



ESC/Java
Annotation Wizard

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with help from Mark Lillibridge,
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Work in
progress

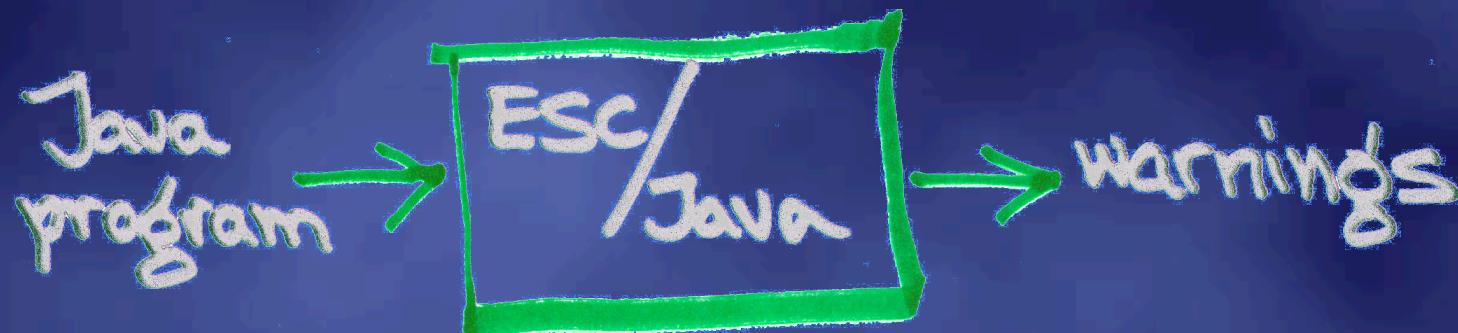
escj 28

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SRC Center Meeting
21 April 1999

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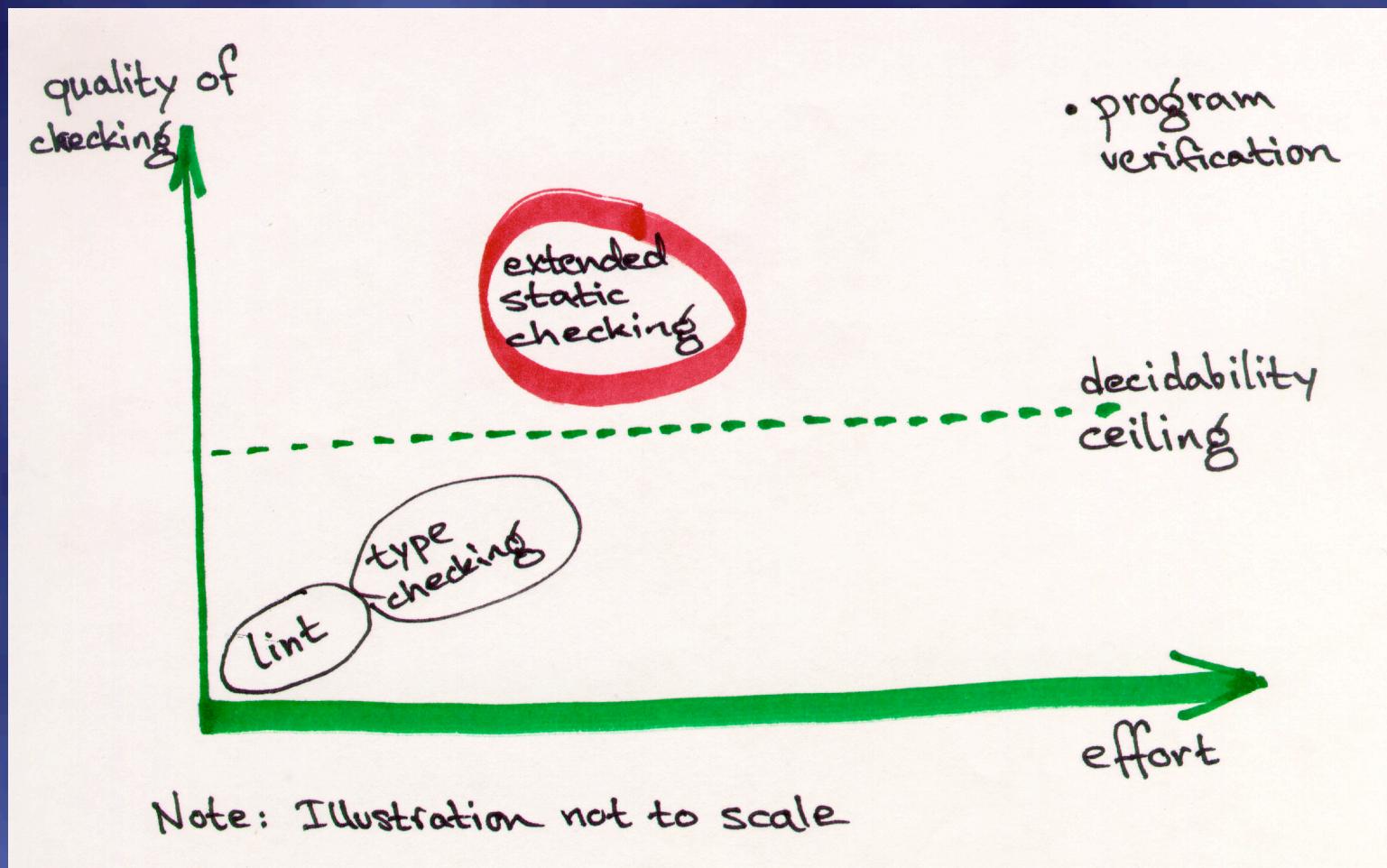
