ESC/Java Annotation Wizard

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with help from Mark Lillibridge, Greg Nelson, Jim Saxe, & Raymie Stata

Work in progress

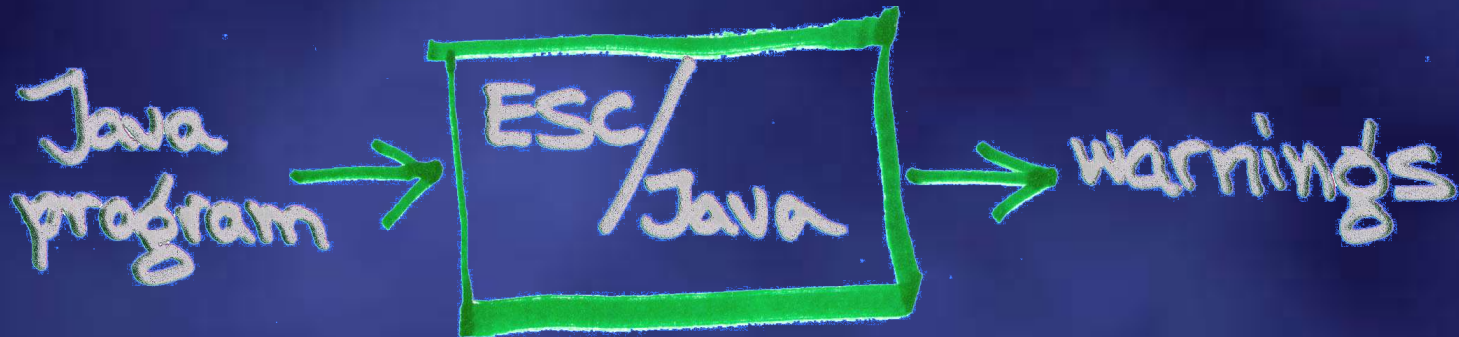SRC Center Meeting
21 April 1999

escj 28

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Java program → [ESC/Java] → warnings

```
> escjava Cup.java
