Contents

CONTEXT Domain_Metamodel_Context

SETS

DomainModel_Set
Relation_Set
Concept_Set
Relation_Maplet_Set
Individual_Set
Attribute_Maplet_Set
Attribute_Set
DataValue_Set
DataSet_Set
RelationCharacteristics_Set

CONSTANTS

_NATURAL
_INTEGER
_FLOAT
_BOOL
_STRING
isTransitive
isSymmetric

AXIOMS

axiom1: $finite(DataValue\_Set)$
axiom2: $\{\_NATURAL, \_INTEGER, \_FLOAT, \_BOOL, \_STRING\} \subseteq DataSet\_Set$
axiom3: $partition(\{\_NATURAL, \_INTEGER, \_FLOAT, \_BOOL, \_STRING\}, \{\_NATURAL\}, \{\_INTEGER\}, \{\_FLOA$

axiom4: $partition(RelationCharacteristics\_Set, \{isTransitive\}, \{isSymmetric\})$
axiom5: $finite(DomainModel\_Set)$
axiom6: $finite(Concept\_Set)$
axiom7: $finite(DataSet\_Set)$
axiom8: $finite(DataValue\_Set)$
axiom9: $finite(Individual\_Set)$
axiom10: $finite(Relation\_Set)$
axiom11: $finite(Attribute\_Set)$
axiom12: $finite(Relation\_Maplet\_Set)$
axiom13: $finite(Attribute\_Maplet\_Set)$

END

CONTEXT EventB_Metamodel_Context

SETS

Component_Set

Variable_Set

Constant_Set

Set_Set

SetItem_Set

LogicFormula_Set

the subset of logical formulas that can directly be expressed within the specification, without the need for an explicit constructor, will not be contained in this set. This is for example the case of equality between elements.

Operator

InitialisationAction_Set

CONSTANTS

B_NATURAL

B_INTEGER

B_FLOAT

B_BOOL

B_STRING

Inclusion_OP

Belonging_OP

BecomeEqual2SetOf_OP

RelationSet_OP

FunctionSet_OP

Maplet_OP

Equal2SetOf_OP

BecomeEqual2EmptySet_OP

RelationComposition_OP

Inversion_OP

Equality_OP

AXIOMS

axiom1: $finite(SetItem\_Set)$

axiom2: $\{B\_NATURAL, B\_INTEGER, B\_FLOAT, B\_BOOL, B\_STRING\} \subseteq Set\_Set$

axiom3: $partition(\{B\_NATURAL, B\_INTEGER, B\_FLOAT, B\_BOOL, B\_STRING\}, \{B\_NATURAL\}, \{B\_INTEGE$

axiom4: $partition(Operator, \{Inclusion\_OP\}, \{Belonging\_OP\}, \{BecomeEqual2SetOf\_OP\}, \{RelationSet\_OP\}, \{Maple$

axiom5: $finite(Variable\_Set)$

axiom6: $finite(Set\_Set)$

axiom7: $finite(Constant\_Set)$

axiom8: $finite(Component\_Set)$

axiom9: $finite(LogicFormula\_Set)$

END

MACHINE event_b_specs_from_ontologies

SEES EventB_Metamodel_Context,Domain_Metamodel_Context

VARIABLES

Component

System

Refinement Event-B associations

Refinement_refines_Component Domain Model sets

DomainModel Domain Model associations

DomainModel_parent_DomainModel correspondences

DomainModel_corresp_Component

INVARIANTS

inv0_1: $Component \subseteq Component\_Set$

inv0_2: $partition(Component, System, Refinement)$

Domain Model

inv0_3: $DomainModel \subseteq DomainModel\_Set$

inv0_4: $DomainModel\_parent\_DomainModel \in DomainModel \nrightarrow DomainModel$

inv0_5: $DomainModel\_corresp\_Component \in DomainModel \nrightarrow Component$

inv0_6: $Refinement\_refines\_Component \in Refinement \rightarrowtail Component$

inv0_7:

$\forall xx \cdot ($
$\forall px \cdot ($
$($
$xx \in dom(DomainModel\_parent\_DomainModel)$
$\wedge\, px = DomainModel\_parent\_DomainModel(xx)$
$\wedge\, px \in dom(DomainModel\_corresp\_Component)$
$\wedge\, xx \notin dom(DomainModel\_corresp\_Component)$
$)$
$\Rightarrow DomainModel\_corresp\_Component(px) \notin ran(Refinement\_refines\_Component)$
$)$
$)$

inv0_8:

$\forall xx, pxx \cdot ($
$(xx \in dom(DomainModel\_parent\_DomainModel)$
$\wedge\, pxx = DomainModel\_parent\_DomainModel(xx)$
$\wedge\, \{xx, pxx\} \subseteq dom(DomainModel\_corresp\_Component))$
$\Rightarrow (DomainModel\_corresp\_Component(xx) \in dom(Refinement\_refines\_Component) \wedge Refinement\_refines\_Compon$
$DomainModel\_corresp\_Component(pxx))$
$)$

inv0_9:

$\forall o\_xx, o\_pxx \cdot ($
$(o\_xx \in dom(Refinement\_refines\_Component)$
$\wedge\, o\_pxx = Refinement\_refines\_Component(o\_xx)$
$\wedge\, \{o\_xx, o\_pxx\} \subseteq ran(DomainModel\_corresp\_Component))$
$\Rightarrow (DomainModel\_corresp\_Component^{-1}(o\_xx) \in dom(DomainModel\_parent\_DomainModel) \wedge DomainModel\_paren$
$DomainModel\_corresp\_Component^{-1}(o\_pxx))$
$)$

inv0_10:

$\forall xx, pxx \cdot ($
$(xx \in dom(DomainModel\_parent\_DomainModel)$
$\wedge\, pxx = DomainModel\_parent\_DomainModel(xx)$
$\wedge\, pxx \notin dom(DomainModel\_corresp\_Component))$
$\Rightarrow xx \notin dom(DomainModel\_corresp\_Component)$
$)$

inv0_11:

$\forall o\_xx, o\_pxx \cdot ($
$(o\_xx \in dom(Refinement\_refines\_Component)$

$\wedge\ o\_pxx = Refinement\_refines\_Component(o\_xx)$
$\wedge\ o\_pxx \notin ran(DomainModel\_corresp\_Component))$
$\Rightarrow o\_xx \notin ran(DomainModel\_corresp\_Component)$
)

VARIANT

$DomainModel \setminus dom(DomainModel\_corresp\_Component)$

EVENTS

Initialisation

begin

act1: $Component := \varnothing$
act2: $System := \varnothing$
act3: $Refinement := \varnothing$
act4: $DomainModel := \varnothing$
act5: $Refinement\_refines\_Component := \varnothing$
act6: $DomainModel\_parent\_DomainModel := \varnothing$
act7: $DomainModel\_corresp\_Component := \varnothing$

end

Event addDomainModel ⟨ordinary⟩ $\widehat{=}$

any

DM

where

grd1: $DM \in DomainModel\_Set$
grd2: $DM \notin DomainModel$
grd3: $DomainModel\_Set \setminus DomainModel \neq \varnothing$

then

act1: $DomainModel := DomainModel \cup \{DM\}$

end

Event rule_1 ⟨convergent⟩ $\widehat{=}$

correspondence of a domain model not associated to a parent domain model

any

DM
o_DM

where

grd0: $DomainModel \setminus (dom(DomainModel\_corresp\_Component) \cup dom(DomainModel\_parent\_DomainModel)) \neq \varnothing$
grd1: $DM \in DomainModel$
grd2: $DM \notin dom(DomainModel\_corresp\_Component)$
grd3: $DM \notin dom(DomainModel\_parent\_DomainModel)$
grd4: $Component\_Set \setminus Component \neq \varnothing$
grd5: $o\_DM \in Component\_Set$
grd6: $o\_DM \notin Component$

then

act1: $System := System \cup \{o\_DM\}$
act2: $Component := Component \cup \{o\_DM\}$
act3: $DomainModel\_corresp\_Component(DM) := o\_DM$

end

Event rule_2 ⟨convergent⟩ $\widehat{=}$

correspondence of a domain model associated to a parent domain model

any

DM
PDM
o_DM

where

grd0: $dom(DomainModel\_parent\_DomainModel) \setminus dom(DomainModel\_corresp\_Component) \neq \varnothing$
grd1: $DM \in dom(DomainModel\_parent\_DomainModel)$
grd2: $DM \notin dom(DomainModel\_corresp\_Component)$
grd3: $dom(DomainModel\_corresp\_Component) \neq \varnothing$

grd4: $PDM \in dom(DomainModel\_corresp\_Component)$
grd5: $DomainModel\_parent\_DomainModel(DM) = PDM$
grd6: $Component\_Set \setminus Component \neq \varnothing$
grd7: $o\_DM \in Component\_Set$
grd8: $o\_DM \notin Component$

then

act1: $Refinement := Refinement \cup \{o\_DM\}$
act2: $Component := Component \cup \{o\_DM\}$
act3: $Refinement\_refines\_Component(o\_DM) := DomainModel\_corresp\_Component(PDM)$
act4: $DomainModel\_corresp\_Component(DM) := o\_DM$

end

END

MACHINE event_b_specs_from_ontologies_ref_1
REFINES event_b_specs_from_ontologies
SEES EventB_Metamodel_Context,Domain_Metamodel_Context
VARIABLES

DomainModel
DomainModel_parent_DomainModel
Variable
Constant
Set
SetItem
AbstractSet
EnumeratedSet
Invariant
Property
LogicFormula
InitialisationAction Event-B associations
Variable_definedIn_Component
Constant_definedIn_Component
Set_definedIn_Component
LogicFormula_definedIn_Component
Invariant_involves_Variables
Constant_isInvolvedIn_LogicFormulas
LogicFormula_involves_Sets
LogicFormula_involves_SetItems
LogicFormula_uses_Operators
Variable_typing_Invariant
Constant_typing_Property
SetItem_itemOf_EnumeratedSet
InitialisationAction_uses_Operators
Variable_init_InitialisationAction
InitialisationAction_involves_Constants Domain Model sets
Concept
Individual
DataValue
DataSet
DefaultDataSet
CustomDataSet
EnumeratedDataSet **********relations/attributes**********
Relation
RelationMaplet
AttributeMaplet
Attribute Domain Model attributes
Concept_isVariable **********relations/attributes**********
Relation_isVariable
Relation_isTransitive
Relation_isSymmetric
relation_isASymmetric
Relation_isReflexive
Relation_isIrreflexive
Attribute_isVariable
Attribute_isFunctional Domain Model associations
Concept_definedIn_DomainModel

DataSet_definedIn_DomainModel
Concept_parentConcept_Concept
Individual_individualOf_Concept
DataValue_valueOf_DataSet
DataValue_elements_EnumeratedDataSet
Relation_definedIn_DomainModel
Attribute_definedIn_DomainModel **********relations/attributes**********
Relation_domain_Concept
Relation_range_Concept
Relation_DomainCardinality_minCardinality
Relation_DomainCardinality_maxCardinality
Relation_RangeCardinality_minCardinality
Relation_RangeCardinality_maxCardinality
RelationMaplet_mapletOf_Relation
RelationMaplet_antecedent_Individual
RelationMaplet_image_Individual
Attribute_domain_Concept
Attribute_range_DataSet
AttributeMaplet_mapletOf_Attribute
AttributeMaplet_antecedent_Individual
AttributeMaplet_image_DataValue correspondences
Concept_corresp_AbstractSet
DomainModel_corresp_Component
EnumeratedDataSet_corresp_EnumeratedSet
DataValue_corresp_SetItem
CustomDataSet_corresp_AbstractSet
DefaultDataSet_corresp_AbstractSet
Concept_corresp_Constant
Individual_corresp_Constant
DataValue_corresp_Constant
Concept_corresp_Variable **********relations/attributes**********
Relation_Type
Relation_corresp_Constant
Relation_corresp_Variable
Attribute_Type
Attribute_corresp_Constant
Attribute_corresp_Variable
RelationCharacteristic_corresp_LogicFormula
RelationMaplet_corresp_Constant
DataSet_corresp_Set
AttributeMaplet_corresp_Constant

INVARIANTS

inv1_1: $Variable \subseteq Variable\_Set$
inv1_2: $Constant \subseteq Constant\_Set$
inv1_3: $Set \subseteq Set\_Set$
inv1_4: $partition(Set, AbstractSet, EnumeratedSet)$
inv1_5: $SetItem \subseteq SetItem\_Set$
inv1_6: $Variable\_definedIn\_Component \in Variable \rightarrow Component$
inv1_7: $Constant\_definedIn\_Component \in Constant \rightarrow Component$
inv1_8: $Set\_definedIn\_Component \in Set \rightarrow Component$
inv1_9: $SetItem\_itemOf\_EnumeratedSet \in SetItem \twoheadrightarrow EnumeratedSet$
Domain Model

inv1_10: $Concept \subseteq Concept\_Set$

inv1_11: $Individual \subseteq Individual\_Set$

inv1_12: $DataValue \subseteq DataValue\_Set$

inv1_13: $DataSet \subseteq DataSet\_Set$

inv1_14: $partition(DataSet, DefaultDataSet, CustomDataSet)$

inv1_15: $EnumeratedDataSet \subseteq CustomDataSet$

inv1_16: $Concept\_isVariable \in Concept \rightarrow BOOL$

inv1_17: $Concept\_definedIn\_DomainModel \in Concept \rightarrow DomainModel$

inv1_18: $DataSet\_definedIn\_DomainModel \in DataSet \rightarrow DomainModel$

inv1_19: $Concept\_parentConcept\_Concept \in Concept \pfun Concept$

inv1_20: $Individual\_individualOf\_Concept \in Individual \rightarrow Concept$

inv1_21: $DataValue\_valueOf\_DataSet \in DataValue \rightarrow DataSet$

inv1_22: $DataValue\_elements\_EnumeratedDataSet \in DataValue \twoheadrightarrow EnumeratedDataSet$

inv1_23: $Concept\_corresp\_AbstractSet \in Concept \pinj AbstractSet$

inv1_24: $EnumeratedDataSet\_corresp\_EnumeratedSet \in EnumeratedDataSet \pinj EnumeratedSet$

inv1_25: $DataValue\_corresp\_SetItem \in DataValue \pinj SetItem$

inv1_26: $\forall xx \cdot (xx \in EnumeratedDataSet \land xx \notin dom(EnumeratedDataSet\_corresp\_EnumeratedSet) \Rightarrow DataValue\_elements\_EnumeratedDataSet^{-1}[\{xx\}] \cap dom(DataValue\_corresp\_SetItem) = \varnothing)$

inv1_27: $CustomDataSet\_corresp\_AbstractSet \in CustomDataSet \pinj AbstractSet$

inv1_28: $\{\_NATURAL, \_INTEGER, \_FLOAT, \_BOOL, \_STRING\} \cap CustomDataSet = \varnothing$

inv1_29: $DefaultDataSet\_corresp\_AbstractSet \in DefaultDataSet \pinj AbstractSet$

inv1_30: $\{B\_NATURAL, B\_INTEGER, B\_FLOAT, B\_BOOL, B\_STRING\} \cap EnumeratedSet = \varnothing$

inv1_31: $Concept\_corresp\_Constant \in Concept \pinj Constant$

@inv1_32 ∀co·(co∈ dom(Concept_parentConcept_Concept)⇒(Individual_individualOf_Concept^{-1}[{co}]⊆ Individual_individualOf_Concept^{-1}[{Concept_parentConcept_Concept(co)}]))

inv1_33: $LogicFormula \subseteq LogicFormula\_Set$

inv1_34: $Property \subseteq LogicFormula$

inv1_35: $Invariant \subseteq LogicFormula$

inv1_36: $LogicFormula\_definedIn\_Component \in LogicFormula \rightarrow Component$

inv1_37: $Invariant\_involves\_Variables \in Invariant \rightarrow (\mathbb{N}_1 \pfun Variable)$

logic formula operands can be variables, constants, sets or set items, indexed by their appearance order number. The first operand is indexed by 1, no matter it's type.

inv1_38: $ran(union(ran(Invariant\_involves\_Variables))) = Variable$

inv1_39: $Constant\_isInvolvedIn\_LogicFormulas \in Constant \rightarrow \mathbb{P}_1(\mathbb{N}_1 \times LogicFormula)$

When appearance order does not matter, we may index all constants using the same number.

inv1_40: $\forall cons \cdot (cons \in Constant \Rightarrow ran(Constant\_isInvolvedIn\_LogicFormulas(cons)) \cap Property \neq \varnothing)$

inv1_41: $LogicFormula\_involves\_Sets \in LogicFormula \rightarrow (\mathbb{N}_1 \pfun Set)$

inv1_42: $LogicFormula\_uses\_Operators \in LogicFormula \rightarrow (\mathbb{N}_1 \pfun Operator)$

inv1_44: $Individual\_corresp\_Constant \in Individual \pinj Constant$

inv1_45: $DataValue\_corresp\_Constant \in DataValue \pinj Constant$

inv1_46: $Concept\_corresp\_Variable \in Concept \pinj Variable$

inv1_47: $InitialisationAction \subseteq InitialisationAction\_Set$

inv1_49: $InitialisationAction\_uses\_Operators \in InitialisationAction \rightarrow (\mathbb{N}_1 \pfun Operator)$

inv1_50: $Variable\_init\_InitialisationAction \in Variable \rightarrowtail\!\!\!\!\rightarrow InitialisationAction$

for initialisation actions, the assigned operand is the involved variable.

inv1_52: $InitialisationAction\_involves\_Constants \in InitialisationAction \rightarrow (\mathbb{N}_1 \pfun Constant)$

