Constructor doesn't have return type

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Matrix

- Diagonal Matrix → set → Get, Display

$$M = \begin{array}{c|ccc} & 1 & 2 & 3 \\ \hline 1 & 1 & 0 & 0 \\ 2 & 0 & 2 & 0 \\ 3 & 0 & 0 & 3 \end{array}$$

3X3

Here $M[i,j] = 0$ if $i \neq j$

- To save space
Diagonal matrix is saved as single dimension matrix eg $M = \begin{array}{ccc} 1 & 2 & 3 \\ 0 & 1 & 2 \end{array}$

```
→ if (i = = j)
    M[i-1] = value
  else
```
} – set value to diagonal matrix

```
→ if (i = j)
    return M[i-1];
  else
    return 0;
```
} – get value at position in diagonal matrix

- Same program with C++ class on github U can checkout

$\frac{n \times (n+1)}{2}$ But for n-1ele $\frac{(n-1) \times n}{2}$

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A[3][2] $\frac{2 \times (2+1)}{2}$ 3

- Lower Triangular matrix

$$M = \begin{bmatrix} 1 & 0 & 0 \\ 2 & 3 & 0 \\ 4 & 5 & 6 \end{bmatrix} \rightarrow A \; \begin{array}{|c|c|c|c|c|c|} \hline 1 & 2 & 3 & 4 & 5 & 6 \\ \hline \end{array}$$

1st row 2nd row

$M[i,j] = 0$ if $j > i$

$M[i,j]$ = non-zero if $j \le i$

Non-zero elements → $1+2+3+5$
$= 1 + \cdots + n = \frac{n(n+1)}{2}$

zero elements = Total element - non-zero elements
$n^2 - \frac{n(n+1)}{2}$

* Row major (filling elements row by row)

to access $M[3,3]$ (i, j) → we need to first cross $(i-1)$ row which is sum of first n natural number as every row has one more element than previous row

as i starts from 1 whereas array starts from 0

∴ In row major mapping $M[3,3]$ (i, j) $\rightarrow A\left[\frac{(i-1)((i-1)+1)}{2} + j - 1\right]$

$$\downarrow$$

$$A\left[\frac{i(i-1)}{2} + (j-1)\right]$$

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* Column major ~~mapping~~ representation

$$M = \begin{array}{c|c} & j\rightarrow \\ i\downarrow & \begin{bmatrix} 1 & 0 & 0 \\ 2 & 3 & 0 \\ 4 & 5 & 6 \end{bmatrix} \end{array} \qquad A = \begin{array}{|c|c|c|c|c|c|} \hline 1 & 2 & 4 & 3 & 5 & 6 \\ \hline \end{array}$$

0

← 1column → ← 2nd → ← 3rd →

M[n×n] Here m=n

Index (A[3][3]) → [3 ~~+~~ 2] + 0

Index (A[3][2] = [3 + 1]

Index [A[i][j]] = ~~[n + n-1 + n-2 -- + n-(j-2)] + (i-j)~~

i.e $\left[n + n-1 + n-2 + \cdots + n-(j-2) \right] + (i-j)$

$-(1+2+3-- (j-2)) + (i-j)$

n is j-2 times → $(n \times (j-2) + n)$

but as extra n is there at starting which is not counted it becomes (j-1) times

↓

$(n(j-1)) - (1+2+3 -- (j-2)) + (i-j)$

$$\left[n(j-1) - \frac{(j-2)(j-2+1)}{2} \right] + (j-j)$$

$$\left[n(j-1) - \frac{(j-1)(j-2)}{2} \right] + (i-j)$$

Index A[3][2] = [3] + 1

Index A[i][j] = [n + (n-1 + --- until n-(j-2) times)] + (i-j)

