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## An Ontology-based Algorithm for Managing the Evolution of Multi-Level Territorial Partitions

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► **To cite this version:**

Camille Bernard, Christine Plumejeaud-Perreau, Marlène Villanova-Oliver, Jérôme Gensel, Hy Dao. An Ontology-based Algorithm for Managing the Evolution of Multi-Level Territorial Partitions. 26th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems (ACM SIGSPATIAL 2018), Nov 2018, Seattle, WA, United States. , 2018, 10.1145/3274895.3274944 . hal-01929649

**HAL Id: hal-01929649**

**<https://hal.science/hal-01929649>**

Submitted on 21 Nov 2018

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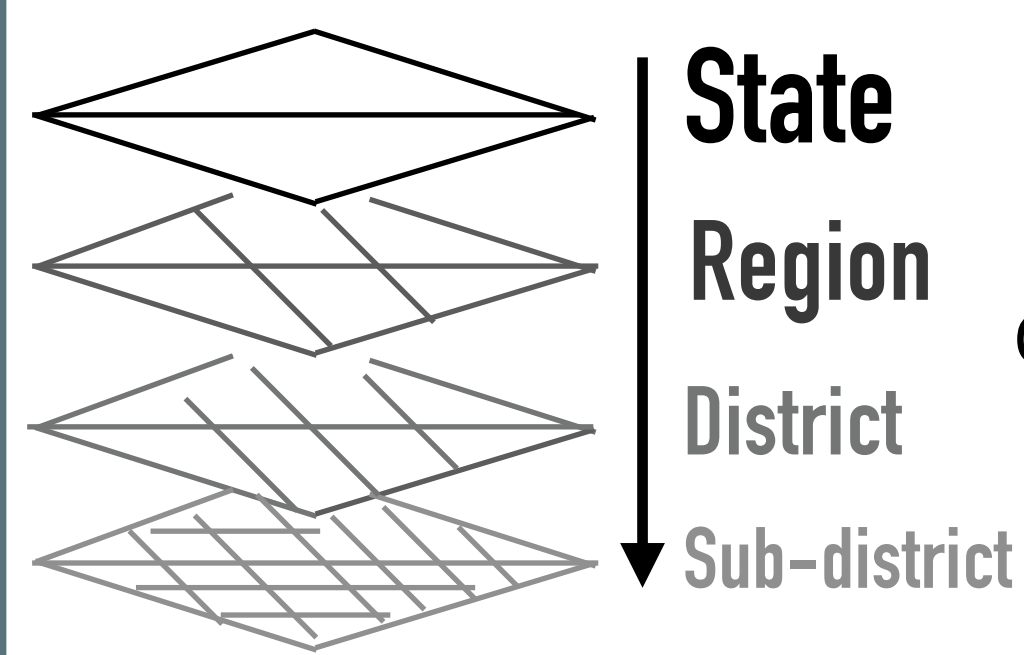
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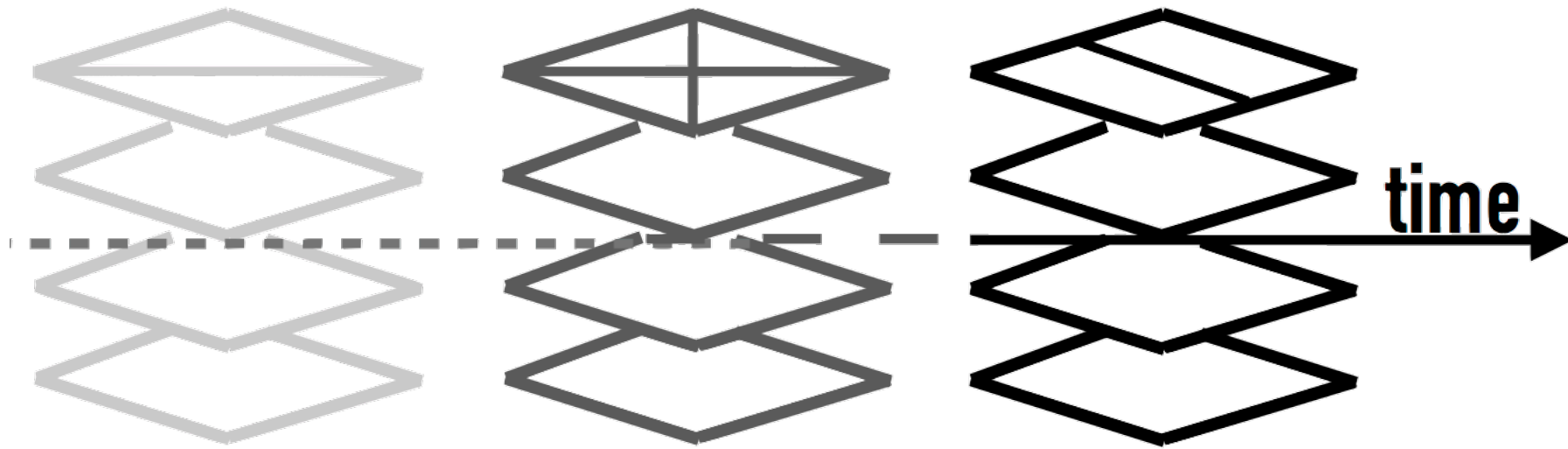
## CONTEXT



