Lecture 3: Writers' aids: Grammatical errors

LING-351 Language Technology and LLMs

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*Acknowledgment: These course slides are based on materials by Lelia Glass @ Georgia Tech (Course: Language & Computers)

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Spelling checker

Traditional method: Dictionary + Edit Distance

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- Calculates distance between misspelling and candidates (very simple, but works quite well)
- Suggests the closest candidate as the correction
- Adds some weights for more realistic correction

Why context matters in spell-checking

Example: Someone types:

`You put the catt before the horse.`

- `put the cart before the horse`
- `put the cat before the horse`

Using N-grams to model context

N-grams are sequences of *n* elements (e.g., words or characters):

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- **Trigram** = three-word sequence: `put the cat`

Other approaches

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- **Statistical Language Models (n-grams)** Use probability of surrounding context e.g., *I went to the shcool* → “school” is more probable
- **Neural Spell Checkers (Deep Learning)** Seq2Seq / Transformer-based models generate corrected text Examples: ChatGPT, Grammarly, Google Docs
- **Hybrid Approaches** Combine edit distance with language models; pick the highest probability candidate

How common are spelling errors?

- About 2–3% of all typed words on a full-size keyboard are misspelled by proficient adults (Flor et al., 2015)

Table 2. Summary statistics for the ETS Spelling Corpus

	GRE Argument	GRE Issue	TOEFL Independent	TOEFL Integrated	TOTAL
Total essays	750	750	750	750	3,000
Essays without misspellings	60	21	18	21	120
Total Word Count	263,578	336,301	212,930	151,031	963,840
Average Word Count	351	448	284	201	321
Total count of Misspellings	5,935	7,962	7,285	5,230	26,412
Misspellings as % of all words	2.25%	2.37%	3.42%	3.46%	2.74%

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- On a mobile phone, however, about 40% of words are misspelled (Grammarly, 2019)
- More multi-error misspellings and real-word errors due to auto-complete (e.g., ***restaurant*** → typed as ***restuarnt*** → auto-corrected to ***restart***)

Lesson plan

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- Grammar

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- Wrap-up

Key idea: Building a grammar checker begins with understanding key linguistic categories

Grammar

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- **Prescriptive Grammar** Lays down rules for how language *should* be used. (Focus: *what speakers ought to do*)

Examples of grammar in use

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- Prescriptive grammar?

Grammar checkers and mixed rules

- Commercial grammar checkers may apply both descriptive rules and prescriptive rules.

Questions (*Shared deck*)

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3. **Even without a grammar checker, speakers often recognize what "sounds right." How do you think this internal system of grammar works in your mind?**

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- Why this matters for grammar checkers?

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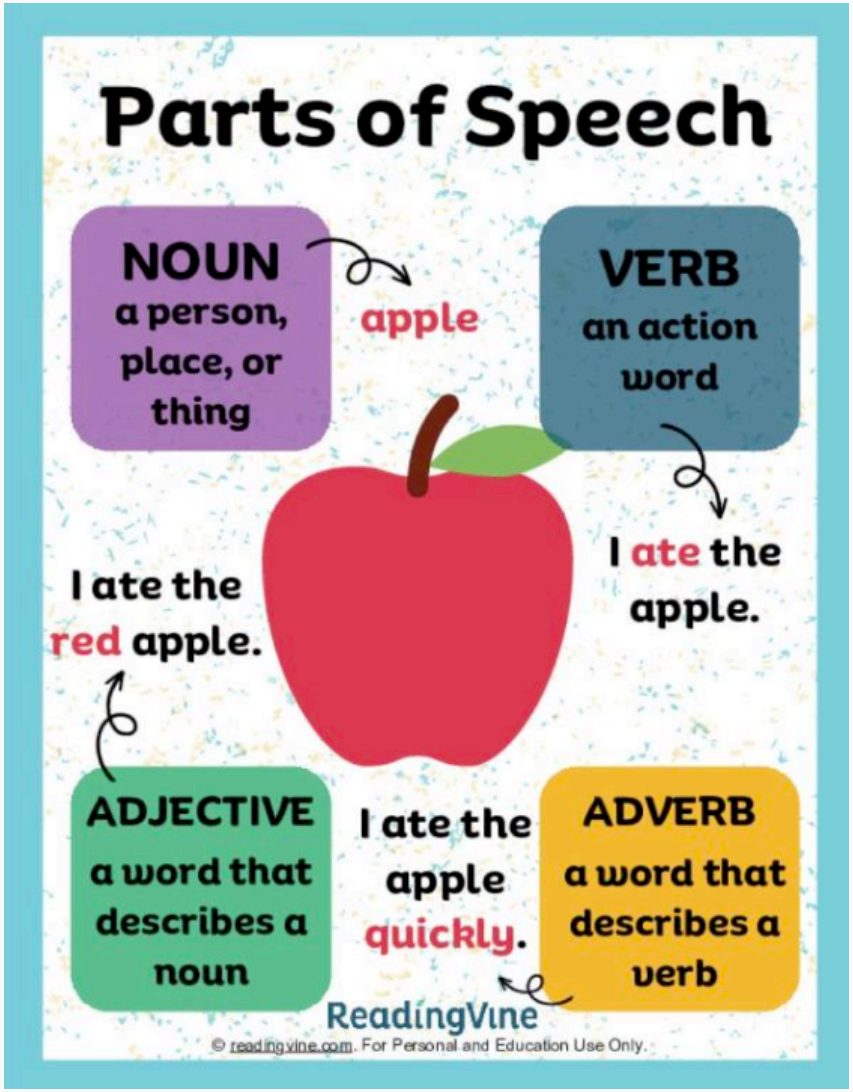

