CSE- 4105

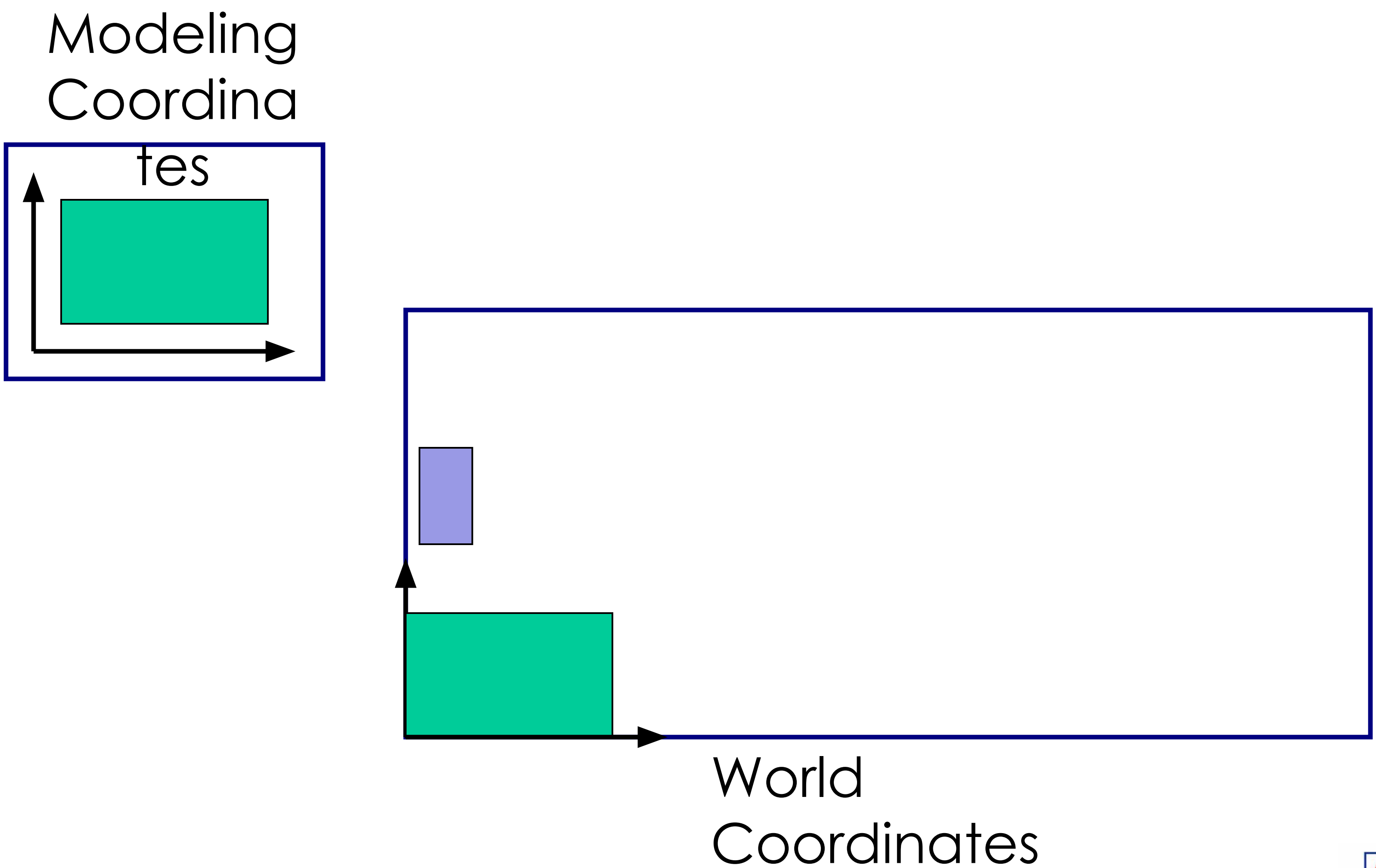
Lecturer-06

Transformation-I

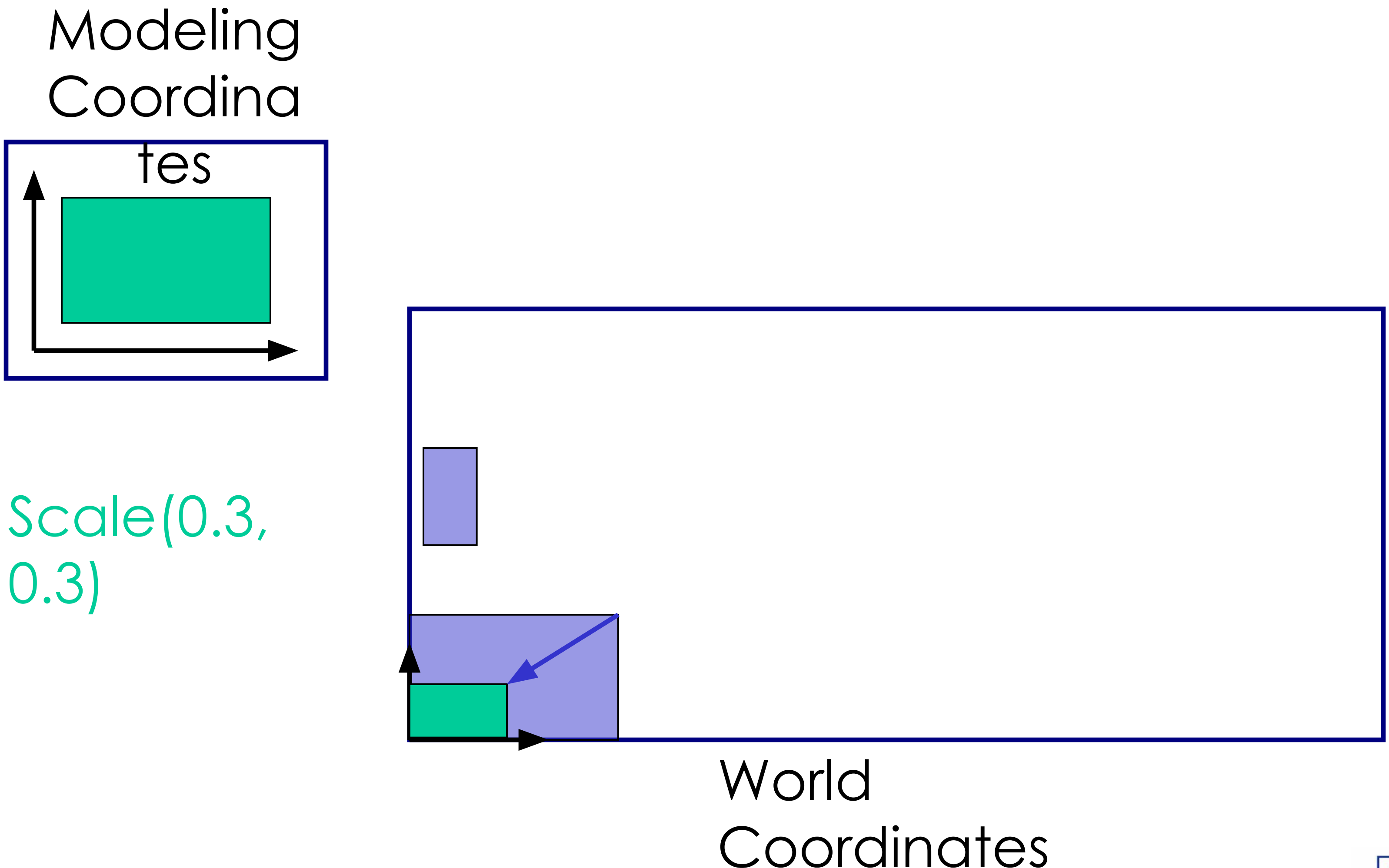
Transformations

- What is transformations?
  - The geometrical changes of an object from a current state to modified state.
- Why the transformations is needed?
  - To manipulate the initially created object and to display the modified object without having to redraw it.

