Testing

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What testing gives us

- Confidence that our software is
  - Correct
  - Robust
  - Scalable
- A way to safely
  - Fix bugs
  - Refactor code
- “if it’s not tested, it’s broken” – bittermanandy, 10/09/2010

Testing

It is a way to check that our software does what we want and expect it to.
That it doesn’t behave unpredictably or mysteriously if given bad inputs or encounters errors.
And that it behaves well if given large volumes of data, for example.
Nothing is worse than fixing a bug only to introduce a new bug.

Why testing isn't done

- "I don't write buggy code"
- "It's too hard"
- "It's not interesting"
- "It takes too much time and I've research to do"

Speak up if this looks familiar!
Well, we are naturally very protective of our work and may refuse to accept that our code has bugs.
Unfortunately, almost all code has bugs.
The practice of actually writing automated tests, code that tests our software, is perceived as being too difficult.
However, if it's hard to write a test for some code, then this is a good sign that the code is not well designed.
Sometimes, testing is just viewed as not being interesting.
What this usually translates to is "I have no time and anyway it's not the focus of our research".
And, this is a fair point. So, why should we care about testing?

Why testing is needed

"er….there was a buffer overflow…"

Testing

Ariane 5, the successor to Ariane 4 with new and improved engines.
Ariane 5 used Ariane 4 code.
Unfortunately, the developers didn't test the code properly.
Ariane 5's faster engines gave rise to a bug which caused a buffer overflow.
And, the buffer overflow caused Ariane 5 to explode.
So, some forgotten tests led to millions of pounds down the drain and some very red faces.
It could have been worse, someone could have died.

Consider Geoffrey Chang…

Department of Molecular Biology, Scripps Institute

5th Annual Presidential Early Career Awards for Scientists and Engineers – 2000

Beckerman Foundation Young Investigator Award – 2001

Publications

Chang G, Roth CB. (2001) Structure of MsbA from E. coli: a homolog of the multidrug resistance ATP binding cassette (ABC) transporters. Science 293(5536):1793-800.

Pornillos O, Chen YJ, Chen AP, Chang G. (2005) X-ray structure of the EmrE multidrug transporter in complex with a substrate. Science 310(5756):1950-3.

Reyes CL, Chang G. (2005) Structure of the ABC transporter MsbA in complex with ADP.vanadate and lipopolysaccharide. Science 308(5724):1028-31.

Letters – Retraction, Science 22 December 2006: Vol. 314 no. 5807 p. 1875 DOI: 10.1126/science.314.5807.1875b

Retraction of Pornillos et al., Science 310 (5756) 1950-1953.

Retraction of Reyes and Chang, Science 308 (5724) 1028-1031.

Retraction of Chang and Roth, Science 293 (5536) 1793-1800.

For us, consequences may not be so drastic but nevertheless they could be damaging.
If our software has bugs then our research results may be flawed and we might not notice until months later.
Or, worse, others might notice before we do.
As a consequence, others may not trust our research or our software, which could affect our chances for collaborations, publications or funding.
PhD and associate professor.
Scripps is one of the world's largest, private, non-profit research organizations, stands at the forefront of basic biomedical science.
Highest honour of the United States Government.
Certificate signed by Bill Clinton.
White House ceremony and NIH tour.
Beckman Award, designed to support researchers early in their academic careers.
Structural biology of multidrug resistance.
Note the 3 in Science, very high profile.
http://en.wikipedia.org/wiki/Geoffrey_Chang

