Best Programming Practices

Ashish Mahabal, Caltech

Ay/Bi 199b

31 Mar 2011

The zen of bug-free programming

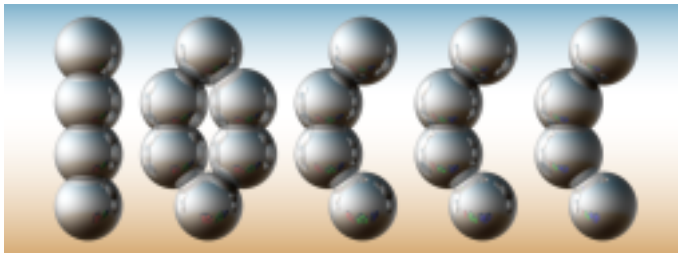
- *If debugging is the process of removing bugs, programming must be the process of introducing them*.

  - Edsger W. Dijkstra (1930-2002)

Don’t program!

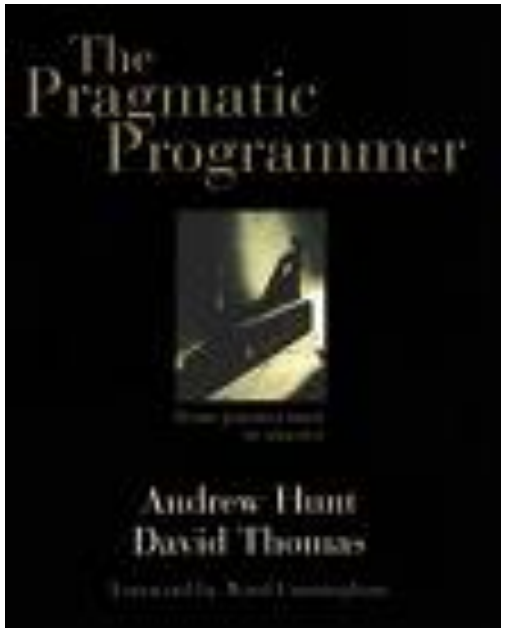
Obfuscated programming contests

- touch selfreproducingprogram.c
- makefile:
    - cp selfreproducingprogram.c a.out
    - chmod 755 a.out
- ./a.out



- Programming style
- Programming tools

My own experience/mistakes



The Pragmatic Programmer

By Andrew Hunt and David Thomas

Perl Best Practices

By Damian Conway

The scene keeps changing

- Drupal http://drupal.org/node/287350
- Django http://www.djangoproject.com/
- iphone apps

http://mashable.com/2009/06/10/build-iphone-app/

- Android apps: http://developer.android.com/guide/webapps/best-practices.html
- Chrome extensions: http://blog.chromium.org/2010/06/making-chrome-more-accessible-with.html

… and yet the basics stay the same

Coding by instinct

- Variable names (caps, underscores, …)
- Types of loops (for, while, …)
- Formatting
  - Indents, brackets, braces, semicolons
- Procedural versus object oriented approach

Conscious and consistent programming style

Necessary ingredients

- Robustness
- Efficiency
- Maintainability

Robustness

- Introducing errors
  - checking for existence (uniform style)
- Edge cases
  - 0? 1? last?
- Error handling
  - exceptions? Verifying terminal input
- Reporting failure
  - Traces? Errors don't get quietly ignored

Efficiency

- Working with strength
- Proper data structures
- Avoiding weaknesses
- Dealing with version changes (backward compatibility)

