

crowd 2.0 Interoperability Rules

Germán Braun^{a,b}, Giuliano Marinelli^{a,b}, Emiliano Ríos Gavagnin^a, Laura Cecchi^a, Pablo Fillottrani^{c,d}, C.Maria Keet¹

^aFacultad de Informática, Universidad Nacional del Comahue,
Buenos Aires 1400, Neuquén, Argentina

^bConsejo Nacional de Investigaciones Científicas y Técnicas, Argentina
^cDepartamento de Ciencias e Ingeniería de la Computación, Universidad Nacional del Sur,
San Andrés 800 - Campus Altos del Palihue, Bahía Blanca, Argentina

^dComisión de Investigaciones Científicas de la provincia de Buenos Aires, Argentina
^eDepartment of Computer Science, University of Cape Town, South Africa

1. KF Rules for crowd 2.0

1.1. UML/KF Rules

(UML-O1) Class $\xrightarrow{\text{UML to KF}}$ Object Type

in: Class

out: Object Type

(UML-IO) Object Type $\xrightarrow{\text{KF to UML}}$ Class

in: Object Type

out: Class

(UML-R1) Association end $\xrightarrow{\text{UML to KF}}$ Role

in: Association end

in: Association(Association end: Class, ..)

in: MultiplicityConstraint(Association end, min, max)

out: Association end \rightarrow Role

out: UML-O1(Class)

out: UML-A1(Association)

out: UML-MC1(MultiplicityConstraint)

out: Role(Relationship, Object type, CardinalityConstraint)

(UML-1R) Role $\xrightarrow{\text{KF to UML}}$ Association end

in: Role(Relationship, Object type, CardinalityConstraint)

in: Relationship(Role: Object type, ..)

in: CardinalityConstraint(Role, min, max)

out: Role \rightarrow Association end

out: UML-IO(Object type)

out: UML-1A(Relationship)

out: UML-1MC(CardinalityConstraint)

(UML-DT1) Data type $\xrightarrow{\text{UML to KF}}$ Data type

in: Data type

out: Data type

(UML-1DT) Data type $\xrightarrow{\text{KF to UML}}$ Data type
in: Data type
out: Data type

(UML-M1) Mandatory role $\xrightarrow{\text{UML to KF}}$ Mandatory
in: MultiplicityConstraint(Association end, 1, max)
out: Mandatory(UML-R1(Association end))

(UML-1M) Mandatory $\xrightarrow{\text{KF to UML}}$ Mandatory role
in: Mandatory(Role)
out: MultiplicityConstraint(UML-1R(Role), 1, ..)

(UML-S1) Subclass $\xrightarrow{\text{UML to KF}}$ Subsumption
in: Subclass(Child: Class, Parent: Class)
out: Subsumption(Child: UML-01(Class), Parent: UML-01(Class))

(UML-1S) Subsumption $\xrightarrow{\text{KF to UML}}$ Subclass
in: Subsumption(Child: Object type, Parent: Object type)
out: Subclass(Child: UML-1O(Object type), Parent: UML-1O(Object type))

(UML-C1) Complete $\xrightarrow{\text{UML to KF}}$ Completeness constraint
in: Subclass(Child-1: Class, Parent: Class)
in: Subclass(Child-2: Class, Parent: Class)
in: Complete(Child-1, Child-2)
out: UML-S1(Subclass)
out: UML-S1(Subclass)
out: CompletenessConstraint(Child-1: Object type, Child-2: Object type)

(UML-1C) Completeness constraint $\xrightarrow{\text{KF to UML}}$ Complete
in: Subsumption(Child-1: Object type, Parent: Object type)
in: Subsumption(Child-2: Object type, Parent: Object type)
in: CompletenessConstraint(Child-1, Child-2)
out: UML-1S(Subsumption)
out: UML-1S(Subsumption)
out: Complete(Child-1: Class, Child-2: Class)

(UML-D1) Disjoint $\xrightarrow{\text{UML to KF}}$ Disjoint object type
in: Subclass(Child-1: Class, Parent: Class)

in: Subclass(Child-2: Class, Parent: Class)
in: Disjoint(Child-1, Child-2)
out: UML-S1(Subclass)
out: UML-S1(Subclass)
out: DisjointObjectType(Child-1: Object type, Child-2: Object type)