Cup.java:18: Warning: Possible null dereference (Null)
      x = o.f;
          ^
```
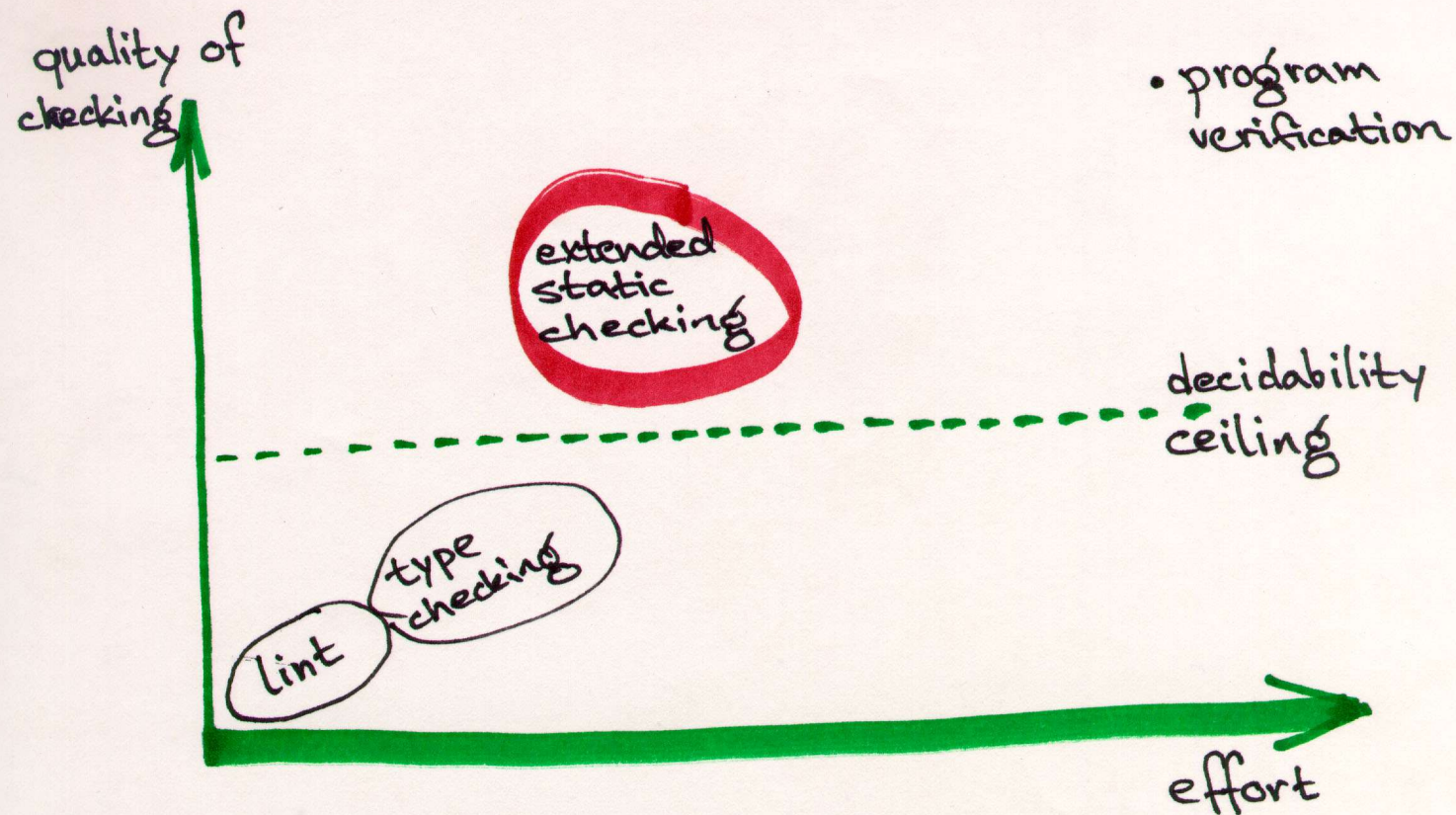
Static checkers

Type checking vs. extended static checking

	Type checking	E.s.c.
Are annotations needed?	yes	yes
How many annotations per variable/method?	1	0 -- many
Escape hatch for when annotation gets too complicated?	dynamic casts	assume, nowarn

What about Legacy code?