2D Geometric Transformation

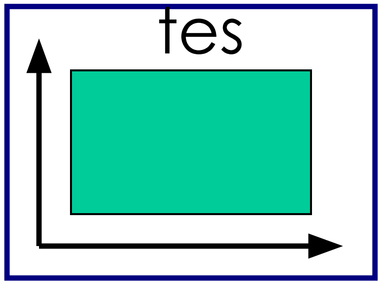


Example: 2D Scaling

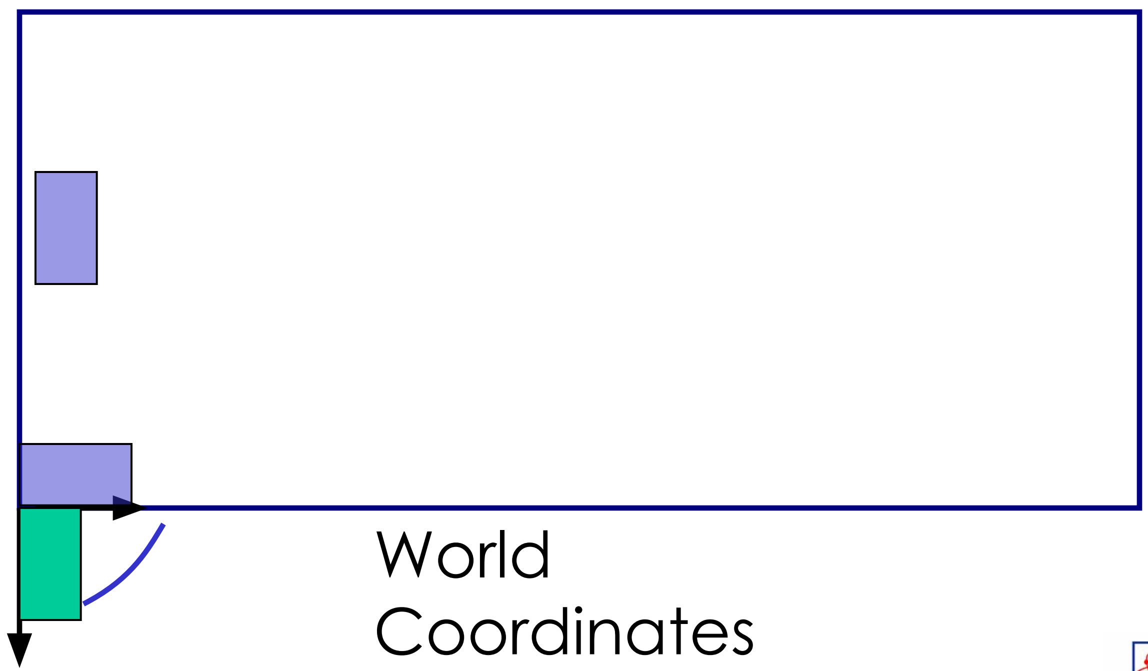


Example: 2D Rotation

Modeling Coordinates

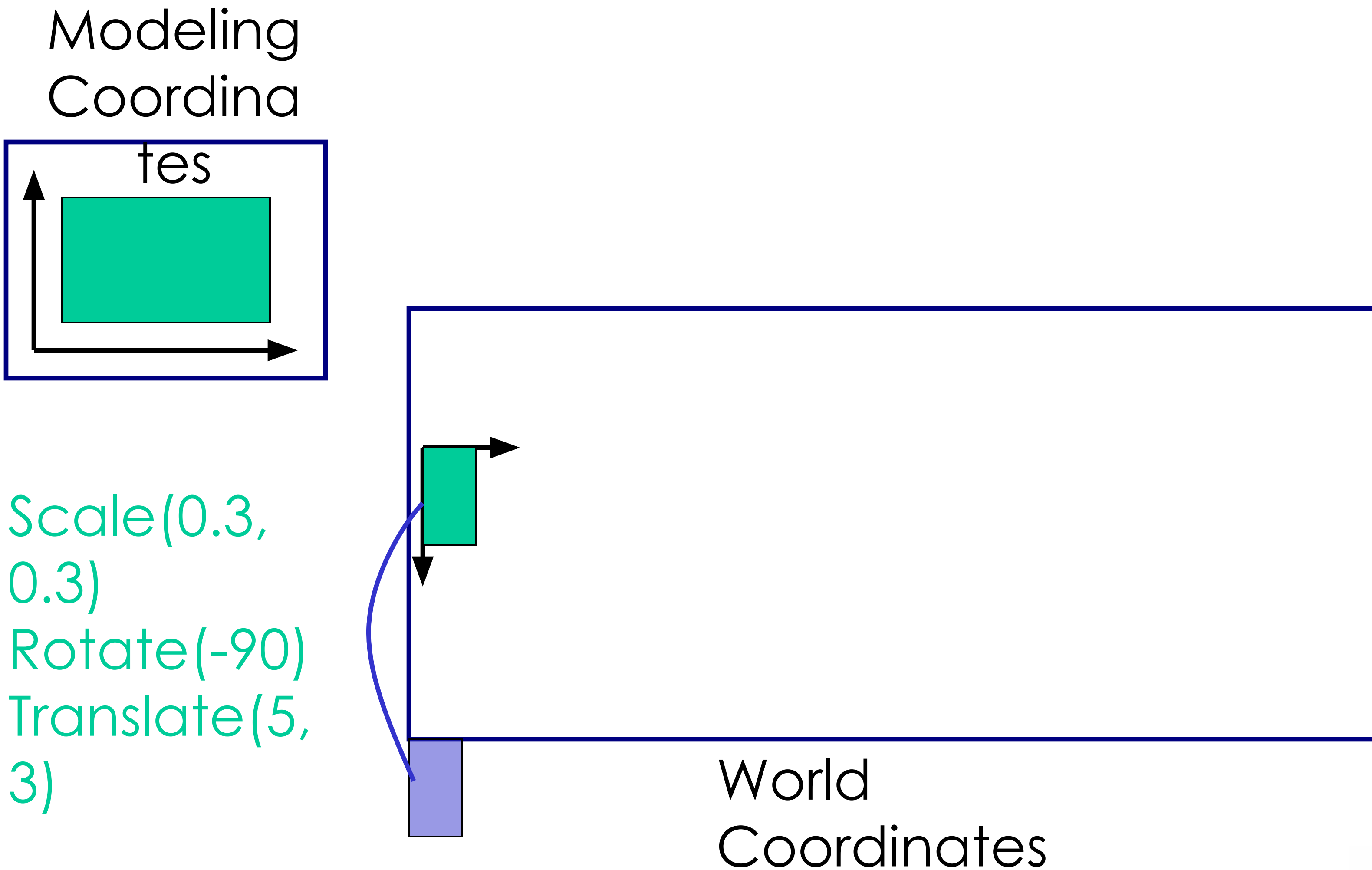


Scale(0.3, 0.3)
Rotate(-90)



