Pointers in C

- holds address of other variable

```
int a = 100;
```

a: 100 (FFFS62 ← adds)

Syntax:-

```
int *p;
```

```
int b = 100;
p = &b;          ← referencing
printf("%d", *p);  ← o/p => 100
                 ← dereferencing
```

```
# include <stdio.h>
# include <conio.h>
main()
{
  int a = 100;
  int *p;
  p = &a;
printf("value of a: %d", a); → 100
printf("value of a: %d", *p); → 100
pf("%p", &a); → 2561
pf("%p", p); → 2561
pf("%p", &p); → 3F
```

a: 100 (2561) p: 2561 (3F)

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Data Structures

- A data structure is a way to store and organize data in a computer, so that it can be used efficiently.

- We talk about data structure as:
  1) Abstract view
     eg TV
     - turns on/off
     - Receives signals.
     - Audio/video play.

     We do not bother how circuits are embedded & which company has manufactured it.

  2) Implementation.

Abstract Data type :-
Defines data & operations, but no implementations.

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Types classification.

Data structure

- Primitive DS
  - Integer
  - Character
  - float
  - Pointers.
- Non Primitive DS.
  - Linear DS
    - Array
    - Stack
    - Queue
    - LinkedList
  - Non-linear DS.
    - Tree
    - Graph

The List of operations applied on linear data structures.

- Add an element
- Delete an Element
- Traverse/Display
- Sort the list
- Search for element.

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1) List (very basic)
- store a given no. of elements of perticular datatype
- write or modify any element at ~~an~~ at a position.
- Read a element at any position.

Q) Are we talking about Arrays?

How to compile in Ubuntu?

compile : gcc filename.c
hello.c
gcc hello.c
if output file is created. a.out

Run ./a.out

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Stack

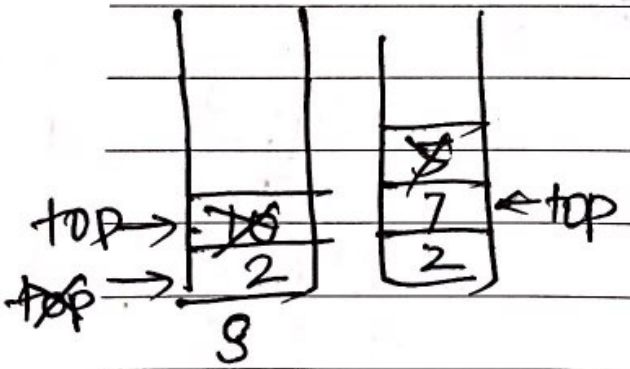
A List with the restriction that insertion & deletion can be performed only from one end, called the TOP.

operations:

1) push(x)
2) pop()
3) Top()
4) IsEmpty()
5) Is Full()

} constant time or O(1) } LIFO

06 Sunday



Push(2)
push(10)
pop()
push(7)
push(5)
Top() → 5
IsEmpty → false
pop().
Top() → 7

App^n :-

(4) Evaluation of Expressions.
(1) - undo in an editor
(3) - Balance Parantheses
[{( )}]
(2) - Reverse a list

07 Monday January 2013

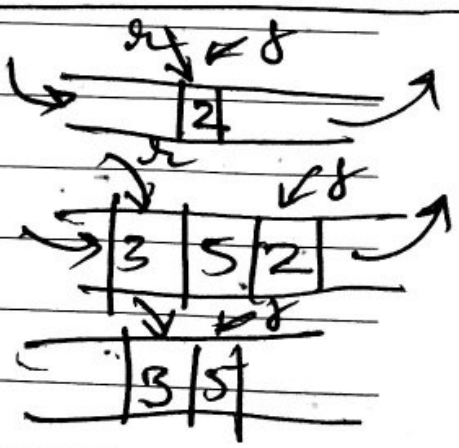
Queues

A list or collection with the restriction that can be performed at one end (rear) & deletion can be performed at the other end (front)

1) Enqueue(x) / push(x)
2) dequeue() / pop()
3) Front()
4) IsEmpty()
5) IsFull() ← optional

} O(1)

Enq(2)
Enq(5)
Enq(3)
dq()
front() → 5
IsEmpty → false



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Applications:

1) Resource service → printer.
2) Processor works on processes.
   ↳ processes scheduling
3) Simulating wait.

Array Implementation :-

0	1	2	3	4	5	6	7	8	9
	2	4	6	8	10	12			

front rear

enqueue (2)
" (4)
" (6)
" (8)
" (10)
" (12)

dequeue()

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Stack Implementation

- Using Array :-

```
void push(int x)
{
  if (top == MAX-1
```

```
#include<stdio.h>
#define MAX 101
  int a[MAX];
  int top = -1;

  void push(int x)
{
    if (top == MAX - 1)
  {
    pf ("stack is full");
    return;
    }
    top++;
    a[top] = x;
}
```

} a[++top] = x;

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```
void top1( )
{
  if (top==-1)
  {
   pf("stack Empty");
  }
  else
   pf("%d", a[top]);
}

void print()
{
  int i;
  pf("stack:\n");
      for (i=0; i<=top; i++)
      {
        pf("%d", a[i]);
      }
}

void pop()
{ if (top==-1)
  {
    pf("No elements);
    return;
  }
  top--;
```

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```
main()
{
  push(2); print()
  push(5); print()
  push(8); print()
  pop(); print();
  push(12); print();
}
```

Complexity < space / time.

- compare various algorithms & & choose the best one to solve a problem
- for that < space / time complexity
- Time complexity :-
  the amt of time taken by an algorithm to run the instructions.
- Space Complexity :-
  the amt of space or memory taken by an algorithm to run as the instructions.

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- They both depend on various factors like h/w, OS, processors etc but dont consider any of them
- We only consider execution ~~of~~ time of an algo.

push (x) — O(1) : best & Average case
— O(n) worst case.

pop()
Top()
IsEmpty() } O(1)

13 Sunday

Check for Balance Paranthesis

(A+B) ✓ [()()]
[(A-B) ✗
{(a*b) ✗ ⇒ ~~Scan from L → R~~

[(]) ✗

)(✗

[()] ✓

Solution:-

1) Scan from left to right push
2) If opening symbol, add it to a ~~list~~ stack pop
3) If closing symbol, ~~remove~~ last opening symbol in ~~list~~ stack

[( ) ( )]

List : ~~[X X~~ Empty

Evaluation of expressions

2+3 — operand

A−B operator

variable a*2 — constant

(2+3) * 4

operand

* (p+q)*(r+s)

* 4+6*2

(4+6)*2

OR

4+(6*2)

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Order of operations

1) Parentheses
2) Exponents (R→L).
3) Multiplication & division (L→R)
4) Addition & Subtraction. (L→R)

eg. ① $4+6*2$ $(4+6)*2$

$4+12 = 16$

② $2*6/2 - 3+7$

$\Rightarrow 12/2 - 3+7$

$\Rightarrow 6 - 3+7$

$\Rightarrow 3+7$

$\Rightarrow 10$

③ $[(2*6)/2] - (3+7) = -4$

$(12/2) - 10 =$

$6 - 10 = -4$

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✓ Prefix (Polish Notation)
✓ Postfix (Reverse Polish Notation)

✓ Infix	Prefix	Postfix
2+3	+23	23+
p-q	-pq	pq-
a+b*c	+a*bc	abc*+

Good for machines

human readable prefix

a+(b*c) ✓	a+(b*c) ✓
a+(*bc)	a+(bc*)
+a(*bc)	a(bc*)+
+a*bc ✓	abc*+ ✓

Evaluation of prefix and postfix expressions :-

Infix to Postfix

[(A*B)+(C*d)]-e

⇒ [(AB*)+(cd*)]-e

[(AB*)(cd*)+]-e

[(AB*)(cd*)+]e-

AB* cd*+e-

① Put parenthises are preference

06 Aditya Choudary

17 Thursday January 2013

Postfix Evaluation

$AB^* \; cd^* + e^-$

$A=2, B=3, C=5, d=4, e=9$

$\Rightarrow (2\ 3^*), (5\ 4^*) + 9^-$

$\Rightarrow [6\ \ 20\ +] \; 9 -$

$\Rightarrow 26\ \ 9 -$

$\Rightarrow 17$

$2\ 3^*\ \ 5\ 4^*\ +\ 9^-$

$\Rightarrow 6\ \ 5\ 4^*\ +\ 9^-$

$\Rightarrow 6\ \ 20\ +\ 9^-$

$\Rightarrow 26\ \ 9 -$

$\Rightarrow 17$

17
9 — 2
26 — 1

26 - 9

*	*	+	+	-	
3 2	4 5 6	20 6	20 6	26	9 26	17

26-9

9 = OP2
26 = OP1

26 - 9 = 17

Infix to prefix

[(A*B) + (C*d)] - e

[(*AB) + (*cd)] - e

[+(*AB)(*cd)] - e

- +(*AB)(*cd) e

-+ *AB *cd e

A=2, B=3, C=5, d=4, e=9

-+ * 2 3 (* 5 4) 9

-+ (* 2 3) 20 9

-+ 6 20 9

- 26 9

17

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prefix Evaluation

- + * 2 8 (* 5 4) 9

op1 op2
26 - 9

*		*	+	-	
5		2	6		
4	20	3	20	26	
9	9	20	9	9	17
		9			

26 - 9

eg ② ABC+*DE/-

A = 5, B = 6, C = 2, D = 12, E = 4

5 6 2 + * 12 4 / -

5 8 * 12 4 / -

40 12 4 / -

40 3 -

20 Sunday = 37

+	*	/	-
2		4	
6	8	12	3
5	5	40	40	37

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2^3

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Prefix $-+/A\wedge BC*DE*AC$

$A=16, B=2, C=3, D=10, E=4$

$-+/16\wedge 2\ 3*\ 10\ 4*\ 16\ 3$

$-+/16\wedge 2\ 3*\ 10\ 4\ 48$ $\quad 2 = 2\wedge 3$

$-+/16\wedge 2\ 3*\ 40\ 48$ $\quad \wedge, \$, \%, \uparrow$ $\quad 2\ 2\wedge 3$ $\quad 3$

$-+/16\ 8\ 40\ 48$

$-+\ 2\ 40\ 48$ $\quad 16/8$

$-*\ 42\ 48$

$= -6$

$-+/A\wedge BC*DE*AC$

$42-48$

*		*		2	16	/	+	-
	10	3		8		2		
16	4	40		40		40	42	
3	48	48		48		48	48	-6

2^3

Priority of operators

1. exponential, %
2. / *
3. + -

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Infix to Postfix using stack

(A + B/C * (D+E) - F).

Symbol	Stack	Postfix
(	(	
A		A
+	(+	A
B	(+	AB
/	(+/	AB
C	(+/	ABC
*	(+*	ABC/
(	(+*(	
D	(+*(	ABC/D
+	(+*(+	ABC/D
E	(+*(+	ABC/DE
)	(+*(+)	ABC/DE
	(+*	ABC/DE+
-	(- (+*	ABC/DE+*
F	(-	ABC/DE+*F
)	(	ABC/DE+*+F-

↓ GFE^D/*CB*-A+

~~+A-*B.C*/D^EFG~~

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Infix to prefix

① Expression

② → reverse

③ → infix to postfix

④ → reverse o/p

① ^ ↑ $ %

② / *

③ + -

A+(B*C-(D/E^F)*G)

(G*(F^E/D)-C*B)+A

Symbol		Stack	Postfix
)	(	(	
G	G	(	G
+	*	(*	G
(	(	(*(	G
B	F	(*(	GF
*	^	(*(^	GF
C	E	(*(^	GFE
-	/	(*(^/	GFE
(	D	(*(^/	GFED
D	)	(*	GFED/^
/	-	(-	GFED/^*
E	C	(-	GFED/^*C
^	*	(-*	GFED/^*C
F	B	(-*	GFED/^*CB
)	)	(	GFED/^*CB*-
*	+	(+	GFED/^*CB*-
G	A	(+	GFED/^*CB*-A
)			GFED/^*CB*-A+

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Postfix = GFED/^*CB*-A+
Prefix = +A-*BC*^/DEFG

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(A*B)+C
→ C+(B*A)

Symbol	Stack	Postfix
C		C
+	+	C
(	+(	C
B	+(	CB
*	+(*	CB
A	+(*	CBA
)	+	CBA*+

+*ABC
prefix

(A+B)+C

(AB+)+C

AB+C+

~~+C+BA~~ X

Postfix evaluation

Algorithm to convert infix to postfix

① Add ")" to the end of the infix expression

② Push "(" on the stack.

③ Repeat until each character in the infix notation is scanned.

1.) If a "(" is encountered, push it on the stack

~~2.) Discard the "(" i.e. remove "(" from stack & do not add it to the postfix expression~~

2.) If a ")" is encountered then

ⓐ Repeatedly pop from stack & add it to the postfix expression until "(" is encountered.

ⓑ Discard ")" i.e remove "(" from the stack & do not add to the postfix expression.

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3.> If an operator is encountered then

(a) Repeatedly pop from stack & add each operator to postfix expression which has same precedence or a higher precedence than operator encountered.

(b) push the operator (encountered operator) on to the stack.

end of if.

27 Sunday

(4.> If a ~~number~~ operand is encountered then add it to postfix expression.

(4) Repeatedly pop from the stack & add it to the postfix expression. until the stack is empty.

(5) Stop.

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Program:-

```
# include<stdio.h>
# includ<ctype.h>
# define MAX 50

typedef struct stack
{
  int data[MAX];
  int top;
} stack;

int precedence(char);
void init(stack *);
int ~~init~~ empty(stack *);
int full(stack *);
int pop(stack *);
void push(stack *, int);
int top(stack *); //value of top element
void infix_to_postfix(char infix[],
                      char postfix[]);
```

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```
void main()
{
  char infix[30], postfix[30];
 pf("Enter an infix expression \n");
 sf("%s", infix);
 infix_to_postfix(infix, postfix);
 pf("\n Postfix expression: %s\n", postfix);

}.

void infix_to_postfix(char infix[],
                      char postfix[])
{
 Stack S;
 Char x, token;
 int i, j; //i→infix index & j→postfix index
 init(&S);
 j=0;

 for(i=0; infix[i] != '\0' ; i++)
 {  token = infix[i];
   if(isalnum(token))
      postfix[j++] = token;
   else
```

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```
    if(token == '(')
      push(&S, '(');
else
    if(token == ')')
    while ((x = pop(&S)) != '(')
      postfix[j++] = x;
  else
  {while(precedence(token) <=
          precedence(top(&S)) &&
          !empty(&S))
    {
      x = pop(&S);
      postfix[j++] = x;
    }
    push(&S, token);
  }
}   // end of for
```

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```
while(!empty(&S))
{
    x=pop(&S);
    postfix[j++]=x;
}
postfix[j]='\0';
} //end of infix_to_postfix

int precedence(char x)
{
  if(x=='(')
    return(0);
  if(x=='+'||x=='-')
      return(1);
  if(x=='*'||x=='/'||x=='%')
    return(2);
  else
//  return(3);
}
```

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```
void init(stack *s)
{
    s->top=-1;
}

int empty(stack *s)
{
    if(s->top == -1)
        return(1);
    else
        return(0);
}

int full (stack *s)
{
    if(s->top == MAX-1)
        return(1);
    else
        return(0);
}
```

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```
void push(stack *s, int x)
{
 s->top = s->top+1;
 s->data[s->top] = x;
}

int pop(stack *s)
{
   int x;
   x = s->data[s->top];
   s->top = s->top-1;
   return(x)
}
```

03 Sunday

```
int top(stack *p)
{ return(p->data[p->top]);
}
```

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04 Monday February 2013

infix to postfix evaluation

```
# include <stdio.h>

# define MAX 20

typedef struct stack
{
    int data[MAX];
    int top;
} stack;

void init(stack *);
int empty(stack *);
int full(stack *);
int pop(stack *);
void push(stack *, int);
int evaluate(char x, int op1, op2);

int main()
{
    stack S;
    char x;
    int op1, op2, val;
```

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```
init(&s)
pf("Enter Expression");

while((x=getchar()!='\n')
{
  if(isdigit(x))
    push(&s, x-48);
  else
  {
    op2 = pop(&s);
    op1 = pop(&s);
    val = evaluate(x, op1, op2);
    push(&s, val);
  }
}

val = pop(&s);
pf("\n Value of expression=%d", val);

  return 0;
}
```

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```
int evaluate(char x, int op1, int op2)
{
    if(x=='+')
      return(op1+op2);
    if(x=='-')
      return(op1-op2);
    --
    --

}
```

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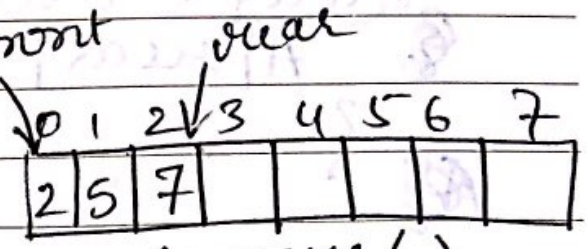
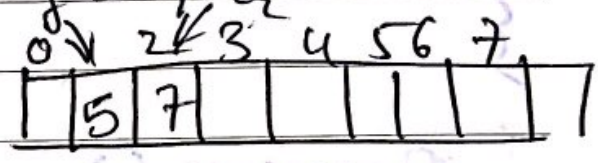
Queue Implementating using Array.

```
int A[10]
front ← -1
rear ← -1
```



dequeue()




```
IsEmpty()
{
  if front = -1 && rear = -1
      return true
  else
      return false
}

Enqueue (x)
{
  if rear == size(A) - 1
      print "Q is full"
      return
  else if IsEmpty()
  {
      front ← rear ← 0
      ~~A[rear] ← x~~
  } A[rear] ← x
```

OR

if (rear+1)%N == front

```
else
{
    rear ← (rear+1) % N
    rear ← rear + 1
    A[rear] ← x
}
}
```

current pos = i
Next " = (i+1) % N
previous = (i + N-1) % N

```
Dequeue()
{
  If IsEmpty().
     return()
  else if front == rear
     front = rear = -1
  else
     front = (front+1) % N
     front ← front + 1
}

front()
{
  return A[front]
}
```

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Implementation of Circular Queue

```
# include <stdio.h>
# define MAX 5

int queue_array[MAX];

int rear = -1;
int front = -1;

int main()
{
  int choice
```

10 Sunday

```
insert ()
{ int add_item;
  if((rear+1)%MAX == front)
  pf("Q overflow");
  else
  {
    if(front == -1)
    front = rear = 0;
    pf("insert an element");
    sf("%d, &add_item);
```

rear = MAX-1

```
    rear = (rear+1) % MAX;
    queue_array[rear] = add_item;
  }
}

delete()
{
  int element;
  if(front == -1)
  { pf(" Underflow");
    return(-1);
  }
  else
  {
    element = queue_array[front]
    if(front == rear)
      front = rear = -1;
    else
    {
      front = (front+1) % MAX;
      printf("the deleted element
          is %d", element);
    }
  }
}
```

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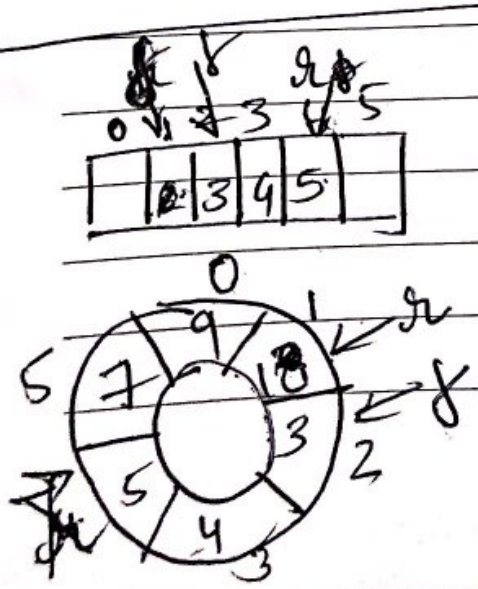
```
display1()
{
    int i, j;
    if (front = -1 && rear = -1)
    {
      pf(Q is underflow);
      return;
    }
    if (front > rear)
    {
      for( i=0; i<=rear; i++)
        pf("%d", queue_array[i]);
      for (j=front; j<=MAX-1; j++)
        pf("%d", queue_array[j]);
      pf("\n rear is at %d\n", queue_array[rear]);
      pf("\n front is at %d\n", queue_array[front]);
    }
```



```
else
{
  for(i=front; i<=rear; i++)
  {
    pf("%d", queue_array[i]);
  }
  pf("rear is at %d", queue_array[rear]);
  pf("front is at %d", queue_array[front]);
}
}
```

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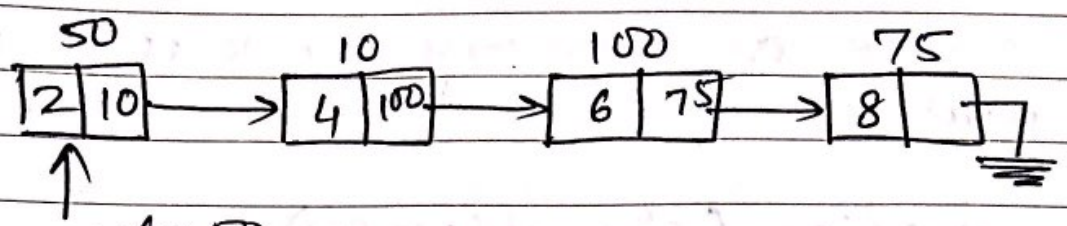
Linked List



head = 50

```
Struct Node
{
    int data;
Struct Node * next;
};
```

Operations:-

1. insert a node
2. Traverse the list.

pointer to head node

```
Struct Node * head;
```

- head = NULL → [main()]

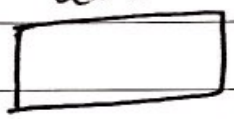
15 Friday February 2013

<u>insertion ()</u>

① create a memory block using malloc

$= \underbrace{\text{malloc (size of(Node))}}_{\text{give me block with size of type Node}}$

200



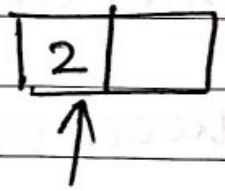
for type cast bcoz malloc return void pointer

```
struct Node* temp = (struct Node*)
        malloc(size of (struct Node));
```

*head=0

~~*temp~~

200



temp = 200

```
temp -> data = 2 ;
temp -> next = NULL;
head = temp;
```

again new node

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Traverse

```
Node* temp1 = head
while (temp1 -> next != NULL)
{
  temp1 = temp1 -> next;
}

temp1 -> next = temp;
```

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insert at the begining of List

```
# include <stdlib.h>
# include <stdio.h>

struct Node
{ int data;
  struct Node* next;
};

struct Node* head;
void insert(int x);
void print();

int main()
{
  head= NULL;
  pf(" How many numbers);
  int n, i, x;
  sf ("%d", &n);
  for( i=0; i<n; i++)
  {
  pf("Enter the number \n");
  sf("%d " &x);
  insert(x);
  print();
  }
```

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```
void insert(int x)
{
struct Node* temp = (struct Node*)
    malloc(size of (struct Node));

  temp -> data = x;
  temp -> next = head;
  head = temp;
}

void Print()
{
struct Node *temp = head;
printf("List is: ");
while (temp -> next != NULL)
{
  printf("%d", temp -> data);
  temp = temp -> next;
}
}
```

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insert node at the end of LL

```
void insert(int ~~data~~ x)
{
 struct Node* temp1 = (struct Node*)
        malloc(size of(struct Node));

 temp1 -> data = x;
 temp1 -> next = NULL

  if(head == NULL)
  {
     head = temp1;
     return;
  }

 Struct Node* temp2 = head;
   int i;
 while(temp2->next != NULL)
 {
   temp2 = temp2 -> next;
 }
 temp2 -> next = temp1;
}
```

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insert node at nth position

```
void insert(int x, int n)
{
 struct Node * temp1 = (struct Node*)
     malloc(sizeof(struct Node));
  temp1 -> data = x;
  temp1 -> next = NULL;
   if (n==1)
   {
      temp1 -> next = head
      head = temp1
      return;
   }

 Node* temp2 = head;
 int i;
 for (i=1; i<n-1; i++)
 {
   temp2 = temp2 -> next;
 }
  temp1 -> next = temp2 -> next
  temp2 -> next = temp1;
}.
```

