Language Convergence Infrastructure

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Motivation

- Does Java source code relates correctly to the model?
- Is the class system serialisable to a standard schema?
- Do a code analyser and a compiler agree on a dialect?
- Which compiler compiler is better?
- Are language documentation claims true?
- Do two idiosyncratic grammars agree on a language?

Approach

- Grammar convergence idea:
  - extract grammars
  - compare grammars
  - transform grammars
- Grammar convergence methodology published as Software Languages Team work with Ralf Lämmel

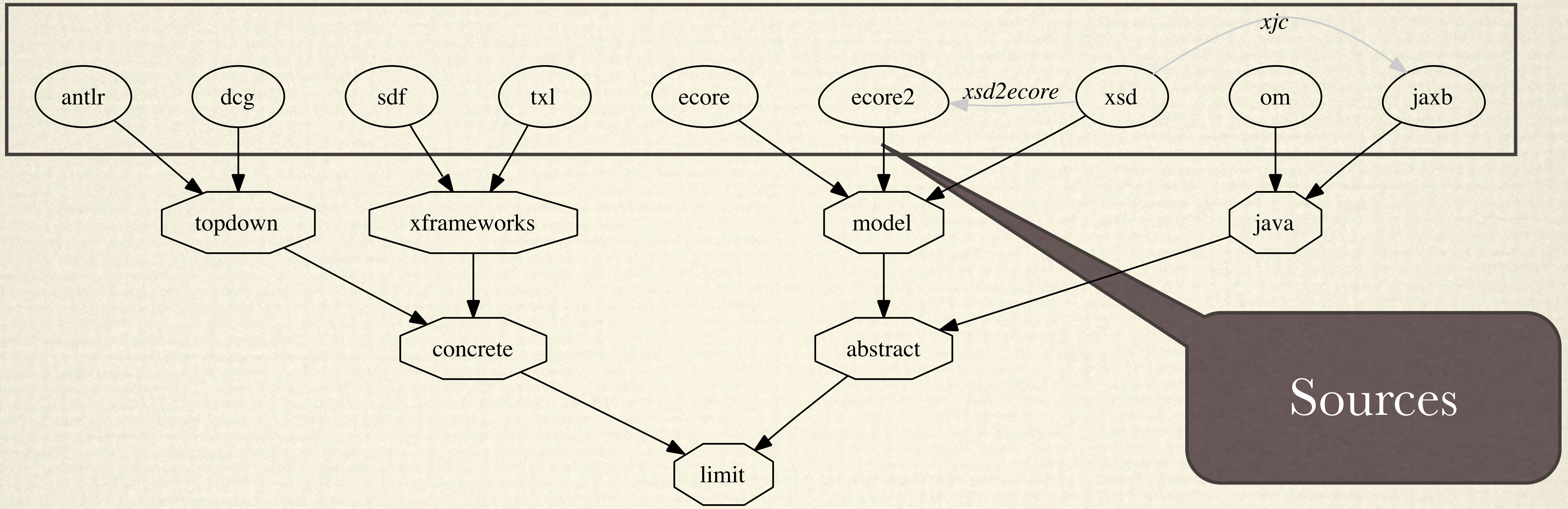
Technical side

- Software Language Processing Suite (SourceForge)
- Prolog
- Python
- Shell scripts
- XML Schema
- …

Core convergence tools

- Comparison
  - gdt left.bgf right.bgf
- Transformation
  - xbgf script.xbgf input.bgf output.bgf
- Validation
  - xmllint --noout --schema bgf.xsd input.bgf

Convergence sources



- Sources of grammar knowledge
-

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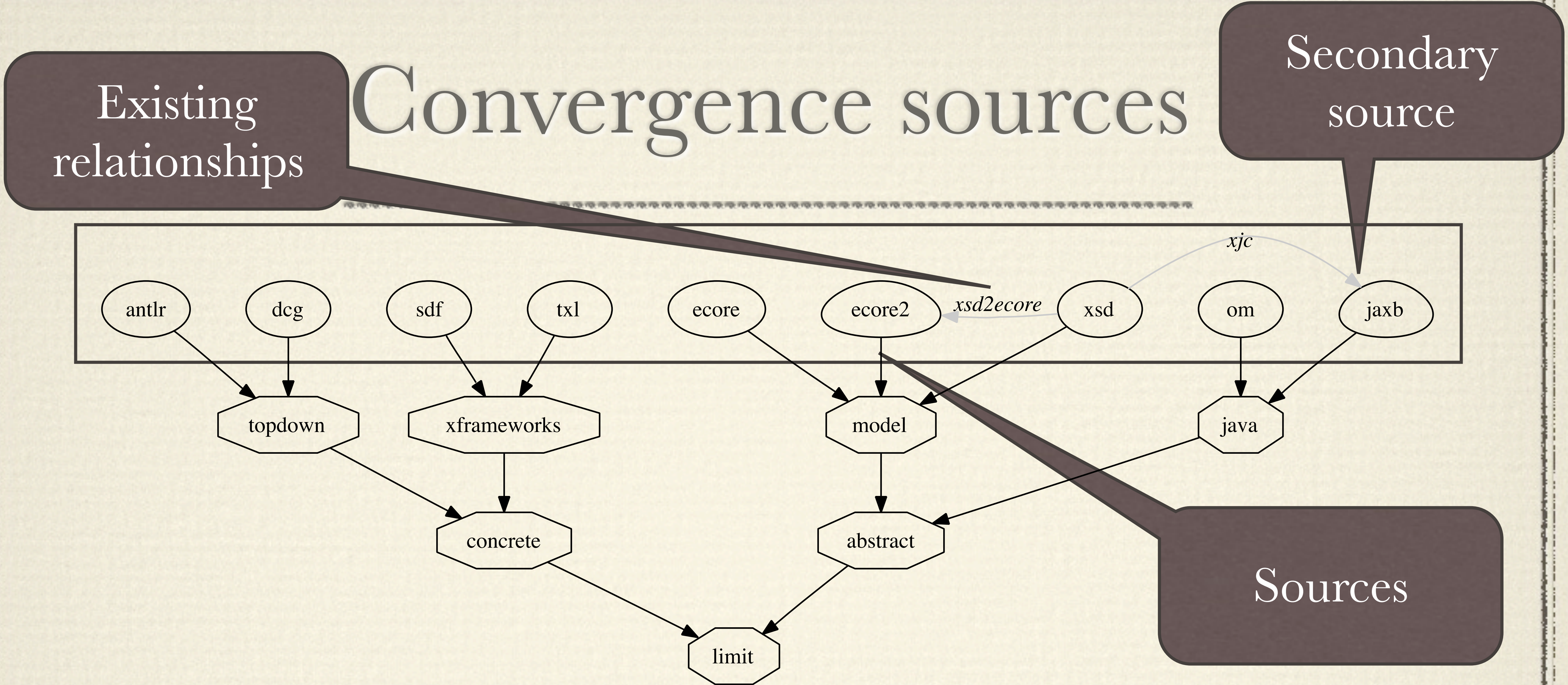

