| Fundamentals of Computer Vision - Spring 1404 (2025) Midterm Exam | B. Nasihatkon | دانشگاه صنعتی خواجه نصیرالدین طوسی K. N. TOOSI UNIVERSITY OF TECHNOLOGY |
|---|---|---|
| Name: | ID: | |

## Question 1- Linear Filtering (25 points)

A 3×3 linear filter is known to be **separable**. Some of its values are shown below. Complete the missing entries in the matrix. Explain how you determined the values.

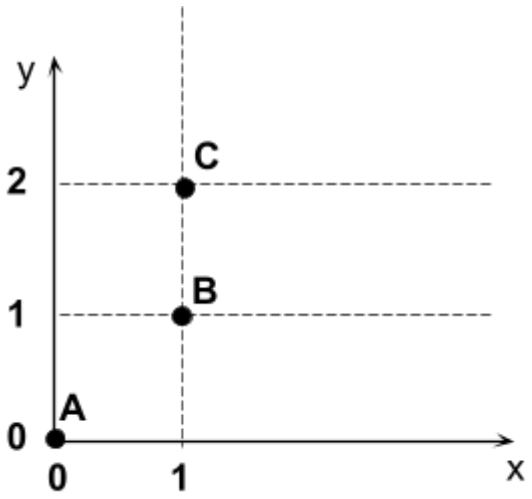
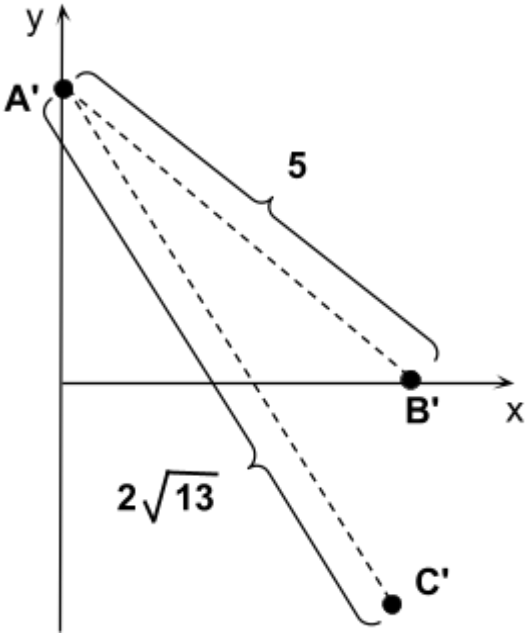
| | | |
|---|---|---|
| **2** | | **6** |
| | | **24** |
| **3** | **21** | |

# Question 2 - Geometric Transformations (35 points)

You are given a special case of an affine transformation: **a non-uniform scaling followed by translation.**

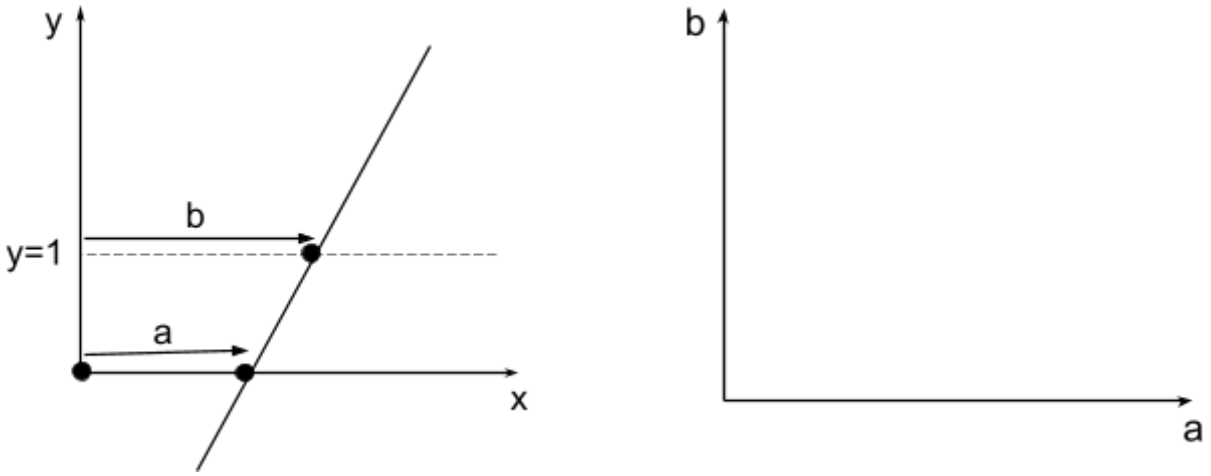
$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{bmatrix} a & 0 \\ 0 & b \end{bmatrix} \begin{pmatrix} x \\ y \end{pmatrix} + \begin{pmatrix} t_1 \\ t_2 \end{pmatrix}$$

Find the values of a,b,$t_1$, and $t_2$ based on the images below. The points A,B, and C in the left are transformed to the points A', B', and C' on the right, respectively.

| Original Points | Transformed Points |
| --- | --- |
|  |  |

# Question 3- Hough Transform (40 points)

A line is parameterized using two parameters a and b, being the x-intercepts at two horizontal slices: **a**: the x-intercept at y=0, and **b**: the x-intercept at y=1.




a) (5 points ) Can every 2D line be parameterized this way? Why?

b) (30 points) For a fixed point (x,y), derive the **geometric locus** of all lines that pass through it in the Hough parameter space.

c) (5 points) Sketch the geometric locus in for the point (4,2) in the a,b coordinate axes above. Label axes clearly.