

Introduction, organization LKB formalism

Ling 567

January 3, 2023

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

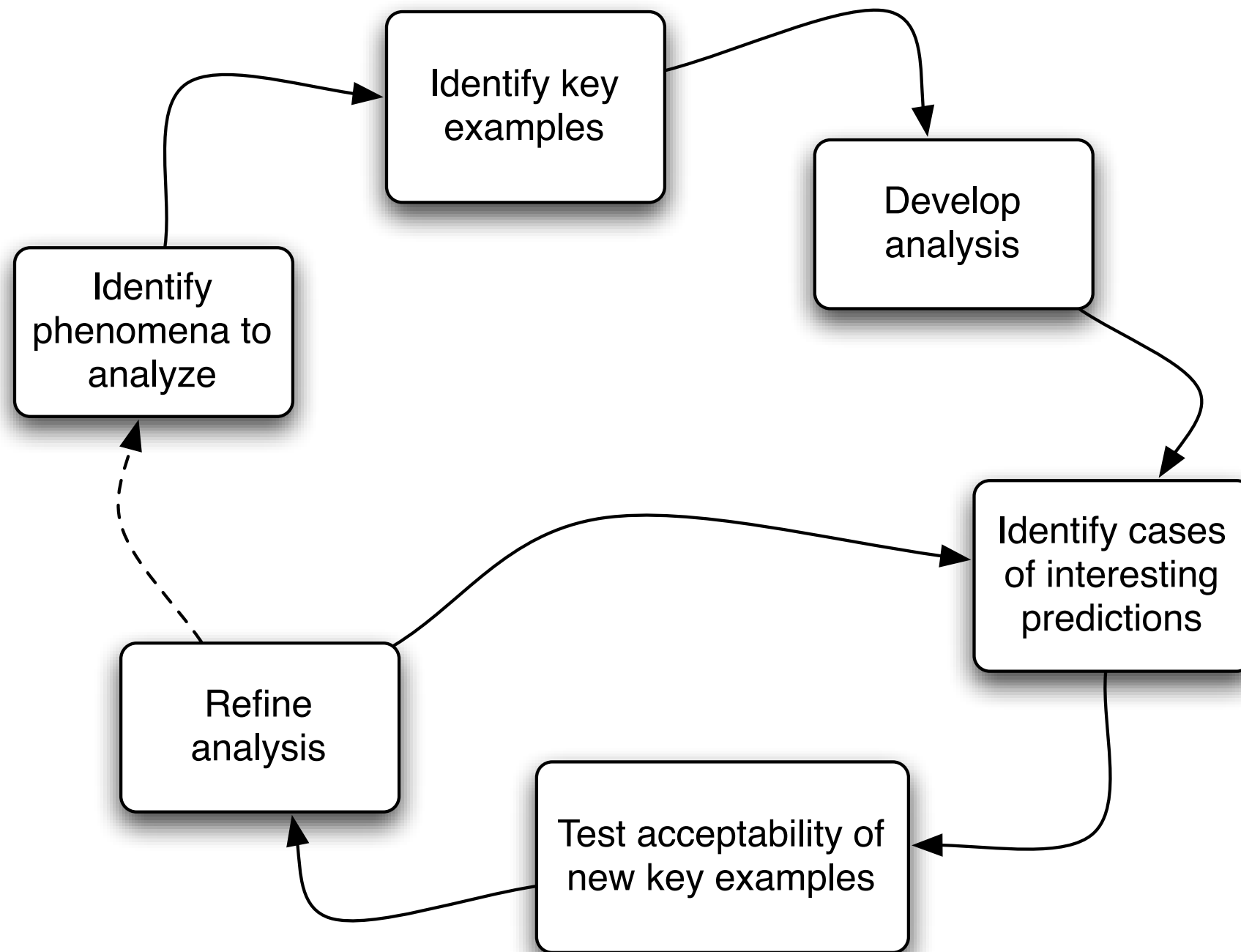
What is grammar engineering?

- 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.

