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## **Algoritmos e Programação de Computadores**

**Disciplina 113476**

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# **Módulo 08**

## **Estrutura de Dados**

### **Bidimensional Homogênea**

#### **Indexada**

#### **(Matrizes)**

---

## 1. Matrizes

- Muitas vezes pode ser útil ter “vetores de vetores”:

NOTAS1	10	5	8	4	2	9	3	1
NOTAS2	1	7	8	9	3	6	3	6
NOTAS3	5	6	4	7	9	4	7	8

## 1. Matrizes

- Muitas vezes pode ser útil ter “vetores de vetores”:

NOTAS

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

## 1. Matrizes

- Muitas vezes pode ser útil ter “vetores de vetores”:

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

## 2. Declaração de Matrizes

- Em Portugal:

```
var  
<nome> : matriz[<linhas>, <colunas>] de <tipo>
```

## 2. Declaração de Matrizes

- Exemplo:

Algoritmo "notas"

var

NOTAS: matriz[3,8] de real

inicio

<comandos>

fimalgoritmo



## 2. Declaração de Matrizes

- Em C:

```
<tipo> <nome> [<linhas>] [<colunas>];
```

## 2. Declaração de Matrizes

- Exemplo:

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

```
int main()
{
    float NOTAS[3][8];

    return 0;
}
```



### 3. Preenchimento de Matrizes

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

int main()
{
    float notas[3][8];
    int i, j;

    for(i=0; i<=2; i++) {
        for(j=0; j<=7; j++) {
            printf("Digite nota [%d][%d]:", i, j);
            scanf("%f", &notas[i][j]);
        }
    }

    return 0;
}
```



## 4. Acessando Elementos de uma Matriz

```
#include <stdio.h>
#include <stdlib.h>
#define MAXL 3
#define MAXC 3

int main()
{
    float matriz[MAXL][MAXC];
    int i, j;

    for(i=0; i<=MAXL-1; i++) {
        for(j=0; j<=MAXC-1; j++) {
            printf("Digite matriz[%d][%d]:", i, j);
            scanf("%f", &matriz[i][j]);
        }
    }
}
```



## 4. Acessando Elementos de uma Matriz

```
for (i=0; i<=MAXL-1; i++) {  
    for (j=0; j<=MAXC-1; j++) {  
        printf ("%f\t", matriz[i][j]);  
    }  
    printf ("\n");  
}  
  
return 0  
}
```



## 5. Macros

```
#include <stdio.h>
#include <stdlib.h>
#define quadrado(x)  x*x

int main()
{
    float numero, numeroquad;

    printf("Digite um número:");
    scanf("%f", &numero);

    numeroquad = quadrado(numero) ;

    printf("%.2f - %.2f \n\n", numero, numeroquad);

    return 0;
}
```



## 5. Macros

```
#include <stdio.h>
#include <stdlib.h>
#define PI 3.1416
#define quadrado(x)  x*x
#define areaesfera(x) 4*PI*quadrado(x)

int main()
{
    float raio, area;

    printf("Digite um raio:");
    scanf("%f", &raio);

    area = areaesfera(raio);

    printf("%.2f \n\n", area);

    return 0;
}
```



## 5. Macros

- Uso de parênteses:

```
#include <stdio.h>
#include <stdlib.h>
#define SOMA(x,y) x+y

int main()
{
    printf("%d \n\n", 10*SOMA(3,4)); // 10*3 + 4

    return 0;
}
```





## 5. Macros

- Uso de parênteses:

```
#include <stdio.h>
#include <stdlib.h>
#define SOMA(x,y) (x+y) // Correção

int main()
{
    printf("%d \n\n", 10*SOMA(3,4)); // 10*(3 + 4)

    return 0;
}
```



## 5. Macros

- Uso de parênteses:

```
#include <stdio.h>
#include <stdlib.h>
#define PROD(x,y)  (x*y)

int main()
{
    printf("%d \n\n", PROD(2+3,4)); // (2+3*4)

    return 0;
}
```



## 5. Macros

- Uso de parênteses:

```
#include <stdio.h>
#include <stdlib.h>
#define PROD(x,y) (x)*(y) // Correção

int main()
{
    printf("%d \n\n", PROD(2+3,4)); // (2+3)*(4)

    return 0;
}
```

## 6. Gerador de Números Pseudo-aleatórios

**Exemplo 1:** Escrever um programa que preenche aleatoriamente uma matriz 5x5 com números entre 0 e 9 e mostra na tela do computador sua diagonal principal.

## **6. Gerador de Números Pseudo-aleatórios**

- Funções interessantes:
  - `srand()`
  - `rand()`
- Requerem a inclusão de `<stdlib.h>`.

## **6. Gerador de Números Pseudo-aleatórios**

- *srand()*: inicia o gerador de números pseudo-aleatórios com um semente.
- *rand()*: gera um número aleatório entre 0 e 32767.

## 6. Gerador de Números Pseudo-aleatórios

- *rand()*

```
#include <stdio.h>
#include <stdlib.h>
#define MAX 10

int main()
{
    int i, numero;

    for (i=0; i<=MAX-1; i++) {
        numero = rand();
        printf("%d ", numero);
        printf("\n");
    }
    printf("\n");
    return 0;
}
```

## 6. Gerador de Números Pseudo-aleatórios

- *rand()*

```
#include <stdio.h>
#include <stdlib.h>
#define MAX 10

int main()
{
    int i, numero;

    for(i=0; i<=MAX-1; i++){
        numero = rand() % 10; ???
        printf("%d ", numero);
        printf("\n");
    }
    printf("\n");
    return 0;
}
```



## 6. Gerador de Números Pseudo-aleatórios

- *rand()*

```
#include <stdio.h>
#include <stdlib.h>
#define MAX 10

int main()
{
    int i, numero;

    for(i=0; i<=MAX-1; i++){
        numero = rand() % 10; // Gera entre 0 e 9.
        printf("%d ", numero);
        printf("\n");
    }
    printf("\n");
    return 0;
}
```

## 6. Gerador de Números Pseudo-aleatórios

- *srand()*

```
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
#define MAX 10
```

```
int main()
```

```
{
```

```
int i, numero;
```

```
srand(2);
```

```
for(i=0; i<=MAX-1; i++){
```

```
    numero = rand();
```

```
    printf("%d ", numero);
```

```
    printf("\n");
```


```
}
```

```
printf("\n");
```

```
return 0;
```

```
}
```

Inicia a semente do gerador  
de números pseudoaleatórios.



## 6. Gerador de Números Pseudo-aleatórios

- *srand()*

```
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
#define MAX 10

int main()
{
    int i, numero;

    srand(time(NULL));
    for(i=0; i<=MAX-1; i++) {
        numero = rand();
        printf("%d ", numero);
        printf("\n");
    }
    printf("\n");
    return 0;
}
```

A semente é gerada a partir da função *time()*, que retorna um valor diferente a cada segundo.

## 6. Gerador de Números Pseudo-aleatórios

- Exemplo 1:

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

int main()
{
    int i, j, valores[MAX][MAX];

    // Inicia o gerador de números pseudo-aleatórios
    srand(time(NULL));

    // Preenche a matriz
    for(i=0; i<=MAX-1; i++)
        for(j=0; j<=MAX-1; j++)
            valores[i][j] = rand() % 10;
```

## 6. Gerador de Números Pseudo-aleatórios

- Exemplo 1:

```
// Mostra a matriz
for(i=0; i<=MAX-1; i++){
    for(j=0; j<=MAX-1; j++){
        printf("%d \t", valores[i][j]);
    }
    printf("\n");
}
printf("\n\n");

// Mostra a diagonal principal
for(i=0; i<=MAX-1; i++){
    printf("%d \t", valores[i][i]);
}
printf("\n");

return 0;
}
```

## 6. Gerador de Números Pseudo-aleatórios

**Exemplo 2:** Um dos mais comuns geradores de números pseudoaleatórios é o *linear congruential generator*, que utiliza a recorrência abaixo. A série de valores gerados por este algoritmo é determinada por um número fixo chamado *semente*.

$$X_{n+1} = (aX_n + b) \bmod m$$

(a) Escreva um algoritmo que gere duas sequencias R1 e R2 de números pseudoaleatórios de comprimento 100000 cada uma. Normaliza as sequencias de forma que os valores fiquem entre 0 e 1. Considere:

R1 →  $X_01 = 5$ ,  $a = 22695477$ ,  $b = 1$  e  $m = 1013904223$

R2 →  $X_02 = 23$ ,  $a = 22695477$ ,  $b = 1$  e  $m = 1013904223$

## 6. Gerador de Números Pseudo-aleatórios

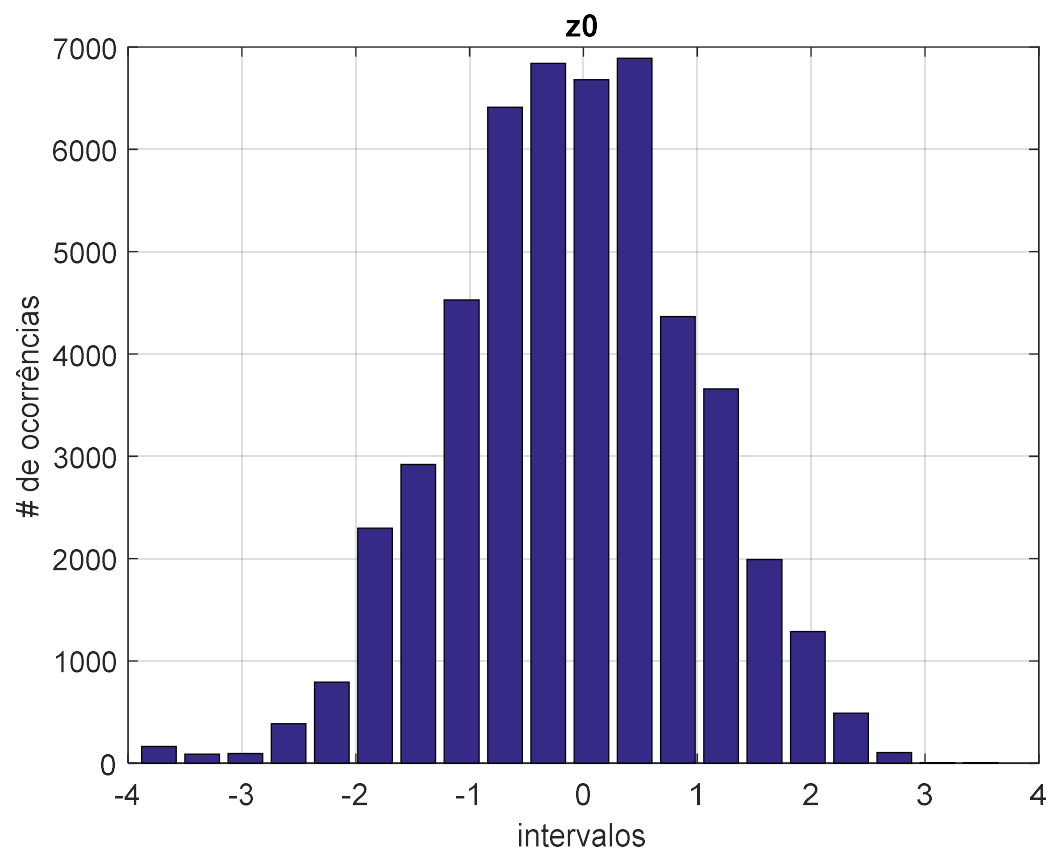
As equações abaixo permitem a obtenção de uma distribuição normal padronizada a partir de duas sequências  $R_1$  e  $R_2$  geradas aleatoriamente.

$$z_0 = \sqrt{-2 \ln R_1} \cos(2\pi R_2)$$

$$z_1 = \sqrt{-2 \ln R_1} \sin(2\pi R_2)$$

(b) Escreva um algoritmo para gerar uma sequência de valores segundo uma distribuição normal padronizada. Calcule o histograma e o valor da média e a variância do conjunto de valores gerados.

