Final

Just pick a W and Run the blue subsection

Constructing W's

To get a letter sequence go to https://www.ncbi.nlm.nih.gov/nuccore/
pick a gene from GenBank
go to FASTA
Copy + paste letter seq into data subsubsection

```
StringReplace[ToString[{StringReplace["ACGTAGTCAATT",
    {"A" → "0,", "C" → "1,", "G" → "2,", "T" → "3,"}]}], ",}" → "}"]
```

```
{0,1,2,3,0,2,3,1,0,0,3,3}
```

```
ToString["ACGTAGTCAATT"]
ToString[ACGTAGTCAATT]
ACGTAGTCAATT // ToString
StringQ[ACGTAGTCAATT // ToString]
StringQ[ACGTAGTCAATT]
```

```
ACGTAGTCAATT
```

```
ACGTAGTCAATT
```

```
ACGTAGTCAATT
```

```
True
```

```
False
```

```
sample = "ACGTAGTCAATT" // ToString;
StringReplace[ToString[{StringReplace[ToString[sample],
    {"A" → "0,", "C" → "1,", "G" → "2,", "T" → "3,"}]}], ",}" → "}"]
```

```
{0,1,2,3,0,2,3,1,0,0,3,3}
```

```
lettersample = {ACGTAGTCAATT} // ToString;
```

```
LetterDNAtoNum[Sample_] := ToExpression[StringReplace[ToString[
    {StringReplace[StringReplace[ToString[{Sample}], {"," → "", " " → "", "{" → "",
        "}" → "", "(" → "", ")" → "", "[" → "", "]" → "", ";" → "", ":" → "", "_" → "",
        "+" → "", "&" → "", "/" → "", "." → "", "RowBox" → "", "Null" → ""}],
      {"0" → "0,", "1" → "1,", "2" → "2,", "3" → "3,", "A" → "0,", "C" → "1,",
       "G" → "2,", "T" → "3,", "a" → "0,", "c" → "1,", "g" → "2,", "t" → "3,"}]}
   ],
   ",}" →
    "}"]]
```

```
LetterDNAtoNum[lettersample]
```

```
{{0, 1, 2, 3, 0, 2, 3, 1, 0, 0, 3, 3}}
```

```
numgenesample = LetterDNAtoNum[lettersample];
```

```
Flatten[numgenesample][[3]]
```

```
2
```

```
lettersample = {ACGTAGTCAATT} // ToString;
LetterDNAtoNum[Sample_] := ToExpression[StringReplace[ToString[
    {StringReplace[StringReplace[ToString[{Sample}], {"," → "", " " → "", "{" → "",
        "}" → "", "(" → "", ")" → "", "[" → "", "]" → "", ";" → "", ":" → "", "_" → "",
        "+" → "", "&" → "", "/" → "", "." → "", "RowBox" → "", "Null" → ""}],
      {"0" → "0,", "1" → "1,", "2" → "2,", "3" → "3,", "A" → "0,", "C" → "1,",
       "G" → "2,", "T" → "3,", "a" → "0,", "c" → "1,", "g" → "2,", "t" → "3,"}]}
   ], ",}" → "}"]]
numgenesample = LetterDNAtoNum[lettersample];
Flatten[numgenesample]
```

```
{0, 1, 2, 3, 0, 2, 3, 1, 0, 0, 3, 3}
```

```
basepairs = ToString[Input["Paste the base pair sequence (ex: AAGCTATGG) here"]];
```

```
Wgenesample = StringJoin[ToString[Input["What Gene is this?"]], " gene"]
(*Lets us know which gene we're dealing with,