**State**  
**Region**  
**District**  
**Sub-district**

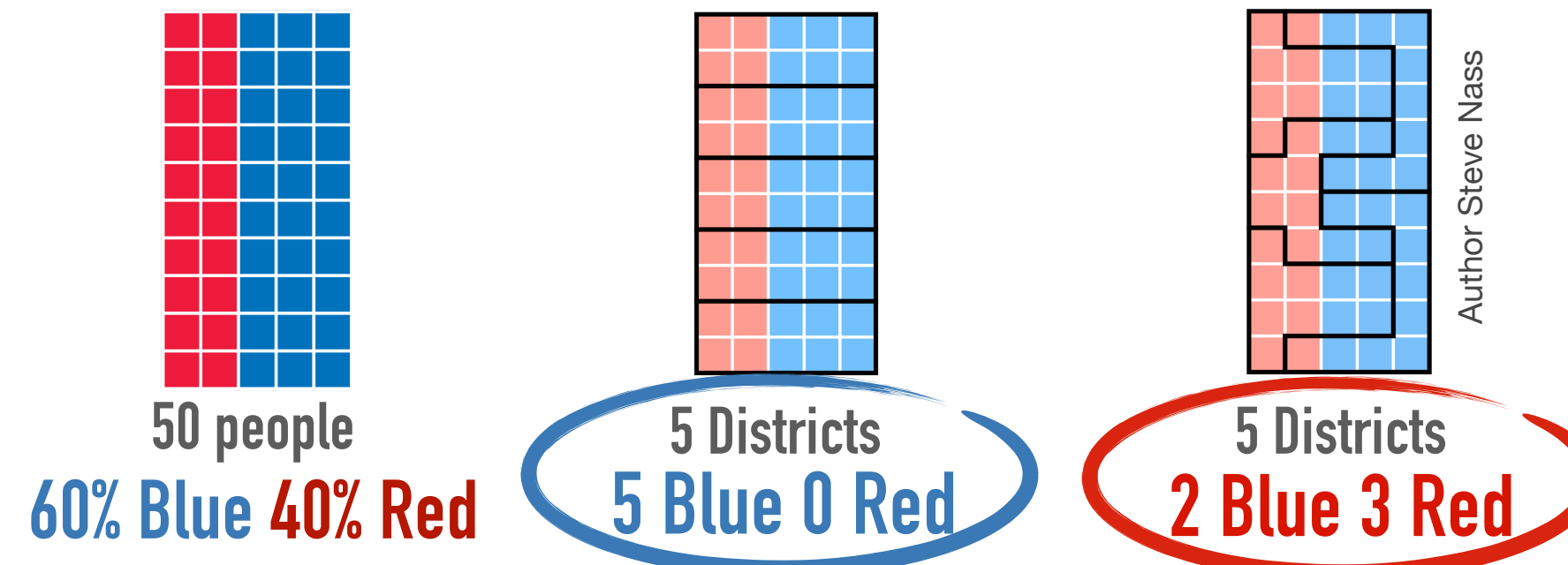
Territorial Statistical Nomenclatures (TSN) are hierarchies of territorial divisions (e.g., district, sub-district levels) defined with the purpose of collecting and presenting statistical data.

TSN **change over time**, for political or administrative reasons



## MODIFIABLE AREAL UNIT PROBLEM (MAUP)

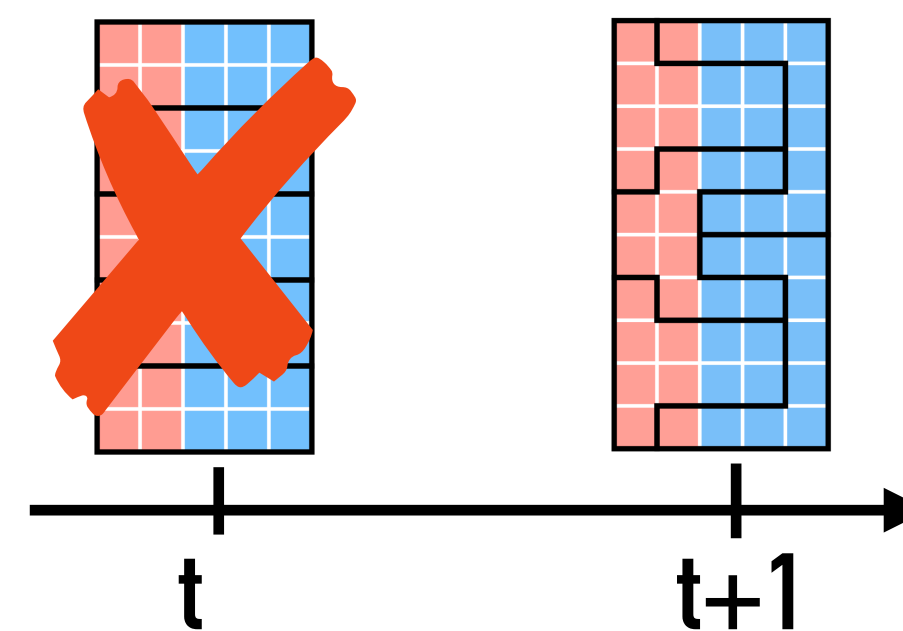
Influence of the **partition** on data [Openshaw & Taylor]



