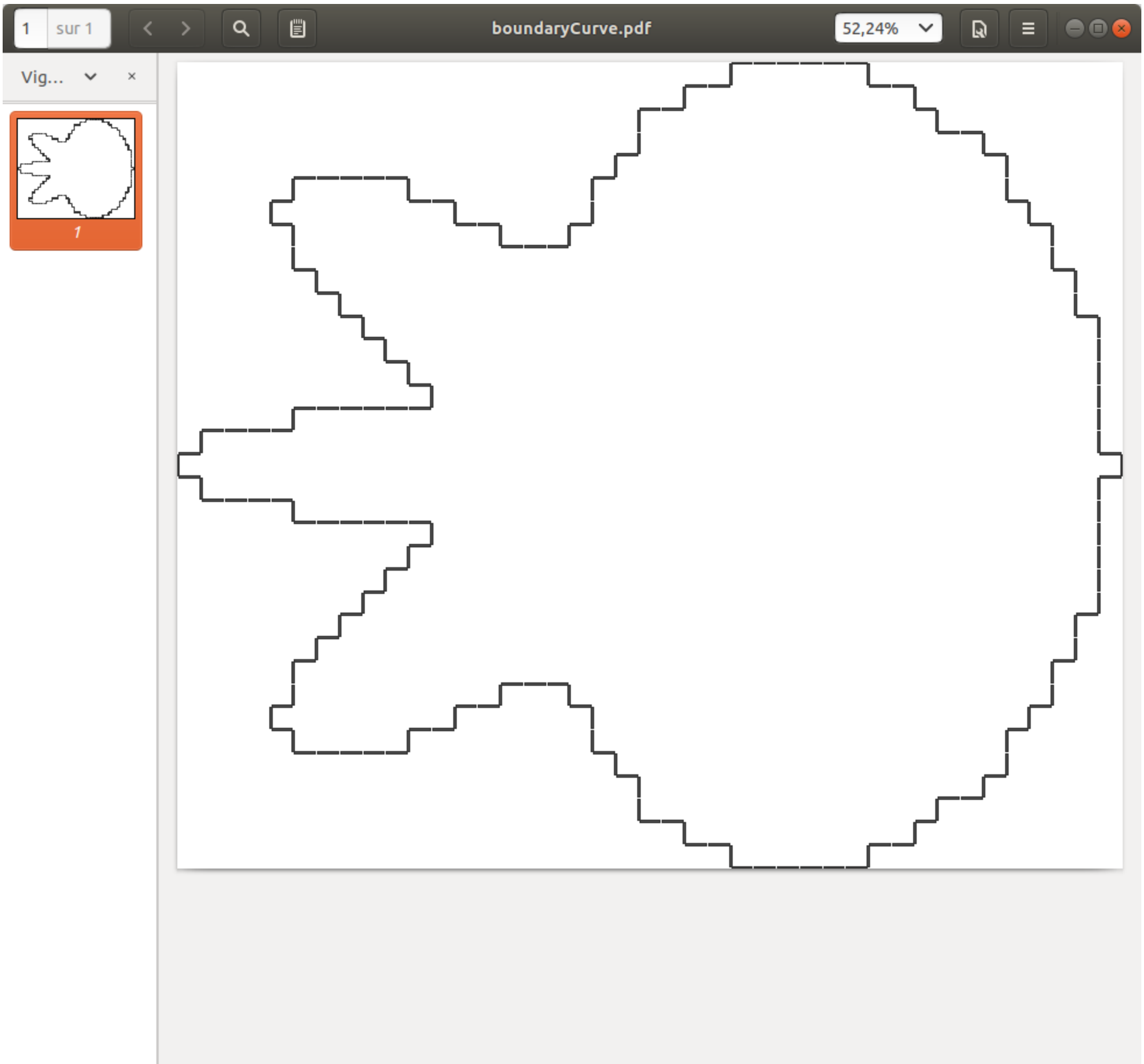
Report TP1 DGtal

Pluchard Maximilien

Step 2: Discretize Euclidean shapes and extract digital shape boundary



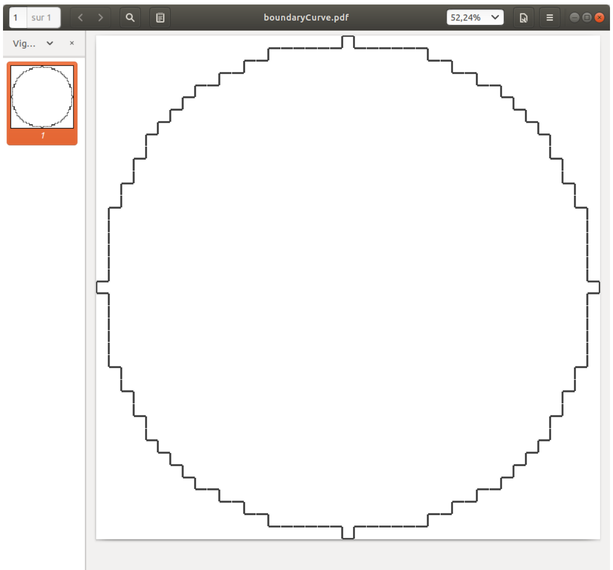
Shape of an AccFlower2D

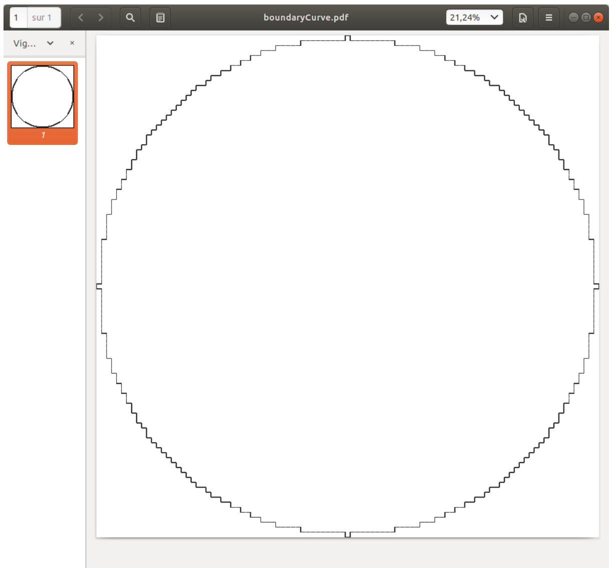
Step 4: Calculate area and perimeter by counting cells