From small seeds…

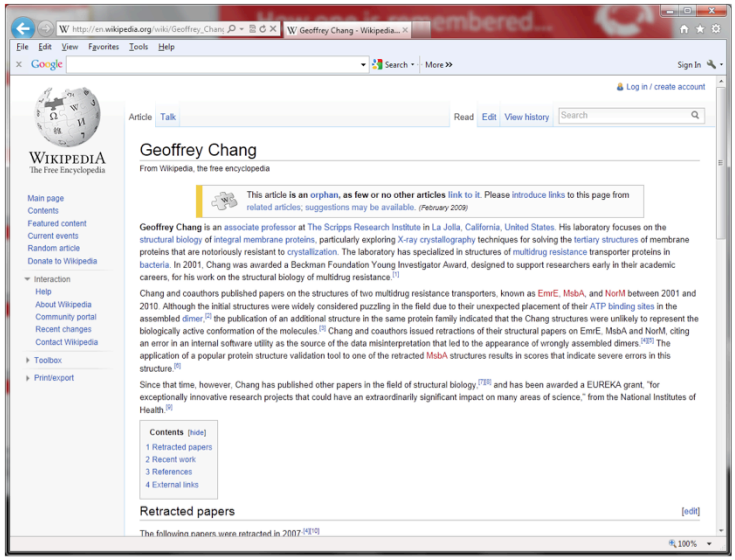
We wish to **retract** our research article … and both of our Reports….our MsbA structures…were **incorrect** …our biological interpretations based on these inverted models for MsbA are **invalid**…

An in-house data reduction program introduced a **change in sign** … (I+ and I-) to (F- and F+)…Unfortunately, the use of the multicopy refinement procedure still allowed us to obtain reasonable refinement values for the wrong structures

…We very sincerely **regret** the confusion that these papers have caused and, in particular, subsequent research efforts that were unproductive as a result of our original findings."

http://www.sciencemag.org/content/314/5807/1875.2.full

Fame has a fifteen minute half-life, infamy lasts a little longer



And he's not alone

software carpentry

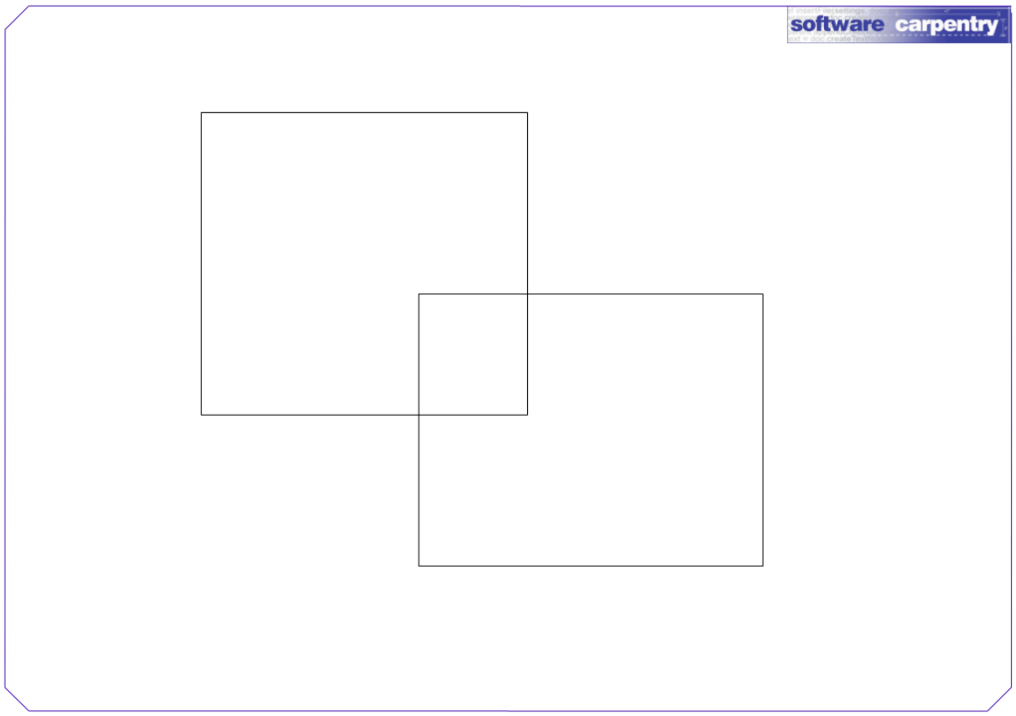
- "A Test of Corrections for Extraneous Signals in Gridded Surface Temperature Data"
  - R. McKitrick and P. Michaels, Climate Research 26(2) 2004
- "McKitrick screws up yet again"
  - Tim Lambert's blog, August 2004
- "McKitrick mucks it up"
  - John Quiggin's blog, August, 2004
- "ERRATUM"
  - R. McKitrick and P. Michaels, Climate Research 27(3) 2004
  - "formula for computing cosine of absolute latitude … takes the angle in radians, but our data were entered in degrees"

