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

$$\begin{aligned} pre(A, n) &\triangleq lrun(A, n, n+1) \\ post(A, n, m) &\triangleq mrun(A, n_0, m) \end{aligned}$$

   by the specification of the procedure, where inv, pre and $post$ implicitly capture parameters (A, n, m) from the frame.

$$\begin{aligned} & n, m : [pre,\ post] \\ \sqsubseteq\ & \{\text{Composition: middle predicate is } inv\} \\ & n, m : [pre,\ inv];\ \ n, m : [inv,\ post] \\ \sqsubseteq\ & \{\text{Assignment: } pre \Rrightarrow inv[m \backslash n+1]\} \\ & m := n+1;\ \ n, m : [inv,\ post] \end{aligned}$$

   $\because$

$$\begin{aligned} inv[m \backslash n+1] &\equiv lrun(A, n_0, m)[m \backslash n+1] \\ &\equiv lrun(A, n_0, n+1) \end{aligned}$$

   and

$$lrun(A, n, n+1) \Rrightarrow lrun(A, n_0, n+1)$$

   Let

$$guard \triangleq m < A.len \wedge A_{n_0} \neq A_m$$

$$\begin{aligned} \sqsubseteq\ & \{\text{Strengthen post: } inv \wedge \neg guard \Rrightarrow post\} \\ & m := n+1;\ \ n, m : [inv,\ inv \wedge \neg guard] \end{aligned}$$

   $\because$

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