

# Assignment 1: Partially Available Expressions (PAE) Analysis

Optimizing Compilers (Winter Term 2012)

Deadline: November 21, 2012

## 1 Intraprocedural PAE Analysis

An available expression analysis finds for a given program point  $P$  the expressions whose results at  $P$  are same as their previously computed values, regardless of the execution path taken to reach  $P$ .

In other words, an expression  $e$  is available at a program point  $P$ , if all paths from the start node  $S$  to the program point  $P$  contain a computation of the expression  $e$  which is not followed by an assignment to any of the operands of  $e$ .

A variant of the available expression analysis is the **partially available expression** analysis that relaxes the condition: an expression is partially available at a program point  $P$ , if the expression is available along *some* path to  $P$ .

In this exercise one shall implement a partially available expression analysis on a control flow graph (CFG) of programs. The following example shows the results of an intraprocedural partially available expression analysis for the WHILE language:

$[a := b + c]^1;$	$\ell$	$\text{PAE}_o(\ell)$	$\text{PAE}_\bullet(\ell)$
$[b := d + e]^2;$	1	{}	{1}
<b>while</b> $[a < 10]^3$ <b>do</b> (	2	{1}	{2}
<b>if</b> $[b < a]^4$ <b>then</b>	3	{2, 3, 4, 5, 6}	{2, 3, 4, 5, 6}
$[a := b + e]^5;$	4	{2, 3, 4, 5, 6}	{2, 3, 4, 5, 6}
<b>else</b>	5	{2, 3, 4, 5, 6}	{2, 5}
$[e := b + a]^6;$	6	{2, 3, 4, 5, 6}	{3, 4, 6}
)			

Specify the partially available expression analysis for WHILE:

- define  $\text{kill}_{\text{PAE}}(\ell)$  and  $\text{gen}_{\text{PAE}}(\ell)$ .
- define the equations for  $\text{PAE}_o(\ell), \text{PAE}_\bullet(\ell): \text{Lab}_\star \rightarrow \mathcal{P}(\text{Lab}_\star)$ .

## 2 Intraprocedural PAE using PAG

Specify the analysis using PAG for the WHILE language. Details about the language and some examples can be found on the PAG website. The analysis should be able to handle `if`-statements and `while`-loops and expressions constructed from the usual arithmetic and relational operators. Implement your PAG-analysis using the PAG Webfrontend available at <http://www.program-analysis.com/>. **Hint:** try adapting the available expressions analysis that is already available. **Note:** the above example outputs sets of statement-labels as solution. For the assignment, it is accepted to output the expressions directly (e.g. `b+c`) instead of 1).

## 3 Deadline

Send your solution via email to [jakob@complang.tuwien.ac.at](mailto:jakob@complang.tuwien.ac.at), subject line “OC-ASGN1-studentid” containing your analysis specification and equations until the 21th of November, 2012. Your submission should include all solutions to the exercises (text in pdf format), together with an example and a short explanation of your solutions.