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Delete a node at n^{th} position

```
void delete(int n)
{
struct Node * temp1 = head;
if (n==1)
{
 head = temp1 -> next;
 free (temp1);
 return;
}
   int i;      n=2
for(i=0; i<n-2; i++)
   temp1 = temp1 -> next;
struct Node* temp2 = temp1 -> next

temp1 -> next = temp2 -> next
free (temp2);
}
```

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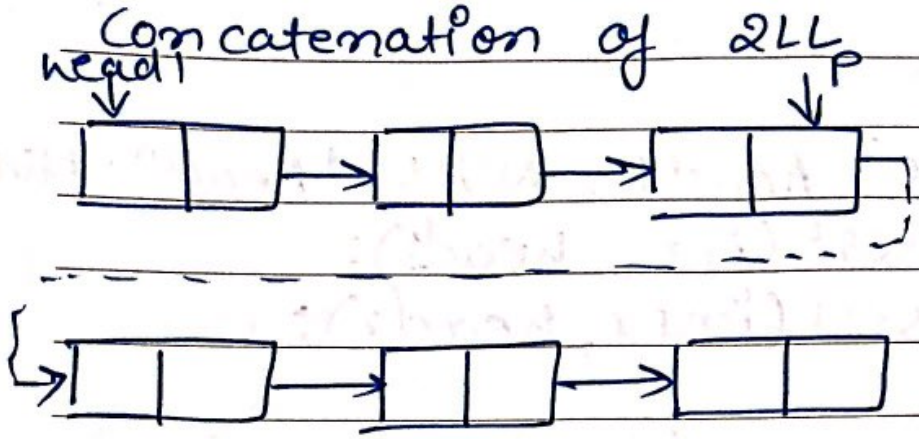
Concatenation of 2LL




```
struct node * concatenate(struct node * head1,
                          struct node * head2)
{
    node *p;
    if (head1 == NULL)
        return(head2);
    if (head2 == NULL)
        return (head1);
    p = head1;
while (p -> next != NULL)
{ p = p -> next;
  p -> next = head;
  return (head 1);

}
```

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```
main()
{
Struct Node * head1 = NULL, *head2=NULL;
head1= insert (int x, head1);
head2 = insert(int x, head2);

pf(" First List is : ");
Display (head1);
pf(" Second list is ");
Display(head 2);

head1 = concatenate (head1, head2)
pf("Final list is ");
display(head1);
}
```

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Searching a data 'x' in LL

```
int search (node *head, int x)
{
  node *p;
  p = head;
  while (p != NULL)
  {
    if (p->data == x)
      return (1);
      p = p->next;
  }
  return(0);
}
```

OR

```
int search(int num)
{ int flag=0;
  struct node *temp = head;
  while (temp != NULL)
  { if (temp->data == num)
      return (1); // Found
    temp = temp->next;
  }
  if (flag == 0)
  { return(0);
```

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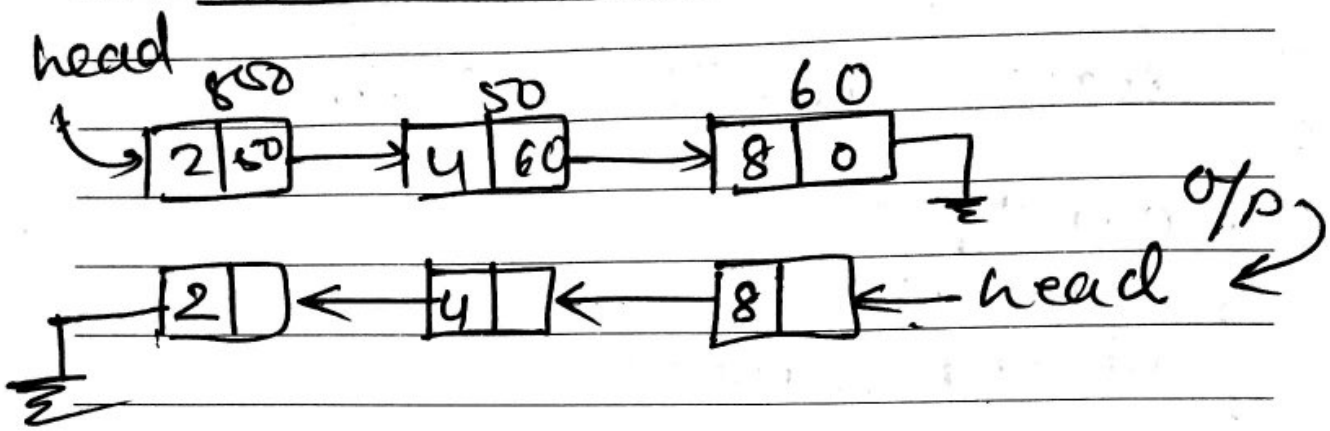
Reverse a Linked List




```
void Reverse()
{
  struct Node *current, *prev, *next;
   current = head;
   prev = NULL
while (current != NULL)
  {
     next = current -> next;
     current -> next = prev;
      prev = current;
      current = next;
  }
  head = prev;
}
```

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* Counting nodes on LL.

```
void count()
{
  struct node *temp=head;
  int length=0;
  temp= start;
  while(temp! =NULL)
  {
    length++;
    ~~length~~ temp = temp->next;
  }
pf("In length is %d", length");
}
```

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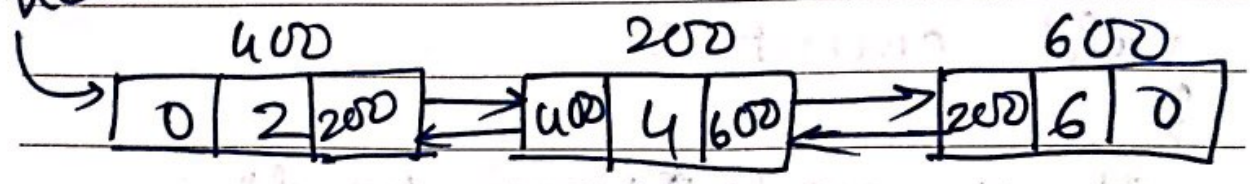
Doubly Linked List.



Adv :- Forward as well reverse lookup is possible

Disadv :-

Extra memory for the pointer to the previous node.

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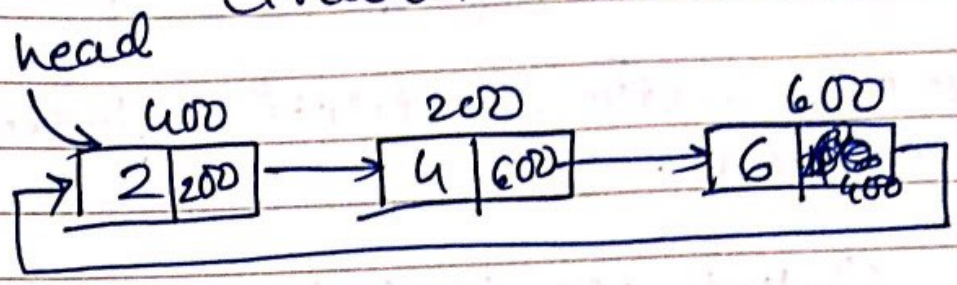
Circular Linked List.



- Any node can be starting point
- useful in application to repeatedly go around the list.

```
void display()
{
  if(head = = NULL)
    pf(" list Empty");
  else
  { x = head;
    while((x -> next ! = head))
    { pf("%d", x -> data);
      x = x -> next;
    }
    pf("%d", x -> data);
  }
}.
```

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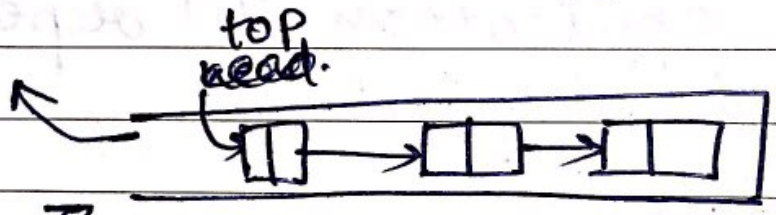
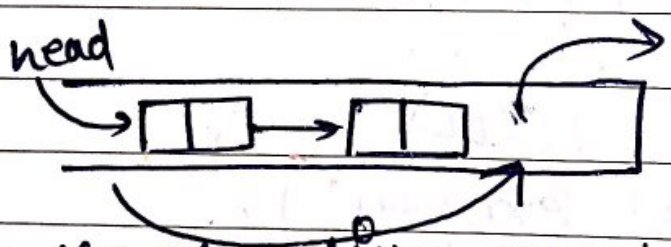
Linked List — Implement stack

Stack :- Insertion & deletion from one end.

with linked we have two options:-
1) insert/delete from head ✓
2) insert/delete from tail ✗



Insertion at head O(1)



Insertion/deletion at tail O(n)

but the operations must take constant time

Adv :- List will never be full

disadv :- More memory required.

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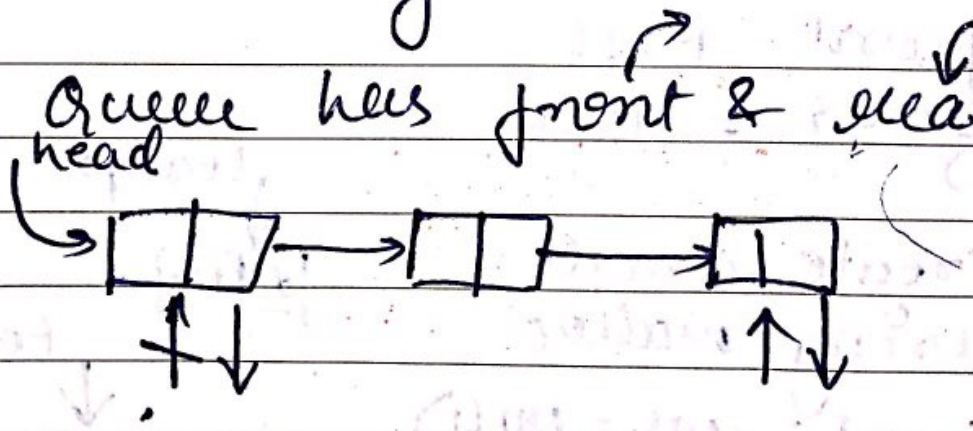
Queue Implementation using LL

- we used circular queue
- disadv :- 1) Array gets filled.
  2) we can ~~to~~ ask an array & copy all the previous elements to the array.

Time complexity → O(n)

3) If we are using larger array then there can be unused memory.

Queue has front & rear



But with LL when you ~~insert/~~

- insert/delete at head O(1)
- insert/delete at tail O(n)

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ur queue with ea. nd.

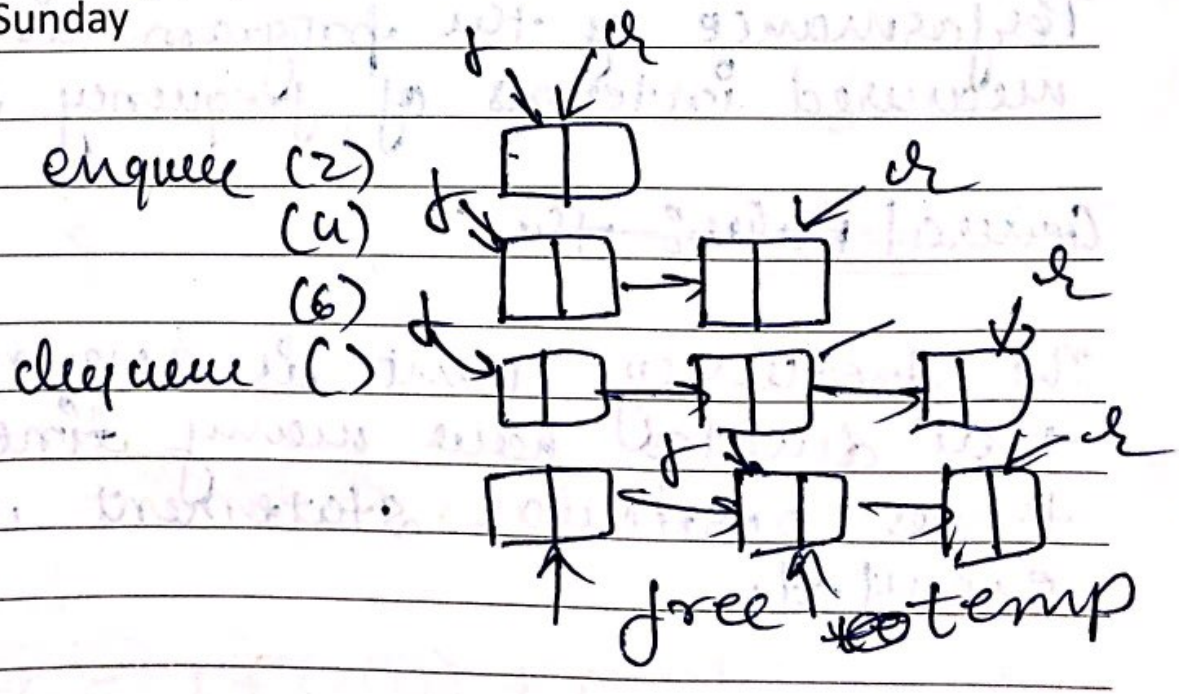
Step 5 :- Insert new node at rear end

set rear → next = temp
rear = temp

step 6 :- Repeat 2 to 5 to enqueue

Step 7 :- To dequeue [temp = front]
a) if (front == NULL) return
b) if (front == rear)
front = rear = NULL
c) else (front = front → next)

& free (temp)



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- Explain circuit.

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Run time Calculation

- Efficiency of algo can be decided by measuring the performance of algo.
- we can measure the performance of an algorithm by counting two factors:

① Amt. of time required by the algo to execute :- Time Complexity

② Amt of space (memory) required by algorithm to execute :- Space Complexity

Performance of the program is measured in terms of frequency count.

~~General Rules:- the~~

The frequency count is a count that denotes how many ~~times~~ times perticular statement is executed.

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12 Tuesday March 2013

Rule 1 :- Simple assignment statement

```
void fun()
{ int a;
    a=10;          —①
    printf("%d", a)  —①
}
```

FC = 2

Rule 2 :- For loops

$\frac{n^2+n+3}{2}$

$O(n^2)$

```
void fun()
{
    int a;
    a=0;                        — 1
  for(int i=0 ; i<n ; i++)      — n+1
  {
    a = a+i ;                   — n
  }
  printf("%d", a);              — 1
}
```

FC = $1+(n+1)+n=1$

$= 2n+3$

$O(n) = TC$

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Rule 3 :- Nested for loops

```
void fun (int a[ ][ ], int b[ ][ ])
{
  int c[3][3];
  for (i=0 ; i<m ; i++)          ---- m+1
  {
    for (j=0 ; j<n ; j++)        m.(n+1)
    {
      c[i][j] = a[i][j] + b[i][j]   m.n
    }
  }
}
```

$FC = (m+1) + [m(n+1)] + m \cdot n$

$= m+1 + mn + m + mn$

$= 2m + 2mn + 1$

```
void add(A, B, n)
{ for (i=0 ; i<n ; i++)
  { for (j=0 ; j<n ; j++)
    { c[i][j] =
```

$2n^2 + 2n + 1$

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queue with eg. or diagram (sh.... 1..

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```
for (i=1 ; i<=n ; i++) ....n+1
{
  for (j=1 ; j<=n ; j++)... n (n+1)
  {
    ~~c[i][j] = a[i][j] + b[i][j]~~
    c[i][j] = 0;          .... n.n
    for (k=1 ; i<=n ; k++)..n.n.(n-1)
      c[i][j] = c[i][j] + a[i][k] * b[k][j];
  }                        .... n.n.n
}
```

$PC = (n+1) + [n(n+1)] + n^2 + n^2(n+1) + n^3$

$= n + 1 + n^2 + n + n^2 + n^3 + n^2 + n^3$

$= 2n^3 + 3n^2 + 2n + 1$

Big Oh notation is a most commonly used algorithmic notation.

For above PC all the constant terms are neglected & only the highest order polynomial is always considered

Hence the time complexity is $O(n^3)$

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Rule 4 :- If-else statement

```
if (a<10)                          --- (1)
Pf("a is less than 10");           --- (1)
else
Pf("a is greater than 10");        --- (1)
```

FC 2 or 2.

eg (1)

```
m = n/2                            --- 1
for(i=0; i+m<n; i++)               --- n/2 + 1
{
    a++;                           --- n/2
    K++;                           --- n/2
}
```

$1 + \frac{n}{2} + 1 + \frac{n}{2} + \frac{n}{2}$

$FC = \frac{3n}{2} + 2$ //

$O(n/2)$

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Imp

eg for (i=1; i<=n ; i++) ... n+1

practice for (j=1; j<=n ; j++) n·(n+1)

x=x+1 n·n

$FC = n+1 + n^2+n+n^2$

$= 2n^2+2n+1$

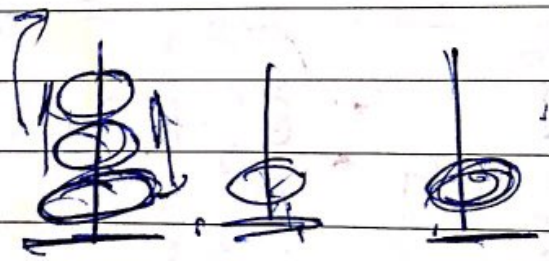
$TC = O(n^2)$

(5) Logarithmic complexity

```
for(i=1; i<=n;)
{
  ---
  ---
  ---
  i = i*2;
}
```

$\log_2 n$

$O(\log n)$



$O(1) < O(\log) < O(n) < O(n \log n) < O(n^2)$

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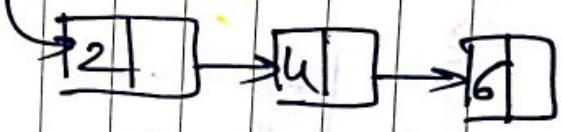
Arrays Vs LL

Factors	Arrays	Linked List
cost of accessing an element:	It takes constant amt. of time array is stored as one contiguous block of memory. If we know the starting address of the block of memory add^s of element with index i $= 200 + i \times 4$ if $i = 4$ $= 200 + 4 \times 4$ $= 200 + 16$ $= 216$ TC $= O(1)$	If data is not stored in contiguous block of memory. Only address that we keep with us is the address of head node. head.  Inserting at:- • head - $O(1)$ • Tail - $O(n)$ • middle → $O(n)$

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Factors	Arrays	Linked List
Memory Requirement	• Fixed size • unused memory 0 1 2 3 4 5 6 2 4 6 - - - - 7×4 = 28 bytes	• No unused memory • Extra memory for pointer head → 2 → 4 → 6 8 8 8 8×3 = 24
cost of Inserting element	At begining - TC O(n) At end - TC O(1) if array is not full - TC O(n) if array is full At middle - TC O(n/2)	At beg - O(1) at tail - O(n) at middle O(n/2)
~~Cost~~		

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Factors	Arrays	Linked List
Ease of use	Easy	Difficult
Cost of deleting	at beg - $O(n)$ at end - $O(1)$ middle - $O(n/2)$	$O(1)$ $O(n)$ $O(n/2)$

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Algorithm :-

```
Merge(L, R, A)
{
 nL ← Length(L)
 nR ← Length(R)
  i ← j ← k ← 0

while(i < nL && j < nR)
{
 if( L[i] <= R[j])
 {
   A[k] ← L[i]
   k ← k+1
   i ← i+1
 }
else
 { A[k] ← R[j]
   k ← k+1
   j ← j+1
 }
}
```

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```
while (i < nL)
{ A[K] ← L[i]
    i ← i+1
    K ← K+1
}
while (j < nR)
{
  A[K] ← R[j]
  j ← j+1
  K ← K+1
}
}     //end of Merge()
```

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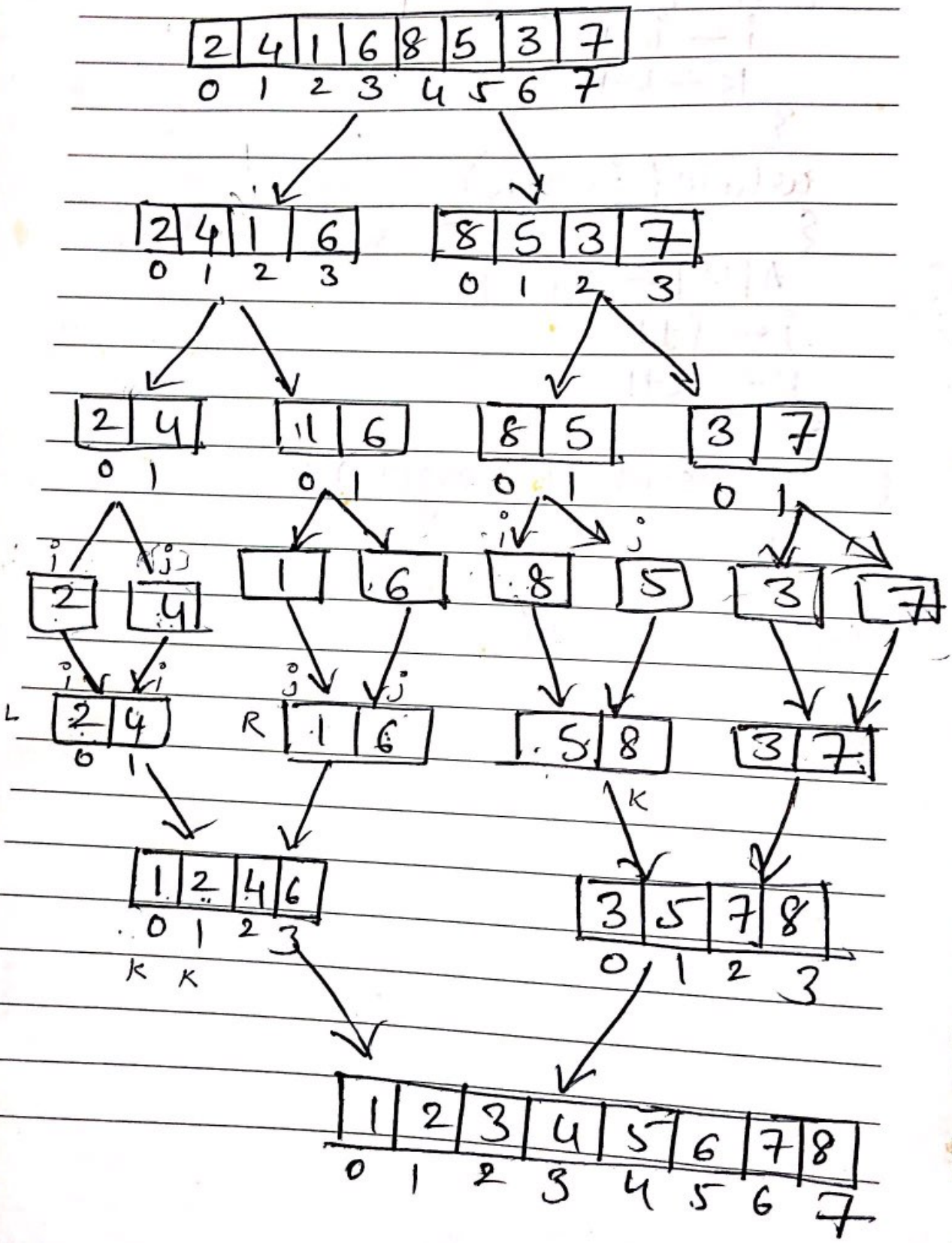
Merge Sort :-



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```
MergeSort(A)
{ n ← length(A)
  if (n<2)
    return
  mid ← n/2
  left ← array of size(mid)
  right ← array of size (n-mid)
  for i ← 0 to mid-1
      left[i] ← A[i]
  for i ← mid to n-1)
      right[i-mid] ← A[i]

  MergeSort(left)
  MergeSort(right)
  Merge(left, right, A)

}.
```

```
for i=0 to 3
left[0-3] ← A[0-3]
for i=4 to i=7
right[0-3] ← A[4-7]
```

n = 8
mid = 4
left = 4
right = 4

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Program:-

```
# Include <stdio.h>
# Include <stdlib.h>

void Mergesort(int *a, int length);
void Merge(int *a, int *L, int *R, int length);

void main()
{
 int a[7] = {99, 36, 55, 2, 1, 27, 92};
 int i=0;
 Mergesort(a, 7)

for(i=0; i<7 ; i++)
{
 pf("%d\t", a[i]);
}

}
```

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queue with eg. or diagram (sh... l...

