

# NdFluents

## An Ontology for Annotated Statements with Inference Preservation

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**LABORATOIRE  
HUBERT CURIEN**

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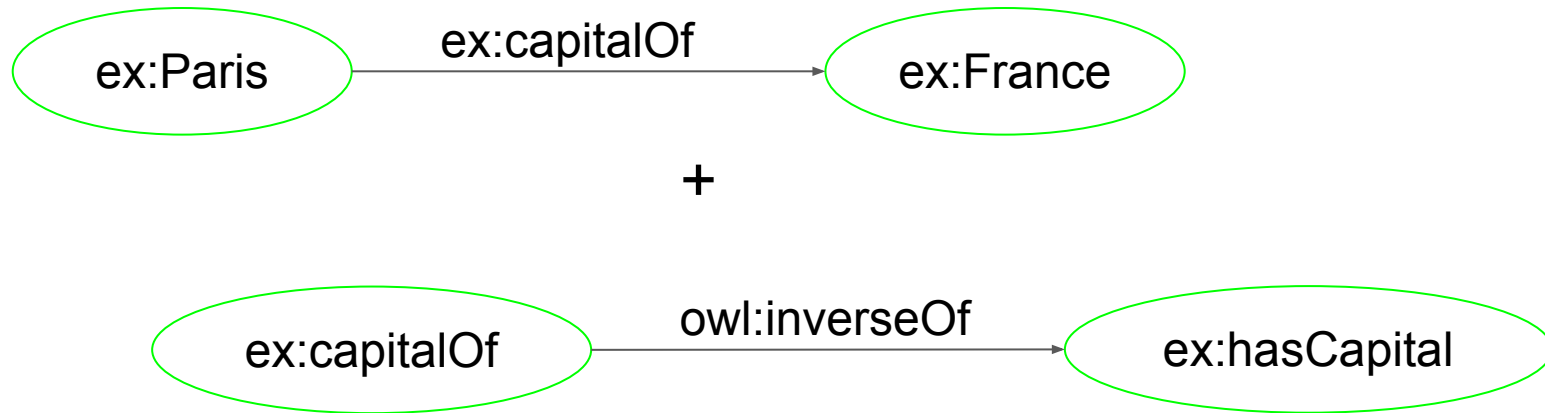
# Introduction

- RDFS and OWL allow to make inferences



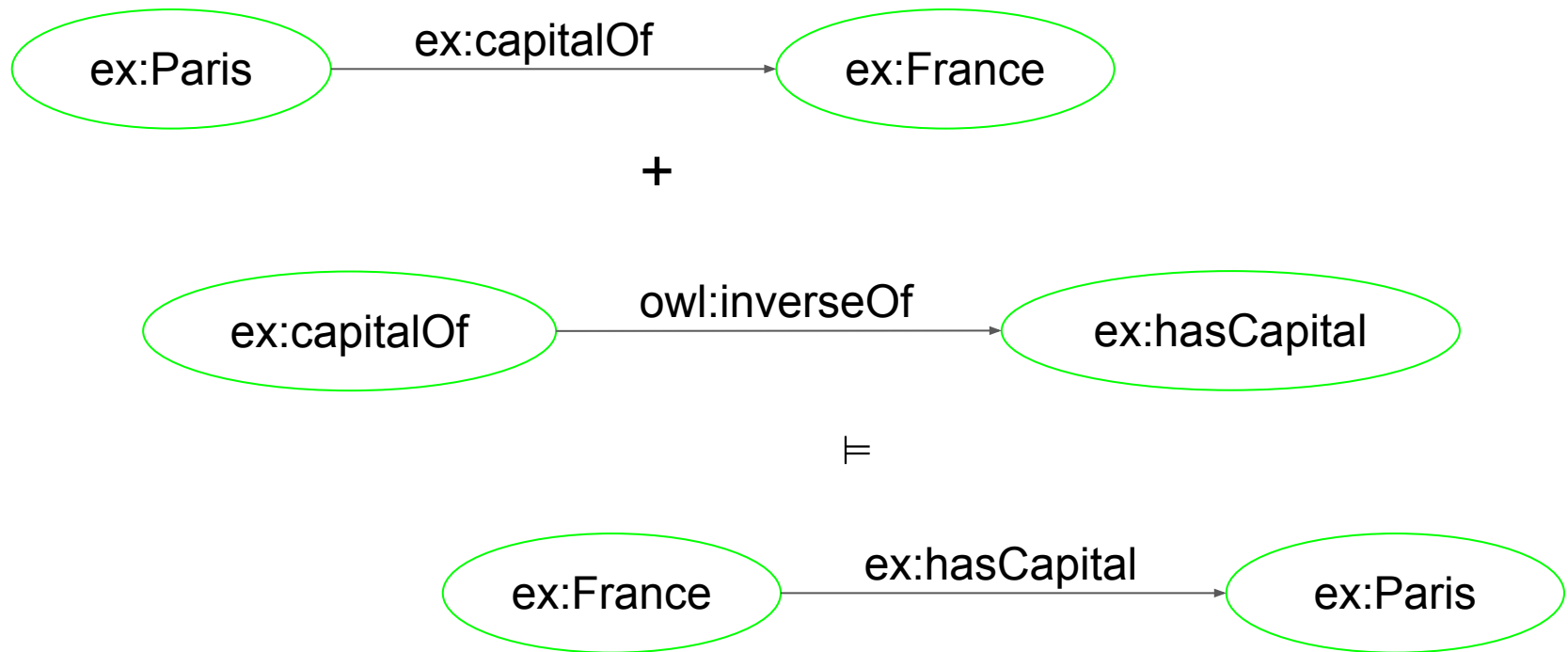
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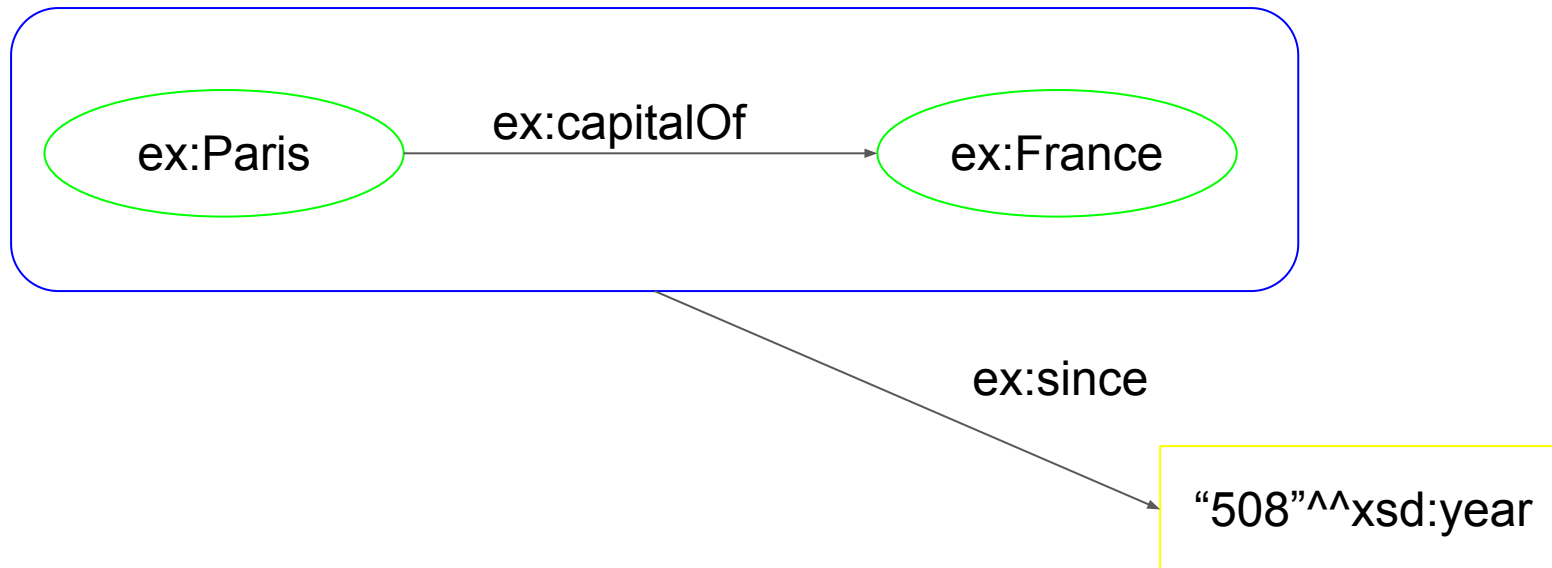
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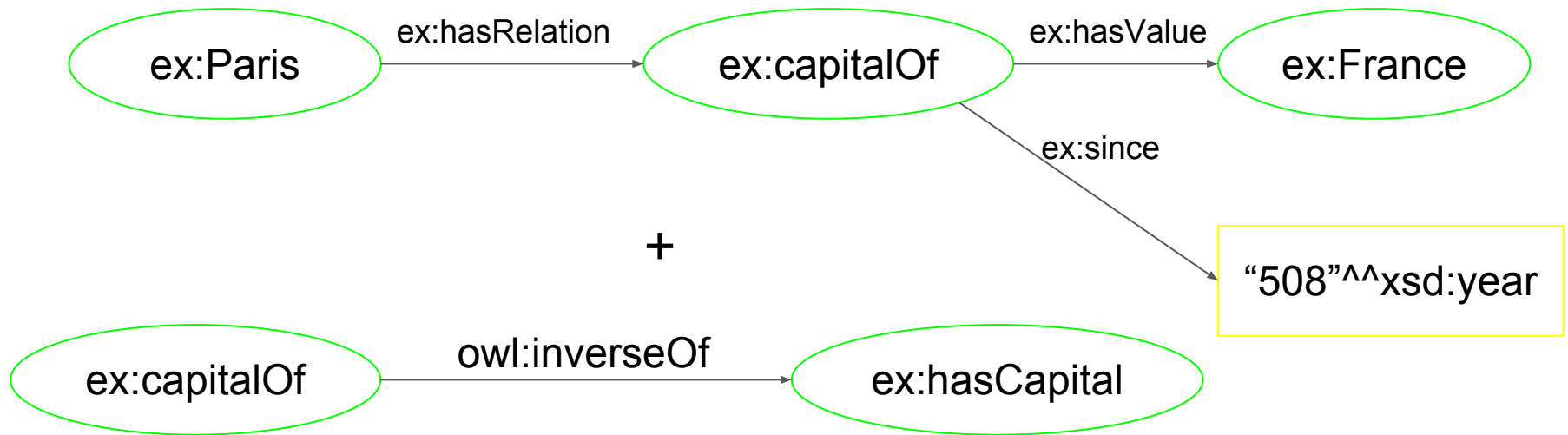
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- However, inferences are lost



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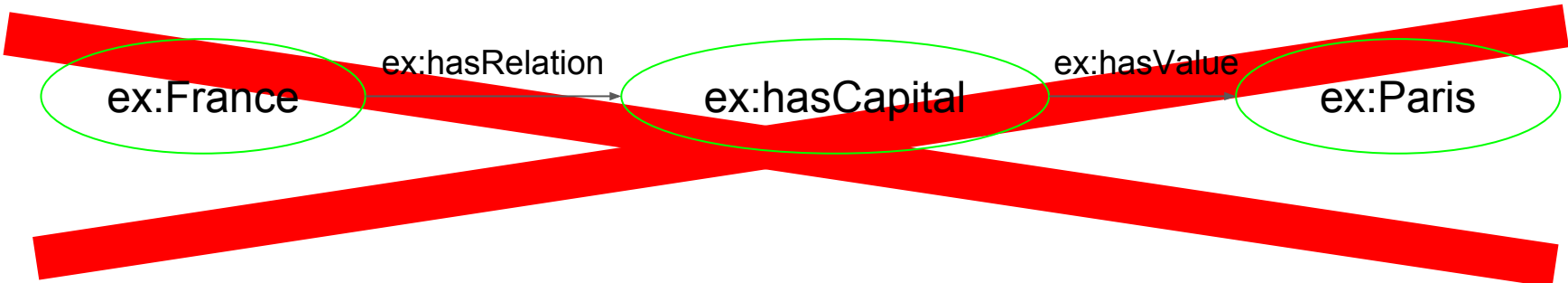
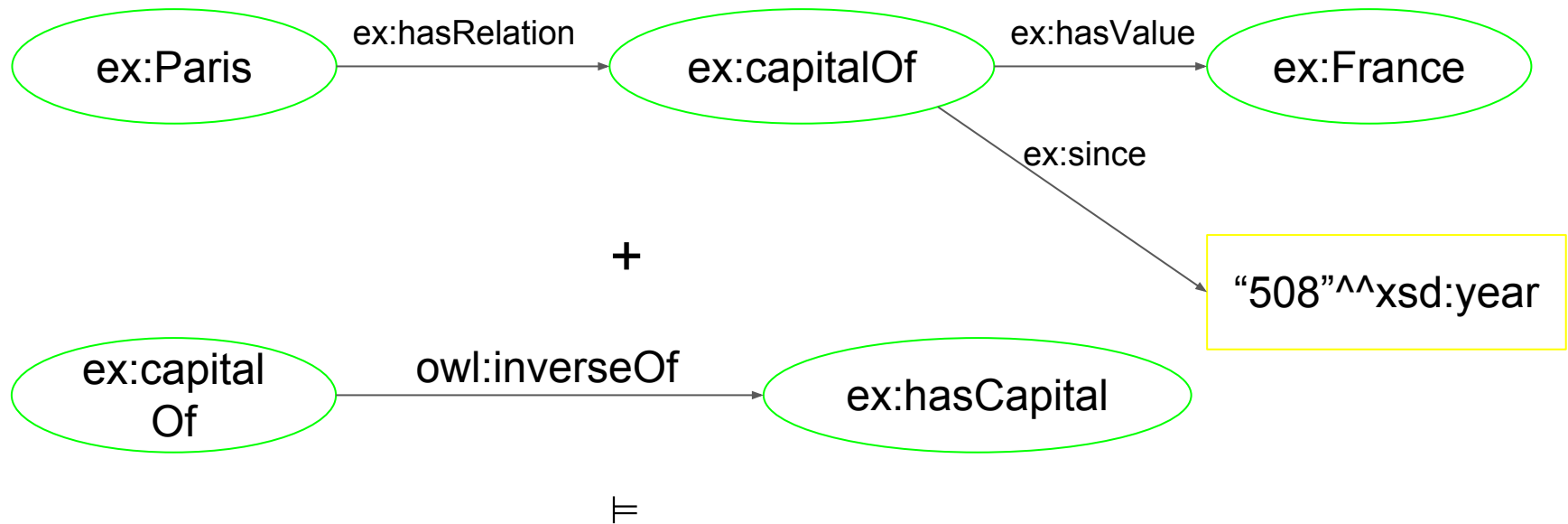
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# Outline

## 1. NdFluents

- a. A bit of history: 4dFluents
- b. The NdFluents Ontology
- c. Problems to Consider

## 2. Comparing reasoning of NdFluents against other approaches

- a. Other approaches
  - i. Reification
  - ii. N-ary properties
  - iii. Singleton Property
- b. Rule Preservation
- c. Results