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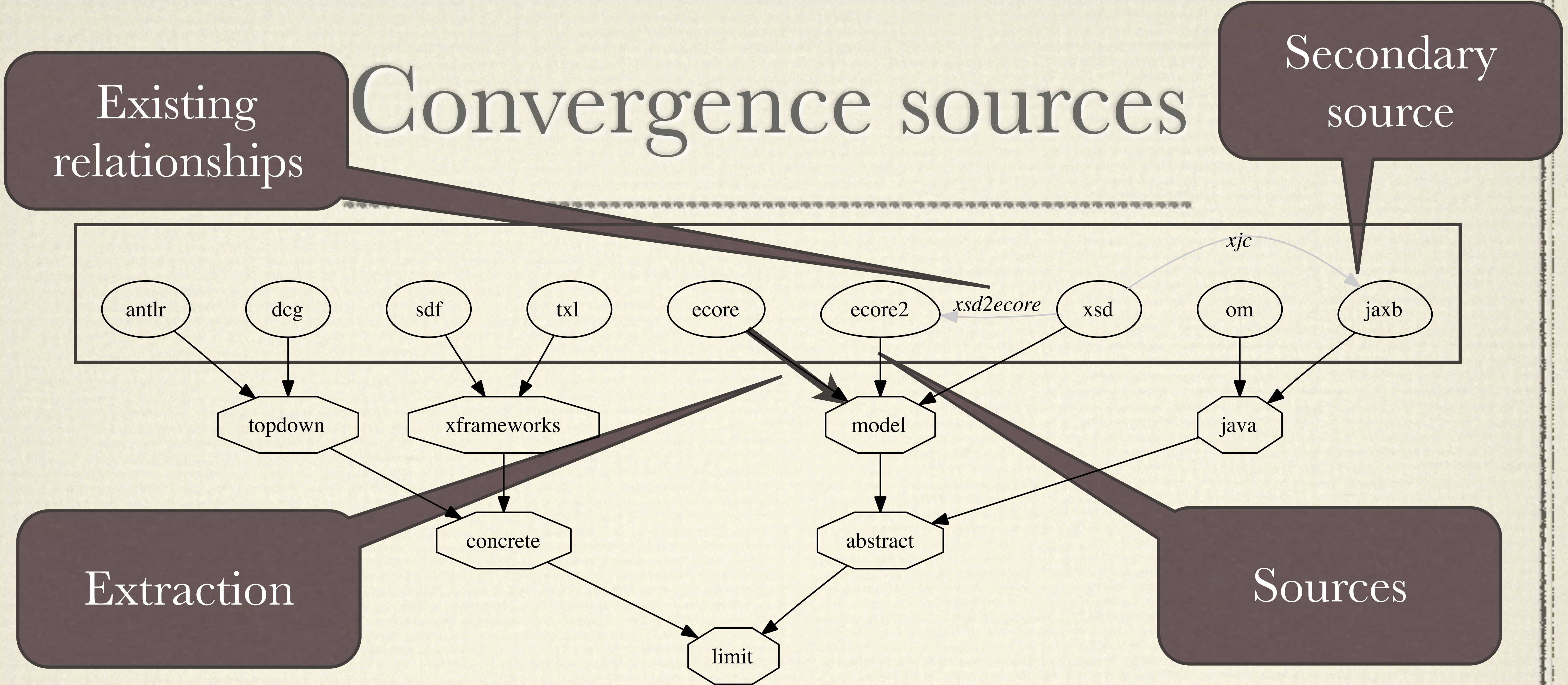

