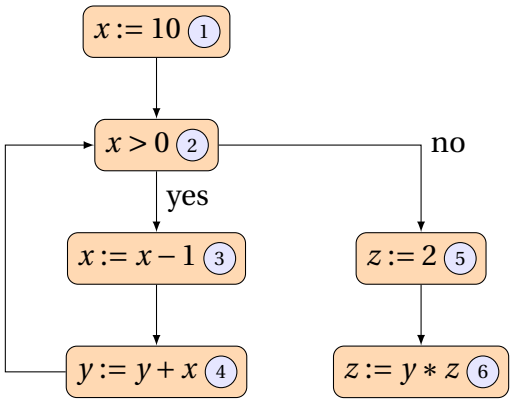
Data flow analysis: live variables

Static Program Analysis and Constraint Solving
Master's Degree in Formal Methods in Computer Science
Year 2020/21

Assume the following program:



1. Write the data flow equations:

$$
\begin{array}{lcl}
In_1 & = & Out_1 \setminus \{x\} \\
In_2 & = & Out_2 \cup \{x\} \\
In_3 & = & (Out_3 \setminus \{x\}) \cup \{x\} = Out_3 \cup \{x\} \\
In_4 & = & (Out_4 \setminus \{y\}) \cup \{x, y\} = Out_4 \cup \{x, y\} \\
In_5 & = & Out_5 \setminus \{z\} \\
In_6 & = & (Out_6 \setminus \{z\}) \cup \{y, z\} = Out_6 \cup \{y, z\}
\end{array}
\qquad
\begin{array}{lcl}
Out_1 & = & In_2 \\
Out_2 & = & In_3 \cup In_5 \\
Out_3 & = & In_4 \\
Out_4 & = & In_2 \\
Out_5 & = & In_6 \\
Out_6 & = & \emptyset
\end{array}
$$

2. Solve the equations by Kleene's ascending chain:

	Start	**Iter. 1**	**Iter. 2**	**Iter. 3**	**Iter. 4**	**Iter. 5**	**Iter. 6**	**Iter. 7**	**Iter. 8**
In_1	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$	$\{y\}$	$\{y\}$
In_2	$\emptyset$	$\{x\}$	$\{x\}$	$\{x\}$	$\{x\}$	$\{x, y\}$	$\{x, y\}$	$\{x, y\}$	$\{x, y\}$
In_3	$\emptyset$	$\{x\}$	$\{x\}$	$\{x, y\}$	$\{x, y\}$	$\{x, y\}$	$\{x, y\}$	$\{x, y\}$	$\{x, y\}$
In_4	$\emptyset$	$\{x, y\}$	$\{x, y\}$	$\{x, y\}$	$\{x, y\}$	$\{x, y\}$	$\{x, y\}$	$\{x, y\}$	$\{x, y\}$
In_5	$\emptyset$	$\emptyset$	$\emptyset$	$\{y\}$	$\{y\}$	$\{y\}$	$\{y\}$	$\{y\}$	$\{y\}$
In_6	$\emptyset$	$\{y, z\}$	$\{y, z\}$	$\{y, z\}$	$\{y, z\}$	$\{y, z\}$	$\{y, z\}$	$\{y, z\}$	$\{y, z\}$
Out_1	$\emptyset$	$\emptyset$	$\{x\}$	$\{x\}$	$\{x\}$	$\{x\}$	$\{x, y\}$	$\{x, y\}$	$\{x, y\}$
Out_2	$\emptyset$	$\emptyset$	$\{x\}$	$\{x\}$	$\{x, y\}$	$\{x, y\}$	$\{x, y\}$	$\{x, y\}$	$\{x, y\}$
Out_3	$\emptyset$	$\emptyset$	$\{x, y\}$	$\{x, y\}$	$\{x, y\}$	$\{x, y\}$	$\{x, y\}$	$\{x, y\}$	$\{x, y\}$
Out_4	$\emptyset$	$\emptyset$	$\{x\}$	$\{x\}$	$\{x\}$	$\{x\}$	$\{x, y\}$	$\{x, y\}$	$\{x, y\}$
Out_5	$\emptyset$	$\emptyset$	$\{y, z\}$	$\{y, z\}$	$\{y, z\}$	$\{y, z\}$	$\{y, z\}$	$\{y, z\}$	$\{y, z\}$
Out_6	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$	$\emptyset$