BINARY MORPHOLOGICAL OPERATIONS

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- **Dilation Operation**

- Erosion Operation
- Opening and Closing operations
- Hit or Miss Transformation

DILATION OPERATION

- The dilation of two sets A and B denoted by $A \oplus B$ is defined as

$$A \oplus B = \bigcup_{b \in B} A_b$$ ----------(1)

- Dilation operation is commutative and associative, that is,

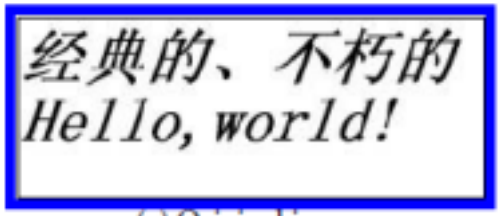
$$A \oplus B = B \oplus A$$

$$A \oplus (B \oplus C) = (A \oplus B) \oplus C$$ ----------(2)

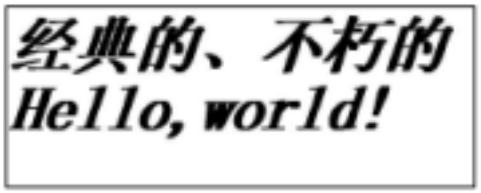
- Dilation operation is used to process an image with a structuring element.

- In equation 1, A is an image and B is structuring element.
- The purpose of performing dilation is to

enlarge a given object. Through this process, some unfilled parts within objects may be filled in.

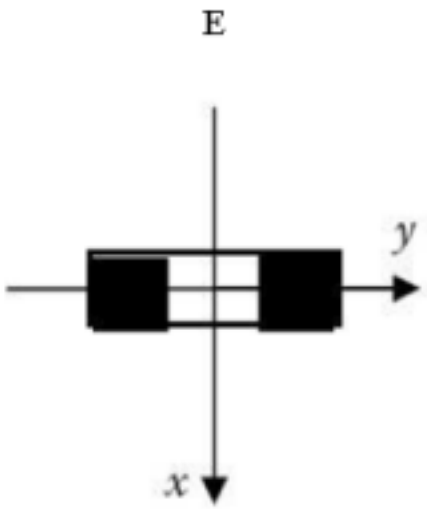


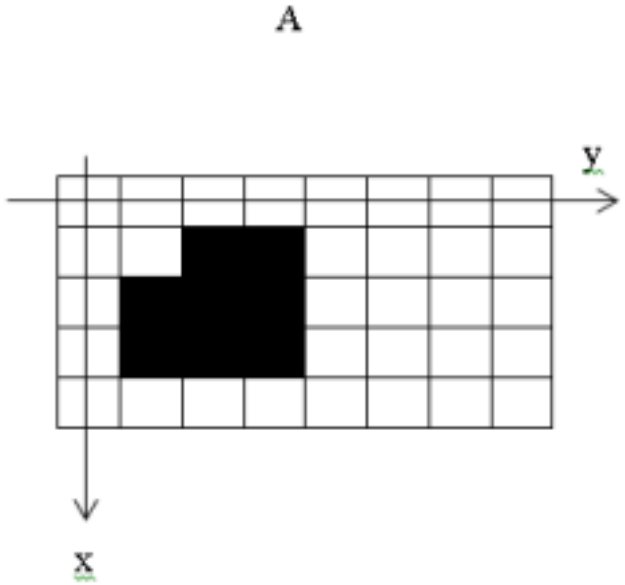
(a) Original image



(b) Dilation result of (a)

- **EXAMPLE 1:** Perform Dilation operation to a binary Image A given with the structuring element E as follows:-