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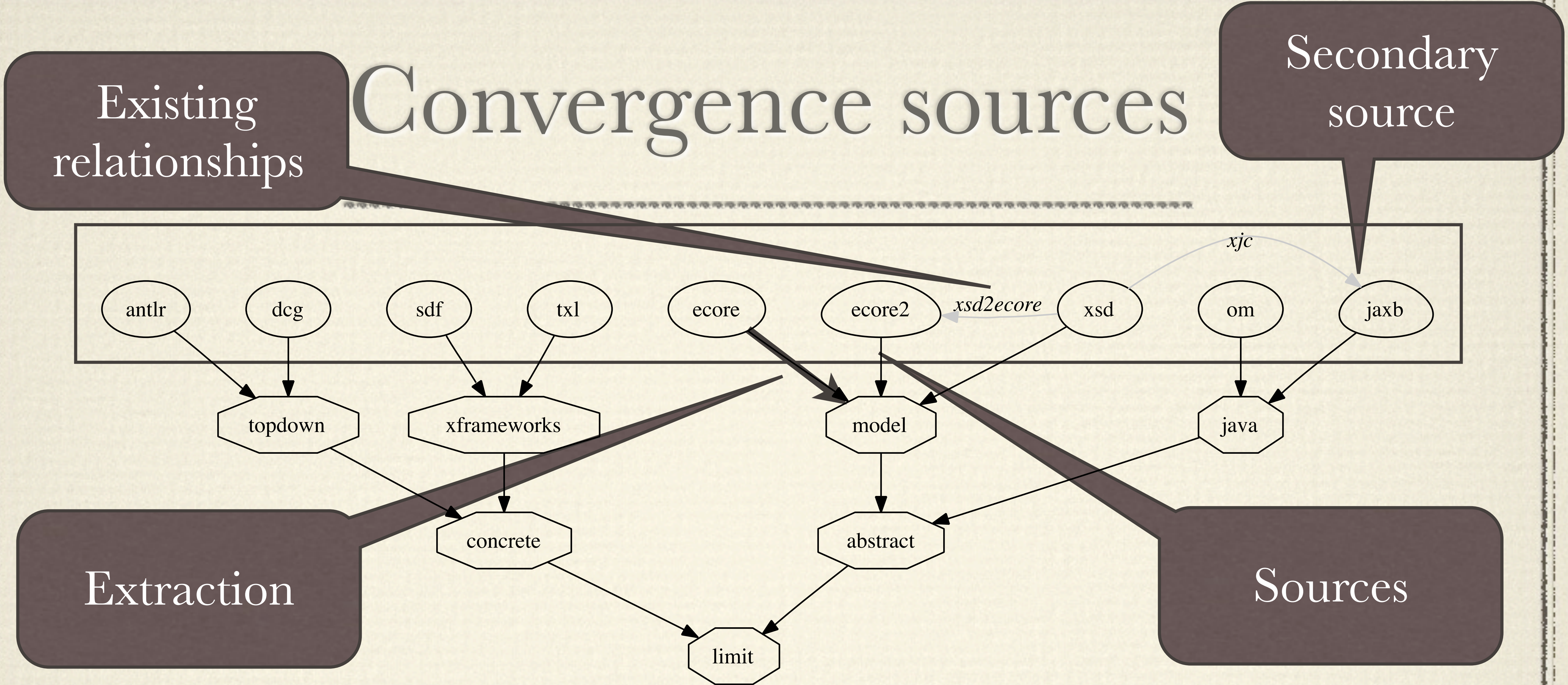
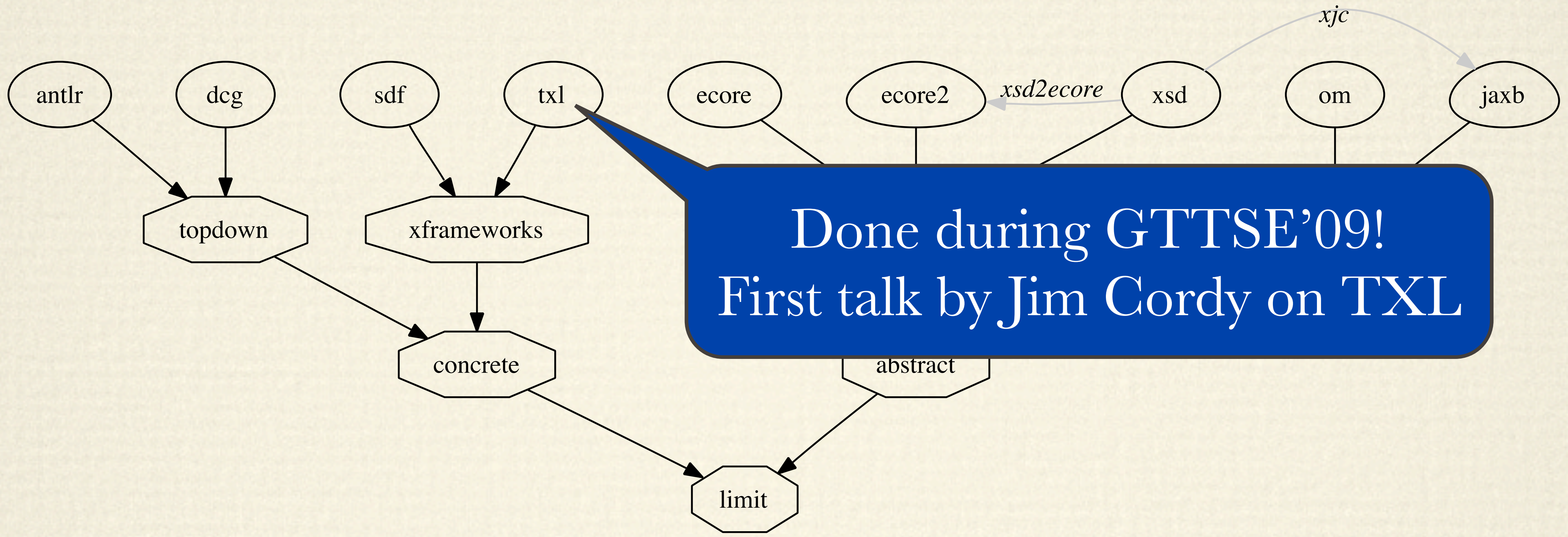
- Heterogeneous artifacts
- Grammar properties: extraction, parsing, evaluation
-

