Linguistics essentials

Linguistics essentials

- Levels of formal description
- Linguistic categories
- Words, phrases, sentences

The Description of Language

- Language = Words and Rules
- → Dictionary (vocabulary) + Grammar

Dictionary

set of words defined in the language

open (dynamic)

- Traditional

  paper based

- Electronic

  machine readable dictionaries; can be obtained from paper-based

The Description of Language (cont.)

Grammar

set of rules which describe what is allowable in a language

- Classic Grammars

  meant for humans who know the language

  definitions and rules are mainly supported by examples

  no (or almost no) formal description tools; cannot be programmed

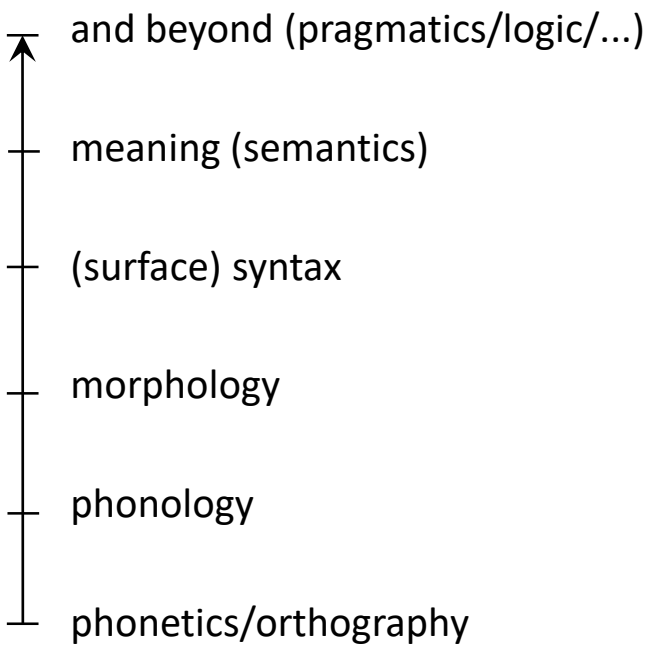
- Explicit Grammar (CFG, Dependency Grammars, Link Grammars,...)

  formal description

  can be programmed & tested on data (texts)

Levels of (Formal) Description

6 basic levels (more or less explicitly present in most theories):



Each level has an input and output representation

- output from one level is the input to the next (upper) level
- sometimes levels might be skipped (merged) or split

Phonetics/Orthography

- Input:
  - acoustic signal (phonetics) / text (orthography)
- Output:
  - phonetic alphabet (phonetics) / text (orthography)
- Deals with:
  - Phonetics:
    - consonant & vowel (& others) formation in the vocal tract
    - classification of consonants, vowels, ... in relation to frequencies, shape & position of the tongue and various muscles
    - intonation
  - Orthography: normalization, punctuation, etc.

Phonology

- Input:
  - sequence of phones/sounds (in a phonetic alphabet); or "normalized" text (sequence of (surface) letters in one language's alphabet) [NB: phones vs. phonemes]

- Output:
  - sequence of phonemes (or (lexical) letters; in an abstract alphabet)

- Deals with:
  - relation between sounds and phonemes (units which might have some function on the upper level)
  - e.g.: [u] - oo (as in book), [æ] - a (cat); i - y (flies)

Morphology

- Input:
  - sequence of phonemes (or (lexical) letters)
- Output:
  - sequence of pairs (lemma, (morphological) tag)
- Deals with:
  - composition of phonemes into word forms and their underlying lemmas (lexical units) + morphological categories (inflection, derivation, compounding)
  - e.g. quotations - quote/V + -ation (der.V->N) + NNS.

Morphology: Morphemes & Order

- Handles what is an ***isolated form*** in written text

- Grouping of phonemes into morphemes
  - sequence **deliverables – deliver**, **able** and **s** (3 ***units***)
  - could as well be some "ID" numbers:
    - e.g. deliver - 23987, s - 12, able - 3456

- Morpheme Combination
  - certain combinations/sequencing possible, other not:
    - deliver+able+s, but not able+derive+s; noun+s, but not noun+ing
    - typically fixed (in any given language)

Morphology: From Morphemes to Lemmas & Categories

- Lemma: lexical unit, “pointer” to lexicon
  - might as well be a number, but typically is represented as the “base form”, or “dictionary headword”
    - possibly indexed when ambiguous/polysemous:
      - state[1] (verb), state[2] (state-of-the-art), state[3] (government)
  - from one or more morphemes (“root”, “stem”, “root+derivation”, ...)