### MAUP + TIME

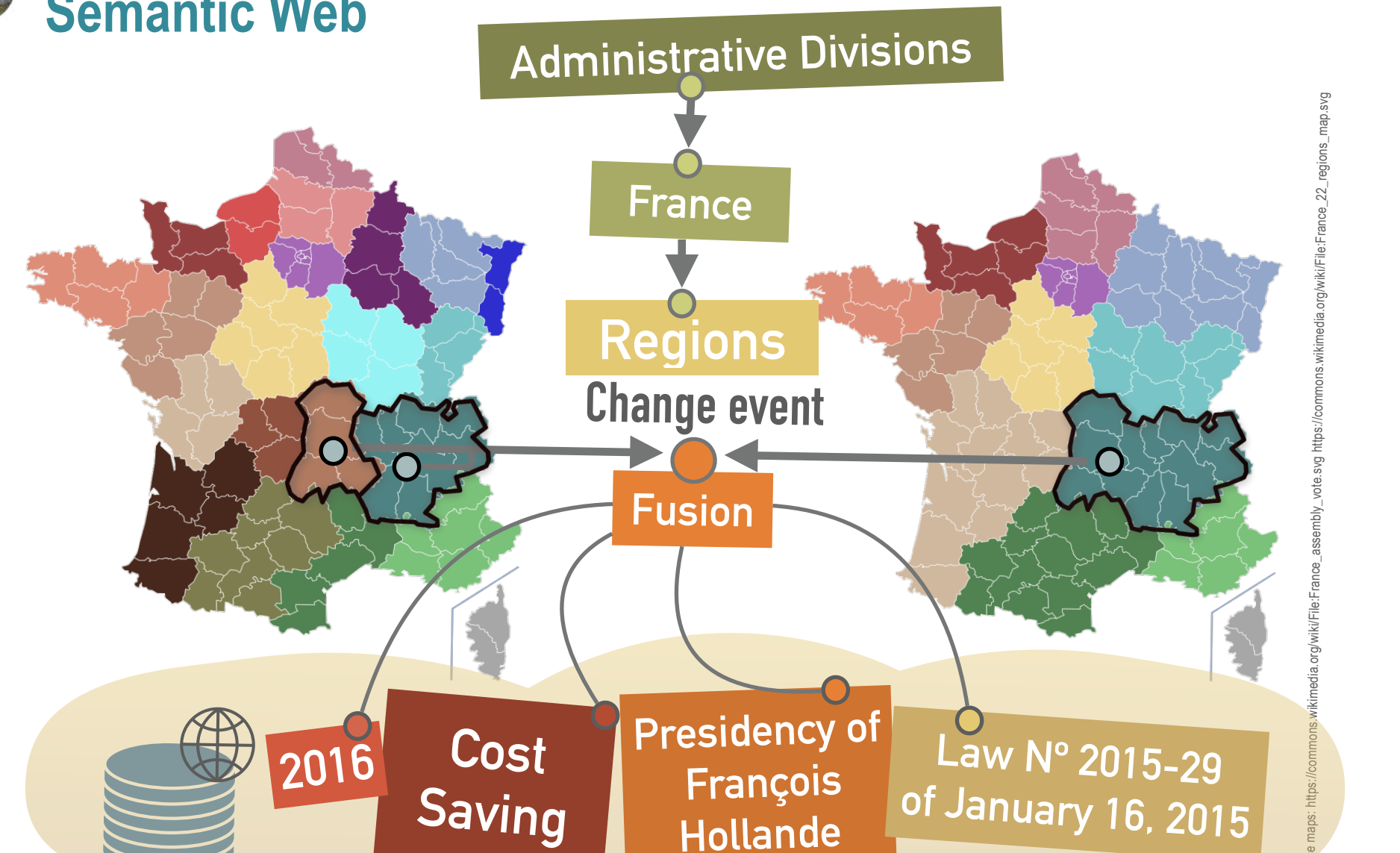
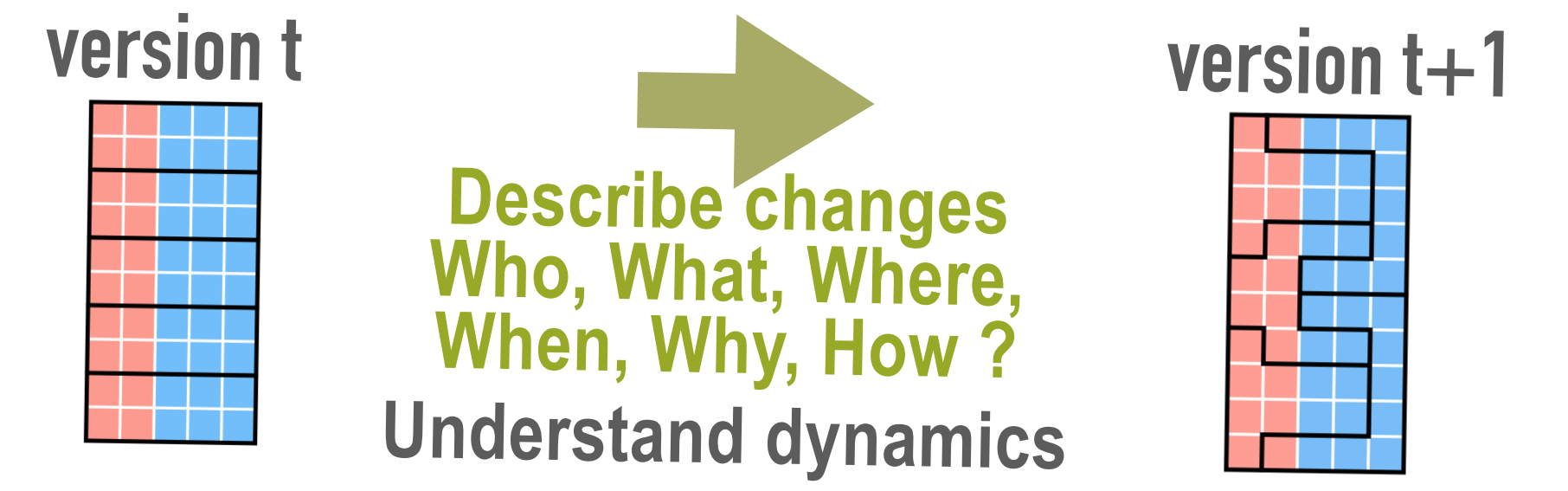
Data are not comparable due to potential changes of the territorial units over time