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- We usually identify POS by:
  - **Distribution:** where a word appears in a sentence (e.g., nouns after articles, verbs after subjects)
  - **Morphology:** how a word changes form (e.g., verbs mark tense: *play* → *played*, sometimes irregularly: *go* → *went*)

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  - Used as binary/frequency features in classifiers
- Before deep learning, POS and morphology were essential **hand-crafted features** (based on the prescribed rules).

Notes. POS tagging: Current NLP


```
# sent_id = file00321.txt_41
# text = And there are a big amusement park
1   And _   CCONJ   CC  _   3   cc  _   _
2   there   _   PRON    EX  _   3   expl    _   _
3   are _   VERB    VBP _   0   root    _   _
4   a   _   DET DT  _   7   det _   _
5   big _   ADJ JJ  _   7   amod    _   _
6   amusement   _   NOUN    NN  _   7   compound    _   _
7   park    _   NOUN    NN  _   3   nsubj   _   _
```

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  - **Noun Phrase** + **Verb Phrase** = Sentence

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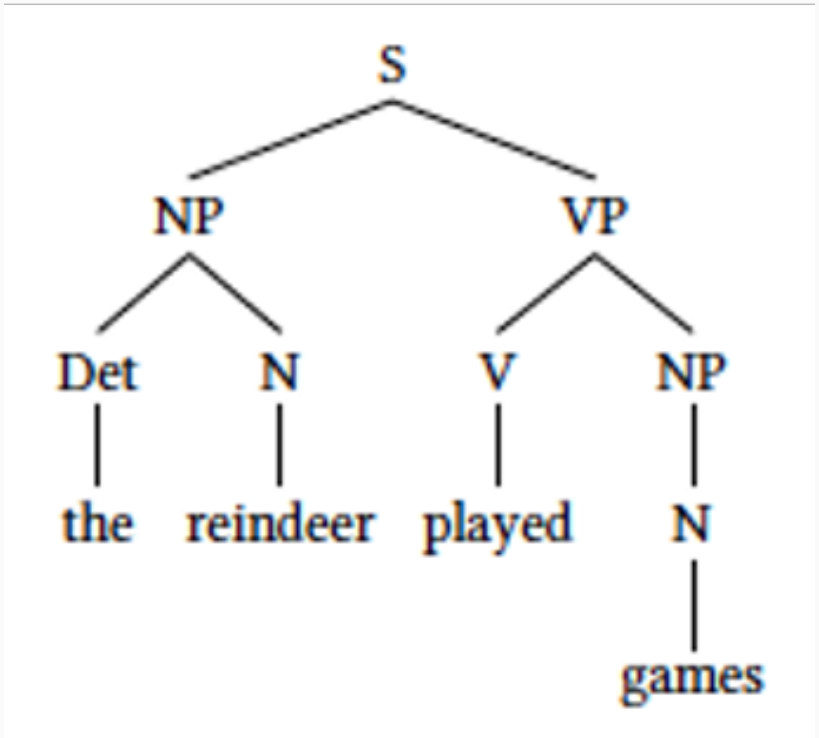
- Syntax is about **structure**, not always meaning.

