/the fat cat went in the house\

/the small mouse went in the vent\

/the gnats and the rats were in the couch\

/the mad spouse chased them all out\

```
stringtext =
 "[;the fat cat went in the house;the small mouse went in the vent;The gnats and
   the rats were in the couch;The mad spouse chased them all out]"
```

```
[;the fat cat went in the house;the small mouse went in the vent;The
  gnats and the rats were in the couch;The mad spouse chased them all out]
```

```
Union[Characters[stringtext]] (*Gives a list of all unique characters *)
Length[Union[Characters[stringtext]]] (*Gives a list of all unique characters *)
```

```
{[, ], ;,  , a, c, d, e, f, g, h, i, l, m, n, o, p, r, s, t, T, u, v, w}
```

```
24
```

```
CharReplaceList =
  Table[Union[Characters[stringtext]][[k]] → StringJoin[ToString[k], ","],
   {k, 1, Length[Union[Characters[stringtext]]]}];
textlistform = ToExpression[StringReplace[
    StringJoin["{", StringReplace[stringtext, CharReplaceList], "}"], {",}" → "}"}]];
```

```
textlistform
```

```
{1, 3, 20, 11, 8, 4, 9, 5, 20, 4, 6, 5, 20, 4, 24, 8, 15, 20, 4, 12, 15, 4, 20, 11,
 8, 4, 11, 16, 22, 19, 8, 3, 20, 11, 8, 4, 19, 14, 5, 13, 13, 4, 14, 16, 22, 19, 8,
 4, 24, 8, 15, 20, 4, 12, 15, 4, 20, 11, 8, 4, 23, 8, 15, 20, 3, 21, 11, 8, 4, 10,
 15, 5, 20, 19, 4, 5, 15, 7, 4, 20, 11, 8, 4, 18, 5, 20, 19, 4, 24, 8, 18, 8, 4, 12,
 15, 4, 20, 11, 8, 4, 6, 16, 22, 6, 11, 3, 21, 11, 8, 4, 14, 5, 7, 4, 19, 17, 16,
 22, 19, 8, 4, 6, 11, 5, 19, 8, 7, 4, 20, 11, 8, 14, 4, 5, 13, 13, 4, 16, 22, 20, 2}
```

