Linguistics and formal languages

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LING 21020: Formal Foundations of Linguistics
April 6, 2020

Hi!

Welcome to Formal Foundations of Linguistics: Remote Edition!

Communication outside class

- Canvas
  - homework, readings, and other class materials
  - all announcements (please keep your notifications on!)

- Zoom chat channel: *Formal Foundations of Linguistics*
  - office hours: WTh 3:00–4:00pm Central Time
  - general discussion and quick questions

Sources

- No required textbook, but (optional) readings will be posted

- Special mention:

  An introductory linguistics textbook to consult for review:

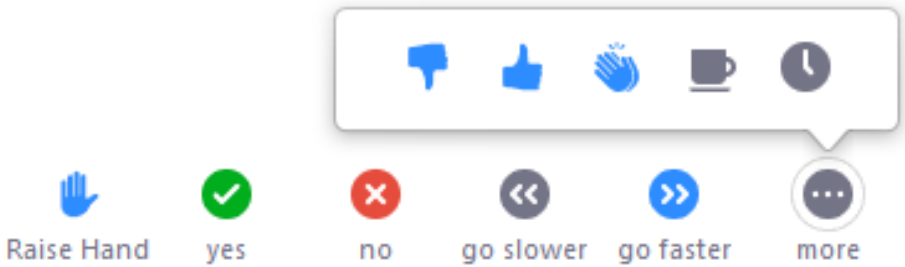
  Hope C. Dawson and Michael Phelan (eds), *Language Files* (2016)

  A major inspiration and source of examples used in this course:

  Thomas Graf, *Computational Linguistics as Language Science* (2019)

Communication in class

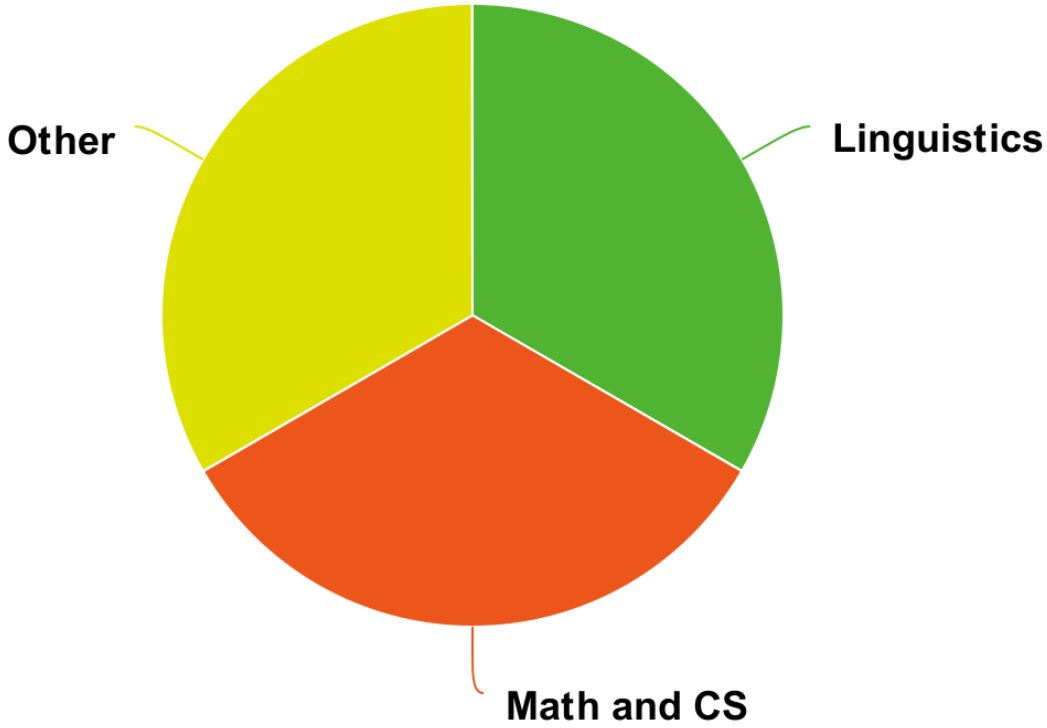
- Chat messages
  - for short questions and comments



- Nonverbal feedback
  - to give me an idea of how the class is going
  - I will sometimes ask you to use this feature for a quick poll

- Audio + video
  - for extended discussion; please raise your hand first
  - make sure to keep your mic muted when not talking

Background survey (preliminary results)



(if you haven't taken the survey yet, please do so after class!)

