# Session 2: Lexical Analysis

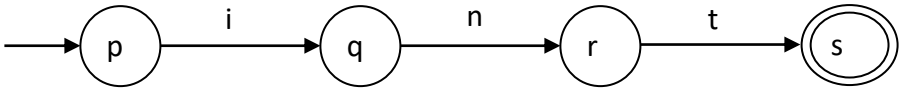
## I. OBJECTIVES:

To write a program that reads any simple program as source and separates out the valid tokens from the source program.

## II. DEMONSTRATION OF USEFUL RESOURCES:

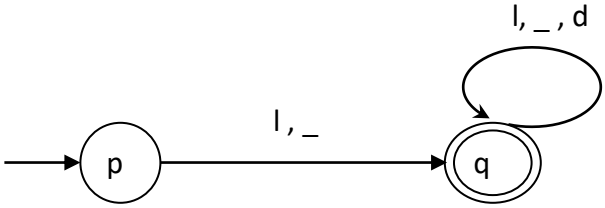
**DFAs for recognition of tokens:** Recognition of keywords using DFA is easier than recognition of identifiers and numbers.

1. **Keyword:** The keywords are predefined, reserved words used in programming that have special meanings to the compiler. To recognize a keyword 'int' we can just use the following DFA:



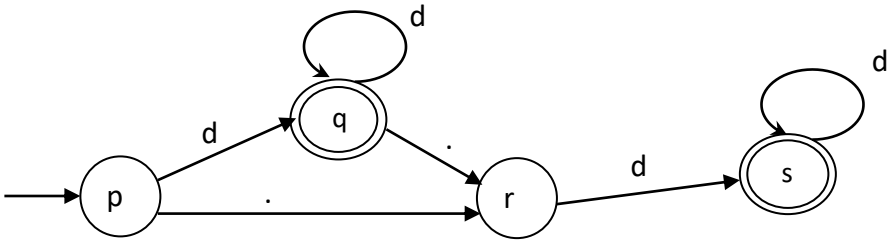

Regular expression: int

2. **Identifier:** An identifier in C is a word which starts with a letter or underscore. The 1st character can be followed repeatedly by letters, underscore or digits. No other character is allowed in the identifier. To recognize a valid C identifier the DFA might look like the one that follows:




Mark that the regular expression for valid C identifiers is l|_(l|_|d)*, where l stands for a|b|c|…|z|A|B|C|…|Z and d stands for 0|1|2|…|9.

3. **Numeric Constant:** A DFA for simple floating point numbers or fixed point numbers might take the following form:




Mark that the regular expression is dd*|d*.dd*, where d stands for 0|1|2|…|9, and mark also that the DFA has two final states.

**4. Sample Implementation of DFA for Numeric Constants**

```
int num_rec(char lex[20])

{ int i, l, s;
 i=0;
 if(isdigit(lex[i]))
          {s=1; i++;}
 else
 if(lex[i]=='.') {s=2; i++;}
 else s=0;

     l=strlen(lex);
```

```
if(s==1)
for(;i<l;i++)
 { if(isdigit(lex[i]))
         s=1;
   else
   if(lex[i]=='.')
          {s=2; i++; break;}
   else {s=0; break;}}
```

```
if(s==2)
  if(isdigit(lex[i]))
          {s=3; i++;}
  else s=0;

if(s==3)
for(;i<l;i++)
  { if(isdigit(lex[i]))
              s=3;
    else {s=0; break;}}

if(s==3) s=1;
return s; }
```

## III. LAB EXERCISE:

1. Write a program to recognize whether the entered string is a keyword or not.
2. Write a program to detect whether the entered string is an identifier or not based on the finite automata described above.

**Some Useful Library Functions:**

Following are the functions defined in the header ctype.h:

| S.N. | Function & Description |
|---|---|
| 1 | int isalnum(int c)<br>Checks whether the passed character is alphanumeric. |
| 2 | int isalpha(int c)<br>Checks whether the passed character is alphabetic. |
| 3 | int isdigit(int c)<br>Checks whether the passed character is a decimal digit. |
| 4 | int islower(int c)<br>Checks whether the passed character is a lowercase letter. |
| 5 | int isspace(int c)<br>Checks whether the passed character is a white-space. |
| 6 | int isupper(int c)<br>Checks whether the passed character is an uppercase letter. |

The library also contains two conversion functions that also accept and return an "int".

| S.N. | Function & Description |
|---|---|
| 1 | int tolower(int c)<br>This function convert an uppercase letter to lowercase. |
| 2 | int toupper(int c)<br>This function convert a lowercase letter to uppercase. |

## IV. ASSIGNMENT #2:

Suppose, we have a C source program scanned and filtered as it was done in Session 1. We now take that modified file as input, and separate the lexemes first. We further recognize and mark the lexemes as different types of tokens like keywords, identifiers, operators, separators, parenthesis, numbers, etc.

**Sample Input:**

```
char c; int x1, x_2; float y1, y2; x1=5; x_2= 10; y1=2.5+x1*45; y2=100.o5-x_2/3; if(y1<=y2) c='y'; else c='n';
```

**Step 1:** Lexemes are separated. Mark that two-character relational operators are also distinguished beside separators, one-character operators, parenthesis, number constants and alphanumeric strings with or without underscore.

```
char c ; int x1 , x_2 ; float y1 , y2 ; x1 = 5 ; x_2 = 10 ; y1 = 2.5 + x1 * 45 ; y2 = 100.o5 - x_2 / 3 ; if ( y1 <= y2 ) c = ' y ' ; else c = ' n ' ;
```

**Step 2:** Lexemes are categorized under the categories kw for keyword, id for identifier, etc. Some may be labeled unkn (unknown).

```
[kw char] [id c] [sep ;] [kw int] [id x1] [sep ,] [id x_2] [sep ;] [kw float] [id y1] [sep ,] [id y2] [sep ;] [id x1] [op =] [num 5] [sep ;] [id x_2] [op =] [num 10] [sep ;] [id y1] [op =] [num 2.5] [op +] [id x1] [op *] [num 45] [sep ;] [id y2] [op =] [unkn 100.o5] [op -] [id x_2] [op /] [num 3] [sep ;] [kw if] [par (] [id y1] [op <=] [id y2] [par )] [id c] [op =] [sep '] [id y] [sep '] [sep ;] [kw else] [id c] [op =] [sep '] [id n] [sep '] [sep ;]
```

- Note that we need to request for generation of an error message for [unkn 100.o5]. And we will further modify some of the tokens (categorized/ recognized lexemes) for symbol table entry. For example, we may replace all [id c] in the same scope with the token, say, [id 1], all [id x1] with [id 2], and so on. Here, 1 and 2 refer to entry pointer (record number) in the Symbol Table.