Bangladesh University of Business and Technology

Lab report - 5

Lab topic: Geometric Transformations of Basic Shapes — Rotation, Translation, Scaling

Course name :Computer Graphics Lab
Course code: CSE 342

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🔹 Experiment Setup

We defined shapes (a triangle and a rectangle) in **homogeneous coordinates** $[x, y, 1]$.

Transformation matrices used:

- **Translation:**

$$T = \begin{bmatrix} 1 & 0 & t_x \\ 0 & 1 & t_y \\ 0 & 0 & 1 \end{bmatrix}$$

- **Scaling:**

$$S = \begin{bmatrix} s_x & 0 & 0 \\ 0 & s_y & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

- **Rotation (θ degrees):**

$$R = \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

- **Shear:**

$$Sh = \begin{bmatrix} 1 & sh_x & 0 \\ sh_y & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Exercise 1: : Single Transform (Rotation 45° around origin) EXAMPLE

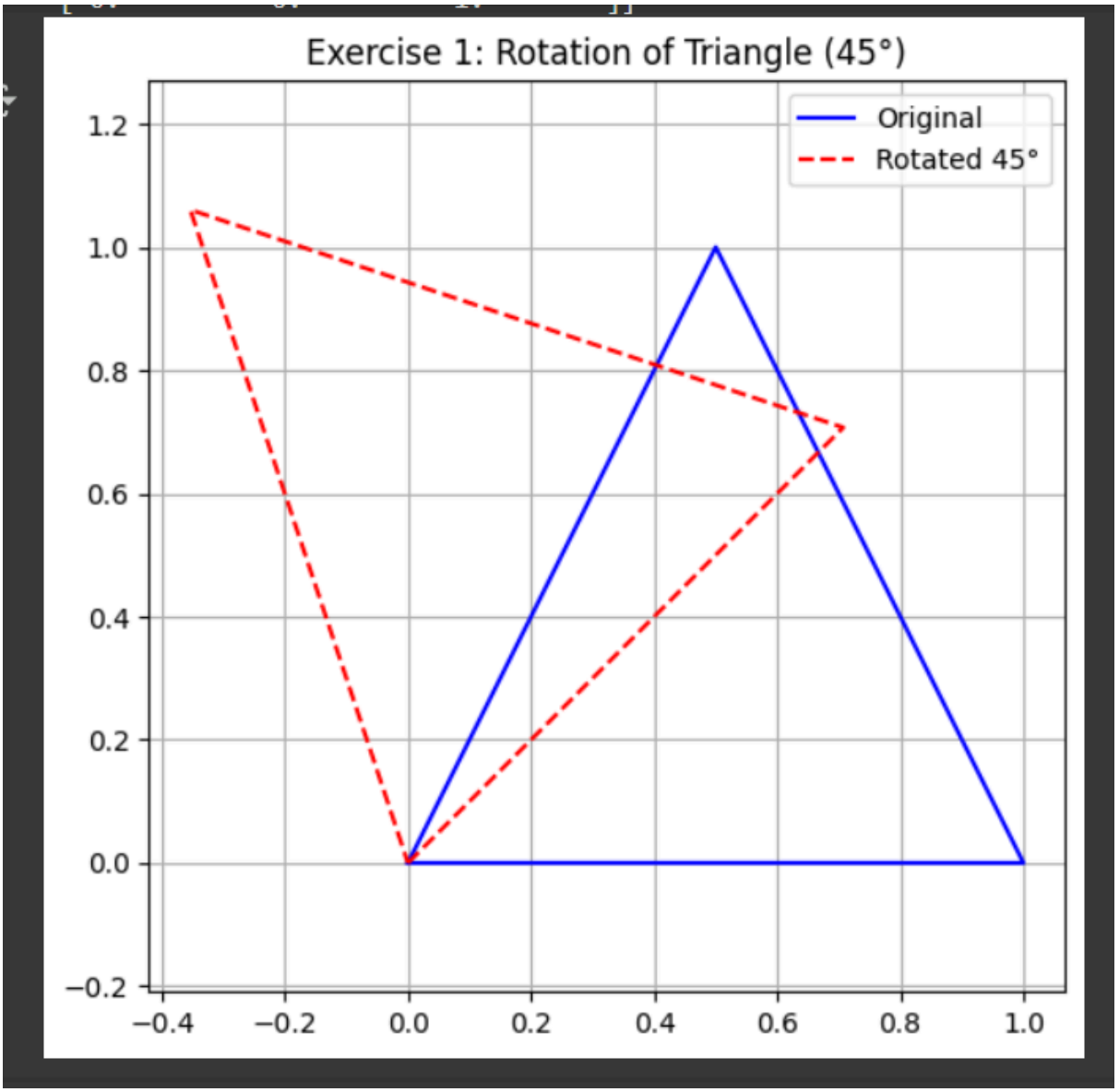
```
Rotation Matrix (45°):
 [[ 0.70710678 -0.70710678  0.        ]
 [ 0.70710678  0.70710678  0.        ]
 [ 0.          0.          1.        ]]

Original Vertex: [1. 0. 1.]
Matrix Multiplication:
 [[ 0.70710678 -0.70710678  0.        ]
 [ 0.70710678  0.70710678  0.        ]
 [ 0.          0.          1.        ]] @ [1. 0. 1.]
Resulting Vertex: [0.70710678 0.70710678 1.        ]

Original Triangle Coordinates:
 [[0.  0.  1. ]
 [1.  0.  1. ]
 [0.5 1.  1. ]
 [0.  0.  1. ]]

Rotated Triangle (45°):
 [[ 0.          0.          1.        ]
 [ 0.70710678  0.70710678  1.        ]
 [-0.35355339  1.06066017  1.        ]
 [ 0.          0.          1.        ]]
```