***********relations/attributes***

inv1_53: $Relation \subseteq Relation\_Set$

inv1_56: $RelationMaplet \subseteq Relation\_Maplet\_Set$

inv1_57: $AttributeMaplet \subseteq Attribute\_Maplet\_Set$

inv1_58: $Attribute \subseteq Attribute\_Set$

inv1_59: $Relation\_isVariable \in Relation \rightarrow BOOL$

inv1_60: $Relation\_isTransitive \in Relation \mathrel{+\!\!\!\!\rightarrow} BOOL$
inv1_61: $Relation\_isSymmetric \in Relation \mathrel{+\!\!\!\!\rightarrow} BOOL$
inv1_62: $relation\_isASymmetric \in Relation \mathrel{+\!\!\!\!\rightarrow} BOOL$
inv1_63: $Relation\_isReflexive \in Relation \mathrel{+\!\!\!\!\rightarrow} BOOL$
inv1_64: $Relation\_isIrreflexive \in Relation \mathrel{+\!\!\!\!\rightarrow} BOOL$
inv1_65: $Relation\_DomainCardinality\_minCardinality \in Relation \mathrel{+\!\!\!\!\rightarrow} \mathbb{N}$
inv1_66: $Relation\_DomainCardinality\_maxCardinality \in Relation \mathrel{+\!\!\!\!\rightarrow} (\mathbb{N} \cup \{-1\})$
inv1_67: $Relation\_RangeCardinality\_minCardinality \in Relation \mathrel{+\!\!\!\!\rightarrow} \mathbb{N}$
inv1_68: $Relation\_RangeCardinality\_maxCardinality \in Relation \mathrel{+\!\!\!\!\rightarrow} (\mathbb{N} \cup \{-1\})$
inv1_69: $Attribute\_isVariable \in Attribute \rightarrow BOOL$
inv1_70: $Attribute\_isFunctional \in Attribute \mathrel{+\!\!\!\!\rightarrow} BOOL$
inv1_71: $Relation\_definedIn\_DomainModel \in Relation \rightarrow DomainModel$
inv1_72: $Attribute\_definedIn\_DomainModel \in Attribute \rightarrow DomainModel$
inv1_73: $Relation\_domain\_Concept \in Relation \rightarrow Concept$
inv1_74: $Relation\_range\_Concept \in Relation \rightarrow Concept$
inv1_77: $RelationMaplet\_mapletOf\_Relation \in RelationMaplet \rightarrow Relation$
inv1_78: $RelationMaplet\_antecedent\_Individual \in RelationMaplet \rightarrow Individual$
inv1_79: $RelationMaplet\_image\_Individual \in RelationMaplet \rightarrow Individual$
inv1_80: $Attribute\_domain\_Concept \in Attribute \rightarrow Concept$
inv1_81: $Attribute\_range\_DataSet \in Attribute \rightarrow DataSet$
inv1_82: $AttributeMaplet\_mapletOf\_Attribute \in AttributeMaplet \rightarrow Attribute$
inv1_83: $AttributeMaplet\_antecedent\_Individual \in AttributeMaplet \rightarrow Individual$
inv1_84: $AttributeMaplet\_image\_DataValue \in AttributeMaplet \rightarrow DataValue$
inv1_85: $\forall rm\cdot(rm \in RelationMaplet \Rightarrow Individual\_individualOf\_Concept(RelationMaplet\_antecedent\_Individual(rm))$
$Relation\_domain\_Concept(RelationMaplet\_mapletOf\_Relation(rm)))$
inv1_86: $\forall rm\cdot(rm \in RelationMaplet \Rightarrow Individual\_individualOf\_Concept(RelationMaplet\_image\_Individual(rm)) =$
$Relation\_range\_Concept(RelationMaplet\_mapletOf\_Relation(rm)))$
inv1_87: $\forall am\cdot(am \in AttributeMaplet \Rightarrow Individual\_individualOf\_Concept(AttributeMaplet\_antecedent\_Individual(am)$
$Attribute\_domain\_Concept(AttributeMaplet\_mapletOf\_Attribute(am)))$
inv1_88: $\forall am\cdot(am \in AttributeMaplet \Rightarrow DataValue\_valueOf\_DataSet(AttributeMaplet\_image\_DataValue(am)) =$
$Attribute\_range\_DataSet(AttributeMaplet\_mapletOf\_Attribute(am)))$
inv1_89: $Relation\_Type \in Relation \mathrel{\rightarrowtail\!\!\!\!\!\!+} Constant$
inv1_90: $Relation\_corresp\_Constant \in Relation \mathrel{\rightarrowtail\!\!\!\!\!\!+} Constant$
inv1_91: $Relation\_corresp\_Variable \in Relation \mathrel{\rightarrowtail\!\!\!\!\!\!+} Variable$
inv1_92: $\forall re\cdot(re \in dom(Relation\_Type) \Leftrightarrow (re \in dom(Relation\_corresp\_Constant) \vee (re \in dom(Relation\_corresp\_Variable$

inv1_93: $Attribute\_Type \in Attribute \mathrel{\rightarrowtail\!\!\!\!\!\!+} Constant$
inv1_94: $Attribute\_corresp\_Constant \in Attribute \mathrel{\rightarrowtail\!\!\!\!\!\!+} Constant$
inv1_95: $Attribute\_corresp\_Variable \in Attribute \mathrel{\rightarrowtail\!\!\!\!\!\!+} Variable$
inv1_96: $\forall re\cdot(re \in dom(Attribute\_Type) \Leftrightarrow (re \in dom(Attribute\_corresp\_Constant) \vee (re \in dom(Attribute\_corresp\_Variab$

inv1_97: $Variable\_typing\_Invariant \in Variable \rightarrowtail Invariant$
inv1_98: $Constant\_typing\_Property \in Constant \rightarrowtail Property$
inv1_99: $RelationCharacteristic\_corresp\_LogicFormula \in (Relation \mathrel{+\!\!\!\!\rightarrow} RelationCharacteristics\_Set) \mathrel{\rightarrowtail\!\!\!\!\!\!+}$
$LogicFormula$
inv1_100: $RelationMaplet\_corresp\_Constant \in RelationMaplet \mathrel{\rightarrowtail\!\!\!\!\!\!+} Constant$
inv1_101: $DataSet\_corresp\_Set \in DataSet \mathrel{\rightarrowtail\!\!\!\!\!\!+} Set$
inv1_102: $AttributeMaplet\_corresp\_Constant \in AttributeMaplet \mathrel{\rightarrowtail\!\!\!\!\!\!+} Constant$
inv1_103: $LogicFormula\_involves\_SetItems \in LogicFormula \mathrel{+\!\!\!\!\rightarrow} (\mathbb{N}_1 \mathrel{+\!\!\!\!\rightarrow} SetItem)$
inv1_104: $EnumeratedDataSet\_corresp\_EnumeratedSet \subseteq DataSet\_corresp\_Set$
inv1_105: $CustomDataSet\_corresp\_AbstractSet \subseteq DataSet\_corresp\_Set$

inv1_106: ⟨theorem⟩

$card(Concept \setminus (dom(Concept\_corresp\_AbstractSet) \cup dom(Concept\_corresp\_Constant)))$
$+ card(DataSet \setminus dom(DataSet\_corresp\_Set))$
$+ card(DataValue \setminus (dom(DataValue\_corresp\_SetItem) \cup dom(DataValue\_corresp\_Constant)))$
$+ card(Individual \setminus dom(Individual\_corresp\_Constant))$
$+ card(Concept\_isVariable^{-1}[\{TRUE\}] \setminus dom(Concept\_corresp\_Variable))$
$+ card(Relation \setminus (dom(Relation\_corresp\_Constant) \cup dom(Relation\_corresp\_Variable)))$
$+ card(Attribute \setminus (dom(Attribute\_corresp\_Constant) \cup dom(Attribute\_corresp\_Variable)))$
$+ card(RelationMaplet \setminus dom(RelationMaplet\_corresp\_Constant))$
$+ card(AttributeMaplet \setminus dom(AttributeMaplet\_corresp\_Constant)) \in \mathbb{N}$

inv1_107:

$\forall xx, pxx, o\_lg \cdot ($
$($
$xx \in dom(Concept\_parentConcept\_Concept)$
$\wedge pxx = Concept\_parentConcept\_Concept(xx)$
$\wedge xx \in dom(Concept\_corresp\_Constant)$
$\wedge pxx \in dom(Concept\_corresp\_AbstractSet)$
$\wedge o\_lg = Constant\_typing\_Property(Concept\_corresp\_Constant(xx))$
$)$
$\Rightarrow ($
$LogicFormula\_uses\_Operators(o\_lg) = \{1 \mapsto Inclusion\_OP\}$
$\wedge (2 \mapsto Concept\_corresp\_AbstractSet(pxx)) \in LogicFormula\_involves\_Sets(o\_lg)$
$)$
$)$

inv1_108:

$\forall o\_xx, o\_pxx, o\_lg \cdot ($
$($
$o\_xx \in dom(Constant\_typing\_Property) \cap ran(Concept\_corresp\_Constant)$
$\wedge o\_lg = Constant\_typing\_Property(o\_xx)$
$\wedge LogicFormula\_uses\_Operators(o\_lg) = \{1 \mapsto Inclusion\_OP\}$
$\wedge o\_pxx \in ran(Concept\_corresp\_AbstractSet)$
$\wedge (2 \mapsto o\_pxx) \in LogicFormula\_involves\_Sets(o\_lg)$
$)$
$\Rightarrow ($
$Concept\_corresp\_Constant^{-1}(o\_xx) \in dom(Concept\_parentConcept\_Concept)$
$\wedge Concept\_corresp\_AbstractSet^{-1}(o\_pxx) = Concept\_parentConcept\_Concept(Concept\_corresp\_Constant^{-1}(o\_xx))$
$)$
$)$

inv1_109: ⟨theorem⟩

$card(AbstractSet \setminus (ran(Concept\_corresp\_AbstractSet) \cup ran(DataSet\_corresp\_Set)))$
$+ card(EnumeratedSet \setminus ran(DataSet\_corresp\_Set))$
$+ card(dom(SetItem\_itemOf\_EnumeratedSet) \setminus ran(DataValue\_corresp\_SetItem))$
$+ card(dom(Constant\_typing\_Property) \setminus (ran(Concept\_corresp\_Constant)$
$\cup ran(Individual\_corresp\_Constant)$
$\cup ran(DataValue\_corresp\_Constant)$
$\cup ran(Relation\_corresp\_Constant)$
$\cup ran(Attribute\_corresp\_Constant)$
$\cup ran(RelationMaplet\_corresp\_Constant)$
$\cup ran(AttributeMaplet\_corresp\_Constant)$
$\cup ran(Attribute\_Type)$
$\cup ran(Relation\_Type)))$
$+ card(dom(Variable\_typing\_Invariant) \setminus (ran(Concept\_corresp\_Variable)$
$\cup ran(Relation\_corresp\_Variable)$
$\cup ran(Attribute\_corresp\_Variable))) \in \mathbb{N}$

inv1_110:

$\forall xx, pxx \cdot ($
$(xx \in dom(Concept\_parentConcept\_Concept)$
$\wedge pxx = Concept\_parentConcept\_Concept(xx)$
$\wedge pxx \notin (dom(Concept\_corresp\_AbstractSet)) \cup dom(Concept\_corresp\_Constant))$

$\Rightarrow xx \notin dom(Concept\_corresp\_Constant)$
)

inv1_111:
$\forall o\_xx, o\_pxx, o\_lg \cdot ($
$(o\_xx \in dom(Constant\_typing\_Property)$
$\land o\_lg = Constant\_typing\_Property(o\_xx)$
$\land LogicFormula\_uses\_Operators(o\_lg) = \{1 \mapsto Inclusion\_OP\}$
$\land (2 \mapsto o\_pxx) \in LogicFormula\_involves\_Sets(o\_lg)$
$\land o\_pxx \notin (ran(Concept\_corresp\_AbstractSet) \cup ran(DataSet\_corresp\_Set)))$
$\Rightarrow o\_xx \notin ran(Concept\_corresp\_Constant)$
)

inv1_112: $partition(dom(Concept\_corresp\_AbstractSet) \cup dom(Concept\_corresp\_Constant), dom(Concept\_corresp\_Consta$

VARIANT

$card(Concept \setminus (dom(Concept\_corresp\_AbstractSet) \cup dom(Concept\_corresp\_Constant)))$
$+ card(DataSet \setminus dom(DataSet\_corresp\_Set))$
$+ card(DataValue \setminus (dom(DataValue\_corresp\_SetItem) \cup dom(DataValue\_corresp\_Constant)))$
$+ card(Individual \setminus dom(Individual\_corresp\_Constant))$
$+ card(Concept\_isVariable^{-1}[\{TRUE\}] \setminus dom(Concept\_corresp\_Variable))$
$+ card(Relation \setminus (dom(Relation\_corresp\_Constant) \cup dom(Relation\_corresp\_Variable)))$
$+ card(Attribute \setminus (dom(Attribute\_corresp\_Constant) \cup dom(Attribute\_corresp\_Variable)))$
$+ card(RelationMaplet \setminus dom(RelationMaplet\_corresp\_Constant))$
$+ card(AttributeMaplet \setminus dom(AttributeMaplet\_corresp\_Constant))$
$+$
$card(AbstractSet \setminus (ran(Concept\_corresp\_AbstractSet) \cup ran(DataSet\_corresp\_Set)))$
$+ card(EnumeratedSet \setminus ran(DataSet\_corresp\_Set))$
$+ card(dom(SetItem\_itemOf\_EnumeratedSet) \setminus ran(DataValue\_corresp\_SetItem))$
$+ card(dom(Constant\_typing\_Property) \setminus (ran(Concept\_corresp\_Constant)$
$\cup ran(Individual\_corresp\_Constant)$
$\cup ran(DataValue\_corresp\_Constant)$
$\cup ran(Relation\_corresp\_Constant)$
$\cup ran(Attribute\_corresp\_Constant)$
$\cup ran(RelationMaplet\_corresp\_Constant)$
$\cup ran(AttributeMaplet\_corresp\_Constant)$
$\cup ran(Attribute\_Type)$
$\cup ran(Relation\_Type)))$
$+ card(dom(Variable\_typing\_Invariant) \setminus (ran(Concept\_corresp\_Variable)$
$\cup ran(Relation\_corresp\_Variable)$
$\cup ran(Attribute\_corresp\_Variable)))$

EVENTS

Initialisation

begin

act1: $DomainModel := \varnothing$
act2: $Variable := \varnothing$
act3: $Constant := \varnothing$
act4: $Set := \varnothing$
act5: $AbstractSet := \varnothing$
act6: $EnumeratedSet := \varnothing$
act7: $SetItem := \varnothing$
act8: $Concept := \varnothing$
act9: $Individual := \varnothing$
act10: $DataValue := \varnothing$
act11: $DataSet := \varnothing$
act12: $DefaultDataSet := \varnothing$
act13: $CustomDataSet := \varnothing$
act14: $EnumeratedDataSet := \varnothing$
act15: $Variable\_definedIn\_Component := \varnothing$
act16: $Constant\_definedIn\_Component := \varnothing$

act17: $Set\_definedIn\_Component := \varnothing$
act18: $SetItem\_itemOf\_EnumeratedSet := \varnothing$
act19: $Concept\_isVariable := \varnothing$
act20: $Concept\_definedIn\_DomainModel := \varnothing$
act21: $DataSet\_definedIn\_DomainModel := \varnothing$
act22: $Concept\_parentConcept\_Concept := \varnothing$
act23: $Individual\_individualOf\_Concept := \varnothing$
act24: $DataValue\_valueOf\_DataSet := \varnothing$
act25: $DataValue\_elements\_EnumeratedDataSet := \varnothing$
act26: $Concept\_corresp\_AbstractSet := \varnothing$
act27: $DomainModel\_corresp\_Component := \varnothing$
act28: $EnumeratedDataSet\_corresp\_EnumeratedSet := \varnothing$
act29: $DataValue\_corresp\_SetItem := \varnothing$
act30: $CustomDataSet\_corresp\_AbstractSet := \varnothing$
act31: $DomainModel\_parent\_DomainModel := \varnothing$
act32: $DefaultDataSet\_corresp\_AbstractSet := \varnothing$
act33: $Concept\_corresp\_Constant := \varnothing$
act34: $Invariant := \varnothing$
act35: $Property := \varnothing$
act36: $LogicFormula := \varnothing$
act37: $LogicFormula\_definedIn\_Component := \varnothing$
act38: $Invariant\_involves\_Variables := \varnothing$
act39: $Constant\_isInvolvedIn\_LogicFormulas := \varnothing$
act40: $LogicFormula\_involves\_Sets := \varnothing$
act41: $LogicFormula\_uses\_Operators := \varnothing$
act42: $Individual\_corresp\_Constant := \varnothing$
act43: $DataValue\_corresp\_Constant := \varnothing$
act44: $Concept\_corresp\_Variable := \varnothing$
act45: $InitialisationAction := \varnothing$
act47: $InitialisationAction\_uses\_Operators := \varnothing$
act48: $Variable\_init\_InitialisationAction := \varnothing$
act49: $InitialisationAction\_involves\_Constants := \varnothing$
***********relations/attributes***
act50: $Relation := \varnothing$
act51: $Relation\_DomainCardinality\_minCardinality := \varnothing$
act52: $Relation\_DomainCardinality\_maxCardinality := \varnothing$
act53: $RelationMaplet := \varnothing$
act54: $AttributeMaplet := \varnothing$
act55: $Attribute := \varnothing$
act56: $Relation\_isVariable := \varnothing$
act57: $Relation\_isTransitive := \varnothing$
act58: $Relation\_isSymmetric := \varnothing$
act59: $relation\_isASymmetric := \varnothing$
act60: $Relation\_isReflexive := \varnothing$
act61: $Relation\_isIrreflexive := \varnothing$
act66: $Attribute\_isVariable := \varnothing$
act67: $Attribute\_isFunctional := \varnothing$
act68: $Relation\_definedIn\_DomainModel := \varnothing$
act69: $Attribute\_definedIn\_DomainModel := \varnothing$
act70: $Relation\_domain\_Concept := \varnothing$
act71: $Relation\_range\_Concept := \varnothing$
act72: $Relation\_RangeCardinality\_minCardinality := \varnothing$
act73: $Relation\_RangeCardinality\_maxCardinality := \varnothing$
act74: $RelationMaplet\_mapletOf\_Relation := \varnothing$
act75: $RelationMaplet\_antecedent\_Individual := \varnothing$
act76: $RelationMaplet\_image\_Individual := \varnothing$
act77: $Attribute\_domain\_Concept := \varnothing$
act78: $Attribute\_range\_DataSet := \varnothing$
act79: $AttributeMaplet\_mapletOf\_Attribute := \varnothing$

