

Compiler Design

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Symbol Table Management

WHO CREATES SYMBOL TABLE?

- ▶ Identifiers and attributes are entered by the analysis phases when processing a definition (declaration) of an identifier.
- ▶ In simple languages with only global variables and implicit declarations:
 - ▶ The scanner can enter an identifier into a symbol table if it is not already there.
- ▶ In block-structured languages with scopes and explicit declarations:
 - ▶ The parser and/or semantic analyzer enter identifiers and corresponding attributes.

USE OF SYMBOL TABLE

- ▶ Symbol table information is used by the analysis and synthesis phases.
- ▶ To verify that used identifiers have been defined (declared).
- ▶ To verify that expressions and assignments are semantically correct - **type checking**.
- ▶ To generate intermediate or target code.

Assumptions

For this work, assume we:

- ▶ use static scoping.
- ▶ require that all names be declared before they are used.
- ▶ do not allow multiple declarations of a name in the same scope.
- ▶ do allow the same name to be declared in multiple nested scopes.
 - ▶ but only once per scope.

What Operations do we need ?

Using the previous given assumptions, we will need:

- ▶ look up a name in the current scope only.
 - ▶ to check if it is multiply declared.
- ▶ Look up a name in the current and enclosing scopes
 - ▶ to check for a use of an undeclared name, and
 - ▶ to link a use with the corresponding Symbol-table entry.
- ▶ insert a new name into the symbol table with its attributes.
- ▶ Do what must be done when a new scope is entered.
- ▶ Do What must be done when when a scope is exited.

SYMBOL TABLE DATA STRUCTURES

- ▶ Issues to consider : Operations required
 - ▶ **Insert** - Add symbol to symbol table
 - ▶ **Look Up** - Find symbol in the symbol table (and get its attributes)
- ▶ Insertion is done only once.
- ▶ Look Up is done many times.
- ▶ Need Fast Look Up.
- ▶ The data structure should be designed to allow the compiler to find the record for each name quickly and to store or retrieve data from that record quickly.

LINKED LIST

- ▶ A linear list of records is the easiest way to implement symbol table.
- ▶ The new names are added to the symbol table in the order they arrive.
- ▶ Whenever a new name is to be added it is first searched linearly or sequentially to check if the name is already present in the table or not and if not , it is added accordingly.
- ▶ Time complexity - $O(n)$.
- ▶ Advantage - less space, additions are simple.
- ▶ Disadvantages - higher access time.

Example:

```
int main()
{
    int f;
    {
        int a, b, c;
        int d;
        char v, g;
    }
    int j;
    {
        {
            char v;
            {
                int k;
            }
        }
    }
}
```

UNSORTED LIST

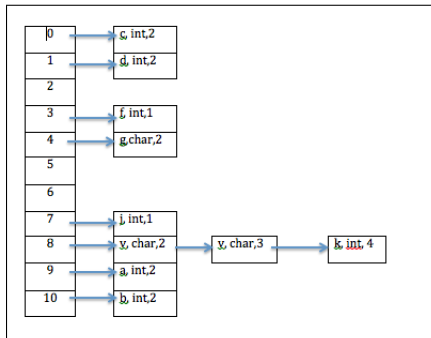
SL No	Name	Class	Datatype	Scope	Line No
1	<i>f</i>	identifier	int	1	3
2	<i>a</i>	identifier	int	2	4
3	<i>b</i>	identifier	int	2	4
4	<i>c</i>	identifier	int	2	4
5	<i>d</i>	identifier	int	2	5
6	<i>v</i>	identifier	char	2	6
7	<i>g</i>	identifier	char	2	6
8	<i>j</i>	identifier	int	1	9
9	<i>v</i>	identifier	char	3	12
10	<i>k</i>	identifier	int	4	14

Hash Table

- ▶ Table of k pointers numbered from *zero* to $k - 1$ that points to the symbol table and a record within the symbol table.
- ▶ To enter a name in to the symbol table we found out the hash value of the name by applying a suitable hash function.
- ▶ The hash function maps the name into an integer between *zero* and $k - 1$ and using this value as an index in the hash table.

$$H_{Key} = ASCII_{id} \bmod 11$$

a	b	c	d	e	f	g	h	i	j
97	98	99	100	101	102	103	104	105	106



Assignment

Consider the assumptions for the language previously considered in last lab sessions. Variables of data types allowed in the subset can be defined at the very beginning of any function / block. A variable must be defined before it is used. Using YACC, define the grammar rules and associated set of actions for the following:

- ▶ Find the data type for each newly created variable and create symbol table by adding the data type and scope information for each declared variable.