EigenEntropy

```
M = textlistform;
lengthM = Length[M]
```

```
141
```

```
For[npow = 1, npow < 1000, npow++, If[Length[M] < (2^(npow)), Break[]];
  FilledSize = 2^(npow + 1)];
Filler[vecvar1_] := Table[4, {i, 1, FilledSize - lengthM}]
FilledVec[vecvar2_] := Join[Flatten[vecvar2], Filler[vecvar2]]

Filler[vecvar4_] := Table[4, {i, 1, FilledSize - lengthM}]
FilledVec[vecvar5_] := Join[Flatten[vecvar5], Filler[vecvar5]]
For[npow = 1, npow < 1000, npow++, If[lengthM ≤ (2^npow), Break[]]];
(* gives npow such that  2^npow > lengthM > 2^(npow -1) *)
FilledSize = 2^npow;
FilledM = FilledVec[M];
numrowsW = √Length[FilledM] ;

W = Table[Table[FilledM[[i]],
    {i, (((j - 1) * (numrowsW)) + 1), (j * (numrowsW))}], {j, 1, numrowsW}];

ρ = (W.Transpose[W]); (* ρ as inner product *)
rhoEigens = Sort[DeleteCases[Eigenvalues[ρ] // N, 0.], Greater];
(*DeleteCases Removes 0's from the set of Eigenvalues,
Sort puts the list in order of greatest to least *)
set = rhoEigens / Total[rhoEigens];
(* This is the set of nonzero normalized eigenvalues in order of greatest to least *)
n = Length[set];
H[α_] := 1/(1 - α) Log[2, Sum[(set[[i]])^α, {i, 1, n}]] // N
H0 = Log[n] // N ;(* H0 = Hartley Entropy*)
H1 = -Sum[((set[[i]])) ((Log[2, set[[i]]])), {i, 1, n}] // N; (* H1 = Shannon Entropy*)
H2onward = Table[H[a], {a, 2, 20}] // N ;(* H2 onward *)
RenyiEntropyofEigenvalues = Join[{H0}, {H1}, H2onward];
```

```
Print["The number of nonzero eigenvalues is  =   ", Length[rhoEigens]]
Print[Table[(rhoEigens)[[i]], {i, 1, Length[rhoEigens]}]]
Do[Print["The i-th Eigenvalue " λi, " is = ", (rhoEigens)[[i]]],
 {i, 1, Length[rhoEigens]}]
Print[Graphics[ListPlot[rhoEigens // N, AxesLabel →
    {Style["i", Medium, Bold], Style["λi", Medium, Bold]}, PlotLabel → "Eigenvalue PLOT"]]]
Print[Graphics[ListLogPlot[rhoEigens // N], AxesLabel → {Style["i", Medium, Bold],
    Style["Log[λi]", Medium, Bold]}, PlotLabel → "Eigenvalue Log PLOT"]]
Print["Zooming in on the Log Plot so as to Exclude the first
   eigenvalue gives the following plot:"]

Print[Graphics[
  Show[ListLogPlot[Table[{i, rhoEigens[[i]]}, {i, 2, Length[rhoEigens]}],
    AxesLabel → {Style["i", Medium, Bold], Style["Log[λi]", Medium, Bold]},
    PlotRange → {{10, 2 * rhoEigens[[2]]}}, PlotStyle → Red,
    PlotLabel → Style["Logplot of Eigenvalues, excluding λ1", Red, Bold, 16]]]]

Print[Style["The First normalized eigenvector is:   ", Blue, Italic, 18],
 Style[set[[1]], Blue, Italic, 18]]
Print[Style["The Second normalized eigenvector is:   ", Blue, Italic, 18],
 Style[set[[2]], Blue, Italic, 18]]
Print[Style["The Last (n-th) normalized (nonzero) eigenvector is:   ", Blue, Italic, 18],
 Style[set[[n]], Blue, Italic, 16]]
Do[Print["The α-th Renyi Entropy Hα ->  " Hi-1, " is = ", RenyiEntropyofEigenvalues[[i]]],
 {i, 1, Length[RenyiEntropyofEigenvalues]}]
Print[Graphics[Show[
   ListPlot[RenyiEntropyofEigenvalues, PlotRange → All,
    AxesLabel → {Style["α", Large, Bold], Style["Hα", Large, Bold]}],
   ListLinePlot[RenyiEntropyofEigenvalues, PlotStyle → {Red, Thin}]
  ]]]
Print[Graphics[ListPlot[Table[{i, Log[2, RenyiEntropyofEigenvalues[[i]]]},
    {i, 1, Length[RenyiEntropyofEigenvalues]}],
   AxesLabel → {Style["α", Large, Bold], Style["Log2[Hα]", Large, Bold]},
   PlotLabel → Style["Plot of Log2[Hα]", Black, Bold, 12]]]]
Print[Graphics[ListPlot[Table[{i, Log[2, RenyiEntropyofEigenvalues[[i]]]},
    {i, 2, Length[RenyiEntropyofEigenvalues]}],
   AxesLabel → {Style["α", Large, Bold], Style["Log2[Hα]", Large, Bold]},
   PlotLabel → Style["Logplot of Hα, excluding H1", Black, Bold, 12]]]]
```

```
The number of nonzero eigenvalues is  =   10
```

```
{20736.8, 1566.58, 1019.75, 826.869, 493.153, 453.427, 343.837, 261.287, 222.973, 29.3509}
```

```
The i-th Eigenvalue λ1 is = 20736.8
```

```
The i-th Eigenvalue λ2 is = 1566.58
```

```
The i-th Eigenvalue λ3 is = 1019.75
```

```
The i-th Eigenvalue λ4 is = 826.869
```

```
The i-th Eigenvalue λ5 is = 493.153
```