KF to UML

(UML-1D) Disjoint object type \Longrightarrow Disjoint
in: Subsumption(Child-1: Object type, Parent: Object type)
in: Subsumption(Child-2: Object type, Parent: Object type)
in: DisjointObjectType(Child-1, Child-2)
out: UML-1S(Subsumption)
out: UML-1S(Subsumption)
out: Disjoint(Child-1: Class, Child-2: Class)

UML to KF

(UML-ATT1) Attribute \Longrightarrow Attribute
in: Attribute(Class, Data type)
out: Attribute(UML-01(Class), UML-DT1(Datatype))

KF to UML

(UML-1ATT) Attribute \Longrightarrow Attribute
in: Attribute(Object type, Data type)
out: Attribute(UML-1O(Object type), UML-1DT(Datatype))

UML to KF

(UML-A1) Association \Longrightarrow Relationship
in: Association(Association end: Class, Association end: Class)
out: Association \rightarrow Relationship
out: Relationship(UML-R1(Association end):UML-01(Class), UML-R1(Association end):UML-01(Class))

KF to UML

(UML-1A) Relationship \Longrightarrow Association
in: Relationship(Role: Object type, Role: Object type)
out: Relationship \rightarrow Association
out: Association(UML-1R(Role):UML-1O(Object type), UML-1R(Role):UML-1O(Object type))

UML to KF

(UML-MC1) Multiplicity constraint \Longrightarrow Object type cardinality constraint
in: MultiplicityConstraint(Association end, min, max)
out: ObjectTypeCardinalityConstraint(UML-R1(Association end), min, max)

KF to UML

(UML-1MC) Object type cardinality constraint \Longrightarrow Multiplicity constraint
in: ObjectTypeCardinalityConstraint(Role, min, max)
out: MultiplicityConstraint(UML-1R(Role), min, max)

UML to KF

(UML-SA1) Subtyping of Association \Longrightarrow Sub - relationship
in: Subtyping(Child: Association, Parent: Association)
out: Association \rightarrow Relationship
out: Association \rightarrow Relationship
out: Subsumption(Child:Relationship, Parent:Relationship)

KF to UML

(UML-ISA) Sub - relationship \Longrightarrow Subtyping of association
in: Subsumption(Child:Relationship, Parent:Relationship)
out: Relationship \rightarrow Association
out: Relationship \rightarrow Association
out: Subtyping(Child:Association, Parent:Association)

1.2. ER/KF Rules

ER to KF

(ER-O1) Entity type \Longrightarrow Object Type
in: Entity type
out: Object Type

KF to ER

(ER-1O) Object Type \Longrightarrow Entity type
in: Object Type
out: Entity type

ER to KF

(ER-R1) Component of relationship \Longrightarrow Role
in: Component of relationship
in: Relationship(Component of relationship: Entity type, ...)
in: CardinalityConstraint(Component of relationship, min, max)
out: Component of relationship \rightarrow Role
out: ER-01(Entity type)
out: ER-A1(Relationship)
out: ER-MC1(CardinalityConstraint)
out: Role(Relationship, Object type, CardinalityConstraint)

KF to ER

(ER-1R) Role \Longrightarrow Component of relationship
in: Role(Relationship, Object type, CardinalityConstraint)
in: Relationship(Role: Object type, ...)
in: CardinalityConstraint(Role, min, max)
out: Role \rightarrow Component of relationship
out: ER-1O(Object type)
out: ER-1A(Relationship)
out: ER-1MC(CardinalityConstraint)

(**ER-M1**) Mandatory $\xrightarrow{\text{ER to KF}}$ Mandatory
in: CardinalityConstraint(Component of relationship, 1, max)
out: Mandatory(ER-R1(Component of relationship))

(**ER-1M**) Mandatory $\xrightarrow{\text{KF to ER}}$ Mandatory
in: Mandatory(Role)
out: CardinalityConstraint(ER-1R(Role), 1, *)

(**ER-S1**) Subtype $\xrightarrow{\text{ER to KF}}$ Subsumption
in: Subtype(Child: Entity type, Parent: Entity type)
out: Subsumption(Child: ER-01(Entity type), Parent: ER-01(Entity type))

(**ER-1S**) Subsumption $\xrightarrow{\text{KF to ER}}$ Subtype
in: Subsumption(Child: Object type, Parent: Object type)
out: Subtype(Child: ER-1O(Object type), Parent: ER-1O(Object type))