act80: $AttributeMaplet\_antecedent\_Individual := \varnothing$
act81: $AttributeMaplet\_image\_DataValue := \varnothing$
act82: $Relation\_Type := \varnothing$
act83: $Relation\_corresp\_Constant := \varnothing$
act84: $Relation\_corresp\_Variable := \varnothing$
act85: $Attribute\_Type := \varnothing$
act86: $Attribute\_corresp\_Constant := \varnothing$
act87: $Attribute\_corresp\_Variable := \varnothing$
act88: $Variable\_typing\_Invariant := \varnothing$
act89: $Constant\_typing\_Property := \varnothing$
act90: $RelationCharacteristic\_corresp\_LogicFormula := \varnothing$
act91: $RelationMaplet\_corresp\_Constant := \varnothing$
act92: $DataSet\_corresp\_Set := \varnothing$
act93: $AttributeMaplet\_corresp\_Constant := \varnothing$
act94: $LogicFormula\_involves\_SetItems := \varnothing$

end

Event initialize_default_datasets ⟨ordinary⟩ $\widehat{=}$

any

DM
o_DM

where

grd0: $dom(DomainModel\_corresp\_Component) \setminus dom(DomainModel\_parent\_DomainModel) \neq \varnothing$
grd1: $DefaultDataSet = \varnothing$
grd2: $DM \in dom(DomainModel\_corresp\_Component)$
grd3: $DM \notin dom(DomainModel\_parent\_DomainModel)$
grd4: $AbstractSet \cap \{B\_NATURAL, B\_INTEGER, B\_FLOAT, B\_BOOL, B\_STRING\} = \varnothing$
grd5: $o\_DM = DomainModel\_corresp\_Component(DM)$

then

act1: $DefaultDataSet := \{\_NATURAL, \_INTEGER, \_FLOAT, \_BOOL, \_STRING\}$
act2: $DataSet := DataSet \cup \{\_NATURAL, \_INTEGER, \_FLOAT, \_BOOL, \_STRING\}$
act3: $DataSet\_definedIn\_DomainModel := DataSet\_definedIn\_DomainModel \cup \{(xx \mapsto yy) | xx \in \{\_NATURAL, \_INTEGER, \_FLOAT, \_BOOL, \_STRING\} \wedge yy = DM\}$
act4: $AbstractSet := AbstractSet \cup \{B\_NATURAL, B\_INTEGER, B\_FLOAT, B\_BOOL, B\_STRING\}$

act5: $Set := Set \cup \{B\_NATURAL, B\_INTEGER, B\_FLOAT, B\_BOOL, B\_STRING\}$
act6: $DefaultDataSet\_corresp\_AbstractSet := \{\_NATURAL \mapsto B\_NATURAL, \_INTEGER \mapsto B\_INTEGER, \_FLOAT \mapsto B\_FLOAT, \_BOOL \mapsto B\_BOOL, \_STRING \mapsto B\_STRING\}$
act7: $Set\_definedIn\_Component := Set\_definedIn\_Component \cup \{(xx \mapsto yy) | xx \in \{B\_NATURAL, B\_INTEGER,$ $yy = o\_DM\}$
act8: $DataSet\_corresp\_Set := DataSet\_corresp\_Set \Leftarrow\!\!\!+ \{\_NATURAL \mapsto B\_NATURAL, \_INTEGER \mapsto B\_INTEGER, \_FLOAT \mapsto B\_FLOAT, \_BOOL \mapsto B\_BOOL, \_STRING \mapsto B\_STRING\}$

end

Event rule_3 ⟨convergent⟩ $\widehat{=}$

correspondence of a concept not associated to a parent concept

any

CO
o_CO

where

grd0: $Concept \setminus (dom(Concept\_parentConcept\_Concept) \cup dom(Concept\_corresp\_AbstractSet)) \neq \varnothing$
grd1: $CO \in Concept$
grd2: $CO \notin dom(Concept\_parentConcept\_Concept)$
grd3: $CO \notin (dom(Concept\_corresp\_AbstractSet) \cup dom(Concept\_corresp\_Constant))$
grd4: $Concept\_definedIn\_DomainModel(CO) \in dom(DomainModel\_corresp\_Component)$
grd5: $Set\_Set \setminus Set \neq \varnothing$
grd6: $o\_CO \in Set\_Set$
grd7: $o\_CO \notin Set$

then

act1: $AbstractSet := AbstractSet \cup \{o\_CO\}$
act2: $Set := Set \cup \{o\_CO\}$
act3: $Concept\_corresp\_AbstractSet(CO) := o\_CO$
act4: $Set\_definedIn\_Component(o\_CO) := DomainModel\_corresp\_Component(Concept\_definedIn\_DomainModel$

end

Event rule_4 ⟨convergent⟩ $\widehat{=}$
correspondence of an instance of EnumeratedDataSet

any
EDS
o_EDS
elements
o_elements
mapping_elements_o_elements

where
grd0: $EnumeratedDataSet \setminus dom(DataSet\_corresp\_Set) \neq \varnothing$
grd1: $EDS \in EnumeratedDataSet$
grd2: $EDS \notin dom(DataSet\_corresp\_Set)$
grd4: $DataSet\_definedIn\_DomainModel(EDS) \in dom(DomainModel\_corresp\_Component)$
grd5: $Set\_Set \setminus Set \neq \varnothing$
grd6: $o\_EDS \in Set\_Set$
grd7: $o\_EDS \notin Set$
grd8: $o\_EDS \notin \{B\_NATURAL, B\_INTEGER, B\_FLOAT, B\_BOOL, B\_STRING\}$
elements
grd9: $o\_elements \subseteq SetItem\_Set$
grd10: $o\_elements \cap SetItem = \varnothing$
grd11: $elements = DataValue\_elements\_EnumeratedDataSet^{-1}[\{EDS\}]$
grd12: $card(o\_elements) = card(elements)$
grd13: $mapping\_elements\_o\_elements \in elements \rightarrowtail o\_elements$

then
act1: $EnumeratedSet := EnumeratedSet \cup \{o\_EDS\}$
act2: $Set := Set \cup \{o\_EDS\}$
act3: $EnumeratedDataSet\_corresp\_EnumeratedSet(EDS) := o\_EDS$
act4: $Set\_definedIn\_Component(o\_EDS) := DomainModel\_corresp\_Component(DataSet\_definedIn\_DomainMod$

elements
act5: $SetItem := SetItem \cup o\_elements$
act6: $SetItem\_itemOf\_EnumeratedSet := SetItem\_itemOf\_EnumeratedSet \cup \{(xx \mapsto yy) | xx \in o\_elements \wedge yy = o\_EDS\}$
act7: $DataValue\_corresp\_SetItem := DataValue\_corresp\_SetItem \cup mapping\_elements\_o\_elements$

act8: $DataSet\_corresp\_Set := DataSet\_corresp\_Set \nleftarrow \{EDS \mapsto o\_EDS\}$

end

Event rule_5 ⟨convergent⟩ $\widehat{=}$
correspondence of an instance of CustomDataSet which is not an instance of EnumeratedDataSet

any
CS
o_CS

where
grd0: $CustomDataSet \setminus (EnumeratedDataSet \cup dom(DataSet\_corresp\_Set)) \neq \varnothing$
grd1: $CS \in CustomDataSet$
grd2: $CS \notin EnumeratedDataSet$
grd3: $CS \notin dom(DataSet\_corresp\_Set)$
grd4: $DataSet\_definedIn\_DomainModel(CS) \in dom(DomainModel\_corresp\_Component)$
grd5: $Set\_Set \setminus Set \neq \varnothing$
grd6: $o\_CS \in Set\_Set$
grd7: $o\_CS \notin Set$

then
act1: $AbstractSet := AbstractSet \cup \{o\_CS\}$

act2: $Set := Set \cup \{o\_CS\}$
act3: $CustomDataSet\_corresp\_AbstractSet(CS) := o\_CS$
act4: $Set\_definedIn\_Component(o\_CS) := DomainModel\_corresp\_Component(DataSet\_definedIn\_DomainModel$

act5: $DataSet\_corresp\_Set := DataSet\_corresp\_Set \Leftarrow \{CS \mapsto o\_CS\}$

end

Event rule_6_1 ⟨convergent⟩ $\widehat{=}$

correspondence of a concept associated to a parent concept (where the parent concept corresponds to an abstract set)

any

CO
o_CO
PCO
o_lg
o_PCO

where

grd0: $dom(Concept\_parentConcept\_Concept) \setminus (dom(Concept\_corresp\_Constant) \cup dom(Concept\_corresp\_AbstractSe$
$\varnothing$
grd1: $CO \in dom(Concept\_parentConcept\_Concept) \setminus (dom(Concept\_corresp\_Constant) \cup dom(Concept\_corresp\_Abst$

grd2: $dom(Concept\_corresp\_AbstractSet) \neq \varnothing$
grd3: $PCO \in dom(Concept\_corresp\_AbstractSet)$
grd4: $Concept\_parentConcept\_Concept(CO) = PCO$
grd5: $Concept\_definedIn\_DomainModel(CO) \in dom(DomainModel\_corresp\_Component)$
grd6: $Constant\_Set \setminus Constant \neq \varnothing$
grd7: $o\_CO \in Constant\_Set \setminus Constant$
grd8: $LogicFormula\_Set \setminus LogicFormula \neq \varnothing$
grd9: $o\_lg \in LogicFormula\_Set \setminus LogicFormula$
grd10: $o\_PCO \in AbstractSet$
grd11: $o\_PCO = Concept\_corresp\_AbstractSet(PCO)$

then

act1: $Constant := Constant \cup \{o\_CO\}$
act2: $Concept\_corresp\_Constant(CO) := o\_CO$
act3: $Constant\_definedIn\_Component(o\_CO) := DomainModel\_corresp\_Component(Concept\_definedIn\_Domain$

act4: $Property := Property \cup \{o\_lg\}$
act5: $LogicFormula := LogicFormula \cup \{o\_lg\}$
act6: $LogicFormula\_uses\_Operators(o\_lg) := \{1 \mapsto Inclusion\_OP\}$
act7: $Constant\_isInvolvedIn\_LogicFormulas(o\_CO) := \{1 \mapsto o\_lg\}$
act8: $LogicFormula\_involves\_Sets(o\_lg) := \{2 \mapsto o\_PCO\}$
act9: $LogicFormula\_definedIn\_Component(o\_lg) := DomainModel\_corresp\_Component(Concept\_definedIn\_Dom$

act10: $Constant\_typing\_Property(o\_CO) := o\_lg$

end

Event rule_6_2 ⟨convergent⟩ $\widehat{=}$

correspondence of a concept associated to a parent concept (where the parent concept corresponds to a constant)

any

CO
o_CO
PCO
o_lg
o_PCO

where

grd0: $dom(Concept\_parentConcept\_Concept) \setminus (dom(Concept\_corresp\_Constant) \cup dom(Concept\_corresp\_AbstractSe$
$\varnothing$
grd1: $CO \in dom(Concept\_parentConcept\_Concept) \setminus (dom(Concept\_corresp\_Constant) \cup dom(Concept\_corresp\_Abst$

grd2: $dom(Concept\_corresp\_Constant) \neq \varnothing$

grd3: $PCO \in dom(Concept\_corresp\_Constant)$
grd4: $Concept\_parentConcept\_Concept(CO) = PCO$
grd5: $Concept\_definedIn\_DomainModel(CO) \in dom(DomainModel\_corresp\_Component)$
grd6: $Constant\_Set \setminus Constant \neq \varnothing$
grd7: $o\_CO \in Constant\_Set \setminus Constant$
grd8: $LogicFormula\_Set \setminus LogicFormula \neq \varnothing$
grd9: $o\_lg \in LogicFormula\_Set \setminus LogicFormula$
grd10: $o\_PCO \in Constant$
grd11: $o\_PCO = Concept\_corresp\_Constant(PCO)$

then

act1: $Constant := Constant \cup \{o\_CO\}$
act2: $Concept\_corresp\_Constant(CO) := o\_CO$
act3: $Constant\_definedIn\_Component(o\_CO) := DomainModel\_corresp\_Component(Concept\_definedIn\_Domain$

act4: $Property := Property \cup \{o\_lg\}$
act5: $LogicFormula := LogicFormula \cup \{o\_lg\}$
act6: $LogicFormula\_uses\_Operators(o\_lg) := \{1 \mapsto Inclusion\_OP\}$
act7: $Constant\_isInvolvedIn\_LogicFormulas := Constant\_isInvolvedIn\_LogicFormulas \lhd \{(o\_CO \mapsto \{1 \mapsto o\_lg\}), o\_PCO \mapsto Constant\_isInvolvedIn\_LogicFormulas(o\_PCO) \cup \{2 \mapsto o\_lg\}\}$
act8: $LogicFormula\_involves\_Sets(o\_lg) := \varnothing$
act9: $LogicFormula\_definedIn\_Component(o\_lg) := DomainModel\_corresp\_Component(Concept\_definedIn\_Dom$

act10: $Constant\_typing\_Property(o\_CO) := o\_lg$

end

Event rule_7_1 ⟨convergent⟩ $\widehat{=}$

correspondence of an instance of Individual (where the concept corresponds to an abstract set)

any

ind
o_ind
CO
o_lg
o_CO

where

grd0: $dom(Individual\_individualOf\_Concept) \setminus dom(Individual\_corresp\_Constant) \neq \varnothing$
grd1: $ind \in dom(Individual\_individualOf\_Concept) \setminus dom(Individual\_corresp\_Constant)$
grd2: $dom(Concept\_corresp\_AbstractSet) \neq \varnothing$
grd3: $CO \in dom(Concept\_corresp\_AbstractSet)$
grd4: $Individual\_individualOf\_Concept(ind) = CO$
grd5: $Concept\_definedIn\_DomainModel(CO) \in dom(DomainModel\_corresp\_Component)$
grd6: $Constant\_Set \setminus Constant \neq \varnothing$
grd7: $o\_ind \in Constant\_Set \setminus Constant$
grd8: $LogicFormula\_Set \setminus LogicFormula \neq \varnothing$
grd9: $o\_lg \in LogicFormula\_Set \setminus LogicFormula$
grd10: $o\_CO \in AbstractSet$
grd11: $o\_CO = Concept\_corresp\_AbstractSet(CO)$

then

act1: $Constant := Constant \cup \{o\_ind\}$
act2: $Individual\_corresp\_Constant(ind) := o\_ind$
act3: $Constant\_definedIn\_Component(o\_ind) := DomainModel\_corresp\_Component(Concept\_definedIn\_Domain$

act4: $Property := Property \cup \{o\_lg\}$
act5: $LogicFormula := LogicFormula \cup \{o\_lg\}$
act6: $LogicFormula\_uses\_Operators(o\_lg) := \{1 \mapsto Belonging\_OP\}$
act7: $Constant\_isInvolvedIn\_LogicFormulas(o\_ind) := \{1 \mapsto o\_lg\}$
act8: $LogicFormula\_involves\_Sets(o\_lg) := \{2 \mapsto o\_CO\}$
act9: $LogicFormula\_definedIn\_Component(o\_lg) := DomainModel\_corresp\_Component(Concept\_definedIn\_Dom$

act10: $Constant\_typing\_Property(o\_ind) := o\_lg$

end

Event rule_7_2 ⟨convergent⟩ $\widehat{=}$

correspondence of an instance of Individual (where the concept corresponds to a constant)

any

ind
o_ind
CO
o_lg
o_CO

where

grd0: $dom(Individual\_individualOf\_Concept) \setminus dom(Individual\_corresp\_Constant) \neq \varnothing$
grd1: $ind \in dom(Individual\_individualOf\_Concept) \setminus dom(Individual\_corresp\_Constant)$
grd2: $dom(Concept\_corresp\_Constant) \neq \varnothing$
grd3: $CO \in dom(Concept\_corresp\_Constant)$
grd4: $Individual\_individualOf\_Concept(ind) = CO$
grd5: $Concept\_definedIn\_DomainModel(CO) \in dom(DomainModel\_corresp\_Component)$
grd6: $Constant\_Set \setminus Constant \neq \varnothing$
grd7: $o\_ind \in Constant\_Set \setminus Constant$
grd8: $LogicFormula\_Set \setminus LogicFormula \neq \varnothing$
grd9: $o\_lg \in LogicFormula\_Set \setminus LogicFormula$
grd10: $o\_CO \in Constant$
grd11: $o\_CO = Concept\_corresp\_Constant(CO)$

then

act1: $Constant := Constant \cup \{o\_ind\}$
act2: $Individual\_corresp\_Constant(ind) := o\_ind$
act3: $Constant\_definedIn\_Component(o\_ind) := DomainModel\_corresp\_Component(Concept\_definedIn\_Domain$

act4: $Property := Property \cup \{o\_lg\}$
act5: $LogicFormula := LogicFormula \cup \{o\_lg\}$
act6: $LogicFormula\_uses\_Operators(o\_lg) := \{1 \mapsto Belonging\_OP\}$
act7: $Constant\_isInvolvedIn\_LogicFormulas := Constant\_isInvolvedIn\_LogicFormulas \lhd \{(o\_ind \mapsto \{1 \mapsto o\_lg\}), o\_CO \mapsto Constant\_isInvolvedIn\_LogicFormulas(o\_CO) \cup \{2 \mapsto o\_lg\}\}$
act8: $LogicFormula\_involves\_Sets(o\_lg) := \varnothing$
act9: $LogicFormula\_definedIn\_Component(o\_lg) := DomainModel\_corresp\_Component(Concept\_definedIn\_Dom$

act10: $Constant\_typing\_Property(o\_ind) := o\_lg$

end

Event rule_8 ⟨convergent⟩ $\widehat{=}$

correspondence of an instance of DataValue (When the data set is an instance of CustomDataSet not instance of EnumeratedDataSet
(for this last case, the rule for instances of EnumeratedDataSet also handles data values))

any

dva
o_dva
DS
o_lg
o_DS

where

grd0: $dom(DataValue\_valueOf\_DataSet) \setminus (dom(DataValue\_corresp\_Constant) \cup dom(DataValue\_corresp\_SetItem$ $\varnothing$
grd1: $dva \in dom(DataValue\_valueOf\_DataSet) \setminus (dom(DataValue\_corresp\_Constant) \cup dom(DataValue\_corresp\_S$

