CS & IT ENGINEERING

Compiler Design

Intermediate code and code optimization

Lecture No. 1

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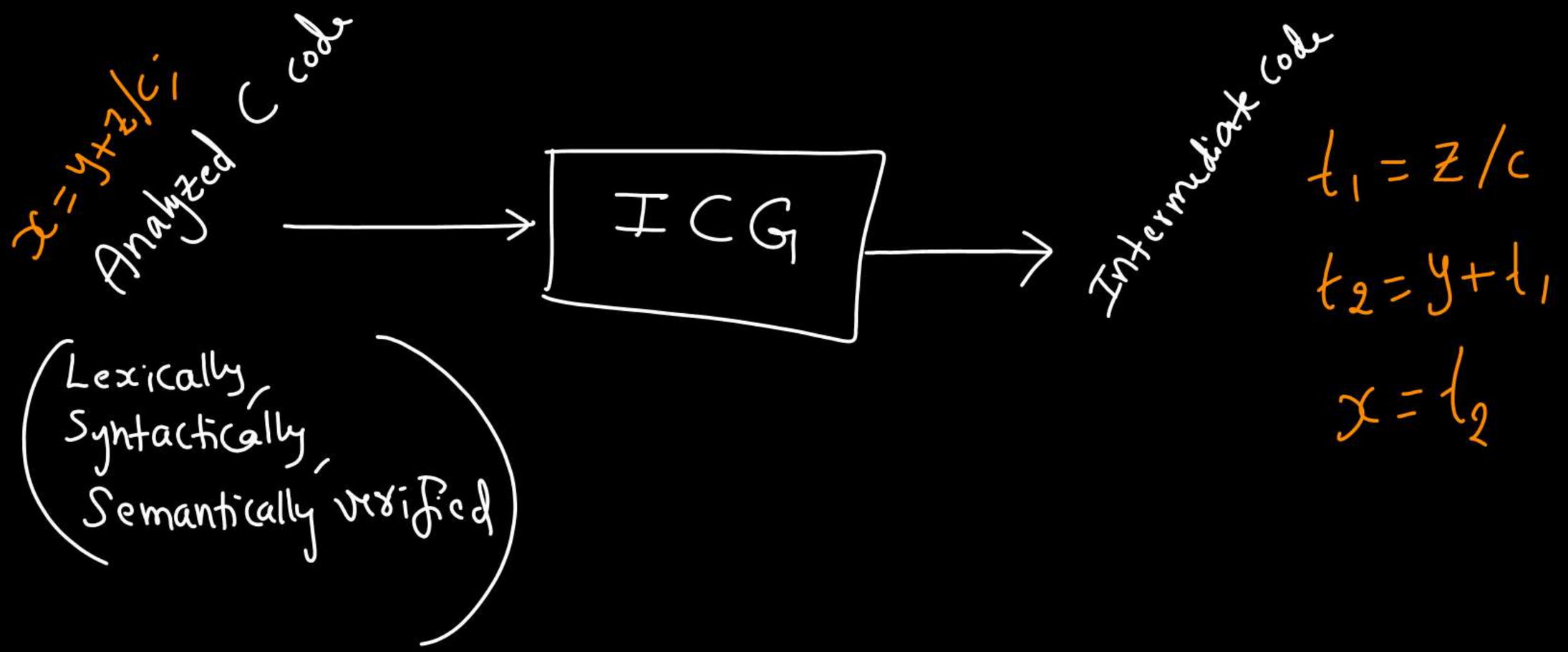
Intermediate code