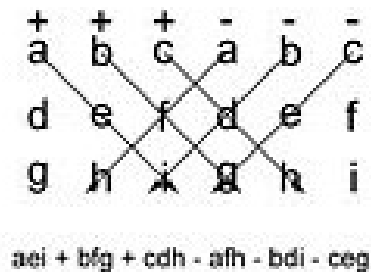
## 6. Gerador de Números Pseudo-aleatórios



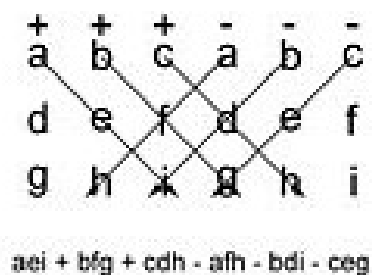


## 7. Exemplos

**Exercício 1:** Escreva um programa que leia uma matriz  $A_{3 \times 3}$  e calcule seu determinante, mostrando o resultado na tela.


$$\begin{array}{ccccc} + & + & + & - & - & - \\ a & b & c & a & b & c \\ d & e & f & d & e & f \\ g & h & i & g & h & i \end{array}$$
$$aei + bfg + cdh - afh - bdi - ceg$$

## 7. Exemplos



$$\begin{aligned}
 a &= B[\textcolor{red}{0}] [0] \\
 e &= B[\textcolor{red}{1}] [1] \\
 i &= B[\textcolor{red}{2}] [2]
 \end{aligned}$$

$$\begin{aligned}
 b &= B[\textcolor{red}{0}] [1] \\
 f &= B[\textcolor{red}{1}] [2] \\
 g &= B[\textcolor{red}{2}] [3]
 \end{aligned}$$

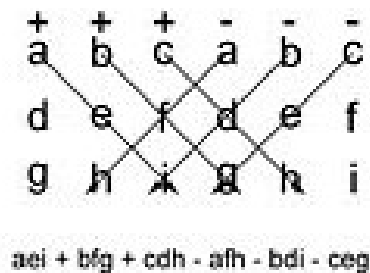
$$\begin{aligned}
 c &= B[\textcolor{red}{0}] [2] \\
 d &= B[\textcolor{red}{1}] [3] \\
 h &= B[\textcolor{red}{2}] [4]
 \end{aligned}$$

## 7. Exemplos

$i = 0..2$

$i$   
 $a = B[0] [0]$   
 $e = B[1] [1]$   
 $i = B[2] [2]$

$i = 0..2$



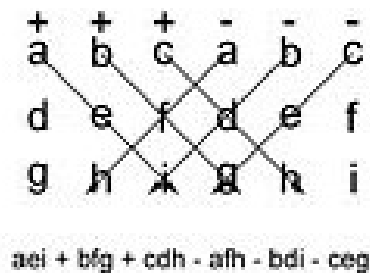
$i$   
 $b = B[0] [1]$   
 $f = B[1] [2]$   
 $g = B[2] [3]$

$i = 0..2$

$i$   
 $c = B[0] [2]$   
 $d = B[1] [3]$   
 $h = B[2] [4]$



## 7. Exemplos



$$\begin{array}{l}
 \phantom{a = B[} i \\
 a = B[\textcolor{red}{0}] \\
 e = B[\textcolor{red}{1}] \\
 i = B[\textcolor{red}{2}]
 \end{array}
 \begin{array}{c}
 [0] \\
 [1] \\
 [2]
 \end{array}
 \begin{array}{l}
 \\
 i+0 \\
 \end{array}$$

$$i = 0..2$$

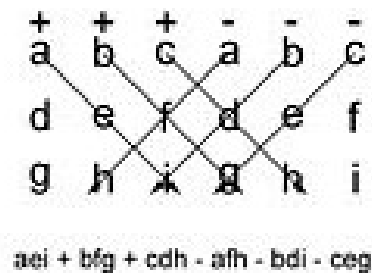
$$\begin{array}{l}
 \phantom{b = B[} i \\
 b = B[\textcolor{red}{0}] \\
 f = B[\textcolor{red}{1}] \\
 g = B[\textcolor{red}{2}]
 \end{array}
 \begin{array}{c}
 [1] \\
 [2] \\
 [3]
 \end{array}
 \begin{array}{l}
 \\
 i+1 \\
 \end{array}$$

$$i = 0..2$$

$$\begin{array}{l}
 \phantom{c = B[} i \\
 c = B[\textcolor{red}{0}] \\
 d = B[\textcolor{red}{1}] \\
 h = B[\textcolor{red}{2}]
 \end{array}
 \begin{array}{c}
 [2] \\
 [3] \\
 [4]
 \end{array}
 \begin{array}{l}
 \\
 i+2 \\
 \end{array}$$

$$i = 0..2$$

## 7. Exemplos



$i$   
 $a = B[0]$   
 $e = B[1]$   
 $i = B[2]$

$i+0$

$i$   
 $b = B[0]$   
 $f = B[1]$   
 $g = B[2]$

$i+1$

$i$   
 $c = B[0]$   
 $d = B[1]$   
 $h = B[2]$

$i+2$

$j = 0..2$

$i = 0..2$

$i = 0..2$

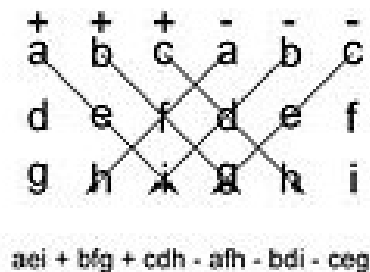
$i = 0..2$

## 7. Exemplos

$j = 0, i = 0..2$

	$i$	$i+j$
$a = B[$	$0]$	$[0]$
$e = B[$	$1]$	$[1]$
$i = B[$	$2]$	$[2]$

$i = 0..2$

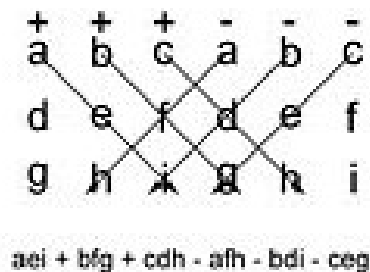


	$i$	$i+j$
$b = B[$	$0]$	$[1]$
$f = B[$	$1]$	$[2]$
$g = B[$	$2]$	$[3]$

$i = 0..2$

	$i$	$i+j$
$c = B[$	$0]$	$[2]$
$d = B[$	$1]$	$[3]$
$h = B[$	$2]$	$[4]$

## 7. Exemplos



$i$      $i+j$   
 $a = B[0] [0]$   
 $e = B[1] [1]$   
 $i = B[2] [2]$

$j = 0, i = 0..2$

$i$      $i+j$   
 $b = B[0] [1]$   
 $f = B[1] [2]$   
 $g = B[2] [3]$

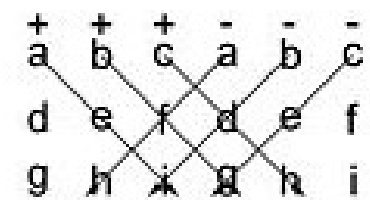
$j = 1, i = 0..2$

$i$      $i+j$   
 $c = B[0] [2]$   
 $d = B[1] [3]$   
 $h = B[2] [4]$

$i = 0..2$



## 7. Exemplos



$aei + bfg + cdh - afh - bdi - ceg$

$i \quad i+j$   
 $a = B[0] \quad [0]$   
 $e = B[1] \quad [1]$   
 $i = B[2] \quad [2]$

$i \quad i+j$   
 $b = B[0] \quad [1]$   
 $f = B[1] \quad [2]$   
 $g = B[2] \quad [3]$

$i \quad i+j$   
 $c = B[0] \quad [2]$   
 $d = B[1] \quad [3]$   
 $h = B[2] \quad [4]$

$j = 0, i = 0..2$

$j = 1, i = 0..2$

$j = 2, i = 0..2$

## 7. Exemplos

$$j = 0, i = 0..2$$

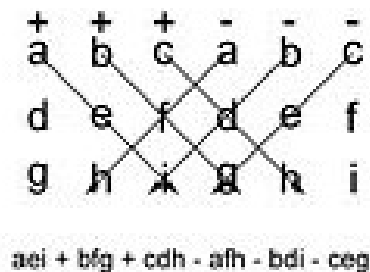
$i$      $i+j$   
 $a = B[0] [0]$   
 $e = B[1] [1] \rightarrow \text{termoP} = a * e * i$   
 $i = B[2] [2]$

$$j = 1, i = 0..2$$

$i$      $i+j$   
 $b = B[0] [1]$   
 $f = B[1] [2] \rightarrow \text{termoP} = b * f * g$   
 $g = B[2] [3]$

$$j = 2, i = 0..2$$

$i$      $i+j$   
 $c = B[0] [2]$   
 $d = B[1] [3] \rightarrow \text{termoP} = c * d * h$   
 $h = B[2] [4]$



## 7. Exemplos

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

int main()
{

    float A[3][3] ={{ {1,2,3}, {4,5,6}, {7,8,9} }};
    float B[3][6], termoP, Soma;
    int i,j;

    for (i=0; i<3; i++){
        for (j=0; j<3; j++){
            B[i][j] = A[i][j];
            B[i][j+3] = A[i][j];
            printf("%f \n", B[i][j]);
        }
    }
```

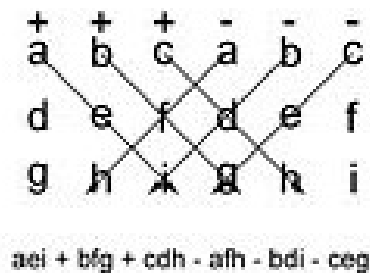
## 7. Exemplos

```
Soma = 0;
for(j=0;j<3;j++){
    termoP = 1;
    for(i=0;i<3;i++){
        termoP = termoP*B[i][i+j];
    }
    Soma = Soma + termoP;
}

printf("Determinante: %f\n", Soma);

return 0;
}
```

## 7. Exemplos



$$\begin{aligned}
 a &= B[0] [3] \\
 f &= B[1] [2] \\
 h &= B[2] [1]
 \end{aligned}$$

$$\begin{aligned}
 b &= B[0] [4] \\
 d &= B[1] [3] \\
 i &= B[2] [2]
 \end{aligned}$$

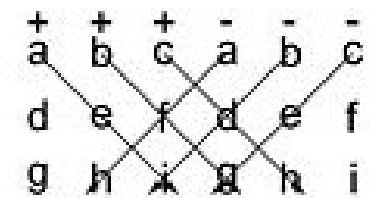
$$\begin{aligned}
 c &= B[0] [5] \\
 e &= B[1] [4] \\
 g &= B[2] [3]
 \end{aligned}$$

## 7. Exemplos

$i = 0..2$

$i$   
 $a = B[0] \quad [3]$   
 $f = B[1] \quad [2]$   
 $h = B[2] \quad [1]$

$i = 0..2$



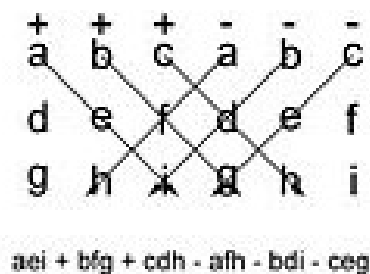
$aei + bfg + cdh - afh - bdi - ceg$

$i$   
 $b = B[0] \quad [4]$   
 $d = B[1] \quad [3]$   
 $i = B[2] \quad [2]$

$i = 0..2$

$i$   
 $c = B[0] \quad [5]$   
 $e = B[1] \quad [4]$   
 $g = B[2] \quad [3]$

## 7. Exemplos



$$\begin{aligned}
 a &= B[\overset{i}{0}] \begin{bmatrix} 3 \\ 2 \\ 1 \end{bmatrix} \\
 f &= B[\overset{i}{1}] \\
 h &= B[\overset{i}{2}]
 \end{aligned}$$

$$\begin{aligned}
 b &= B[\overset{i}{0}] \begin{bmatrix} 4 \\ 3 \\ 2 \end{bmatrix} \\
 d &= B[\overset{i}{1}] \\
 i &= B[\overset{i}{2}]
 \end{aligned}$$

$$\begin{aligned}
 c &= B[\overset{i}{0}] \begin{bmatrix} 5 \\ 4 \\ 3 \end{bmatrix} \\
 e &= B[\overset{i}{1}] \\
 g &= B[\overset{i}{2}]
 \end{aligned}$$

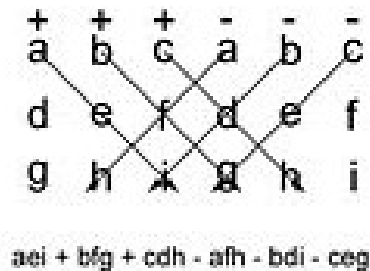
$$i = 0..2$$

$$i = 0..2$$

$$i = 0..2$$

$$j+3-i$$

## 7. Exemplos



$i \quad j+3-i$   
 $a = B[0] \quad [3]$   
 $f = B[1] \quad [2]$   
 $h = B[2] \quad [1]$

$j = 0, i = 0..2$

$i \quad j+3-i$   
 $b = B[0] \quad [4]$   
 $d = B[1] \quad [3]$   
 $i = B[2] \quad [2]$

$j = 1, i = 0..2$

$i \quad j+3-i$   
 $c = B[0] \quad [5]$   
 $e = B[1] \quad [4]$   
 $g = B[2] \quad [3]$

$j = 2, i = 0..2$



## 7. Exemplos

$$j = 0, i = 0..2$$

$$i \quad j+3-i$$

$$a = B[0] \quad [3]$$

$$f = B[1] \quad [2] \rightarrow \text{termoN} = a*f*h$$

$$h = B[2] \quad [1]$$

$$j = 1, i = 0..2$$

$$i \quad j+3-i$$

$$b = B[0] \quad [4]$$

$$d = B[1] \quad [3] \rightarrow \text{termoN} = b*d*i$$

$$i = B[2] \quad [2]$$

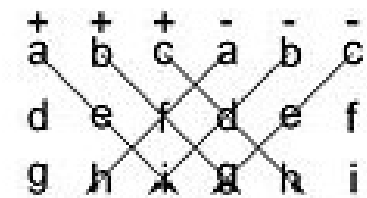
$$j = 2, i = 0..2$$

$$i \quad j+3-i$$

$$c = B[0] \quad [5]$$

$$e = B[1] \quad [4] \rightarrow \text{termoN} = c*e*g$$

$$g = B[2] \quad [3]$$



$$aei + bfg + cdh - afh - bdi - ceg$$

## 7. Exemplos

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

int main()
{

    float A[3][3] = { {1,2,3}, {4,5,6}, {7,8,9} };
    float B[3][6], termoP, termoN, Soma;
    int i,j;

    for (i=0; i<3; i++){
        for (j=0; j<3; j++){
            B[i][j] = A[i][j];
            B[i][j+3] = A[i][j];
            printf("%f \n", B[i][j]);
        }
    }
}
```