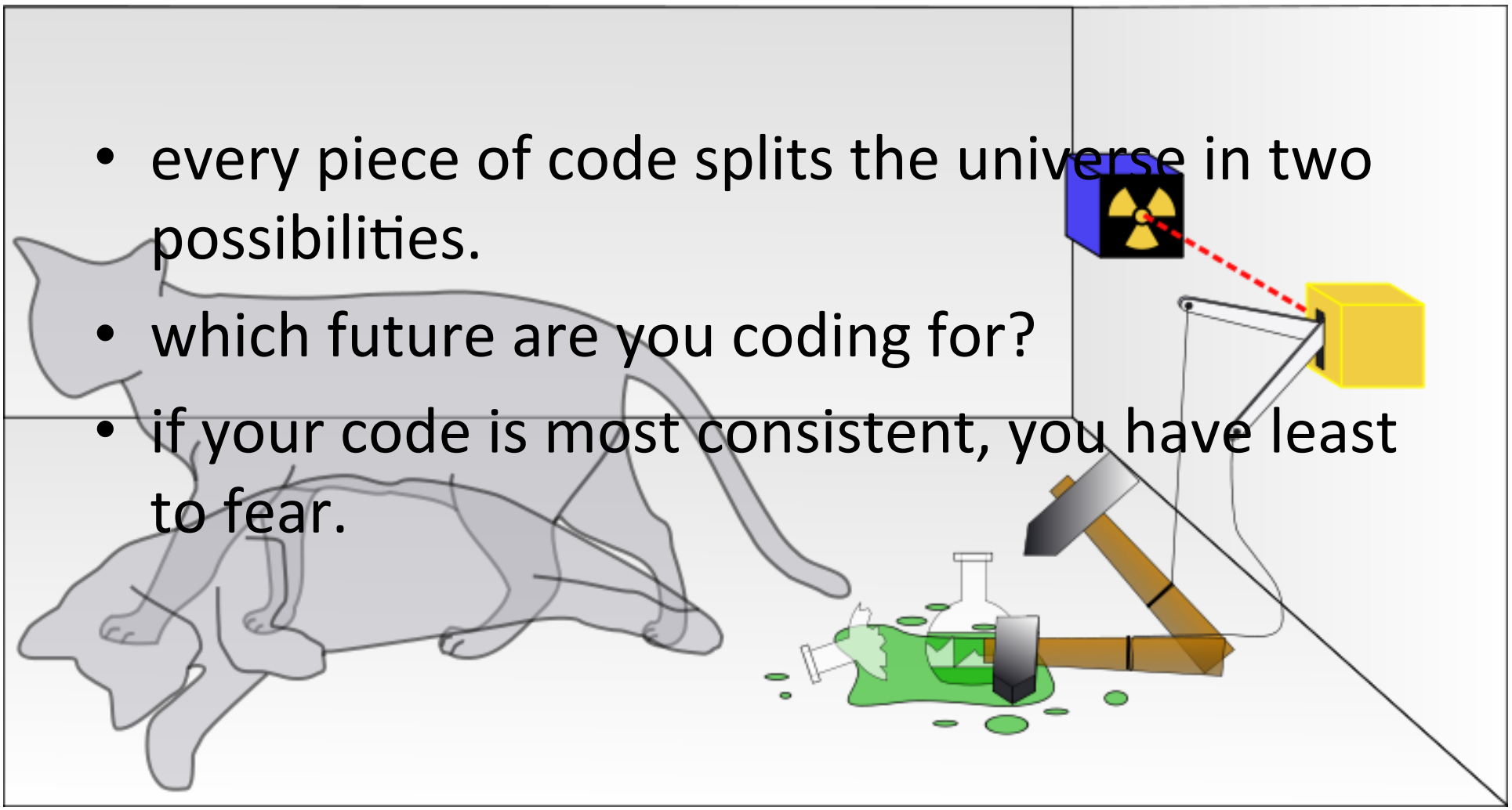
Maintainability

- More time than writing
- You don't understand your own code
- You yourself will maintain it
- Consistent practices
  - Braces, brackets, spaces
  - Semicolon (after last statement)
  - Trailing , in lists
  - Linelengths, tabs, blank lines
- cb, bcpp, perltidy, jacobe, Jxbeauty

- my @countries = (
  USA,
  UK,
  UAE,
  Ukraine
  );

- my @countries = (
  USA,
  UK,
  UAE,
  Ukraine,
  );

- every piece of code splits the universe in two possibilities.
- which future are you coding for?
- if your code is most consistent, you have least to fear.



Some simple recommendations

- Use underscores
  - $tax_form rather than $taxForm
- Don't use abbrvs
  - don't drop all vowels if you do
- Don't use single letter variable names
  - Except perhaps in trivial small loops
- Don't use too common words as variable names
  - e.g. no, yes, count, left, okay
- Empty strings: name and use them
  - my $empty_string = " ";
- Constants: use Readonly
  - my READONLY $PI = 3;

- easy development versus easy maintenance
  - projects live much longer than intended
  - adopt more complex and readable language
- check requirements
- design, implement, integrate
- validate

- Don’t trust the work of others
  - Validate data (numbers, chars etc.)
  - Put constraints (-90 <= dec <= 90)
  - Check consistency

- Don’t trust the work of others
  - Validate data
  - Put constraints
  - Check consistency
- Don’t trust yourself
  - Do all the above to your code too

Design by contract (Eiffel, Meyer ’97)

