Overview of Annotation Tasks II

Sequence Labeling Tasks

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February 4, 2025

Today's Agenda

1. Review of classification tasks
2. Introduction to sequence labeling
3. Named Entity Recognition (NER)
4. Part-of-Speech tagging
5. BIO/IOB tagging schemes
6. Span annotation challenges
7. Guidelines for sequence labeling

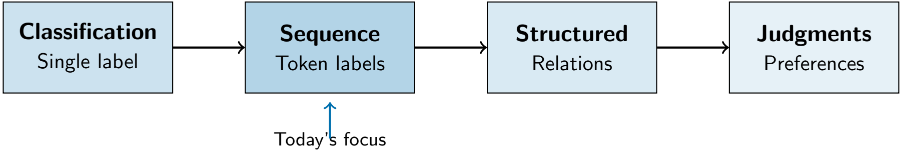
Quick Review: Classification

From last lecture:

- Classification assigns one or more labels to a text unit
- Sentiment analysis, topic classification, intent detection
- Multi-class (exclusive) vs. multi-label (non-exclusive)
- Schema design: mutually exclusive, exhaustive, clear boundaries

Today: Moving from document-level to token-level annotation

The Task Spectrum



Sequence Labeling: Assign a label to each token in a sequence

- More complex than classification
- Introduces span boundary decisions
- Moderate inter-annotator agreement

What is Sequence Labeling?

Definition: Assigning labels to individual tokens or spans within a text

Key characteristics

- Each token gets a label (including "Outside")
- Labels often form contiguous spans
- Order and context matter
- Need to handle span boundaries

Common tasks:

- Named Entity Recognition (NER)
- Part-of-Speech (POS) tagging
- Chunking (noun phrases, verb phrases)
- Slot filling in dialogue systems

Named Entity Recognition (NER)

Goal: Identify and classify named entities in text

Standard entity types:

- **PER** – Person names
- **ORG** – Organizations
- **LOC** – Locations
- **DATE** – Temporal expressions
- **MISC** – Miscellaneous entities

Example:
"[Apple]$_{ORG}$ announced a new [iPhone]$_{PROD}$ in [Cupertino]$_{LOC}$."

Challenge: "Apple" could be a company, fruit, or person's name

NER Annotation Decisions

What counts as an entity?

Clear cases:

- “Barack Obama” – PER
- “Google” – ORG
- “New York City” – LOC
- “January 15, 2025” – DATE

Difficult cases:

- “the president” – PER?
- “American” – nationality?
- “iPhone” – product?
- “COVID-19” – disease?

Guideline questions:

- Do we annotate generic mentions (“the company”)?
- How do we handle nested entities?
- What about abbreviated names?

Part-of-Speech Tagging

Goal: Assign grammatical categories to each word

Common POS tags:

- NN – Noun
- VB – Verb
- JJ – Adjective
- RB – Adverb
- DT – Determiner
- IN – Preposition
- PRP – Pronoun
- CC – Conjunction
- . – Punctuation
- CD – Cardinal number

Example:

The/DT quick/JJ brown/JJ fox/NN jumps/VBZ over/IN the/DT lazy/JJ dog/NN

Challenge: Many words have multiple possible POS (“run” can be noun or verb)

The BIO Tagging Scheme

Standard format for sequence labeling

- **B** – Beginning of an entity
- **I** – Inside (continuation) of an entity
- **O** – Outside any entity

Example:

Token	Apple	announced	iPhone	in	New	York
BIO	B-ORG	O	B-PROD	O	B-LOC	I-LOC

Why B and I? To distinguish adjacent entities of the same type
"[John]$_{PER}$ [Smith]$_{PER}$" vs. *"[John Smith]$_{PER}$"*

BIO Variants

IOB1 vs. IOB2 (BIO):

- **IOB1:** B only used when two entities are adjacent
- **IOB2 (BIO):** B always starts a new entity (most common)

BIOES/BILOU:

- **B** – Beginning
- **I** – Inside
- **O** – Outside
- **E/L** – End of entity (last token)
- **S/U** – Single-token entity

Example with BIOES:

Token	Apple	announced	iPhone	in	New	York
BIOES	S-ORG	O	S-PROD	O	B-LOC	E-LOC

Span Boundary Challenges

Where does an entity start and end?

Common difficulties

- **Modifiers:** "the [Microsoft] Corporation" or "[the Microsoft Corporation]"?
- **Titles:** "[President Biden]" or "President [Biden]"?
- **Possessives:** "[Apple's] iPhone" – is "'s" part of the entity?
- **Coordination:** "[North and South Korea]" – one or two entities?

