VANDERBILT UNIVERSITY

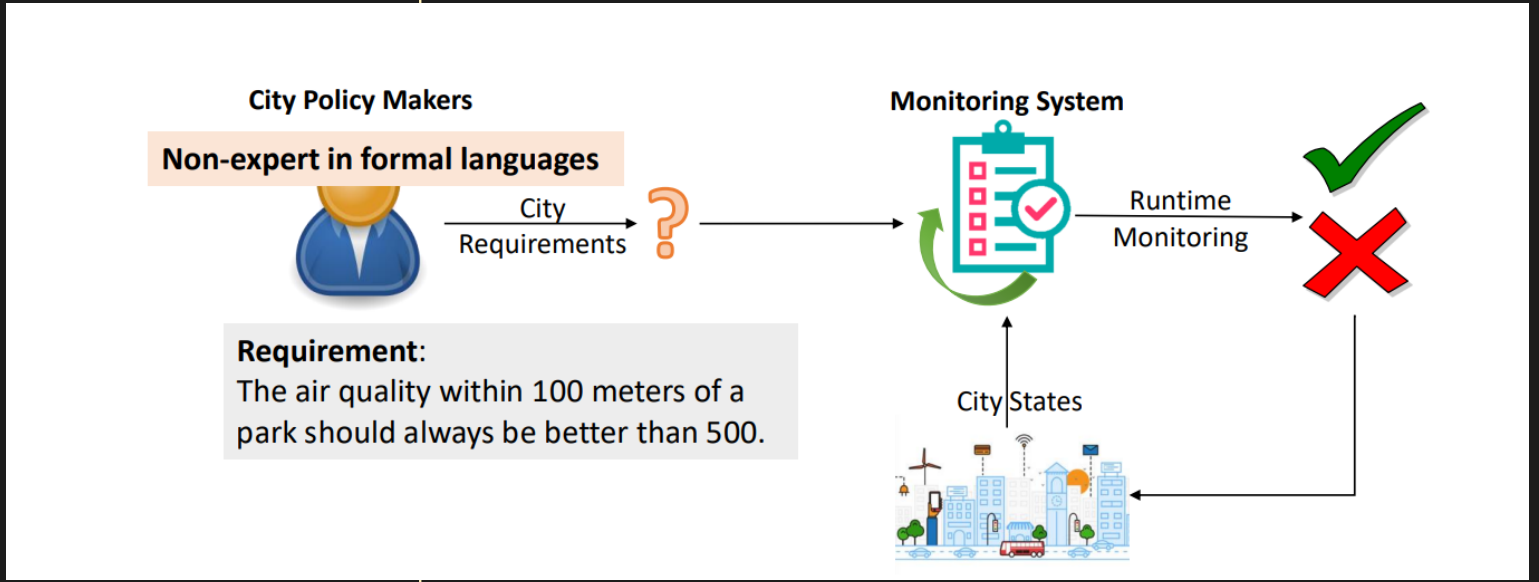
Xinxuan Lu

Logical Conflicts Detection on City Requirements

Overview

1. Motivations
2. Challenges and contributions
3. Dataset and examples
4. Conflict types
5. Framework
6. Recursive comparison
7. Check for normal senses
8. Evaluations

Motivations



1. Monitoring systems for smart cities
   Integrates all sensor data
2. Decision makers for smart cities
   Formulate specified requirements
   Set up standard for some quota