## 7. Exemplos

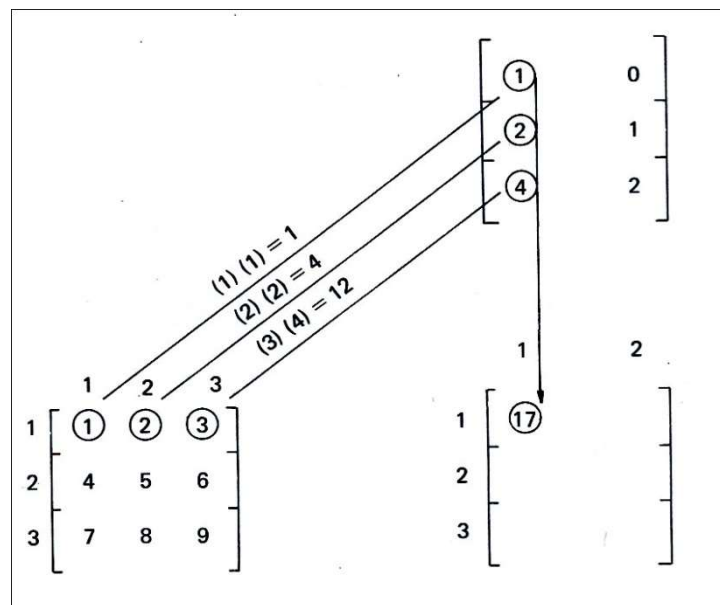
```
Soma = 0;
for (j=0;j<3;j++){
    termoP = 1;
    termoN = 1;
    for (i=0;i<3;i++){
        termoP = termoP*B[i][i+j];
        termoN = termoN*B[i][j+3-i];
    }
    Soma = Soma + termoP - termoN;
}

printf("Determinante: %f\n", Soma);

return 0;
}
```

## 7. Exemplos

**Exercício 2:** Escreva um programa que leia duas matrizes  $A_{3 \times 3}$  e  $B_{3 \times 2}$ , e realiza o produto matricial entre elas, guardando o resultado em uma terceira matriz  $C_{3 \times 2}$ , que é mostrada na tela do computador.



## 7. Exemplos

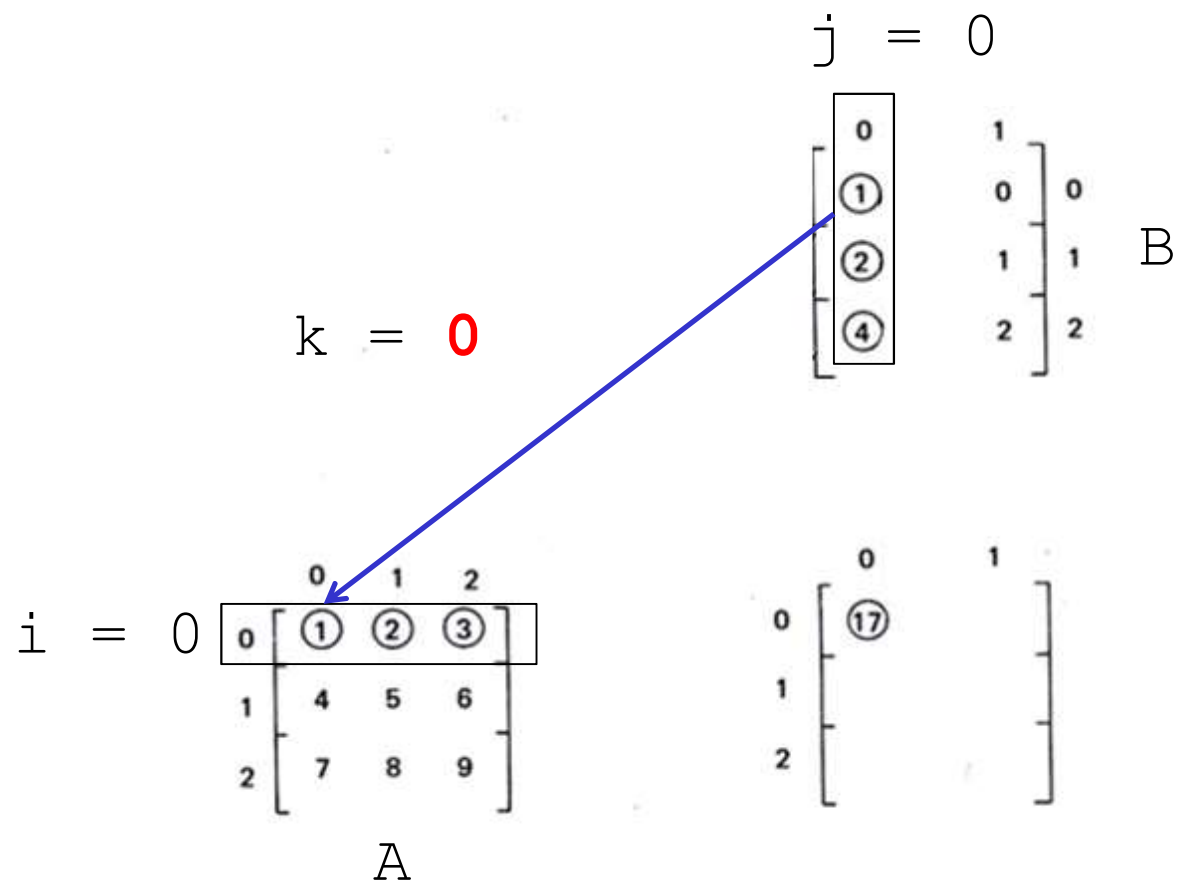
$$j = 0$$

$$\begin{bmatrix} 0 \\ \textcircled{1} \\ \textcircled{2} \\ \textcircled{4} \end{bmatrix}
 \begin{array}{c} 1 \\ 0 \\ 1 \\ 2 \end{array}
 \begin{array}{c} 0 \\ 1 \\ 2 \end{array}
 \quad B$$

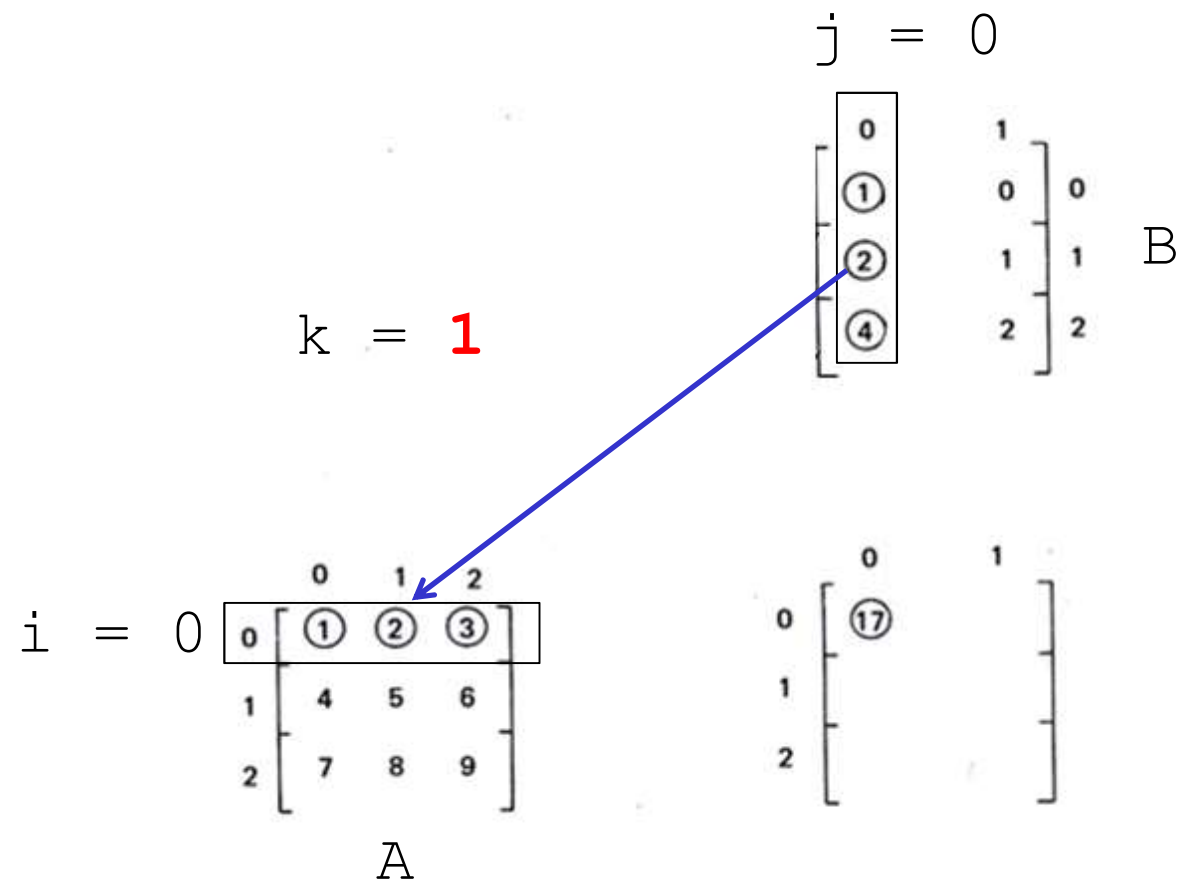
$$i = 0 \quad
 \begin{array}{c} 0 \quad 1 \quad 2 \\ 0 \quad \textcircled{1} \quad \textcircled{2} \quad \textcircled{3} \\ 1 \quad \begin{bmatrix} 4 & 5 & 6 \end{bmatrix} \\ 2 \quad \begin{bmatrix} 7 & 8 & 9 \end{bmatrix} \end{array}
 \quad A$$

$$\begin{array}{c} 0 \quad 1 \\ 0 \quad \textcircled{17} \\ 1 \quad \begin{bmatrix} \end{bmatrix} \\ 2 \quad \begin{bmatrix} \end{bmatrix} \end{array}$$

