhead with method calls, so don't go crazy
  - * The more I can break it into pieces, the easier it is for other people to subclass.
- Perhaps I don't like the "Hello Perl World!" message. To change it, I have to override all of the `run()` method. That's no fun.

Adding to the program

- Instead, I rewrite *MyApplication.pm* so the action and the data are separate:

```
#!/usr/bin/perl

package MyApplication;

__PACKAGE__->run() unless caller();

sub run {
 print $_[0]->message, "\n";
 }

sub message {
 "Just Another " . $_[0]->topic . " Hacker,"
 }

sub topic { "Perl" }
```

Finer-grained testing

- Now with several components, I can test parts of it separately:

```
use Test::More tests => 7;
use Test::Output;

my $class = 'MyApplication';

use_ok( $class );

can_ok( $class, 'topic' );
is( $class->topic, 'Perl',
 'The default topic is Perl' );

can_ok( $class, 'message' );
is( $class->message,
 'Just Another Perl Hacker,' );

can_ok( $class, 'run' );
stdout_is( sub{ $class->run() },
 "Just Another Perl Hacker,\n" );
```

Packaging

- Since my program now behaves like a module, I can package it as a module.
- There's nothing particularly special about creating the module, so use your favorite tool to do it.
- `Module::Starter`

```
$ module-starter --module=MyApplication
  --author=Joe \
  --email=joe@example.com
```

- `Distribution::Cooker`

```
$ dist_cooker MyApplication
```

- It's easier to do this before I write *MyApplication.pm* so all the documentation and other bits are there.
- If I don't start this way, I just copy the *MyApplication.pm* file into the right place.

Wrapper programs

- Even though the module file acts like a program, it's usually not in the user's path.
- I have a couple ways to make my program available. The best is probably a wrapper script that passes the arguments to the module.
- Here's the modern `perldoc` program:

```
require 5;
BEGIN { $^W = 1 if $ENV{'PERLDOCDEBUG'} }
use Pod::Perldoc;
exit( Pod::Perldoc->run() );
```

- The `dist_cooker` program from `Distribution::Cooker` does the same sort of thing:

```
use Distribution::Cooker;

Distribution::Cooker->run( @ARGV );
```

Installing programs

- For MakeMaker, you list the programs you want to install in the `EXE_FILES` parameter to `WriteMakefile()`:

```
use ExtUtils::MakeMaker;

 WriteMakefile(
 ...
 EXE_FILES => [ qw(script/my_program) ]
 );
```

- For Module::Build, use the script_file parameter to new:

```
use Module::Build;
my $build = Module::Build->new(

 script_files   => ['script/dist_cooker'],
 ...
 );

$build->create_build_script;
```

Installing programs, continued

- Both of these alter your script slightly to make it work for the person installing the script

  * Alter the shebang line for the perl that invoked the build script

  * Adds some shell magic to find perl in odd cases:

```
#!/usr/local/perls/perl-5.10.1/bin/perl
    eval 'exec /usr/local/perls/perl-5.10.1/
 bin/perl -S $0 ${1+"$@"}'
        if $running_under_some_shell;
```

Other methods

- I don’t have to create a separate program if I can link to the module file.

  * Not all systems support linking

- In the pre-build, I can copy the module file to a file with the program’s name.

  * The module docs and the program docs would be the same

  * I could make separate doc pages (*program.pod*, *my_program.1*, *my_program.html*)

Distribute through CPAN

- CPAN has a“Script Archive”, but virtually nobody uses it.
- The `App::` namespace collects distributions that represent applications
- As a distribution, there is nothing special about my program. Install it like a module:

```
$ cpan App::MyApplication
```

- For free, I automatically get:

  * RT bug tracking

  * CPAN Testers reports

  * AnnoCPAN

  * *and much more*

- If this isn’t open source, you can still create your own CPAN and use the same open source tools for all of that.

Conclusion

- All the good tools are built around modules and distributions.
- Modules are easy to test, so write programs based on modules.
- Distribute programs as normal Perl distributions.

Further reading

- “How a Script Becomes a Module” originally appeared on Perlmonks:

  `http://www.perlmonks.org/index.pl?node_id=396759`

- I also wrote about this idea for *The Perl Journal* in “Scripts as Modules”. Although it’s the same idea, I chose a completely different topic: turning the RSS feed from *The Perl Journal* into HTML:

  `http://www.ddj.com/dept/lightlang/184416165`

- Denis Kosykh wrote “Test-Driven Development” for *The Perl Review* 1.0 (Summer 2004) and covers some of the same ideas as modulino development:

  `http://www.theperlreview.com/Issues/subscribers.html`

Jury rigging modules

Sometimes modules don’t work

- Modules might not work for various reasons
  - * design bugs
  - * conflicts with other modules
  - * interfaces change
  - * underlying libraries change
  - * an older version works, but the newer one doesn’t
- You want to fix them, but there are some problems
  - * you don’t want change the original source
  - * you don’t want to maintain a fork
  - * you want your changes to make it in the main line

Maintaining your local version

- You might maintain a local version
- But if you change the original source, you might overwrite it
- CPAN tools always install the latest CPAN versions, but only if it thinks your version is older.
- You could set the version to be virtually infinite:

```
our $VERSION = 0xFFFFFFFF;
```

- But now you can’t update your local version, and it might be incompatible with updates for other modules.

