



KATHOLIEKE UNIVERSITEIT  
**LEUVEN**



# Spatial Role Labeling:

## Task Definition and Annotation Scheme

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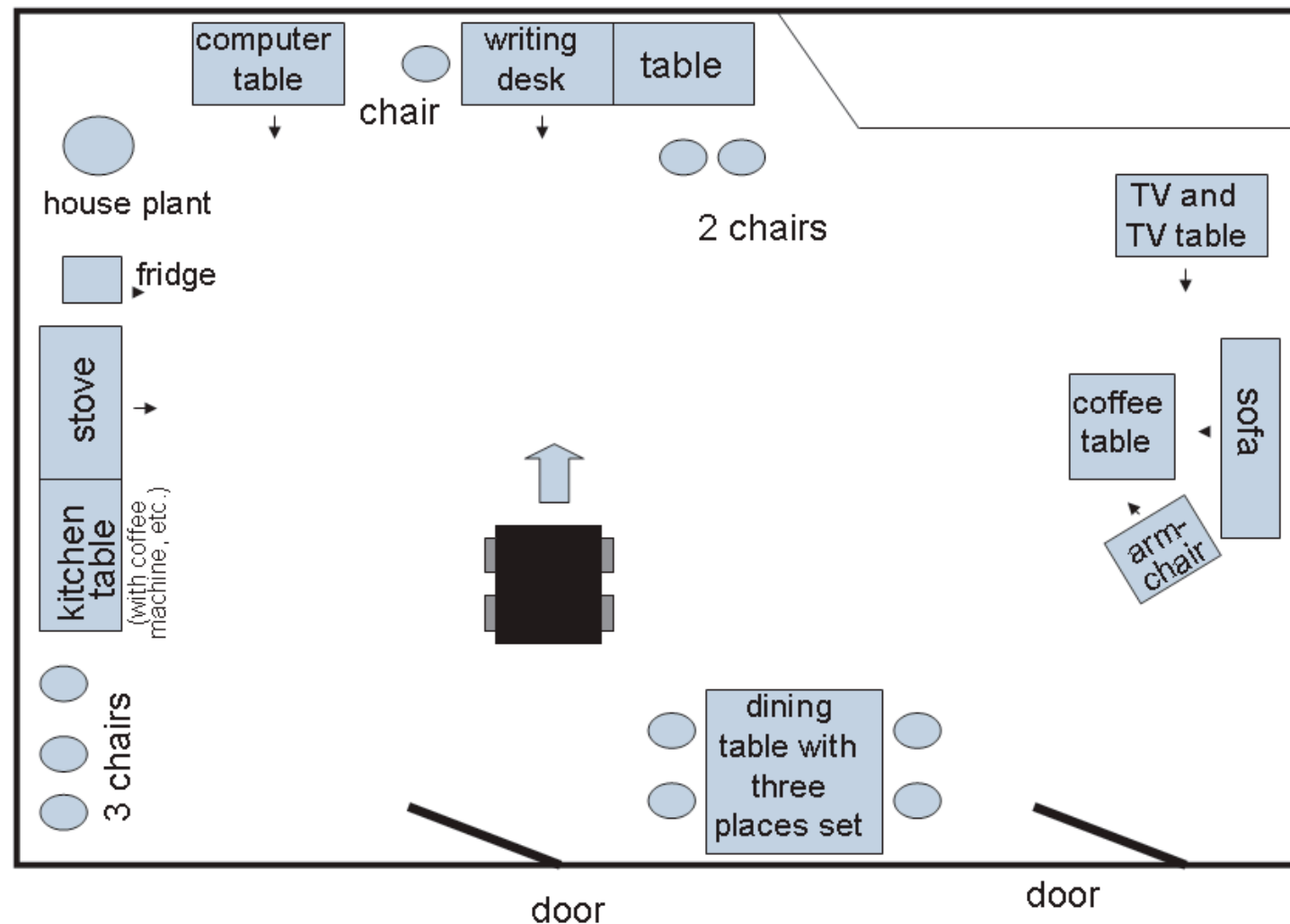
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# Introduction

- Problem Setting
  - Multimodal environment
  - Unrestricted language
  - Machine learning
    - Task definition (Spatial role labeling)
    - Lack of and difficulty of making Data
- Annotation scheme