A =

{(1,2),(1,3),(2,1),(2,2),(2,3),(3,1),(3,2),(3,3)}

E = {(0,-1),(0,1)}

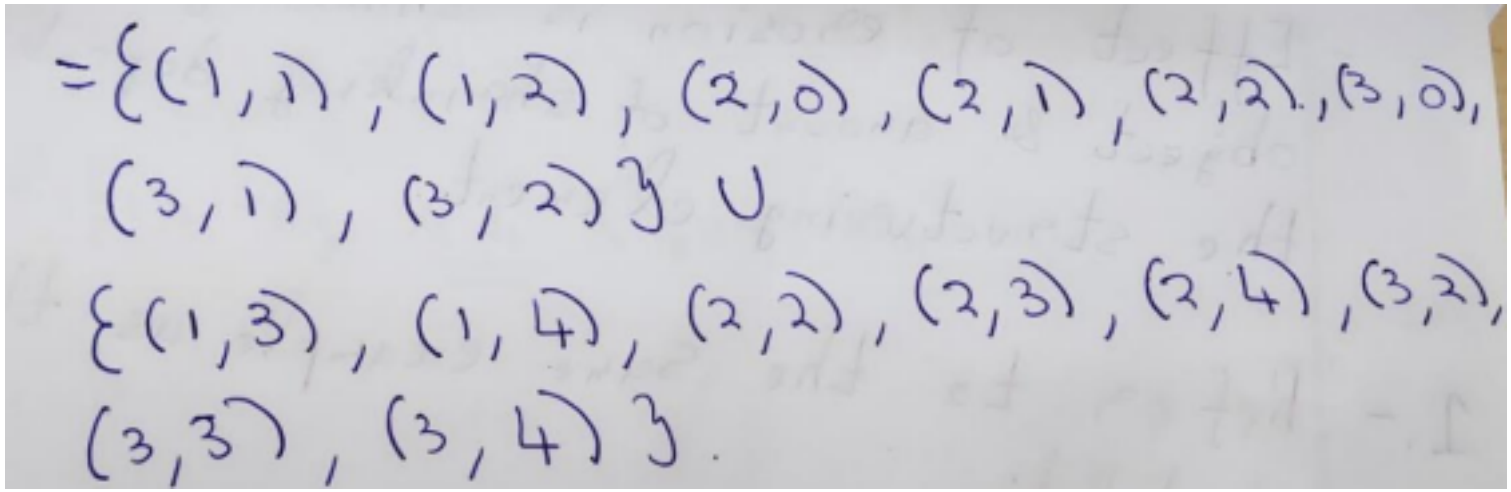
$$A \oplus E = \bigcup_{b \in B} A_b = A_{(0,-1)} \cup A_{(0,1)}$$

$$= \{(1,2)+(0,-1),(1,3)+(0,-1),(2,1)+(0,-1),(2,2)+(0,-1),(2,3)+(0,-1),$$

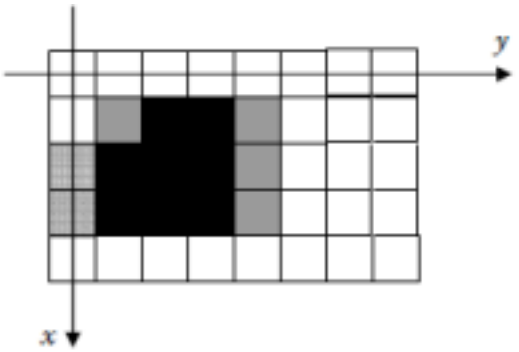
$$(3,1)+(0,-1),(3,2)+(0,-1),(3,3)+(0,-1)\} \cup \{(1,2)+(0,1),(1,3)+(0,1),$$

$$(2,1)+(0,1),(2,2)+(0,1),(2,3)+(0,1),(3,1)+(0,1),(3,2)+(0,1),(3,3)+(0,1)\}$$

7



$$=\{(1,1),(1,2),(1,3),(1,4),(2,0),(2,1),(2,2),(2,3),(2,4),(3,0),(3,1),(3,2),(3,3),(3,4)\}$$