grd2: $dom(CustomDataSet\_corresp\_AbstractSet) \neq \varnothing$
grd3: $DS \in dom(CustomDataSet\_corresp\_AbstractSet)$
grd4: $DataValue\_valueOf\_DataSet(dva) = DS$
grd5: $DataSet\_definedIn\_DomainModel(DS) \in dom(DomainModel\_corresp\_Component)$
grd6: $Constant\_Set \setminus Constant \neq \varnothing$
grd7: $o\_dva \in Constant\_Set \setminus Constant$
grd8: $LogicFormula\_Set \setminus LogicFormula \neq \varnothing$
grd9: $o\_lg \in LogicFormula\_Set \setminus LogicFormula$

grd10: $o\_DS \in AbstractSet$
grd11: $o\_DS = CustomDataSet\_corresp\_AbstractSet(DS)$

then

act1: $Constant := Constant \cup \{o\_dva\}$
act2: $DataValue\_corresp\_Constant(dva) := o\_dva$
act3: $Constant\_definedIn\_Component(o\_dva) := DomainModel\_corresp\_Component(DataSet\_definedIn\_Domain$

act4: $Property := Property \cup \{o\_lg\}$
act5: $LogicFormula := LogicFormula \cup \{o\_lg\}$
act6: $LogicFormula\_uses\_Operators(o\_lg) := \{1 \mapsto Belonging\_OP\}$
act7: $Constant\_isInvolvedIn\_LogicFormulas(o\_dva) := \{1 \mapsto o\_lg\}$
act8: $LogicFormula\_involves\_Sets(o\_lg) := \{2 \mapsto o\_DS\}$
act9: $LogicFormula\_definedIn\_Component(o\_lg) := DomainModel\_corresp\_Component(DataSet\_definedIn\_Dom$

act10: $Constant\_typing\_Property(o\_dva) := o\_lg$

end

Event rule_9_1 ⟨convergent⟩ $\widehat{=}$

handling the variability of a concept and initializing the associated variable (when the concept corresponds to an abstract set)

any

CO
x_CO
o_lg
o_CO
o_ia
o_inds
bij_o_inds

where

grd0: $(dom(Concept\_corresp\_AbstractSet) \cap Concept\_isVariable^{-1}[\{TRUE\}]) \setminus dom(Concept\_corresp\_Variable) \neq \varnothing$
grd1: $CO \in (dom(Concept\_corresp\_AbstractSet) \cap Concept\_isVariable^{-1}[\{TRUE\}]) \setminus dom(Concept\_corresp\_Variabl$

grd2: $Concept\_definedIn\_DomainModel(CO) \in dom(DomainModel\_corresp\_Component)$
grd3: $Individual\_individualOf\_Concept^{-1}[\{CO\}] \subseteq dom(Individual\_corresp\_Constant)$
grd4: $Variable\_Set \setminus Variable \neq \varnothing$
grd5: $x\_CO \in Variable\_Set \setminus Variable$
grd6: $LogicFormula\_Set \setminus LogicFormula \neq \varnothing$
grd7: $o\_lg \in LogicFormula\_Set \setminus LogicFormula$
grd8: $o\_CO \in AbstractSet$
grd9: $o\_CO = Concept\_corresp\_AbstractSet(CO)$
grd10: $InitialisationAction\_Set \setminus InitialisationAction \neq \varnothing$
grd11: $o\_ia \in InitialisationAction\_Set \setminus InitialisationAction$
grd12: $o\_inds = Individual\_corresp\_Constant[Individual\_individualOf\_Concept^{-1}[\{CO\}]]$
grd13: $finite(o\_inds)$
grd14: $bij\_o\_inds \in 1 \mathinner{..} card(o\_inds) \rightarrowtail\!\!\!\!\!\!\twoheadrightarrow o\_inds$

then

act1: $Variable := Variable \cup \{x\_CO\}$
act2: $Concept\_corresp\_Variable(CO) := x\_CO$
act3: $Variable\_definedIn\_Component(x\_CO) := DomainModel\_corresp\_Component(Concept\_definedIn\_DomainM$

act4: $Invariant := Invariant \cup \{o\_lg\}$
act5: $LogicFormula := LogicFormula \cup \{o\_lg\}$
act6: $LogicFormula\_uses\_Operators(o\_lg) := \{1 \mapsto Inclusion\_OP\}$
act7: $Invariant\_involves\_Variables(o\_lg) := \{1 \mapsto x\_CO\}$
act8: $LogicFormula\_involves\_Sets(o\_lg) := \{2 \mapsto o\_CO\}$
act9: $LogicFormula\_definedIn\_Component(o\_lg) := DomainModel\_corresp\_Component(Concept\_definedIn\_Dom$

act10: $InitialisationAction := InitialisationAction \cup \{o\_ia\}$
act11: $InitialisationAction\_uses\_Operators(o\_ia) := \{1 \mapsto BecomeEqual2SetOf\_OP\}$
act12: $Variable\_init\_InitialisationAction(x\_CO) := o\_ia$

act13: $InitialisationAction\_involves\_Constants(o\_ia) := bij\_o\_inds$
act14: $Variable\_typing\_Invariant(x\_CO) := o\_lg$

end

Event rule_9_2 ⟨convergent⟩ $\widehat{=}$

handling the variability of a concept and initializing the associated variable (when the concept corresponds to a constant)

any

CO
x_CO
o_lg
o_CO
o_ia
o_inds
bij_o_inds

where

grd0: $(dom(Concept\_corresp\_Constant) \cap Concept\_isVariable^{-1}[\{TRUE\}]) \setminus dom(Concept\_corresp\_Variable) \neq \varnothing$
grd1: $CO \in (dom(Concept\_corresp\_Constant) \cap Concept\_isVariable^{-1}[\{TRUE\}]) \setminus dom(Concept\_corresp\_Variable)$

grd2: $Concept\_definedIn\_DomainModel(CO) \in dom(DomainModel\_corresp\_Component)$
grd3: $Individual\_individualOf\_Concept^{-1}[\{CO\}] \subseteq dom(Individual\_corresp\_Constant)$
grd4: $Variable\_Set \setminus Variable \neq \varnothing$
grd5: $x\_CO \in Variable\_Set \setminus Variable$
grd6: $LogicFormula\_Set \setminus LogicFormula \neq \varnothing$
grd7: $o\_lg \in LogicFormula\_Set \setminus LogicFormula$
grd8: $o\_CO \in Constant$
grd9: $o\_CO = Concept\_corresp\_Constant(CO)$
grd10: $InitialisationAction\_Set \setminus InitialisationAction \neq \varnothing$
grd11: $o\_ia \in InitialisationAction\_Set \setminus InitialisationAction$
grd12: $o\_inds = Individual\_corresp\_Constant[Individual\_individualOf\_Concept^{-1}[\{CO\}]]$
grd13: $finite(o\_inds)$
grd14: $bij\_o\_inds \in 1 \mathinner{..} card(o\_inds) \rightarrowtail\!\!\!\!\!\!\twoheadrightarrow o\_inds$

then

act1: $Variable := Variable \cup \{x\_CO\}$
act2: $Concept\_corresp\_Variable(CO) := x\_CO$
act3: $Variable\_definedIn\_Component(x\_CO) := DomainModel\_corresp\_Component(Concept\_definedIn\_DomainM$

act4: $Invariant := Invariant \cup \{o\_lg\}$
act5: $LogicFormula := LogicFormula \cup \{o\_lg\}$
act6: $LogicFormula\_uses\_Operators(o\_lg) := \{1 \mapsto Inclusion\_OP\}$
act7: $Invariant\_involves\_Variables(o\_lg) := \{1 \mapsto x\_CO\}$
act8: $Constant\_isInvolvedIn\_LogicFormulas(o\_CO) := Constant\_isInvolvedIn\_LogicFormulas(o\_CO) \cup \{2 \mapsto o\_lg\}$
act9: $LogicFormula\_involves\_Sets(o\_lg) := \varnothing$
act10: $LogicFormula\_definedIn\_Component(o\_lg) := DomainModel\_corresp\_Component(Concept\_definedIn\_Don$

act11: $InitialisationAction := InitialisationAction \cup \{o\_ia\}$
act12: $InitialisationAction\_uses\_Operators(o\_ia) := \{1 \mapsto BecomeEqual2SetOf\_OP\}$
act13: $Variable\_init\_InitialisationAction(x\_CO) := o\_ia$
act14: $InitialisationAction\_involves\_Constants(o\_ia) := bij\_o\_inds$
act15: $Variable\_typing\_Invariant(x\_CO) := o\_lg$

end

Event rule_10_1 ⟨convergent⟩ $\widehat{=}$

correspondence of an instance of Relation having its isVariable property set to false (case where domain and range correspond to abstract sets)

any

RE
T_RE
o_RE

CO1
o_CO1
CO2
o_CO2
o_lg1
o_lg2
DM

where

grd0: $Relation\_isVariable^{-1}[\{FALSE\}] \setminus dom(Relation\_Type) \neq \varnothing$
grd1: $RE \in Relation\_isVariable^{-1}[\{FALSE\}] \setminus dom(Relation\_Type)$
grd2: $dom(Concept\_corresp\_AbstractSet) \neq \varnothing$
grd3: $CO1 = Relation\_domain\_Concept(RE)$
grd4: $CO2 = Relation\_range\_Concept(RE)$
grd5: $\{CO1, CO2\} \subseteq dom(Concept\_corresp\_AbstractSet)$
grd6: $Relation\_definedIn\_DomainModel(RE) \in dom(DomainModel\_corresp\_Component)$
grd7: $Constant\_Set \setminus Constant \neq \varnothing$
grd8: $\{T\_RE, o\_RE\} \subseteq Constant\_Set \setminus Constant$
grd9: $LogicFormula\_Set \setminus LogicFormula \neq \varnothing$
grd10: $\{o\_lg1, o\_lg2\} \subseteq LogicFormula\_Set \setminus LogicFormula$
grd11: $o\_CO1 = Concept\_corresp\_AbstractSet(CO1)$
grd12: $o\_CO2 = Concept\_corresp\_AbstractSet(CO2)$
grd13: $DM = Relation\_definedIn\_DomainModel(RE)$
grd14: $T\_RE \neq o\_RE$
grd15: $o\_lg1 \neq o\_lg2$

then

act1: $Constant := Constant \cup \{T\_RE, o\_RE\}$
act2: $Relation\_Type(RE) := T\_RE$
act3: $Relation\_corresp\_Constant(RE) := o\_RE$
act4: $Constant\_definedIn\_Component := Constant\_definedIn\_Component \cup \{o\_RE \mapsto DomainModel\_corresp\_Co$
$DomainModel\_corresp\_Component(DM)\}$
act5: $Property := Property \cup \{o\_lg1, o\_lg2\}$
act6: $LogicFormula := LogicFormula \cup \{o\_lg1, o\_lg2\}$
act7: $Constant\_typing\_Property := Constant\_typing\_Property \cup \{T\_RE \mapsto o\_lg1, o\_RE \mapsto o\_lg2\}$
act8: $Constant\_isInvolvedIn\_LogicFormulas := Constant\_isInvolvedIn\_LogicFormulas \cup \{T\_RE \mapsto$
$\{1 \mapsto o\_lg1, 2 \mapsto o\_lg2\}, o\_RE \mapsto \{1 \mapsto o\_lg2\}\}$
act9: $LogicFormula\_uses\_Operators := LogicFormula\_uses\_Operators \cup \{o\_lg1 \mapsto \{1 \mapsto RelationSet\_OP\}, o\_lg2 \mapsto$
$\{1 \mapsto Belonging\_OP\}\}$
act10: $LogicFormula\_involves\_Sets := LogicFormula\_involves\_Sets \cup \{o\_lg1 \mapsto \{2 \mapsto o\_CO1, 3 \mapsto$
$o\_CO2\}, o\_lg2 \mapsto \varnothing\}$
act11: $LogicFormula\_definedIn\_Component := LogicFormula\_definedIn\_Component \cup \{o\_lg1 \mapsto$
$DomainModel\_corresp\_Component(DM), o\_lg2 \mapsto DomainModel\_corresp\_Component(DM)\}$

end

Event rule_10_2 ⟨convergent⟩ $\widehat{=}$

correspondence of an instance of Relation having its isVariable property set to false (case where domain corresponds to an abstract set and range corresponds to a constant)

any

RE
T_RE
o_RE
CO1
o_CO1
CO2
o_CO2
o_lg1
o_lg2
DM

where

grd0: $Relation\_isVariable^{-1}[\{FALSE\}] \setminus dom(Relation\_Type) \neq \varnothing$
grd1: $RE \in Relation\_isVariable^{-1}[\{FALSE\}] \setminus dom(Relation\_Type)$
grd2: $dom(Concept\_corresp\_AbstractSet) \neq \varnothing$

grd3: $CO1 = Relation\_domain\_Concept(RE)$
grd4: $CO1 \in dom(Concept\_corresp\_AbstractSet)$
grd5: $dom(Concept\_corresp\_Constant) \neq \varnothing$
grd6: $CO2 = Relation\_range\_Concept(RE)$
grd7: $CO2 \in dom(Concept\_corresp\_Constant)$
grd8: $Relation\_definedIn\_DomainModel(RE) \in dom(DomainModel\_corresp\_Component)$
grd9: $Constant\_Set \setminus Constant \neq \varnothing$
grd10: $\{T\_RE, o\_RE\} \subseteq Constant\_Set \setminus Constant$
grd11: $LogicFormula\_Set \setminus LogicFormula \neq \varnothing$
grd12: $\{o\_lg1, o\_lg2\} \subseteq LogicFormula\_Set \setminus LogicFormula$
grd13: $o\_CO1 = Concept\_corresp\_AbstractSet(CO1)$
grd14: $o\_CO2 = Concept\_corresp\_Constant(CO2)$
grd15: $DM = Relation\_definedIn\_DomainModel(RE)$
grd16: $T\_RE \neq o\_RE$
grd17: $o\_lg1 \neq o\_lg2$

then

act1: $Constant := Constant \cup \{T\_RE, o\_RE\}$
act2: $Relation\_Type(RE) := T\_RE$
act3: $Relation\_corresp\_Constant(RE) := o\_RE$
act4: $Constant\_definedIn\_Component := Constant\_definedIn\_Component \cup \{o\_RE \mapsto DomainModel\_corresp\_Component(DM)\}$
act5: $Property := Property \cup \{o\_lg1, o\_lg2\}$
act6: $LogicFormula := LogicFormula \cup \{o\_lg1, o\_lg2\}$
act7: $Constant\_typing\_Property := Constant\_typing\_Property \cup \{T\_RE \mapsto o\_lg1, o\_RE \mapsto o\_lg2\}$
act8: $Constant\_isInvolvedIn\_LogicFormulas := Constant\_isInvolvedIn\_LogicFormulas \Leftarrow \{T\_RE \mapsto \{1 \mapsto o\_lg1, 2 \mapsto o\_lg2\}, o\_RE \mapsto \{1 \mapsto o\_lg2\}, o\_CO2 \mapsto \{3 \mapsto o\_lg1\} \cup Constant\_isInvolvedIn\_LogicFormulas(o\_C$
act9: $LogicFormula\_uses\_Operators := LogicFormula\_uses\_Operators \cup \{o\_lg1 \mapsto \{1 \mapsto RelationSet\_OP\}, o\_lg2 \mapsto \{2 \mapsto Belonging\_OP\}\}$
act10: $LogicFormula\_involves\_Sets := LogicFormula\_involves\_Sets \cup \{o\_lg1 \mapsto \{2 \mapsto o\_CO1\}, o\_lg2 \mapsto \varnothing\}$
act11: $LogicFormula\_definedIn\_Component := LogicFormula\_definedIn\_Component \cup \{o\_lg1 \mapsto DomainModel\_corresp\_Component(DM), o\_lg2 \mapsto DomainModel\_corresp\_Component(DM)\}$

end

Event rule_10_3 ⟨convergent⟩ $\widehat{=}$

correspondence of an instance of Relation having its isVariable property set to false (case where range corresponds to an abstract set and domain corresponds to a constant)

any

RE
T_RE
o_RE
CO1
o_CO1
CO2
o_CO2
o_lg1
o_lg2
DM

where

grd0: $Relation\_isVariable^{-1}[\{FALSE\}] \setminus dom(Relation\_Type) \neq \varnothing$
grd1: $RE \in Relation\_isVariable^{-1}[\{FALSE\}] \setminus dom(Relation\_Type)$
grd2: $dom(Concept\_corresp\_Constant) \neq \varnothing$
grd3: $CO1 = Relation\_domain\_Concept(RE)$
grd4: $CO1 \in dom(Concept\_corresp\_Constant)$
grd5: $dom(Concept\_corresp\_AbstractSet) \neq \varnothing$
grd6: $CO2 = Relation\_range\_Concept(RE)$
grd7: $CO2 \in dom(Concept\_corresp\_AbstractSet)$
grd8: $Relation\_definedIn\_DomainModel(RE) \in dom(DomainModel\_corresp\_Component)$
grd9: $Constant\_Set \setminus Constant \neq \varnothing$
grd10: $\{T\_RE, o\_RE\} \subseteq Constant\_Set \setminus Constant$

grd11: $LogicFormula\_Set \setminus LogicFormula \neq \varnothing$
grd12: $\{o\_lg1, o\_lg2\} \subseteq LogicFormula\_Set \setminus LogicFormula$
grd13: $o\_CO2 = Concept\_corresp\_AbstractSet(CO2)$
grd14: $o\_CO1 = Concept\_corresp\_Constant(CO1)$
grd15: $DM = Relation\_definedIn\_DomainModel(RE)$
grd16: $T\_RE \neq o\_RE$
grd17: $o\_lg1 \neq o\_lg2$