= [n + (n × (j-2) - (1 + 2 + 3 -- j-2 times) + (i-j)

$$= \left[n \times (j-1) - \frac{(j-2)(j-1)}{2} \right] + (i-j)$$

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* Upper triangular Matrix

$$\begin{array}{c|c} & j \rightarrow \\ i \downarrow & M = \begin{bmatrix} 1 & 2 & 3 & 4 \\ 0 & 1 & 2 & 3 \\ 0 & 0 & 1 & 2 \\ 0 & 0 & 0 & 1 \end{bmatrix} \end{array}$$

if $i > j$ then $M[i, j] = 0$

row major → same as column major formula of lower triangular matrix

$$\text{Index}(A[i][j]) = [n + n-1 + n-2 + \cdots + n-(i-2)] + (j-i)$$

$$= n \times (i-1) - \frac{(1+2+3+\cdots+(i-2))}{2} + j-i$$

$$= \left(n \times (i-1) - \frac{(i-2)(i-1)}{2}\right) + (j-i)$$

$$= n \times (i-1) - \frac{(i-1)(i-2)}{2} + (j-i)$$

Column major.

$$\text{Index}(A[i][j]) = [1+2+3+\cdots+j-1] + i-1$$

$$= \left[\frac{j(j-1)}{2}\right] + i-1$$

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* Symmetric Matrix

$$A = \begin{bmatrix} 2 & 2 & 2 & 2 \\ 2 & 3 & 3 & 3 \\ 2 & 3 & 4 & 4 \\ 3 & 3 & 4 & 5 \end{bmatrix}$$

if $M[i,j] = M[j,i]$

you use any (upper or lower Triangular Matrix) and retrive others.

* Tri diagonal Matrix

$A[i \times j]$

$$A = \begin{bmatrix} 1 & 8 & 0 & 0 \\ 5 & 2 & 9 & 0 \\ 0 & 6 & 3 & 10 \\ 0 & 0 & 7 & 4 \end{bmatrix}$$

Main diagonal $(i-j) = 0$
lower diagonal $(i-j) = +1$
upper diagonal $(i-j) = -1$

|← lower →|← main →|← upper →|

$$M = \begin{array}{|c|c|c|c|c|c|c|c|c|c|} \hline 5 & 6 & 7 & 1 & 2 & 3 & 4 & 8 & 9 & 10 \\ \hline \end{array}$$
$$\quad\; 0 \quad 1 \quad 2 \quad 3 \quad 4 \quad 5 \quad 6 \quad 7 \quad 8 \quad 9$$

Index $(A[i][j])$

case 1: if $i-j=1$ → lower diagonal

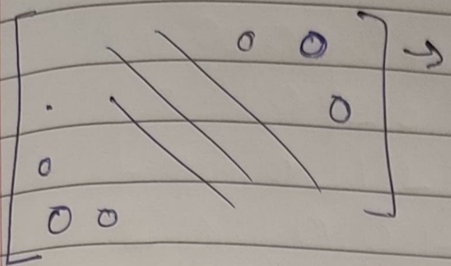
index $= i-2$

Main $= (n-1) + i - 1$

upper $= 2(n) - 1 + i - 1$

↑ no of elements

* Square band matrix.



* ~~Complex~~ IOP
* Toeplitz Matrix

$$M = \begin{array}{c} \begin{array}{cccc} 1 & 2 & 3 & 4 \end{array} \\ \begin{bmatrix} 1 & 3 & 4 & 6 \\ 2 & 1 & 3 & 4 \\ 5 & 2 & 1 & 3 \\ 6 & 5 & 2 & 1 \end{bmatrix} \\ \begin{array}{ccc} i-j=3 & i-j=2 & i-j=1 \end{array} \end{array}$$

→ no of elements required $= n + (n-1)$

A = | 1 | 3 | 4 | 6 | 2 | 5 | 6 |

Index (A[i][j])

case 1: if $i <= j$ ← Top row

Index $= j - i$

case 2: if $i > j$ $= n$

Index $= n + i - j - 1$

* Menu driven program for any of matrix

* Menu driven program for any matrix using function.

* write all matrices using C++ class