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Measure for Measure

Quantifying the Effect of TDD

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Slide 1
7 March 2008

Keith Braithwaite

Keith Braithwaite

Principle Consultant with Zuhlke

Formerly:

- Head of Development, WDS Global A-PAC
- Senior Software Developer, Penrillian

XtC and XpDay Regular

- Presented at every XpDay London

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An On–going Story

See http://peripateticaxiom.blogspot.com/search/label/test-first%20complexity

For the history

Previous presentations at XpDay, Spa, Agile have been workshops

This is a tutorial

Download the tool, have a go and let me know

http://www.keithbraithwaite.demon.co.uk/professional/software/index.html

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Looking for hot spots

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A team was fretting about quality

- Cyclomatic Complexity is supposed to highlight trouble
- ran a tool
- graphed the results...

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Cyclomatic Complexity

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Devised for FORTRAN

- A guide to refactoring
- An indicator of effort to test
- Not bad for the early 70's

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Cyclomatic Complexity: Creature of Structured Programming

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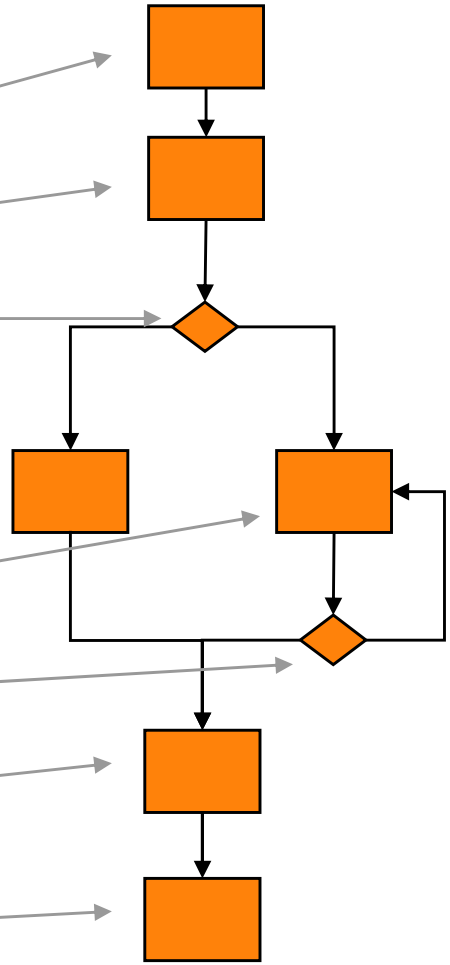
```
a = getStuff();
b = getOther();
if(a > b){
    doThis();
} else {
    do{
        tweak(a);
    } while (a < b)
}
wibble();

wobble();
```



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Cyclomatic Complexity

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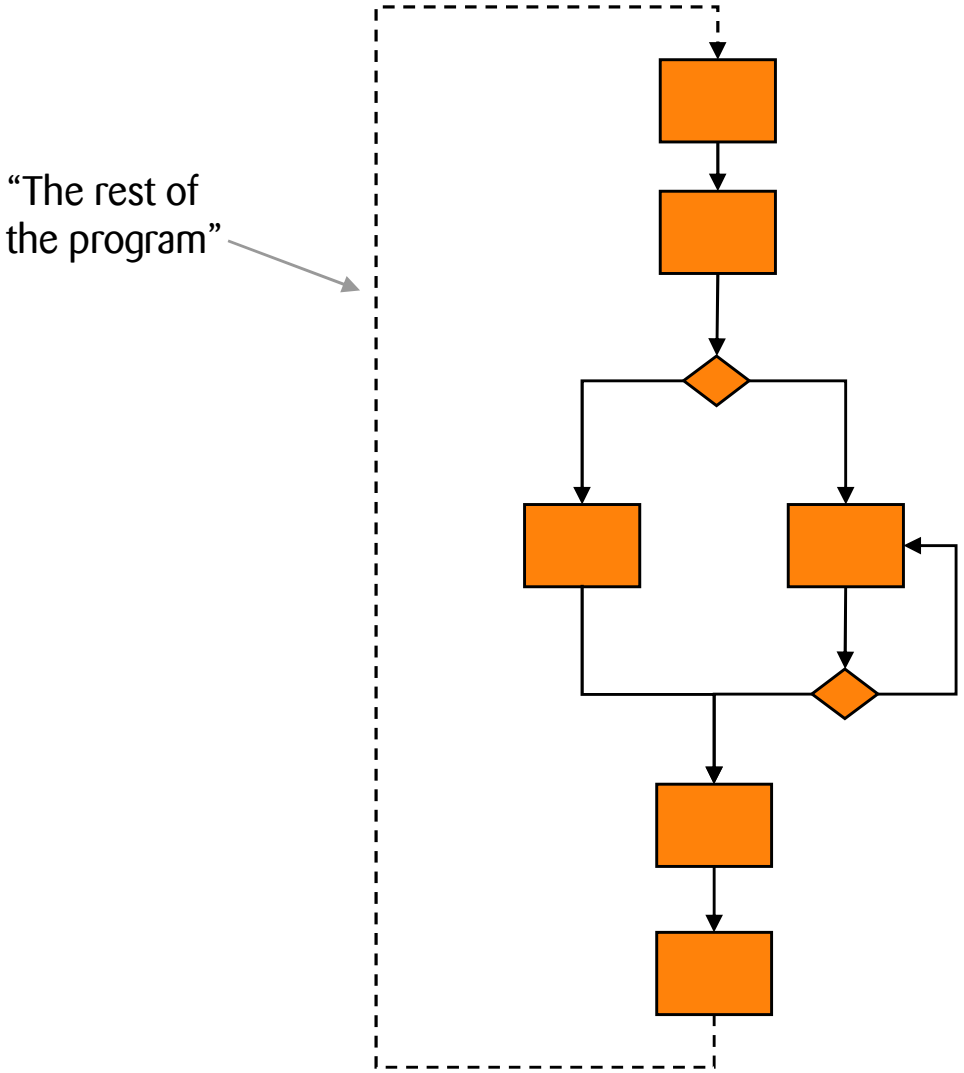