## 3. Conclusions and future work

# Outline

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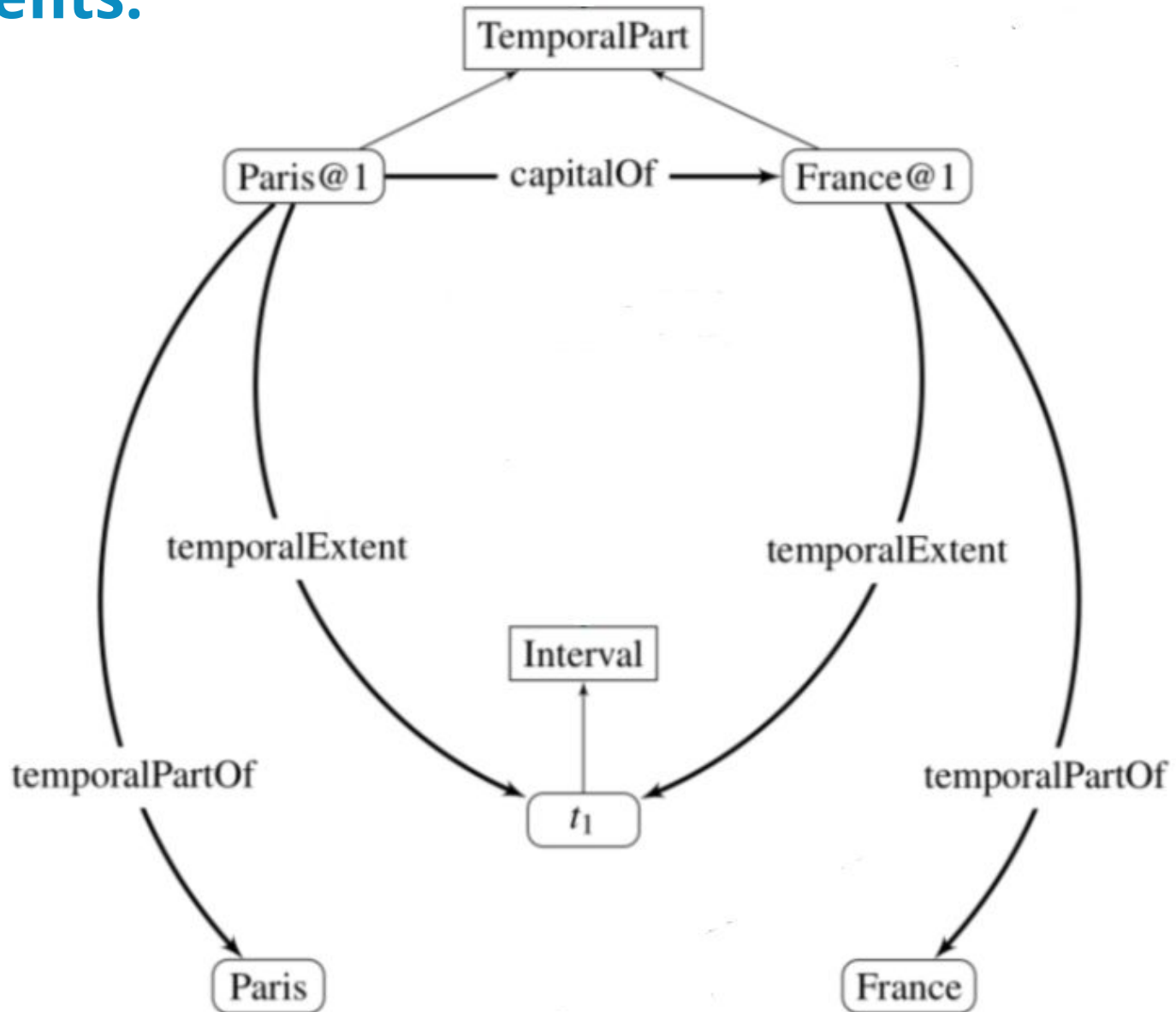
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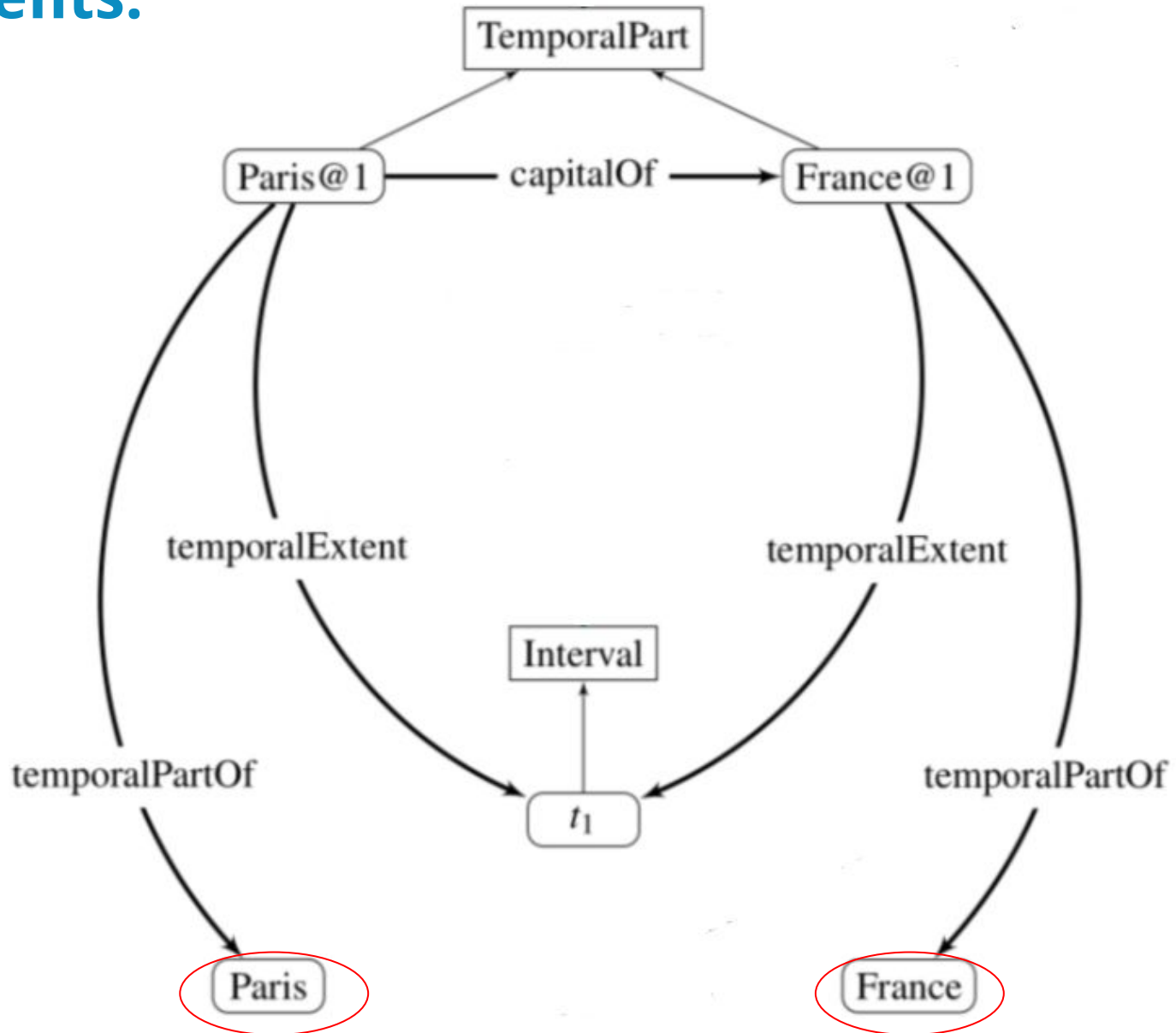
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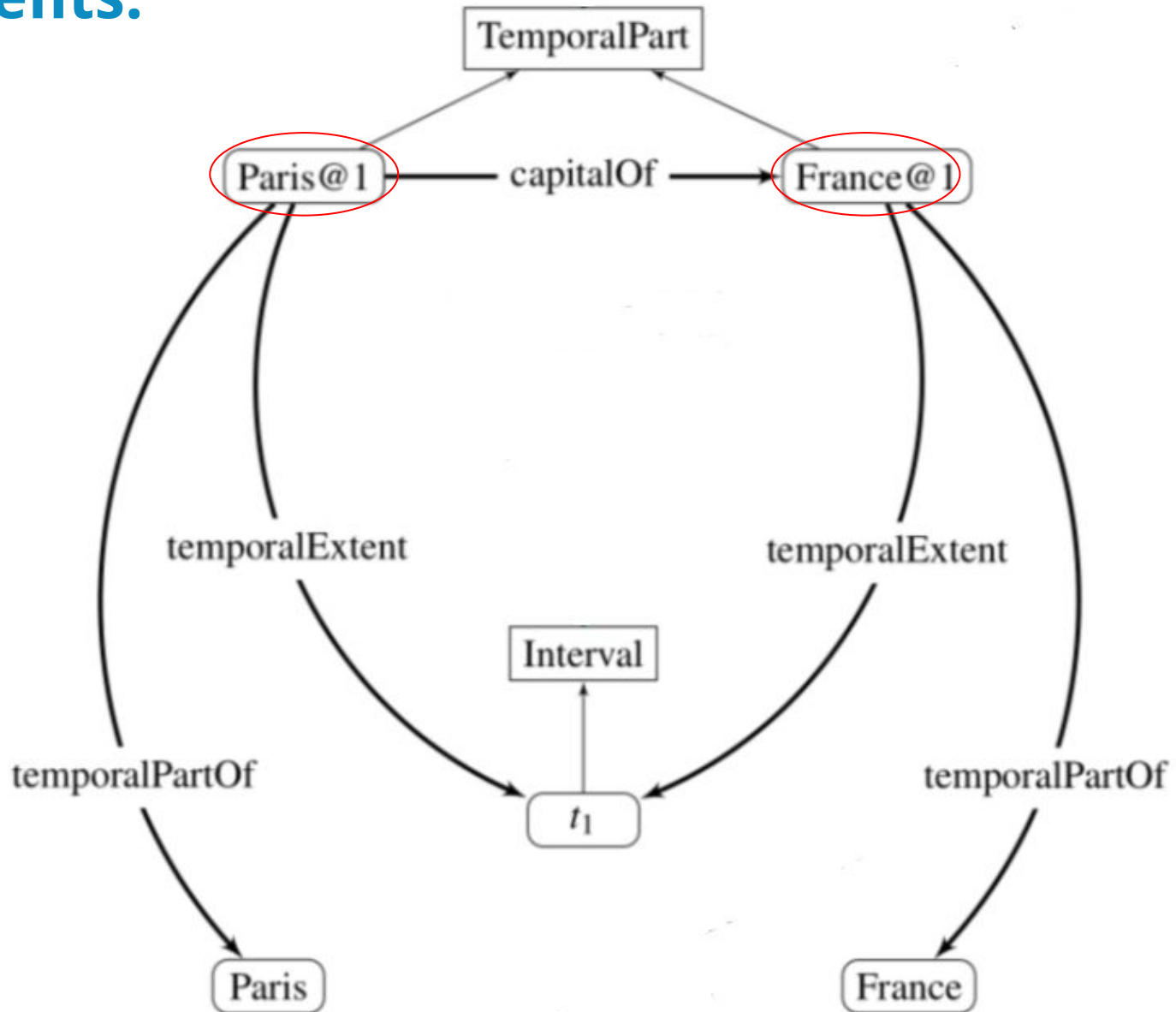
# 4dFluents.



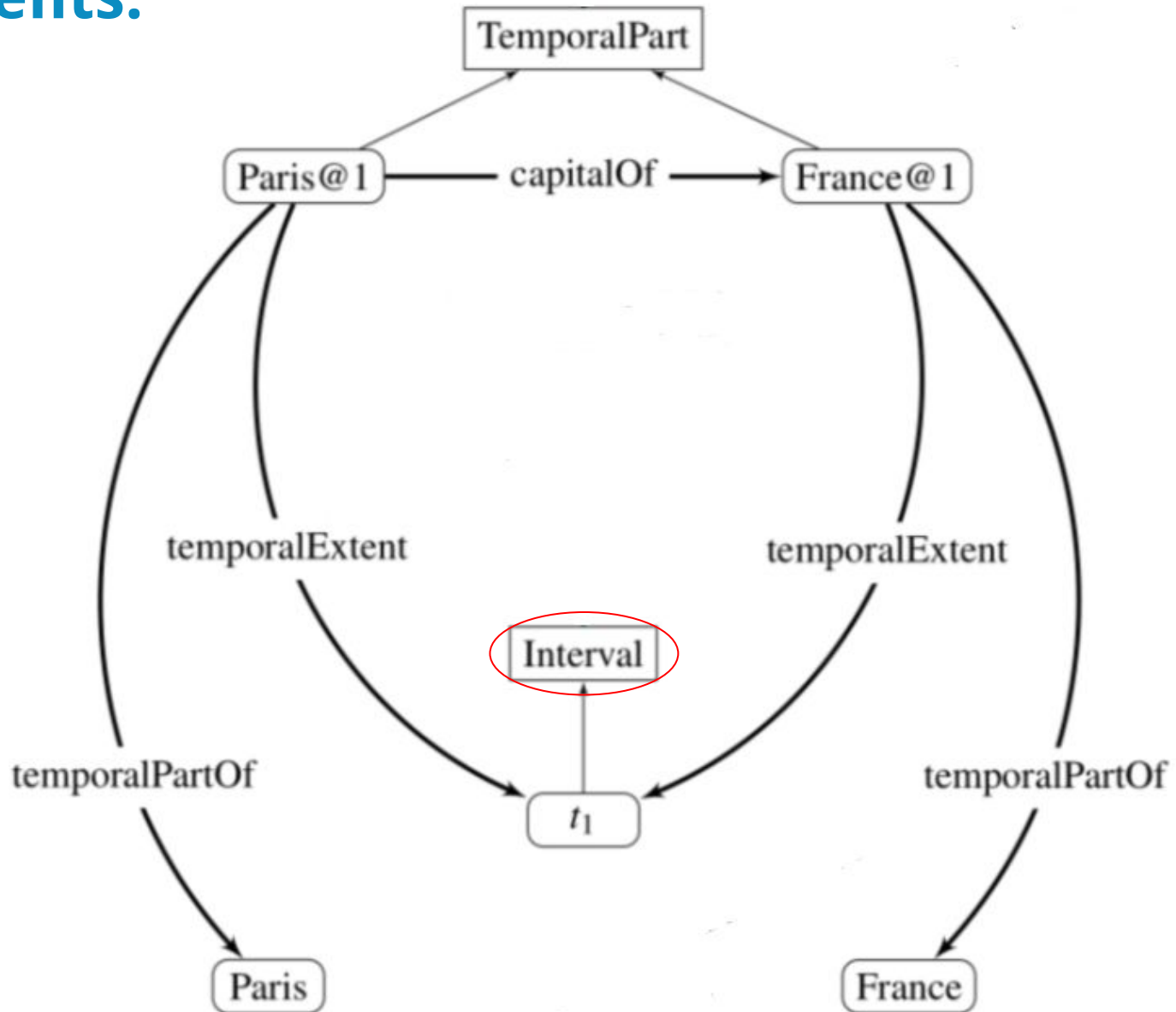
# 4dFluents.



