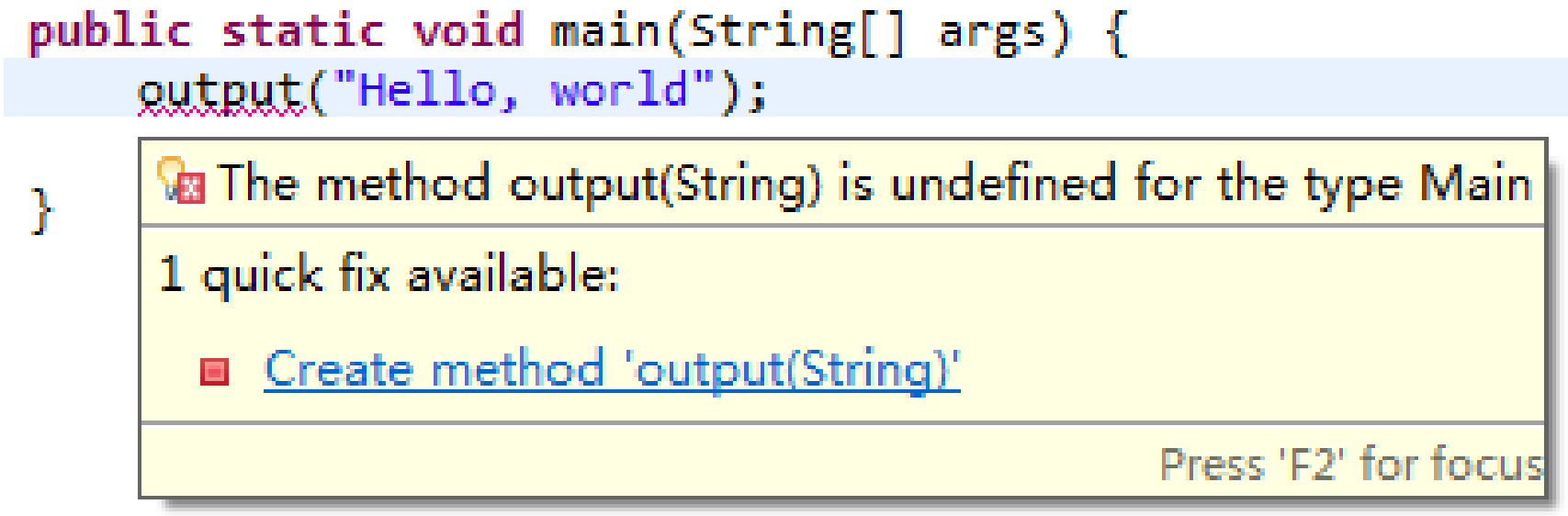
Range Fixes and Their Application on Software Configuration

Yingfei Xiong, Peking University, 2012

Based on an ICSE'12 paper with
Arnaud Hubaux (U. Namur),
Steven She and Krzysztof Czarnekci (U. Waterloo)

We produce errors everyday



We use fixes everyday

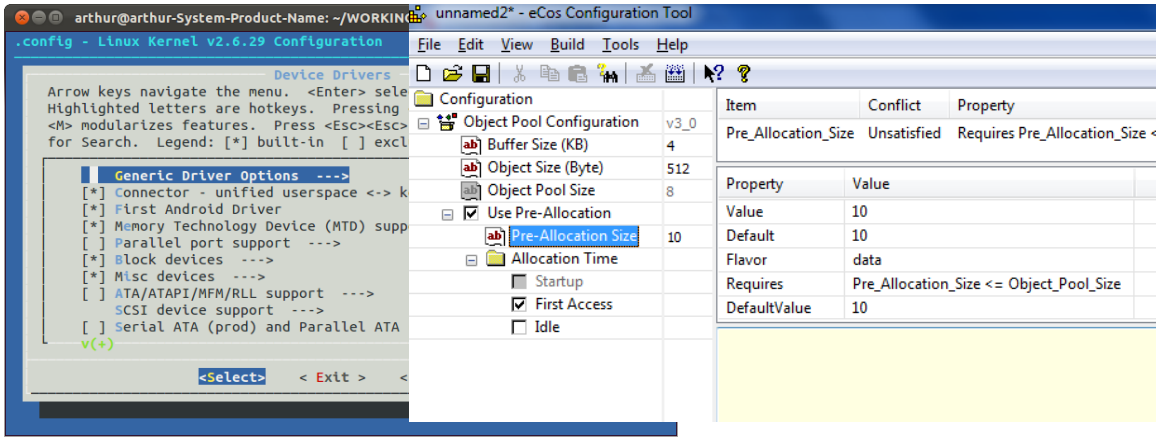
```
public static void main(String[] args) {
    output("Hello, world");

}

private static void output(String msg) {
    // TODO Auto-generated method stub

}
```

How much do we know about fixes?

- How much are fixes needed?
- What fixes are desirable?
- Can we generate fixes automatically?