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Cyclomatic Complexity

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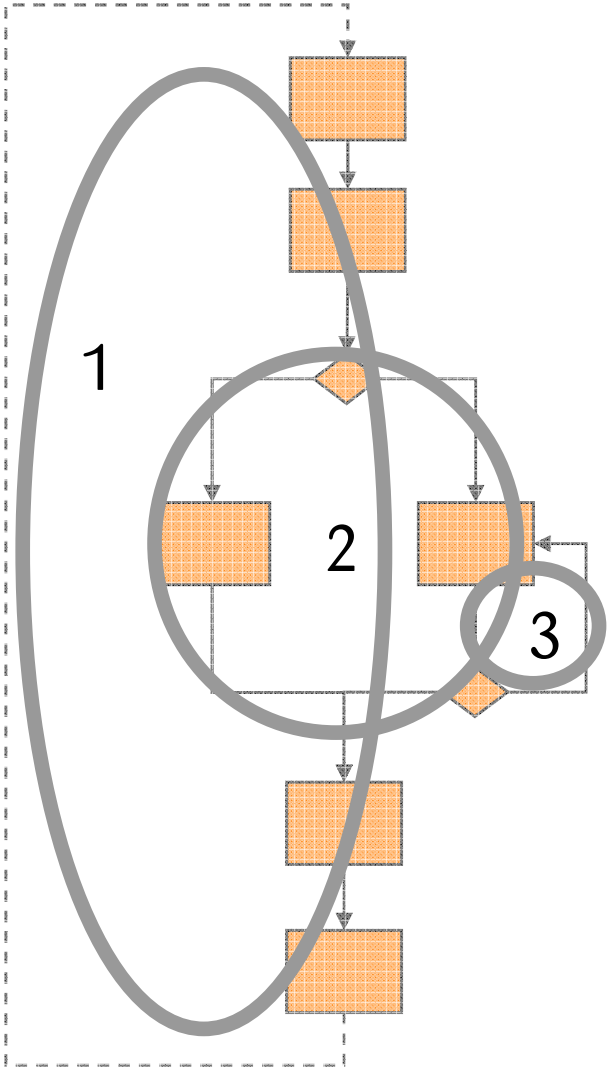

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Cyclomatic Complexity

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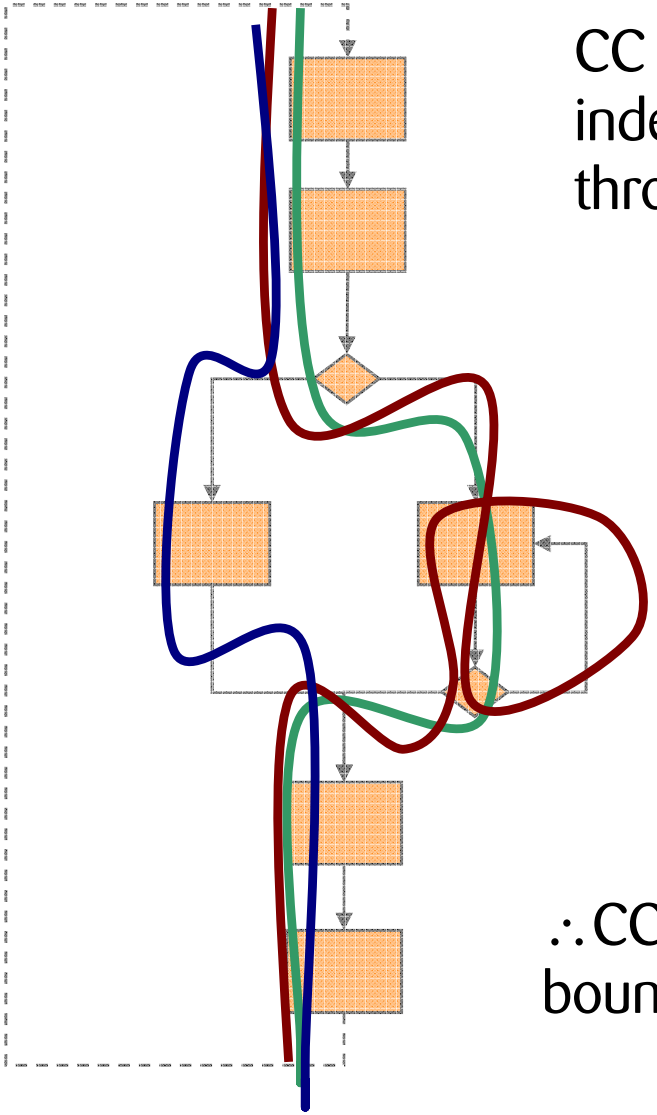

CC = # {linearly independent route through the code}

∴ CC = greatest lower bound on #{test case}

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Where is the complexity?

Used Checkstyle to report on Complexity

Charted the number of methods at each complexity

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Why Would You Care?