- Categories:
  - small number of possible values (< 100, often < 5-10)

(Surface) Syntax

- Input:
  - sequence of pairs (lemma, (morphological) tag)

- Output:
  - sentence structure (tree) with annotated nodes (all lemmas, (morphosyntactic) tags, functions), of various forms

- Deals with:
  - the relation between lemmas & morphological categories and the sentence structure
  - uses syntactic categories such as Subject, Verb, Object,...

e.g.: I/PP1 see/VB a/DT dog/NN –
((I/sg)SB ((see/pres)V (a/det dog/sg)OBJ)VP)S

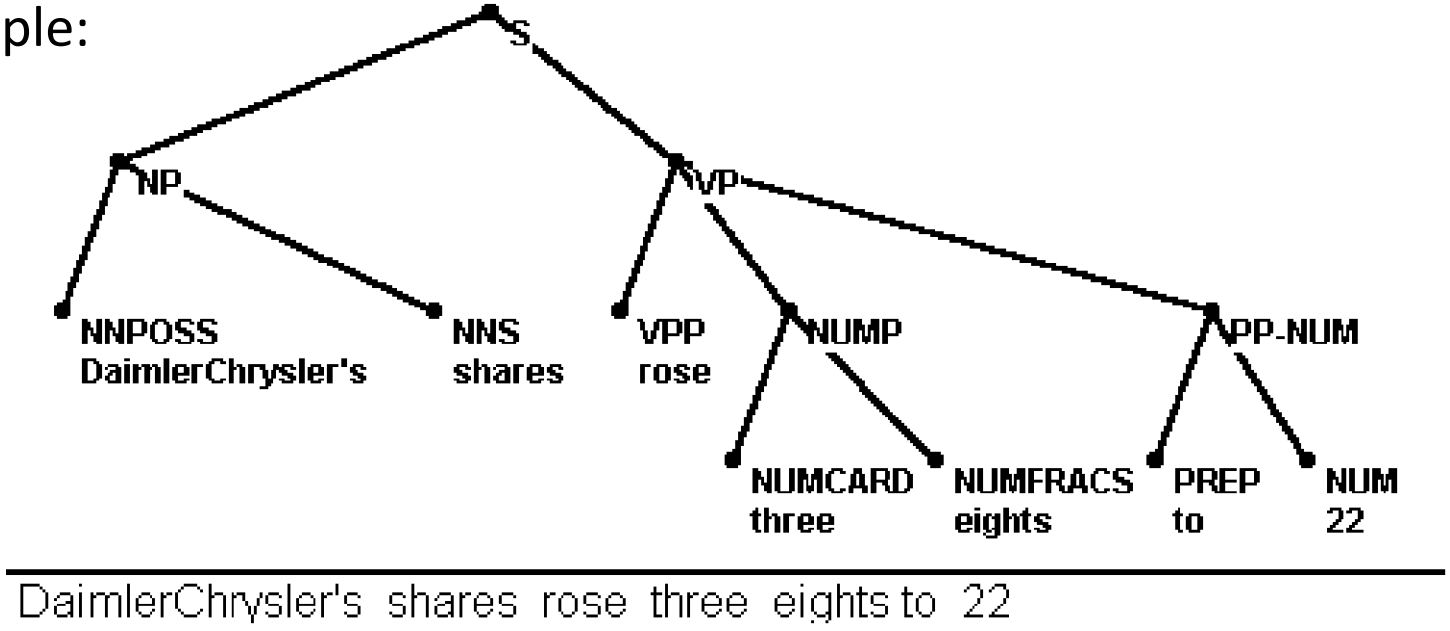
Syntax: Representation

- Tree structure (“tree” in the sense of graph theory)
  - one tree per sentence

- Two main ideas for the shape of the tree:
  - phrase structure (derivation tree, cf. parsing later)
    - using bracketed grouping
    - brackets annotated by phrase type
    - heads (often) explicitly marked
  - dependency structure (lexical relations “local”, functions)
    - basic relation: head (governor) - dependent
    - links (edges) annotated by syntactic function (Sb, Obj, ...)
    - phrase structure: implicitly present