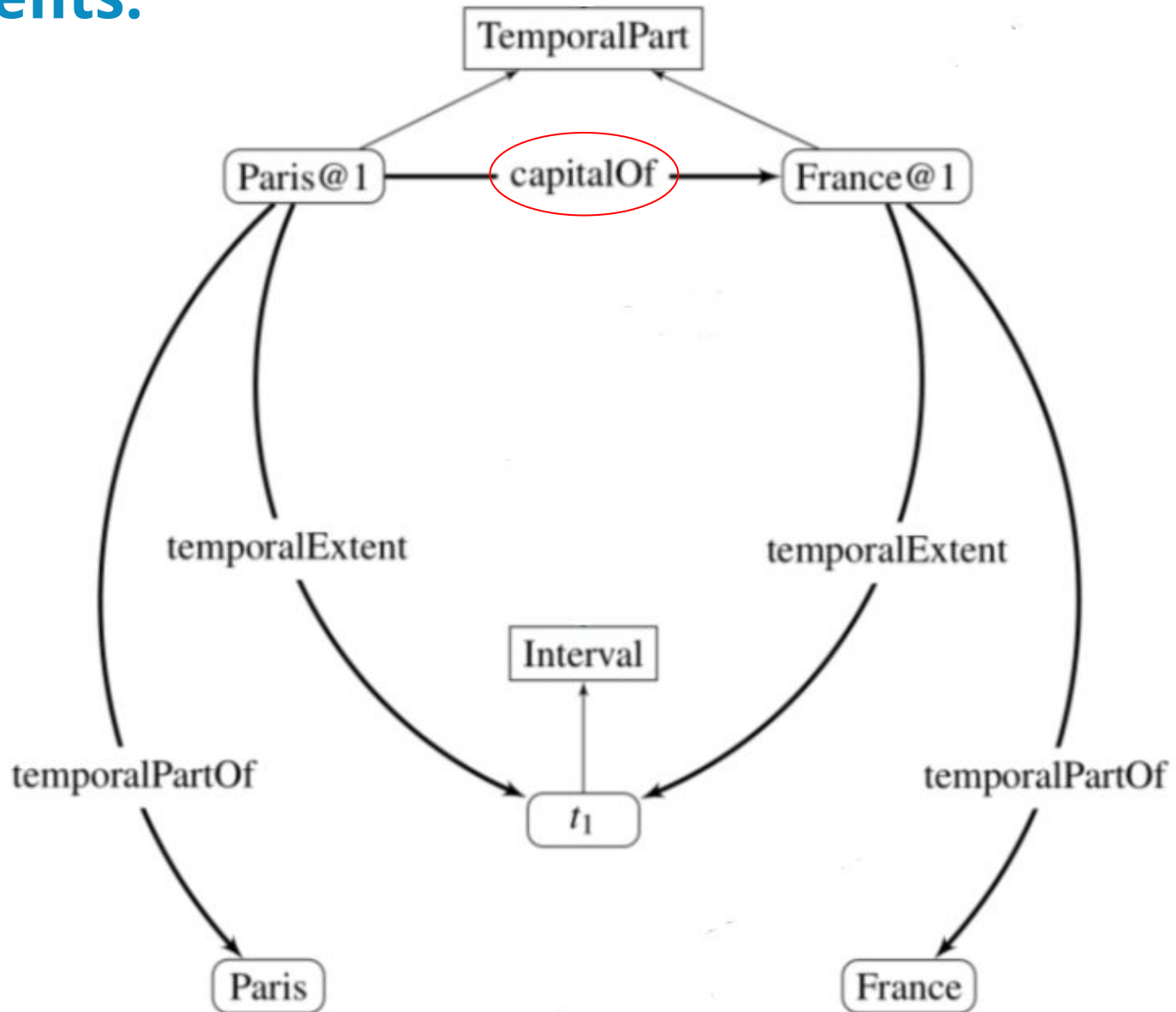
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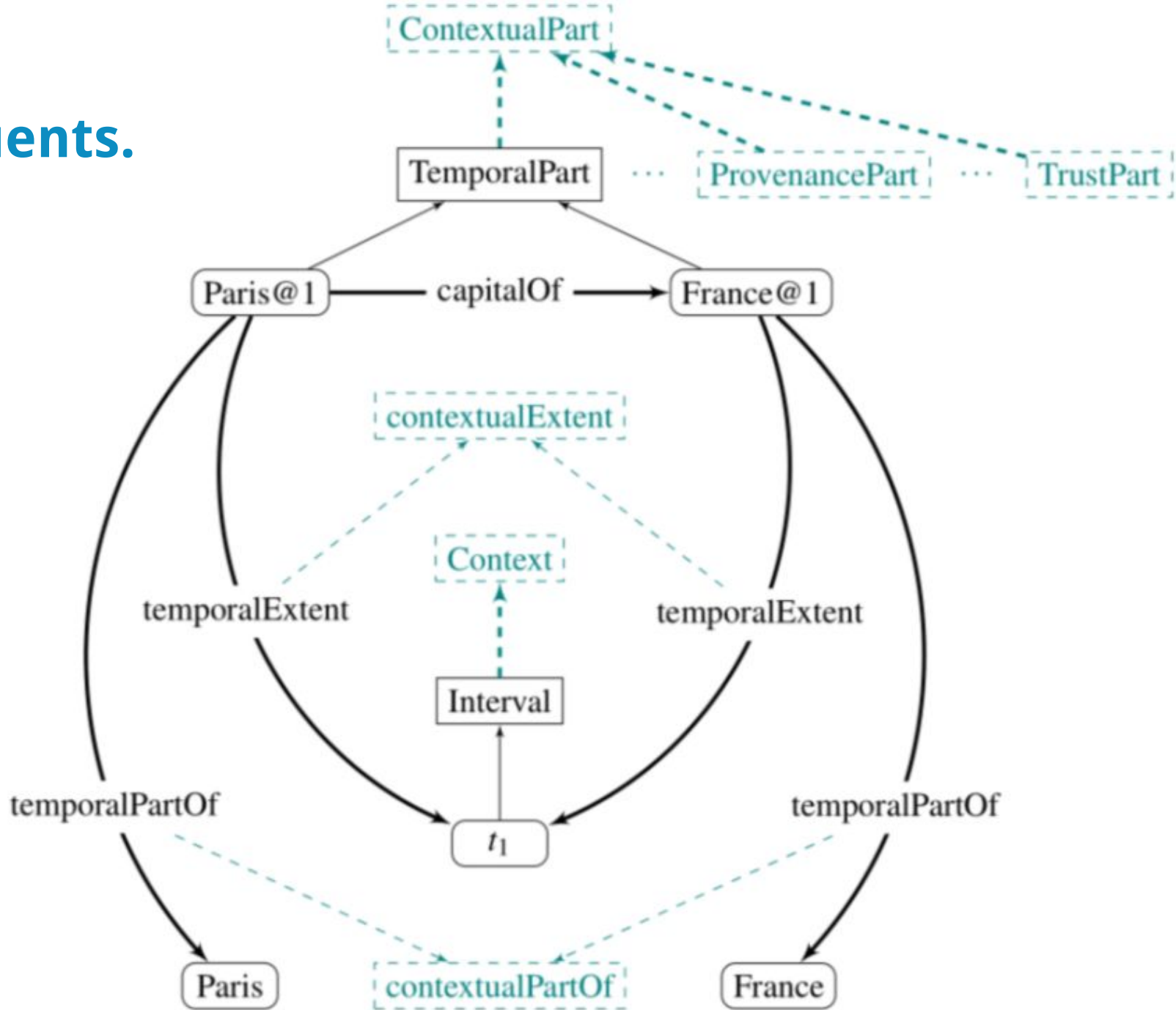


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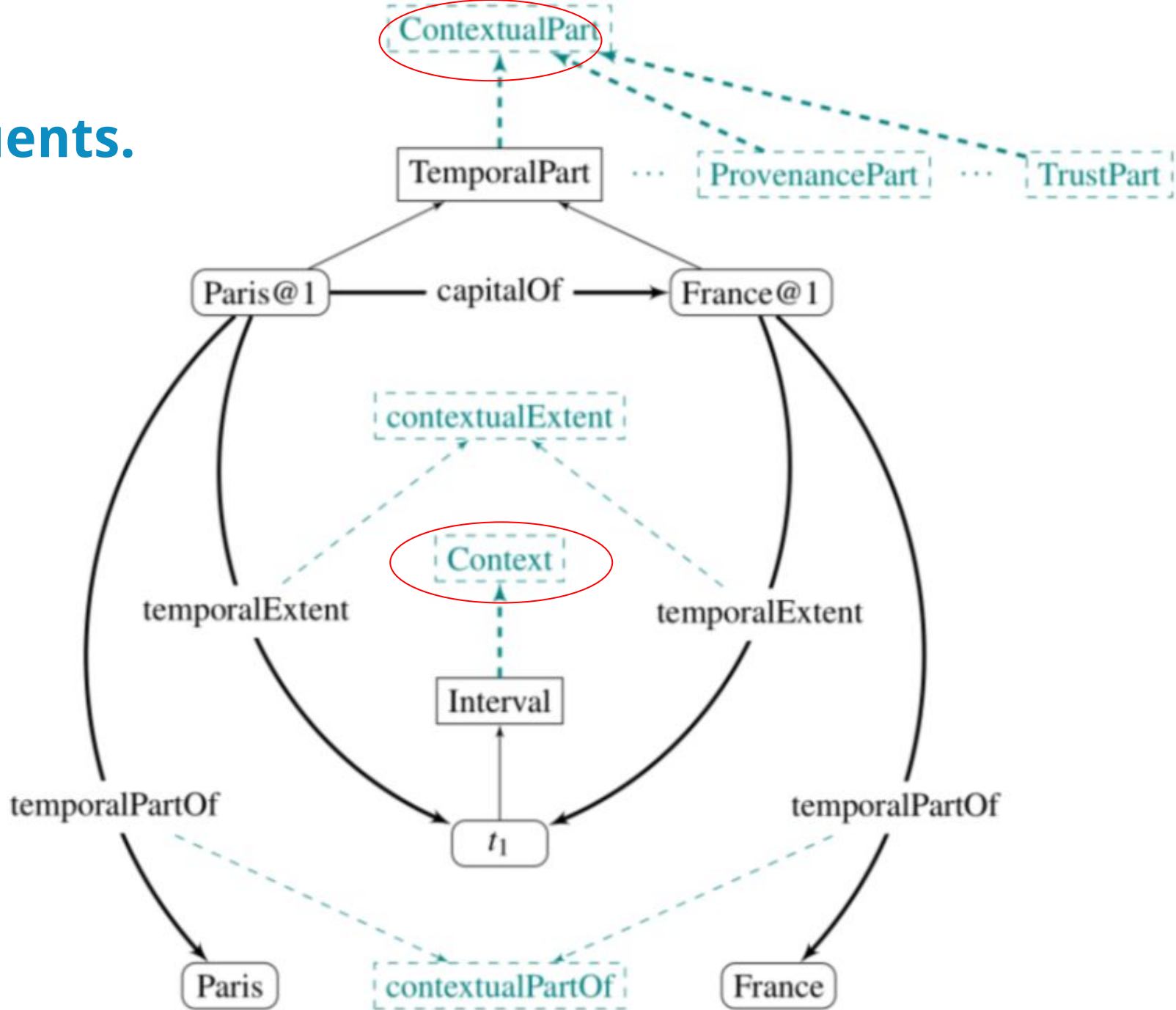




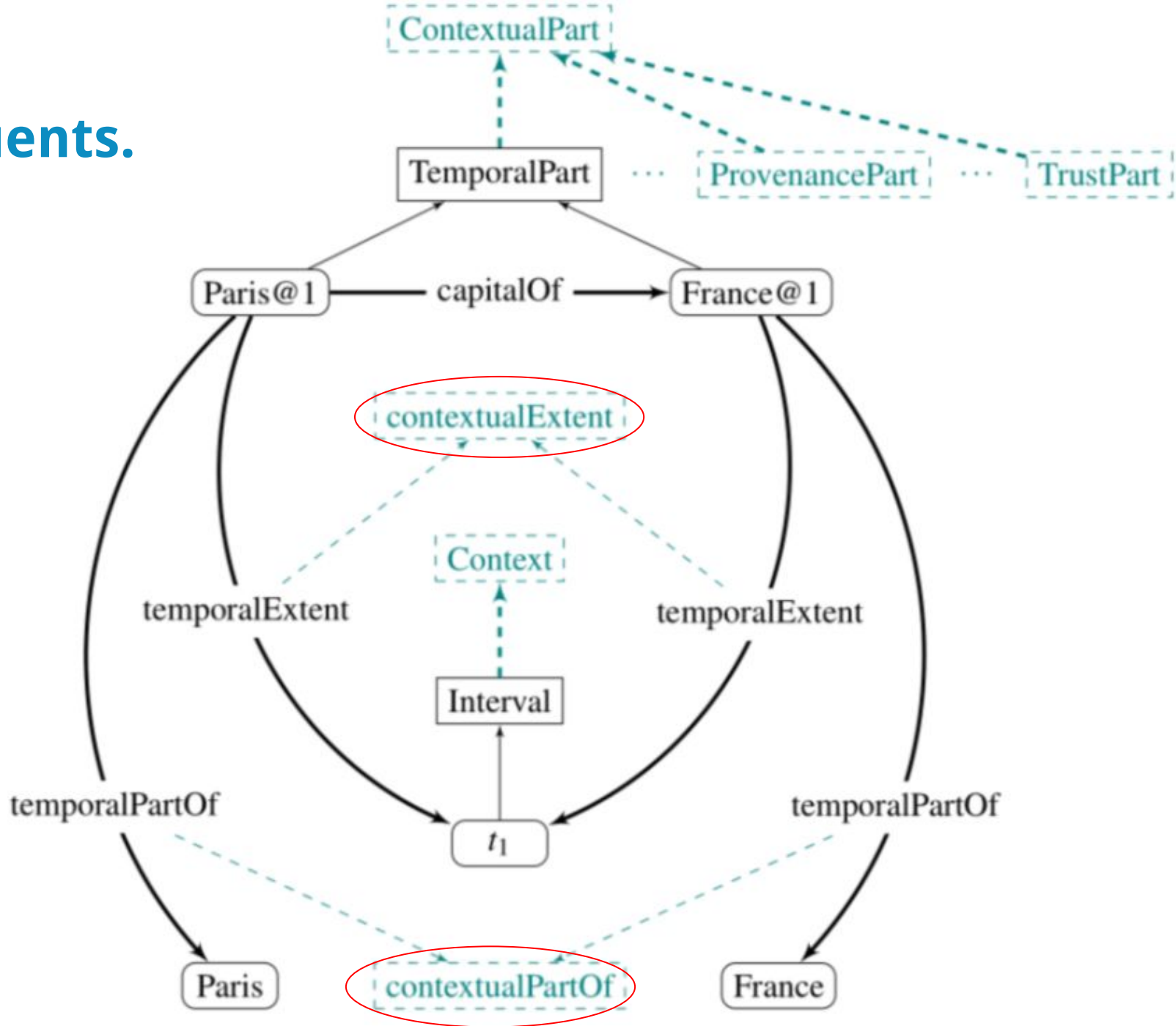
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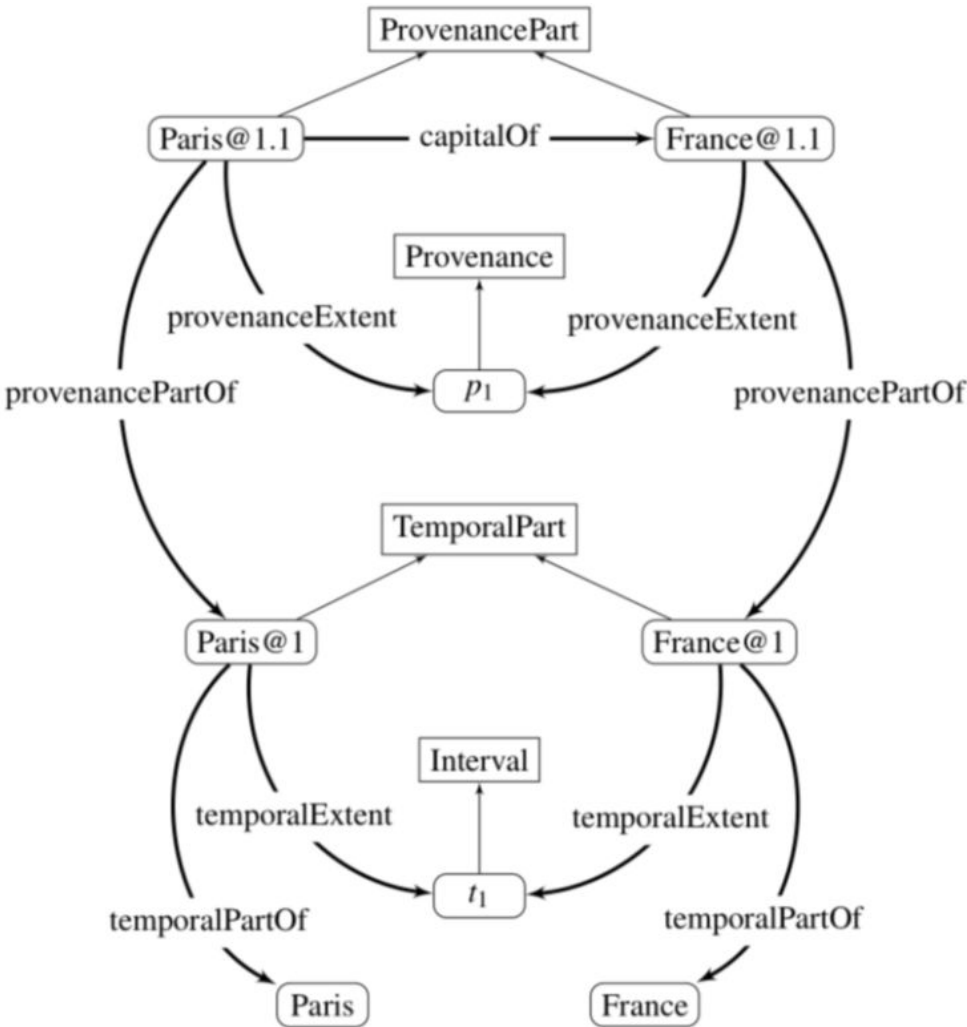




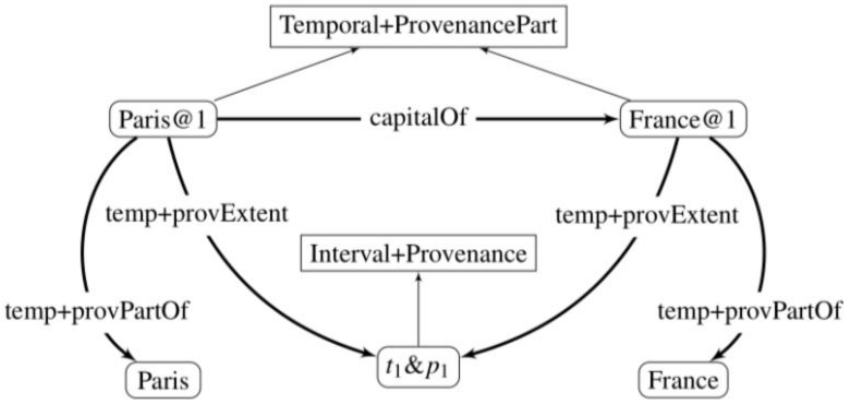
# Problems to consider

- Combination of different contexts
- Inference Preservation
- Explosion in the number of triples

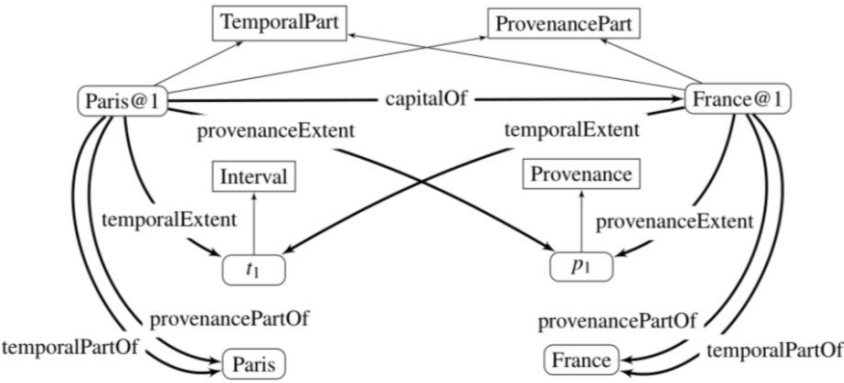
# Combination of Different Contexts.