Study domain: operating system configuration

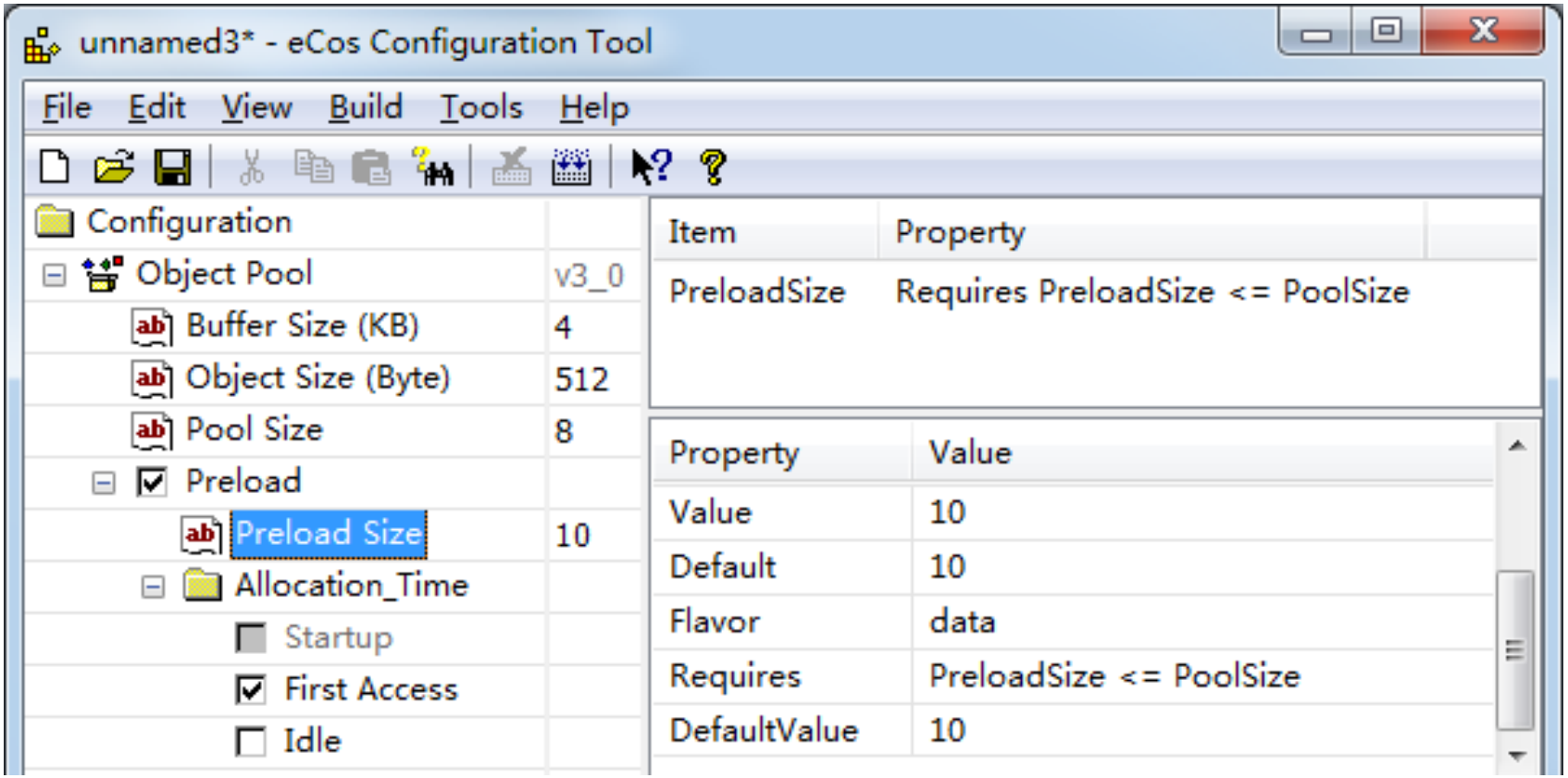
Configuration



Linux Kconfig,
eCos CDL,
…

Variability Models

eCos Configurator - Errors



Contributions

- How much are fixes needed?
  - A survey revealing manual fixes take minutes
- What fixes are desirable?
  - A new type of fix, range fix, and evaluated desirable properties of fixes
- Can we generate fixes automatically?
  - An algorithm generating range fixes in tens of milliseconds

How much are fixes needed?

