



Pattern Recognition-Project 1

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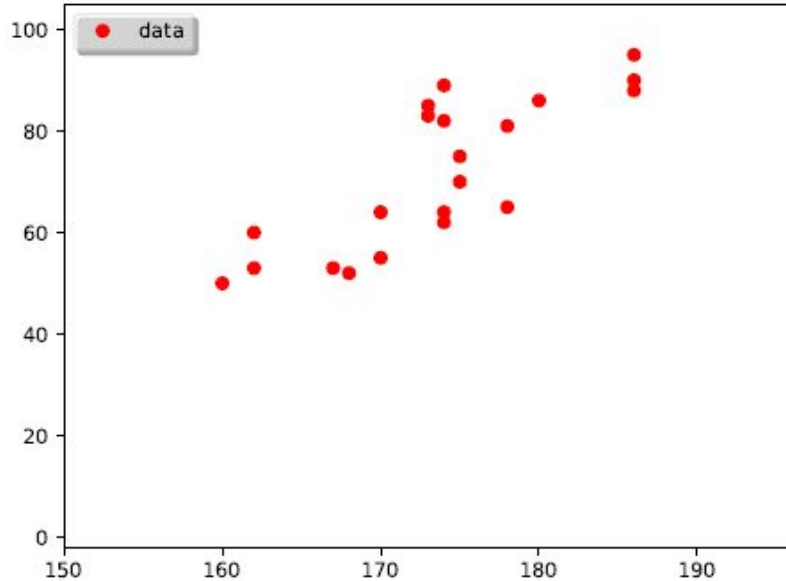
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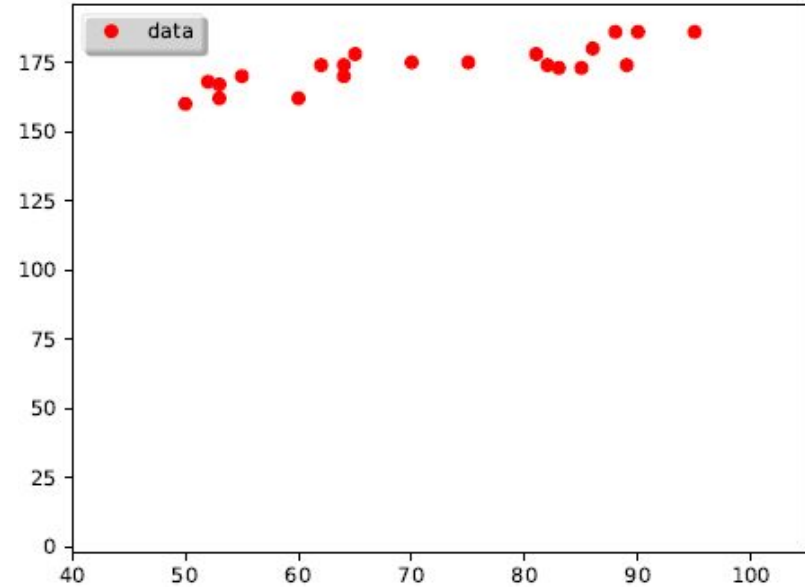
Overview

1. Outliers in data
2. Fitting a Normal distribution to 1D data
3. Fitting a Weibull distribution to 1D data
4. Drawing unit circles
5. Estimating dimension of fractal objects