The shape I used are a circle and an ellipsis.

I computed the area and perimeter using different resolutions

Circle

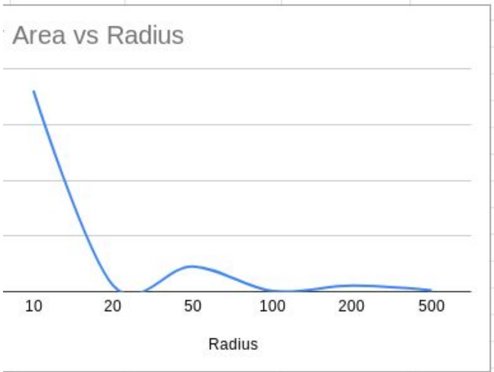


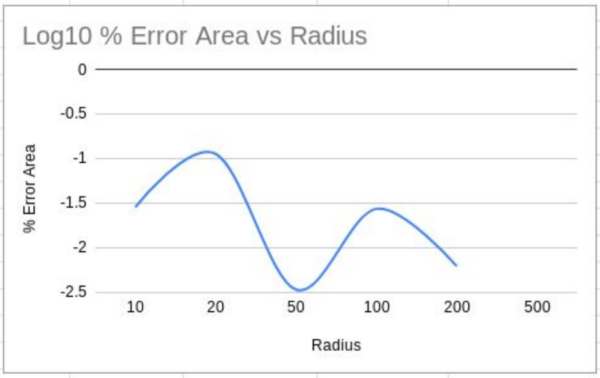


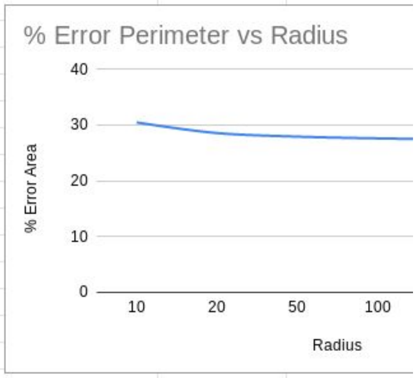
For the circle, the better the resolution is, the more it looks like a euclidean circle.