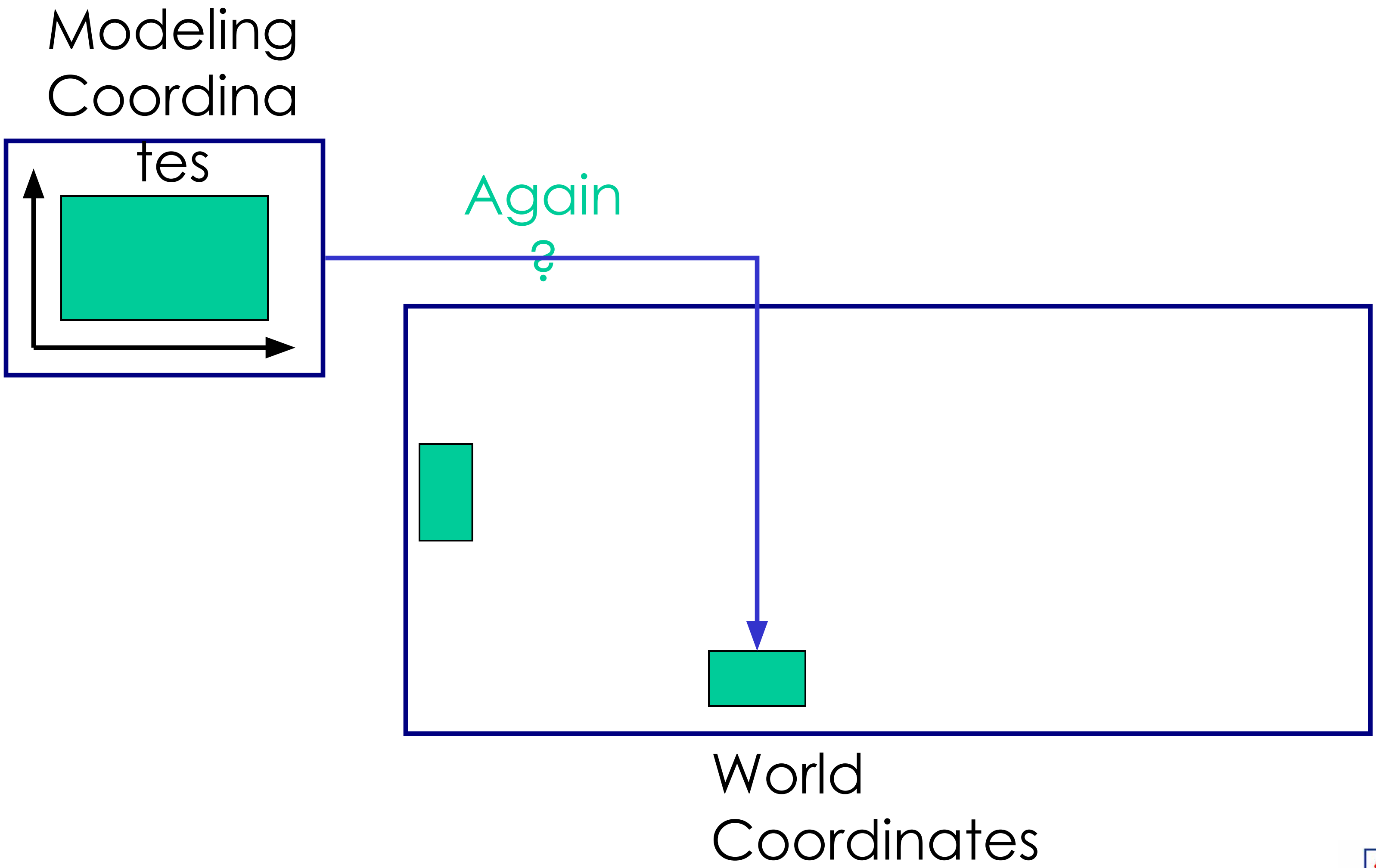
World Coordinates

Example: 2D Translation

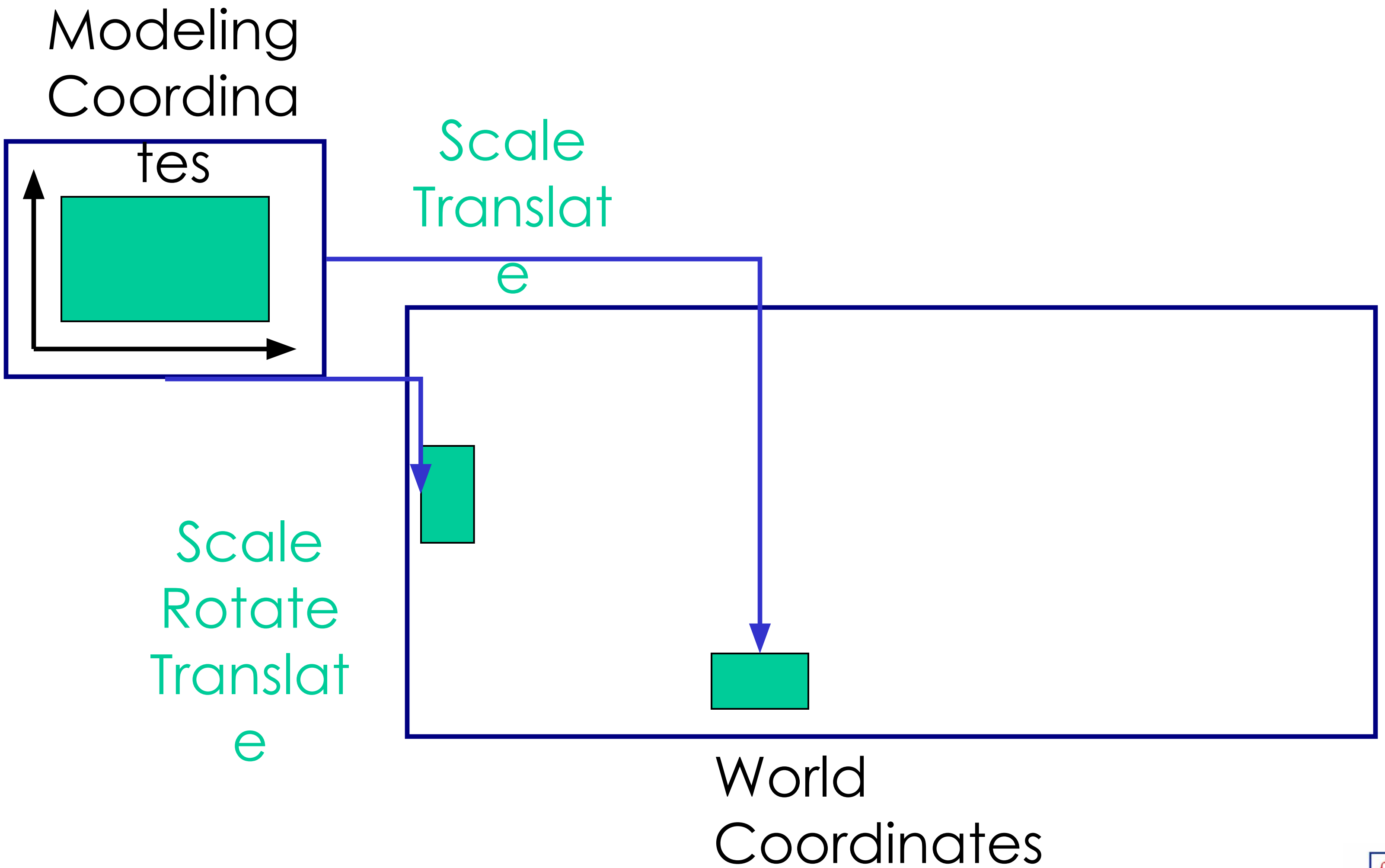


Scale(0.3, 0.3)
Rotate(-90)
Translate(5, 3)