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```
void Mergesort(int *a, int length)
{
  int mid = 0; int *L, *R; int i=0;
  mid = length/2;

// exit cond^n for recursion
  if (length < 2)
    return;
else
  { L = (int*) malloc(sizeof(int)*mid);
    R = (int*) malloc(sizeof(int)*(length-mid));

// this code is to create left & right child arrays

// this code is to copy contents into childs

for (i=0; i< mid; i++)
{ L[i] = a[i]; }
for (i=mid; i< length; i++)
{ R[i-mid] = a[i]; }

Mergesort(L, mid);
Mergesort(R, length-mid);
Merge(a, L, R, length);  // start merge the children
}
```

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```
void Merge(int *a, int *L, int *R, int length)
{
int i=0, j=0, k=0;
int mL, mR;
mL = length/2;
mR = length - mL

while (i<mL && j<mR)
{
  if(L[i] < R[j])
  {  a[k] = L[i];
     i++;
  }
  else
  {
    a[k] = R[j];
     j++
  }
  k++;
}
while(i< mL)
{
  a[k] = L[i]
   i++;
}
```

```
while(j< mR)
{
a[k] = R[j];
  j++;
  k++;
}
}
```

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```
Quicksort(A, start, end)
{
    if (start < end)
    {
      pIndex ← partition (A, start, end)
      Quicksort(A, start, pIndex - 1)
      Quicksort(A, pIndex+1, end)
    }
}
```

pivot

7	2	1	6	8	5	3	4
0	1	2	3	4	5	6	7

PI

pivot

2	7	1	6	8	5	3	4
0	1	2	3	4	5	6	7

PI

2	7	1	6	8	5	3	4
0	1	2	3	4	5	6	7

PI

2	7	3	6	8	5	1	4
0	1	2	3	4	5	6	7

PI

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```
Partition (A, start, end)
{
  pivot ← A[end]
  pIndex ← start
  for i ← start to end-1
  {
    if (A[i] <= pivot)
    {
      swap (A[i], A[pIndex])
      pIndex ← pIndex+1
    }
  }
  swap (A[pIndex], A[end])
  return pIndex
```

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Program :-

```
int partition(int *A[], int start, int end)
{ int pivot = A[end];
  int ~~partition~~ pIndex = start
  for(int i = start ; i<end ; i++)
    {
      if (A[i] <= pivot)
        {
          swap(A[i], A[pIndex]);
          pIndex++;
        }
    }
  swap(A[pIndex], A[end]);
  return pIndex;
}
void QuickSort(int A[], int start, int end)
{ if(start < end)
    {
      int pIndex = partition(A, start, end);
      Quicksort(A, start pIndex - 1);
      Quicksort(A, pIndex+1, end);
    }
}
```

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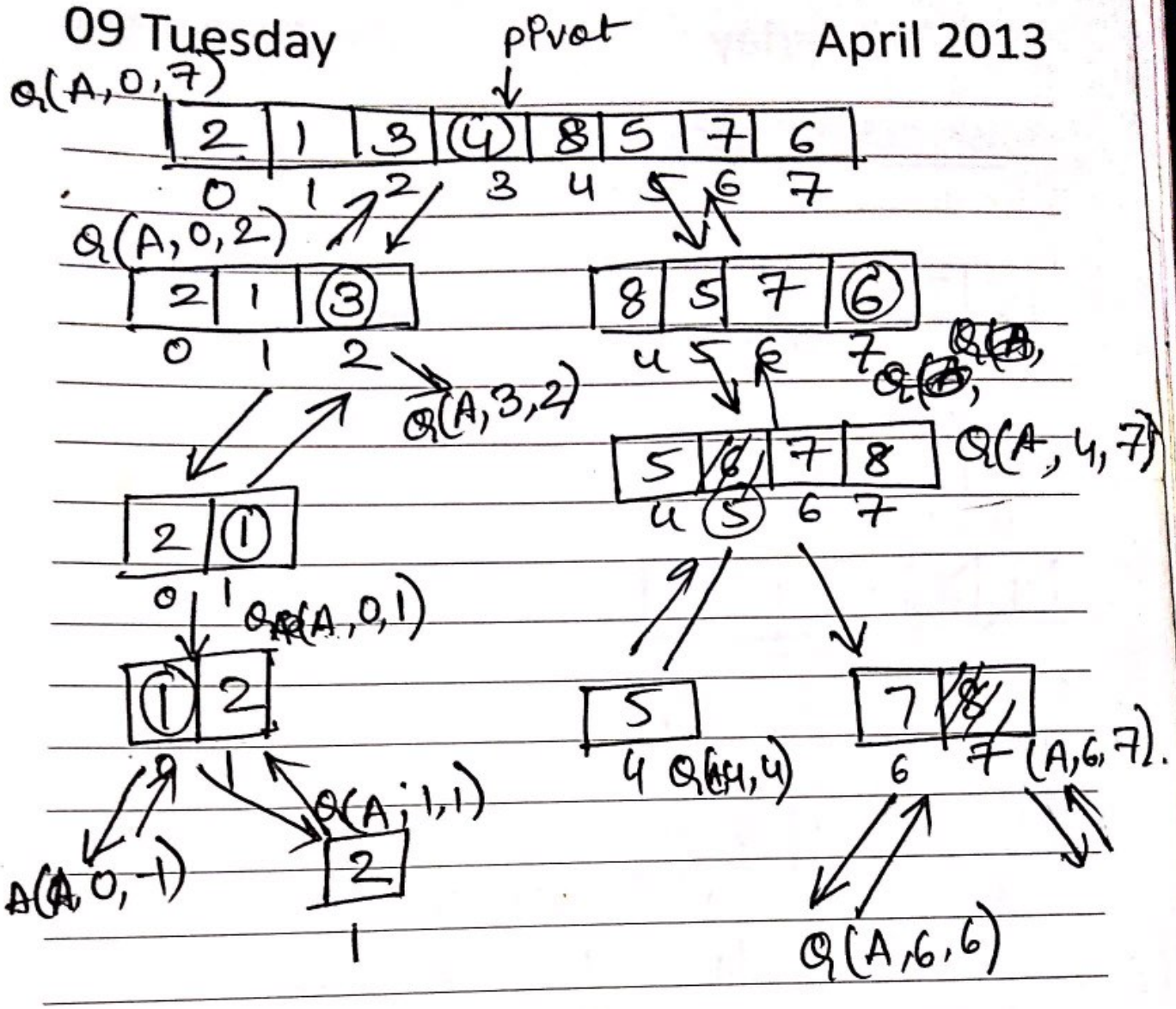

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Selection Sort

2	7	4	1	5	3
0	1	2	3	4	5

⇒

1	7	4	2	5	3
0	1	2	3	4	5

~~1~~	~~2~~	4	7	5	3

1	2	3	7	5	4

1	2	3	4	5	7

0	1	1	2	3	4
2	7	4	1	5	3
i iMin			iMin		

```
SelectionSort(A,n)
{ for i ← 0 to n-2
{ iMin ← i
  for j ← i+1 to n-1
  {
    if (A[j] < A[iMin])
      iMin ← j
  }
  Swap(A[i], A[iMin])
}
```

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```
void selection(int A[], int n)
{
for(int i=0 ; i<n-1 ; i++)
{
  int iMin = i
  for( int j = i+1 ; j<n ; j++)
  {
    if(A[j] < A[iMin])
      iMin = j
  }
  int temp = A[i];
  A[i] = A[iMin];
  A[iMin] = temp;
}
}
```

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Bubble Sort

4 1 7 5 3 7

2 7 4 1 5 3

↑ ↑ ↑ ↑ ↑

~~repeat~~ 1 4 3 5

⇒ 2 4 1 5 3 7

↑ ↑ ↑ ↑

1 2 3 4

⇒ 2 1 4 3 5 7

↑ ↑ ↑ ↑

= 1 2 3 4 5 7

```
BubbleSort(A, n)
{ for k ← 1 to n-1
  {
    for i ← 0 to n-2
    {
      if (A[i] > A[i+1])
      {
      swap(A[i], A[i+1])
      }
    }
  }
}
```

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```
Insertion Sort(A, n)
{
 for i ← 1 to to n-1
 {
  value ← A[i]
  hole ← i
 while (hole > 0 && A[hole - 1] > value)
 {
  A[hole] ← A[hole - 1]
   hole ← hole - 1
 }
 A[hole] ← value
 }
}
```

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7	~~2~~	4	1	5	3
0	1	2	3	4	5

value = 2

2 7 | ~~4~~ 1 5 3

value = 4

2 ~~4~~ 7 | 1 5 3

value = 1

1 2 4 7 | ~~8~~ 3

value = 5

1 2 4 5 7 | 3

value = 3.

1 2 3 4 5 7

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Searching Techniques

~~1) Linear Search :-~~

- when we store & organize data, there are various operations that are performed in it.
- Searching is most frequent performed operation
- It ~~is~~ should be efficient & fast.

Types :-

① Linear Search (Sequential search)

In this, search is done one by one from top to bottom.

② Binary search.

- It is done on sorted data.
- find the middle element
- choose the data to be searched.
- If the data is lesser go to the left side else go to right.

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mid
↓
2 6 7 9 10 12 15

No. to be searched. = 7

$\boxed{7<9}$ → go left & scan each element

~~Bin search(~~
void main()
{
int A[] = {3, 11, 15, 16, 19, 20, 22}
int item = 20;
bin_search (A, 7, item);
}

void bin_search(int L[], int N,
int item)
{
int l=0, u=N-1;
while (l<=u)
{
m=(l+u)/2
if (item==L[m])

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```
{ pf("Success")
    return;
}
else if (item>L[m])
    l = m+1
else
    u = m-1;
}
pf("Unsuccessfull")
}.
```

<u>Searching : Time complexity</u>

- Linked List - $O(n)$
- Array (unsorted.) - $O(n)$
- Array (sorted) - $O(\log_2 n)$
- BST - $O(\log_2 n)$
- Hash Table - $O(1)$

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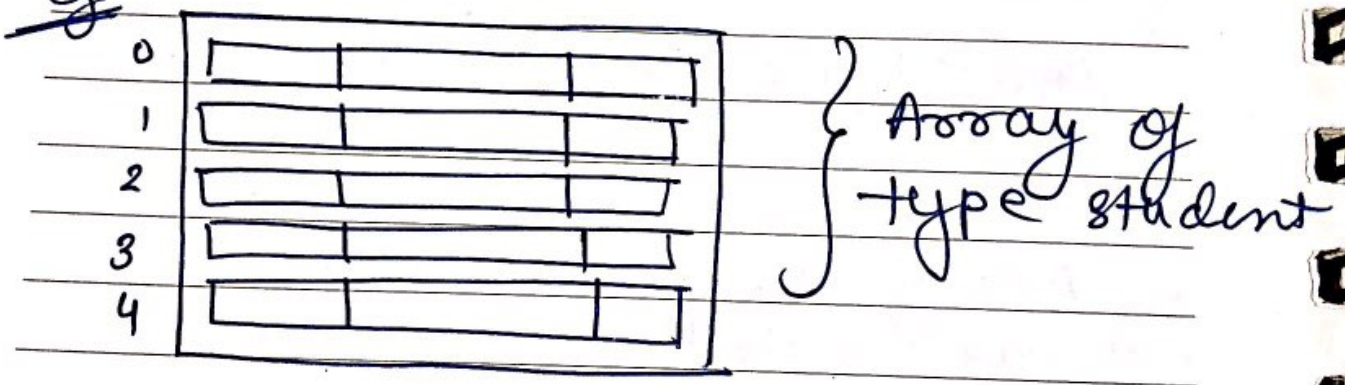
Hash Table — custom array

```
struct student
{ int rollno;
  char name[20];
  int age;
};

student s1;
student s[5];
```

eg



$\boxed{\text{candidate NO} = \text{Index NO}}$

Give the candidate NO & in constant time you can search student info".

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20 Saturday April 2013

eg 2 complaint System.

Complaint key [0 - - - 9]
m = spaces = 10
n = data = 5
key = bigger Number.

$n \leq m \leq$ key.

In case when keys are large & can't be directly used as index. then we have to map them.

21 Sunday CN (Key) = 1000 to 9999 ✓

CN
1081
1523
3446
7189
5524

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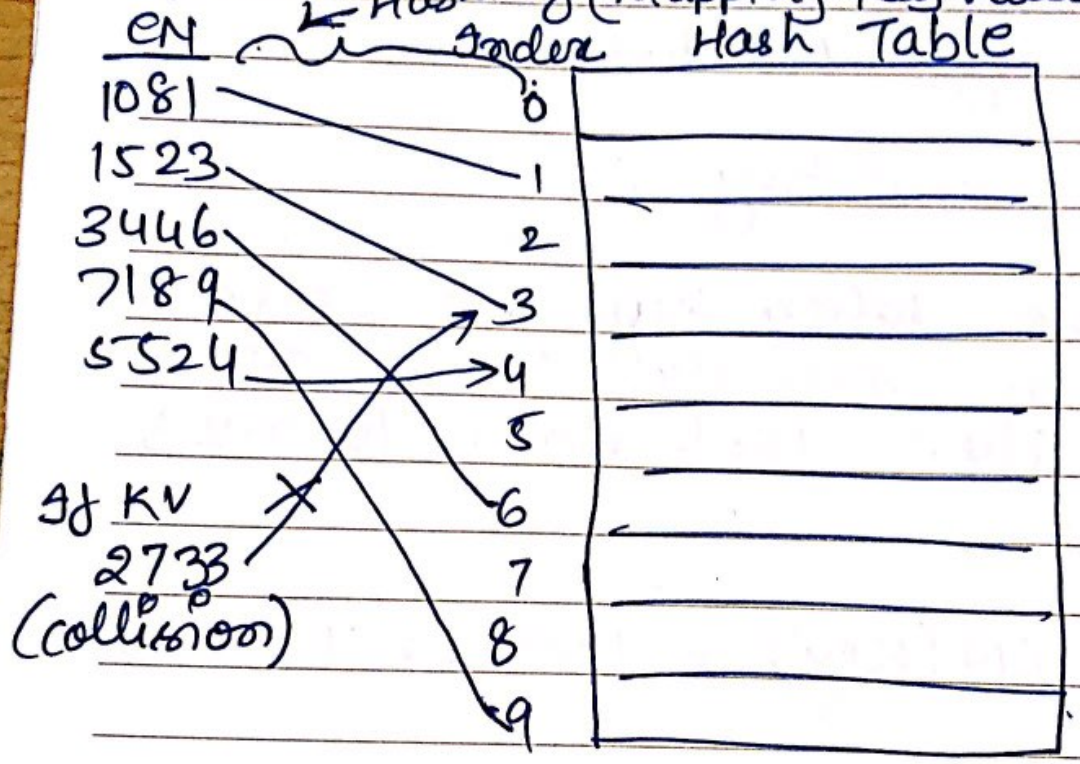
22 Monday ⇒ any formula. April 2013

Hash function (CN) ⇒ Index

assume $\boxed{HF = CN \% 10}$

key value ← Hashing (Mapping key value with index)



- To avoid collision we should create Hash function better & efficient

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1) Hash Table :-
- Mostly it is an array to store dataset. It is the data structure.

2) Hash Function :-
It is funⁿ that can be used to map dataset of arbitrary size to dataset of fixed size which falls into Hash table

3) Hashing :-
large keys are converted into small ones by using hash funⁿ & then the values are stored in data structure called hash tables.

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22 Wednesday April 2013

Hash function :-

- A hash function usually means a function that compresses, meaning the output is shorter than the input.

- A hash function is any function that can be used to map data of arbitrary size to data of fixed size.

- Parameters of good function :-
  1) Easy to compute
  2) Even distribution
  3) Minimize collision

- Perfect hashing maps each valid input to a different hash value (no collision).

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Collision Resolution :-

- Hash table is a Data structure where the data elements are stored (inserted), searched, deleted based on the keys generated for each element, which is obtained from a hashing function

- A perfectly implemented hash table would always promise an avg insert/ delete/ retrival time of O(1)

- A situation when the resultant hashes for two or more data elements in the data sets, maps to the same location in the has table, is called callision.

- In such situation two or more data elements would qualify to be stored/ mapped to the same location in the hash table.

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26 Friday April 2013

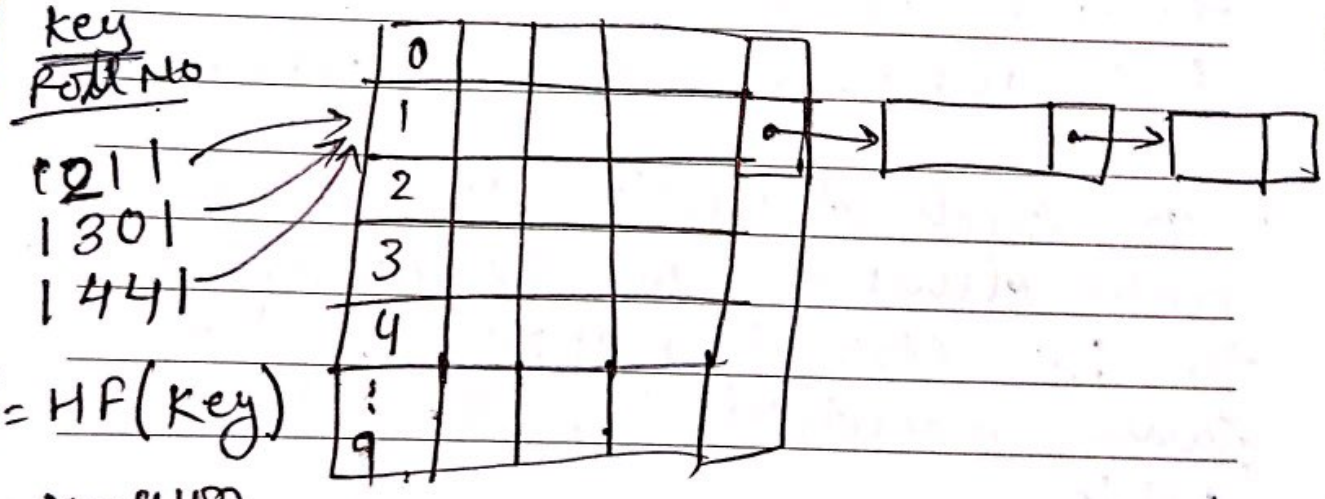
Hash Collision Resolution Techniques :-

1. Open Hashing (chaining)
2. Closed Hashing (Open Addressing)

Open Hashing :-
When collisions are stored outside the table

Closed Hashing :-
when collisions result in storing one of the records at another slot in the table (closed hashing).

Open Hashing



i = HF(Key)

HF = Key % 100

- It defines each slot in the hash table to be the head of linked list.

- All the records that hash to a particular slot are placed on that slot's linked list.

(2) Closed Hashing

(1) Linear Probing

$i+1$
$i+2$
$i+3$

28 Sunday

(2) Quadratic Probing

$i+1$
$i+4^{2^2}$
$i+9^{3^2}$

(3) ~~i+5~~ Double Hashing

$i+5$
$i+2*5$
$i+3*5$
$i+4*5$

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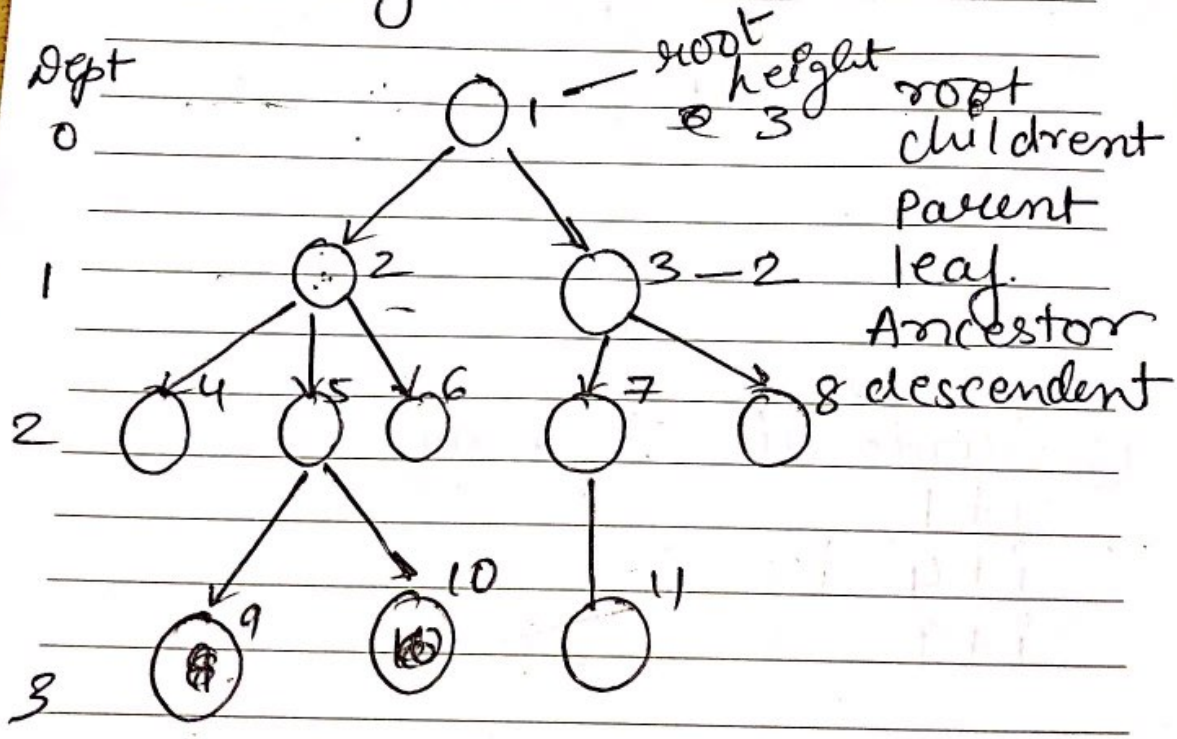
Trees

- Non Linear Data structure
- Used to store hirarchical data.
- Definition :-

Collection of nodes linked together to represent a hirarchy.



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leaf – has no child.

Tree – recursive data structure
- → N nodes
- → N-1 edges.

} valid tree.

Depth & Height

Depth of node x = length of path from root to x
OR
No. of edges from root to x

Height of node x =
No. of edges in longest path from x to a leaf.

Height of tree = height of root node

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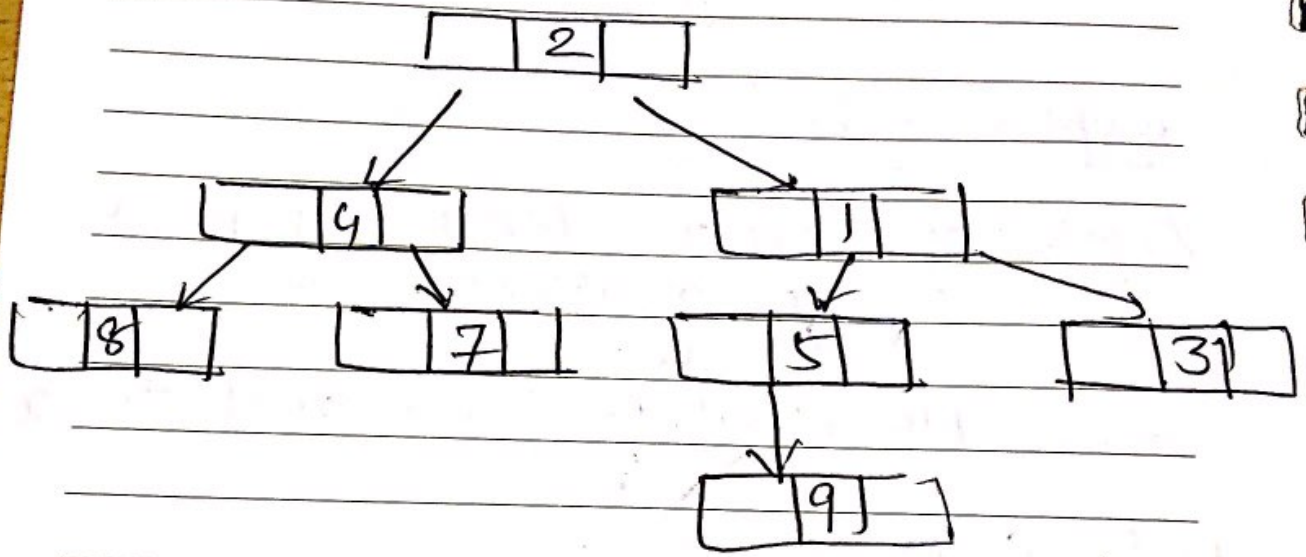
01 Wednesday May 2013

- Binary Tree:-
  A tree in which each node can have at most (max) 2 children.