Task 1: Plots with outliers removed

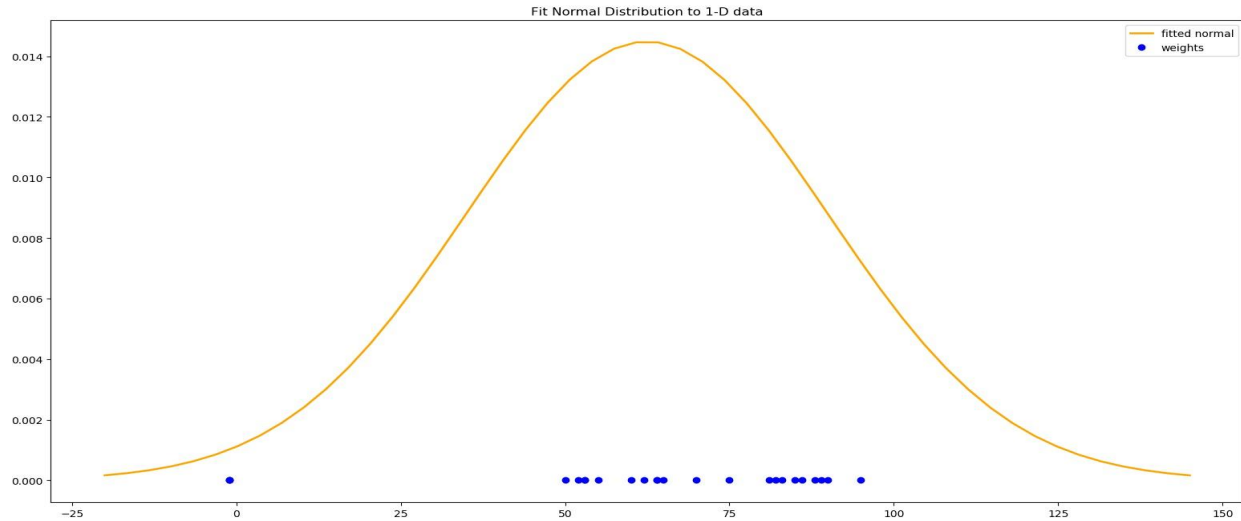


Height vs Weight



Weight vs Height

Task 2: Fitting a Normal distribution to 1D data

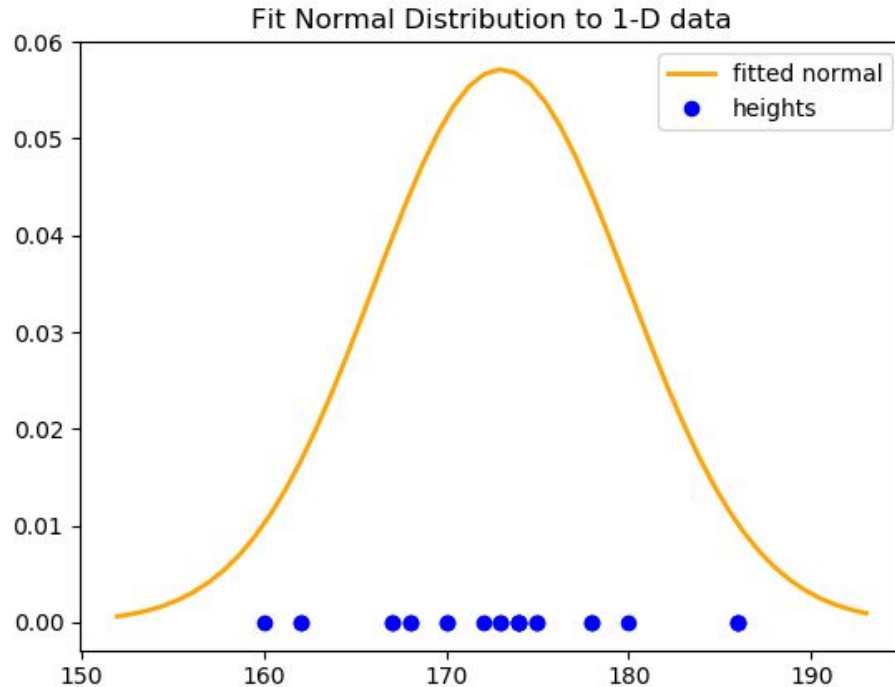


Before handling outliers

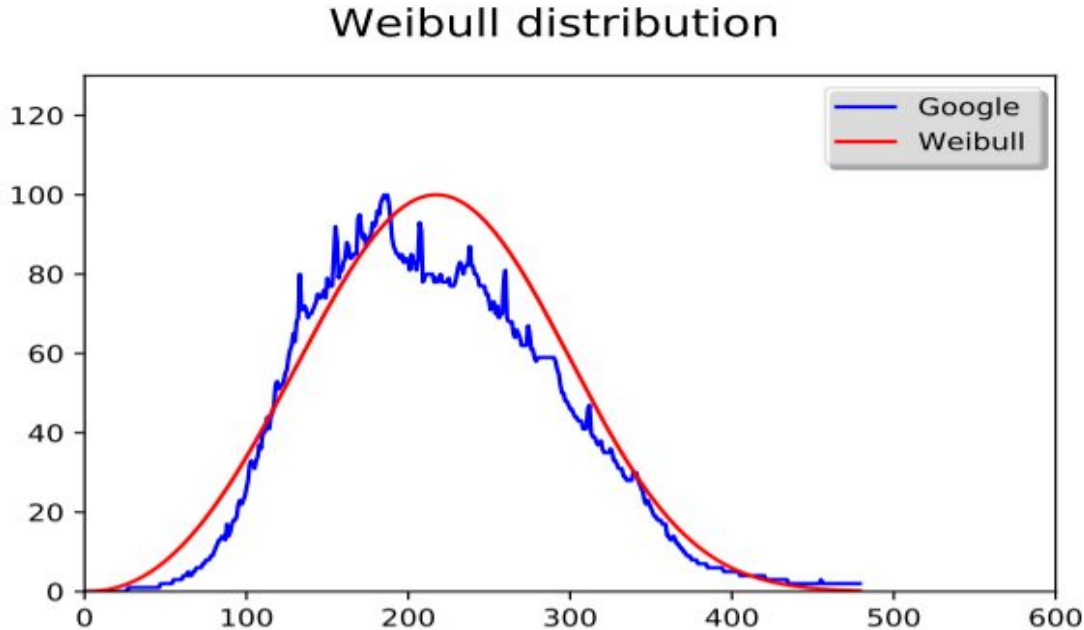
Task 2: Fitting a Normal distribution to 1D data