Send a patch to the author

- The least amount of work is to get the module maintainer to incorporate your fix.
- Git is handy because you don’t need a server
- Download the source and make a git archive:

```
% cd Some-Module-1.23
% git init
% git add .
% git commit -a -m "Some::Module 1.23"
```

- Make your changes, and commit again:

```
% git commit -a -m "Explain your changes"
```

- Make some diffs:

```
% git diff XXX
```

- Most distros use *http://rt.cpan.org*
- Some distros are in Github.

Some authors disappear

- The distribution maintainer might be long gone
- PAUSE has a process to let people take over abandoned modules
- *http://www.cpan.org/misc/cpan-faq.html#How_adopt_module*
- Sometimes you can even convince someone else to take it over

Some authors hate you

- Well, maybe not hate, but they don’t want your patches.
- That’s different than them working slower than you’d prefer.
- If you’ve been patient and nothing else works, a fork might be appropriate.
- Make your changes, upload to PAUSE with new package names.
- Now you get to be the maintainer who disappears.
- That’s the most amount of work, and work is bad.

Jury rigging methods

- There are a variety of ways to do things, each appropriate for different sorts of fixes.

  * change a copy of the source

  * replace subroutines

  * wrap subroutines

  * subclass and extend

  * subclass and override

Change a copy

- Instead of changing the original source, change a copy
- Reverting isn't as foolproof as it should be.
- Copy the original source to a new file.
- Make your changes, without ever losing the original.
- Adjust `PERL5LIB` to load your version:

```
export PERL5LIB=/dir/with/copy:$PERL5LIB
```

- Perl always loads the first one it finds, not the latest version.
- To find the one you loaded, check `%INC` at the end

```
END {
  use Data::Dumper;
  print Dumper( \%INC );
  }
```

Globally replace a subroutine

- I can override the broken subroutine in my program:

```
BEGIN {
  use Broken::Module;
  package Broken::Module;
  no warnings 'redefine';

  *broken_sub = sub {
   # fixed code;
   };
  }
```

get old definitions first!

- When the module is fixed, I can remove this code.
- With a little extra work, I can limit the fix to specific versions:

```
unless(eval { Broken::Module->VERSION('1.23')})
  {
  *broken_sub = sub {...};
  }
```

- The `version` module provides facilities for version math, too.

Locally replace a subroutine

- I can override the broken subroutine temporarily:

get old definitions first!

```
use Broken::Module;

{
no warnings 'redefine';
package Broken::Module;

local *broken_sub = sub {
  # fixed code;
  };

broken_sub( @args );
}
```

Save the original definition

- Maybe you want to save the original subroutine:

get old definitions first!

```
use Broken::Module;

my $old_broken_sub = \&broken_sub;

{
package Broken::Module;

no warnings 'redefine';
*broken_sub = sub {
  # fixed code;
  };
}

broken_sub( @args );

$old_broken_sub->( @other_args );
```

Move a subroutine definition

- You can also rename the bad subroutine:

```
use Broken::Module;

{
package Broken::Module;
*old_broken_sub = \&broken_sub;

no warnings 'redefine';
*broken_sub = sub {
  # fixed code;
  };
}

broken_sub( @args );

old_broken_sub( @other_args );
```

get old definitions first!

Wrapping subroutines

- Sometimes you can just wrap the subroutine.
- You can wrap a subroutine so you can adjust input and output:

```
sub wrapped_foo
 {
 my @args = @_;
 ...;                                   # prepare @args for next step;
 my $result = foo( @args );
 ...;                                   # clean up $result
 return $result;
 }
```

Handling context

- You might have to do more than you really imagined:

```
sub wrapped_foo
  {
  my @args = @_;
  ...;                                        # prepare @args for next step;
  if( wantarray ) {                           # list context
    my @result = foo( @args );
    return @result;
    }
  elsif( defined wantarray ) {                # scalar context
    my $result = foo( @args );
    ...;                                      # clean up $result
    return $result;
    }
  else {                                      # void context
    foo( @args );
    }
  }
```

Hook::LexWrap

- `Hook::LexWrap` can handle all of the details:

```
use Hook::LexWrap;

wrap 'sub_to_watch',
 pre  =>
   sub { print "The arguments are [@_]\n" },
 post =>
   sub { print "Result was [$_[-1]]\n" }
 ;

sub_to_watch( @args );
```

Watch before and after

- Use `Hook::LexWrap` to see before and after a subroutine, globally:

```
use Hook::LexWrap;

sub divide {
  my( $n, $m ) = @_;
  my $quotient = $n / $m;
  }

wrap 'divide',
  pre  =>
    sub { print "The arguments are [@_]\n" },
  post =>
    sub { print "Result was [$_[-1]]\n" };

my $result = divide( 4, 4 );
```

- This is very handy for debugging.

These are only temporary fixes

- None of these are long term solutions.
- What if someone wants to patch your patch? Which redefinition gets there first?
- Or when you want to back out your changes? What is the final definition?

Methods are a bit different

- Don’t try any of this with methods, which are different beasts.
- There definition might not be where you think it is due to inheritance.

Make a subclass

- If you can, create a subclass.
- You can override or extend just the broken parts.
- Start with an empty subclass (the null subclass test):

```
package Local::Foo
use parent qw(Foo);
1;
```

Local shouldn’t ever conflict
or base.pm

- Adjust your program to use your subclass:

```
# use Foo
use Local::Foo;

#my $object = Foo->new();
my $object = Local::Foo->new( ... );
```

- Your program should still work.
- If not, there are even more bugs in the module.