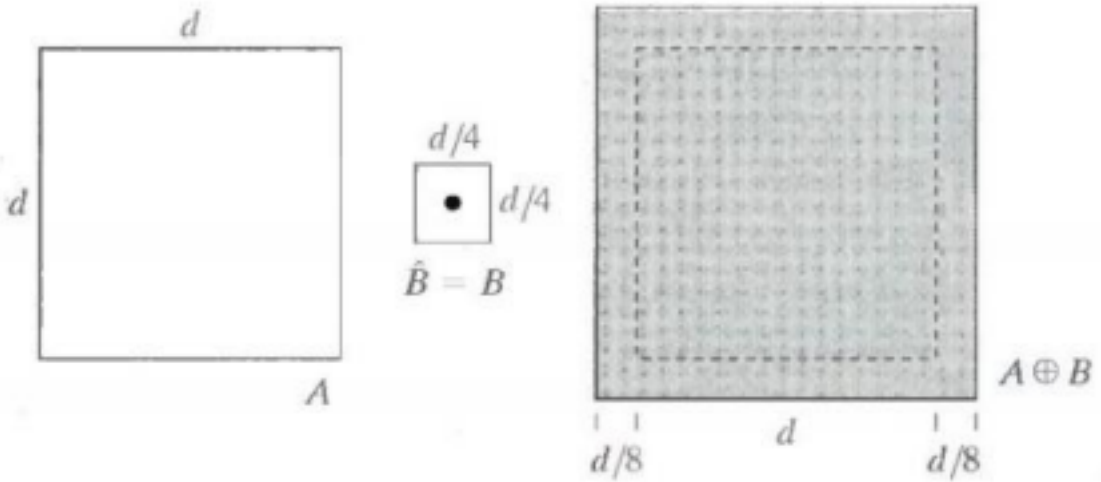
Algorithm 5.1: Dilation algorithm
For the given binary image $f(i,j), 0 \le i,j \le n-1$ with
the given structure element array $e(s,t), 0 \le s,t \le m-1$:-
For $i = 0$ to $n = 1$
    For $j = 0$ to $n = 1$ do
        $g(i,j) = 1$;
        For $s = -m$ to m

```
                For t = −m to m do
                    If ((e(s, t) == 1) and (f(i + s, j+ t) == 0)) then
                      g(i, j) = 0;
                      exit;
                    End-If
                End-For
                If (g(i, j) == 0) exit;
            End-For
        End-For
    End-For
    Output of the resulting image: g(i, j), 0 ≤ i, j ≤ n − 1
    End-Algorithm
```