Contexts in context



Combination of different dimensions on one contextual extent



Multiple Contexts on each ContextualPart

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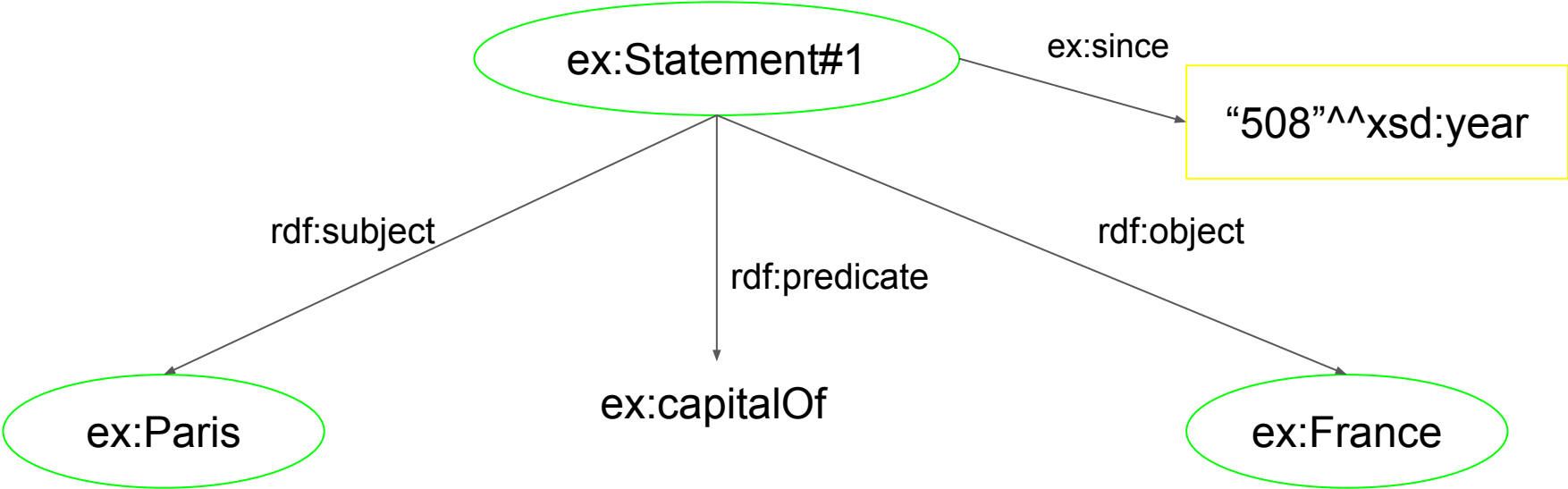
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# Comparing NdFluents against other approaches.

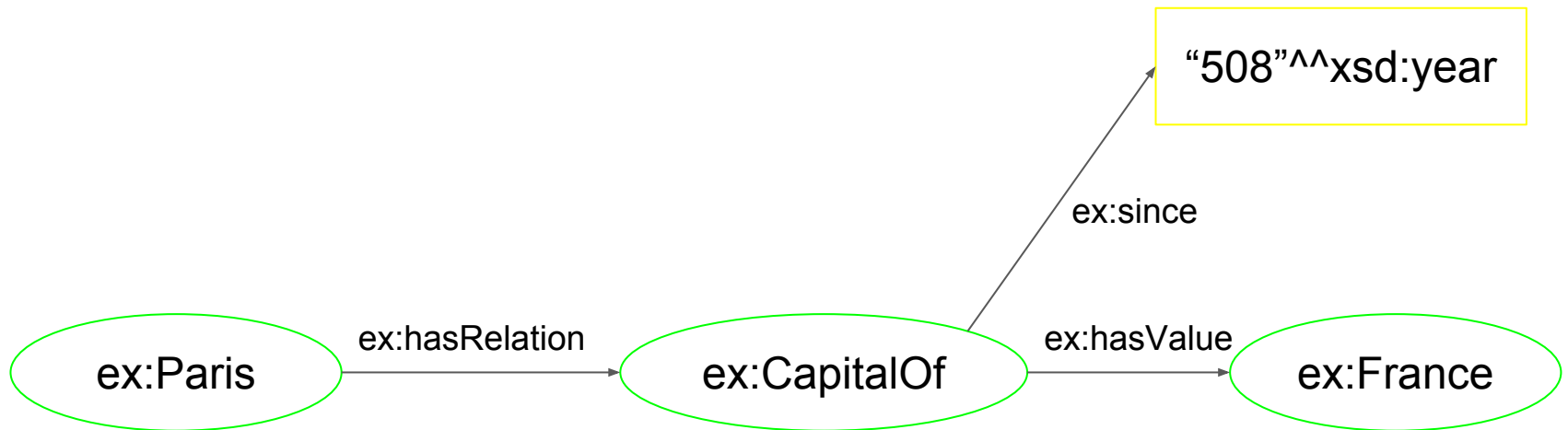




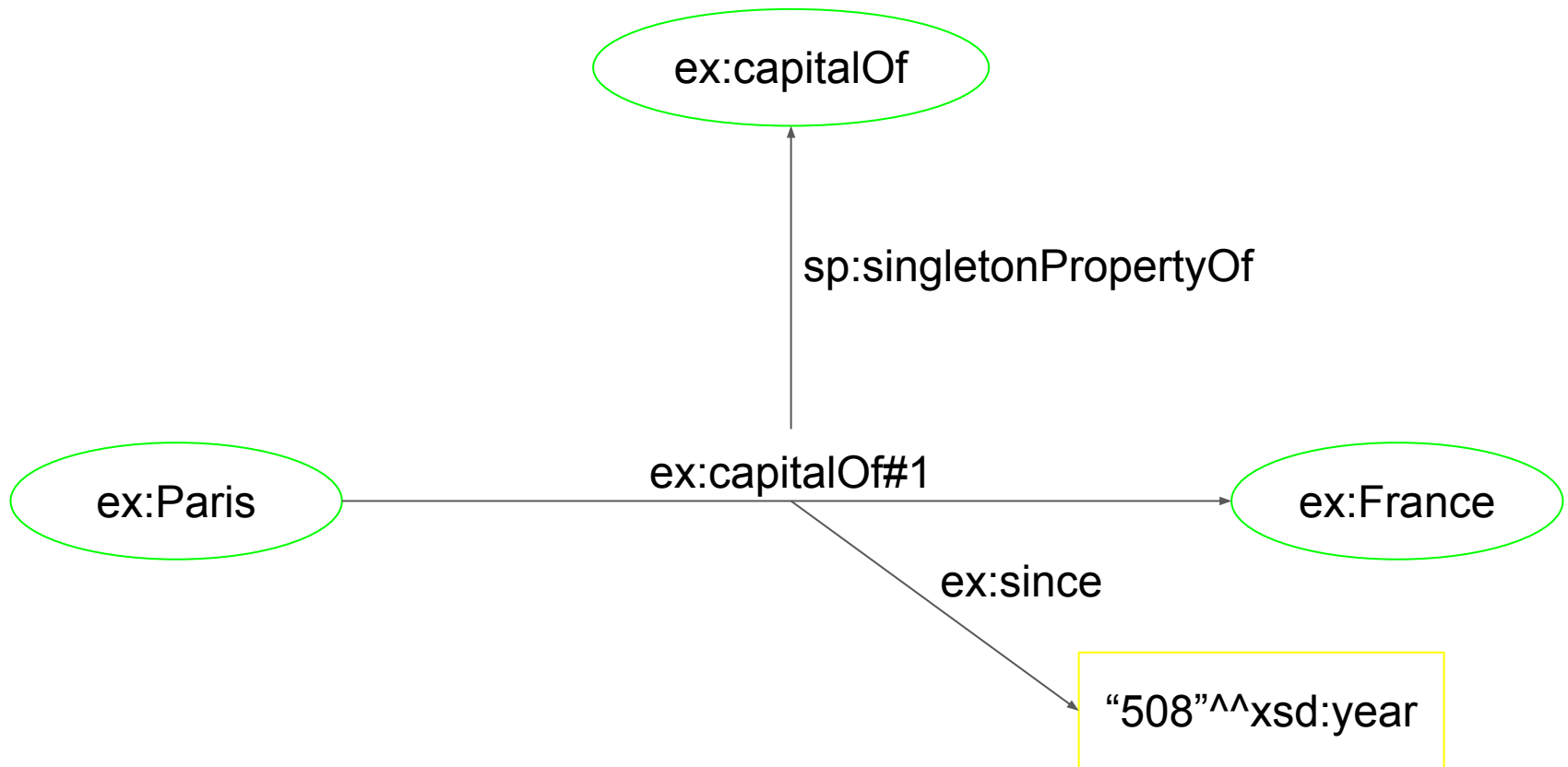
# Reification.



# N-ary relations.



# Singleton Property.



# Rule Preservation.

- We use pD\* fragments of ter Horst
  - Modified subsets of RDFS and OWL
  - Can be expressed as a complete set of rules (18 for RDFS and 23 for OWL)
  - Computationally feasible

```
?p    a    SymmetricProperty
?v    ?p   ?w
⊨
?w    ?p   ?v
```

# Rule Preservation.

$$f( \begin{matrix} ?p & a & \text{SymmetricProperty} \\ ?v & ?p & ?w \end{matrix} )$$
$$\models$$
$$f( \begin{matrix} ?w & ?p & ?v \end{matrix} )$$

# Rule Preservation.

$$f\left(\begin{array}{ccc} ?p & a & \text{SymmetricProperty} \\ ?v & ?p & ?w \end{array}\right)$$

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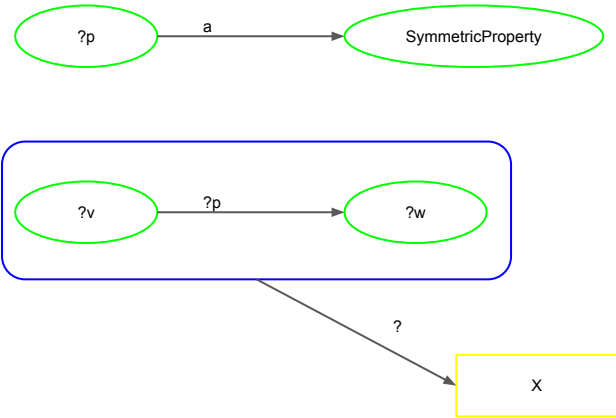
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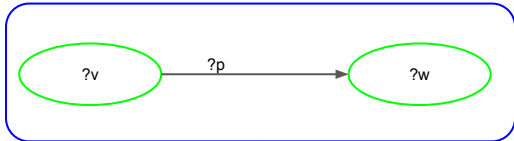


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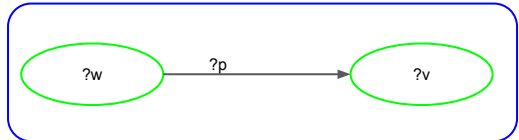
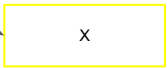
$\models$

$f( \begin{matrix} ?w & ?p & ?v \end{matrix} )$

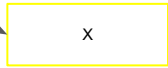


?

$\models$



?



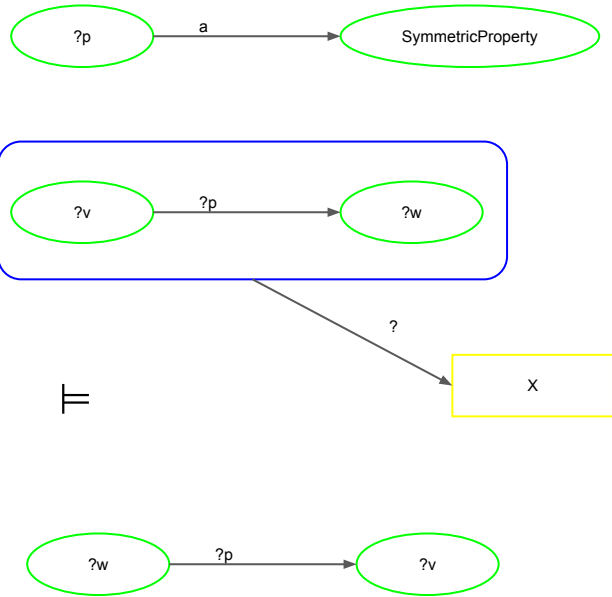


# Non-Contextual Rule Preservation.

$f( \begin{matrix} ?p & a & \text{SymmetricProperty} \\ ?v & ?p & ?w \end{matrix} )$

$\models$

$?w \quad ?p \quad ?v$



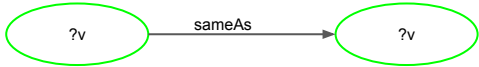
# Rule Preservation with conclusion unchanged.