Convergence sources



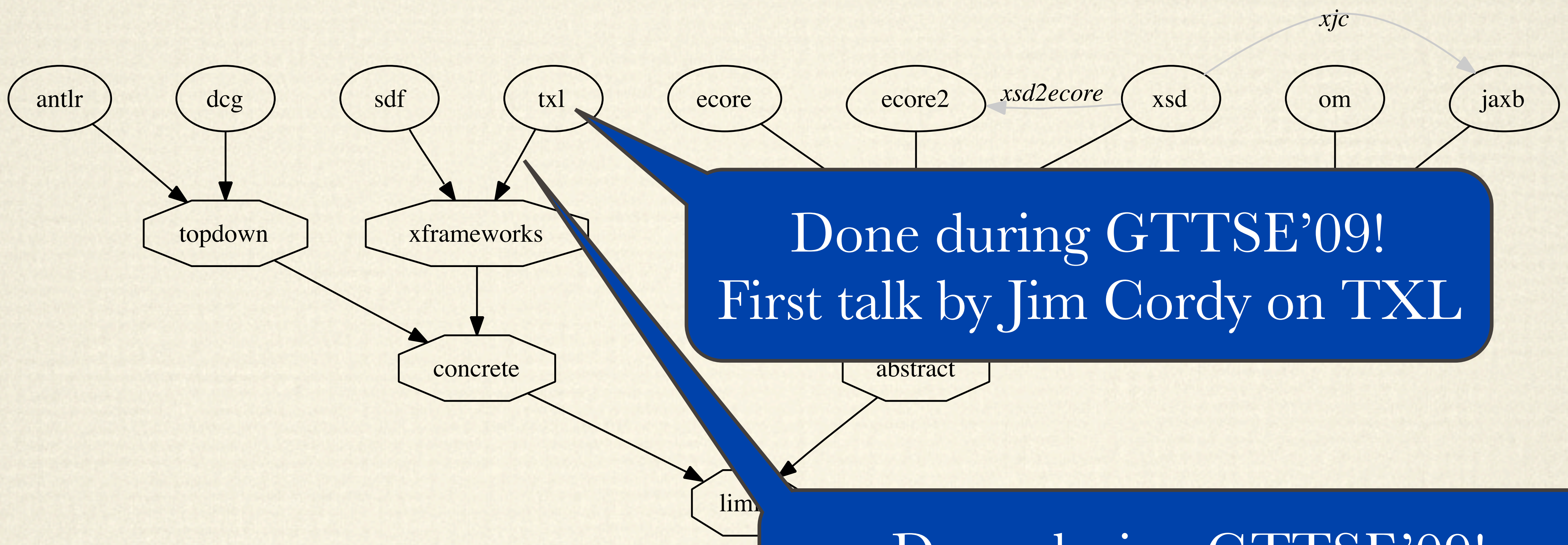
- Sources of grammar knowledge
- Heterogeneous artifacts
- Grammar properties: extraction, parsing, evaluation
- Instance properties; testing properties