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Annotation assistant

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Annotation assistant
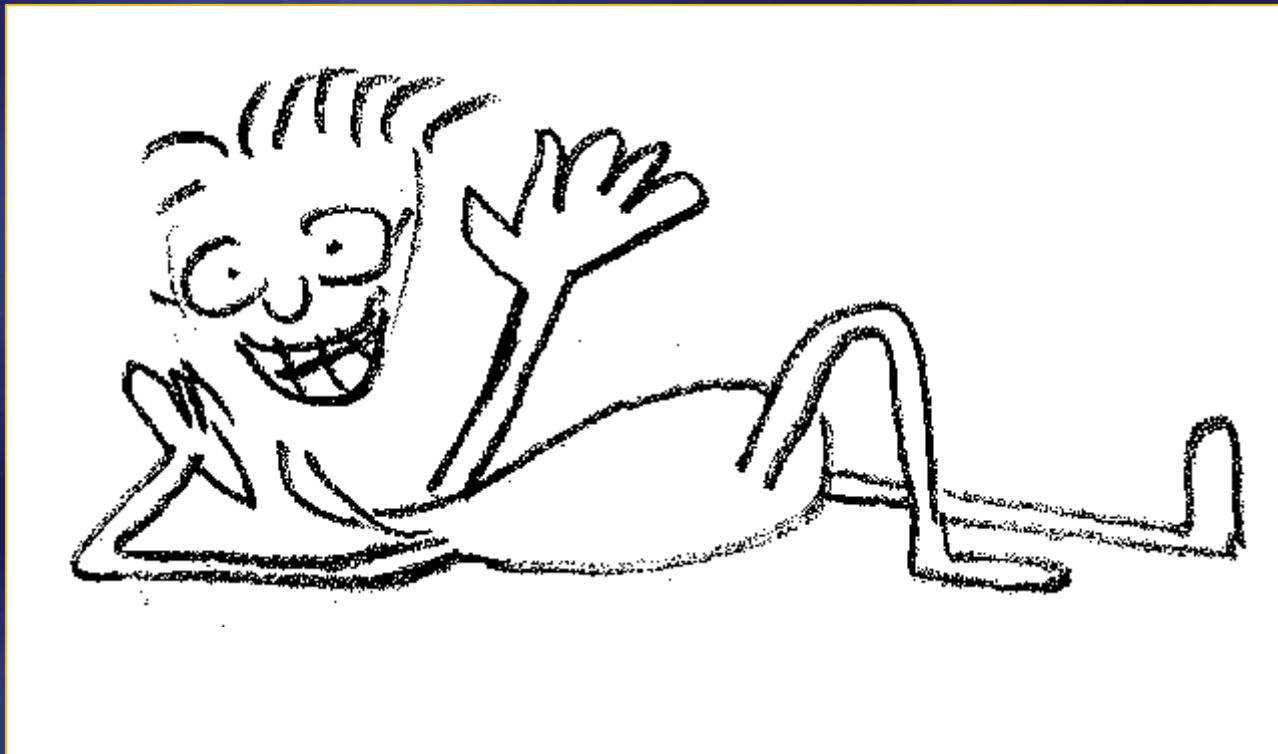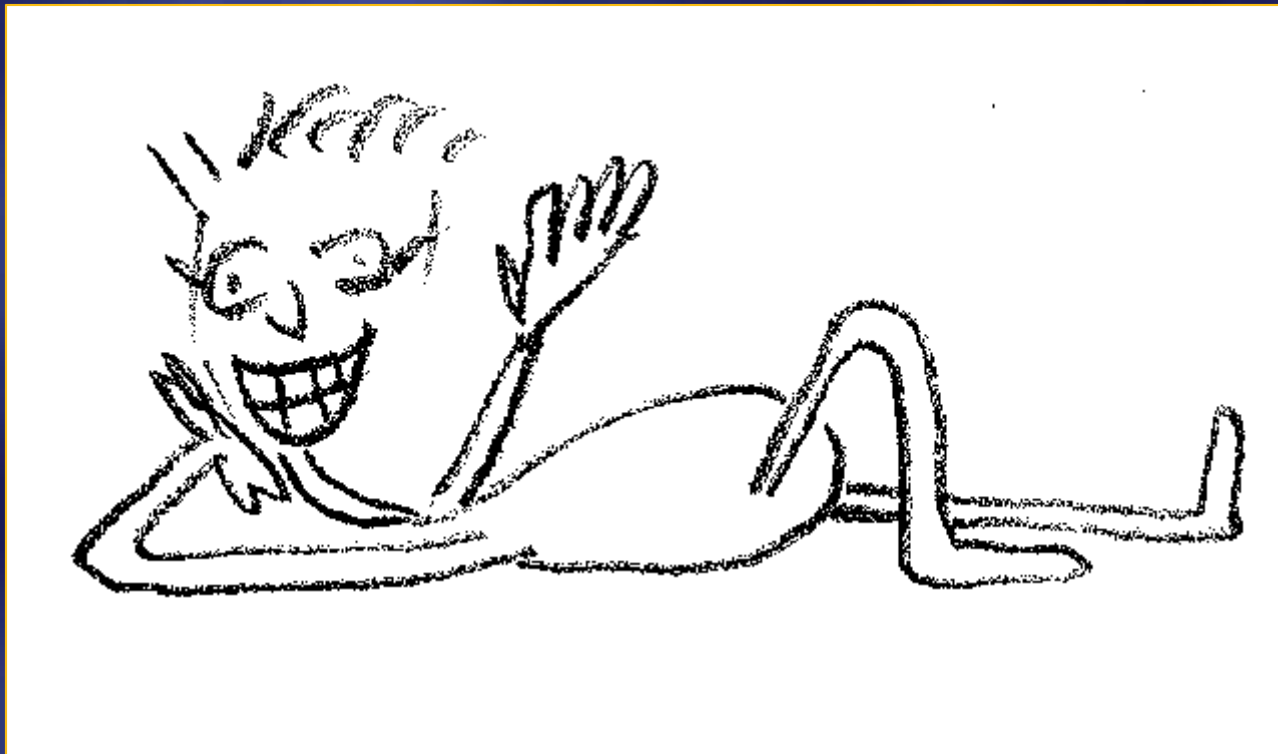
Compaq Confidential - Need to Know Required
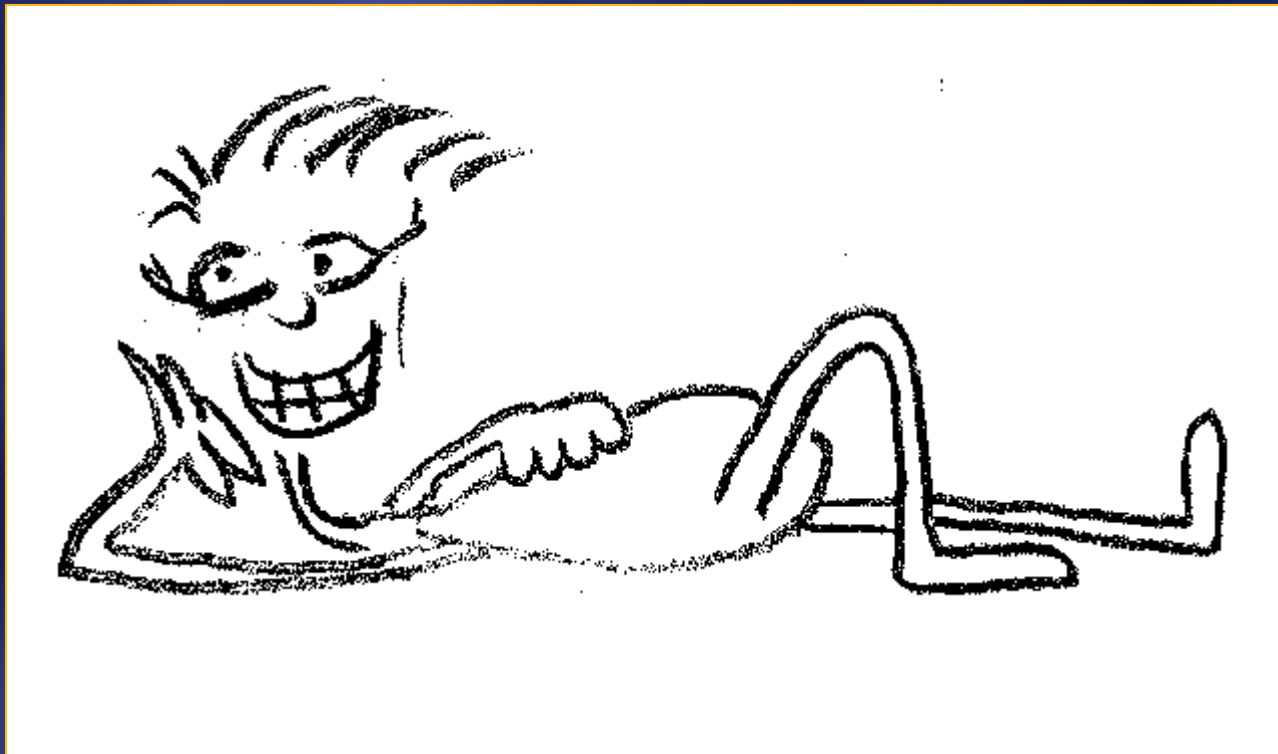
Annotation assistant