(**ER-C1**) Total $\xrightarrow{\text{ER to KF}}$ Completeness constraint
in: Subtype(Child-1: Entity type, Parent: Entity type)
in: Subtype(Child-2: Entity type, Parent: Entity type)
in: Total(Child-1, Child-2)
out: ER-S1(Subtype)
out: ER-S1(Subtype)
out: CompletenessConstraint(Child-1: Object type, Child-2: Object type)

(**ER-1C**) Completeness constraint $\xrightarrow{\text{KF to ER}}$ Total
in: Subsumption(Child-1: Object type, Parent: Object type)
in: Subsumption(Child-2: Object type, Parent: Object type)
in: CompletenessConstraint(Child-1, Child-2)
out: ER-1S(Subsumption)
out: ER-1S(Subsumption)
out: Total(Child-1: Entity type, Child-2: Entity type)

(**ER-D1**) Disjoint $\xrightarrow{\text{ER to KF}}$ Disjoint object type
in: Subtype(Child-1: Entity type, Parent: Entity type)
in: Subtype(Child-2: Entity type, Parent: Entity type)
in: Disjoint(Child-1, Child-2)
out: ER-S1(Subtype)
out: ER-S1(Subtype)
out: DisjointObjectType(Child-1: Object type, Child-2: Object type)

(**ER-1D**) Disjoint object type $\xrightarrow{\text{KF to ER}}$ Disjoint
in: Subsumption(Child-1: Object type, Parent: Object type)

in: Subsumption(Child-2: Object type, Parent: Object type)
in: DisjointObjectType(Child-1, Child-2)
out: ER-1S(Subsumption)
out: ER-1S(Subsumption)
out: Disjoint(Child-1: Entity type, Child-2: Entity type)

ER to KF

(ER-ATT1) Attribute \Longrightarrow Attribute
in: Attribute(Entity type, ...)
out: ER-01(Entity type)
out: ER-D1(...)
out: Attribute(Object type, Data type)

// Datatype given by the user

KF to ER

(ER-1ATT) Attribute \Longrightarrow Attribute
in: Attribute(Object type, Data type)
out: ER-1O(Object type)
out: Attribute(Entity type, ...)

ER to KF

(ER-A1) Relationship \Longrightarrow Relationship
in: Relationship(Component of relationship: Entity type, Component of relationship: Entity type)
out: Relationship \rightarrow Relationship
out: Relationship(ER-R1(Component of relationship):ER-01(Entity type), ER-R1(Component of relationship):ER-01(Entity type))

KF to ER

(ER-1A) Relationship \Longrightarrow Relationship
in: Relationship(Role: Object type, Role: Object type)
out: Relationship \rightarrow Relationship
out: Relationship(ER-1R(Role):ER-1O(Object type), ER-1R(Role):ER-1O(Object type))

ER to KF

(ER-MC1) Cardinality constraint \Longrightarrow Object type cardinality constraint
in: CardinalityConstraint(Component of relationship, min, max)
out: ObjectTypeCardinalityConstraint(ER-R1(Component of relationship), min, max)

KF to ER

(ER-1MC) Object type cardinality constraint \Longrightarrow Cardinality constraint
in: ObjectTypeCardinalityConstraint(Role, min, max)
out: CardinalityConstraint(ER-1R(Role), min, max)

ER to KF

(ER-SA1) Subtyping of Relationship \Longrightarrow Sub - relationship
in: Subtyping(Child:Relationship, Parent:Relationship)
out: Relationship \rightarrow Relationship
out: Relationship \rightarrow Relationship
out: Subsumption(Child:Relationship, Parent:Relationship)

(**ER-1SA**) Sub - relationship $\xrightarrow{\text{KF to ER}}$ Subtyping of relationship
in: Subsumption(Child:Relationship, Parent:Relationship)
out: Relationship \rightarrow Relationship
out: Relationship \rightarrow Relationship
out: Subtyping(Child:Relationship, Parent:Relationship)

1.3. ORM 2/KF Rules

(**ORM2-O1**) Object type $\xrightarrow{\text{ORM 2 to KF}}$ Object Type
in: Object type
out: Object Type

(**ORM2-1O**) Object Type $\xrightarrow{\text{KF to ORM 2}}$ Object type
in: Object Type
out: Object type

(**ORM2-R1**) Role $\xrightarrow{\text{ORM 2 to KF}}$ Role
in: Role
in: FactType(Role: Object type, ...)
in: FrequencyConstraint(Role, min, max)
out: Role \rightarrow Role
out: ORM2-O1(Object type)
out: ORM2-A1(FactType)
out: ORM2-MC1-1/ORM2-MC1-2(FrequencyConstraint)
out: Role(Relationship, Object type, CardinalityConstraint)