Override a method

- Overriding replaces the definition of a method

```
package Local::Foo
use parent qw(Foo);

sub some_method
  {
  my( $class, @args ) = @_;
  ...;
  }

1;
```

do what you need to do

Extend a method

- Extending adds to the definition of a method
- You could provide an adapter:

```
package Local::Foo
use parent qw(Foo);

sub some_method
 {
 my( $class, @args ) = @_;
 ... munge arguments here
 my $self = $class->SUPER::some_method(
     @args );
 ... do my new stuff here.
 }

1;
```

Further reading

- The *perlboot* documentation has an extended subclassing example. It's also in *Intermediate Perl*.

- I talk about `Hook::LexWrap` in "Wrapping Subroutines to Trace Code Execution," *The Perl Journal*, July 2005: *http://www.ddj.com/dept/lightlang/184416218*.

- The documentation of `diff` and `patch` discusses their use. The patch manpage is particularly instructive because it contains a section near the end that talks about the pragmatic considerations of using the tools and dealing with other programmers.

Data Security

Caveats

- This isn’t a security course, so we’re not talking about application-level stuff.
- The Perl langauge has some features that can cause some pain if you don’t use them wisely.
- We’ll cover some basic good practices
- Most of the section features taint-checking
- This isn’t comprehensive

Bad data can ruin your day

- Most programs have to deal with external data and resources.
- Given any chance to give input, people will do it wrong.
- Not checking file names is more common than we would expect:

```
open FILE, $input{in_file};
while( <FILE> ) { print }
```

- Imagine some of the input that could mess up this poor code:

```
/etc/passwd
rm -rf |
```

- The problem is a pre-Perl 5.6 thing when we only had the filename to do everything:

```
open FILE, 'output.dat';
open FILE, '> output.dat';
open FILE, '>> output.dat';
open FILE, 'program |';
open FILE, '| program';
```

- Not only that, none of these check errors!

Use three-argument open

- With Perl 5.6 and later we can fix problems by separating the modes from the name.

```
open FILE, ">", $file or die "Could not open
 $file: $!";
```

- Even if we are reading files, use the three-arguments just to be sure

```
open FILE, "<", $file or die "Could not open
 $file: $!";
```

Use it with strings too

- Okay, this really has nothing to do with security, but since we’re talking about `open`, now’s a good time for this.
- Most people build up strings with concatenation:

```
while( <$fh> ) {
  my $record = ...do some processing...;
  $string .= $record;
  }
```

- Do it with a filehandle instead by using a scalar reference

```
my $file = \ '';
open my($output), '>', $file or die ...;

while( <$fh> ) {
  my $record = ...do some processing...;
  print $output, $record;
  }
```

Use it with strings too, continued

- No more special as_string method code!

```
sub as_string {
 my $self = shift;
 my $string = \ '';
 open my($output), '>', $string or die ...;
 $self->to_fh( $output );
 }
```

You can also read from strings

- Multi-line regexes can be a pain.

```
my @matches = m/^.......$/m;
```

what's $/

- You might think splitting is better:

```
my @lines = split /$/, $string;
while( @lines ) { ... }
```

- If you want to deal with strings line--by-line, read from them as a filehandle:

```
open my( $fh ), '<', \ $string;

while( <$fh> ) {
  ... process line from string ...
  }
```

- No more splitting on lines!

Use list form of system and exec

- The system and exec built-ins have the problem too:

```
system( "/bin/echo $message" );
```

WRONG!

- What's in message? Maybe there are shell metacharacters!

```
'Hello World!'; mail joe@example.com < /etc/
 passwd
```

- In the single argument form, Perl passes everything to the shell just as it is. The shell then interprets it as it likes.

- In the multiple argument form, Perl quotes the meta-characters for me:

```
@args = ( "/bin/echo", $message );
system @args;
```

list form, which is fine.

- That's still a problem is everything shows up in `$args[0]`, making it the single argument call again:

```
my @args = ( '/bin/echo; rm -rf /' );
system @args;
```

still only one argument!

Use list form of system and exec, continued

- I get around this with a bit of indirect object notation that always uses the list mode:

```
system { $args[0] } @args;
```

- Whatever is in `$args[0]` is the command name. There shouldn’t be a command named `'/bin/echo; rm -rf /'`
- This is still a bit platform-dependent.

IPC::System::Simple

- `system` and `exec` interact with the shell.
- Mostly, we don't care as long as we get the answer.
- Paul Fenwick spent a lot of time figuring out the edge cases on various platforms and put it all into `IPC::System::Simple`, available on CPAN.
- The `systemx` and `capturex` versions never touch the shell:

```
use IPC::System::Simple qw(systemx capturex);

systemx( $command, @args );
```

like system(), but no shell

```
my $output = capturex( $command, @args );
```

like backticks, but no shell

```
my @output = capturex( $command, @args );
```

- `IPC::System::Simple` also handles all of the operating system specific problems.

Don’t trust external data

- Avoiding the shell keeps the shell from doing some damage, but we should catch problems sooner.
- Examine the data before you use it.
- There are many sources of external data:

  * user input

  * environment variables

  * command-line arguments

  * data files

  * config files

Taint checking

- Perl has a special mode that can mark data as tainted and trace it through the entire program.
- Anything that touches the tainted data also becomes tainted.
- Perl stops you from sending tainted data outside the program.
- Taint-checking affects the entire program, and you have to turn it on before you start doing anything.
- Use the -T switch from the command line:

```
% perl -T program.pl
```

- Or on the shebang line:

```
#!perl -T
```

- For modperl, turn on taint checking in the apache configuration

`PerlTaintCheck On` *mod_perl 1*

`PerlSwitches -T` *mod_perl 2*

Taint checking, continued

- Taint-checking is automatically on if the real and effective user or group is different
- There’s a big caveat here: taint-checking is a development tool, not a guarantee that nothing bad will happen.
- It’s easy for programmers to defeat taint-checking, so you still have to examine code.