used in pdf coding later, so be sure to name it *)
```

```
BRCA2 mRNA Wolf gene
```

```
lettersample = {ACGTAGTCAATT} // ToString;
```

```
LetterDNAtoNum[Sample_] := ToExpression[StringReplace[ToString[
    {StringReplace[StringReplace[ToString[{Sample}], {"," → "", " " → "", "{" → "",
        "}" → "", "(" → "", ")" → "", "[" → "", "]" → "", ";" → "", ":" → "", "_" → "",
        "+" → "", "&" → "", "/" → "", "." → "", "RowBox" → "", "Null" → ""}],
      {"0" → "0,", "1" → "1,", "2" → "2,", "3" → "3,", "A" → "0,", "C" → "1,",
       "G" → "2,", "T" → "3,", "a" → "0,", "c" → "1,", "g" → "2,", "t" → "3,"}]}
   ], ",}" → "}"]]
numgenesample = LetterDNAtoNum[lettersample];
Export[StringReplace["GENE_genesample.txt", "GENE_gene" → Wgenesample],
 Flatten[numgenesample]]
```

```
wolf genesample.txt
```

Test of method of Construction of W

H1Avec =

```
{{3, 0, 2, 2, 1, 3, 2, 1, 2, 3, 3, 2, 2, 2, 2, 1, 1, 3, 3, 3, 3, 3, 3, 3, 1, 2, 1, 0, 3, 1, 1, 3, 2,
  1, 3, 3, 1, 2, 3, 1, 0, 2, 2, 3, 3, 3, 0, 3, 0, 1, 1, 0, 1, 3, 3, 3, 0, 3, 3, 3, 2, 2, 3, 2, 3,
  2, 1, 3, 2, 3, 2, 3, 3, 0, 2, 3, 1, 0, 1, 1, 0, 3, 2, 3, 1, 3, 2, 0, 0, 0, 1, 0, 2, 3, 2, 1, 1,
  3, 1, 1, 1, 2, 1, 1, 1, 1, 1, 2, 1, 1, 2, 1, 3, 3, 1, 3, 2, 1, 3, 2, 1, 3, 1, 1, 3, 2, 0,
  2, 0, 0, 0, 1, 1, 3, 3, 3, 0, 2, 1, 3, 2, 2, 1, 0, 0, 2, 0, 0, 2, 2, 1, 0, 0, 0, 2, 0, 0,
  0, 1, 1, 3, 2, 1, 3, 0, 0, 2, 2, 1, 3, 2, 1, 0, 2, 1, 0, 2, 1, 1, 3, 1, 1, 0, 0, 2, 0, 0,
  0, 0, 0, 0, 1, 1, 1, 2, 1, 3, 2, 2, 1, 1, 1, 3, 3, 1, 1, 2, 3, 2, 3, 1, 0, 2, 0, 2, 1, 3,
  2, 0, 3, 1, 2, 3, 2, 1, 0, 2, 2, 1, 3, 2, 1, 3, 3, 1, 1, 3, 1, 1, 3, 1, 3, 0, 0, 2, 2, 0,
  2, 1, 2, 3, 2, 2, 3, 2, 2, 3, 2, 3, 2, 3, 1, 2, 3, 3, 2, 2, 1, 0, 2, 1, 3, 1, 3, 3, 0, 0,
  0, 0, 0, 2, 2, 1, 2, 1, 3, 2, 2, 1, 2, 2, 1, 1, 2, 1, 0, 2, 2, 1, 3, 0, 1, 2, 0, 1, 2, 3,
  2, 2, 0, 2, 0, 0, 2, 0, 0, 1, 0, 0, 1, 0, 2, 1, 1, 2, 1, 0, 3, 3, 0, 0, 2, 1, 3, 2, 2, 2,
  1, 0, 3, 3, 0, 0, 2, 0, 2, 1, 1, 3, 2, 2, 3, 0, 0, 2, 1, 0, 0, 2, 2, 2, 0, 0, 1, 2, 3, 3,
  2, 2, 3, 2, 1, 0, 2, 0, 1, 0, 0, 0, 2, 2, 2, 3, 0, 1, 1, 2, 2, 0, 2, 1, 1, 3, 1, 2, 2, 2,
  3, 3, 1, 1, 3, 3, 1, 0, 0, 2, 1, 3, 1, 0, 0, 1, 0, 0, 2, 0, 0, 2, 2, 1, 2, 3, 1, 1, 3, 1,
  1, 2, 3, 2, 2, 0, 0, 0, 1, 1, 0, 0, 2, 1, 1, 1, 2, 2, 1, 2, 1, 1, 3, 1, 0, 0, 0, 2, 2, 3,
  2, 2, 1, 3, 0, 1, 0, 0, 0, 0, 0, 1, 3, 0, 0, 2, 2, 1, 0, 0, 1, 2, 2, 2, 3, 2, 1, 0, 3, 1,
  3, 0, 0, 0, 0, 0, 2, 1, 3, 1, 0, 0, 0, 0, 0, 2, 2, 1, 1, 0, 1, 2, 2, 2, 2, 2, 1, 3, 0, 2,