Example: 2D Geometric Transformation

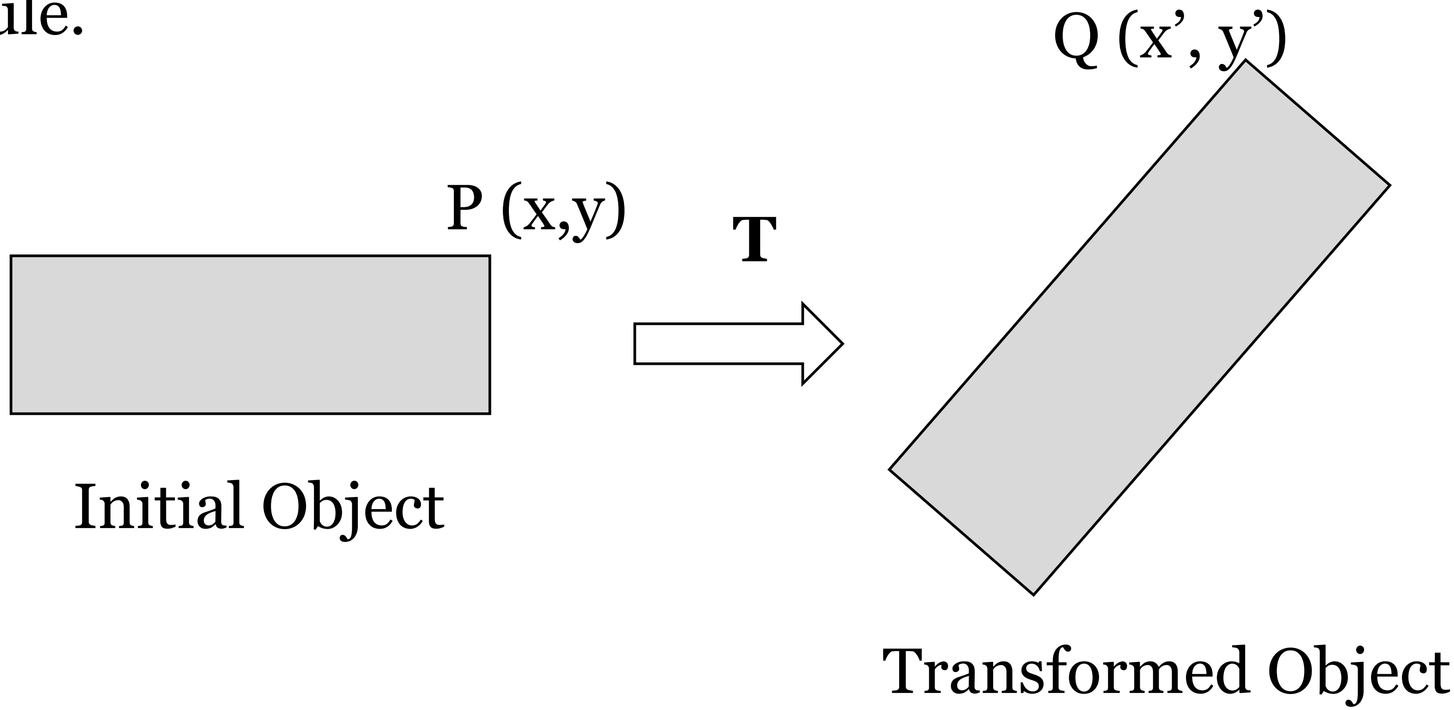


2D Geometric Transformation



Transformations

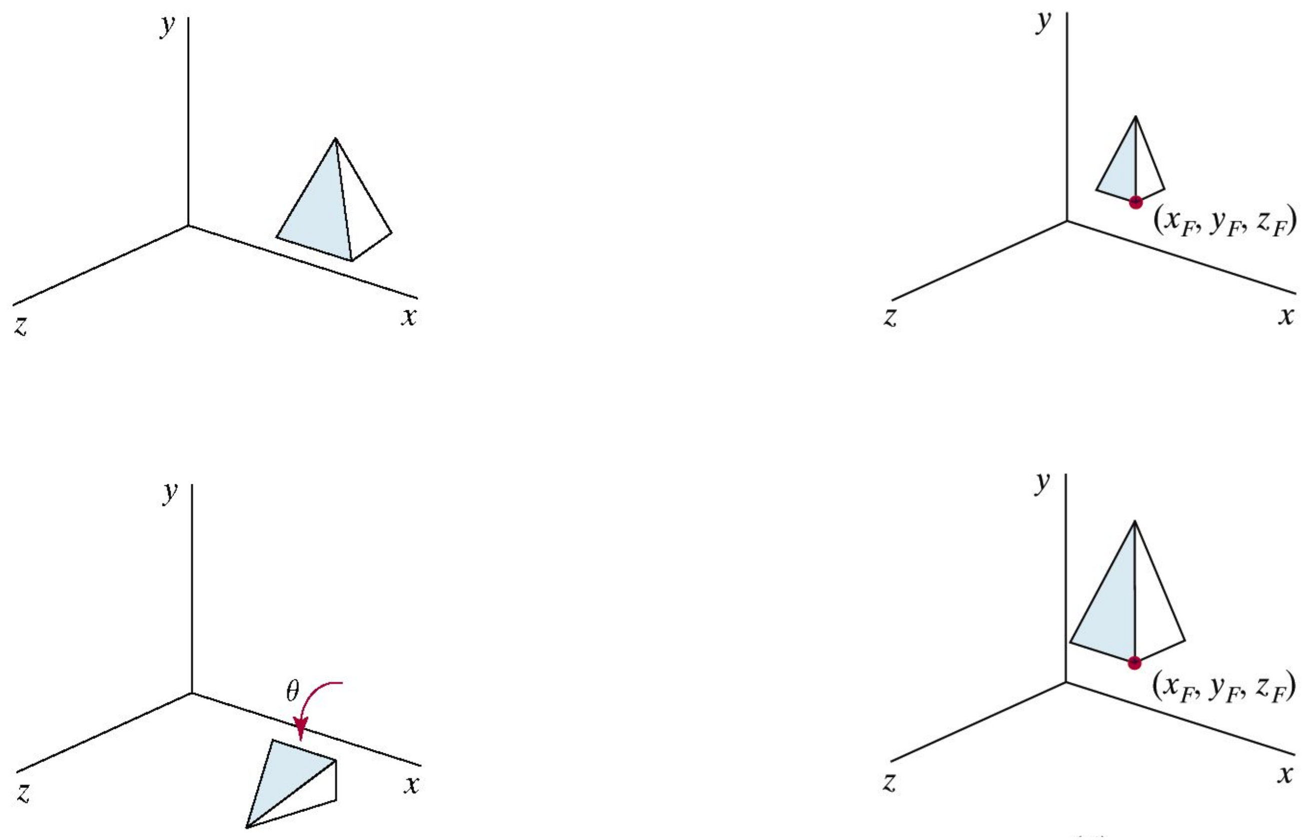
- Transform every point on an object according to certain rule.



$x \rightarrow x'$ $y \rightarrow y'$	The point Q is the image of P under the transformation T.

Why Transformations?

- In graphics, once we have an object described, transformations are used to move that object, scale it and rotate it

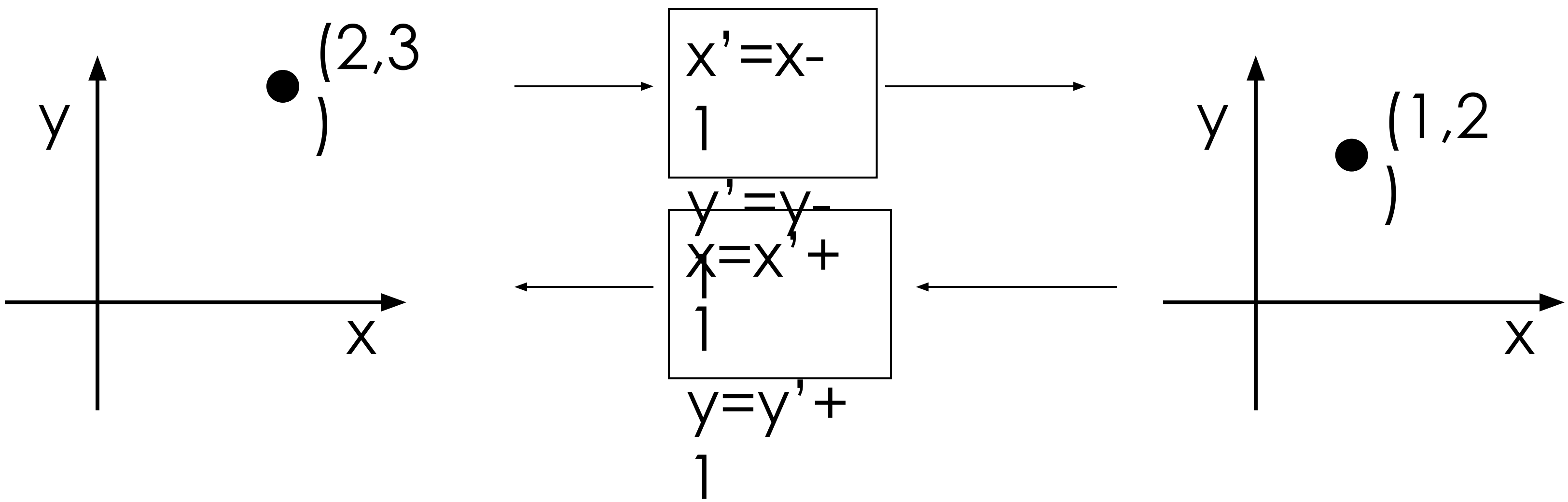


Transformations

- 2 ways