Task 2: Fitting a Normal distribution to 1D data



Task 3: Fitting a Weibull distribution to 1D data



After 20 iterations the value of $k=3.190$ and $a=243.17$

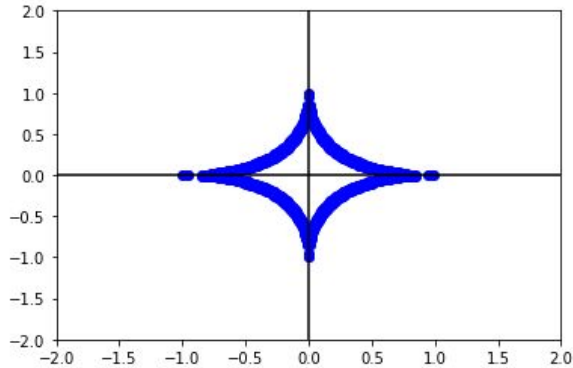
Task 4: Drawing unit circles



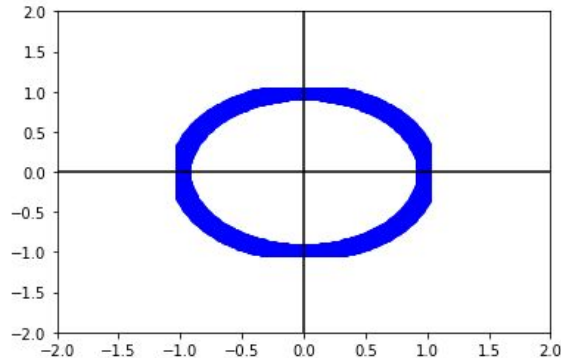
Unit circle using L_p norm for $p=1/2$ in \mathbb{R}^2

