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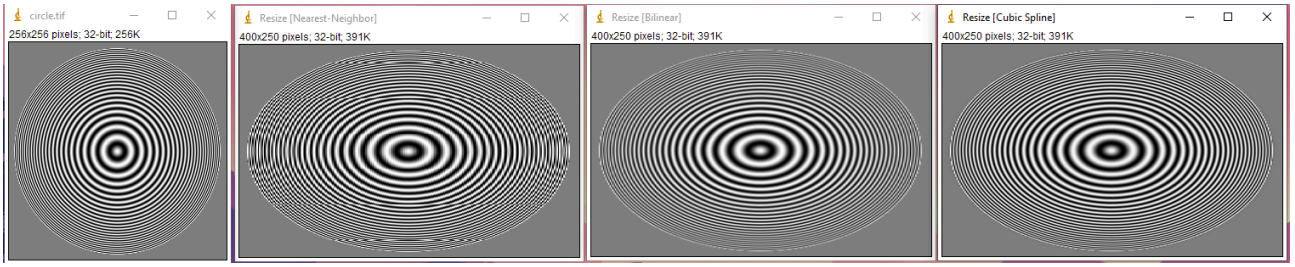
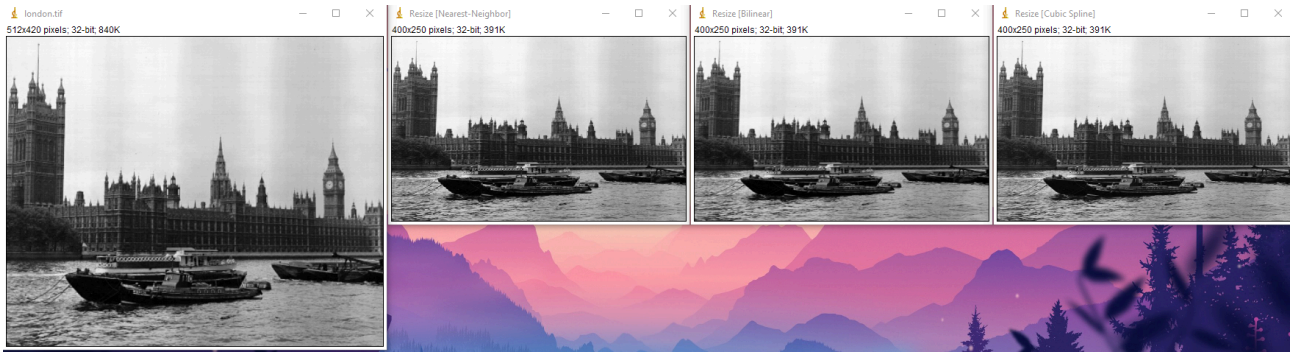
relatório.doc Interpolação e transformação geométrica

Questão 1





Questão 1.1

Apenas explicativa.

Questão 1.2

Código:

```
private static double getInterpolatedPixelNearestNeigbor(ImageAccess image,
double x, double y) {
        int i = (int) Math.round(x);
        int j = (int) Math.round(y);

        i = Math.min(Math.max(i, 0), image.getWidth()  - 1);
        j = Math.min(Math.max(j, 0), image.getHeight() - 1);

        return image.getPixel(i, j);
    }
```