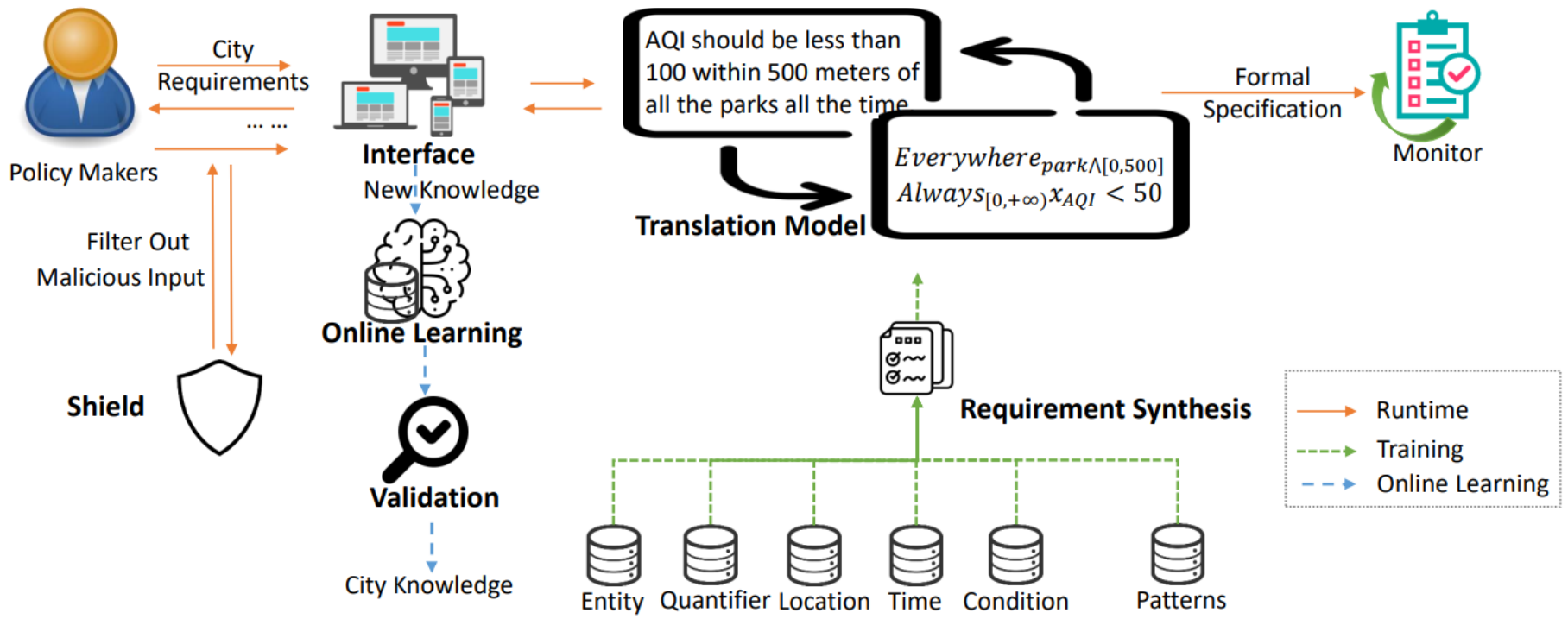
Motivations

1. For online learning and monitoring systems, new input may have logical conflicts with old ones, polluting the model
2. There is not a simple way to detect them
3. Difficult for humans to detect

Between the hours of 5 a.m. and 8 a.m., vehicles should not exceed 30 mph within 1 miles of hospitals.

Between the hours of 10 p.m. and 7 a.m. during weekdays , and between the hours of 10 p.m. and 9 a.m. on weekends and legal holidays, vehicles have maximum speed of 30 km/s near parks.

System Overview



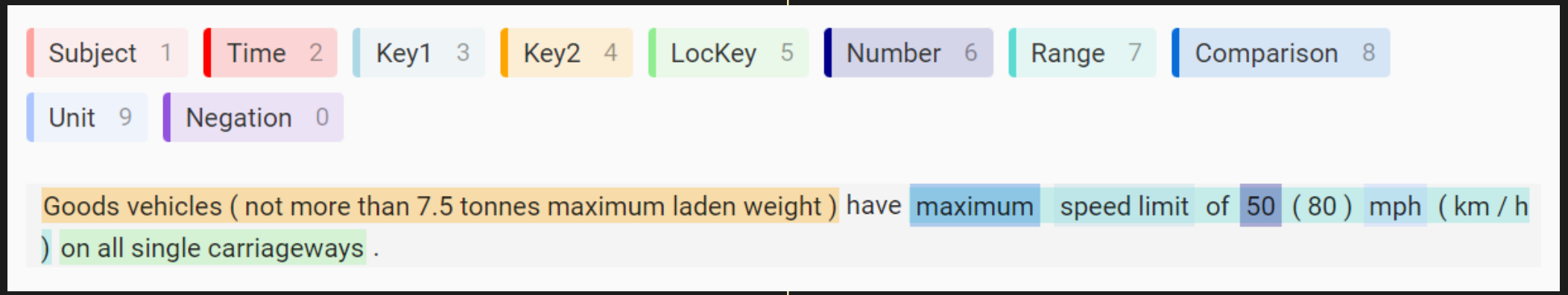
Challenges and Contributions

1. Lack of data
2. Various conflict type
3. Hard to compare locations
4. Complicated specifications

1. 781 lines of city specifications and annotations
2. Conflict type definitions
3. Comparing locations from texts and geometric information
4. Rule-based detection system and recursive framework