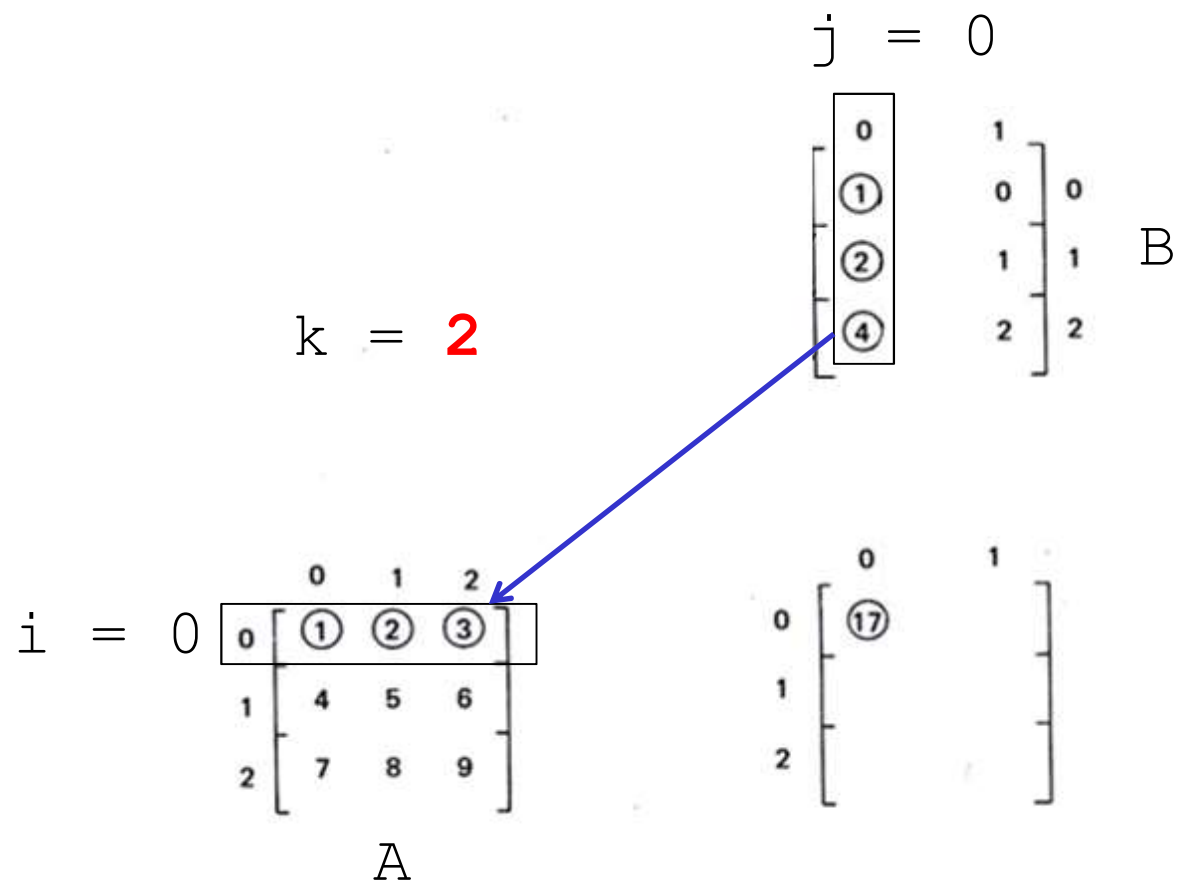
## 7. Exemplos



## 7. Exemplos



## 7. Exemplos





## 7. Exemplos

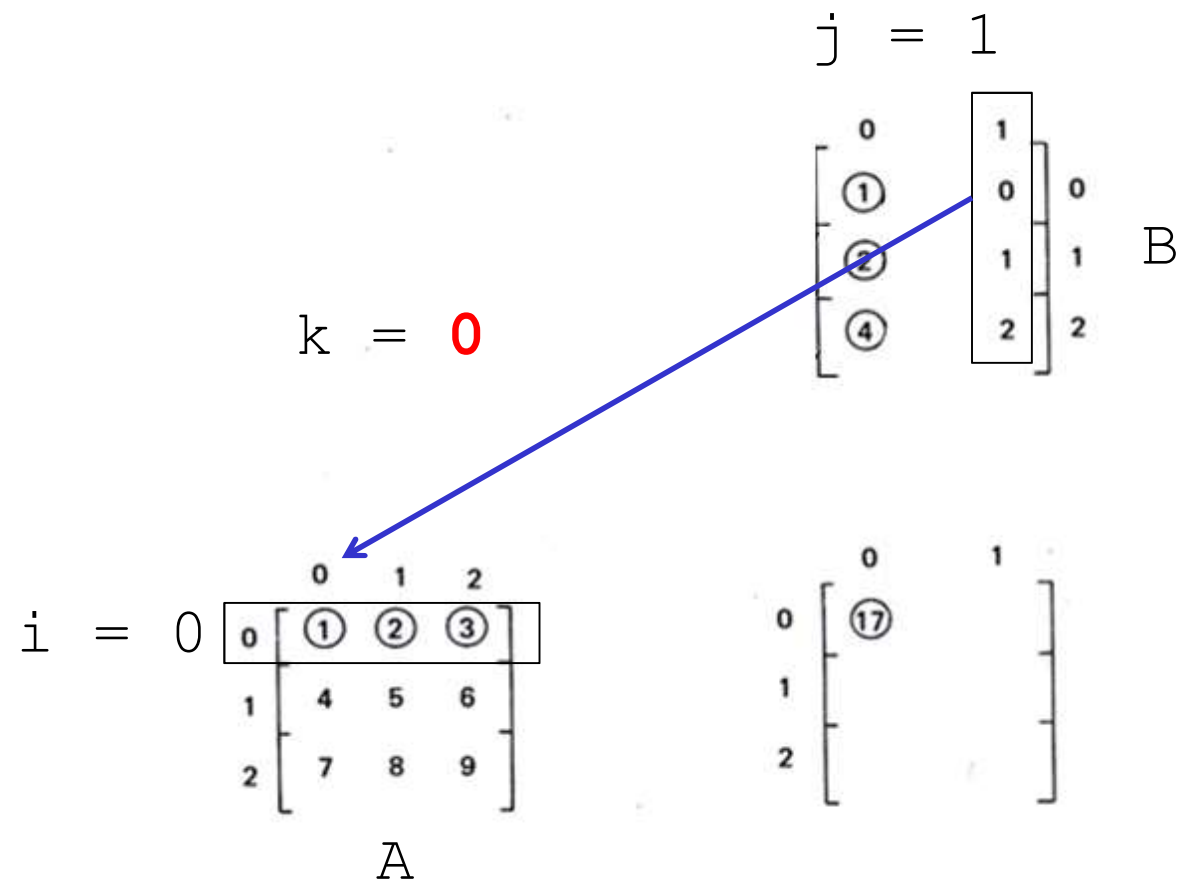
$$j = 1$$

$$\begin{array}{c}
 0 \\
 \left[ \begin{array}{c} \textcircled{1} \\ \textcircled{2} \\ \textcircled{4} \end{array} \right]
 \end{array}
 \begin{array}{c}
 1 \\
 \left[ \begin{array}{c} 0 \\ 1 \\ 2 \end{array} \right]
 \end{array}
 \begin{array}{c}
 0 \\
 1 \\
 2
 \end{array}
 \quad B$$

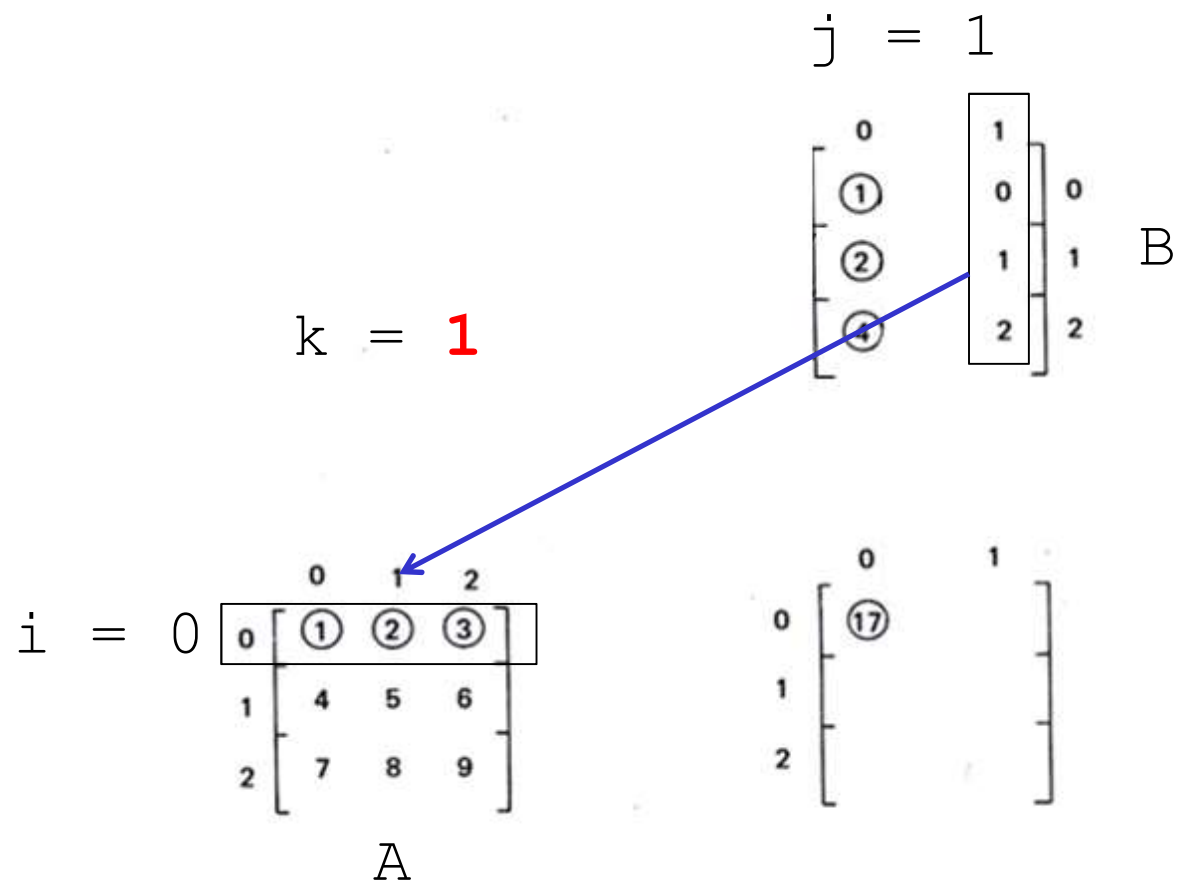
$$\begin{array}{c}
 i = 0 \\
 \left[ \begin{array}{ccc} 0 & \textcircled{1} & \textcircled{2} & \textcircled{3} \end{array} \right]
 \end{array}
 \begin{array}{c}
 0 \quad 1 \quad 2 \\
 \left[ \begin{array}{ccc} 4 & 5 & 6 \\ 7 & 8 & 9 \end{array} \right]
 \end{array}
 \quad A$$

$$\begin{array}{c}
 0 \quad 1 \\
 \left[ \begin{array}{c} \textcircled{17} \\ \phantom{0} \\ \phantom{0} \end{array} \right]
 \end{array}$$