then

act1: $Constant := Constant \cup \{T\_RE, o\_RE\}$
act2: $Relation\_Type(RE) := T\_RE$
act3: $Relation\_corresp\_Constant(RE) := o\_RE$
act4: $Constant\_definedIn\_Component := Constant\_definedIn\_Component \cup \{o\_RE \mapsto DomainModel\_corresp\_Com$
$DomainModel\_corresp\_Component(DM)\}$
act5: $Property := Property \cup \{o\_lg1, o\_lg2\}$
act6: $LogicFormula := LogicFormula \cup \{o\_lg1, o\_lg2\}$
act7: $Constant\_typing\_Property := Constant\_typing\_Property \cup \{T\_RE \mapsto o\_lg1, o\_RE \mapsto o\_lg2\}$
act8: $Constant\_isInvolvedIn\_LogicFormulas := Constant\_isInvolvedIn\_LogicFormulas \Leftarrow \{T\_RE \mapsto$
$\{1 \mapsto o\_lg1, 2 \mapsto o\_lg2\}, o\_RE \mapsto \{1 \mapsto o\_lg2\}, o\_CO1 \mapsto \{2 \mapsto o\_lg1\} \cup Constant\_isInvolvedIn\_LogicFormulas(o\_C$

act9: $LogicFormula\_uses\_Operators := LogicFormula\_uses\_Operators \cup \{o\_lg1 \mapsto \{1 \mapsto RelationSet\_OP\}, o\_lg2 \mapsto$
$\{1 \mapsto Belonging\_OP\}\}$
act10: $LogicFormula\_involves\_Sets := LogicFormula\_involves\_Sets \cup \{o\_lg1 \mapsto \{3 \mapsto o\_CO2\}, o\_lg2 \mapsto$
$\varnothing\}$
act11: $LogicFormula\_definedIn\_Component := LogicFormula\_definedIn\_Component \cup \{o\_lg1 \mapsto$
$DomainModel\_corresp\_Component(DM), o\_lg2 \mapsto DomainModel\_corresp\_Component(DM)\}$

end

Event rule_10_4 ⟨convergent⟩ $\widehat{=}$

correspondence of an instance of Relation having its isVariable property set to false (case where domain and range correspond to constants)

any

RE
T_RE
o_RE
$CO1$
o_CO1
$CO2$
o_CO2
o_lg1
o_lg2
DM

where

grd0: $Relation\_isVariable^{-1}[\{FALSE\}] \setminus dom(Relation\_Type) \neq \varnothing$
grd1: $RE \in Relation\_isVariable^{-1}[\{FALSE\}] \setminus dom(Relation\_Type)$
grd2: $dom(Concept\_corresp\_Constant) \neq \varnothing$
grd3: $CO1 = Relation\_domain\_Concept(RE)$
grd4: $CO2 = Relation\_range\_Concept(RE)$
grd5: $\{CO1, CO2\} \subseteq dom(Concept\_corresp\_Constant)$
grd6: $Relation\_definedIn\_DomainModel(RE) \in dom(DomainModel\_corresp\_Component)$
grd7: $Constant\_Set \setminus Constant \neq \varnothing$
grd8: $\{T\_RE, o\_RE\} \subseteq Constant\_Set \setminus Constant$
grd9: $LogicFormula\_Set \setminus LogicFormula \neq \varnothing$
grd10: $\{o\_lg1, o\_lg2\} \subseteq LogicFormula\_Set \setminus LogicFormula$
grd11: $o\_CO1 = Concept\_corresp\_Constant(CO1)$
grd12: $o\_CO2 = Concept\_corresp\_Constant(CO2)$
grd13: $DM = Relation\_definedIn\_DomainModel(RE)$
grd14: $T\_RE \neq o\_RE$
grd15: $o\_lg1 \neq o\_lg2$
grd16: $o\_CO1 \neq o\_CO2$

then

act1: $Constant := Constant \cup \{T\_RE, o\_RE\}$

act2: $Relation\_Type(RE) := T\_RE$
act3: $Relation\_corresp\_Constant(RE) := o\_RE$
act4: $Constant\_definedIn\_Component := Constant\_definedIn\_Component \cup \{o\_RE \mapsto DomainModel\_corresp\_Component(DM)\}$
act5: $Property := Property \cup \{o\_lg1, o\_lg2\}$
act6: $LogicFormula := LogicFormula \cup \{o\_lg1, o\_lg2\}$
act7: $Constant\_typing\_Property := Constant\_typing\_Property \cup \{T\_RE \mapsto o\_lg1, o\_RE \mapsto o\_lg2\}$
act8: $Constant\_isInvolvedIn\_LogicFormulas := Constant\_isInvolvedIn\_LogicFormulas \Leftarrow \{T\_RE \mapsto \{1 \mapsto o\_lg1, 2 \mapsto o\_lg2\}, o\_RE \mapsto \{1 \mapsto o\_lg2\}, o\_CO1 \mapsto \{2 \mapsto o\_lg1\} \cup Constant\_isInvolvedIn\_LogicFormulas(o\_C \{3 \mapsto o\_lg1\} \cup Constant\_isInvolvedIn\_LogicFormulas(o\_CO2)\}$
act9: $LogicFormula\_uses\_Operators := LogicFormula\_uses\_Operators \cup \{o\_lg1 \mapsto \{1 \mapsto RelationSet\_OP\}, o\_lg2 \mapsto \{1 \mapsto Belonging\_OP\}\}$
act10: $LogicFormula\_involves\_Sets := LogicFormula\_involves\_Sets \cup \{o\_lg1 \mapsto \varnothing, o\_lg2 \mapsto \varnothing\}$
act11: $LogicFormula\_definedIn\_Component := LogicFormula\_definedIn\_Component \cup \{o\_lg1 \mapsto DomainModel\_corresp\_Component(DM), o\_lg2 \mapsto DomainModel\_corresp\_Component(DM)\}$

end

Event rule_11_1 ⟨convergent⟩ $\widehat{=}$

correspondence of an instance of RelationMaplet

any

remap
o_remap
RE
antecedent
image
o_lg
o_antecedent
o_image

where

grd0: $RelationMaplet \setminus dom(RelationMaplet\_corresp\_Constant) \neq \varnothing$
grd1: $remap \in RelationMaplet \setminus dom(RelationMaplet\_corresp\_Constant)$
grd2: $dom(Relation\_corresp\_Constant) \cup dom(Relation\_corresp\_Variable) \neq \varnothing$
grd3: $RelationMaplet\_mapletOf\_Relation(remap) = RE$
grd4: $RE \in dom(Relation\_corresp\_Constant) \cup dom(Relation\_corresp\_Variable)$
grd5: $Relation\_definedIn\_DomainModel(RE) \in dom(DomainModel\_corresp\_Component)$
grd6: $Constant\_Set \setminus Constant \neq \varnothing$
grd7: $o\_remap \in Constant\_Set \setminus Constant$
grd8: $LogicFormula\_Set \setminus LogicFormula \neq \varnothing$
grd9: $o\_lg \in LogicFormula\_Set \setminus LogicFormula$
grd10: $antecedent = RelationMaplet\_antecedent\_Individual(remap)$
grd11: $image = RelationMaplet\_image\_Individual(remap)$
grd12: $\{antecedent, image\} \subseteq dom(Individual\_corresp\_Constant)$
grd13: $o\_antecedent = Individual\_corresp\_Constant(antecedent)$
grd14: $o\_image = Individual\_corresp\_Constant(image)$
grd15: $o\_antecedent \neq o\_image$

then, for each relation already treated for which all the maplets have been processed,
if it is variable, we generate the initialization, otherwise, we generate the closure property,
knowing that the maplets give rise to variables in case of variable relation and constants
in case of constant relationship

then

act1: $Constant := Constant \cup \{o\_remap\}$
act2: $RelationMaplet\_corresp\_Constant(remap) := o\_remap$
act3: $Constant\_definedIn\_Component(o\_remap) := DomainModel\_corresp\_Component(Relation\_definedIn\_Dom$

act4: $Property := Property \cup \{o\_lg\}$
act5: $LogicFormula := LogicFormula \cup \{o\_lg\}$
act6: $LogicFormula\_uses\_Operators(o\_lg) := \{1 \mapsto Maplet\_OP\}$
act7: $Constant\_isInvolvedIn\_LogicFormulas := Constant\_isInvolvedIn\_LogicFormulas \Leftarrow \{o\_remap \mapsto \{1 \mapsto o\_lg\}, o\_antecedent \mapsto \{2 \mapsto o\_lg\} \cup Constant\_isInvolvedIn\_LogicFormulas(o\_antecedent), o\_image \mapsto \{3 \mapsto o\_lg\} \cup Constant\_isInvolvedIn\_LogicFormulas(o\_image)\}$
act8: $LogicFormula\_involves\_Sets(o\_lg) := \varnothing$

act9: $LogicFormula\_definedIn\_Component(o\_lg) := DomainModel\_corresp\_Component(Relation\_definedIn\_Dom$

act10: $Constant\_typing\_Property(o\_remap) := o\_lg$

end

Event rule_11_2_1 ⟨convergent⟩ $\widehat{=}$

correspondence of an instance of AttributeMaplet (case where the image (of type DataValue) corresponds to a constant (it can also corresponds to a set item)

any

atmap
o_atmap
AT
antecedent
image
o_lg
o_antecedent
o_image

where

grd0: $AttributeMaplet \setminus dom(AttributeMaplet\_corresp\_Constant) \neq \varnothing$
grd1: $atmap \in AttributeMaplet \setminus dom(AttributeMaplet\_corresp\_Constant)$
grd2: $dom(Attribute\_corresp\_Constant) \cup dom(Attribute\_corresp\_Variable) \neq \varnothing$
grd3: $AttributeMaplet\_mapletOf\_Attribute(atmap) = AT$
grd4: $AT \in dom(Attribute\_corresp\_Constant) \cup dom(Attribute\_corresp\_Variable)$
grd5: $Attribute\_definedIn\_DomainModel(AT) \in dom(DomainModel\_corresp\_Component)$
grd6: $Constant\_Set \setminus Constant \neq \varnothing$
grd7: $o\_atmap \in Constant\_Set \setminus Constant$
grd8: $LogicFormula\_Set \setminus LogicFormula \neq \varnothing$
grd9: $o\_lg \in LogicFormula\_Set \setminus LogicFormula$
grd10: $antecedent = AttributeMaplet\_antecedent\_Individual(atmap)$
grd11: $image = AttributeMaplet\_image\_DataValue(atmap)$
grd12: $antecedent \in dom(Individual\_corresp\_Constant)$
grd13: $image \in dom(DataValue\_corresp\_Constant)$
grd14: $o\_antecedent = Individual\_corresp\_Constant(antecedent)$
grd15: $o\_image = DataValue\_corresp\_Constant(image)$
grd16: $o\_antecedent \neq o\_image$

then

act1: $Constant := Constant \cup \{o\_atmap\}$
act2: $AttributeMaplet\_corresp\_Constant(atmap) := o\_atmap$
act3: $Constant\_definedIn\_Component(o\_atmap) := DomainModel\_corresp\_Component(Attribute\_definedIn\_Dom$

act4: $Property := Property \cup \{o\_lg\}$
act5: $LogicFormula := LogicFormula \cup \{o\_lg\}$
act6: $LogicFormula\_uses\_Operators(o\_lg) := \{1 \mapsto Maplet\_OP\}$
act7: $Constant\_isInvolvedIn\_LogicFormulas := Constant\_isInvolvedIn\_LogicFormulas \lhd \{o\_atmap \mapsto \{1 \mapsto o\_lg\}, o\_antecedent \mapsto \{2 \mapsto o\_lg\} \cup Constant\_isInvolvedIn\_LogicFormulas(o\_antecedent), o\_image \mapsto \{3 \mapsto o\_lg\} \cup Constant\_isInvolvedIn\_LogicFormulas(o\_image)\}$
act8: $LogicFormula\_involves\_Sets(o\_lg) := \varnothing$
act9: $LogicFormula\_definedIn\_Component(o\_lg) := DomainModel\_corresp\_Component(Attribute\_definedIn\_Dom$

act10: $Constant\_typing\_Property(o\_atmap) := o\_lg$

end

Event rule_11_2_2 ⟨convergent⟩ $\widehat{=}$

correspondence of an instance of AttributeMaplet (case where the image (of type DataValue) corresponds to a set item

any

atmap
o_atmap
AT
antecedent
image

o_lg
o_antecedent
o_image

where

grd0: $AttributeMaplet \setminus dom(AttributeMaplet\_corresp\_Constant) \neq \varnothing$
grd1: $atmap \in AttributeMaplet \setminus dom(AttributeMaplet\_corresp\_Constant)$
grd2: $dom(Attribute\_corresp\_Constant) \cup dom(Attribute\_corresp\_Variable) \neq \varnothing$
grd3: $AttributeMaplet\_mapletOf\_Attribute(atmap) = AT$
grd4: $AT \in dom(Attribute\_corresp\_Constant) \cup dom(Attribute\_corresp\_Variable)$
grd5: $Attribute\_definedIn\_DomainModel(AT) \in dom(DomainModel\_corresp\_Component)$
grd6: $Constant\_Set \setminus Constant \neq \varnothing$
grd7: $o\_atmap \in Constant\_Set \setminus Constant$
grd8: $LogicFormula\_Set \setminus LogicFormula \neq \varnothing$
grd9: $o\_lg \in LogicFormula\_Set \setminus LogicFormula$
grd10: $antecedent = AttributeMaplet\_antecedent\_Individual(atmap)$
grd11: $image = AttributeMaplet\_image\_DataValue(atmap)$
grd12: $antecedent \in dom(Individual\_corresp\_Constant)$
grd13: $image \in dom(DataValue\_corresp\_SetItem)$
grd14: $o\_antecedent = Individual\_corresp\_Constant(antecedent)$
grd15: $o\_image = DataValue\_corresp\_SetItem(image)$

then

act1: $Constant := Constant \cup \{o\_atmap\}$
act2: $AttributeMaplet\_corresp\_Constant(atmap) := o\_atmap$
act3: $Constant\_definedIn\_Component(o\_atmap) := DomainModel\_corresp\_Component(Attribute\_definedIn\_Dom$

act4: $Property := Property \cup \{o\_lg\}$
act5: $LogicFormula := LogicFormula \cup \{o\_lg\}$
act6: $LogicFormula\_uses\_Operators(o\_lg) := \{1 \mapsto Maplet\_OP\}$
act7: $Constant\_isInvolvedIn\_LogicFormulas := Constant\_isInvolvedIn\_LogicFormulas \lhd \{o\_atmap \mapsto \{1 \mapsto o\_lg\}, o\_antecedent \mapsto \{2 \mapsto o\_lg\} \cup Constant\_isInvolvedIn\_LogicFormulas(o\_antecedent)\}$

act8: $LogicFormula\_involves\_Sets(o\_lg) := \varnothing$
act9: $LogicFormula\_involves\_SetItems(o\_lg) := \{3 \mapsto o\_image\}$
act10: $LogicFormula\_definedIn\_Component(o\_lg) := DomainModel\_corresp\_Component(Attribute\_definedIn\_Do$

act11: $Constant\_typing\_Property(o\_atmap) := o\_lg$

end

Event rule_12_1 ⟨ordinary⟩ $\widehat{=}$

closure property for constant relations

any

RE
o_lg
o_RE
maplets
o_maplets

where

grd0: $dom(Relation\_corresp\_Constant) \neq \varnothing$
grd1: $RE \in dom(Relation\_corresp\_Constant)$
grd2: $o\_RE = Relation\_corresp\_Constant(RE)$
grd3: $LogicFormula\_uses\_Operators^{-1}[\{\{1 \mapsto Equal2SetOf\_OP\}\}] \cap ran(Constant\_isInvolvedIn\_LogicFormulas($
$\varnothing$
grd4: $RelationMaplet\_mapletOf\_Relation^{-1}[\{RE\}] = maplets$
grd5: $maplets \subseteq dom(RelationMaplet\_corresp\_Constant)$
grd6: $o\_maplets = RelationMaplet\_corresp\_Constant[maplets]$
grd7: $Relation\_definedIn\_DomainModel(RE) \in dom(DomainModel\_corresp\_Component)$
grd8: $LogicFormula\_Set \setminus LogicFormula \neq \varnothing$
grd9: $o\_lg \in LogicFormula\_Set \setminus LogicFormula$
grd10: $o\_RE \notin o\_maplets$

then

act1: $Property := Property \cup \{o\_lg\}$

act2: $LogicFormula := LogicFormula \cup \{o\_lg\}$
act3: $LogicFormula\_uses\_Operators(o\_lg) := \{1 \mapsto Equal2SetOf\_OP\}$
act4: $Constant\_isInvolvedIn\_LogicFormulas := Constant\_isInvolvedIn\_LogicFormulas \Leftarrow (\{o\_RE \mapsto \{1 \mapsto o\_lg\} \cup Constant\_isInvolvedIn\_LogicFormulas(o\_RE)\} \cup \{co \mapsto lgs | co \in o\_maplets \wedge lgs = \{2 \mapsto o\_lg\} \cup Constant\_isInvolvedIn\_LogicFormulas(co)\})$
appearence order does not matter
act5: $LogicFormula\_involves\_Sets(o\_lg) := \varnothing$
act6: $LogicFormula\_definedIn\_Component(o\_lg) := DomainModel\_corresp\_Component(Relation\_definedIn\_Dom$

end

Event rule_12_2 ⟨ordinary⟩ $\widehat{=}$

closure action for variable relations

any

RE
o_ia
o_RE
maplets
o_maplets
ex_o_ia
bij_o_maplets

where

grd0: $dom(Relation\_corresp\_Variable) \neq \varnothing$
grd1: $RE \in dom(Relation\_corresp\_Variable)$
grd2: $o\_RE = Relation\_corresp\_Variable(RE)$
grd3: $Variable\_init\_InitialisationAction(o\_RE) \notin InitialisationAction\_uses\_Operators^{-1}[\{\{1 \mapsto BecomeEqual2SetOf\_OP\}\}]$
grd4: $RelationMaplet\_mapletOf\_Relation^{-1}[\{RE\}] = maplets$
grd5: $maplets \subseteq dom(RelationMaplet\_corresp\_Constant)$
grd6: $o\_maplets = RelationMaplet\_corresp\_Constant[maplets]$
grd7: $Relation\_definedIn\_DomainModel(RE) \in dom(DomainModel\_corresp\_Component)$
grd8: $InitialisationAction\_Set \setminus InitialisationAction \neq \varnothing$
grd9: $o\_ia \in InitialisationAction\_Set \setminus InitialisationAction$
grd10: $ex\_o\_ia = Variable\_init\_InitialisationAction(o\_RE)$
grd11: $Variable\_init\_InitialisationAction^{-1}[\{ex\_o\_ia\}] = \{o\_RE\}$
nous sommes certains que dans le cas d'espèce, l'action d'initialisation de o_RE ne fait intervenir que o_RE : en effet nous l'avons explicitement definie (rule 13)
grd12: $finite(o\_maplets)$
grd13: $bij\_o\_maplets \in 1 \,..\, card(o\_maplets) \rightarrowtail o\_maplets$