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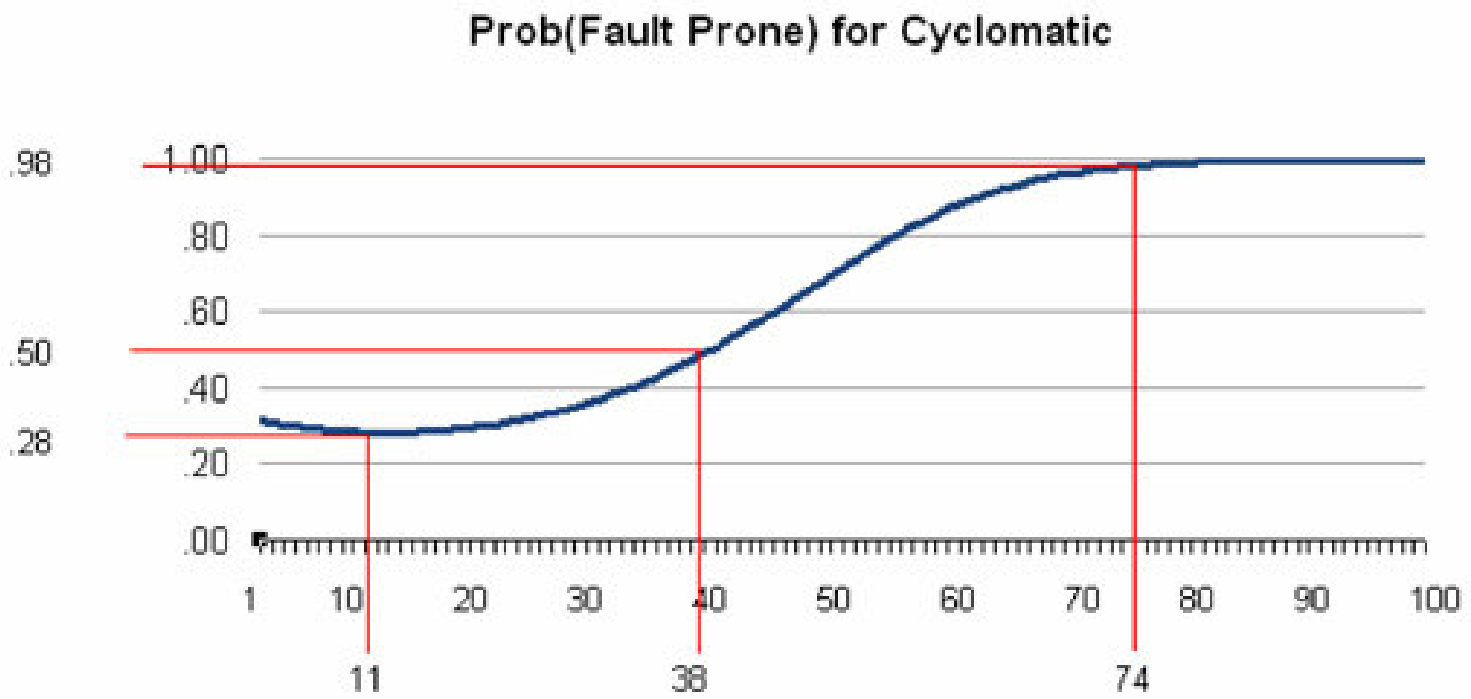

From http://www.enerjy.com/blog/?m=200802

Note that this is total complexity *per file*

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Something Familiar

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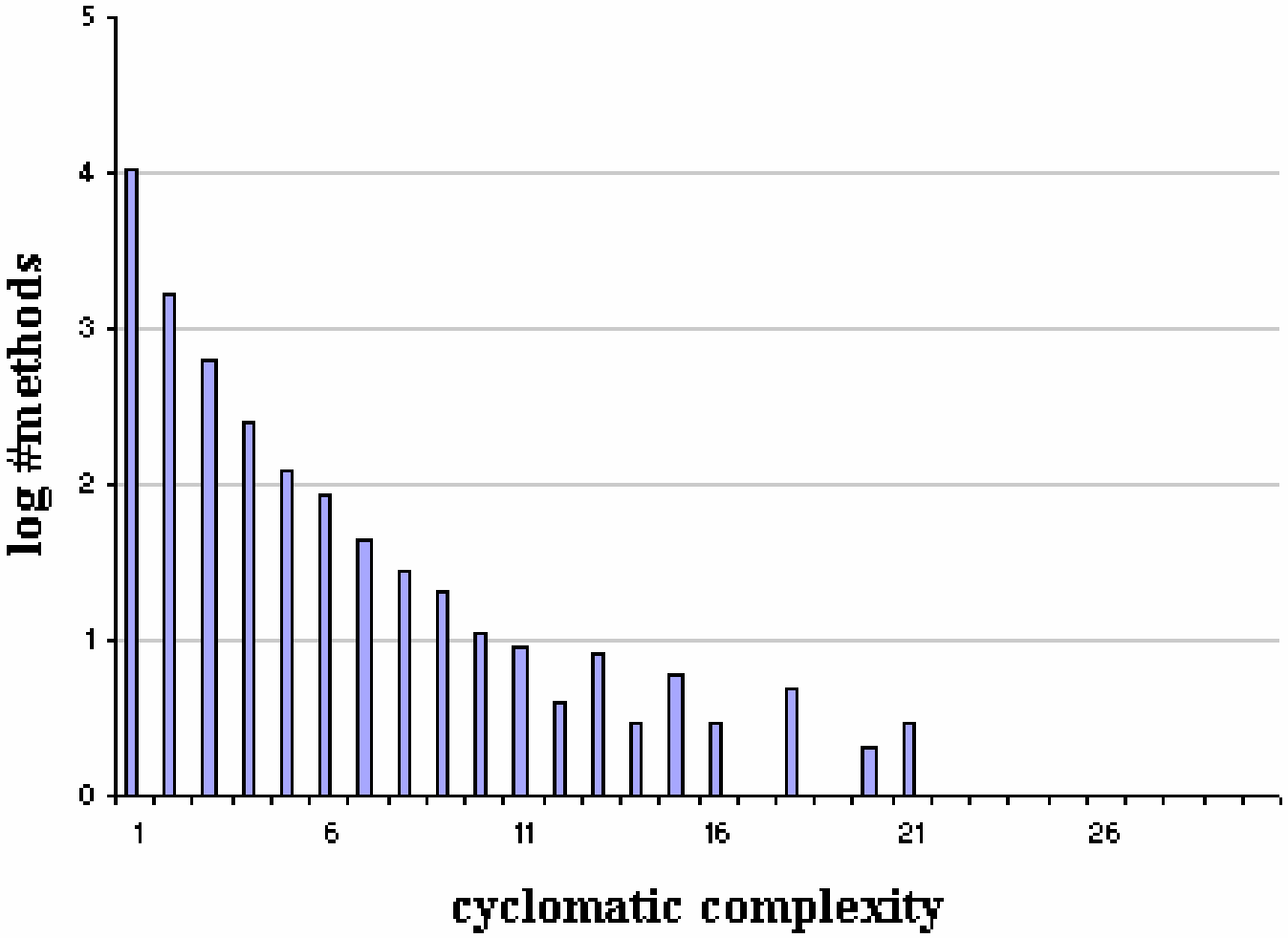