(**ORM2-1R**) Role $\xrightarrow{\text{KF to ORM 2}}$ Role
in: Role(Relationship, Object type, CardinalityConstraint)
in: Relationship(Role: Object type, ...)
in: CardinalityConstraint(Role, min, max)
out: Role \rightarrow Role
out: ORM2-1O(Object type)
out: ORM2-1A(Relationship)
out: ORM2-1MC-1/ORM2-1MC-2(CardinalityConstraint)

(**ORM2-M1**) Mandatory $\xrightarrow{\text{ORM 2 to KF}}$ Mandatory
in: Mandatory(Role)
out: Mandatory(ORM2-R1(Role))

(**ORM2-1M**) Mandatory $\xrightarrow{\text{KF to ORM 2}}$ Mandatory
in: Mandatory(Role)

out: Mandatory(ORM2-1R(Role)))

(**ORM2-S1**) Subtype $\xrightarrow{\text{ORM 2 to KF}}$ Subsumption
in: Subtype(Child: Object type, Parent: Object type)
out: Subsumption(Child: ORM2-01(Object type), Parent: ORM2-01(Object type))

(**ORM2-1S**) Subsumption $\xrightarrow{\text{KF to ORM 2}}$ Subtype
in: Subsumption(Child: Object type, Parent: Object type)
out: Subtype(Child: ORM2-1O(Object type), Parent: ORM2-1O(Object type))

(**ORM2-C1**) Total $\xrightarrow{\text{ORM 2 to KF}}$ Completeness constraint
in: Subtype(Child-1: Object type, Parent: Object type)
in: Subtype(Child-2: Object type, Parent: Object type)
in: Total(Child-1, Child-2)
out: ORM2-S1(Subtype)
out: ORM2-S1(Subtype)
out: CompletenessConstraint(Child-1: Object type, Child-2: Object type)

(**ORM2-1C**) Completeness constraint $\xrightarrow{\text{KF to ORM 2}}$ Total
in: Subsumption(Child-1: Object type, Parent: Object type)
in: Subsumption(Child-2: Object type, Parent: Object type)
in: CompletenessConstraint(Child-1, Child-2)
out: ORM2-1S(Subsumption)
out: ORM2-1S(Subsumption)
out: Total(Child-1: Object type, Child-2: Object type)

(**ORM2-D1**) Exclusive $\xrightarrow{\text{ORM 2 to KF}}$ Disjoint object type
in: Subtype(Child-1: Object type, Parent: Object type)
in: Subtype(Child-2: Object type, Parent: Object type)
in: Exclusive(Child-1, Child-2)
out: ORM2-S1(Subtype)
out: ORM2-S1(Subtype)
out: DisjointObjectType(Child-1: Object type, Child-2: Object type)

(**ORM2-1D**) Disjoint object type $\xrightarrow{\text{KF to ORM 2}}$ Exclusive
in: Subsumption(Child-1: Object type, Parent: Object type)
in: Subsumption(Child-2: Object type, Parent: Object type)
in: DisjointObjectType(Child-1, Child-2)
out: ORM2-1S(Subsumption)
out: ORM2-1S(Subsumption)
out: Exclusive(Child-1: Object type, Child-2: Object type)

ORM 2 to KF

(ORM2-VT1) Value type $\xRightarrow{\text{ORM 2 to KF}}$ Value type
in: Value type
in: MappedTo(Value type, Data type)
out: ORM2-DT1(Data type)
out: MappedTo \rightarrow MappedTo
out: Value type \rightarrow Value type
out: MappedTo(Value type, Data type)

KF to ORM 2

(ORM2-1VT) Value type $\xRightarrow{\text{KF to ORM 2}}$ Value type
in: Value type \wedge MappedTo(Value type, Data type)
out: ORM2-1DT(Data type)
out: MappedTo \rightarrow MappedTo
out: Value type \rightarrow Value type
out: MappedTo(Value type, Data type)

ORM 2 to KF

(ORM2-A1) Fact type $\xRightarrow{\text{ORM 2 to KF}}$ Relationship
in: Fact type(Role: Object type, Role: Object type)
out: Fact type \rightarrow Relationship
out: Relationship(ORM2-R1(Role):ORM2-O1(Object type), ORM2-R1(Role):ORM2-O1(Object type))

