

**CC7220-1**

**LA WEB DE DATOS**

**PRIMAVERA 2020**

**LECTURE 10: SHAPES**

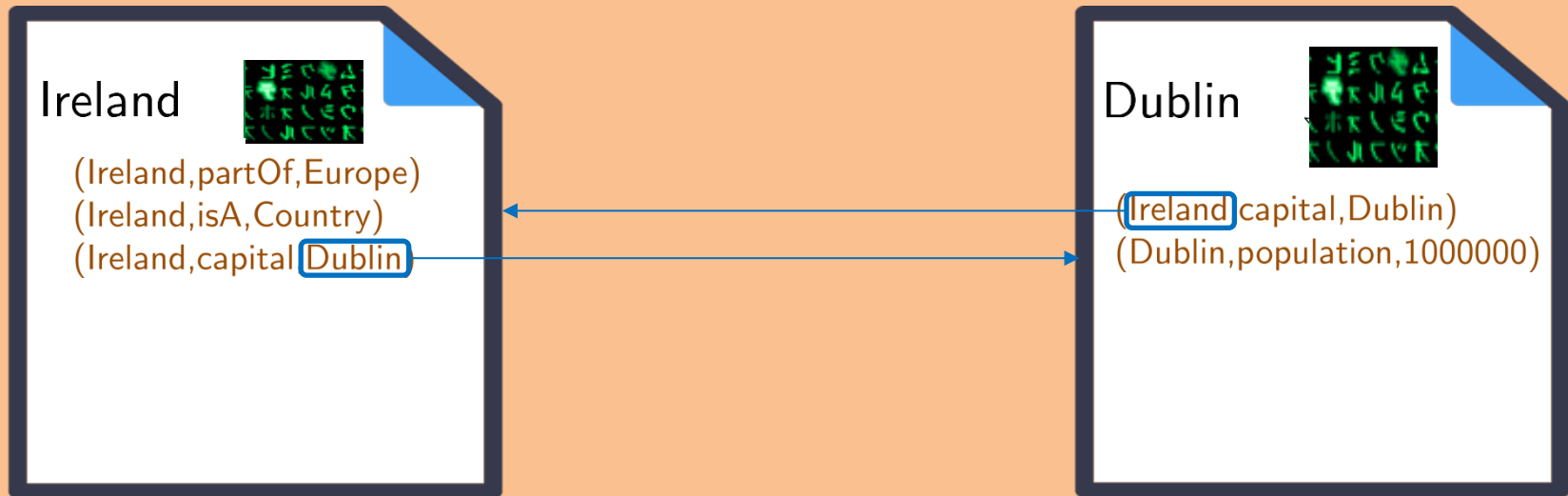
Aidan Hogan

aidhog@gmail.com

PREVIOUSLY ...

# SEMANTIC WEB: DATA, LOGIC, QUERY, LINKS

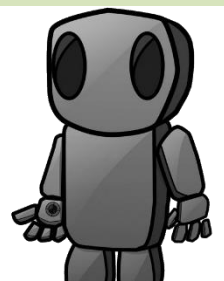
## DATA:



LOGIC:  $((b, \text{capital}, a) \rightarrow (a, \text{partOf}, b))$   
 $((a, \text{partOf}, b), (b, \text{partOf}, c) \rightarrow (a, \text{partOf}, c))$

QUERY:  $((x, \text{partOf}, y)?)$

OUTPUT:  $\{(x \mapsto \text{Ireland}, y \mapsto \text{Europe}),$   
 $(x \mapsto \text{Dublin}, y \mapsto \text{Ireland}),$   
 $(x \mapsto \text{Dublin}, y \mapsto \text{Europe})\}$



# SEMANTIC WEB: DATA, LOGIC, QUERY, LINKS

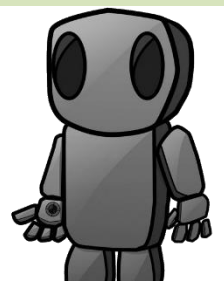
## DATA:



LOGIC:  $(b, \text{capital}, a) \rightarrow (a, \text{partOf}, b)$   
 $(a, \text{partOf}, b), (b, \text{partOf}, c) \rightarrow (a, \text{partOf}, c)$

QUERY:  $“(x, \text{partOf}, y)?”$

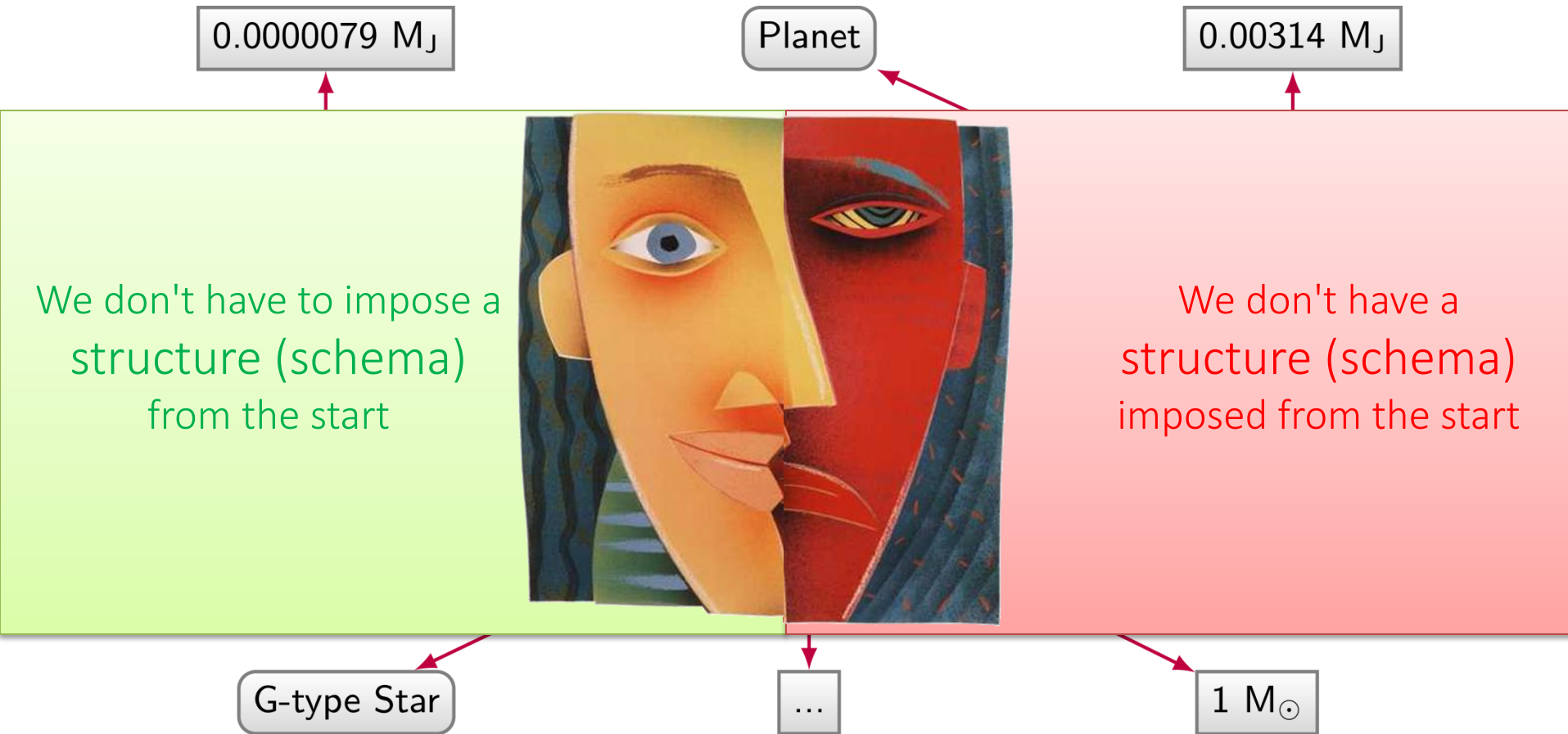
OUTPUT:  $\{(x \mapsto \text{Ireland}, y \mapsto \text{Europe}),$   
 $(x \mapsto \text{Dublin}, y \mapsto \text{Ireland}),$   
 $(x \mapsto \text{Dublin}, y \mapsto \text{Europe})\}$





GRAPHS ...

# GRAPH DATA: PROS AND CONS





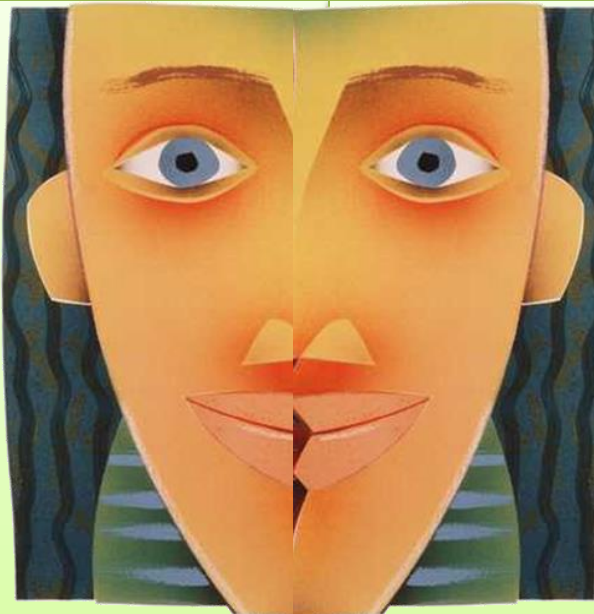
# GRAPH DATA: PROS AND PROS

0.0000079  $M_J$

Planet

0.00314  $M_J$

We don't have to impose a  
structure (schema)  
from the start



... and we can impose a  
schema any time we like

G-type Star

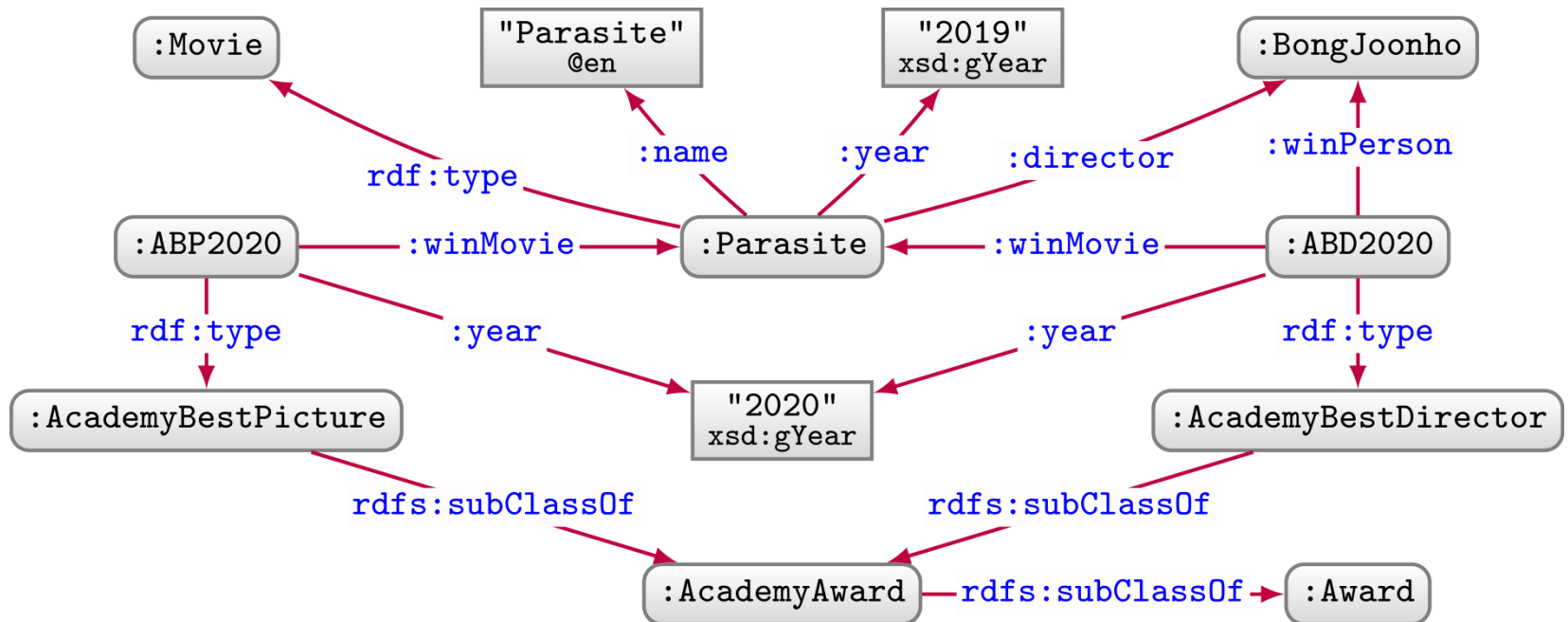
...

1  $M_{\odot}$

So how can we define and impose a schema for graphs?