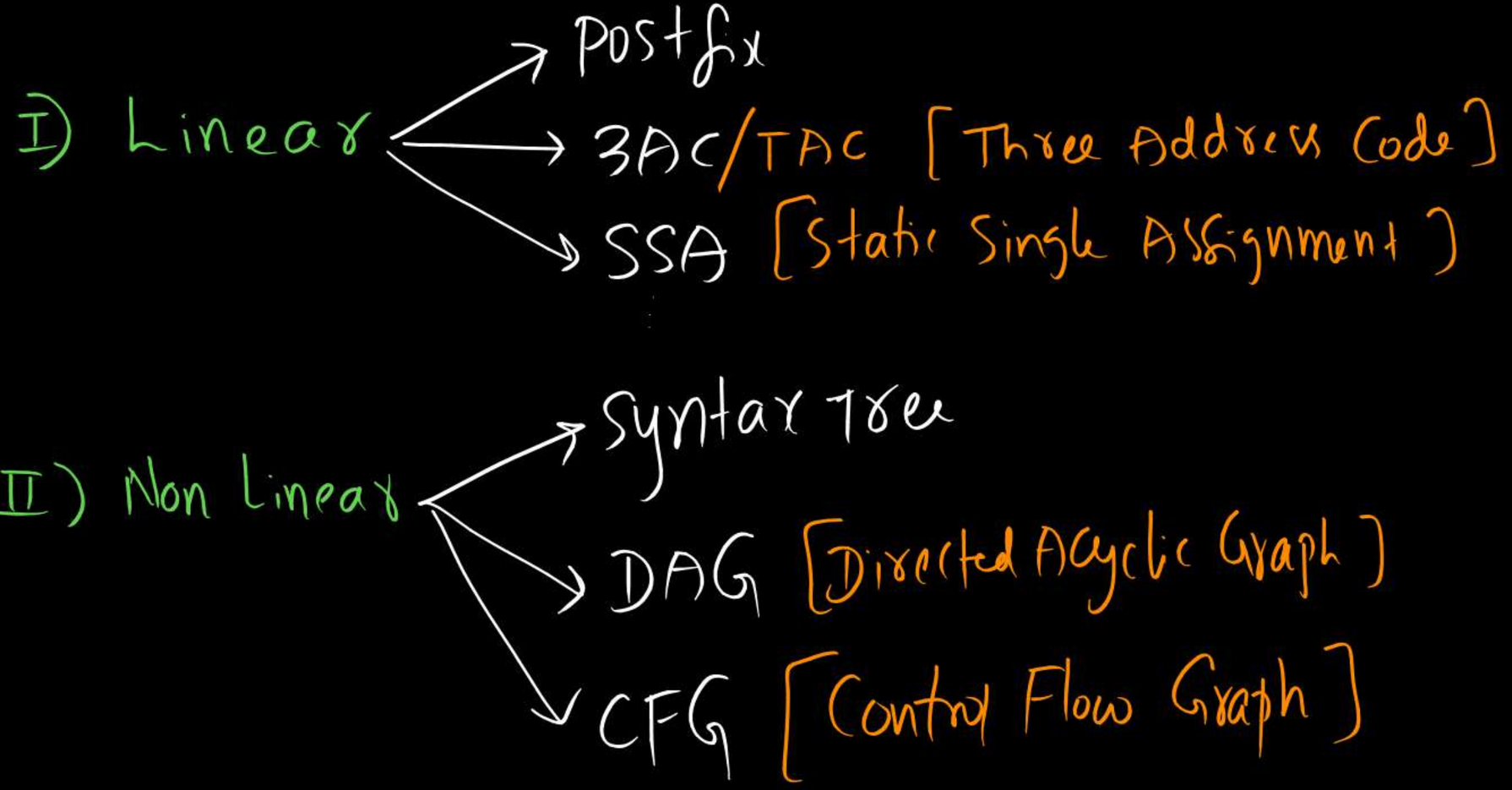
- Postfix code
- Three Address code
- SSA code
- Syntax Tree
- DAG
- Control Flow Graph

What is Intermediate code ?