$f( \begin{matrix} ?p & a & \text{InverseFunctionalProperty} \\ ?u & ?p & ?v \\ ?u & ?p & ?w \end{matrix} ) \quad (\dots)$

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$f( ?v \quad \text{sameAs} \quad ?v )$



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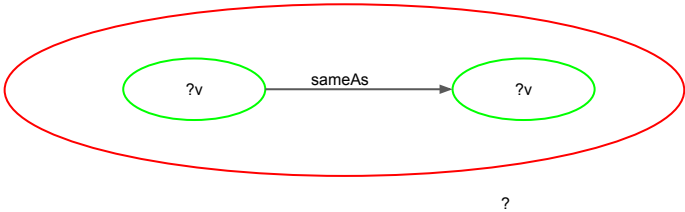
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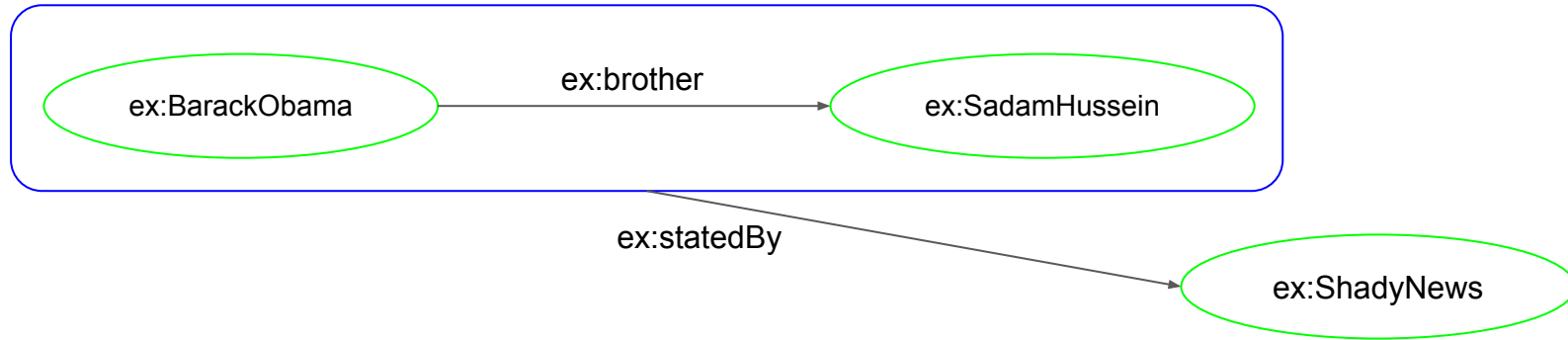
$\models$

$f( ?v \text{ sameAs } ?v )$



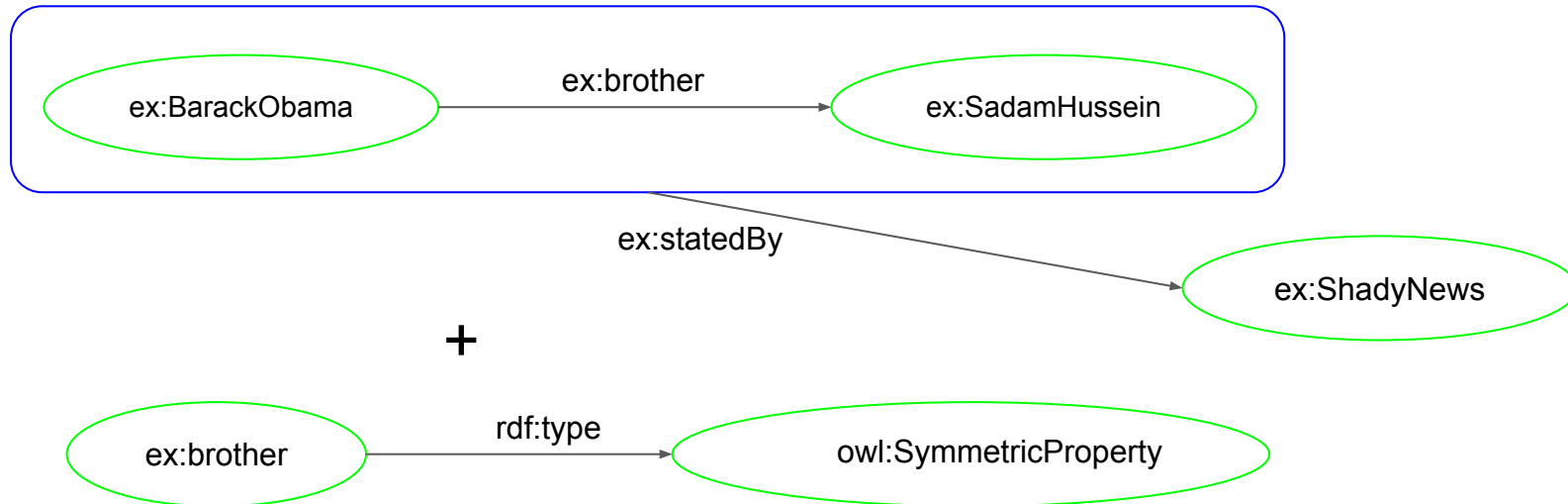
# Comparing NdFluents against other approaches

## Example (rule preservation)



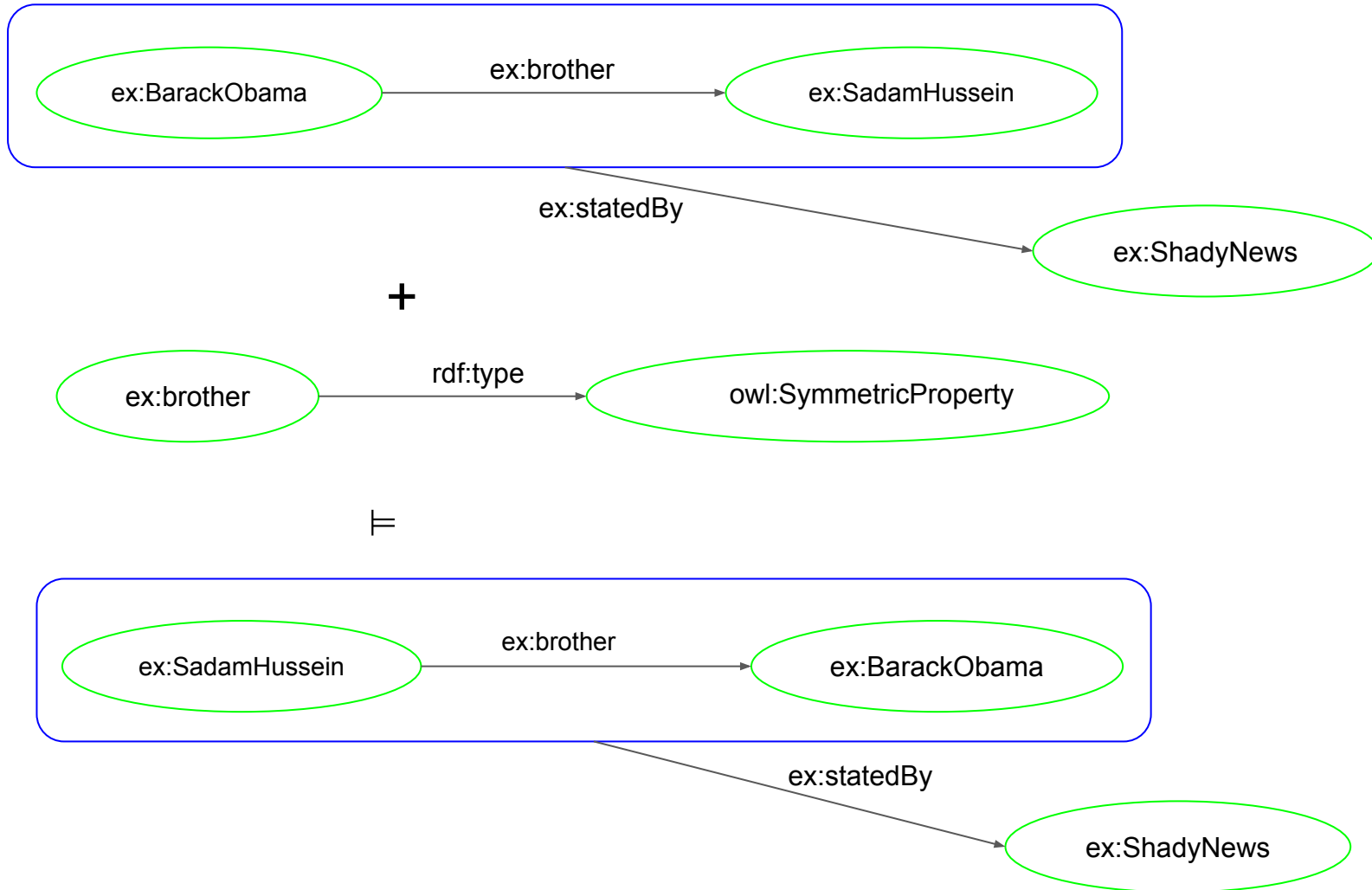
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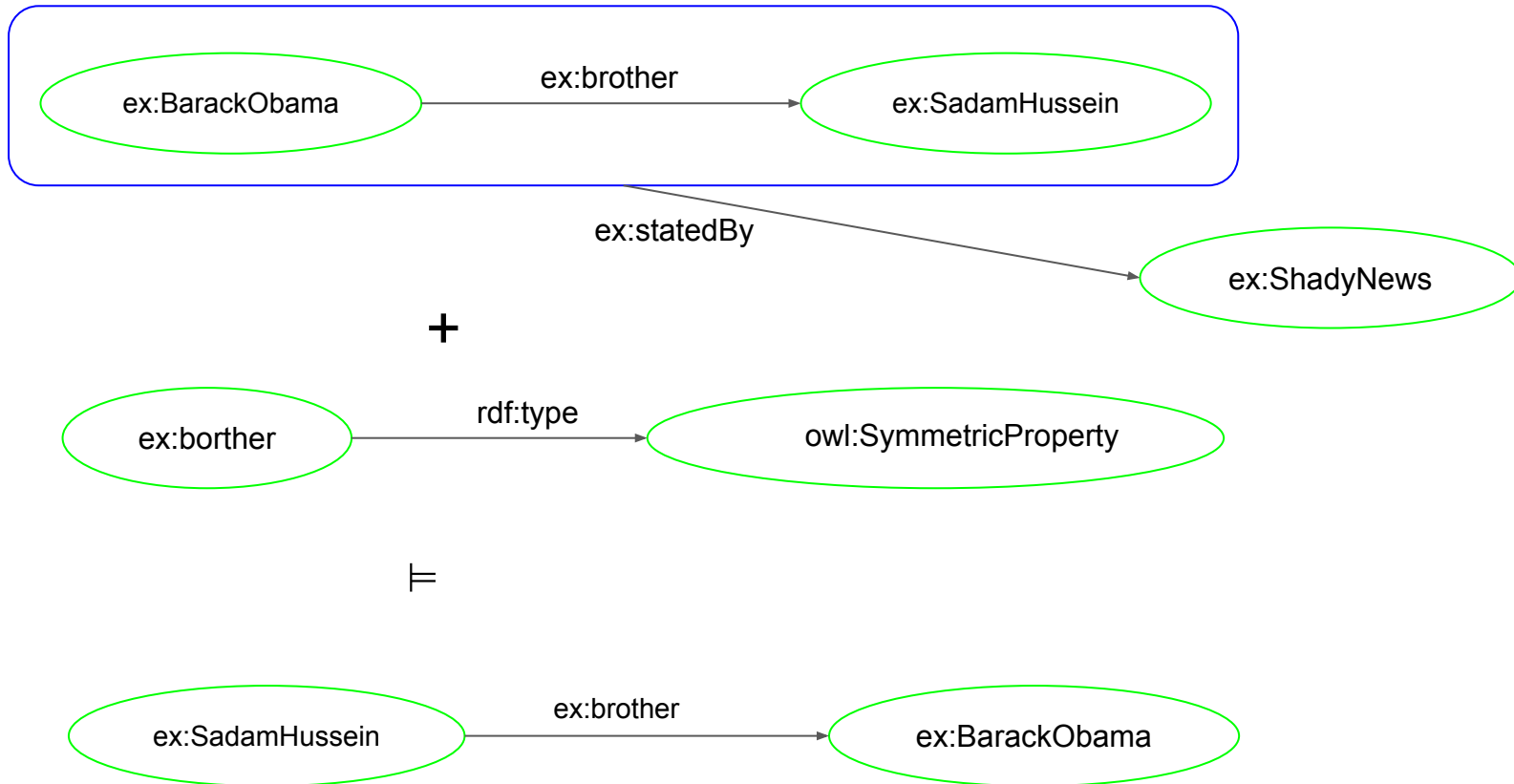
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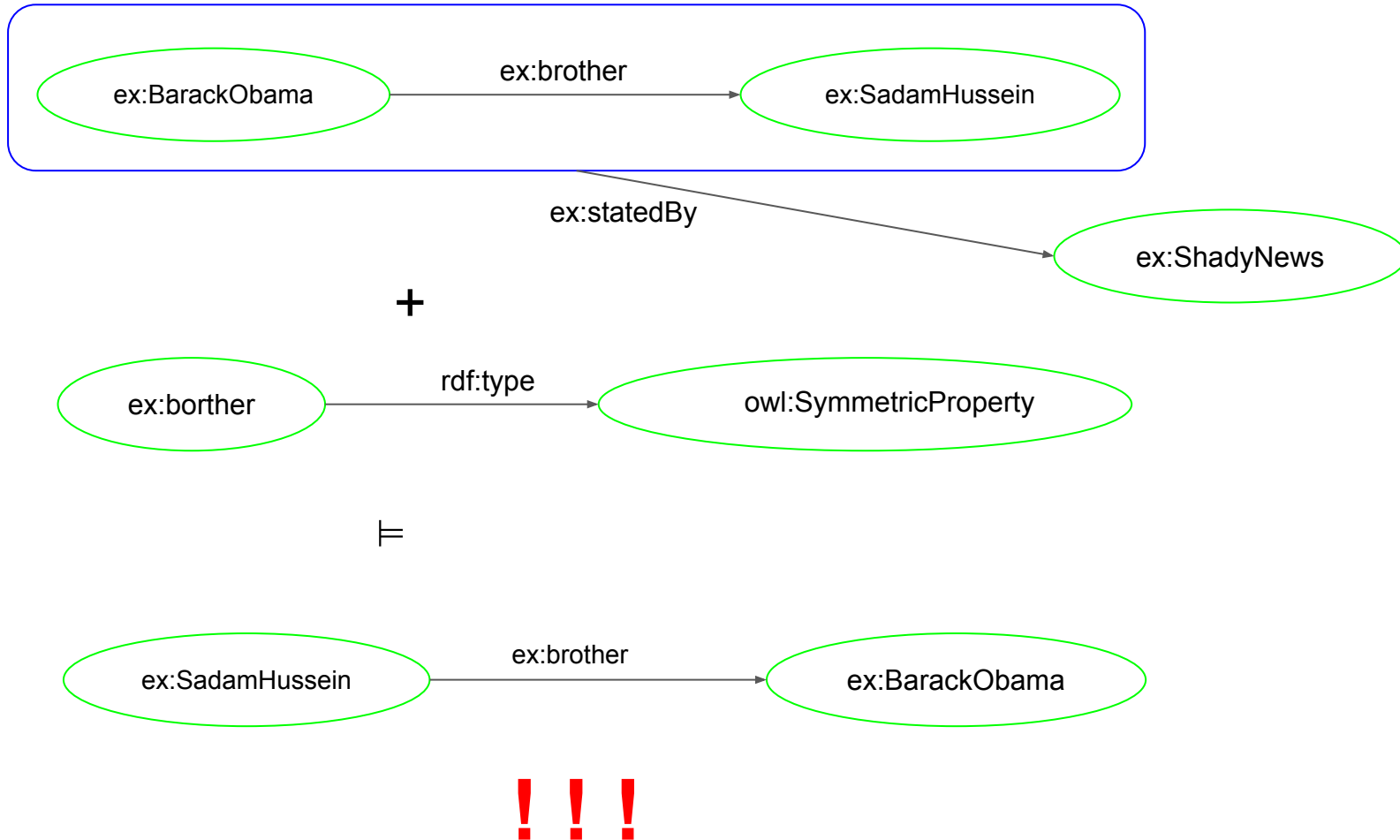
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## Example (non-contextual rule preservation)



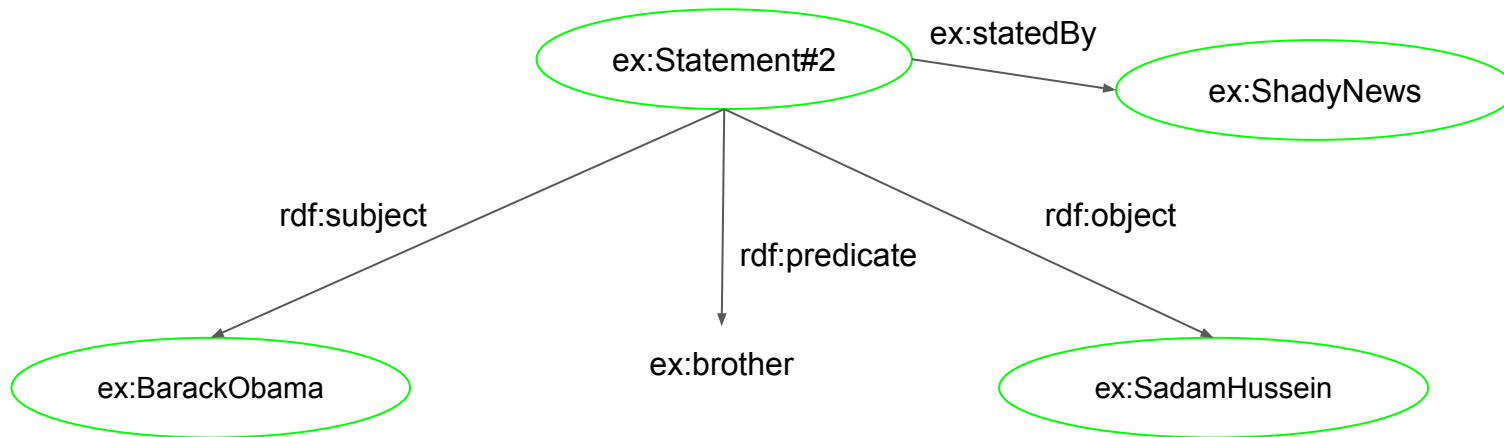
# Comparing NdFluents against other approaches