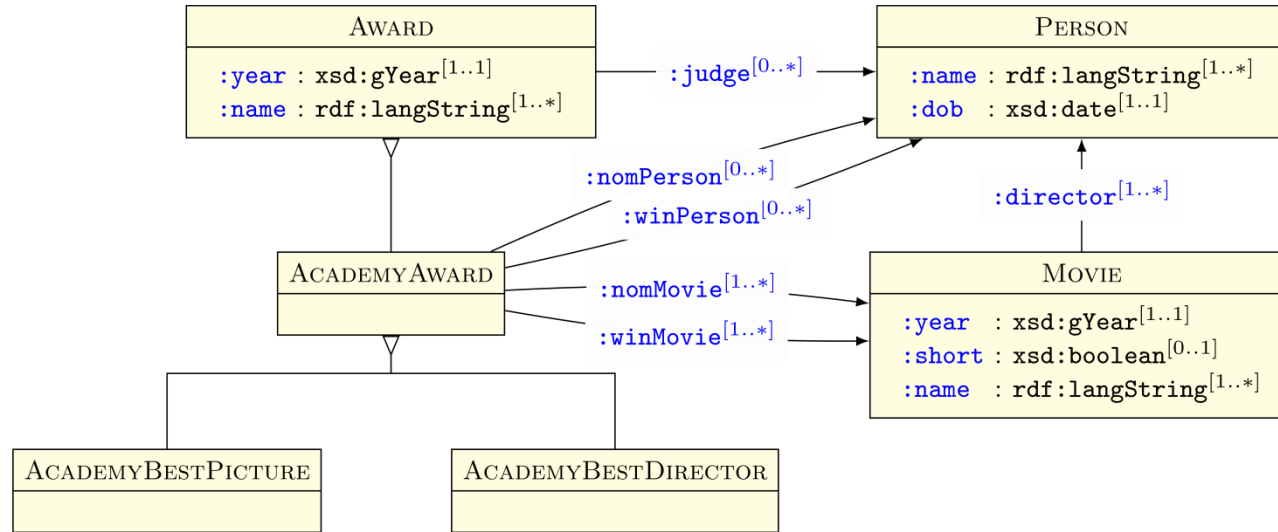
SHAPES

# GRAPH DATA: VALIDATION

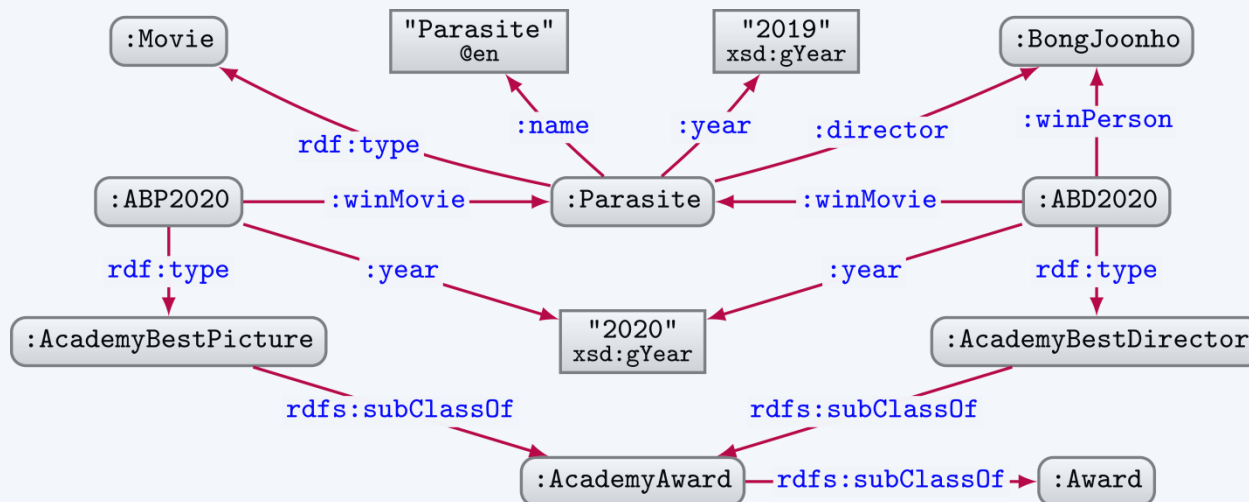
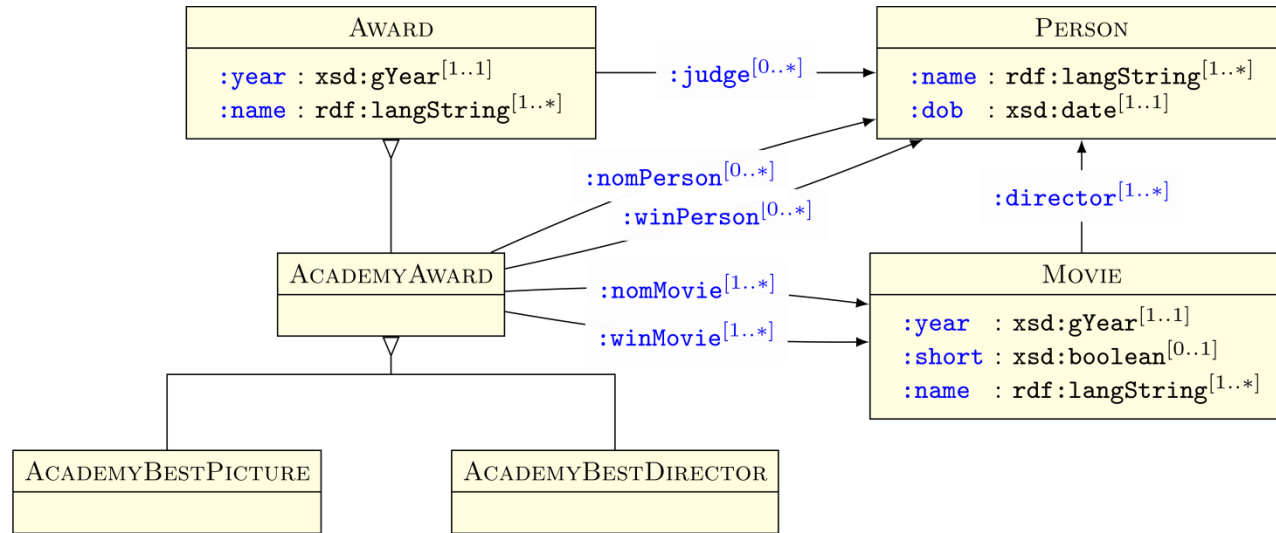


Is this graph "complete"?  
Does it have "errors"?  
How do we define "completeness" and "errors"?

# SHAPES GRAPH: VALIDATING SCHEMA



# SHAPES GRAPH: VALIDATE RDF GRAPHS



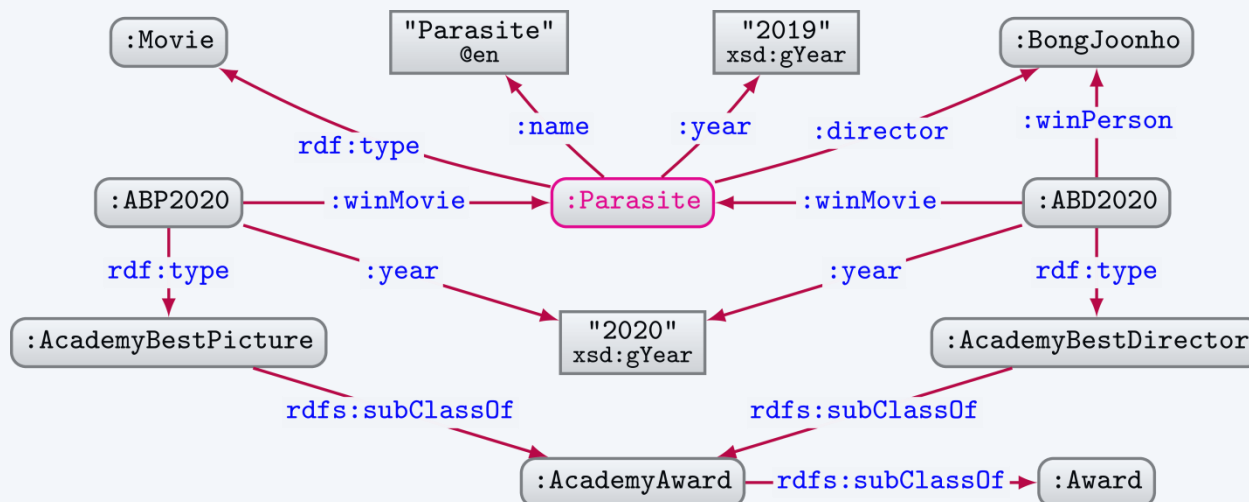
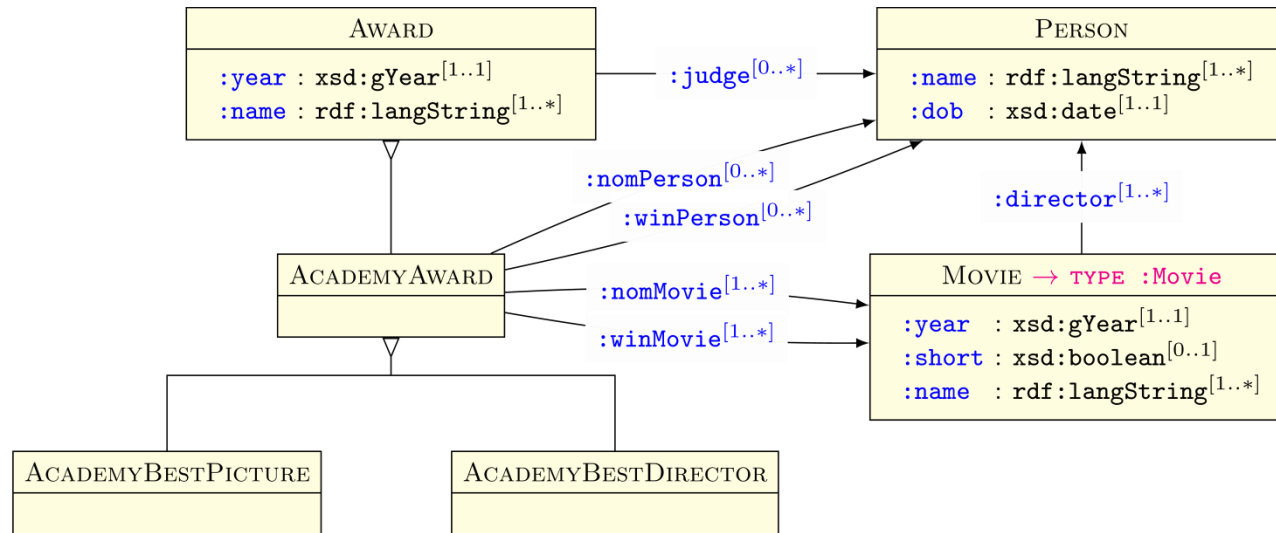
Does it pass?



We have not yet defined a **target** for a shape, so we don't know which shape applies to which node in the data



# SHAPES GRAPH: DEFINE A TARGET

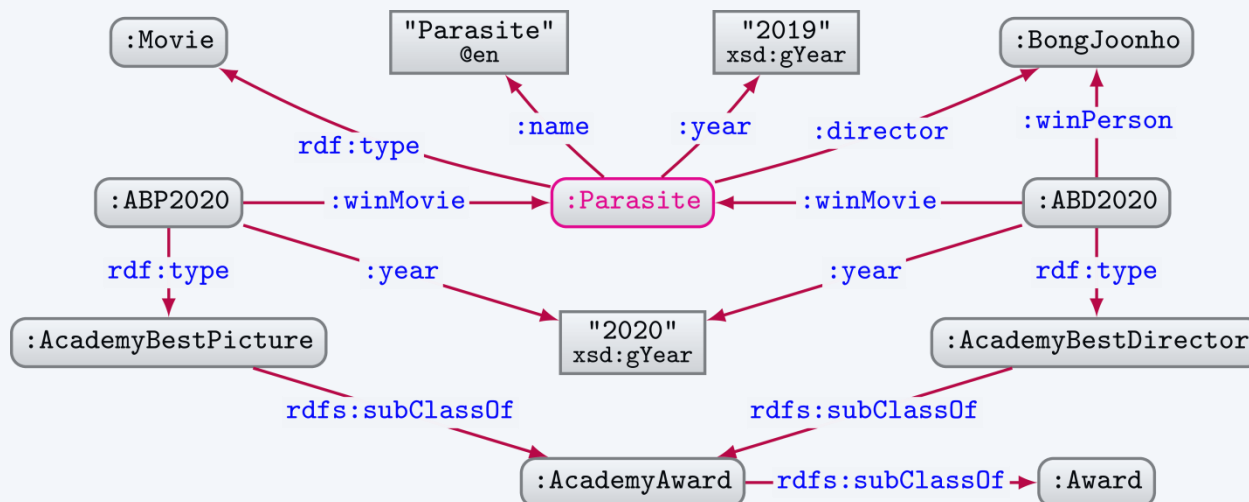
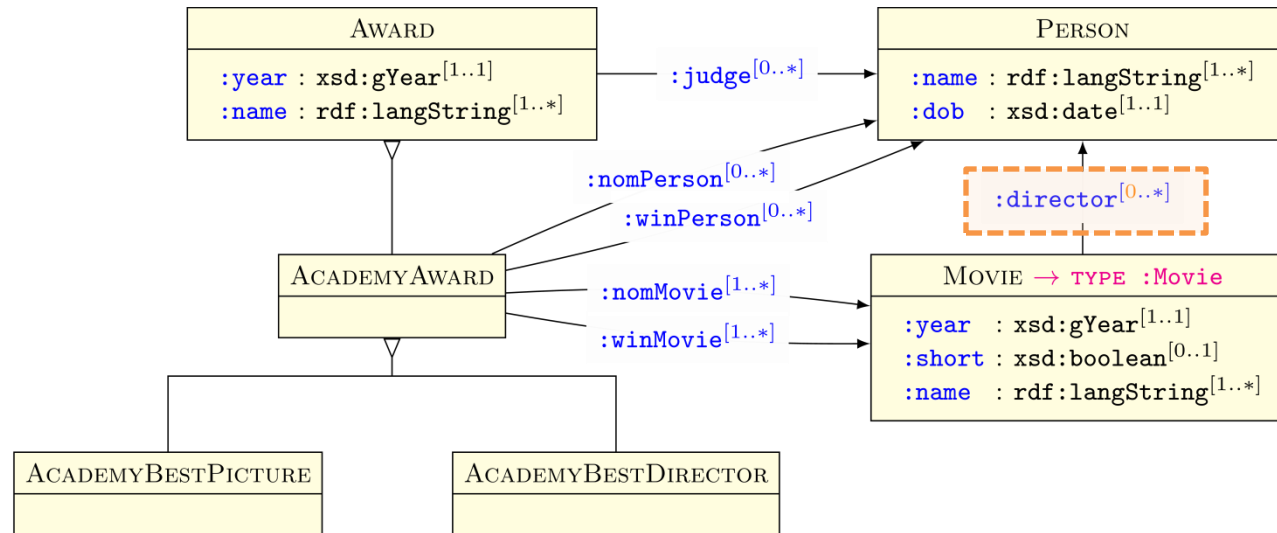


Does it pass?

No. :Parasite does not have a director satisfying PERSON.

We are missing a name and a date of birth for Bong Joon-ho!

# SHAPES GRAPH: MULTIPLICITY

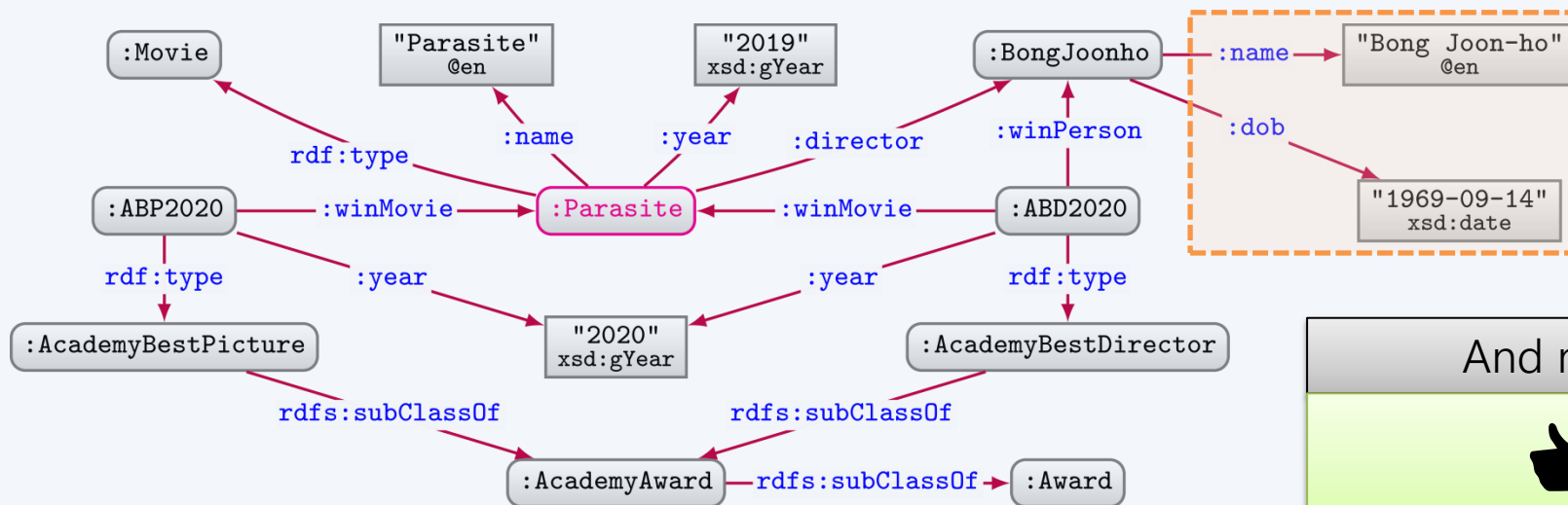
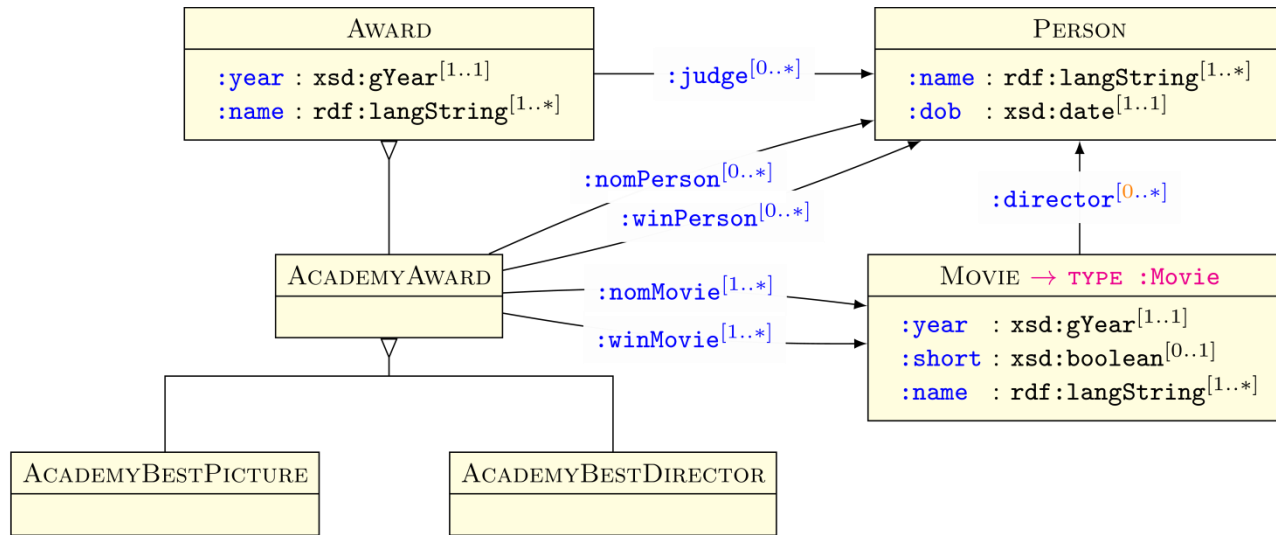


How about now?