**Classic solution:**  
Access to statistical data in the latest territorial division version only



## OUR APPROACH

Modifiable Areal Unit Potential [Grasland and Madelin]

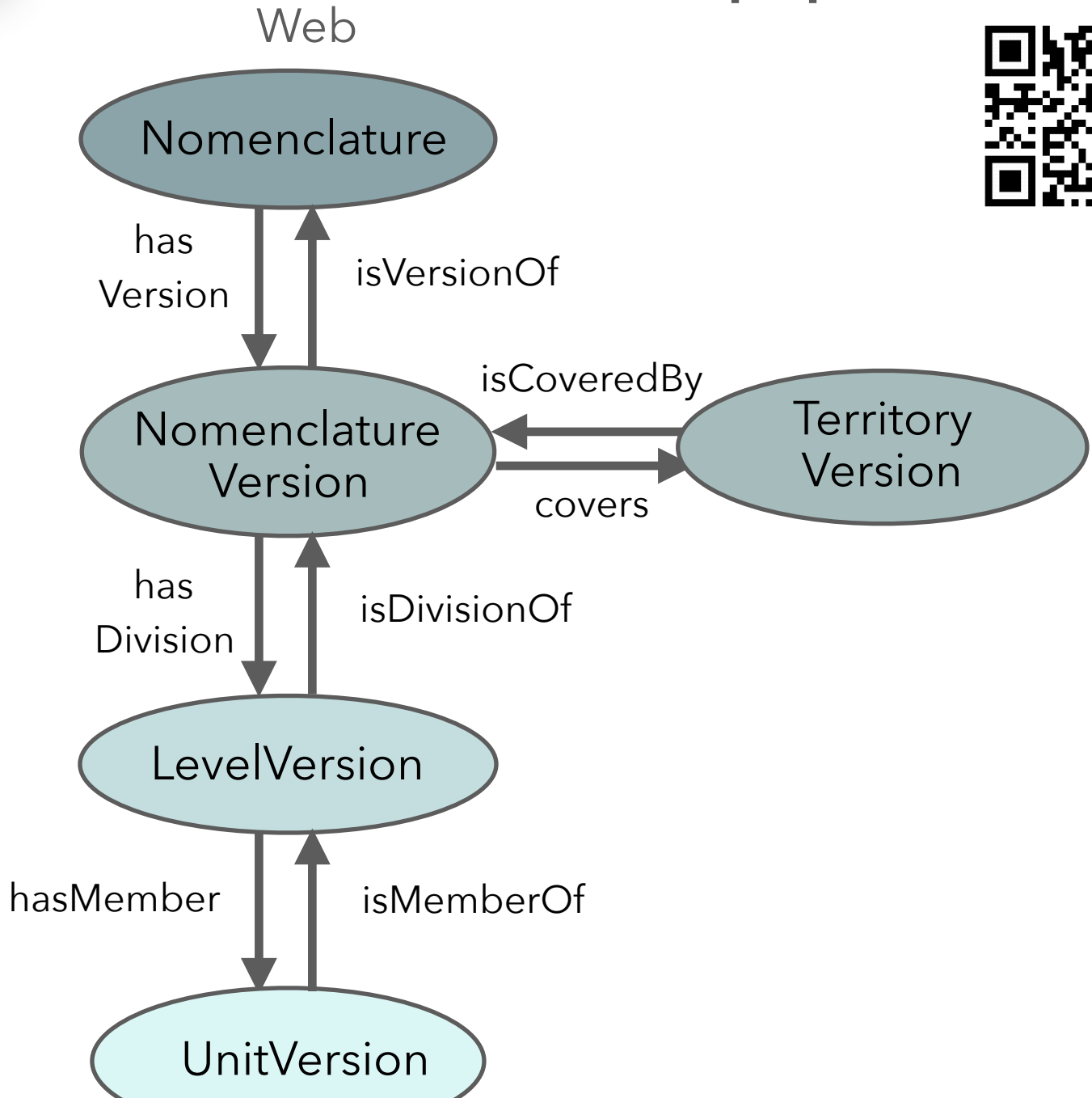


## PROPOSITIONS

### 1 TSN ONTOLOGY

A generic