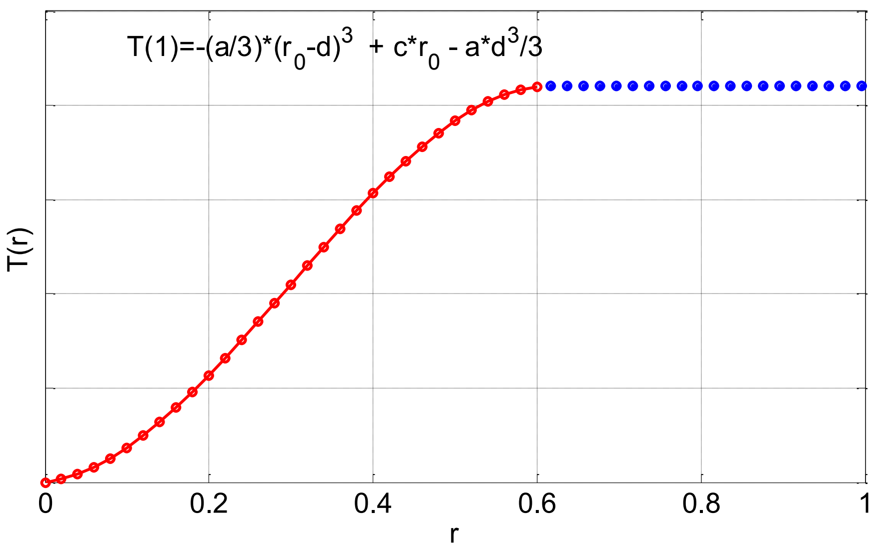
P1.1:

$$p(r) = -a \cdot (x-d)^2 + c$$

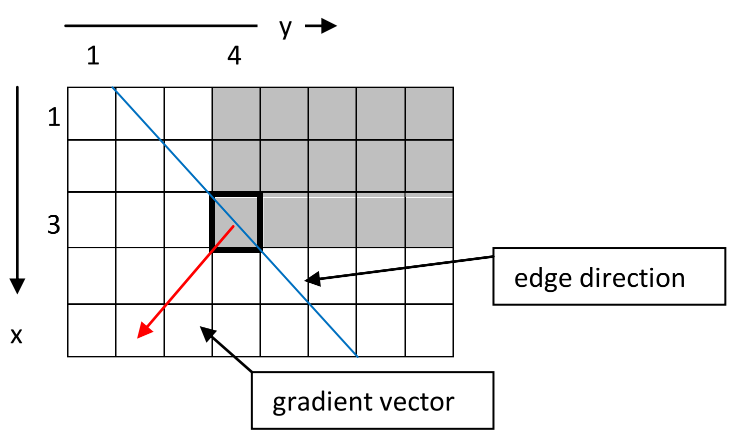
$$T(r) = \int_0^r p(w)dw = \left[\frac{-a \cdot (w-d)^3}{3} + c \cdot w\right] = \frac{-a \cdot (r-d)^3}{3} + c \cdot r - \frac{a \cdot d^3}{3} \qquad for\ 0 \le r \le r_0$$



$$T(r) = \frac{-a \cdot (r_0-d)^3}{3} + c \cdot r_0 - \frac{a \cdot d^3}{3} \qquad for\ \ r_0 \le r \le 1$$

$$r_0 = \sqrt{\frac{c}{a}} + d$$

P1.2: 1.2 Gradient vector = $[g_x,\ g_y] = [2, -2]$, gradient magnitude = $\sqrt{8}$



P1.3:

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P2.1: $A \cdot [\,u\ v\,]^T = b$, I = image (ex frame #1)

Let hx = [-1 -1 -1; 0 0 0; 1 1 1], hx = [-1 0 1; -1 0 1; -1 0 1]; // Prewitt filter
Then fx = imfilter(I,hx), fy = imfilter(I, hy); and
A =
[fx(1,1) fy(1,1)
fx(1,2) fy(1,2)
fx(1,3) fy(1,3)
fx(2,1) ....
... .
fx(3,3) fy(3,3)];

b = - ft = [F1(1,1)- F2(1,1)
F1(1,2)- F2(1,2)
....
F1(3,3)- F2(3,3)]

Final solution: $[u\ v]^T = (A^T A)^{-1} A^T b$

P2.2: See for example region growing, Lecture X.