No. Any director of :Parasite must still satisfy PERSON.

We are missing a name and a date of birth for Bong Joon-ho!

## SHAPES GRAPH: VALIDATION

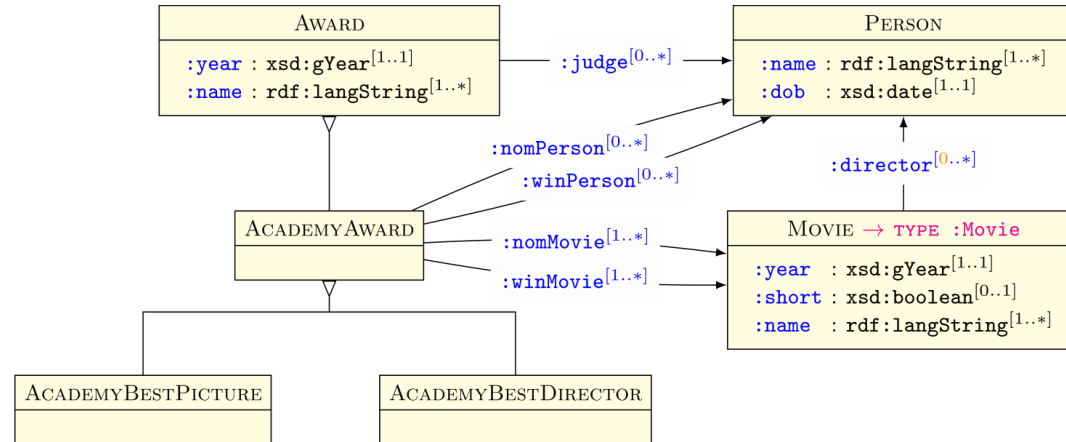


And now?



SHAPES vs. RDFS/OWL AND SPARQL

# SHAPES VS. RDFS/OWL



```

#[...]
:Award rdfs:subClassOf
  [ owl:allValuesFrom xsd:gYear ; owl:onProperty :year ] ,
  [ owl:cardinality 1 ; owl:onProperty :year ] ,
  [ owl:allValuesFrom rdf:langString ; owl:onProperty :name ] ,
  [ owl:minCardinality 1 ; owl:onProperty :name ] ,
  [ owl:allValuesFrom :Person ; owl:onProperty :judge ] .

```

```

AcademyAward rdfs:subClassOf :Award ,
  [ owl:allValuesFrom :Person ; owl:onProperty :nomPerson ] ,
  [ owl:allValuesFrom :Person ; owl:onProperty :winPerson ] ,
  [ owl:allValuesFrom :Movie ; owl:onProperty :nomMovie ] ,
  [ owl:minCardinality 1 ; owl:onProperty :nomMovie ] ,
  [ owl:minCardinality 1 ; owl:onProperty :winMovie ] .

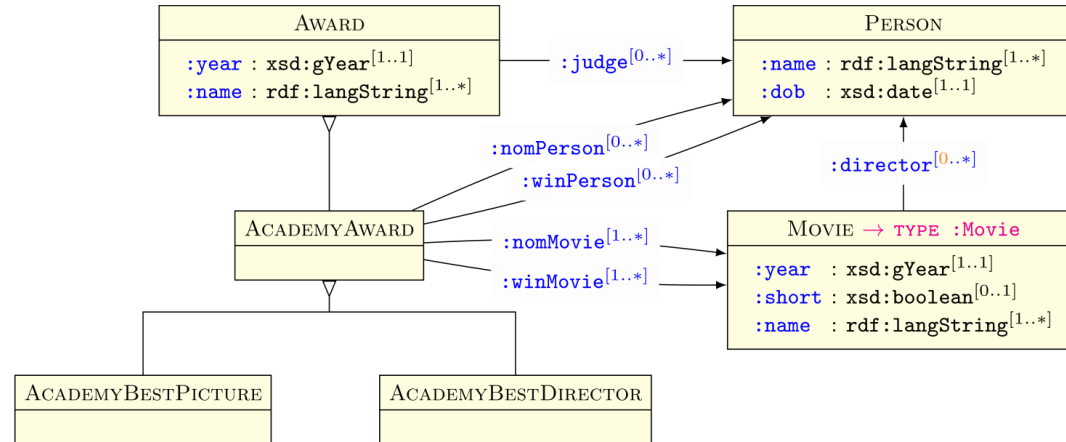
```

```
#[...]
```



OWL assumes OWA and no UNA. Cannot easily detect missing data or duplicated values!

# SHAPES VS. SPARQL



#[...]

# finds constraint violations

```
SELECT DISTINCT ?movie WHERE {
  ?movie a :Movie .
  OPTIONAL { ?movie :year ?year1 . }
  OPTIONAL { ?movie :year ?year2 . }
  FILTER(!bound(?year1) || datatype(?year1)!=xsd:gYear || ?year1 != ?year2)
  OPTIONAL { ?movie :short ?short1 . }
  OPTIONAL { ?movie :short ?short2 . }
  FILTER(bound(?short1) && (datatype(?short1)!=xsd:boolean || ?short1 != ?short2))
  OPTIONAL { ?movie :name ?name . }
  FILTER(!bound(?name) || lang(?name)='')
  OPTIONAL { ?movie :director ?director . }
  # check that ?director satisfies Person shape
}
```

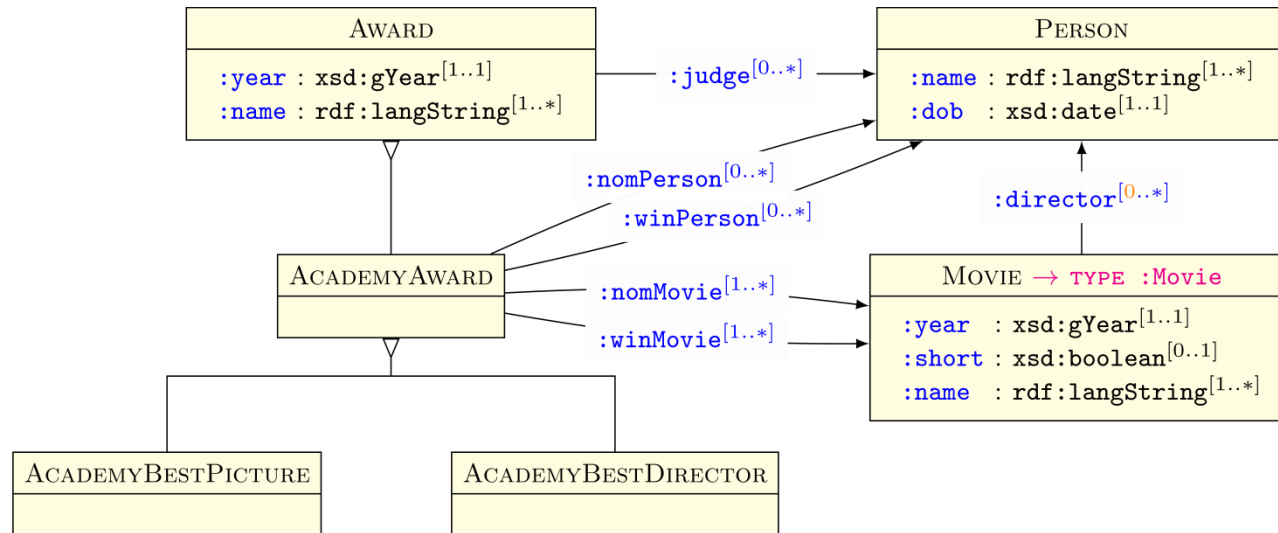


Correct semantics, but difficult to express these types of constraints.

SHACL:

SHAPES CONSTRAINT LANGUAGE

# SHAPES GRAPH: HOW DO WE DEFINE THEM?



So how do we define shapes graphs?



# Shapes Constraint Language (SHACL)

W3C Recommendation 20 July 2017



## **This version:**

<https://www.w3.org/TR/2017/REC-shacl-20170720/>

## **Latest published version:**

<https://www.w3.org/TR/shacl/>

## **Latest editor's draft:**

<https://w3c.github.io/data-shapes/shacl/>

## **Implementation report:**

<https://w3c.github.io/data-shapes/data-shapes-test-suite/>

## **Previous version:**

<https://www.w3.org/TR/2017/PR-shacl-20170608/>

## **Editors:**

[Holger Knublauch](#), [TopQuadrant, Inc.](#)

[Dimitris Kontokostas](#), [University of Leipzig](#)

## **Repository:**

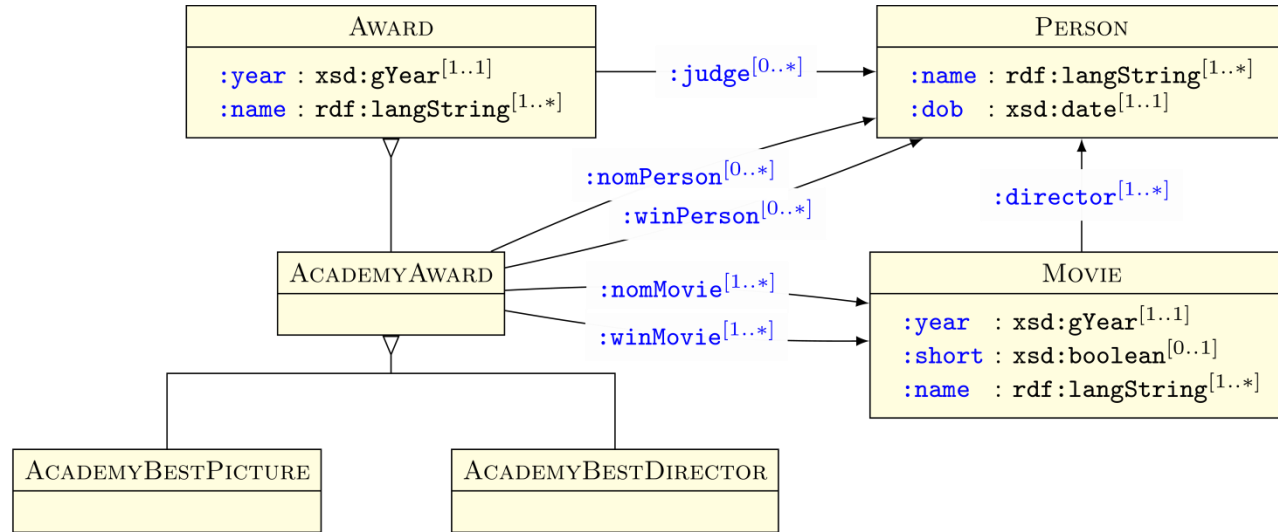
[GitHub](#)

[Issues](#)

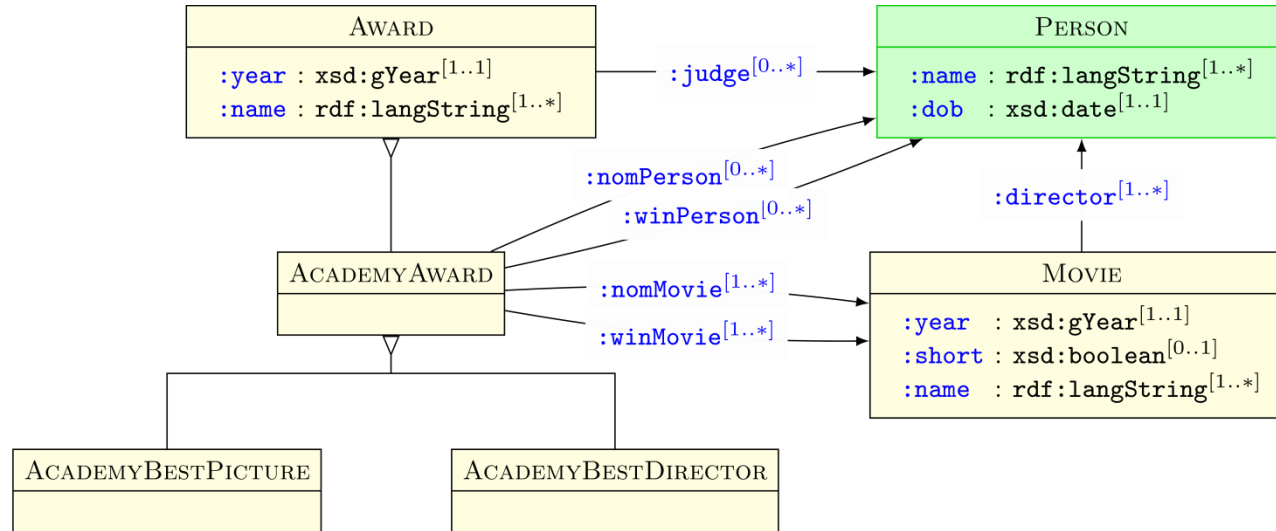
## **Test Suite:**

[SHACL Test Suite](#)

# SHACL: SHAPES GRAPH



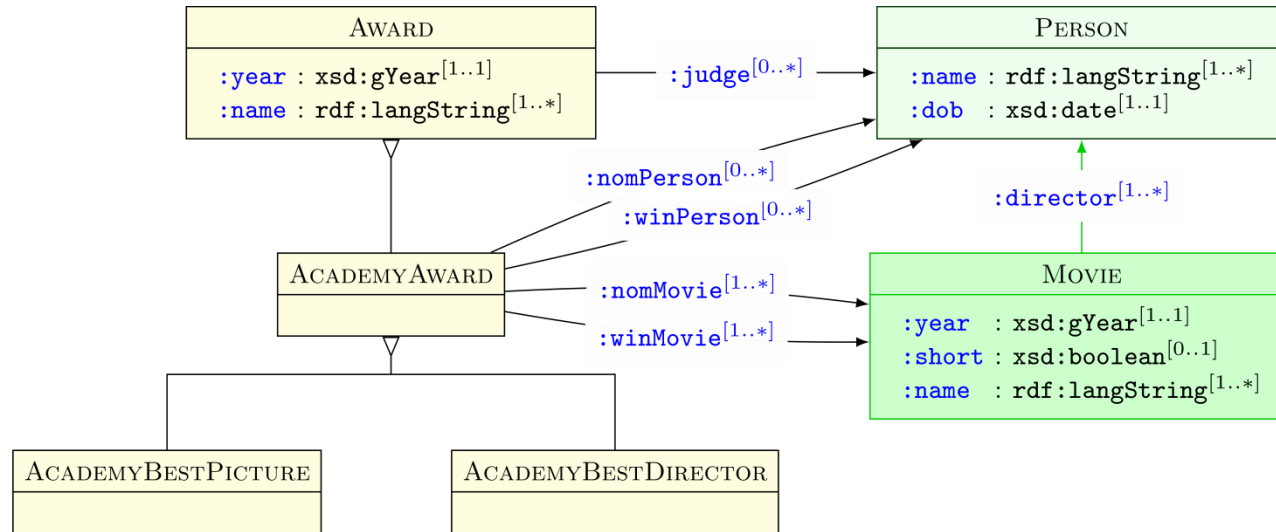
# SHACL: NODE AND PROPERTY SHAPES



```
@prefix : <http://ex.org/data/> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>.
@prefix s: <http://ex.org/shapes/> .
@prefix sh: <http://www.w3.org/ns/shacl#> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#>.

s:Person a sh:NodeShape ;
  sh:property [ sh:path :name ; sh:datatype rdf:langString ; sh:minCount 1 ] ;
  sh:property [ sh:path :dob ; sh:datatype xsd:date ; sh:minCount 1 ; sh:maxCount 1 ] .
```