model for Territorial Statistical Nomenclature in the LOD Web

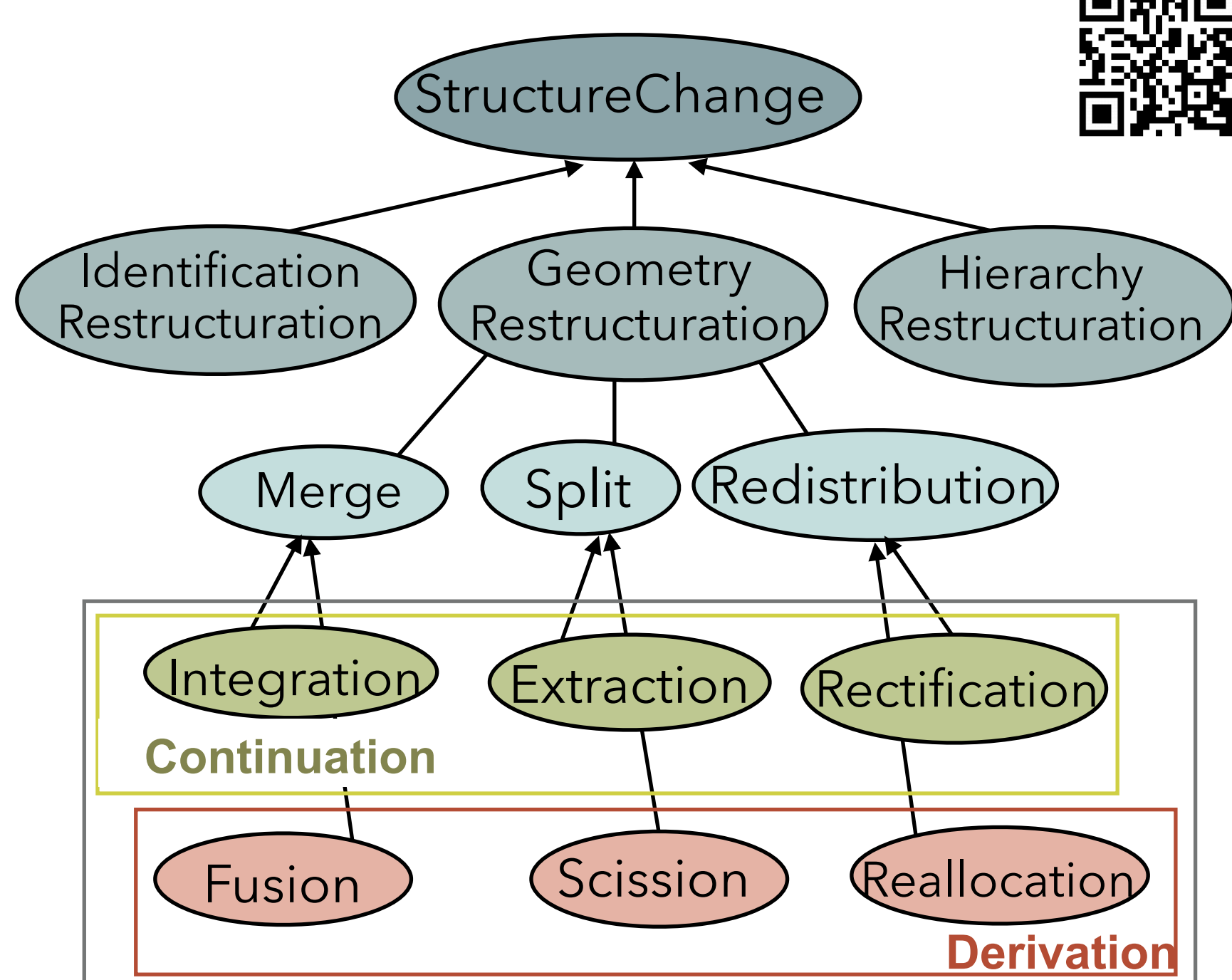
<http://purl.org/net/tsn#>



### 2 TSN-CHANGE ONTOLOGY

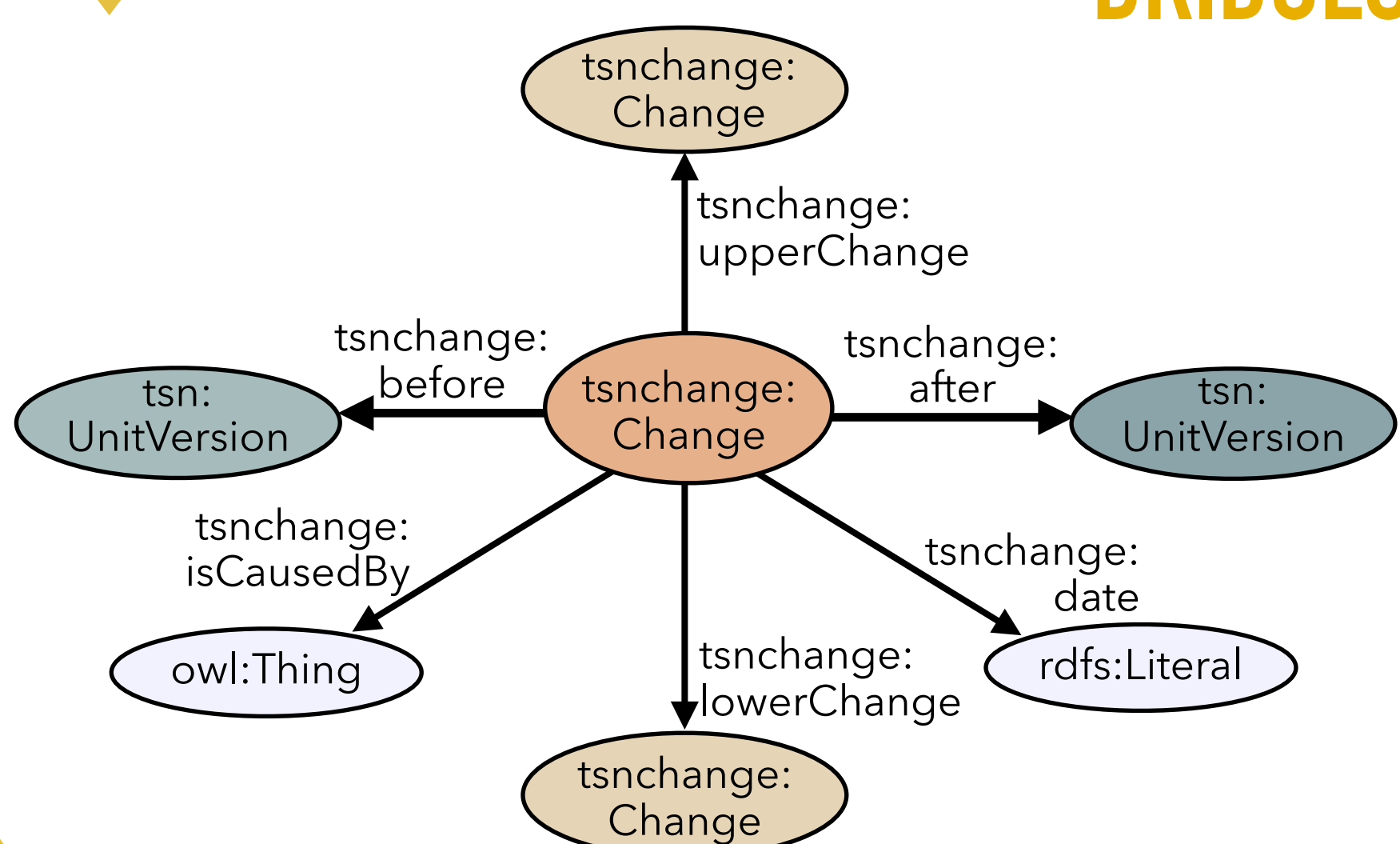
A set of tags to describe changes in TSN over time, in the LOD Web