Q



```
> 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?



Annotation assistant



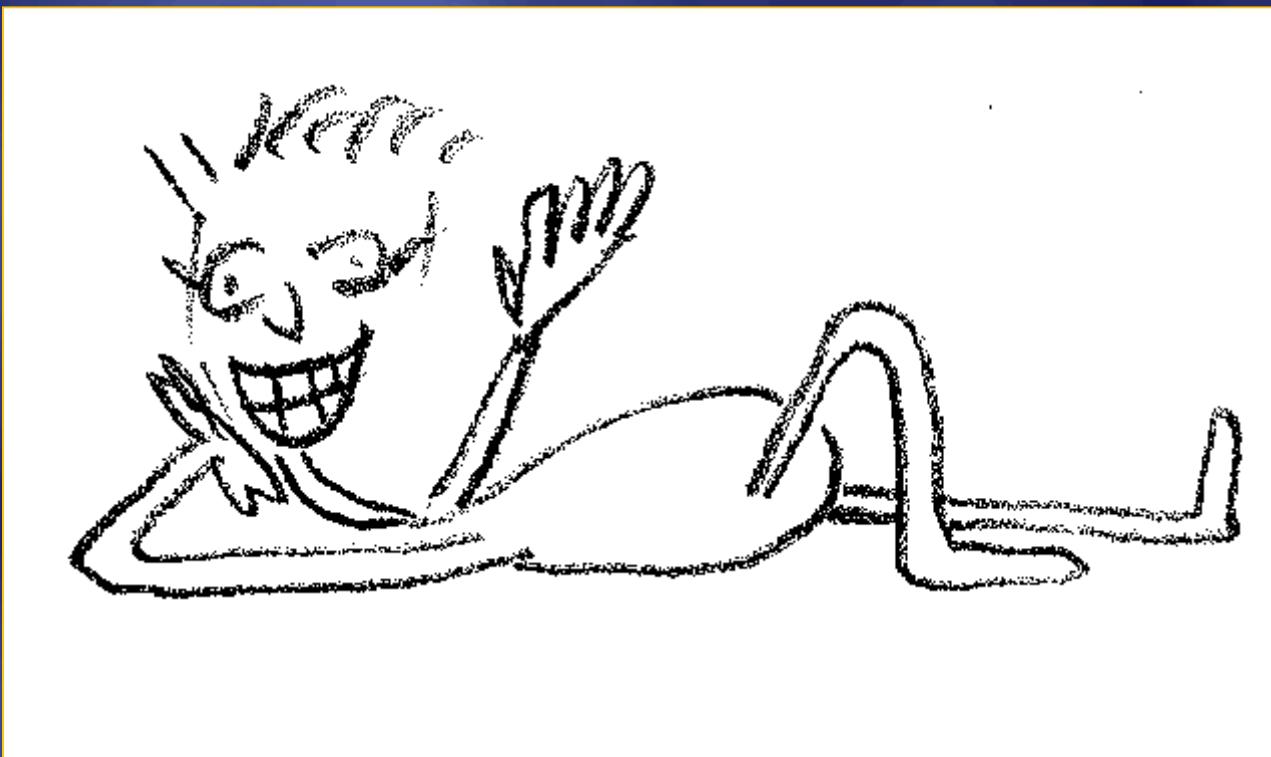


Annotation assistant



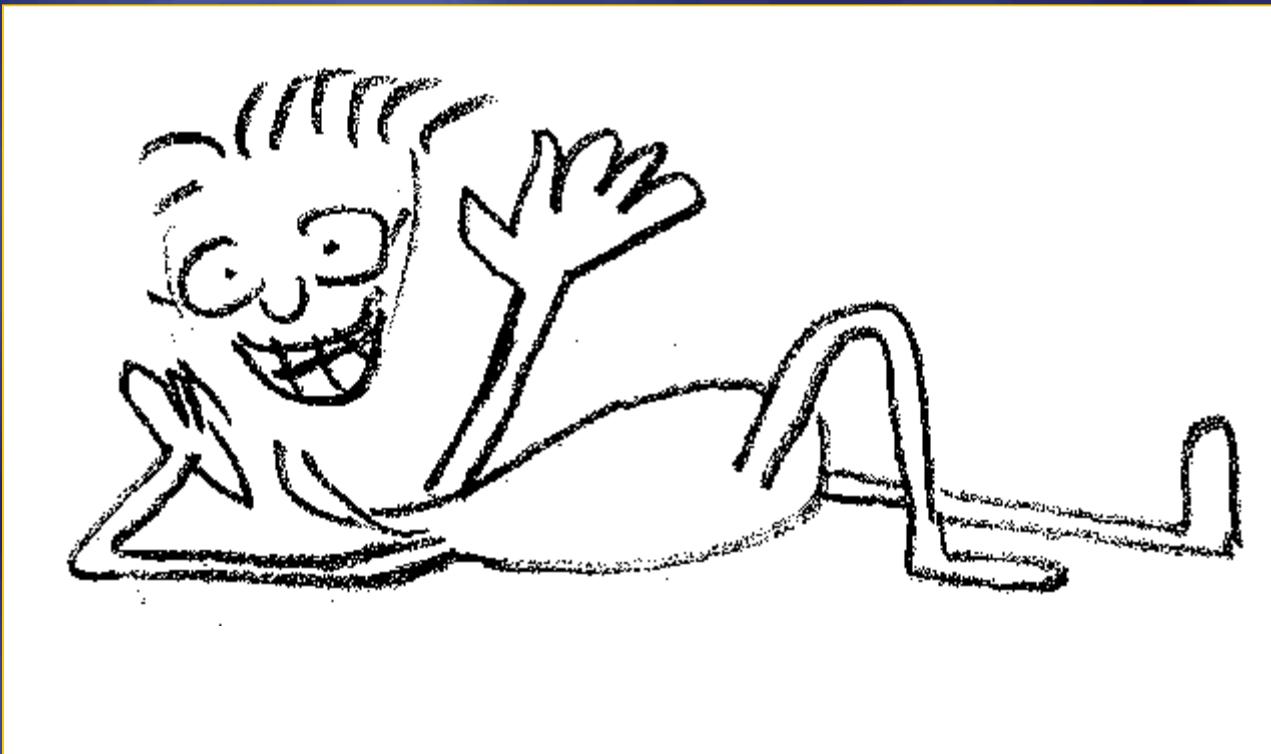


Annotation assistant



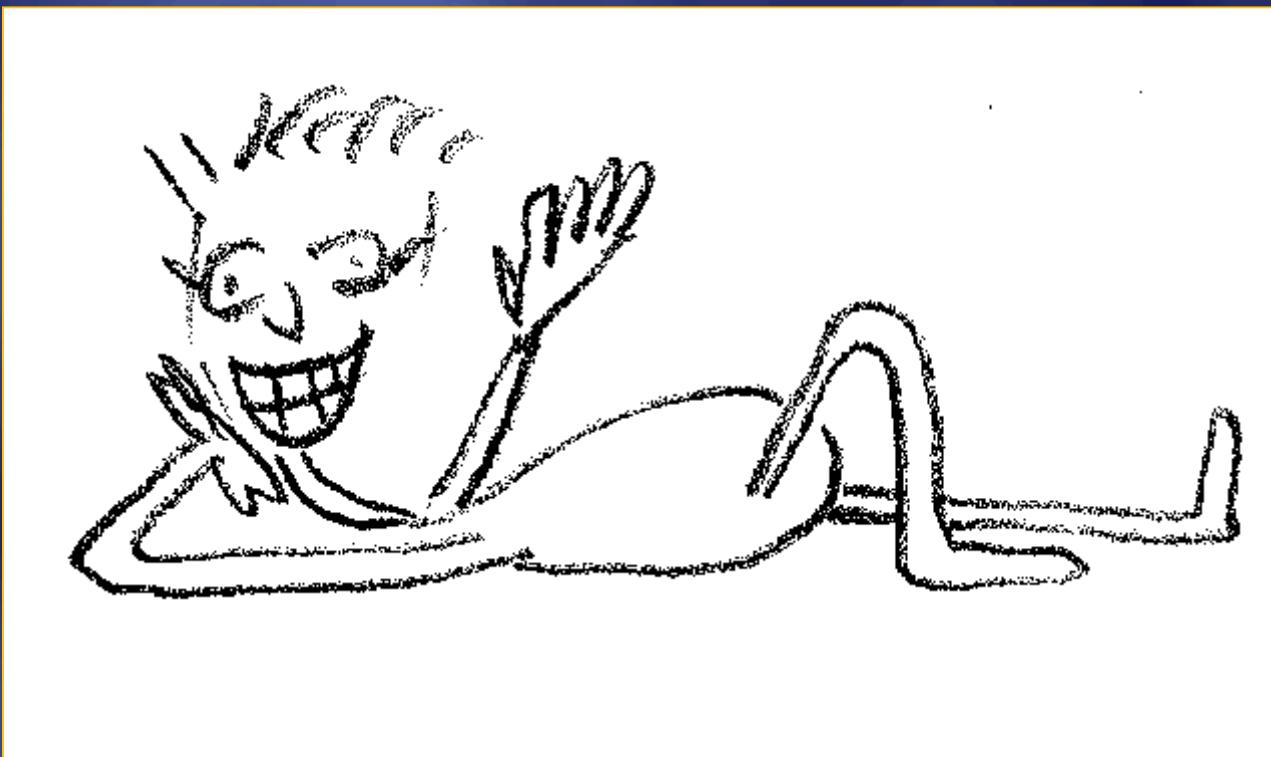


Annotation assistant





Annotation assistant





Annotation assistant





-suggest switch

- ◆ Use simple (possibly bogus) heuristics

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

x = o.f;
 ^



-suggest switch

- ◆ Use simple (possibly bogus) heuristics

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

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 ^

Suggestion: perhaps declare 'o' as 'non_null'





Annotation wizard design

repeat

call ESC/Java -suggest on sources;

distill output into update instructions;

act on update instructions

until quiescence



Update instructions

insert “`/*@ ... */` at 6,12 in `Cup.java`

else “`/*@ nowarn ... */` at 28,17 in `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



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

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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