Zed Block Examples

Example 1 : Basic Variable Declarations

Use axdef for variable declarations with types:

$$[Person, Department]$$

$$\begin{array}{|l}
assignment : Person \pfun Department \\
employees : \mathbb{F}\ Person \\
departments : \mathbb{F}\ Department
\end{array}$$

This groups related variable declarations in a single block (given types must be declared outside).

Example 2 : Abbreviations

$$N\_PLUS == \{\, n : \mathbb{N} \mid n > 0 \,\}$$

$$N\_EVEN == \{\, n : \mathbb{N} \mid n \mathbin{\mathsf{mod}} 2 = 0 \,\}$$

$$N\_ODD == \{\, n : \mathbb{N} \mid n \mathbin{\mathsf{mod}} 2 = 1 \,\}$$

Abbreviations can be defined standalone (zed blocks for abbreviations may not be fully supported yet).

Example 3 : Type Parameters

$$[Company]$$

Declare given types using the given keyword.

Example 4 : Predicates elem Zed Block

$$\begin{array}{|l}
x : \mathbb{N} \\
y : \mathbb{N} \\
\hline
x > 0 \\
y > 0 \\
x + y < 100
\end{array}$$

Multiple predicates can constrain variables defined in axdef.

Example 5 : Free Type Definitions

$$Color ::= red \mid green \mid blue$$

$$Size ::= small \mid medium \mid large$$

$$\begin{array}{|l}
\hline
\quad Product \\
\hline
color : Color \\
size : Size \\
price : \mathbb{N} \\
\hline
price > 0 \\
\hline
\end{array}$$

Free types are defined standalone, then used in schemas.

Example 6 : Multiple Schemas

$[AccountZB, BalanceZB]$

$$\begin{array}{|l}
\multicolumn{1}{l}{\mathit{BankAccountZB}} \\
\hline
accountNumber : \mathbb{N} \\
balance : \mathbb{Z} \\
\hline
balance \geq 0 \\
\hline
\end{array}$$

$$\begin{array}{|l}
\multicolumn{1}{l}{\mathit{TransactionZB}} \\
\hline
from : BankAccountZB \\
to : BankAccountZB \\
amount : \mathbb{N} \\
\hline
amount > 0 \\
from.balance \geq amount \\
\hline
\end{array}$$

Multiple schemas can be defined separately, each with their own constraints.

Example 7 : Schema with External Variables

$[Student, Course]$

$$\begin{array}{|l}
enrolled : Student \leftrightarrow Course \\
maxCourses : \mathbb{N} \\
maxStudents : \mathbb{N} \\
\hline
maxCourses = 7 \\
maxStudents = 500
\end{array}$$

$$\begin{array}{|l}
\multicolumn{1}{l}{\mathit{Enrollment}} \\
\hline
students : \mathbb{F}\ Student \\
courses : \mathbb{F}\ Course \\
\hline
students = \mathrm{dom}\ enrolled \\
courses = \mathrm{ran}\ enrolled \\
\# students \leq maxStudents \\
\# courses \leq maxCourses \\
\hline
\end{array}$$

Schemas can reference variables defined in axdef blocks.

Example 8 : Nested Schemas

$[Char]$

$$\begin{array}{|l}
\multicolumn{1}{l}{\mathit{Address}} \\
\hline
street : \mathrm{seq}\ Char \\
city : \mathrm{seq}\ Char \\
zipCode : \mathbb{N} \\
\hline
zipCode \geq 10000 \land zipCode \leq 99999 \\
\hline
\end{array}$$

$$
\begin{array}{|l}
\multicolumn{1}{l}{\mathit{PersonData}} \\
\hline
\mathit{name} : \operatorname{seq} \mathit{Char} \\
\mathit{address} : \mathit{Address} \\
\mathit{age} : \mathbb{N} \\
\hline
\mathit{age} \geq 0 \land \mathit{age} \leq 150 \\
\hline
\end{array}
$$

$$
\begin{array}{|l}
\mathit{population} : \mathbb{F}\ \mathit{PersonData}
\end{array}
$$

Schema Address is used within schema PersonData. Variables using schemas go in axdef.

Example 9 : Constants land Functions

$$\mathit{PI} == 3$$

$$E == 2$$

$$
\begin{array}{|l}
\mathit{circumference} : \mathbb{N} \longrightarrow \mathbb{N} \\
\mathit{area} : \mathbb{N} \longrightarrow \mathbb{N} \\
\hline
\forall r : \mathbb{N} \bullet \mathit{circumference}(r) = 2 * \mathit{PI} * r \\
\forall r : \mathbb{N} \bullet \mathit{area}(r) = \mathit{PI} * r * r
\end{array}
$$

Mathematical constants defined as abbreviations, functions in axdef.

Example 10 : Permission System Example

$$[\mathit{UserID}, \mathit{DocumentID}]$$

$$\mathit{PermissionType} ::= \mathit{read} \mid \mathit{write} \mid \mathit{admin}$$

$$
\begin{array}{|l}
\multicolumn{1}{l}{\mathit{User}} \\
\hline
\mathit{userId} : \mathit{UserID} \\
\mathit{documents} : \mathbb{P}\ \mathit{DocumentID} \\
\mathit{permissions} : \mathit{DocumentID} ⇸ \mathit{PermissionType} \\
\hline
\operatorname{dom} \mathit{permissions} \subseteq \mathit{documents} \\
\hline
\end{array}
$$

$$
\begin{array}{|l}
\multicolumn{1}{l}{\mathit{System}} \\
\hline
\mathit{users} : \mathit{UserID} ⇸ \mathit{User} \\
\mathit{allDocuments} : \mathbb{F}\ \mathit{DocumentID} \\
\hline
\mathit{allDocuments} = \bigcup \{ u : \operatorname{ran} \mathit{users} \bullet u.\mathit{documents} \} \\
\hline
\end{array}
$$

$$
\begin{array}{|l}
\mathit{users} : \mathit{UserID} ⇸ \mathit{User}
\end{array}
$$

A permission system specification using free types and schemas.

Example 11 : Best Practices

Use zed blocks for:

1. Type parameter declarations [X, Y]

2. Abbreviations (N_PLUS, N_EVEN, etc.)

3. Simple predicates without variable declarations

Use axdef for:

1. Variable declarations with types

2. Constraints on those variables

3. Function definitions

Use schema for:

1. State spaces with declarations

2. Operations on state

3. Reusable component specifications