Annotations and Examples

1. Annotation tags: Key1, Key2, Location, Time, Comparison word, Number, Unit, Negation word



Conflict types

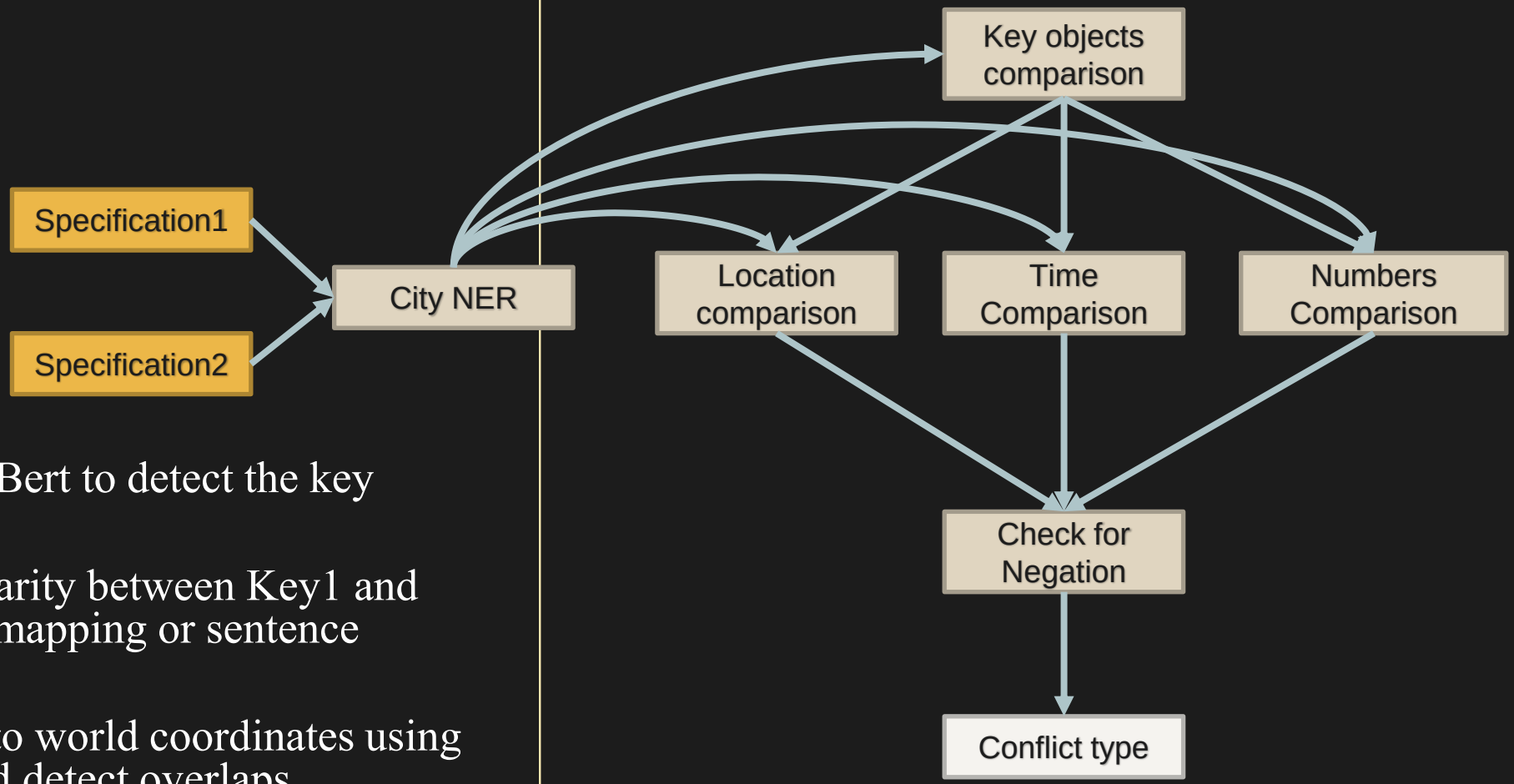
1. Define conflicts in keys, locations, time, and numbers.
2. In order to have conflicts, the keys in two specifications must be the same, similar, or possibly similar.
3. The locations must be the same or have some overlaps in geometric locations.
4. The time must be the same of have some overlaps. (8 am – 11 am overlaps with 10-12)
5. The numbers must be different or partially different