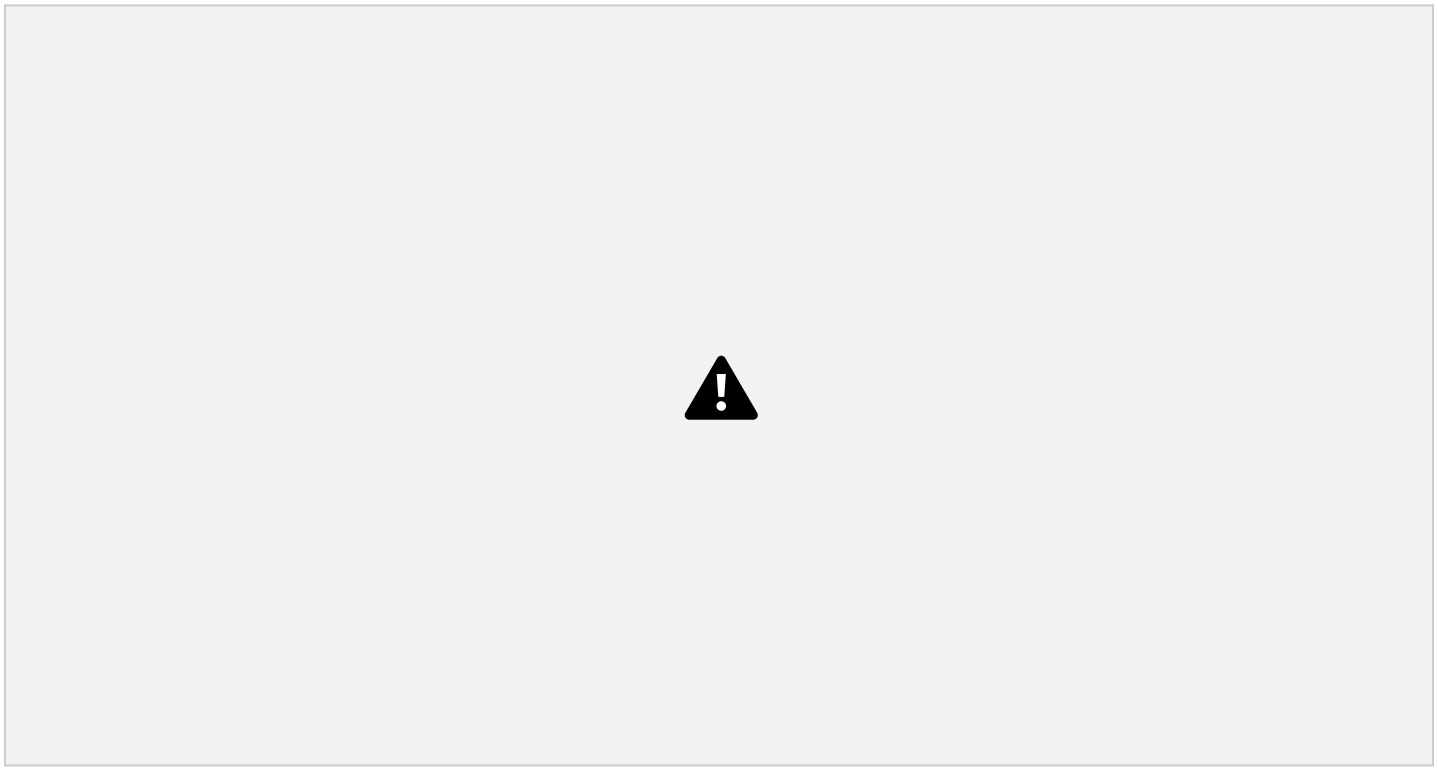

EXAMPLE 2

a b c

FIGURE 9.4
(a) Set A.
(b) Square structuring element (dot is the center).
(c) Dilation of A by B, shown shaded.



- **EXAMPLE 3**



BINARY MORPHOLOGICAL OPERATIONS

- Dilation Operation

- **Erosion Operation**
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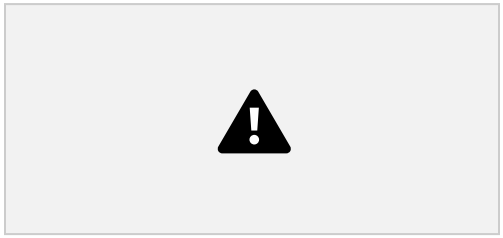
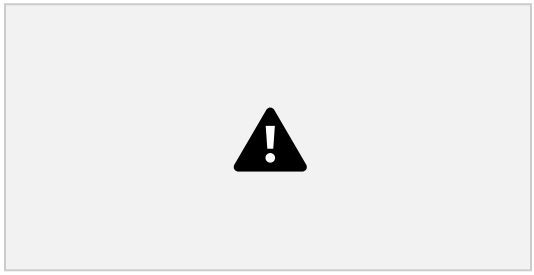
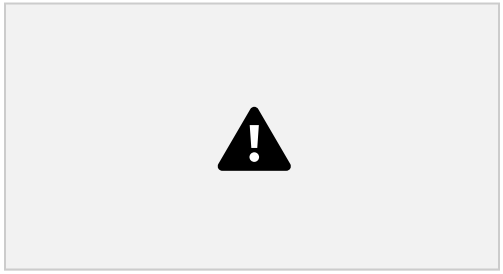
EROSION OPERATION

