Compiler Design

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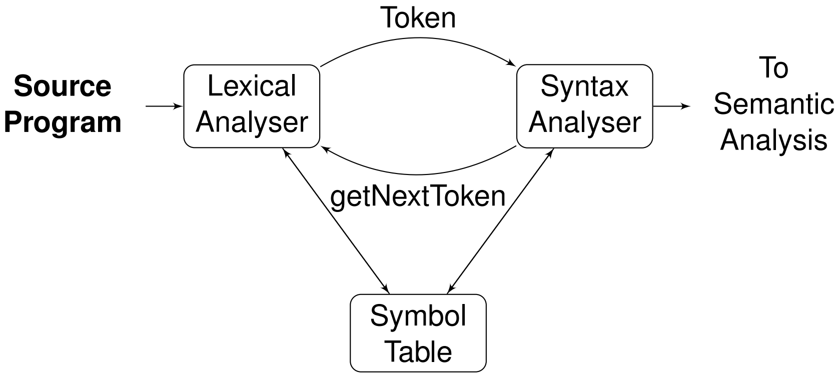
Lexical Analyser



Lexical Analyser

- Main task is to read the input characters and produce as output a sequence of tokens.
- Stripping from the source program comments and white space in the form of blank, tab and newline characters.
- Correlating error messages from the compiler with the same source program

Tokens, Patterns and Lexemes

- A token is a pair consisting of a token name and an optional attribute value. The token name is an abstract symbol representing a kind of lexical unit, e.g., a particular keyword, or a sequence of input characters denoting an identifier.
- This set of strings is described by a rule called pattern associated with that token. The pattern is said to match each string in the set.
- A lexeme is a sequence of characters in the source program that matches the pattern for a token and is identified by the lexical analyser as an instance of that token. These are smallest logical unit (words) of a program such as $A, B, 1.0, \textit{true}, +, <=$ ....

Examples - Tokens, Patterns and Lexemes

Consider The Following C Statement:
printf (“Total = %d”, score) ;

- **printf** and **score** are lexemes matching the pattern for token id
- **“Total = %d”** is a lexeme matching literal.

Examples - Tokens, Patterns and Lexemes

Token	**Sample lexemes**	**Informal Description of Pattern**
if	if	characters i,f
else	else	characters e,l,s,e
comparison	$<, <=, ==, != , >, >=$	$<$ *or* $>$ *or* $<=$ *or* $>=$ *or* $==$ *or* $!=$
id	*pi*, *score*, *D2*	Letters followed by letters and digit.
number	3.14159, 0, 6.02e23	any numeric constant
literal	“Total = %d”	Total = %d

Attributes of Tokens

- The token names and associated attribute values for the Fortran statement are written below as a sequence of pairs.
  $E = M * C * *2$

<id, pointer to symbol-table entry for E>
< assign-op >
<id, pointer to symbol-table entry for M>
<mult -op>
<id, pointer to symbol-table entry for C>
<exp-op>
<number, integer value 2 >

Specification of Tokens

- Regular Expression.
- Deterministic FiniteAutomata.
- Non-Deterministic Finite Automata.
- Non-Deterministic Finite Automata with empty transitions.

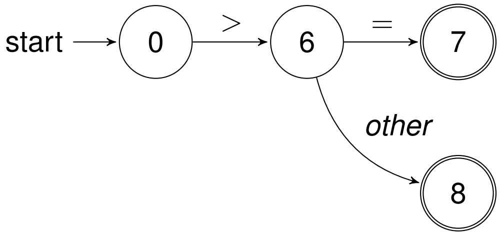
Recognitions of Tokens

Regular-Expression Pattern

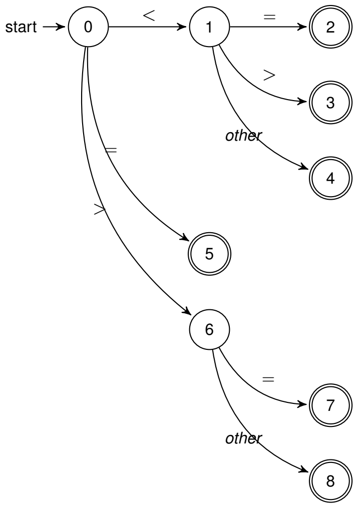
Regular Expression	Token	Attribute Value
WS	–	–
if	if	–
then	then	–
else	else	–
id	id	pointer to table entry
num	num	pointer to table entry
$<$	relop	LT
$<=$	relop	LE
$=$	relop	EQ
$<>$	relop	NE
$>$	relop	GT
$>=$	relop	GE

Construct a lexical analyser that will isolate the lexeme for the next token in the input buffer and produce as output a pair consisting of the appropriate token and attribute-value, using the given translation table.