  1, 0, 0, 0, 0, 0, 2, 0, 2, 1, 2, 3, 1, 0, 0, 2, 0, 1, 3, 1, 1, 2, 0, 0, 0, 0, 0, 2, 2, 1,
  3, 0, 0, 0, 0, 0, 2, 1, 1, 3, 2, 1, 2, 2, 1, 0, 0, 1, 0, 0, 2, 2, 0, 0, 0, 3, 1, 1, 3, 1,
  1, 0, 0, 2, 0, 0, 3, 1, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0, 0, 0, 1, 3, 2, 3, 0, 0, 0,
  2, 1, 1, 1, 0, 0, 2, 0, 0, 0, 2, 3, 0, 2, 1, 3, 0, 0, 0, 0, 2, 1, 1, 1, 3, 2, 1, 3, 0,
  0, 0, 2, 1, 3, 0, 0, 2, 2, 1, 3, 2, 3, 0, 0, 0, 0, 1, 1, 1, 0, 0, 2, 2, 1, 2, 2, 1, 1,
  0, 0, 2, 2, 1, 3, 0, 2, 2, 2, 3, 2, 0, 1, 2, 0, 0, 2, 1, 1, 0, 0, 0, 2, 0, 1, 3, 2, 1,
  1, 0, 0, 0, 1, 1, 1, 0, 0, 2, 0, 0, 0, 2, 1, 2, 2, 1, 0, 1, 1, 1, 0, 0, 2, 0, 0, 0, 0,
  0, 2, 3, 0, 0, 0, 3, 3, 1, 0, 2, 3, 3, 0, 2, 0, 0, 2, 3, 3, 3, 1, 3, 3, 1, 3, 0, 2, 3,
  0, 0, 1, 1, 1, 0, 0, 1, 2, 2, 1, 3, 1, 3, 3, 3, 3, 0, 0, 2, 0, 2, 1, 1, 0, 1, 1, 3, 0}};
```

```
H1AW =
  {{3, 0, 2, 2, 1, 3, 2, 1, 2, 3, 3, 2, 2, 2, 2, 1, 1, 3, 3, 3, 3, 3, 3, 3, 1, 2, 1, 0, 3, 1, 1, 3},
   {2, 1, 3, 3, 1, 2, 3, 1, 0, 2, 2, 3, 3, 3, 0, 3, 0, 1, 1, 0, 1, 3, 3, 3, 0, 3, 3, 3, 2, 2, 3, 2},
   {3, 2, 1, 3, 2, 3, 2, 3, 3, 0, 2, 3, 1, 0, 1, 1, 0, 3, 2, 3, 1, 3, 2, 0, 0, 0, 1, 0, 2, 3, 2, 1},
   {1, 3, 1, 1, 1, 2, 1, 1, 1, 1, 1, 2, 1, 1, 2, 1, 3, 3, 1, 3, 2, 1, 3, 2, 1, 3, 1, 1, 3, 2, 0, 2},
   {0, 0, 0, 1, 1, 3, 3, 3, 0, 2, 1, 3, 2, 2, 1, 0, 0, 2, 0, 0, 2, 2, 1, 0, 0, 0, 2, 0, 0, 0, 1, 1},
   {3, 2, 1, 3, 0, 0, 2, 2, 1, 3, 2, 1, 0, 2, 1, 0, 2, 1, 1, 3, 1, 1, 0, 0, 2, 0, 0, 0, 0, 0, 0, 1},
   {1, 1, 2, 1, 3, 2, 2, 1, 1, 1, 3, 3, 1, 1, 2, 3, 2, 3, 1, 0, 2, 0, 2, 1, 3, 2, 0, 3, 1, 2, 3, 2},
   {1, 0, 2, 2, 1, 3, 2, 1, 3, 3, 1, 1, 3, 1, 1, 3, 1, 3, 0, 0, 2, 2, 0, 2, 1, 2, 3, 2, 2, 3, 2, 2},
   {3, 2, 3, 2, 3, 1, 2, 3, 3, 2, 2, 1, 0, 2, 1, 3, 1, 3, 3, 0, 0, 0, 0, 0, 2, 2, 1, 2, 1, 3, 2, 2},
   {1, 2, 2, 1, 1, 2, 1, 0, 2, 2, 1, 3, 0, 1, 2, 0, 1, 2, 3, 2, 2, 0, 2, 0, 0, 2, 0, 0, 1, 0, 0, 1},
   {0, 2, 1, 1, 2, 1, 0, 3, 3, 0, 0, 2, 1, 3, 2, 2, 2, 1, 0, 3, 3, 0, 0, 2, 0, 2, 1, 1, 3, 2, 2, 3},
   {0, 0, 2, 1, 0, 0, 2, 2, 2, 0, 0, 1, 2, 3, 3, 2, 2, 3, 2, 1, 0, 2, 0, 1, 0, 0, 0, 2, 2, 2, 3, 0},
   {1, 1, 2, 2, 0, 2, 1, 1, 3, 1, 2, 2, 2, 3, 3, 1, 1, 3, 3, 1, 0, 0, 2, 1, 3, 1, 0, 0, 1, 0, 0, 2},
   {0, 0, 2, 2, 1, 2, 3, 1, 1, 3, 1, 1, 2, 3, 2, 2, 0, 0, 0, 1, 1, 0, 0, 2, 1, 1, 1, 2, 2, 1, 2, 1},
   {1, 3, 1, 0, 0, 0, 2, 2, 3, 2, 2, 1, 3, 0, 1, 0, 0, 0, 0, 0, 1, 3, 0, 0, 2, 2, 1, 0, 0, 1, 2, 2},
   {2, 3, 2, 1, 0, 3, 1, 3, 0, 0, 0, 0, 0, 2, 1, 3, 1, 0, 0, 0, 0, 0, 2, 2, 1, 1, 0, 1, 2, 2, 2, 2},
