Introduction, organization
LKB formalism

Ling 567
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Overview

- The BIG picture
- Goals (of grammar engineering, of this course)
- The LinGO Grammar Matrix
- Other approaches
- Course requirements/workflow
- Pick a language
- Components
- Lab 1 preview
- LKB formalism

But first:

- https://www.washington.edu/uwem/plans-and-procedures/uw-emergency-procedures/

- Mass Assembly Point: Denny Yard

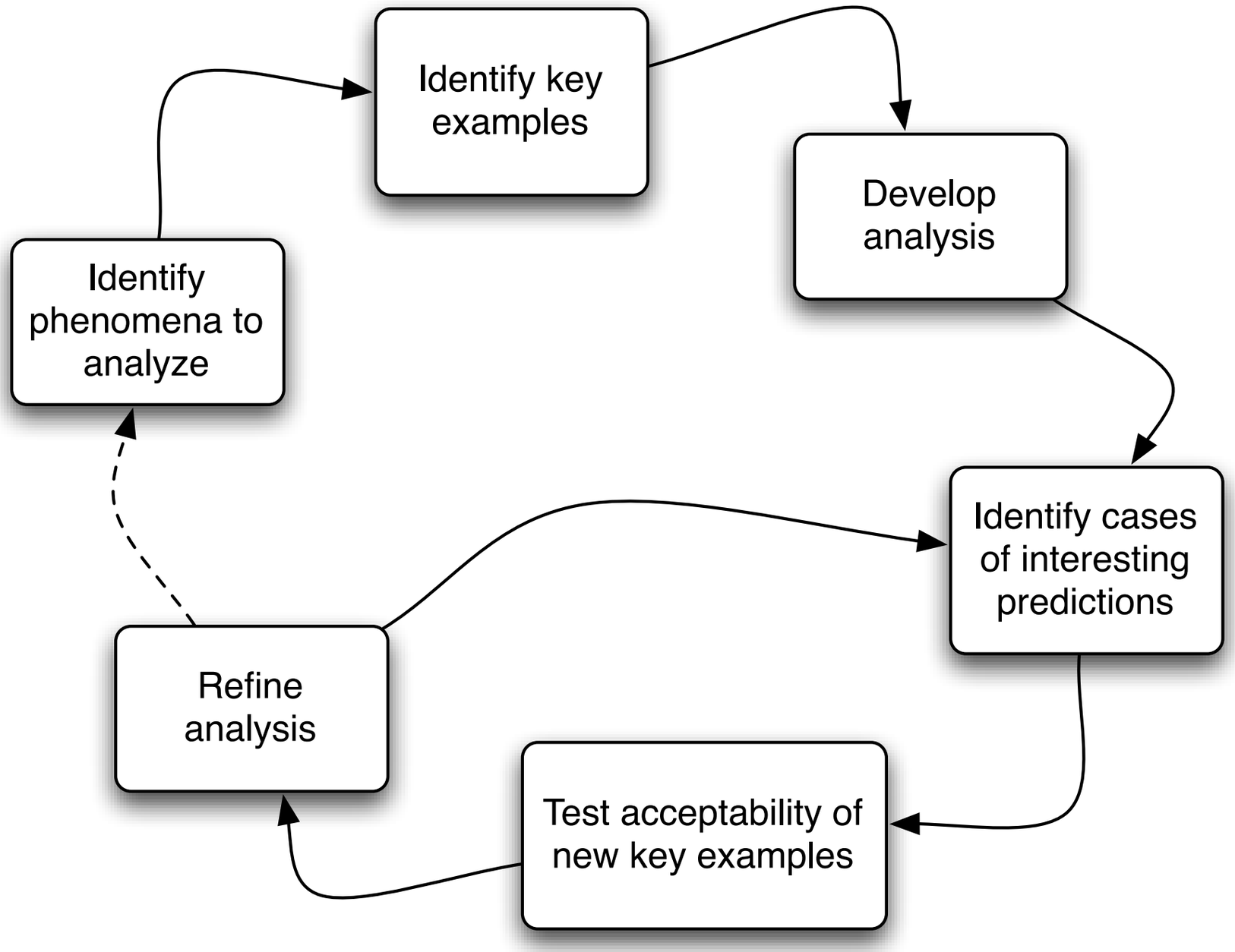
What is grammar engineering?