Taint environments

- `%ENV` is tainted because it is external data.

```
#!/usr/bin/perl -T
system qq|echo "Hello Perl!"|;
```

- The error message tells us that `PATH` is suspicious:

```
 Insecure $ENV{PATH} while running with -T
 switch at ...
```

- What happens if someone made thier own `echo`?

```
$ cat >> echo
rm -rf /
^D
$ export PATH=.:$PATH
$ perl program.pl
```

- Now we’re running the wrong `echo`!

- Perl knows this and only allows certain paths in `$ENV{PATH}`

Taint environments, continued

- The best thing to do is to scrub the values and assign your own:

```
delete @ENV{qw(IFS CDPATH ENV BASH_ENV)};
$ENV{PATH} = '/usr/bin/local:/usr/bin';
```

- Better yet, use full paths everywhere:

```
#!/usr/bin/perl -T
delete $ENV{PATH};
system "/bin/cat /Users/brian/.bashrc"
```

Tainted arguments

- The command-line arguments are tainted too.
- We can checked taintedness with `Scalar::Util`:

```
#!/usr/bin/perl -T
# tainted-args.pl

use Scalar::Util qw(tainted);

# this one won't work
print "ARGV is tainted\n" if tainted( @ARGV );

# this one will work
print "Argument [$ARGV[0]] is tainted\n" if
  tainted( $ARGV[0] );
```

- When we run this command, Perl stops us:

```
$ perl tainted-args.pl foo
Argument [foo] is tainted
```

Tainting is viral

- Any tainted data affects data we build from them:

```
#!/usr/bin/perl -T
use strict;
use warnings;

use File::Spec;
use Scalar::Util qw(tainted);

my $path = File::Spec->catfile( $ENV{HOME},
  "data.txt" );
```

$path is tainted

```
print "Result [$path] is tainted\n" if tainted(
  $path );

open my($fh), $path or die "Could not open
  $path";

print while( <$fh> );
```

Tainting is viral, continued

- The problem is `$ENV{HOME}`. What if it has a pipe in it?

```
$ HOME="| cat /../../../etc/passwd;" ./sub*
```

- Perl catches that:

```
Insecure dependency in piped open while running
  with -T switch at ...
```

- We could also solve this with three-argument `open`:

```
open my($fh), '<', $path or die "Could not open
  $path";
```

Side effects of tainting

- Perl ignores some external data when we turn on taint-checking, like `PERLLIB` and `PERL5LIB`.
- You can still change `@INC`:

```
$ perl -Mlib=/Users/brian/lib/perl5 program.pl

$ perl -I/Users/brian/lib/perl5 program.pl

$ perl -I$PERL5LIB program.pl
```

Untainting data

- The only *APPROVED* way to untaint data is with a regex that captures the data:

```
my( $file ) = $ARGV[0] =~ m/^([A-Z0-9_.-]+)$/
  ig;
```

$file is not tainted

- The lazy programmer can easily cheat:

```
my( $file ) = $ARGV[0] =~ m/(.*)/i;
```

- If we’re in a non-ASCII evnironment, matching just A to Z isn’t any good. The locale pragma knows how to deal with `\w`.

```
{
use locale;

my( $file ) = $ARGV[0] =~ m/^([\w.-]+)$/;
}
```

- There are two philosophies on untainting data: the Prussian and the American way.

The American method

- The American method disallows characters that it thinks are bad

```
my( $file ) = $ARGV[0] =~ m/([^$%;|]+)/i;
```

- We have to be really careful that we list all the possible bad characters.
- This isn’t a good solution

The Prussian method

- The Prussian method checks that the data only has allowed characters:

```
my( $file ) = $ARGV[0] =~ m/([a-z0-9_.-]+)/i;
```

- Maybe I miss some allowed characters, but missing valid input is better than missing malicious input.

- Taking it even farther, we can specifically turn off the untainting features:

```
{
use re 'taint';

# $file still tainted
my( $file ) = $ARGV[0] =~ m/^([\w.-]+)$/;
}
```

actually turns off untainting

Scoped regex tainting

- We can turn off untainting for all regexes and only turn on untainting when we need it:

```
use re 'taint';

{
no re 'taint';

# $file not tainted
my( $file ) = $ARGV[0] =~ m/^([\w.-]+)$/;
}
```

Choosing good data with tainted data

- We can choose the good data with tainted data, and the taint does not affect

```
my $value = $tainted_scalar ? "Fred" :
  "Barney";
```

- The ternary operator is really just shorthand for the full `if()` structure:

```
my $value = do {
  if( $tainted_scalar ) { "Fred"   }
  else                  { "Barney" }
  };
```

Tainted I/O

- Data that I read from files is tainted too:

```
use Scalar::Util qw(tainted);

open my($fh), $0 or
 die "Could not open myself! $!";

my $line = <$fh>;

print "Line is tainted!\n" if tainted( $line );
```

Tainted I/O, continued

- Untaint data per-filehandle by using the `IO::Handle` module:

```
use IO::Handle;
use Scalar::Util qw(tainted);

open my($fh), '<', $0 or
 die "Could not open myself! $!";

$fh->untaint;

my $line = <$fh>;

print "Line is not tainted!\n" unless tainted(
 $line );
```