Phrase structure grammar (Chomsky, 1950s-1960s)

Lexicon:
N → *reindeer, dragon, lunch, game, evening, morning*
V(trans) → *play, eat*
V(intrans) → *run, swim, dance*
Adj → *fun, beautiful, interesting*
Det → *the, a, some, many*
P → *for, in, to, at*

Phrase structure rules:
S → NP VP
VP → V(trans) NP
VP → V(intrans)
NP → Det (A*) N
NP → N
NP → NP PP
PP → P NP



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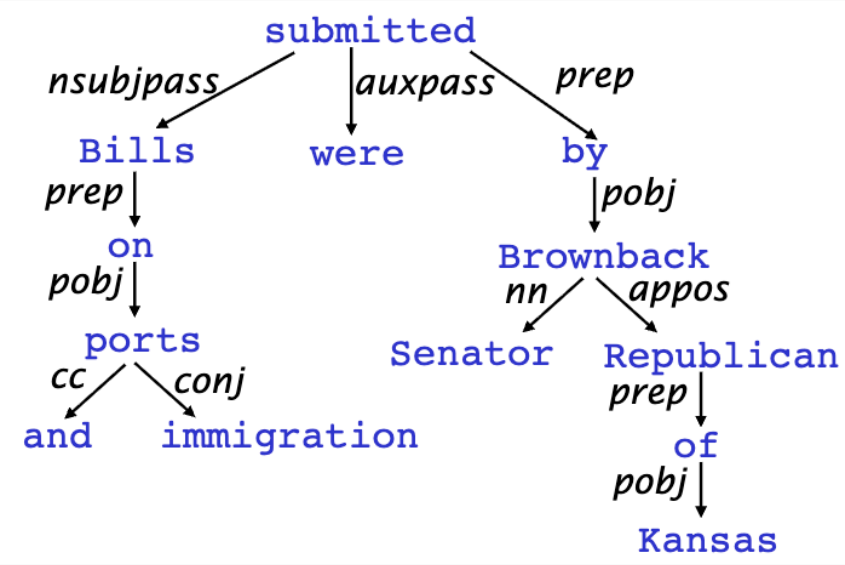
  - **Dependency Grammar** (widely used in **NLP**)

Dependency grammar

What is dependency grammar?

Dependency syntax postulates that syntactic structure consists of **relationships** between lexical items, normally binary asymmetric relations ("arrows") called dependencies.



Sourced from:
https://web.stanford.edu/class/archive/cs/cs224n/cs224n.1162/handouts/SLoSP-2014-4-dependencies.pdf

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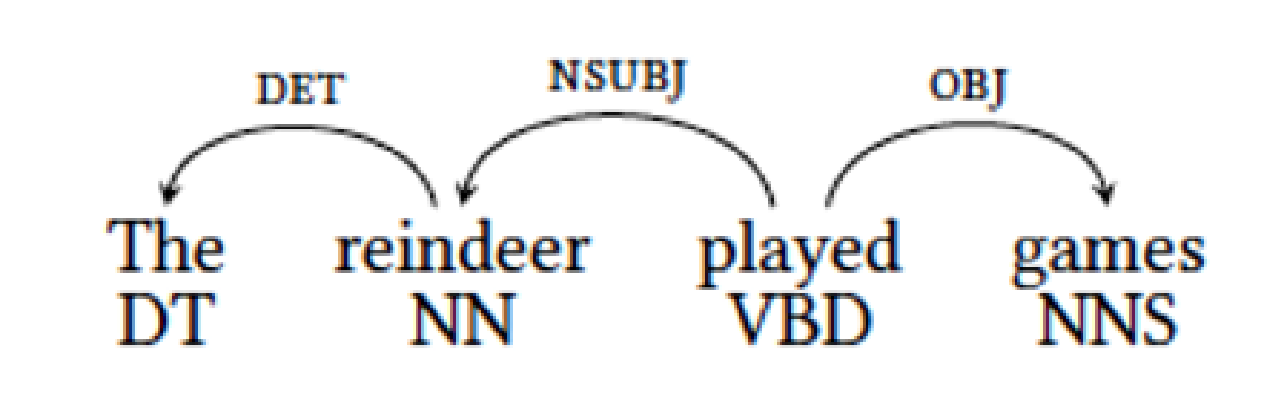