Use simple (possibly bogus) heuristics
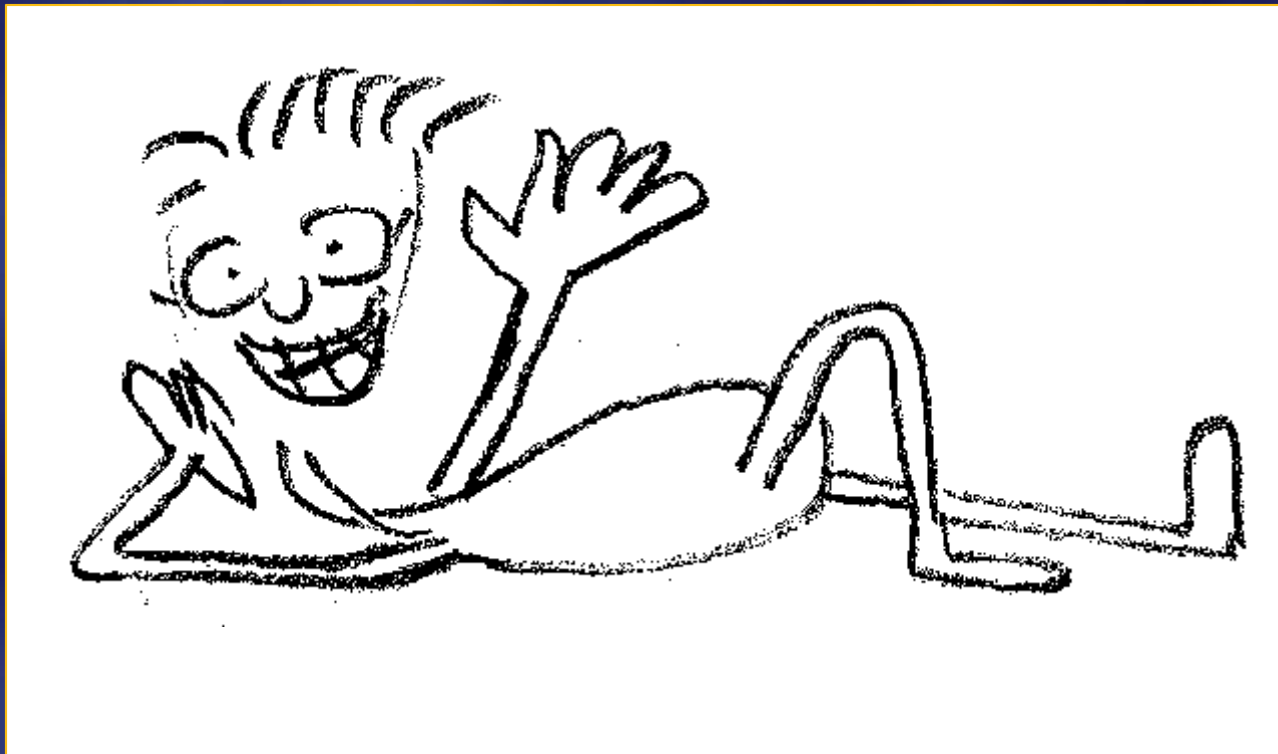
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