then

act1: $InitialisationAction := (InitialisationAction \setminus \{ex\_o\_ia\}) \cup \{o\_ia\}$
act2: $InitialisationAction\_uses\_Operators := (InitialisationAction\_uses\_Operators \setminus \{ex\_o\_ia \mapsto InitialisationAction\_uses\_Operators(ex\_o\_ia)\}) \Leftarrow \{o\_ia \mapsto \{1 \mapsto BecomeEqual2SetOf\_OP\}\}$
act3: $Variable\_init\_InitialisationAction(o\_RE) := o\_ia$
act4: $InitialisationAction\_involves\_Constants := (InitialisationAction\_involves\_Constants \setminus \{ex\_o\_ia \mapsto InitialisationAction\_involves\_Constants(ex\_o\_ia)\}) \Leftarrow \{o\_ia \mapsto bij\_o\_maplets\}$

end

Event rule_13_1 ⟨convergent⟩ $\widehat{=}$

correspondence of an instance of Relation having its isVariable property set to true (case where domain and range correspond to abstract sets. The others cases will not explicitely included here, since they can easily be obtained based on rules 10_2, 10_3 and 10_4)

any

RE
T_RE
o_RE
CO1
o_CO1
CO2
o_CO2
o_lg1

o_lg2
DM
o_ia

where

grd0: $Relation\_isVariable^{-1}[\{TRUE\}] \setminus dom(Relation\_Type) \neq \varnothing$
grd1: $RE \in Relation\_isVariable^{-1}[\{TRUE\}] \setminus dom(Relation\_Type)$
grd2: $dom(Concept\_corresp\_AbstractSet) \neq \varnothing$
grd3: $CO1 = Relation\_domain\_Concept(RE)$
grd4: $CO2 = Relation\_range\_Concept(RE)$
grd5: $\{CO1, CO2\} \subseteq dom(Concept\_corresp\_AbstractSet)$
grd6: $Relation\_definedIn\_DomainModel(RE) \in dom(DomainModel\_corresp\_Component)$
grd7: $Constant\_Set \setminus Constant \neq \varnothing$
grd8: $T\_RE \in Constant\_Set \setminus Constant$
grd9: $Variable\_Set \setminus Variable \neq \varnothing$
grd10: $o\_RE \in Variable\_Set \setminus Variable$
grd11: $LogicFormula\_Set \setminus LogicFormula \neq \varnothing$
grd12: $\{o\_lg1, o\_lg2\} \subseteq LogicFormula\_Set \setminus LogicFormula$
grd13: $o\_CO1 = Concept\_corresp\_AbstractSet(CO1)$
grd14: $o\_CO2 = Concept\_corresp\_AbstractSet(CO2)$
grd15: $DM = Relation\_definedIn\_DomainModel(RE)$
grd16: $o\_lg1 \neq o\_lg2$
grd17: $InitialisationAction\_Set \setminus InitialisationAction \neq \varnothing$
grd18: $o\_ia \in InitialisationAction\_Set \setminus InitialisationAction$

then

act1: $Constant := Constant \cup \{T\_RE\}$
act2: $Variable := Variable \cup \{o\_RE\}$
act3: $Relation\_Type(RE) := T\_RE$
act4: $Relation\_corresp\_Variable(RE) := o\_RE$
act5: $Constant\_definedIn\_Component(T\_RE) := DomainModel\_corresp\_Component(DM)$
act6: $Variable\_definedIn\_Component(o\_RE) := DomainModel\_corresp\_Component(DM)$
act7: $Property := Property \cup \{o\_lg1\}$
act8: $Invariant := Invariant \cup \{o\_lg2\}$
act9: $LogicFormula := LogicFormula \cup \{o\_lg1, o\_lg2\}$
act10: $Constant\_typing\_Property(T\_RE) := o\_lg1$
act11: $Variable\_typing\_Invariant(o\_RE) := o\_lg2$
act12: $Constant\_isInvolvedIn\_LogicFormulas(T\_RE) := \{1 \mapsto o\_lg1, 2 \mapsto o\_lg2\}$
act13: $Invariant\_involves\_Variables(o\_lg2) := \{1 \mapsto o\_RE\}$
act14: $LogicFormula\_uses\_Operators := LogicFormula\_uses\_Operators \cup \{o\_lg1 \mapsto \{1 \mapsto RelationSet\_OP\}, o\_lg2 \mapsto \{1 \mapsto Belonging\_OP\}\}$
act15: $LogicFormula\_involves\_Sets := LogicFormula\_involves\_Sets \cup \{o\_lg1 \mapsto \{2 \mapsto o\_CO1, 3 \mapsto o\_CO2\}, o\_lg2 \mapsto \varnothing\}$
act16: $LogicFormula\_definedIn\_Component := LogicFormula\_definedIn\_Component \cup \{o\_lg1 \mapsto DomainModel\_corresp\_Component(DM), o\_lg2 \mapsto DomainModel\_corresp\_Component(DM)\}$
act17: $InitialisationAction := InitialisationAction \cup \{o\_ia\}$
act18: $InitialisationAction\_uses\_Operators(o\_ia) := \{1 \mapsto BecomeEqual2EmptySet\_OP\}$
act19: $Variable\_init\_InitialisationAction(o\_RE) := o\_ia$
act20: $InitialisationAction\_involves\_Constants(o\_ia) := \varnothing$

end

Event rule_14_1 ⟨convergent⟩ $\widehat{=}$

correspondence of an instance of Attribute having its isVariable property set to false and its isFunctional property set to false (case where the domain corresponds to an abstract set, knowing that the range always corresponds to a set)

any

AT
T_AT
o_AT
CO
o_CO
DS
o_DS

o_lg1
o_lg2
DM

where

grd0: $Attribute\_isVariable^{-1}[\{FALSE\}] \setminus dom(Attribute\_Type) \neq \varnothing$
grd1: $AT \in Attribute\_isVariable^{-1}[\{FALSE\}] \setminus dom(Attribute\_Type)$
grd2: $dom(Concept\_corresp\_AbstractSet) \neq \varnothing$
grd3: $CO = Attribute\_domain\_Concept(AT)$
grd4: $CO \in dom(Concept\_corresp\_AbstractSet)$
grd5: $dom(DataSet\_corresp\_Set) \neq \varnothing$
grd6: $DS = Attribute\_range\_DataSet(AT)$
grd7: $DS \in dom(DataSet\_corresp\_Set)$
grd8: $Attribute\_definedIn\_DomainModel(AT) \in dom(DomainModel\_corresp\_Component)$
grd9: $Constant\_Set \setminus Constant \neq \varnothing$
grd10: $\{T\_AT, o\_AT\} \subseteq Constant\_Set \setminus Constant$
grd11: $LogicFormula\_Set \setminus LogicFormula \neq \varnothing$
grd12: $\{o\_lg1, o\_lg2\} \subseteq LogicFormula\_Set \setminus LogicFormula$
grd13: $o\_CO = Concept\_corresp\_AbstractSet(CO)$
grd14: $o\_DS = DataSet\_corresp\_Set(DS)$
grd15: $DM = Attribute\_definedIn\_DomainModel(AT)$
grd16: $T\_AT \neq o\_AT$
grd17: $o\_lg1 \neq o\_lg2$
grd18: $AT \in Attribute\_isFunctional^{-1}[\{FALSE\}]$

then

act1: $Constant := Constant \cup \{T\_AT, o\_AT\}$
act2: $Attribute\_Type(AT) := T\_AT$
act3: $Attribute\_corresp\_Constant(AT) := o\_AT$
act4: $Constant\_definedIn\_Component := Constant\_definedIn\_Component \cup \{o\_AT \mapsto DomainModel\_corresp\_Component(DM)\}$
act5: $Property := Property \cup \{o\_lg1, o\_lg2\}$
act6: $LogicFormula := LogicFormula \cup \{o\_lg1, o\_lg2\}$
act7: $Constant\_typing\_Property := Constant\_typing\_Property \cup \{T\_AT \mapsto o\_lg1, o\_AT \mapsto o\_lg2\}$
act8: $Constant\_isInvolvedIn\_LogicFormulas := Constant\_isInvolvedIn\_LogicFormulas \cup \{T\_AT \mapsto \{1 \mapsto o\_lg1, 2 \mapsto o\_lg2\}, o\_AT \mapsto \{1 \mapsto o\_lg2\}\}$
act9: $LogicFormula\_uses\_Operators := LogicFormula\_uses\_Operators \cup \{o\_lg1 \mapsto \{1 \mapsto RelationSet\_OP\}, o\_lg2 \mapsto \{1 \mapsto Belonging\_OP\}\}$
act10: $LogicFormula\_involves\_Sets := LogicFormula\_involves\_Sets \cup \{o\_lg1 \mapsto \{2 \mapsto o\_CO, 3 \mapsto o\_DS\}, o\_lg2 \mapsto \varnothing\}$
act11: $LogicFormula\_definedIn\_Component := LogicFormula\_definedIn\_Component \cup \{o\_lg1 \mapsto DomainModel\_corresp\_Component(DM), o\_lg2 \mapsto DomainModel\_corresp\_Component(DM)\}$

end

Event rule_14_2 ⟨convergent⟩ $\widehat{=}$

correspondence of an instance of Attribute having its isVariable property set to false and its isFunctional property set to false (case where the domain corresponds to a constant, knowing that the range always corresponds to a set)

any

AT
T_AT
o_AT
CO
o_CO
DS
o_DS
o_lg1
o_lg2
DM

where

grd0: $Attribute\_isVariable^{-1}[\{FALSE\}] \setminus dom(Attribute\_Type) \neq \varnothing$
grd1: $AT \in Attribute\_isVariable^{-1}[\{FALSE\}] \setminus dom(Attribute\_Type)$
grd2: $dom(Concept\_corresp\_Constant) \neq \varnothing$

grd3: $CO = Attribute\_domain\_Concept(AT)$
grd4: $CO \in dom(Concept\_corresp\_Constant)$
grd5: $dom(DataSet\_corresp\_Set) \neq \varnothing$
grd6: $DS = Attribute\_range\_DataSet(AT)$
grd7: $DS \in dom(DataSet\_corresp\_Set)$
grd8: $Attribute\_definedIn\_DomainModel(AT) \in dom(DomainModel\_corresp\_Component)$
grd9: $Constant\_Set \setminus Constant \neq \varnothing$
grd10: $\{T\_AT, o\_AT\} \subseteq Constant\_Set \setminus Constant$
grd11: $LogicFormula\_Set \setminus LogicFormula \neq \varnothing$
grd12: $\{o\_lg1, o\_lg2\} \subseteq LogicFormula\_Set \setminus LogicFormula$
grd13: $o\_CO = Concept\_corresp\_Constant(CO)$
grd14: $o\_DS = DataSet\_corresp\_Set(DS)$
grd15: $DM = Attribute\_definedIn\_DomainModel(AT)$
grd16: $T\_AT \neq o\_AT$
grd17: $o\_lg1 \neq o\_lg2$
grd18: $AT \in Attribute\_isFunctional^{-1}[\{FALSE\}]$

then

act1: $Constant := Constant \cup \{T\_AT, o\_AT\}$
act2: $Attribute\_Type(AT) := T\_AT$
act3: $Attribute\_corresp\_Constant(AT) := o\_AT$
act4: $Constant\_definedIn\_Component := Constant\_definedIn\_Component \cup \{o\_AT \mapsto DomainModel\_corresp\_Component(DM)\}$
act5: $Property := Property \cup \{o\_lg1, o\_lg2\}$
act6: $LogicFormula := LogicFormula \cup \{o\_lg1, o\_lg2\}$
act7: $Constant\_typing\_Property := Constant\_typing\_Property \cup \{T\_AT \mapsto o\_lg1, o\_AT \mapsto o\_lg2\}$
act8: $Constant\_isInvolvedIn\_LogicFormulas := Constant\_isInvolvedIn\_LogicFormulas \Leftarrow \{T\_AT \mapsto \{1 \mapsto o\_lg1, 2 \mapsto o\_lg2\}, o\_AT \mapsto \{1 \mapsto o\_lg2\}, o\_CO \mapsto \{2 \mapsto o\_lg1\} \cup Constant\_isInvolvedIn\_LogicFormulas(o\_C$
act9: $LogicFormula\_uses\_Operators := LogicFormula\_uses\_Operators \cup \{o\_lg1 \mapsto \{1 \mapsto RelationSet\_OP\}, o\_lg2 \mapsto \{1 \mapsto Belonging\_OP\}\}$
act10: $LogicFormula\_involves\_Sets := LogicFormula\_involves\_Sets \cup \{o\_lg1 \mapsto \{3 \mapsto o\_DS\}, o\_lg2 \mapsto \varnothing\}$
act11: $LogicFormula\_definedIn\_Component := LogicFormula\_definedIn\_Component \cup \{o\_lg1 \mapsto DomainModel\_corresp\_Component(DM), o\_lg2 \mapsto DomainModel\_corresp\_Component(DM)\}$

end

Event rule_14_3 ⟨convergent⟩ $\widehat{=}$

correspondence of an instance of Attribute having its isVariable property set to false and its isFunctional property set to true (case where the domain corresponds to an abstract set, knowing that the range always corresponds to a set)

any

AT
T_AT
o_AT
CO
o_CO
DS
o_DS
o_lg1
o_lg2
DM

where

grd0: $Attribute\_isVariable^{-1}[\{FALSE\}] \setminus dom(Attribute\_Type) \neq \varnothing$
grd1: $AT \in Attribute\_isVariable^{-1}[\{FALSE\}] \setminus dom(Attribute\_Type)$
grd2: $dom(Concept\_corresp\_AbstractSet) \neq \varnothing$
grd3: $CO = Attribute\_domain\_Concept(AT)$
grd4: $CO \in dom(Concept\_corresp\_AbstractSet)$
grd5: $dom(DataSet\_corresp\_Set) \neq \varnothing$
grd6: $DS = Attribute\_range\_DataSet(AT)$
grd7: $DS \in dom(DataSet\_corresp\_Set)$
grd8: $Attribute\_definedIn\_DomainModel(AT) \in dom(DomainModel\_corresp\_Component)$

grd9: $Constant\_Set \setminus Constant \neq \varnothing$
grd10: $\{T\_AT, o\_AT\} \subseteq Constant\_Set \setminus Constant$
grd11: $LogicFormula\_Set \setminus LogicFormula \neq \varnothing$
grd12: $\{o\_lg1, o\_lg2\} \subseteq LogicFormula\_Set \setminus LogicFormula$
grd13: $o\_CO = Concept\_corresp\_AbstractSet(CO)$
grd14: $o\_DS = DataSet\_corresp\_Set(DS)$
grd15: $DM = Attribute\_definedIn\_DomainModel(AT)$
grd16: $T\_AT \neq o\_AT$
grd17: $o\_lg1 \neq o\_lg2$
grd18: $AT \in Attribute\_isFunctional^{-1}[\{TRUE\}]$

then

act1: $Constant := Constant \cup \{T\_AT, o\_AT\}$
act2: $Attribute\_Type(AT) := T\_AT$
act3: $Attribute\_corresp\_Constant(AT) := o\_AT$
act4: $Constant\_definedIn\_Component := Constant\_definedIn\_Component \cup \{o\_AT \mapsto DomainModel\_corresp\_Con$
$DomainModel\_corresp\_Component(DM)\}$
act5: $Property := Property \cup \{o\_lg1, o\_lg2\}$
act6: $LogicFormula := LogicFormula \cup \{o\_lg1, o\_lg2\}$
act7: $Constant\_typing\_Property := Constant\_typing\_Property \cup \{T\_AT \mapsto o\_lg1, o\_AT \mapsto o\_lg2\}$
act8: $Constant\_isInvolvedIn\_LogicFormulas := Constant\_isInvolvedIn\_LogicFormulas \cup \{T\_AT \mapsto$
$\{1 \mapsto o\_lg1, 2 \mapsto o\_lg2\}, o\_AT \mapsto \{1 \mapsto o\_lg2\}\}$
act9: $LogicFormula\_uses\_Operators := LogicFormula\_uses\_Operators \cup \{o\_lg1 \mapsto \{1 \mapsto FunctionSet\_OP\}, o\_lg2 \mapsto$
$\{1 \mapsto Belonging\_OP\}\}$
act10: $LogicFormula\_involves\_Sets := LogicFormula\_involves\_Sets \cup \{o\_lg1 \mapsto \{2 \mapsto o\_CO, 3 \mapsto$
$o\_DS\}, o\_lg2 \mapsto \varnothing\}$
act11: $LogicFormula\_definedIn\_Component := LogicFormula\_definedIn\_Component \cup \{o\_lg1 \mapsto$
$DomainModel\_corresp\_Component(DM), o\_lg2 \mapsto DomainModel\_corresp\_Component(DM)\}$

end

Event rule_14_4 ⟨convergent⟩ $\widehat{=}$

correspondence of an instance of Attribute having its isVariable property set to false and its isFunctional property set to true (case where the domain corresponds to a constant, knowing that the range always corresponds to a set)

any

AT
T_AT
o_AT
CO
o_CO
DS
o_DS
o_lg1
o_lg2
DM

where

grd0: $Attribute\_isVariable^{-1}[\{FALSE\}] \setminus dom(Attribute\_Type) \neq \varnothing$
grd1: $AT \in Attribute\_isVariable^{-1}[\{FALSE\}] \setminus dom(Attribute\_Type)$
grd2: $dom(Concept\_corresp\_Constant) \neq \varnothing$
grd3: $CO = Attribute\_domain\_Concept(AT)$
grd4: $CO \in dom(Concept\_corresp\_Constant)$
grd5: $dom(DataSet\_corresp\_Set) \neq \varnothing$
grd6: $DS = Attribute\_range\_DataSet(AT)$
grd7: $DS \in dom(DataSet\_corresp\_Set)$
grd8: $Attribute\_definedIn\_DomainModel(AT) \in dom(DomainModel\_corresp\_Component)$
grd9: $Constant\_Set \setminus Constant \neq \varnothing$
grd10: $\{T\_AT, o\_AT\} \subseteq Constant\_Set \setminus Constant$
grd11: $LogicFormula\_Set \setminus LogicFormula \neq \varnothing$
grd12: $\{o\_lg1, o\_lg2\} \subseteq LogicFormula\_Set \setminus LogicFormula$
grd13: $o\_CO = Concept\_corresp\_Constant(CO)$
grd14: $o\_DS = DataSet\_corresp\_Set(DS)$
grd15: $DM = Attribute\_definedIn\_DomainModel(AT)$