Convergence sources



Done during GTTSE'09!
First talk by Jim Cordy on TXL

Convergence sources



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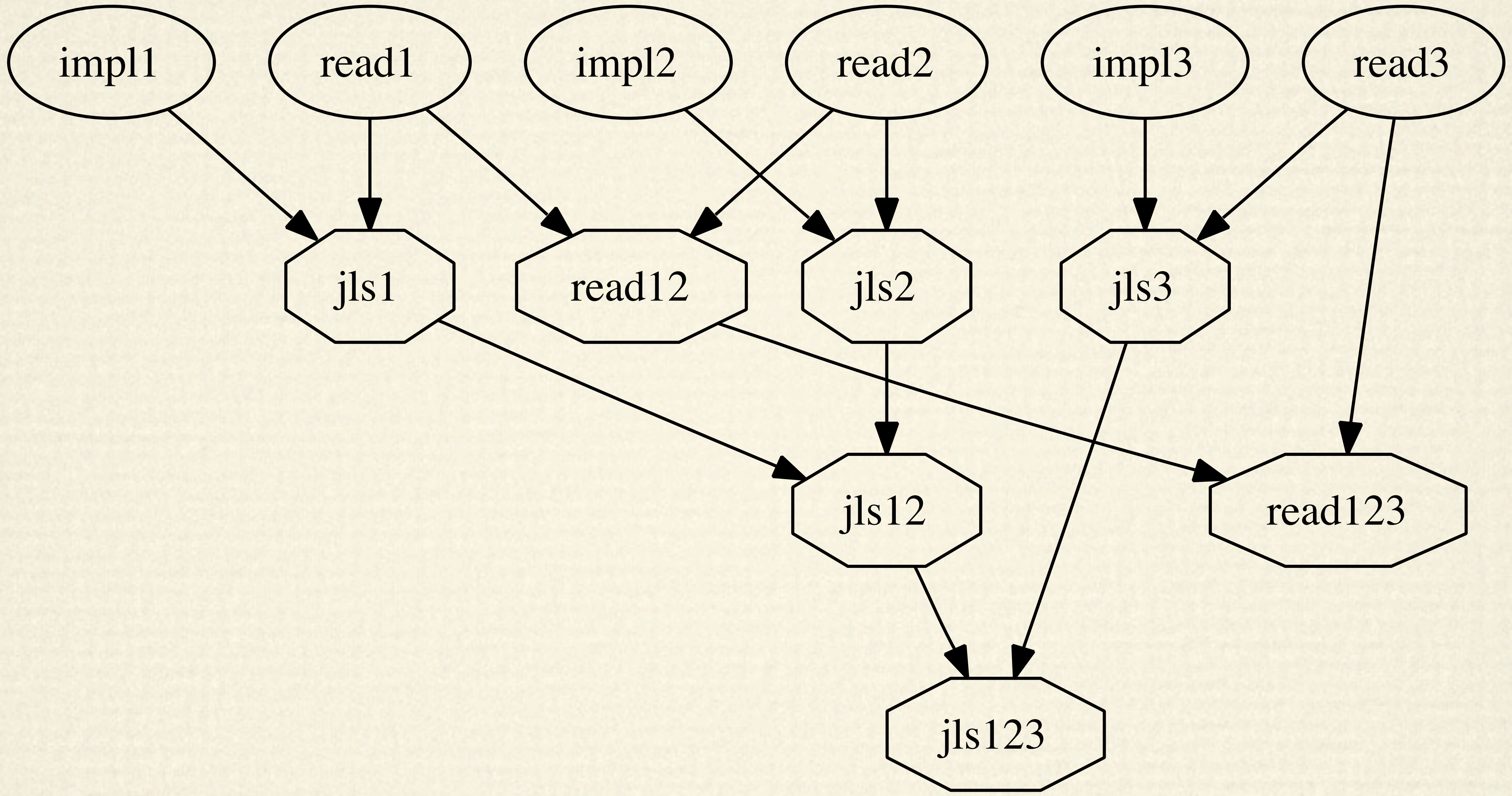
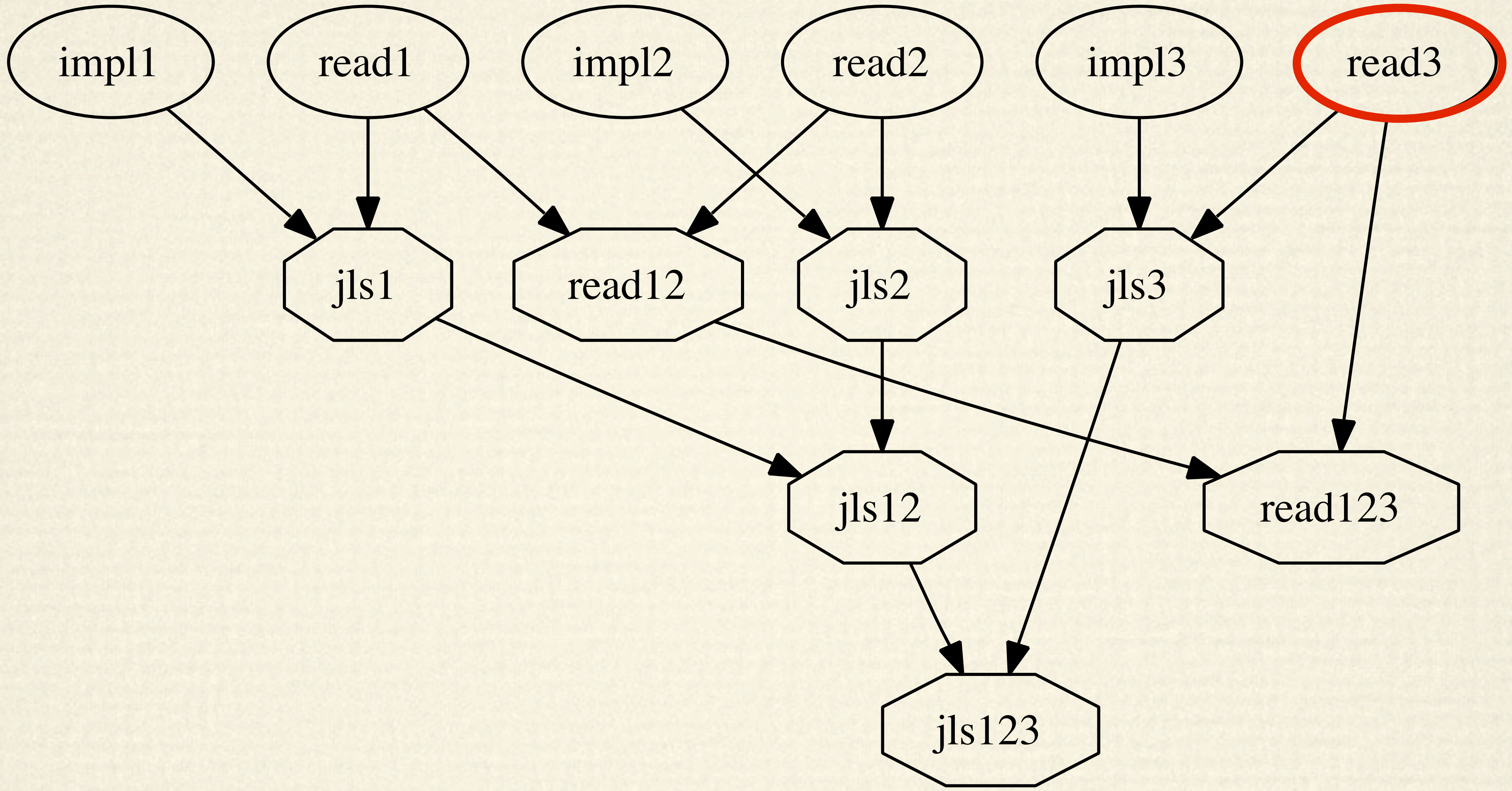
Convergence sources (2)



- Extraction happens once per source
-

Convergence sources (2)