R. McKitrick and P. Michaels, "A Test of Corrections for Extraneous Signals in Gridded Surface Temperature Data", Climate Research, vol. 26, no. 2, 2004, pp. 159-173.
http://www.int-res.com/articles/cr2004/26/c026p159.pdf
Climate sceptics.
"McKitrick screws up yet again", Tim Lambert, August 26, 2004
http://scienceblogs.com/deltoid/2004/08/26/mckitrick6/
"If you do calculations and get degrees and radians mixed up, you get the wrong answer."
"analysis included a variable cosablat, which was supposed to be the cosine of absolute latitude. Trouble is, the software he used expects angles to be measured in radians, his data has latitude in degrees, and he didn't convert from degrees to radians."
"McKitrick mucks it up", John Quiggin, August 25, 2004
http://crookedtimber.org/2004/08/25/mckitrick-mucks-it-up/
ERRATUM
McKitrick & Michaels, Vol. 26: 159-173 (2004) CR 27(3):265-268
http://www.int-res.com/articles/cr2004/27/c027p265.pdf
http://www.uoguelph.ca/~rmckitri/research/Erratum_McKitrick.pdf
"There was a mistake in the command file used to compute the results in our paper (McKitrick & Michaels 2004). The formula for computing cosine of absolute latitude (COSABLAT) takes the angle in radians, but our data were entered in degrees"