grd16: $T\_AT \neq o\_AT$
grd17: $o\_lg1 \neq o\_lg2$
grd18: $AT \in Attribute\_isFunctional^{-1}[\{TRUE\}]$

then

act1: $Constant := Constant \cup \{T\_AT, o\_AT\}$
act2: $Attribute\_Type(AT) := T\_AT$
act3: $Attribute\_corresp\_Constant(AT) := o\_AT$
act4: $Constant\_definedIn\_Component := Constant\_definedIn\_Component \cup \{o\_AT \mapsto DomainModel\_corresp\_Con$
$DomainModel\_corresp\_Component(DM)\}$
act5: $Property := Property \cup \{o\_lg1, o\_lg2\}$
act6: $LogicFormula := LogicFormula \cup \{o\_lg1, o\_lg2\}$
act7: $Constant\_typing\_Property := Constant\_typing\_Property \cup \{T\_AT \mapsto o\_lg1, o\_AT \mapsto o\_lg2\}$
act8: $Constant\_isInvolvedIn\_LogicFormulas := Constant\_isInvolvedIn\_LogicFormulas \Leftarrow \{T\_AT \mapsto$
$\{1 \mapsto o\_lg1, 2 \mapsto o\_lg2\}, o\_AT \mapsto \{1 \mapsto o\_lg2\}, o\_CO \mapsto \{2 \mapsto o\_lg1\} \cup Constant\_isInvolvedIn\_LogicFormulas(o\_C$

act9: $LogicFormula\_uses\_Operators := LogicFormula\_uses\_Operators \cup \{o\_lg1 \mapsto \{1 \mapsto FunctionSet\_OP\}, o\_lg2 \mapsto$
$\{1 \mapsto Belonging\_OP\}\}$
act10: $LogicFormula\_involves\_Sets := LogicFormula\_involves\_Sets \cup \{o\_lg1 \mapsto \{3 \mapsto o\_DS\}, o\_lg2 \mapsto$
$\varnothing\}$
act11: $LogicFormula\_definedIn\_Component := LogicFormula\_definedIn\_Component \cup \{o\_lg1 \mapsto$
$DomainModel\_corresp\_Component(DM), o\_lg2 \mapsto DomainModel\_corresp\_Component(DM)\}$

end

Event rule_15_1 ⟨ordinary⟩ $\widehat{=}$

closure property for constant attribute

any

AT
o_lg
o_AT
maplets
o_maplets

where

grd0: $dom(Attribute\_corresp\_Constant) \neq \varnothing$
grd1: $AT \in dom(Attribute\_corresp\_Constant)$
grd2: $o\_AT = Attribute\_corresp\_Constant(AT)$
grd3: $LogicFormula\_uses\_Operators^{-1}[\{\{1 \mapsto Equal2SetOf\_OP\}\}] \cap ran(Constant\_isInvolvedIn\_LogicFormulas($
$\varnothing$
grd4: $AttributeMaplet\_mapletOf\_Attribute^{-1}[\{AT\}] = maplets$
grd5: $maplets \subseteq dom(AttributeMaplet\_corresp\_Constant)$
grd6: $o\_maplets = AttributeMaplet\_corresp\_Constant[maplets]$
grd7: $Attribute\_definedIn\_DomainModel(AT) \in dom(DomainModel\_corresp\_Component)$
grd8: $LogicFormula\_Set \setminus LogicFormula \neq \varnothing$
grd9: $o\_lg \in LogicFormula\_Set \setminus LogicFormula$
grd10: $o\_AT \notin o\_maplets$

then

act1: $Property := Property \cup \{o\_lg\}$
act2: $LogicFormula := LogicFormula \cup \{o\_lg\}$
act3: $LogicFormula\_uses\_Operators(o\_lg) := \{1 \mapsto Equal2SetOf\_OP\}$
act4: $Constant\_isInvolvedIn\_LogicFormulas := Constant\_isInvolvedIn\_LogicFormulas \Leftarrow (\{o\_AT \mapsto$
$(\{1 \mapsto o\_lg\} \cup Constant\_isInvolvedIn\_LogicFormulas(o\_AT))\} \cup \{co \mapsto lgs | co \in o\_maplets \wedge$
$lgs = \{2 \mapsto o\_lg\} \cup Constant\_isInvolvedIn\_LogicFormulas(co)\})$
appearence order does not matter
act5: $LogicFormula\_involves\_Sets(o\_lg) := \varnothing$
act6: $LogicFormula\_definedIn\_Component(o\_lg) := DomainModel\_corresp\_Component(Attribute\_definedIn\_Don$

end

Event rule_16_1 ⟨ordinary⟩ $\widehat{=}$

handling the transitivity of a constant relation

any

RE

o_lg1
o_lg2
o_RE
composition

where

grd0: $(dom(Relation\_corresp\_Constant) \cap Relation\_isTransitive^{-1}[\{TRUE\}]) \neq \varnothing$
grd1: $RE \in (dom(Relation\_corresp\_Constant) \cap Relation\_isTransitive^{-1}[\{TRUE\}])$
grd2: $(\{RE \mapsto isTransitive\}) \notin dom(RelationCharacteristic\_corresp\_LogicFormula)$
grd3: $o\_RE = Relation\_corresp\_Constant(RE)$
grd4: $Relation\_definedIn\_DomainModel(RE) \in dom(DomainModel\_corresp\_Component)$
grd5: $LogicFormula\_Set \setminus LogicFormula \neq \varnothing$
grd6: $\{o\_lg1, o\_lg2\} \subseteq LogicFormula\_Set \setminus LogicFormula$
grd7: $partition(\{o\_lg1, o\_lg2\}, \{o\_lg1\}, \{o\_lg2\})$
grd8: $Constant\_Set \setminus Constant \neq \varnothing$
grd9: $composition \in Constant\_Set \setminus Constant$

then

act0: $Constant := Constant \cup \{composition\}$
act1: $Property := Property \cup \{o\_lg1, o\_lg2\}$
act2: $LogicFormula := LogicFormula \cup \{o\_lg1, o\_lg2\}$
act3: $Constant\_typing\_Property(composition) := o\_lg1$
act4: $RelationCharacteristic\_corresp\_LogicFormula(\{RE \mapsto isTransitive\}) := o\_lg2$
act5: $Constant\_isInvolvedIn\_LogicFormulas := Constant\_isInvolvedIn\_LogicFormulas \lhd \{composition \mapsto \{1 \mapsto o\_lg1, 1 \mapsto o\_lg2\}, o\_RE \mapsto \{2 \mapsto o\_lg1, 3 \mapsto o\_lg1, 2 \mapsto o\_lg2\} \cup Constant\_isInvolvedIn\_LogicFormulas(o\_RE$

act6: $LogicFormula\_uses\_Operators := LogicFormula\_uses\_Operators \cup \{o\_lg1 \mapsto \{1 \mapsto RelationComposition\_OP\} \{1 \mapsto Inclusion\_OP\}\}$
act7: $LogicFormula\_involves\_Sets := LogicFormula\_involves\_Sets \cup \{o\_lg1 \mapsto \varnothing, o\_lg2 \mapsto \varnothing\}$
act8: $LogicFormula\_definedIn\_Component := LogicFormula\_definedIn\_Component \cup \{o\_lg1 \mapsto DomainModel\_corresp\_Component(Relation\_definedIn\_DomainModel(RE)), o\_lg2 \mapsto DomainModel\_corresp\_C$

act9: $Constant\_definedIn\_Component(composition) := DomainModel\_corresp\_Component(Relation\_definedIn\_D$

end

Event rule_16_2 ⟨ordinary⟩ $\widehat{=}$

handling the symmetrie of a constant relation

any

RE
o_lg1
o_lg2
o_RE
inverse

where

grd0: $(dom(Relation\_corresp\_Constant) \cap Relation\_isSymmetric^{-1}[\{TRUE\}]) \neq \varnothing$
grd1: $RE \in (dom(Relation\_corresp\_Constant) \cap Relation\_isSymmetric^{-1}[\{TRUE\}])$
grd2: $(\{RE \mapsto isSymmetric\}) \notin dom(RelationCharacteristic\_corresp\_LogicFormula)$
grd3: $o\_RE = Relation\_corresp\_Constant(RE)$
grd4: $Relation\_definedIn\_DomainModel(RE) \in dom(DomainModel\_corresp\_Component)$
grd5: $LogicFormula\_Set \setminus LogicFormula \neq \varnothing$
grd6: $\{o\_lg1, o\_lg2\} \subseteq LogicFormula\_Set \setminus LogicFormula$
grd7: $partition(\{o\_lg1, o\_lg2\}, \{o\_lg1\}, \{o\_lg2\})$
grd8: $Constant\_Set \setminus Constant \neq \varnothing$
grd9: $inverse \in Constant\_Set \setminus Constant$

then

act0: $Constant := Constant \cup \{inverse\}$
act1: $Property := Property \cup \{o\_lg1, o\_lg2\}$
act2: $LogicFormula := LogicFormula \cup \{o\_lg1, o\_lg2\}$
act3: $Constant\_typing\_Property(inverse) := o\_lg1$
act4: $RelationCharacteristic\_corresp\_LogicFormula(\{RE \mapsto isSymmetric\}) := o\_lg2$
act5: $Constant\_isInvolvedIn\_LogicFormulas := Constant\_isInvolvedIn\_LogicFormulas \lhd \{inverse \mapsto \{1 \mapsto o\_lg1, 1 \mapsto o\_lg2\}, o\_RE \mapsto \{2 \mapsto o\_lg1, 2 \mapsto o\_lg2\} \cup Constant\_isInvolvedIn\_LogicFormulas(o\_RE)\}$

act6: $LogicFormula\_uses\_Operators := LogicFormula\_uses\_Operators \cup \{o\_lg1 \mapsto \{1 \mapsto Inversion\_OP\}, o\_lg2 \mapsto \{1 \mapsto Equality\_OP\}\}$
act7: $LogicFormula\_involves\_Sets := LogicFormula\_involves\_Sets \cup \{o\_lg1 \mapsto \varnothing, o\_lg2 \mapsto \varnothing\}$
act8: $LogicFormula\_definedIn\_Component := LogicFormula\_definedIn\_Component \cup \{o\_lg1 \mapsto DomainModel\_corresp\_Component(Relation\_definedIn\_DomainModel(RE)), o\_lg2 \mapsto DomainModel\_corresp\_C$

act9: $Constant\_definedIn\_Component(inverse) := DomainModel\_corresp\_Component(Relation\_definedIn\_Doma$

end

Event rule_101 ⟨convergent⟩ $\widehat{=}$

handling the addition of a new abstract set (correspondence to a concept)

any

CO
o_CO

where

grd0: $AbstractSet \setminus (ran(Concept\_corresp\_AbstractSet) \cup ran(DataSet\_corresp\_Set)) \neq \varnothing$
grd1: $o\_CO \in AbstractSet \setminus (ran(Concept\_corresp\_AbstractSet) \cup ran(DataSet\_corresp\_Set))$
grd2: $Set\_definedIn\_Component(o\_CO) \in ran(DomainModel\_corresp\_Component)$
grd3: $Concept\_Set \setminus Concept \neq \varnothing$
grd4: $CO \in Concept\_Set \setminus Concept$

then

act1: $Concept := Concept \cup \{CO\}$
act2: $Concept\_corresp\_AbstractSet(CO) := o\_CO$
act3: $Concept\_definedIn\_DomainModel(CO) := DomainModel\_corresp\_Component^{-1}(Set\_definedIn\_Componen$

act4: $Concept\_isVariable(CO) := FALSE$

end

Event rule_102 ⟨convergent⟩ $\widehat{=}$

handling the addition of a new abstract set (correspondence to a custom data set)

any

DS
o_DS

where

grd0: $AbstractSet \setminus (ran(Concept\_corresp\_AbstractSet) \cup ran(DataSet\_corresp\_Set)) \neq \varnothing$
grd1: $o\_DS \in AbstractSet \setminus (ran(Concept\_corresp\_AbstractSet) \cup ran(DataSet\_corresp\_Set))$
grd2: $Set\_definedIn\_Component(o\_DS) \in ran(DomainModel\_corresp\_Component)$
grd3: $DataSet\_Set \setminus DataSet \neq \varnothing$
grd4: $DS \in DataSet\_Set \setminus DataSet$
grd5: $DS \notin \{\_NATURAL, \_INTEGER, \_FLOAT, \_BOOL, \_STRING\}$

then

act1: $CustomDataSet := CustomDataSet \cup \{DS\}$
act2: $DataSet := DataSet \cup \{DS\}$
act3: $CustomDataSet\_corresp\_AbstractSet(DS) := o\_DS$
act4: $DataSet\_definedIn\_DomainModel(DS) := DomainModel\_corresp\_Component^{-1}(Set\_definedIn\_Componen$

act5: $DataSet\_corresp\_Set(DS) := o\_DS$

end

Event rule_103 ⟨convergent⟩ $\widehat{=}$

handling the addition of an enumerated set

any

EDS
o_EDS
elements
o_elements
mapping_elements_o_elements

where

grd0: $EnumeratedSet \setminus ran(DataSet\_corresp\_Set) \neq \varnothing$
grd1: $o\_EDS \in EnumeratedSet \setminus ran(DataSet\_corresp\_Set)$

grd2: $Set\_definedIn\_Component(o\_EDS) \in ran(DomainModel\_corresp\_Component)$
grd3: $DataSet\_Set \setminus DataSet \neq \varnothing$
grd4: $EDS \in DataSet\_Set \setminus DataSet$
grd5: $DataValue\_Set \setminus DataValue \neq \varnothing$
grd6: $elements \subseteq DataValue\_Set \setminus DataValue$
grd7: $o\_elements = SetItem\_itemOf\_EnumeratedSet^{-1}[\{o\_EDS\}]$
grd8: $card(o\_elements) = card(elements)$
grd9: $mapping\_elements\_o\_elements \in elements \rightarrowtail\!\!\!\!\!\rightarrow o\_elements$
grd10: $ran(DataValue\_corresp\_SetItem) \cap o\_elements = \varnothing$
grd11: $EDS \notin \{\_NATURAL, \_INTEGER, \_FLOAT, \_BOOL, \_STRING\}$

then

act1: $EnumeratedDataSet := EnumeratedDataSet \cup \{EDS\}$
act2: $DataSet := DataSet \cup \{EDS\}$
act3: $EnumeratedDataSet\_corresp\_EnumeratedSet(EDS) := o\_EDS$
act4: $DataSet\_definedIn\_DomainModel(EDS) := DomainModel\_corresp\_Component^{-1}(Set\_definedIn\_Compone$

act5: $DataValue := DataValue \cup elements$
act6: $DataValue\_elements\_EnumeratedDataSet := DataValue\_elements\_EnumeratedDataSet \cup \{(xx \mapsto yy) | xx \in elements \wedge yy = EDS\}$
act7: $DataValue\_corresp\_SetItem := DataValue\_corresp\_SetItem \cup mapping\_elements\_o\_elements$

act8: $DataSet\_corresp\_Set := DataSet\_corresp\_Set \lhd\!\!\!\!\!\rightarrow \{EDS \mapsto o\_EDS\}$
act9: $DataValue\_valueOf\_DataSet := DataValue\_valueOf\_DataSet \cup \{(xx \mapsto yy) | xx \in elements \wedge yy = EDS\}$
act10: $CustomDataSet := CustomDataSet \cup \{EDS\}$

end

Event rule_104 ⟨convergent⟩ $\widehat{=}$

handling the addition of a new element in an existing enumerated set

any

EDS
o_EDS
element
o_element

where

grd0: $dom(SetItem\_itemOf\_EnumeratedSet) \setminus ran(DataValue\_corresp\_SetItem) \neq \varnothing$
grd1: $o\_element \in dom(SetItem\_itemOf\_EnumeratedSet) \setminus ran(DataValue\_corresp\_SetItem)$
grd2: $o\_EDS = SetItem\_itemOf\_EnumeratedSet(o\_element)$
grd3: $o\_EDS \in ran(EnumeratedDataSet\_corresp\_EnumeratedSet)$
grd4: $EDS = EnumeratedDataSet\_corresp\_EnumeratedSet^{-1}(o\_EDS)$
grd5: $DataValue\_Set \setminus DataValue \neq \varnothing$
grd6: $element \in DataValue\_Set \setminus DataValue$

then

act1: $DataValue := DataValue \cup \{element\}$
act2: $DataValue\_elements\_EnumeratedDataSet(element) := EDS$
act3: $DataValue\_corresp\_SetItem(element) := o\_element$
act4: $DataValue\_valueOf\_DataSet(element) := EDS$

end

Event rule_105_1 ⟨convergent⟩ $\widehat{=}$

handling the addition of a constant, sub set of an instance of Concept (case where the concept corresponds to an abstract set)

any

CO
o_CO
PCO
o_lg
o_PCO

where

grd0:
$dom(Constant\_typing\_Property) \setminus (ran(Concept\_corresp\_Constant)$

