CS 365 Artificial Intelligence
Project Proposal

Spatial Role Labeling

Submitted by
Satvik Gupta (12633) and Garvit Pahal (12264)

Under the guidance of
Dr. Amitabha Mukerjee

Department of Computer Science and Engineering
Indian Institute of Technology , Kanpur
Uttar Pradesh, India – 208016

0.1 Problem Statement

Spatial role labeling is the task of automatic labeling of words and phrases in a sentence with a set of spatial roles such as trajector, landmark, spatial indicator, distance, direction etc. More specifically, the task involves identifying and classifying spatial arguments that are triggered by spatial expressions mentioned in a sentence and establishing relations between them with attributes of holistic spatial semantics.

- **Spatial indicators**: Signals a spatial relation between objects (trajectors and landmarks) of a spatial scene.
- **Trajector** : Entities like a person, object or event whose location is described.
- **Landmark**: The reference entity in relation to which the location or trajectory of the trajectors motion is specified

For Example: John(Trajector) is sitting on(Spatial Indicator) the ground(Landmark) The vase(Trajector1) is on(Spacial Indicator1) the ground(Lanmark1,Trajector2) on(Spatial Indicator2) your left(Landmark2)

0.2 Motivation

Spatial role labeling is a key task for many NLP applications which require information about locations of objects referenced in text, or relations between them in space. For example, the phrase 'a book on the desk' contains information about the location of the object book with respect to another object desk. Various applications of spatial role labeling includes controlling a robot by audio instructions, performing text-to-scene conversion and generation of textual descriptions from visual data, geographical information systems etc.

0.3 Previous Works

- **SpatialML (Mani et al., 2008)** Focuses on geographical information
- **(Pustejovsky and Moszkowicz, 2009)** Considers pivot of the spatial information is the spatial verb.
- **(Kordjamshidi et al., 2011c)** Provides a domain independent linguistic and spatial analysis to this problem.

0.4 Dataset

The data we got from the organizers of SemEval is a subset of CLEF Corpus and Confluence Corpus in XML format. The text are not always limited to spatial descriptions. Therefore they are less domain-specic and contain free explanations about the title. All the files in the training set have been split into sentences with proper tags.

0.5 Methodology

There are variety of approaches to the given problems

- **Conditional random fields (CRFs)** Conditional random fields [2] are a class of statistical modelling method often applied in pattern recognition and machine learning, where they are used for structured prediction. Whereas an ordinary classifier predicts a label for a single sample without regard to "neighboring" samples, a CRF can take context into account. A CRF is an undirected graphical model or Markov random field. A conditional random field model is used to tag single words in a sentence with the roles TRAJECTOR, LANDMARK, SPATIAL INDICATOR, NONE.
  Let $x_{1:N}$ be the observations (e.g., words in a document), and $z_{1:N}$ be the labels (e.g., tags), Then a linear chain Conditional Random Field defines a conditional probability
  $p(z_{1:N}|x_{1:N}) = \frac{exp(\sum_{n=1}^{N}\sum_{i=1}^{F}\lambda_i f_i(z_{n-1},z_n,x_{1:N}))}{Z}$
  where Z is the normalization factor so that the sum of probability is 1, we sum over n=1 . . . N word positions in the sequence. For each position, we sum over i = 1 . . . F weighted features. The scalar λ_i is the weight for feature $f_i()$. Example of feature function can be

$$fi(z_{n-1}, z_n, x_{1:N}) = \begin{cases} 1, z_n = \text{PERSON and } x_n = \text{John} \\ 0, \text{ o/w} \end{cases}$$

- **Dependency Parsing** In order to identify the spacial indicators we need to identify the preposition in a sentence. For identification of preposition we can use dependency parser which returns the relation between each word to all other words which are dependent on that. Then inorder to classify the spatial and non spatial indicator we can use preposition disambiguation. For identifying the trajectors and landmarks we can use the dependency between the words and the spatial indicators. [4]

References

[1] Spatial role Labeling: Task definition and annotation scheme, P. Kordjamshidi et.al, In Proceedings of the 7th Conference on International Language Resources and Evaluation(LREC) 2010, http://www.researchgate.net/publication/220745904_Spatial_Role_Labeling_Task_Definition_and_Annotation_Scheme

[2] Learning to Interpret Spatial Natural Language in terms of Qualitative Spatial Relations Parisa Kordjamshidi1, Representing space in cognition: interrelations of behavior, language, and formal models, Series Explorations in Language and Space, Oxford University Press, Oxford University Press, 2013, pp. 115146 https://lirias.kuleuven.be/bitstream/123456789/351891/1/KordjamshidiHoisOtterloMoens.pdf

[3] SemEval-2013 Task 3: Spatial Role Labeling , http://www.cs.york.ac.uk/semeval-2013/task3/

[4] Spatial Role Labeling: Towards Extraction of Spatial Relations from Natural Language By PARISA KORDJAMSHIDI etal, ACM Transactions on Speech and Language Processing, 8(3):article 4, 36 p, 2011 https://lirias.kuleuven.be/bitstream/123456789/321540/1/Kordjamshidietal-ACM-TSLP-2011.pdf