Assignment 3: Derivation

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1. (a) n is a **value** parameter. m is a **result** parameter.

   (b) $inv \triangleq lrun(A, n_0, m)$

   (c) Let

$$
\begin{array}{ll}
 & n, m : [lrun(A, n, n+1),\ mrun(A, n_0, m)] \\
\sqsubseteq & \{\text{Composition: middle predicate is } inv\} \\
 & n, m : [lrun(A, n, n+1), lrun(A, n_0, m)];\quad n, m : [lrun(A, n_0, m),\ mrun(A, n_0, m)] \\
\sqsubseteq & \{\text{Assignment: } lrun(A, n, n+1) \Rrightarrow lrun(A, n_0, m)[m \backslash n+1]\} \\
 & m := n+1;\quad n, m : [lrun(A, n_0, m),\ mrun(A, n_0, m)]
\end{array}
$$

$\because$

$$lrun(A, n_0, m)[m \backslash n+1] \quad \equiv \quad lrun(A, n_0, n+1)$$

$$
\begin{array}{ll}
\sqsubseteq & \{\text{Strengthen post: } lrun(A, n_0, m) \wedge \neg(m < A.len \wedge A_{n_0} \neq A_m) \ \Rrightarrow\ mrun(A, n_0, m)\} \\
 & m := n+1;\quad n, m : [lrun(A, n_0, m),\ lrun(A, n_0, m) \wedge \neg(m < A.len \wedge A_{n_0} \neq A_m)]
\end{array}
$$

$\because$

$$lrun(A, n_0, m)[m \backslash n+1 \quad \equiv \quad lrun(A, n_0, n+1)$$

$$
\begin{array}{ll}
 & lrun(A, n_0, m) \wedge \neg(m < A.len \wedge A_{n_0} \neq A_m) \ \Rrightarrow\ mrun(A, n_0, m) \\
\equiv & lrun(A, n_0, m) \wedge \neg(m < A.len \wedge A_{n_0} \neq A_m) \ \Rrightarrow\ lrun(A, n_0, m) \wedge (m < A.len \Rightarrow A_{n_0} \neq A_m) \\
\equiv & lrun(A, n_0, m) \wedge (\neg(m < M.len) \vee \neg(A_{n_0} \neq A_m)) \ \Rrightarrow\ lrun(A, n_0, m) \wedge (\neg(m < A.len) \vee (A_{n_0} \neq A_m))
\end{array}
$$