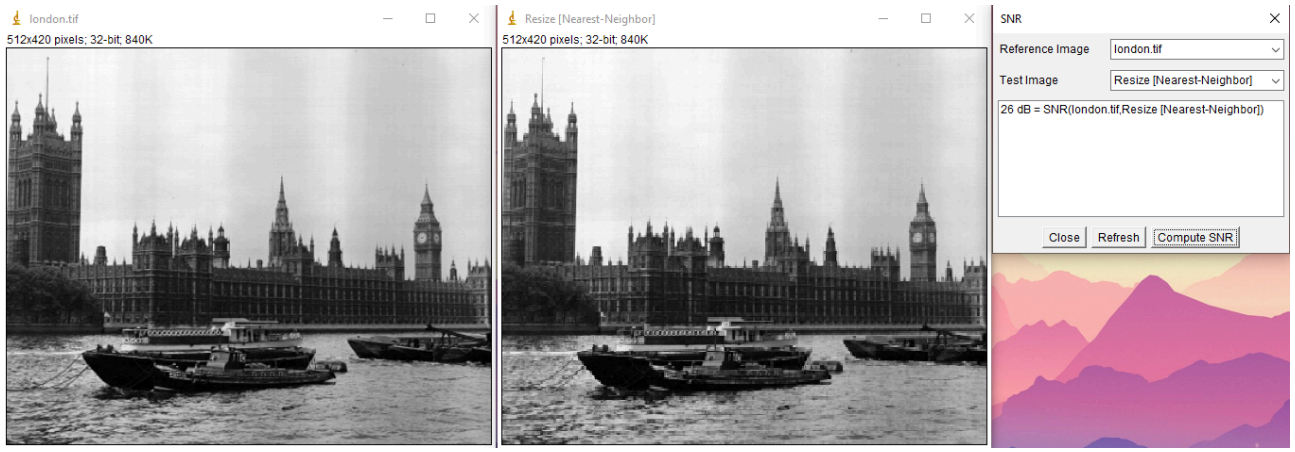
Questão 1.3

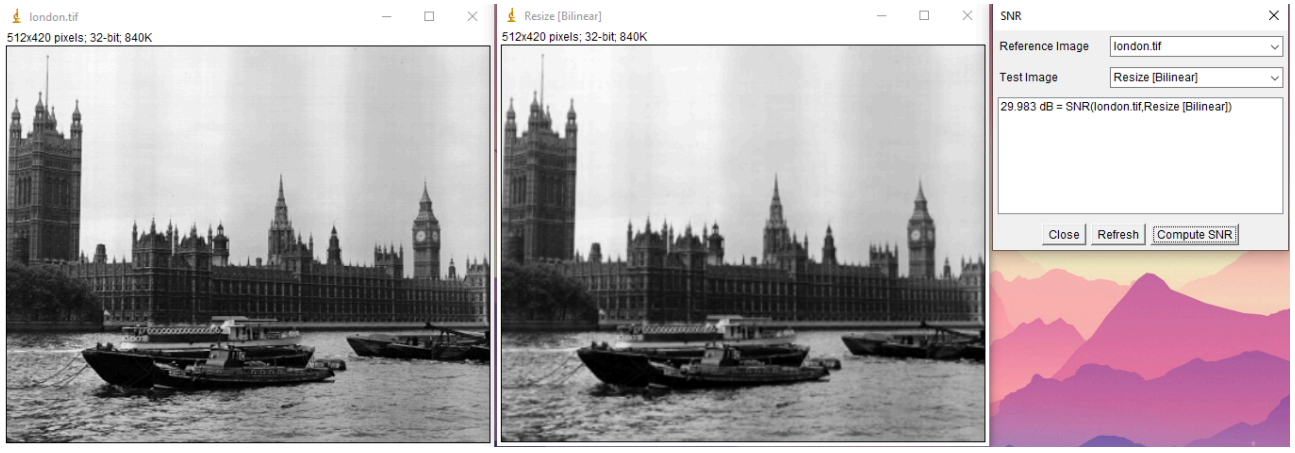
Código:

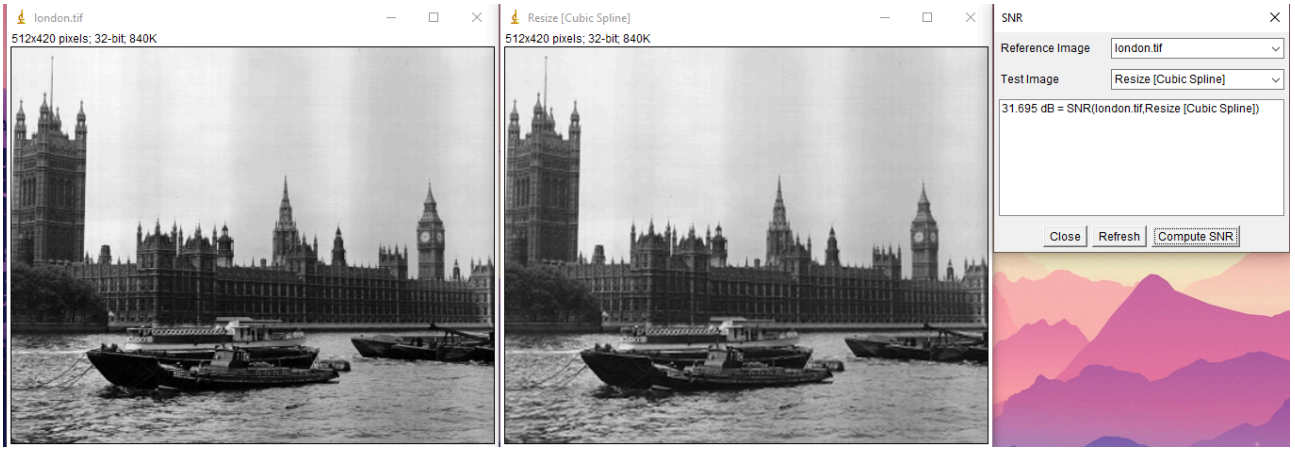
```
private static double getInterpolatedPixelCubicSpline(ImageAccess coef,
double x, double y) {
        // floor to get the "upper-left" integer pixel
        int m = (int) Math.floor(x);
        int n = (int) Math.floor(y);

        // grab the 4×4 neighborhood of SPLINE COEFFICIENTS around (m,n)
        double[][] neighbor = new double[4][4];
        coef.getNeighborhood(m, n, neighbor);

        // fractional offsets inside that 4×4 block
        double dx = x - m;
        double dy = y - n;

        // evaluate the 2D tensor-product B-spline basis
        return getSampleCubicSpline(dx, dy, neighbor);
    }

static private double getSampleCubicSpline(double x, double y, double
neighbor[][]) {
        double sum = 0.0;
        double[] cubicSplineRow = getCubicSpline(x);
        double[] cubicSplineCol = getCubicSpline(y);

        for (int i = 0; i < 4; ++i) {
            for (int j = 0; j < 4; ++j) {
                sum += neighbor[j][i] * cubicSplineRow[j] * cubicSplineCol[i];
            }
        }

        return sum;
    }

static private double[] getCubicSpline(double t) {
        double v[] = new double[4];

        if (t < 0.0 || t > 1.0) {
            throw new ArrayStoreException(
                    "Argument t for cubic B-spline outside of expected range.");
        }

        double t1 = 1.0 - t;
```

```
        double t2 = t * t;
        v[0] = (t1 * t1 * t1) / 6.0;
        v[1] = (2.0 / 3.0) + 0.5 * t2 * (t-2);
        v[3] = (t2 * t) / 6.0;
        v[2] = 1.0 - v[3] - v[1] - v[0];
        return v;
    }
```

Questão 1.4







Reduzir/Ampliar london.tif
Interpolação SNR (relação sinal / ruído)

Nearest-Neighbor *26* dB
Linear B-Spline *29.983* dB
Cubic B-Spline *31.695* dB

Questão 2

Código:

```
public static ImageAccess unwarp(ImageAccess input, double d) {
        int nx = input.getWidth();
        int ny = input.getHeight();
        double m = Math.max(nx, ny);
        double a = 4.0 * (1.0 - d) / m;
        double b = 2.0 * d - 1.0;
        double cx = (nx - 1) / 2.0;
        double cy = (ny - 1) / 2.0;
        ImageAccess coef = computeCubicSplineCoeffients(input);
        ImageAccess output = new ImageAccess(nx, ny);

        for (int xo = 0; xo < nx; xo++) {
            for (int yo = 0; yo < ny; yo++) {
                double dxp = xo - cx;
                double dyp = yo - cy;
                double rhoP = Math.hypot(dxp, dyp);

                double rho;
                if (rhoP == 0) {
                    rho = 0;
                } else {
                    double discr = b*b + 4*a*rhoP;
                    rho = (-b + Math.sqrt(discr)) / (2*a);
                }

                double x = cx + dxp / (rhoP == 0 ? 1 : rhoP) * rho;
                double y = cy + dyp / (rhoP == 0 ? 1 : rhoP) * rho;
                double v = getInterpolatedPixelCubicSpline(coef, x, y);
                output.putPixel(xo, yo, v);
            }
        }

        return output;
    }
```

Dados os parâmetros:
a = *(4(1 - d))/m*
b = *2d - 1*
c = *0*

Insira a imagem transformada:

Qual o melhor valor para d?
1.18

Questão 3

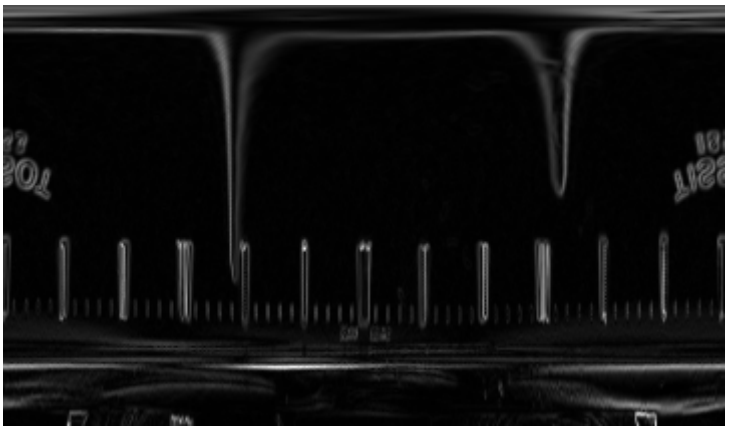
Código:

```
public static String whatTime(ImageAccess input) {
    int nx = input.getWidth(), ny = input.getHeight();
    double cx = (nx - 1) / 2.0, cy = (ny - 1) / 2.0;
    int R = (int)(Math.min(nx, ny) / 2.0);

    // 1) obtém magnitude do gradiente (Sobel)
    double[][] G = computeGradientMagnitude(input);

    // 2) projetor de gradiente
    int nAngles = 360;
    double[] projection = new double[nAngles];

    // Criar imagem polar: largura = 360 (ângulo), altura = R (raio)
    ImageAccess polarImage = new ImageAccess(nAngles, R);

    for (int t = 0; t < nAngles; t++) {
        // converte t - ângulo de relógio (0 em 12h, CW)
        double ang = Math.toRadians(90 - t);
        double cosA = Math.cos(ang), sinA = Math.sin(ang);

        double sum = 0;
        for (int r = 0; r < R; r++) {
            double x = cx + r * cosA;
            double y = cy - r * sinA;

            // Interpola valor do gradiente
            double v = interpolate(G, x, y);
            sum += v;

            // Salva na imagem polar
            polarImage.putPixel(t, r, v);
        }
        projection[t] = sum;
    }

    // 3) encontra os dois maiores picos em 'projection'
    int idx1 = 0, idx2 = 0;
    double p1 = -1, p2 = -1;
    for (int t = 0; t < nAngles; t++) {
        double v = projection[t];
        if (v > p1) {
            p2 = p1; idx2 = idx1;
```

```
                p1 = v;  idx1 = t;
            } else if (v > p2) {
                p2 = v; idx2 = t;
            }
        }
        int minuteAngle = idx1, hourAngle = idx2;

        // 4) converte em hora/minuto
        int minute = (int)Math.round(minuteAngle * 60.0 / 360.0) % 60;
        int hour   = (int)Math.round(hourAngle   * 12.0 / 360.0) % 12;
        if (hour == 0) hour = 12;

        // Mostra imagem polar
        polarImage.show("Polar Projection");

        String time = String.format("%02d:%02d", hour, minute);
        IJ.write("Time: " + time);
        return time;
    }

    private static double[][] computeGradientMagnitude(ImageAccess img) {
        int nx = img.getWidth(), ny = img.getHeight();
        double[][] G = new double[ny][nx];
        for (int y = 1; y < ny-1; y++) {
            for (int x = 1; x < nx-1; x++) {
                // Sobel X
                double gx =
                    -img.getPixel(x-1,y-1) + img.getPixel(x+1,y-1)
                -2*img.getPixel(x-1,y  ) + 2*img.getPixel(x+1,y  )
                -img.getPixel(x-1,y+1) + img.getPixel(x+1,y+1);
                // Sobel Y
                double gy =
                    -img.getPixel(x-1,y-1) -2*img.getPixel(x,y-1)
-img.getPixel(x+1,y-1)
                +img.getPixel(x-1,y+1) +2*img.getPixel(x,y+1)
+img.getPixel(x+1,y+1);
                G[y][x] = Math.hypot(gx, gy);
            }
        }
        return G;
    }

    private static double interpolate(double[][] G, double xf, double yf) {
        int x0 = (int)Math.floor(xf), y0 = (int)Math.floor(yf);
        int x1 = x0+1, y1 = y0+1;
```

```
        double a = xf - x0, b = yf - y0;
        x0 = clamp(x0, 0, G[0].length-1);
        x1 = clamp(x1, 0, G[0].length-1);
        y0 = clamp(y0, 0, G.length-1);
        y1 = clamp(y1, 0, G.length-1);
        double v00 = G[y0][x0], v10 = G[y0][x1],
            v01 = G[y1][x0], v11 = G[y1][x1];
        return v00*(1-a)*(1-b) + v10*(a)*(1-b) + v01*(1-a)*(b) + v11*(a)*(b);
    }

    private static int clamp(int v, int lo, int hi) {
        return (v<lo?lo:(v>hi?hi:v));
    }
```

Insira a imagem em coordenadas polares:



Que horas são?
09:19