- M/C Independent
- Portable


x = y + z / c ;
Analyzed C code
ICG
Intermediate code
t1 = z / c
t2 = y + t1
x = t2
Lexically
Syntactically
Semantically verified

Intermediate Code Representations :



$$x = a + a + a + a$$

$$x = (((a+a)+a)+a)$$

I) Syntax Tree

I) Postfix code :

$x\,aa+a+a+=$

II) Three Address Code [Every Instruction has atmost 3 Addresses]

$t_1 = a+a$
$t_2 = a+a$
$x = t_1+t_2$

OR

$t_1 = a+a$
$x = t_1+t_1$

OR

$a = a+a$
$a = a+a$

II) DAG

III) SSA Code :

Every variable is having single assignment

It is 3AC but

SSA

SSA

Not SSA code

$$x = a + a + a + a$$

I) Postfix code :

$a+b \Rightarrow ab+$

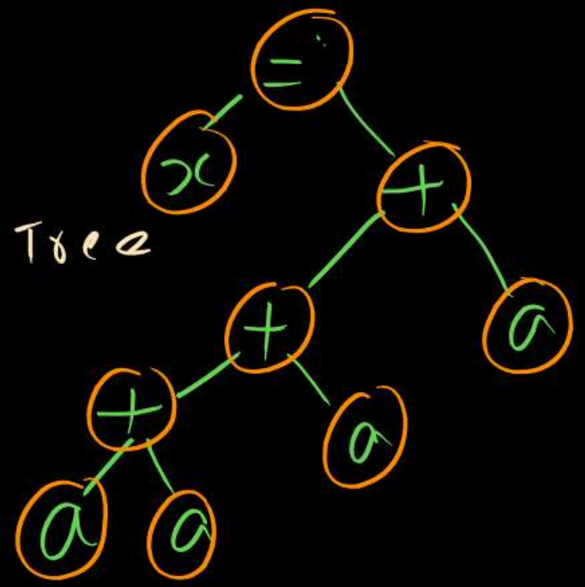
II) Three Address code

III) SSA code :

I) Syntax Tree

Leaf → operand

Non leaf → operator



II) DAG

Eliminates common sub expressions

3 nodes
4 edges

① $x = a * b$

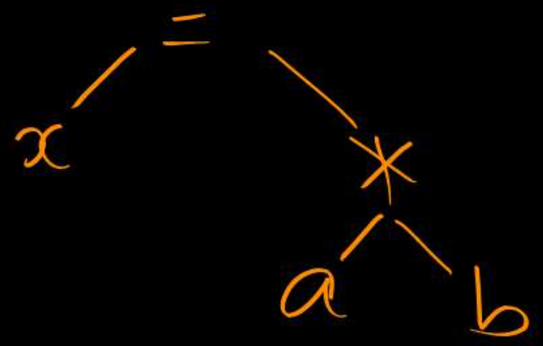
postfix : $x\ a\ b\ *\ =$

3AC : $x = a * b$ OR $a = a * b$ OR $b = a * b$

SSA : $x = a * b$

① $x = a * b$

Syntax Tree :



DAG

② $\underbrace{a+a}_{t_1}+a$

Postfix : $aa+a+$

3AC : Best 3AC

$t_1 = a+a$
$a = t_1+a$

2 variables

OR

$t_1 = a+a$
$t_2 = t_1+a$

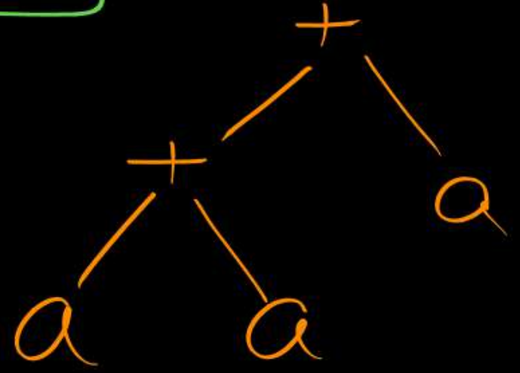
3 variables

SSA :