# Motivation



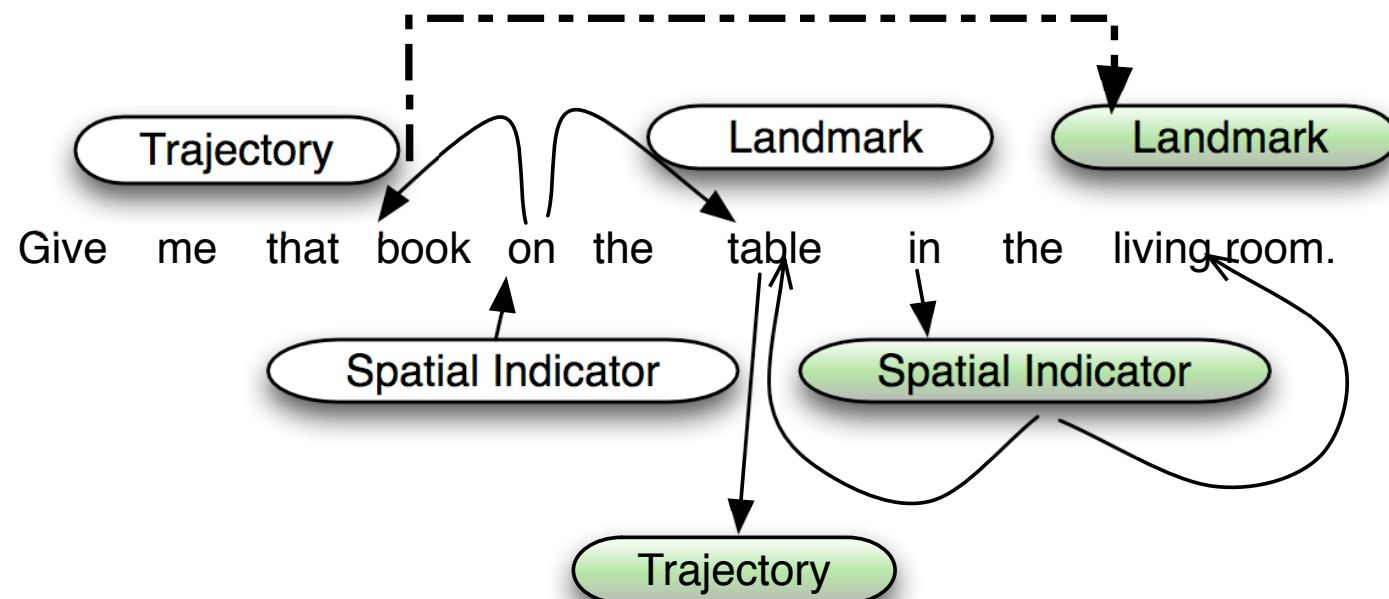
Room Description [Bateman, et.al, 2006]

1. so from here exactly opposite is my desk.
2. and next to that left of that is my computer, perhaps a meter away.
3. (breathing) ähm.
4. next to that at the wall is my kitchen, first there is my fridge all the way to the right.

