NLP for Annotation, Extraction and Classification of Pulmonary Embolism MIMIC III clinical notes

Soyoung An

Goal

- Using Regular Expression (for d-dimer) and PyContextNLP (for PE) to:
- Extract and annotate mentions and relations of d-dimer and pulmonary embolism.
- Classify the clinical documents into: Affirmed and Negated.
- Evaluate the system classified documents with manually classified ones.

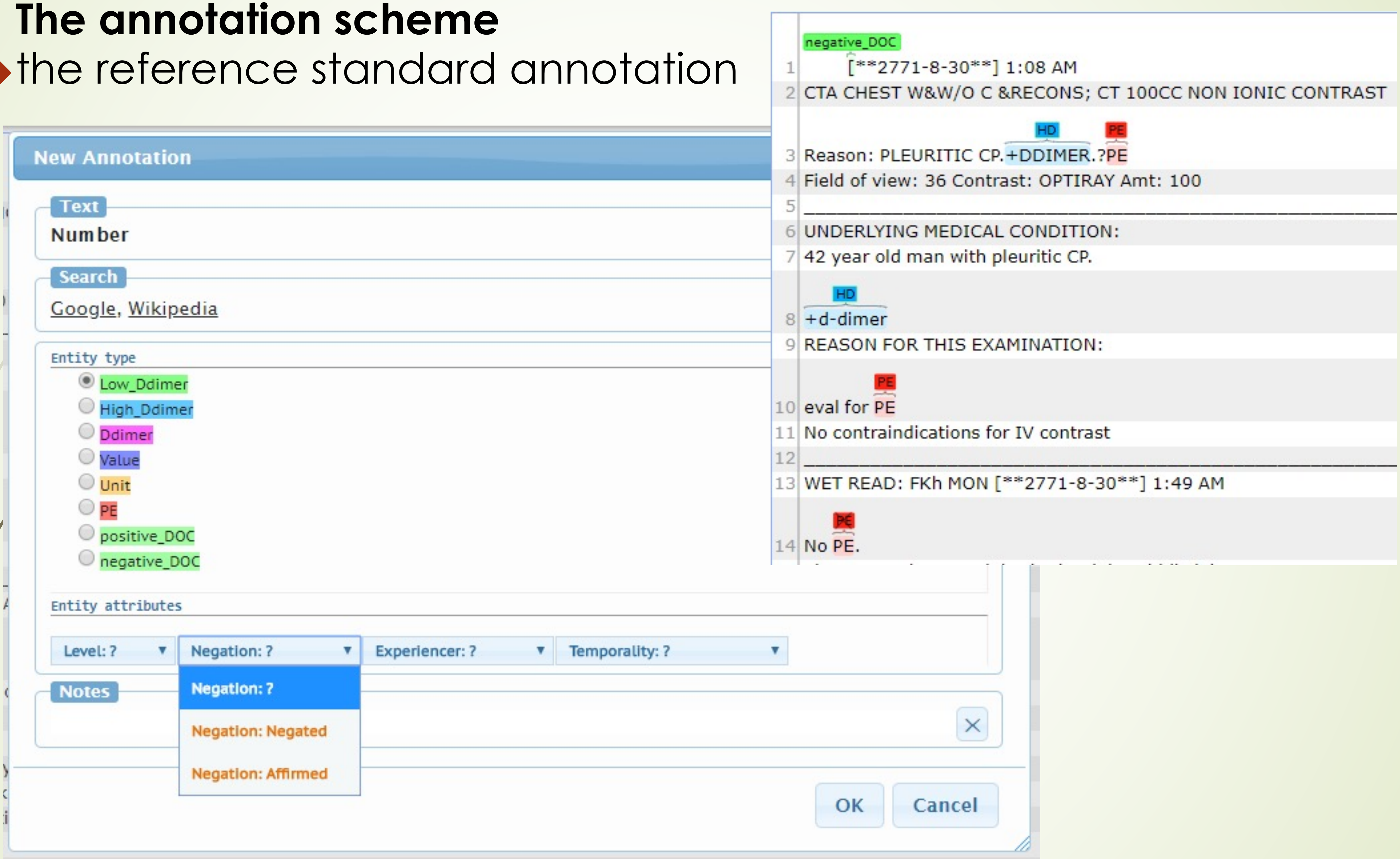
Document Selection

- MIMIC-III documents

- Using MIMIC-III MySQL server
- Selected from NOTEEVENTS containing d-dimer, CT, and pulmonary emboli (PE)
  - 335 notes were selected and saved into Brat directories.
  - 30 notes for training
  - 20 notes for testing

The annotation scheme

the reference standard annotation



Text: Number

Search: Google, Wikipedia

Entity type

- ● Low_Ddimer
- ○ High_Ddimer
- ○ Ddimer
- ○ Value
- ○ Unit
- ○ PE
- ○ positive_DOC
- ○ negative_DOC