- Preconditions
- Postconditions
- Class invariants

Be strict in what you accept
Promise as little as possible
Be lazy

Inheritance and polymorphism result

- Crash early
  - Sqrt of negative numbers (require, ensure, NaN)
- Crash, don't trash
  - Die
  - Croak (blaming the caller)
  - Confess (more details)
  - Try/catch (own error handlers e.g. HTML 404)
- Exceptions – when to raise them
  - should it have existed?
  - Don't know?

```
sub locate_and_open {
    open my $fh,'<',"filename";
    return $fh;
    }
sub load_header_from {
    TRY TO READ HEADER HERE
    }
 my $fh = locate_and_open($filename);
 my $head = load_header_from($fh);
```

```
sub locate_and_open {
    open my $fh,'<',"filename" or croak "cant";
    return $fh;
    }
my $fh = locate_and_open($filename);
my $head = load_header_from($fh);
```

```
If(my $fh = eval { locate_and_open($filename)}){
   my $head = load_header_from($fh);
   }
else{
   carp “Couldn’t access $filename.\n”;
   }
```

- Tests
- Comments
- Arguments
- Debugging

Tests

- Test against contract
  - Sqrt: negative, zero, string
  - Testvalue(0,0)
  - Testvalue(4,2)
  - Testvalue(-4,0)
  - Testvalue(1.e12,1000000)
- Test harness
  - Standardize logs and errors
- Test templates
- Write tests that fail

http://ib.ptb.de/8/85/851/sps/swq/graphix

All software will be tested

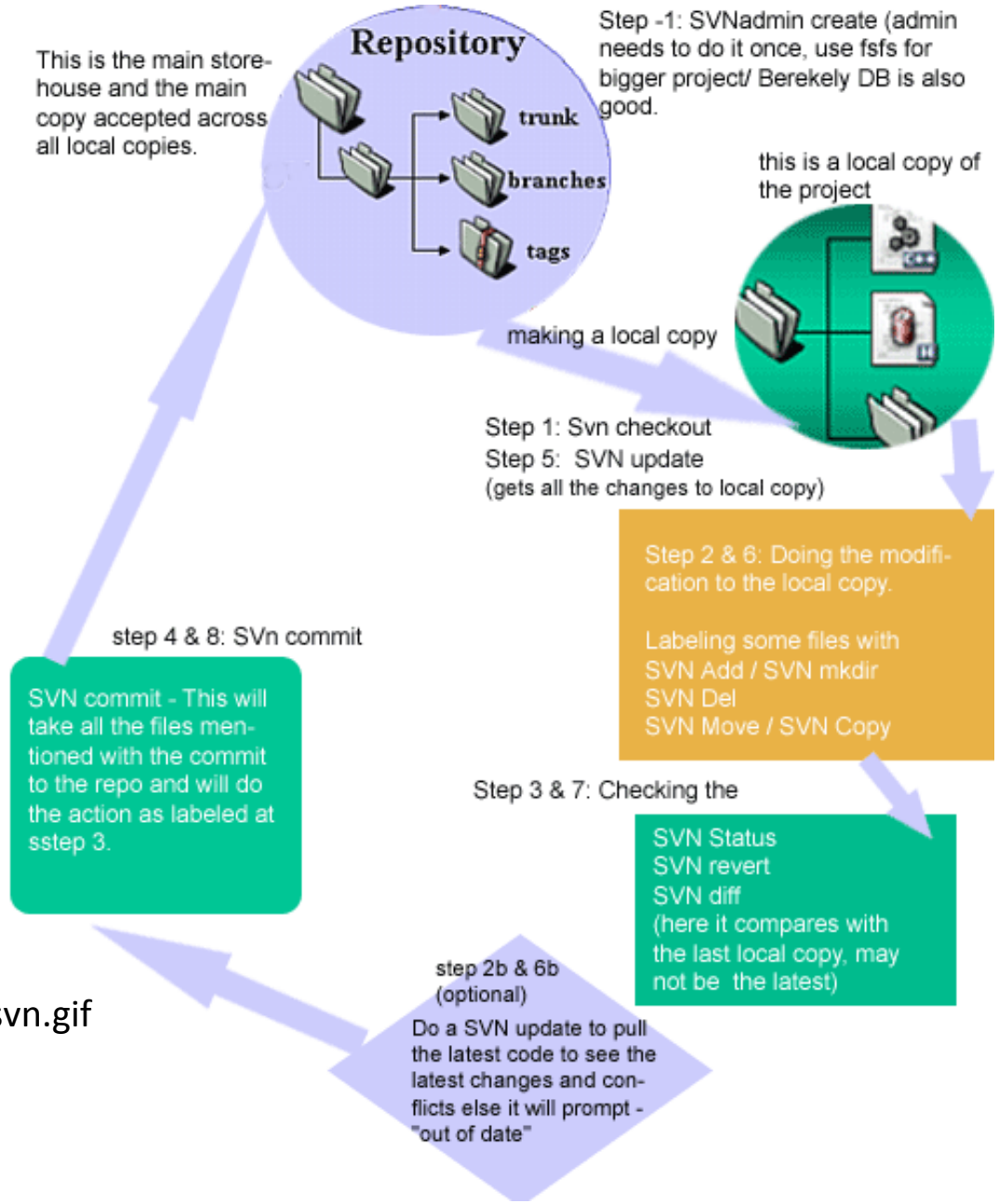
- If not by you, by other users!
  - perl Makefile.pl
  - make
  - make test
  - make install