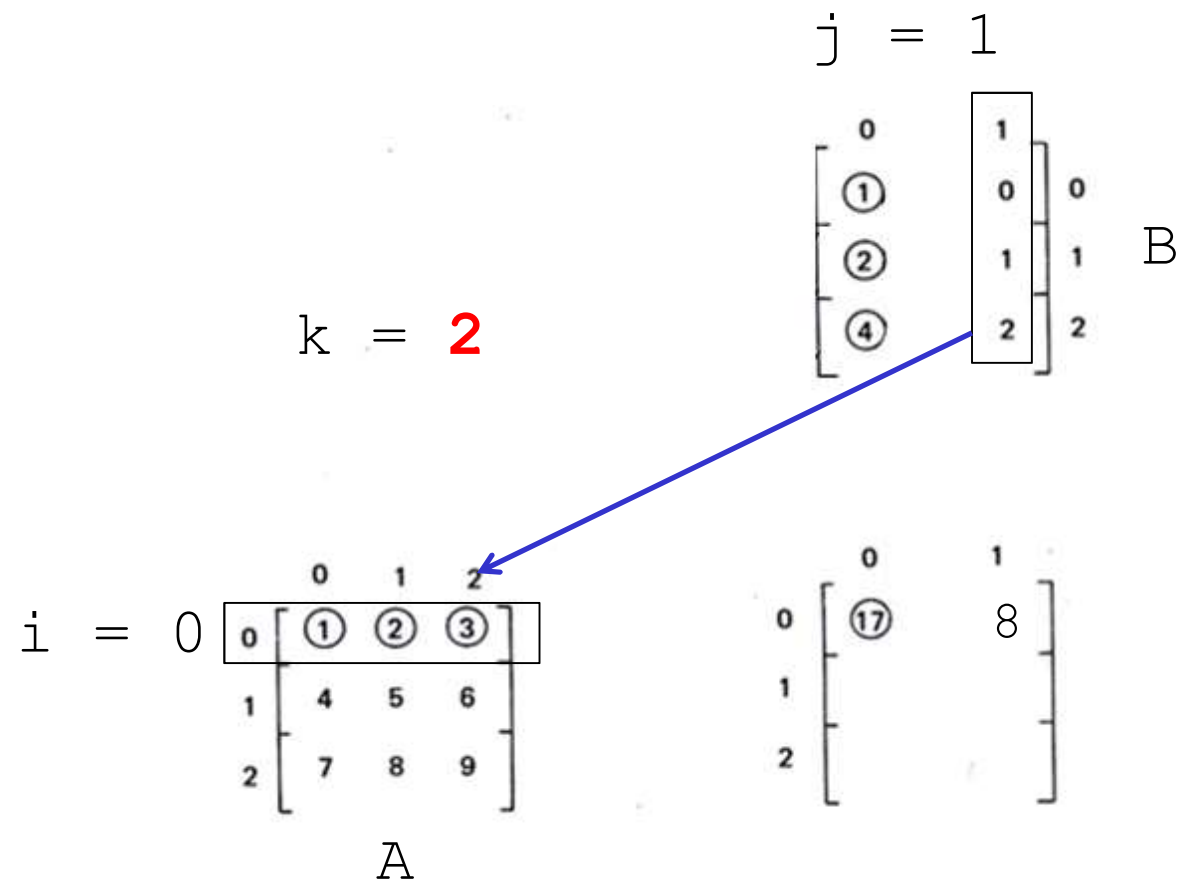
## 7. Exemplos



## 7. Exemplos



## 7. Exemplos



## 7. Exemplos

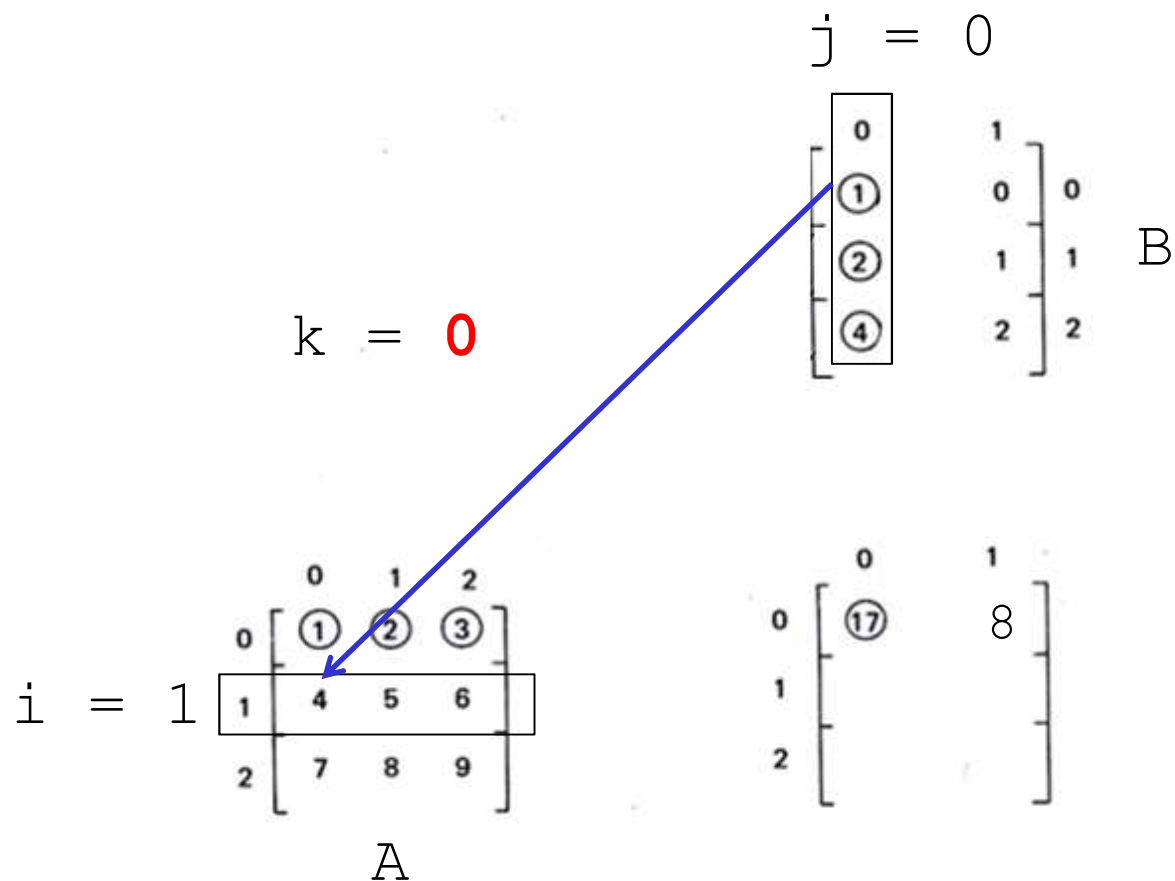
$$j = 0$$

$$\begin{array}{c}
 \boxed{\begin{array}{c} 0 \\ \textcircled{1} \\ \textcircled{2} \\ \textcircled{4} \end{array}} \quad \begin{array}{c} 1 \\ 0 \\ 1 \\ 2 \end{array} \begin{array}{c} 0 \\ 1 \\ 2 \end{array}
 \end{array}
 \quad B$$

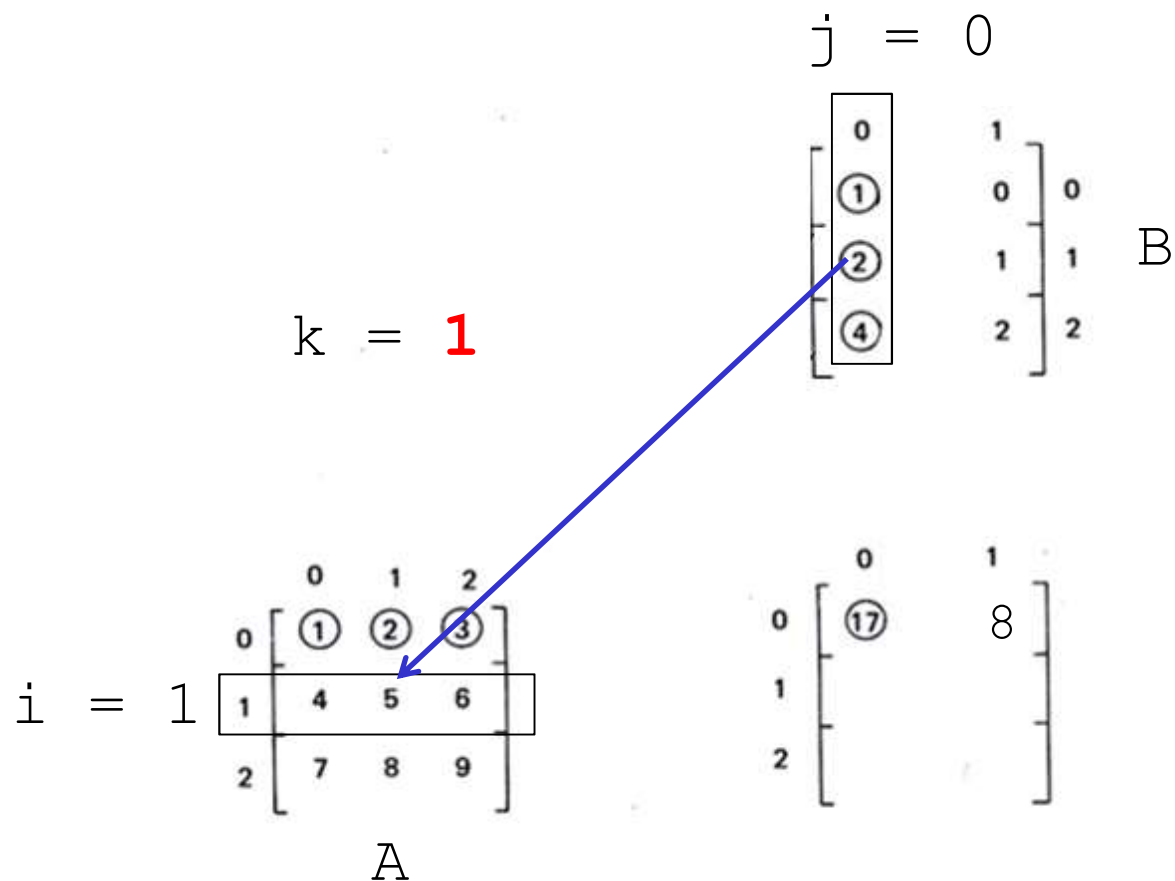
$$\begin{array}{c}
 i = 1 \\
 \boxed{\begin{array}{c} 1 \\ 2 \end{array}} \quad \begin{array}{c} 0 \quad 1 \quad 2 \\ \begin{array}{c} \textcircled{1} \quad \textcircled{2} \quad \textcircled{3} \\ 4 \quad 5 \quad 6 \\ 7 \quad 8 \quad 9 \end{array} \end{array}
 \end{array}
 \quad A$$

$$\begin{array}{c}
 0 \quad 1 \\
 \begin{array}{c} \textcircled{17} \\ 8 \end{array}
 \end{array}$$

