Zed Exercise

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1 Introduction

The package is kept in a file `oz.sty` in the directory `/opt/local/lib/tex/lib/site-inputs`. This directory should be mentioned in your `TEXINPUTS` shell variable.

2 Schema Boxes

BirthdayBook

$known : \mathbb{P}\, NAME$

$birthday : NAME \pfun DATE$

$known = \mathrm{dom}\, birthday$

```
\begin{schema}{BirthdayBook}
    known: \pset NAME \\
    birthday: NAME \pfun DATE
\ST
    known = \dom birthday
\end{schema}
```

PhoneDB

$members : \mathbb{P}\, Person$

$telephones : Person \rel Phone$

$\mathrm{dom}\, telephones \subseteq members$

PhoneDB′

$members' : \mathbb{P}\, Person$

$telephones' : Person \rel Phone$

$\mathrm{dom}\, telephones' \subseteq members'$

AddEntry

$members, members' : \mathbb{P}\, Person$

$telephones, telephones' : Person \rel Phone$

$name? : Person$

$newnumber? : Phone$

$\mathrm{dom}\, telephones \subseteq members$

$\mathrm{dom}\, elephones' \subseteq members'$

$name? \in members$

$name? \mapsto newnumber? \notin telephones$

$telephones' = telephones \cup \{name? \mapsto newnumber?\}$

$members' = members$

AddressBook

$names : \mathbb{P}\, NAME$

$address : NAME \pfun NUMBER$

$names = \mathrm{dom}\, address$

In document preamble:

```
\leftschemas
\zedcornerheight=3ex
\zedlinethickness=0.9pt
\zedbar=10em\zedleftsep=3em
```

$AddressBook \mathrel{\widehat=} [\, names : \mathbb{P}\, Name, address : NAME \pfun NUMBER \mid names = \mathrm{dom}\, address \,]$

Pool [*RESOURCE*]

$owner : RESOURCE \pfun USER$
$free : \mathbb{P}\, RESOURCE$

$(\mathrm{dom}\ owner) \cup free = RESOURCE$
$(\mathrm{dom}\ owner) \cap free = \varnothing$

```
\begin{genschema}{Pool}{RESOURCE}
owner : RESOURCE \pfun USER \\
free : \pset RESOURCE
\ST
(\dom owner) \uni free = RESOURCE \\
(\dom owner) \int free = \emptyset
\end{genschema}
```

Pool [*RESOURCE*]

$owner : RESOURCE \pfun USER$
$free : \mathbb{P}\, RESOURCE$

$(\mathrm{dom}\ owner) \cup free = RESOURCE$
$(\mathrm{dom}\ owner) \cap free = \varnothing$

3 Axiomatic definitions

$limit : \mathbb{N}$

$limit \leq 65536$

```
\begin{axdef}
limit : \nat
\ST
limit \leq 65536
\end{axdef}
```

$limit : \mathbb{N}$

$limit \leq 1000000$

[X, Y]

$first : X \times Y \to X$

$\forall\, x : X;\ y : Y \bullet first(x, y) = x$

$\pi : \mathbb{R}$

$\pi = 3,14159265\ldots$

4 Object-Z Class Boxes

aaa

5 Other Display Envioronments

This resulted in the first two columns being equally spaced and together taking up as much space as the third column. You can have more than 2 columns without nesting by specifying an optional parameter to `sidebyside`. For example, the display below has three equally spaced columns obtained using `\begin{sidebyside}[3]`.

Alpha

$x : \mathbf{Z}$
$U, V : \mathbb{P}\, \mathbf{Z}$

$x \in V$
$U \subseteq V$

Beta

$x, y : \mathbf{Z}$
$U : \mathbb{P}\, \mathbf{Z}$

$x \neq y$
$x + y \in U$

6 Scheme Operations

Gamma

$x, y : \mathbf{Z}$
$U, V : \mathbb{P}\,\mathbf{Z}$

$(x \in V \wedge U \subseteq V) \heartsuit (x \neq \wedge x + y \in U)$

Iota

$y : 1..57$
$U : \mathbb{P}\,\mathbf{Z}$

$y \notin U$

Kappa

$y : \mathbf{Z}$
$U : \mathbb{P}\,\mathbf{Z}$

$\neg(y \in 1..57 \wedge y \in U)$

p.52

Lambda

$x, y : \mathbf{Z}$
$U : \mathbf{PZ}$

$x < y$

Mu

Lambda
$V : \mathbf{PV}$

$x \in V$

$\Delta State$

State
State$'$

$\Delta PhoneDB$

$members, members' : \mathbf{P}\,Person$
$telephones, telephones' : Person \leftrightarrow Phone$