- *the* → dependent of *reindeer* via `det`

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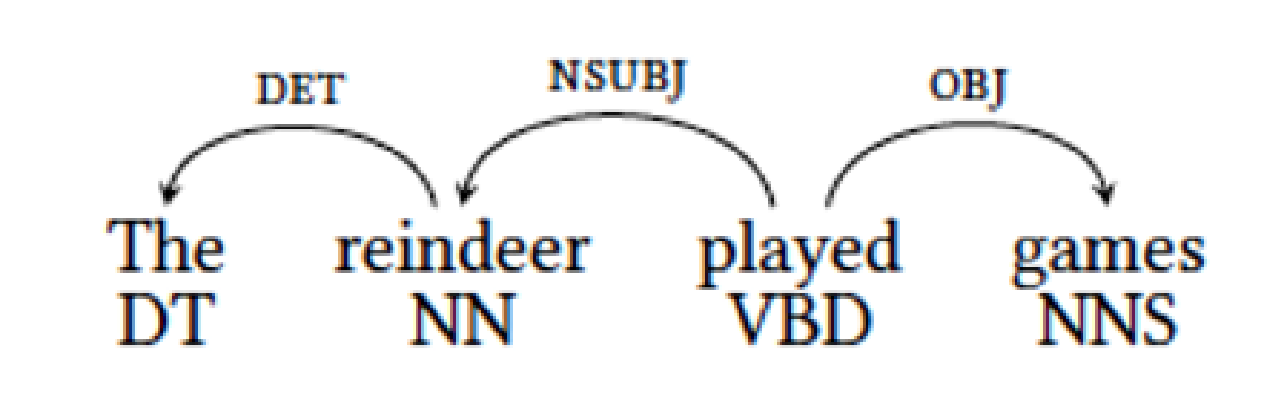

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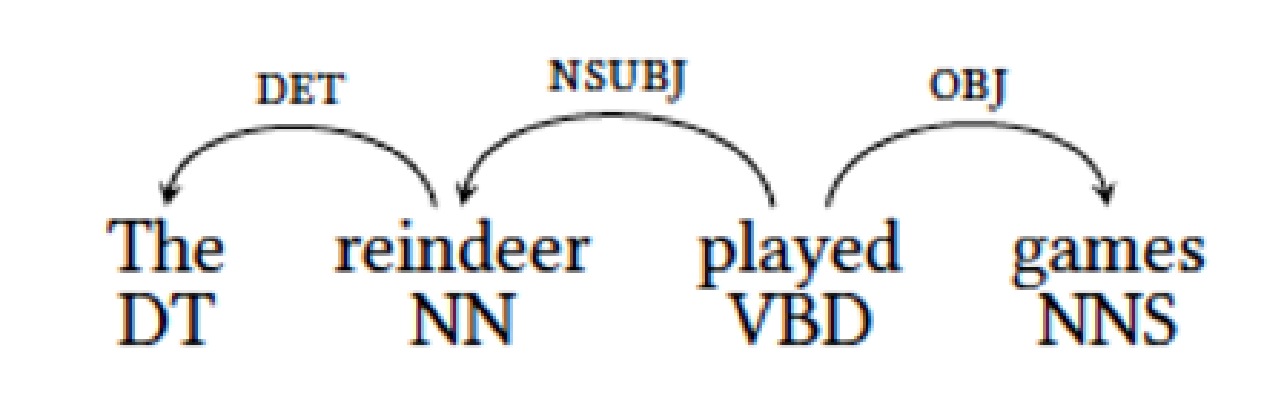