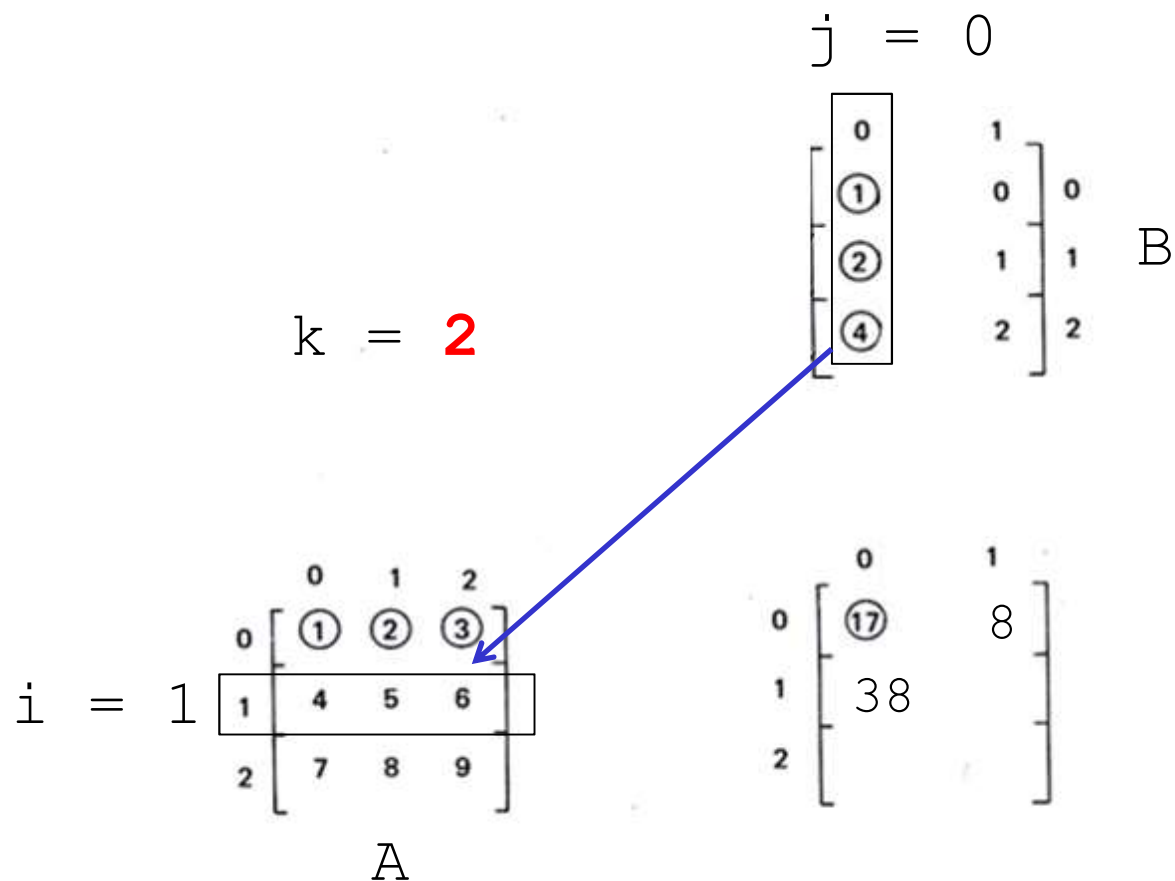
## 7. Exemplos



## 7. Exemplos



## 7. Exemplos





## 7. Exemplos

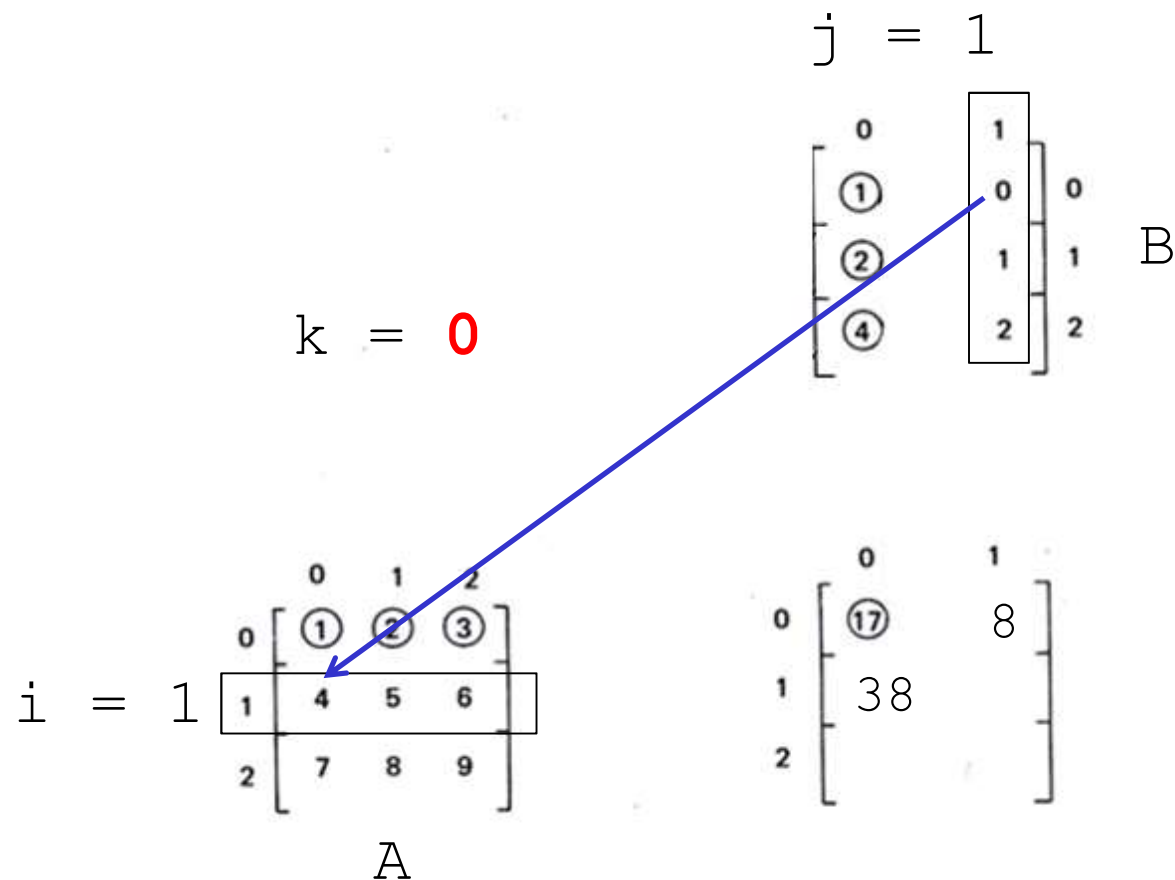
$$j = 0$$

$$\begin{array}{c}
 \boxed{\begin{array}{c} 0 \\ \textcircled{1} \\ \textcircled{2} \\ \textcircled{4} \end{array}} \quad \begin{array}{c} 1 \\ 0 \\ 1 \\ 2 \end{array} \begin{array}{c} 0 \\ 1 \\ 2 \end{array}
 \end{array}
 \quad B$$

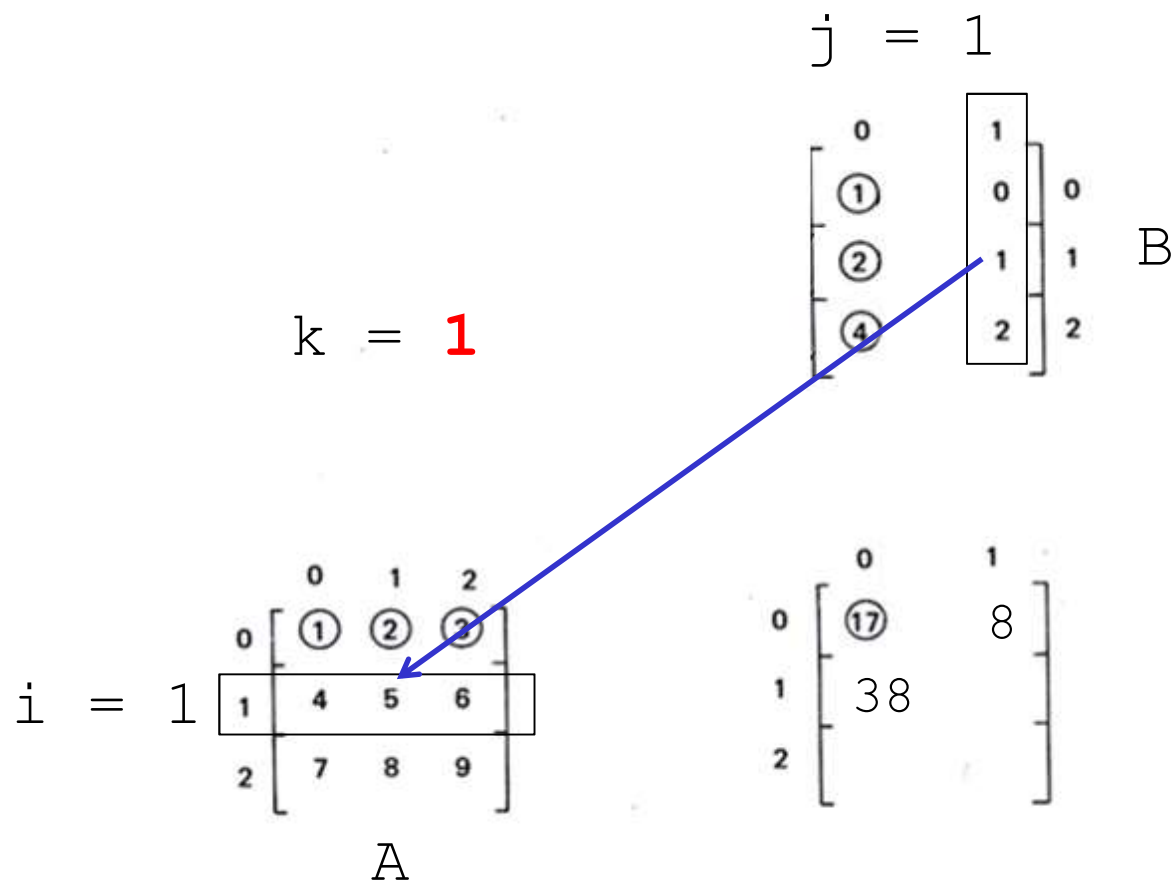
$$\begin{array}{c}
 \begin{array}{c} 0 \quad 1 \quad 2 \\ \textcircled{1} \quad \textcircled{2} \quad \textcircled{3} \end{array} \\
 i = 1 \quad \boxed{\begin{array}{c} 1 \\ 4 \quad 5 \quad 6 \\ 7 \quad 8 \quad 9 \end{array}}
 \end{array}
 \quad A$$

$$\begin{array}{c}
 0 \quad 1 \\
 \begin{array}{c} \textcircled{17} \\ 38 \end{array} \quad \begin{array}{c} 8 \end{array}
 \end{array}$$