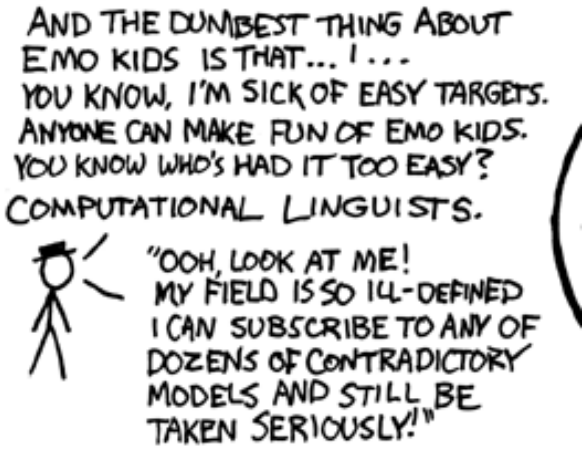
Before we continue...

- Record our Zoom meetings: yes or no?

- Let's have a vote!

Update: "yes" – 6, "no" – 0, "either is OK" – 6.

Language + Math = ?



(source: xkcd)

- Computational linguistics
  – often used as an umbrella term
- Natural language processing
  – using computers to solve practical language-related tasks
- Mathematical linguistics
  – applying mathematical methods to understand natural language
  – **formal language theory**: languages as mathematical objects generated by rule systems

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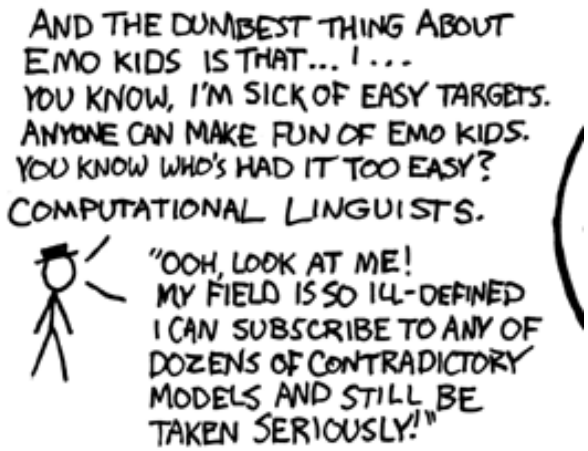

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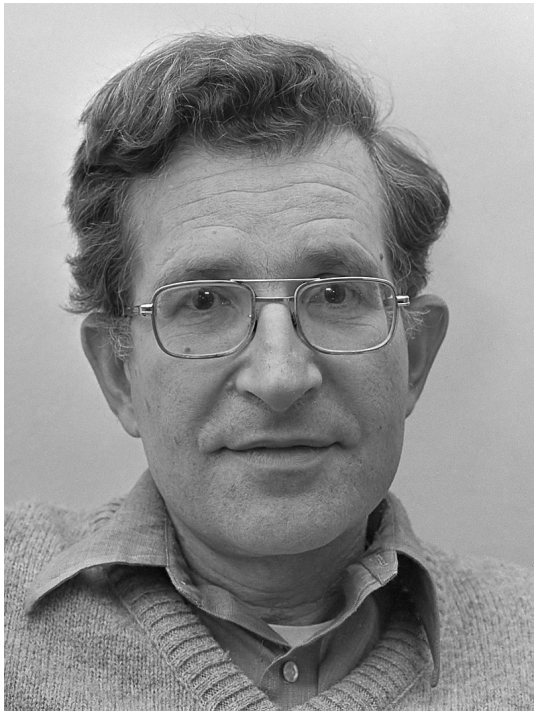
Formalization in linguistics



"The search for rigorous formulation in linguistics has a much more serious motivation than mere concern for logical niceties or the desire to purify well-established methods of linguistic analysis. [...] By pushing a precise but inadequate formulation to an unacceptable conclusion, we can often expose the exact source of this inadequacy and, consequently, gain a deeper understanding of the linguistic data."

Noam Chomsky, *Syntactic Structures* (1957)

Formal languages

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  - The set of all grammatical sentences of English is **not** an alphabet

Formal languages

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  Example: $\Sigma = \{a,\ b\}$

- Σ^*: the set of all finite strings of symbols from Σ

  We use ϵ to denote the **empty string**

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  Examples of languages: $\emptyset$, Σ, Σ^*,
  all 5-symbol strings of *a*'s and *b*'s,
  all even-length strings of only *a*'s
  ...