Here are the values computed for analog and discrete shape :

Discrete Area	Discrete Perimeter	Analytical Area	Analytical Perimeter	Error Area	Error Perimeter	% Error Area	% Error Perimeter	Log10 % Error Area
317	84	314.1592654	62.83185307	2.840734641	21.16814693	0.9042339203	33.6901522	-0.04371920543
1257	164	1256.637061	125.6637061	0.3629385641	38.33629386	0.02888173326	30.50705334	-1.539376747
7845	404	7853.981634	314.1592654	8.981633974	89.84073464	0.1143577155	28.59719402	-0.9417345289
31417	804	31415.92654	628.3185307	1.073464102	175.6814693	0.003416942362	27.96057425	-2.466362347
125629	1604	125663.7061	1256.637061	34.70614359	347.3629386	0.02761827154	27.64226436	-1.558803505
785349	4004	785398.1634	3141.592654	49.16339745	862.4073464	0.006259678178	27.45127843	-2.203447994





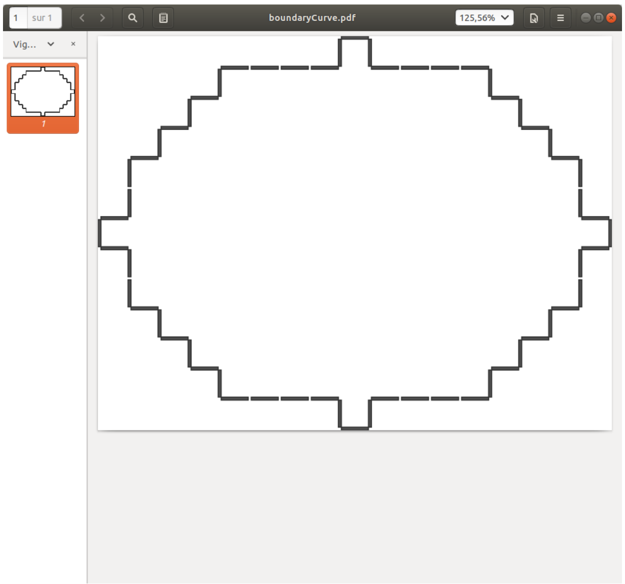


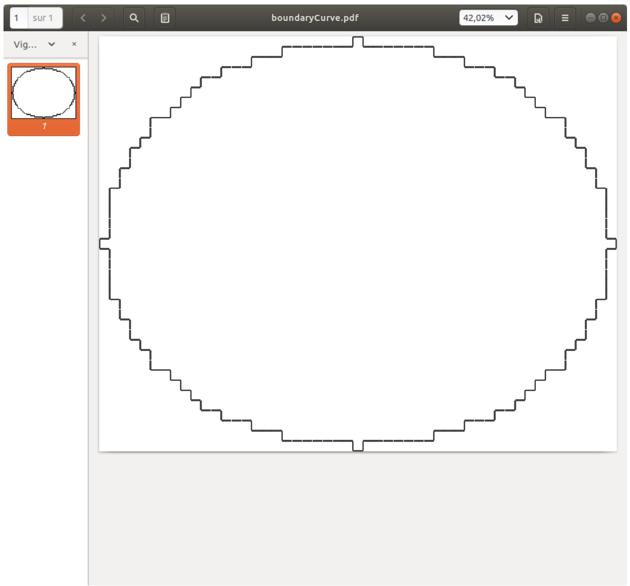
We can see the percentage of error for the area is getting smaller and smaller as we increase the resolution. For a resolution of 10, it is about 1% and for a resolution of 50 it is about 0.1%, which is insignificant for a shape this size.

Therefore, we can say the discretization of a shape preserve it's area.

On the other hand, we can see the percentage of error of the perimeter is always about 30%, no matter the resolution of the circle. The discretization of the shape do not preserve the perimeter. The discrete perimeter is about 30% bigger than the analytical one.