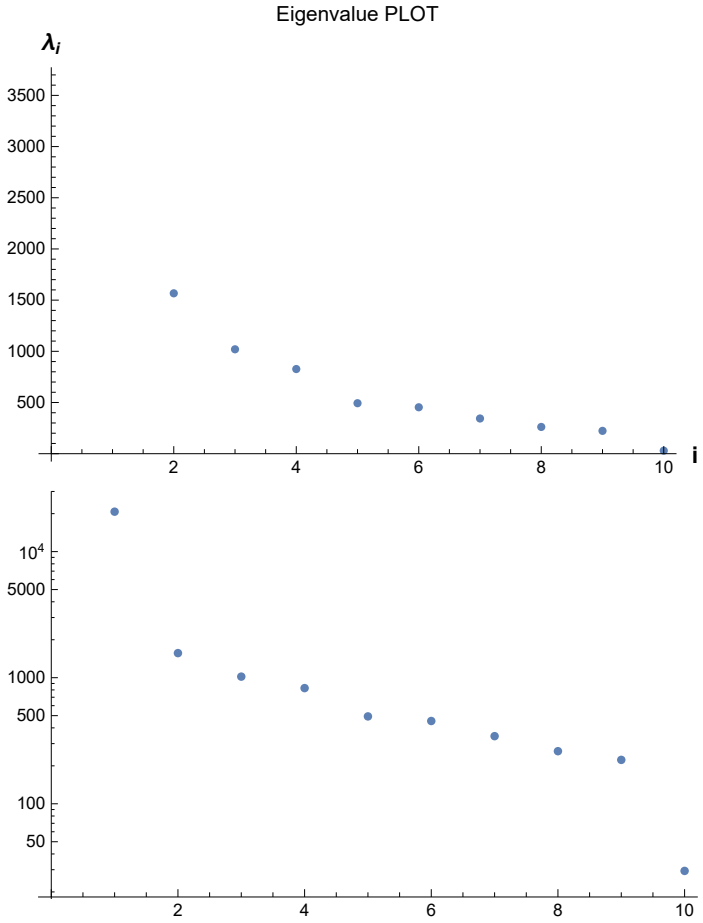
```
The i-th Eigenvalue λ6 is = 453.427
```

```
The i-th Eigenvalue λ7 is = 343.837
```

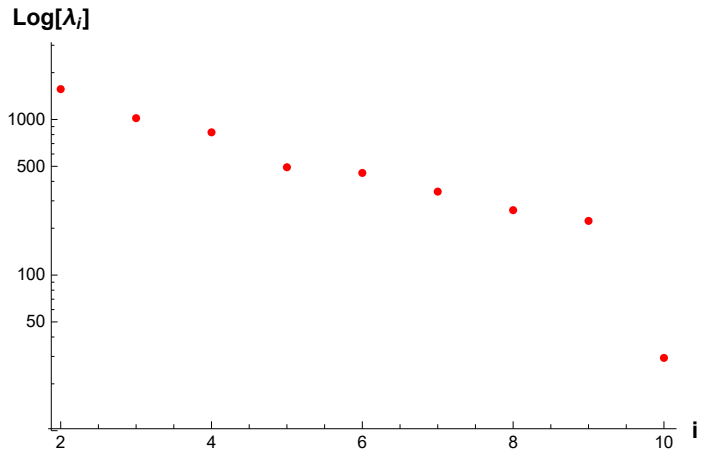
The i-th Eigenvalue λ_8 is = 261.287

The i-th Eigenvalue λ_9 is = 222.973

The i-th Eigenvalue λ_{10} is = 29.3509



Zooming in on the Log Plot so as to Exclude the first eigenvalue gives the following plot:



The First normalized eigenvector is: 0.798981

The Second normalized eigenvector is: 0.06036

The Last (n-th) normalized (nonzero) eigenvector is: 0.00113088

The α-th Renyi Entropy H_α -> H_0 is = 2.30259

The α-th Renyi Entropy H_α -> H_1 is = 1.27515

The α-th Renyi Entropy H_α -> H_2 is = 0.631306

The α-th Renyi Entropy H_α -> H_3 is = 0.485184

The α-th Renyi Entropy H_α -> H_4 is = 0.431668

The α-th Renyi Entropy H_α -> H_5 is = 0.404707

The α-th Renyi Entropy H_α -> H_6 is = 0.388519

The α-th Renyi Entropy H_α -> H_7 is = 0.377727

The α-th Renyi Entropy H_α -> H_8 is = 0.370018

The α-th Renyi Entropy H_α -> H_9 is = 0.364237

The α-th Renyi Entropy H_α -> H_{10} is = 0.35974

The α-th Renyi Entropy H_α -> H_{11} is = 0.356143

The α-th Renyi Entropy H_α -> H_{12} is = 0.353199

The α-th Renyi Entropy H_α -> H_{13} is = 0.350747

The α-th Renyi Entropy H_α -> H_{14} is = 0.348671

The α-th Renyi Entropy H_α -> H_{15} is = 0.346892

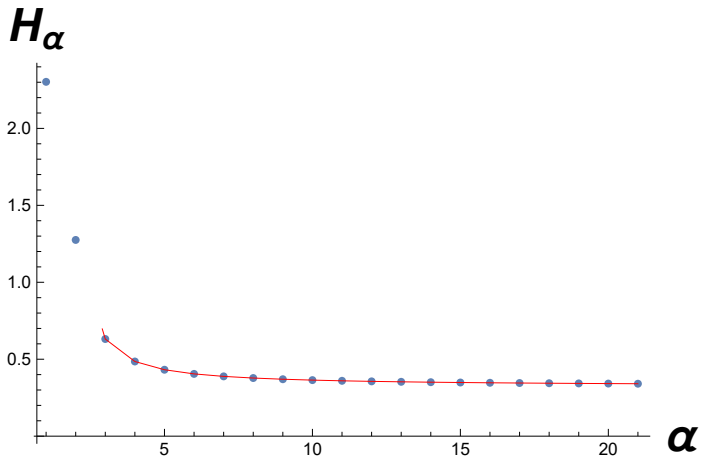
The α-th Renyi Entropy H_α -> H_{16} is = 0.34535

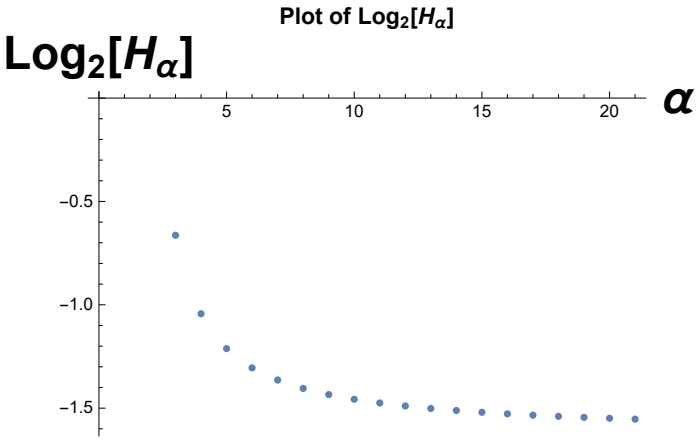
The α-th Renyi Entropy H_α -> H_{17} is = 0.344001

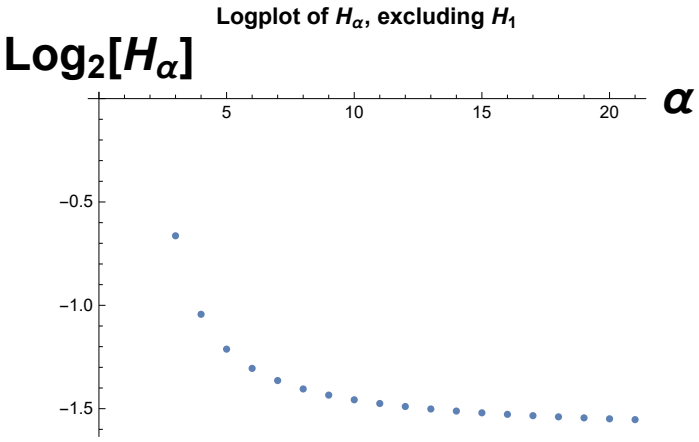
The α-th Renyi Entropy H_α -> H_{18} is = 0.342811

The α-th Renyi Entropy H_α -> H_{19} is = 0.341753

The α-th Renyi Entropy H_α -> H_{20} is = 0.340806




Plot of Log2[Hα]
Log2[Hα]
α
5
10
15
20
−0.5
−1.0
−1.5


Logplot of Hα, excluding H1
Log2[Hα]
α
5
10
15
20
−0.5
−1.0
−1.5