## Example (non-contextual rule preservation)

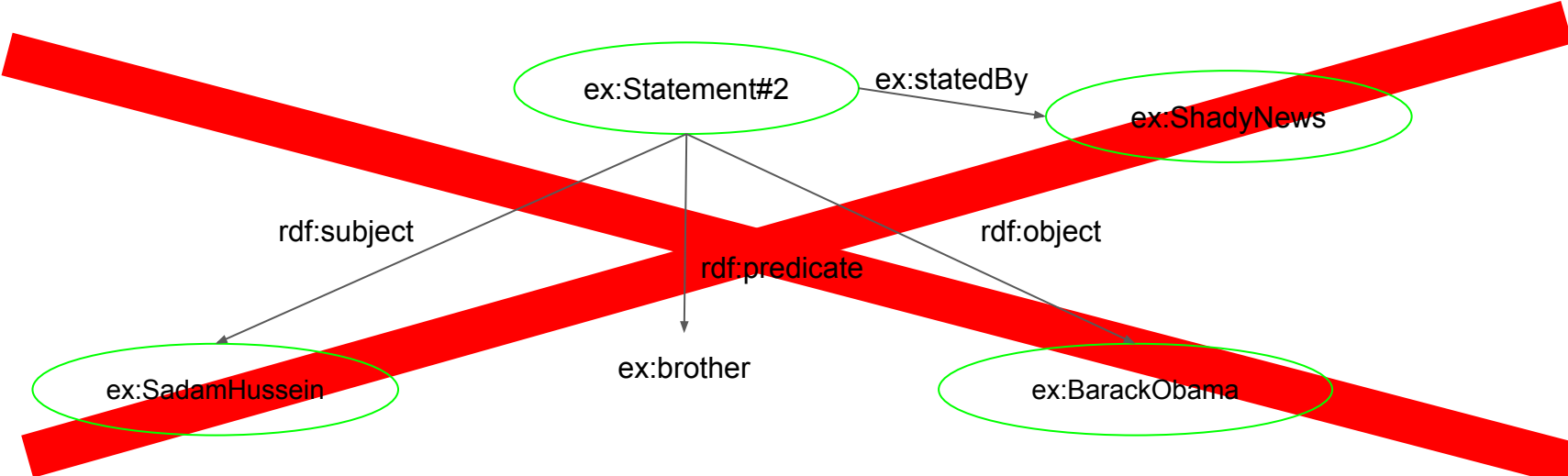
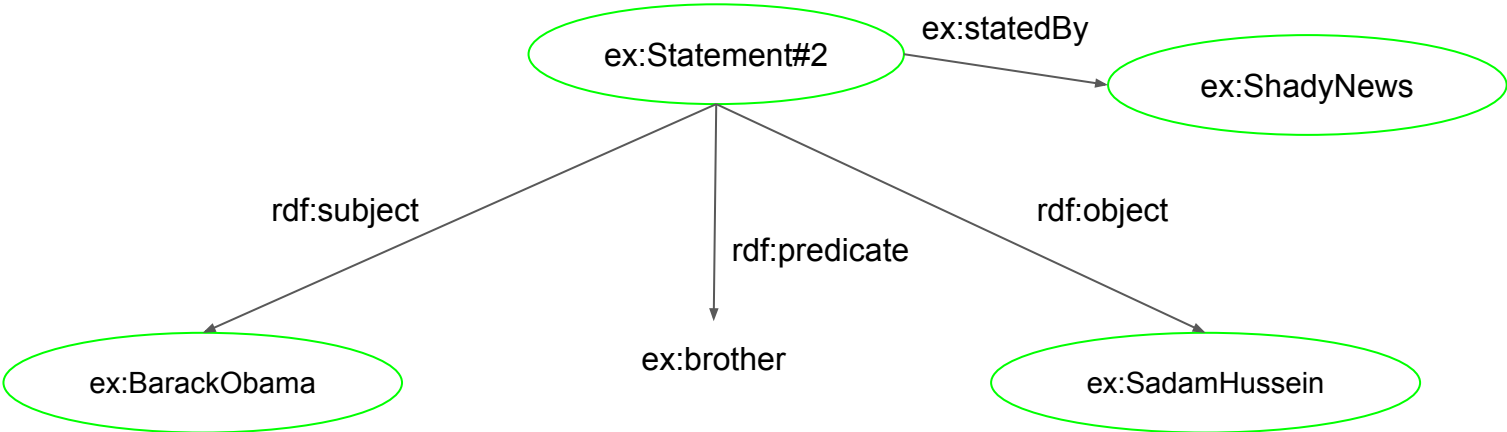




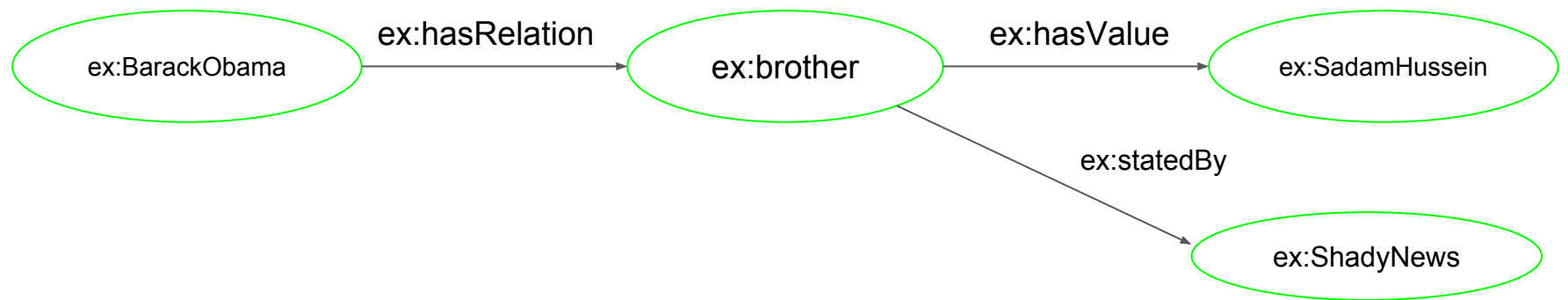
# Reification.



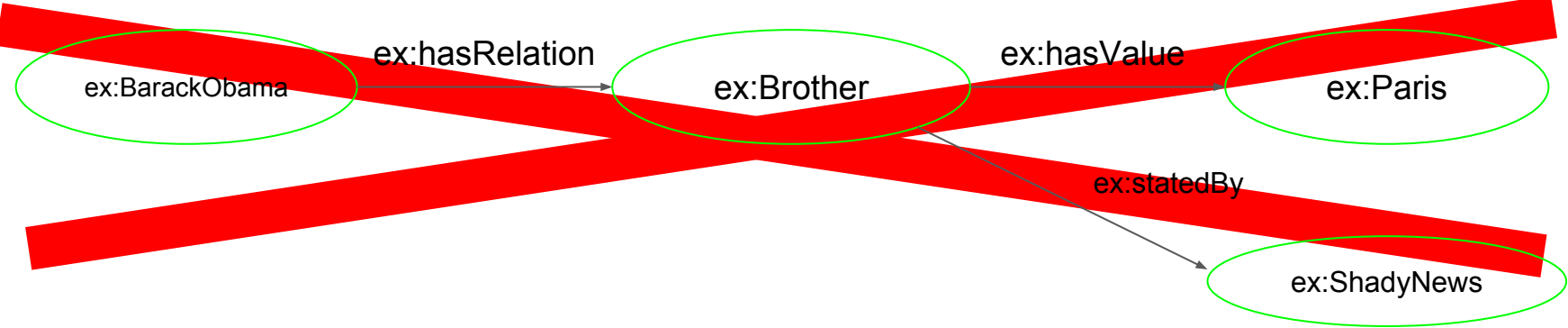
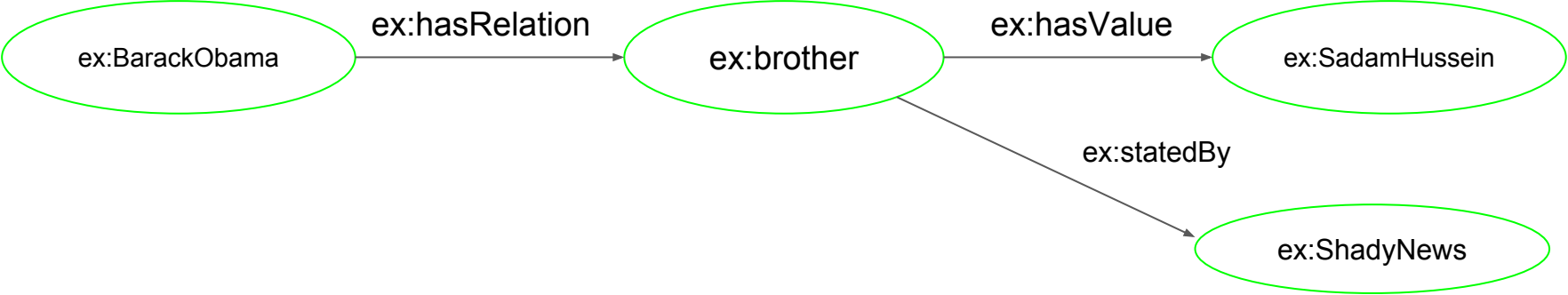
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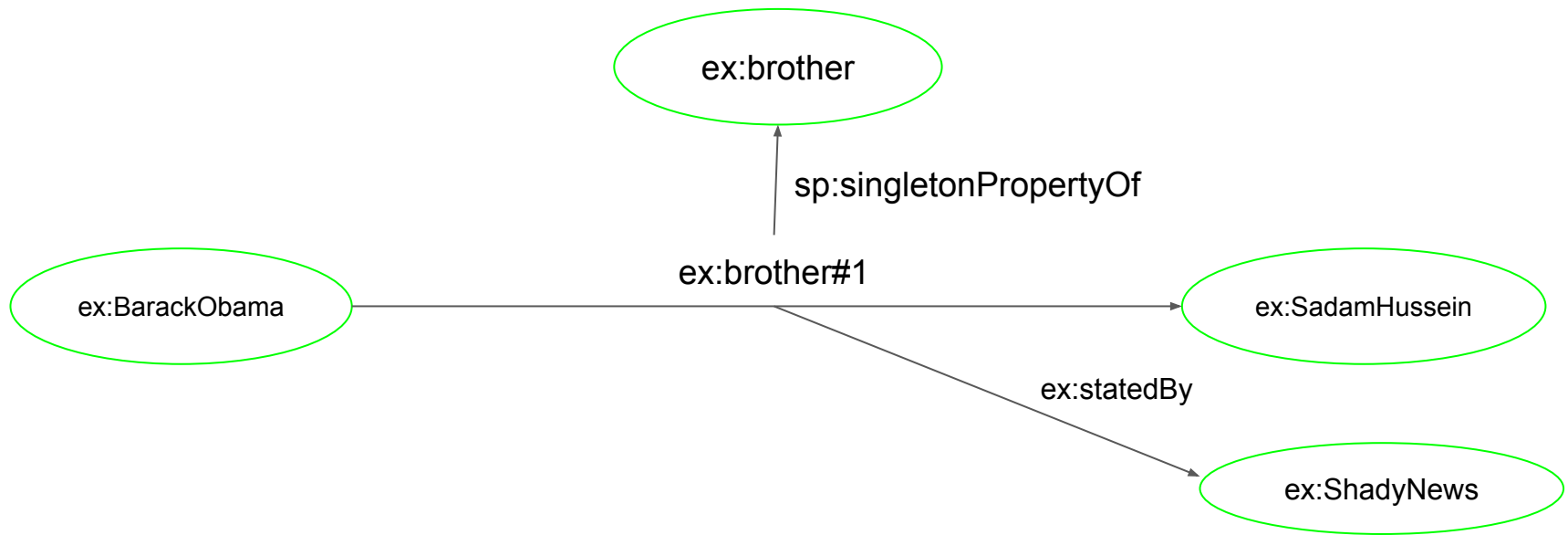
# N-Ary Relations.



