

# 1 Syntax

## 1.1 Programs

P ::= (Use | TypeDef | Stmt)\*

## 1.2 Type definitions

TypeDef ::= type ID (ID)\* = (| ID Type)+  
Type ::= ' | int | byte | bool | float | str  
      ::= ( (Type ,)+ Type )  
      ::= Type => Type  
      ::= [ Type ]  
      ::= ( Type )

## 1.3 Statements

Stmt ::= let (rec)? Pat = Exp | ID Pat  
      ::= let ID . ID = FnExp

## 1.4 Patterns

Pat ::= Lit | ( (Pat ,)+ Pat ) | ID Pat  
      ::= [] | [ (Pat ,)\* Pat (, ... ID)? ]  
      ::= ( Pat )

## 1.5 Expressions

Exp ::= Lit | ID | ( (Exp ,)+ Exp )  
      ::= Unop Exp | Exp Binop Exp  
      ::= FnExp  
      ::= Exp Exp | Exp \$ Exp  
      ::= Exp . ID  
      ::= ( Exp )  
FnExp ::= { ((Pat ,)\* => Exp ,)\* }

# 2 Hello World!

Hello World

$$\frac{A}{\perp} 1 \quad \frac{A}{\perp} (2) \quad \frac{A}{\perp} (3) \quad (4) \quad \frac{A}{\perp}$$

# 3 Typing

## 3.1 Type Definitions

### 3.1.1 Composable Types

$$\frac{\tau_1 \text{ ctype} \quad \dots \quad \tau_n \text{ ctype}}{(\tau_1, \dots, \tau_n) \text{ ctype}} \quad \frac{\overline{s_i \text{ ctype}} \quad \overline{\alpha_i \text{ ctype}}}{c_i\{\tau_1 \dots \tau_n\} \text{ ctype}}$$

$$\frac{\tau_1 \text{ ctype} \quad \tau_2 \text{ ctype}}{\tau_1 \rightarrow \tau_2 \text{ ctype}} \quad \frac{m_1 \text{ method} \quad \dots \quad m_n \text{ method}}{\text{trait}\{m_1, \dots, m_n\} \text{ ctype}}$$

### 3.1.2 Methods

$$\frac{\tau_1 \xrightarrow{\ell} \tau \text{ type} \quad \dots \quad \tau_n \xrightarrow{\ell} \tau \text{ type}}{(\ell, \tau) \text{ method}}$$

### 3.1.3 Types

$$\frac{\tau \text{ ctype}}{\tau \text{ type}} \quad \frac{\tau_1 \text{ ctype} \quad \tau_2 \text{ ctype}}{\tau_1 \xrightarrow{\ell} \tau_2 \text{ type}}$$

### 3.1.4 Subtyping

$$\frac{\tau_1 \preceq \tau'_1 \quad \dots \quad \tau_n \preceq \tau'_n}{(\tau_1, \dots, \tau_n) \preceq (\tau'_1, \dots, \tau'_n)} \quad \frac{\frac{\tau \text{ ctype}}{\tau \preceq \tau} \quad \frac{\tau \text{ ctype}}{\tau \preceq \alpha_i}}{\tau_1 \preceq \tau'_1 \quad \dots \quad \tau_n \preceq \tau'_n} \quad \frac{\tau_1 \preceq \tau'_1 \quad \dots \quad \tau_n \preceq \tau'_n}{c_i\{\tau_1 \dots \tau_n\} \preceq c_i\{\tau'_1 \dots \tau'_n\}}$$

$$\frac{\tau_1 \preceq \tau'_1 \quad \tau_2 \preceq \tau'_2}{\tau_1 \rightarrow \tau_2 \preceq \tau'_1 \rightarrow \tau'_2} \quad \frac{M_1 \subseteq M_2}{\text{trait}\{M_1\} \preceq \text{trait}\{M_2\}}$$

## 3.2 Programs

$$\frac{}{\text{lit}(\tau)_i \text{ exp}} \quad \frac{e_1 \text{ exp} \quad e_2 \text{ exp}}{e_1 \ e_2 \text{ exp}} \quad \frac{e_1 \text{ exp}}{e_1 \cdot \ell \text{ exp}}$$

$x$