An Overview of Biomedical Entity Recognition

Jeffry Scott

University of Washington
MEBI 591C

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What is an Entity?

- NE: Named Entity, uniquely identified.
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  - Person: Abraham Lincoln, Mae West
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  - Person: Abraham Lincoln, Mae West
  - Place: Taj Mahal, Cairo, Washington D.C., The Pentagon
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  - Person: Abraham Lincoln, Mae West
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  - Thing: Gone With The Wind (a book), Gone With The Wind (a movie), Kleenex, The Beatles, Exxon Corporation, Her Majesty’s Royal Navy.
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  - Not a common noun.
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- NER: Named Entity Recognition, techniques for named entity identification.
Problems in Entity Identification

Feature Specification:

- English: capitalization indicates proper names. Very language dependent. What of messages using all capital letters (telegrams, military message traffic)?
- Other languages: ?
Problems in Entity Identification

Feature Specification:
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- Other languages: ?

Ambiguity
- May: the month? A girl named May? The verb *may* at the beginning of a question: *May I sit down*?
Problems in Entity Identification (cont.)

- Variability in Spelling
  - Exxon Corporation vs. Exxon vs. Exxon Corp. vs. Exxon, Inc.
Problems in Entity Identification (cont.)

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- Volume
  - Low volume/small corpora easier to analyze with a lexicon or a rule set
  - Higher volume/very large corpora need to be quickly addressed with some loss of precision.
Problems in Entity Identification (cont.)

- **Variability in Spelling**
  - Exxon Corporation vs. Exxon vs. Exxon Corp. vs. Exxon, Inc.

- **Volume**
  - Low volume/small corpora easier to analyze with a lexicon or a rule set
  - Higher volume/very large corpora need to be quickly addressed with some loss of precision.

- **Unknown Names**
  - New names are introduced constantly, mandating constant updates to a lexicon or rule set.
Outline

1 Biomedical Entities
   • Methods
     • POS Tagging
     • NP Chunking
     • Segmentation (Sequence Labeling)

2 i2b2 Concepts
   • Concept Syntax
   • Concept Semantic Categories
     • Medical Problems
     • Treatments
     • Tests
   • Category Exclusion
   • Open Issues, Recommendations

3 Questions

Biomedical Entities
i2b2 Concepts
Questions
Methods
POS Tagging
NP Chunking
Segmentation (Sequence Labeling)
Methods for NE Identification

- **Lexicon**: precise, but slow, requires constant update.
Methods for NE Identification

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- **Hybrid Systems**: combining two or more methods.
Methods for NE Identification

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- **Hybrid Systems**: combining two or more methods.
- **Voting**: use several different statistical techniques where each method gets a vote. Choose the result with the most votes.
Computational Linguistic Statistical Methods

- Find statistical patterns when rule based patterns cannot be used.
- Heavily borrows from Pattern Recognition in EE and AI, Statistical Methods for Classification, Clustering in Statistics.
- Known as ‘Machine Learning’.
Computational Linguistic Statistical Methods

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- Can handle higher volume than rule based methods.
- Allows for unknown data.
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- Can handle higher volume than rule based methods.
- Allows for unknown data.
- Requires
  - A set of features defined to characterize the data
  - Training data to establish patterns for use in classification
  - A sufficient amount of training data
  - Training data that is representative of the target corpus.
Biomedical Entities
i2b2 Concepts
Questions

Methods
POS Tagging
NP Chunking
Segmentation (Sequence Labeling)

Common Statistical Methods

- Naive Bayes
- HMM (Hidden Markov Model)
- MaxEnt (Maximum Entropy)
- SVM (Support Vector Machine)
- CRF (Conditional Random Fields)
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Part-Of-Speech (POS) Analysis

- POS provides insight into what might be an entity.
- POS tagging an intermediate step
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- POS provides insight into what might be an entity.
- POS tagging an intermediate step
- Components:
  - Tokenizer: find individual words, defined by white space or special characters.
  - Lexicon: a list of words, corresponding POS tags
Part-Of-Speech (POS) Analysis

- POS provides insight into what might be an entity.
- POS tagging an intermediate step

Components:

- Tokenizer: find individual words, defined by white space or special characters.
- Lexicon: a list of words, corresponding POS tags
- Annotated corpus: used to define the lexicon, and provide training data
- Statistical method: method used for pattern recognition
POS Tagging Example

The patient was evaluated for repair of false femoral aneurysm.
POS Tagging Example

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- Simple Tagging
  - The/D patient/N was/V evaluated/V for/P repair/N of/P false/ADJ femoral/ADJ aneurysm/N.
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    * (NP (DT The) (NN patient))

An Overview of Biomedical Entity Recognition
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  )
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      (PP (IN for) (NN repair)
       (PP (IN of) (JJ false) (JJ femoral) (NN aneurysm) )
      )
    )
  )
Unknown Words in POS Tagging

Q: How are unknown words handled?