Taint warnings instead of errors

- If you are adding taint-checking to an existing script, you might not be able to get it to run quickly.

```
#!/usr/bin/perl -T
# print_args.pl

system qq|echo "Args are @ARGV"|;
```

- Instead of real taint-checking, we can get taint-warnings with `-t` to find the problems but not stop the script:

```
$ perl -t print_args.pl foo bar
Insecure $ENV{PATH} while running with -t
  switch at ....
Insecure dependency in system while running
  with -t switch at ...
Args are foo bar
```

The -U switch

- We can also disable taint-checking with `-U`, but we don’t get warnings:

```
$ perl -TU print_args.pl foo bar
Args are foo bar
```

- We can get warnings back with -w:

```
$ perl -TUw print_args.pl foo bar
Insecure $ENV{PATH} while running with -T
  switch at ....
Insecure dependency in system while running
  with -T switch at ...
Args are foo bar
```

Tainting DBI

- Tainting works because Perl recognizes when we are explicitly using an external resource.
- It can’t tell when modules, such as DBI, might harm us.
- DBI can turn on its own taint mode:

```
my $dbh = DBI->connect( $dsn, $user, $password,
   { TaintIn => 1, ... }
   );
```

- We can also tell DBI to taint the results:

```
my $dbh = DBI->connect( $dsn, $user, $password,
  { TaintOut => 1, ...}
  );
```

- Or we can do both at the same time:

```
my $dbh = DBI->connect( $dsn, $user, $password,
  { TaintIn  => 1, TaintOut => 1,   ... }
  );
```

Use DBI placeholders

- Database operations can have the same problem:

```
use CGI;
use DBI;

my $cgi   = CGI->new;
my $dbh   = DBI->connect( ... ); # fill in the
  details yourself
my $name  = $cgi->param( 'username' );

my $query = "SELECT * FROM Users WHERE
  name='$name'";
```

WRONG!

- What is in that username parameter? Maybe it’s an SQL injection:

```
buster'; DELETE FROM Users; SELECT * FROM Users
  WHERE name='
```

Use DBI placeholders, continued

- Avoid the problem with a prepared statement that uses placeholders:

```
my $sth = $dbh->prepare("SELECT * FROM Users
  WHERE name=?");
my $rc  = $dbh->execute( $name );
```

- Placeholders handle proper quoting and escaping, and can also do some very basic validation:

```
$sth->bind_param(1, $value,
  { TYPE => SQL_INTEGER }
  );
```

Use different database handles

- Create separate database users with only the permissions that they need:

    * Read only

    * Update only

- Create different database handles for each:

```
my $dbh_reader = DBI->connect( $dsn, $reader,
  $reader_password,
  { TaintIn  => 1, TaintOut => 1, ... }
  );

my $dbh_updater = DBI->connect( $dsn, $updater,
  $updater_password,
  { TaintIn  => 1, TaintOut => 1, ... }
  );
```

How users can cheat

- Even if you never cheat, someone around you probably will and you need to recognize their tricks.
- They can just match everything:

```
my( $file )= $input =~ m/(.*)/;
```

- They can use hash keys, which aren't real SVs (scalar value structures in perl internals)

```
my @data = keys %{ map { $_, 1 } @input };
```

Further Reading

- Start with the *perlsec* documentation, which gives an overview of secure programming techniques for Perl.

- The *perltaint* documentation gives the full details on taint checking. The entries in *perlfunc* for `system` and `exec` talk about their security features.

- The *perlfunc* documentation explains everything the `open` built-in can do, and there is even more in *perlopentut*.

- Although targeted toward web applications, the Open Web Application Security Project (OWASP, *http://www.owasp.org*) has plenty of good advice for all types of applications.dd

- Even if you don't want to read warnings from the Computer Emergency Response Team (CERT, *http://www.cert.org*) or SecurityFocus (*http://www.securityfocus.com/*), reading some of their advisories about perl interpreters or programs is often instructive.

Further Reading, continued

- The documentation for `DBI` has more information about placeholders and bind parameters, as well as `TaintIn` and `TaintOut`. *Programming the Perl DBI* by Tim Bunce and Alligator Descartes is another good source, although it does not cover the newer taint features of `DBI`.

Profiling

Profiling is better than benchmarking

- Benchmarking is often pre-mature
- Profiling shows you the performance of your program

  * speed

  * memory

  * whatever
- See what’s taking up your resources
- Focus your efforts in the right places

The basics of profiling

- Profiling counts something
- All the code runs through a central point, a recorder
- While recording, the program is slower
- At the end I get a report
- Use the report to make a decision

A recursive subroutine

- A recursive subroutine runs itself many, many times.
- Everyone seems to like to use the factorial implementation, so I'll use that:

```
sub factorial
  {
  return unless int( $_[0] ) == $_[0];
  return 1 if $_[0] == 1;
  return $_[0] * factorial( $_[0] - 1 );
  }

print factorial($ARGV[0]), "\n";
```

Calling a Profiler

- Invoke a custom debugger with `-d`

```
perl -d:MyDebugger program.pl
```

- `MyDebugger` needs to be in the `Devel::*` namespace
- Uses special `DB` hooks for each statement
- Find several on CPAN

  * `Devel::DProf`
  * `Devel::NYTProf`
  * `Devel::SmallProf`
  * `Devel::LineProfiler`

Recursion profile

- Runs several statements for each call

```
% perl -d:SmallProf factorial.pl 170
```