---

dom $telephones \subseteq members$
dom $telephones' \subseteq members'$

$$\Delta PhoneDB \mathrel{\widehat=} PhoneDB \wedge PhoneDB'$$

p.53

AddEntry

$\Delta PhoneDB$
$name? : Person$
$newnumber? : Phone$

$name? \in members$
$name? \mapsto newnumber? \notin telephones$
$telephones' = telephones \cup \{name? \mapsto newnumber?\}$
$members' = members$

p.54

NotMember

$\Xi PhoneDB$
$name? : Person$
$rep! : Report$

$name? \notin members$
$rep! =' Notamember'$

EntryAlreadyExists

$\Xi PhoneDB$
$name? : Person$
$newnumber? : Phone$
$rep! : Report$

$name? \mapsto newnumber? \in telephones$
$rep! =' Entryalreadyexists'$

Success

$rep! : Report$

$rep! =' Okay'$

$$DoAddEntry \mathrel{\widehat=} AddEntry \land Success$$
$$\lor$$
$$NotMember$$
$$\lor$$
$$EntryAlreadyExists$$

7 Relational Image

$$y \in F(\!|\ U_1 \cup U_2\ |\!) = F(\!|\ U_1\ |\!) \cup F(\!|\ U_2\ |\!)$$
$$F(\!|\ U_1 \cap U_2\ |\!) \subseteq F(\!|\ U_1\ |\!) \cap F(\!|\ U_2\ |\!)$$
$$y \in F(\!|\ U\ |\!) \Leftrightarrow (\exists\, x : U \bullet x \mapsto y \in F)$$

$$telephones(\!|\ staff\ |\!) = \{4794, 4936, 5317\}$$
$$telephones(\!|\ proles\ |\!) = \{3174\}$$

8 specifying the operation

FindPhones

$\Xi PhoneDB$
$name? : Person$
$newnumbers! : \mathbb{P}\, Phone$

$name? \in \mathrm{dom}\, telephones$
$numbers! = telephones(\!|\ \{name?\}\ |\!)$

UnknownName

$\Xi PhoneDB$
$name? : Person$
$rep! : Report$

$name? \notin \mathrm{dom}\, telephones$
$rep! =' Unkownname'$

$$DoFindPhones \mathrel{\widehat=} FindPhones \land Success$$

$$\lor$$

$$UnknownName$$

$$y \mapsto x \in F^{\sim} \Leftrightarrow x \mapsto y \in F$$

$$telephones^{\sim} = \{49 \mapsto jar, 53 \mapsto jar, 47 \mapsto di, 31 \mapsto sm, 31 \mapsto jo\}.$$

RemoveEntry

$\Delta PhoneDB$
$oldnumber? : Phone$
$name? : Person$

$name? \mapsto oldnumber? \in telephones$
$telephones' = telephones \setminus \{name? \mapsto oldnumber?\}$
$members' = members$

UnknownEntry

$\Xi PhoneDB$
$oldnumber? : Phone$
$name? : Person$
$rep! : Report$

$name? \mapsto oldnumber? \notin telephones$
$rep! =' Unknownentry'$

$$DoRemoveEntry \mathrel{\widehat=} RemoveEntry \land Success$$

$$\lor$$

$$UnknownEntry$$

9 Classcom envioronment

Shape

$colour : Colour$

$perim : \mathbb{R}$

$perim > 0$

This class has 2 constants $colour$ and $perim$.