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Distribution of Complexity

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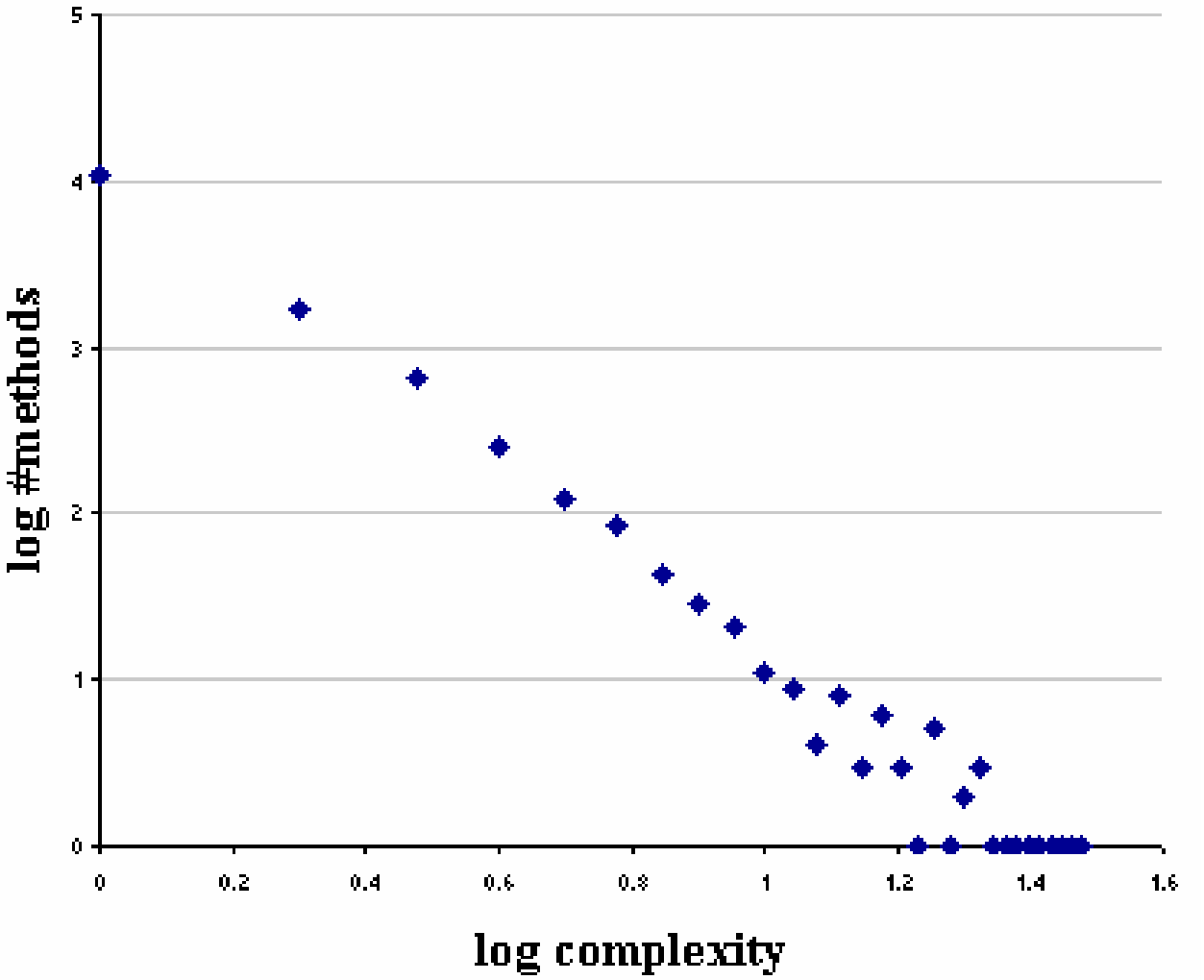

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Distribution of Complexity

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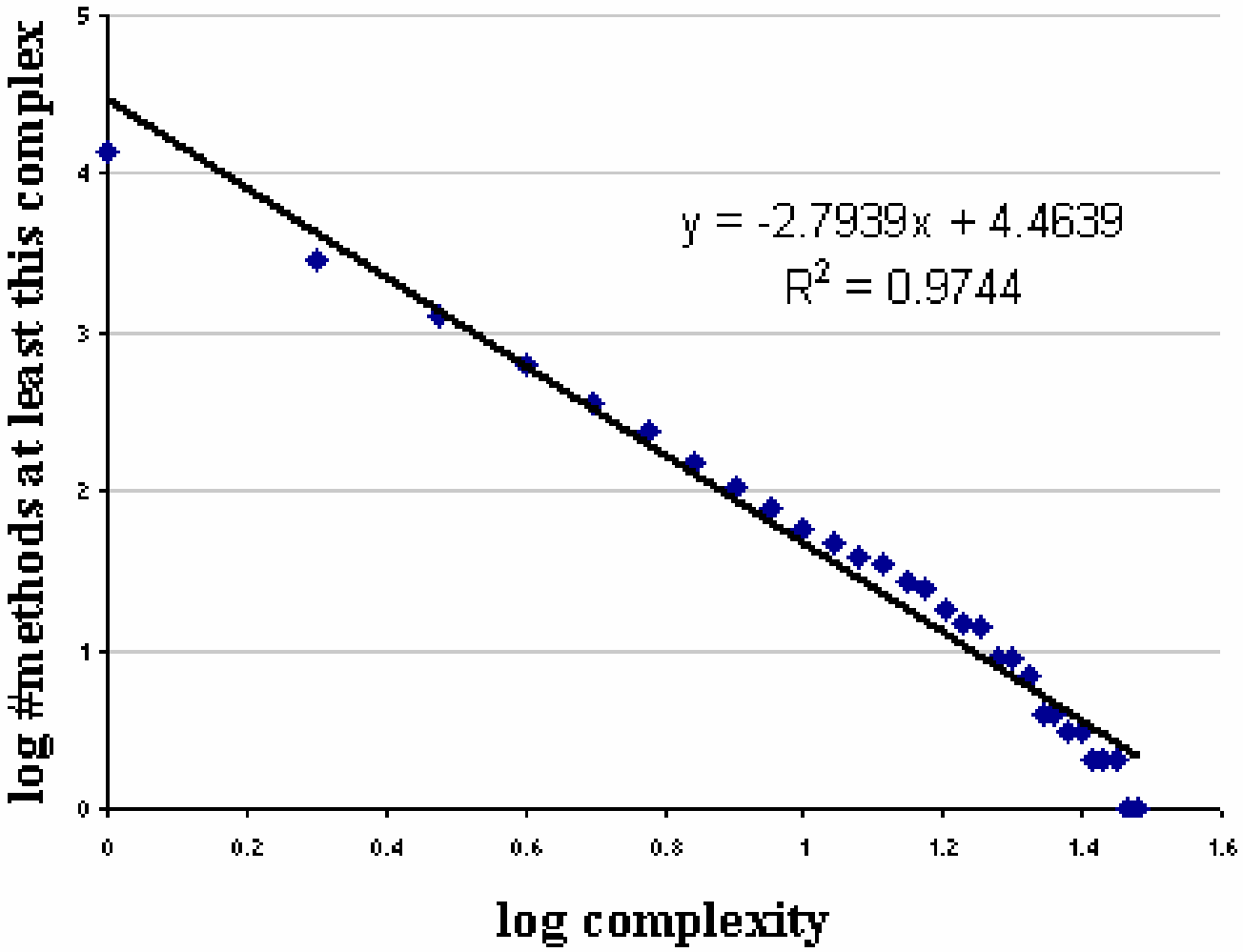