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-

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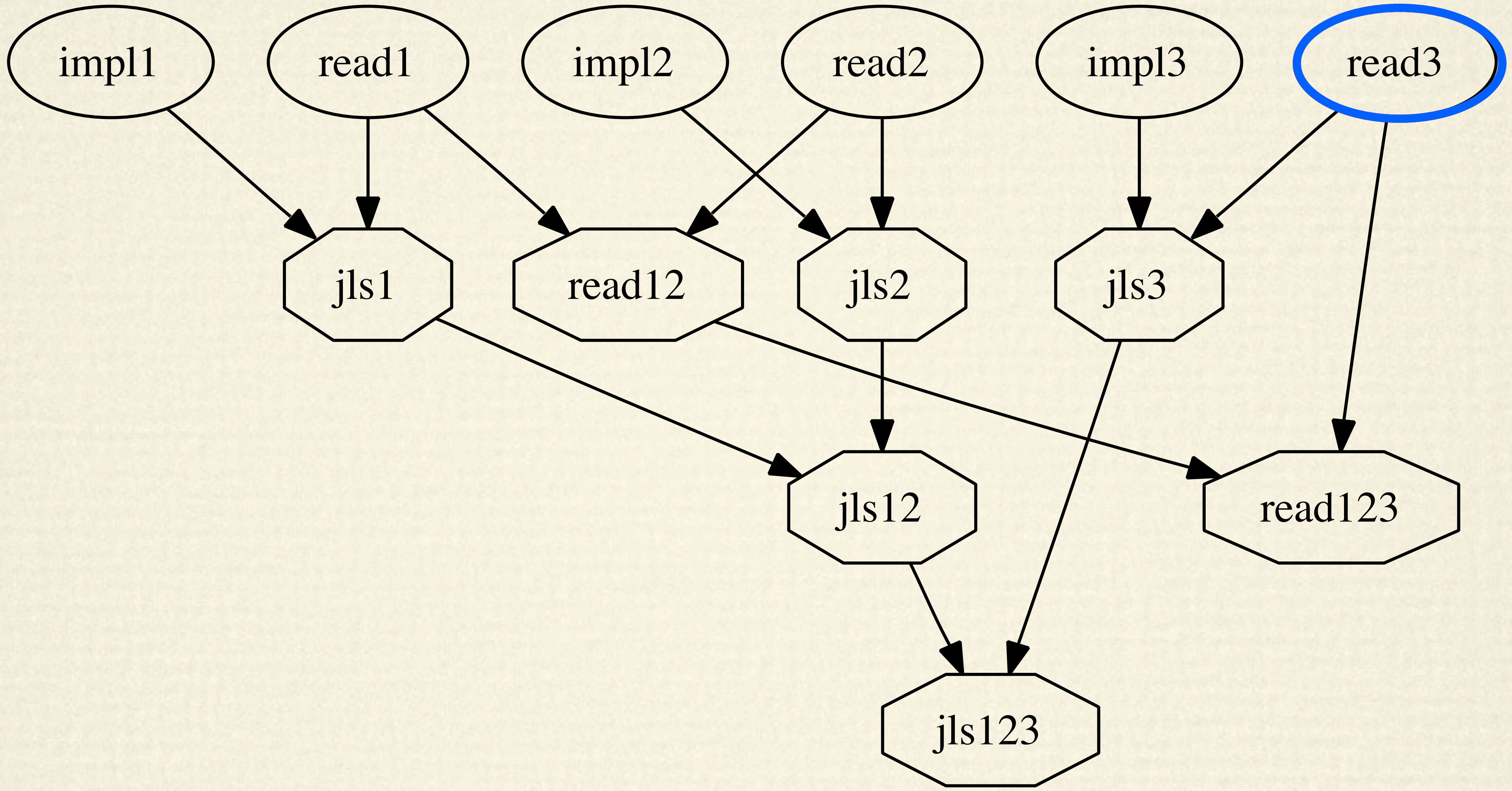


- Extraction happens once per source
- Failed extraction are marked on the diagram
- Snapshots and fallback

Grammar definition formalism

- BGF: BNF-like Grammar Format
- BNF: symbols, composition
- EBNF: *, +, ?
- Production labels and expression selectors
- …
- XML

A word on extractors

- Source format → unified format
- Abstraction from idiosyncrasies
- Can be intricate
- Specific for the source type, not the source