- Don’t use code you do not understand

Source Code Control

- SVN
  - Checkin
  - Checkout
  - Comment
  - Merge

Git, google docs, wiki, trac



http://img.idealwebtools.com/blog/svn.gif

Modification cycle

- write test
- run and make sure it fails
- Checkout
- change, comment, edit readme etc.
- Compile
- run: make sure test passes
- checkin

Comments

- If it was difficult to write, it must be difficult to understand
- bad code requires more comments
- tying documentation and code
- use Euclid;

Documentation/comments in code

- List of functions exported
- Revision history
- List of other files used
- Name of the file

Documentation

- Algorithmic:

full line comments to explain the algorithm

- Elucidating: # end of line comments
- Defensive: # Has puzzled me before. Do this.
- Indicative: # This should rather be rewritten
- Discursive: # Details in POD

Arguments

- Don’t let your subroutines have too many arguments
  - universe(G,e,h,c,phi,nu)
- Look for missing arguments
- Set default argument values

- Use explicit return values

Needing/demanding arguments

- unless(@ARGV==4){exit;}
- my ($a,$b,$c,$d) = @ARGV;

use Getopt::Euclid; # not just demands arguments

but provides constraints

```
PROMPT> pq_images.pl
Missing required arguments:
        -r[a] [=] <RA>
        -d[ec] [=] <Dec>
(Try: pq_images.pl --help)
PROMPT>
```

```
PROMPT> pq_images.pl --help
Usage:
   pq_images.pl -r <RA> -d <Dec> [options]

Required arguments:
   -r[a] [=] <RA>
      Specify RA in degrees [0 <= RA <= 360]

   -d[ec] [=] <Dec>
      Specify Dec in degrees [PQ: -25 <= Dec <= 25]

Options:
   -i[d] [=] <id> [string]
      ID of the object
```

-c[leanup] [=] <cleanup>
Level of cleanup after the program is done [default: 2] 0: Do not remove anything 1: Remove everything except individual mosiacs (and final product) 2: Leave only final coadded image