Entity attributes

Level: ? ▾ | Negation: ? ▾ | Experiencer: ? ▾ | Temporality: ? ▾

```
     [**2771-8-30**] 1:08 AM
CTA CHEST W&W/O C &RECONS; CT 100CC NON IONIC CONTRAST
Reason: PLEURITIC CP.+DDIMER.?PE
Field of view: 36 Contrast: OPTIRAY Amt: 100
______________________________________________________________
UNDERLYING MEDICAL CONDITION:
42 year old man with pleuritic CP.
+d-dimer
REASON FOR THIS EXAMINATION:
eval for PE
No contraindications for IV contrast
______________________________________________________________
WET READ: FKh MON [**2771-8-30**] 1:49 AM
No PE.
```

Design (d-dimer pipeline)

D-dimer: Regular Expression

D-dimer 910
d-dimer (530)
D-DIMER-3827
D-Dimer-6229**
d-dimer of/to/was 3013
D-Dimer-417
D-Dimer-[**Numeric Identifier 5683**]*
D-dimer:[**Numeric Identifier 5409**] ng/mL

High d-dimer
pos ddimer
d dimer
elevated ddimer
+ D-dimer
+DDimer
increased d-dimer
d-dimer returned positive

- 3 rules for avoiding cross/repeat extract d-dimer/ddimer.
- Some notes have more than 20 other values (Fibrino 449, Glucose 194, Lipase 160, …), to separately match value will be hard.

```
rule=r'(?P<name>(d-dimer|ddimer))
        (?P<n1>.{1,25}?)
        (?P<value>[0-9]{1,4}(\.[0-9]{0,3})?\s*)
        (?P<n2>\W*)
        (?P<unit>(ug\/l|ng\/ml|mg\/l|nmol\/l)?)'
rule1=r'(elevated|pos|positive|increased|high|\+)(.{1,20})?(d-dimer|d\s?dimer)'
rule2=r'(d-dimer|d\s?dimer)([^0-9-:]{1,15})?(positive|pos)'
```

D-dimer pipeline

- Instantiation pipeUtils Annotation and Document
- Read and pre-process the clinical notes
- Apply one d-dimer rule
- Check the unit
- Normalize the numeric value
- Compare with the threshold (500 ng/mL)
- Annotate d-dimer mention
- Sequentially apply next rules, annotate mentions
- Append/write annotations to each annotation files (same as ann file with different ext)
- Classify the document

- Mention level evaluation

- Read annotation file and convert to data frame
- Convert data frame to annotation object
- Mention level evaluation

Design (PE pipeline)

- Target:

PE
Pulmonary embolism/li/lus
septic embolism/li/lus
embolism/li/lus
pulmonary artery embolism/li/lus

- Modifier: tried many different modifiers

- According to the modifier to set the type of target PE
- According to the types of targets to classify the document

PyContextNLP

Developed

- PE target rules
- PE Modifiers
- PE Feature inferences
- PE Document inferences

- Revised DocumentClassifier module
- Built a process module
- Write annotation to file for later validation
- Built functions to read annotation file and convert to dataframe and annotation object for validation.

PE pipeline

- Read rules
- Instantiation MyPipe (wrapper of PyContextNLP using PyRush as sentence segmenter)
- Save annotations dataframe to corresponding files
- Document level evaluation
  - By compare with manually annotated BRAT files, which has document level marks inside
- Mention level evaluation (for fp, fn)
  - Read saved annotation file and standard ann file to compare. (training process)

Results

- Trained, revised by 30 training set notes
- Tested by 20 test set notes.
- D-dimer pipeline can correctly extract, annotate and classify all test notes.

- The result of PE pipeline:
- Training set:
  - Precision: 1.0
  - Recall: 1.0
  - F1: 1.0

- **Testing set: (2 fn out of 20 notes)**
  - **Precision: 1.0**
  - **Recall: 0.8**
  - **F1: 0.89**

Discussion and challengers

For d-dimer pipeline

- Most importance is not overlap between rules
- Changed from 2 rules to 3 regular expression rules
- Example: rule1 = (d-dimer)(Value)(Unit)

  rule2_old = (pre_modifier)?(d-dimer)(post_modifier)?
- Try to use less greedy rules (match more than wanted)

- The value should normalize according to the units

Discussion and challengers (Cont.)

For PE pipeline

- Use restricted target rules and modifier rules.
  - \bno\s{1,10}(?=pe)
  - \bno\s{1,10}(?=pulmonary embolism) instead of \bno\b
- Challenge
  - Right/left no ……left/right yes
- Example: (**one fn**)
  - No central PE on L, but …. Not excluded…
  - No central pulmonary embolus is identified on the left, …. Subsegmental pe involving the right low lobe …
- Possible solution: May use IMPRESSION part, Conclusion part for classification.
- Sentence segment/context window is very important. (**one fn**)
- Possible solution: Define context window in rule definition.
- Modifier: tiny

Future work

- Modify rules
- Test more notes
- Clean the code

THANK YOU