A survey showing manual fixes take minutes

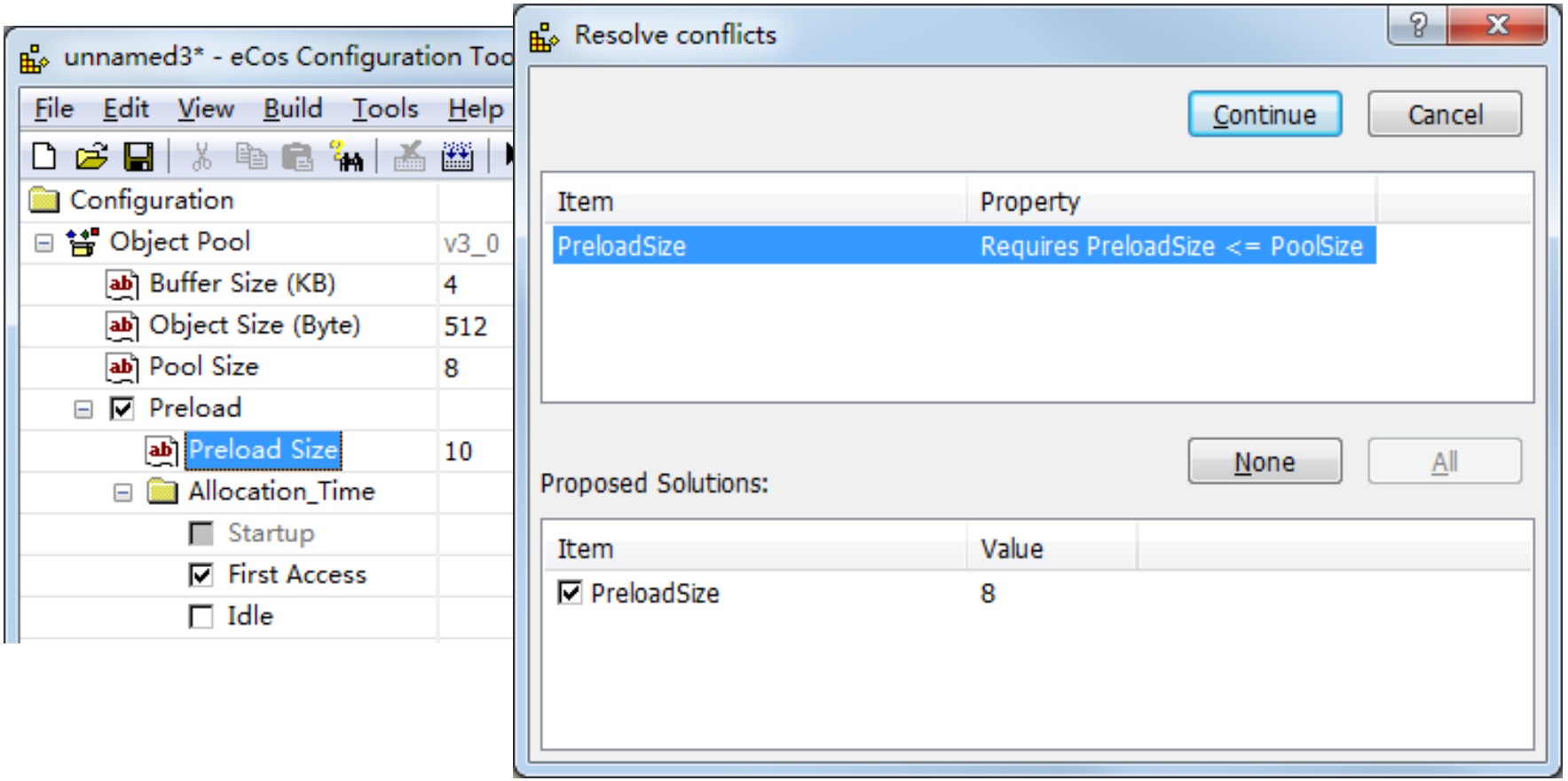
Survey

- 97 Linux users and 9 eCos users
- Resolving a violation is hard
  - 20% Linux users need "a few dozen minutes" to resolve a violation in average
  - 56% eCos users consider violation resolution to be a problem

What fixes are desirable?

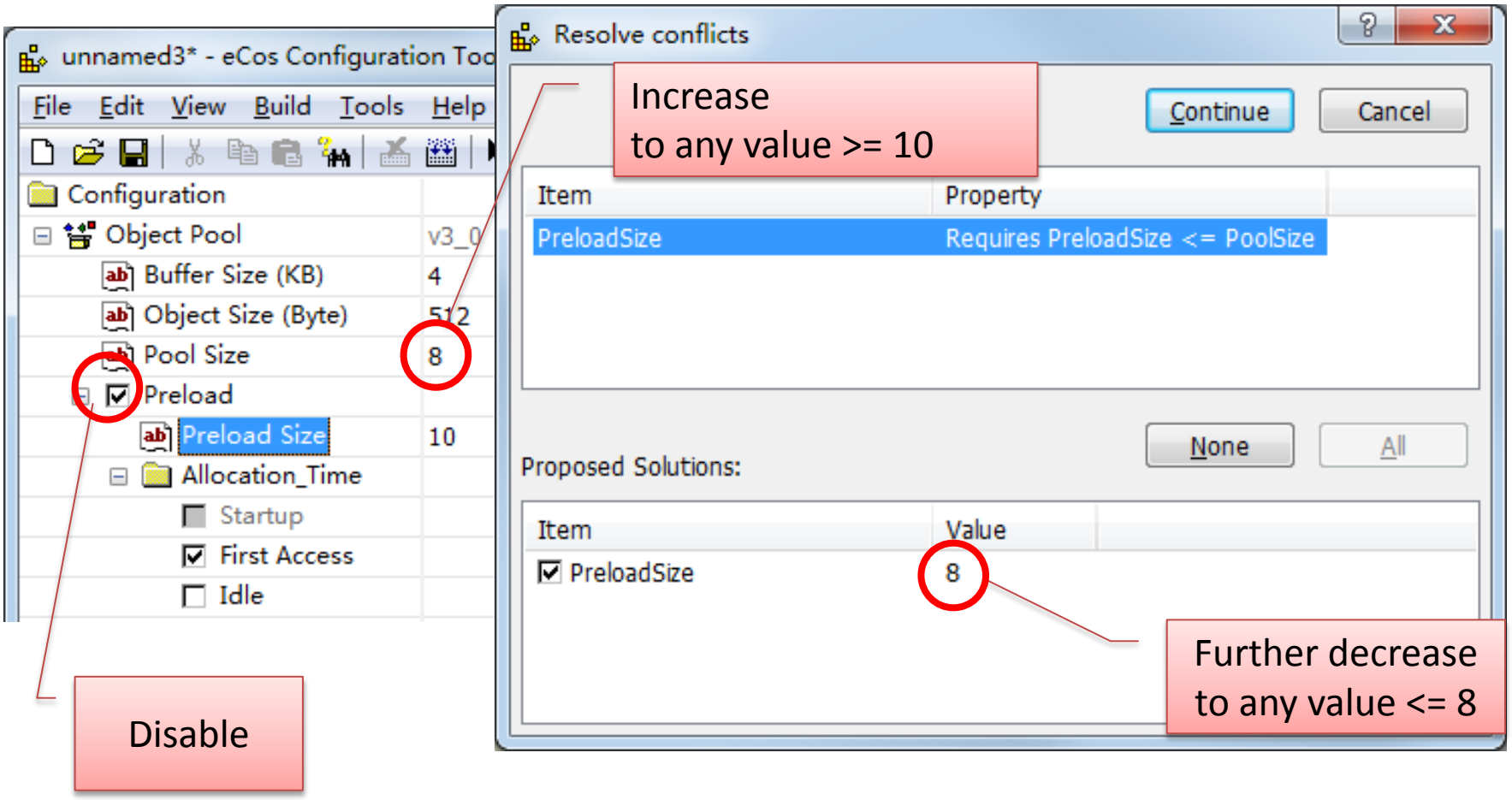
A new type of fixes, range fixes, and evaluated desirable properties