KF to ORM 2

(ORM2-1A) Relationship $\xRightarrow{\text{KF to ORM 2}}$ Fact type
in: Relationship(Role: Object type, Role: Object type)
out: Relationship \rightarrow Fact type
out: FactType(ORM2-1R(Role):ORM2-1O(Object type), ORM2-1R(Role):ORM2-1O(Object type))

ORM 2 to KF

(ORM2-MC1-1) Frequency constraint $\xRightarrow{\text{ORM 2 to KF}}$ Object type cardinality constraint
in: FrequencyConstraint(Role, min, max), // min=0 o min=1
out: ObjectTypeCardinalityConstraint(ORM2-R1(Role), 0, max)

ORM 2 to KF

(ORM2-MC1-2) Frequency constraint $\xRightarrow{\text{ORM 2 to KF}}$ Object type cardinality constraint
in: FrequencyConstraint(Role, min, max), Mandatory(Role) // min > 1
out: ObjectTypeCardinalityConstraint(ORM2-R1(Role), min,max)

KF to ORM 2

(ORM2-1MC-1) Object type cardinality constraint $\xRightarrow{\text{KF to ORM 2}}$ Frequency constraint
in: ObjectTypeCardinalityConstraint(Role, 0, max)
out: FrequencyConstraint(ORM2-1R(Role), 0, max)

KF to ORM 2

(ORM2-1MC-2) Object type cardinality constraint $\xRightarrow{\text{KF to ORM 2}}$ Frequency constraint
in: ObjectTypeCardinalityConstraint(Role, min, max) // min \leq 1
out: FrequencyConstraint(ORM2-1R(Role), min, max)

ORM 2 to KF

(ORM2-SA1) *Subset constraint on fact type* $\xrightarrow{\text{ORM 2 to KF}}$ Sub - relationship
in: Subset(Child:Fact type, Parent:Fact type)
out: Fact type \rightarrow Relationship
out: Fact type \rightarrow Relationship
out: Subsumption(Child:Relationship, Parent:Relationship)

KF to ORM 2

(ORM2-ISA) Sub - relationship $\xrightarrow{\text{KF to ORM 2}}$ *Subset constraint on fact type*
in: Subsumption(Child:Relationship, Parent:Relationship)
out: Relationship \rightarrow Fact type
out: Relationship \rightarrow Fact type
out: Subset(Child:Fact type, Parent:Fact type)

1.4. MM/MM Rules

KF

(MM-ATT-VT) Attribute $\xrightarrow{\text{KF}}$ Value type
in: Attribute(Object type, Data type)
out: Data type
out: Role
out: Relationship
out: MappedTo
out: Attribute \rightarrow Value type
out: Relationship(Role:Object type, Role:Value type)
out: MappedTo(Value type, Data type)

KF

(MM-VT-ATT) Value type $\xrightarrow{\text{KF}}$ Attribute
in: Value type \wedge MappedTo(Value type, Data type)
out: Data type
out: Object type
out: Attribute(Object type, Data type)

1.5. DL/KF Embedding Rules

DL to KF

(KO1) Atomic Concept C_i $\xrightarrow{\text{DL to KF}}$ Object type
out: $C_i \rightarrow$ Object type

DL to KF

(IKS) $C_i \sqsubseteq C_j$ $\xrightarrow{\text{DL to KF}}$ Subsumption
in: $C_i \sqsubseteq C_j$ // *A, B atomic concepts*
out: $C_i \rightarrow$ Object type
out: $C_j \rightarrow$ Object type
out: Subsumption(Child: Object type, Parent: Object type)

DL to KF

(OK2) $A \equiv B$ $\xrightarrow{\text{DL to KF}}$ KF
in: normalised $A \equiv B$
out: $A \rightarrow$ Object type

out: $B \rightarrow$ Object type
out: Subsumption(Child: A , Parent: B)
out: Subsumption(Child: B , Parent: A)