Transition Diagram for $>=$

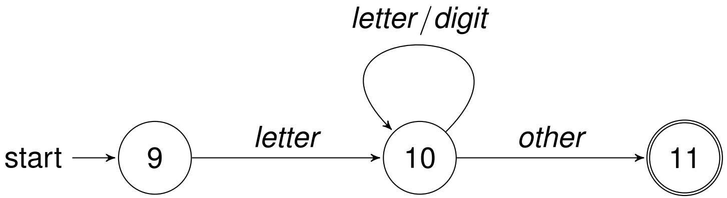


Transition Diagrams for Relational Operators



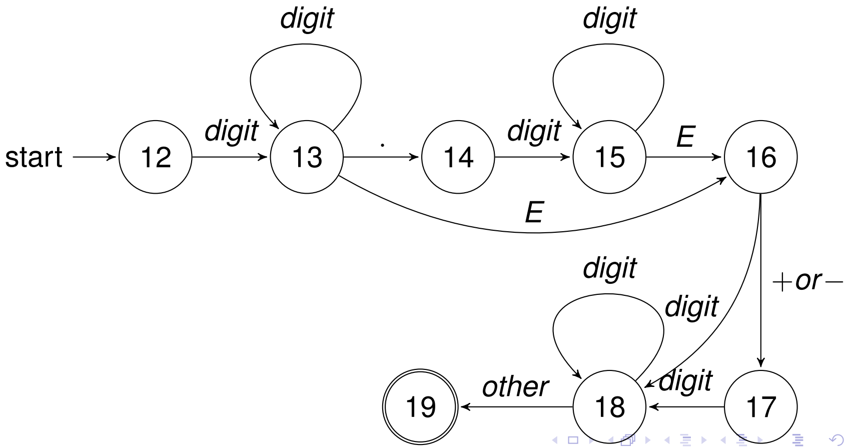
Recognitions of Tokens

Transition Diagrams for Identifiers or Keywords


$$\begin{tikzcd}
\text{start} \arrow[r] & \boxed{9} \arrow[r, "letter"] & \boxed{10} \arrow[loop above, "letter\,/\,digit"] \arrow[r, "other"] & \boxed{\boxed{11}}
\end{tikzcd}$$

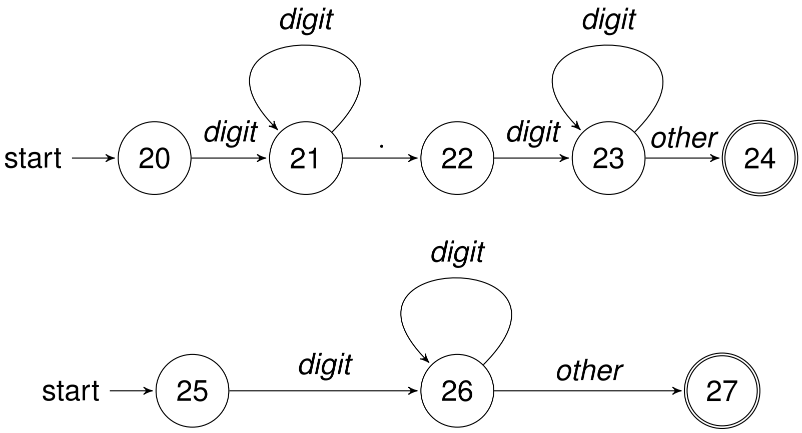
Recognitions of Tokens

Transition Diagram for Numbers



Recognitions of Tokens

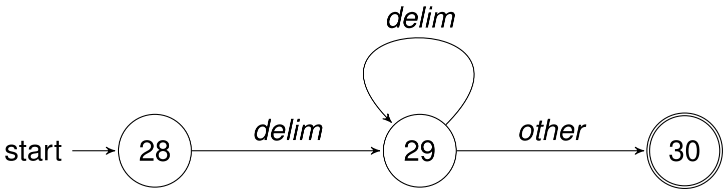
Transition Diagram for Numbers


$$\begin{tikzcd}
\text{start} \arrow[r] & 20 \arrow[r, "digit"] & 21 \arrow[loop above, "digit"] \arrow[r, "."] & 22 \arrow[r, "digit"] & 23 \arrow[loop above, "digit"] \arrow[r, "other"] & \boxed{24}
\end{tikzcd}$$

$$\begin{tikzcd}
\text{start} \arrow[r] & 25 \arrow[r, "digit"] & 26 \arrow[loop above, "digit"] \arrow[r, "other"] & \boxed{27}
\end{tikzcd}$$

Recognitions of Tokens

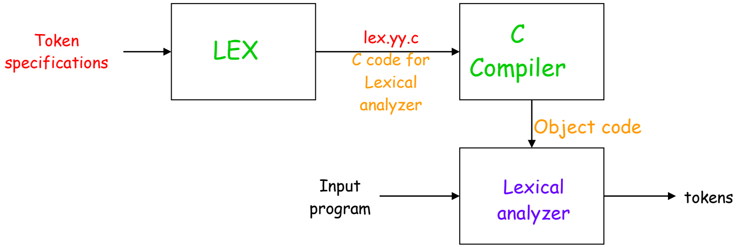
Transition Diagrams for White spaces


$$\begin{tikzcd}
\text{start} \arrow[r] & \boxed{28} \arrow[r, "delim"] & \boxed{29} \arrow[loop above, "delim"] \arrow[r, "other"] & \boxed{\boxed{30}}
\end{tikzcd}$$

Implementing a Transition Diagram

```
token nexttoken()
{ while (1) {
    switch (state) {
    case 0: c = nextchar();
       if (c==blank || c==tab || c==newline) {
         state = 0;
         lexeme_beginning++;
       }
       else if (c=='<') state = 1;
       else if (c=='=') state = 5;
       else if (c=='>') state = 6;
       else state = fail();
       break;
     case 1:
       ...
     case 9: c = nextchar();
       if (isletter(c)) state = 10;
       else state = fail();
       break;
     case 10: c = nextchar();
       if (isletter(c)) state = 10;
       else if (isdigit(c)) state = 10;
       else state = 11;
       break;
     ...
```

Lexical Analyser Generators — Lex



References

- Alfred V. Aho, Ravi Sethi, Jeffrey D Ullman, “Compilers Principles Techniques and Tools”, Pearson Education.

Thank You