Details in the next slides

Three main types:

1. Strict Conflicts (Keys, locations, time are the same or overlap, and the numbers are different.)
2. Partial Conflicts (Keys, locations, time are the same or overlap, and the numbers are partially different.)
3. Potential Conflicts (Keys, locations, time are possibly the same or overlap, and the numbers are different or partially different.)

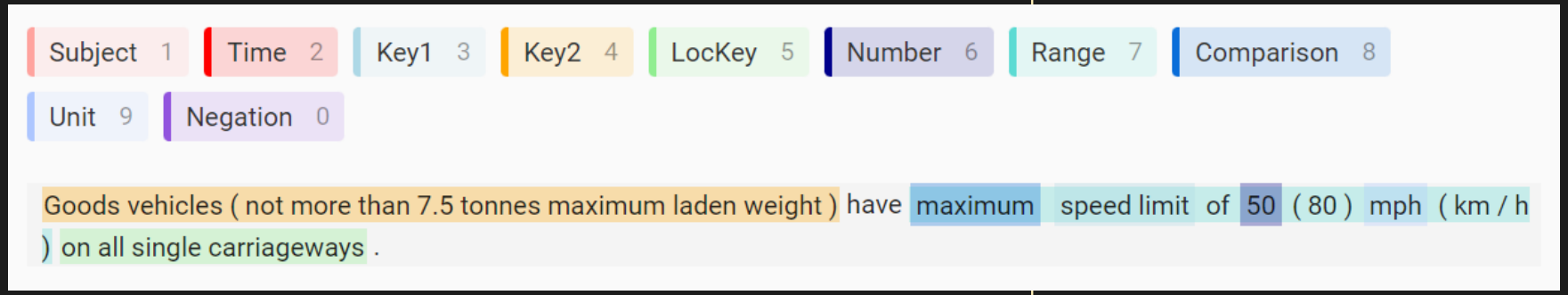
Framework



1. Use City specific Bert to detect the key entities
2. Measure the similarity between Key1 and Key2 using strict mapping or sentence transformers
3. Map the location to world coordinates using openstreetmap and detect overlaps
4. Compare Time, Number, Unit
5. Check for negation if necessary

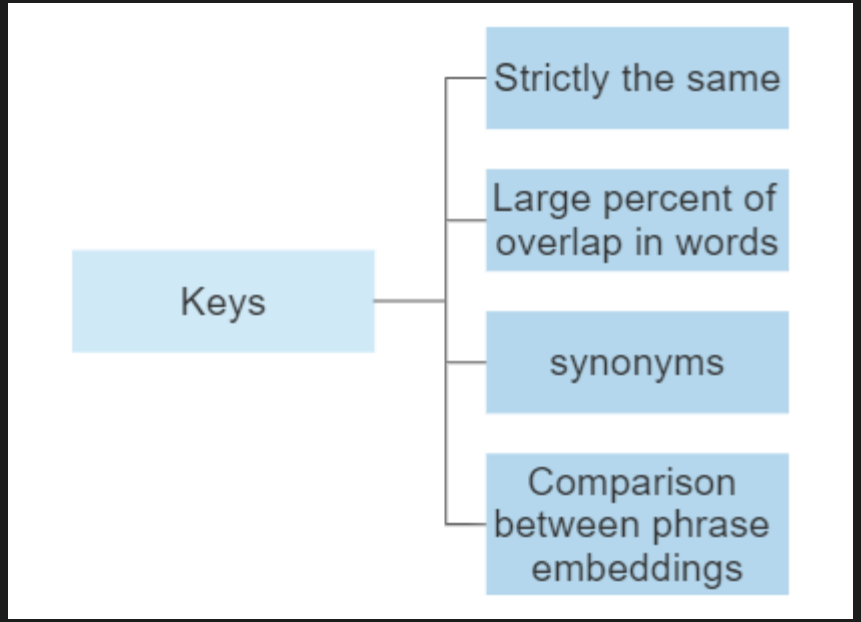
Name Entity Recognition

1. Fine-tuned BERT on our city requirements dataset with custom labels
2. Better performance at detecting city vocabulary than pretrained BERT