- The/D XXXX was/V evaluated/V for/P renal/ADJ failure/N.
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Outline

1. Biomedical Entities
   - Methods
   - POS Tagging
   - NP Chunking
   - Segmentation (Sequence Labeling)

2. i2b2 Concepts
   - Concept Syntax
   - Concept Semantic Categories
     - Medical Problems
     - Treatments
     - Tests
   - Category Exclusion
   - Open Issues, Recommendations

3. Questions
NP Chunking

- Entities of interest beyond scope of Named Entities
- Usually defined as NPs (Noun Phrases)
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- Usually defined as NPs (Noun Phrases)
- Different techniques required beyond Lexicon and Rule Sets
  - Compound nouns: *diabetes medication*
  - Adjectives: *distended abdomen*
  - NP + PP: *Queen of England*
  - Complex phrases: *the man who would be king*
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  - NP + PP: *Queen of England*
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- Segmentation primary method for NP Chunking
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Segmentation (Sequence Labeling)

- Used to identify non-overlapping sequences of text.
- Requires a statistical method, features, training data.
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- Uses IOB convention to identify tokens in segments
  - I: (token) inside segment
  - O: outside segment
  - B: beginning of segment
Segmentation (Sequence Labeling)

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- Requires a statistical method, features, training data.
- Uses IOB convention to identify tokens in segments
  - I: (token) inside segment
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  - B: beginning of segment
- POS tag a common feature for segmentation tasks
Segmentation Example

Sample sentence: *The patient was evaluated for repair of heart valve.*
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Labeling NP (noun phrases):

\[[The \ patient] \ was \ evaluated \ for \ [repair] \ of \ [heart \ valve]\]

*B I*
Segmentation Example

Sample sentence: *The patient was evaluated for repair of heart valve.*

Labeling NP (noun phrases):

\[
\begin{array}{cccccc}
 B & I & O & O & O & B \\
[The patient] & was & evaluated & for & [repair] & of & [heart valve]
\end{array}
\]
Segmentation Example

Sample sentence: *The patient was evaluated for repair of heart valve.*

Labeling NP (noun phrases):

```
[ The  patient ]  was  evaluated  for  [ repair ]  of  [ heart  valve ]
  B    I    O    O    O    B    O    B
```
Segmentation Example

Sample sentence: *The patient was evaluated for repair of heart valve.*

Labeling NP (noun phrases):

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[The patient] was evaluated for [repair] of [heart valve]
```

```
B I O O O B O B I
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**Segmentation Example**

Sample sentence: *The patient was evaluated for repair of heart valve.*

Labeling NP (noun phrases):

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[The patient] was evaluated for [repair] of [heart valve]
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```
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Segmentation Example

Sample sentence: *The patient was evaluated for repair of heart valve.*

Labeling NP (noun phrases):

\[
[\text{The patient}] \quad \text{was evaluated} \quad \text{for} \quad [\text{repair}] \quad \text{of} \quad [\text{heart valve}]
\]

\[
B \quad I \quad O \quad O \quad O \quad B \quad O \quad B \quad I
\]

Labeling PP (prepositional phrases):

\[
\text{The patient was evaluated} \quad [\text{for repair}] \quad [\text{of heart valve}]
\]

\[
O \quad O \quad O \quad O
\]
Segmentation Example

Sample sentence: *The patient was evaluated for repair of heart valve.*

Labeling NP (noun phrases):

```
[The patient] was evaluated for [repair] of [heart valve]
B     I     O     O     O     B     O     B     I
```

Labeling PP (prepositional phrases):

```
The patient was evaluated [for repair] [of heart valve]
O     O     O     O     B     I
```
Segmentation Example

Sample sentence: *The patient was evaluated for repair of heart valve.*

Labeling NP (noun phrases):

```
[The patient] was evaluated for [repair] of [heart valve]
B   I   O   O   O   B   O   B   I
```

Labeling PP (prepositional phrases):

```
The patient was evaluated [for repair] [of heart valve]
O   O   O   O   B   I   B   I   I
```

* EOS == End of Sentence
BER Checklist

- Use NLP techniques for NER
  - POS Tagging
  - Segmentation
  - Word Sense Disambiguation
BER Checklist

- Use NLP techniques for NER
  - POS Tagging
  - Segmentation
  - Word Sense Disambiguation
- Augment with biomedical lexicon
 BER Checklist

