Introduction, organization
LKB formalism

Ling 567
January 4, 2012

Overview

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

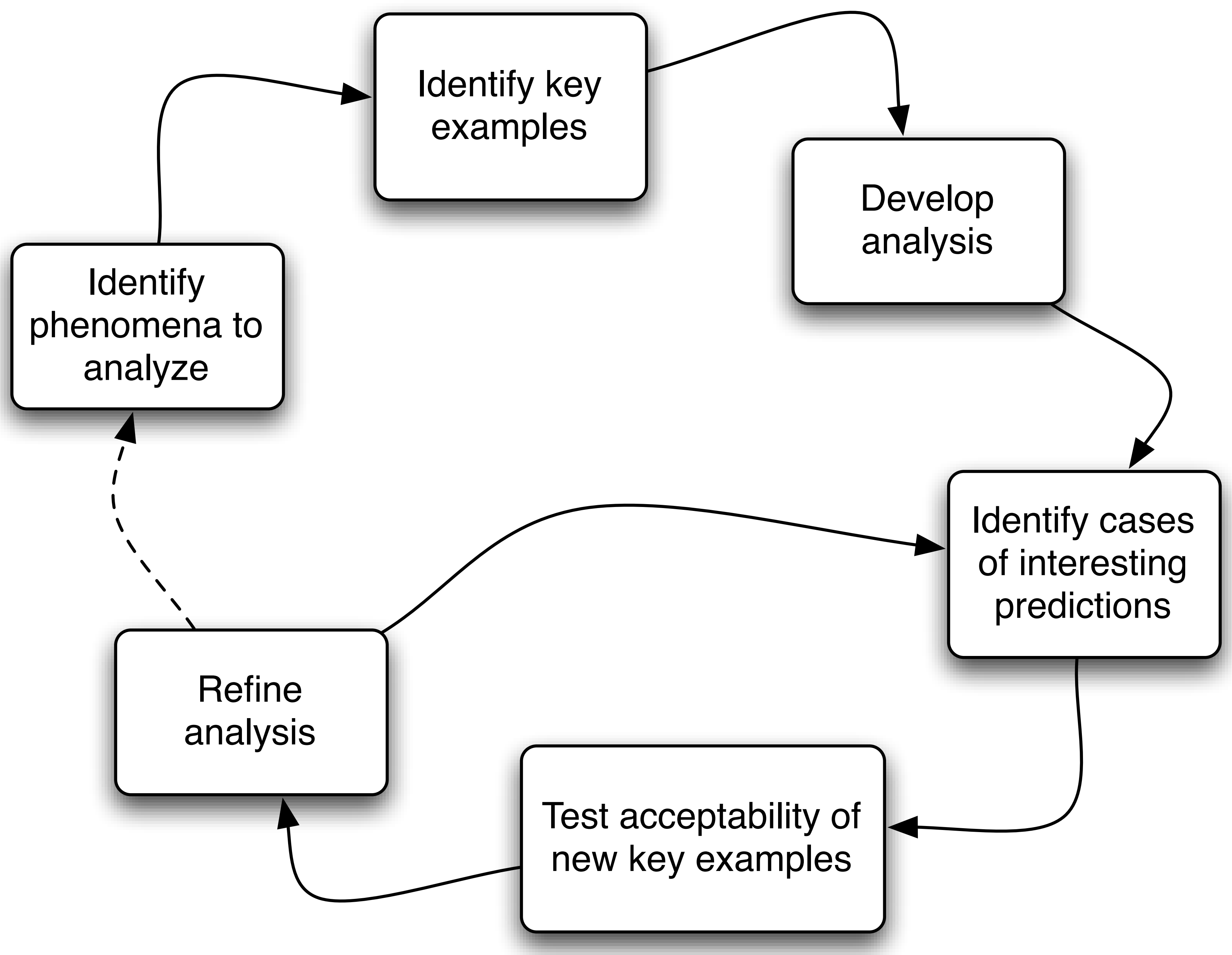
What is grammar engineering?

- 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.