# Related schemes

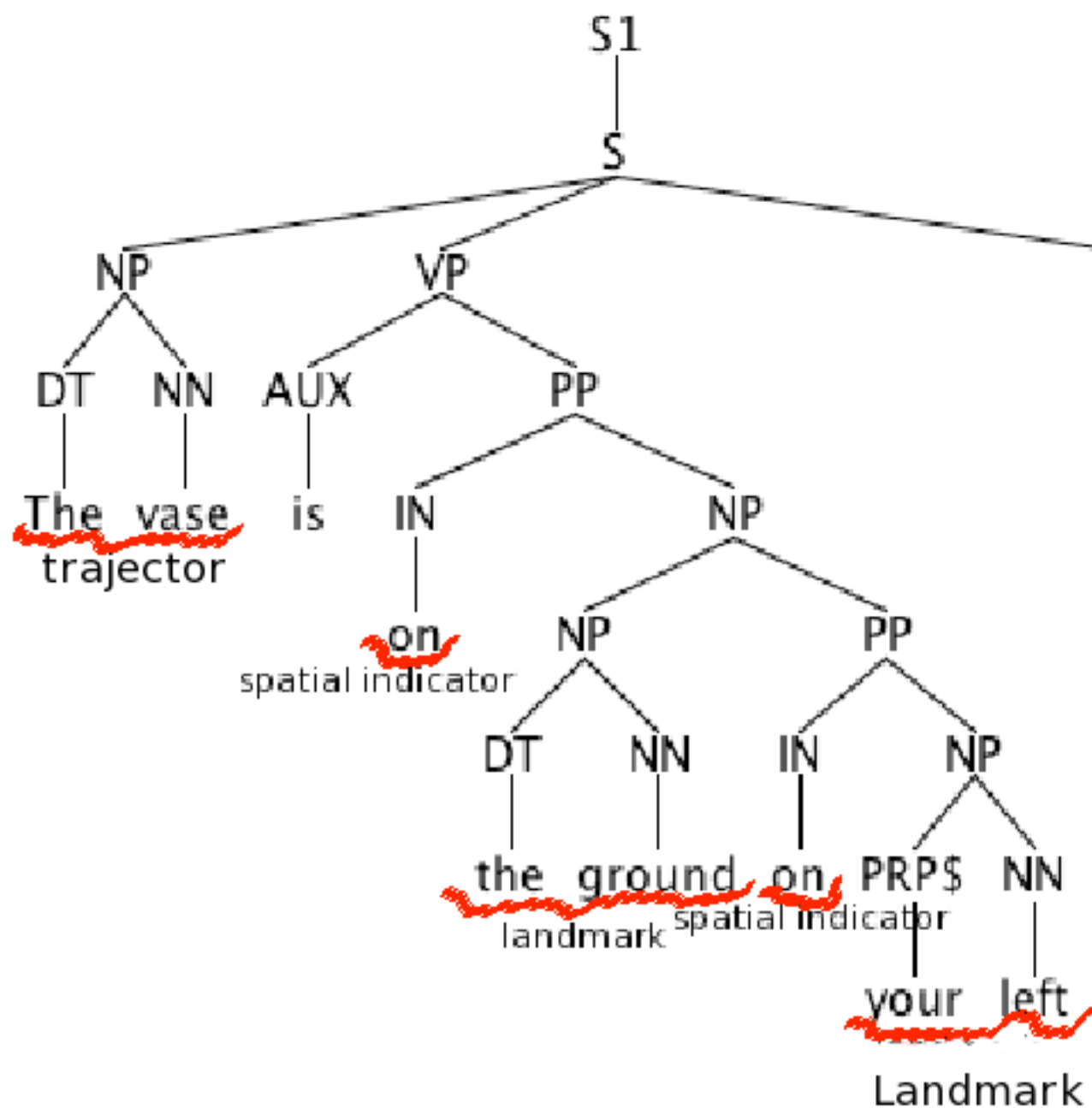
- SpatialML
- Generalized upper model (GUM)
- Geographical scheme (Q. Shen, et.al. 2009)
- Spatial temporal markup(STM) (Pustejovsky and Moszkowicz, 2009)
- ...

