

<p><b>Syntax:</b></p> <p>CL ::= class C extends C {<math>\bar{C}</math> <math>\bar{f}</math>; K <math>\bar{M}</math>}</p> <p>K ::= C(<math>\bar{C}</math> <math>\bar{f}</math>) {super(<math>\bar{f}</math>); this.<math>\bar{f}</math> = <math>\bar{f}</math>;}</p> <p>M ::= C m(<math>\bar{C}</math> <math>\bar{x}</math>) {return e;}</p> <p>e ::= x                e.f                e.m(<math>\bar{e}</math>)                new C(<math>\bar{e}</math>)                (C)e</p>	$\frac{e_i \longrightarrow e_i'}{\text{new } C(\dots, e_i, \dots) \longrightarrow \text{new } C(\dots, e_i', \dots)} \quad (\text{RC-NEW-ARG})$ $\frac{e_0 \longrightarrow e_0'}{(C)e_0 \longrightarrow (C)e_0'} \quad (\text{RC-CAST})$
<p><b>Subtyping:</b></p> $C \leqslant C$ $\frac{C \leqslant D \quad D \leqslant E}{C \leqslant E}$ $\frac{CT(C) = \text{class } C \text{ extends } D \{ \dots \}}{C \leqslant D}$	<p><b>Expression typing:</b></p> $\Gamma \vdash x \in \Gamma(x) \quad (\text{T-VAR})$ $\frac{\Gamma \vdash e_0 \in C_0 \quad \text{fields}(C_0) = \bar{C} \ \bar{f}}{\Gamma \vdash e_0.f_i \in C_i} \quad (\text{T-FIELD})$ $\frac{\Gamma \vdash e_0 \in C_0 \quad \text{mtype}(m, C_0) = \bar{D} \rightarrow C \quad \Gamma \vdash \bar{e} \in \bar{C} \quad \bar{C} \leqslant \bar{D}}{\Gamma \vdash e_0.m(\bar{e}) \in C} \quad (\text{T-INVK})$ $\frac{\text{fields}(C) = \bar{D} \ \bar{f} \quad \Gamma \vdash \bar{e} \in \bar{C} \quad \bar{C} \leqslant \bar{D}}{\Gamma \vdash \text{new } C(\bar{e}) \in C} \quad (\text{T-NEW})$ $\frac{\Gamma \vdash e_0 \in D \quad D \leqslant C}{\Gamma \vdash (C)e_0 \in C} \quad (\text{T-UCAST})$ $\frac{\Gamma \vdash e_0 \in D \quad C \leqslant D \quad C \neq D}{\Gamma \vdash (C)e_0 \in C} \quad (\text{T-DCAST})$ $\frac{\Gamma \vdash e_0 \in D \quad C \not\leqslant D \quad D \not\leqslant C \quad \text{stupid warning}}{\Gamma \vdash (C)e_0 \in C} \quad (\text{T-SCAST})$
<p><b>Computation:</b></p> $\frac{\text{fields}(C) = \bar{C} \ \bar{f}}{(\text{new } C(\bar{e})).f_i \longrightarrow e_i} \quad (\text{R-FIELD})$ $\frac{\text{mbody}(m, C) = (\bar{x}, e_0)}{(\text{new } C(\bar{e})).m(\bar{d}) \longrightarrow [\bar{d}/\bar{x}, \text{new } C(\bar{e})/\text{this}]e_0} \quad (\text{R-INVK})$ $\frac{C \leqslant D}{(D)(\text{new } C(\bar{e})) \longrightarrow \text{new } C(\bar{e})} \quad (\text{R-CAST})$	<p><b>Method typing:</b></p> $\frac{\bar{x} : \bar{C}, \text{this} : C \vdash e_0 \in E_0 \quad E_0 \leqslant C_0 \quad CT(C) = \text{class } C \text{ extends } D \{ \dots \} \quad \text{override}(m, D, \bar{C} \rightarrow C_0)}{C_0 \ m \ (\bar{C} \ \bar{x}) \ \{\text{return } e_0;\} \text{ OK IN } C} \quad (\text{T-METHOD})$
<p><b>Congruence:</b></p> $\frac{e_0 \longrightarrow e_0'}{e_0.f \longrightarrow e_0'.f} \quad (\text{RC-FIELD})$ $\frac{e_0 \longrightarrow e_0'}{e_0.m(\bar{e}) \longrightarrow e_0'.m(\bar{e})} \quad (\text{RC-INVK-RECV})$ $\frac{e_i \longrightarrow e_i'}{e_0.m(\dots, e_i, \dots) \longrightarrow e_0.m(\dots, e_i', \dots)} \quad (\text{RC-INVK-ARG})$	<p><b>Class typing:</b></p> $\frac{K = C(\bar{D} \ \bar{g}, \bar{C} \ \bar{f}) \ \{\text{super}(\bar{g}); \text{this}.\bar{f} = \bar{f};\} \quad \text{fields}(D) = \bar{D} \ \bar{g} \quad \bar{M} \text{ OK IN } C}{\text{class } C \text{ extends } D \ \{\bar{C} \ \bar{f}; K \ \bar{M}\} \text{ OK}} \quad (\text{T-CLASS})$

Figure 1: FJ: Main definitions

<p><b>Field lookup:</b></p> $fields(Object) = \bullet$ $\frac{CT(C) = \text{class } C \text{ extends } D \{ \bar{C} \ \bar{f}; K \ \bar{M} \} \quad fields(D) = \bar{D} \ \bar{g}}{fields(C) = \bar{D} \ \bar{g}, \bar{C} \ \bar{f}}$ <p><b>Method type lookup:</b></p> $\frac{CT(C) = \text{class } C \text{ extends } D \{ \bar{C} \ \bar{f}; K \ \bar{M} \} \quad B \ m \ (\bar{B} \ \bar{x}) \ \{ \text{return } e; \} \in \bar{M}}{mtype(m, C) = \bar{B} \rightarrow B}$ $\frac{CT(C) = \text{class } C \text{ extends } D \{ \bar{C} \ \bar{f}; K \ \bar{M} \} \quad m \text{ is not defined in } \bar{M}}{mtype(m, C) = mtype(m, D)}$	<p><b>Method body lookup:</b></p> $\frac{CT(C) = \text{class } C \text{ extends } D \{ \bar{C} \ \bar{f}; K \ \bar{M} \} \quad B \ m \ (\bar{B} \ \bar{x}) \ \{ \text{return } e; \} \in \bar{M}}{mbody(m, C) = (\bar{x}, e)}$ $\frac{CT(C) = \text{class } C \text{ extends } D \{ \bar{C} \ \bar{f}; K \ \bar{M} \} \quad m \text{ is not defined in } \bar{M}}{mbody(m, C) = mbody(m, D)}$ <p><b>Valid method overriding:</b></p> $\frac{mtype(m, D) = \bar{D} \rightarrow D_0, \text{ implies } \bar{C} = \bar{D} \text{ and } C_0 = D_0}{override(m, D, \bar{C} \rightarrow C_0)}$
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Figure 2: FJ: Auxiliary definitions