   {2, 1, 3, 0, 2, 1, 0, 0, 0, 0, 0, 2, 0, 2, 1, 2, 3, 1, 0, 0, 2, 0, 1, 3, 1, 1, 2, 0, 0, 0, 0, 0},
   {2, 2, 1, 3, 0, 0, 0, 0, 0, 2, 1, 1, 3, 2, 1, 2, 2, 1, 0, 0, 1, 0, 0, 2, 2, 0, 0, 0, 3, 1, 1, 3},
   {1, 1, 0, 0, 2, 0, 0, 3, 1, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0, 0, 0, 1, 3, 2, 3, 0, 0, 0, 2},
   {1, 1, 1, 0, 0, 2, 0, 0, 0, 2, 3, 0, 2, 1, 3, 0, 0, 0, 0, 2, 1, 1, 1, 3, 2, 1, 3, 0, 0, 0, 2, 1},
   {3, 0, 0, 2, 2, 1, 3, 2, 3, 0, 0, 0, 0, 1, 1, 1, 0, 0, 2, 2, 1, 2, 2, 1, 1, 0, 0, 2, 2, 1, 3, 0},
   {2, 2, 2, 3, 2, 0, 1, 2, 0, 0, 2, 1, 1, 0, 0, 0, 2, 0, 1, 3, 2, 1, 1, 0, 0, 0, 1, 1, 1, 0, 0, 2},
   {0, 0, 0, 2, 1, 2, 2, 1, 0, 1, 1, 1, 0, 0, 2, 0, 0, 0, 0, 0, 2, 3, 0, 0, 0, 3, 3, 1, 0, 2, 3, 3},
   {0, 2, 0, 0, 2, 3, 3, 3, 1, 3, 3, 1, 3, 0, 2, 3, 0, 0, 1, 1, 1, 0, 0, 1, 2, 2, 1, 3, 1, 3, 3, 3},
   {3, 0, 0, 2, 0, 2, 1, 1, 0, 1, 1, 3, 0, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4},
   {4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4},
   {4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4},
   {4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4},
   {4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4},
   {4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4},
   {4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4},
   {4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4}};

numgenesample = H1Avec;

M = numgenesample;
lengthvec[M_] := Length[M[[1, All]]]
For[npow = 1, npow < 1000, npow++, If[lengthvec[M] < (2^(npow)), Break[]];
  FilledSize = 2^(npow + 1)];
Filler[M_] := Table[4, {i, 1, FilledSize - lengthvec[M]}]
FilledVec[M_] := Join[Flatten[M], Filler[M]]
lengthvec[M_] := Length[M[[1, All]]]
Filler[M_] := Table[4, {i, 1, FilledSize - lengthvec[M]}]
FilledVec[M_] := Join[Flatten[M], Filler[M]]
For[npow = 1, npow < 1000, npow++, If[lengthvec[M] ≤ (2^npow), Break[]]];
(* gives npow such that  2^npow > lengthvec[M] > 2^(npow -1) *)
FilledSize = 2^npow;
FilledM = FilledVec[M];
```

```
npow
Length[FilledM] (*Should be an (even) power of 2*)
numrowsW = √Length[FilledM]
```

```
10
```

```
1024
```

```
32
```

```
(*Table[FilledM[[i]],{i,1,numrowsW}]
 Table[FilledM[[i]],{i,33,2*(numrowsW)}]
 Table[FilledM[[i]],{i,(2*(numrowsW))+1,3*(numrowsW)}]*)
```

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

```
Print["so this construction is valid if and only if the following:   ",
 H1AW - testWW // Union // Flatten // Union ,
