Static Single Assignment Form

Technische Universität München

March 7, 2019

Analysis Module

Maybe skip slide

- Own Java module
- Implement different analyses
- Main method takes input file and runs analyses on main function and generates pictures

How to implement an analysis?

All analyses and transformations are visitors

1. Which type do I want to propagate (domain $\mathbb{D}$)?

```
1 public class ReachingDefinitionsAnalysis extends
      AbstractPropagatingVisitor
2         <Set<Tupel<Variable, Long>>>
```

How to implement an analysis?

2. Implement methods
   - *lower upper bound* — Merge results
   - *less or equal* — Detect if our solution changed

```
1  static Set<Tupel<Variable, Long>> lub(
2      Set<Tupel<Variable, Long>> s1,
3      Set<Tupel<Variable, Long>> s2) {
4      if (s1 == null) return s2;
5      if (s2 == null) return s1;
6      HashSet<Tupel<Variable,Long>> res = new HashSet<>();
7      // Union
8      res.addAll(s1);
9      res.addAll(s2);
10     return res;
11 }
12
13 static boolean lessoreq(Set<Tupel<Variable, Long>> s1,
       Set<Tupel<Variable, Long>> s2) {
14     if (s1 == null) return true;
15     if (s2 == null) return false;
16     return s2.containsAll(s1);
17 }
```

How to implement an analysis?

3. Implement `visit` for states and interesting transitions

```
1  public Set<Tupel<Variable, Long>> visit(Assignment
       assignment, Set<Tupel<Variable, Long>>
       reachingDefinitions) {
2      Set<Tupel<Variable, Long>> newDefinitions =
3          new HashSet<>(reachingDefinitions);
4      if (assignment.getLhs() instanceof Variable) {
5          Variable variable =
6              (Variable) assignment.getLhs();
7          this.processVariableAssignment(newDefinitions,
               variable, assignment.getDest().getId());
8      }
9      return newDefinitions;
10 }
```

How to implement an analysis?

4. If the solution converged, return `null` to end the fix point iteration

```
1  public Set<Tupel<Variable, Long>> visit(State state,
2      Set<Tupel<Variable, Long>> reachingDefinitions) {
3      Set<Tupel<Variable,Long>> oldRD = dataflowOf(state);
4      if (oldRD == null) {
5          oldRD = new HashSet<>();
6          dataflowOf(state, reachingDefinitions);
7          if (reachingDefinitions.equals(oldRD)) {
8              return reachingDefinitions;
9          }
10     }
11
12     if (!lessoreq(reachingDefinitions, oldRD)) {
13         dataflowOf(state,
14             lub(oldRD, reachingDefinitions));
15         return lub(oldRD, reachingDefinitions);
16     }
17     return null;
18 }
```

How to implement an analysis?

All analyses and transformations are visitors

1. Which type do I want to propagate (domain $\mathbb{D}$)?
2. Implement methods

lower upper bound	Merge results
less or equal	Detect if our solution changed

3. Implement `visit` for states and interesting transitions
4. If the solution converged, return `null` to end the fix point iteration

Partial Redundancy Elimination

1. Compute Available Expressions
2. Compute Very Busy Expressions (needed at all paths)
3. Move computations to the earliest possible point

Partial Redundancy Elimination

1. Compute Available Expressions
2. Compute Very Busy Expressions (needed at all paths)
3. Move computations to the earliest possible point
4. Insert $T_e = e$ at (u, lab, v) if $e \in \mathcal{B}[v] \setminus ([\![lab]\!]^\sharp_{\mathcal{A}}(\mathcal{A}[u] \cup \mathcal{B}[u]))$

Questions?