浙江大学

# 本科实验报告

姓名：

学院：生物医学工程与仪器科学学院

系：生物医学工程

专业：生物医学工程

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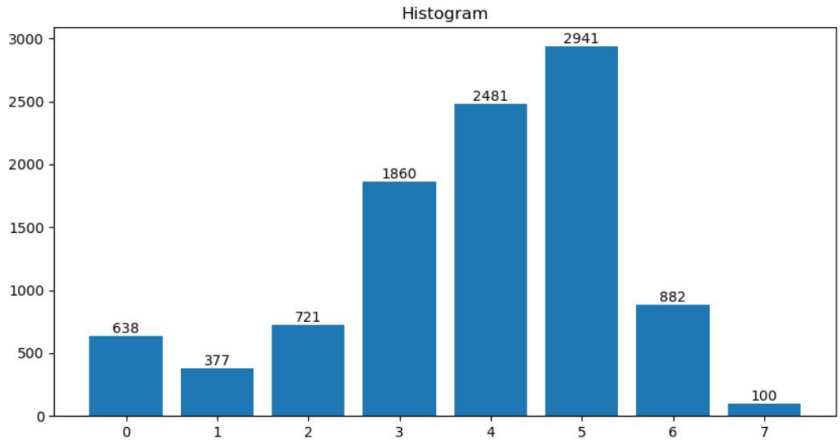
2025 年 3 月 16 日

# Homework 1

Given the histogram of a grayscale image, apply the histogram equalization algorithm to enhance the image's contrast.




像素总数 $= \sum_{i=1} r_i = 10000$

则其累积分布函数 $CDF = \frac{1}{N} \sum_{j=0}^{i} r_i$

| 灰度级 i | CDF |
|---|---|
| 0 | 0.0638 |
| 1 | 0.1015 |
| 2 | 0.1736 |
| 3 | 0.3596 |
| 4 | 0.6077 |
| 5 | 0.9018 |
| 6 | 0.9900 |
| 7 | 1.0000 |

将其映射到新灰度级 $s_k = T(r_i) = (L-1) \times CDF(r_i)$

$T(0) = \lfloor 7 \times 0.0638 \rfloor = 0$

$T(1) = \lfloor 7 \times 0.1015 \rfloor = 0$

$T(2) = \lfloor 7 \times 0.1736 \rfloor = 1$

$T(3) = \lfloor 7 \times 0.3596 \rfloor = 2$

$T(4) = \lfloor 7 \times 0.6077 \rfloor = 4$

$T(5) = \lfloor 7 \times 0.9018 \rfloor = 6$

$T(6) = \lfloor 7 \times 0.9900 \rfloor = 6$

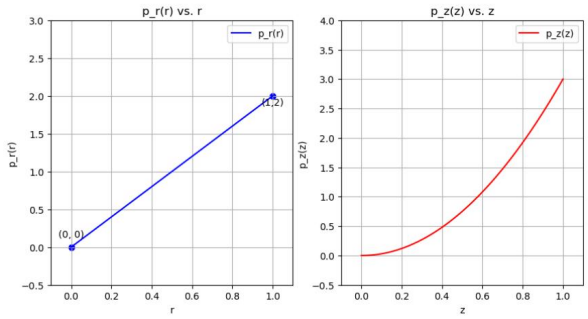
$T(7) = \lfloor 7 \times 1.0000 \rfloor = 7$

故有：

| $r_k$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| $s_k$ | 0 | 0 | 1 | 2 | 4 | 6 | 6 | 7 |

# Homework 2

Given two random variables R and Z with the following probability density functions (PDFs):
R has a PDF $p_r(r)$, $p_r(r) = 2r$
Z has a PDF $p_z(z)$, $p_z(z) = 3z^2$
Find the transformation (expressed in terms of $r$ and z) that will accomplish this.




给定 $P_r(r) = 2r$ , $P_z(z) = 3z^2$ , $r, z \in [0,1]$

则有 $F_R(r) = \int_0^r P_r(w)dw = \int_0^r 2w\,dw = r^2$, $0 \le r \le 1$

$F_z(z) = \int_0^z P_z(v)dv = \int_0^z 3v^2 dv = z^3$, $0 \le z \le 1$

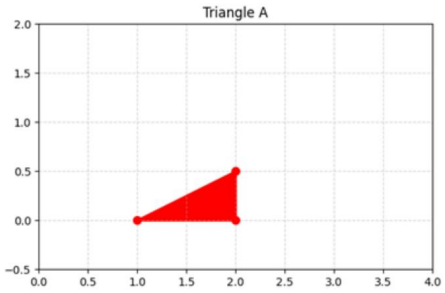
$\therefore Z = F_z^{-1}(F_r(R)) = (R^2)^{\frac{1}{3}} = R^{\frac{2}{3}}$

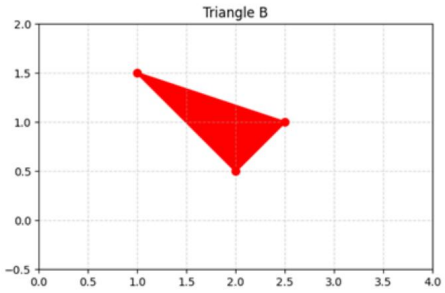
验证 $P_z(z) = P_r(r)\left|\frac{dr}{dz}\right| = P_r(g^{-1}(z))\left|\frac{d}{dz}g^{-1}(z)\right| = 2z^{\frac{2}{3}} \cdot \frac{2}{3}z^{-\frac{1}{3}} = 3z^2$

$\therefore$ 该变换为 $Z = R^{\frac{2}{3}}$

# Homework 3

Triangle A's vertices are in the position (1,0), (2,0) and (2,0.5), design a list of affine transformation matrices to transform the triangle A to triangle B, which's vertices are in (1,1.5), (2,0.5) and (2.5,1) respectively. After that, give the inverse transformation matrices list to transform the triangle B to triangle A.




顶点对应关系为：$(1,0)\to(1,1.5)$

$(2,0)\to(2,0.5)$

$(2,0.5)\to(2.5,1)$

设仿射变换为：$\begin{pmatrix} x' \\ y' \\ 1 \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ 1 \end{pmatrix}$

则有 $\begin{cases} a_{11}+a_{13}=1 \\ a_{21}+a_{23}=1.5 \\ 2a_{11}+a_{13}=2 \\ 2a_{21}+a_{23}=0.5 \\ 2a_{11}+0.5a_{12}+a_{13}=2.5 \\ 2a_{21}+0.5a_{22}+a_{23}=1 \end{cases} \Rightarrow T = \begin{pmatrix} 1 & 1 & 0 \\ -1 & 1 & 2.5 \\ 0 & 0 & 1 \end{pmatrix}$

增广矩阵 $T|E = \left(\begin{array}{cccccc} 1 & 1 & 0 & 1 & 0 & 0 \\ -1 & 1 & 2.5 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 & 1 \end{array}\right) = \left(\begin{array}{cccccc} 1 & 0 & 0 & 0.5 & -0.5 & 1.25 \\ 0 & 1 & 0 & 0.5 & 0.5 & -1.25 \\ 0 & 0 & 1 & 0 & 0 & 1 \end{array}\right)$

$\therefore T^{-1} = \begin{pmatrix} 0.5 & -0.5 & 1.25 \\ 0.5 & 0.5 & -1.25 \\ 0 & 0 & 1 \end{pmatrix}$