CS 456 Fall 2022 Project 1 Inference Rules

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The full list of inference rules for Heapy Imp in addition to the big step semantics already defined is below. Assume S stands for the set of statements. Assume y $\in$ Id.

$$\frac{\Gamma(x) = T}{\Gamma \vdash x : T} \quad \text{(T-Var)}$$

$$\frac{}{\Gamma \vdash \text{true} : \text{bool}} \quad \text{(T-True)}$$

$$\frac{}{\Gamma \vdash \text{false} : \text{bool}} \quad \text{(T-False)}$$

$$\frac{}{\Gamma \vdash n : \text{nat}} \quad \text{(T-Nat)}$$

$$\frac{\Gamma \vdash e : \text{nat}}{\Gamma \vdash \text{new}(e) : \text{ptrnat}} \quad \text{(E-NewNat)}$$

$$\frac{\Gamma \vdash e_1 : \text{nat} \qquad \Gamma \vdash e_2 : \text{nat}}{\Gamma \vdash e_1 + e_2 : \text{nat}} \quad \text{(E-Add)}$$

$$\frac{\Gamma \vdash e_1 : \text{bool}}{\Gamma \vdash \neg e1 : \text{bool}} \quad \text{(E-Neg)}$$

$$\frac{\Gamma \vdash e_1 : \text{bool} \qquad \Gamma \vdash e_2 : \text{bool}}{\Gamma \vdash e_1 \wedge e_2 : \text{bool}} \quad \text{(E-And)}$$

$$\frac{\Gamma \vdash e_1 : \text{nat} \qquad \Gamma \vdash e_2 : \text{nat}}{\Gamma \vdash e_1 \leq e_2 : \text{bool}} \quad \text{(E-LessEq)}$$

$$\frac{\Gamma \vdash x : \text{ptrnat}}{\Gamma \vdash !x : \text{nat}} \quad \text{(E-HeapReadNat)}$$

$$\frac{\Gamma \vdash e : \mathsf{true} \qquad \Gamma \vdash s_1 : S; \Gamma_2 \qquad \Gamma \vdash s_2 : S; \Gamma_3}{\Gamma \vdash \text{if } e \text{ then } s_1 \text{ else } s_2 : \Gamma_2} \quad \text{(S-CondTrue)}$$

$$\frac{\Gamma \vdash e : \mathsf{false} \qquad \Gamma \vdash s_1 : S; \Gamma_2 \qquad \Gamma \vdash s_2 : S; \Gamma_3}{\Gamma \vdash \text{if } e \text{ then } s_1 \text{ else } s_2 : \Gamma_3} \quad \text{(S-CondFalse)}$$

$$\frac{\Gamma \vdash e : \mathsf{false} \qquad \Gamma \vdash s : S; \Gamma_2}{\Gamma \vdash \text{while } e \text{ do } s : \Gamma} \quad \text{(S-LoopFalse)}$$

$$\frac{\Gamma \vdash e : \mathsf{true} \qquad \Gamma \vdash s : S; \Gamma_2 \qquad \Gamma_2 \vdash \text{while } e \text{ do } s : S; \Gamma_3}{\Gamma \vdash \text{while } e \text{ do } s : \Gamma_3} \quad \text{(S-LoopTrue)}$$

$$\frac{\Gamma \vdash s_1 : S; \Gamma_2 \qquad \Gamma_2 \vdash s_2 : S; \Gamma_3}{\Gamma \vdash s_1; s_2 : \Gamma_3} \quad \text{(S-Seq)}$$

$$\frac{\Gamma \vdash x : \mathsf{nat} \qquad \Gamma \vdash e : \mathsf{nat}}{\Gamma \vdash x := e : \Gamma} \quad \text{(S-AssignNatExistingVar)}$$

$$\frac{x \notin \Gamma \qquad \Gamma \vdash e : \mathsf{nat}}{\Gamma \vdash x := e : \Gamma[x \mapsto \mathsf{nat}]} \quad \text{(S-AssignNatNewVar)}$$

$$\frac{\Gamma \vdash x : \mathsf{bool} \qquad \Gamma \vdash e : \mathsf{bool}}{\Gamma \vdash x := e : \Gamma} \quad \text{(S-AssignBoolExistingVar)}$$

$$\frac{x \notin \Gamma \qquad \Gamma \vdash e : \mathsf{bool}}{\Gamma \vdash x := e : \Gamma[x \mapsto \mathsf{bool}]} \quad \text{(S-AssignBoolNewVar)}$$

$$\frac{\Gamma \vdash x : \mathsf{ptrnat} \qquad \Gamma \vdash e : \mathsf{nat}}{\Gamma \vdash !x := e : \Gamma} \quad \text{(S-Updateptrnat)}$$

$$\frac{x \notin \Gamma \qquad \Gamma \vdash y : \mathsf{ptrnat}}{\Gamma \vdash x = y : \Gamma[x \mapsto \mathsf{ptrnat}]} \quad \text{(S-Newaliasptrnat)}$$

$$\frac{\Gamma \vdash x : \mathsf{ptrnat} \qquad \Gamma \vdash y : \mathsf{ptrnat}}{\Gamma \vdash x = y : \Gamma} \quad \text{(S-Existingaliasptrnat)}$$

$$\frac{\Gamma \vdash x : \mathsf{ptrnat} \qquad \Gamma \vdash \mathsf{new}(e) : \mathsf{ptrnat}}{\Gamma \vdash x := \mathsf{new}(e) : \Gamma} \quad \text{(S-ExistingPtrNat)}$$

$$\frac{x \notin \Gamma \qquad \Gamma \vdash \mathsf{new}(e) : \mathsf{ptrnat}}{\Gamma \vdash x := \mathsf{new}(e) : \Gamma[x \mapsto \mathsf{ptrnat}]} \quad \text{(S-NewPtrNat)}$$

$$\frac{}{\Gamma \vdash \mathsf{skip} : \Gamma} \quad \text{(S-Skip)}$$