<http://purl.org/net/tsnchange#>



### 3 MULTI-LEVEL CHANGE BRIDGES

A graph structure to navigate through the TSN versions + observe the propagation of a change event through the levels



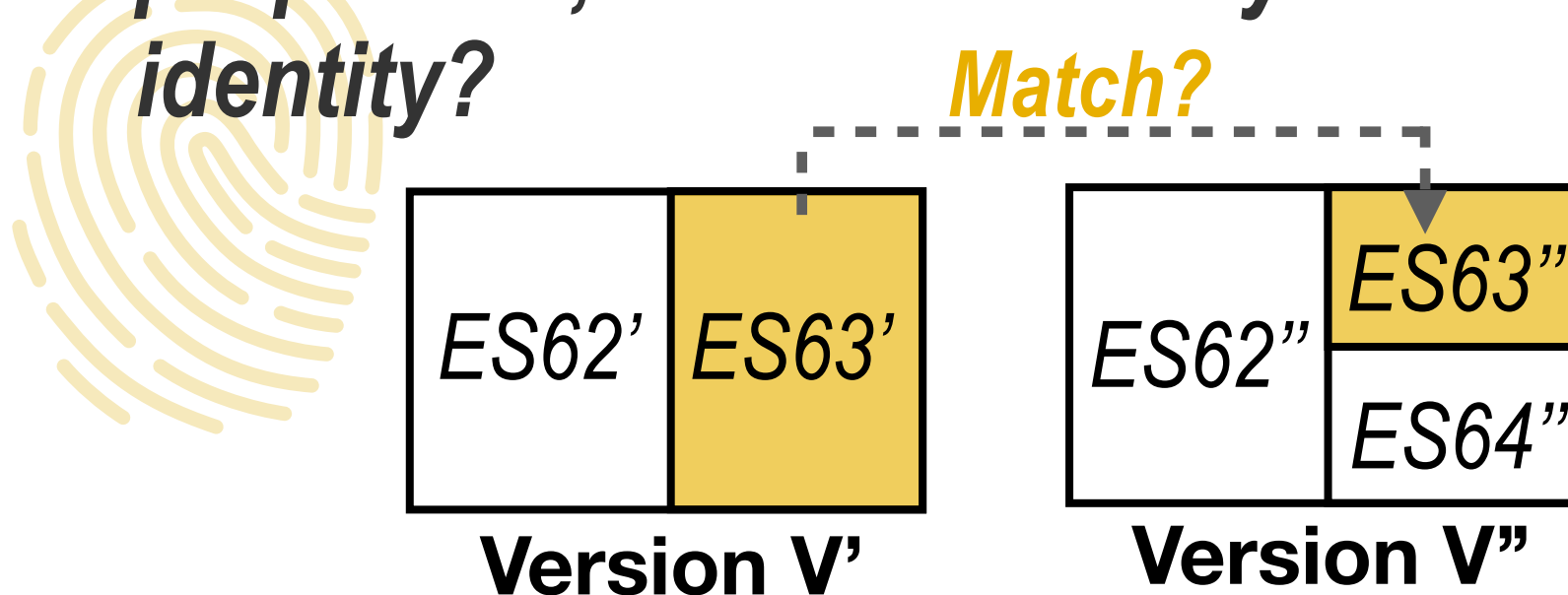
### 4 Generic algorithm for automatic matching and changes detection between two TSN's versions [Plumejeaud, 2010]