^
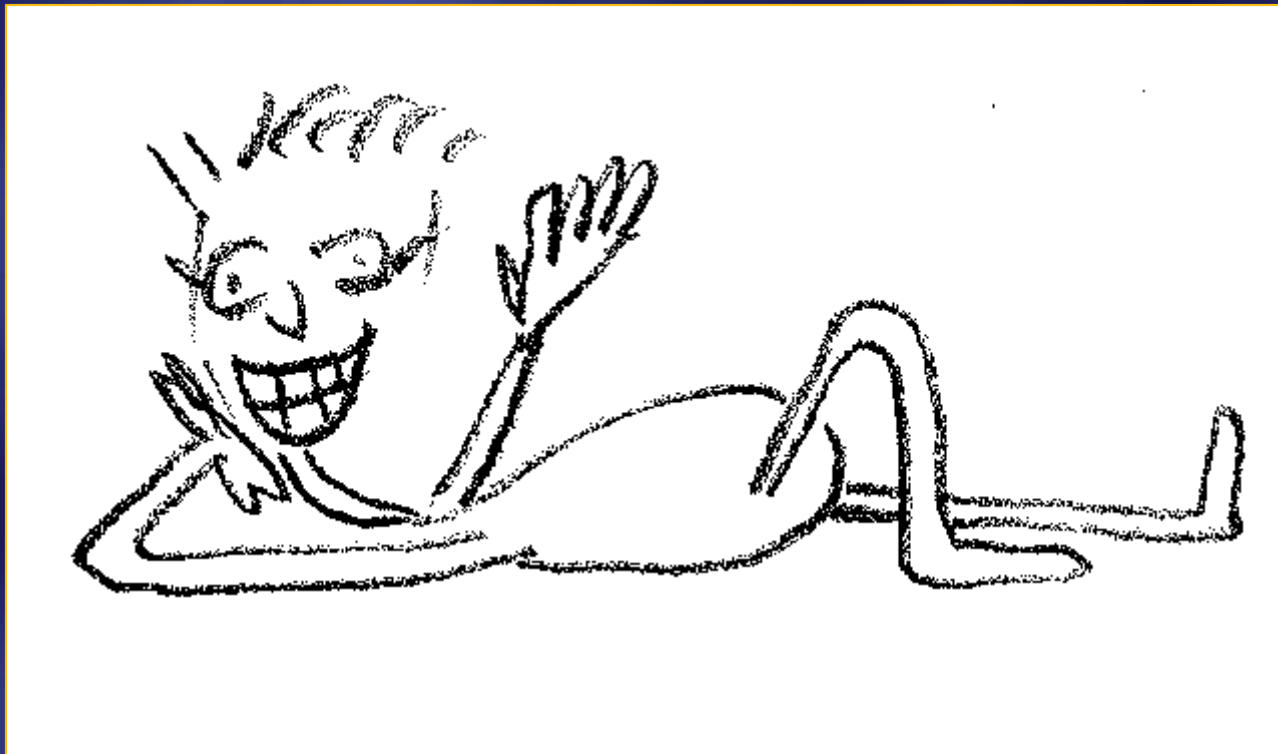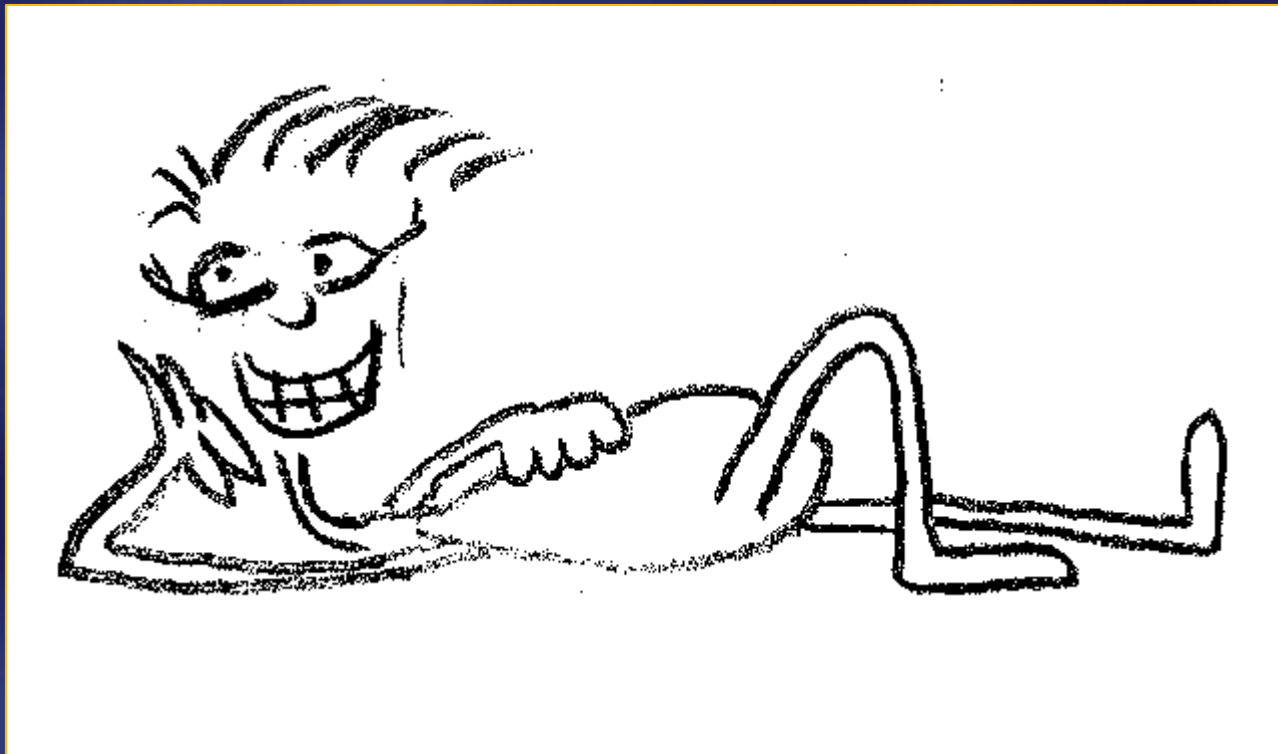
-suggest switch

