AdaSlicer: An Ada Program Slicer

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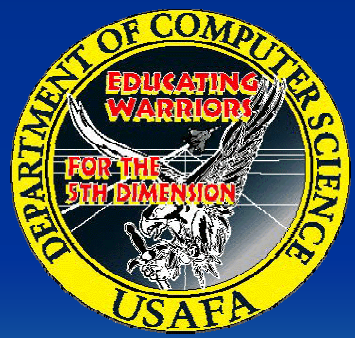

Overview

- Background
- Program slicing
- Processing statements
- Inter-procedural slicing
- ASIS
- Conclusions

Background

- Program slicing projects behavior
  - Extracts functionality from original program required to produce the value of a single variable
- Used in software maintenance
- Used in software testing for test case generation
- Used in debugging to focus the search for bugs
- Used in re-engineering

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Program Slicing

- A *program slice* is a projection of behavior from the original procedure
- Build slice by extracting statements needed to produce *slice variable*

```
procedure Assignscalar is
   A : Integer := 0;
   B : Integer := 1;
   C : Integer := 2;
   D : Integer := 3;
begin
   C := A + B;
   D := B * 2;
end Assignscalar;
```

```
procedure Assignscalar_D is
   B : Integer := 1;
   D : Integer := 3;
begin
   D := B * 2;
end Assignscalar_D;
```

Program Slicing

- Static analysis tool, uses statement information
- A variable is *defined* in a statement if it can assigned a new value,
- Any variables that appear in a statement are *referenced* in that statement
- For each statement collect DEF and REF set
- Conservative slices, not necessarily minimal
- Relevant set tracks variables needed for slice

Program Slicing

```
procedure Assignscalar is
   A : Integer := 0;
   B : Integer := 1;
   C : Integer := 2;
   D : Integer := 3;
begin
   C := A + B;
   D := B * 2;
end Assignscalar;
```

```
procedure Assignscalar_D is
   B : Integer := 1;
   D : Integer := 3;
begin
   D := B * 2;
end Assignscalar_D;
```

Relevant set: { B, D }

REF set: { B }

DEF set: { D }

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Processing Statements

- Intra-procedural slicing
- Begin processing with last statement
- Assignment statements

Relevant set: { E, B, D }

```
procedure Assignscalar is
   A : Integer := 0;
   B : Integer := 1;
   C : Integer := 2;
   D : Integer := 3;
   E : Integer := 4;
begin
   C := A + B;        -- process third
   D := B * 2;        -- process second
   E := D * 3;        -- process first
end Assignscalar;
```

```
procedure Assignscalar_E is
   B : Integer := 1;
   D : Integer := 3;
   E : Integer := 4;
begin
   D := B * 2;
   E := D * 3;
end Assignscalar_E;
```

Processing Statements

- If-then-else statements
- Statements in paths are processed recursively
- Conservative approach, expression copied verbatim

```
procedure Ifthenelsescalar is
   C : Integer;
   D : Integer;
   E : Integer;
begin
   C := 0;
   D := 0;
   E := 0;
   if C = 2  then
      D := D + 1;
   else
      E := E + 1;
   end if;
end Ifthenelsescalar;
```

Relevant set: { C, E }

```
procedure Ifthenelsescalar_E is
   C : Integer;
   E : Integer;
begin
   C := 0;
   E := 0;
   if C = 2 then
      null;
   else
      E := E + 1;
   end if;
end Ifthenelsescalar_E;
```

Processing Statements

```
procedure Elsiftest is
   F : Integer := 0;
   G : Integer := 0;
   H : Integer := 0;
    I : Integer := 0;
   J : Integer := 0;
  W : Integer := 0;
   Z : Integer := 0;
begin
   W := W - 5;
   if F = 3 then
      G := G + 1;
   elsif H = 4 then
      I := I + 2;
elsif W = 1 then
      Z := -3;
   else
      J := J + 3;
   end if;
   W := W + 1;
end Elsiftest;
```

- If-then-elsif-else statements
- Include only the elsif paths that are needed

Relevant set: { F, H, I }

```
procedure Elsiftest_I is
   F : Integer := 0;
   H : Integer := 0;
   I : Integer := 0;
begin
   if F = 3 then
      null;
   elsif H = 4 then
      I := I + 2;
   end if;
end Elsiftest_I;
```

Processing Statements

- Case statements
- Must include all paths

```
procedure Casescalar is
   K : Integer := 0;
   L : Integer := 0;
   O : Integer := 0;
   Q : Integer := 0;
begin
   case K is
      when 5 =>
         L := L + 1;
      when 6 =>
         O := O + 1;
      when 7 =>
         Q := Q + 1;
      when others =>
         Q := Q + 2;
   end case;
end Casescalar;
```

```
procedure Casescalar_Q is
   K : Integer := 0;
   Q : Integer := 0;
begin
   case K is
      when 5 =>
         null;
      when 6 =>
         null;
      when 7 =>
         Q := Q + 1;
      when others =>
         Q := Q + 2;
   end case;
end Casescalar_Q;
```