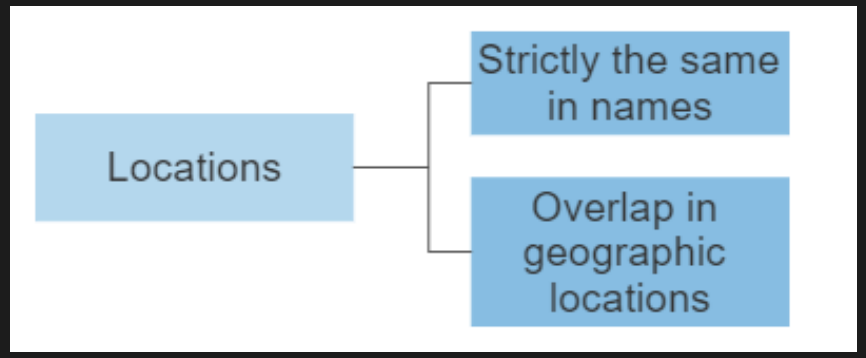


Key comparison

1. Cross compare both key1s and key2s.
2. Four different measure methods

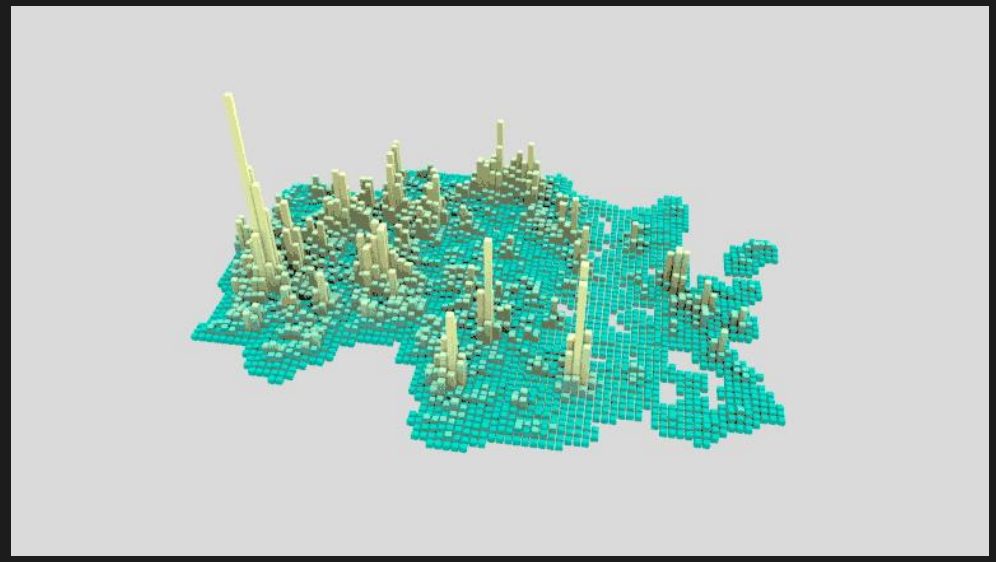


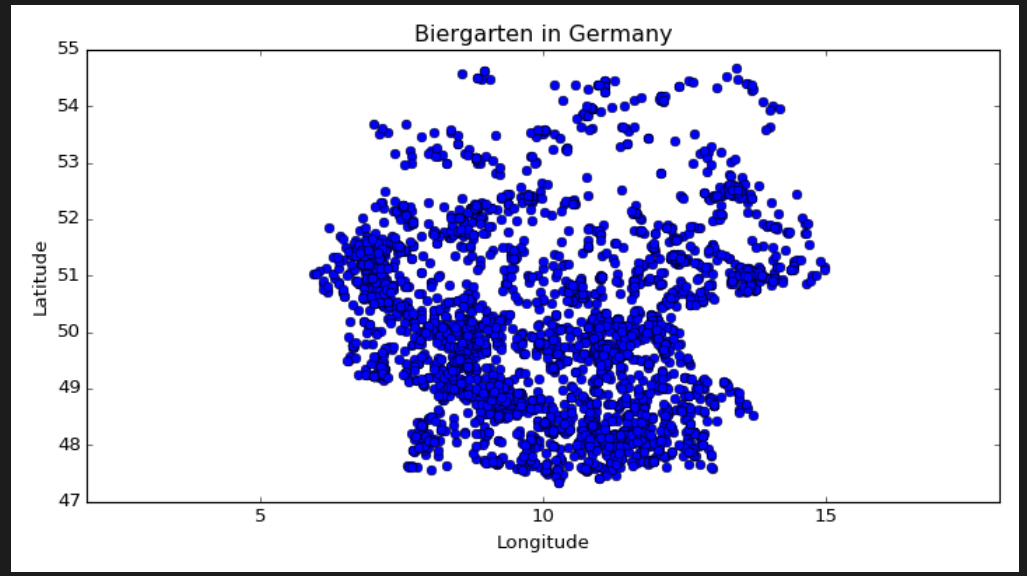