Syntax: Phrase Structure Tree

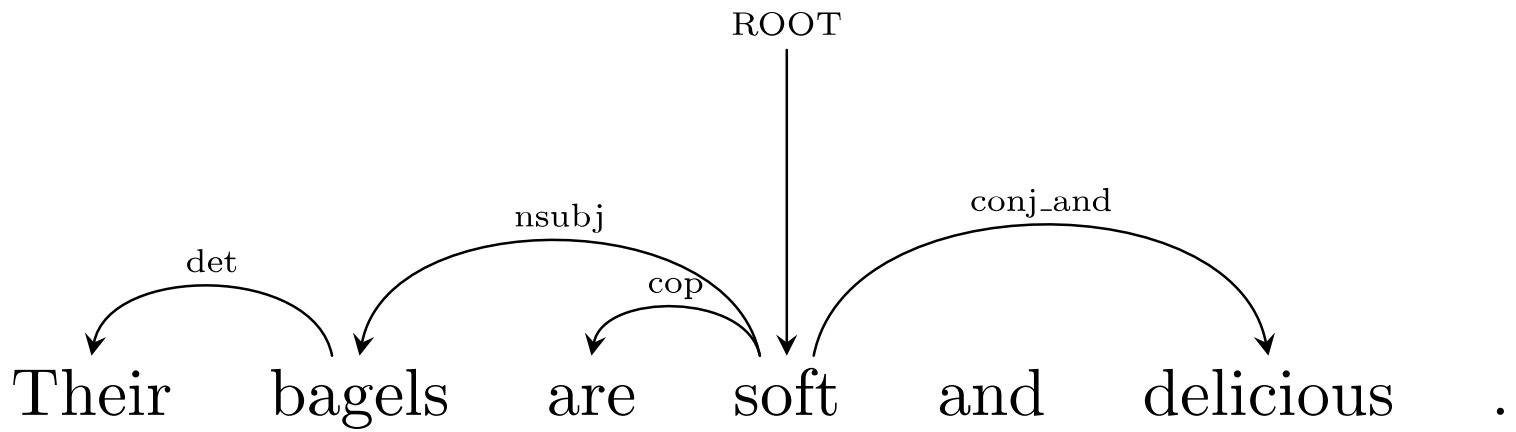
- Example:



- ((DaimlerChrysler's shares)$_{NP}$ (rose (three eights)$_{NUMP}$ (to 22)$_{PP\text{-}NUM}$)$_{VP}$)$_{S}$

Syntax: Dependency Relations

- Example:



Meaning (semantics)

- Input:
  - sentence structure (tree) with annotated nodes (lemmas, (morphosyntactic) tags, surface functions)

- Output:
  - sentence structure (tree) with annotated nodes (semantic lemmas, (morpho-syntactic) tags, deep functions)

- Deals with:
  - relation between categories such as “Subject”, “Object” and (deep) categories such as “Agent”, “Effect”; adds other categories

    e.g. ((I)SB ((was seen)V (by Tom)OBJ)VP)S -
    (I/Sg/Pat (see/Perf/Pred) Tom/Sg/Ag)

...and Beyond

- Input:
  - sentence structure (tree): annotated nodes (autosemantic lemmas, (morphosyntactic) tags, deep functions)

- Output:
  - logical form, which can be evaluated (true/false)

- Deals with:
  - assignment of objects from the real world to the nodes of the sentence structure

e.g.: (I/Sg/Pat (see/Perf/Pred) Tom/Sg/Ag) -

see(Mark-Twain[SSN:...],Tom-Sawyer[SSN:...])$_{[Time:bef\ 99/9/27/14:15][Place:39.19'40"N76.37'10"W]}$

Linguistics essentials

- Levels of formal description
- Linguistic categories
- Words, phrases, sentences

The Categories: Part of Speech: Open and Closed Categories

- Part of Speech - POS (pretty much stable set across languages); morphological "behavior" is typically consistent within a POS category
  - Open categories: ("open" to additions)
    - verb, noun, pronoun, adjective, numeral, adverb
      - subject to inflection (in general); subject to cross-category derivations
      - newly coined words always belong to open POS categories
      - potentially unlimited number of words
  - Closed categories:
    - preposition, conjunction, article, interjection, particle
      - not a base for derivation (possibly only by compounding)
      - finite and (very) small number of words

Open class (lexical) words

- **Nouns**
  - **Proper** — *IBM*, *Italy*
  - **Common** — *cat / cats*, *snow*
- **Verbs**
  - **Main** — *see*, *registered*
  - **Modals** — *can*, *had*
- **Adjectives** — *old* *older* *oldest*
- **Adverbs** — *slowly*
- **Numerals** — *122,312*, *one, fifth*