Relevant set: { K, Q }

Processing Statements

```
procedure Looptest is
   C : Integer := 0;
   D : Integer := 0;
   E : Integer := 0;
begin
   C := 0;
   while C <= 10 loop
      D := D + E;
      E := E + C;
      C := C + 1;
   end loop;
end Looptest;
```

- Loop statements
- Iterate over statements until relevant set becomes stable

```
procedure Looptest_D is
   C : Integer := 0;
   D : Integer := 0;
   E : Integer := 0;
begin
   C := 0;
   while C <= 10 loop
      D := D + E;
      E := E + C;
      C := C + 1;
   end loop;
end Looptest_D;
```

```
procedure Looptest_C is
   C : Integer := 0;
begin
   C := 0;
   while C <= 10 loop
      C := C + 1;
   end loop;
end Looptest_C;
```

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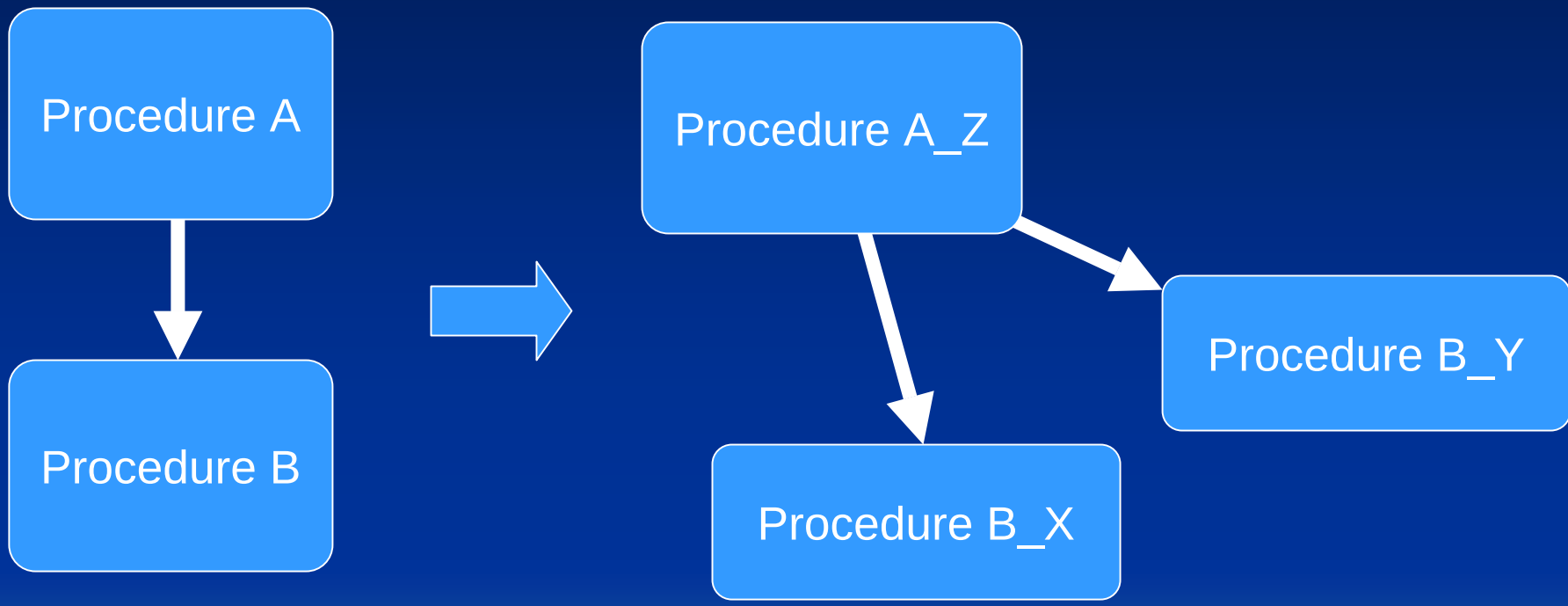
Inter-procedural Slicing

- So far dealt with slicing within a procedure
  - Intra-procedural slicing
- What about procedure call statements?
- How to handle?
- Have to slice called procedure if a variable in the relevant set is an out parameter of the called procedure

Inter-procedural Slicing

Inter-procedural Slicing



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Ada Semantic Interface Specification (ASIS)

- Procedures for accessing Ada program structure
- Used ASIS 3.15a1 & GNAT Ada Compiler 3.15a1
- Reasonable learning curve
- Examples provided with ASIS are great
- Very powerful tool

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Conclusions

- Currently working on graphical user interface
- Targeted at re-engineering efforts
- Experiment in under-graduate and graduate software engineering course
- Also applications in driving refactoring decisions