Comparing *Bottom-up* with *Top-down* Parsing Architectures for the **S**yntax **D**efinition **F**ormalism from a Disambiguation Standpoint

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The Syntax Definition Formalism

NOT a complete picture!

1966 Eelco Visser 👶

1977 Jurgen Vinju 👶

1982 Summer

Paul Klint

1984 **SDF**

Jan Heering
Paul Klint

Pregmatic

1992 Incremental SDF

Jan Rekers

2001 Stratego

1998 ToolBus

1997 Scannerless

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2015 Data-dependent GLL

Anastastasia Izmaylova
Ali Afroozeh

Trevor Jim
Yitzha k Mandelbaum
David Walker

scope of this paper

definite clause grammars

Earley’s Algorithm

Tomita’s GLR

Rekers & Farshi’s GLR

ASF+SDF

Stratego XT, Spoofax

Rascal

Izmaylova & Afroozeh’s DD-GLL

Scott & Johnstone’s GLL

Economopoulus’ SRNGLR

Vissers’ Scannerless GLR

Ambiguity in context-free grammars

- context-free general parsing allows non-determinism and ambiguity
- this **enables** modular and extensible syntax definition
- including unpredicted compositions of lexical syntax (“scannerless”)
- but.. **ambiguity** seems to be the “communicating vessel” of modularity
- hence: **declarative disambiguations** and their challenging *implementation*

{ A* b; }

IF IF
ELSE

```
if x == a:
␣␣␣␣print (“not offside”)
```

IF IF=FI THEN
THEN=FI FI

leta = b

Duality of Parsing & Disambiguation

- **Parsing** algorithms create parse trees
- **Disambiguation** algorithms remove parse trees
- **Parsing** is defined by context-free grammars
- **Disambiguation** is defined by disambiguation constructs

```
Stat = “if” Exp “then” Stat “else” Stat
     | “while” Exp Stat
```

In theory disambiguation is orthogonal to/ compositional with parsing!

```
left Exp “*” Exp > left Exp “+” Exp
```

