Graphs, Code & Cyclomatic Complexity

A Brief Overview & Applications

Sandeep Murthy, 29 October 2024

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A Brief Overview & Applications (Sandeep Murthy)

Graphs

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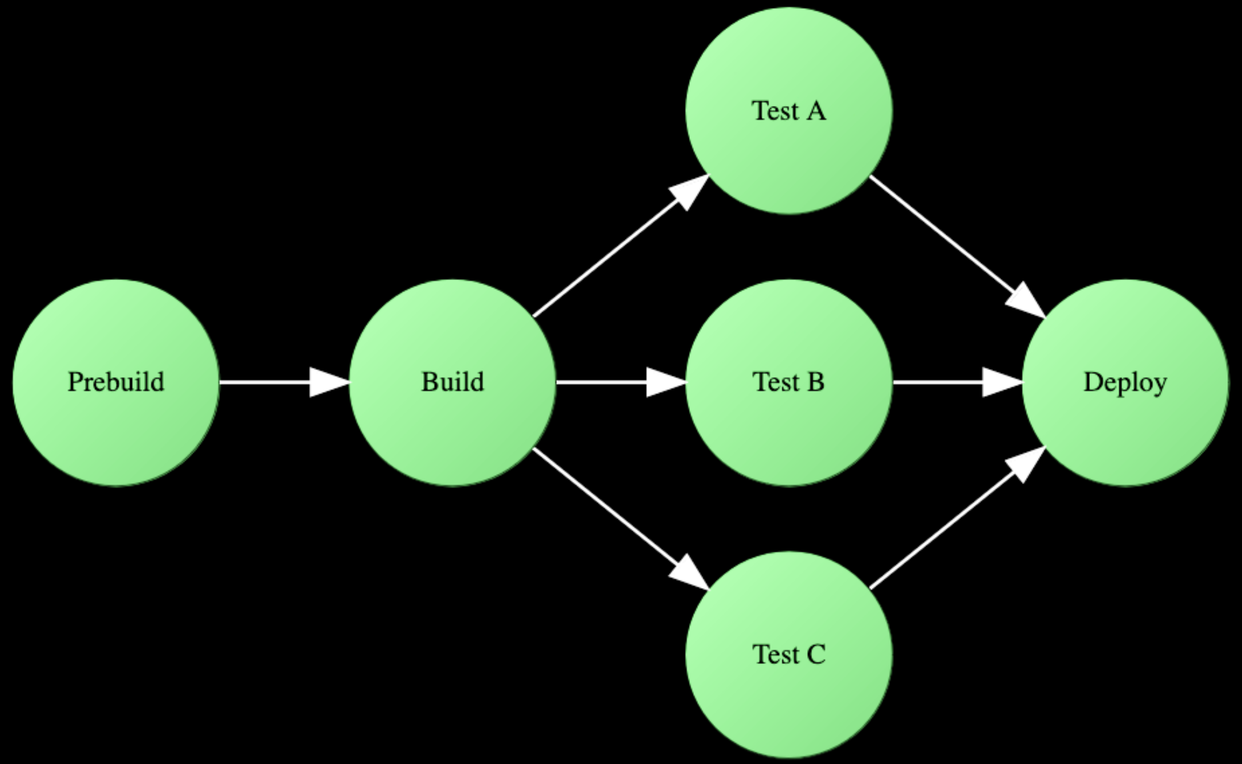

An example DAG of a simple CI pipeline

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- Key #2: Linearly independent (LI) DAG paths are unique ways of moving from an initial to a final state

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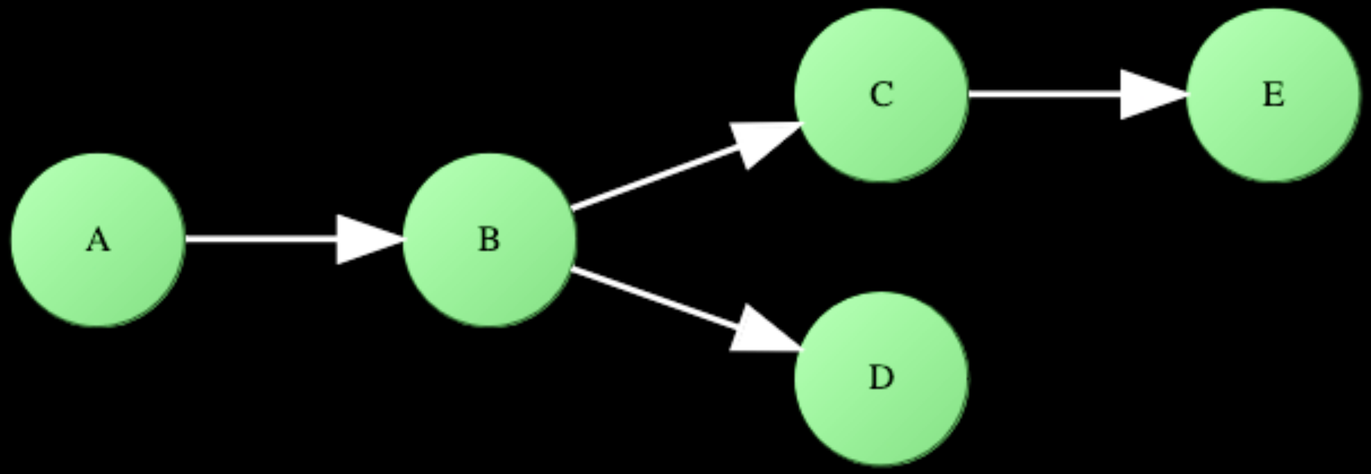

