

**Homework 3**

CS 541  
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1 Consider the denotational semantics specification for literals, expressions, and constant declarations on pp. 24–27 of the notes. Assume expressions are defined as enhanced on p. 27 of the notes.

- a) Draw the derivation tree for the expression `let val x=5 in 2*x`.
- b) Compute  $\mathcal{CD}[\text{val } x=5]$ .
- c) Compute  $\mathcal{E}[2*x]$ .
- d) Compute  $\mathcal{E}[\text{let val } x=5 \text{ in } 2*x]$ .

2 Consider the following denotational semantics specification:

- Syntax

$$\begin{aligned} L &\longrightarrow N\# && \text{(Literal)} \\ N &\longrightarrow D\# \mid N_1D && \text{(Based-Numeral)} \\ D &\longrightarrow 0 \mid 1 \mid \dots \mid 9 && \text{(Digit)} \end{aligned}$$

- Semantic Elements

$\langle : \mathbf{N}_\perp \otimes \mathbf{N}_\perp \circ \rightarrow \mathbf{T}$  is defined as usual.

- Semantic Functions

$\mathcal{L}$ : Literal  $\rightarrow \mathbf{N}_\perp$  is defined by

$$\mathcal{L}[N\#] = \text{on}_2 \mathcal{N}[N]$$

$\mathcal{N}$ : Based-Numeral  $\rightarrow \mathbf{N}_\perp \times \mathbf{N}_\perp$  is defined by

$$\begin{aligned} \mathcal{N}[D\#] &= (\mathcal{D}[D], 0) \\ \mathcal{N}[N_1D] &= (\text{on}_1 \mathcal{N}[N_1], \text{if } < (\text{smash}(\mathcal{D}[D], \text{on}_1 \mathcal{N}[N_1])) \\ &\quad \text{then sum}(\text{smash}(\text{prod}(\text{smash } \mathcal{N}[N_1]), \mathcal{D}[D])) \\ &\quad \text{else } \perp_{\mathbf{N}_\perp}) \end{aligned}$$

$\mathcal{D}$ : Digit  $\rightarrow \mathbf{N}_\perp$  is defined by

$$\begin{aligned} \mathcal{D}[0] &= 0 \\ \mathcal{D}[1] &= 1 \\ &\vdots \\ \mathcal{D}[9] &= 9 \end{aligned}$$

- a) Compute  $\mathcal{L}[8\#35\#]$ .
- b) Compute  $\mathcal{L}[2\#\#]$ .
- c) Compute  $\mathcal{L}[2\#21\#]$ .