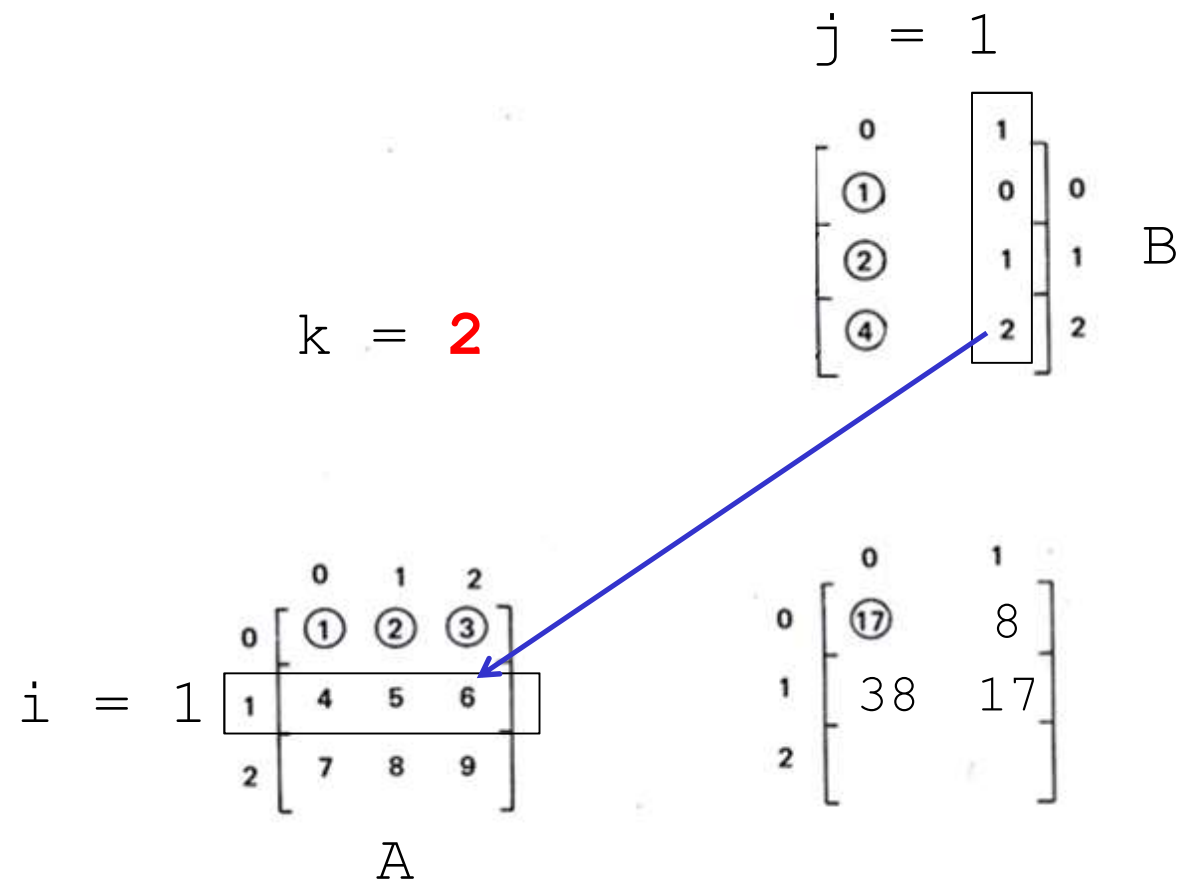
## 7. Exemplos



## 7. Exemplos



## 7. Exemplos



## 7. Exemplos

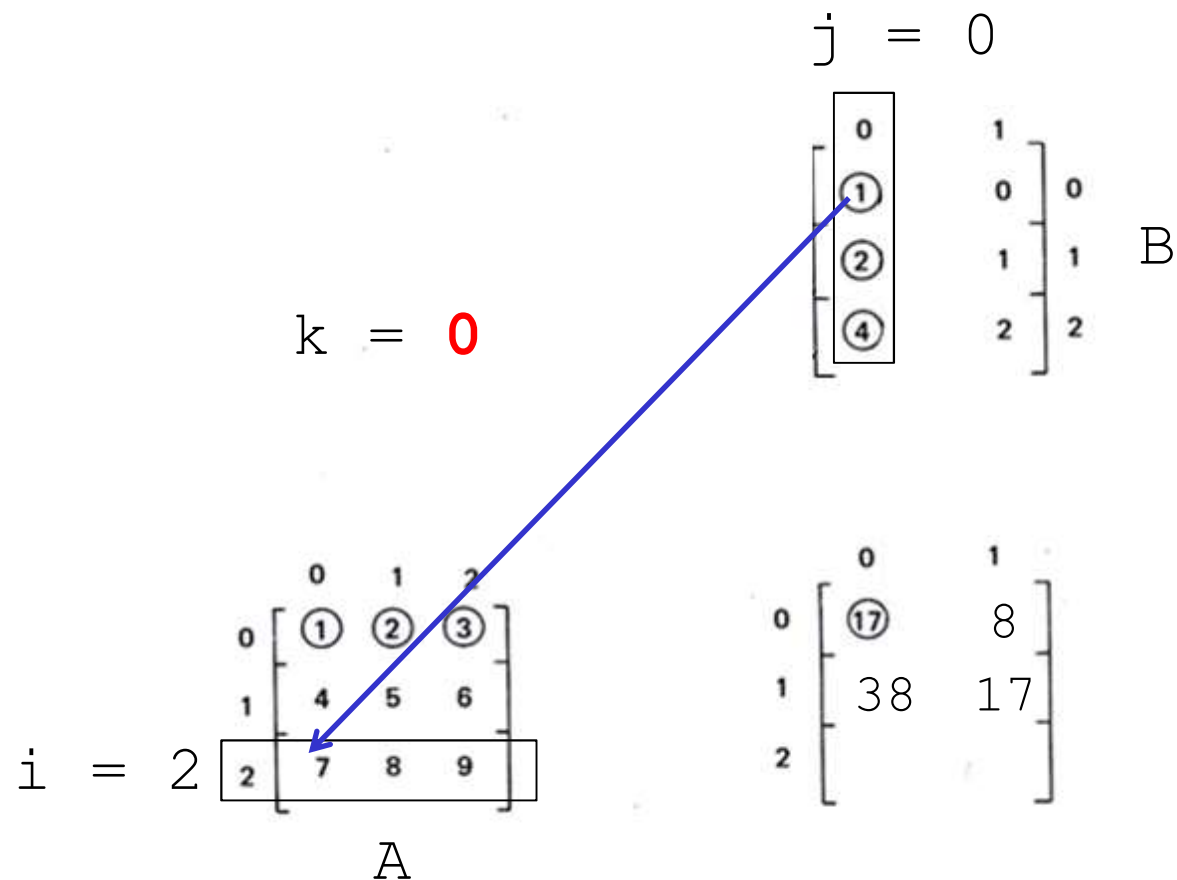
$$j = 1$$

$$\begin{array}{c}
 0 \\
 \left[ \begin{array}{c} \textcircled{1} \\ \textcircled{2} \\ \textcircled{4} \end{array} \right]
 \end{array}
 \begin{array}{c}
 0 \\
 \left[ \begin{array}{c} 1 \\ 0 \\ 1 \\ 2 \end{array} \right]
 \end{array}
 \begin{array}{c}
 0 \\
 1 \\
 2
 \end{array}
 \quad B$$

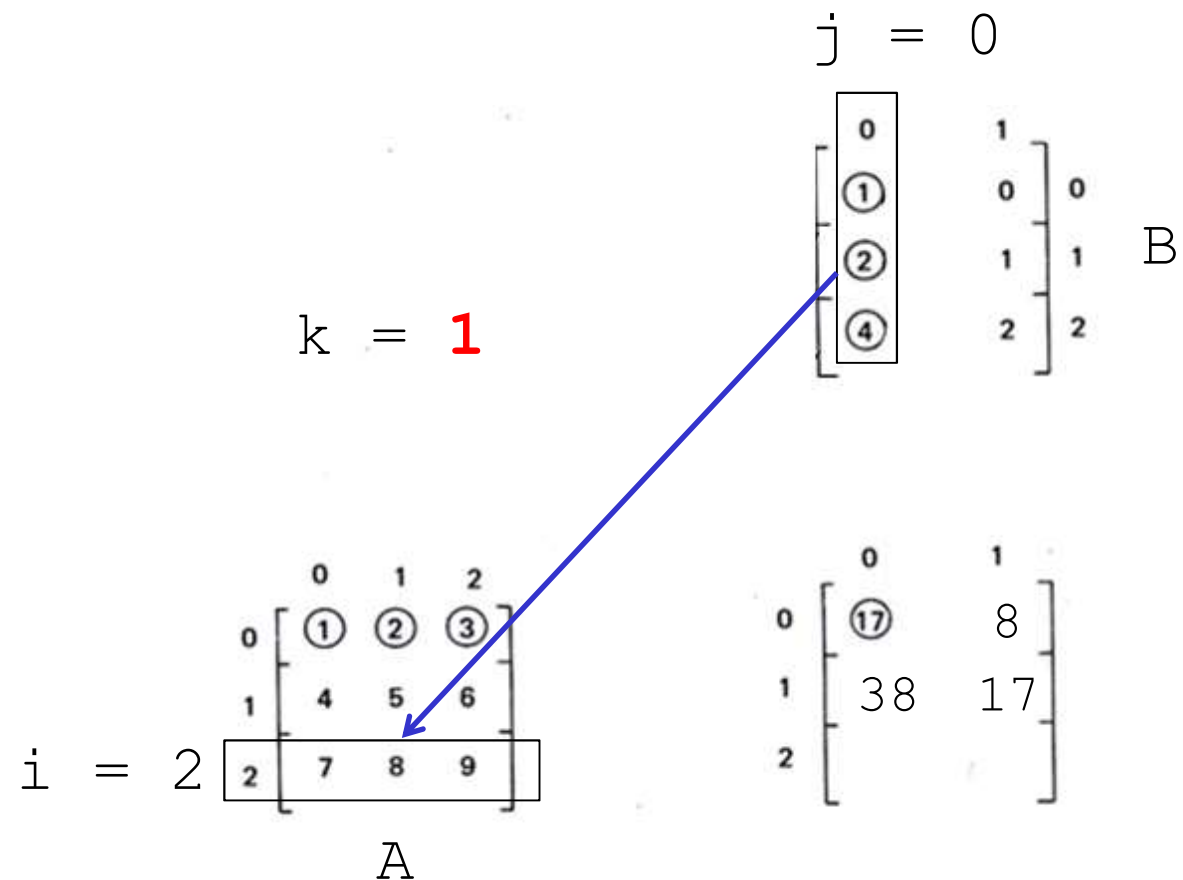
$$\begin{array}{c}
 i = 1 \\
 \left[ \begin{array}{c} 1 \\ 2 \end{array} \right]
 \begin{array}{c}
 0 \quad 1 \quad 2 \\
 \left[ \begin{array}{ccc} \textcircled{1} & \textcircled{2} & \textcircled{3} \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{array} \right]
 \end{array}
 \end{array}
 \quad A$$

$$\begin{array}{c}
 0 \quad 1 \\
 \left[ \begin{array}{cc} \textcircled{17} & 8 \\ 38 & 17 \end{array} \right]
 \end{array}$$