- The erosion of two sets A and B is denoted by $A \ominus B$, and is defined as

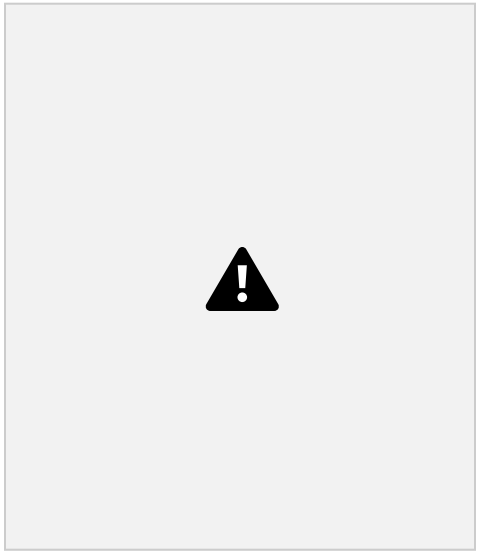


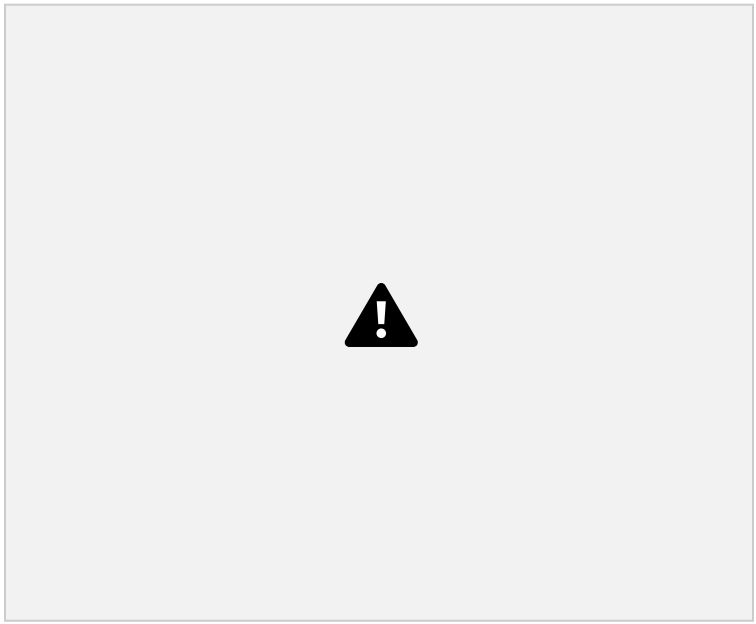
- The effect of erosion is shrinking of an object, and the amount of shrinkage depends on the structuring element.





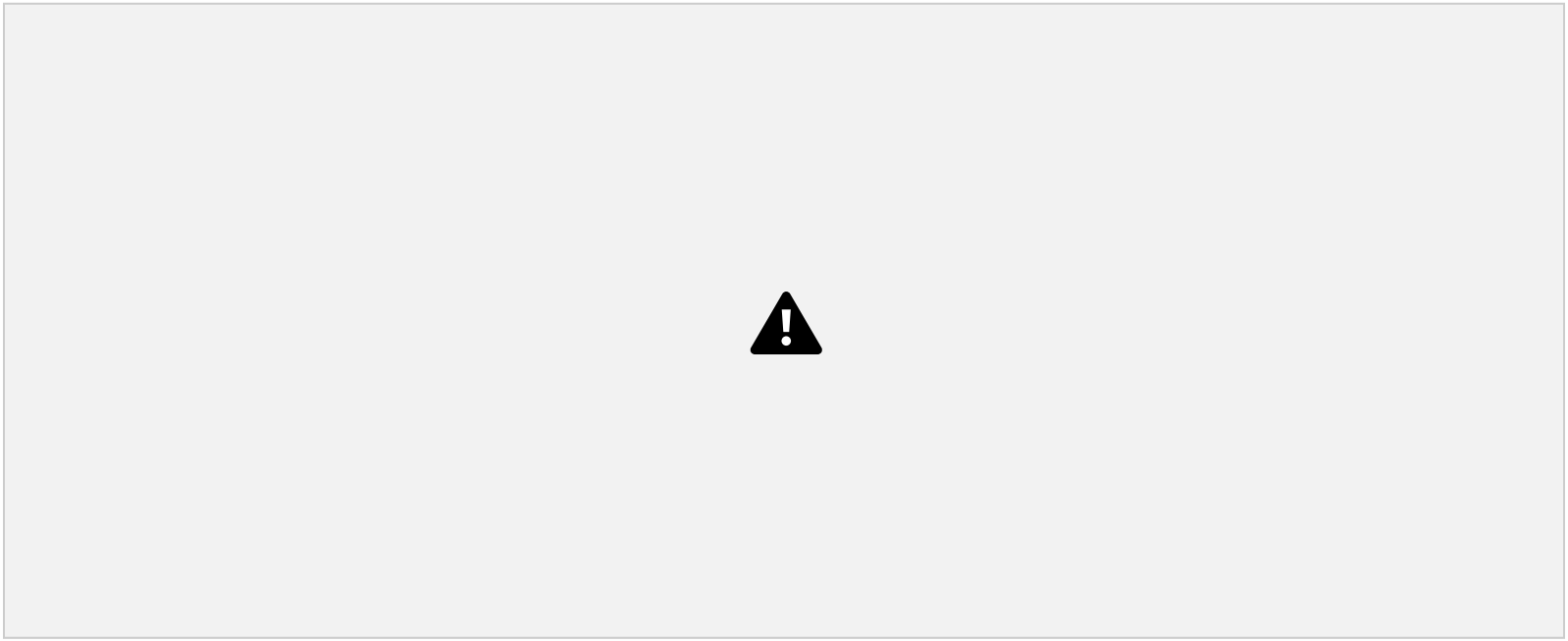
- **EXAMPLE 1:** Perform Erosion operation to a binary Image A given with the structuring element E as follows:-

