Errata for the book titled "Data Flow Analysis: Theory and Practice"

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This is an errata for the book "Data Flow Analysis: Theory and Practice" by Uday P. Khedker, Amitabha Sanyal, and Bageshri Karkare, published by the CRC Press (Taylor and Francis Group). Wherever applicable, we have mentioned the name of the person who has pointed out the error to us. If you discover additional errors, we would appreciate hearing from you and will gladly acknowledge your contribution.

We have reorganized this errata into two parts. The first part lists the errors that may affect technical understanding of the concepts whereas the second part lists minor corrections that are linguistic, grammatical, or typographical in nature.

1 Errors that may affect conceptual understanding

- Page 6, second table listing the liveness.

  Liveness set associated with the entry of n_5 and exit of n_4 in iteration 3 is $\{n, next \text{-}\!\triangleright sib \text{-}\!\triangleright \star\}$. The "$\text{-}\!\triangleright$" before $\star$ is missing. (*Credit: Ahmed Khademzadeh*)

- Page 7, first two tables listing the interprocedural liveness.

  Column headings should read "Liveness in iteration 1" and "Liveness in iteration 2" (instead of "2" and "3"). (*Credit: Ahmed Khademzadeh*)

- Page 7, second table listing the interprocedural liveness.

  In iteration 1 (erroneously called iteration 2), liveness set at the entry of n_3.call should be $\{succ\}$. Hence the liveness set at the exit of n_2 should be $\{n, succ\}$. (*Credit: Ahmed Khademzadeh*)

- Page 8, table listing comparison of liveness computed by the three methods.

  – The liveness set associated with the entry of n_5 and exit of n_4 in simple intraprocedural liveness is $\{n, next \text{-}\!\triangleright sib \text{-}\!\triangleright \star\}$. The "$\text{-}\!\triangleright$" before $\star$ is missing. (*Credit: Ahmed Khademzadeh*)

  – The liveness set associated with the exit of n_6 in intraprocedural liveness with interprocedural approximation should be $\{n \text{-}\!\triangleright \star\}$ rather than $\emptyset$. (*Credit: Ahmed Khademzadeh*)

- Page 9, line 5 from the bottom.

  n_6 should actually be n_5 (*Credit: Ahmed Khademzadeh*)

- Page 28, line 1 from the top.

  "revervse postorder" should be just "postorder" (i.e. drop "reverse"). (*Credit: Vaivaswatha N*)

- Page 29, second paragraph, definition of liveness paths.

  Condition in second bullet should be dropped.

- Page 31, Figure 2.2, Result of reaching definitions analysis.

  Out_{n_4} in iteration #1 should contain d_1 and not d_2. (*Credit: Ahmed Khademzadeh*)

- Page 31, third paragraph, definition of definition reaching paths.

  Condition in second bullet should be dropped.

- Page 35, third paragraph, definition of availability paths.

  The condition listed in the second bullet should be dropped.

- Page 33, first bullet on the top.

  $Kill_b$ should actually be $Kill_n$. *(Credit: Mohadeseh Delavarian)*

- Page 39, second bullet from the top, definition of anticipability paths.

  The condition listed in this bullet should be dropped. *(Credit: Ahmed Khademzadeh)*

- Page 39, section 2.4.4, second paragraph.

  The last sentence should read as "This hoisting subsumes loop invariant movement as illustrated in Figure 2.7 and common subexpression elimination". The words "as illustrated in Figure 2.7" are missing. *(Credit: Ahmed Khademzadeh)*

- Page 41, condition (**D.2.b**) in the desirability of hoisting.

  "...need not be inserted at $Exit$(n)" should read as "...need not be inserted at $Entry$(n)". *(Credit: Ahmed Khademzadeh)*

- Page 44, equation (2.16) should read

$$Insert_n = Out_n \cap (\neg AvOut_n) \cap (\neg In_n \cup Kill_n)$$

  The term $(\neg AvOut_n)$ is missing.

- Page 46, second paragraph after the list, line 2.

  "node n_2 in Figure 2.11(b)" should read as "node n_1 in Figure 2.11(b)" (i.e. replace n_2 by n_1). *(Credit: Mohadeseh Delavarian)*

- Page 46, example 2.20, line 1.

  Edge $n_7 \rightarrow n_3$ should also be included. *(Credit: Ahmed Khademzadeh)*

- Page 47, second paragraph, line 5.

  Replace "Figure 2.11" by "Figure 2.11(a)". *(Credit: Mohadeseh Delavarian)*

- Page 56, Figure 2.17, result of combined may-must availability analysis.

  Out_{n_8} should be $\langle 00, 00, 00, 00, 00 \rangle$ and In_{n_8} should be $\langle 00, 00, 00, 10, 10 \rangle$. The data flow value for expression $a + b$ (second value in the vector) should be 00 instead of 10. *(Credit: Manisha Gaonkar)*

- Page 49, definition of code motion preventing region (CMP).

  The terms $PantIn_n$ and $PantOut_n$ refer to partial anticipability at $Entry(n)$ and $Exit(n)$ respectively. *(Credit: Ahmed Khademzadeh)*

- Page 104, first paragraph, line 2.

  "...the left and side variable is faint" should read as "...the left and side variable is *not* faint". The word "not" is missing. *(Credit: Seema Ravandale)*

- Page 105, Figure 4.2, result for faint variables analysis.

  In_{n_4} in iteration #2 should be $\{a, c\}$ instead of $\{c\}$. *(Credit: Sandhya Rani)*

  In_{n_4} in iteration #4 should be $\{a\}$ instead of $\emptyset$ and In_{n_6} in iteration #3 should be $\{b\}$ instead of $\emptyset$. *(Credit: Pritam Gharat)*

- Page 107, Example 4.2, possibly uninitialized variables analysis.