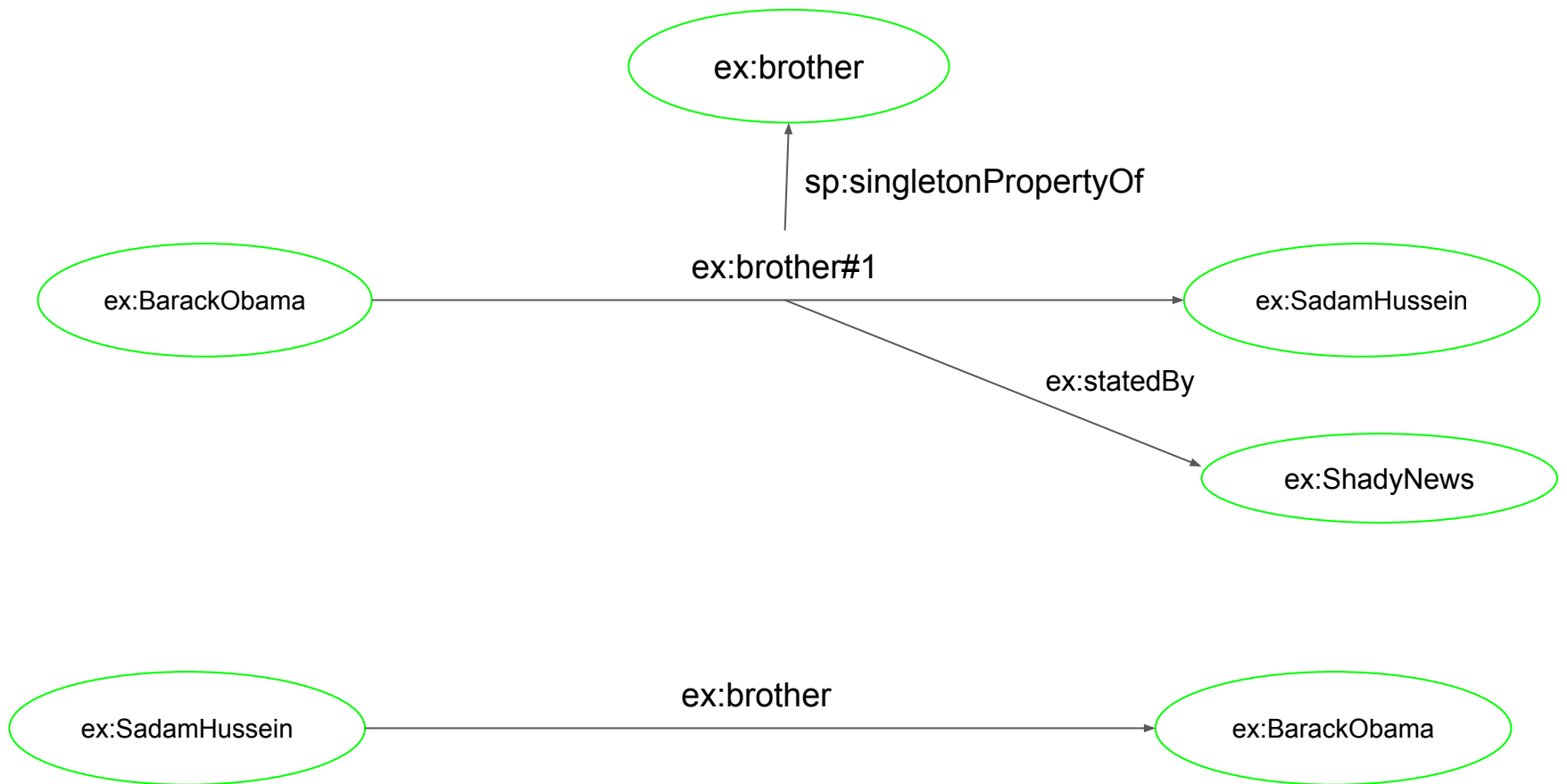
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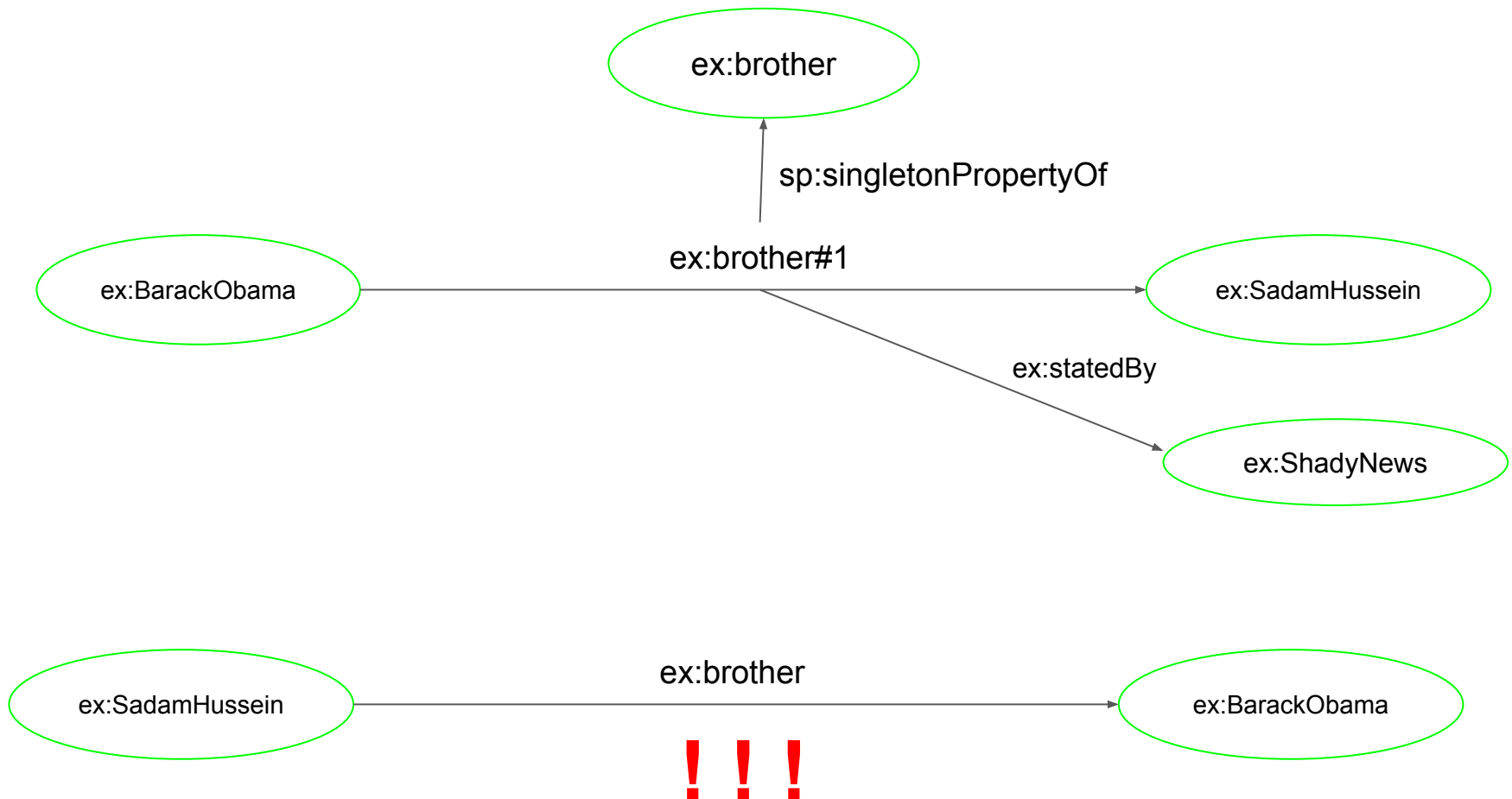
# Singleton Property.



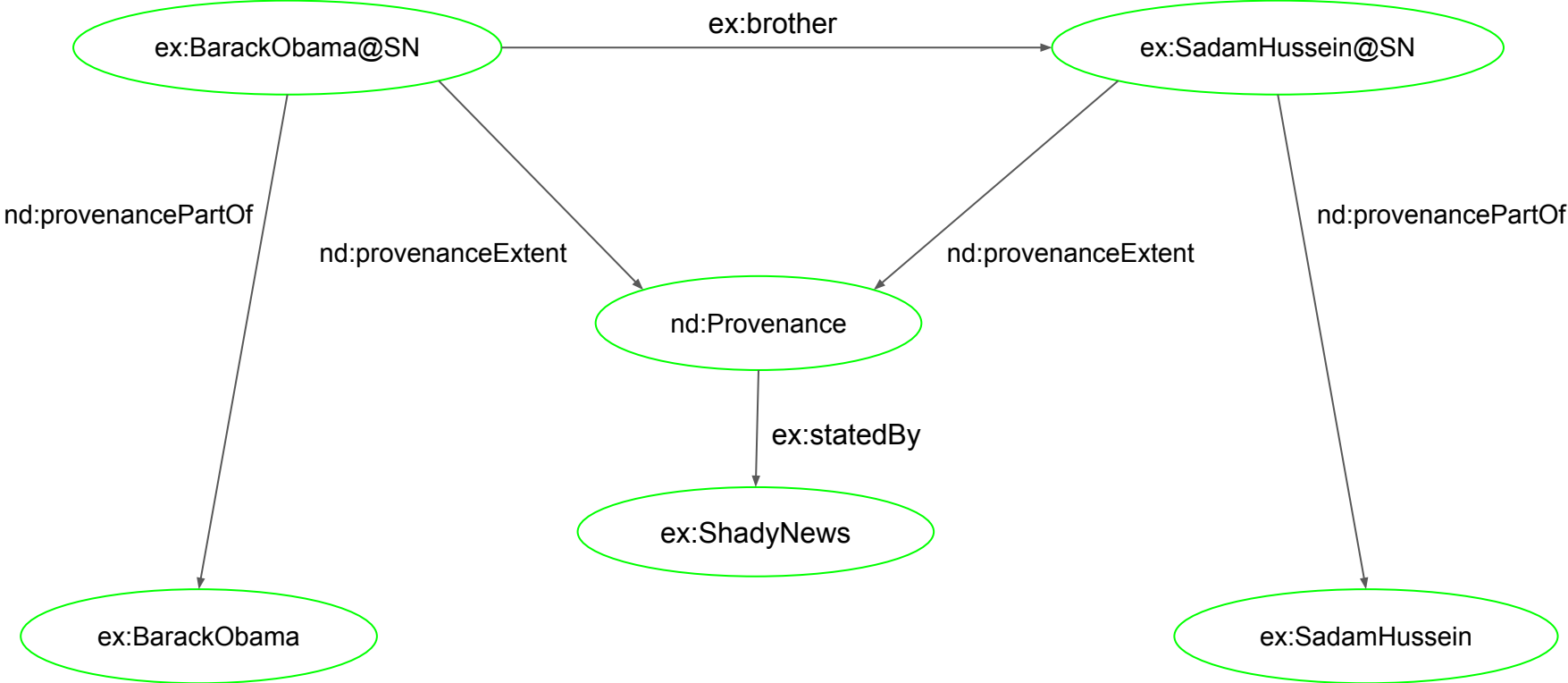
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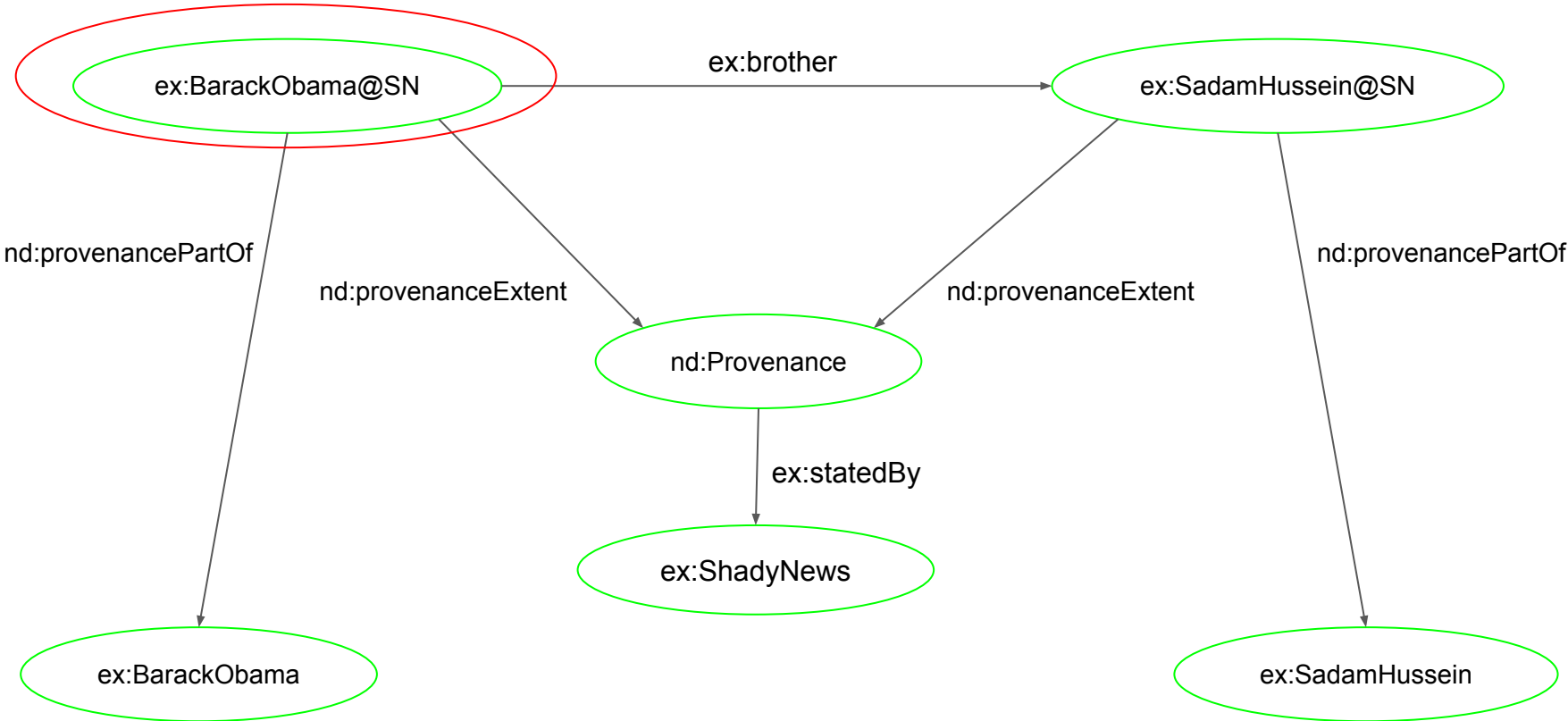


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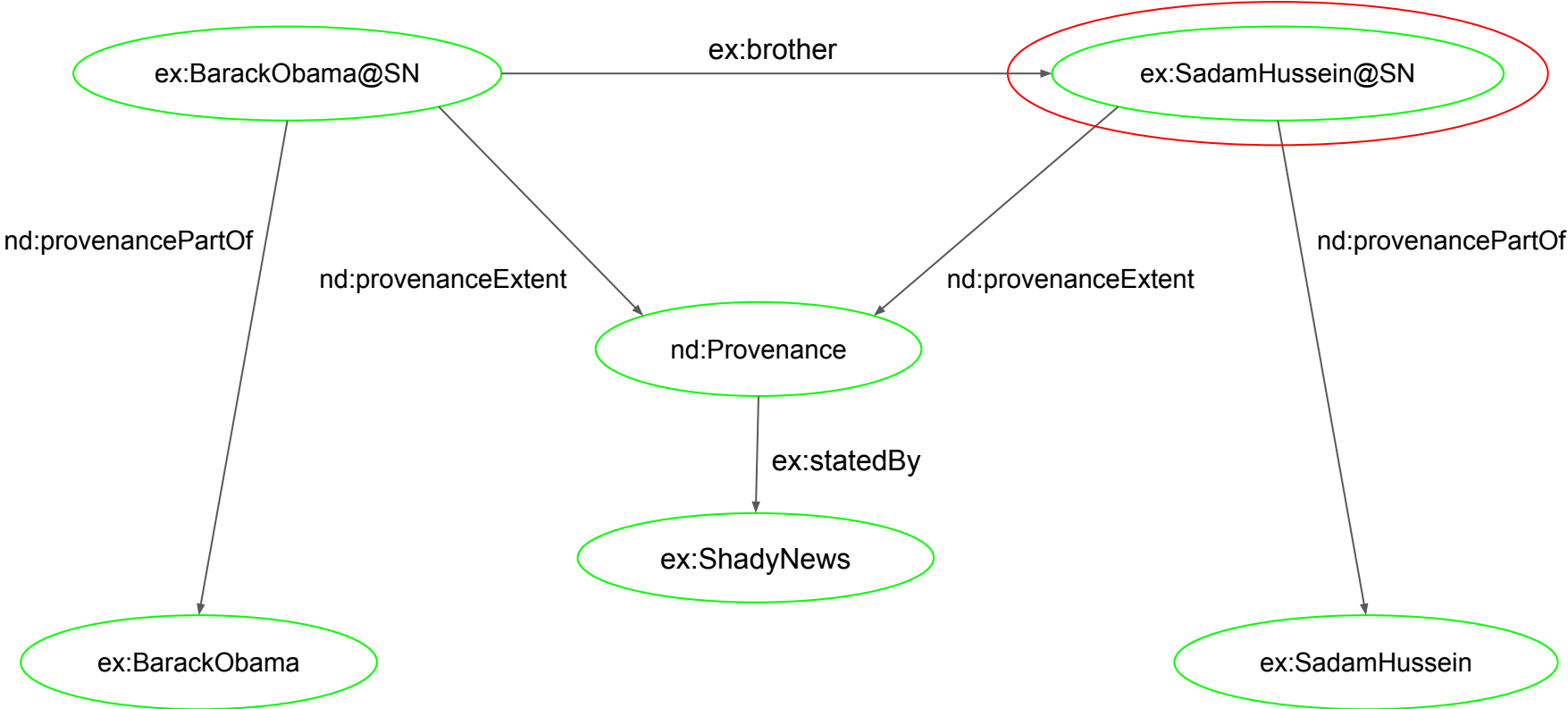