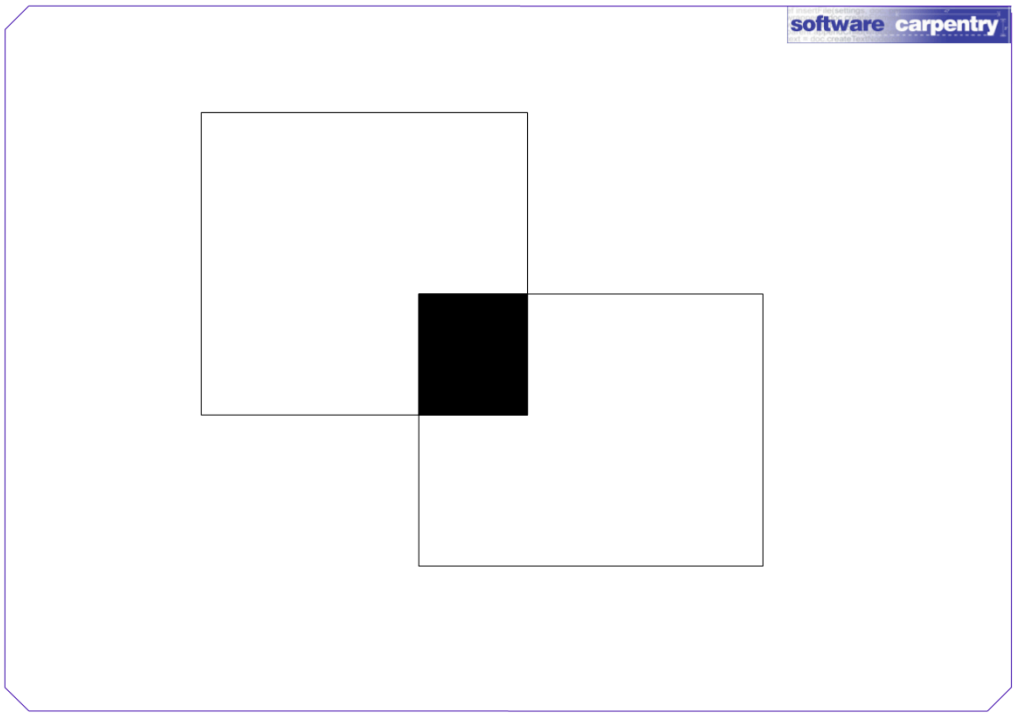
What testing gives you

- Confidence that your code does what it is supposed to
- Examples of what the code is supposed to do
  - A runnable specification
- Ability to detect, and fix, bugs more quickly
- Confidence to refactor or fix bugs without creating new bugs
- Examples of how to use your code

Practical



Testing



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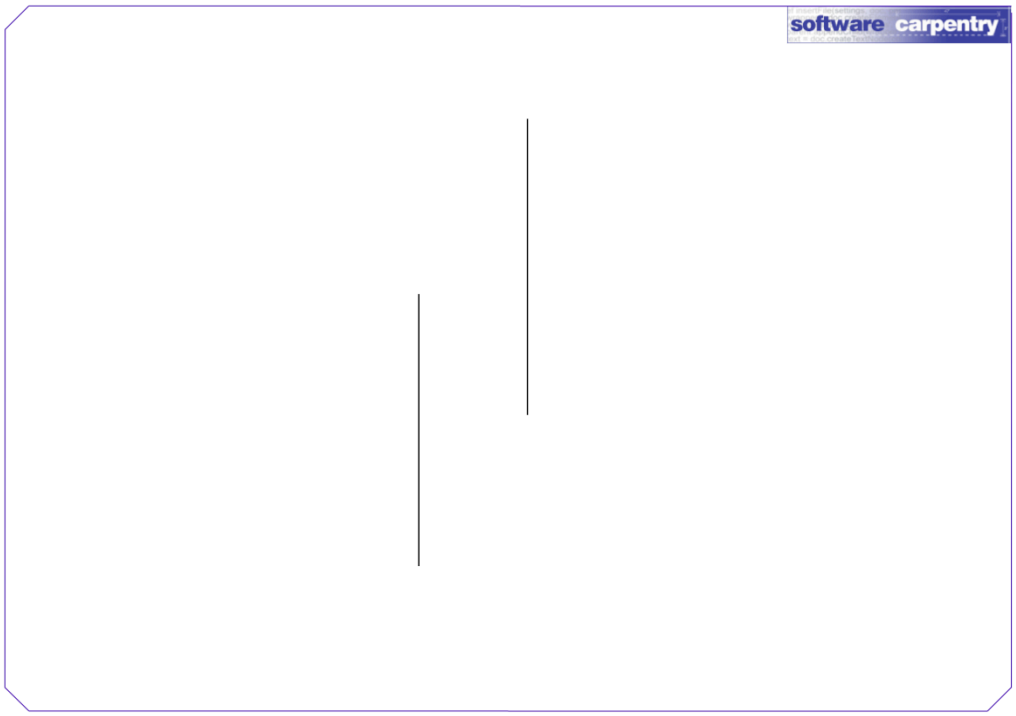

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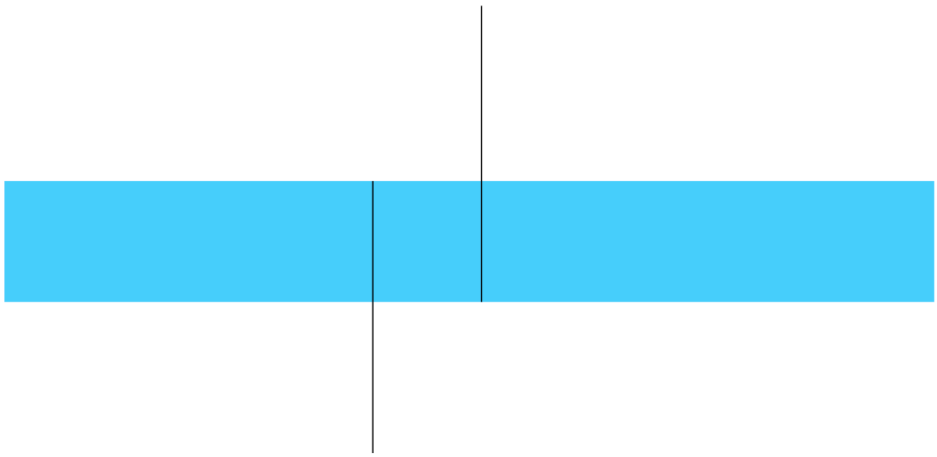

