Beyond the Mouse – A Short Course on Programming

1. Thinking programs

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"The Uncomfortable Truths Well", http://xkcd.com/568 (April 13, 2009)

Outline

1. Overview and Philosophies
2. Thinking programs
3. Building programs
4. Summary

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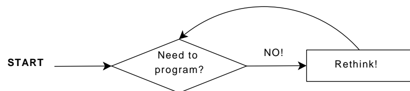
The Program . . .



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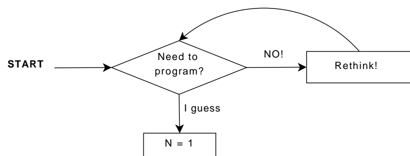

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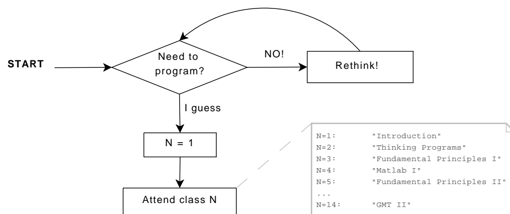

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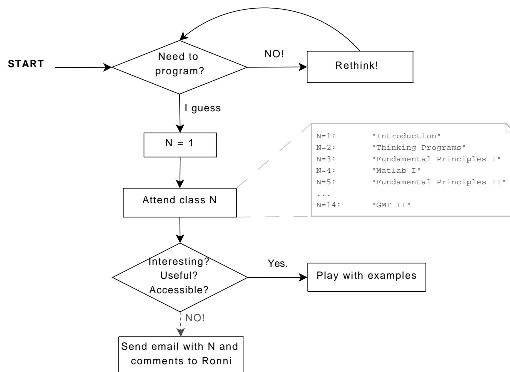

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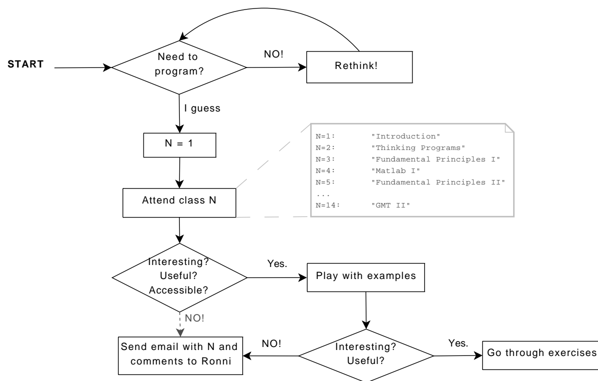

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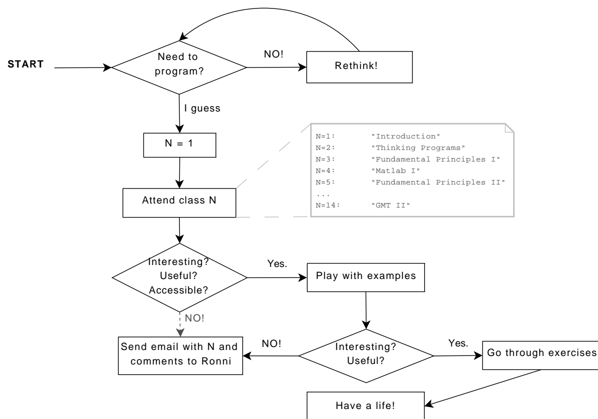

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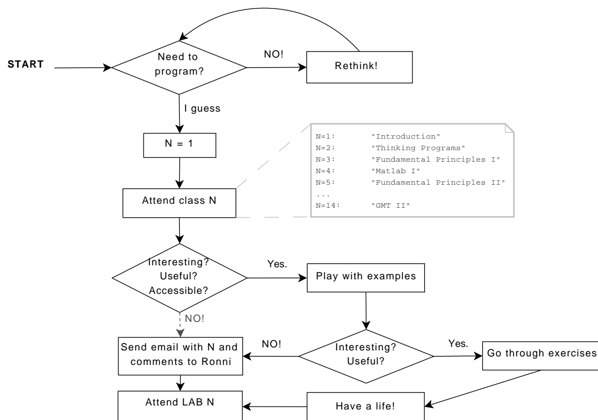