- Creates a file named *smallprof.out*

```
========== SmallProf version 1.15 ==================
                   Profile of factorial.pl
  Page 1
====================================================
count wall tm  cpu time line
  0 0.000000 0.000000   1:#!/usr/bin/perl
  0 0.000000 0.000000   2:
170 0.000000 0.000000   3:sub factorial {
170 0.001451 0.000000   4: return unless int($_
  [0]) == $_[0];
170 0.004367 0.000000   5: return 1 if $_[0] == 1;
169 0.004371 0.000000   6: return $_[0] *
  factorial($_[0]-1);
  0 0.000000 0.000000   7: }
```

Iteration, not recursion

- Perl 5 doesn’t optimize for tail recursion, so it can’t optimize recursion.
- I shouldn’t run more statements than I need.
- Better algorithms beat anything else for efficiency.
- With iteration, I don’t need to create more levels in the call stack.

```
sub factorial {
 return unless int( $_[0] ) == $_[0];

 my $product = 1;

 foreach ( 1 .. $_[0] ) { $product *= $_ }

 $product;
 }

print factorial( $ARGV[0] ), "\n";
```

Iteration profile

- Now I don’t call needless statements

```
======== SmallProf version 2.02=================
          Profile of factorial-iterate.pl
 Page 1
===============================================
count wall tm  cpu time line
  0   0.00000   0.00000     1:#!/usr/bin/perl
  0   0.00000   0.00000     2:
  0   0.00000   0.00000     3:sub factorial {
  1   0.00001   0.00000     4: return unless
 int($_[0] ) == $_[0];
  1   0.00000   0.00000     5: my $f = 1;
170   0.00011   0.00000     6: foreach ( 2 ..
 $_[0] ) {$f *= $_ };
  1   0.00009   0.00000     7: $f;
  0   0.00000   0.00000     8: }
```

Really big numbers

- Now I want have a program that takes a long time.
- My perl tops out at 170!, then returns `inf`.
- The `bignum` package comes with Perl 5.8, and I can use really big numbers

```
use bignum;

sub factorial {
  return unless int( $_[0] ) == $_[0];

  my $product = 1;

  foreach ( 1 .. $_[0] ) { $product *= $_ }

  $product;
  }

print factorial( $ARGV[0] ), "\n";
```

get really large numbers

Memoize

- This still isn’t good because it’s one shot.
- By *memoizing*, I remember previous computations for future speed-ups:

```
my @Memo       =  (1);

sub factorial {
 my $number = shift;

 return unless int( $number ) == $number;
 return $Memo[$number] if $Memo[$number];

 foreach ( @Memo .. $number ) {
  $Memo[$_] = $Memo[$_ - 1] * $_;
  }

 $Memo[ $number ];
 }
```

Memoize, continued

```
while(1) {
 print 'Enter a number> ';
 chomp( my $number = <STDIN> );
 exit unless defined $number;
 print factorial( $number ), "\n";
 }
```

What happened?

- One shot is not so bad
- I redo a lot of work if I call `factorial` many times.
- Memoizing is faster each time, but takes more memory.

Modern profiling with NYTProf

- `Devel::NYTProf` is a `Devel::DProf` replacement written by Adam Kaplan at the New York *Times*, and now maintained by Tim Bunce.

- Devel::NYTProf is both a statement profiler and a subroutine profiler, so I get more information out of it.

- I invoke it in the same way:

```
% perl -d:NYTProf journals
```

- I can get different sets of reports:

```
% nytprofhtml
% nytprofcvs
```

- A demostration is the best way to show off NYTProf.

Record DBI queries

- Create a routine through which all queries flow:

```
package My::Database;

my %Queries;

sub simple_query
  {
  my( $self, @args ) = @_;
  my $sql_statement = shift @args;

  $Queries{$sql_statement}++;

  my $sth = $self->dbh->prepare($sql_statement);
  unless( ref $sth ) { warn $@; return }

  my $rc   = $sth->execute( @args );

  wantarray ? ( $sth, $rc ) : $rc;
  }
```

Profiling hook

Database optimization

- Often, the database bits are the slowest part of my program
- Most of the work is not in my program because it's in the database server
- My program waits for the database response
- I usually talk to the database more than I need to
  - * Repeated `SELECT`s for the same, unchanging data
- My queries are too slow
  - * Optimize the slowest, most frequent ones

Profiling DBI Statements

- Uses the `DBI_PROFILE` environment variable
- Using `!Statement` orders by the query text

```
$ env DBI_PROFILE='!Statement' perl dbi-
 profile.pl

DBI::Profile: 109.671362s 99.70% (1986 calls)
 dbi-profile.pl @ 2006-10-10 02:18:40

'CREATE TABLE names ( id INTEGER, name CHAR(64)
 )' => 0.004258s
'DROP TABLE names' => 0.008017s
'INSERT INTO names VALUES ( ?, ? )' =>
  3.229462s / 1002 = 0.003223s avg (first
 0.001767s, min 0.000037s, max 0.108636s)
'SELECT name FROM names WHERE id = 1' =>
  1.204614s / 18 = 0.066923s avg (first
 0.012831s, min 0.010301s, max 0.274951s)
'SELECT name FROM names WHERE id = 10' =>
  1.118565s / 9 = 0.124285s avg (first
```