# Spatial role labeling task

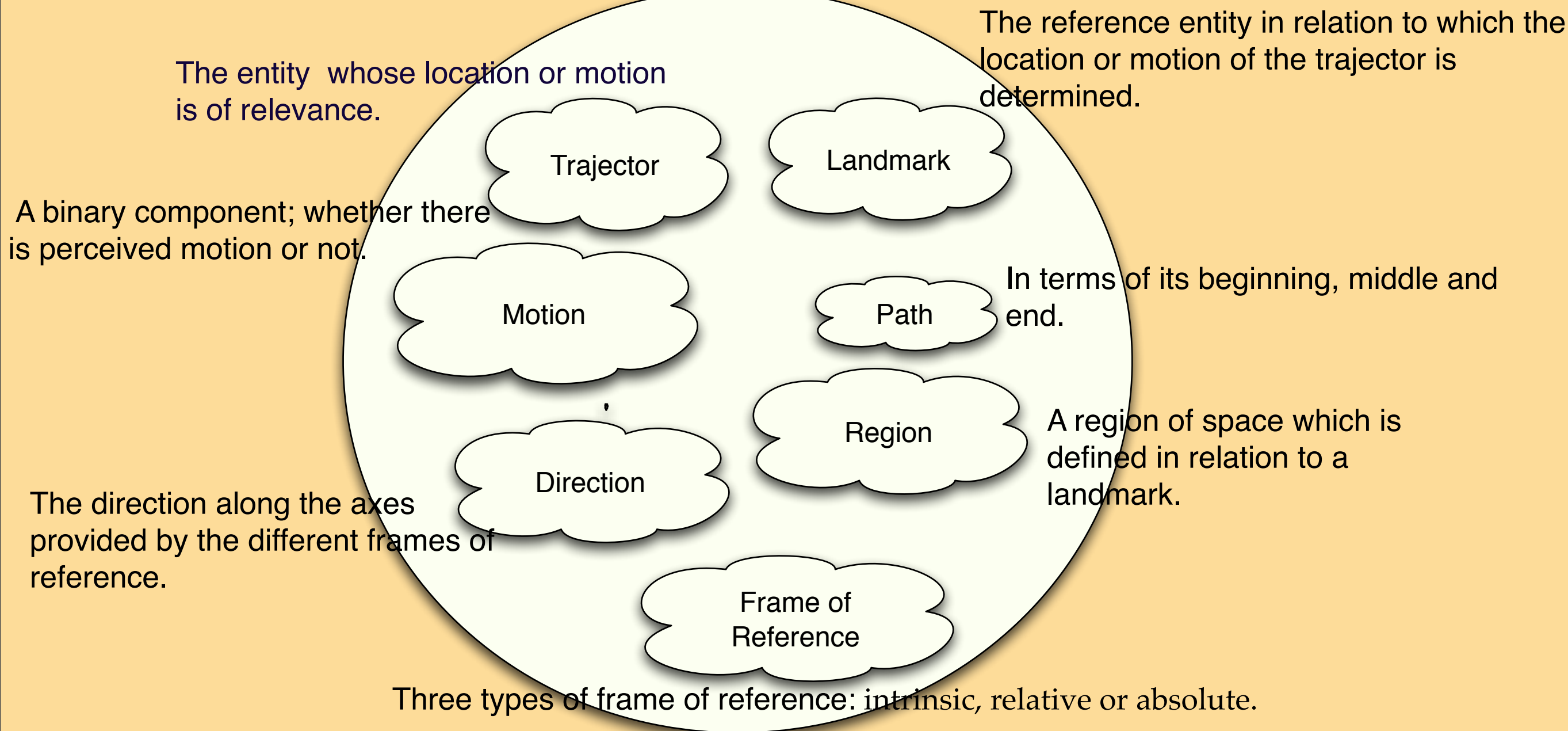


ON(book,table)  
IN(table, living room)  
IN(book,living room)?

# Labeling the parse tree



# Holistic spatial semantics



# Relational representation

**TRAJECTOR**(id, token)

**LANDMARK**(id, token, path)

**SPATIAL-INDICATOR**(id, token, general-type, specific-type, spatial-value)

**MOTION-INDICATOR**(id, token)

**SR**(id, trajector, landmark, spatial-indicator, frame-of-reference, motion-indicator)



# Trajector

a. She is at school.

**<TRAJECTOR id='1'> She </TRAJECTOR>**

**TRAJECTOR(1, she).**



Landmark

Path

a. The balloon passed over the house.

**<LANDMARK id='1' path='ZERO'>the house </LANDMARK>**

**LANDMARK(1, the house, ZERO).**

Direction

Region

a. He is in front of the bush.

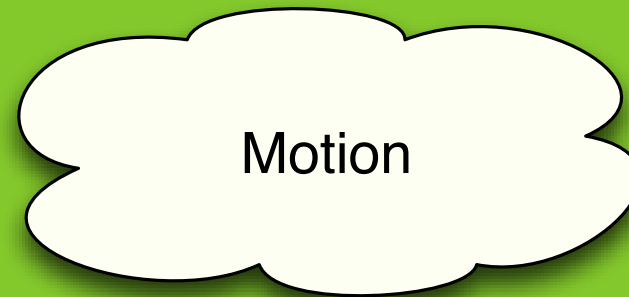
**<SPATIAL-INDICATOR** *id='1' general-type='DIRECTION' specific-type='RELATIVE' spatial-value='FRONT'* **>** in front of **</SPATIAL-INDICATOR>**

**SPATIAL-INDICATOR(1, in front of,DIRECTION, RELATIVE, FRONT)**

b. John is in the room.