eCos Configurator



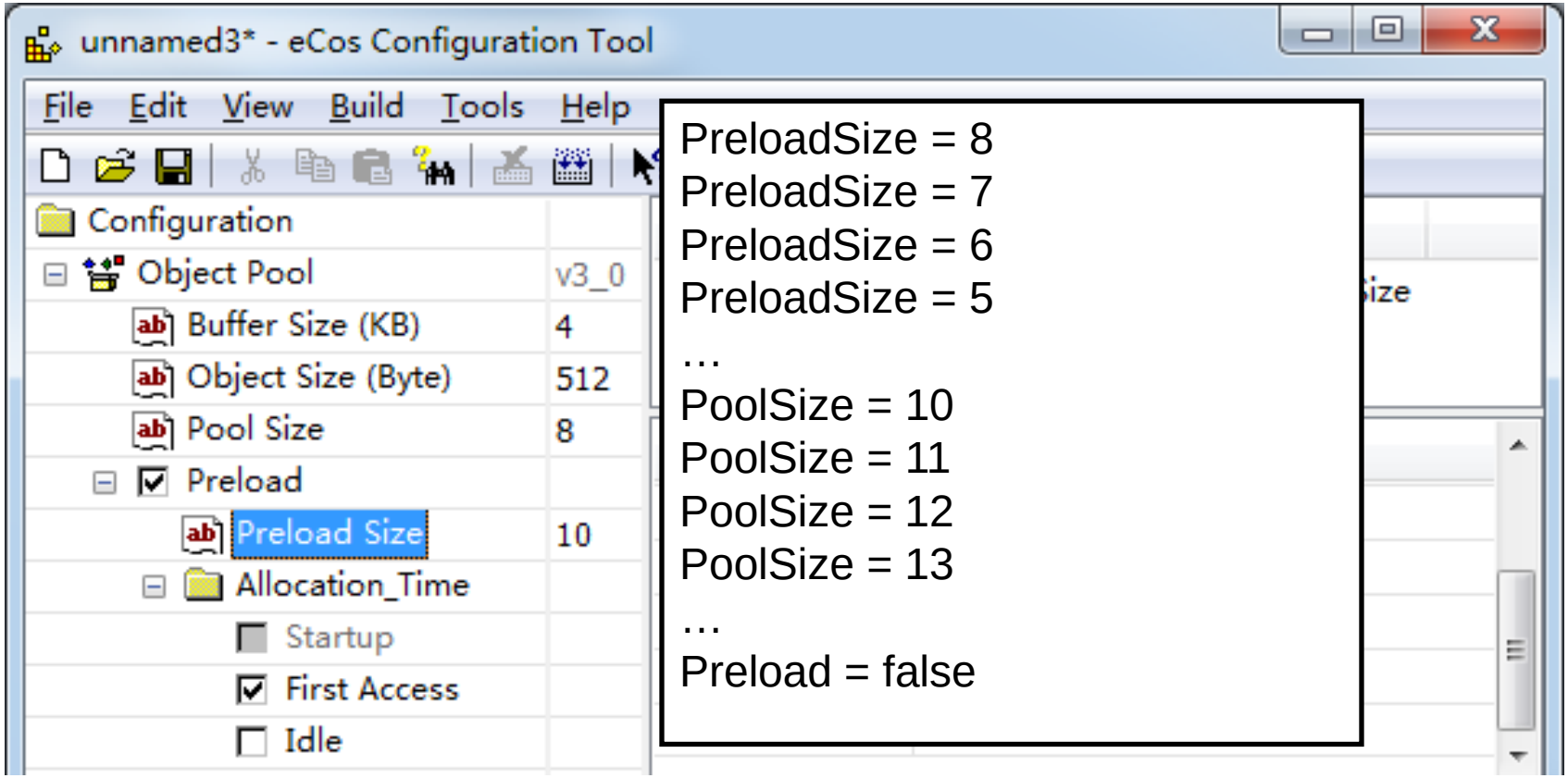
eCos configurator has built-in fixes

Fix Incompleteness

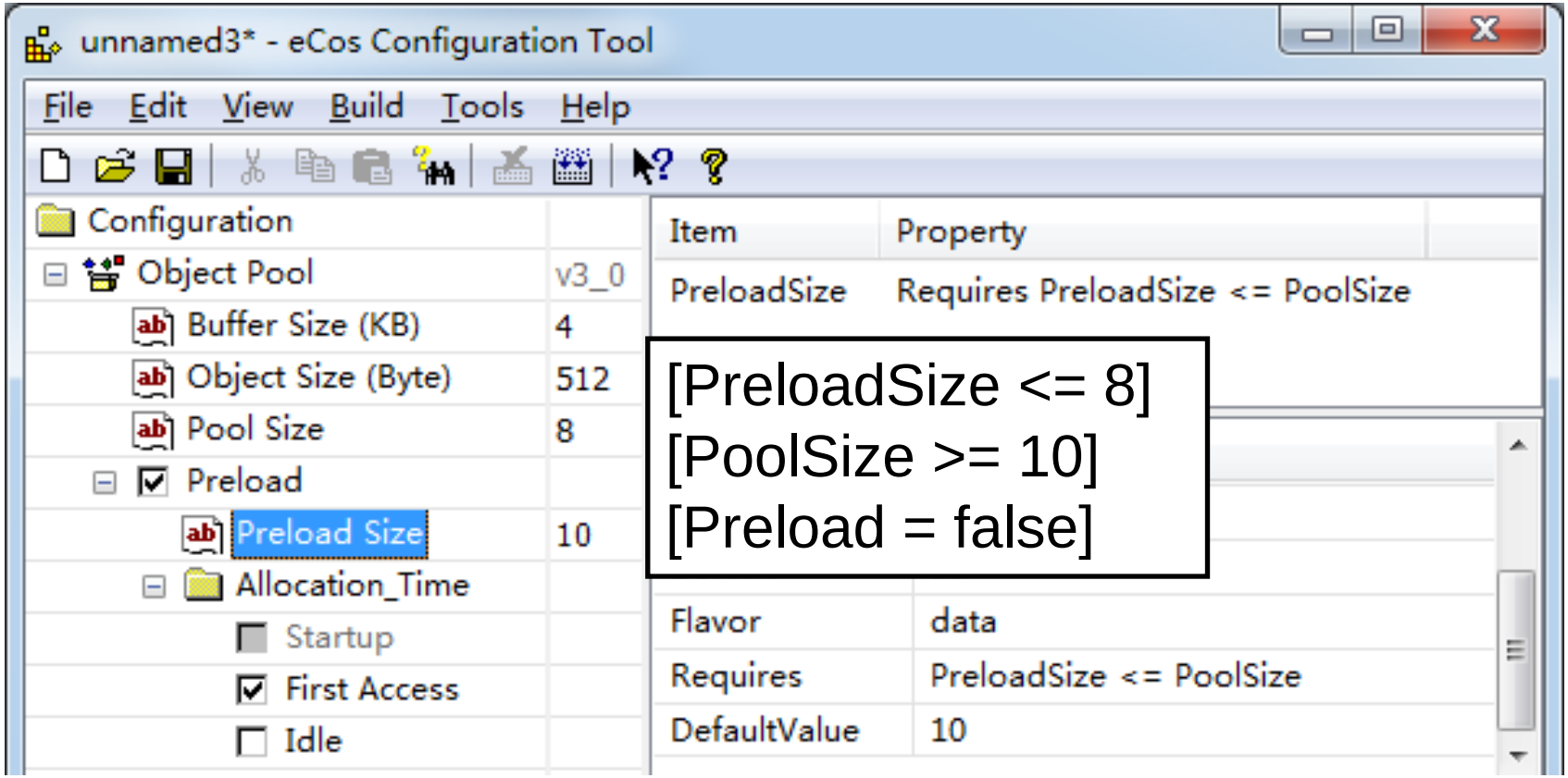


