The impact of experience on software developer performance

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My Background

What developers actually wrote

Compiler writer – front ends, back ends, language translators

Static analysis – finding faults

What developers meant to write

Book- The New C Standard: An Economic and Cultural Commentary
www.knosof.co.uk/cbook/cbook.html

Introduction

Cognitive psychology

Predicting developer performance

A hypothesis

- Source code measurements
- Experiment
- Results

Human Mental Characteristics

Orders-of-magnitude

10^{-4} - 10^{-2} Biological band
10^{-1} - 10^{+1} Cognitive band
10^{+2} - 10^{+5} Social band

Abilities

Built-in – autonomic nervous system
Learned

Some Performance Factors

Performance improves with Practice

Response time, error rate

$E = c\ P^{-m}$

Power law of forgetting

Retention rate decreases with time

$R = k\ T^{-n}$

Developer Performance

What improves?

How much; how to measure; cost of measurement
Formula to calculate...

Source code

My interest; lots available; can be measured

Developers spend time interacting with code

Lots and lots of time
Doing things not generally done elsewhere

Binary Operator Precedence

Lots of rules

13'ish rules (shared by C, C++, Java, Perl, Python, C#)

```
x  +  y  | z
```

Amenably to measurement

Source code
Developer performance

Hypothesis

Every source occurrence provides practice

Relative percentage a measure of relative practice

More practice aids learning/retention

Practice only occurs when a decision has to be made

Occurrences rare enough that performance not 'saturated'

```
P = x  +  y ;
Q = a  +  b  |  c ;
```

Prediction

More source code occurrences $\rightarrow$ better developer performance

Source Measurements

What measured

Large C programs
Visible source
Binary operators common to C/C++/Java/Perl/etc.
Operator pairs in expressions

```
x =  y +  z ;
a =  b +  c  *  d ;
```

Ignored (not considered to be operators)

```
=    .    ->    []    ()
```

The Experiment

The ACCU

- C and C++ user group: now includes Java, C#, Perl + others
- Annual conference: 250+ professional developers
- Willing to make lunchtime slot available

Practical constraints

- Time: 40 minutes
- Venue: Room at a conference
- Subjects: Volunteers willing to give time during lunch

What Subjects asked to do

Three stage problem, repeated

Remember information

```
zip = 4;
zap = 8;
bat = 6;
```

Time filler task

```
x  +  y  *  z
p  ||   q   >>  r
```

Recall information

Results '06/'07 Overview

Numbers

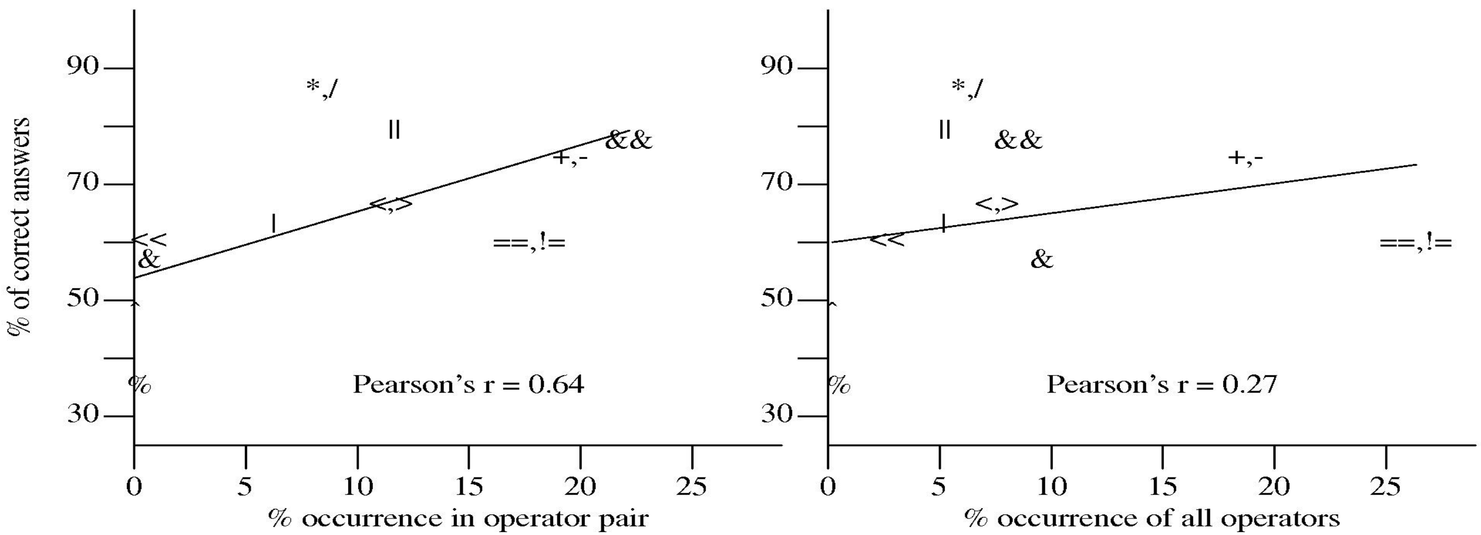
Subjects (years experience): 17 (14.6) /6 (14.5)
Answers: 123.5/116.2 sd 35.0
Percent correct: 66.7/63.3 sd 8.7
Random answers, binomial distribution: 0.1% prob > 60% correct

Bradley-Terry Statistics

`/   *   ^   +   -   &   <<   |   <   %   &&   ==   ||   !=`

Highest ... Lowest

Performance/Source Correlation



33% incorrect!?!

Implication for faults in real code

- 2% of expressions contain two or more binary operators
- Implies almost 1% of expressions 'wrong'

'Naked' expressions rare in code

- Expressions generally exist within a context
- Expressions often contain context information

Context Information

x + y | z

arith + context_clue | bit

Source Measurements

Names of operand identifiers

Arithmetic names: `size, len, count`

Bitwise names: `flags, status, mask`

Boolean names: `finished, done, started`

Anonymous names: `val, temp, field`

Experimental Manipulation

arith + arith_bit_anon | bit

Result '07 Naming

arith + arith_bit_bool_anon | bit

Same context	76.3 (96,56,58)
Match higher/Not match lower	72.5
Match higher/Match lower	61.5
Not match higher/Not match lower	64.4
Not match higher/Match lower	43.4

Conclusion

Occurrence/performance correlation

Exists for experienced developers
Unexperienced developers?

Use of non-precedence information

Developers associate some words with some operators
Operator/operand spacing?

TODO

Measurements of other language source