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So What?

This distribution is *highly* suggestive

- A wide range of phenomena show a similar one

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Zipf's Law

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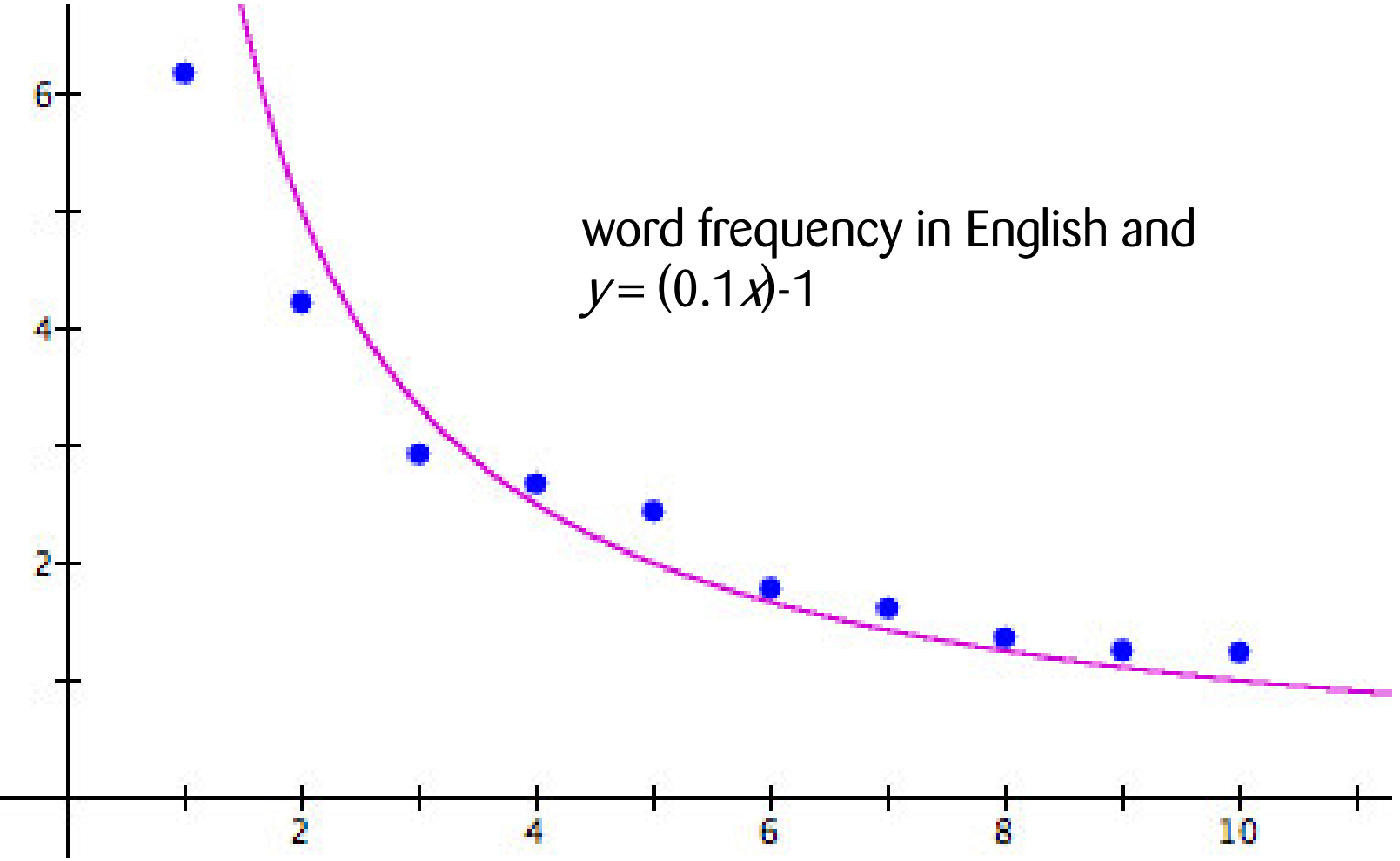
frequency of a word ∝1/rank