  - Object Transformation
    - Alter the coordinates descriptions an object
    - Translation, rotation, scaling etc.
    - Coordinate system unchanged
  - Coordinate transformation
    - Produce a different coordinate system

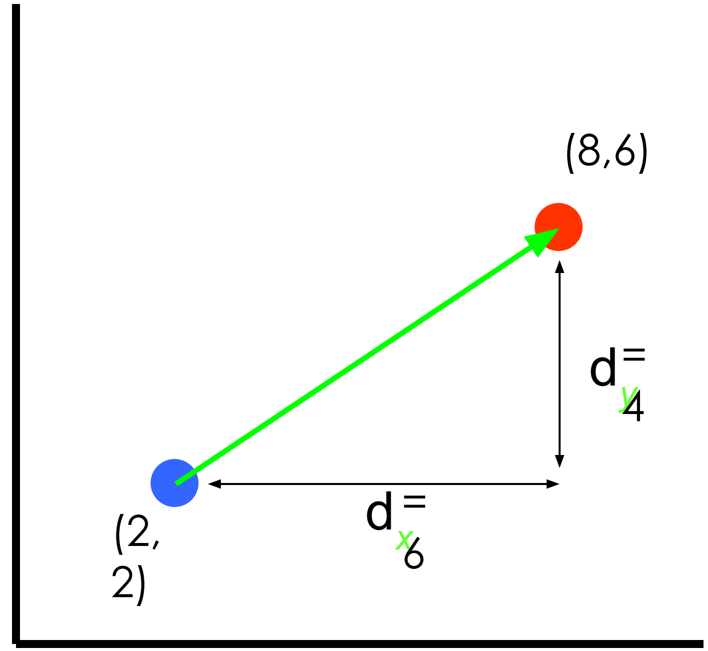
Transformations

- Transformations modify an object's shape and location in one coordinate system



Translation

- A translation moves all points in an object along the same straight-line path to new positions.
- The path is represented by a vector, called the translation or shift vector.