```
Struct Node
{
 int data;
 Node *right;
 Node * left;
};
```

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02 Thursday May 2

Applications :-

1) Storing naturally hierarchical data →
   eg :- file System

2) Organize data
   → quick search, insertion, deletion.

3) Trie → dictionary
   Dynamic Spell checking.

4) Network Routing Algorithm.

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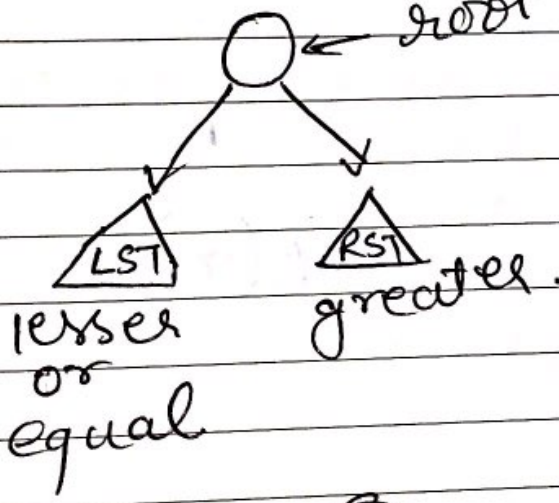
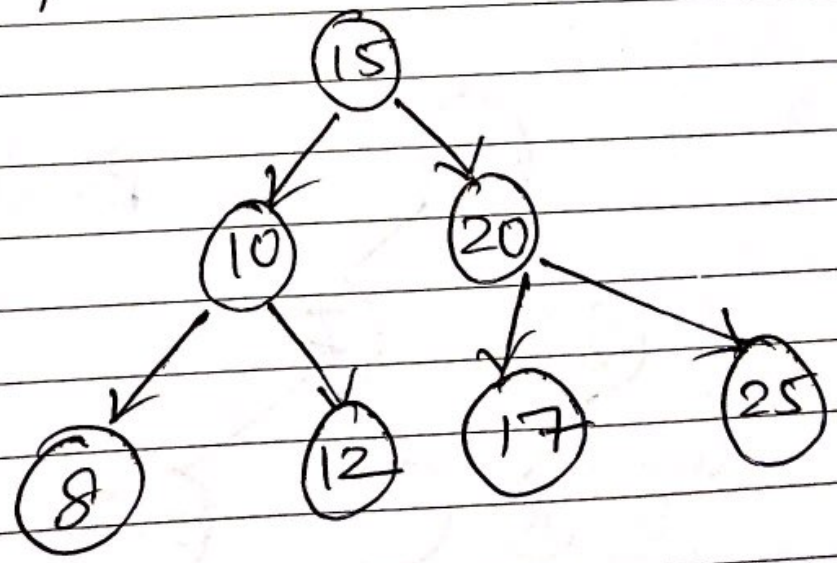
07 Tuesday May 2013

Binary Search Tree (BST)

A binary search tree in which for each node, value of all the nodes in left subtree is lesser or equal and values of all the nodes in right subtree is greater.





$n \rightarrow n/2 \rightarrow n/4 \rightarrow \cdots \rightarrow 1$

$O(\log_2 n)$

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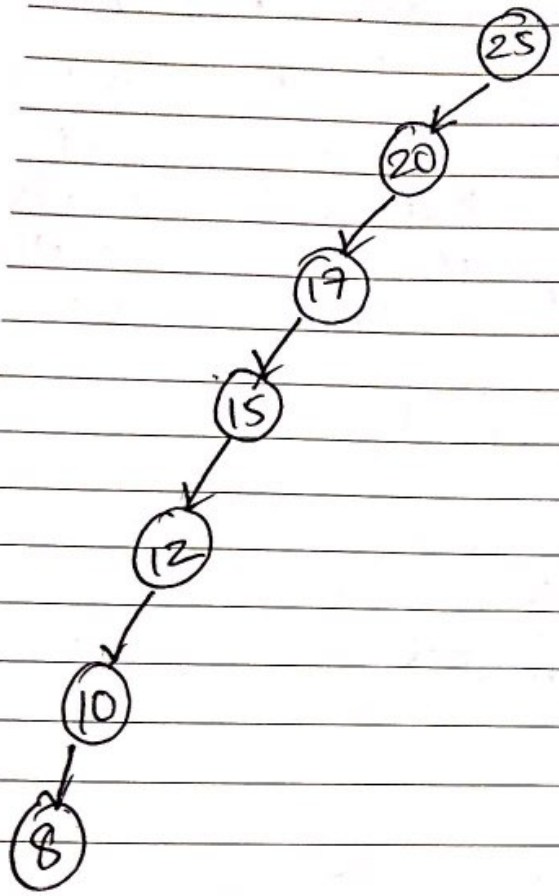
08 Wednesday May 2013

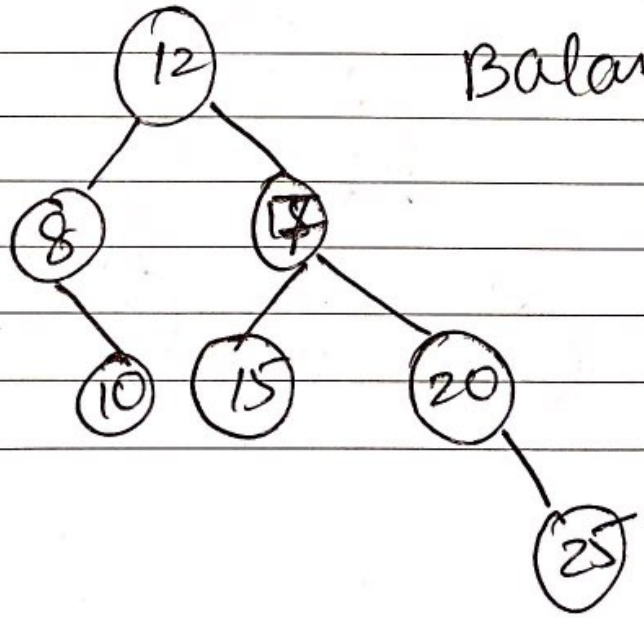
Unbalance BST



$n \rightarrow n-1 \rightarrow n-2 \rightarrow \vdots \rightarrow 1$

$O(n)$

Balanced



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09 Thursday May 2013

Implementation using Linked List

```
Struct Node
{ int data;
  Struct Node * left;
  Struct Node * right;
};
int main()
{
Struct Node * root = NULL;
root = Insert (root, 15);
root = Insert (root, 10);
root = Insert (root, 20);
root = Insert (root, 25);
}

Struct Node * Insert(struct Node *root,
                     int data)
{ if (root == NULL)
{ root =(struct Node*) malloc (sizeof
                (struct Node*));
  root -> data = data;
  root -> left = root -> right = NULL;
}
```

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```
else if (data <= root -> data)
  root -> left = Insert(root -> left, data);
else
  root -> right = Insert(root -> right, data);

return root;
}

int search(struct Node *root, int data)
{
  if (root == NULL)
  return 0;
else if (root -> data == data)
  return 1;
else if (data <= root -> data)
  return search(root -> left, data);
else
  return search (root -> right, data);
}
```

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11 Saturday May 2013

Binary Tree Traversal :-

→ Breadth first-

F, D, J, B, E, G, K, A, C, I, H

→ Depth first:-

<root> <left> <right> — preorder

<left> <root> <right> — inorder

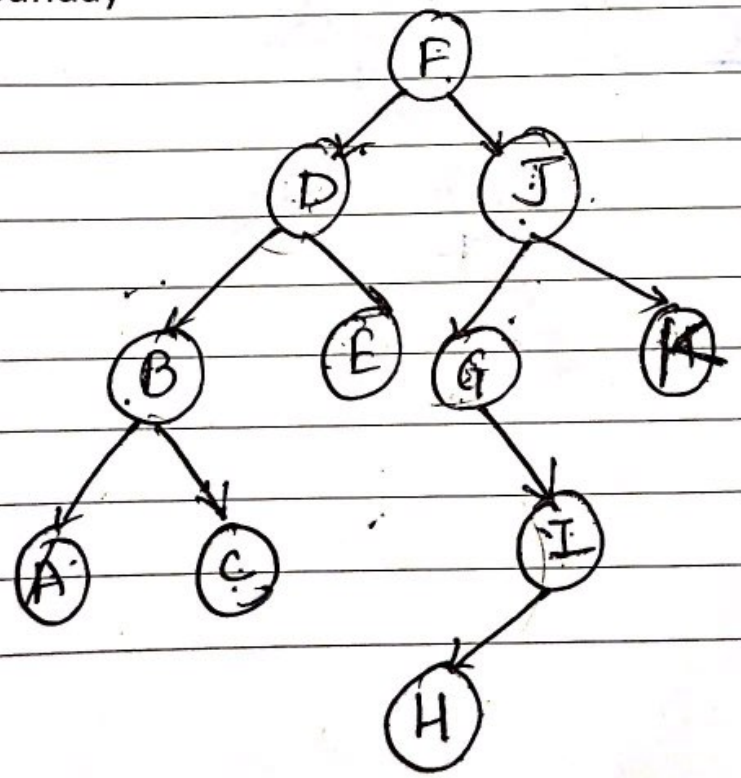
<left> <right> <root> — postorder

preorder:- F, D, B, A, C, E, J, G, I, H, K

inorder:- A, B, C, D, E, F, G, H, I, J, K,

Postorder:- A, C, B, E, D, H, I, G, K, J, F

12 Sunday



L-0

L-1

L-2

L-3

L-4

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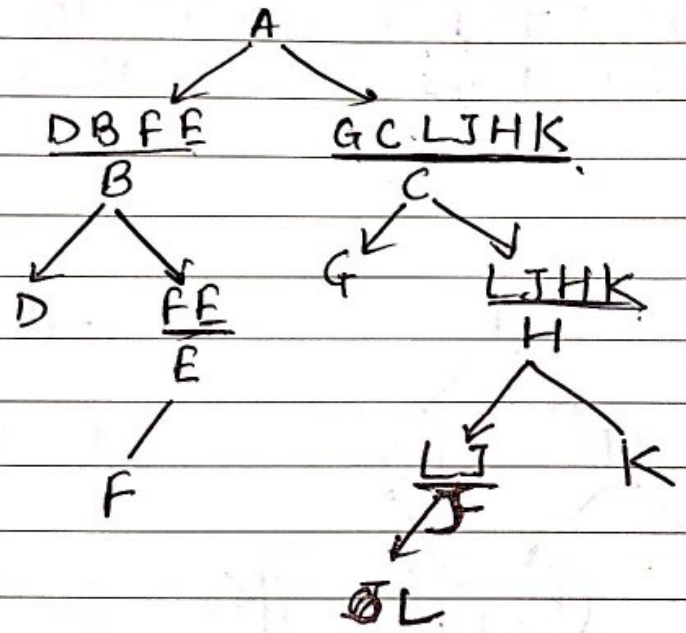
13 Monday May 2013

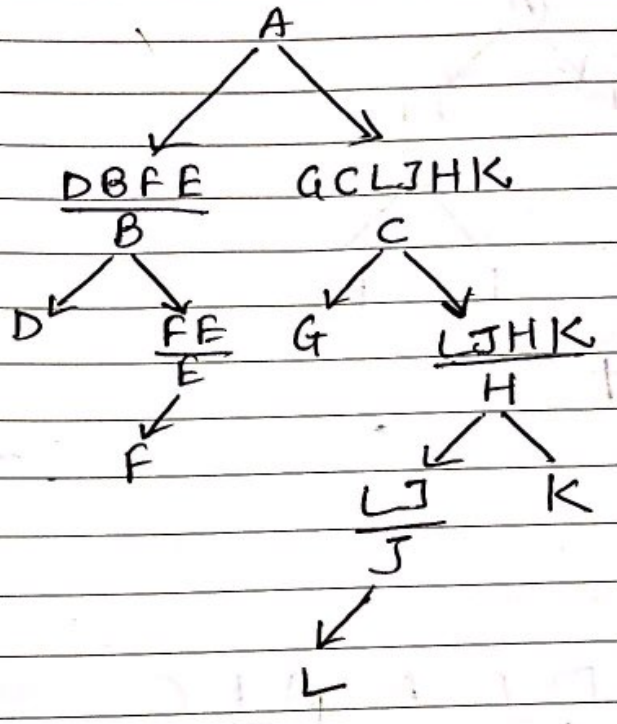
Construct Binary Search Tree using preorder, Inorder & postorder.

Preorder :- Root L R
Inorder :- L Root Right
Postorder :- L R Root

① Preorder :- A B D E F C G H J L K
Inorder :- D B F E A G C L J H K



② Postorder : D F E B G L J K H C A
Inorder : D B F E A G C L J H K



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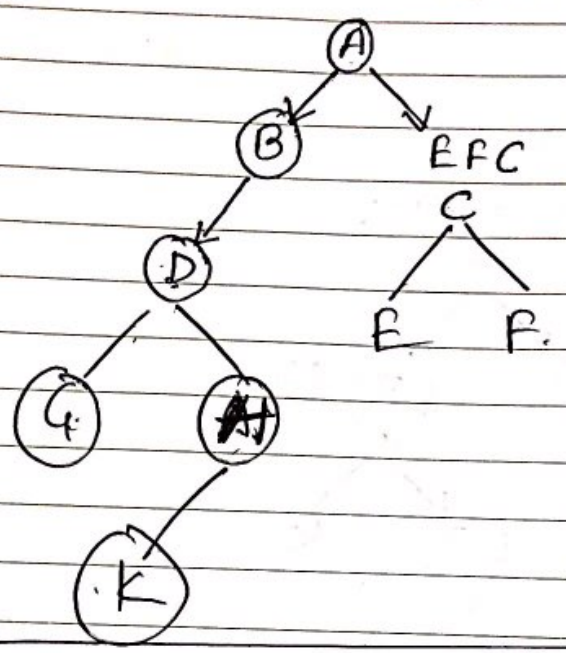
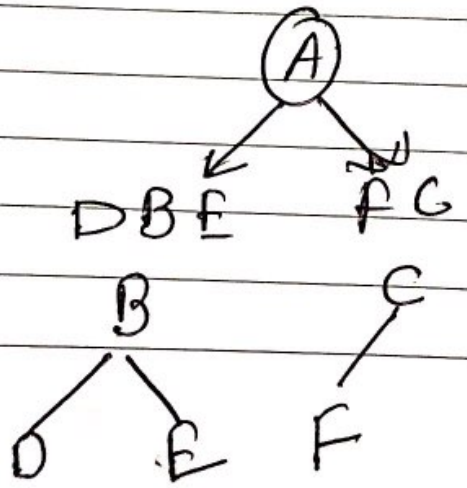
15 Wednesday May 2013

(3) Preorder :- A B D G H K C E F
Postorder :- ~~G H~~ G K H D B E F C A } Tricky



Inorder :- D B E A F C

Preorder :- A B D E C F



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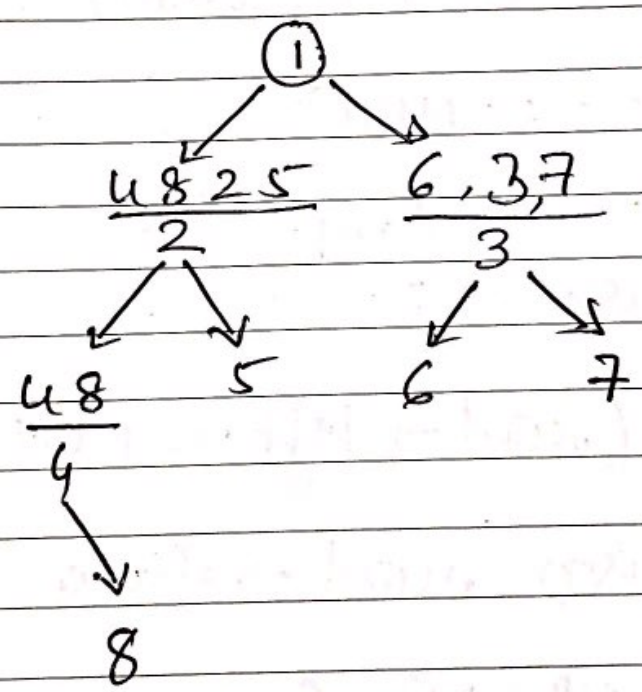
eg

① Preorder : ~~ABCD~~ A B D E F C G H J K

Inorder : D B F E A G C L J H K

Inorder :- 4, 8, 2, 5, 1, 6, 3, 7

postorder :- 8, 4, 5, 2, 6, 7, 3, 1



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17 Friday

May 2013

Find min & max element in BST

```
struct BstNode
{ int data;
  BstNode * left;
  BstNode * right;
};

int FindMin(BstNode* root)
{
  if (root == NULL)
  {
    pf("Tree Empty");
    return -1;
  }
else if (root -> left == NULL)
  {
    return root -> data
  }
return FindMin(root -> left);
}
```

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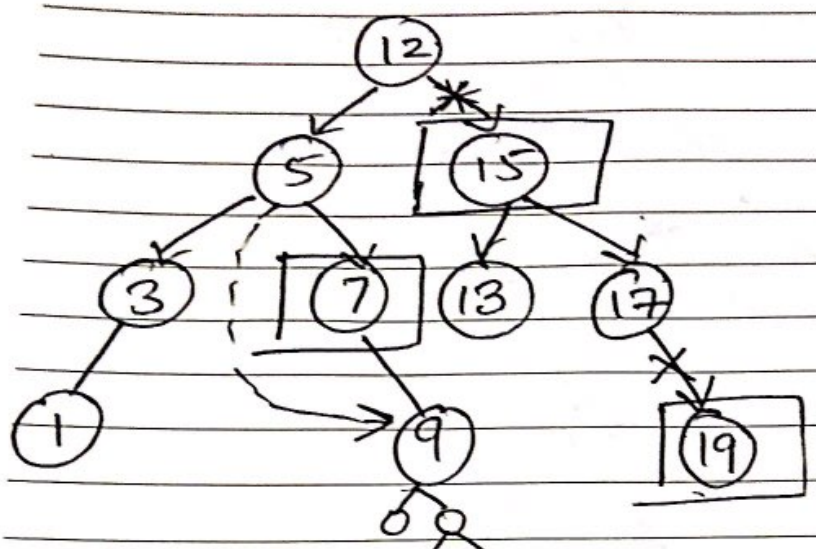
18 Saturday May 20_

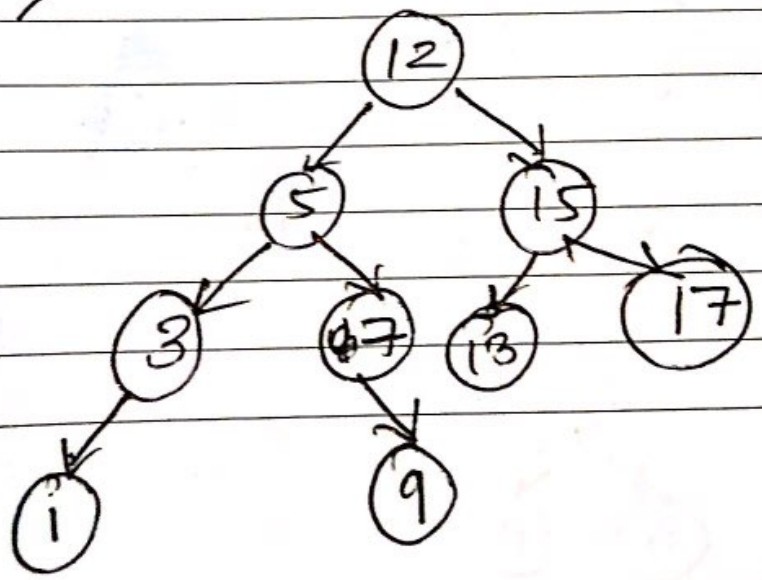
Delete a node from BST



(1) – Remove the reference (link)
(2) – free the node from memory

19 Sunday

Case 1 Node with No child.



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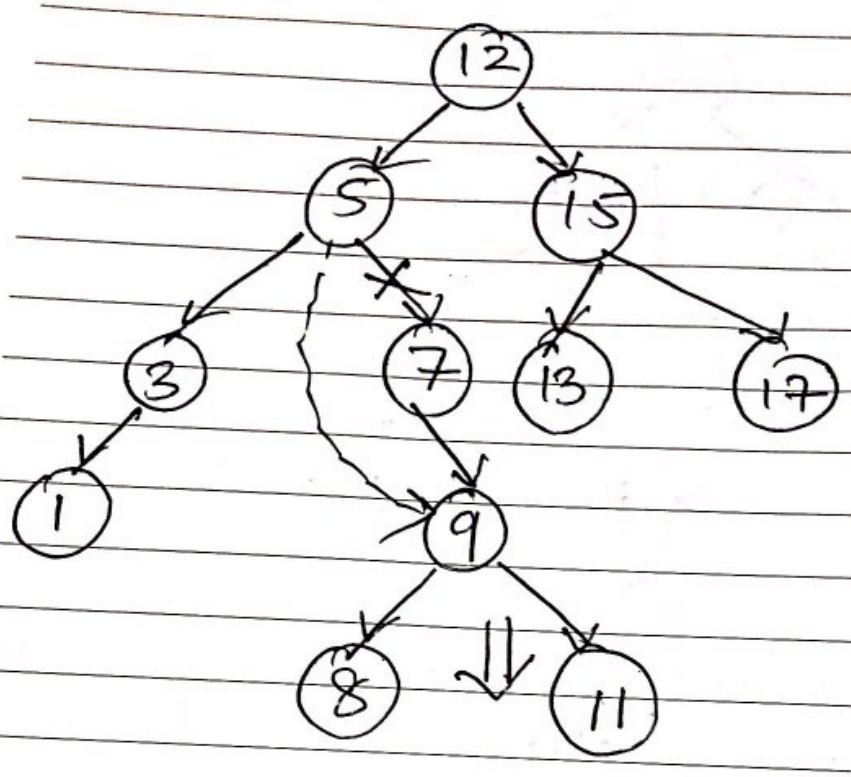
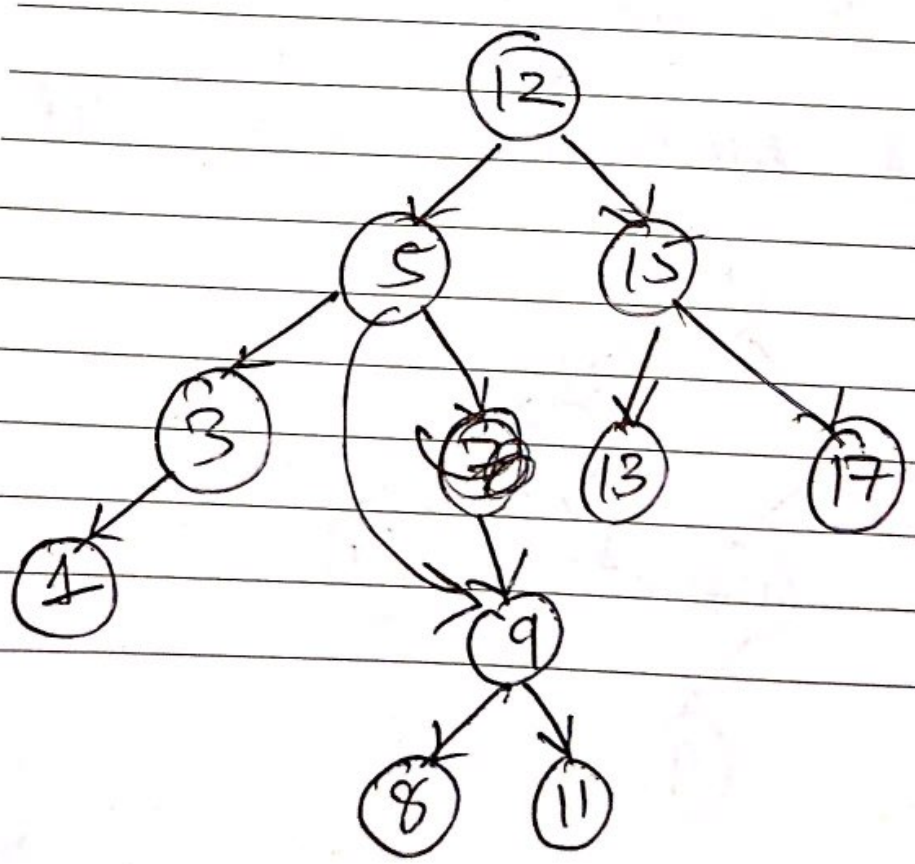
Case 2 Node with one child.