word frequency in English and
$y = (0.1x)^{-1}$

*word frequency from http://www.eecs.umich.edu/~qstout/586/bncfreq.html

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Log–log

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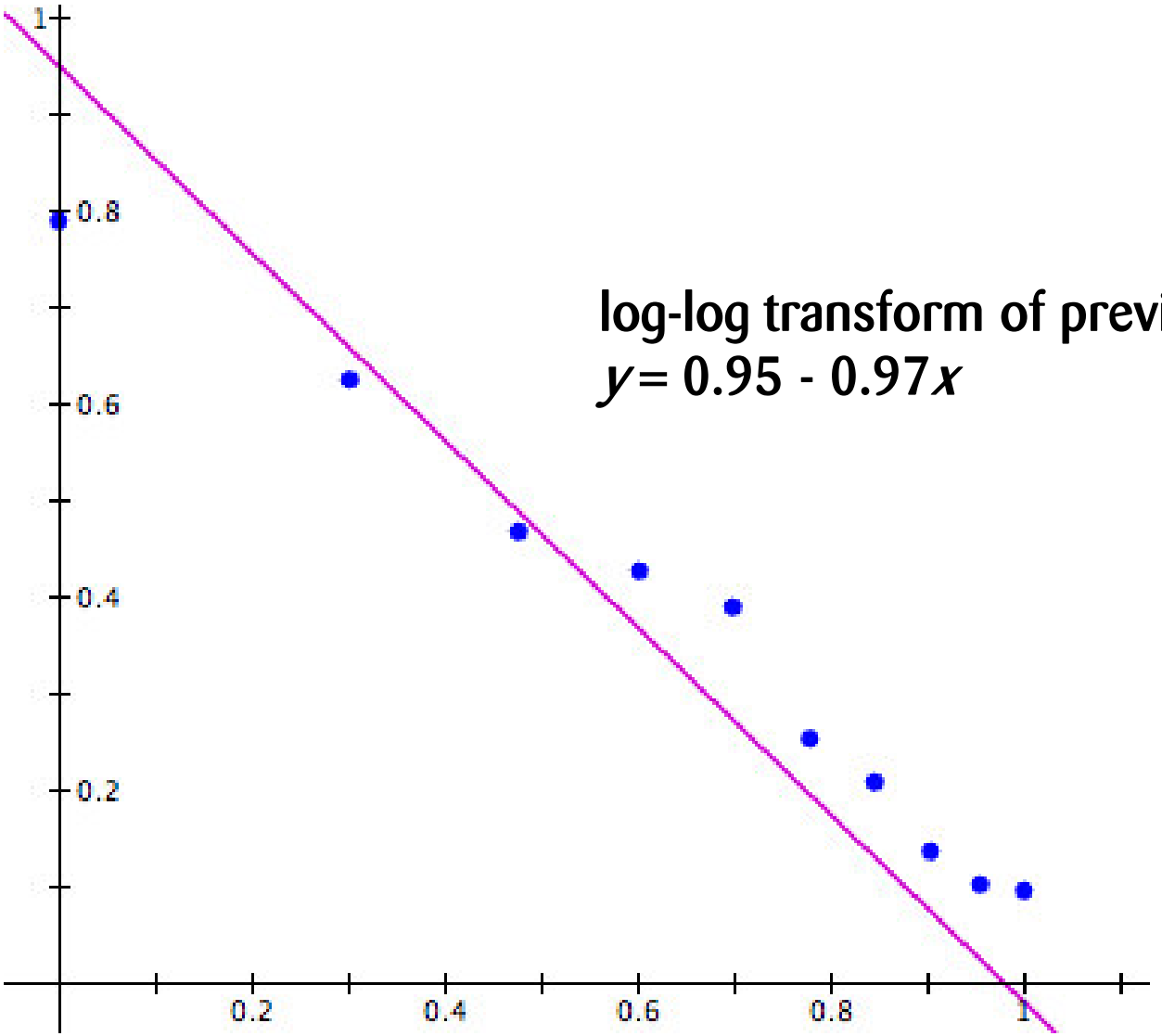

log-log transform of previous data and
$y = 0.95 - 0.97x$

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Language Variation

Fit a linear regression in log–log space

Consider the (magnitude of the) slope of that line

The slope is (somewhat) characteristic of a language

Language	|Slope|
English	0.974
Russian	0.893

http://www.gelbukh.com/CV/Publications/2001/CICLing-2001-Zipf.htm

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Other Examples

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Pareto

- $P[W > x] = (x/x_m)^{-k}$

Where W is the wealth of a individual, x_m is the smallest x and $k > 0$

Benford's Law

- $P[F(X) = d] = log_{10}(1 + 1/d)$

Where $F(X)$ is the most significant digit of X

This holds only when X is a measurement

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Other Examples

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Horton's Law

- The merging of headwaters into larger streams

Social networks

- "small world" effects, Kevin Bacon etc.
  - Very few "mavens" with lots of links
  - Vast majority with fewer links

Gutenberg-Richter

- Earthquake magnitude and frequency (almost…)

Topics in genomics research

The Web!

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Scale–free Properties

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These 1/x distributions have no well–defined mean

- So there is no one wealth/word frequency/whatever that particularly well summarises the data
- No “characteristic length”
- Similar richness of structure at all scales

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Nature is Often Scale–free

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One of these is a macro shot of sand on a beach, one an aerial shot of desert dunes.

Which is which and how can you tell?

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Nature is Often Scale–free

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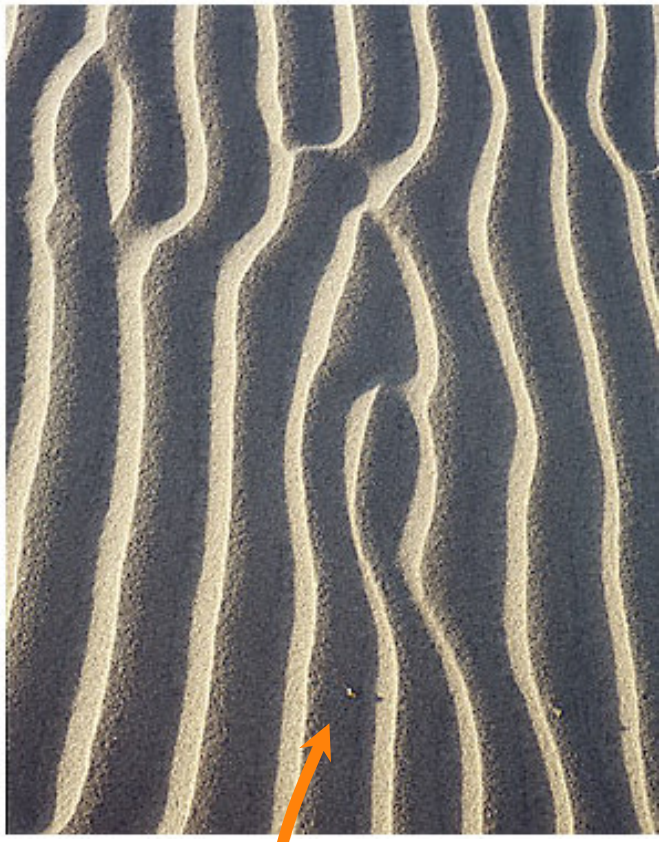