**<SPATIAL-INDICATOR** *id='1' general-type='REGION' specific-type='RCC8' spatial-value='TPP'* **>** in **</SPATIAL-INDICATOR>**

**SPATIAL-INDICATOR(1, in ,REGION, RCC8, TPP)**



a. The bird flew to its nest.

**<MOTION-INDICATOR *id*='1' > flew to </MOTIONINDICATOR>**

**MOTION-INDICATOR(1, flew to)**

# Spatial relation (SR)

+

Frame of  
Reference

She went to school.

**<TRAJECTOR id='1' > She</TRAJECTOR>**

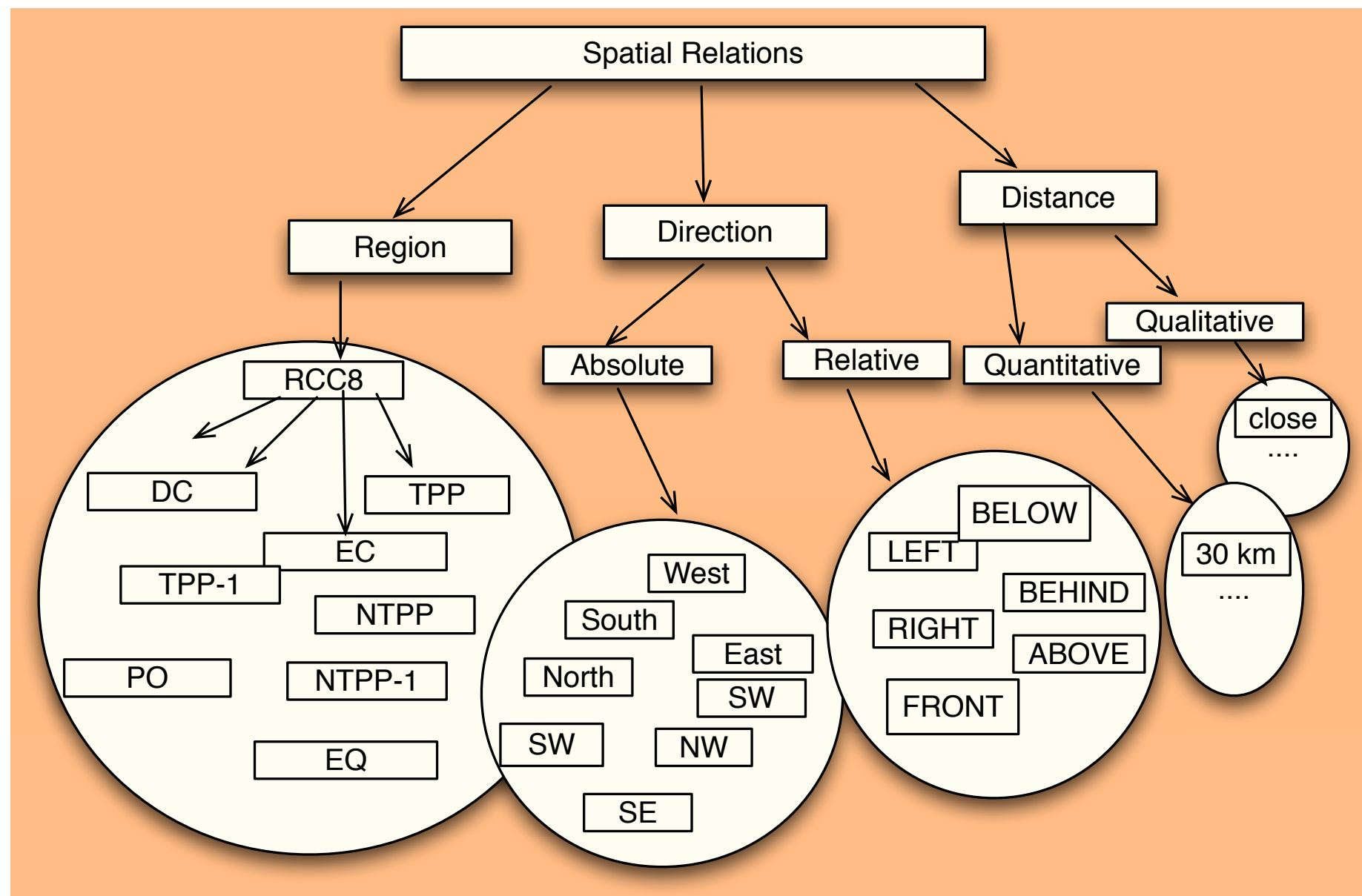
**<LANDMARK id='1' path='END'> school </LANDMARK>**