-v
--verbose
Print all warnings

--version
--usage
--help
--man
Print the usual program information
PROMPT>

PROMPT>pq_images.pl --man

AUTHOR

Ashish Mahabal <aam@astro.caltech.edu>

BUGS

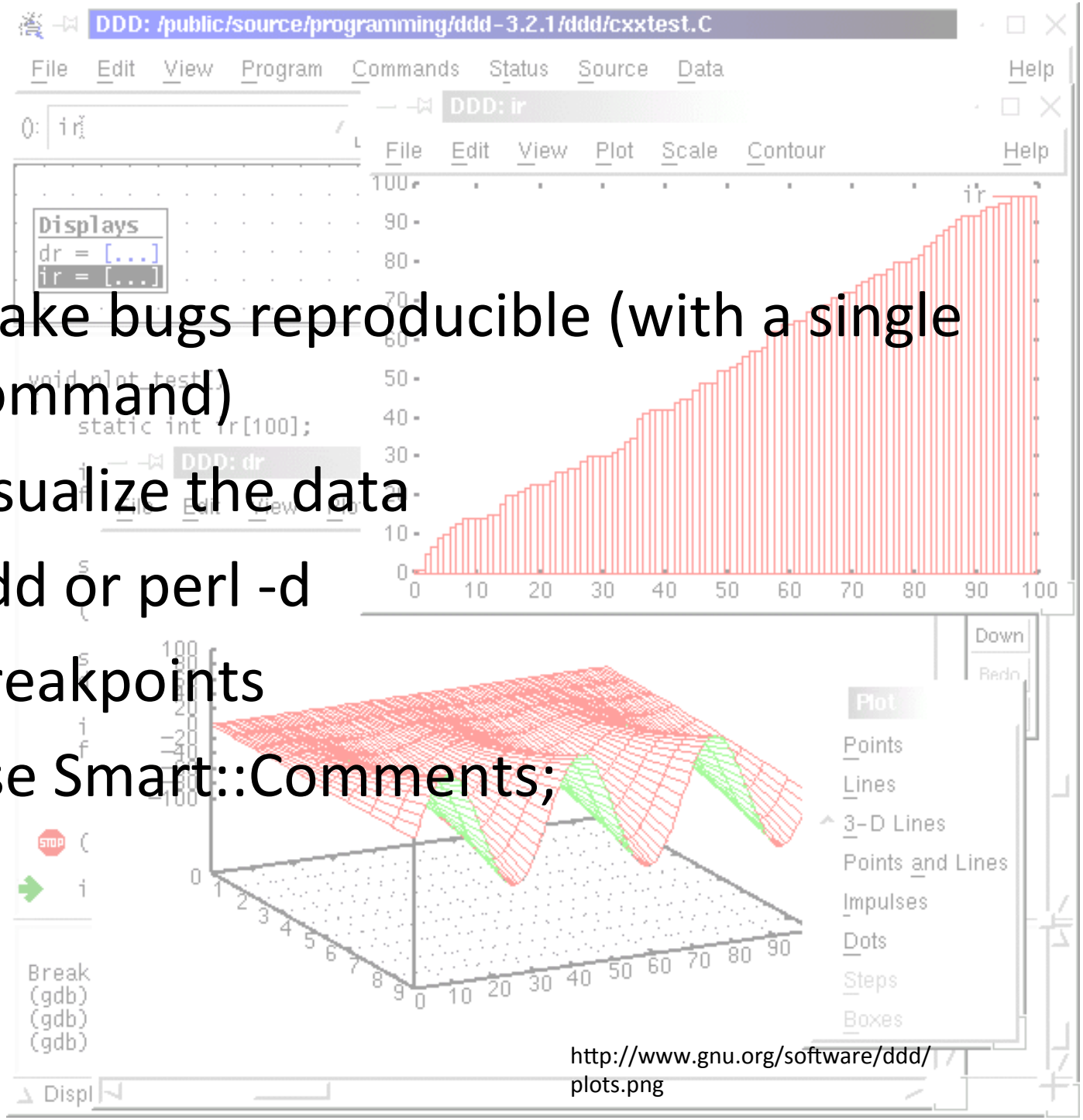
There are undoubtedly serious bugs lurking somewhere in this code. Bug reports and other feedback are most welcome.

```
use Getopt::Euclid;
…
=head1 REQUIRED ARGUMENTS
=over
=item -r[a] [=] <RA>
Specify RA in degrees [0 <= RA <= 360]
=for Euclid:
      RA.type:       number >= 0
      RA.type:       number <= 360
=item -d[ec] [=] <Dec>
Specify Dec in degrees [PQ: -25 <= Dec <= 25]
=for Euclid:
      Dec.type:      number >= -25
      Dec.type:      number <= 25
=back
```

Debugging

- there will be bugs!
- the only bugfree program is one that does not do anything
- tests: write unit tests first
- make sure the program compiles without warnings (perl -c)

- make bugs reproducible (with a single command)
- visualize the data
- ddd or perl -d
- Breakpoints
- use Smart::Comments;



http://www.gnu.org/software/ddd/plots.png

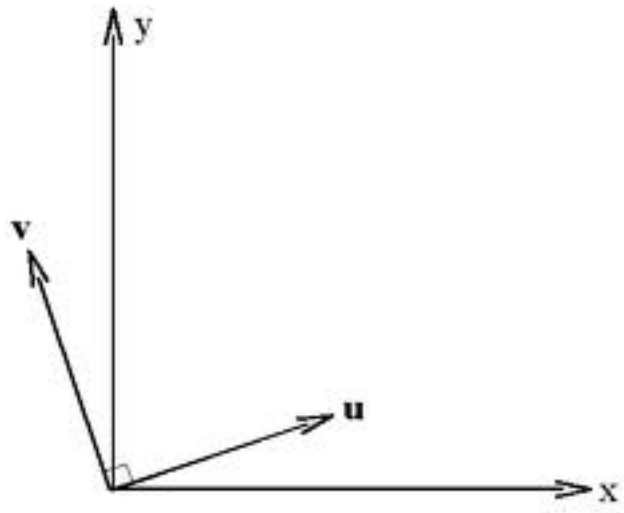
```
use Smart::Comments;

### seeing: $seeing
### calcmag: $cmag
### calcmag2: $cmag2;
```

When you find a bug …

- check boundary conditions
  - first and last elements of lists
- describe the problem to someone else
- why wasn't it caught before
- could it be lurking elsewhere (orthogonality!)
- if tests ran fine, are the tests bad?