78% eCos users have ecountered situations where the proposed fix is not useful

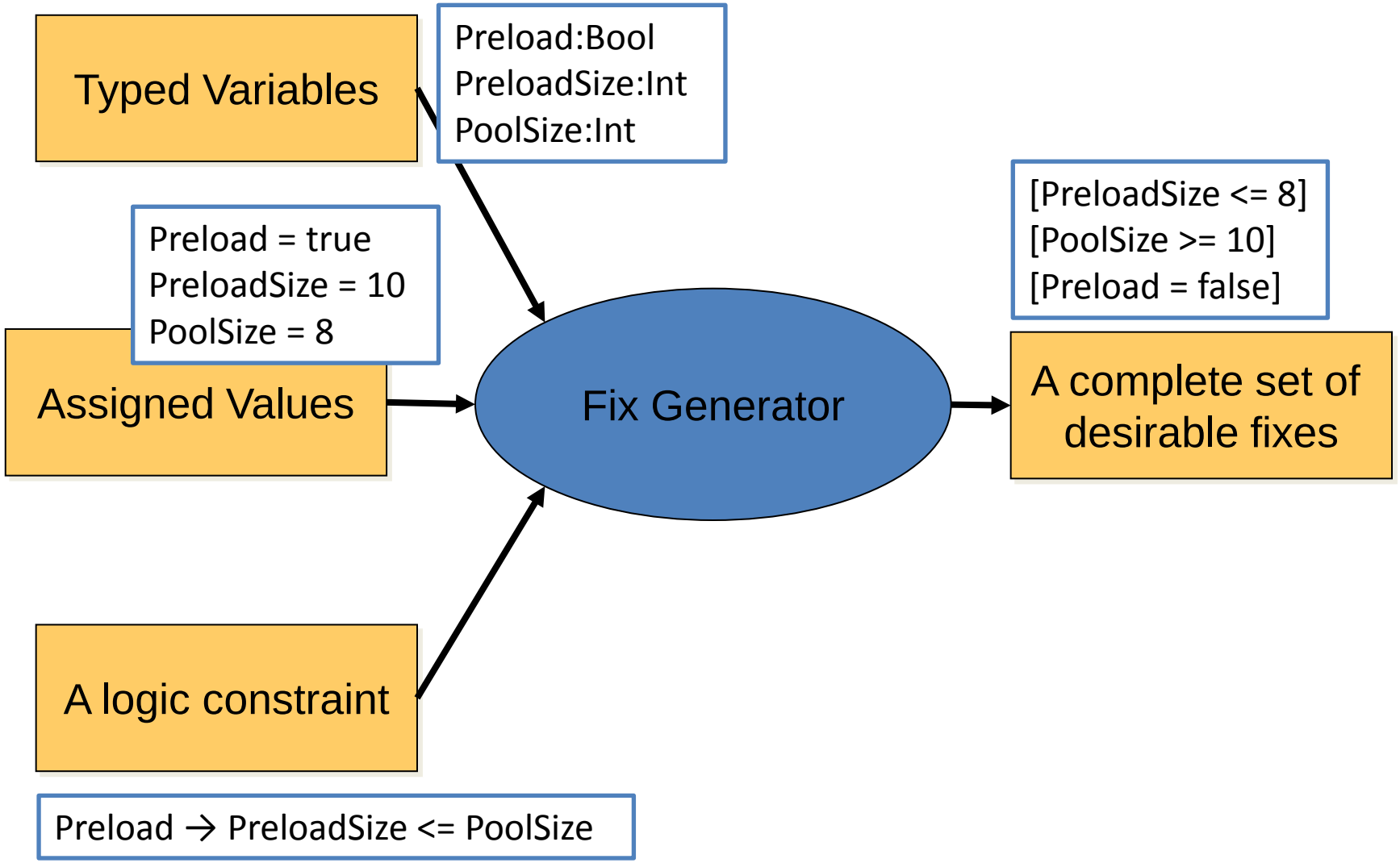