OUTPUT:


Exercise 1: Rotation of Triangle (45°)
Original
Rotated 45°
1.2
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.2
0.0
0.2
0.4
0.6
0.8
1.0

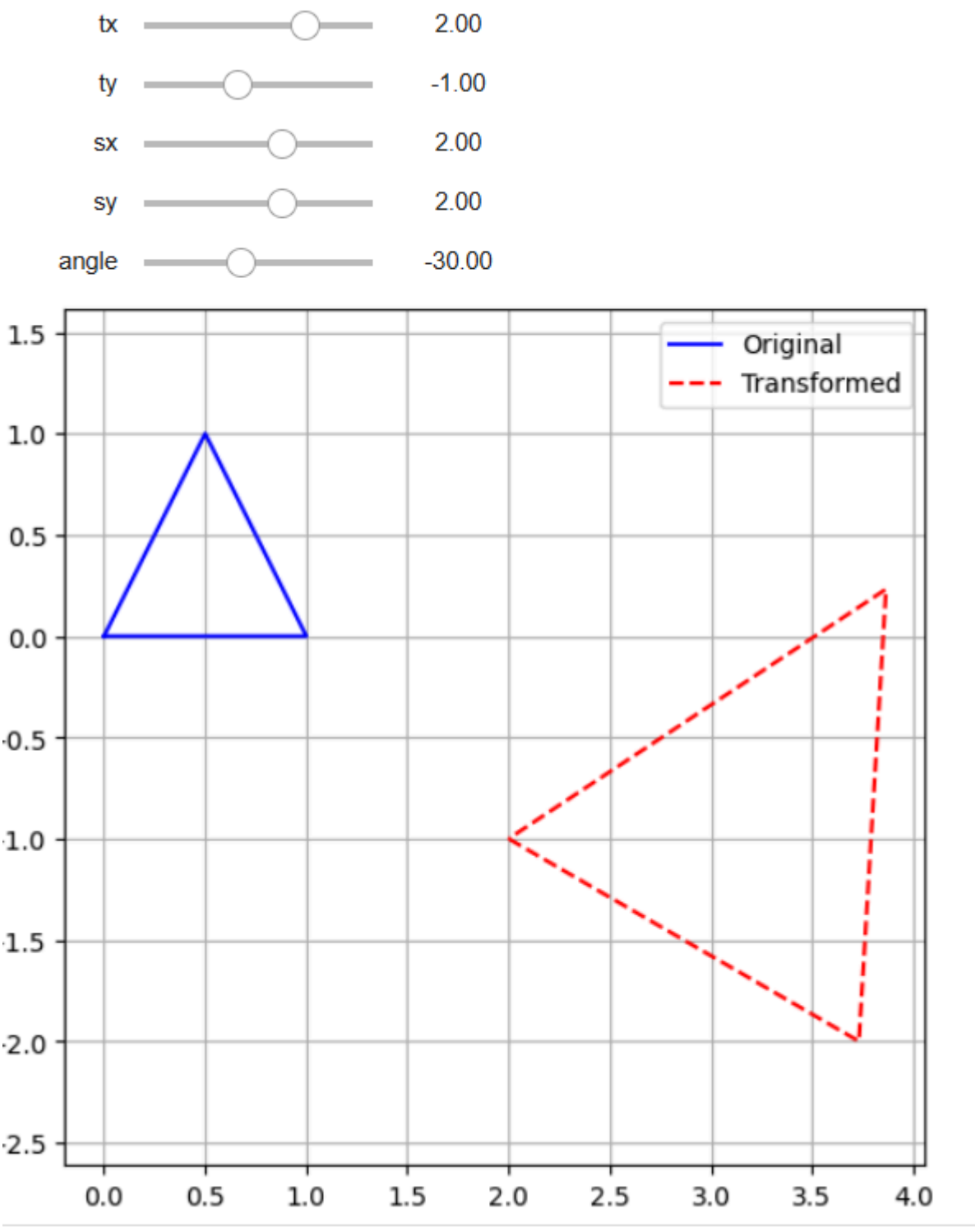
:**Exercise 2: Order Matters (Scaling vs Translation)**

```
Scale -> Translate:
 [[2.  1.  1. ]
 [6.  1.  1. ]
 [6.  2.5 1. ]
 [2.  2.5 1. ]
 [2.  1.  1. ]]

Translate -> Scale:
 [[4.  1.5 1. ]
 [8.  1.5 1. ]
 [8.  3.  1. ]
 [4.  3.  1. ]
 [4.  1.5 1. ]]
```

Observation: **Order of transformations matters.** If we scale first, the translation is applied normally. If we translate first, the translation is also scaled.

Exercise 3: Combined Transform (Interactive Sliders)



Exercise 4 (Extra): Shear

```
Sheared Triangle Coordinates:
 [[0.  0.  1. ]
 [1.  0.2 1. ]
 [1.  1.1 1. ]
 [0.  0.  1. ]]
```