 "   is exactly {0}, if not something is wrong"]
```

```
so this construction is valid if and only if the following:
 {0}   is exactly {0}, if not something is wrong
```

W for Wolf BRCA2 mRNA

Data

Source: GenBank: AB043895.5

```
(*lettersample={}//ToString;*)
```

```
lettersample = {AAAGAAGGTCGGCGGAGGCGGAGGCGGAGCTGCTGGGGCTTGGCGCTCTGGAAGTCGTCCCAGCCGCGGG ×
TCGCCGAGGAAAGGAGCCTGCGGGTCAGCTTTCTGGCCGAAGTGCCGGCGCGAATTTGTTAGCCGTCTCC ×
GGCCAAAAAGAGCGGCACCTCGGAAGGCGAGTTATTTACCAAGCACTGGAGTAATATTGTAGATAAAAAT ×
GCCTGTTGGATGCAAAGAGAGGCCAACATTTTTTGAAATTTTTAAGACGCGGTGCAATCAAGCAGATTTA ×
GGACCAATAAGCCTTAATTGGTTTGAAGAACTTTCTTTAGAAGCTCCACCCTATAATTCTGAACCCACAG ×
AAGAATCTGGTTATAAAATCAGCTATGAACCAAACCTATTTAAAACACCACAAAGGAAACCTTATAATCA ×
GTTGGCTTCAACTCCAATAGTATTCAGAGAGCCAATATACCAACAATCTCCTTTAAAAGAATTAGATAAA ×
TACAGATTAGATTCAGGAAAGGATATTACCGATAGTAAACATAAAAGTTGTTGCACAATGAAGTCTAAAA ×
TGGATCGAGCAAATGATGTTACCAGCCCACCTCTAAATTCTTATCTTAGTGAAAGTCCTGTTCTACGATG ×
TACACATGTAACACCACAGAGAGAAAAGTCGGTGGTATGTGGAAGCTTATTTCATACACCGAAGCTTATG ×
AAGGGTCAGACACCAAAACGCATTTCTGAAAGTCTAGGAGCTGAGGTGGATTCTGATATGTCTTGGTCAA ×
GTTCTTTAGCCACACCACCAACCCTTAGTTCTACTGTGCTAATAGTCAGAGATGAAGAAGTATCTGCAGC ×
TGTATTTCCTAATGACACTACTGCTATTTTTAAAAGCTGTTTTTCTAACCATGATGAAAGTCTGAAGAAA ×
AATGATCGGTTTATCCCTTGTGGTCCAGGCAAAGAAAACAAAAATCAAAGGGAAGCTAAAAGTCAAAGTT ×
TGGGGAATTCATTTGGTAAAGTAAATAGCACCAAAGACCATTTTGTAAAGTCTACACCAAATGTCCTAGA ×
GGATGAAGTACATGAAAAAGTTCTAGATGTTTCTGAAGAAGAAGATAGTTTTTCATTATGTGTTCCTAAA ×
TATAAAACAAGAAATCTACAAAAAATAAAAACTAGCAAAACTAGGAAAAATATTTTTAATGAGACAAAAA ×
CCAGTGAATGTGAAGAAGCTAAAAAGCAAATGAAAGAAAATAAACATTCATTGGTATCTGAAATGGAACC ×
AAATGACAGTCATCCATTAGATTGGAATGTAACACATGAGAAGCCCTTTGGGAATGGAACTGACAAAATC ×
TCCAAGGAAATTGTACTGTCTTCAGCCTCTGGATGTTCTGACCTAACCCTCTCAAGTCTAAATGGAGCTC ×
```

AGATGGAGAAAACACCTCTATTGCATACTTCTTATGACCAAAATAATTCAGAAAAAGACCTCATAATCAC ×
AGATAAAGAATGCACCAACTTCATTACTTTGGAAAATTCTTGGCCACAGATTTCAAATGTACCAAAGTAT ×
TCAGAGAAGACGTTAAATGAGGAAATAGTAGTAAATAAGATAAACGAAGGGCAGTGTCTTGAATCTCATG ×
AAGATTCCGTTGTTTCGGTAAAGCAAGCAATATATGAAACTACTTTAATAGCTTCTCCACTTCAGGGTAT ×
CAGAAAGTCTATATTCAGGATAAGAGAATCACCTGAAGGGATGTCCAATGCAATGTTCTCAAATAATATG ×
ACTAATCCAAACTTTAAAGAACCTGAAGCCTCTGAAAGTGGATTGGAAAAACATACTATTTGCTCTCAGA ×
AAGAGGATTCTTTATGTACAAGTTCAATTGATGATGGAAGCTGGCCAGCAACTATCAAACATACTTCTGT ×
AGCTTTGAAGAATTTAGGTTTAATATCTAGTTTGAAAAAGAAAACAAAAAAGTTTATTTACGTTATAAAT ×
GATGAAACATCTAATCAAGGCCTGAAAACACAGAAAGACCAAGAGTCAAGACTAATTAACCTTTCGACCC ×
AATTTGAAGCAAATGCTTTTGAAGGACCCCTGACATTTACAAATGCTGATTCAGGTTTATTGCATTCTTC ×
