MILCOM 2016

SECURE COMMUNICATIONS AT THE SPEED OF CYBER

Graph Compactification for Efficient Program Comprehension and Analysis

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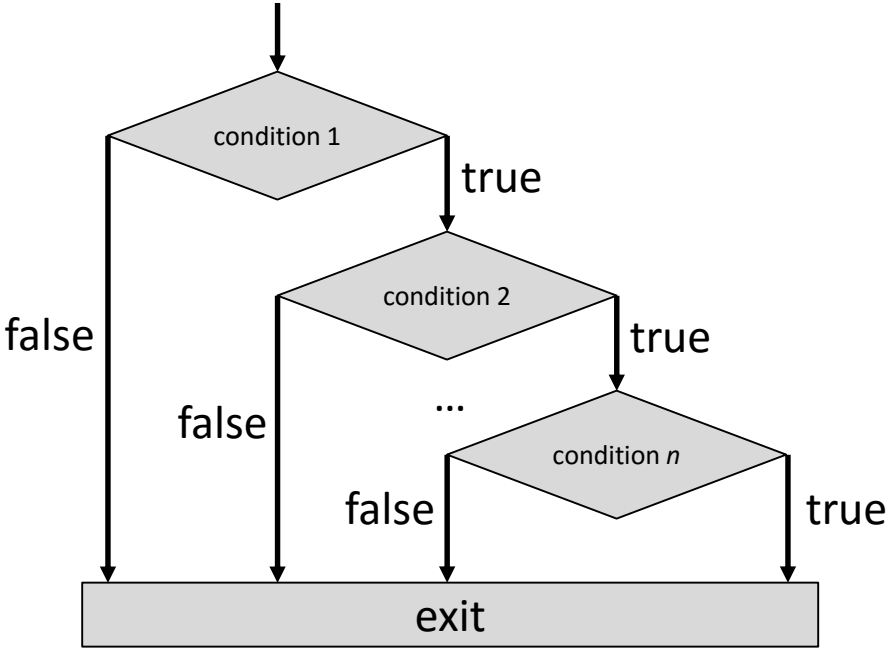
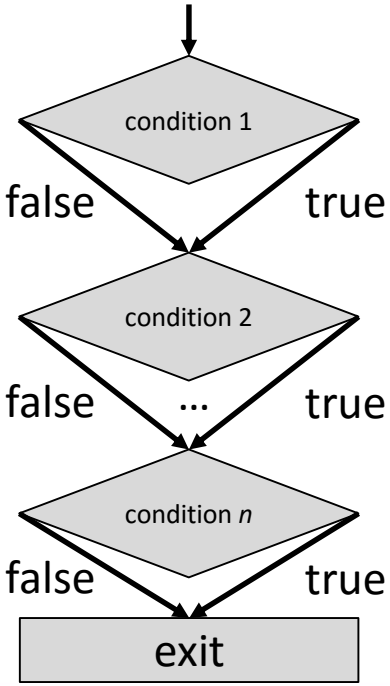
Counting Paths

- How many paths are possible for *n* nested conditions?
  - Answer: *n*+1 paths



Counting Paths

- How many paths are possible for *n* non-nested conditions?
  - Answer: 2^n paths

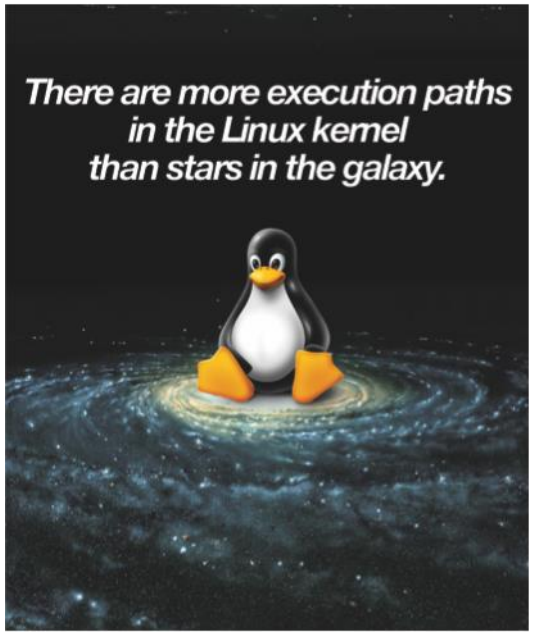


Counting Paths

- How many paths are *feasible* if c1 == c2?
  - i.e. How many paths could produce valid runtime execution traces?
  - More or less?

Counting Paths

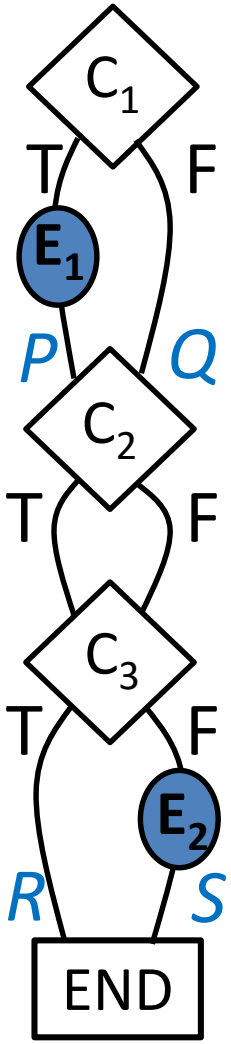
- In the worst case all conditions are non-nested and all paths are feasible.
  - Number of paths to consider in software is exponential!
  - In reality the number of feasible paths is much smaller.



Intuition: Efficient Path-Sensitive Analysis

- A large number of paths could be partitioned into a small number of groups.
- All Paths in a group are equivalent – have the same execution behavior w.r.t. the property to be verified.
- Efficient computation by examining only one path from each group.
- Challenge: How can the groups be formed without examining each path at least once?

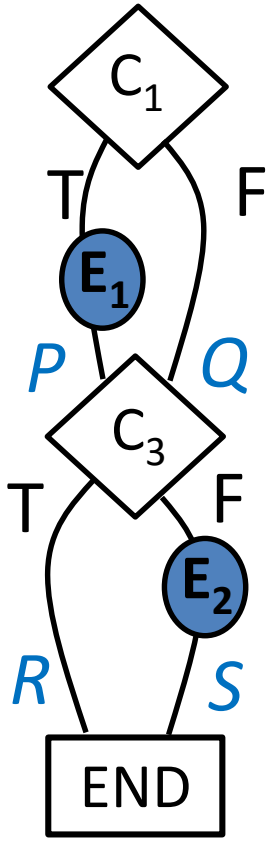
Irrelevant Branch Conditions



C_2 irrelevant to path-sensitive analysis w.r.t. E_1 and E_2

Remove the irrelevant branch conditions to avoid unnecessary path explosion & simplify the path feasibility check.

paths reduced from 8 to 4



conditions for feasibility check reduced from 3 to 2