- The implementation of natural language grammars in software.
- Grammars can be used for parsing and/or generation.
  - Relate surface strings to semantic representations
- Grammars can be practically focused or theoretically focused.
- Knowledge-engineering approach to parsing.
  - “Precision” grammars can give deeper representations
  - ... but tend to be less robust.

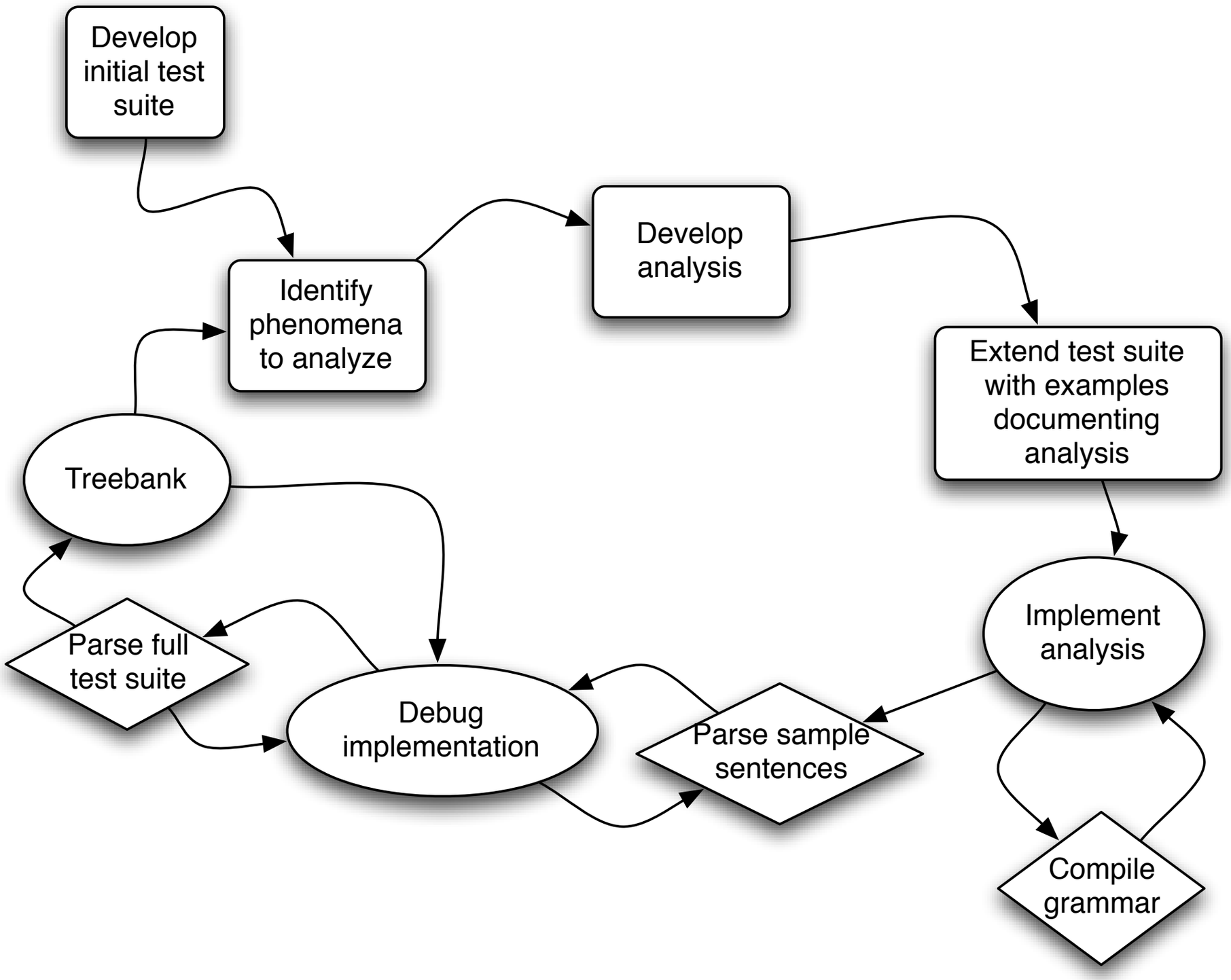
How is grammar engineering different from other approaches to syntax?