Use simple (possibly bogus) heuristics

Cup.java:18: Warning: possible null dereference (Null)

    x = o.f;

         ^

Suggestion: perhaps declare 'o' as 'non_null'

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Annotation wizard design

repeat

    call ESC/Java -suggest on sources;

    distill output into update instructions;

    act on update instructions

until quiescence

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Update instructions

<u>insert</u> "/*@ … */" <u>at</u> 6,12 <u>in</u> Cup.java

<u>else</u> "/*@ nowarn … */" <u>at</u> 28,17 <u>in</u> Client.java

Pachyclient case study

~11,000 lines of code

~650 methods

43 files

110 minutes (2.5 minutes to compile)

13 iterations

971 annotations

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How were the 110 minutes spent?

Iteration	Warnings	Minutes
0	392	14
1	256	12
2	136	10
3	78	9
4	42	8
5	24	8
6	20	7
7	11	7
8	6	7
9	3	7
10	2	7
11	1	7
12	0	7
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TOTAL: 13	971	110

What became of the 971 warnings?

non_null

instance fields	304	
parameters	219	
local variables	108	(later: 27)
static fields	5	
postcondition RES != null	49	
requires 0 <= x	2	
ensures 0 <= RES	2	
invariant 0 <= x	1	

no heuristic

null related	47	(29 for 'null')
negative related	16	
suggestion in different file	169	
annotation inserter gives up	49	

Did the wizard help?

null and negative checking only

    warnings on unannotated code: 938

    warnings on wizard-annotated code: 274

all checking (but heuristics only for null and negative)

    warnings on unannotated code: >1100

    warnings on wizard-annotated code: 488

What kinds of warnings remain?

Null	121	(83)	Cast	111	
NonNull	131	(83)	Pre	48	
NonNullInit	5		IndexTooBig	32	
IndexNegative	15		Post	14	
NegSize	2	(1)	ZeroDiv	7	
			Invariant	2	

(Numbers in parentheses indicate how many of the warnings have annotation suggestions in libraries.)

Annotating libraries

Suggestion [359,52]: perhaps declare method 'getText' in /tmp_mnt/bill/r/dlusers14/sanjay/srcjava1.1/files/../files/jdk-114.zip: java/awt/TextComponent.class with 'ensures RES != null;'

Conclusions

Simple heuristics can reduce annotation effort in legacy code.

Future work

- More heuristics
- Multiple warnings per routine
- Automated analysis of added annotations
- User experience

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