**<SPATIAL-INDICATOR id='1' general-type='REGION' specific-type='RCC8' spatial-value='TPP' > to </SPATIALINDICATOR>**

**<MOTION-INDICATOR id='1' > went to </MOTIONINDICATOR>**

**<SR id='1' trajector='1' landmark='1' spatial-indicator='1' frame-of-reference='INTRINSIC' motion-indicator='1'/>**

# Mapping to formal spatial relations



# Mapping to formal spatial relations

Direction

Region

a. He is in front of the bush.

**<SPATIAL-INDICATOR** *id='1'* **general-type='DIRECTION'**  
**specific-type='RELATIVE'** **spatial-value='FRONT'****>**  
in front of **</SPATIAL-INDICATOR>**

**SPATIAL-INDICATOR(1, in front of,DIRECTION, RELATIVE, FRONT)**

b. John is in the room.

**<SPATIAL-INDICATOR** *id='1'* **general-type='REGION'**  
**specific-type='RCC8'** **spatial-value='TPP'** **>** in  
**</SPATIAL-INDICATOR>**

**SPATIAL-INDICATOR(1, in ,REGION, RCC8, TPP)**

# Mapping to formal spatial relations

She went to school.

<**TRAJECTOR** id='1' > She</**TRAJECTOR**>

<**LANDMARK** id='1' path='END'> school </**LANDMARK**>

<**SPATIAL-INDICATOR** id='1' **general-type='REGION' specific-type='RCC8' spatial-value='TPP'** > to </**SPATIALINDICATOR**>

<**MOTION-INDICATOR** id='1' > went to </**MOTIONINDICATOR**>

<**SR** id='1' trajector='1' landmark='1' spatial-indicator='1' frame-of-reference='INTRINSIC' motion-indicator='1'/>



# More complex descriptions

## Sentence level:

### I: Complex locative statements

The vase is in the living room, on the table under the window.

### II: Sequential scene descriptions

Behind the shops is a church, to the left of the church is the town hall, in front of the town hall is a fountain.

### III: Path and route descriptions

The man came from between the shops, ran along the road and disappeared down the alley by the church.

## Discourse level:

*so from here exactly opposite is my desk.*

*and next to that left of that is my computer, perhaps a meter away.*

*(breathing) ähm, .*

*next to that at the wall is my kitchen, first there is my fridge all the way to the right.*

computer

desk

desk

in kitchen

**<TRAJECTOR id='1' > The vase <TRAJECTOR\>**

**<LANDMARK id='1' path='ZERO'> the living room <LANDMARK \>**

**<LANDMARK id='2' path='ZERO'> the table <LANDMARK \>**

**<LANDMARK id='3' path='ZERO'>the window <LANDMARK \>**

**<SPATIAL-INDICATOR id='1' general-type='REGION' specific-type='RCC8'  
spatial-value='NTPP' > in <SPATIAL-INDICATOR \>**

**<SPATIAL-INDICATOR id='2' general-type='REGION' specific-type='RCC8'  
spatial-value='EC' > on <SPATIAL-INDICATOR \>**

**<SPATIAL-INDICATOR id='3' general-type='DIRECTION' specific-type='RELATIVE'  
spatial-value='BELOW' > under <SPATIAL-INDICATOR \>**

**<SR id='1' trajectory='1' landmark='1' spatial-indicator='1' frame-of-reference='INTRINSIC'  
motion-indicator='NIL'\>**

**<SR id='2' trajectory='1' landmark='2' spatial-indicator='2' frame-of-reference='INTRINSIC'  
motion-indicator='NIL'\>**

**<SR id=3 trajectory=1 landmark=3 spatial-indicator=3 frame-of-reference=INTRINSIC motion-  
indicator=NIL\>**

# Conclusion & Future directions

- **Conclusion**
  - General definition of the task
  - Language-independent scheme
  - Covering spatial semantics including dynamic and static spatial information
- **Ongoing work and Future directions**
  - Getting annotated corpus
  - Machine learning (Statistical relational learning)
  - Spatial reasoning, combining multimodal information



**Thank you !**

**Questions?**