**Input** Two lists  $V'$  and  $V''$  of units  $u'$  and  $u''$ , all units being at one Level  $l$ .

**Output** A RDF graph describing Matching and Changes on Units

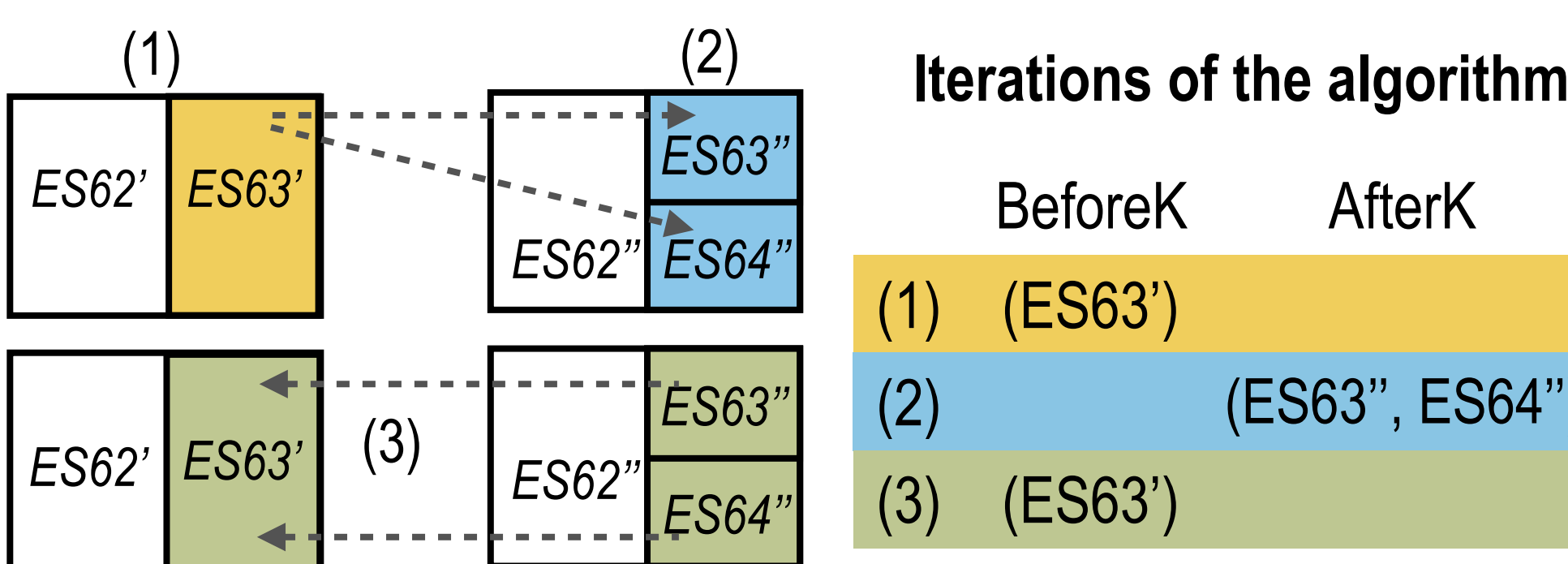
#### 4.1 Matchings of territorial units

Which attributes may vary, in which proportion, before the entity loses its identity?



#### 4.2 Identifying clusters of changes

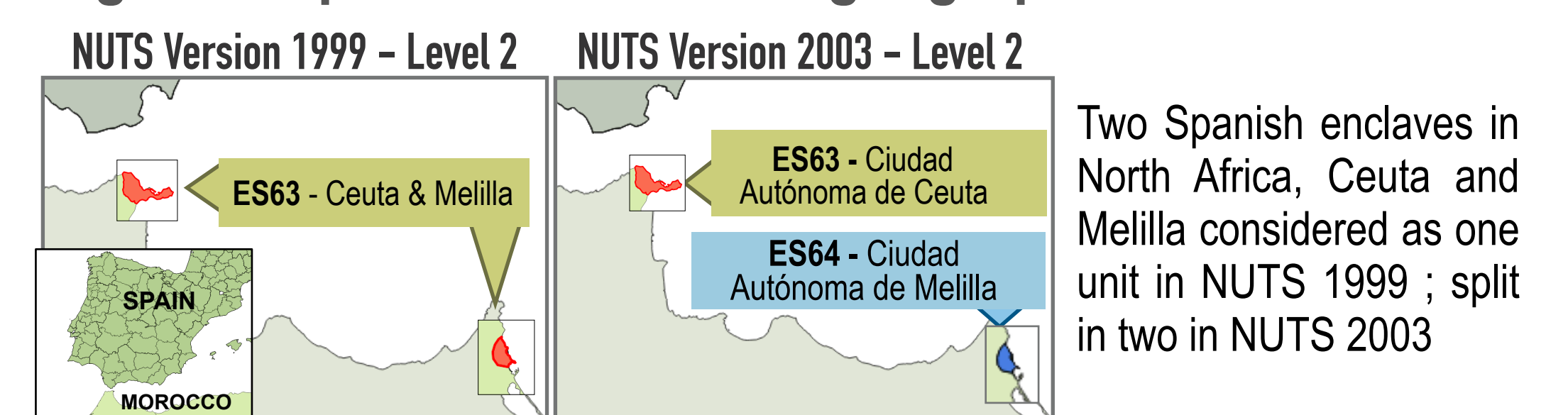
Builds through iterations two sets of units  $BeforeK$  and  $AfterK$ . Adds successively to the sets, units that intersect ones in the other version. Stops when one set ( $BeforeK$  or  $AfterK$ ) remains identical between two iterations.