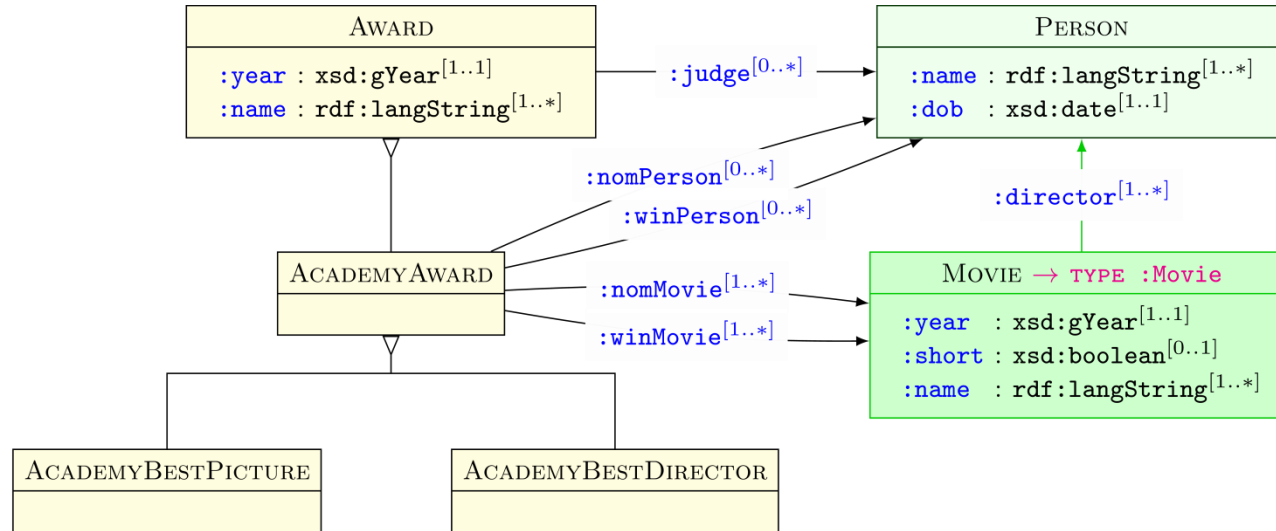
# SHACL: REFERENCING NODE SHAPES



```
#[...]
s:Person a sh:NodeShape ; #[...]

s:Movie a sh:NodeShape ;
  sh:property [ sh:path :year ; sh:datatype xsd:gYear ; sh:maxCount 1 ; sh:minCount 1 ] ;
  sh:property [ sh:path :short ; sh:datatype xsd:boolean ; sh:maxCount 1 ] ;
  sh:property [ sh:path :name ; sh:datatype rdf:langString ; sh:minCount 1 ] ;
  sh:property [ sh:path :director ; sh:node s:Person ; sh:minCount 1 ] .
```

# SHACL: TARGETS



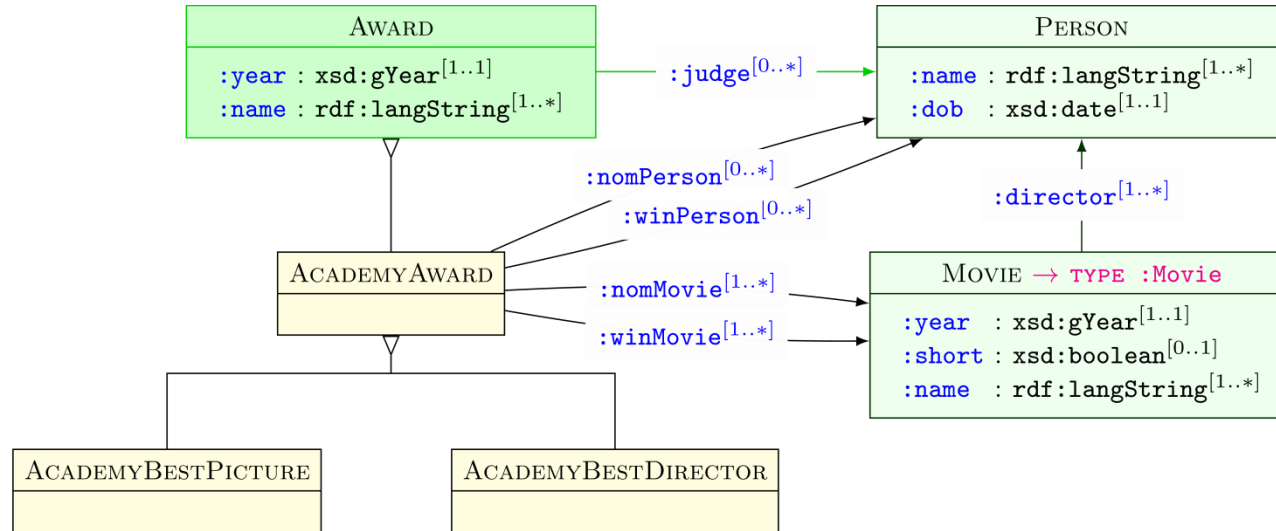
```

#[...]
s:Person a sh:NodeShape ; #[...]

s:Movie a sh:NodeShape ;
  sh:targetClass :Movie ;
  sh:property [ sh:path :year ; sh:datatype xsd:gYear ; sh:maxCount 1 ; sh:minCount 1 ] ;
  sh:property [ sh:path :short ; sh:datatype xsd:boolean ; sh:maxCount 1 ] ;
  sh:property [ sh:path :name ; sh:datatype rdf:langString ; sh:minCount 1 ] ;
  sh:property [ sh:path :director ; sh:node s:Person ; sh:minCount 1 ] .

```

# SHACL: INHERITANCE

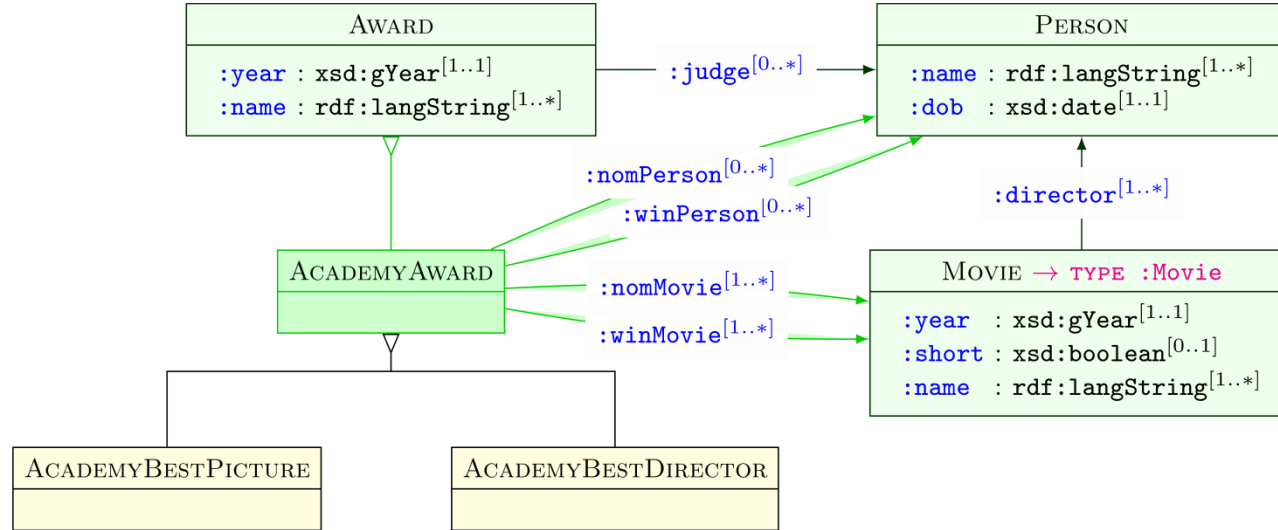


```

#[...]
s:Person a sh:NodeShape ; #[...]
s:Movie a sh:NodeShape ; #[...]

s:Award a sh:NodeShape ;
  sh:property [ sh:path :year ; sh:datatype xsd:gYear ; sh:maxCount 1 ; sh:minCount 1 ] ;
  sh:property [ sh:path :name ; sh:datatype rdf:langString ; sh:minCount 1 ] ;
  sh:property [ sh:path :judge ; sh:node s:Person ] .
  
```

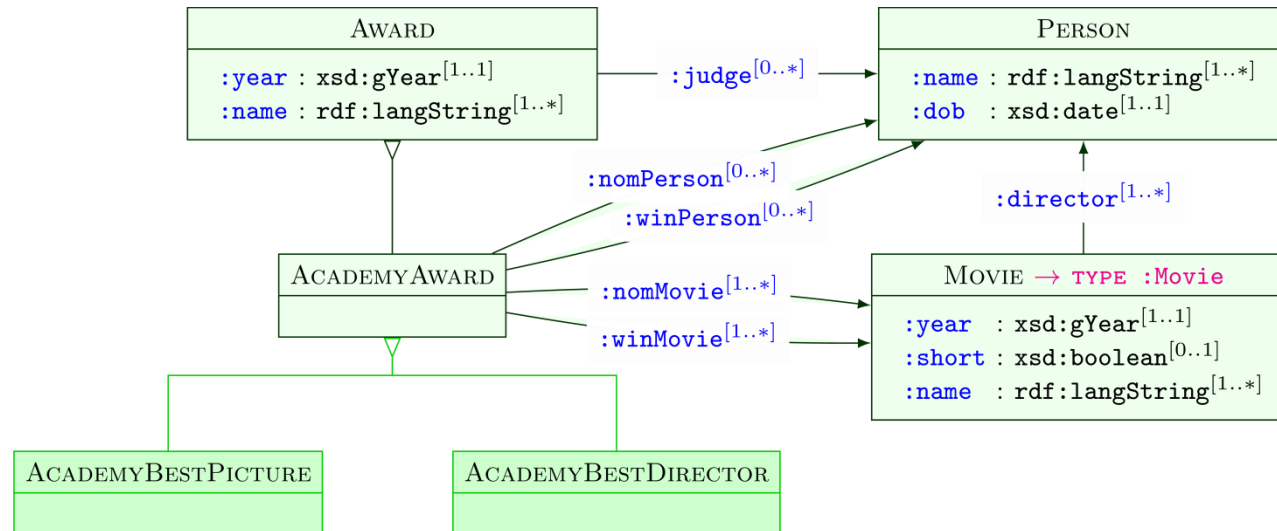
# SHACL: INHERITANCE



```
#[...]
s:Person a sh:NodeShape ; #[...]
s:Movie a sh:NodeShape ; #[...]
s:Award a sh:NodeShape ; #[...]

s:AcademyAward a sh:NodeShape ;
  sh:node s:Award ;
  sh:property [ sh:path :nomPerson ; sh:node s:Person ] ;
  sh:property [ sh:path :winPerson ; sh:node s:Person ] ;
  sh:property [ sh:path :nomMovie ; sh:node s:Movie ; sh:minCount 1 ] ;
  sh:property [ sh:path :winMovie ; sh:node s:Movie ; sh:minCount 1 ] ;
```

# SHACL: INHERITANCE



```
#[...]
s:Person a sh:NodeShape ; #[...]
s:Movie a sh:NodeShape ; #[...]
s:Award a sh:NodeShape ; #[...]
s:AcademyAward a sh:NodeShape ; #[...]

s:AcademyBestPicture a sh:NodeShape ;
  sh:node s:AcademyAward .

s:AcademyBestDirector a sh:NodeShape ;
  sh:node s:AcademyAward .
```

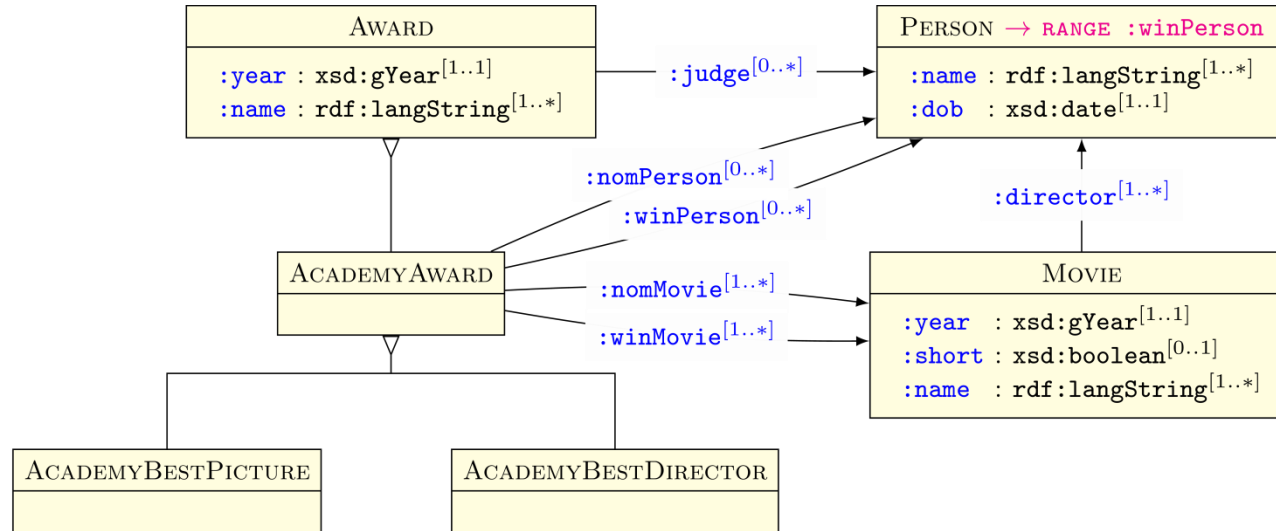


SHACL:  
TARGETS

# SHACL: TARGETS

- `sh:targetClass` instances of a class
- `sh:targetSubjectsOf` domain of a property
- `sh:targetObjectsOf` range of a property
- `sh:targetNode` a specific node