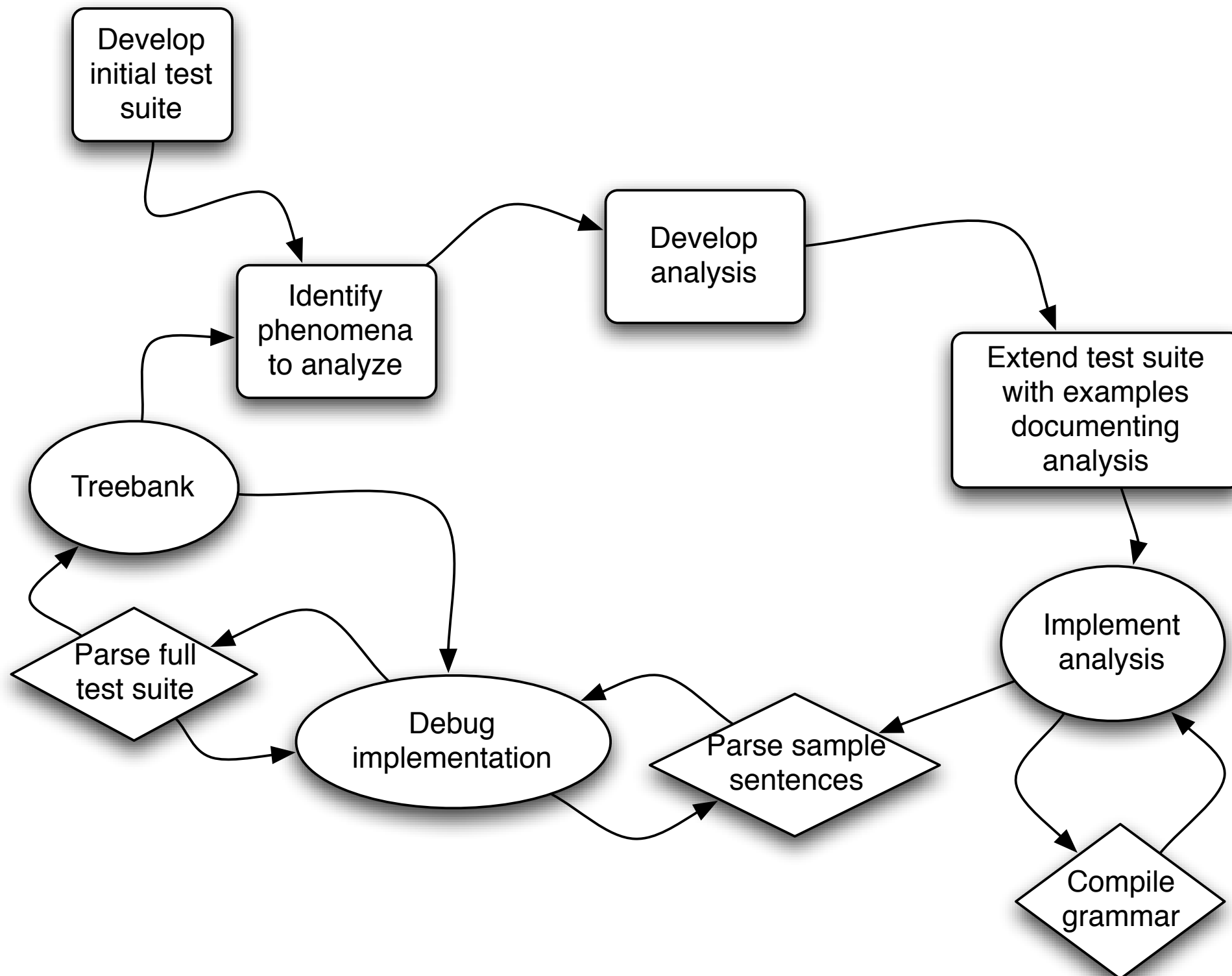
How is grammar engineering different from other approaches to syntax?