Ellipsis

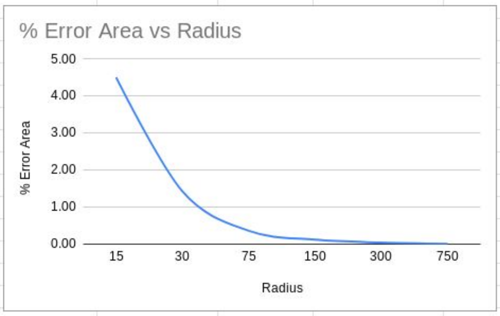


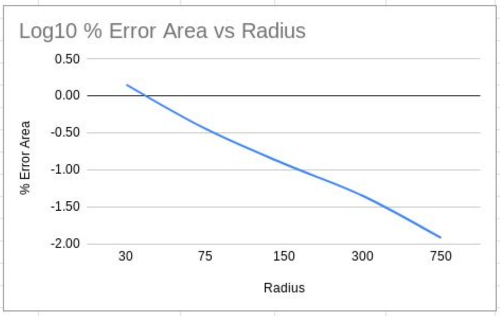


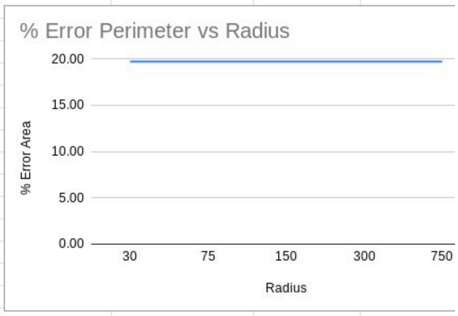
Again, the better the resolution is, the more it looks like a euclidean ellipsis.

Here are the values computed for analog and discrete shape :

r1	r2	Discrete Area	Discrete Perimeter	Analytical Area	Analytical Perimeter	Error Area	Error Perimeter	% Error Area	% Error Perimeter	Log10 % Error Area
15	5	225.00	80.00	235.62	66.82	10.62	13.18	4.51	19.72	0.65
30	10	929.00	160.00	942.48	133.64	13.48	26.36	1.43	19.72	0.16
75	25	5,869.00	400.00	5,890.49	334.11	21.49	65.89	0.36	19.72	-0.44
150	50	23,533.00	800.00	23,561.94	668.22	28.94	131.78	0.12	19.72	-0.91
300	100	94,205.00	1,600.00	94,247.78	1,336.44	42.78	263.56	0.05	19.72	-1.34
750	250	588,977.00	4,000.00	589,048.62	3,341.11	71.62	658.89	0.01	19.72	-1.92

