CSC 410F: Assignment 3

Due on October 30, 2017

Harman Sran **Ryan Downes** **Michael Li**

October 28, 2017

Problem 1: Upwards Exposed Uses

(a)

Formally define the property space for this problem (i.e. a set and its corresponding meet operator).

The set in our property space is the set of flows between all nodes u and v, in V, cross joined with the power set of all variables being read at node v (power set because multiple variables read at v may be upwards exposed at u). Formally:

$$Set := (((u, v) \mid (u, v) \in Flow(\langle Label(V), E \rangle)) \times \mathcal{P}(read(v)) \tag{1}$$

Particular sets in our property space are of the form:

$$\{var \in read(v)\}^{lab(v)} \tag{2}$$

That is, an element of the set is a variable in the read at some vertex v; uniquely identified as belonging to (read at) v with the unique label $lab(v)$.

$lab(v)$ ensures that the same variable read at different vertices are treated as separate elements of the set.

The join operator in our property space is union ($\cup$) - we union the sets at the entries of all the branching root node's children Formally:

$$\sqcup := \cup \tag{3}$$

(b)

Define the (statement) transformer functions for this analysis.

We define the transformer functions at some node l (where $(l, l') \in E$ denotes a directed edge from l to l'; and $lab(*)$ is a wild-card equivalent to $lab(v)$ for any $v \in V$):

$$EU_{exit}(l) = \bigcup_{l'} (EU_{entry}(l') \mid (l, l') \in E) \tag{4}$$

$$EU_{entry}(l) = (EU_{exit}(l) \setminus \{var \in write(l)\}^{lab(*)}) \cup \{var \in read(l)\}^{lab(l)} \tag{5}$$

Problem 1: Upwards Exposed Uses continued on next page...

(c)

Fully define the analysis by characterizing whether it is forward or backward, what the initial nodes are, and what value is given to these initial nodes and all the other nodes before the default iterative work-list algorithm start.

The analysis here is backwards (which fits our definition of transformer functions above).

All nodes have their entry and exit initialized to $\emptyset$.

When the flow through begins at the leaf nodes, their entries ($EU_{entry}(l)$) will be set to $\{var \in read(v)\}^{lab(v)}$ by the transformer functions.