… more

Closed class (functional)

- **Determiners** — *the some*
- **Conjunctions** — *and or*
- **Pronouns** — *he its*
- **Prepositions** — *to with*
- **Particles** — *off* *up*
- **Interjections** — *Ow* *Eh*

… more

The Categories: Part of Speech, Open Categories: Nouns

- Nouns: typically refer to entities

  Inflection:

number	singular, plural
gender	feminine, masculine, neuter
case	nominative, genitive, accusative, dative, vocative

  - semantic classification:
    - human/animal/(non-living) things: driver/bird/stone
    - concrete/abstract: computer/thought
    - common/proper: table/Microsoft

  - syntactic classification: countable/uncountable: book, water

  - morphological classification:
    - pluralia/singularia tantum: data (is), police (are)
    - “adverbial” nouns: afternoon, home, east (no inflection)

The Categories: Part of Speech, Open Categories: Verbs

Verbs:

Inflectional:

subject number	singular, plural
subject person	first *(I* read*),* second *(you* read*),* …
tense	present tense, past tense …
aspect	progressive, perfect
modality	possibility, …
voice	active, passive

- syntactic/semantic: classification:
  - ordinary: (to) speak, (to) write
  - auxiliaries: be, have, will, would, do, go (going)
  - modals: can, could, may, should, must, want
  - phasal (aspectual): begin, start, end

- morphological classification
  - ***conjugation*** type: regular/irregular, (Ge.: weak/strong/irregular)
  - *conjugation* class: (e.g. Italian: -are, -ere, -ire …)

The Categories: Part of Speech, Open Categories: Pronouns

- Pronouns:
  - Inflectional: number, person, gender, case
  - much like nouns (syntactic usage also similar)
  - (pro)noun - “stands for” a noun

  - classification (mostly syntactic/semantic):
    - personal: I, you, she, she, it, we, you, they
    - demonstrative: this, that
    - possessive: my, your, her, his, its, our, their; mine, yours, ours,...
    - reflexive: myself, yourself, herself,..., oneself
    - interrogative: what, which, who, whom, whose, that
    - indefinite (“nominal”): somebody, something, one

The Categories: Part of Speech, Open Categories: Adjectives

- Adjectives: describe properties of nouns

  Inflectional: degree of comparison (comparative/superlative), number, gender, case

  - classification:
    - ordinary: new, interesting
    - possessive: John's, driver's
    - proper: Appalachian (Mountains)
    - often derived from verbs/nouns: teaching (assistant), trendy, stylish

  - morphological classification
    - degrees of comparison (En.: big, bigger, biggest)
    - usually requires agreement with the noun

The Categories: Part of Speech, Open Categories: Adverbs

- Adverbs: modify a verb, and specify place, time, manner, degree

  Inflectional: degree of comparison

  - derivation from adjectives is common:
    - new → newly, interesting → interestingly
  - non-derived adverbs:
    - ordinary: so, well, just, too, then, often, there
    - wh-adverbs (interrogative): why, when, where, how
    - degree adverbs/qualifiers: very, too

  - morphological classification (not much, really...)
    - degree of comparison: well, better, best
    - soon, sooner

The Categories: Part of Speech, Open Categories: Numerals

- Numerals: used to indicate numbers

  Inflectional: number, gender, case, negation

  - open (infinite?) category: compounding (Ge.: einundzwanzig, 21)

  - classification:
    - cardinals: one, five, hundred
      - NB: million etc. often considered noun
    - ordinals: first, second, thirtieth
    - quantifiers: all, many, some, none
    - multiplicative: times, twice
    - multilateral: single, triple, twofold

  - morphological classification: as nouns/adjectives; many irregulars

The Categories: Part of Speech, Closed Categories

- Closed categories: preposition, conjunction, article, interjection, clitic, particle
  - Morphological behavior: indeclinable
    - preposition: of, without, by, to;
    - conjunction:
    - coordinating: and, but, or, however
    - subordinating: that, if, because, before, after, although, as
    - Article (determiner): a, an, the
    - interjection: wow, eh, hello;
    - clitic: ‘s; may be attached to whole phrases (at the end)
    - particle: yes, no, not; to (+verb);
      - many (otherwise) prepositions if part of phrasal verbs, e.g. (look) up