Translation

- $P(x, y)$ move to $P'(x', y')$

$$x' = x + d_x$$

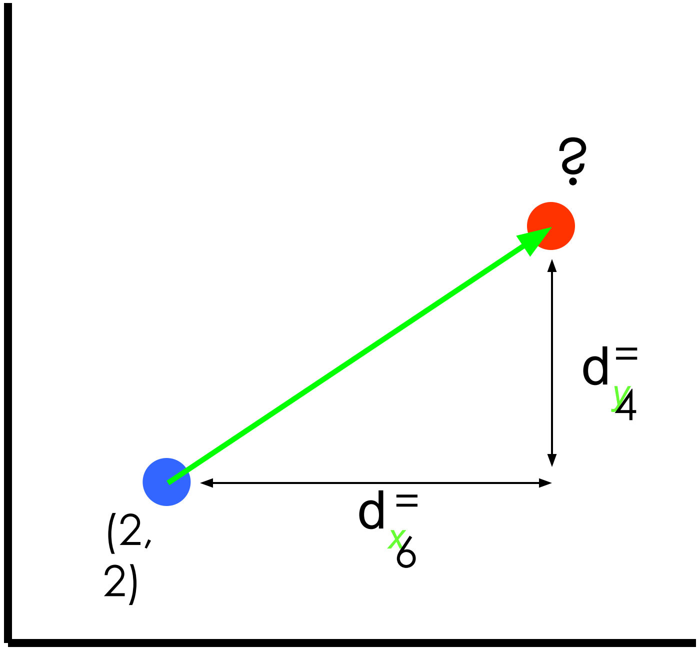
$$y' = y + d_y$$

- Represent in in matrix

- $P = \begin{bmatrix} x \\ y \end{bmatrix}, \; P' = \begin{bmatrix} x' \\ y' \end{bmatrix}, \; T = \begin{bmatrix} d_x \\ d_y \end{bmatrix}$

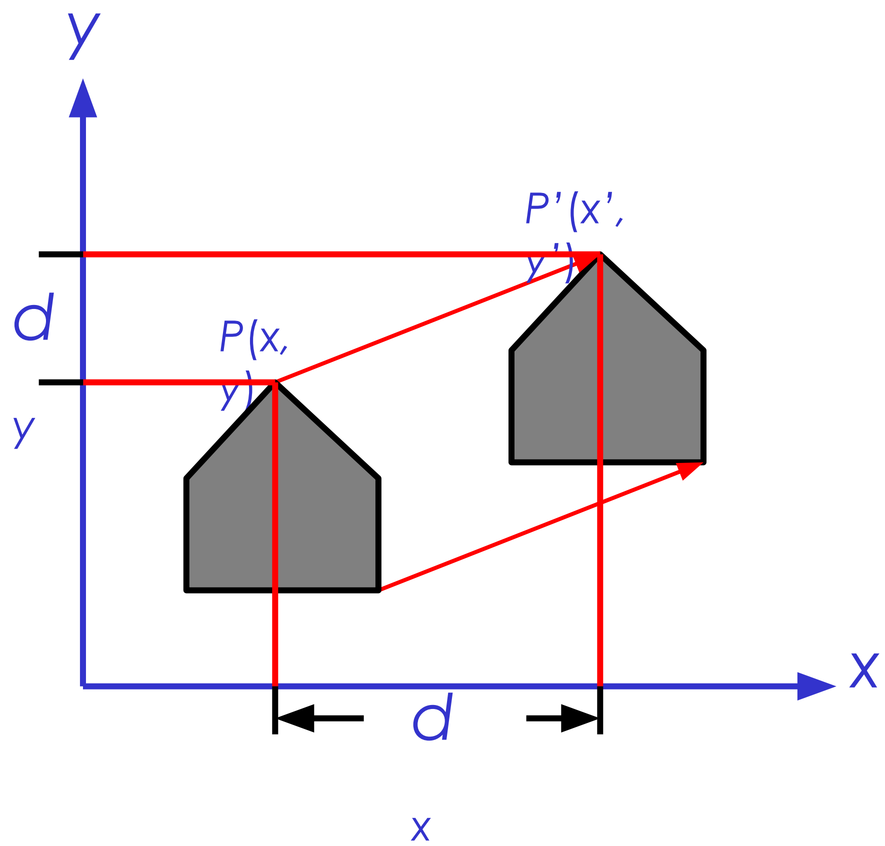
- $P' = P + T$

- $\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} d_x \\ d_y \end{bmatrix}$

