Program Analysis

Data Flow Analysis (Part 6)

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Outline

- First example: Available expressions
- Basic principles
- More examples
- Solving data flow problems
- Inter-procedural analysis
- Sensitivities
Every static analysis: Sensitivities

- **Flow-sensitive**: Takes into account the order of statements
- **Path-sensitive**: Takes into account the predicates at conditional branches
- **Context-sensitive** (inter-procedural analysis only): Takes into account the specific call site that leads into another function
Flow sensitivity: Example

```plaintext
if (…) {
  x = 3
  x = 5
}

Value of x?

Flow-sensitive: 5
Flow-insensitive: 3 or 5
```
Path sensitivity: Example

```plaintext
x = 0
if (a > 0) {
    x = 1
} else {
    x = 2
}
if (a > 0) {
    x += 3
}
```

Path-sensitive: No

Can x be 5? Path-insensitive: Yes
Context sensitivity: Example

\[ n = 7 \]
\[
\text{function } f(x) \{ \\
\text{ if } (x) \{ \\
\quad g(3) \\
\text{ else } \\
\quad n = 3 \\
\quad g(5) \\
\}
\}
\]

function \( g(y) \) {
  \< Can \( n \) be equal to \( y \)? \>

context-insensitive: Yes
  (conflates all call sites of \( g \))

context-sensitive: No
Quiz: Sensitivities

Consider an intra-procedural data flow analysis (specifically: live variables analysis).

What sensitivities does it have?
Quiz: Sensitivities

Consider an intra-procedural data flow analysis (specifically: live variables analysis).

What sensitivities does it have?

- Flow-sensitive: Yes (every data flow analysis)
- Path-sensitive: No (doesn’t track predicates)
- Context-sensitive: Irrelevant (because intra-procedural)
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