1.6. KF/DL Embedding Rules

Table 1: KF/DL Embedding Rules

KF	DL
Object type O	Concept O
Role $r_{endConcept}$	Role $r_{endConcept}$
Data Type D	Concept D
Attribute A of data type DT for the object type O	Role A $\exists A.T \sqsubseteq O$ $T \sqsubseteq \forall A.DT$ $O \sqsubseteq \leq 1 A.DT$
Binary Relationship R between O_1 and O_2	Concept R $R \sqsubseteq \exists r_{o1}.O_1$ $R \sqsubseteq \exists r_{o2}.O_2$
Object type O cardinality constraint:	
(1)Range (min, max)	$O \sqsubseteq (\geq \min r_o^-.R) \sqcap (\leq \max r_o^-.R)$
(2)Range (.. max)	$O \sqsubseteq (\leq \max r_o^-.R)$
(3)Range(min ..)	$O \sqsubseteq (\geq \min r_o^-.R)$
Mandatory role r_o	$O \sqsubseteq \geq 1 r_o^-$
Object type subsumption	$OSub \sqsubseteq OSup$
Disjoint object type subsumption	$O_1 \sqsubseteq OSup$ $O_2 \sqsubseteq OSup$ \vdots $O_n \sqsubseteq OSup$ $O_i \sqsubseteq \prod_{j=i+1}^n \neg O_j$, for $i = 1, \dots, n-1$
Completeness object type subsumption	$O_1 \sqsubseteq OSup$ $O_2 \sqsubseteq OSup$ \dots $O_n \sqsubseteq OSup$ $OSup \sqsubseteq O_1 \sqcup O_2 \sqcup \dots \sqcup O_n$
Relationship Subsumption	$RChild \sqsubseteq RParent$

1.7. KF/CNL (en) Rules

$(\mathbf{KF-CNL-1O})$ Object Type $\xrightarrow{KF \text{ to } CNL(en)} text$
in: Object Type
out: [Object Type] is an Object Type

$(\mathbf{UML-CNL-1R})$ Role $\xrightarrow{KF \text{ to } CNL(en)} text$
in: Role(Relationship, Object type, CardinalityConstraint)
out: [Role] is a Role

(UML-CNL-1DT) Data type $\xrightarrow{KF\ to\ CNL(en)} text$
in: Data type
out: [Data type] is a Data Type

(UML-CNL-1M) Mandatory $\xrightarrow{KF\ to\ CNL(en)} text$
in: Mandatory(Role)
out: [Role] is Mandatory

(UML-CNL-1S) Subsumption $\xrightarrow{KF\ to\ CNL(en)} text$
in: Subsumption(Child: Object type, Parent: Object type)
out: Each [Child] is a [Parent]

(UML-CNL-1C) Completeness constraint $\xrightarrow{KF\ to\ CNL(en)} text$
in: Subsumption(Child-1: Object type, Parent: Object type)
in: Subsumption(Child-2: Object type, Parent: Object type)
in: CompletenessConstraint(Child-1, Child-2)
out: UML-CNL-1S(Subsumption)
out: UML-CNL-1S(Subsumption)
out: [Child-1] and [Child-2] cover [Parent]

(UML-CNL-1D) Disjoint object type $\xrightarrow{KF\ to\ CNL(en)} text$
in: Subsumption(Child-1: Object type, Parent: Object type)
in: Subsumption(Child-2: Object type, Parent: Object type)
in: DisjointObjectType(Child-1, Child-2)
out: UML-CNL-1S(Subsumption)
out: UML-CNL-1S(Subsumption)
out: [Child-1] and [Child-2] are disjoint from each other.

(UML-CNL-1ATT) Attribute $\xrightarrow{KF\ to\ CNL(en)} text$
in: Attribute(Object type, Data type)
out: UML-CNL-1DT(Data type)
out: [Attribute] is an attribute with data type [Data type]
out: [Object type] has attribute [Attribute]

(UML-CNL-1A) Relationship $\xrightarrow{KF\ to\ CNL(en)} text$
in: Relationship(Role-1: Object type-1, Role-2: Object type-2)

out: UML-CNL-1O(Object type-1)
out: UML-CNL-1O(Object type-2)
out: [Relationship] is a relationship between [Object type-1] and [Object type-2]
out: [Role-1] is a Role in the relationship [Relationship]
out: [Role-2] is a Role in the relationship [Relationship]

(UML-CNL-1MC) Object type cardinality constraint $\xrightarrow{KF\ to\ CNL(en)} text$
in: Role(Relationship, Object type-1, ObjectTypeCardinalityConstraint)
in: Relationship(Object type-1, Object type-2)
in: ObjectTypeCardinalityConstraint(Role, min, max)
out: Each [Object type-1] [Role] at least [min] [Object type-2] and at most [max] [Object type-2]

(UML-CNL-1SA) Sub - relationship $\xrightarrow{KF\ to\ CNL(en)} text$
in: Subsumption(Child:Relationship, Parent:Relationship)
out: Each [Child] is a [Parent]