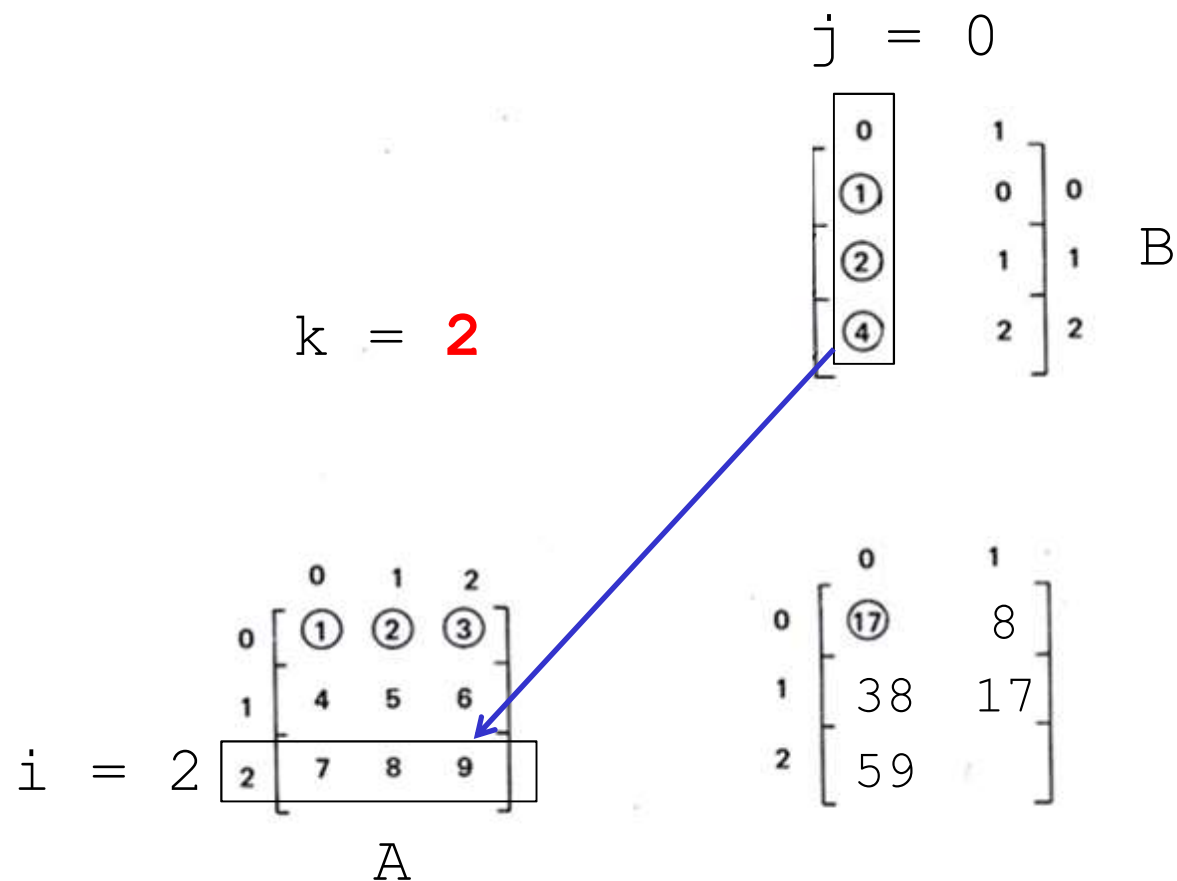
## 7. Exemplos



## 7. Exemplos



## 7. Exemplos





## 7. Exemplos

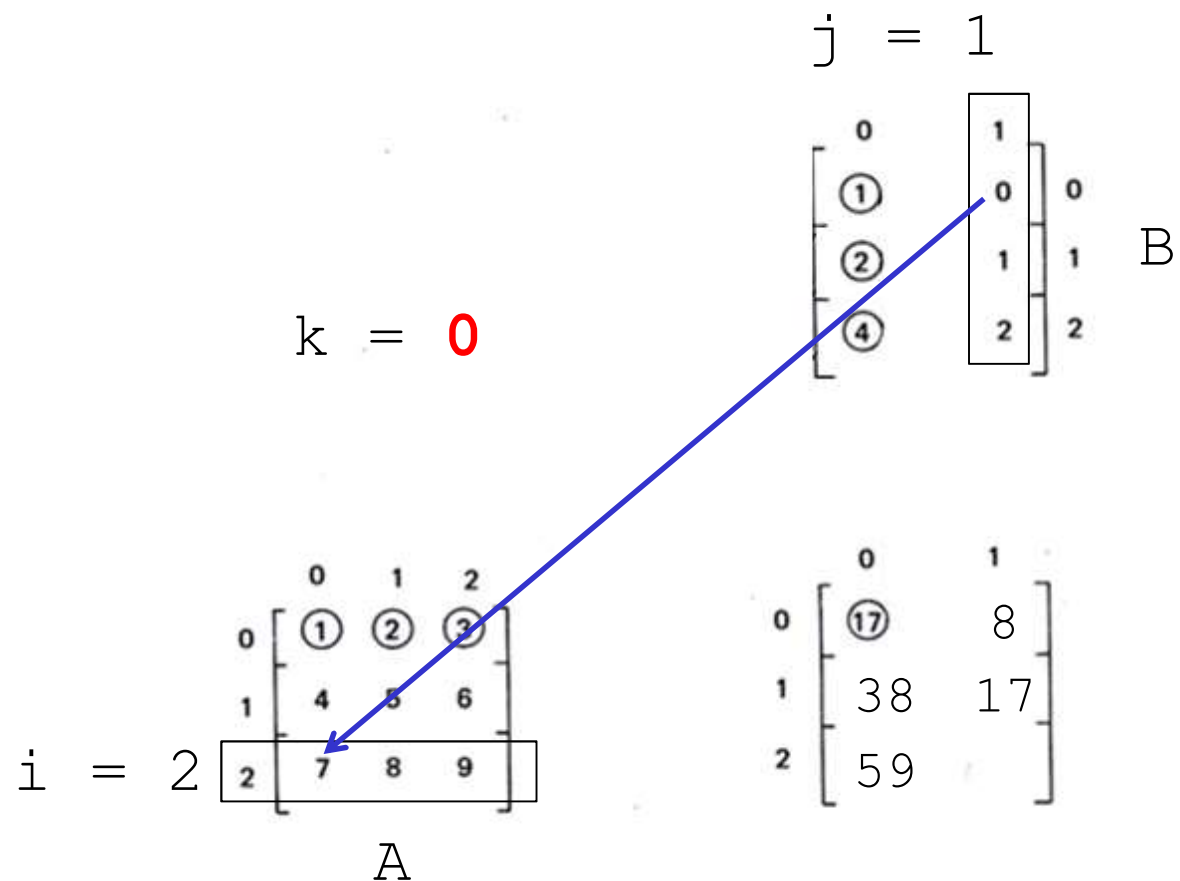
$$j = 0$$

$$\begin{bmatrix} 0 \\ \textcircled{1} \\ \textcircled{2} \\ \textcircled{4} \end{bmatrix}
 \begin{bmatrix} 1 \\ 0 \\ 1 \\ 2 \end{bmatrix}
 \begin{bmatrix} 0 \\ 1 \\ 2 \end{bmatrix}
 \quad B$$

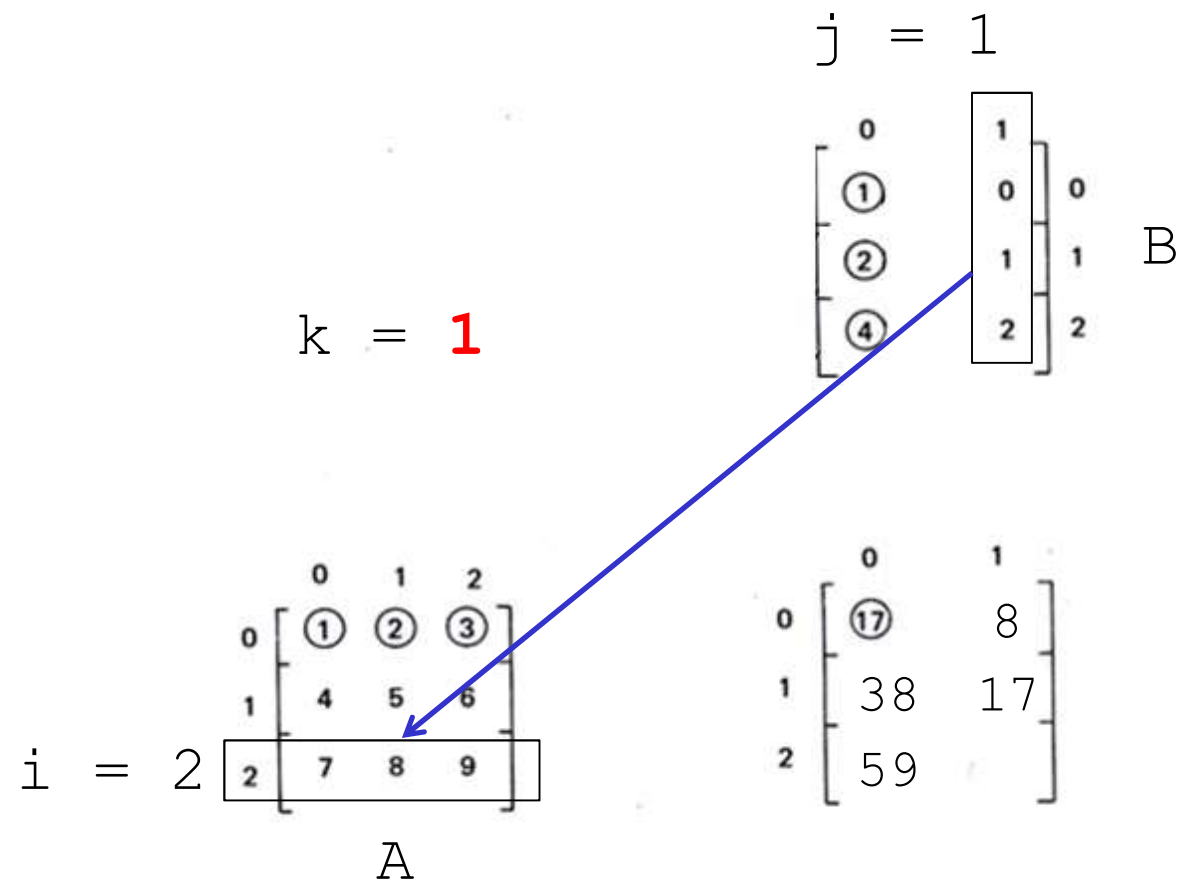
$$\begin{matrix} & & 0 & 1 & 2 \\ \begin{matrix} 0 \\ 1 \\ 2 \end{matrix} & \begin{bmatrix} \textcircled{1} & \textcircled{2} & \textcircled{3} \\ 4 & 5 & 6 \\ 2 & 7 & 8 & 9 \end{bmatrix} \end{matrix}
 \quad A$$

$$\begin{matrix} & 0 & 1 \\ \begin{matrix} 0 \\ 1 \\ 2 \end{matrix} & \begin{bmatrix} \textcircled{17} & 8 \\ 38 & 17 \\ 59 & \end{bmatrix} \end{matrix}$$

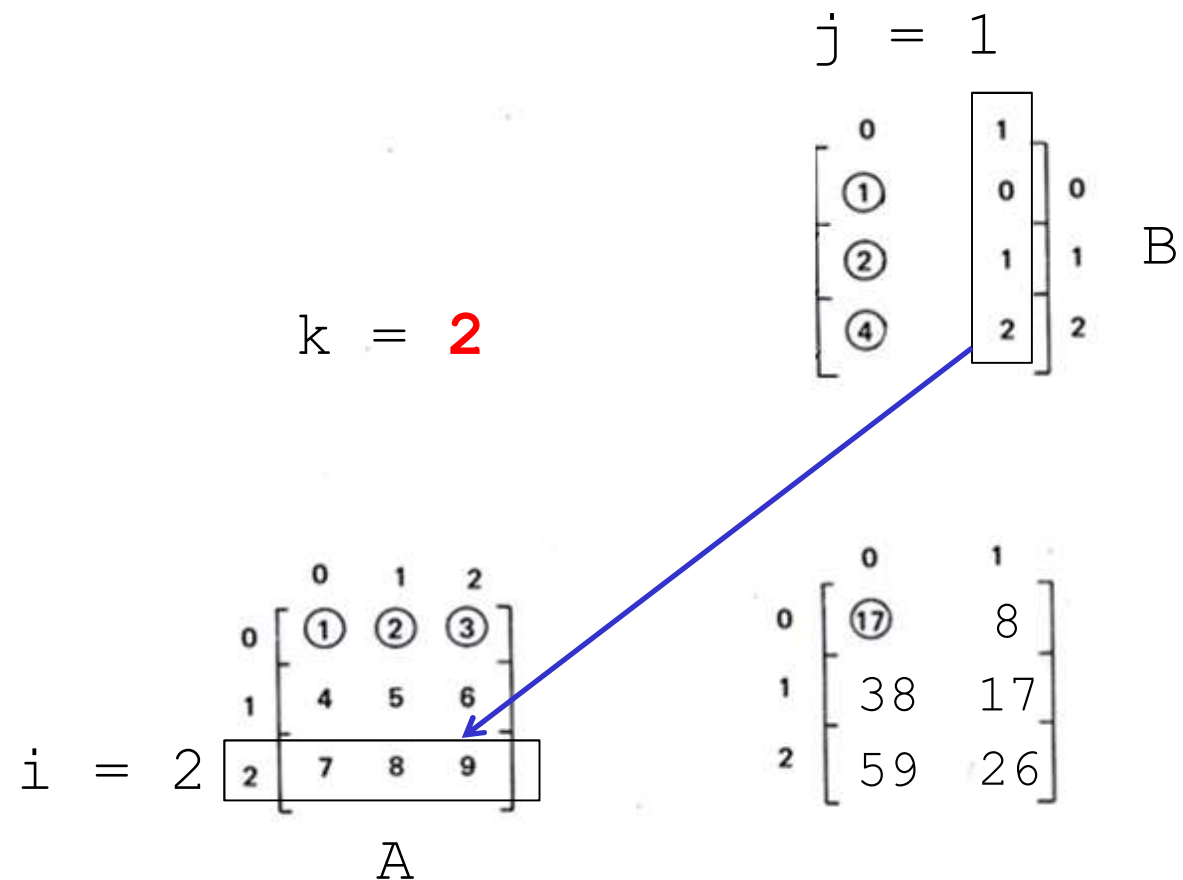
## 7. Exemplos



## 7. Exemplos



## 7. Exemplos



## 7. Exemplos

$$j = 1$$

$$\begin{array}{c}
 0 \\
 \left[ \begin{array}{c} \textcircled{1} \\ \textcircled{2} \\ \textcircled{4} \end{array} \right]
 \end{array}
 \begin{array}{c}
 0 \\
 \left[ \begin{array}{c} 1 \\ 0 \\ 1 \\ 2 \end{array} \right]
 \end{array}
 \begin{array}{c}
 0 \\
 1 \\
 2
 \end{array}
 \quad B$$

$$\begin{array}{c}
 0 \quad 1 \quad 2 \\
 \left[ \begin{array}{ccc} \textcircled{1} & \textcircled{2} & \textcircled{3} \\ 4 & 5 & 6 \\ 2 & 7 & 8 & 9 \end{array} \right]
 \end{array}
 \quad A$$

$$\begin{array}{c}
 0 \quad 1 \\
 \left[ \begin{array}{cc} \textcircled{17} & 8 \\ 38 & 17 \\ 59 & 26 \end{array} \right]
 \end{array}$$

## 7. Exemplos

```

Para i de 0 ate 2 passo 1
  Para j de 0 ate 1 passo 1
    elemento = 0;

```

```

  Para k de 0 ate 2
    elemento = elemento +
      A[i][k]*B[k][j];

```

fimpara

fimpara

fimpara

i = 2

	0	1	2
0	①	②	③
1	4	5	6
2	7	8	9

A

j = 1

	0	1
0	①	0
1	②	1
2	④	2

B

	0	1
0	①7	8
1	38	17
2	59	26



## 7. Exemplos

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

```
int main ()
{
```

```
    float A[3][3] = {{1,2,3}, {4,5,6}, {7,8,9}};
```

```
    float B[3][2] = {{1,2}, {4,5}, {7,8}};
```

```
    float C[3][2], elemento;
```

```
    int i, j, k;
```



## 7. Exemplos

```
for (i=0; i<3; i++){  
    for (j=0; j<2;j++)    {  
        elemento = 0;  
        for (k=0;k<3;k++)  
            elemento = elemento + A[i][k]*B[k][j];  
  
        C[i][j] = elemento;  
    }  
}
```

```
for (i=0; i<3; i++){  
    for (j=0; j<3;j++)    {  
        printf("%f ", A[i][j]);  
    }  
    printf("\n");  
}  
  
printf("\n\n");
```





## 7. Exemplos

```
for (i=0; i<3; i++){  
    for (j=0; j<2;j++)    {  
        printf("%f ", B[i][j]);  
    }  
    printf("\n");  
}
```

```
printf("\n\n");
```

```
for (i=0; i<3; i++){  
    for (j=0; j<2;j++)    {  
        printf("%f \t", C[i][j]);  
    }  
    printf("\n");  
}
```

```
return 0;  
}
```

"It is no measure of health to be well adjusted to a profoundly sick society".

Jiddu Krishnamurti