# SHACL: TARGETING RANGE



```

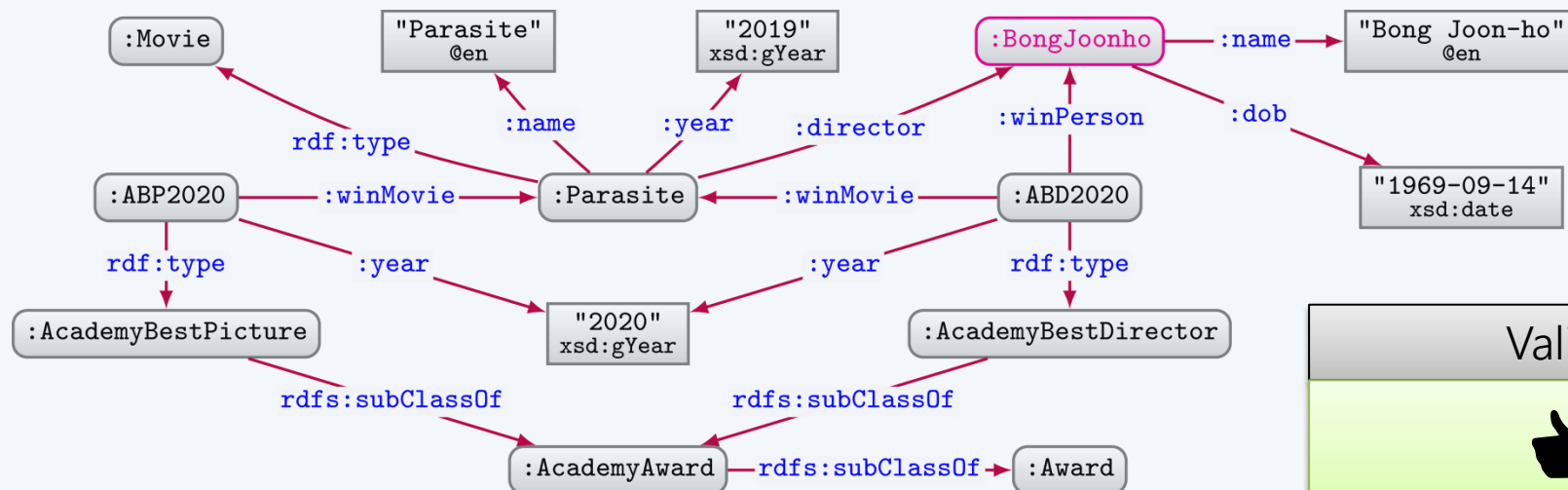
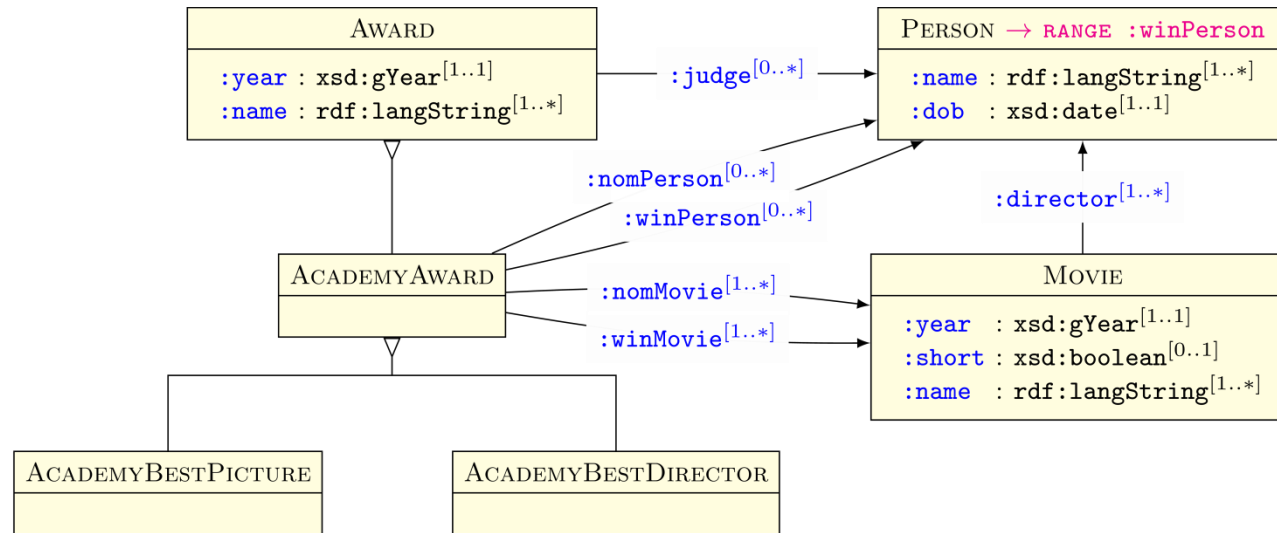
@prefix : <http://ex.org/data/> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>.
@prefix s: <http://ex.org/shapes/> .
@prefix sh: <http://www.w3.org/ns/shacl#> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#>.

s:Person a sh:NodeShape ;
  sh:targetObjectsOf :winPerson ;
  sh:property [ sh:path :name ; sh:datatype rdf:langString ; sh:minCount 1 ] ;
  sh:property [ sh:path :dob ; sh:datatype xsd:date ; sh:minCount 1 ; sh:maxCount 1 ] .

#[...]

```

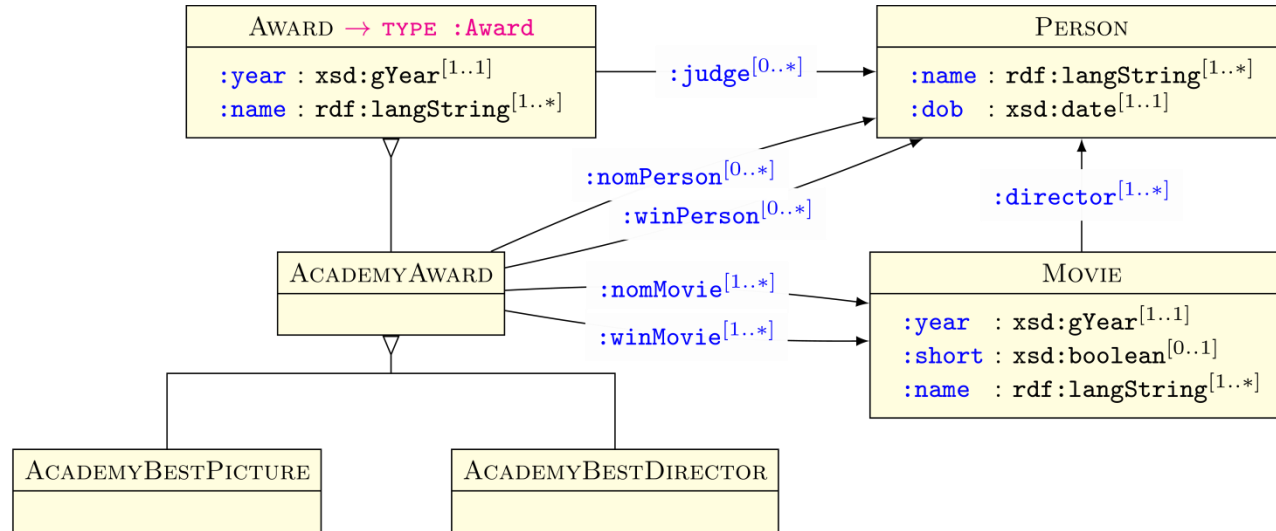
# SHACL: TARGETING RANGE



Valid?



# SHACL: TARGETING SUBCLASSES

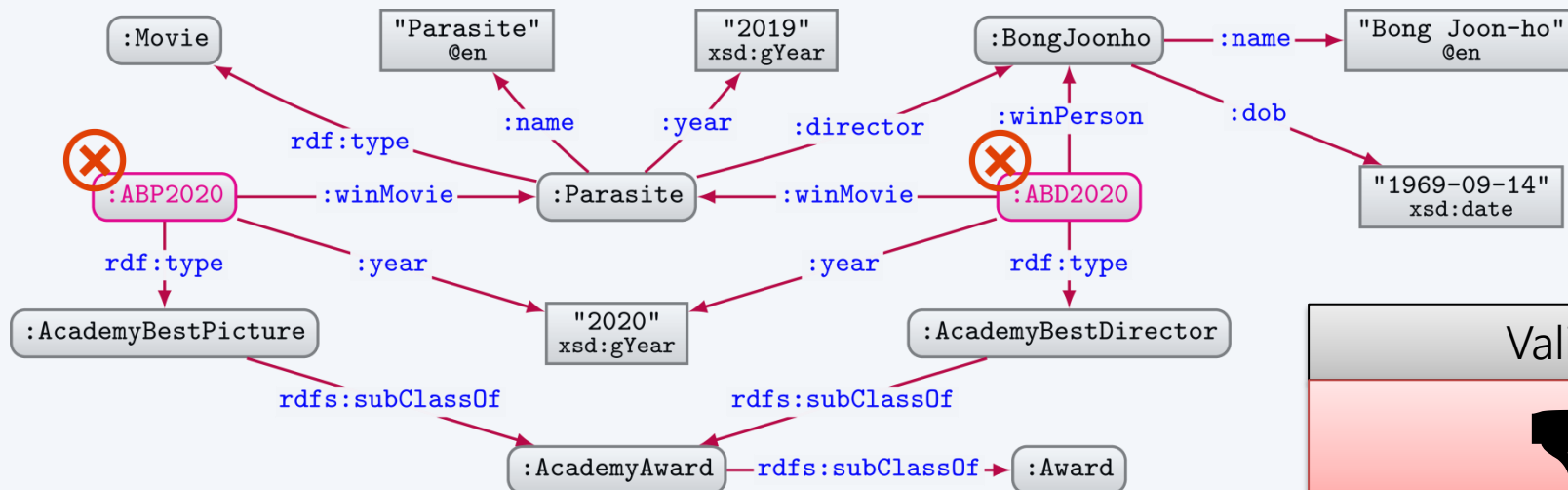
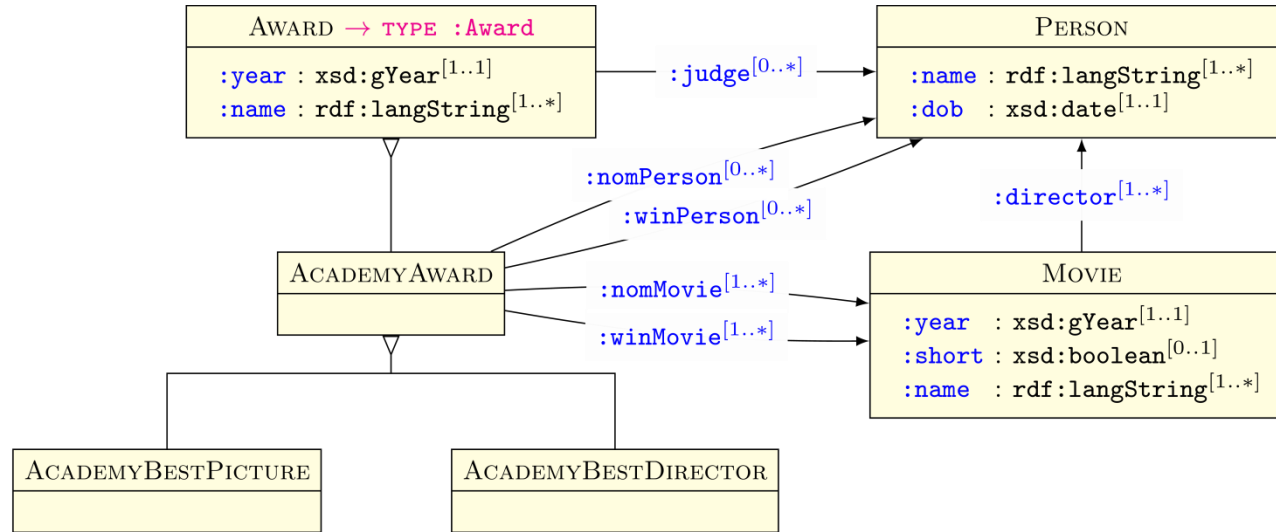


```
#[...]
s:Person a sh:NodeShape ; #[...]
s:Movie a sh:NodeShape ; #[...]

s:Award a sh:NodeShape ;
  sh:targetClass :Award ;
  sh:property [ sh:path :year ; sh:datatype xsd:gYear ; sh:maxCount 1 ; sh:minCount 1 ] ;
  sh:property [ sh:path :name ; sh:datatype rdf:langString ; sh:minCount 1 ] ;
  sh:property [ sh:path :judge ; sh:node s:Person ] .

# [...]
```

# SHACL: TARGETS SUBCLASSES



Valid?



SHACL:

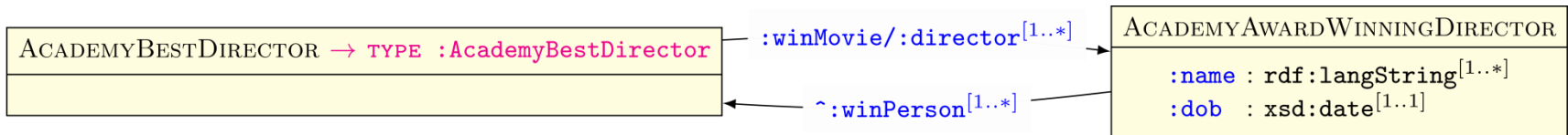
PATHS

# SHACL: PATHS

- |  |                        |                                     |
|--|------------------------|-------------------------------------|
| • <code>:p</code>                                    | property               | <code>(:p)</code>                   |
| • <code>[ sh:inversePath <i>e</i> ]</code>           | inverse of <i>e</i>    | <code>(<sup>^</sup><i>e</i>)</code> |
| • <code>( <i>e f</i> )</code>                        | <i>e</i> then <i>f</i> | <code>(<i>e/f</i>)</code>           |
| • <code>[ sh:alternativePath ( <i>e f</i> ) ]</code> | <i>e</i> or <i>f</i>   | <code>(<i>e f</i>)</code>           |
| • <code>[ sh:zeroOrMorePath <i>e</i> ]</code>        | recursive <i>e</i>     | <code>(<i>e</i>*)</code>            |
| • <code>[ sh:oneOrMorePath <i>e</i> ]</code>         | recursive+ <i>e</i>    | <code>(<i>e</i>*)</code>            |
| • <code>[ sh:zeroOrOnePath <i>e</i> ]</code>         | optional <i>e</i>      | <code>(<i>e</i>?)</code>            |

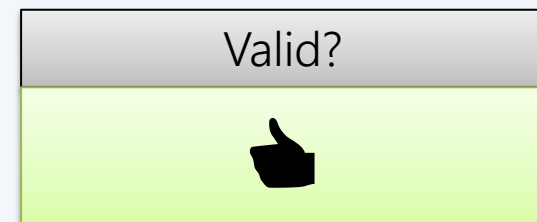
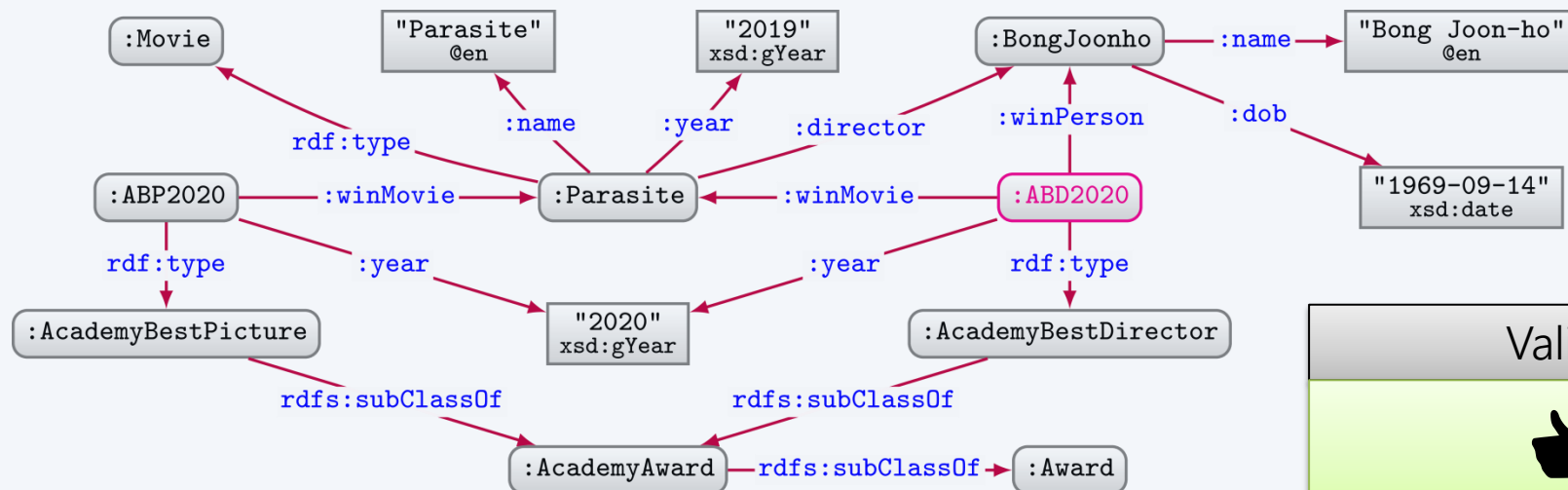
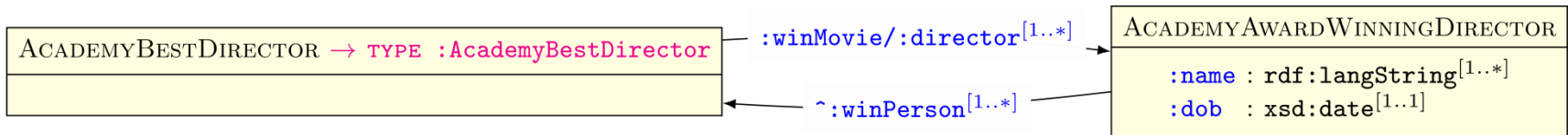