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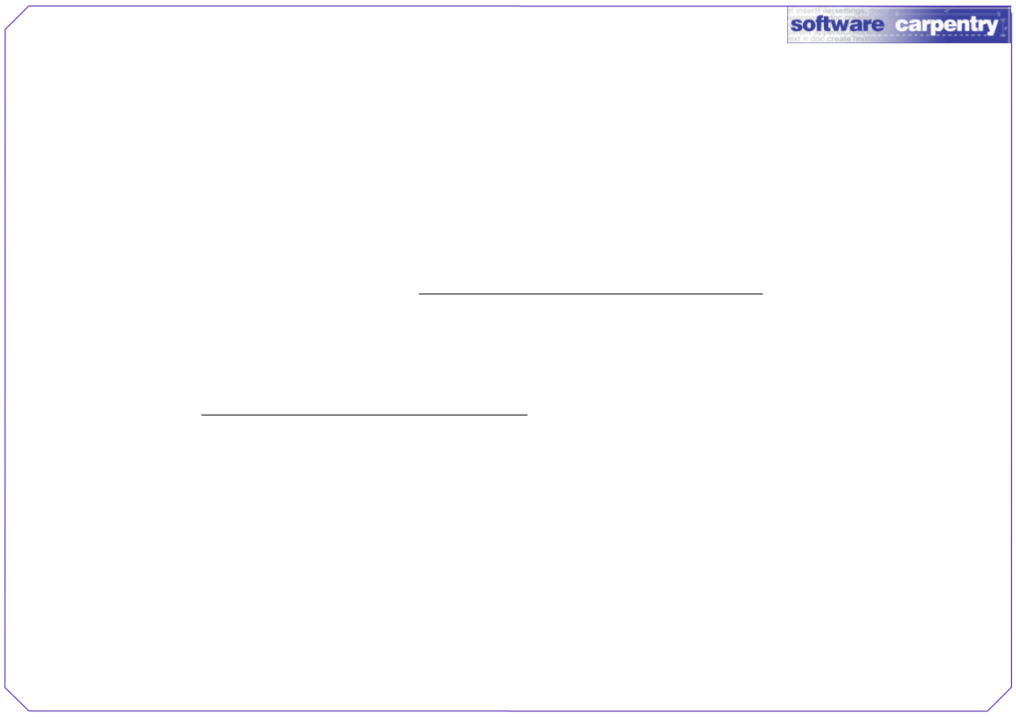