How to complete fixes



Our Proposal – Range Fixes



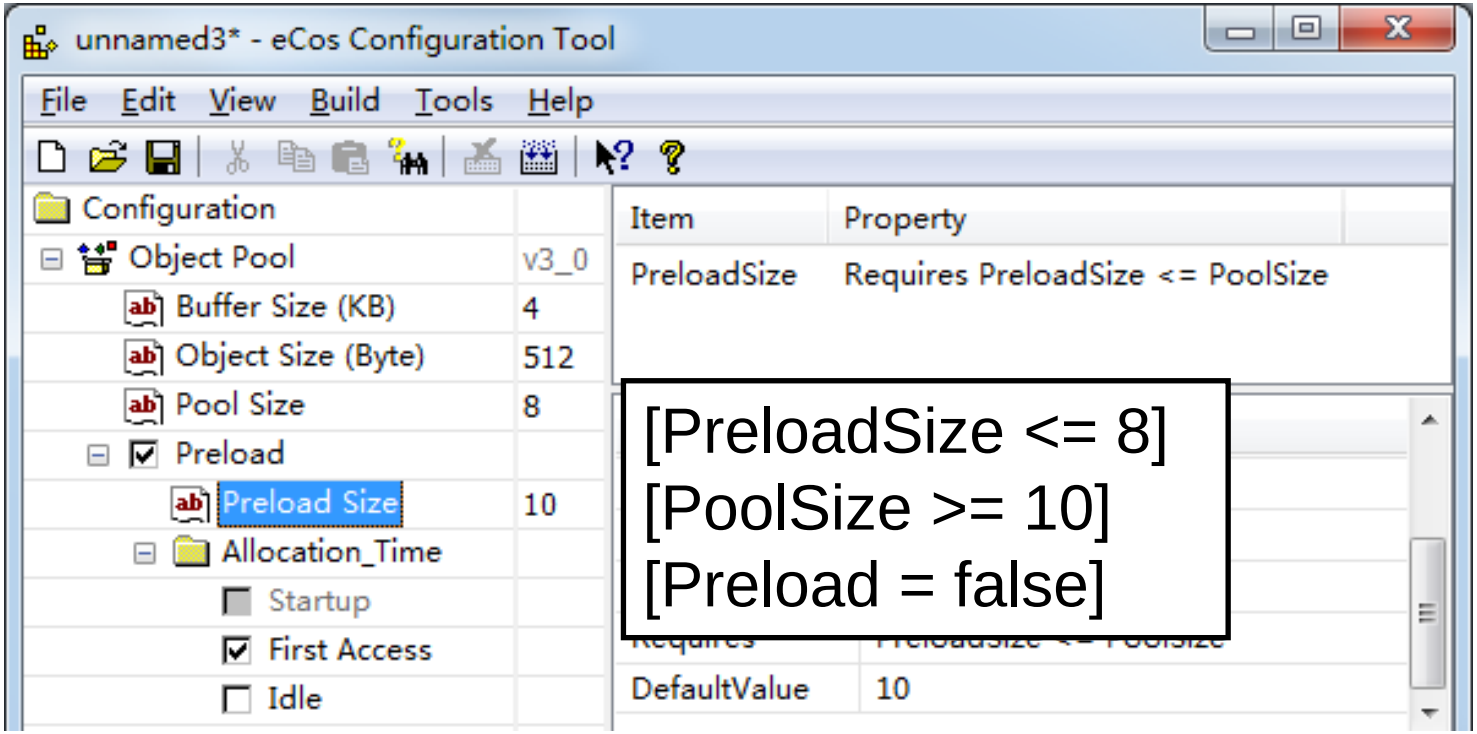
Fix Generation Problem – a General Definition