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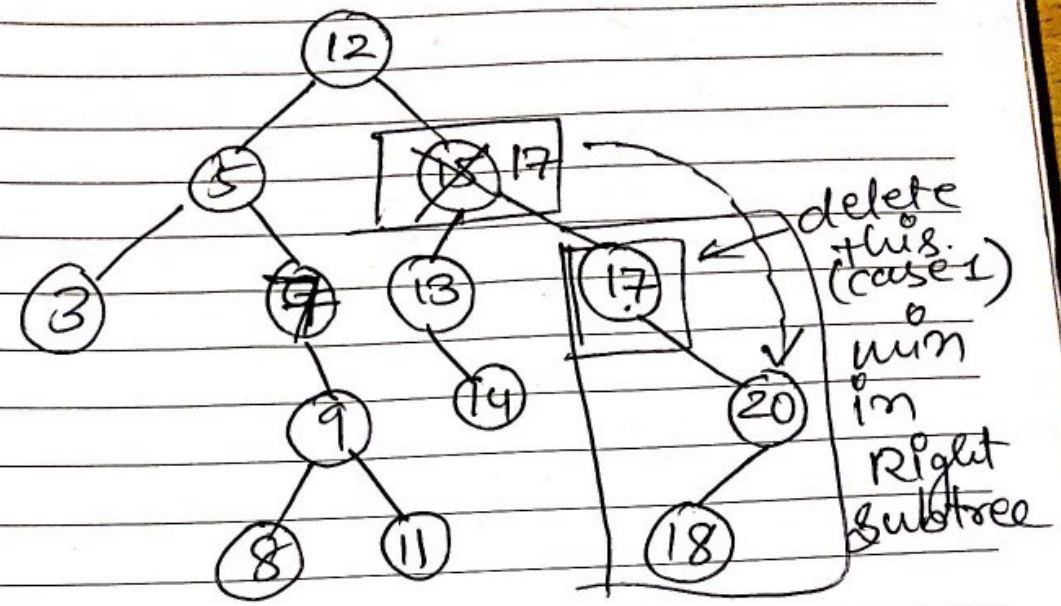
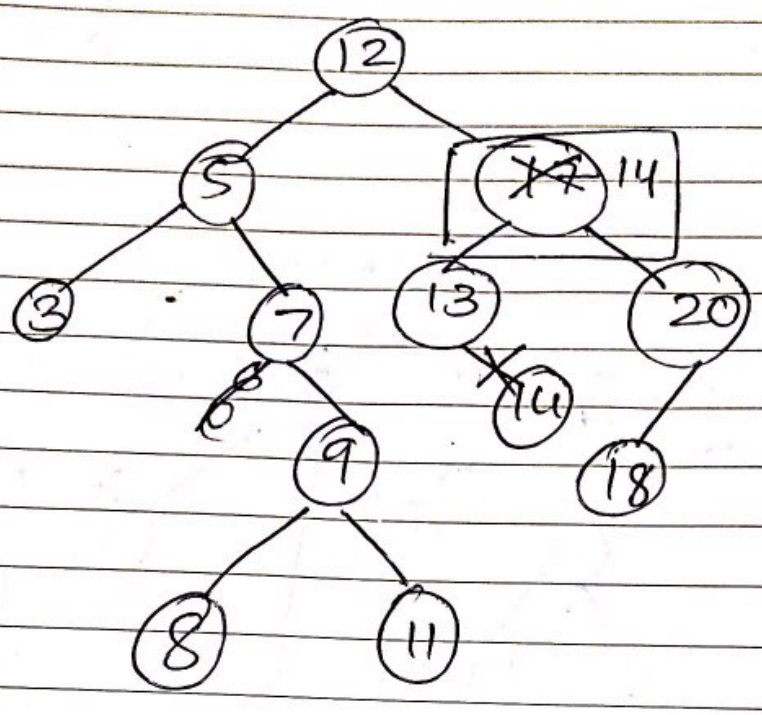
case 3 : Node with 2 children



- Reduce to case 2 or case 1

1. Min of RST and copy in root → data.
2. We now have two node of 17
3. 17 in RST has only one child so its easy to delete (case 2)
4. Min from RST will have all node LST lesser & RST will have greater & equal values
5. If a subtree having min value, it won have a left child



BST after deleting node 15

① choose max from LST & copy ~~with~~ in (root → data)

② Delete the duplicate Node

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23 Thursday May 2

Case 3: 2 children

① Find min in RST	① Find max in LST
② Copy the value in targetted node	② copy the value in the targetted ~~value~~ node
③ Delete the duplicate from RST	③ Delete duplicate from left subtree.

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24 Friday May 2013

Delete a Node in BST

```
Struct Node* Delete (struct Node *root,
                     int data)
{
    if(root == NULL)
    return root;

    else if (data < root -> data)
    root -> left = Delete(root -> left, data)

    else if (data > root -> data)
    root -> right = Delete(root -> right, data);

// Node is found

    else
{
    // case 1: No Child

    if(root -> left == NULL &&
                root -> right == NULL)
    {
        free(root);
        root = NULL;
    }
```

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```
// case 2: One child

else if(root->left == NULL)
{
  struct Node* temp = root
  root = root->right;
  free(temp);
}
else if(root->right == NULL)
{
  struct Node *temp = root;
  root = root->left;
  free(temp);
}
```

26 Sunday