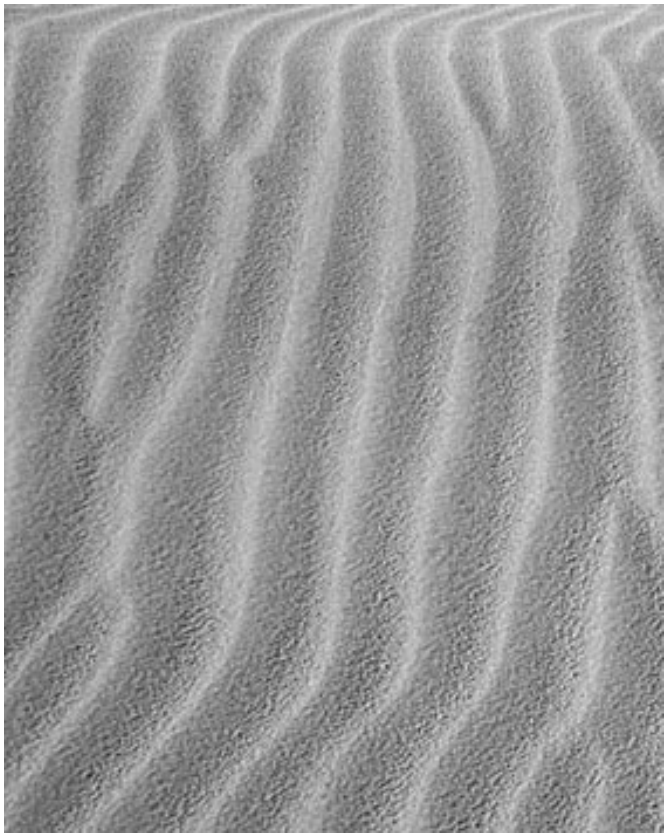

Camels!

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Programs, Too (kinda)

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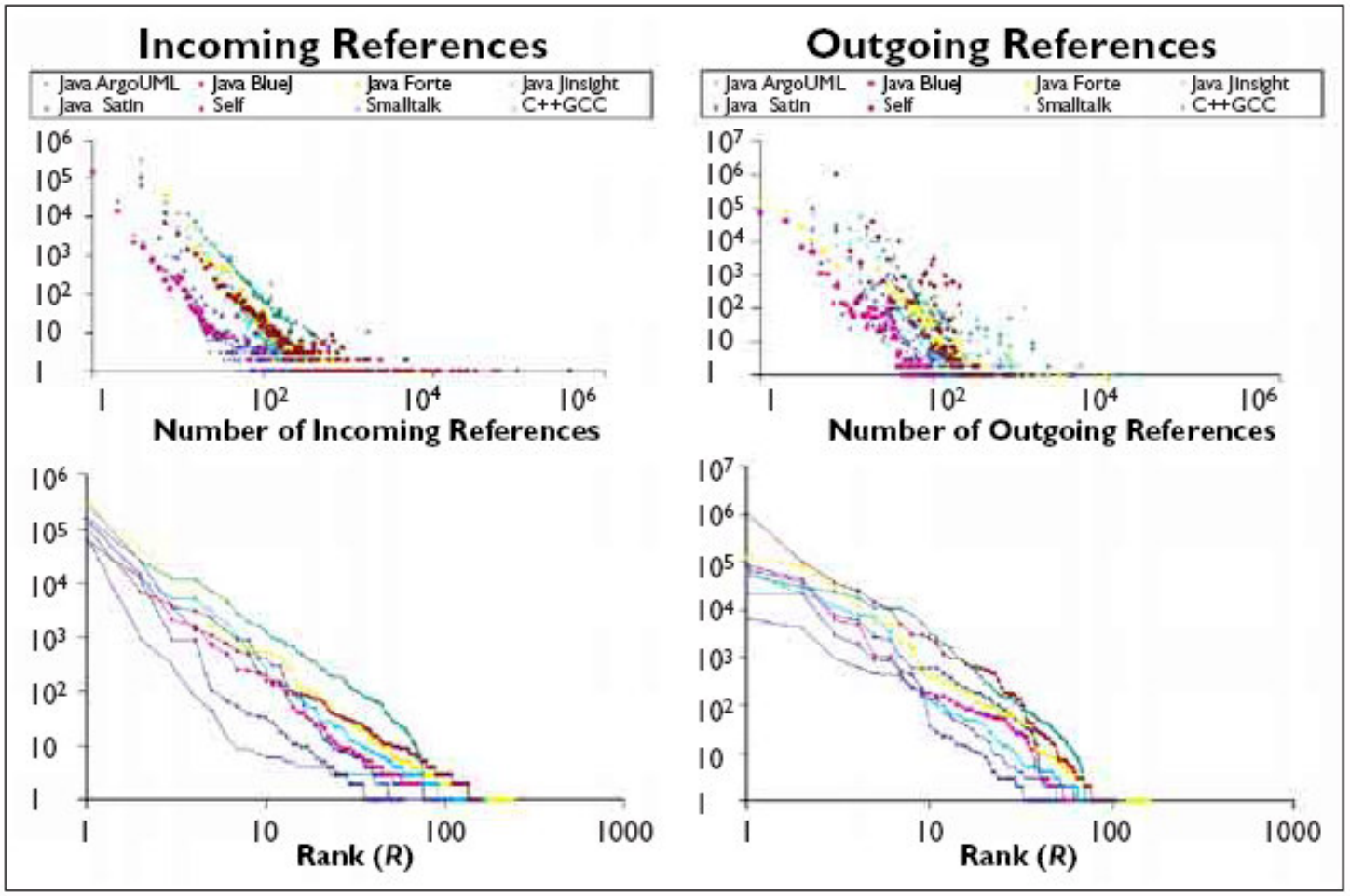

Scale Free Geometry in in OO-Programs

Potanin, Noble, Frean and Biddle, CACM v. 4 No. 5

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(Properties of) Programs Vary a Lot

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Baxter *et al* have studied a lot of variables over a lot of code, and found a lot of distributions

- some power–law
- many more log–normal or other

http://www.mcs.vuw.ac.nz/~marcus/manuscripts/BaxterShape.pdf

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Variation

Remember the English and Russian?