An example DAG with two LI paths: A -> B -> C -> E and A -> B -> D

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Code

```
1   def sign(x: int | float) -> typing.Literal[-1, 0, 1]:
2       if x < 0:
3           return -1
4       if x == 0:
5           return 0
6       return 1
```

Source listing of a simple Python version of the sign function for real numbers

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Code

```
  1           0 RESUME                   0

  2           2 LOAD_FAST                0 (x)
              4 LOAD_CONST               1 (0)
              6 COMPARE_OP               0 (<)
             12 POP_JUMP_FORWARD_IF_FALSE     2 (to 18)

  3          14 LOAD_CONST               2 (-1)
             16 RETURN_VALUE

  4     >>   18 LOAD_FAST                0 (x)
             20 LOAD_CONST               1 (0)
             22 COMPARE_OP               2 (==)
             28 POP_JUMP_FORWARD_IF_FALSE     2 (to 34)

  5          30 LOAD_CONST               1 (0)
             32 RETURN_VALUE

  6     >>   34 LOAD_CONST               3 (1)
             36 RETURN_VALUE
```

Bytecode listing of the Python implementation of the sign function for real numbers

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Code

```
b'\x97\x00|\x00d\x01k\x00\x00\x00\x00\x00r\x02d\x02S\x00|
\x00d\x01k\x02\x00\x00\x00\x00r\x02d\x01S\x00d\x03S\x00'
```

Object code listing of the Python implementation of the sign function for real numbers

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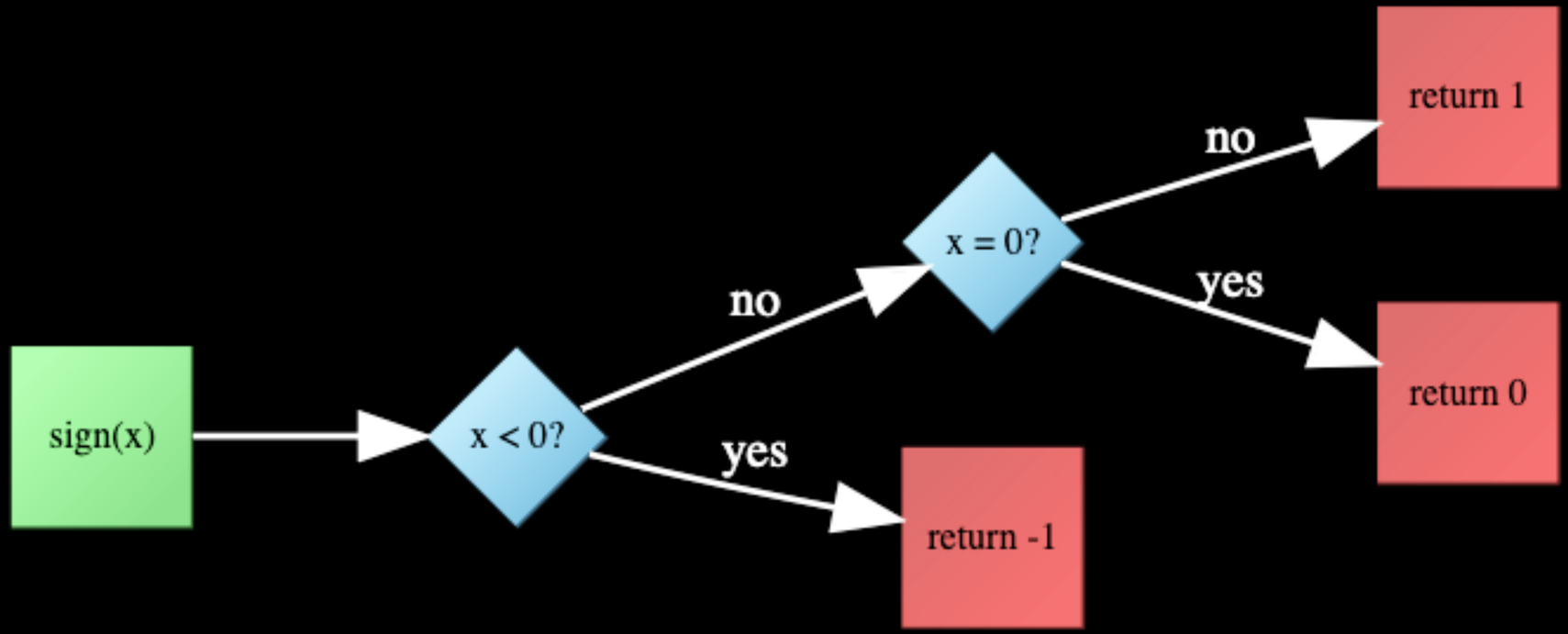

DAG for the Python sign function

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- General notion of “complexity”: diversity (or variability) and predictability of the modes of behaviour of a system or process, where higher complexity is usually associated with greater diversity and unpredictability of the modes of behaviour

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- Key #3: Cyclomatic complexity has limitations: ignores data flows, exogenous variables, e.g. environment, platform

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Applications: Test Coverage

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- My (open source) GitHub project **ccm** (https://github.com/sr-murthy/ccm) is intended as an aid to automating test coverage in a rigorous way using the cyclomatic approach!

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Applications: Security - Vulnerability & Threat Detection

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