- Implementation requires fully explicit analyses
- Implementation allows automated verification of analyses
    - Parse test suites
    - Parse test corpora
    - Generate from stored semantic representations
- Implementations allows/requires incremental development
    - Interrelatedness of analyses becomes more apparent

Pen and paper syntax work-flow



Grammar engineering work flow (Bender et al 2011)



How is grammar engineering different from other approaches to parsing?

- All parsers require linguistic knowledge --- information about possible and probable pairings of strings and linguistic structure

- Grammar engineering: Rules behind possible strings are hand-coded (Flickinger 2000, Riezler et al 2002, ...); probabilities derived from grammar-based treebank

- Treebank-trained parsers: Knowledge extracted from treebank, which in turn is (mostly) hand-coded (Charniak 1997, Collins 1999, Petrov et al 2006, ...)

- Unsupervised parsers: Knowledge extracted from co-occurrence patterns of words (Clark 2001, Klein and Manning 2004)

- Hybrid-approaches: Skeleton grammar built by hand, complemented by information from treebank (O'Donovan et al 2004, Miyao et al 2004, ...)

Applications of grammar engineering

- Language documentation
- Linguistic hypothesis testing
- MT
- IR (“semantic search” --- PowerSet)
- Automated email response
- Augmentative and assistive communication
- Computer assisted language learning (CALL)
- ...

Challenges for grammar engineering

- efficient processing (Oepen et al 2002)
- ambiguity resolution (Toutanova et al 2005)
- domain portability
- lexical acquisition (Baldwin 2005)
- extragrammatical/ungrammatical input
- scaling to many languages

Hybrid approaches

- Naturally occurring language is noisy
  - typos
  - “mark up”
  - addresses and other non-linguistic strings
  - false starts
  - hesitations
- Allowing for noise within the grammar would reduce precision
- And then there’s ambiguity, unknown words, ...

Hybrid approaches

- Combine knowledge engineering and machine learning approaches:
  - Statistical parse selection
  - (Statistical) named-entity recognition and POS tagging in a pre-processing step (for unknown word handling)
  - Tiered systems with shallow parser as fallback for precision grammar
- Other direction:
  - Deep grammars providing richer linguistic resources or seed information to train machine learners

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Goals: Of Grammar Engineering

- Build useful, usable resources
- Test linguistic hypotheses
- Represent grammaticality/minimize ambiguity
- Build modular systems: maintenance, reuse

Goals: Of this course

- Mastery of tfs formalism
- Hands-on experience with grammar engineering
- A different perspective on natural language syntax
- Practice building (and debugging!) extensible system
- Contribute to on-going research in multilingual grammar engineering & automated grammar inference
- Contribute to language documentation efforts

Goals: Of this course

- Understand a range of grammatical facts about a language, plus how to get them from descriptive materials

- Learn more about using HPSG to model grammatical facts

- Deeper understanding of relationship between syntax and semantics

- Lean how to use the computational tools of grammar engineering to test and develop formalizations

Testing and developing formalizations

- Tools: LKB, [incr tsdb()]
- Steps:
  - Identify intended analysis (primarily semantic)
  - Hypothesize new rules/lexical entries or new constraints on existing rules/lexical entries that will produce intended analyses
  - Implement constraints (and debug until grammar compiles)
  - Test and examine results: Overconstrained? Underconstrained?

Relationship between syntax and semantics

- What does syntax do?
  - Constrain ambiguity
  - Provide scaffolding for building semantic representations
  - Handle grammaticality (agreement, word order, case, ...)
- What do semantic representations do?
  - Make explicit who did what to whom
  - Serve as input for tactical generation
  - Relate multiple surface forms to each other
  - Differentiate multiple analyses of same surface form

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The LinGO Grammar Matrix

- Addresses the scalability challenge by reducing the cost of creating grammars

- Starter-kit which allows for quick initial development while supporting long-term expansion

- Represents a set of hypotheses about cross-linguistic universals and cross-linguistic variation

- Includes typologically grounded “libraries” exploring the range of variation in certain phenomena

A sampling of hypotheses

- Words and phrases combine to make larger phrases.
- The semantics of a phrase is determined by the words in the phrase and how they are put together.
- Some rules for phrases add semantics (but some don’t).
- Most phrases have an identifiable head daughter.
- Heads determine which arguments they require and how they combine semantically with those arguments.
- Modifiers determine which kinds of heads they can modify, and how they combine semantically with those heads.
- No lexical or syntactic rule can remove semantic information.