The Categories: Number and Gender

- Grammatical Number: Singular, Plural
  - nouns, pronouns, verbs, adjectives, numerals
    - computer / computers; (he) goes / (they) go
  - In some languages: (Czech): Dual (nouns, pronouns, adjectives)
    - (Pl.) nohami / (Dl.) nohama (Cz., (by) legs (of sth) / (by) legs (of sb))

- Grammatical Gender: Masculine, Feminine, Neuter
  - nouns, pronouns, verbs, adjectives, numerals
    - he/she/it; qital, qitala, qitalo (Ru., (he/she/it) was reading)
    - nouns: (mostly) do not change gender for a single lexical unit
  - Also: animate/inanimate (gram., some genders), etc.
    - Mädchen (Ge.; girl, neuter); děti (Cz.; children, masc. inanim.)

The Categories: Case

- Case
  - English: only personal pronouns/possessives, 2 forms
  - other languages: 4 (German), 6 (Russian), 7 (Czech,Slovak,...), 5 (Romanian)
    - nouns, pronouns, adjectives, numerals

  - most common cases (forms in singular/plural)
    - nominative I/we (work) eu/noi (Ro)
    - genitive (picture of) me/us a mea/al meu
    - dative (give to) me/us mie
    - accusative (see) me/us pe mine
    - vocative you! tu!
    - locative (about) me/us (Czech)
    - instrumental (by) me/us (Czech)

The Categories: Person, Tense

- Person
  - verbs, personal pronouns
  - 1st, 2nd, 3rd: (I) go, (you) go, (he) goes; (we) go, (you) go, (they) go

    merg, mergi, merge mergem mergeti merg (Ro)
- Tense
  - past:
  - present:
  - future:
  - concurrent (gerund)

	(Ro)	(Pol.: go)
(you) went	ai mers	szliście
(you pl.) go	mergeti	idziecie
(you) will go	veti merge	-
going	mergind	idąc

Note on Tense

- Examples of (traditional) tense:
  - infinitive: (to) write (tenseless, personless, ..., except negation (Cz.))
  - simple present/past: (I) write/(she) writes; (I,she) wrote
  - progressive present/past: (I) am writing; (I) was writing
  - perfect present/past: (I) have written; (I) had written
  - all in passive voice, too:
    - (the book) is being/has been/had been written etc.
  - all in conditional mood, too (mood: in Eng. not a morph. category)
    - (the book) would have been written

The Categories: Voice & Aspect

- Voice
  - active vs. passive
    - (I) drive / (I am being) driven
    - (Ich) setzte (mich) / (Ich bin) gesetzt (Ge.: to sit down)
- Aspect
  - imperfective vs. perfective:
    - покупал / купил (Ru.: I used to buy, I was buying) / I (have) bought)
  - imperfective continuous vs. iterative (repeating)
    - spal / spával (Cz.: I was sleeping / I used to sleep (every ...))

The Categories: Negation, Degree of Comparison

- Negation:
  - even in English: impossible (not possible)
  - Cz: every verb, adjective, adverb, some nouns; prefix *ne-*
- It: some adjectives: irregular negation (s-, non)
- Degree of Comparison (non-analytical):
  - adjectives, adverbs:
    - positive (big), comparative (bigger), superlative (biggest)
    - Pol.: (new) nowy, nowszy, najnowszy
- Combination (by prefixing):
  - order? both possible: (neg.: Cz./Pol.: *ne-/nie-*, sup.: nej-/naj-)
    - Cz.: nej*ne*možnější (the most impossible)
    - Pol.: *nie*najwierniejszy (the most unfaithful)

Typology of Languages

- By morphological features
  - Analytic: using (function) words to express categories
    - English, also French, Italian, ..., Japanese, Chinese
      - I would have been going – (Pol.) szłabym
  - Inflective: using prefix/suffix/infix, combines several categories
    - Slavic: Czech, Russian, Polish,... (not Bulgarian); also French, German; Arabic
      - (Cz. new(acc.)) nov***ou*** (Adj, Fem., Sg., Acc., Non-neg.)
  - Agglutinative: one category per (non-lexical) morpheme
    - Finnish, Turkish, Hungarian
      - (Fin. plural): -i-

Categories & Tags

- Tagset:
  - list of all possible combinations of category values for a given language
  - typically string of letters & digits:
    - compact system: short idiosyncratic abbreviations:
      - NNS (gen. noun, plural)
    - positional system: each position i corresponds to C_i:
      - AAMP3----2A---- (gen. Adj., Masc., Pl., 3rd case (dative), comparative (2nd degree of comparison), Affirmative (no negation))
      - tense, person, variant, etc.: N/A (marked by “empty position”, or ‘-’)
- Famous tagsets: Brown, Penn, Multext[-East], ...