Location mapping



Map the location text to exact coordinates in two ways.

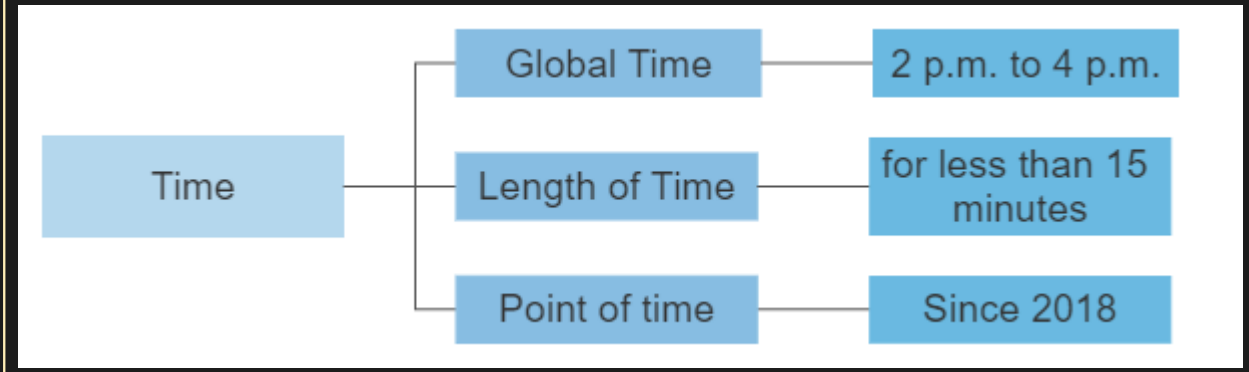
1. Map location types. (e.g. parks, roads, highways)
2. Exact locations. (e.g. Vanderbilt University, 21st Ave S)





