Delta Logics: Logics for Change

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APPENDIX

We give here the detailed definitions of the other measures that were omitted in Section 4.

- We have recursive definitions that capture the multiset of data elements (through a data-field *key*) stored in list segments, where again the multiset of data of list-segments from an element v in Δ to z (where $z \in \Delta \cup \{nil\}$) is imbibed from the set variable $MSKeys_z^v$:

$$mskeys_z^P(x) :=_{lfp} \begin{cases} \emptyset & \text{if } [\![x]\!]=[\![z]\!] \\ \{key(x)\} \cup_m mskeys_z^P(n(x)) & \text{if } [\![x]\!] \neq [\![z]\!] \wedge [\![x]\!] \neq [\![nil]\!] \wedge [\![x]\!] \notin [\![\Delta]\!] \\ MSKeys_z^x & \text{if } [\![x]\!] \neq [\![z]\!] \wedge [\![x]\!] = [\![v]\!] \wedge v \in \Delta \end{cases}$$

- We have recursive definitions that capture the maximum/minimum element of data elements stored in list segments, where again the maximum/minimum element of list-segments from an element v in Δ to z where $z \in \Delta \cup \{nil\}$) is imbibed from the data variable Max_z^v (or Min_z^v). We assume the data-domain has a linear-order $\leq$, and that there are special constants $-\infty$ and $+\infty$ that are the minimum and maximum elements of this order. Let $max(r_1, r_2) \equiv ite(r_1 \leq r_2, r_2, r_1)$.

$$Max_z^P(x) :=_{lfp} \begin{cases} -\infty & \text{if } [\![x]\!]=[\![z]\!] \\ max(key(x), Max_z^P(n(x))) & \text{if } [\![x]\!] \neq [\![z]\!] \wedge [\![x]\!] \neq [\![nil]\!] \wedge [\![x]\!] \notin [\![\Delta]\!] \\ MSKeys_z^v & \text{if } [\![x]\!] \neq [\![z]\!] \wedge [\![x]\!] = [\![v]\!] \wedge v \in \Delta \end{cases}$$

  The function Min_z^P is similarly defined.

- We have a recursive definition that captures sortedness, using the minimum measure.

$$\begin{aligned} &Sorted_z^P(x) :=_{lfp} \Big(x = z \vee \\ &\Big(x \neq z \wedge x \neq nil \wedge x \notin \Delta \wedge min_z^P(x) \neq \bot \wedge key(x) \leq min_z^P(x) \wedge Sorted_z^P(n(x))\Big) \vee \\ &\Big(x \neq z \wedge x \in \Delta \wedge min_z^P(x) \neq \bot \wedge key(x) \leq min_z^P(x) \wedge \bigwedge_{v \in \Delta} (x = v \Rightarrow SORTED_z^v\Big)\Big) \end{aligned}$$