Profiling DBI methods

- Set `DBI_PROFILE` to `!MethodName`

```
$ env DBI_PROFILE='!MethodName' perl dbi-
 profile2.pl

DBI::Profile: 2.168271s 72.28% (1015 calls)
 dbi-profile2.pl @ 2006-10-10 02:37:16
'DESTROY' =>
 0.000141s / 2 = 0.000070s avg (first
 0.000040s, min 0.000040s, max 0.000101s)
'FETCH' => 0.000001s
'STORE' =>
 0.000067s / 5 = 0.000013s avg (first
 0.000022s, min 0.000006s, max 0.000022s)
'do' =>
 0.010498s / 2 = 0.005249s avg (first
 0.006602s, min 0.003896s, max 0.006602s)
'execute' =>
 2.155318s / 1000 = 0.002155s avg (first
 0.002481s, min 0.001777s, max 0.007023s)
'prepare' => 0.001570s
```

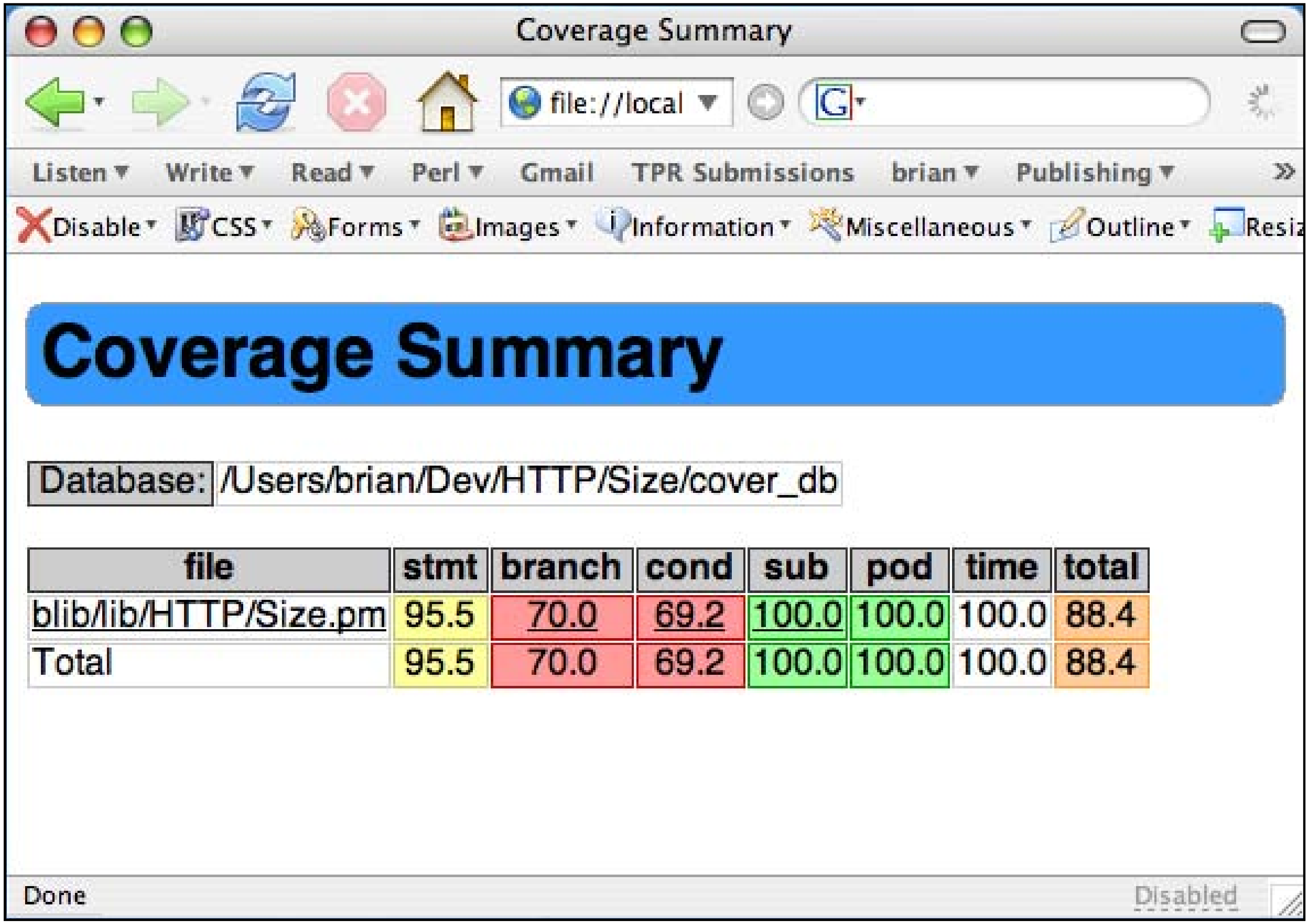
Profiling test suites

- I can profile my test suite to see how much code it tests
- I want to test all code, but then there is reality
- Where should I spend my testing time to get maximum benefit?
- The `Devel::Cover` module does this for me

```
% cover -delete                                  clear previous report

% HARNESS_PERL_SWITCHES=-MDevel::Cover make
 test

% ./Build testcover                              for Module::Build

% cover                                   generates report from data
Reading database from Dev/HTTP/Size/cover_db
```