- (non)Duplication
- Orthogonality
- Refactoring



Duplication

- Don't repeat yourself
- Impatience
- Reinventing wheels

Orthogonality

- Decouple routines
- Make them independent
- Change in one should not affect the other
- Changes are localized
- Unit testing is easy
- Reuse is easy
- If requirements change for one function, how many modules should be affected? 1
- Configurable

```
sub line{
        my ($startpoint, $endpoint, $length);
        …
        }
```

2 Choose a **template**

preview template

preview template

Choose a custom look for your blog.

You can easily **change the template later**, or even create your own custom template design once your blog is set up.

CONTINUE

- if while entertaining libraries you need to write/handle special code, it is not good.
- avoid global data
- avoid similar functions
- even if you are coding for a particular flavor of a particular OS, be flexible

Refactoring

- Early and often
  - Duplication
  - Non-orthogonal design
  - Outdated knowledge
  - Performance
- Don't add functionality at the same time
- Good tests
- Short deliberate steps

Portfolio building

- learn general tools, invest in different ones
  - plain text
    - easier to test (config files, for instance)
  - Shells
    - find, sed, awk, grep, locate
    - .tcshrc, .Xdefaults
  - learn different (types of) languages
  - Editor
    - if you know emacs, learn just a little bit of vi
    - Configurable, extensible, programmable (cheat sheet)
      - syntax highlighting
      - auto completion
      - auto indentation
      - Boilerplates
      - built-in help