```
// case 3: 2 children

else
{
  struct Node *temp = findMin(root->right);
  root->data = temp->data;
  root->right = Delete(root->right,
                       temp->data);
}
}.
```

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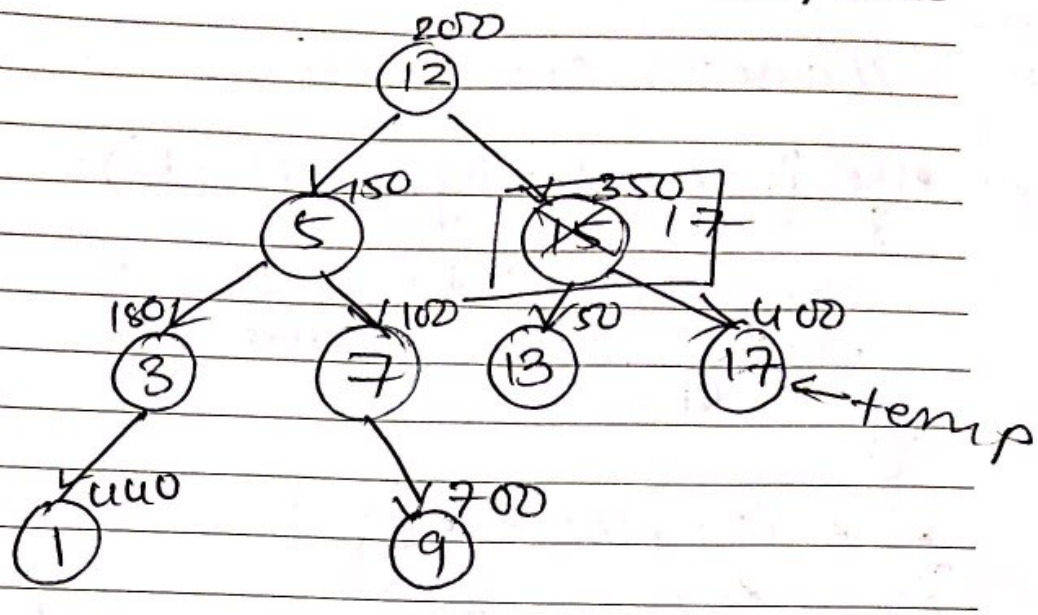

main()

Delete(200, 15)

↓ ↑ 200

200→right = Delete(350, 15)

~~temp~~ ↓ ↑ 350

350→right = Delete(400, 17)

=NULL

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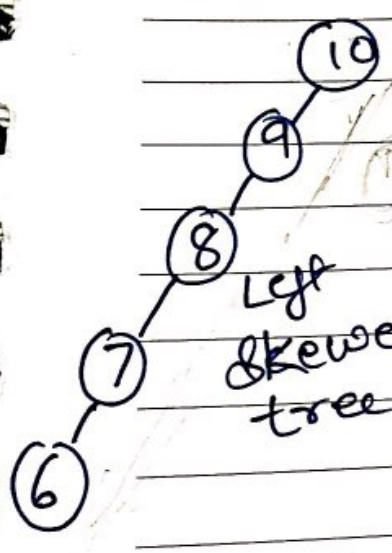
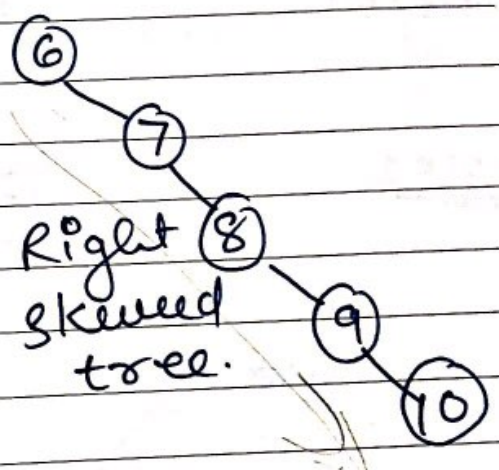
AVL Trees

- BST are always unbalanced
- when unbalance the operations on it might take more than ($\log_2 n$) time to complete.

- Extreme cases for unbalance BST



Left skewed tree



Right skewed tree.

Above BST will take n instruct^{n}s to perform any operation.

$\therefore$ BST needs to be Balanced.

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AVL Trees

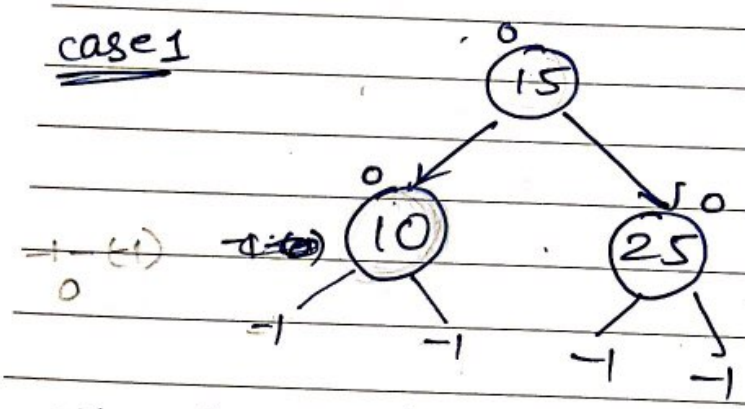
- Self-balancing BST
- Every Node has Balancing Factor

Balancing Factor

$$BF = \left(h_{(LST)} - h_{(RST)}\right)$$

$$BF = \boxed{-1, 0, 1}$$ ← Permissible Values

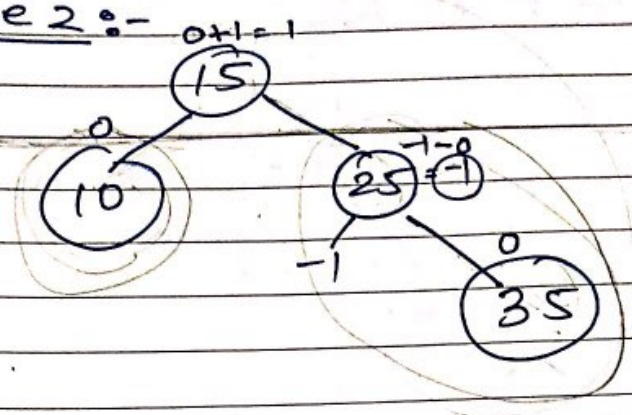
case 1



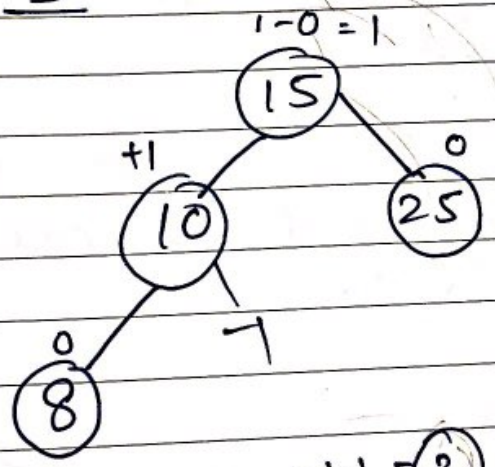
Ht of empty tree −1

Ht of ~~one~~ tree with one node 0

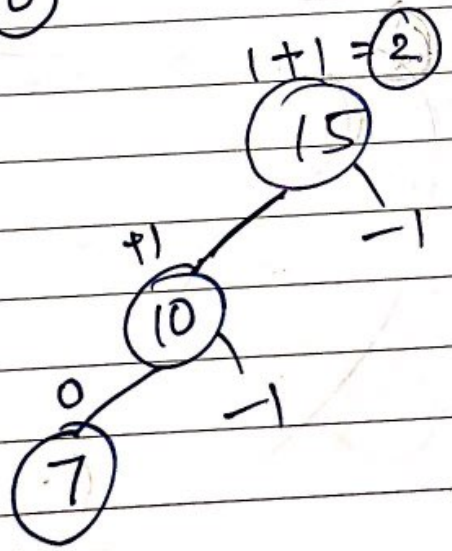
case 2 :-



Case 3



case 4



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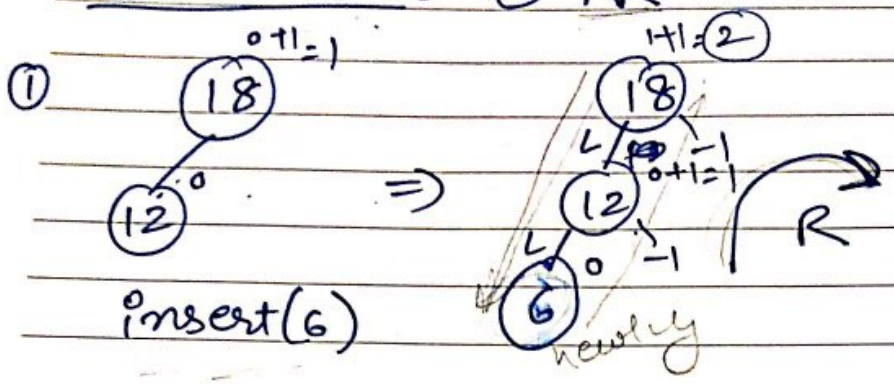
Rotations :- ① RR Rotation



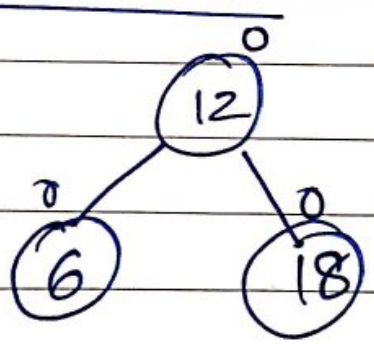
insert(6)

① Start from the newly inserted node to the node whose BF is not valid.

② from that node go back to newly inserted node & count first two moves

LL → R

After Rotation



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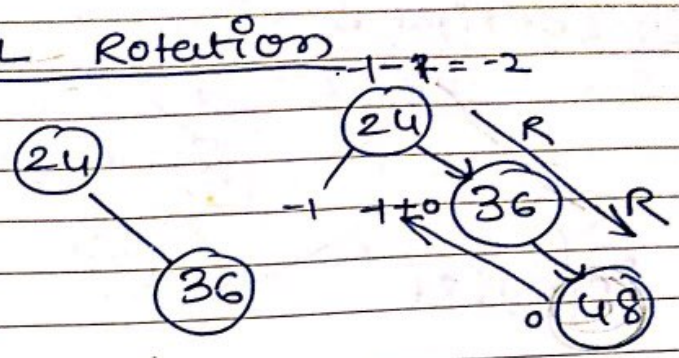
01 Saturday June 2013

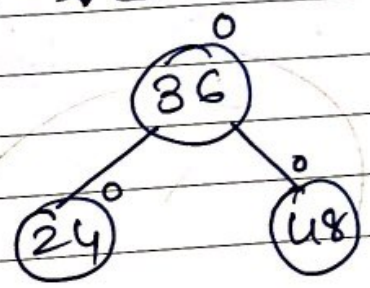
(2) ~~RR~~ LL Rotation



insert(48)

← Follow same steps.

RR → L



02 Sunday

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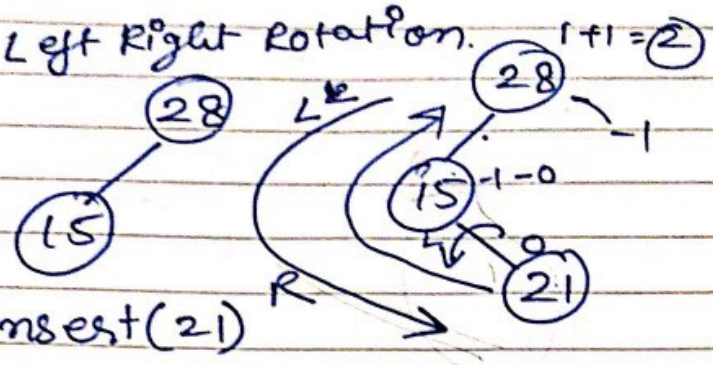
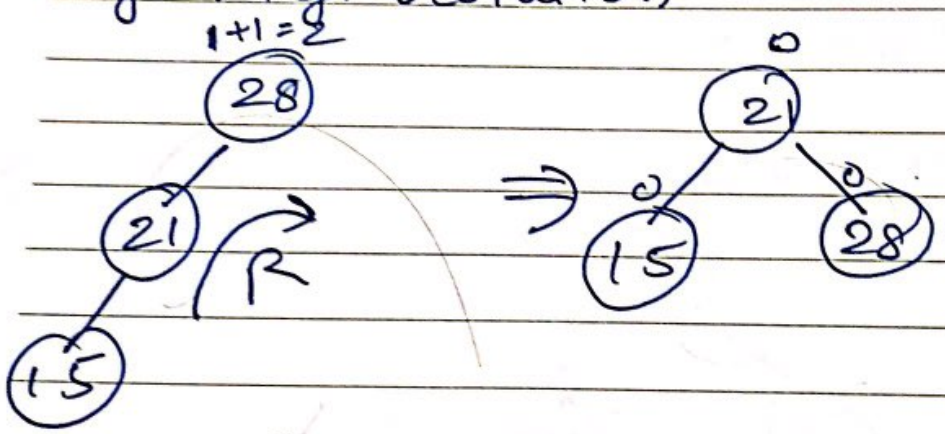
③ Left Right Rotation.



insert(21)

LR → LR

after left rotation



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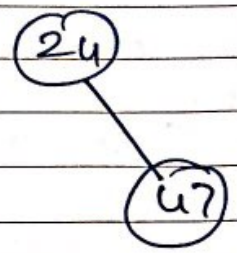
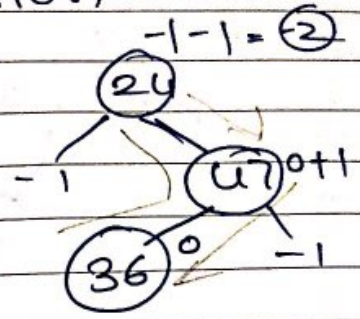
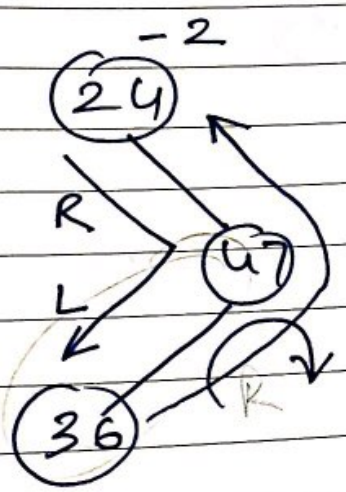
04 Tuesday June 2013

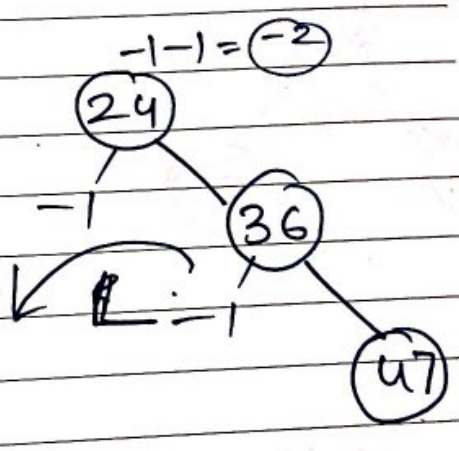
(4) Right Left Rotation

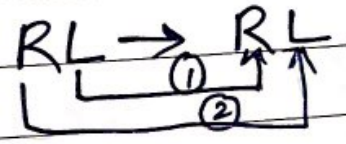


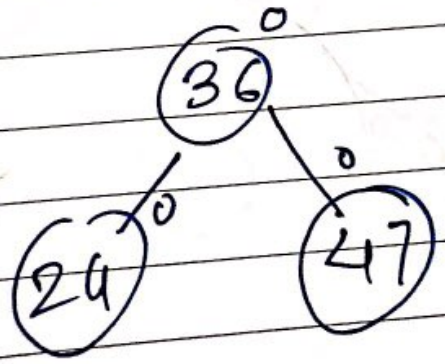


insert (36)









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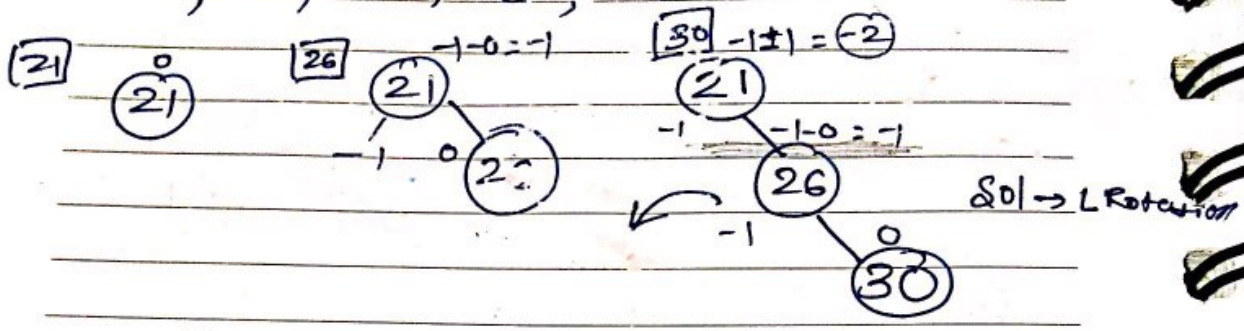
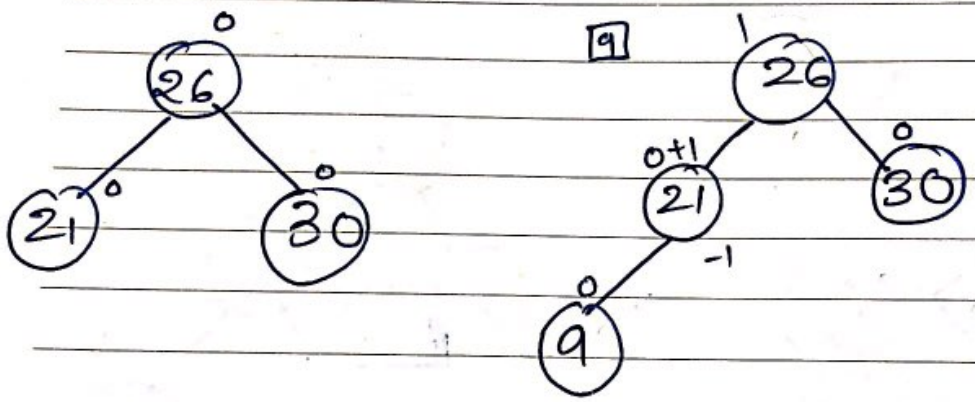
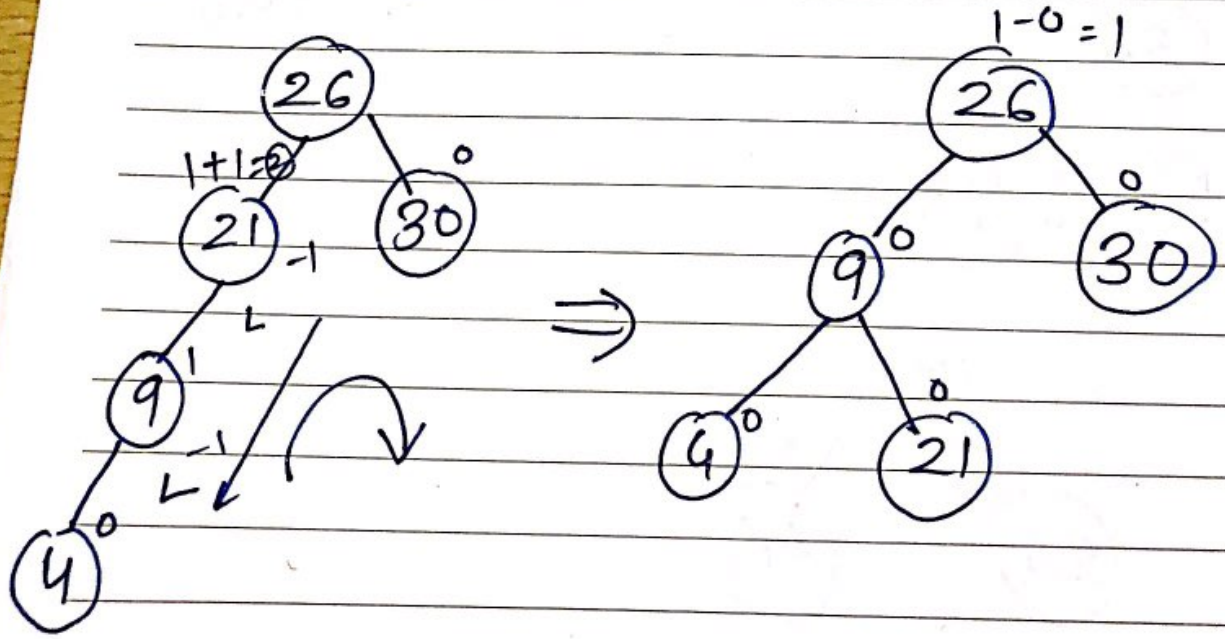
05 Wednesday June 2013

Q 21, 26, 30, 9, 4, 14, 28, 18, 15, 10, 2, 3, 7







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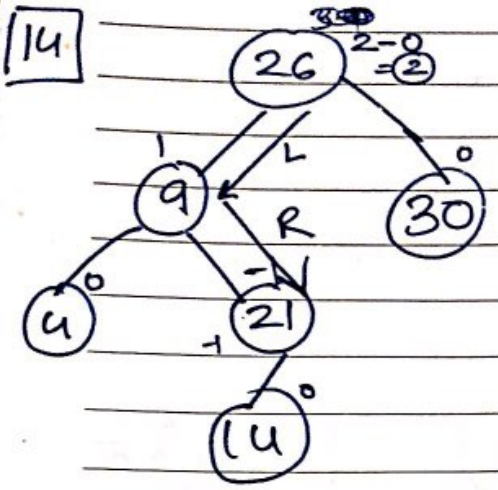
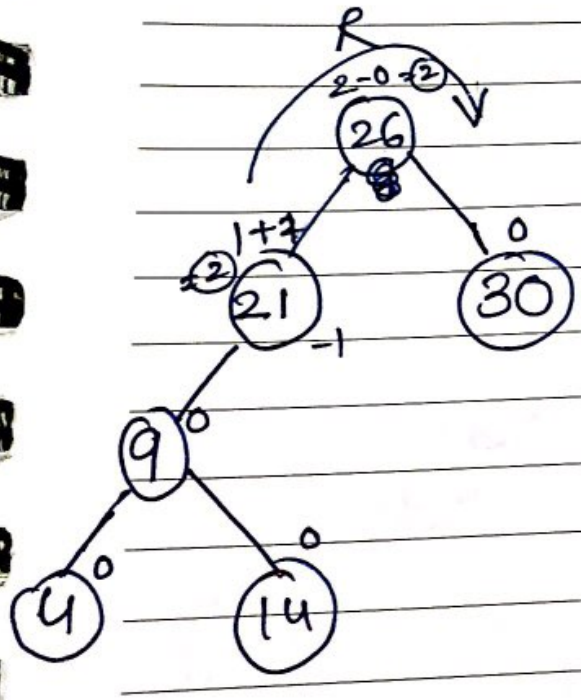
06 Thursday June 2013

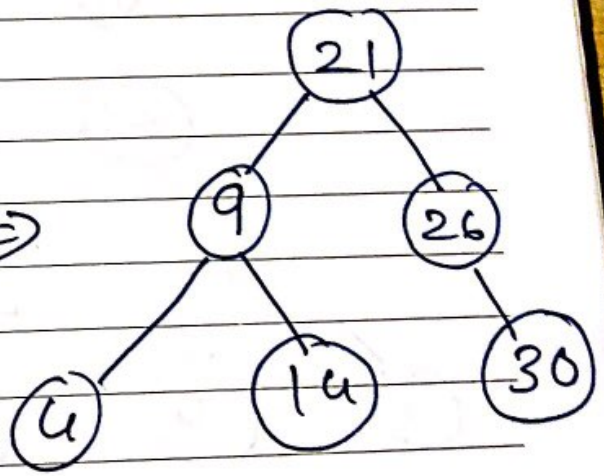
14



LR → LR



⇒



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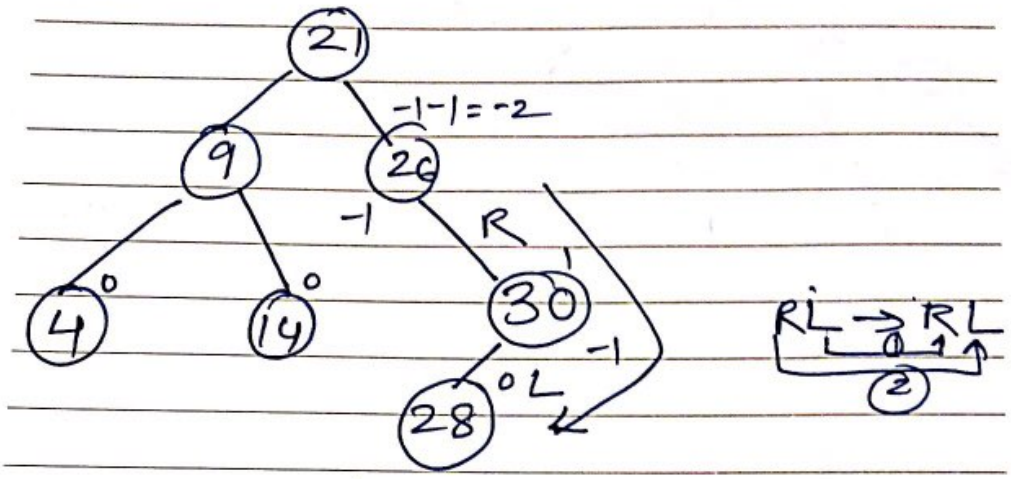
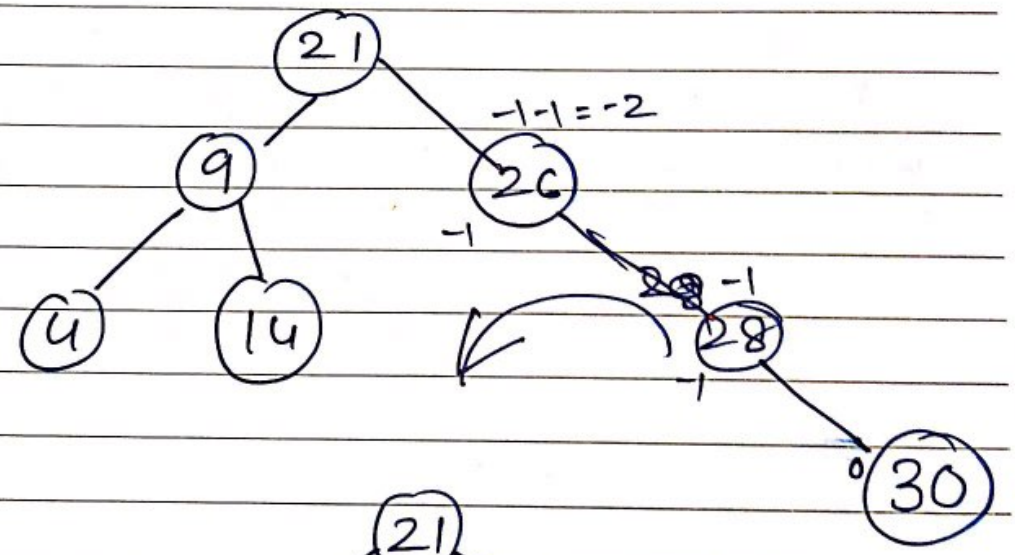
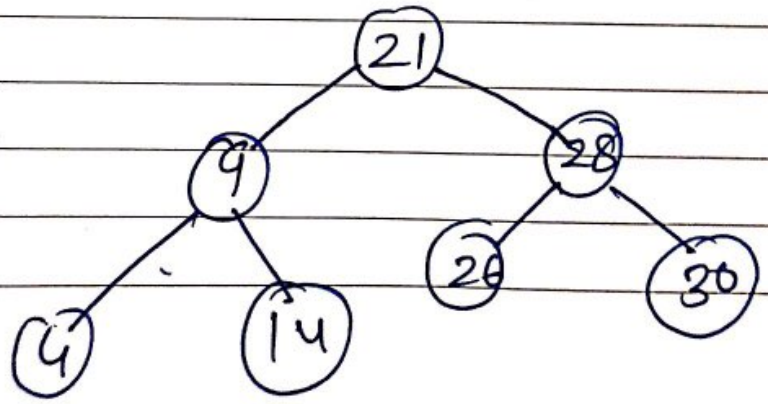
07 Friday June 2013

28







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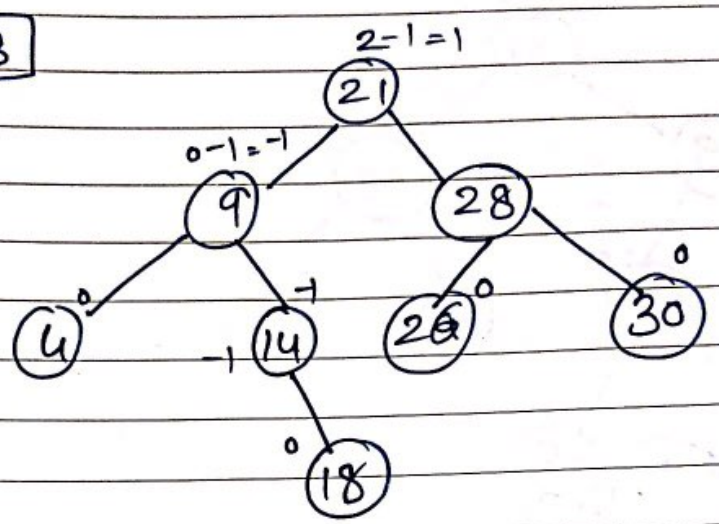
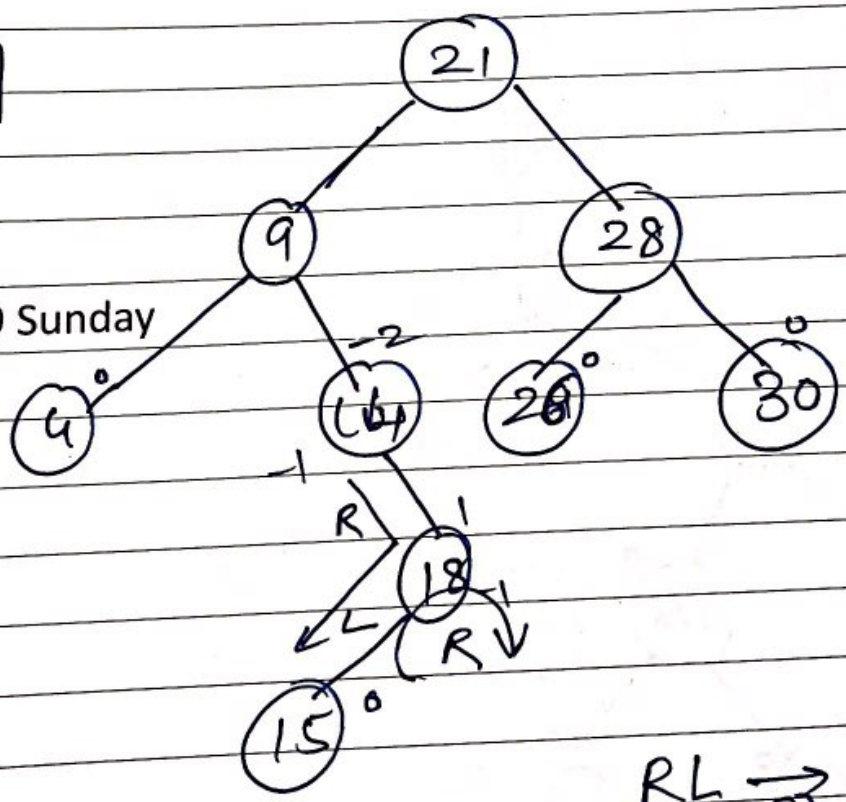
08 Saturday June 2013

18



NO problem

15



09 Sunday

RL → RL

1

2

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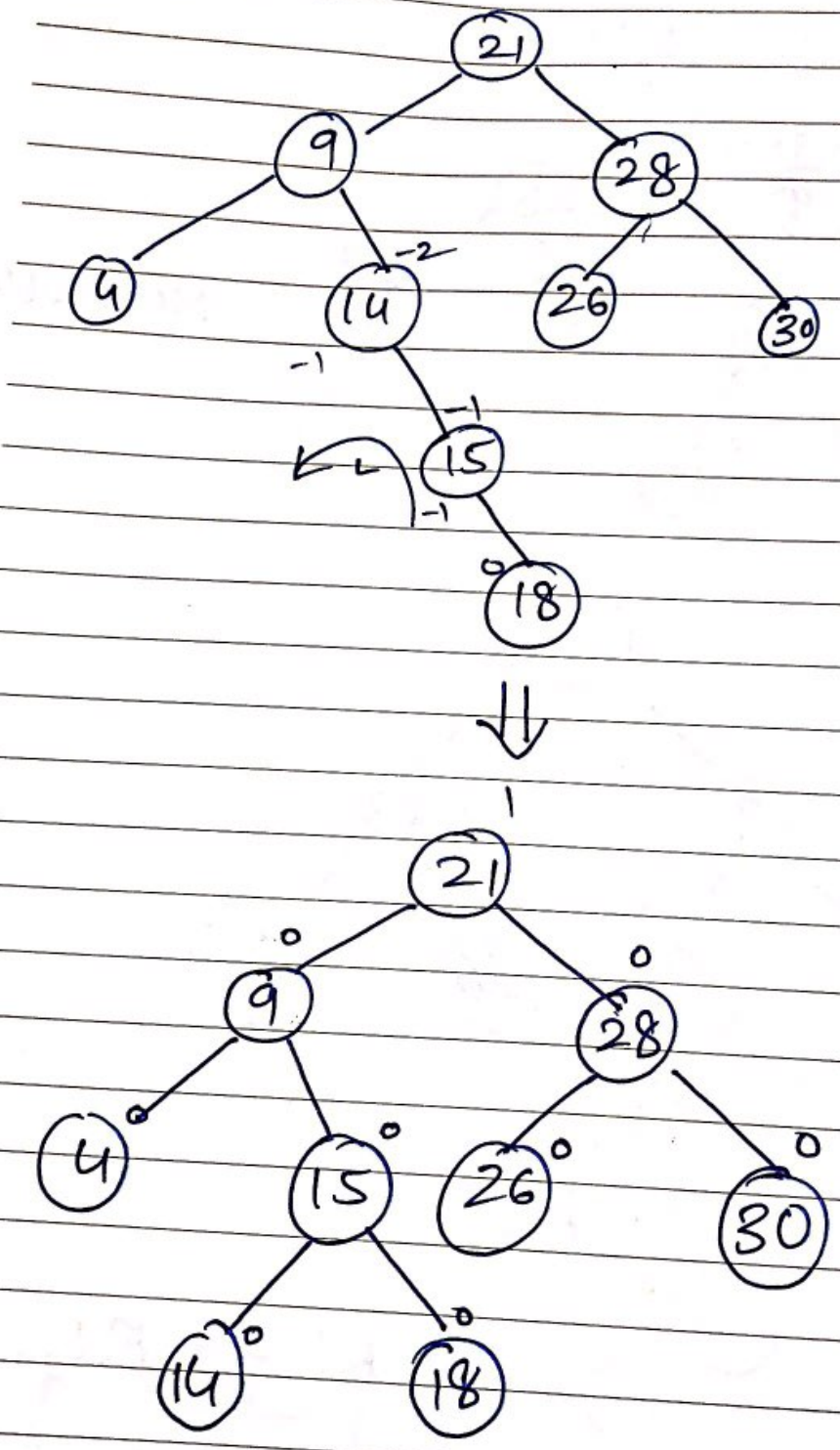
10 Monday

June 2013



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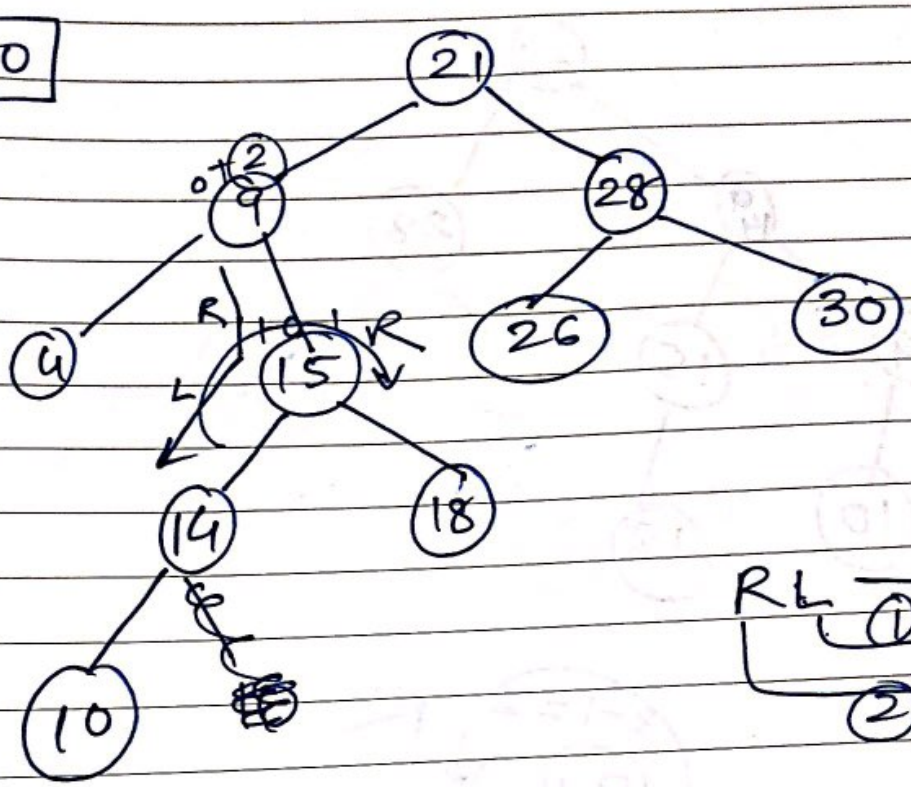
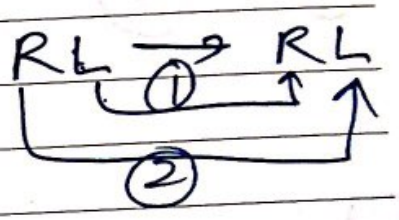
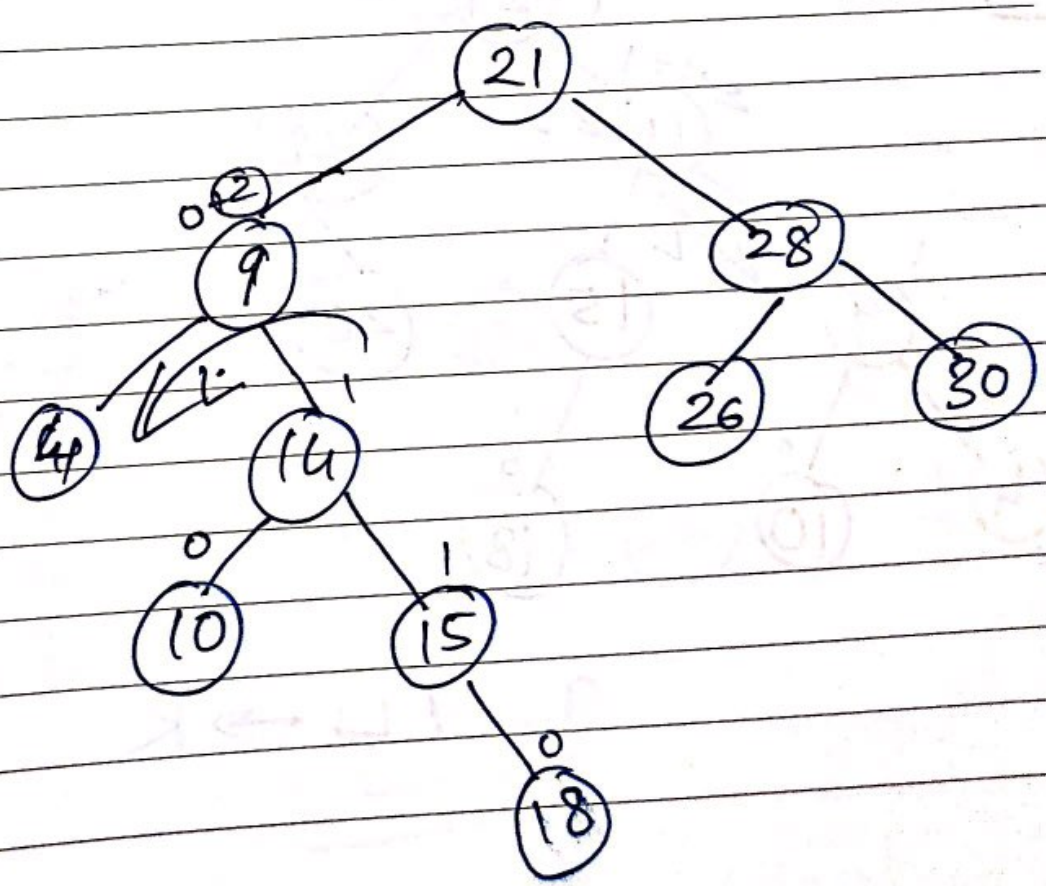
10