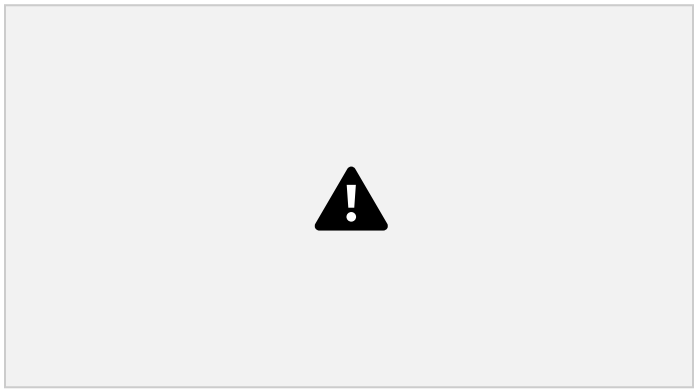


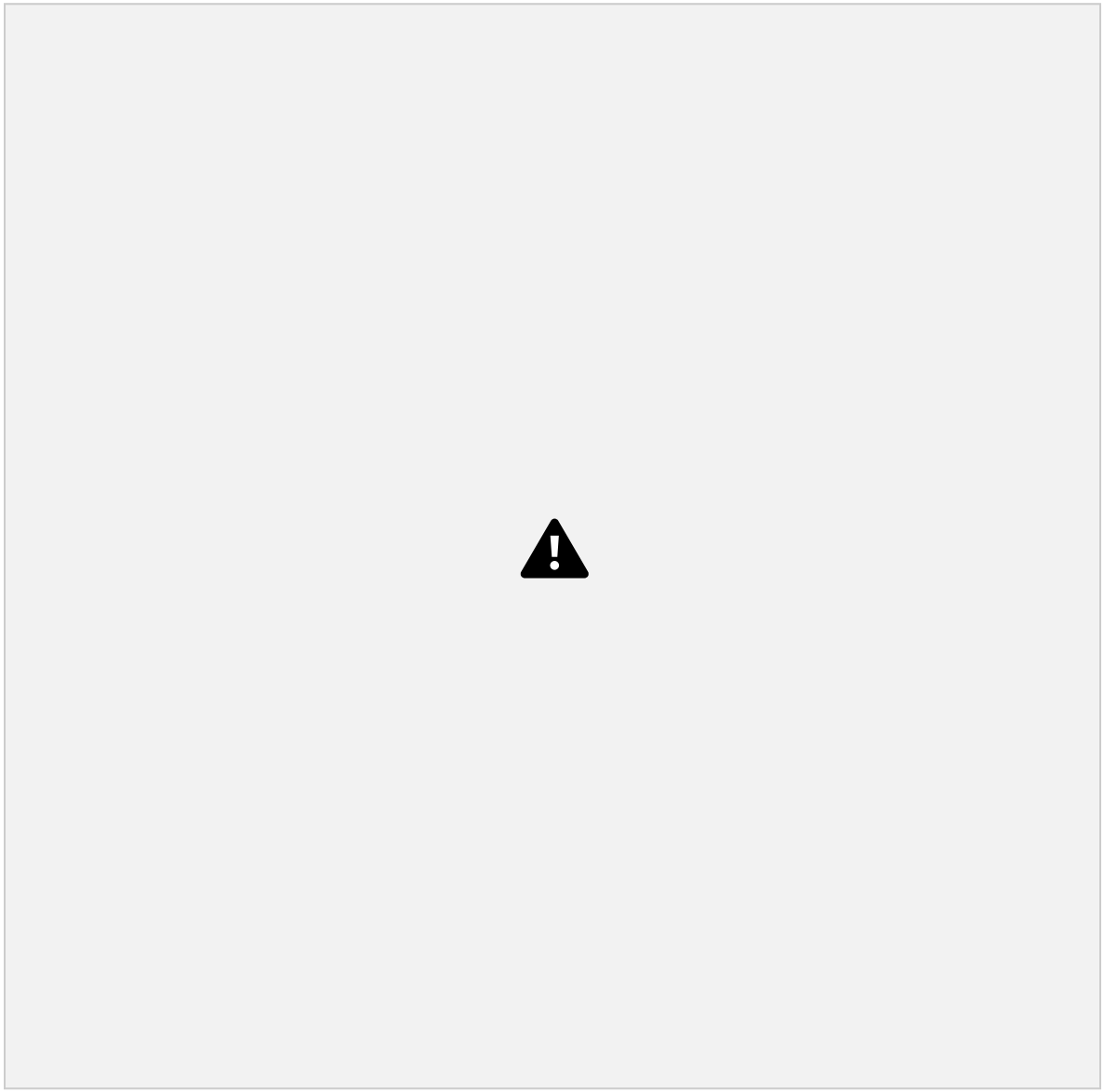


$A = \{(1,2),(1,3),(2,1),(2,2),(2,3),(3,