Multilingual grammar engineering: Other approaches

- The DELPH-IN consortium specializes in large HPSG grammars
- Other broad-coverage precision grammars have been built by/in/with
  - LFG (ParGram: Butt et al 1999)
  - F/XTAG (Doran et al 1994)
  - ALE/Controll (Götz & Meurers 1997)
  - SFG (Bateman 1997)
  - GF (Ranta 2007)
  - OpenCCG (Baldridge et al 2007)
- Proprietary formalisms and Microsoft and Boeing and IBM

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Course requirements/workflow

- Tuesdays lecture, Thursdays discussion
- Office/lab hours on (most) Tuesdays and Fridays
- Weekly lab assignments, posted one week ahead, due on Friday
- Be sure to start the lab early in the week, so you can bring useful questions
- At least half of each lab grade will be on the documentation
- Labs 2-8 as partner projects, taking turns doing the write-up
- No exams; front-loaded course schedule
- “Uncheatable”

Course requirements/workflow

- Week 1: Getting to know the LKB (English exercise); pick your language
- Weeks 2-4: Test suite construction, iteratively customize starter grammar
- Weeks 5-9: Build out your grammar
- Week 10: MT extravaganza

Surviving the course

- Communication is key: Please ask questions!
    - Get started early, to have time for collaboration and question turn-around
- Use Canvas discussions
    - Subscribe to Canvas notifications
- Read my feedback on labs quickly & ask for clarification if necessary
- Read (and contribute to!) FAQs, glossary (-> demo)
- EMB’s office hours
- 10 minute rule

Surviving this course

- Invest the time to get comfortable with emacs
- Resist the urge to build a perfect grammar
- Read the assignments carefully/ask questions to clarify what exactly is being asked for
- Ask lots of questions, ask early and often!
    - 2017: 2,016 (15)
    - 2016: 1,074 (12)
    - 2015: 1,248 (18)
    - 2014: 1,224 (14)

Languages

- This year we're working from field resources.
- Find a partner
- Languages we have resources for so far: Abui (abz), Chintang (ctn), Yupik (esu), Ik (ikx), Matsigenka (mcb), Wambaya (wmb), [Nuuchahnulth (nuk)]

Why assume a morphophonological analyzer?

- Easy case: Swahili [swh]

Mi-ti mi-kubwa hi-i y-a mwitu i-li-anguka jana.
c4-trees c4-big these-c4 of.c4-poss forest c4-pst-fall yesterday.
'These big trees of the forest fell yesterday.' [swh] (Reynolds & Eastman 1989:64)

- Impossible case: Slave [scs]

a. *ya-de-**d**-Ø-ʔáh* ⟶ *yádeht'ǫ*
ADV-INC-D-Ø-be.fooled
"I was fooled." (Rice 1989:444)

b. *íd-Ø-ʔáh* ⟶ *yít'ah*
1PL-Ø-go
"We two are going." (Rice 1989:476)

Respectful communication

- There's a history of conflict between documentary & theoretical linguistics, with theoretical linguists not fully appreciating the difficulty and importance of the work done by field linguists.

- When working with field linguists, please be respectful of both the effort they have already put in and the time they give for answering your questions.

- When working with data/describing your work, please be respectful of the intellectual property of field linguists and speaker communities. Ask the field linguist what to cite, what can be shared, etc.

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Components

- HPSG: Theoretical foundations
- LKB
- Grammar (Matrix-provided, plus extensions)
- Emacs: editor, interaction with LKB
- [incr tsdb()]

LKB

- tdl reader/compiler
- parser
- generator
- grammar exploration tools
  - parse chart
  - interactive unification
  - type and hierarchy exploration

Grammar

- A set of tdl files:
  - Grammar Matrix core
  - Additions from the customization system
  - Your additions
- Actually separated into:
  - Type definitions
  - Instances of grammar rules, lexical rules, lexical entries
  - Root symbols
  - Node label abbreviations
- Also includes: Lisp code for LKB interaction

[incr tsdb()]

- Pronounced “tee ess dee bee plus plus”
- Loading in test suites
- Running test suites (batch processing)
- Comparing multiple test suite runs:
  - Changes in which examples parse
  - Changes in number of analyses per item
  - Changes in representations per item
- Treebanking

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