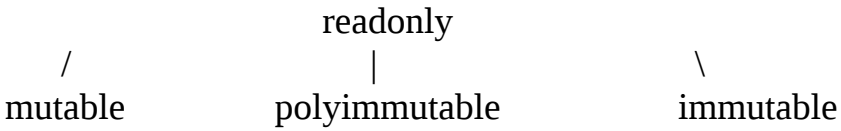
cd ::= class C { $\overline{fd}$; kd $\overline{md}$ }	class
fd ::= t f	field
kd ::= q C (t f) { this.f = f; }; // Doesn't support subclassing yet	constructor
md ::= t m (t this, t x) { $\overline{t\ y}$ s; return y }	instance method
s ::= s;s | x = new t() | x = y | x = y.f | x.f = y | x = y.m(z)	statement
t ::= q C	qualified type
q ::= readonly | polyimmutable | mutable | immutable	qualifier

Type Hierarchy



Helper Functions

$$\frac{q\ C\ f}{typeof(f) = q}$$

$$\frac{m \text{ is annotated with @initialize}}{initializable(m)}$$

$$\frac{x = \text{“this”} \text{ in constructor} \lor (x = \text{“this”} \text{ in } m \land\ initializable(m))}{initializable(x)}$$

Viewpoint Adaptation Rules

_ ▷ mutable = mutable
_ ▷ readonly = readonly
_ ▷ immutable = immutable
q ▷ polyimmutable = q

Special Rules

- Forbid mutable and readonly on fields
- Forbid readonly constructor return type
- In constructor, $q_{this} = q_{ret}$

Typing Rules

$$\frac{\Gamma(x) = q_x \quad \Gamma(y) = q_y \quad q_y <: q_x}{\Gamma \vdash x = y} \text{ (T-VAR)}$$

$$\frac{\Gamma(x) = q_x \quad \Gamma(y) = q_y \quad \text{typeof(f)} = q_f \quad q_y \triangleright q_f <: q_x}{\Gamma \vdash x = y.f} \text{ (T-READ)}$$

$$\frac{\Gamma(x) = q_x \quad \Gamma(y) = q_y \quad \text{typeof(f)} = q_f \quad q_y <: q_x \triangleright q_f \quad q_x = \text{mutable} \vee (\text{initializable(x)} \wedge q_x = \{\text{immutable, polyimmutable}\})}{\Gamma \vdash x.f = y} \text{ (T-WRITE)}$$

$$\frac{\Gamma(x) = q_x \quad \Gamma(y) = q_y \quad \Gamma(z) = q_z \quad \text{typeof(m)} = q_{this}, q_p \rightarrow q_{ret} \quad q_y <: q_x \triangleright q_{this} \quad q_z <: q_x \triangleright q_p \quad q_x \triangleright q_{ret} <: q_x \quad ! \text{ inside constructor} \wedge !(\text{inside m'} \wedge \text{initializable(m')}) \rightarrow ! \text{ initializable(m)}}{\Gamma \vdash x = y.m(z)} \text{ (T-INVK)}$$

$$\frac{\Gamma(x) = q_x \quad \Gamma(y) = q_y \quad \text{typeof(C)} = q_p \rightarrow q_{ret} \quad q_y <: q \triangleright q_P \quad q <: q \triangleright q_{ret} \quad q_x = \text{mutable} \vee \text{immutable} \quad q <: q_x}{\Gamma \vdash x = \text{new } q\ C(y)} \text{ (T-NEW)}$$

Example