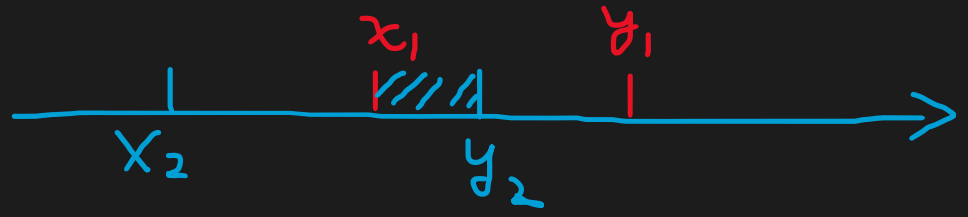
Time

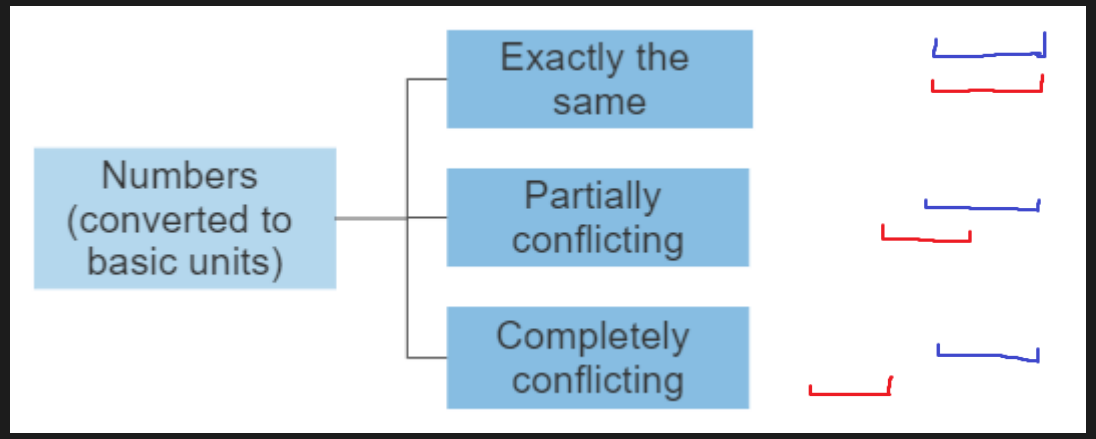
1. Map texts to time
2. Comparison between same time types
3. Comparison between different time types



Number and Unit

1. Map texts to numbers
2. Construct unit dictionary
3. Detect different units
4. Translation between different units
5. Detect conflicts based on ranges





Check for normal sense

1. Check for abnormal pairing between numbers and units
2. For example, 1000 mph does not make sense in city specifications

Recursive Comparison

1. If key1 and key2 are not enough to describe a specification or they are too long, we do a recursive comparison on key1 or key2.

All Remote Compressor ice makers that have air cooling and have harvest rate < 934 lbs ice / day shall have maximum energy use 8.85 - 0.0038H kWh/100 lbs ice .

All Remote Compressor ice makers that have air cooling and have harvest rate < 934 lbs ice / day

Dataset and Evaluations

1. 781 lines of data were split into 546 for training, and 235 for testing.
2. We generated testing dataset for conflict detection from the 235 lines of specifications.
3. The generation was done based on random pairs chosen from the 235 lines of specifications.

Test dataset Generation

Specification 1	Template for Specification 2	Conflict Type	Specification 2
Vehicles should not exceed 75 mph on rural interstates of Nashville .	Except when necessary to avoid conflict with other traffic , or when in compliance with law or the directions of a police officer or official traffic - control device , no person shall stop , stand or park a vehicle On a sidewalk ;	1	Except when necessary to avoid conflict with other traffic , or when in compliance with law or the directions of a police officer or official traffic - control device , no vehicles shall exceed 35 mph on a sidewalk ;

Evaluations

Task	Accuracy	F1
Key1 (BERT)	0.66	0.72
Key2 (BERT)	0.38	0.45
Keys		
Location (BERT)	0.48	0.52
Location		
Time (BERT)	0.64	0.67
Time		
Number (BERT)	0.92	0.93
Unit (BERT)	0.84	0.87
Comparison (BERT)	0.82	0.88
Number and Unit		
Negation (BERT)	0.86	0.89
Sentence (BERT)	0.69	0.74
Overall (only on 100 sets)	0.85	

Problems and Future work

1. Not able to distinguish between time that is condition and time that we should compare.

   Quiet hours at Disney Resort Hotels are from 11:00 PM to 7:00 AM .

   Quiet hours at Disney Resort Hotels are from 10:00 PM to 7:00 AM .

2. Dataset may not be comprehensive with respect to all categories of city specifications
3. Can’t detect “strange” specifications. i.g. In federal buildings, people that have ballast efficacy factor (BEF) at least 4.70 for one lamp should not drive faster than 10 lumens.

Problems and Future work

1. Data Augmentation (train the network with synthesized specifications to include more city vocabulary.)
2. Use end-to-end model to predict the overlaps between time and the conflicts between numbers and ranges
3. Increase the diversity and size of the dataset
4. Check for broader normal senses (whether a sentence make sense)
5. Teacher student network