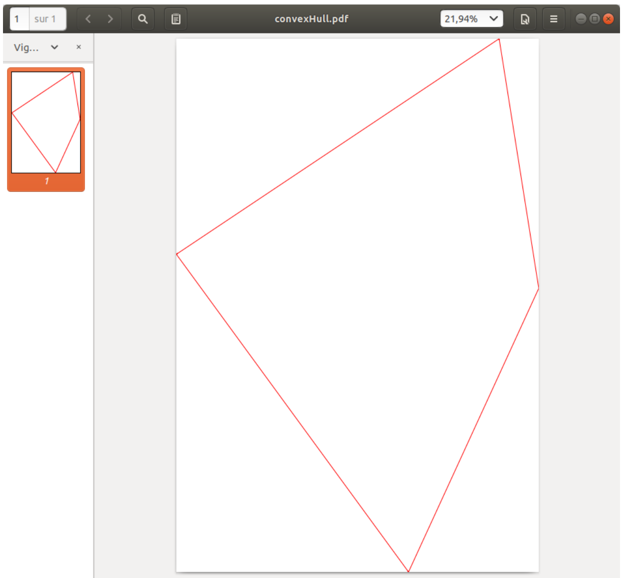


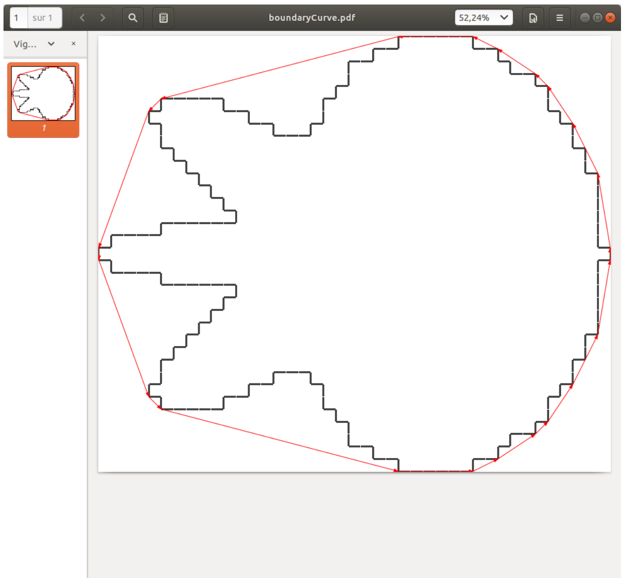




Again, the results for the ellipsis are the same as the circle. The discretization preserve the area but do not preserve the perimeter.

Step 5: Make the convex hull of digital shapes boundary





Default convex hull | AccFlower2D convex hull

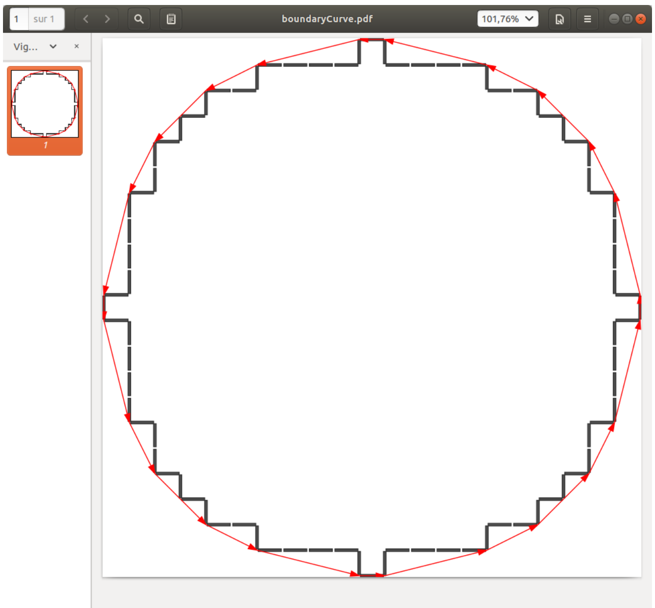
The convex hull is a tool that can represent nicely a convex shape, but it is very inaccurate as soon as the shape is concave.

Step 6: Calculate area and perimeter via convex hull

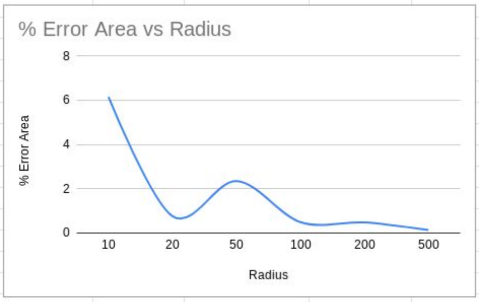
The shape I used are a circle and an ellipsis.

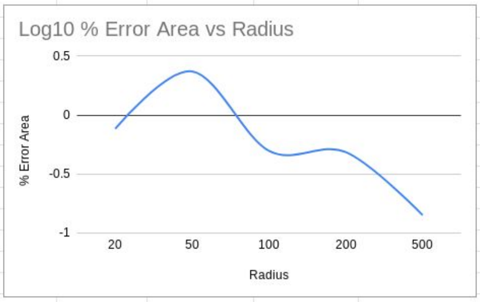
I computed the area and perimeter of the generated convex hull using different resolutions.