The Dictionary (or Lexicon)

- Repository of information about words:
  - Morphological:
    - description of morphological “behavior”: inflection patterns/classes
  - Syntactic:
    - Part of Speech
    - relations to other words:
      - subcategorization (or “surface valency frames”)
  - Semantic:
    - semantic features
    - synonyms, antonyms
  - ...and any other! (e.g., translation)

Linguistics essentials

- Levels of formal description
- Linguistic categories
- Words, phrases, clauses, sentences

Words, Phrases, Clauses, Sentences

- Words
  - smallest units on the syntax level
    - function/semantic
- Phrases
  - consist of words and/or phrases; “constituents”
- Clauses
  - have predicative meaning (single predicate)
- Sentences
  - consist of clauses (one or more)

Words

- Words
  - lexical units
    - auxiliary (function) words: have grammatical function
    - have meaning
  - idioms
    - fixed phrases (non-compositional) “hot dog”, “kick the bucket”

- Relate to other words
  - dictionary: repository of information for each words about its (idiosyncratic) relations to other words

Phrases

- Phrases
  - sequences of words and/or phrases (i.e. of constituents)
    - may be discontinuous, sometimes
- Types of Phrases:
  - Simple/Clausal (i.e. clauses, which consist of phrases, behave like phrases... recursively!)
  - According to head type:
    - Noun phrase: a new book
    - Adjective phrase: brand new
    - Adverbial phrase: so much
    - Prepositional phrase: in a class
    - Verb phrase: catch a ball

Noun Phrases

- Head: noun
  - water
  - a book
  - new ideas
  - that small village
  - The greatest rise of interest rates since W.W.II within a single year
  - an operating system which, despite great efforts on the part of our administrators, fails all too often

Adjective Phrases

- Head: adjective
- Simple APs very common, complex APs rare
  - old
  - very old
  - really very old
  - five times older than the oldest elephant in our ZOO
  - (was) sure, as far as I know, to be there first

Adjective phrases (cont.)

- Generally, the adjective order in English is:
  - Quantity or number
  - Quality or opinion
  - Size
  - Age
  - Shape
  - Color
  - Proper adjective (often nationality, other place of origin, or material)
  - Purpose or qualifier

Adverbial and Numerical Phrases

- Head: adverb
  - three times as much
  - quickly
  - really
  - (... speaks) more loudly than anybody could imagine
  - yesterday
- Numerical Phrases
  - (... lasted) three hours
  - twenty-two

Prepositional Phrases

- Head: preposition
- In fact, play the role of Adverbial Phrases often
  - in the City
  - at five o'clock
  - to a brightest future
  - without a glitch
  - to the point where neither of them could get out of it
  - up to five points
  - instead of Charles

Verb Phrases

- Head: verb
  - (It) rains
  - ... could ever see a large Unidentified Flying Object
  - ..., why (we) have got so much rain
  - Please!
  - On Sunday, (he) was driven to the hospital
  - (It) began to snow
  - (...) prohibits smoking in this area

Coordination of Phrases

- “Head”: conjunction, punctuation
  - and, or, but
    - cats and dogs
    - new or even newer
    - quickly and precisely
    - he came to the conclusion that it makes no sense to hide himself anymore and therefore we could hear him today
    - (flights) from and to Dallas
    - eat your lunch now or at the picnic table

Clauses

- Predicative function:
  - some activity of some subjects/objects, somewhere in time, under certain circumstances

- Main clause
  - not part of a greater clause

- Embedded clause
  - part of other clause, having some function (like a phrase)

- *A tile falling from the roof nearly killed him.*
- *He fell asleep while listening to the news.*

- Function of a Clause
  - same as for phrase, plus some (direct speech etc.)

Sentences

- Consist of a single or several main clauses
- If several main clauses:
  - coordination, much like coordinated phrases
  - more coordinating conjunctions:
    - and, or, but, (and) therefore, ...
- In written text, starts with a capital letter
- Ends by period/question mark/exclamation mark
    - not all periods end a sentence! – example?
- Sometimes even semicolon (;) might be a sentence break (...vague)

Credits

This slide set has been adapted from the NLP course of Paul Tarau, UNT:

http://www.cse.unt.edu/%7Etarau/teaching/NLP/nlp.html