- Use NLP techniques for NER
  - POS Tagging
  - Segmentation
  - Word Sense Disambiguation
- Augment with biomedical lexicon
- Allow for new “unknown” entities
i2b2 Concepts

- Varied syntax beyond BER and NP
i2b2 Concepts

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- Semantic categories:
  - Medical Problems
  - Treatments
  - Tests
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- Exclusion of Concepts from Semantic Categories
i2b2 Concepts

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- Semantic categories:
  - *Medical Problems*
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  - *Tests*
- Exclusion of Concepts from Semantic Categories
- Relation and Assertion tasks build on the Concepts task
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3. Questions

Biomedical Entities

Concept Syntax

Concept Semantic Categories

Category Exclusion

Open Issues, Recommendations

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An Overview of Biomedical Entity Recognition
Concept Syntax Highly Varied

More than just NP chunks:

NP (noun phrase):  \textit{high grade fever}

Compound noun:  \textit{diabetes medication}
Concept Syntax Highly Varied

More than just NP chunks:

- NP (noun phrase): *high grade fever*
- Compound noun: *diabetes medication*
- AP (adjective phrase): *actively ischemic*
- NP + PP*: *placement of stent, subtotal occlusion of the RCA*
Concept Syntax Highly Varied

More than just NP chunks:

- **NP (noun phrase):** high grade fever
- **Compound noun:** diabetes medication
- **AP (adjective phrase):** actively ischemic
- **NP + PP**: placement of stent
- **subtotal occlusion of the RCA**

* With restrictions on the type of PP (prepositional phrase) that may be used.

Q: what is the definition of a partial noun phrase?
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3. Questions
Category: Medical Problems

- Disease name, syndrome, sign, symptom
- Mental or behavioral status
- Virus or bacterium
- Injury
- Abnormality

Concern: this could be a very long list of entities.
Category: Treatments

- Medications: brand names, generic names, collective names
- Biological substances
- Drugs, treatment delivery devices
- Treatment procedures, related devices and hardware
Category: Tests

- Test procedures
- Panels and tests on body fluids
- Physiologic measures and vital signs
- Physical examination
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3. Questions
Exclude from Categories

Medical Problems
- Normal states of health
- Physiologic measurements, vital signs
- Verbs describing outcome

Treatments
- Verbs indicating application of treatment

Tests
- Verbs indicating application of treatment
- Test values and measurements
- Mentions of tests stated as problems

Partial noun phrases are excluded from all Concept Categories.
Methods for Exclusion

Requires explicit steps/techniques to exclude concepts from a category.

1. Explicit rules for exclusion
Methods for Exclusion

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1. Explicit rules for exclusion
2. Statistical training data for concepts to exclude
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1. Explicit rules for exclusion
2. Statistical training data for concepts to exclude
3. Both
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3. Questions
Open Issues

1. New concepts properly identified? Steps to make concept identification robust, even for new concepts?
2. New concept mapping to Concept Category? How will that be done?
Open Issues

1. New concepts properly identified? Steps to make concept identification robust, even for new concepts?
2. New concept mapping to Concept Category? How will that be done?
3. Low data volume: the i2b2 test data set will be small, and may not be sufficient for training.
4. What is a *partial noun phrase*?
Partial Noun Phrase Exclusion

Definition is by example, and seems incomplete.

Medical Problem: He was a [moderately obese] man in acute respiratory distress.

- *moderately obese* is marked as a partial noun phrase.
- Wouldn’t *a moderately obese man* be appropriate?
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- wouldn’t a *moderately obese man* be appropriate?
- or *man in acute respiratory distress*?

Treatment: [The needle jejunostomy tube] was utilized on the first post[operative] day.
- *operative* (in postoperative) is marked as a partial noun phrase.
- unclear as to what this example really shows.
Recommendations

1. Find Comprehensive Lexicon: UMLS or something like it, addressing wide range of biomedical entities.

2. Mix of POS Tagging and NP Chunking: low data volume gives more opportunities to focus on precision and recall where high throughput not needed.
Recommendations

1. Find Comprehensive Lexicon: UMLS or something like it, addressing wide range of biomedical entities.
2. Mix of POS Tagging and NP Chunking: low data volume gives more opportunities to focus on precision and recall where high throughput not needed.
3. Low data volume: supplement with additional corpora to test and train UW system.
4. GENIA corpus: use the GENIA corpus for training and test data. i2b2 annotation may be required.
5. Additional clinical data: acquire more annotated clinical data. Some annotation by the i2b2 team may be needed.
Recommendations (cont.)

1. Use Metamap: develop scheme for mapping Metamap (UMLS) concepts to i2b2 Semantic Categories. Use Metamap to vet concepts and assist in i2b2 concept classification. Given low data volume this seems reasonable.
Questions?