- Text manipulation
  - perl and ruby are very powerful

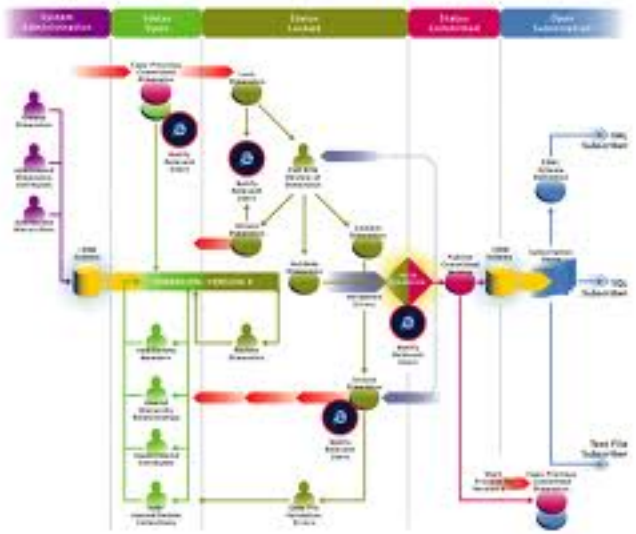
Metaprogramming

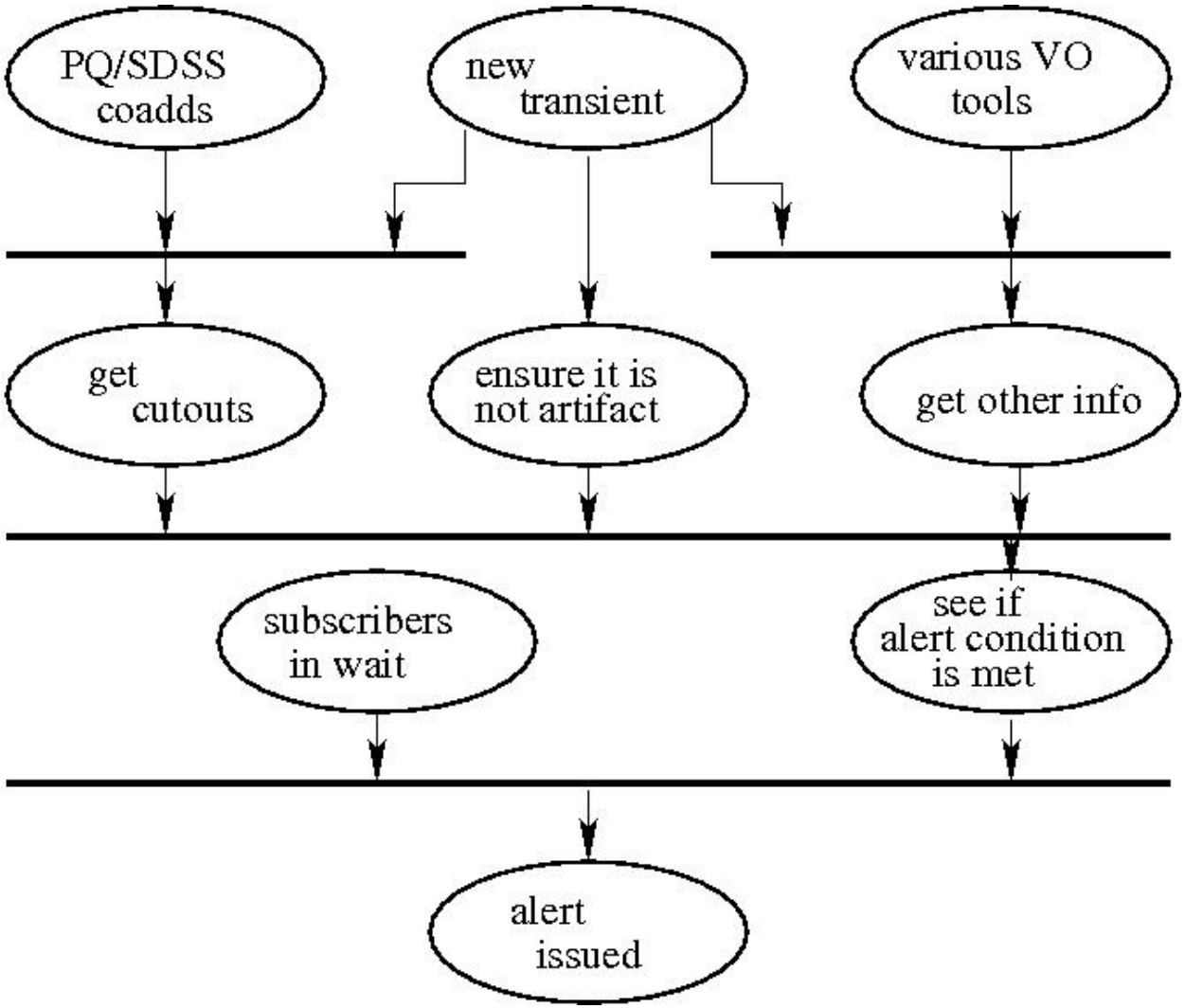
- Configure
- Abstraction in code, details in metadata
  - Decode design
  - Pod files (plain old documentation)

- Code generators
  - make files, config files, shell scripts., …
- Active code generator:
  - Skyalert (streams)
    - new transient
    - obtain new data
    - incorporate it
    - if certain conditions met,
      - run other programs
      - or raise alerts
      - drive other telescopes
      - and obtain feedback

Workflow

- Improving concurrency
- Unified Modeling Language (UML) diagrams
- Architecture
  - Action
  - Synchronization
  - Connect actions