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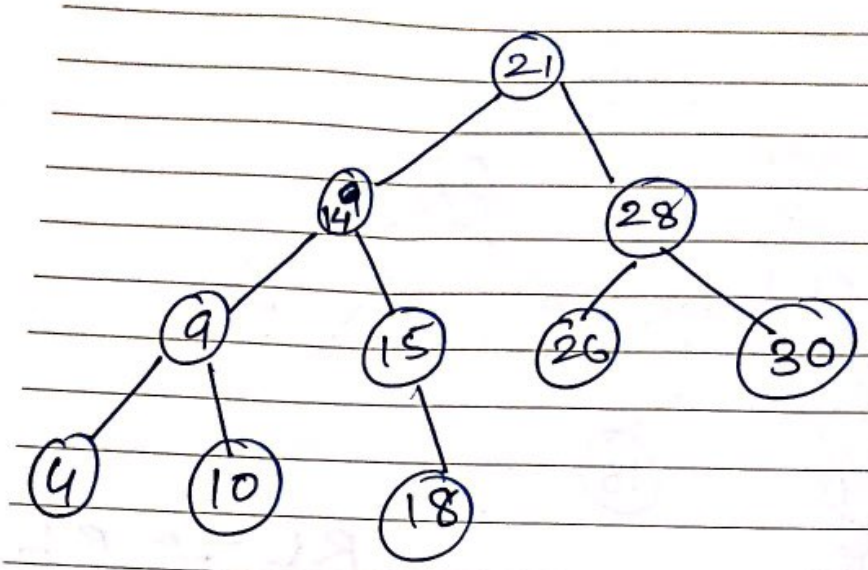
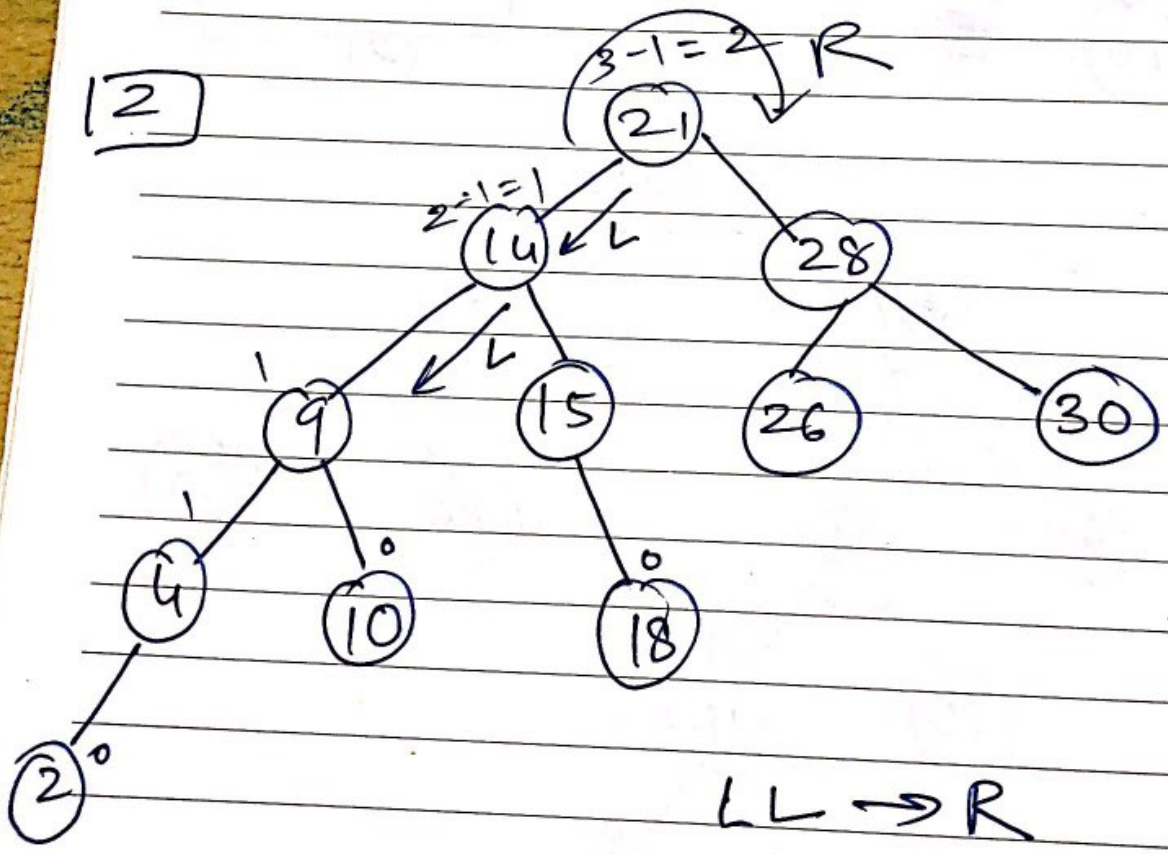
12 Wednesday June 2013

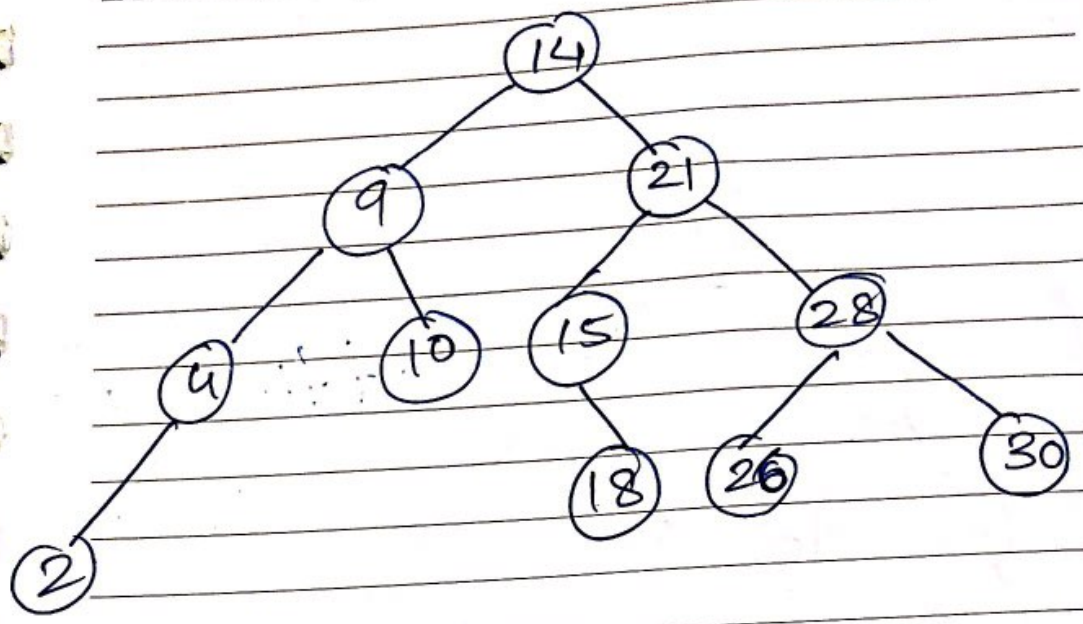


$\boxed{2}$

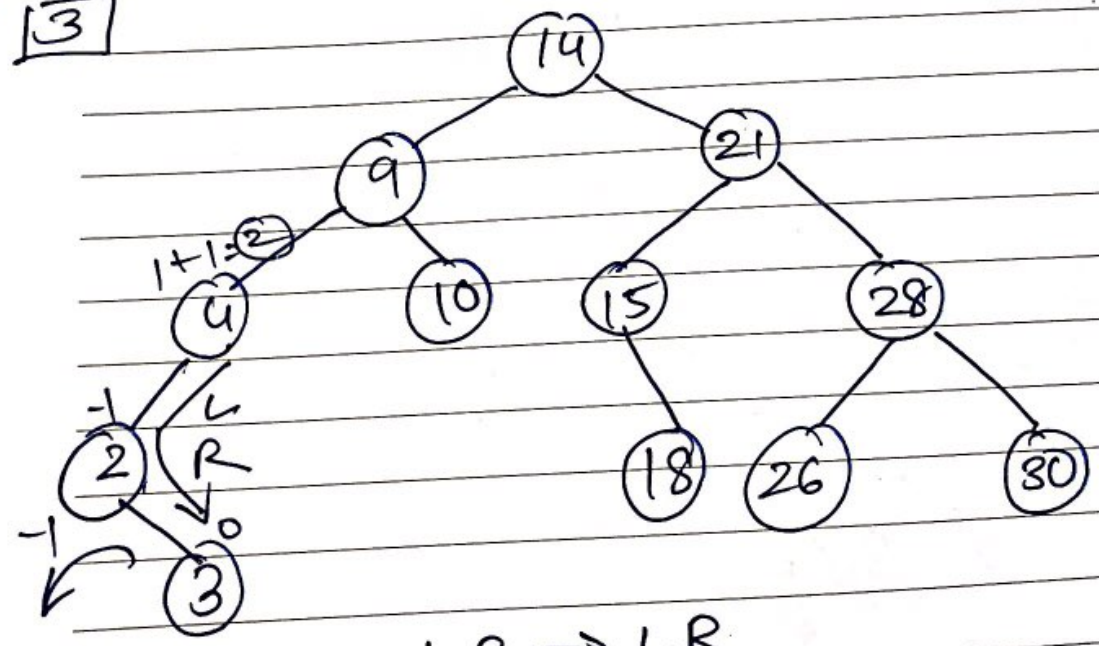


LL → R

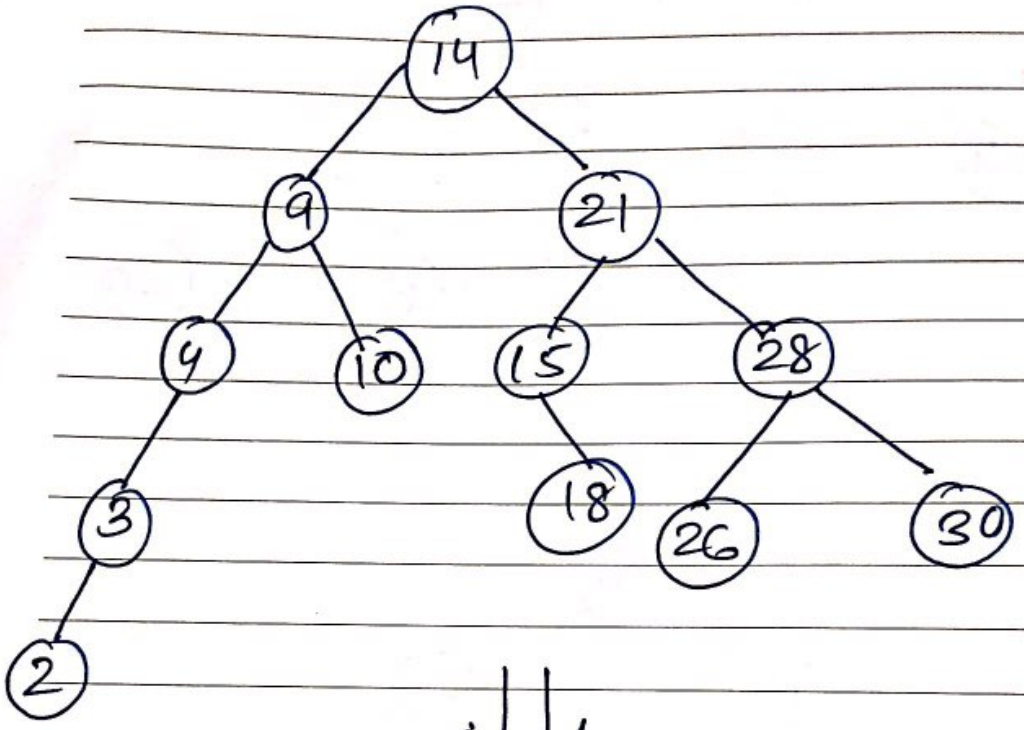
Scanned with CamScanner



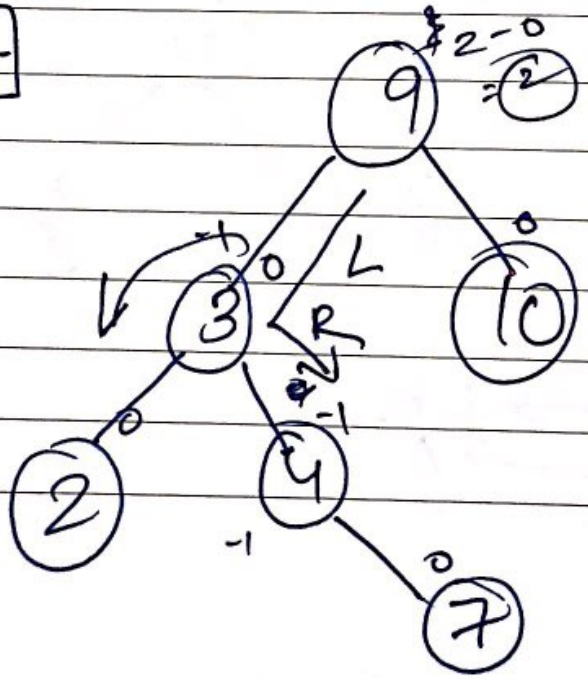
$\boxed{3}$



LR → LR



$\boxed{7}$



LR → LR

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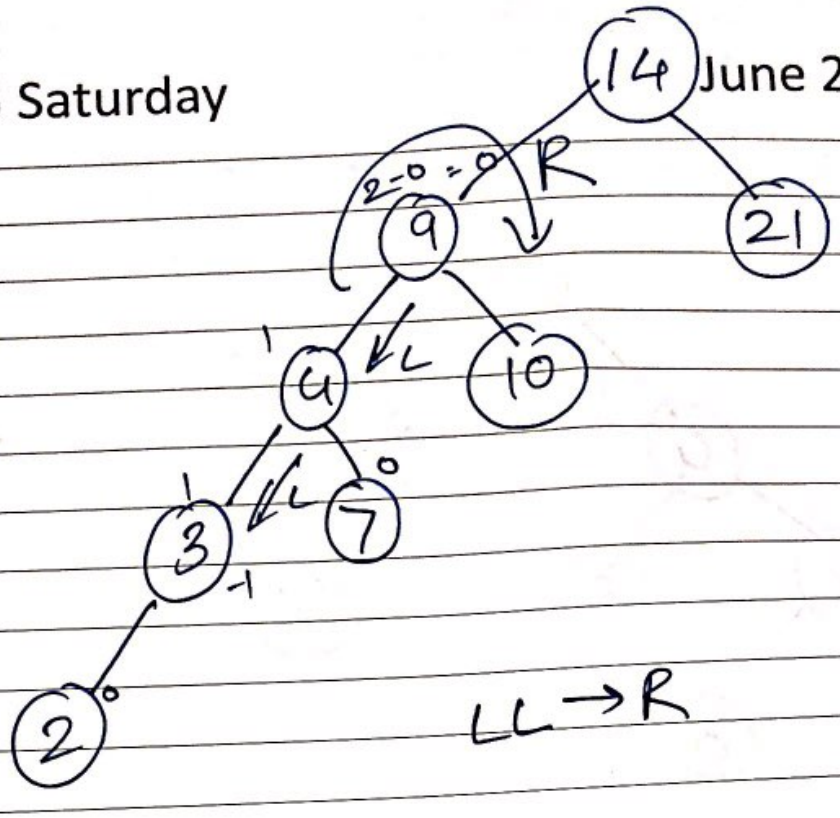
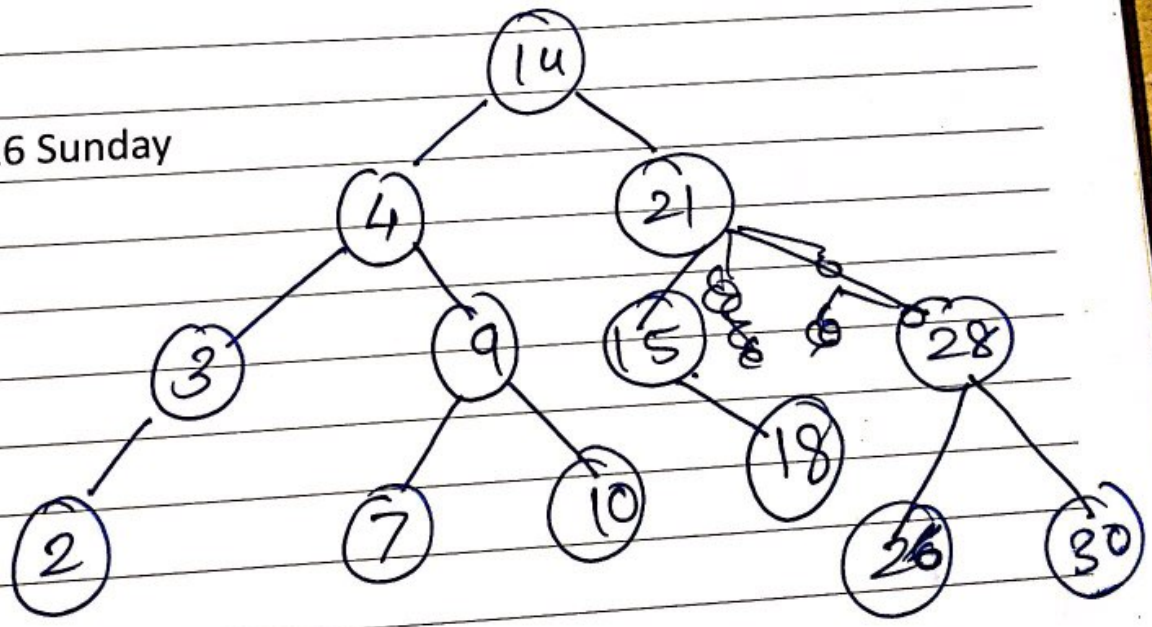
15 Saturday June 2013



LL → R

16 Sunday



eg

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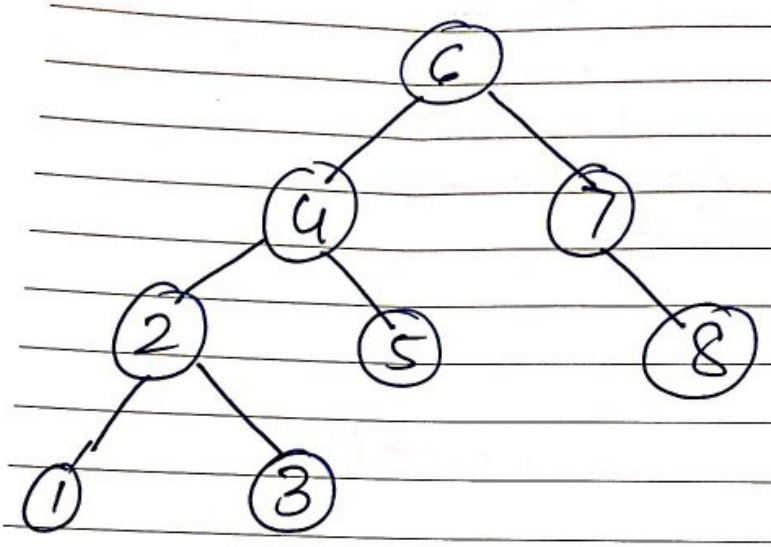
eg 3, 4, 8, 6, 7, 5, 2, 1



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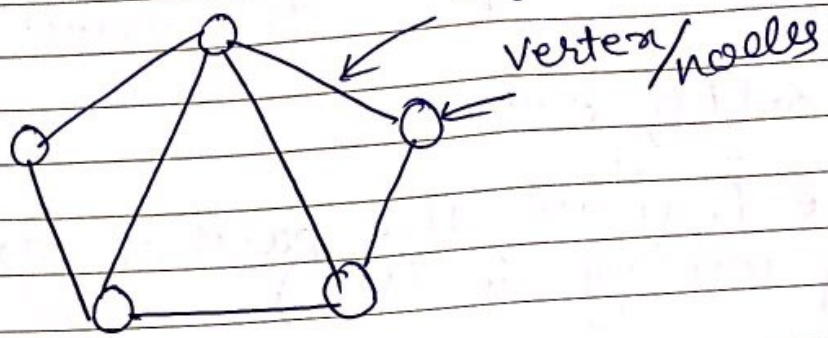
June 2013

18 Tuesday

Graphs



- collection of nodes connected by edges.

Applications:-

1. Set of cities via rail route
2. connection among computers (routers)
3. ~~Tree~~ Tree is a graph.

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A graph G consists of 2 things:-

- A set V of elements called nodes
- A set E of Edges
- We indicate the parts of graph by writing $G = (V, E)$.

Types:

1. Undirected
2. directed
3. Weighted.
4. Cyclic

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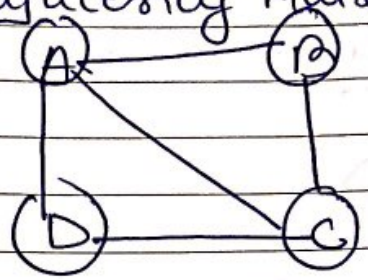
Representation of Graphs.

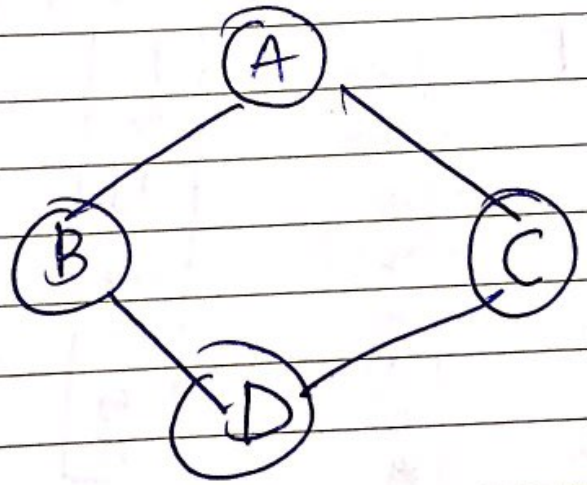
① Adjacency Matrix

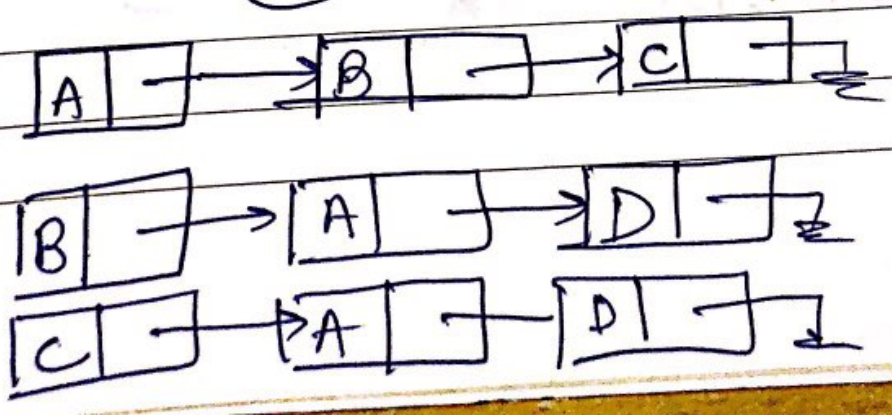


2D array

	A	B	C	D
A	0	1	1	1
B	1	0	1	0
C	1	1	0	1
D	1	0	1	0

②





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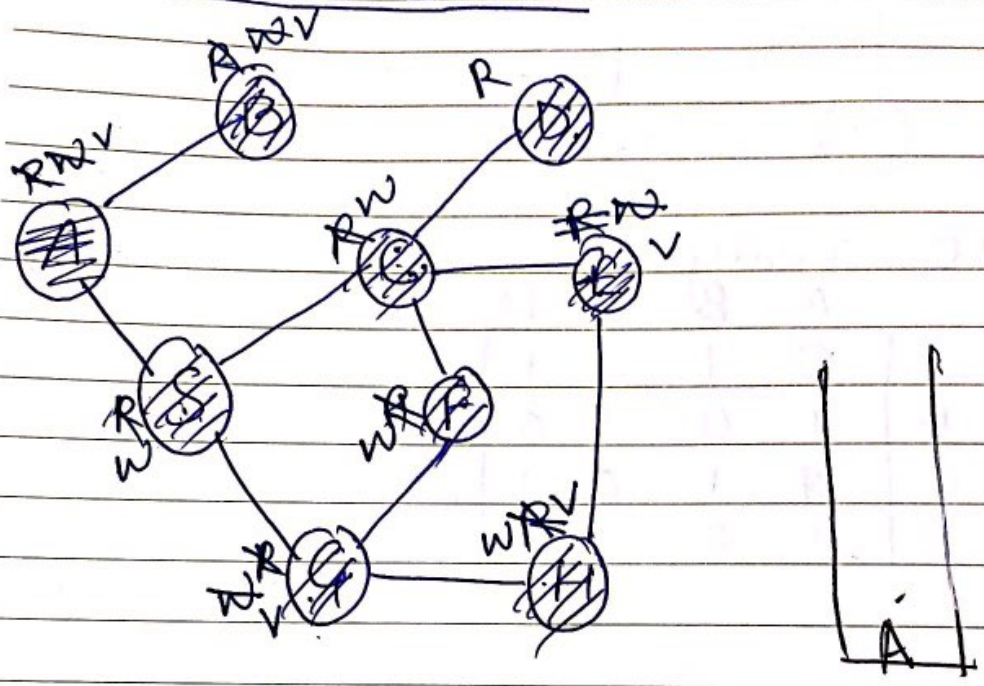
Graph Traversal algorithms

① Depth first Search :-



ABSCDEHGF

ASGHEFCDB

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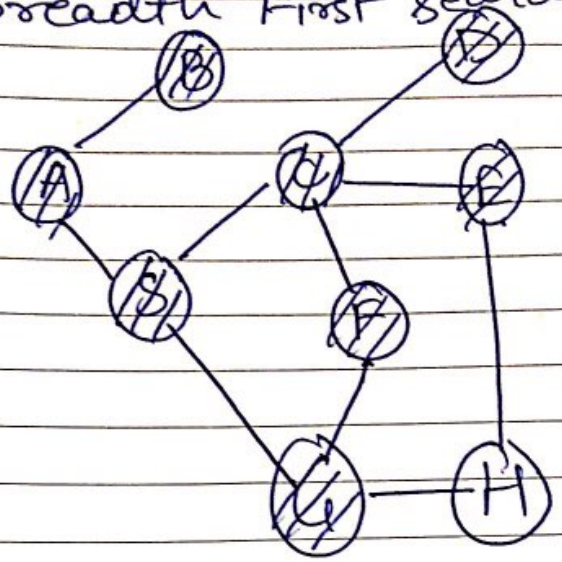
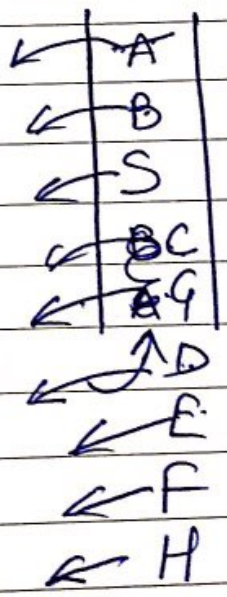
Breadth first search.



O/P: ABSCGDEFH



23 Sunday

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BFS Algorithm :-

During execution of algo each node N of G will be in one of three nodes called status of N:

Status 1 = Ready
2 = Waiting
3 = ~~Processed~~ visited

Algorithm :-

1) Initialize all nodes to ready state(1)

2) Put the starting node A in Q & change it status ~~to~~ to the waiting state (2)

3) Loop
Repeat 4 & 5 until Q is Empty

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4) Remove the front node N of Q
Process N & change status of
~~processed~~ visited state (3)

5) Add to the rear of Q all
the neighbors of N that are
in the ready (1) state &
change their status to
waiting state (2)

end of loop

6) Exit.

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DFS Algorithm

1) Initialize all nodes to the ready state (1)

2) Push the starting node A onto stack & change its status to the waiting state (2)

3) Loop
Repeat step 4 & 5 until stack is empty

4) Pop the top node N of stack. Process N & change it status to the ~~processed~~ visited state (3)

5) Push onto stack all the neighbours of N that are still in ready state (1) & change their status to waiting state (2)
end loop

6) Exit.

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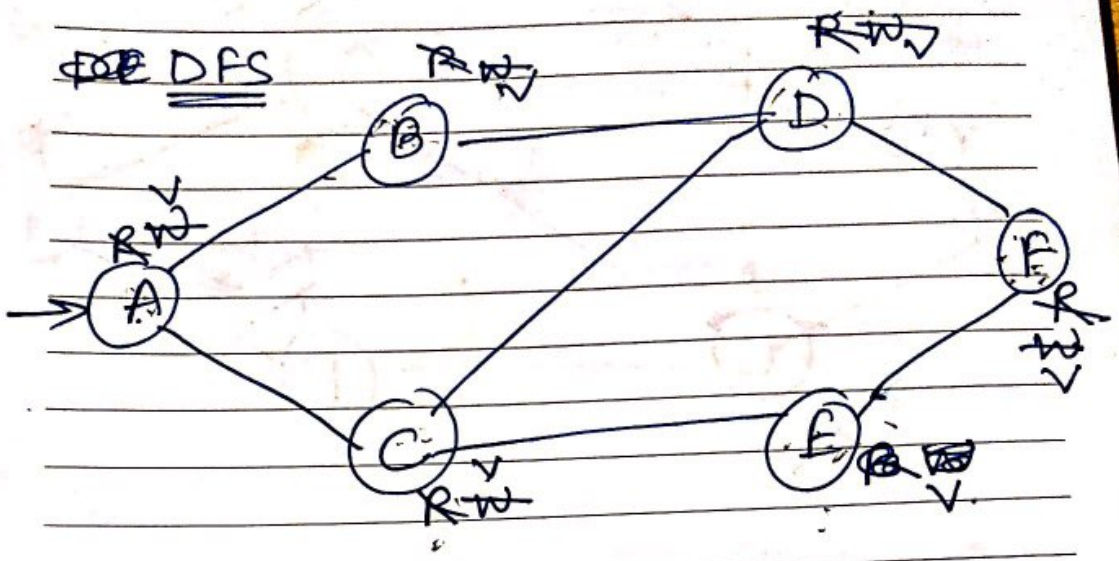
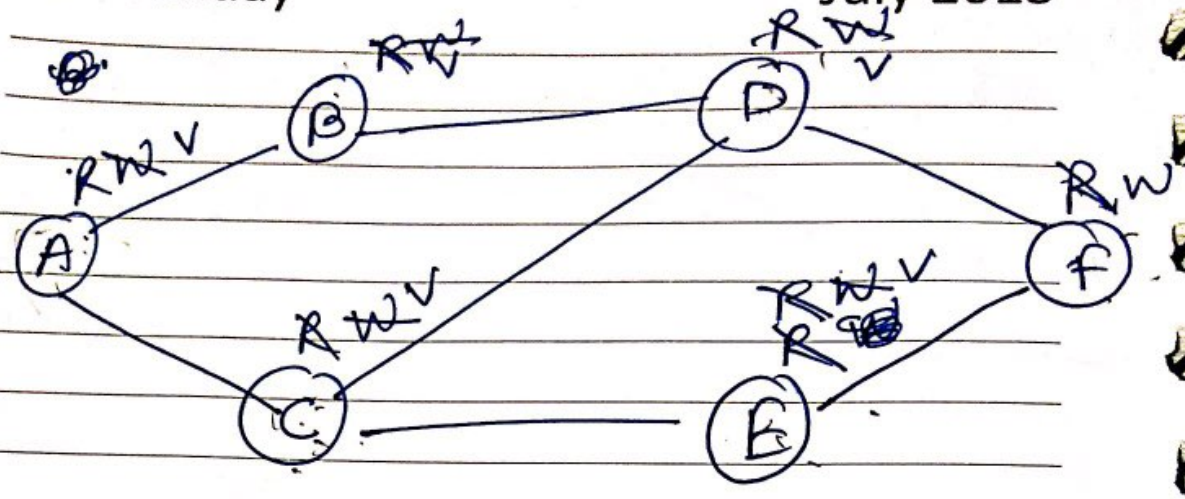
DFS



30 Sunday

A C E F D B

01 Monday July 2013



A B C D E F

03 Wednesday July 2013

Singly Linked List operations

(1)
```
void search(int num)
{
struct Node *temp = head;
int a=1;
while (temp! = NULL)
{
  if (temp->data == num)
  {
    break;
  }
else
  {
    a++;
    temp = temp-> next;
  }
}
printf("Enter value is at: %d", a);
}
```

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04 Thursday July 20.

Count No. of Nodes :-