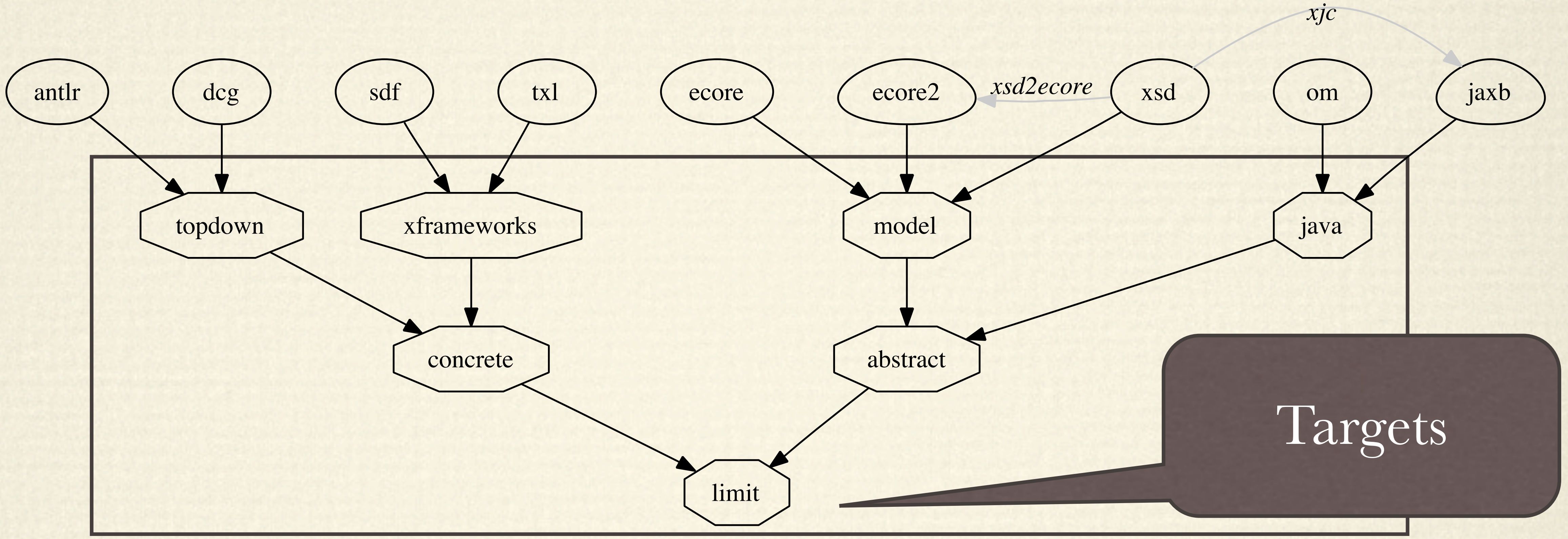
Nontrivial extraction in numbers

	app1	**app2**	**app3**	**doc1**	**doc2**	**doc3**	**Total**
Arbitrary lexical decisions	2	109	60	1	90	161	423
Well-formedness violations	5	0	7	4	11	4	31
Indentation violations	1	2	7	1	4	8	23
Recovery rules	3	12	18	2	59	47	141
◦ Match parentheses	0	3	6	0	0	0	9
◦ Metasymbol to terminal	0	1	7	0	27	7	42
◦ Merge adjacent symbols	1	0	0	1	1	0	3
◦ Split compound symbol	0	1	1	0	3	8	13
◦ Nonterminal to terminal	0	7	3	0	8	11	29
◦ Terminal to nonterminal	1	0	1	1	17	13	33
◦ Recover optionality	1	0	0	0	3	8	12
Purge duplicate definitions	0	0	0	16	17	18	51
Total	11	123	92	24	181	238	669

Available extractors

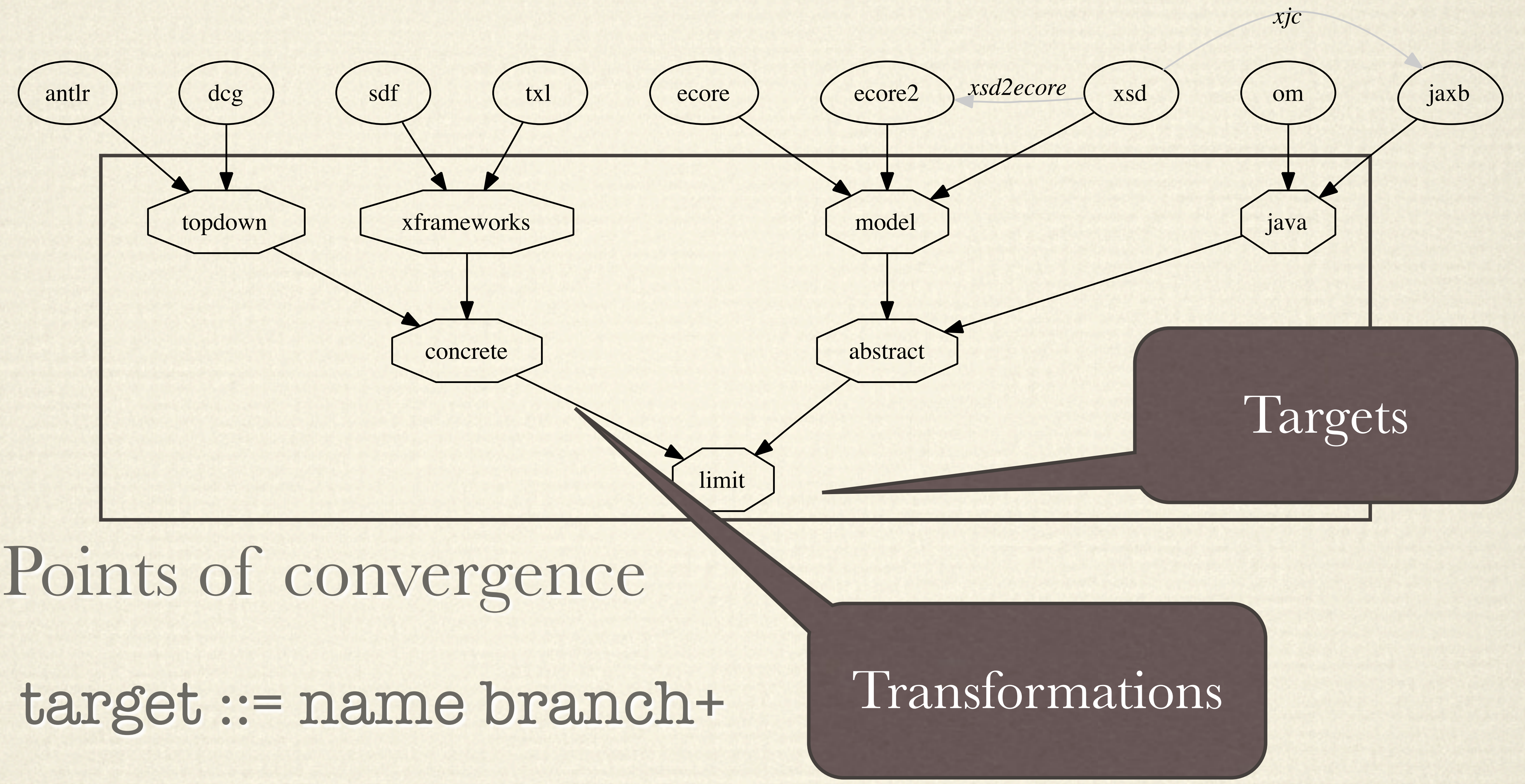
- ✓ ANTLR parser definitions
  - ➡ ANTLR self-application
- ✓ Syntax Defnition Formalism
  - ➡ ASF+SDF MetaEnvironment or Stratego/XT
- ✓ Definite clause grammars in Prolog
  - ➡ Prolog
- ✓ Java object models
  - ➡ reflection with `java.lang.reflect` or `com.sun.source.tree`
- ✓ ECore models in XMI
  - ➡ XSLT
- ✓ XML Schema schemata
- ✓ Language specifications

Convergence targets



- Points of convergence
- target ::= name branch+
- branch ::= input phase*
- Use comparison tool at the end

Convergence targets



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Grammar trasformation

- Initial corrections
- Nominal matching
- Structured matching by refactoring
- Relaxation/restriction
- Extension
- Correction