# SHACL: PATHS

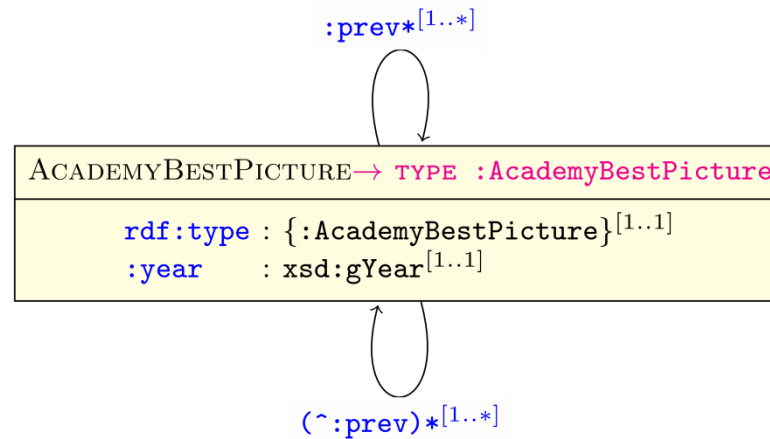


```
#[...]  
  
s:AcademyBestDirector a sh:NodeShape ;  
  sh:targetClass :AcademyBestDirector .  
  sh:property [  
    sh:path ( :winMovie :director ) ;  
    sh:node s:AcademyAwardWinningDirector ; sh:minCount 1  
  ] .  
  
s:AcademyAwardWinningDirector a sh:NodeShape ;  
  sh:property [ sh:path :name ; sh:datatype rdf:langString ; sh:minCount 1 ] ;  
  sh:property [ sh:path :dob ; sh:datatype xsd:date ; sh:minCount 1 ; sh:maxCount 1 ] ;  
  sh:property [  
    sh:path [ sh:inversePath :winPerson ] ;  
    sh:node s:AcademyBestDirector ; sh:minCount 1  
  ] .  
  
#[...]
```

# SHACL: PATHS

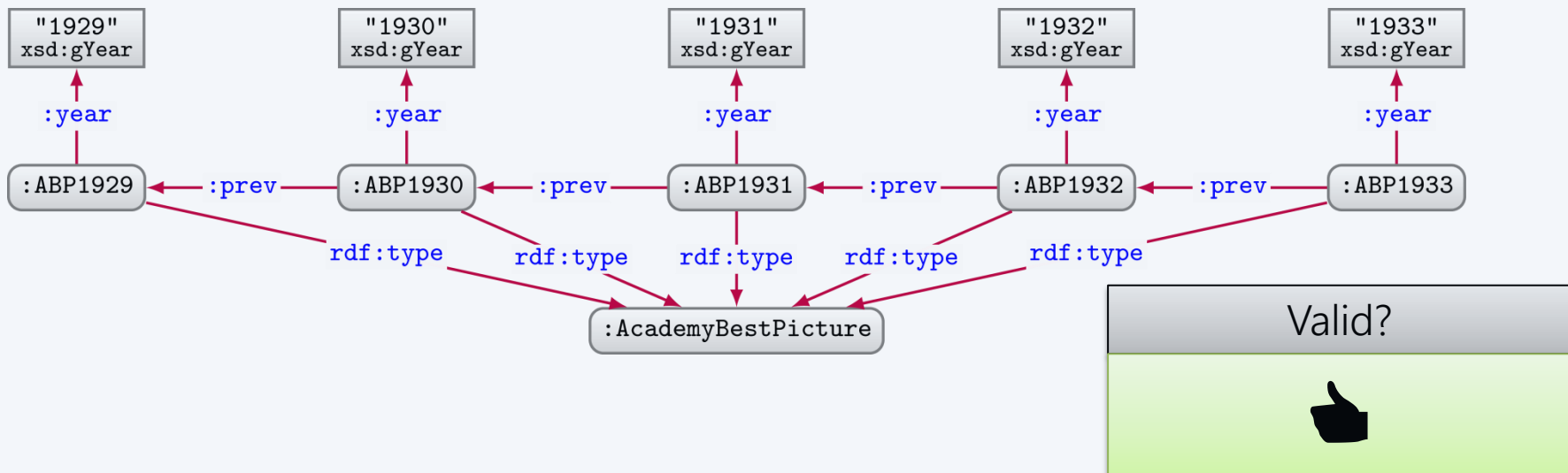
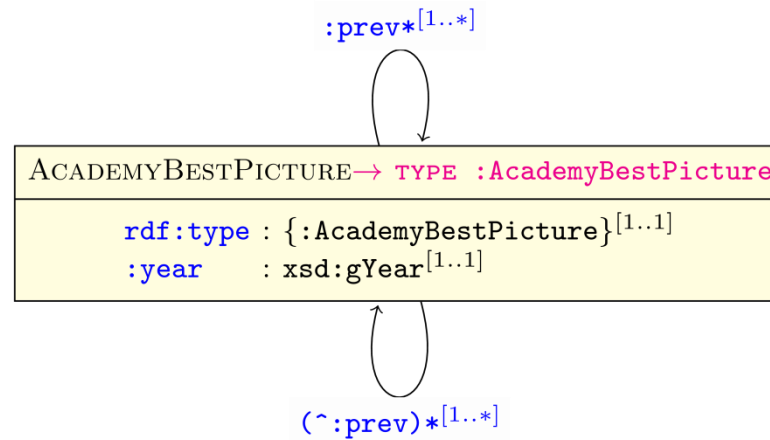


# SHACL: PATHS



```
#[...]  
  
s:AcademyBestPicture a sh:NodeShape ;  
  sh:targetClass :AcademyBestPicture ;  
  sh:class :AcademyBestPicture ;  
  sh:property [ sh:path :year ; sh:datatype xsd:gYear ] ;  
  sh:property [  
    sh:path [ sh:zeroOrMorePath :prev ] ;  
    sh:node s:AcademyBestPicture ; sh:minCount 1  
  ] ;  
  sh:property [  
    sh:path [ sh:zeroOrMorePath [ sh:inversePath :prev ] ] ;  
    sh:node s:AcademyBestPicture ; sh:minCount 1  
  ] .  
  
#[...]
```

# SHACL: PATHS



SHACL:

CORE CONSTRAINTS

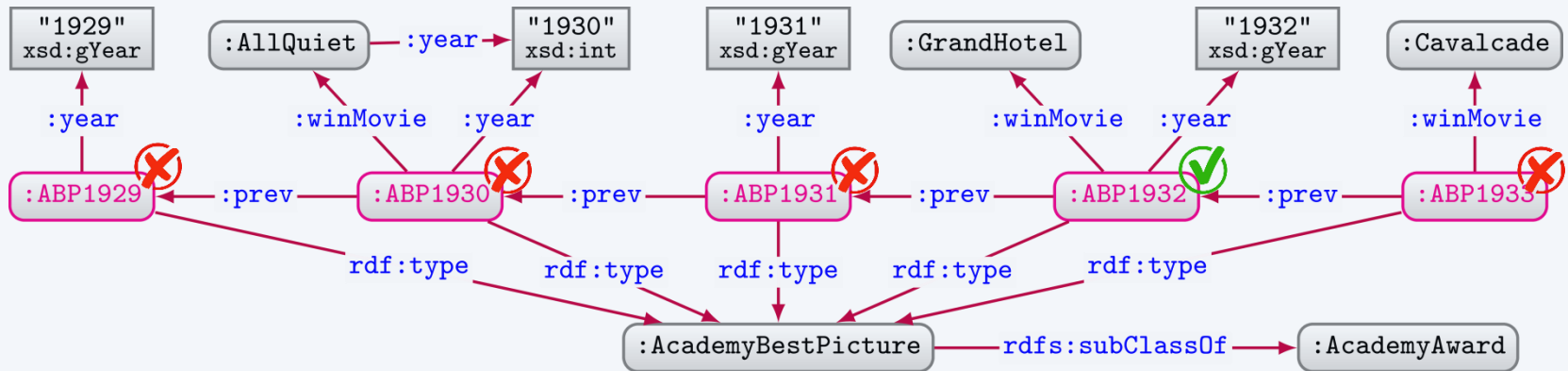
# SHACL: SHAPE CONSTRAINTS

Given  $\phi$  a shape and  $e$  a path ...

- `sh:node  $\phi$`                       all target nodes in  $N$  satisfy shape  $\phi$
- `sh:property  $\phi, e$`               all value nodes  $V_n^e$  connected by path  $e$  from each target node  $n \in N$  satisfy shape  $\phi$

```
#[...]  
s:Movie a sh:NodeShape ;  
  sh:property [ sh:path :year ; sh:datatype xsd:gYear ] .  
  
s:Award a sh:NodeShape ;  
  sh:property [ sh:path :year ; sh:datatype xsd:gYear ; sh:minCount 1 ] .  
  
s:AcademyAward a sh:NodeShape ;  
  sh:targetClass :AcademyAward ;  
  sh:node s:Award ;  
  sh:property [ sh:path :winMovie ; sh:node s:Movie ; sh:minCount 1 ] .
```

# SHACL: SHAPE CONSTRAINTS



```
#[...]  
s:Movie a sh:NodeShape ;  
  sh:property [ sh:path :year ; sh:datatype xsd:gYear ] .  
  
s:Award a sh:NodeShape ;  
  sh:property [ sh:path :year ; sh:datatype xsd:gYear ; sh:minCount 1 ] .  
  
s:AcademyAward a sh:NodeShape ;  
  sh:targetClass :AcademyAward ;  
  sh:node s:Award ;  
  sh:property [ sh:path :winMovie ; sh:node s:Movie ; sh:minCount 1 ] .
```

# SHACL: BOOLEAN CONSTRAINTS

Assuming that  $\phi, \phi_1, \dots, \phi_n$  are shapes then ...

- $sh: \text{not } \phi$  negation  $(\neg \phi)$
- $sh: \text{or } ( \phi_1 \dots \phi_n )$  disjunction  $(\phi_1 \vee \dots \vee \phi_n)$
- $sh: \text{and } ( \phi_1 \dots \phi_n )$  conjunction  $(\phi_1 \wedge \dots \wedge \phi_n)$
- $sh: \text{xone } ( \phi_1 \dots \phi_n )$  excl. disjunction  $(\phi_1 \oplus \dots \oplus \phi_n)$

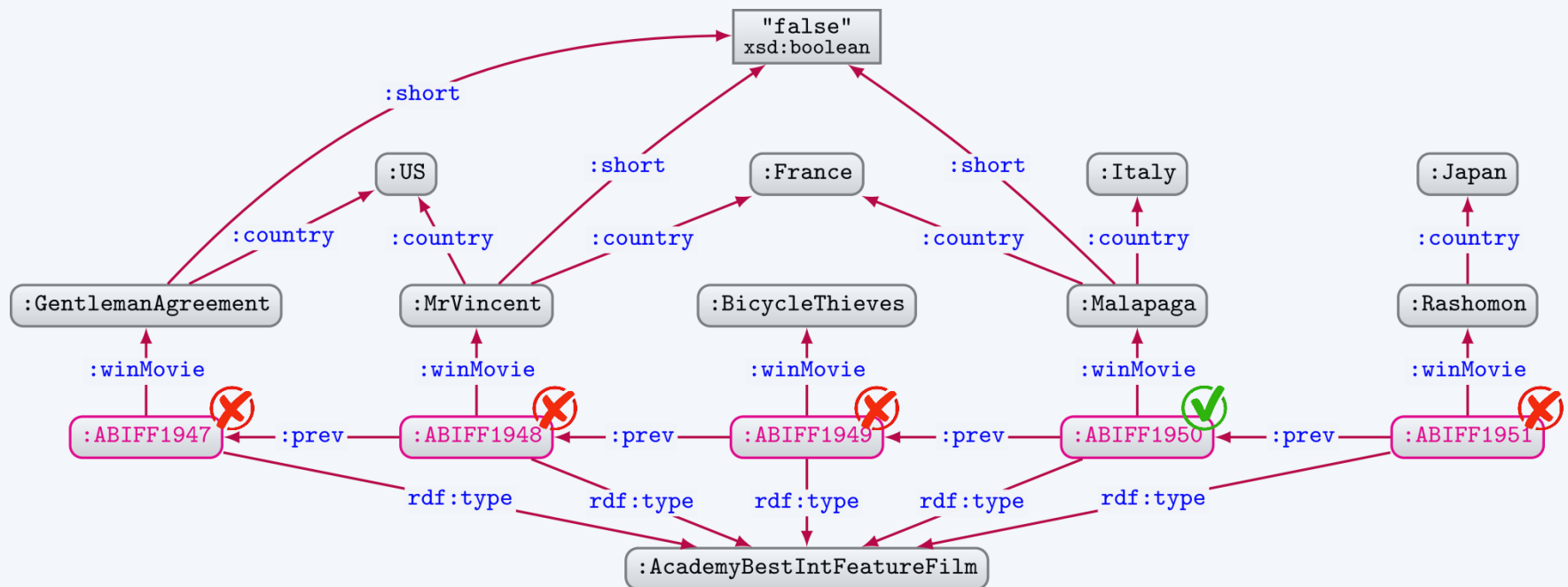
... are also shapes.

```
#[...]
s:FromUS a sh:NodeShape ; sh:property [ sh:path :country ; sh:hasValue :US ] .
s:FeatureMovie a sh:NodeShape ; sh:property [ sh:path :short ; sh:hasValue false ] .

s:AcademyBestIntFeatureFilm a sh:NodeShape ;
  sh:targetClass :AcademyBestIntFeatureFilm ;
  sh:property [
    sh:path :winMovie ;
    sh:and ( [ sh:not s:FromUS ] s:FeatureMovie ) ;
    sh:minCount 1 ; sh:maxCount 1
  ] .
```



# SHACL: BOOLEAN CONSTRAINTS



```
#[...]
s:FromUS a sh:NodeShape ; sh:property [ sh:path :country ; sh:hasValue :US ] .
s:FeatureMovie a sh:NodeShape ; sh:property [ sh:path :short ; sh:hasValue false ] .

s:AcademyBestIntFeatureFilm a sh:NodeShape ;
  sh:targetClass :AcademyBestIntFeatureFilm ;
  sh:property [
    sh:path :winMovie ;
    sh:and ( [ sh:not s:FromUS ] s:FeatureMovie ) ;
    sh:minCount 1 ; sh:maxCount 1
  ] .
```