```
void count( )
{
Struct Node *temp=head;
 int a=0
  while (temp!=NULL)
  {
   a++;
   temp= temp->next;
  }
 printf("No. of nodes : %d", a);
}
```

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(3) Concatenate two linked list

```
void concat()
{
 struct Node *temp1, *temp2
  temp1 = head1
  temp2 = head2

 if(temp1 == NULL)
 {
  temp1 = temp2
 }
 else
 {
  while(temp1 -> next != NULL)
  {
   temp1 = temp1 -> next;
  }
 ~~temp1 -> next temp1 ->~~
  temp1 -> next = temp2
}
```

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(4) Sorting nodes in Linked List

```
void sorting ()
{
struct Node * ptr1, ptr2;
int temp;
ptr1 = head;
while (ptr1 -> next != NULL)
{
  ptr2 = ptr1 -> next;
  while (ptr2 != NULL)
  {
    if (ptr1 -> data > ptr2 -> data)
    {
      temp = ptr1 -> data;
      ptr1 -> data = ptr2 -> data;
      ptr2 -> data = temp;
    }
    ptr2 = ptr2 -> next;
  }
  ptr1 = ptr1 -> next;
}
}
```


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```
void sort( )
{
struct Node *p, *q;
int temp;
for( p=link; p->next != NULL ; p=p->next)
{
  for(q=p->next; q != NULL ; q=q->next)
  {
    if(p->info > q->info)
    {
      temp= p->info;
      p->info = q->info;
      q->info = temp;
    }
  }
}
}
```

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09 Tuesday July 2013

Sorting Linked List

```
void sort()
{

/* start, ~~head~~ next & data declared
   as global variable */

int num;
struct node *temp1, *temp2;

for(temp1 = start; temp1 != "NULL";
        temp1 = temp1 -> next)

{
  for(temp2 = temp1 -> next;
      temp2 != "NULL"; temp2 = temp2 -> next)
  {
    if(temp1 -> data > temp2 -> data)
    {
      num = temp1 -> data;
      temp1 -> data = temp2 -> data;
      temp2 -> data = num
    }
  }
}
}
```

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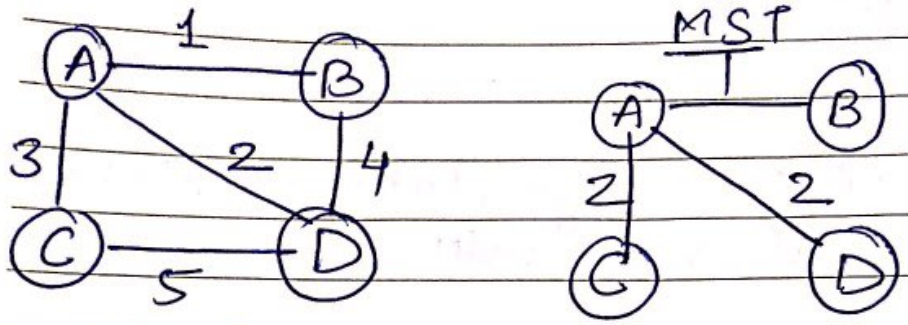
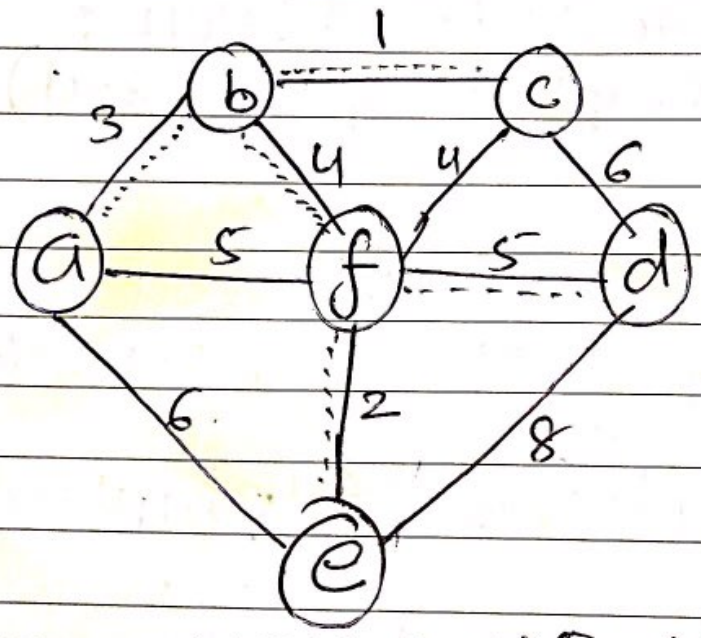
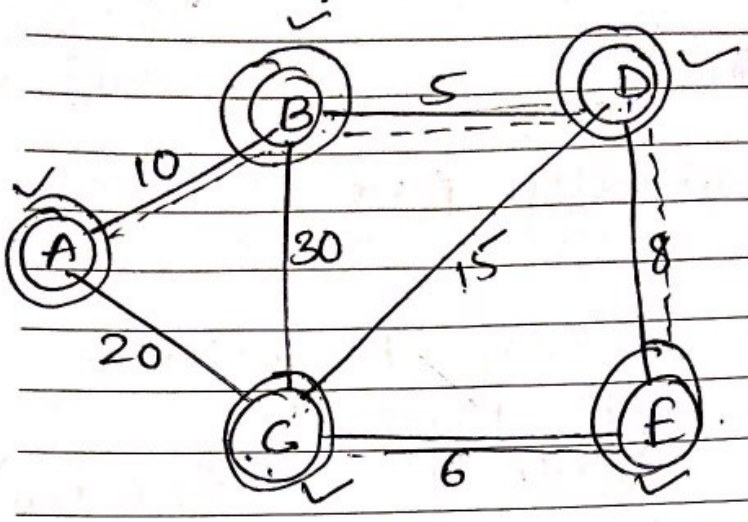
Minimum Spanning Tree



Prim's Algorithm



sum = 1+3+4+2+5 = 15



Vertex	Key	Parent
A X	0	
B X	~~∞~~ 10.	A
C X	~~∞~~ ~~20~~ ~~15~~ 6	~~A~~ ~~D~~ E
D X	~~∞~~ 5.	B
E X	~~∞~~ 8	D

$10 + 6 + 5 + 8 = 29$

A	0	
B X	10	A
C	~~20~~ 15.	~~A~~ D
D.	~~∞~~ 5	B
E.	~~∞~~ 8	D

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Algorithm:

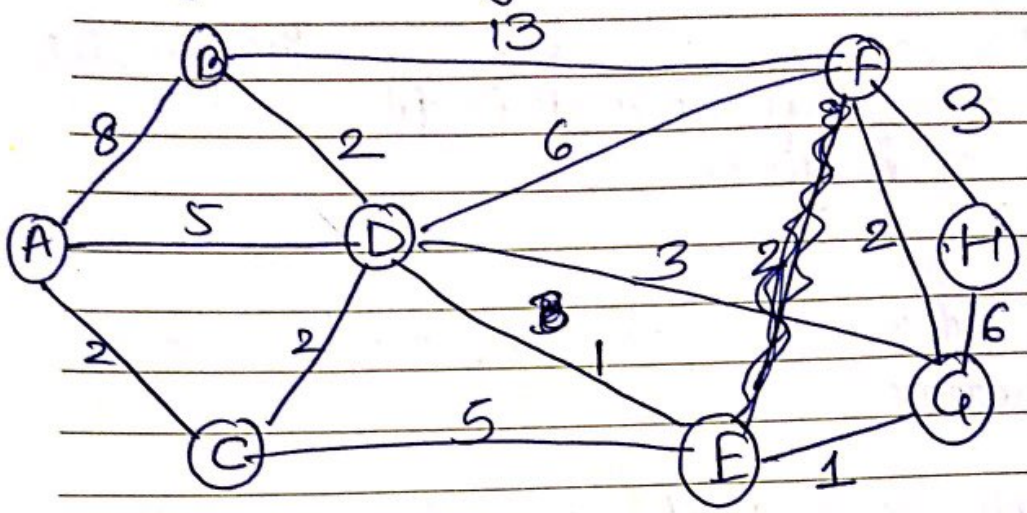
1) Create an array parent[] of size V & initialize to NULL.

2) Create an array H which all vertices such that key value of starting vertex is 0 & key value of other vertices are infinite.

3) while H is not empty
{
a) u = extractMin(H)
b) for every adjacent v of u
{
if V is in H
{i) update key value of v in H if weight of edge uv is smaller than current key value of v
ii) parent[v] = u
}
}
}

Shortest Path Algorithm :-

Dijkstra's Algorithm :-



14 Sunday

V	A	B	C	D	E	F	G	H
A	$\boxed{0_A}$	8_A	2_A	5_A	∞	∞	∞	∞
C	—	8_A	$\boxed{2_A}$	4_C	7_C	∞	∞	∞
D	—	6_D	—	$\boxed{4_C}$	5_D	10_D	7_D	∞
E	—	6_D	—	—	$\boxed{5_D}$	10_D	6_E	∞
B	—	$\boxed{6_D}$	—	—	—	10_D	6_E	∞
G	—	—	—	—	—	$\boxed{8_G}$	$\boxed{6_E}$	12_G
F	—	—	—	—	—	$\boxed{8_G}$	—	11_F
	—	—	—	—	—	—	—	$\boxed{11_F}$

G → A C D E G

15 Monday July 2013

Analysis of Algorithm :-

Why Performance Analysis

- Performance is currency with which we can buy new things.
- Speed is fun.

Two Algos for task, which one is better?

- Implement both → which takes more time.
  - * for some i/p 1st algorithm better
    " 2nd " "
  - * ~~for One~~ 1st Algo — works on 1st half

Asymtotic Analysis:-

- we evalute the performance in terms of i/p size (not actual running time)

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- we calculate, how does the time (or space) taken by an algorithm increases with input size

Linear	Binary
fast	slow
less i/p size	More input size
less time	takes less time

Example of Linear Search & analyze it using Asymptotic analysis.

3 cases to analyze an algorithm.

1) worst case
- calculate upper bound on Running time of an algo.
- max no. of operations.
- eg. Linear Search - x not present in array.
- worst case complexity of Linear Search would be $O(n)$

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Avg case

Best case :-

- Calculate lower bound
- min no. of operations to be executed.
- Guaranting lower bound doesnt provide any info
- bogus case.

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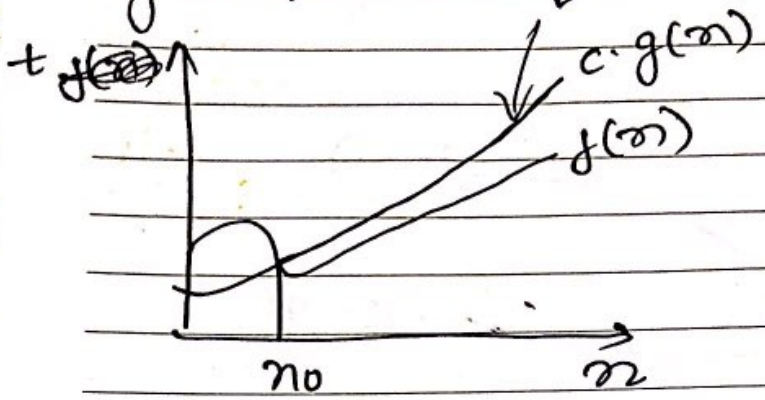
18 Thursday July 2013

Big oh(O) (Upper Bound)



$$\boxed{\begin{array}{l} f(n) \le c \cdot g(n) \\ \qquad n \ge n_0 \\ c > 0, \quad n_0 \ge 1 \end{array}}$$

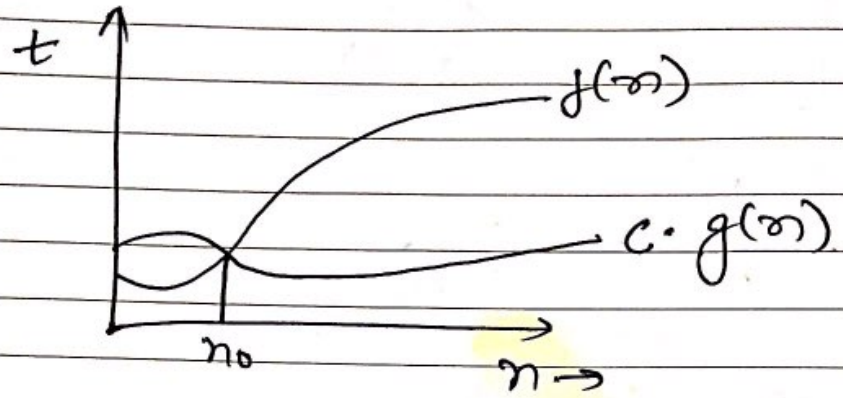
$$f(n) = O(g(n))$$

- useful to describe limit of worst case running time for a algo.

Q

19 Friday July 2013

Big Omega (Ω) → Lower bound (Ω)



$f(n) \geq c \cdot g(n)$

$n \geq n_0$

$f(n) = \Omega(g(n))$

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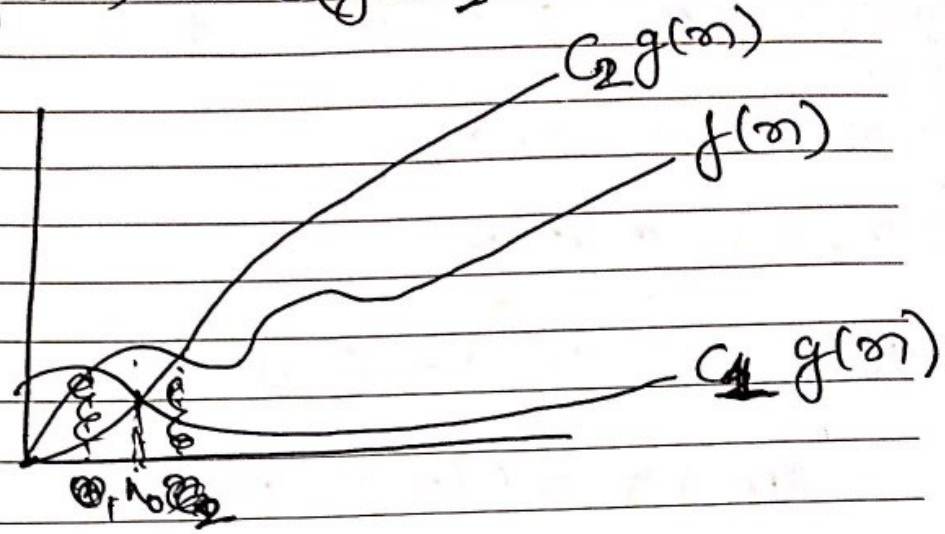
20 Saturday July 2013

Θ (theta) [tight Bound]

$f(n) = \Theta(g(n))$



21 Sunday $C_1 g(n) \leq f(n) \leq C_2 g(n)$

$n \geq n_0$

22 Monday July 2013

Big oh

$f(n) = 2n+5 \quad g(n) = n$

$c = 3$

$2n+5 \leq n$

$f(n) = O\,g(n)$

$2n+5 = O(n)$ for $\forall\, n \geq 5$

& $c = 3$

Omega (Ω)

$f(n) \geq c \cdot g(n)$

$2n+5 \geq c \cdot n$

$c = 2$

$n = 1 \quad 7 \geq 2$

$2n+5 = \Omega(n)\ \forall\, n \geq 1$

$c = 2$

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23 Tuesday July 2013

Theta

$c_1 g(n) \leq f(n) \leq c_2 \cdot g(n)$

$c_1 \cdot n \leq 2n+5 \leq c_2 \cdot n$

$c_1 = 2 \quad c_2 = 3$

$2n \leq 2n+5 \leq 3n.$

$n = 5 \quad f(n) = \Theta(g(n))$

$2n+5 = \Theta(n) \ \forall n \geq 5$

$c_1 = 2, \ c2 = 3.$

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24 Wednesday July 2013

① • She is not supervised.

② Thinking of solⁿ.
- alternatives
- encourage in diff. situations.
- Good mentor.

Leadership skills

18-34 work hard.
35-52 OK
53-90 Excellent

SWOT analysis

This Multidisciplinary conference aims to impart advanced Knowledge by bringing together all academicians, professionals, researchers & students to facilitate close interaction for exchange of views & dissemination of knowledge

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26 Friday July 2013

1. Emotional Intelligence. Connection
2. Persuade Team members
3. Make them aware of your vision time to time with example.
4.

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27 Saturday July 2013

10 Technologies in MIT

1. 3D Metal Printing.
2. Artificial Embryos.
3. Smarter Smart City
4. AI for Everybody
5. Dueling Neural Network
6. Babel fish Earbuds
7. 28 Sunday Zero Carbon Natural Gas
8. Perfect Online Privacy
9. Genetic Forture Telling
10. Material Quantum Leap
11. Google Duplex
12. Smart Clothes
13. Little Dairy takes cows to cloud

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29 Monday July 2013

Assignment :-

2COS → One assignment

Test

Tabular Form — Question Paper.

- atleast 2 intercollege events.
- interview.
- today induction
- CSI magazine
- Industrial visit.
- Something diff than regular.

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