  "$Out_{n_6} = \{a,c\}$, $Out_{n_6} = \{a,b\}$" should read as "$Out_{n_6} = \{a,c\}$, $Out_{n_7} = \{a,b\}$" (i.e. the second Out_{n_6} should be actually Out_{n_7}.   (*Credit: Ankur Deshwal*)

- Page 114, Figure 4.8, constant propagation for the running example.

  The data flow value of variable f (in the column for iteration #1) should be $\widehat{\top}$ and not $\widehat{\bot}$ in In_{n_2}.
                                                                                 (*Credit: Somil Bhandari*)

- Page 117, Figure 4.9, result of conditional constant propagation.

    - Mix up in the data flow values for nodes n_5 and n_6 in the last iteration. The correct values are:

Data flow variable	Changes in iteration #3
In_{n_5}	$N, \top = \langle \widehat{\top}, \widehat{\top}, \widehat{\top}, \widehat{\top}, \widehat{\top}, \widehat{\top} \rangle$
Out_{n_5}	$N, \top = \langle \widehat{\top}, \widehat{\top}, \widehat{\top}, \widehat{\top}, \widehat{\top}, \widehat{\top} \rangle$
In_{n_6}	$R, \langle 2, 2, 6, 3, \bot, \bot \rangle$
Out_{n_6}	$R, \langle 2, 2, 6, 3, \widehat{\bot}, \widehat{\bot} \rangle$

    - Wrong value for variable b in In_{n_9} and Out_{n_9} in the last iteration. Instead of $\widehat{\bot}$, b should be 2.
                                                                                 (*Credit: Sandhya Rani*)

- Page 124, Figure 4.11, inverse dependence of *May* and *Must* points-to relations.

  Typo in the item in the fourth bullet. The sentence fragment should read as

  "$a \rightarrow b \in MustOut_{n_4}$ because a is not in $DepLeftL_{n_4}(MustIn_{n_4})$".

- Page 125, Example 4.10, non distributivity of points-to analysis, second paragraph for *May* points-to analysis.

  $x_1 = \{x \rightarrow y\}$ should be replaced by $x_1 = \{x \rightarrow z\}$. Besides, the correct values of $DepGen_n$ are:

  $$DepGen_n(x_1 \cup x_2) = \{z \rightarrow w\}$$
  $$DepGen_n(x_1) = \emptyset$$
  $$DepGen_n(x_2) = \emptyset$$

- Page 146, equation 4.24 defining $ELOut_v(i)$.

  The condition should be "$i = Start$" instead of "$i = End$".

- Page 262, table in Figure 8.2.

  In iteration #2, Out_{c_4} for *MustKill* should be $\{a,b,c\}$ instead of $\{a,b\}$.   (*Credit: Pritam Gharat*)

- Page 263, table in Figure 8.3.

  MayUse and *MustUse* values are the values of *Start* node of a procedure rather than *End* node. The table has correct values copied from *Start* node, just that they are mentioned as the values of *End* nodes.   (*Credit: Pritam Gharat*)

- Page 275, Figure 8.12, Lattice of flow functions for two variables.

  The flow functions in the row above $\phi_{\bot\bot}$ should be $\phi_{I\bot}$ (instead of $\phi_{I\top}$) and and $\phi_{\bot I}$ (instead of $\phi_{\top I}$).
                                                                                 (*Credit: Sriraj Paul*)

- Page 280, table in Figure 8.14, last but one row, third column.

  Function f_{Start_p} should be f_{Start_q} (i.e. p should be replaced by q). *(Credit: Harshada Gune)*

- Page 297, equation 9.2.

  X should be IN_n and "−" at two places should be replaced by $\cup$. The correct equations is:

  $$\begin{aligned} OUT_n \ = \ & ConstGEN_n \cup DepGEN_n(IN_n) \cup \\ & (IN_n - (ConstKILL_n \cup DepKILL_n(IN_n))) \end{aligned}$$

- Page 303, equation defining OUT_n.

  X should be IN_n and "−" at two places should be replaced by $\cup$. The correct equations is:

  $$\begin{aligned} OUT_n \ = \ & ConstGEN_n \cup DepGEN_n(IN_n) \cup \\ & (IN_n - (ConstKILL_n \cup DepKILL_n(IN_n))) \end{aligned}$$

  Besides, $DepKILL_n(X)$ has been defined to be $\emptyset$ which is incorrect. Instead, $DepKILL_n(X) = X$.

- Page 309, second paragraph, last line.

  "...must be traversed exactly as least as many times ..." should read as "...must be traversed exactly as many times ..." (strike out, "as least"). *(Credit: Arun Lakhotia)*

2 Minor linguistic, grammatical, or typographical corrections

- Page 9, table listing aliases.

  Missing comma after $next \doteq succ\dashrightarrow sib$ in the alias set at the exit of n_4 and entry of n_5.
  (Credit: Ahmed Khademzadeh)

- Page 34, example 2.9, line 2.

  Replace "expression" by "expressions" (should be plural). Further, "position a bit" should read "position of a bit". *(Credit: Ahmed Khademzadeh)*

- Page 42, example 2.16, line 1.

  The word "hosting" should actually be "hoisting". *(Credit: Ahmed Khademzadeh)*

- Page 47, subtitle of Figure 2.11(b).

  Replace the word "Block" by "node". *(Credit: Mohadeseh Delavarian)*

- Page 305, figure 9.6.

  Remove the extra opening brace on line 11.

- Page 329, last para, third line from bottom.

  Remove "the" before "Emami's method".

- Page 311, section 9.4, third bullet, line 2.

  Replace the word "not" by "no".