Example: square brackets

- Let $\Sigma = \{ [,] \}$
- Let L be a language over Σ such that:

  (1) $[\,] \in L$;

  (2) For any string $s \in L$, $[s] \in L$;

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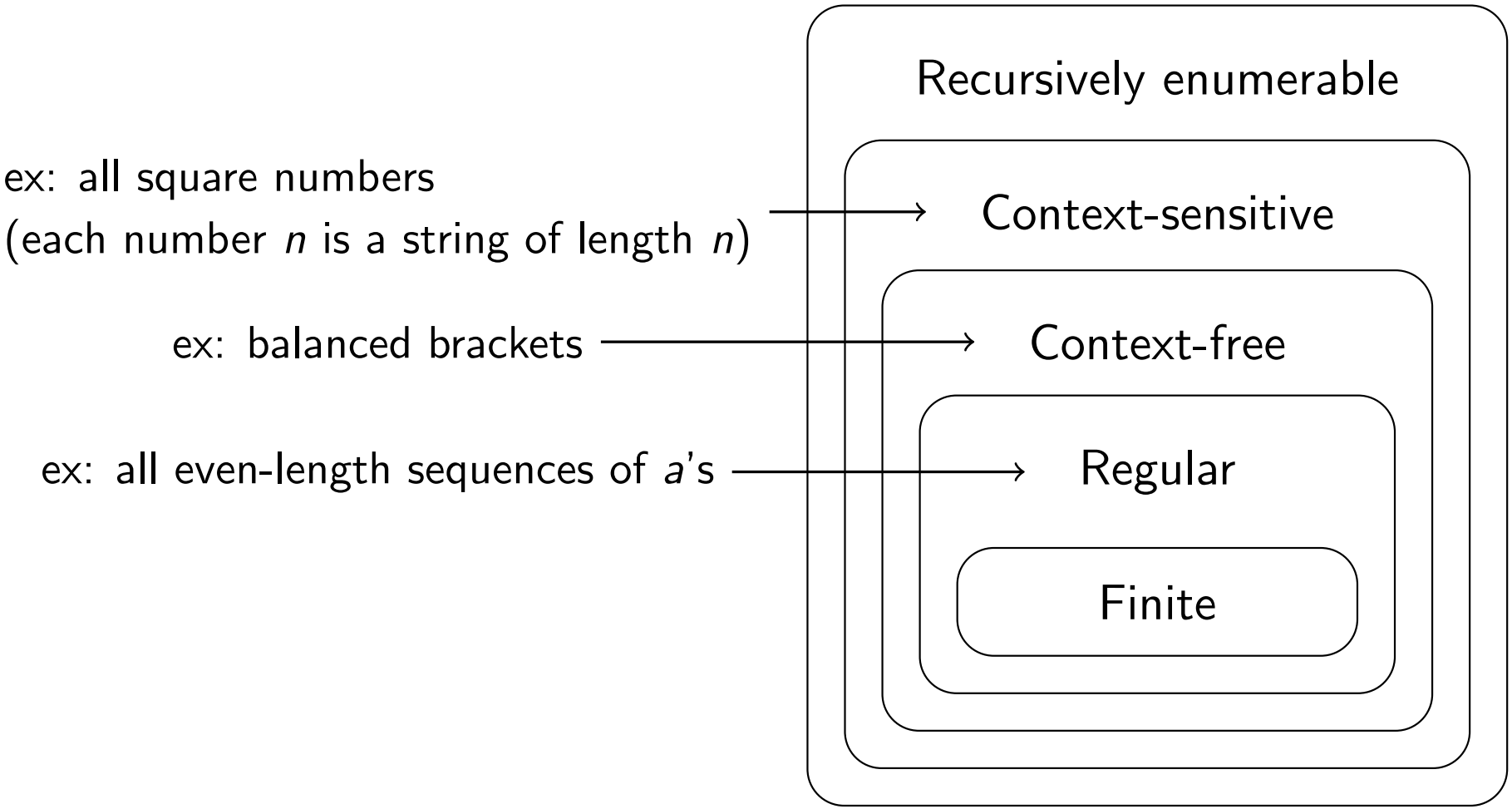
  We will touch on these, but we are primarily interested in the following:

- What formal languages are a better fit to model natural language?