$x, y : \mathbb{R}$

INIT

$x = y = 0$

Translate

$\Delta(x, y)$
$dx?, dy? : \mathbb{R}$

$x' = x + dx?$
$y' = y + dy?$

Test

$x, y : \mathbb{N}$

$x + 1/x = 0 \Rightarrow y + 1/y = 0$
$y = x$

10 University

AddMember

$\Xi PhoneDB$
$name? : Person$

$name? \notin members$
$members' = members \cup \{name?\}$
$telephones' = telephones$

AlreadyMember

$\Xi PhoneDB$
$name? : Person$
$rep! : Report$

$name? \in member$
$rep! =' Alreadyamember'$

$$DoAddMember \mathrel{\widehat=} AddMember \land Success$$

$$\lor$$

$$AlreadyMember$$

$$ages = \{arch \mapsto 23$$
$$bell \mapsto 30,$$
$$cox \mapsto 27,$$
$$fry \mapsto 53,$$
$$hart \mapsto 21\}$$

$$male \lhd ages = \{arch \mapsto 23, cox \mapsto 27 fry \mapsto 53\}$$

$$x \mapsto y \in U \lhd F \Leftrightarrow (x \in U \land x \mapsto y \in F)$$

$$male \lhd ages$$

$$male \lhd ages$$

$$male \lhd ages$$

$$male \rhd ages$$

$$male \rhd ages$$

$$male \rhd ages$$

11 User-interface

$$DoAddEntryCommand \mathrel{\widehat=} [cmd? : Command \mid cmd? = ae]$$

DoAddEntryCommand

$cmd? : Commdn$

$cmd? = ae$

$$PhoneDatabase \mathrel{\widehat=} CODoAddMember$$
$$\lor$$
$$CODoRemoveMember$$
$$\lor$$
$$UnknownCommand$$

$$PhoneDatabase \mathrel{\widehat=} CODoAddMember$$

$$\lor$$

$$CODoRemoveMember$$

$$\lor$$

$$UnknownCommand$$

$$x \mapsto y \in U \lhd F \Longleftrightarrow (x \in U \land x \mapsto y \in F)$$

$$U \lhd F \subseteq F$$

$$\mathrm{dom}(U \lhd F) = U \cap (\mathrm{dom}\, F)$$

$$U_1 \lhd (U_2 \lhd F) = (U_1 \cap U_2) \lhd F$$

$$female \lhd ages = \{bell \mapsto 30,$$

$$hart \mapsto 21\}$$

$$male \cap femal = \varnothing$$

$$male \lhd ages = \{bell \mapsto 30$$

$$hart \mapsto 21\}$$

$$x \mapsto y \in U \lhd F \iff (x \notin U \cap x \mapsto y \in F)$$

RemoveMember

$\Delta PhoneDB$
$name? : Person$

$name? \in members$
$members' = members \setminus \{name?\}$
$telephones' = \{name?\} \lhd telephones$

dom *occupies*

12 Exercise

4.1) a) dom $occupies = \{arch, bell, cox, dove, earl, fry\}$

b) ran $occupies = \{m7, m5, g3, m3, g8, g4\}$

c) $\neg \exists x (x \in \text{dom } occupies \cap \text{ran } occupies)$

d) $aigroup : \mathbb{P}\, Person,\ aigroup == \{cox, dove, earl, fry\}$

$y \in F(\!|\ U\ |\!) \leftrightarrow \exists x : Person \bullet x \in U \land x \mapsto y \in F$

$occupies(\!|\ aigroup\ |\!) = \{g3, m3, g8, g4\}$

$occupies(\!|\ aigroup\ |\!)$ AI

e) $\forall x : Person (x \in aigroup \Rightarrow \exists y : Room (x \mapsto y \in occupied \land y \in ground))$

f) $aigroup \lhd occupies = \{cox \mapsto g3, cox \mapsto m3, dove \mapsto g8, earl \mapsto g4, fry \mapsto g4\}$

g) $(aigroup \lhd occupies)(\!|\ fmgroup\ |\!) = \{g3, m3\}$

$(fmgroup = \{arch, bell, cox\})$

h) $(aigroup \lhd occupies)^{\sim} = \{g3 \mapsto cox, m3 \mapsto cox, g8 \mapsto dove, g4 \mapsto earl, g4 \mapsto fry\}$

i) $(aigroup \lhd occupies)^{\sim}(\!|\ (aigroup \lhd occupies)(\!|\ fmgroup\ |\!)\ |\!) = \{cox\}$

$(\!|\ (aigroup \lhd occupies)(\!|\ fmgroup\ |\!)\ |\!) = \{g3, m3\}$

j) $(aigroup \lhd occupies)^{\sim} = \{m7 \mapsto arch, m5 \mapsto bell\}$