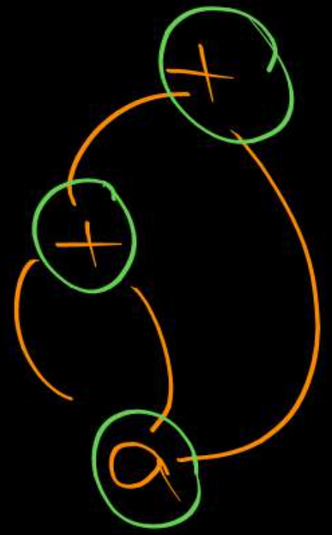
$t_1 = a+a$
$t_2 = t_1+a$

② a + a + a

Syntax Tree



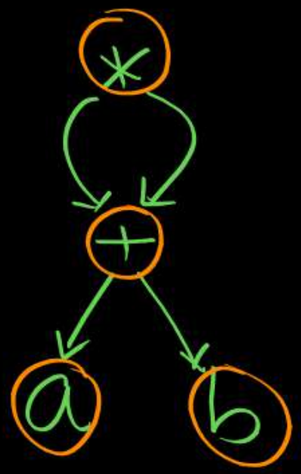
DAG for a+a+a



3 nodes
4 edges

③ Find no. of nodes and edges in DAG for

$$x = (a+b) * (a+b)$$



4 nodes
4 edges

④ Find no. of minimum variables in 3AC for $x = (a+b) * (a+b)$

a a

$a = a+b$
$q = a*q$

= 2 variables

OR

$b = a+b$
$b = b*b$

- - -

(5) Find min no. of variables in SSA code for:

$$x = (a+b) * (a+b)$$

SSA:

$$t_1 = a + b$$
$$t_2 = t_1 * t_1$$

OR

$$a_1 = a + b$$
$$a_2 = a_1 * a_1$$

= 4 variables

⑥ $x = a + b + c - a$

How many min variables in 3AC ?

$x = b + c \Rightarrow b = b + c$

2 variables

Using Algebraic Laws

$a + b + c - a$

$b + a + c - a$

$b + c + a - a = b + c$

⑦ $x = (a * b) + b + (a * c)$

Independent

st

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How many min variables in 3AC ?

Reordering

$= 3$

$c = a * c$

$a = a * b$

$a = a + b$

$a = a + c$

H.W.

Find best 3AC, best SSA, DAG.

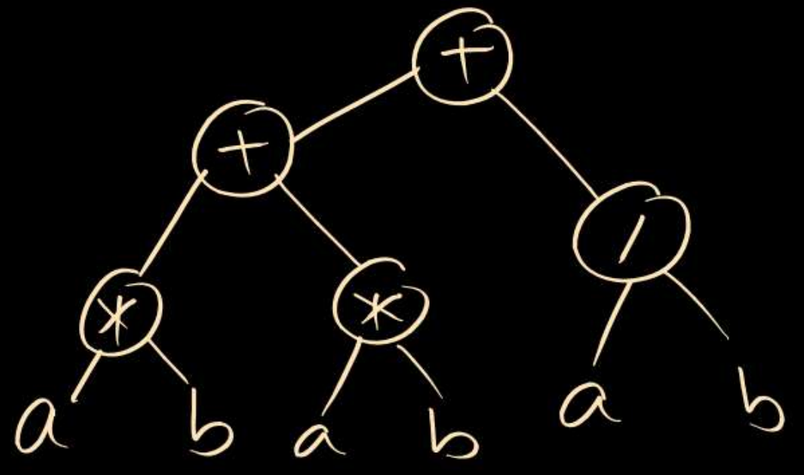
(8)

$x = a+b$
$y = a+b$
$z = a+b$
$t = x*z$
$w = t*y$

$\downarrow$

$w = t * y$
$w = (x*z) * (a+b)$
$w = ([a+b] * [a+b]) * (a+b)$

(9)



$\downarrow$

$((a*b)+(a*b))+(a/b)$

Whatever is given? 3AC / Syntax tree / FND

⇒ Expression ⟹ (Laws / Reordering) ⟹ Find Best


THANK YOU
GW
SOLDIERS !