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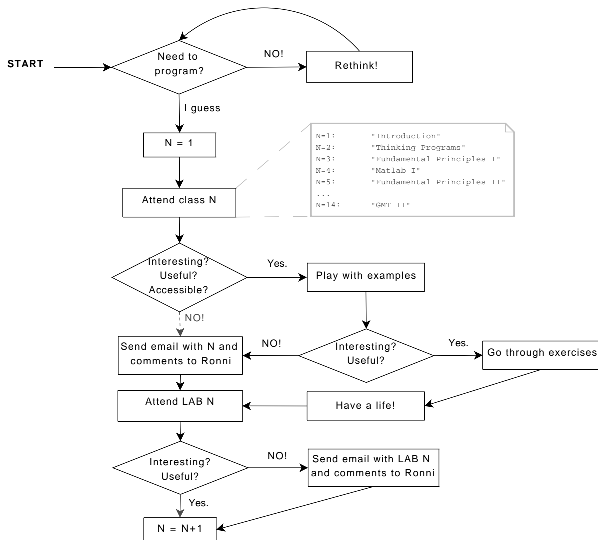

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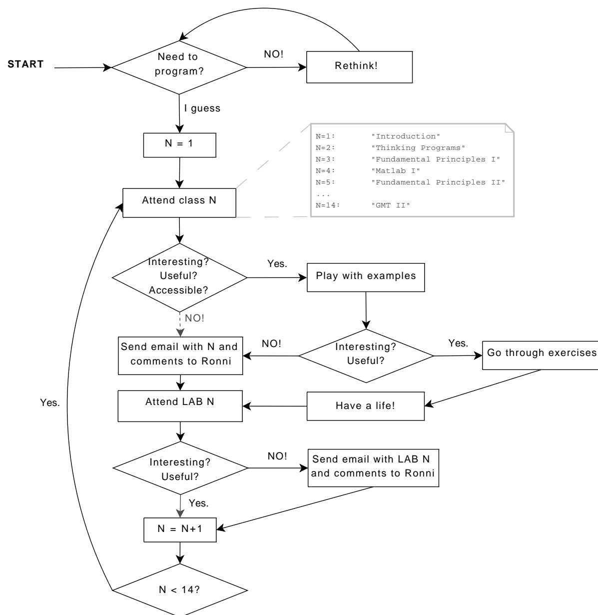

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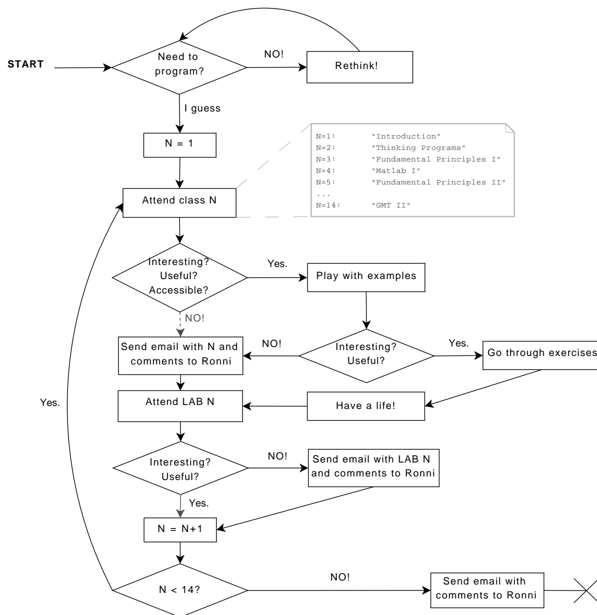

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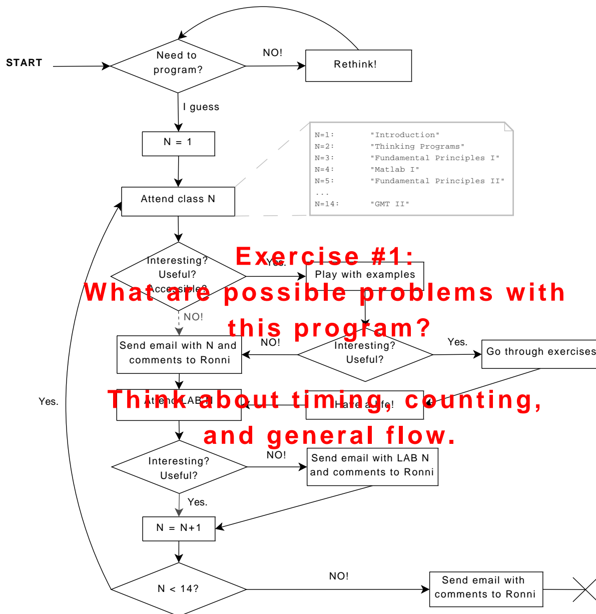


Exercise #1:
What are possible problems with this program?