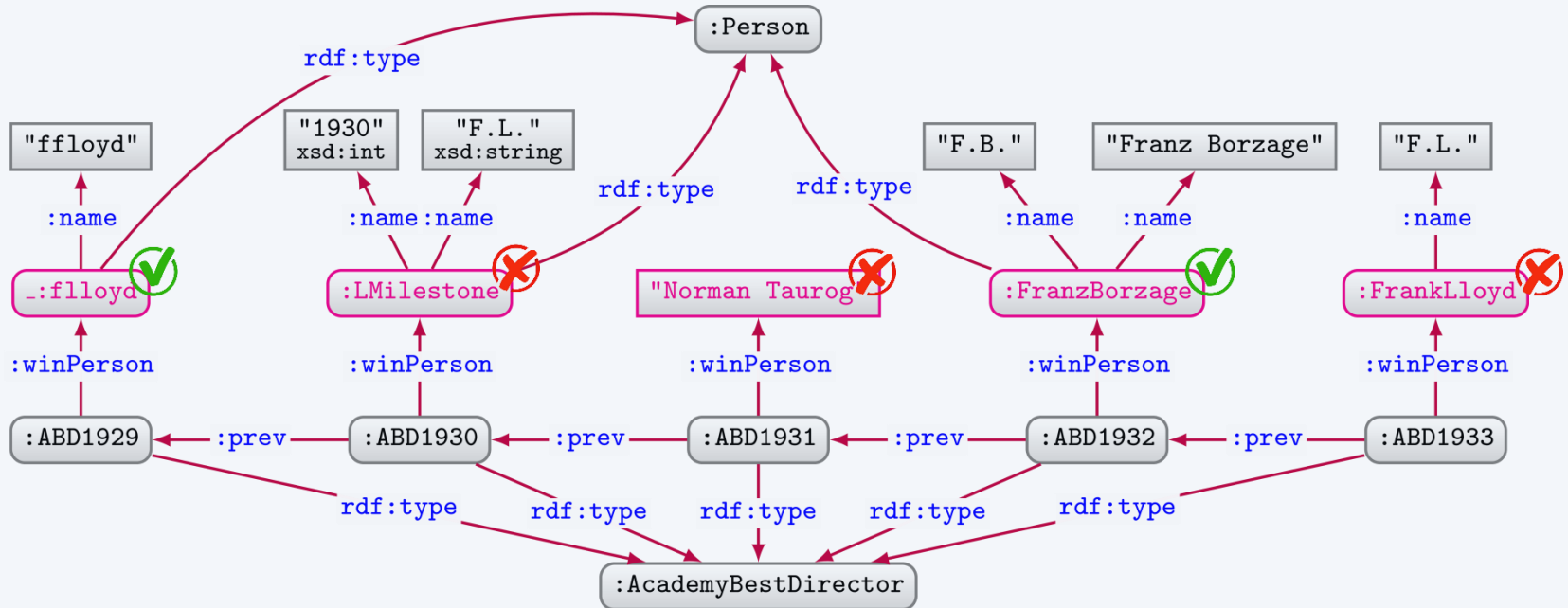
# SHACL: VALUE TYPE CONSTRAINTS

For each node  $n \in N$  it holds that:

- `sh:class  $C$`   $n$  is an instance of class  $C$
- `sh:datatype  $D$`   $n$  has the datatype  $D$
- `sh:nodeKind  $K$`   $n$  is of kind  $K$ 
  - $K$  can be: `sh:BlankNode`, `sh:IRI`, `sh:Literal`, `sh:BlankNodeOrIRI`, `sh:BlankNodeOrLiteral`, `sh:IRIOrLiteral`

```
#[...]  
  
s:Person a sh:NodeShape ;  
  sh:targetObjectsOf :winPerson ;  
  sh:class :Person ;  
  sh:nodeKind sh:BlankNodeOrIRI ;  
  sh:property [ sh:path :name ; sh:datatype xsd:string ; sh:minCount 1 ] .
```

# SHACL: VALUE TYPE CONSTRAINTS



# SHACL: VALUE RANGE CONSTRAINTS

For each node  $n \in N$  it holds that:

- `sh:minInclusive  $m$`                        $n \geq m$
- `sh:maxInclusive  $m$`                        $n \leq m$
- `sh:minExclusive  $m$`                        $n > m$
- `sh:maxExclusive  $m$`                        $n \leq m$

```
#[...]
```

```
s:AcademyBestPicture a sh:NodeShape ;  
  sh:targetClass :AcademyBestPicture ;  
  sh:property [ sh:path :year ; sh:datatype xsd:gYear ; sh:minInclusive "1929"^^xsd:gYear ] .
```

```
s:AcademyBestPicture a sh:NodeShape ;
  sh:targetClass :AcademyBestPicture ;
  sh:property [ sh:path :year ; sh:datatype xsd:gYear ; sh:minInclusive "1929"^^xsd:gYear ] .
```

# SHACL: VALUE RANGE CONSTRAINTS

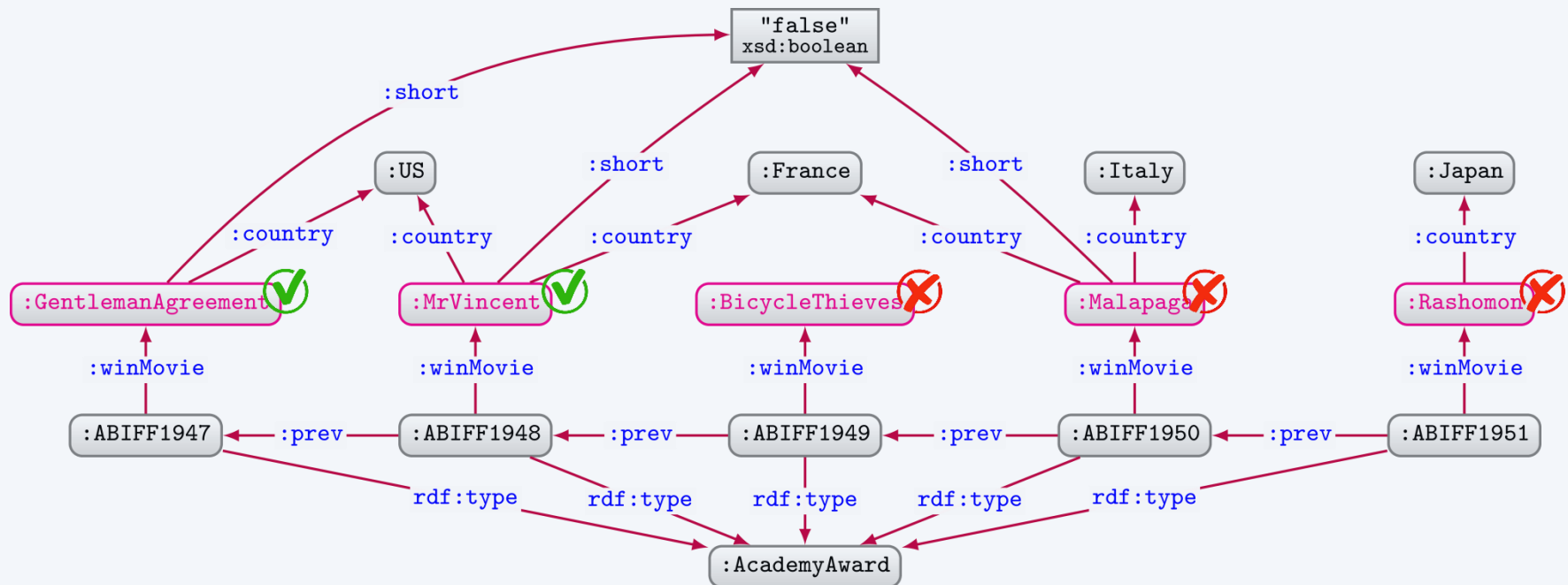
For the set of nodes  $N$  it holds that:

- $\text{sh:hasValue } v$   $v \in N$
- $\text{sh:in } ( v_1 \dots v_n )$   $N \subseteq \{ v_1, \dots, v_n \}$

```
#[...]
```

```
s:USMovie a sh:NodeShape ;  
  sh:targetObjectsOf :winMovie ;  
  sh:property [ sh:path :country ; sh:hasValue :US ] .
```

# SHACL: VALUE RANGE CONSTRAINTS



#[...]

```
s:USMovie a sh:NodeShape ;  
  sh:targetObjectsOf :winMovie ;  
  sh:property [ sh:path :country ; sh:hasValue :US ] .
```

# SHACL: STRING-BASED CONSTRAINTS

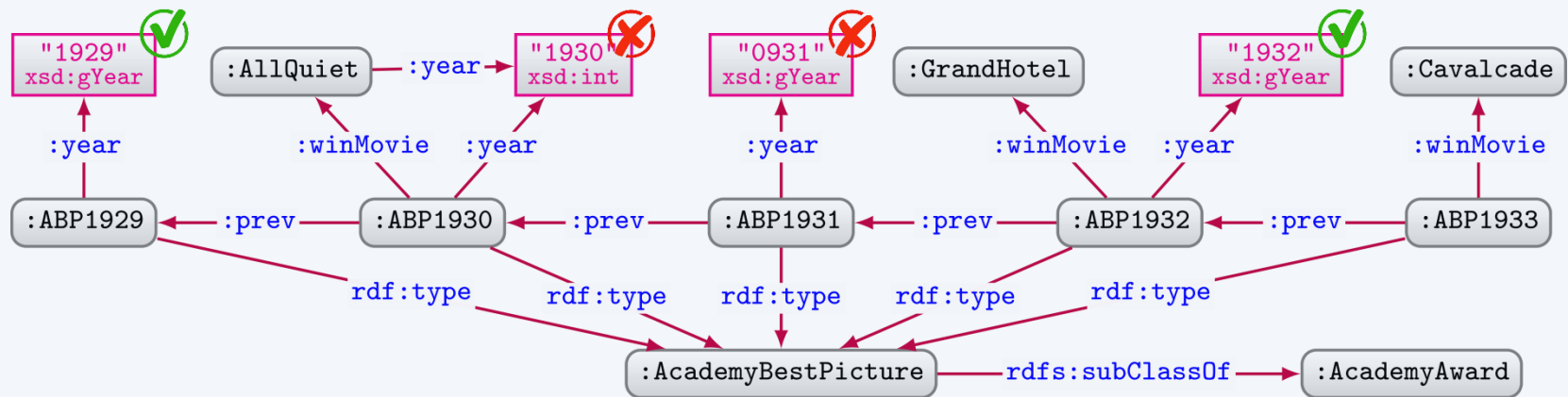
Each node  $n \in N$  is not a blank node and:

- `sh:minLength  $m$`  has string length  $\geq m$
- `sh:maxLength  $m$`  has string length  $\leq m$
- `sh:pattern  $p, f$`  matches regex  $p$  with flags  $f$

```
#[...]  
  
s:ModernYear a sh:NodeShape ;  
  sh:targetObjectsOf :year ;  
  sh:datatype xsd:gYear ;  
  sh:minLength 4 ;  
  sh:maxLength 4 ;  
  sh:pattern "(19|20)[0-9][0-9]" ;  
  sh:flags "i" . # case insensitive pattern (just for the example)
```



# SHACL: STRING-BASED CONSTRAINTS



#[...]

```
s:ModernYear a sh:NodeShape ;
  sh:targetObjectsOf :year ;
  sh:datatype xsd:gYear ;
  sh:minLength 4 ;
  sh:maxLength 4 ;
  sh:pattern "(19|20)[0-9][0-9]" ;
  sh:flags "i" . # case insensitive pattern (just for the example)
```

# SHACL: STRING-BASED CONSTRAINTS

Each node  $n \in N$  is a literal and:

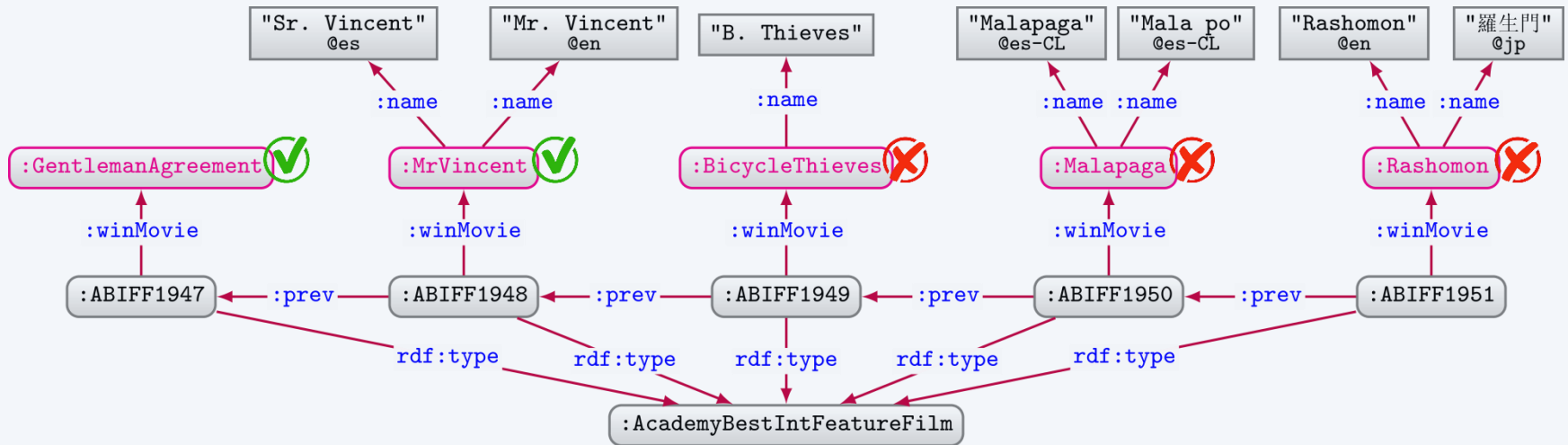
- `sh:languageIn (  $l_1 \dots l_n$  )` has a lang. tag matching  $l \in \{l_1, \dots, l_n\}$

Each node  $n \in N$ :

- `sh:uniqueLang true` has no lang. tag, an empty lang. tag or  
or a lang. tag unique in  $N$

```
#[...]  
  
s:MovieHasUniqueEnglishSpanishName a sh:NodeShape ;  
  sh:targetObjectsOf :winMovie ;  
  sh:property [  
    sh:path :name ;  
    sh:languageIn ( "es" "en" ) ; # will also match "es-CL", etc.  
    sh:uniqueLang true  
  ] .
```

# SHACL: STRING-BASED CONSTRAINTS



```
#[...]  
  
s:MovieHasUniqueEnglishSpanishName a sh:NodeShape ;  
  sh:targetObjectsOf :winMovie ;  
  sh:property [  
    sh:path :name ;  
    sh:languageIn ( "es" "en" ) ; # will also match "es-CL", etc.  
    sh:uniqueLang true  
  ] .
```

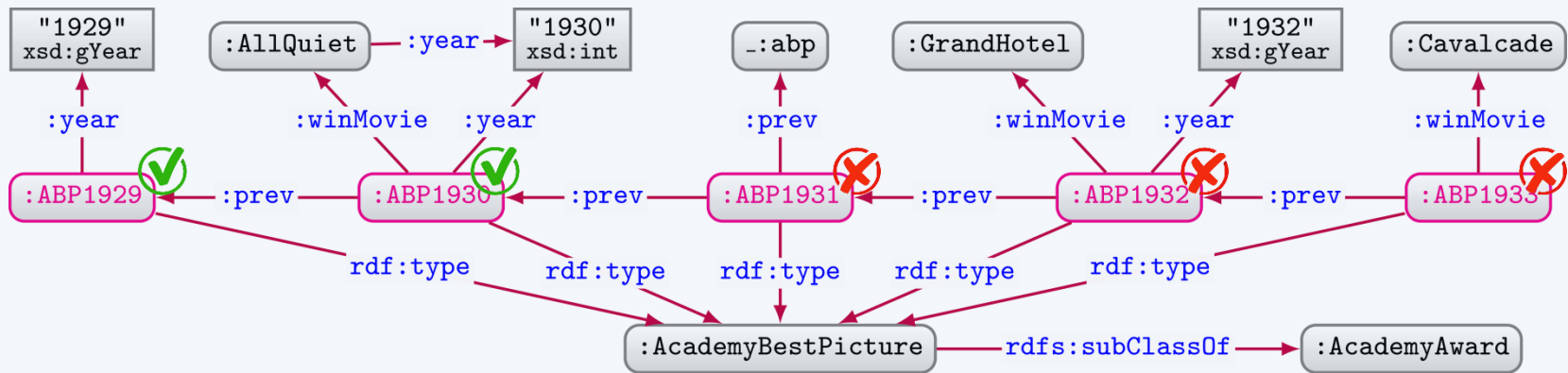
# SHACL: CARDINALITY CONSTRAINTS

Given a path  $e$ , for each node  $n \in N$ , there are ...