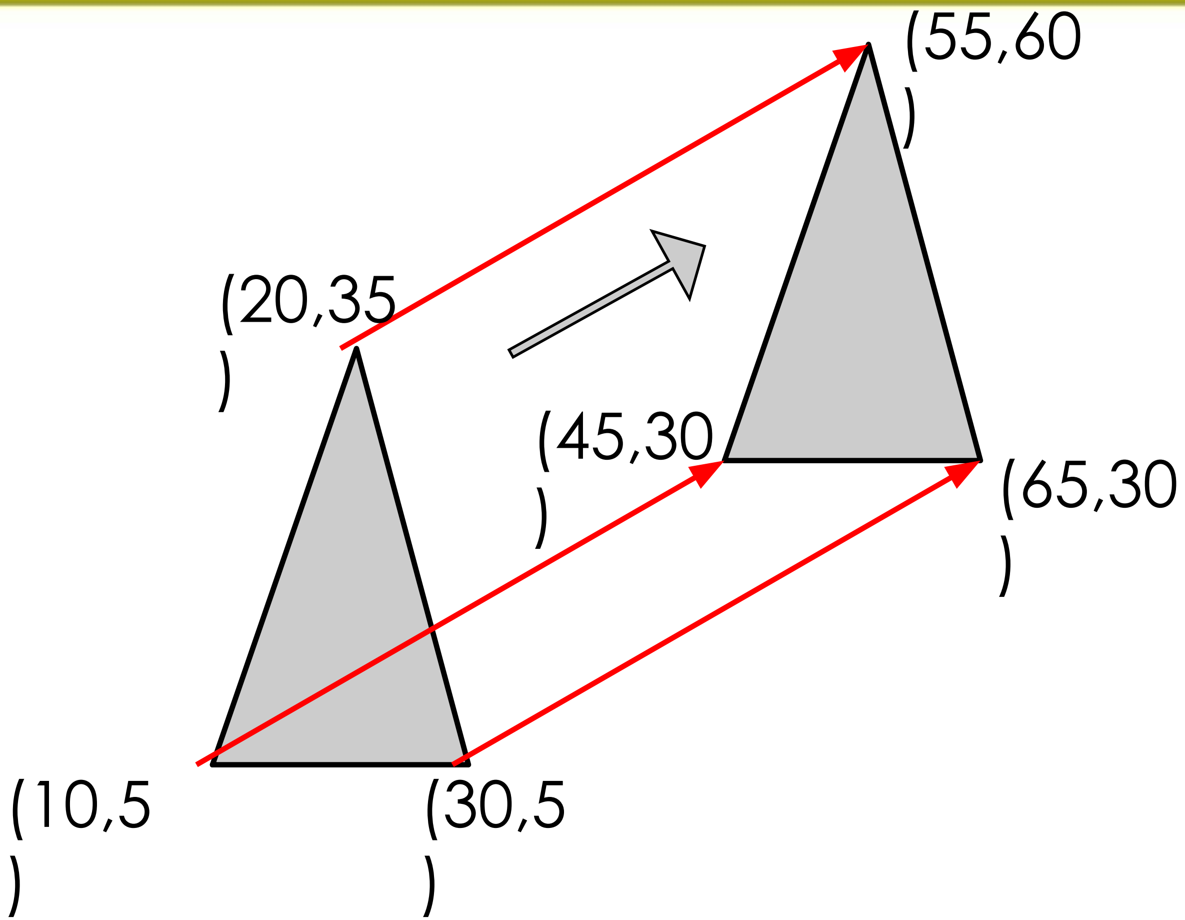


Translation

- Translation



Translations



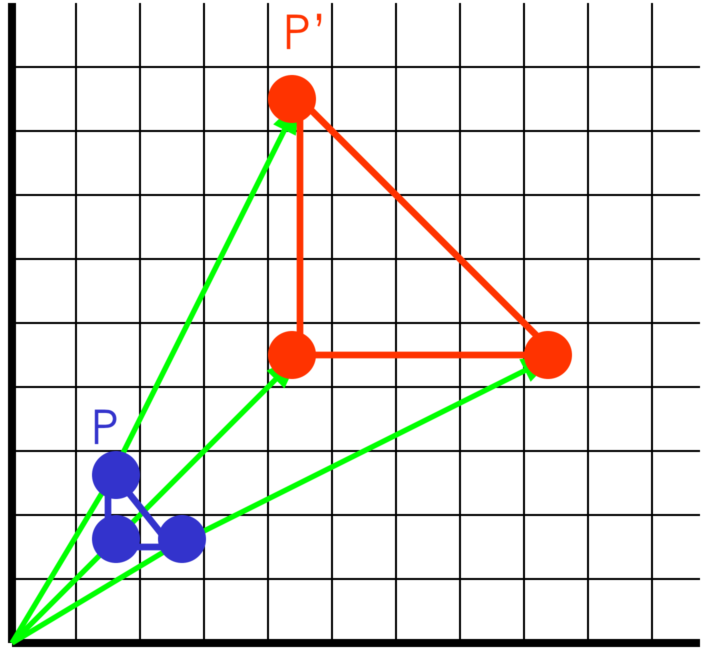
The vector (d_x, d_y) is called the *offset vector*.

Scaling

- Resizes an object in each dimension to altering the size of an object.
- Scaling changes the size of an object and involves two scale factors, S_x and S_y for the x- and y- coordinates respectively.
- If $S_x = S_y$ then uniform scaling then

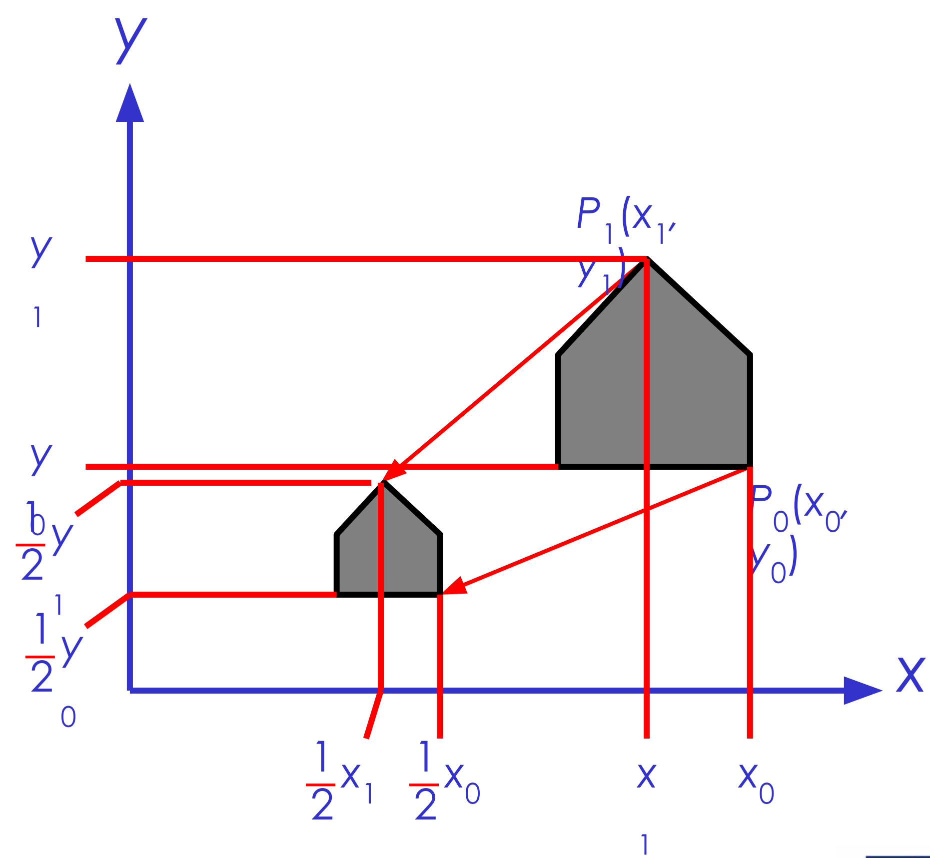
$$x' = xS_x$$

$$y' = yS_y$$



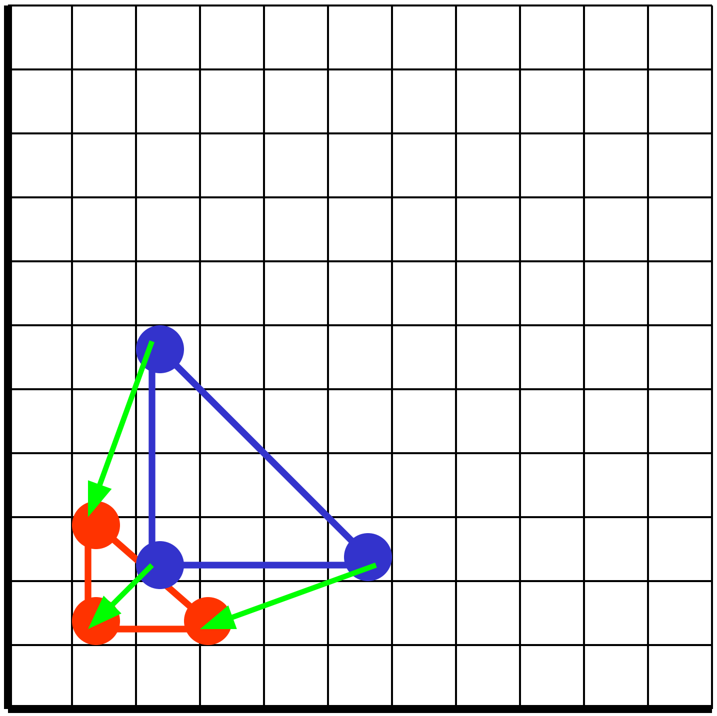
Scaling

- Represent in in matrix
- $$P = \begin{bmatrix} x \\ y \end{bmatrix} \quad S = \begin{bmatrix} s_x & 0 \\ 0 & s_y \end{bmatrix}$$
- $$P' = \begin{bmatrix} x' \\ y' \end{bmatrix}$$
- $$P' = S \cdot P$$
  $$= \begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} s_x & 0 \\ 0 & s_y \end{bmatrix} \cdot \begin{bmatrix} x \\ y \end{bmatrix}$$