Think about timing, counting, and general flow.

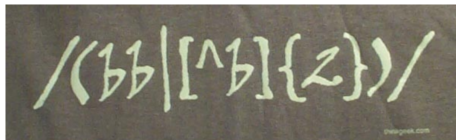
The very basics (1)

From ‘The Conscience of a Hacker’, The Mentor (1986):

[...] I made a discovery today. I found a computer. Wait a second, this is cool. It does what I want it to. If it makes a mistake, it’s because I screwed it up. Not because it doesn’t like me ...
Or feels threatened by me ...
Or thinks I’m a smart ass [...]

The very basics (2)

- Programming is beyond language.



http://thinkgeek.com

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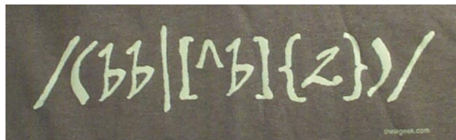
- Programming is beyond language.
- Programming is about writing code that people can read.



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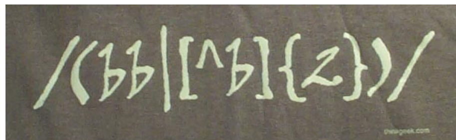

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“When I’m writing poetry, it feels like the center of my thinking is in a particular place, and when I’m writing code the center of my thinking feels in the same kind of place.”

Richard Gabriel,

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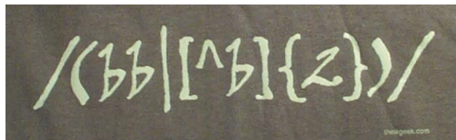
- RTFM *and/or* the internet



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More Philosophy . . .

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More Philosophy . . .

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Implications . . .

- publications should include data and code (example: Okada)
- figures should be reproducible by readers
- write code that others can use!

What does that mean?

Good

```
1  function fp = screw2d(x, xf, d, sdot)
   % function fp = screw2d(x, xf, d, sdot)
3  %
   % Computes fault-parallel slip rate for 2D screw dislocation
5  % with fault located at xf, with locking depth d and slip rate sdot.
   % Will compute at one or many locations x.
7  %
   % x    column vector
9  % xf   scalar
   % d    scalar
11 % sdot scalar
   %
13 if ( d == 0 )
     fp = sdot*0.5*sign(x-xf*ones(size(x)));
15 else
     fp = sdot*atan2((x-xf*ones(size(x))),d)/pi;
17 end
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Bad

```
   function fp = screw2d(x, xf, d, sdot)
 2 if(d==0)fp=sdot*0.5*sign(x-xf*ones(size(x)));else fp=sdot*atan2((x-xf*ones(size(x))),d)/pi;
   end
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Example 1:

Getting into grad school ... and out.

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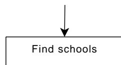
things to do:

apply, figure out where to go, visa stuff, class work, research, thesis . . .

Thinking programs – Breaking down complex tasks



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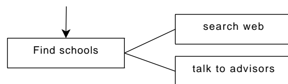

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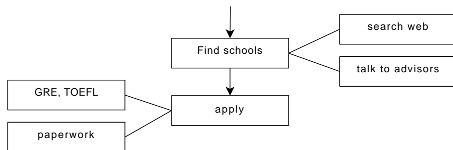

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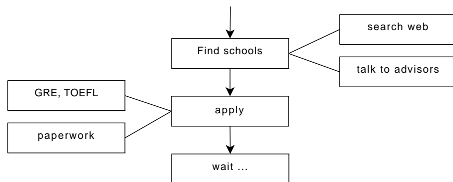

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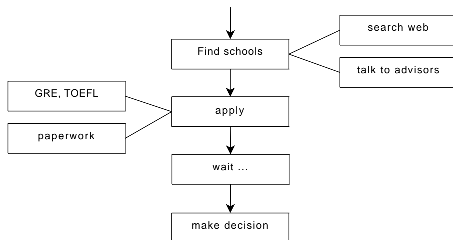

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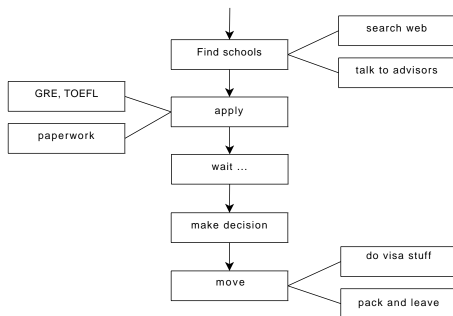