TTCCATCAAAAAAAACTGTTTACAGAATGACTCAGAAAAACCAGCTTTGTCTTTAACCAGCTCTTTTGGG ×
ACAATTCTGAGAAAAGTTTCCAGTAATGGAGCCAGTTCTCCTAATAATAAAATAATATCTCAGGATCCTG ×
ATTATAAAGAAGCAAAAATTAATAAGAAAAAATTGGAGTCATTTATAACCACAGAAACTGATTGTCTGTC ×
ATCCCTGCAGGAAAAACATTGGGAAGATGATGCAAAAAAACAAAGAGTTTCAGATATAAAAGAAAAAGTC ×
TTGCCTACAGTAAGTCACCCTCCTGTGCCACATTCAGAAGTGGAAGGTAGTGATATTCACTTTCAGTCTC ×
CAGAAAGCTTTTCATTTGACTGTGATAATACCAGTCTGTTAACTCCTAGCTCTAGGGATTCTCCATCAAG ×
CCTAGTTGTGATGTCTAGAGGAAAAGAATCATATAAAATATCAGAGAAACTAAAATGTAAGAATCATGAA ×
ACTGGTTTTGAATTAACCAAAAATATTCCCATGGAAAAGAATCAAGACATACATGTTTTAAATGCAGATT ×
CTAAAAATGCTAAACTGTTGTCAACTGAAAAACATATAACAGTAGCATCATCTTCAGTAAAGGTTCAGTT ×
CAACCAAAATGCAAATCTCACCACAATCCAAAAAGACCAAAAAGAAACTACTTTAATTTCAAAAATAACT ×
GTTAATCCAAACTCTGAAGAACTTTTCCCAGATGATGAAAATAATTTTGTCTTAAAGATAACTAATGAAA ×
GTAATACTCCTGTTTTAGGAAATACTAAGGAACTACATGATTCAAACCTCTGTTGTGTAAGAGATTCTGT ×
TCCTAAGAACTCTACCATGGTAGTATGTACAGACCTGGATGACAAACAAACAGCCAAAGTGTCGATTATG ×
AAAGATTGTTATTCATCAAGCATAGATGATCTTACAGAAAGGAACAGAAGTACCATAAAGCAACAACTAA ×
AAATGACTCTAGATCAAGATTCAAAATCAGACATTACCTCAGATATAGTTAGGAAATCAAATGGAAACAG ×
TGATTATATGGATAATTGGGCAAGACTGTCTGATCCAATTTCAAATCACAGTTTTGAAAATGGCTTCAAA ×
ACAGCTTCTAATAAAGAGATAAAACTCTCTGAAAACAACATTAGGAAAAGTAAAATGCTTTTCAAAGATA ×
TTGAGGAACATTATCCTACTAACTTAGCATGTCTTGAAATTGTAAATACTTCATCATTAGAAAGTCAAAA ×
GAAACCAAGCAAATCTCATGCACTTGATCCACAGTCAATTAATATCATATCTGGGTTTGTGCAGAATAGC ×
ACATATGTTTCTGATAGTGAAAGTGGTCACACAGCTCCTCCAACTTTATCTTTAAAGCAAGATTTTGATT ×
CAAATCGTAATTTAACTCCTAGTCAAAAGGCAGAAATTACAGAACTTTCTACTATTTTGGAAGAATCAGG ×
AAGCCAGTTTGAATTTACACAGTTTAGAAAACCAAGCCACATAATACAGAAAAATCCATTTGAAATGCCT ×
GAAAACCAGCTGACTATCTTGAATAGCACTTCTAAGGAATGGAAAGATGATGATCTTCATCTCACAACTA ×
ATGCTCCATCTATCAGTCAGGTAGATAGCAAGAAATCTGAAGGTATAATTGGAGGTAAGCAGAAGTTTGC ×
TTGCTTGTCAAGAACCAGCTGTAACAGAAGTGCTTCTGGCTATTCAACAGATAAAAATGAAGTGGAGTTT ×
AGAGGCTTTTATTCTGCTCGTGGCACAAAACTGAATGTTGGTAGTGAAGCATTGCAAAAAGCTAAGAAAC ×
TGTTCAGTGACCTTGAGAATATCAATGAGGAAACTTCTGTAGAAGTAGATAGAAGTTTCTCCTCAAGCAA ×
ATACAATGATTCTGTCTCAATGATTCAGATAGAAGATTGTAATGATAAAAATTTAAATGAGAAAAATAAT ×
AAATGCCGGCTAATACTACAAAATAATATTGAAATGACTACTGACATTTTTGTTGAAGAATATACTGAAA ×
GTTACAGGAGAAATACAGAAAATGAAGGTAACCAATGTACTGACGCTGGTAGAAATACTTGTAACTCAGA ×
ATCTGATGGCAGTGATTCAAGTAAAAATGATACAGTTTATATTCATGAAGAAGAAAATGGCTTGCCCTGT ×
ATTGATCAGCACAACATAGATCTGAAATTATTTAGCCAGTTTATGAAGGAGGGGAACACTCAAATTAAAG ×
AAGGTTTGTCAGATTTAACCTGTTTGGAAGTTATGAAAGCTGAAGAAACATCTCATGTTACTATGTCAAA ×