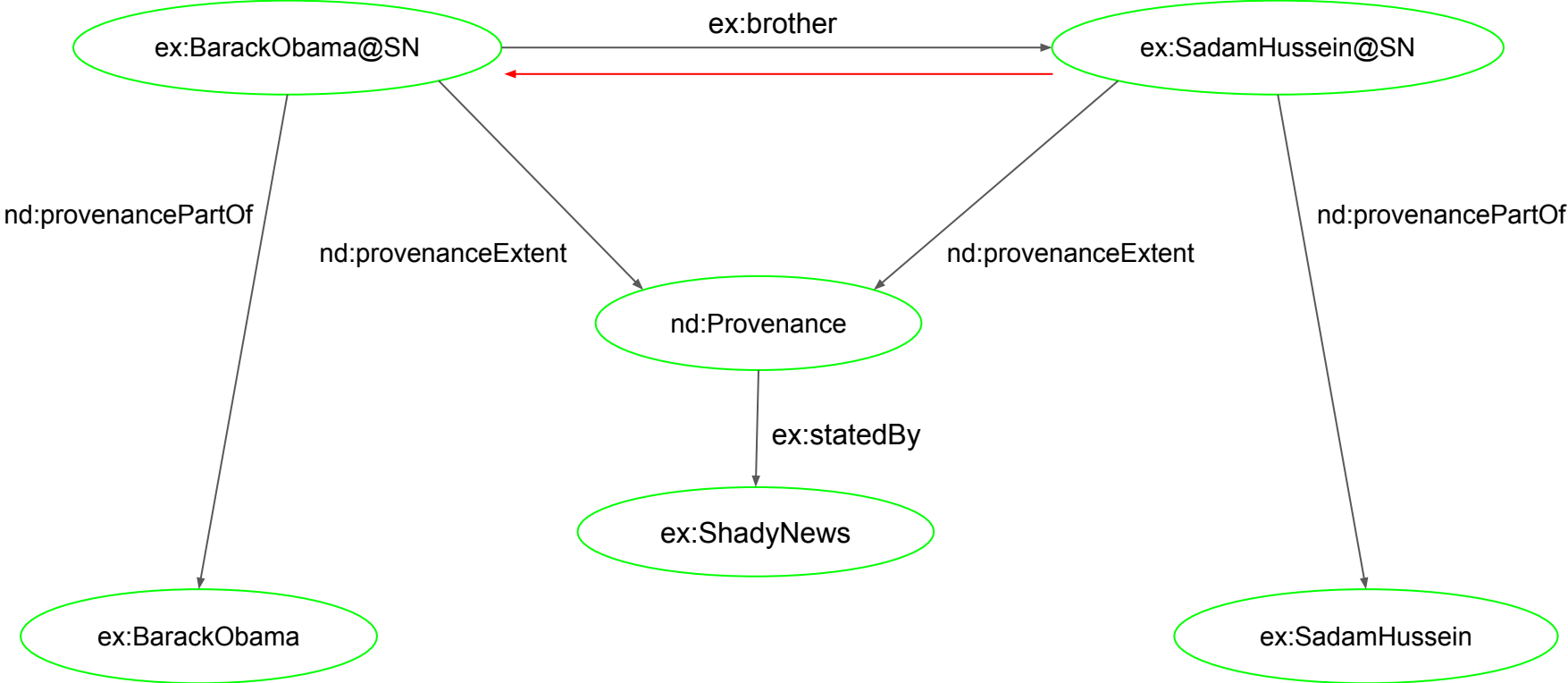
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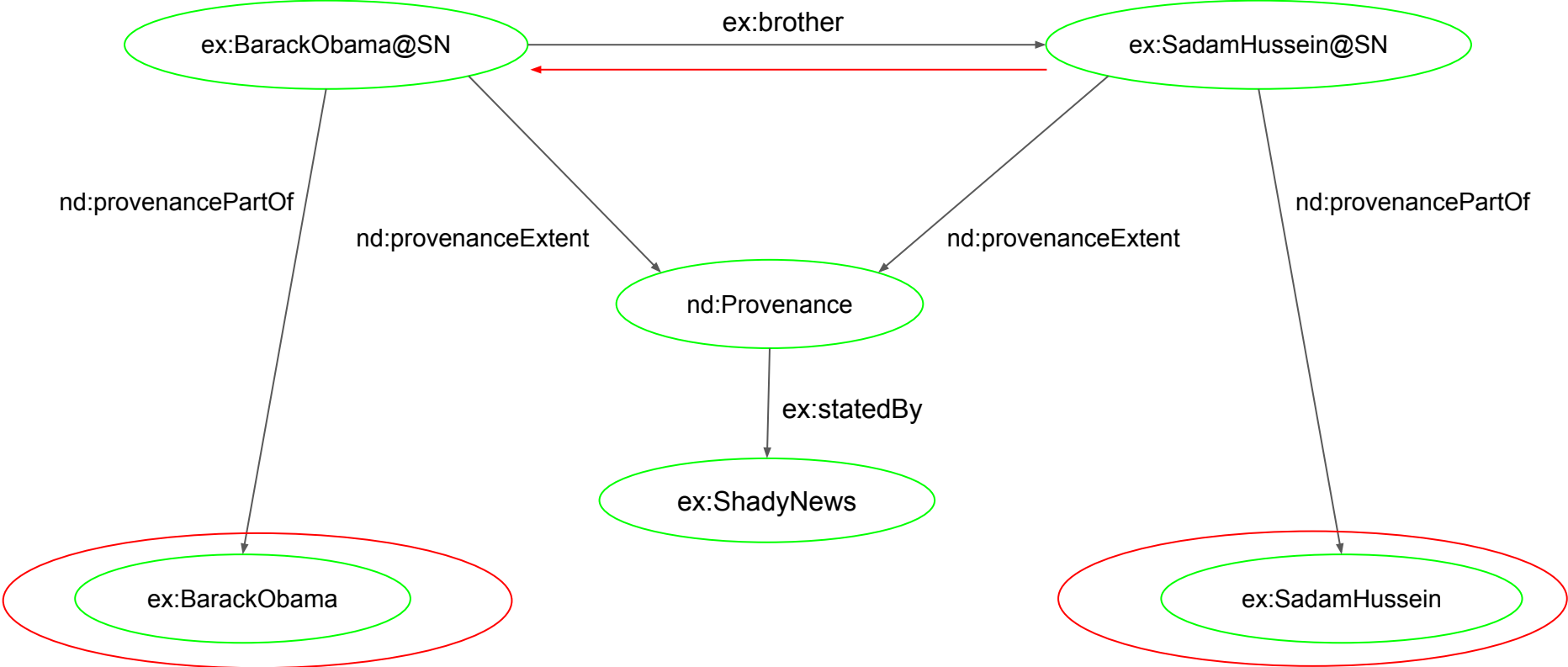
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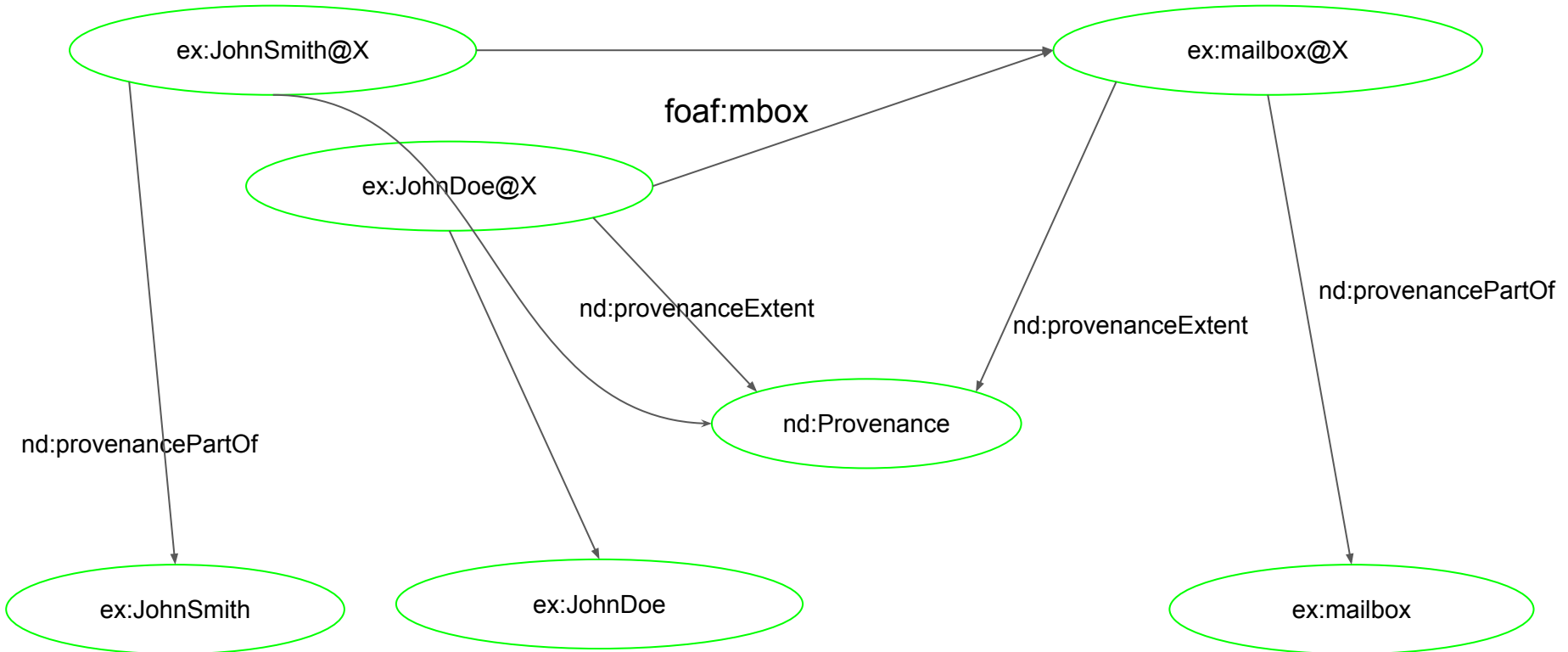


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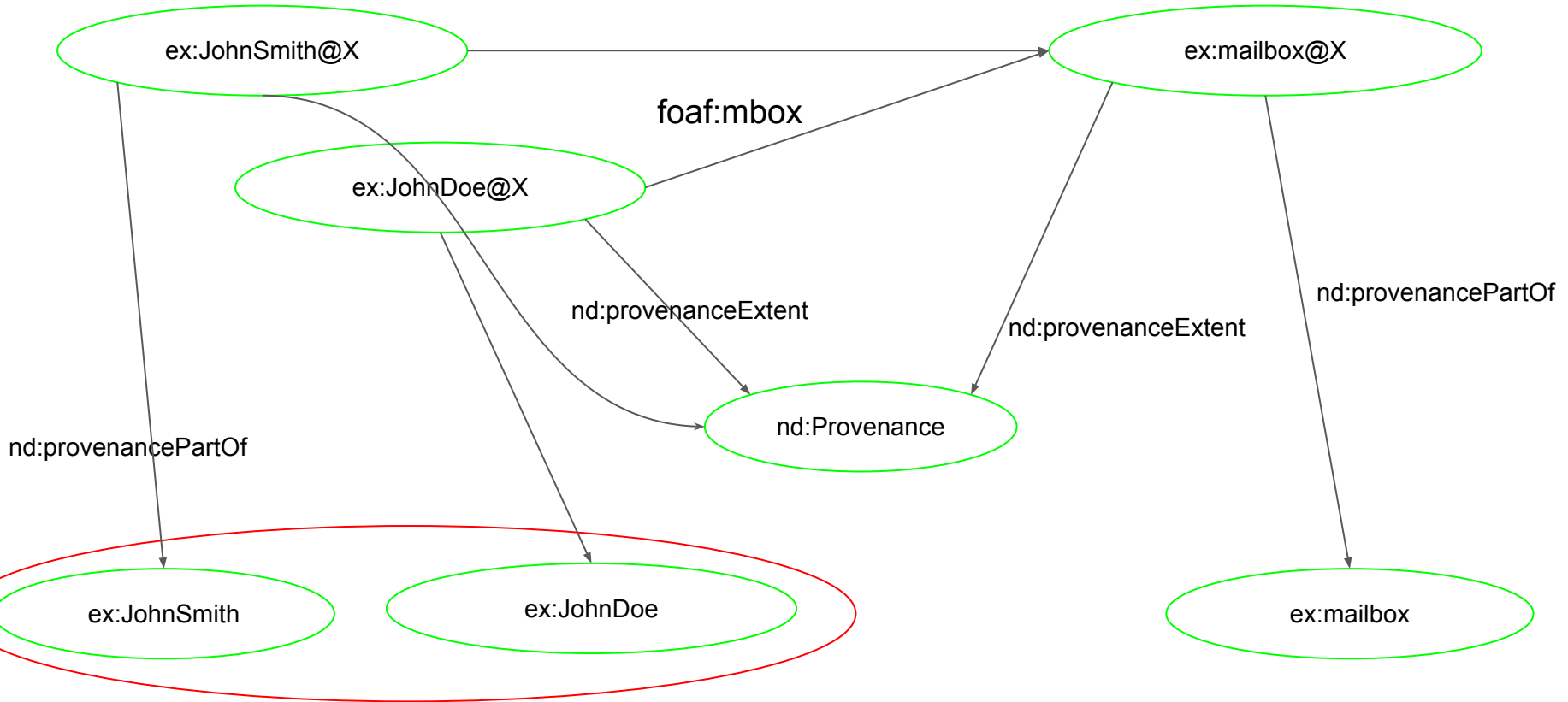
# NdFluents. Additional Inferences

$$f\left(\begin{array}{l} ?p \text{ a InverseFunctionalProperty} \\ ?u \text{ ?p ?v} \\ ?u \text{ ?p ?w} \end{array}\right) \models f\left(\begin{array}{l} ?v \text{ sameAs ?v} \end{array}\right)$$



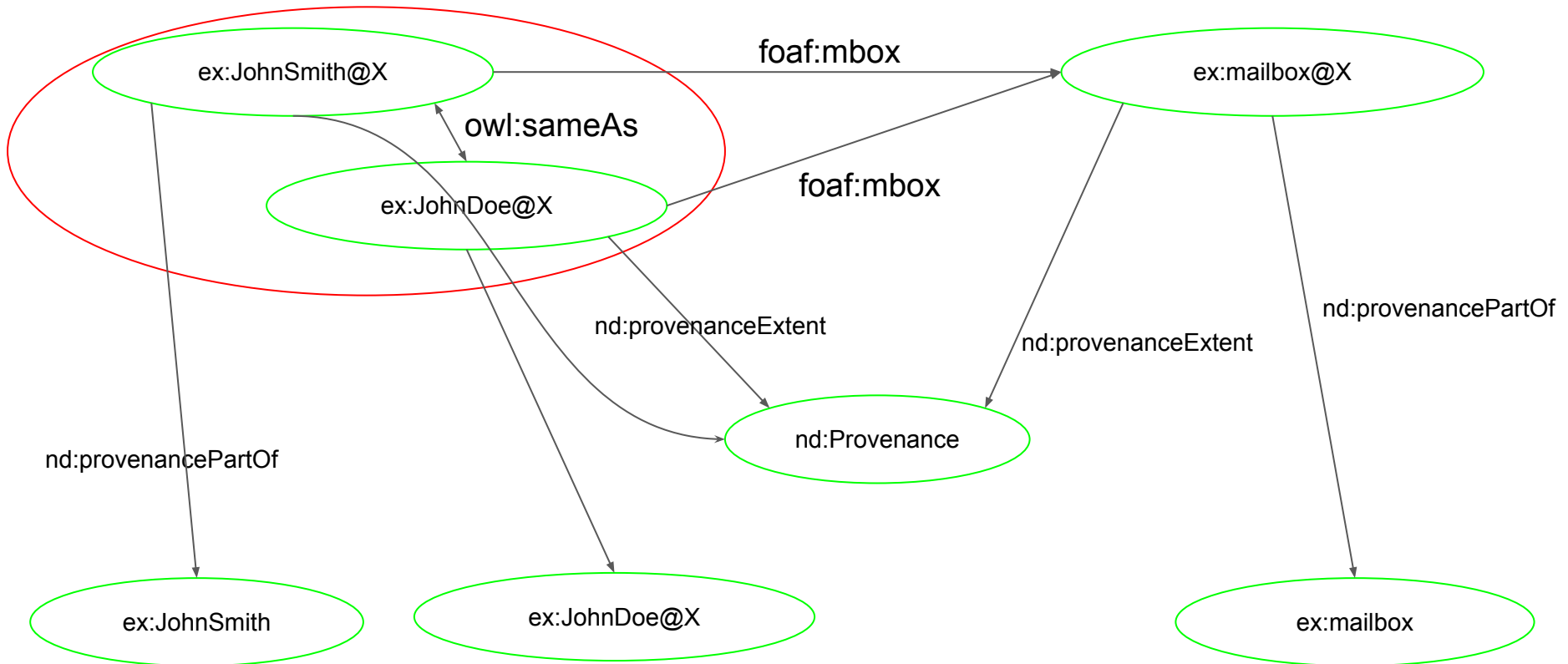
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# Comparing NdFluents against other approaches

## Results

- Compared 10 D\* (subset of RDFS) rules and 13 P (subset of OWL) rules.
- Including additional inferences:

Approach	Preservation	Non-Contextual Preservation	Additional Inferences	Risk
Reification	9	1	0	0
N-Ary	9	1	0	0
Singleton Property	16	6	0	13
NdFluents	14	1	6	0



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# Conclusions and Future Work

## Conclusions:

- First extension of 4dFluents for arbitrary combinations of any number of contexts
- Standard RDFS and OWL semantics
- 8+2 out of 10 D\* rules covered
- 7+4 out of 13 P rules covered
- No risk of undesirable inferences

## Future Work:

- Apply to real-world datasets for question answering
- Delve more into rule preservation
- Perform experimental evaluations of the models

# NdFluents

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