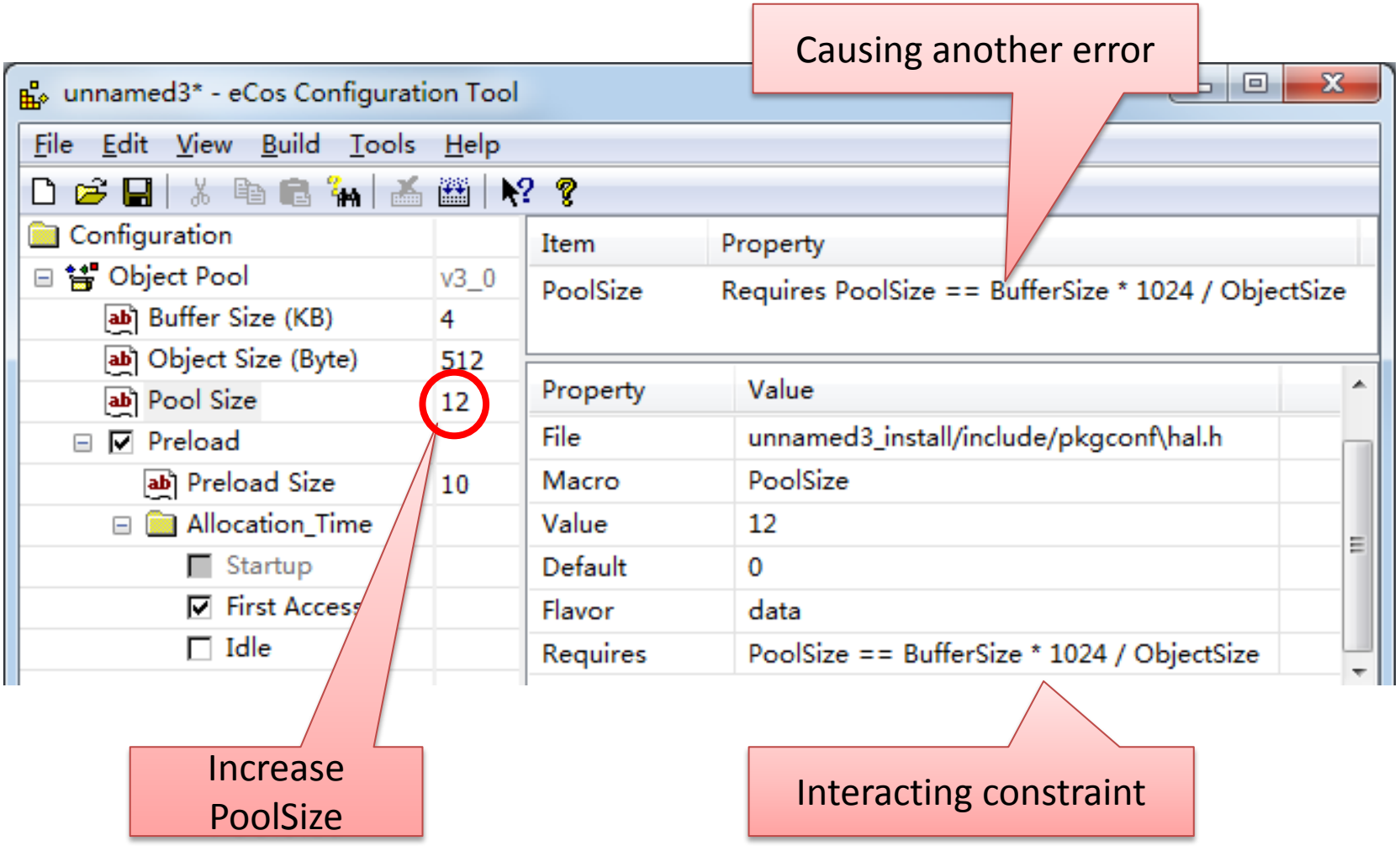
Desired Properties of Fixes

Correctness	Minimality of variables	Maximality of ranges
Any change represented by a range fix will satisfy the constraint	There is no way to change a subset of variables to satisfy the constraint	A range fix represents the maximal ranges over the variables
A desirable one: [PreloadSize <=8]		
Undesirable ones		
[PreloadSize <= 9]	[PreloadSize <=8, Preload = false]	[PreloadSize <=7]