- 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
- Learn 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

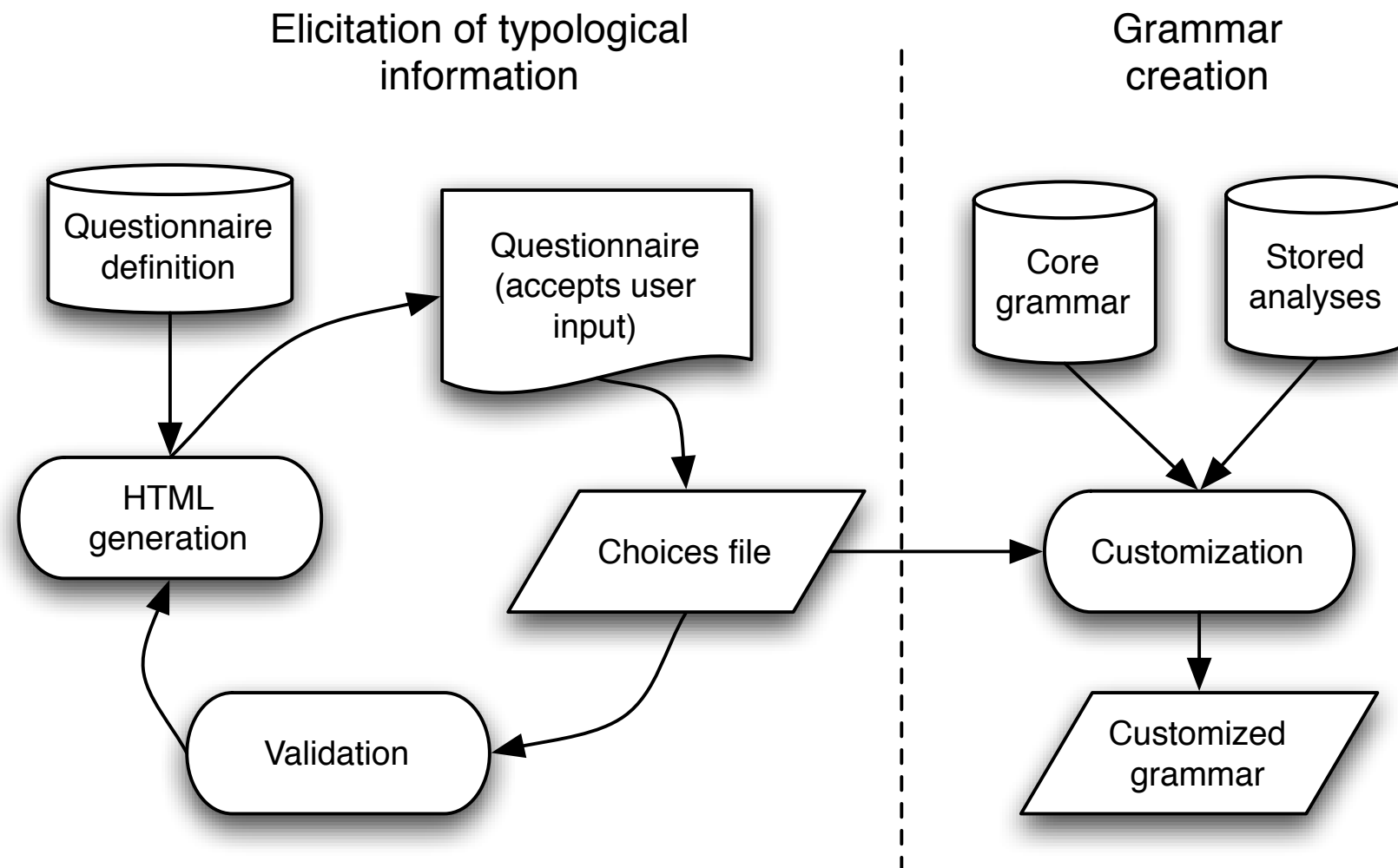
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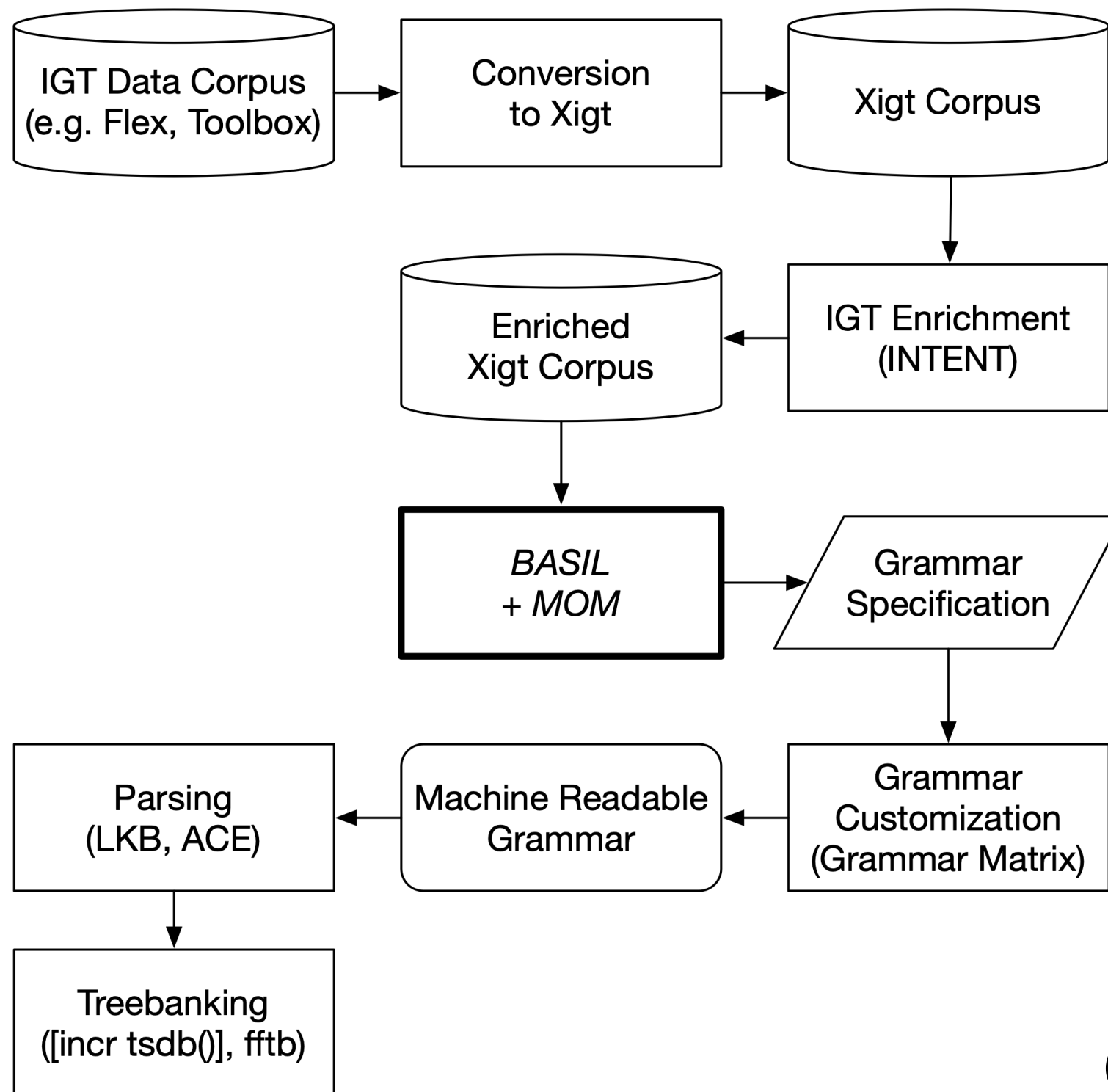
The LinGO Grammar Matrix

- 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

The Grammar Matrix and AGGREGATION



The Grammar Matrix and AGGREGATION



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 (Baldrige 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 (online) on (most) Wednesday and Thursdays
- 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 2-9 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
- Week 2: First run with grammar, initial testsuite construction and choices file refinement
- Week 3: Morphotactics clean up, testsuite extension
- Week 4: Customization clean up, testsuite extension
- Week 5: Customization clean up, first MT
- Week 6-8: MT & corpus driven grammar development (tdl editing)
- Week 9: Transfer rules

Surviving this course

- Communication is key: Please ask questions!
 - High-bandwidth communication with partner
 - Lots of questions to me
 - 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 (most W 2-3pm & Th 1-2pm)
- 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

- Priority:
 - Northern Alta [aqn]
 - Sawila [swt]
 - Thulung [tdh]
 - Yakkha [ybh]
 - Yauyos Quechua [qux]
 - P'urepecha [tsz] NB: resources in French & Spanish
- (Mbya [gun]: primary resources are in Portuguese)
- Also:
 - Hixkaryana [hix] NB: Main grammar is available as hard copy only
 - South Efate [erk]
 - Tsova-Tush [bbt]
 - Wahki [wbl]

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’q*
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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