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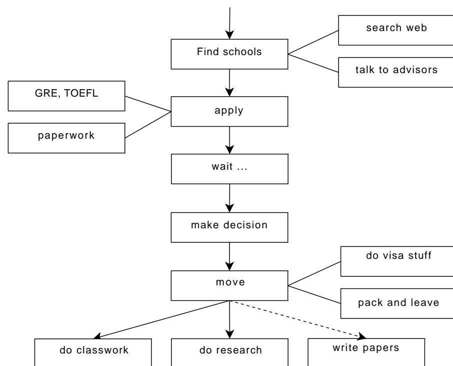

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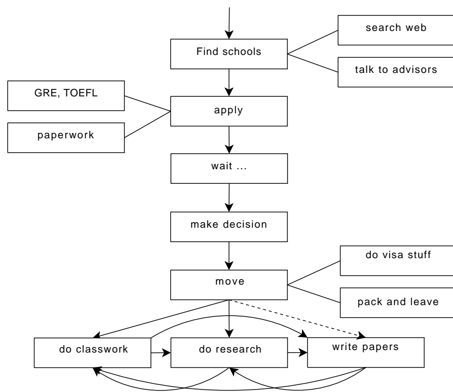

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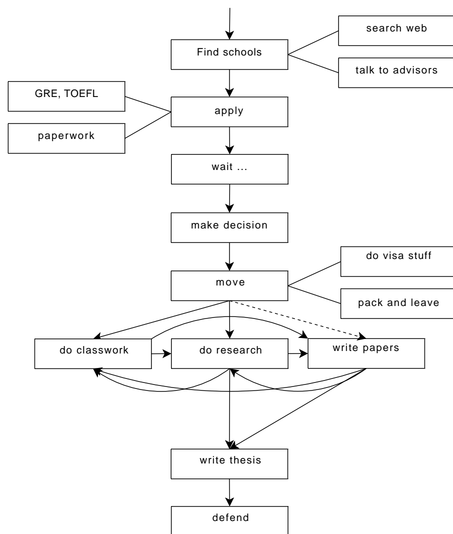

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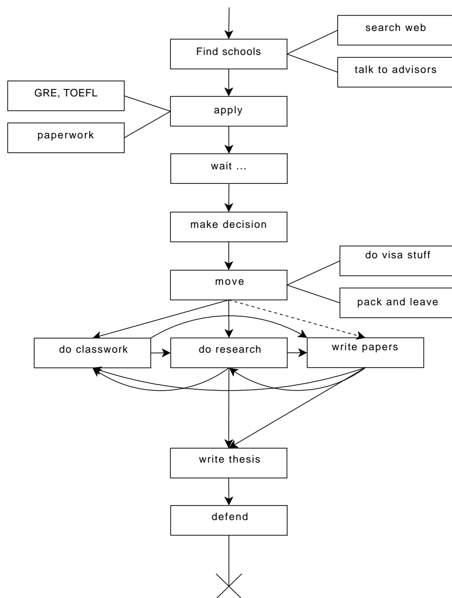

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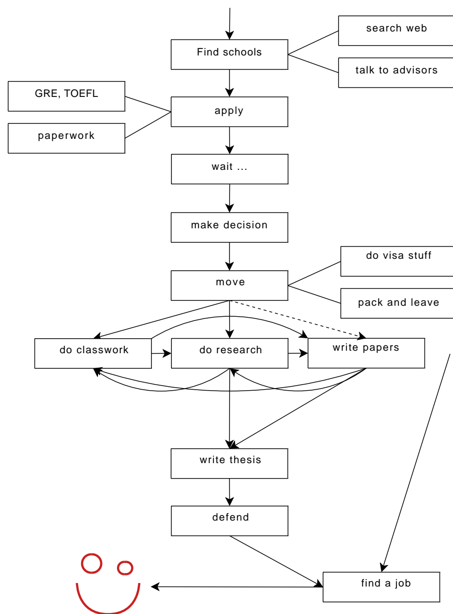

Example 2:

Grad student’s Average Day

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possible activities:

eat, sleep, work, do stuff, ...

