Automatic Generation of Efficient Compilers

using a complete tool box containing:

Rex	scanner generator
Lalr	LALR(1) parser generator
Ell	LL(1) parser generator
Ast	generator for abstract syntax trees
Ag	attribute evaluator generator (OAG)
Estra	transformation of attributed syntax trees
Beg	back end generator
Reuse	library of reusable modules

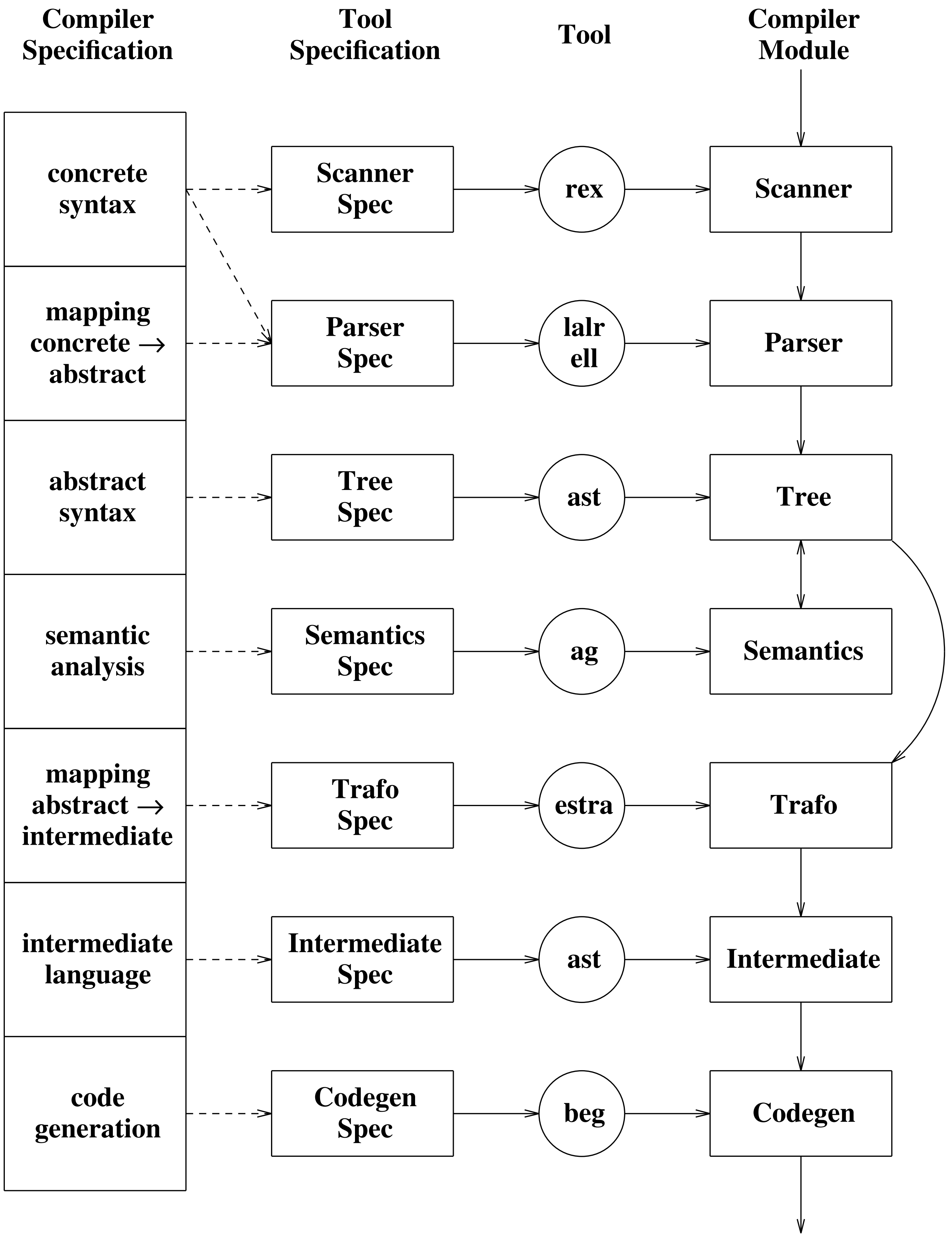
advantages:

- specification replaces implementation
- tools reduce construction effort
- consistency checks avoid errors
- program generation increases reliability
- efficiency comparable to hand-written implementations

common properties:

- implementation languages are Modula-2 or C
- target languages are Modula-2 or C

Compiler Generation



Rex

a scanner generator

- specifications are based on regular expressions
- actions are composed of target language statements
- right context is handled by an additional regular expression
- left context is handled by start states
- conflicts are resolved in favour of longest match and first rule given
- provides line and column of every token
- can normalize tokens to lower or upper case letters
- knows predefined rules to skip white space
- can handle include files
- generates table-driven scanners
- generates efficient scanners
- generates scanners in Modula-2 or C
- scanners process up to 180,000 lines/minute (on MC 68020)
- scanners are 4 times faster than those of LEX

Lalr

a parser generator

- processes LALR(1) grammars
- actions are composed of target language statements
- allows to evaluate an S-Attribution during parsing
- reports grammar conflicts by easy to understand derivation trees
- resolves grammar conflicts with precedence and associativity
- generates automatic error reporting, recovery, and repair
- generates table-driven parsers
- generates efficient parsers
- generates parsers in Modula-2 or C
- parsers process up to 35,000 tokens/sec. or 580,000 lines/min. (on MC 68020)
- parsers are 3 times faster than those of YACC

Ell

a parser generator

- processes LL(1) grammars in extended BNF

- actions are composed of target language statements

- allows to evaluate an L-Attribution during parsing

- generates automatic error reporting, recovery, and repair

- generates recursive descent parsers

- generates efficient parsers

- generates parsers in Modula-2 or C

- parsers process up to 55,000 tokens/sec. or 900,000 lines/min. (on MC 68020)

Ast

a generator for abstract syntax trees

- generates abstract data types (program modules) to handle trees
- the trees may be attributed
- besides trees graphs are handled as well
- nodes may be associated with arbitrary many attributes of arbitrary type
- specifications are based on extended context-free grammars
- common notation for concrete and abstract syntax
- as well as for attributed trees and graphs
- an extension mechanism provides single inheritance
- trees are stored as linked records
- generates efficient program modules
- generates modules in Modula-2 or C
- provides many tree operations (procedures):
- node constructors combine aggregate notation and storage management
- ascii graph reader and writer
- binary graph reader and writer
- reversal of lists
- top down and bottom up traversal
- interactive graph browser

Ag

an attribute evaluator generator

- processes ordered attribute grammars (OAGs)
- processes higher order attribute grammars (HAGs)
- operates on abstract syntax
- is based on tree modules generated by Ast
- the tree structure is fully known
- terminals and nonterminals may have arbitrary many attributes
- attributes can have any target language type
- allows tree-valued attributes
- differentiates input and output attributes
- allows attributes local to rules
- allows to eliminate chain rules
- offers an extension mechanism (single inheritance)
- attributes are denoted by unique selector names
  instead of nonterminal names with subscripts

Ag

an attribute evaluator generator (continued)

- attribute computations are expressed in the target language
- attribute computations are written in a functional style
- attribute computations can call external functions
- non-functional statements and side-effects are possible
- allows to write compact, modular, and readable specifications
- AGs can consist of several modules
- the context-free grammar is specified only once
- checks an AG for completeness of the attribute computations
- checks for unused attributes
- checks an AG for the classes SNC, DNC, OAG, LAG, and SAG
- the evaluators are directly coded using recursive procedures
- generates efficient evaluators
- generates evaluators in Modula-2 (or C)

Estra

a generator for transformations of attributed syntax trees

- is based on tree modules generated by Ast

- specifications are rule based

- a rule consists of a pattern and an action

- actions are composed of target language statements

- patterns describe tree fragments

- several transformations can be specified

- subtrees can be transformed in any order

- subtrees can be transformed several times

- subtrees can be transformed by several transformations

- inherited and synthesized attributes can be evaluated

- ambiguities are resolved using costs

- application of rules can be restricted by conditions

- pattern-matching by directly coded dynamic programming algorithm

- or by table-driven tree pattern-matcher

- generates efficient transformation modules

- generates transformation modules in Modula-2