Syntax Analysis

Amitabha Sanyal

(www.cse.iitb.ac.in/˜as)

Department of Computer Science and Engineering,

Indian Institute of Technology, Bombay

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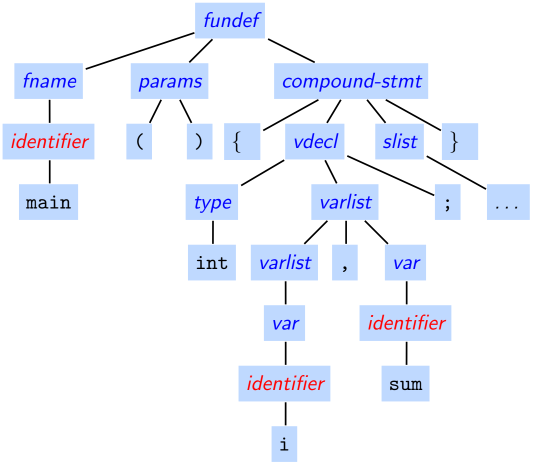
Syntax analysis – example

Syntax analysis discovers the larger structures in a program.



```
main ()
{
  int i,sum;
  sum = 0;
  for (i=1; i<=10; i++)
    sum = sum + i;
  printf("%d\n",sum);
}
```

Parsing

A syntax analyzer or parser

- Ensures that the input program is well-formed by attempting to group tokens according to certain rules. This is syntax checking.

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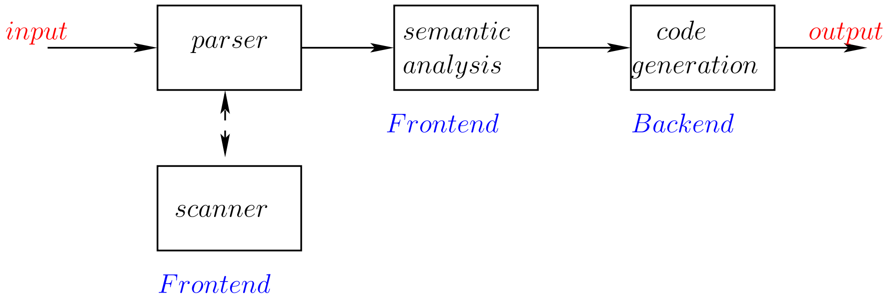
-
  - May also create the hierarchical structure that arises out of such grouping.
  - The tree like representation of the structure is called a *parse tree*.
  - This information is required by subsequent phases.

Place of a parser in a compiler organization

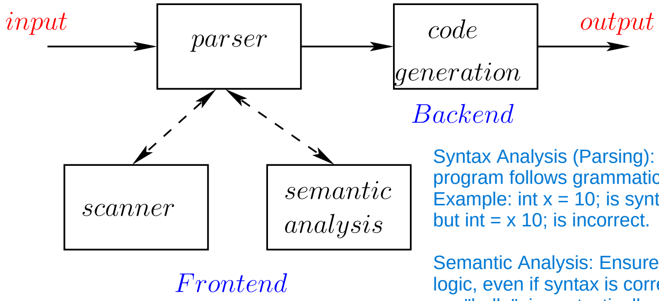
Where is the place of the parser in the overall organization of the compiler?

1. Parser driven syntax tree creation. The parser creates the entire syntax tree and passes control to the later stages.



Place of a parser in a compiler organization

2. Parser driven front-end. The parser also does the semantic analysis along with parsing.



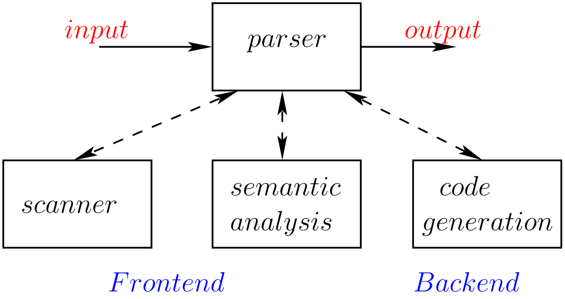
Syntax Analysis (Parsing): Checks if the program follows grammatical rules. Example: int x = 10; is syntactically correct, but int = x 10; is incorrect.

Semantic Analysis: Ensures meaningful logic, even if syntax is correct. Example: int x = "hello"; is syntactically valid but semantically incorrect (type mismatch).

Difference: Syntax is about structure; semantics is about meaning.

Place of a parser in a compiler organization

3. Parser driven compilation. The entire compilation is interleaved along with parsing.



Parser Construction

How are parsers constructed ?

- Till early seventies, parsers (in fact the entire compiler) were written manually.
- A better understanding of parsing algorithms has resulted in tools that can automatically generate parsers.
- Examples of parser generating tools:
  - Yacc/Bison: Bottom-up (LALR) parser generator
  - Antlr: Top-down (LL) scanner cum parser generator. (Terence Parr)
  - PCCTS:Precursor of Antlr (Terence Parr)
  - COCO/R: Lexer and Parser Generators in various languages, generates recursive descent parsers (Hanspeter Mossenbock).
  - Java Compiler Compiler (JavaCC)
  - . . .

LALR: Look-Ahead Left-to-Right, Rightmost Derivation (in a reduced form)
LL: Left-to-Right, Leftmost Derivation

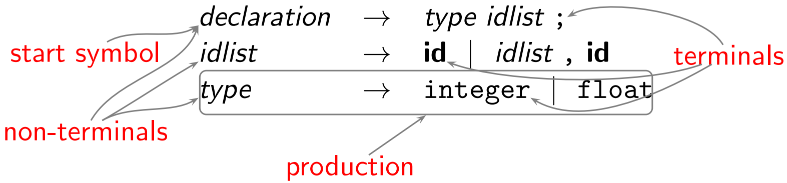
Specification of syntax

- To check whether a program is well-formed requires a specification of what is a well-formed program:

  1. The specification should be unambiguous.
  2. The specification should be correct and complete. Must cover all the syntactic details of the language
  3. the specification must be convenient to use by both language designer and the implementer

A *context free grammar* meets these requirements.

Context Free Grammar (CFG)



$$\begin{array}{lcl} \textit{declaration} & \rightarrow & \textit{type idlist} \; ; \\ \textit{idlist} & \rightarrow & \textbf{id} \mid \textit{idlist} \; , \; \textbf{id} \\ \textit{type} & \rightarrow & \texttt{integer} \mid \texttt{float} \end{array}$$

A CFG G is a 4-tuple (N, T, S, P), where :

1. N is a finite set of nonterminals.
2. T is a finite set of terminals.
3. S is a special nonterminal (from N) called the *start* symbol.
4. P is a finite set of production rules of the form such as $A \rightarrow \alpha$, where A is from N and α from $(N \cup T)^*$