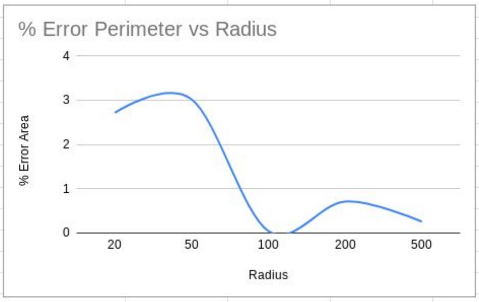
Circle



Radius	Hull Area	Hull Perimeter	Analytical Area	Analytical Perimeter	Error Area	Error Perimeter	% Error Area	% Error Perimeter	Log10 % Error Area
10	333.5	63.951	314.1592654	62.83185307	19.34073464	1.119146928	6.156347042	1.781177657	0.7893230937
20	1247	122.247	1256.637061	125.6637061	9.637061436	3.416706144	0.7668929822	2.718928359	-0.1152652364
50	7669.5	304.661	7853.981634	314.1592654	184.481634	9.498265359	2.348893117	3.023391765	0.3708632552
100	31572.5	628.628	31415.92654	628.3185307	156.5734641	0.309469282	0.4983888154	0.04925356597	-0.3024317125
200	125053	1247.66	125663.7061	1256.637061	610.7061436	8.977061436	0.4859845076	0.714371851	-0.3133775751
500	784281	3133.42	785398.1634	3141.592654	1117.163397	8.17265359	0.1422416616	0.2601436434	-0.8469731833