associativity & priority

```
Exp = Id | “if” {reject}
```

keyword reservation

```
Id -/- [a-z]        Id = [a-z]+ !>> [a-z]
```

longest match / maximal munch / shift over reduce

Parsing⊥Disambiguation Architectures

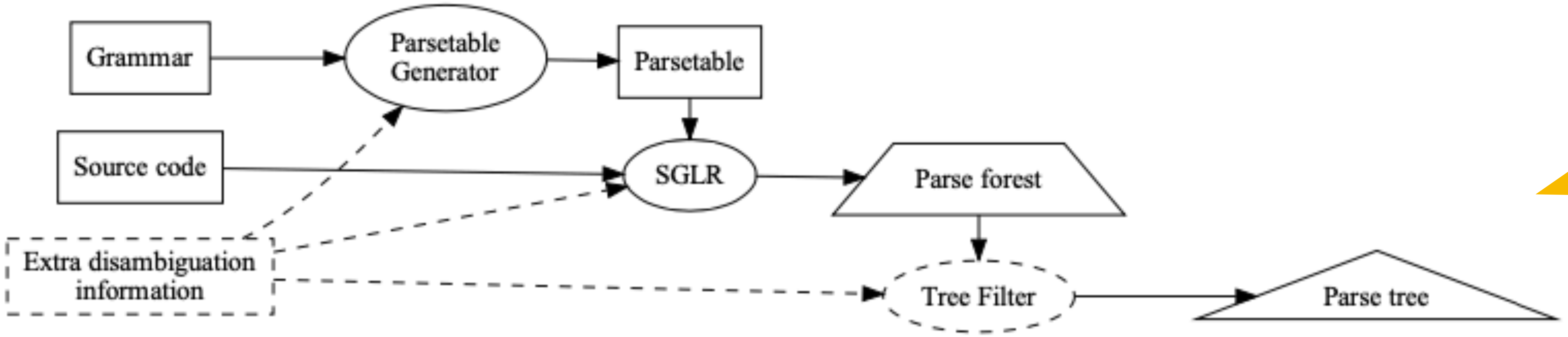


Figure 4 Bottom-up SDF2 architecture based on SGLR

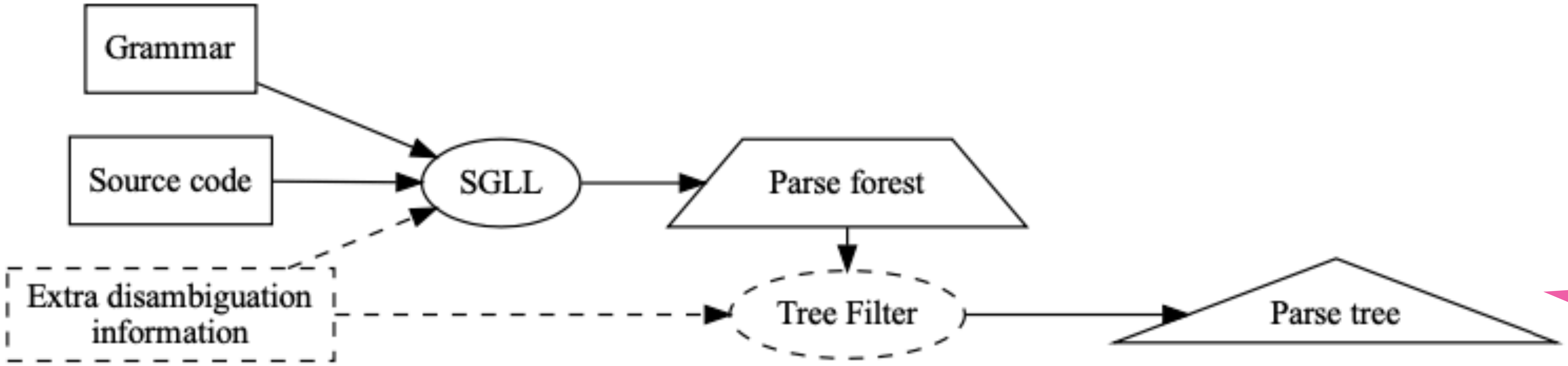


Figure 5 Top-down Rascal architecture based on SGLL

In practice disambiguation is scattered and tangled!

parse tables are partially evaluated grammars

parse functions are “grammars as code”

Bottom-up disambiguation = partially evaluated grammars + ad-hoc disambiguation filters

- priorities/associativity became **reduction filters** in the **modified** SLR table
- reject rules became additional synchronization of **reductions** per “level”
- follow restrictions became both **goto sets filters** plus reduction filters
- **disambiguation code easily breaks parsing algorithm correctness**
- Every disambiguation filter requires **a new theory**: is the new algorithm correct? are the old data structures still sufficient? do generated parsers still compose? etc.

Top-down disambiguation = parsing functions plus prediction & completion predicates

- Every disambiguation construct is a predicate kind over state of the parser
- Parsing functions can **transparently** fail for more reasons than grammar+input
- The concept of disambiguation code can be **generalized and encapsulated**
- New disambiguation constructs do **not require new implementation theory**
- Data structures must be protected for non-context-freeness like GLR.

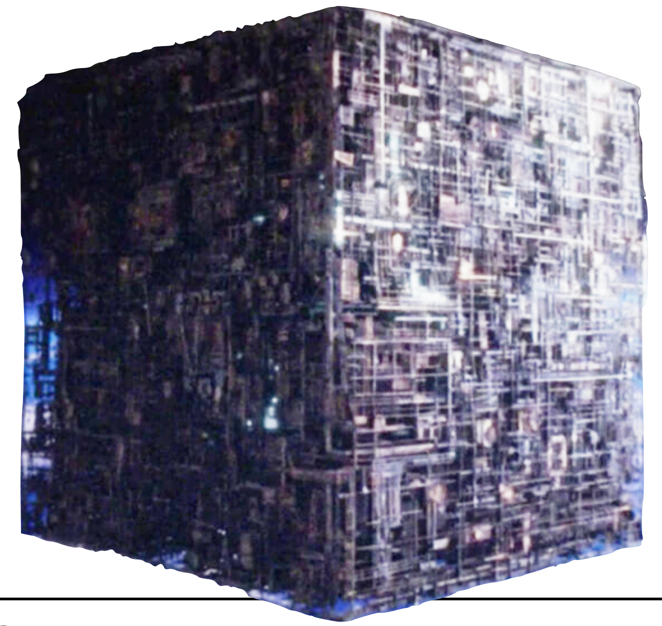
One more step: a general theory of disambiguation

- Generalized prediction/completion filters with GLL:
  - **Implementation** theory for disambiguations.
  - Preferable from an understandability viewpoint
  - just as fast or faster than SGLR
- What is a generalized theory of disambiguation on the grammar level?
  - data-dependent context-free grammars [Jim, Mandelbaum, Walker]
  - grammar rules + data parameters + **predicates**
  - “Iguana” is a top-down data-dependent GLL [Izmaylova, Afroozeh]
  - DD-CFG’s lift filtering predicates from the implementation to the specification level
- From *orthogonal* ad-hoc specification to *integrated* generalized disambiguation

orthogonality brought us **understanding**, now integration is bringing us **generality**.

disambiguation != grammar transformation

context-sensitive grammars != data-dependent grammars



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