The Chomsky Hierarchy of formal languages

(also known as the Chomsky–Schützenberger hierarchy)



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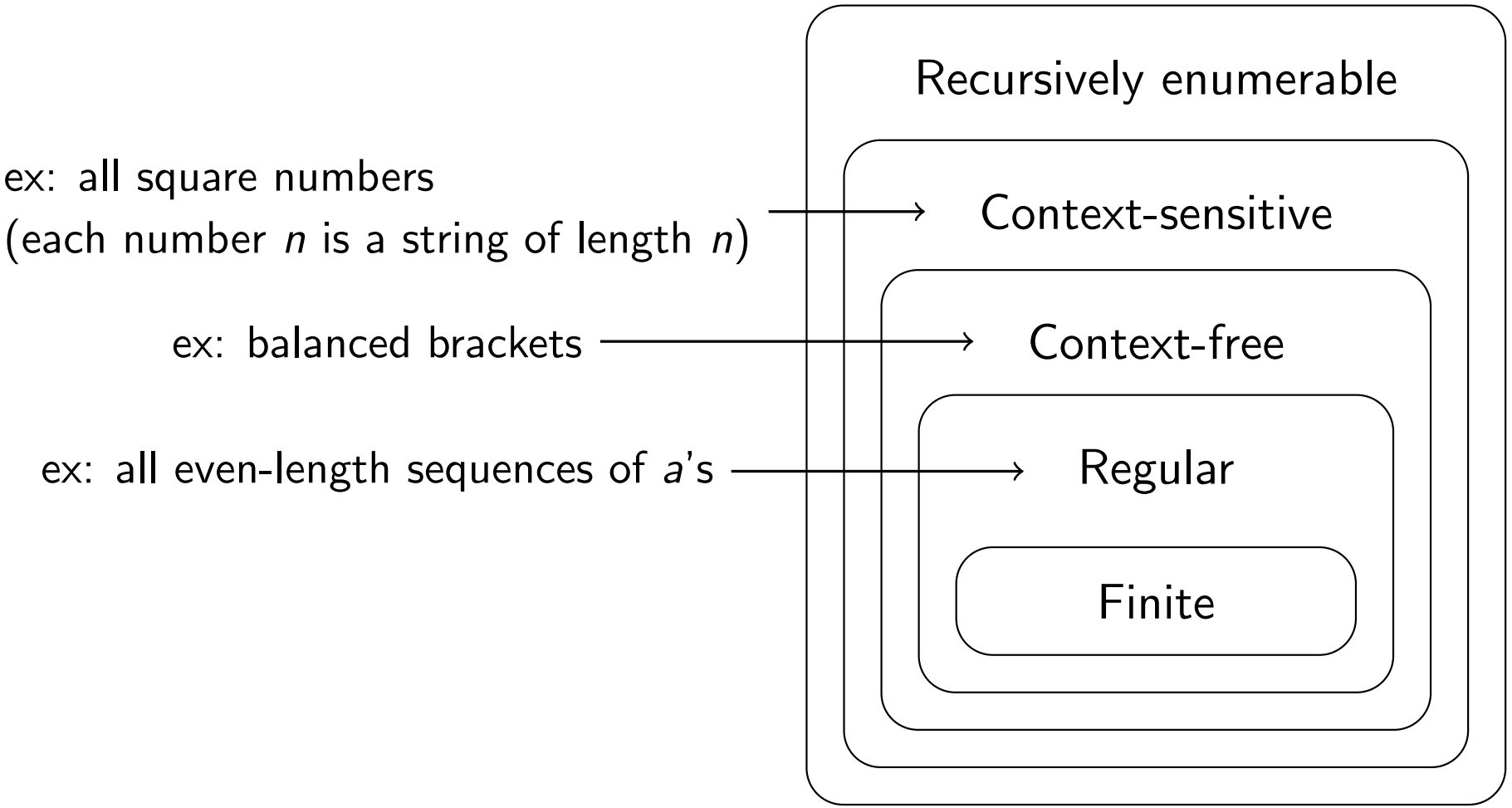

- Where do phonology, morphology, and syntax fit in this hierarchy?

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• Intro to linguistics	...but we will look at some basic concepts of linguistics in a more precise way
• Intro to formal language theory	...but we will use formal grammars to describe patterns in natural language
• Natural language processing	...but we will use various tools implementing these grammars

Background survey

- Regular expressions
- Finite-state automata
- Context-free languages
- Subregular languages
- Mildly context-sensitive languages
- International Phonetic Alphabet
- Phonemes and allophones
- Phonological rewriting rules
- Autosegmental phonology
- Syntactic constituents
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...and how we can use the connection to model natural language phenomena

Next time

- Formal grammars

- Regular languages, and why linguists should care about them