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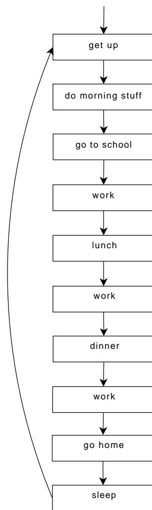

Listing 1: make_my_day

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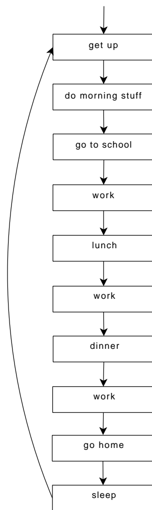

possible implementation

```
  % make_my_day.m
2 %———————————
  % program that shows how much fun
4 % live as a grad student is :)

6 getUp;
  eat('breakfast');
8 walk('school');
  work;
10 eat('lunch');
  work();
12 eat('dinner');
  work();
14 walk('home');
  haveLife;
16 sleep;
```

Listing 1: make_my_day

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Building programs – One black box at a time

Strategies to implement a program:

Top down

Same as the examples above:

- start with the big picture
- identify reasonable subtasks
- try to divide things to a level of managable complexity (atoms)
- implement atoms
- implement main routine (flow control)

Building programs – One black box at a time

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- start with the big picture
- identify reasonable subtasks
- try to divide things to a level of managable complexity (atoms)
- implement atoms
- implement main routine (flow control)

Bottom up

- problems accumulate
- implement an atom at the time
- at some point you figure out that things could go together
- revise main routine constantly
- add necessary subroutines

Building programs – One black box at a time

Bottom line

- Try building tools that solve a set of similar problems in a generic way. Use Parameters!
- Build and test each atom individually, test all scenarios (and more) with synthetic input.
- Treat atoms as black boxes that implement desired functionality. Don't care about them once they're working

Building programs – One black box at a time

Keys to good programs

- **Modularity**: split problem in manageable tasks, implement and test one at a time

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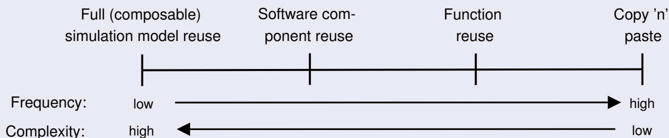

Pidd, 2002

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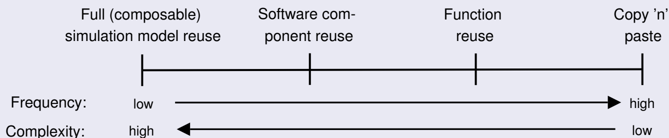

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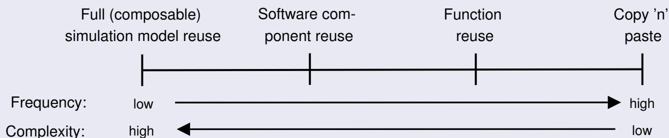

Pidd, 2002

- **Generalize**: use variables instead of hard coded values, hand parameters to functions
- Functionality, then efficiency

Building programs

The Control Routine

```
   % make_my_day.m
 2 % ----------------
   % program that shows how much fun
 4 % live as a grad student is :)

 6 getUp;
   eat('breakfast');
 8 walk('school');
   work;
10 eat('lunch');
   work();
12 eat('dinner');
   work();
14 walk('home');
   haveLife;
16 sleep;
```

Using Parameters

```
   % eat.m
 2 % ----------------
   function eat(what)
 4     disp(sprintf('%s: yummy ... %s', ...
           mfilename, what));
 6     pause(1);
   end
```

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Summary – Take home messages

Thinking . . .

- Think modular
- Think in general cases
- Think non-redundant
- Think about reuse
- Think about reproducibility

Exercising . . .

- Read other peoples' code . . . critically
- The first version is for the trash bin (unintentionally)

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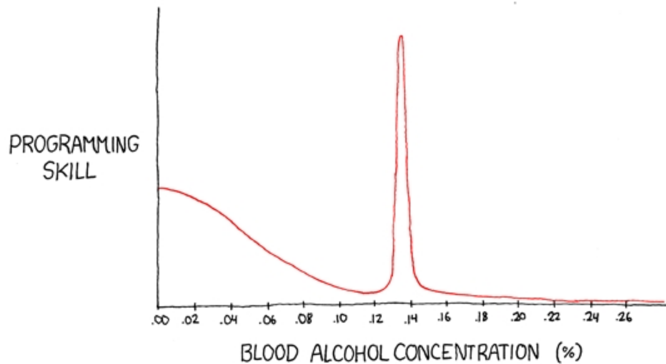
Truth . . .

Your working environment will change, concepts likely survive! Be flexible in the choice of languages and tools.

If all fails . . .



"The Ballmer Peak"

http://www.xkcd.com/323/