- Sends text report to standard output
- Also creates an HTML report

Devel::Cover HTML report

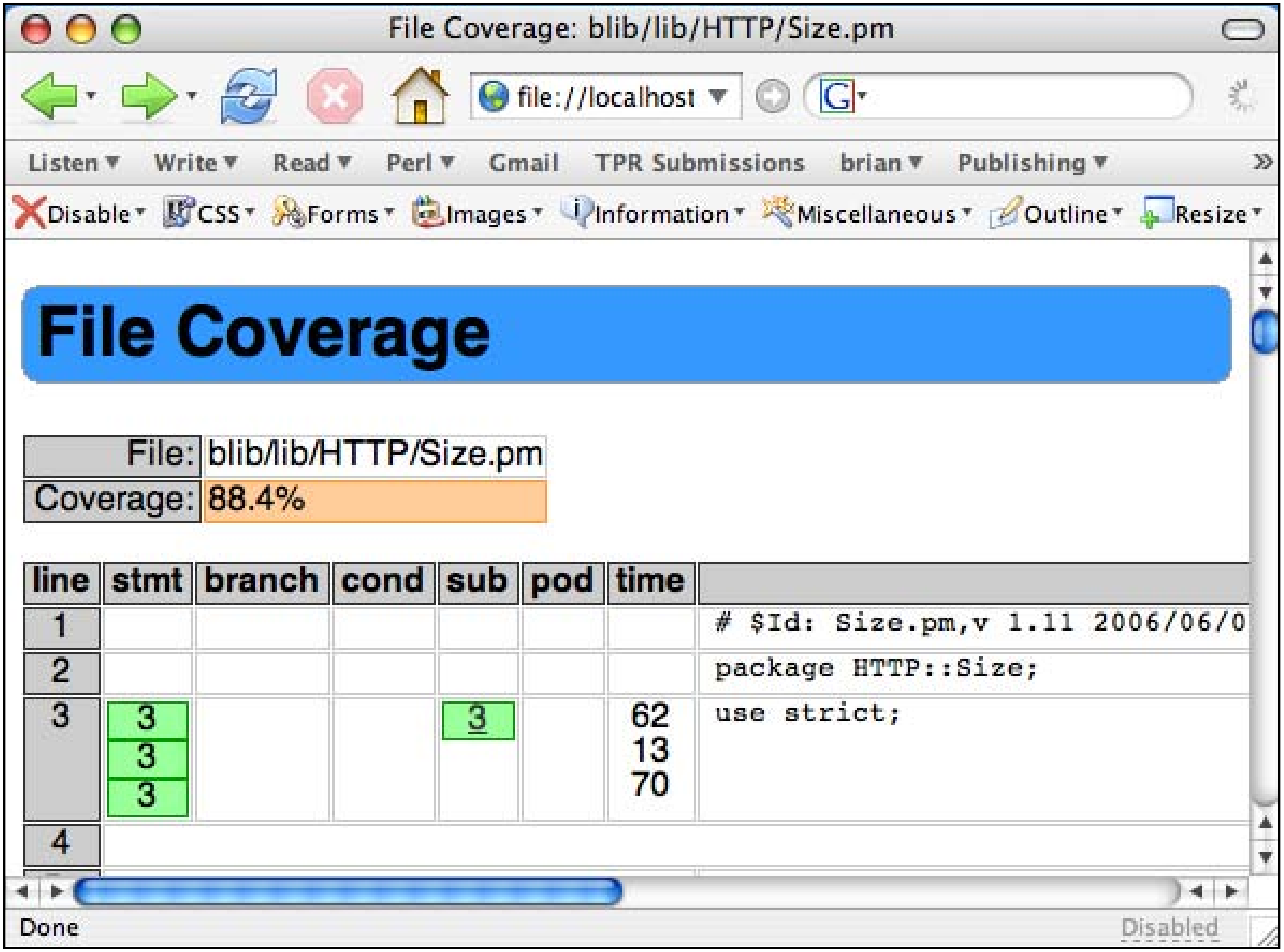


Coverage Summary

Database: /Users/brian/Dev/HTTP/Size/cover_db

file	stmt	branch	cond	sub	pod	time	total
blib/lib/HTTP/Size.pm	95.5	70.0	69.2	100.0	100.0	100.0	88.4
Total	95.5	70.0	69.2	100.0	100.0	100.0	88.4

Devel::Cover detail



File Coverage

File:	blib/lib/HTTP/Size.pm
Coverage:	88.4%

line	stmt	branch	cond	sub	pod	time	
1							# $Id: Size.pm,v 1.11 2006/06/0
2							package HTTP::Size;
3	3 3 3			3		62 13 70	use strict;
4							

Further reading

- The *perldebguts* documentation explains custom debuggers
- “Creating a Perl Debugger” (*http://www.ddj.com/184404522*) and “Profiling in Perl” (*http://www.ddj.com/184404580*) by brian d foy
- “The Perl Profiler”, Chapter 20 of *Programming Perl, Third Edition*
- “Profiling Perl” (*http://www.perl.com/lpt/a/850*) by Simon Cozens
- “Debugging and Profiling mod_perl Applications” (*http://www.perl.com/pub/a/2006/02/09/debug_mod_perl.html*) by Frank Wiles
- “Speeding up Your Perl Programs” (*http://www.stonehenge.com/merlyn/UnixReview/col49.html*) and “Profiling in Template Toolkit via Overriding” (*http://www.stonehenge.com/merlyn/LinuxMag/col75.html*) by Randal Schwartz

Conclusion

Main points

- Profile your application before you try to improve it
- Be very careful and sceptical with benchmarks
- Make your program flexible through configuration
- Use Log4perl to watch program progress, report errors, or debug
- Use lightweight persistence when you don’t need a full dataase server

More information

- The Perl Review: *www.theperlreview.com*
- Feel free to email me: *brian.d.foy@gmail.com*
- See all of my talks, *http://www.pair.com/~comdog/*
- Also on SlideShare, *http://www.slideshare.net/brian_d_foy*
- Often on Perlcast, *http://www.perlcast.com*

Questions