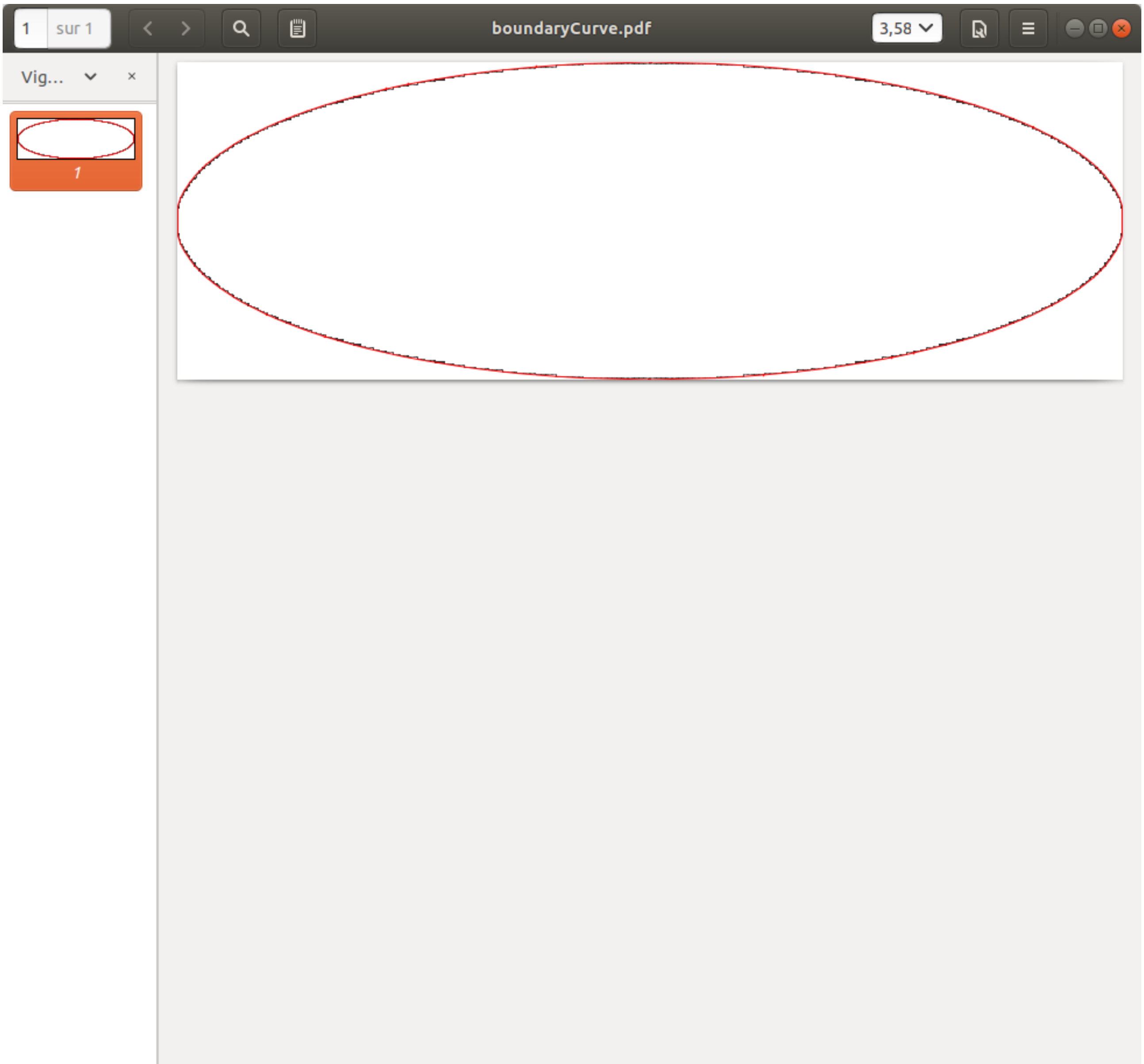




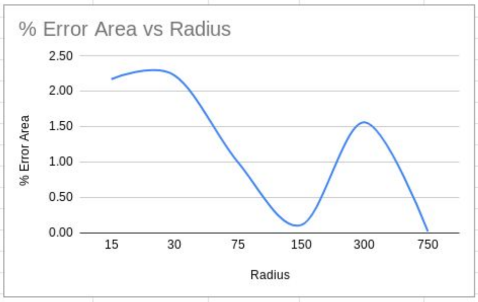
The convex hull of a circle looks a lot like the euclidean shape. The error percentage between the convex hull area and the disk area is very small, and get smaller as we increase the resolution of the shape. It is the same values than for the discrete disk shape.

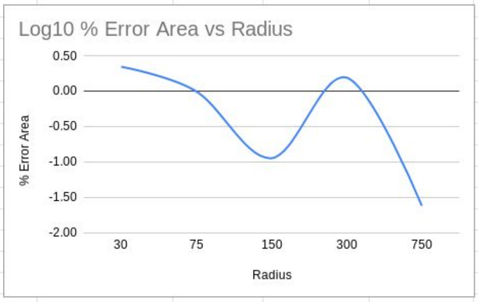
However, if we take a look at the percentage of error between the convex hull perimeter and the euclidean shape perimeter, we can see that the error is much smaller than the one we observed for the discretized shape. At a resolution of 500, the percentage of error is less than 1%, which is a really good result.

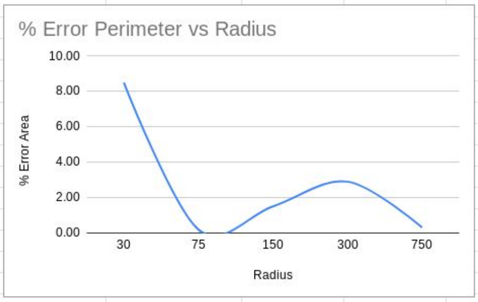
Ellipsis



r1	r2	Hull Area	Hull Perimeter	Analytical Area	Analytical Perimeter	Error Area	Error Perimeter	% Error Area	% Error Perimeter	Log10 % Error Area
15	5	230.50	58.58	235.62	66.82	5.12	8.25	2.17	12.34	0.34
30	10	921.50	122.28	942.48	133.64	20.98	11.37	2.23	8.51	0.35
75	25	5,949.50	333.44	5,890.49	334.11	59.01	0.67	1.00	0.20	0.00
150	50	23,535.00	658.10	23,561.94	668.22	26.94	10.12	0.11	1.51	-0.94
300	100	92,774.00	1,297.61	94,247.78	1,336.44	1,473.78	38.83	1.56	2.91	0.19
750	250	588,905.00	3,330.45	589,048.62	3,341.11	143.62	10.66	0.02	0.32	-1.61







For the Ellipsis convex hull, the results are about the same than the disk. We can see that both Convex hull area and perimeter are getting smaller and smaller. The percentage of error for the perimeter is less than 1% at a resolution of 500.

To conclude, I would say that the convex hull of a discretized shape can be a better object than the discrete shape itself, because both its perimeter and area grow really close to those of the euclidean shape. However, the convex hull is not always a nicely representing the discretized shape. If the shape is concave, then we can't use a convex hull.