Constraint Interaction



Constraint Interaction



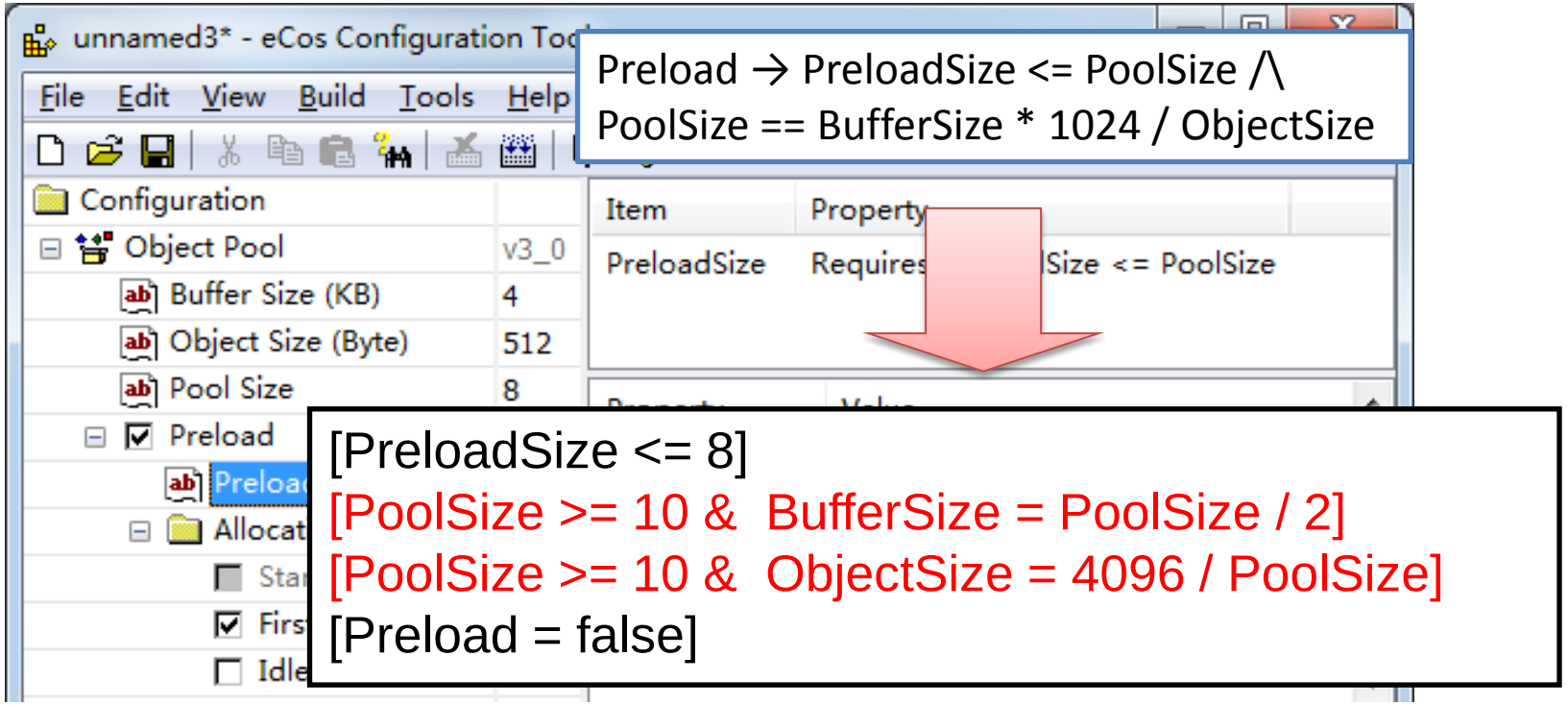
Three Strategies

- Ignorance
- Elimination
- Propagation

- Summarized from existing approaches

Propagation Strategy

Make a conjunction of all satisfied constraints plus the violated one



Evaluation

- Source
  - Version histories from 5 open source projects
- Steps
  - Compare each pair of consecutive versions
  - Replay the user changes in different orders
  - Generate fixes for the violations and compare with user changes

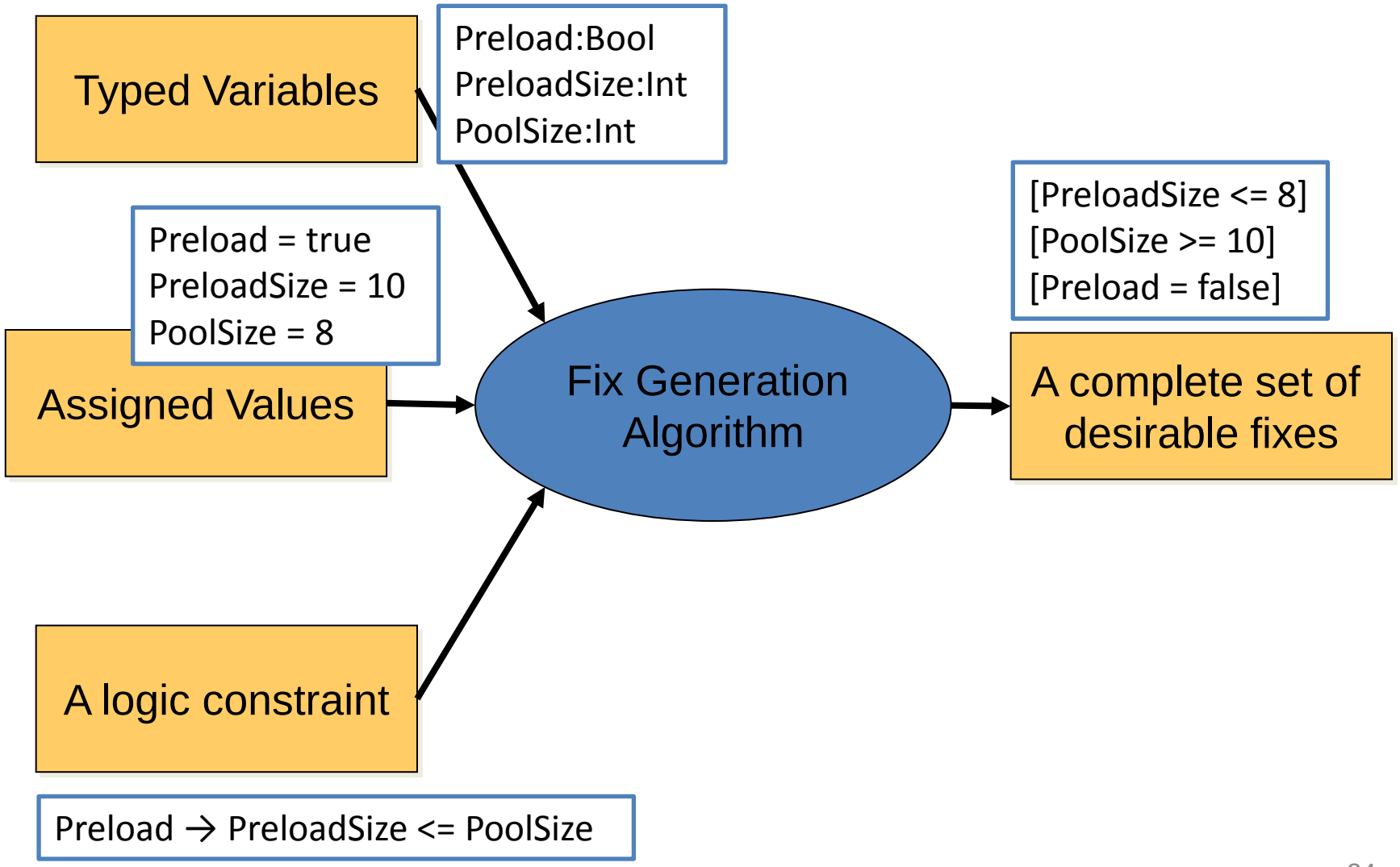
Results

- Coverage of User changes: 100%
- Complexity of fix lists
  - measured by adding up the number of variables in each fix
  - Median: 2
  - Maximum: 58
  - 83% of the fix lists contain less than 10 variables

Can we generate fixes automatically?

An algorithm generating range fixes
in tens of milliseconds

Interface of our algorithm



Algorithm Outline

- Step 1: find the variables to change
  - Basic idea: translating to an SMT proble
    1. treat configurations also as constraints
    2. ask an SMT solver for unsatisfiable cores
    3. combine the unsatisfiable cores
- Step 2: find the range of the variables
  - Basic idea: simplify the constraint
    1. replace unchangeable variables with their current values
    2. simplify the constraint and convert to CNF

Performance of the algorithm

- Published results
  - Average: 50ms
  - Maximum: 250ms

- We have recently improved the performance

Thank you for your attention!

EccFixer: http://gsd.uwaterloo.ca/eccfixer