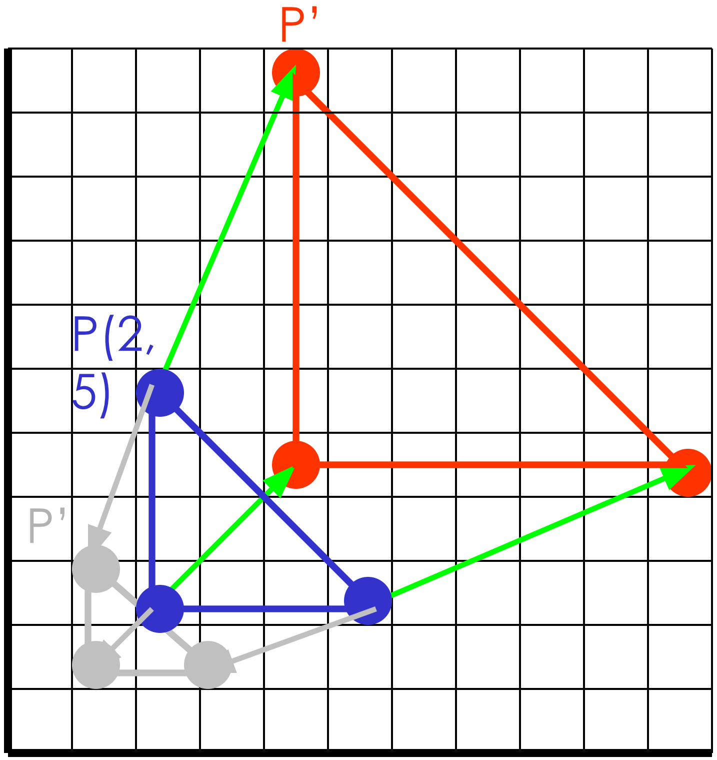
Scaling

- If the scale factors are in between 0 and 1
- The points will be moved closer to the origin
- The object will be smaller.
- Example :
  - P(2, 5), Sx = 0.5, Sy = 0.5
  - Find P' ?



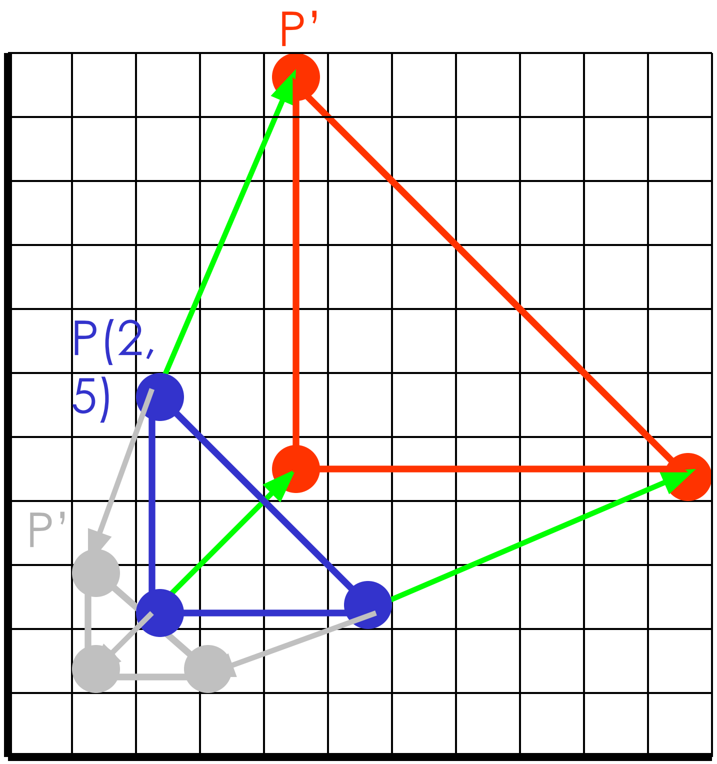
Scaling

- If the scale factors are larger than 1
- the points will be moved away from the origin
- the object will be larger.
- Example :
  - P(2, 5), Sx = 2, Sy = 2
  - Find P' ?



Scaling

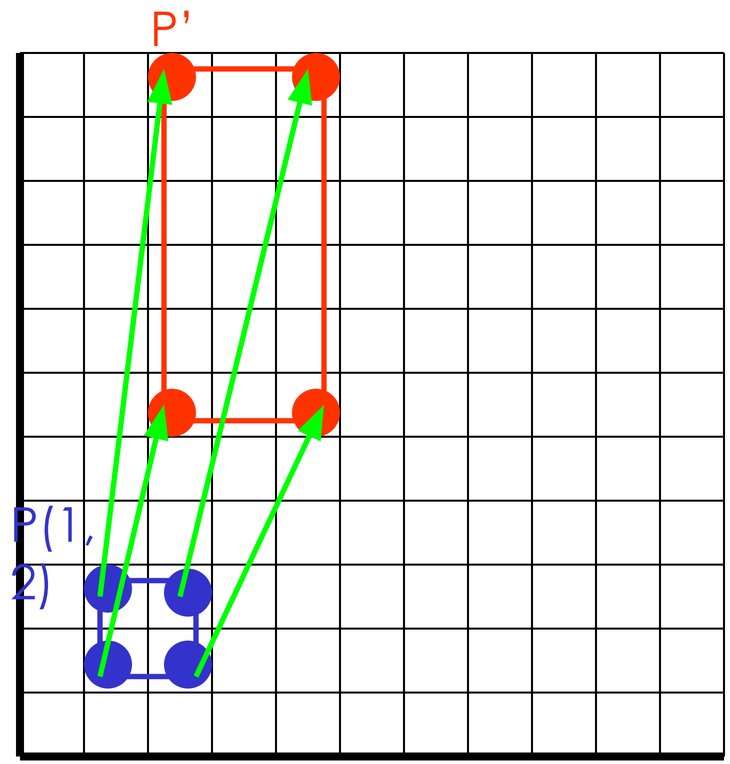
- If the scale factors are larger than 1
- the points will be moved away from the origin
- the object will be larger.
- Example :
  - P(2, 5), Sx = 2, Sy = 2
  - Find P' ?



- If the scale factors are the same,
  - $S_x = S_y$ uniform scaling
- Only change in size

Scaling

- If $S_x \neq S_y$,differential scaling.
- Change in size and shape
- Example : square ☐ rectangle
  - P(1, 3), $S_x = 2$, $S_y = 5$, P' ?



Thank You