TAAACAGCAGTTAACAGCTAATACGGGGCAAAACATAAAAGATTTTGACACTTTTTATTTATCCTTTCAG ×
ACTGCAAGCAGAAAAAATATAAGGGTCTCCAAAGAGTCATTAAATAAAGCTAGAAGTCTCCTTAATCAAA ×
AATGGACAGAAGAAGAATTAAATAACTTTTCAGATTCCTTGAATTCTGAATTACTTCCTGGCATAGATAT ×
CAAGAAAACAGACATCTCAAATCATGAGGTAATAGAAAATACTGAAAGAAAAGACAAAATAACGAAAGAA ×
AGTGACCTAATTGGTACTGAAAATATATTACTGATCCTGCAGCAAAGACCAGAAAGTAAAATAAAAAAGA ×
TCAAAGAATCTGCTGTGTTGGGTTTTCATACAGCTAGTGGGAAAAAAATAGAAATTACAAAGGAATCTTT ×
GGACAAAGTAAAAAATCTTTTTGAAGAAAAAGAGCAAGATAATAGTGAAATCACTAATTTTAGCCATCGA ×
GGGGCAAAGATGTCCAAGGACAGAGAAGAATGTAAAGATGGGCGTGAATTAGCTTGTGGGACAACTGAAA ×

TAACAACTACCCCAGAGTATGAAGAAACTCACAGTTCTCTAGAGAAGAAAAAACTTGTTTCTAATGAGAT ×
TGCAGCCTTAAGACCCAGGCTCTTAAGTGATAATTTATACAAACAAACTGAAAATCTTAAAATATCAGAT ×
CATGCCTCTCAGAAAGTTGATGTACATGAAAATACAGAAAAAGAAACAGCAAAAAAGCCTACAATGTATA ×
CAAATCAATCCACTTATTCAGCCATTGAAAACTCACCTTTAACATTTTACACAGGACACGGAAGAAAAAT ×
TTCTGTGAGTGAGGCTTCACTATTTGAAGCAAAAAAATGGCTTAGAGAAGGAGAATGGGATGATCAATCA ×
GAAAGAATAAATGCTGCCAAGGTTAACTGCTTAAAAGAATATCCTGATGATTACGTAGAAAATCCTTCAT ×
GTGGAAATAGTTCAAATAGTGCCATAACTGAAAATGACAAAAATCATCTCTCTGAAAAACAAGGCTCAAC ×
TTATTTAAGTAATAGTACCATGTCTAACAGCTATTCATACCATCCTGGCTTTTGTCATTCTAGTGAAGTG ×
TATAATAAATCAGAATATCTTTCAAGAAGTAAAATTGATAATTCTGGTATTGAACCAGTAATAAAGAATA ×
TTAGAGAGAGAAAAAACATTGGTTTTTCTGAAATAATGTCCCCTGGAAGAGAAGCAGACACAGACCCACA ×
AAGTGTAAATGAAGATATTTGTGTTGAGAAACTTGCGACTAACTCTTCATGCAAAAATAAAAATACAGCC ×
ATTAAAGTGGCCATATCTGACTCAAATAATTTTAATACAATTCAAAAGTTGAATTCTGATTCAAATAATT ×
CTGTACCTGCATACAGTACAGTAAATAGTAAAAGAGTCTTTGTTGCACACCAGACAAAAGTGACAGAGGG ×
GTTTACAGACAACTGCAGCATGGTAACTAAACAAAACACCAAGAGTAAATCAGACACTTGCCATGCAGAA ×
ATTGTGGCAGATTATCCTAAGGCACTGGATGATTCAGAGGCTATTTTTCCTAACTCTCTGGGTGCTATAG ×
AATGTTCACCTTCACATAAGGTTTTTGCTGACATTCAAAGTGAACAAACTTCACAACTTAACCAAAGTAT ×
GTCTGGATTGGAGAAAGTTTCTGAAACACCACCTTGTCAGATTAATTCAAAAACTTCTGATAGATGTGAA ×
CTTCCTAGGGGGAAGCTTCCCAAGTCAGTCTCTTACACAAATGCATGTGGGATTTTTAGCACAGCAAGTG ×
GAAAATCTGTACAAGTATCAGATGCTGCAATACAAAAGGCAAGAGAGGTGTTTTCTAAGCTAGAAGATAG ×
TGCCAAGCAACTCTTTCCTGAAGTATCACTTAAAGATAATGAAGAACATTCAGAAAAGTTCACAAATGAA ×
GAAAATACTGTGATATATACCTCCCAAAATTTACTATCATCTGCTTTCTCTGGATTTAGGACAGCAAGTG ×
GGAAACAAGTTCCAGTTTCTGAAAGTGCCTTATGCAAAGTTAAGGGAATGTTAGAAGAATTCAATCTGAT ×
CAGAACTGAAAGTTGTCTTCAGCATTCATCTACTTCTAGACAAGATGTATCAAAAATGCCTCCTCCCTCT ×
TGTATTGGTAAGAGAACCCCAGAACACTCCAGAAACTCCAAATTGGATAAAGCCTGCAATAAAGAATTTA ×
GATTATCAAGTAACTGTAACAATCAGAGTGGTTCTTCAGAAAATCATCACTCTATTAAAGTTTCTCCATG ×
TCCCTCTCAATTGAAGCGAGACAAACCACAGTTGCTAGTCGGAAGCAAAGGATCACTTGTTGAGAACATT ×