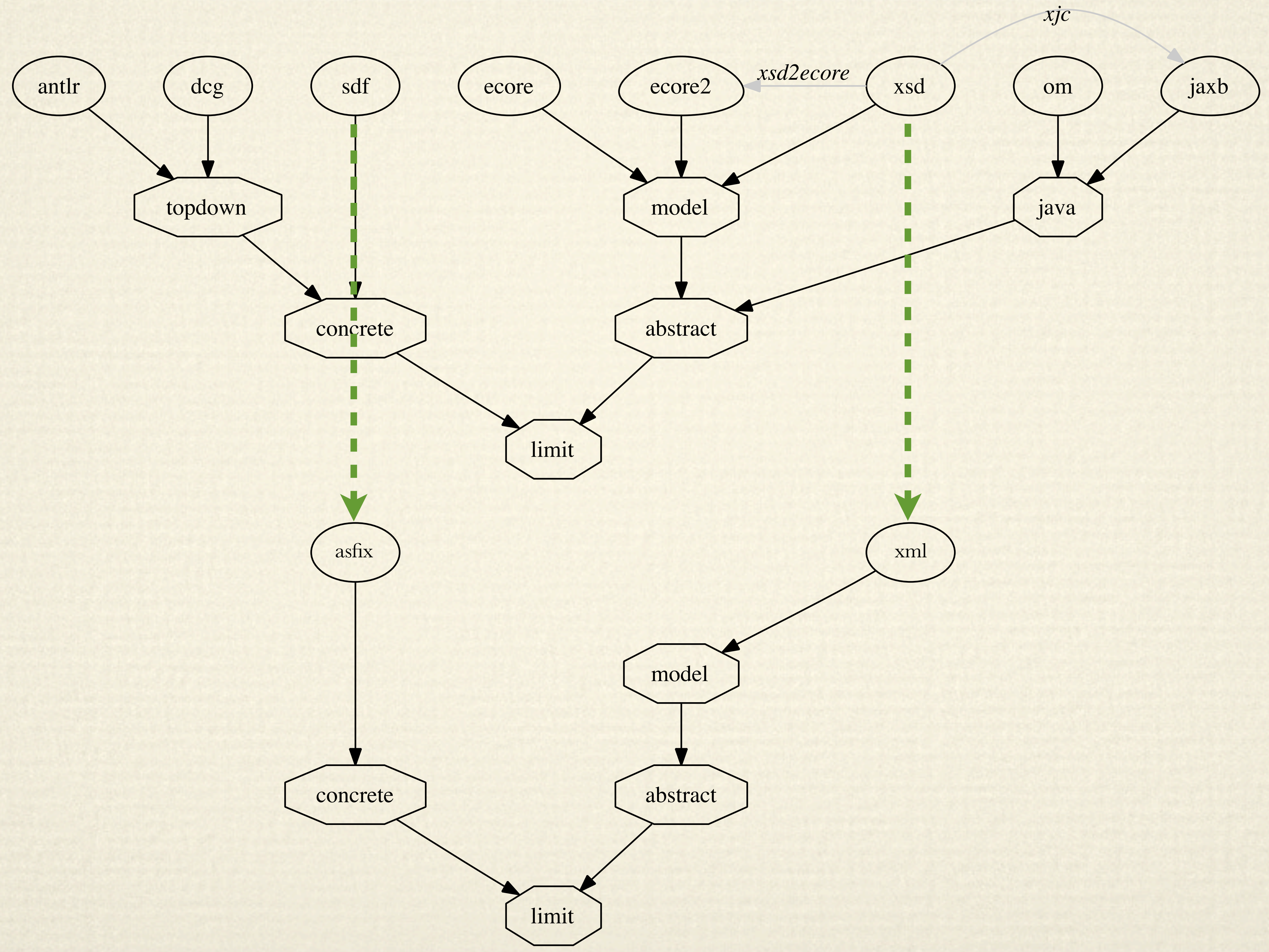
Grammar transformation (2)

- Static XBGF script
  - can be reused
- Transformation generator
  - strip away all terminal symbols
  - eliminate unused nonterminal symbols
  - apply naming convention

Transformation statistics for JLS

	jls1	**jls12**	**jls123**	**jls2**	**jls3**	**read12**	**read123**	**Total**
Number of lines	682	5116	2847	6772	10715	1639	3082	30853
Number of transformations	67	298	111	395	544	77	135	1627
◦ Semantics-preserving	45	239	80	283	381	31	78	1137
◦ Semantics-increasing or -decreasing	22	58	31	102	150	39	53	455
◦ Semantics-revising	—	1	—	10	13	7	4	35
Preparation phase	1	—	—	15	24	11	14	65
◦ Known bugs (Ex. 3.7)	—	—	—	1	11	—	4	16
◦ Post-extraction (Ex. 3.8)	—	—	—	7	8	7	5	27
◦ Initial correction (Ex. 3.9)	1	—	—	7	5	4	5	22
Resolution phase	21	59	31	97	139	35	43	425
◦ Extension (Ex. 3.4)	—	17	26	—	—	31	38	112
◦ Relaxation (Ex. 3.5)	18	39	5	75	112	—	2	251
◦ Correction (Ex. 3.6)	3	3	—	22	27	4	3	62

Coupled transformations



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  - a (sliced) (formal) grammar
  - textual annotations for human understanding
  - source code samples
- Language evolution vs
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Extract

Test

Language documentation

Converge!

Extract

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Test

The end.

- More questions?
- Suggestions?
- Related work advice?

Discussion topics

- Transformation scripts reengineering and maintenance (XXBGF?)
- Transformation generators — what input?
- Extended comparison results (advice)
- Defining metrics and benchmarking
- Extending the infrastructure for documentation
- Formal algebraic proof for operator semantics