- Identify finite number of points for (x,y) with range for x, y between -1 and $+1$
- Calculate distance from origin for those points using l_p norm formula for $p=0.5$
- Identify points at approximately unit distance and plot

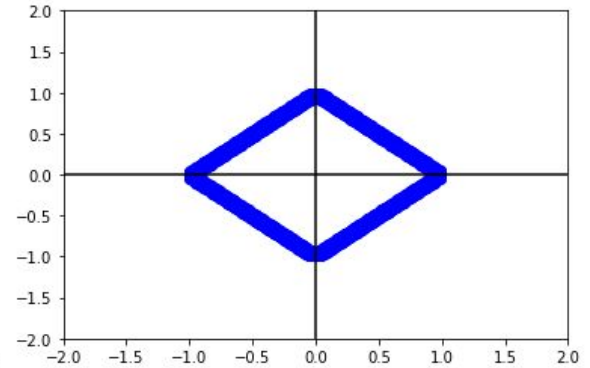
Task 4: Drawing unit circles



$p=0.5$



$p=2$

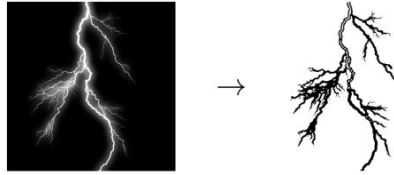


$p=1$

L_p for $p = 0.5$ does not define a norm, because it violates the triangle inequality

Task 5: Estimating the dimension of fractal objects in an image

- Apply binarization to image.



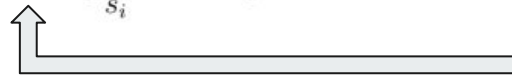
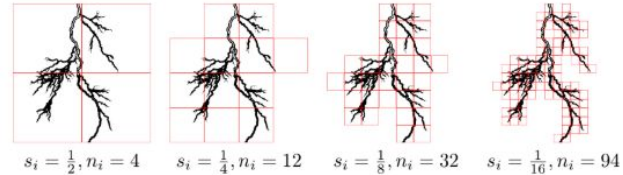
- Specify a set of scaling factors $S = \left\{ \frac{1}{2^i} \mid i \in \{1, 2, \dots, L-2\} \right\}$

- For each $s_i \in S$, divide the binary image with boxes of size $s_i \times s_i$

- Count the number n_i of boxes which contain at least one foreground pixel.

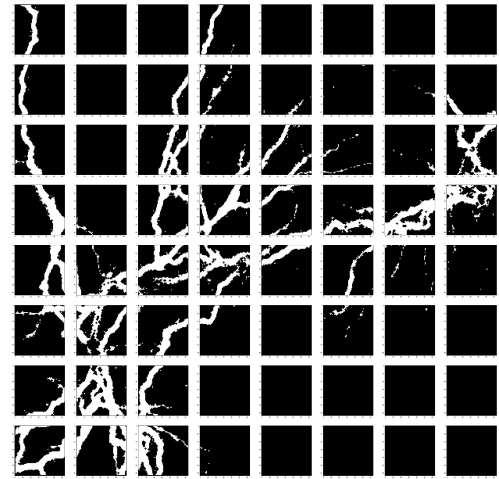
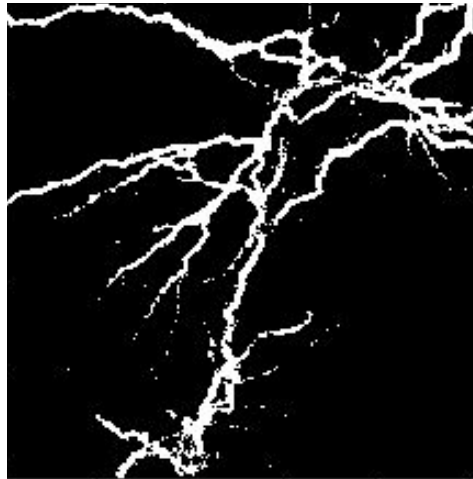
- Plot $\log n_i$ against $\log (1/s_i)$