$\cup\ ran(Individual\_corresp\_Constant)$
$\cup\ ran(DataValue\_corresp\_Constant)$
$\cup\ ran(Relation\_corresp\_Constant)$
$\cup\ ran(Attribute\_corresp\_Constant)$
$\cup\ ran(RelationMaplet\_corresp\_Constant)$
$\cup\ ran(AttributeMaplet\_corresp\_Constant)$
$\cup\ ran(Attribute\_Type)$
$\cup\ ran(Relation\_Type)) \neq \varnothing$

grd1:
$o\_CO \in dom(Constant\_typing\_Property) \setminus (ran(Concept\_corresp\_Constant)$
$\cup\ ran(Individual\_corresp\_Constant)$
$\cup\ ran(DataValue\_corresp\_Constant)$
$\cup\ ran(Relation\_corresp\_Constant)$
$\cup\ ran(Attribute\_corresp\_Constant)$
$\cup\ ran(RelationMaplet\_corresp\_Constant)$
$\cup\ ran(AttributeMaplet\_corresp\_Constant)$
$\cup\ ran(Attribute\_Type)$
$\cup\ ran(Relation\_Type))$

grd2: $o\_lg = Constant\_typing\_Property(o\_CO)$
grd3: $LogicFormula\_uses\_Operators(o\_lg) = \{1 \mapsto Inclusion\_OP\}$
grd4: $LogicFormula\_involves\_Sets(o\_lg) \neq \varnothing$
grd5: $(2 \mapsto o\_PCO) \in LogicFormula\_involves\_Sets(o\_lg)$
grd6: $o\_PCO \in ran(Concept\_corresp\_AbstractSet)$
grd7: $PCO = Concept\_corresp\_AbstractSet^{-1}(o\_PCO)$
grd8: $Concept\_Set \setminus Concept \neq \varnothing$
grd9: $CO \in Concept\_Set \setminus Concept$
grd10: $Constant\_definedIn\_Component(o\_CO) \in ran(DomainModel\_corresp\_Component)$

then

act1: $Concept := Concept \cup \{CO\}$
act2: $Concept\_corresp\_Constant(CO) := o\_CO$
act3: $Concept\_definedIn\_DomainModel(CO) := DomainModel\_corresp\_Component^{-1}(Constant\_definedIn\_Com$

act4: $Concept\_parentConcept\_Concept(CO) := PCO$
act5: $Concept\_isVariable(CO) := FALSE$

end

Event rule_105_2 ⟨convergent⟩ $\widehat{=}$

handling the addition of a constant, sub set of an instance of Concept (case where the concept corresponds to a constant)

any

CO
o_CO
PCO
o_lg
o_PCO

where

grd0:
$dom(Constant\_typing\_Property) \setminus (ran(Concept\_corresp\_Constant)$
$\cup\ ran(Individual\_corresp\_Constant)$
$\cup\ ran(DataValue\_corresp\_Constant)$
$\cup\ ran(Relation\_corresp\_Constant)$
$\cup\ ran(Attribute\_corresp\_Constant)$
$\cup\ ran(RelationMaplet\_corresp\_Constant)$
$\cup\ ran(AttributeMaplet\_corresp\_Constant)$
$\cup\ ran(Attribute\_Type)$
$\cup\ ran(Relation\_Type)) \neq \varnothing$

grd1:
$o\_CO \in dom(Constant\_typing\_Property) \setminus (ran(Concept\_corresp\_Constant)$
$\cup\ ran(Individual\_corresp\_Constant)$
$\cup\ ran(DataValue\_corresp\_Constant)$
$\cup\ ran(Relation\_corresp\_Constant)$

$\cup\, ran(Attribute\_corresp\_Constant)$
$\cup\, ran(RelationMaplet\_corresp\_Constant)$
$\cup\, ran(AttributeMaplet\_corresp\_Constant)$
$\cup\, ran(Attribute\_Type)$
$\cup\, ran(Relation\_Type))$

grd2: $o\_lg = Constant\_typing\_Property(o\_CO)$
grd3: $LogicFormula\_uses\_Operators(o\_lg) = \{1 \mapsto Inclusion\_OP\}$
grd4: $LogicFormula\_involves\_Sets(o\_lg) = \varnothing$
grd5: $o\_PCO \in dom(Constant\_isInvolvedIn\_LogicFormulas)$
grd6: $(2 \mapsto o\_lg) \in Constant\_isInvolvedIn\_LogicFormulas(o\_PCO)$
grd7: $o\_PCO \in ran(Concept\_corresp\_Constant)$
grd8: $PCO = Concept\_corresp\_Constant^{-1}(o\_PCO)$
grd9: $Concept\_Set \setminus Concept \neq \varnothing$
grd10: $CO \in Concept\_Set \setminus Concept$
grd11: $Constant\_definedIn\_Component(o\_CO) \in ran(DomainModel\_corresp\_Component)$

then

act1: $Concept := Concept \cup \{CO\}$
act2: $Concept\_corresp\_Constant(CO) := o\_CO$
act3: $Concept\_definedIn\_DomainModel(CO) := DomainModel\_corresp\_Component^{-1}(Constant\_definedIn\_Com$

act4: $Concept\_parentConcept\_Concept(CO) := PCO$
act5: $Concept\_isVariable(CO) := FALSE$

end

Event rule_106_1 ⟨convergent⟩ $\widehat{=}$

handling the addition of an individual (case where the concept corresponds to an abstract set)

any

ind
o_ind
CO
o_lg
o_CO

where

grd0:
$dom(Constant\_typing\_Property) \setminus (ran(Concept\_corresp\_Constant)$
$\cup\, ran(Individual\_corresp\_Constant)$
$\cup\, ran(DataValue\_corresp\_Constant)$
$\cup\, ran(Relation\_corresp\_Constant)$
$\cup\, ran(Attribute\_corresp\_Constant)$
$\cup\, ran(RelationMaplet\_corresp\_Constant)$
$\cup\, ran(AttributeMaplet\_corresp\_Constant)$
$\cup\, ran(Attribute\_Type)$
$\cup\, ran(Relation\_Type)) \neq \varnothing$

grd1:
$o\_ind \in dom(Constant\_typing\_Property) \setminus (ran(Concept\_corresp\_Constant)$
$\cup\, ran(Individual\_corresp\_Constant)$
$\cup\, ran(DataValue\_corresp\_Constant)$
$\cup\, ran(Relation\_corresp\_Constant)$
$\cup\, ran(Attribute\_corresp\_Constant)$
$\cup\, ran(RelationMaplet\_corresp\_Constant)$
$\cup\, ran(AttributeMaplet\_corresp\_Constant)$
$\cup\, ran(Attribute\_Type)$
$\cup\, ran(Relation\_Type))$

grd2: $o\_lg = Constant\_typing\_Property(o\_ind)$
grd3: $LogicFormula\_uses\_Operators(o\_lg) = \{1 \mapsto Belonging\_OP\}$
grd4: $LogicFormula\_involves\_Sets(o\_lg) \neq \varnothing$
grd5: $(2 \mapsto o\_CO) \in LogicFormula\_involves\_Sets(o\_lg)$
grd6: $o\_CO \in ran(Concept\_corresp\_AbstractSet)$
grd7: $CO = Concept\_corresp\_AbstractSet^{-1}(o\_CO)$
grd8: $Individual\_Set \setminus Individual \neq \varnothing$
grd9: $ind \in Individual\_Set \setminus Individual$

then

act1: $Individual := Individual \cup \{ind\}$

act2: $Individual\_individualOf\_Concept(ind) := CO$

act3: $Individual\_corresp\_Constant(ind) := o\_ind$

end

Event rule_106_2 ⟨convergent⟩ $\widehat{=}$

handling the addition of an individual (case where the concept corresponds to a constant)

any

ind

o_ind

CO

o_lg

o_CO

where

grd0:

$dom(Constant\_typing\_Property) \setminus (ran(Concept\_corresp\_Constant)$
$\cup\, ran(Individual\_corresp\_Constant)$
$\cup\, ran(DataValue\_corresp\_Constant)$
$\cup\, ran(Relation\_corresp\_Constant)$
$\cup\, ran(Attribute\_corresp\_Constant)$
$\cup\, ran(RelationMaplet\_corresp\_Constant)$
$\cup\, ran(AttributeMaplet\_corresp\_Constant)$
$\cup\, ran(Attribute\_Type)$
$\cup\, ran(Relation\_Type)) \neq \varnothing$

grd1:

$o\_ind \in dom(Constant\_typing\_Property) \setminus (ran(Concept\_corresp\_Constant)$
$\cup\, ran(Individual\_corresp\_Constant)$
$\cup\, ran(DataValue\_corresp\_Constant)$
$\cup\, ran(Relation\_corresp\_Constant)$
$\cup\, ran(Attribute\_corresp\_Constant)$
$\cup\, ran(RelationMaplet\_corresp\_Constant)$
$\cup\, ran(AttributeMaplet\_corresp\_Constant)$
$\cup\, ran(Attribute\_Type)$
$\cup\, ran(Relation\_Type))$

grd2: $o\_lg = Constant\_typing\_Property(o\_ind)$

grd3: $LogicFormula\_uses\_Operators(o\_lg) = \{1 \mapsto Belonging\_OP\}$

grd4: $LogicFormula\_involves\_Sets(o\_lg) = \varnothing$

grd5: $o\_CO \in dom(Constant\_isInvolvedIn\_LogicFormulas)$

grd6: $(2 \mapsto o\_lg) \in Constant\_isInvolvedIn\_LogicFormulas(o\_CO)$

grd7: $o\_CO \in ran(Concept\_corresp\_Constant)$

grd8: $CO = Concept\_corresp\_Constant^{-1}(o\_CO)$

grd9: $Individual\_Set \setminus Individual \neq \varnothing$

grd10: $ind \in Individual\_Set \setminus Individual$

then

act1: $Individual := Individual \cup \{ind\}$

act2: $Individual\_individualOf\_Concept(ind) := CO$

act3: $Individual\_corresp\_Constant(ind) := o\_ind$

end

Event rule_107 ⟨convergent⟩ $\widehat{=}$

handling the addition of a data value

any

dva

o_dva

DS

o_lg

o_DS

where

grd0:

$dom(Constant\_typing\_Property) \setminus (ran(Concept\_corresp\_Constant)$

$\cup\ ran(Individual\_corresp\_Constant)$
$\cup\ ran(DataValue\_corresp\_Constant)$
$\cup\ ran(Relation\_corresp\_Constant)$
$\cup\ ran(Attribute\_corresp\_Constant)$
$\cup\ ran(RelationMaplet\_corresp\_Constant)$
$\cup\ ran(AttributeMaplet\_corresp\_Constant)$
$\cup\ ran(Attribute\_Type)$
$\cup\ ran(Relation\_Type)) \neq \varnothing$

grd1:
$o\_dva \in dom(Constant\_typing\_Property) \setminus (ran(Concept\_corresp\_Constant)$
$\cup\ ran(Individual\_corresp\_Constant)$
$\cup\ ran(DataValue\_corresp\_Constant)$
$\cup\ ran(Relation\_corresp\_Constant)$
$\cup\ ran(Attribute\_corresp\_Constant)$
$\cup\ ran(RelationMaplet\_corresp\_Constant)$
$\cup\ ran(AttributeMaplet\_corresp\_Constant)$
$\cup\ ran(Attribute\_Type)$
$\cup\ ran(Relation\_Type))$

grd2: $o\_lg = Constant\_typing\_Property(o\_dva)$
grd3: $LogicFormula\_uses\_Operators(o\_lg) = \{1 \mapsto Belonging\_OP\}$
grd4: $LogicFormula\_involves\_Sets(o\_lg) \neq \varnothing$
grd5: $(2 \mapsto o\_DS) \in LogicFormula\_involves\_Sets(o\_lg)$
grd6: $o\_DS \in ran(DataSet\_corresp\_Set)$
grd7: $DS = DataSet\_corresp\_Set^{-1}(o\_DS)$
grd8: $DataValue\_Set \setminus DataValue \neq \varnothing$
grd9: $dva \in DataValue\_Set \setminus DataValue$

then

act1: $DataValue := DataValue \cup \{dva\}$
act2: $DataValue\_valueOf\_DataSet(dva) := DS$
act3: $DataValue\_corresp\_Constant(dva) := o\_dva$

end

Event rule_108_1 ⟨convergent⟩ $\widehat{=}$

handling the addition of a variable, sub set of an instance of Concept (case where the concept corresponds to an abstract set)

any

x_CO
CO
o_lg
o_CO

where

grd0:
$dom(Variable\_typing\_Invariant) \setminus (ran(Concept\_corresp\_Variable)$
$\cup\ ran(Relation\_corresp\_Variable)$
$\cup\ ran(Attribute\_corresp\_Variable)) \neq \varnothing$

grd1:
$x\_CO \in dom(Variable\_typing\_Invariant) \setminus (ran(Concept\_corresp\_Variable)$
$\cup\ ran(Relation\_corresp\_Variable)$
$\cup\ ran(Attribute\_corresp\_Variable))$

grd2: $o\_lg = Variable\_typing\_Invariant(x\_CO)$
grd3: $LogicFormula\_uses\_Operators(o\_lg) = \{1 \mapsto Inclusion\_OP\}$
grd4: $LogicFormula\_involves\_Sets(o\_lg) \neq \varnothing$
grd5: $(2 \mapsto o\_CO) \in LogicFormula\_involves\_Sets(o\_lg)$
grd6: $o\_CO \in ran(Concept\_corresp\_AbstractSet)$
grd7: $CO = Concept\_corresp\_AbstractSet^{-1}(o\_CO)$
grd8: $CO \notin dom(Concept\_corresp\_Variable)$

then

act1: $Concept\_isVariable(CO) := TRUE$
act2: $Concept\_corresp\_Variable(CO) := x\_CO$

end

Event rule_108_2 ⟨convergent⟩ $\widehat{=}$

handling the addition of a variable, sub set of an instance of Concept (case where the concept corresponds to a constant)

any

x_CO
CO
o_lg
o_CO

where

grd0:
$dom(Variable\_typing\_Invariant) \setminus (ran(Concept\_corresp\_Variable) \cup ran(Relation\_corresp\_Variable) \cup ran(Attribute\_corresp\_Variable)) \neq \varnothing$

grd1:
$x\_CO \in dom(Variable\_typing\_Invariant) \setminus (ran(Concept\_corresp\_Variable) \cup ran(Relation\_corresp\_Variable) \cup ran(Attribute\_corresp\_Variable))$

grd2: $o\_lg = Variable\_typing\_Invariant(x\_CO)$

grd3: $LogicFormula\_uses\_Operators(o\_lg) = \{1 \mapsto Inclusion\_OP\}$

grd4: $LogicFormula\_involves\_Sets(o\_lg) = \varnothing$

grd5: $o\_CO \in dom(Constant\_isInvolvedIn\_LogicFormulas)$

grd6: $(2 \mapsto o\_lg) \in Constant\_isInvolvedIn\_LogicFormulas(o\_CO)$

grd7: $o\_CO \in ran(Concept\_corresp\_Constant)$

grd8: $CO = Concept\_corresp\_Constant^{-1}(o\_CO)$

grd9: $CO \notin dom(Concept\_corresp\_Variable)$

then

act1: $Concept\_isVariable(CO) := TRUE$

act2: $Concept\_corresp\_Variable(CO) := x\_CO$

end

Event rule_109_1 ⟨convergent⟩ $\widehat{=}$

handling the addition of a constant, defined as a maplet, element of a relation (case where the relation corresponds to a constant relation)

any

o_maplet
maplet
o_RE
RE
o_lg1
o_lg2
antecedent
image
o_antecedent
o_image

where

grd0:
$dom(Constant\_typing\_Property) \setminus (ran(Concept\_corresp\_Constant) \cup ran(Individual\_corresp\_Constant) \cup ran(DataValue\_corresp\_Constant) \cup ran(Relation\_corresp\_Constant) \cup ran(Attribute\_corresp\_Constant) \cup ran(RelationMaplet\_corresp\_Constant) \cup ran(AttributeMaplet\_corresp\_Constant) \cup ran(Attribute\_Type) \cup ran(Relation\_Type)) \neq \varnothing$

grd1:
$o\_maplet \in dom(Constant\_typing\_Property) \setminus (ran(Concept\_corresp\_Constant) \cup ran(Individual\_corresp\_Constant) \cup ran(DataValue\_corresp\_Constant) \cup ran(Relation\_corresp\_Constant)$

$\cup\ ran(Attribute\_corresp\_Constant)$
$\cup\ ran(RelationMaplet\_corresp\_Constant)$
$\cup\ ran(AttributeMaplet\_corresp\_Constant)$
$\cup\ ran(Attribute\_Type)$
$\cup\ ran(Relation\_Type))$

grd2: $o\_lg1 = Constant\_typing\_Property(o\_maplet)$
grd3: $LogicFormula\_uses\_Operators(o\_lg1) = \{1 \mapsto Maplet\_OP\}$
grd4: $\{o\_antecedent, o\_image\} \subseteq (dom(Constant\_isInvolvedIn\_LogicFormulas) \cap ran(Individual\_corresp\_Constan$

grd5: $(2 \mapsto o\_lg1) \in Constant\_isInvolvedIn\_LogicFormulas(o\_antecedent)$
grd6: $(3 \mapsto o\_lg1) \in Constant\_isInvolvedIn\_LogicFormulas(o\_image)$
grd7: $antecedent = Individual\_corresp\_Constant^{-1}(o\_antecedent)$
grd8: $image = Individual\_corresp\_Constant^{-1}(o\_image)$
grd9: $o\_lg2 \in LogicFormula$
grd10: $LogicFormula\_uses\_Operators(o\_lg2) = \{1 \mapsto Equal2SetOf\_OP\}$
grd11: $(2 \mapsto o\_lg2) \in Constant\_isInvolvedIn\_LogicFormulas(o\_maplet)$
grd12: $o\_RE \in ran(Relation\_corresp\_Constant)$
grd13: $(1 \mapsto o\_lg2) \in Constant\_isInvolvedIn\_LogicFormulas(o\_RE)$
grd14: $RE = Relation\_corresp\_Constant^{-1}(o\_RE)$
grd15: $Relation\_Maplet\_Set \setminus RelationMaplet \neq \varnothing$
grd16: $maplet \in Relation\_Maplet\_Set \setminus RelationMaplet$
grd17: $Individual\_individualOf\_Concept(antecedent) = Relation\_domain\_Concept(RE)$
grd18: $Individual\_individualOf\_Concept(image) = Relation\_range\_Concept(RE)$

then

act1: $RelationMaplet := RelationMaplet \cup \{maplet\}$
act2: $RelationMaplet\_corresp\_Constant(maplet) := o\_maplet$
act3: $RelationMaplet\_mapletOf\_Relation(maplet) := RE$
act4: $RelationMaplet\_antecedent\_Individual(maplet) := antecedent$
act5: $RelationMaplet\_image\_Individual(maplet) := image$

end

END