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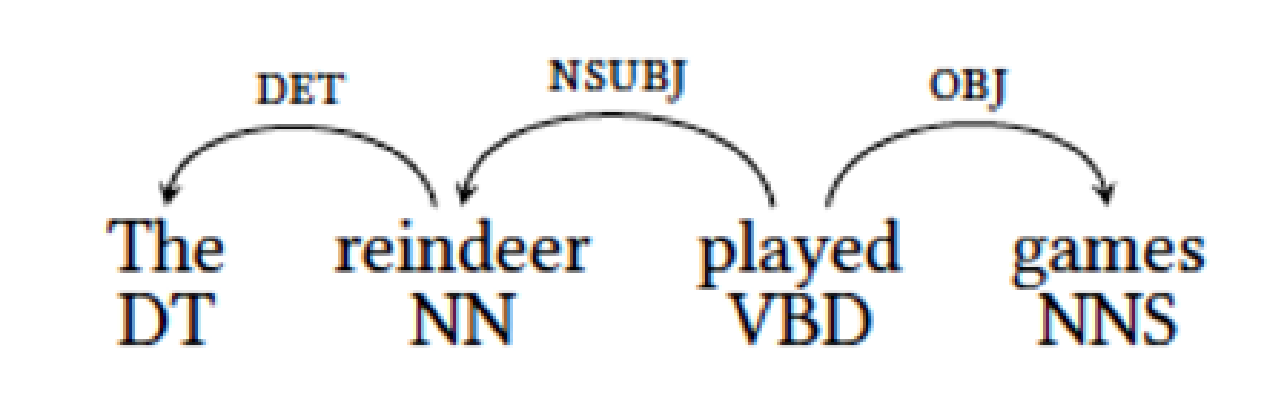

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  - State-of-the-art parsers trained on this format work very effectively in many languages (`https://stanfordnlp.github.io/stanza/performance.html`)

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  - Provides a foundation for multilingual NLP tools

More guides

The secret to understanding the design and current success of UD is to realize that the design is a very subtle compromise between approximately 6 things:

1. UD needs to be satisfactory on linguistic analysis grounds for **individual** languages.
2. UD needs to be good for linguistic **typology**, i.e., providing a suitable basis for bringing out cross-linguistic parallelism across languages and language families.
3. UD must be suitable for rapid, consistent **annotation** by a human annotator.
4. UD must be suitable for computer **parsing** with high accuracy.
5. UD must be easily comprehended and used by a **non-linguist**, whether a language learner or an engineer with prosaic needs for language processing. We refer to this as seeking a habitable design, and it leads us to favor traditional grammar notions and terminology.
6. UD must support well downstream language **understanding** tasks (relation extraction, reading comprehension, machine translation, …).

Sourced from: `https://people.cs.georgetown.edu/nschneid/p/UD-for-English.pdf`

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- Built using machine learning and large annotated corpora

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Grammar checker

From grammar to grammar Checkers

- So far, we've built a foundation by analyzing sentence structure.
- Now we can apply this knowledge to automatic grammar checking. For example:
- Try to assign a **dependency parse**.
  - If parsing fails → likely an error.
  - If parsing succeeds → compare to known grammar rules.

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- Example:
  - If the subject (`nsubj`) is tagged `NN` (singular noun),
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  - *The dog swim* (X) → should be *The dog swims*.

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- Confusion sets for **commonly misused words**?
- What else?

Rule-Based vs. LLM-Based Grammar Checkers

Rule-Based Checkers

- Use explicit grammar rules and POS/dependency tags
- Rely on parsing + handcrafted logic
- Example: Check for subject–verb agreement via `nsubj` and `VBZ`
- Explainable and controllable, but less flexible

LLM-Based Checkers

- Use large neural language models (e.g., GPT, BERT)
- *Learn grammar implicitly from vast corpora*
- Can handle diverse errors *without explicit rules*
- Often produce fluent rewrites, but less transparent

Wrap-up

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- In Linguistics, grammar is often studied under syntax.
- Two key concepts for grammar checkers:
  - **Part of Speech (POS)** – classifies each word
  - **Dependency grammar** – shows how words are connected
- **Why this matters for grammar checkers?**
  - Detect whether words fit together according to rules
  - Spot unusual or incorrect structures

Updates

Syllabus updated

The syllabus has been updated:

2	9/2	Writer's aids: Grammar errors	[LC] Ch.2.5-2.8	
	9/4	Python tutorial 1		Exercise 1
3	9/9	Computer-assisted language learning	[LC] Ch.3	
	9/11	Python tutorial 2		Exercise 2
4	9/16	Text as data		
	9/18	Python tutorial 3		
5	9/23	Word vectors		
	9/25	Python tutorial 4		Exercise 3

So, bring your laptop on Thursday!