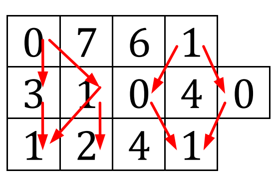
P3: $-\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1 \quad \rightarrow b = \frac{a \cdot y}{\sqrt{a^2+x^2}}$

The voting matrix A vill have parameters a and b: A(a,b).
Let a vary between 1..2, and discretize with e.g steps=0.1,
then the A matrix will have 10 rows.

(x, y) = (3,-2.6) → for a =1 → $b = ay/\sqrt{aa + xx}$
→Point (3, -2.6) will vote for entry A(1, -0.82) in its discrete representation.

P4 : (1-f) (2-g) (3-a) (4-c) (5-i)

P5.1(a):

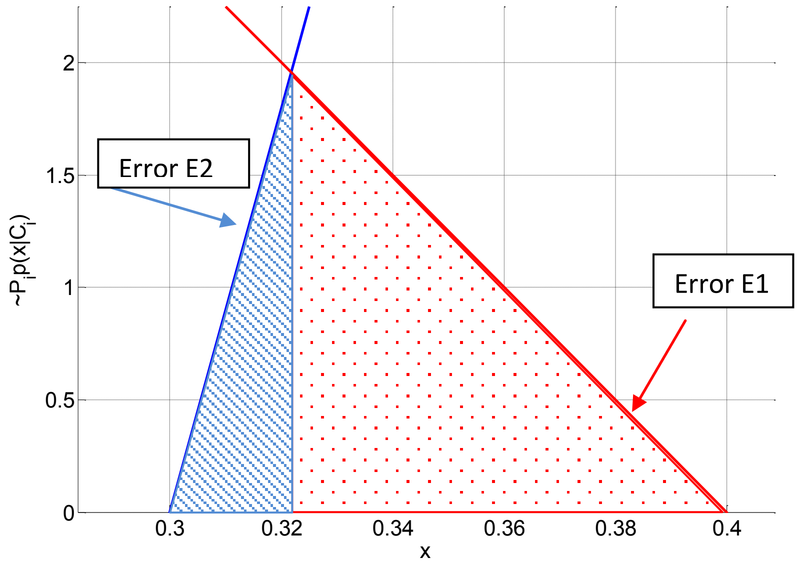


P5.1(b): $4 \cdot 5 \cdot 4 = 80$

P5.2(a): Use Hu moment invariant nr 7, Φ_7, (see Lecture 7, p.18-19). This moment invariant will change the sign for mirrored images.

P5.2(b): First we need to extract the boundary of the letters by some edge detection method, the we have to calculate the scale, translation and rotation invariant Fourier descriptors, e.g. NFD (see Lecture 7, p.8)

P6: (b) $T_1 = 37/115 = 0.3217, \quad T_2 = 1 - 37/115 = 0.6783$



$error\ E1 = 2\int_{T1}^{0.4} P_1 p(x|C1)dx \qquad area\ A1 = 2\int_0^1 P_1 p(x|C_1)dx$

E1 = 2*(0.4 -37/115)*(45/23)/2 = 81/529 = 0.153 A1 = 2

E2 = 2*(37/115-0.3)*(45/23)/2 = (45/23)/46 = 45/1058 = 0.0425 A2 = 18/5 = 3.6

$error\ E2 = \int_{0.3}^{T1} P_2 p(x|C_2)dx \qquad area\ A2 = \int_0^1 P_2 p(x|C_2)dx$

Total error = (E1 + E2)/(A1+A2) = 9/56 = 0.0349

(c) Sensitivity = 1-E1/A1 = 977/1058 = 0.923, Specificity = 1-E2/A2 = 1171/1185 = 0.988

(d)

$(T_1 = T, T_2 = 1 - T)$	**Sensitivity**	**Specificity**
$0 \le T \le 0.2$	$1 - (25/2) \cdot T \cdot T$	1
$0.2 \le T \le 0.3$	½ $\cdot (2 - (0.4 - T) \cdot f_1(T))$, $f_1(T) = 5 - \lvert T - 0.2 \rvert \cdot 25$	1
$0.3 \le T \le 0.4$	½ $\cdot (2 - (0.4 - T) \cdot f_1(T))$, $f_1(T) = 5 - \lvert T - 0.2 \rvert \cdot 25$	$1 - E2/B$ $E2 = (1/2) \cdot (T - 0.3) \cdot f_3(T)$ $B = (1/2) \cdot 18 \cdot 0.2$ $f_3(T) = 18 - \lvert T - 0.5 \rvert \cdot 90$
$0.4 \le T \le 0.5$	1	$1 - E2/B$