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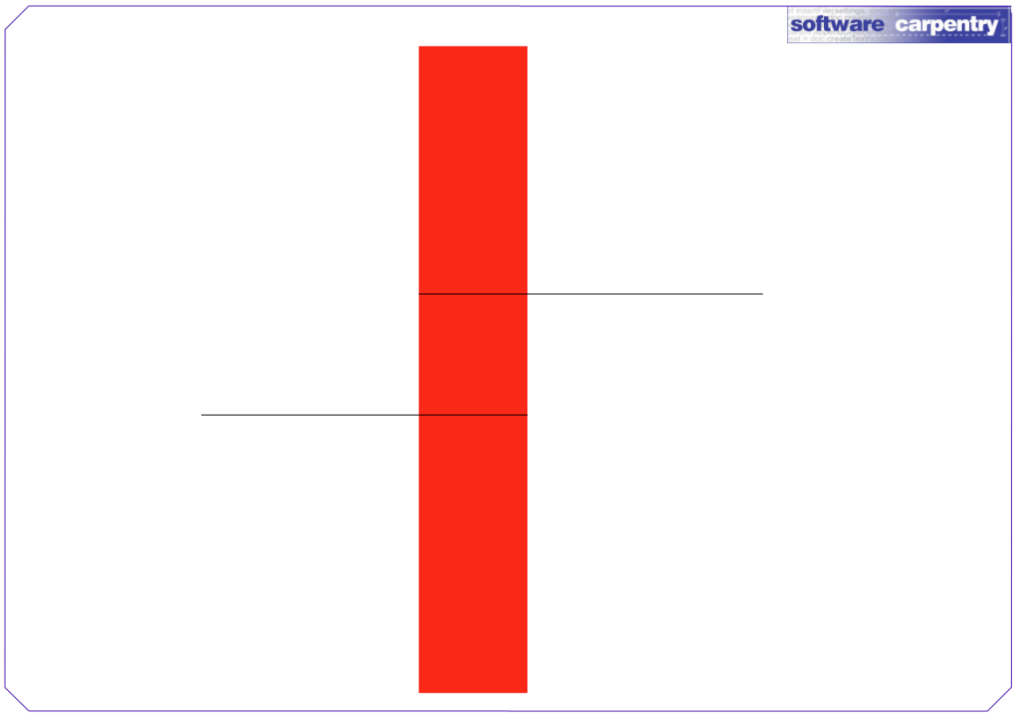

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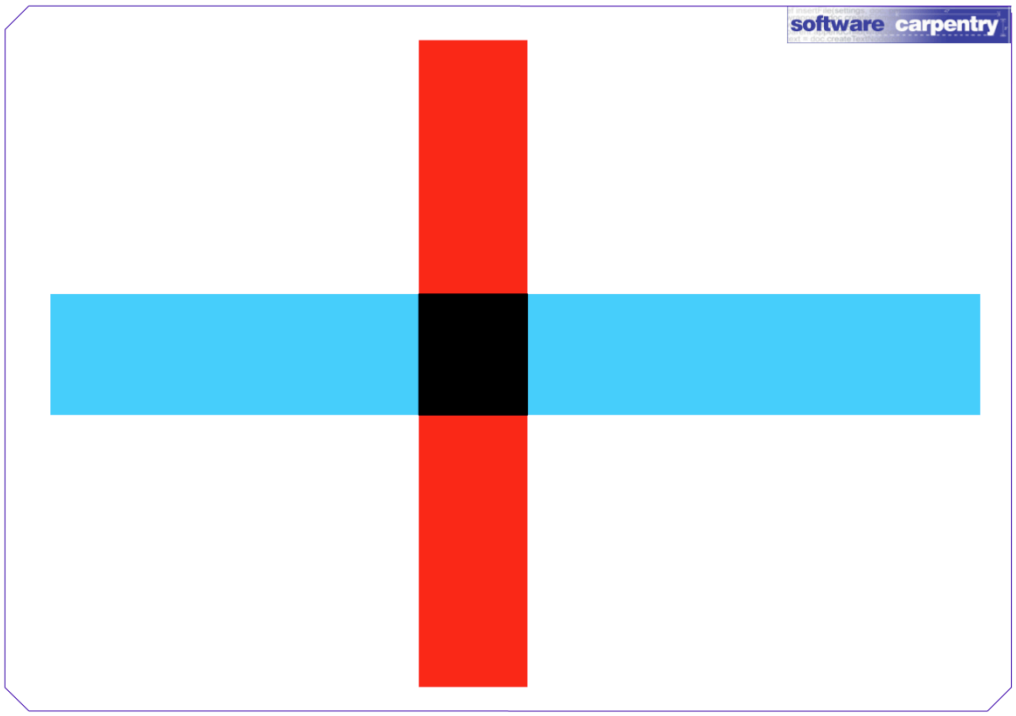

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