

Program Analysis

Program Slicing (Part 3)

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Outline

1. Introduction

2. Static Slicing

3. Thin Slicing 

4. Dynamic Slicing

Mostly based on these papers:

- *Program Slicing*, Weiser., IEEE TSE, 1984
- *Thin Slicing*, Sridharan et al., PLDI 2007
- *Dynamic Program Slicing*, Agrawal and Horgan, PLDI 1990
- *A Survey of Program Slicing Techniques*, Tip, J Prog Lang 1995

Thin Slicing: Overview

- Challenge: **Static slices** are often **very large**
 - Worst case: Entire program
 - Too large for common debugging and program understanding tasks
- Main reason: Aims at an **executable program**
 - But: **Not needed** for many tasks
- Idea: Heuristically focus on statements needed for common debugging tasks
 - **Thin slice**
- Let user expand the thin slice on demand

Thin Slicing: Definition

- Statement **directly uses** a memory location if it uses it for some computation other than pointer dereference
 - Example: $x.f + y$ uses x for pointer dereference and directly uses y
- **Dependence graph** G for thin slicing:
Data dependences computed based on **direct uses** only
- **Thin slice**: Statements **reachable** from criterion's statement via G

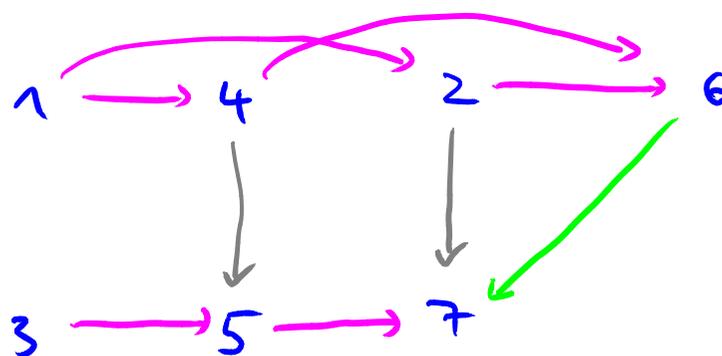
Example: Thin Slicing

```

1 var x = {};
2 var z = x;
3 var y = {};
4 var w = x;
5 w.f = y;
6 if (w === z) {
7   var v = z.f; // criterion
}
```

- .. direct data dep.
- ... data dep. only for pointer deref. (ignored)
- .. control flow dep. (ignored)

Dependence graph



- Traditional slice
All statements
- Thin slice

Expanding Thin Slices

- Thin slices include "producer statements" but exclude "explainer statements"
 - Why do heap accesses read/write the same object?
 - Why can this producer execute?
- Most explainers are not useful for common tasks
- Expose explainers on demand via incremental expansion

Example: Thin Slicing

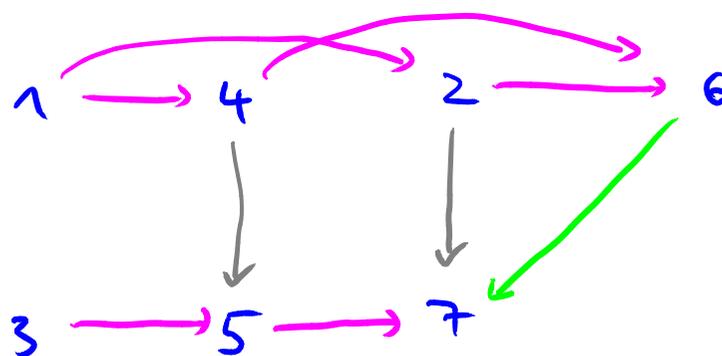
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Dependence graph



- Traditional slice
All statements
- Thin slice
- On demand expansion, e.g.,
"Why are w and z aliases?"

Evaluation and Results

- **Simulate** developer effort for **bug finding**
 - Set of known bugs that crash the program (and their root causes)
 - Assume that developer inspects statements with breadth-first search on PDG, starting from crash point
 - Count inspected statements with traditional and thin slice
- **Results:**
 - Mean of **12 inspected statements** per thin slice
 - Overall, **3.3x fewer inspected statements**