THREE ADDRESS CODE (Module V)

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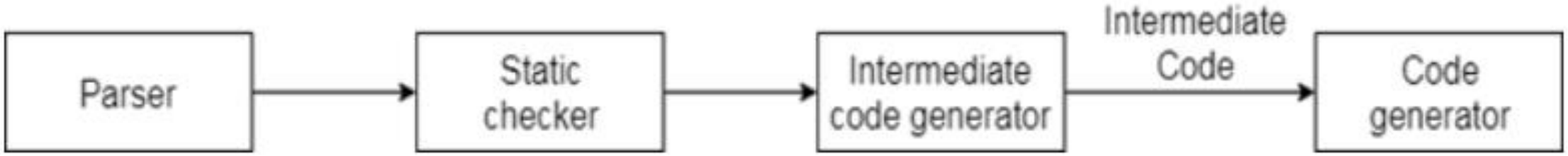
Three Address Code

- Three-address code is an **intermediate code**. It is used by the optimizing compilers.
- In three-address code, the given expression is **broken down into several separate instructions**. These instructions can easily translate into **assembly language**.
- Each three address code instruction has at most three operands. It is a combination of assignment and a binary operator.
- **Intermediate code** is used to translate the **source code** into the **machine code**. Intermediate code lies between the high-level language and the machine language.



An assembly language is a type of **low-level programming language** that is intended to communicate directly with a computer's hardware. Unlike machine language, which consists of binary and hexadecimal characters, assembly languages are designed to be readable by humans.

Example of assembly language

"EAX," "EBX" and "ECX" are the **variable**s. The first line of code loads "3" into the register "eax." The second line of code loads "4" into the register "ebx." Finally, the last line of code adds "eax" and "ebx" and stores the result of the addition, which is seven, in "ecx."

Examples

Given Expression

$a := (-c * b) + (-c * d)$

Three-address code is as follows

$t_1 := -c$

$t_2 := t_1 * b$

$t_3 := -c$

$t_4 := t_3 * d$

$t_5 := t_2 + t_4$

$a := t_5$

Implementation of Three Address Code

The three address code can be represented in two forms:

1. Quadruples
2. Triples

Quadruples

The quadruples have four fields to implement the three address code. The field of quadruples contains the name of the

1. Operator,
2. The first source operand,
3. The second source operand and
4. The result respectively.

Cont…

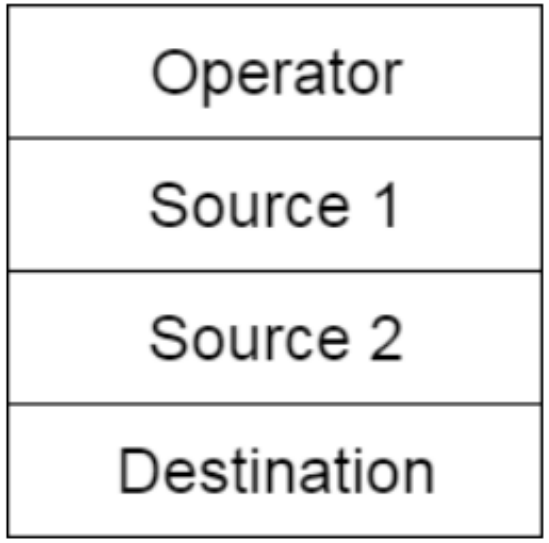


Fig: Quadruples field

Example

a := -b * c + d

Three-address code is as follows:

t_1 := -b

t_2 := c + d

t_3 := t_1 * t_2

a := t_3

These statements are represented by quadruples as follows:

$t_1 := -b$
$t_2 := c + d$
$t_3 := t_1 * t_2$
$a := t_3$

	Operator	Source 1	Source 2	Destination
(0)	uminus	b	-	t_1
(1)	+	c	d	t_2
(2)	*	t_1	t_2	t_3
(3)	:=	t_3	-	a

Triples

- The triples have three fields to implement the three address code. The field of triples contains the name of the operator, the first source operand and the second source operand.
- In triples, the results of respective sub-expressions are denoted by the position of expression. Triple is equivalent to DAG while representing expressions.

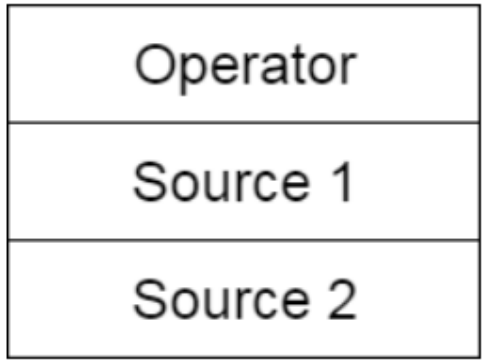


Fig: Triples field

Example

a := -b * c + d

Three address code is as follows:

t_1 := -b

t_2 := c + d

t_3 := t_1 * t_2

a := t_3

	Operator	Source 1	Source 2
(0)	uminus	b	-
(1)	+	c	d
(2)	*	(0)	(1)
(3)	:=	(2)	-

Indirect Triple Representation

	Operator	Source 1	Source 2
(0)	uminus	b	-
(1)	+	c	d
(2)	*	(41)	(42)
(3)	:=	(43)	-

Index	Indirect Index
(0)	(41)
(1)	(42)
(2)	(43)
(3)	(44)

Problem-01

1. Write Three Address Code for the following expression-

   a = b + c + d

a = b + c + d

Solution

Three Address Code for the given expression is-

(1) T1 = b + c

(2) T2 = T1 + d

(3) a = T2

Consider expression a = b * – c + b * – c. The three address code is:

t1 = uminus c

t2 = b * t1

t3 = uminus c

t4 = b * t3

t5 = t2 + t4

a = t5

Problem-02

2. Write Three Address Code for the following expression-

$$-(a \times b) + (c + d) - (a + b + c + d)$$

Solution-

Three Address Code for the given expression is-

(1) T1 = a x b

(2) T2 = uminus T1

(3) T3 = c + d

(4) T4 = T2 + T3

(5) T5 = a + b

(6) T6 = T3 + T5

(7) T7 = T4 – T6

Problem-03:

3. Write Three Address Code for the following expression-

If A < B then 1 else 0

Solution-

Three Address Code for the given expression is-

(1) If (A < B) goto (4)

(2) T1 = 0

(3) goto (5)

(4) T1 = 1

(5)

Problem-04:

4. Write Three Address Code for the following expression-

- If A < B and C < D then t = 1 else t = 0

If A < B and C < D then t = 1 else t = 0

Solution-

Three Address Code for the given expression is-

(1) If (A < B) goto (3)

(2) goto (4)

(3) If (C < D) goto (6)

(4) t = 0

(5) goto (7)

(6) t = 1

(7)