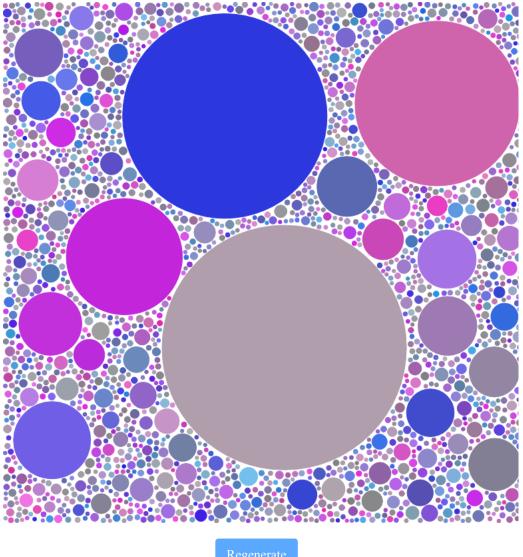
## Algorithmic Art

We want to generate probabilistic artwork, efficiently. We are going to use random variables to make a picture filled with non-overlapping circles:



In our art, the circles are different sizes. Specifically, each circle's radius is drawn from a Pareto distribution (which is described below). The placement algorithm is greedy: we sample 1000 circle sizes. Sort them by size, largest to smallest. Loop over the circle sizes and place circles one by one.

To place a circle on the canvas, we sample the location of the center of the circle. Both the x and y coordinates are uniformly distributed over the dimensions of the canvas. Once we have selected a prospective location we then check if there would be a collision with a circle that has already been placed. If there is a collision we keep trying new locations until you find one that has no collisions.

## The Pareto Distribution

## Pareto Random Variable

**Notation:**  $X \sim \operatorname{Pareto}(a)$ 

**Description:** A long tail distribution. Large values are rare and small values are common.

**Parameters:**  $a \ge 1$ , the shape parameter

Note there are other optional params. See wikipedia

**Support:**  $x \in [0,1]$ 

**PDF equation:**  $f(x) = \frac{1}{x^{a+1}}$ 

**CDF equation:**  $F(x) = 1 - \frac{1}{x^a}$ 

## Sampling from a Pareto Distribution

How can we draw samples from a pareto? In python its simple: **stats.pareto.rvs(a)** however in JavaScript, or other languages, it might not be made transparent. We can use "inverse transform sampling". The simple idea is to choose a uniform random variable in the range (0, 1) and then select the value x assignment such that F(x) equals the randomly chosen value.

$$y = 1 - \left(\frac{1}{x}\right)^{\alpha}$$
$$\left(\frac{1}{x}\right)^{\alpha} = 1 - y$$
$$\frac{1}{x} = (1 - y)^{\frac{1}{\alpha}}$$
$$x = \frac{1}{(1 - y)^{\frac{1}{\alpha}}}$$