- Fit a line to the plot $D \cdot \log \frac{1}{s_i} + b = \log n_i$

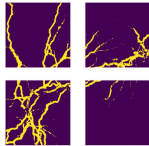
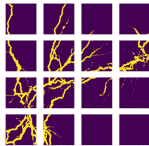
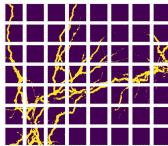


Fractal Dimension

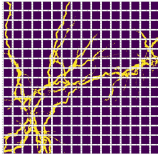
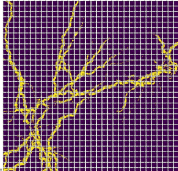
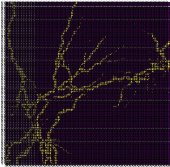
Image to Binary Image to Square Boxes



Counting square boxes

$i=1$	$s=1/2$		squares = 4	fg_squares = 4
$i = 2$	$s = 1/4$		squares = 16	fg_squares = 14
$i = 3$	$s = 1/8$		squares = 64	fg_squares = 45

Counting square boxes

$i=4$	$s=1/16$		squares = 256	fg_squares = 147
$i = 5$	$s = 1/25$		squares = 1024	fg_squares = 404
$i = 6$	$s = 1/36$		squares = 4096	fg_squares = 1064
$i = 7$	$s = 1/49$		squares = 16384	fg_squares = 2905

Solving equation using least squares



Equations:

$S = \{1/s_i; i = 1 \text{ to } L-2\}$ where $L = 9$ in this problem ($L = \log_2 512$)

$D \cdot \log 1/s_i + b = \log n_i$ where n_i = no. of foreground squares for index i , s_i = scaling factor for index i

Solution:

$$w = (XX^T)^{-1}Xy$$

where $w = [b, D]$

and $X = \{x_i; i = 1 \text{ to } L-2\}$ where $x_i = [1, \log 1/s_i]^T$

and $y = \{\log n_i; i = 1 \text{ to } L-2\}$

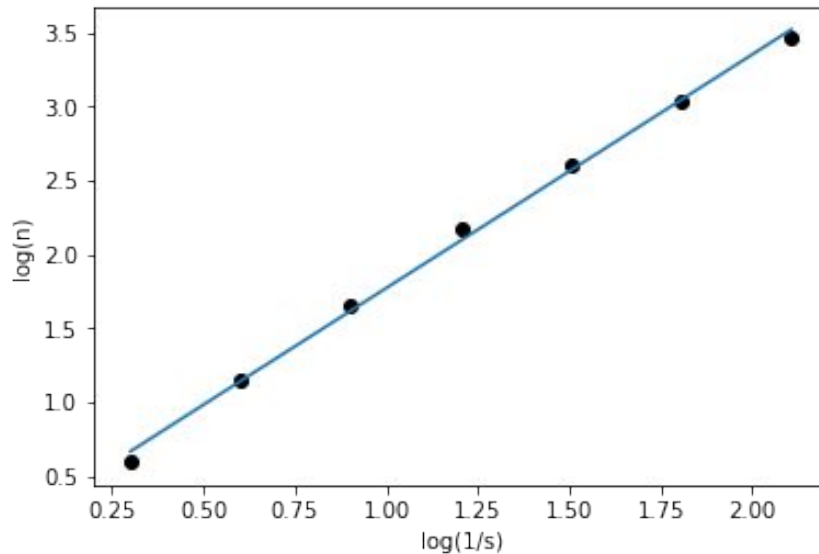
Results of image of lightning

slope $D = 1.5776850270780338$

y-intercept $b = 0.19530464760481436$

Line fitted using:

$y_{\text{predicted}_i} = D \cdot x_i + b$ where $x_i = \log 1/s_i$



Results for image of tree

Count:

i = 1 : 4 / 4

i = 2 : 16 / 16

i = 3 : 61 / 64

i = 4 : 218 / 256

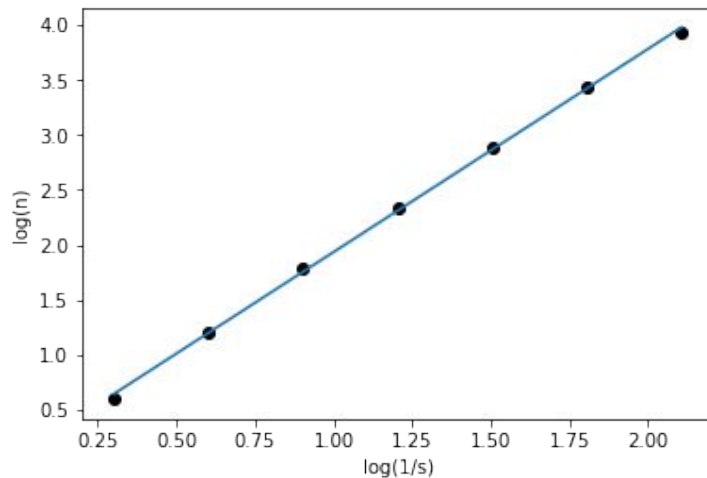
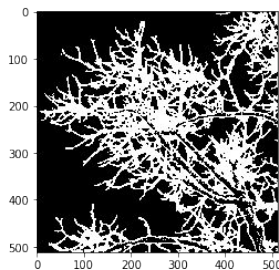
i = 5 : 777 / 1024

i = 6 : 2679 / 4096

i = 7 : 8685 / 16384

slope D = 1.8463900565472438

y-intercept b = 0.08917195967590175



Comparison

Lightning:

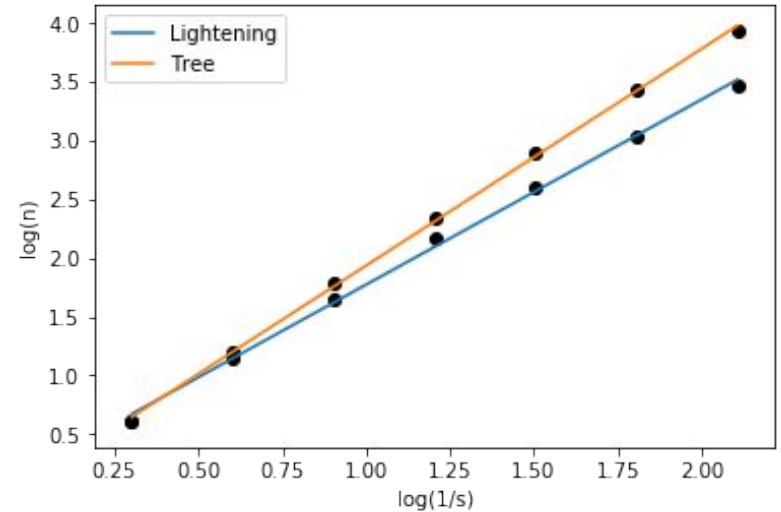
slope $D = 1.5776850270780338$

y-intercept $b = 0.19530464760481436$

Tree:

slope $D = 1.8463900565472438$

y-intercept $b = 0.08917195967590175$



Conclusion



1. Important to handle Missing Values/Outliers as they can skew the statistics.
2. Shape parameter has an influence on the weibull distribution steepness.
3. For value $p=0.5$, it does not define a norm(L_p) and unit circle appears further shrunk
4. Calculated fractal dimension of 2 imperfect fractals using box counting and least squares. The image of tree had a higher fractal dimension.



*Thank
you*