Uses relations between units in order to link changes through the TSN levels

### ALGORITHM FOR CHANGE DETECTION

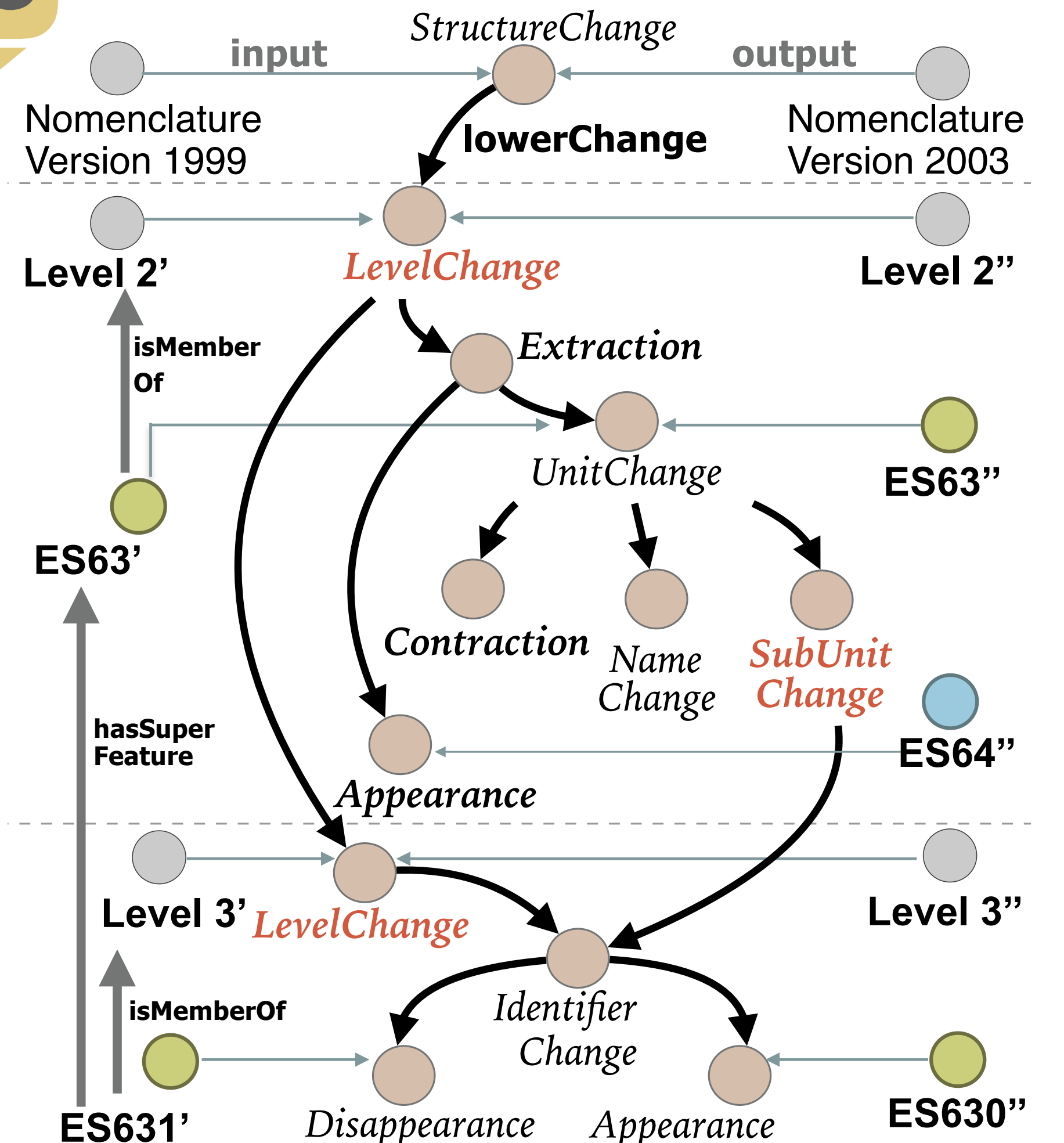
Change example in the EuroStat geographic nomenclature



#### Solution - configurable identity test in 3 steps:

1. An expert defines which attributes hold the identity of the units **ID? Name? Geom? Super Unit?**
2. For each attribute: a specific **Comparison Operator** is defined to measure distance between the two versions:  
 $|u'.attribute - u''.attribute|$
3. Coefficients  $\alpha_k$  assigned to attributes = define in which **proportion** attributes can vary before unit loses its identity. E.g:  
 $F(\alpha_1, identifier), (\alpha_2, geom), (\alpha_3, name)$  where  $\alpha_1 = 1/3, \alpha_2 = 1/3, \alpha_3 = 1/3$   
 $1/3 * (|u'.identifier - u''.identifier|) +$   
 $1/3 * (|u'.geom - u''.geom|) + 1/6 * (|u'.name - u''.name|)$

#### 4.3 Linking changes through the levels



## RESULTS

Automatize detection & semantic description of TSN changes: feature by feature + cluster of changes + chain of changes + 2 case studies

✓ **Europe** - Nomenclature of Territorial Units for Statistics (NUTS)

4 versions, 4 levels, 7619 geographic units

122,000 resources describing European Units

39,306 resources describing matching and changes

✓ **Australia** - Australian Statistical Geography Standard (ASGS)

2 versions, 4 levels, 5356 geographic units



<http://purl.org/steamer/nuts>

#### WHAT'S NEXT?

Geo-visualisation of Territorial Changes Over Time on the basis of GitHub, Inc. initiatives