Language	|Slope|
English	0.974
Russian	0.893

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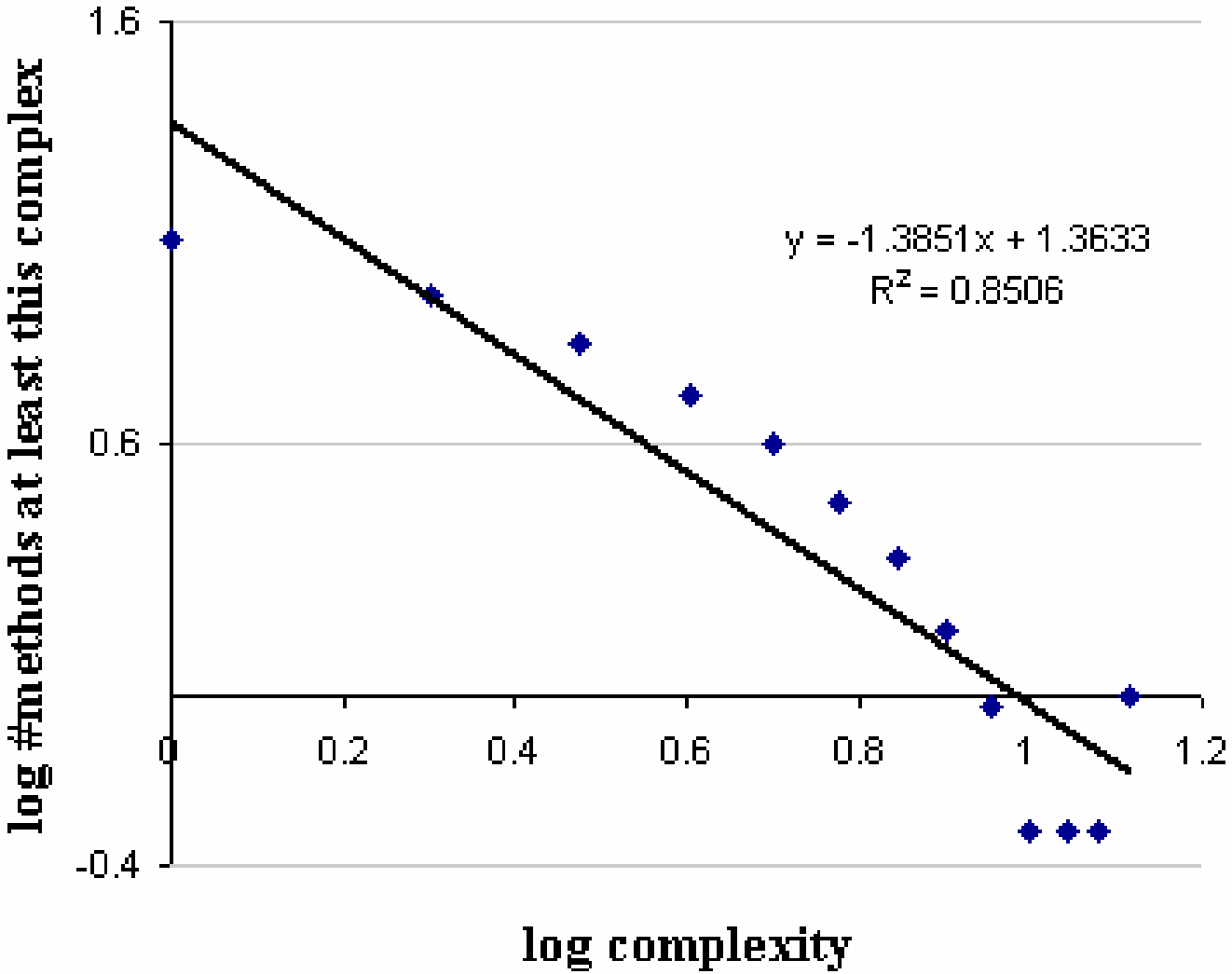
Another Codebase



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So, What Variation is there in Code?

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Codebase	Slope
Jasml 0.1	0.95
Sunflow 0.06.3	1.59
m-e-c scehdule α3-10	1.69
NanoXML 2.2.1	1.77
Syncbuilder1999	1.84
Itext 1.4.8	1.88
Xcool 0.1	1.93
Ant 1.7.0	2.25
Jfreechart 1.0.3	2.30
MarsProject 2.79	2.33
Log4j 1.2.14	2.43
Junit 3.8.1	2.49
Jmock 1.1.0	2.79
Spring 2.0.1	2.78

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So, What Variation is there in Code?

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Codebase	Slope	Automated unit tests?
Jasml 0.1	0.95	N
Sunflow 0.06.3	1.59	N
m-e-c scehdule α3-10	1.69	N
NanoXML 2.2.1	1.77	N
Syncbuilder1999	1.84	N
Itext 1.4.8	1.88	N
Xcool 0.1	1.93	N
Ant 1.7.0	2.25	Y
Jfreechart 1.0.3	2.30	Y
MarsProject 2.79	2.33	Y
Log4j 1.2.14	2.43	Y
Junit 3.8.1	2.49	Y
Jmock 1.1.0	2.79	Y
Spring 2.0.1	2.78	Y

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Interesting!

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It looks very much as if:

- **Code that's published with (JUnit–style tests)**
- Slope > 2
- **Code that doesn't**
- Slope < 2

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And Not Only That…

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Folks who've played with measure find that:

- All the code they've looked at (so far) has is on the expected side of the breakpoint at 2.0
- Code that they are happier with has a steeper slope
- Over time, refactoring that they are happy with makes the distribution steeper

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Interpretation

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A steeper distribution suggests a *preference* for less complex methods

- Although there will still be high(er) complexity methods

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Question

Where does the richness of behaviour come from?

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Let's Take a Look...

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What's Going on?

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Not sure, but maybe something like this:

- Big tests are harder to write than big methods
- Extract method is a favourite refactoring

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Questions?

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