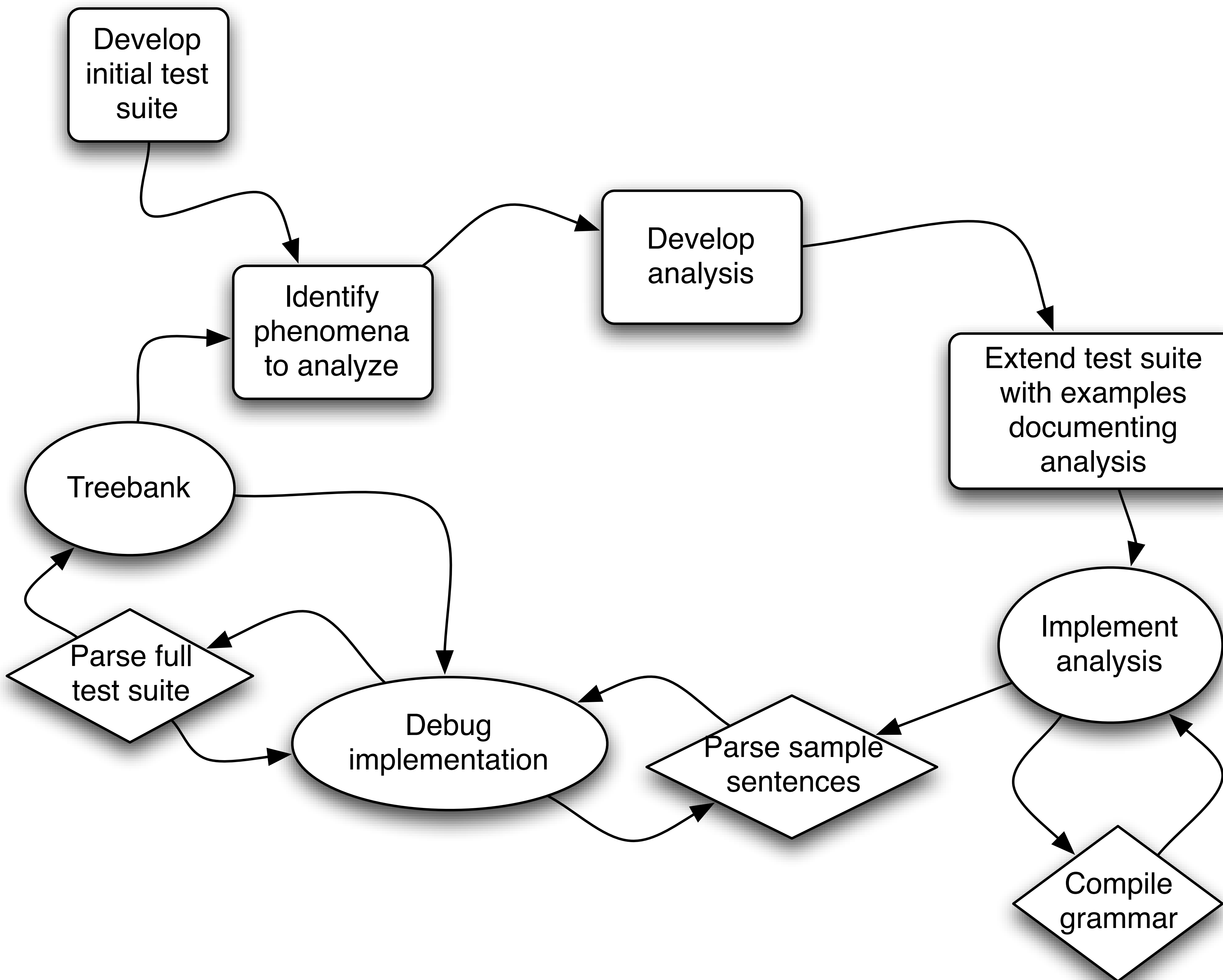
How is grammar engineering different from other approaches to syntax?

- 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



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

Overview

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

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
- Contribute to language documentation efforts (optional)

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

Overview

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

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)
- Proprietary formalisms and Microsoft and Boeing and IBM

Overview

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

Course requirements/workflow

- Mondays lecture, Wednesdays discussion
- Office/lab hours on (most) Fridays
- Weekly lab assignments, posted one week ahead, due on Friday (except Lab 1, due Monday)
- Be sure to start the lab by class on Wednesday, so you can bring useful questions
- At least half of each lab grade will be on the documentation
- Labs 2-9 as partner projects, taking turns doing the write-up
- No exams; front-loaded course schedule

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 GoPost (link on course page)
  - Subscribe to the GoPost
- Read (and contribute to!) FAQs, glossary (-> demo)
- EB's lab hours
- 10 minute rule

Pick a language, any language

- And pick a partner. (Ideally each team should have at least one linguist.)
- Each team must pick a different language.
- Previous languages are on the wiki, only languages most recently done in 2004 or 2005 are available for re-treatment.
- No English, non-Indo European preferred.
- Consider using an ascii transliteration.
- Languages with complex morphophonology require abstraction (assume a morphophonological preprocessor).
- Pick a language with a good descriptive grammar available.

New for 2012: Field languages!

- Contacted field linguists interested in having grammars built for the languages they are working on
- Advantages:
  - Contribute to documentation of under-described (and in many cases endangered) languages
  - Contribute to emerging intersection of compling and language documentation
  - Work directly with field linguists who can help answer questions in a way that published materials can’t

New for 2012: Field languages!

- Disadvantages:
  - Languages are in process of documentation; some information might not be available
  - Higher level of responsibility to create a good grammar (don’t let the field linguist and the speakers of the language down!)
- Overall, field languages should be very interesting

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.

Overview

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

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

Overview

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