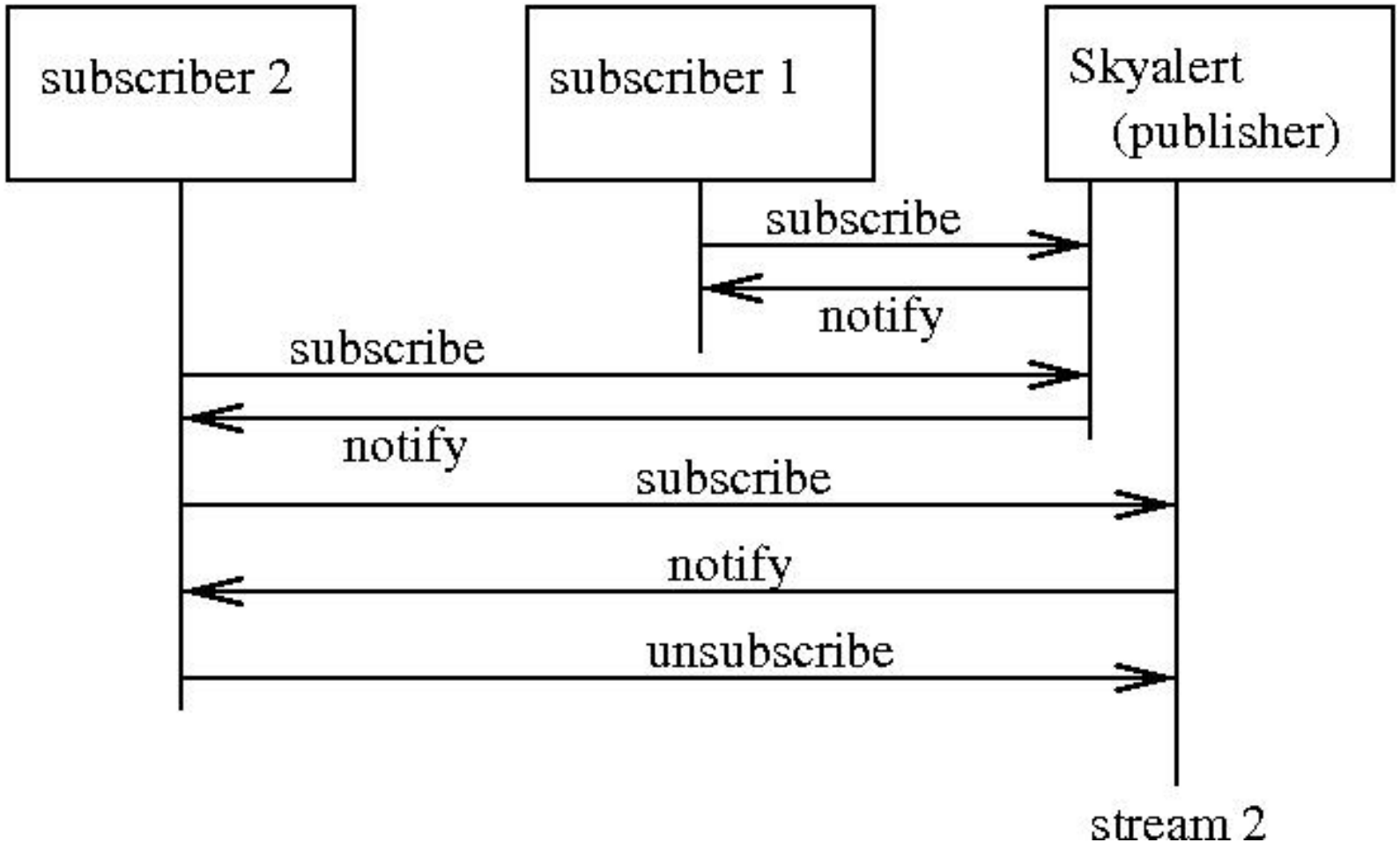



PQ/SDSS coadds
new transient
various VO tools
get cutouts
ensure it is not artifact
get other info
subscribers in wait
see if alert condition is met
alert issued

Publish-subscribe rather than push

- Allow people to subscribe
- Let them subselect
- Allows separate view of model

Skyalert http://www.skyalert.org


subscriber 2
subscriber 1
Skyalert
(publisher)
subscribe
notify
subscribe
notify
subscribe
notify
unsubscribe
stream 2

Before the project

- Dig for requirements
- Document requirements
- Make use case diagrams
- Maintain a glossary
- document

- Don’t optimize code – benchmark it
- Don’t optimize data structures – measure them
- Cache data when you can – use Memoize
- Benchmark caching strategies
- Don’t optimize applications – profile them (find where they spend most time)

```
use Benchmark qw( cmpthese );

my @sqrt_of = map {sqrt $_} 0..255;

cmpthese -30, {
   recompute      => q{ for my $n (0..255) {
                        my $res = sqrt $n      } },
   look_up_array  => q{ for my $n (0..255) {
                        my $res = $sqrt_of[$n] } },
};
```

Summarizing …

- Software entropy
  - Fix broken windows
- Know when to stop
  - Don't overperfect
- Widen knowledge portfolio
  - Hotjava
  - Postscript
  - vi/emacs

- Languages/tools/OSes/editors
  - 99 bottles of beer
  - Programming shootout
  - Project Euler
    - Python
    - Perl
    - J
    - Haskell

Whats the lesson?

- Chain as weak as its weakest link
- Comment! For others and for yourself
- Tests!
- Orthogonality
- Don’t duplicate
- Designing by contract
- Know the features

- Review/balance
  - Public forums
    - Ask specific things
    - Check FAQs, webresults etc.
  - Maintain your own bookmarks
- Use wikis
- Use SVN, trac
- CHECK REPOSITORIES (like CPAN)

- Law 1: Every program can be optimized to be smaller.
- Law 2: There's always one more bug.
- Corollary: Every program can be reduced to a one-line bug.

From a Bug's life