1),(3,2),(3,3)\}$

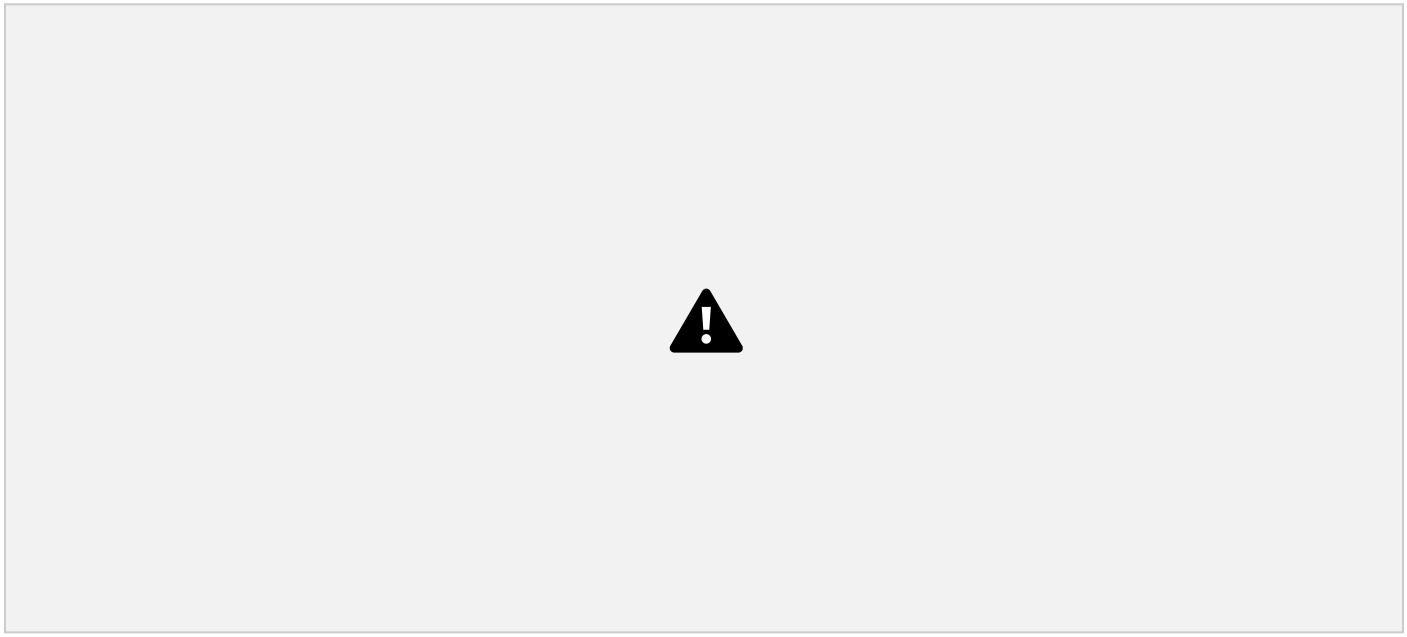
$E = \{(0,-1),(0,1)\}$







- **EXAMPLE 2:**



- **EXAMPLE 3:**