Solution: Clear guidelines with examples for each case

- Document your boundary conventions
- Be consistent within your dataset
- Include edge cases in annotator training

Nested and Overlapping Entities

Problem: Some entities contain other entities

Example:
"The [University of [California]$_{LOC}$]$_{ORG}$"

Options:

1. **Flat annotation:** Only annotate outermost entity
2. **Nested annotation:** Allow entities to contain others
3. **Multiple passes:** Separate annotation layers

BIO limitation: Standard BIO cannot represent nested entities
Solutions:

- Extended tagging schemes (nested BIO)
- Separate annotation layers
- Different data format (standoff, JSON)

Tokenization Matters

Sequence labeling depends on tokenization

Tokenization decisions affect annotation

- "New York" – 1 token or 2?
- "don't" – 1 token ("don't") or 2 ("do", "n't")?
- "U.S.A." – how many tokens?
- Hyphenated words: "state-of-the-art"

Best practices:

1. Tokenize **before** annotation
2. Document your tokenization rules
3. Use consistent tokenization for train/test
4. Consider subword tokenization for models

Annotation Tools for Sequence Labeling

Tools designed for span annotation:

- **brat:** Classic tool, standoff format, good for NER
- **Label Studio:** Modern, flexible, supports multiple formats
- **Prodigy:** Active learning, spaCy integration
- **Doccano:** Simple, open-source

Key features to look for:

- Easy span selection (click and drag)
- Keyboard shortcuts for labels
- Pre-annotation / suggestions
- Export to BIO format

IAA for Sequence Labeling

Measuring agreement is more complex than classification

Token-level agreement:

- Treat each token as an instance
- Calculate Cohen's/Fleiss' Kappa
- Simple but doesn't capture span structure

Entity-level agreement:

- Count matching spans (exact or partial)
- Precision, recall, F1 between annotators
- Better reflects actual task

Typical targets:

- Token-level: $\kappa > 0.8$
- Entity-level F1: > 0.85 for clear tasks

Guidelines for Sequence Labeling

Essential elements:

1. **Entity definitions:** What qualifies as each type?
2. **Boundary rules:** Where entities start and end
3. **Examples:** Positive and negative for each type
4. **Edge cases:** Abbreviations, nicknames, titles
5. **Nesting policy:** How to handle overlapping entities

Example guideline entry:

PERSON (PER)

Names of people, including fictional characters. Include titles only if they are part of the proper name. Do NOT annotate generic references like "the president."

✓ "Barack Obama", "Dr. Smith", "Queen Elizabeth II"

× "the CEO", "my brother", "the author"

LLM Annotation for Sequence Labeling

More challenging than classification for LLMs

Challenges:

- Need to maintain token alignment
- Boundary decisions can be inconsistent
- Output format must be precise

Strategies:

- Request JSON output with character offsets
- Use few-shot examples with exact format
- Post-process to align with tokenization
- Validate output programmatically

Best approach: LLM pre-annotation + human correction
LLM suggests entities, humans verify and fix boundaries

Data Format: From Annotation to Training

Converting annotations to model input:

Annotation format (standoff):

- Text: "Apple is in Cupertino"
- T1: ORG 0 5 "Apple"
- T2: LOC 12 21 "Cupertino"

Training format (BIO):

- Apple B-ORG
- is O
- in O
- Cupertino B-LOC

Conversion requires:

- Tokenization of source text
- Mapping character offsets to tokens
- Handling multi-token entities
- Export scripts (Label Studio, brat provide these)

Next Class: MATTER Cycle Deep Dive

Lecture 8 (Feb 9): Task Formalization

Topics:

- Formalizing annotation tasks
- Document Type Definitions (DTDs)
- JSON Schema for annotation specifications
- Tag types: non-consuming, span, link, attribute
- Prompts as lightweight task specifications

Reading: Pustejovsky & Stubbs, Chapter 5

Key Takeaways

1. **Sequence labeling** assigns labels to each token in a text
2. **NER** identifies named entities – boundary decisions are crucial
3. **BIO scheme** is the standard format: Beginning, Inside, Outside
4. **Span boundaries** are the main source of annotator disagreement
5. **Tokenization** must be done before annotation and documented
6. **IAA** can be measured at token-level or entity-level

Questions?

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Office Hours: Wednesdays 1-3pm, Volen 109

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