- `sh:maxCount  $m$`  at most  $m$  nodes in  $V_n^e$
- `sh:minCount  $m$`  at least  $m$  nodes in  $V_n^e$
- `sh:qualifiedMinCount  $m, \phi$`  at least  $m$  nodes in  $V_n^e$  that satisfy  $\phi$
- `sh:qualifiedMaxCount  $m, \phi$`  at most  $m$  nodes in  $V_n^e$  that satisfy  $\phi$

```
#[...]  
  
s:FirstInSeries a sh:NodeShape ;  
  sh:property [ sh:path :prev ; sh:maxCount 0 ] .  
  
s:AcademyBestPicture a sh:NodeShape ;  
  sh:targetClass :AcademyBestPicture ;  
  sh:property [  
    sh:path [ sh:zeroOrMorePath :prev ] ;  
    sh:qualifiedMaxCount 1 ;  
    sh:qualifiedMinCount 1 ;  
    sh:qualifiedValueShape s:FirstInSeries  
  ] .
```

# SHACL: CARDINALITY CONSTRAINTS



```
#[...]  
  
s:FirstInSeries a sh:NodeShape ;  
  sh:property [ sh:path :prev ; sh:maxCount 0 ] .  
  
s:AcademyBestPicture a sh:NodeShape ;  
  sh:targetClass :AcademyBestPicture ;  
  sh:property [  
    sh:path [ sh:zeroOrMorePath :prev ] ;  
    sh:qualifiedMaxCount 1 ;  
    sh:qualifiedMinCount 1 ;  
    sh:qualifiedValueShape s:FirstInSeries  
  ] .
```

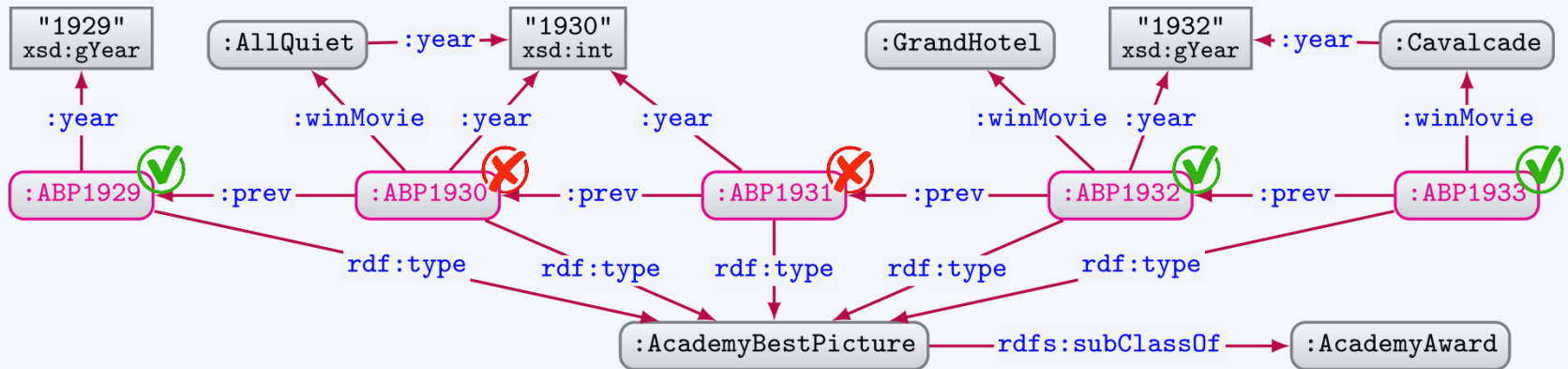
# SHACL: PROPERTY-PAIR CONSTRAINTS

Given a path  $e$ , for each target node  $n \in N$ , it holds that ...

- `sh:equals  $p$`   $V_n^e = V_n^f$
- `sh:disjoint  $p$`   $V_n^e \cap V_n^f = \emptyset$
- `sh:lessThan  $p$`   $\max(V_n^e) < \min(V_n^f)$
- `sh:lessThanOrEquals  $p$`   $\max(V_n^e) \leq \min(V_n^f)$

```
#[...]  
  
s:AcademyBestPicture a sh:NodeShape ;  
  sh:targetClass :AcademyBestPicture ;  
  sh:property [  
    sh:path ( :winMovie :year ) ;  
    sh:lessThan :year  
  ] ;  
  sh:property [  
    sh:path [  
      [ sh:alternativePath (  
        [ sh:oneOrMorePath [ sh:inversePath :prev ] ] [ sh:oneOrMorePath :prev ]  
      ) ]  
      :year  
    ] ;  
    sh:disjoint :year  
  ] .
```

# SHACL: PROPERTY-PAIR CONSTRAINTS



```
#[...]
```

```
s:AcademyBestPicture a sh:NodeShape ;
  sh:targetClass :AcademyBestPicture ;
  sh:property [
    sh:path ( :winMovie :year ) ;
    sh:lessThan :year
  ] ;
  sh:property [
    sh:path [
      [ sh:alternativePath (
        [ sh:oneOrMorePath [ sh:inversePath :prev ] ] [ sh:oneOrMorePath :prev ]
      ) ]
      :year
    ] ;
    sh:disjoint :year
  ] .
```

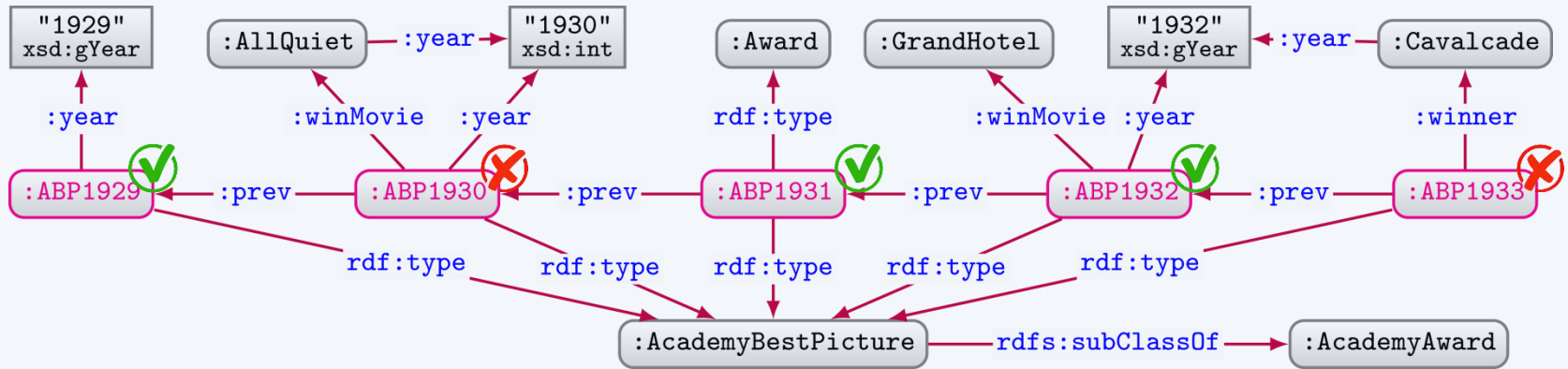
# SHACL: CLOSED CONSTRAINTS

- `sh:closed true` only properties in shapes graph allowed
  - `sh:ignoredProperties` optional list of exceptions

```
#[...]
s:AcademyAward a sh:NodeShape ;
  sh:targetClass :AcademyAward ;
  sh:property [ sh:path :winMovie ; sh:nodeKind sh:IRI ] ;
  sh:property [ sh:path :year ; sh:datatype xsd:gYear ] ;
  sh:closed true ; sh:ignoredProperties ( :prev rdf:type ) .
```



# SHACL: CLOSED CONSTRAINTS

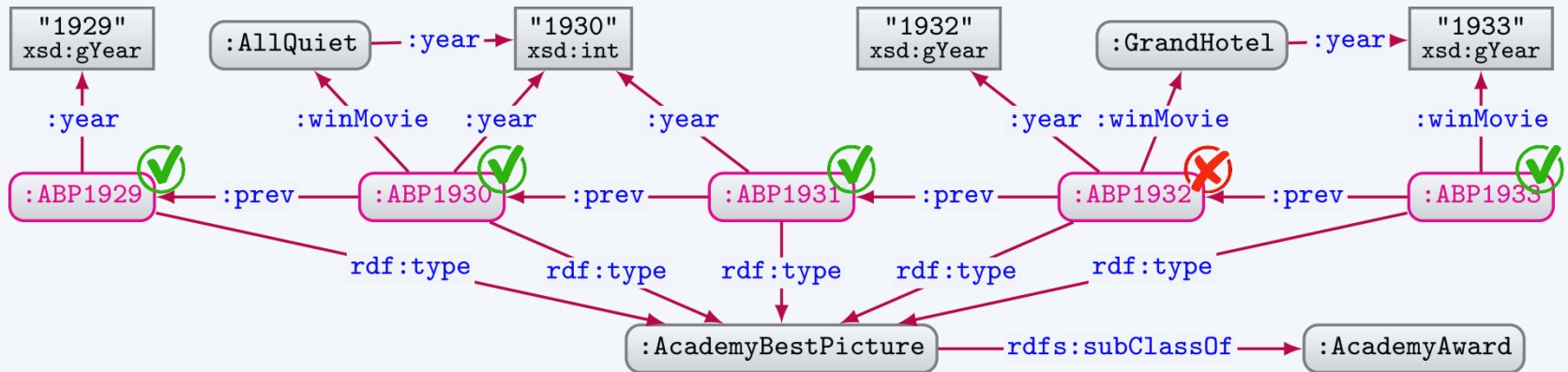


```
#[...]
s:AcademyAward a sh:NodeShape ;
  sh:targetClass :AcademyAward ;
  sh:property [ sh:path :winMovie ; sh:nodeKind sh:IRI ] ;
  sh:property [ sh:path :year ; sh:datatype xsd:gYear ] ;
  sh:closed true ; sh:ignoredProperties ( :prev rdf:type ) .
```

SHACL:

SPARQL CONSTRAINTS

# SHACL: SPARQL CONSTRAINTS



```
#[...]
s:AcademyBestPicture a sh:NodeShape ;
  sh:targetClass :AcademyBestPicture ;
  sh:sparql [
    a sh:SPARQLConstraint ;
    sh:select """
      PREFIX : <http://ex.org/data/>
      PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
      SELECT $this (:year AS ?path) ?value
      WHERE {
        $this :year ?value .
        $this :winMovie/:year ?yearM .
        FILTER(xsd:int(str(?yearM))+1 != xsd:int(str(?value))
          && xsd:int(str(?yearM)) != xsd:int(str(?value)))
      }
    """
  ] .
```

Results indicate  
constraint violations.

\$this will be replaced  
with target nodes.

SHEx:

SHAPE EXPRESSIONS LANGUAGE

# Shape Expressions Language 2.1

Final Community Group Report 8 October 2019



## **This version:**

<http://shex.io/shex-semantic-20191008/>

## **Latest published version:**

<http://shex.io/shex-semantic/>

## **Editor's draft:**

<https://shexspec.github.io/spec/>

## **Previous version:**

<http://shex.io/shex-semantic-20181122/>

## **Test suite:**

<https://github.com/shexSpec/shexTest>

## **Bug tracker:**

[File a bug \(open bugs\)](#)

## **Editors:**

[Eric Prud'hommeaux \(W3C/MIT\)](#)

[Iovka Boneva \(University of Lille\)](#)

[Jose Emilio Labra Gayo \(University of Oviedo\)](#)

[Gregg Kellogg \(Spec-Ops\)](#)

## **Participate:**

[GitHub shexSpec/spec](#)

[File a bug](#)

[Commit history](#)

[Pull requests](#)

# SHEx: SHAPE EXPRESSIONS LANGUAGE

```
prefix : <http://ex.org/data/>
prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
prefix xsd: <http://www.w3.org/2001/XMLSchema#>
```

```
:Award {
  :year    xsd:gYear ;
  :name    rdf:langString + ;
  :judge   @:Person *
}
```

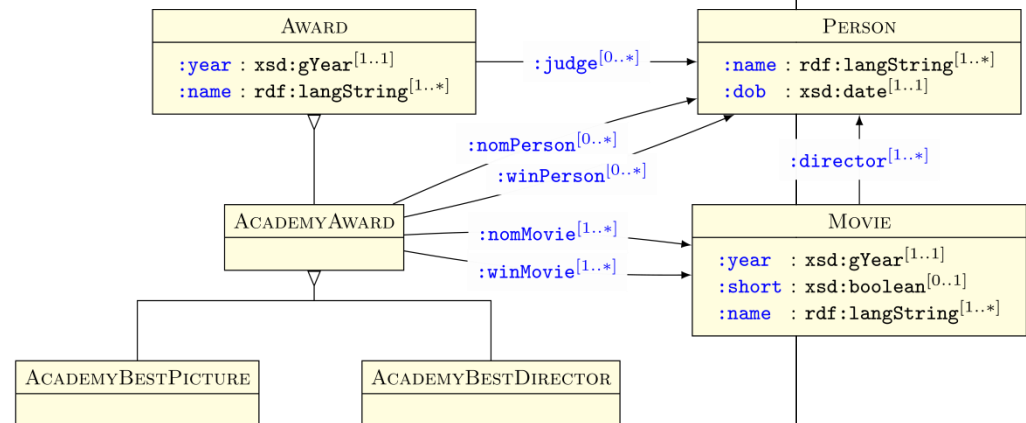
```
:AcademyAward @:Award AND {
  :winMovie @:Movie + ;
  :nomMovie @:Movie + ;
  :winPerson @:Person * ;
  :nomPerson @:Person *
}
```

```
:AcademyBestDirector @:AcademyAward
```

```
:AcademyBestPicture @:AcademyAward
```

```
:Person {
  :name    rdf:langString + ;
  :dob     xsd:date
}
```

```
:Movie {
  :year    xsd:gYear ;
  :short   xsd:boolean ? ;
  :name    rdf:langString + ;
  :director @:Person +
}
```



# SHEx: USED BY WIKIDATA



EntitySchema

Discussion

Read

View history

**actor** (E25)

```
PREFIX p: <http://www.wikidata.org/prop/>
PREFIX wd: <http://www.wikidata.org/entity/>
PREFIX wdt: <http://www.wikidata.org/prop/direct/>

start = @<actor>

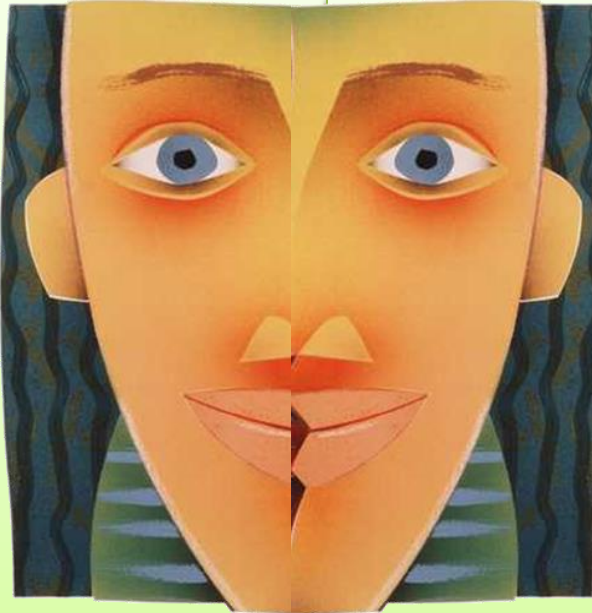
<actor> {
    wdt:P31 [wd:Q5] ;
    wdt:P21 . ;
    wdt:P106 . * ;
    wdt:P106 [ wd:Q33999 wd:Q21169216]
}
```

SHAPES:

(OPTIONAL) VALIDATING SCHEMA!



We don't have to impose a  
structure (schema)  
from the start



... and we can impose a  
schema any time we like  
**using shapes!**

QUESTIONS?

