CS215 Assignment-2

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1 Sampling within a Euclidean Plane

1.1 Ellipse

1.1.1 Idea

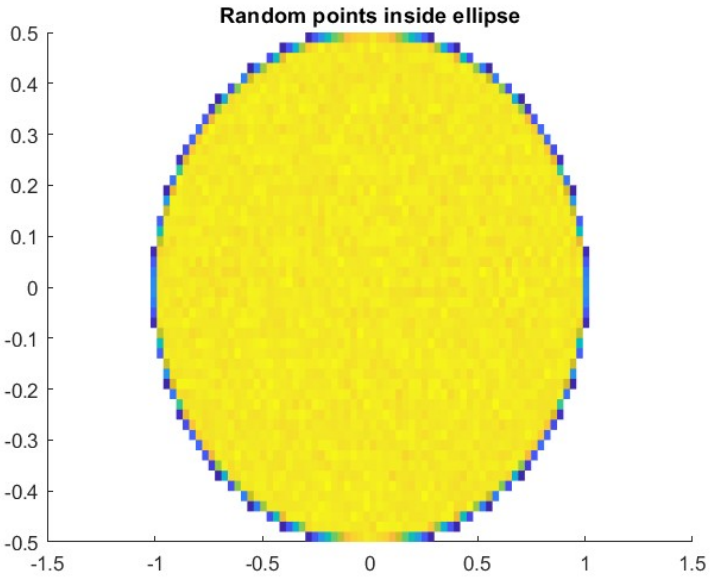
1. First generating random theta between [0,2*π]
2. Generating another random number and taking the square root of it (proof is attached in pdf proof)
3. Writing co-ordinates as semiMajorAxis * d * cos(t) and semiMinorAxis * d * sin(t).
4. Plotting histogram

1.1.2 Algorithm

Algorithm 1: Algorithm for generating random points (in 2D) distributed uniformly inside the ellipse

function ellipse
N = 10^7;
semiMajorAxis = 1;
semiMinorAxis = 0.5;
t = 2$*\pi*$ rand(N,1); // calculate random theta between [0,2π]
d = sqrt(rand(N,1));
x = semiMajorAxis * d * cos(t);
y = semiMinorAxis * d * sin(t);
histogram2(x,y)
end

1.1.3 Result

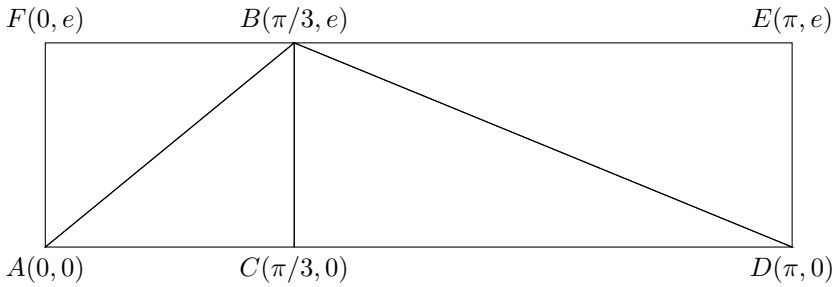


Instructions to run the code:
Run ellipse.m from code folder of Q1

1.2 Triangle

1.2.1 Idea

1. Generated 2 random numbers between [0, π] and [0,e]
2. Let triangle ABF be described with [0,0], [0,e], [π/3,e]. Triangle ACB be described with [0,0], [π/3,0], [π/3,e]. Triangle CDB be described with [π/3,0], [π,0], [π/3,e]. Triangle DEB be described with [0,π], [π,e], [π/3,e].
3. Triangle ACB and BFA are congruent as they have the same side lengths. So every point in triangle ACB has an equivalent position in triangle BFA. So generated points in triangle ACB can be flipped to triangle BFA.
4. Similarly flipping the points of triangle DEB into triangle BCD.

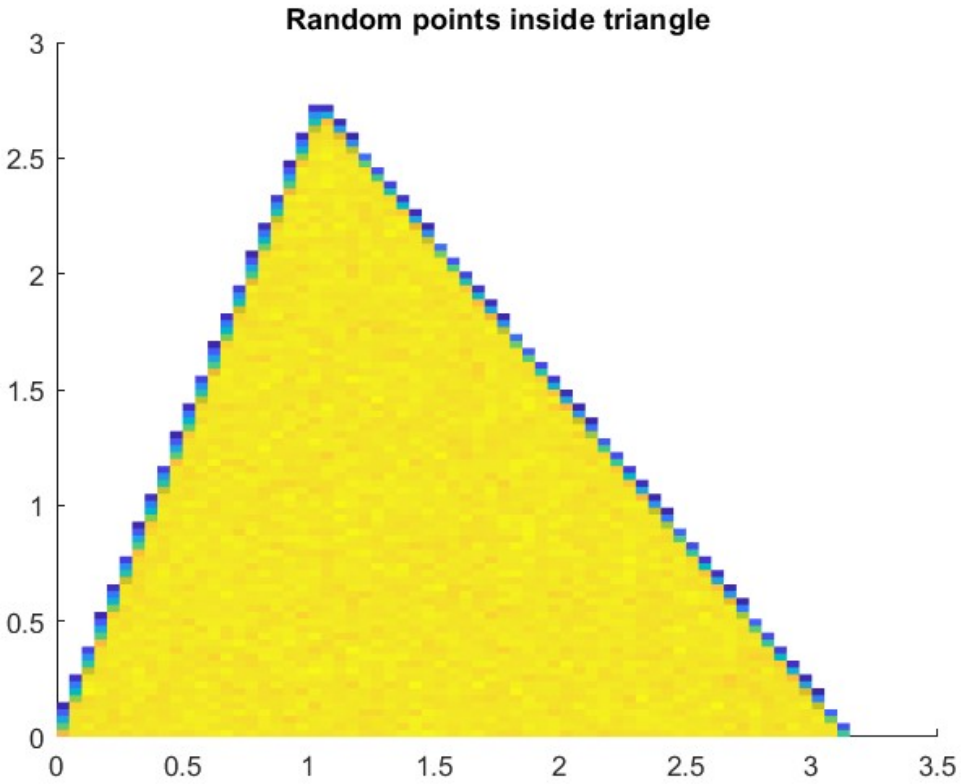


1.2.2 Algorithm

Algorithm 2: Algorithm for generating random points (in 2D) distributed uniformly inside the triangle

```
function triangle
N = 10^7;
points=zeros(N,2);
for i = 1:N do
    a = π*rand;      // random x value in the rectangle [0,π]x[0,e]
    b = e*rand;      // random y value in the rectangle [0,π]x[0,e]
    x1 = a;
    y1 = b;
    if point (x1,y1) is in triangle ABF then
        Shift point (x1,y1) to its equivalent position in triangle ACB
    end
    if point (x1,y1) is in triangle DEB then
        Shift point (x1,y1) to its equivalent position in triangle CDB
    end
    points(i,1)=x1;
    points(i,2)=y1;
end
histogram2(points(:,1),points(:,2))
end
```

1.2.3 Result



Instructions to run the code:
Run triangle.m from code folder of Q1