CATCCTTTGGGAAAAGAACAAGCTTTACCTAAAAATATAAAAACAGAGATTGGGAAAGCTGAAACTTTTC ×
CTAATCTTCCTGTGAAAACAAATATAGAATTTTGTTCTACTTACTCCAAGGATCCAGAAAACTATTTTGA ×
AACAGAAACCGTAGAGATTGCCAAAGCTTTTATGGAAGATGGTGAGCTGACAGATTCCGAACTGCTAAGT ×
CATGCCAAACACTTTGTTTTTACATGCCAAAACACTAAGGAAATGGTTTTGTTAAATTCAAGAATTGGAA ×
AAAGAAGAGGAGATGCACTTGTCTCAGTTGGAGAACCCCCAATTAAAAGAAACTTGTTAAATGAATTCGA ×
CAGGATAATAAAAAATCAAGAAACATCTTTAAAAGCTTCAAAAAGCACTCCAGACGGCATCCTAAAAGAC ×
AGAAGCTTGTTTATGCATCATATTTCTTTAGAGCCAATTTCCTGTGGACCCTTTCGCACAACTGAGGAAC ×
GGCAAGAAATACAGAATCCAAATTTCACTGCACCTGGTCAAGAATTTTTGCCTAAATCTCATTTTTATGA ×
ACACCTGGCTTCAGAAAAATCTTCAAGTAATTTATCAGTTTCACGGCAACCATTTTGTATGGTTCCTGCC ×
ACAGGAAATGAAAAAAGGAGACACTTGATTGCTCCAGGCAAACCAGTGAAAGTCTTTGTCCCACCTTTTA ×
AAACTAAATCACATTTTCACAGAGATGAGCAGTGCATTAGCAAGAATACTAAATTGGAAAAAAACAAACA ×
AAACTCCAAAGACATAGATGAACTTGGCTCTGGTGATAGTGAAAAAAATATTAATGACAGTGGAATCCAT ×
CAGCTTAAGAAAAATAACTCCAATCAAGCAGCAACTATAATATTCACAAAGAATGAAAAAGAACCTTTAG ×
ATTTAATTACAAATCTTCAGAACGCCAGAGATATACAGGATATGCGGATTAAAAAGAAACAAAGGCAGCA ×
TATTTTTCCACAGCCAGGTAGTCTGTATCTTGCAAAAACCTCCACTTTGCCTAGAATCTCTCTGAGAGAA ×
GCAGTAGAAGGCCGAGTCCCCTCTGCATGTTCTCATAAACAGCTCTATATGTATGGTGTTTCCAAACATT ×
GTGTAAAAATAAACAGCAAAAATGCAGAGTCTTTTCAGTTTCATGCTCAGGATTATTTTGGTAAGGAAGG ×
CCTATGGTCTGGAGAAGGAATACAATTGGCTGATGGTGGATGGCTCATACCCTCCAATGATGGAAAGATT ×
GGAAAAGAAGAATTTTATAGGGCTCTGTGTGACACCCCAGGTGTGGATCCAAATTGTATTTCTAGAGTTT ×
GGGTATATAATCACTATAGATGGATTATATGGAAATTGGCAGCCATGGAATTTGCCTTTCCTAAGGAATT ×
TGCTAATAGGTGTCTAAGTCCAGAAAGAGTGCTTCTTCAACTAAAATACAGATATGATGTGGAAATTGAT ×
AAAAGCAGAAGATCAGCTATAAAGAAGATAATGGAAAGGGATGACACAGCTGCAAAAACACTTGTTCTCT ×
GTATTTCTGAAATCATTTCGTCAAGTGCAGATATATCTGAAACTTCTAGTAGTAAAACTAGTAGTGTGGG ×
TACCAAAAAAGTGGGCATTATTGAGCTCACAGATGGGTGGTATGCTATTAAGGCCCAGTTAGACCCTCCC ×
CTCTTAGCTCTCGTAAAGAACGGGAGATTGACTGTGGGTCAGAAGATCACTATTCATGGAGCAGAACTGG ×

```
TAGGCTCTCCTGATGCCTGCACACCACTTGAAGCCCCAGAATCTCTTATGTTAAAGATTTCTGCTAACAG ×
TACTCGTCCTGCTTGCTGGTATACCAAACTTGGATTCTCTCCTGATCCTAGACCTTTCCCTCTCCCCTTG ×
TCATCACTTTTCAGTGATGGAGGAAATGTTGGTTGTGTTGATGTAGTTGTTCAAAGAGCATACCCAATAC ×
AGTGGATGGAGAGGACCCCATCTGGATTATGCATATTTCGCAATGAAAGAGAGGAAGAAAAGGAAGCAAC ×
AAAATATGCAGAAATCCAACAAAAGAAACTAGAAGTTTTATTCAATAAAATTCAAGCAGAATTTGAAAAG ×
AATGATGAAAATATAACAAAGCAGTGTATACCATCATGTGCATTAACAAGACAGCAGATCTGTGCTCTGC ×
AAGATGGTGCAGAGCTTTATGAAGCAGTGACAAATGCACCAGACCCAAGTGACCTGGAGGGTTATTTTAG ×
TGAAGAGCAGTTAAGAGCCTTGAATAATCACAGACAGATGTTGAATGATAAGAAGCAAGCACAGATCCAG ×
TTAGAATTCAAGAAGGCTATGGAATCTGCTGAGCAAGGAGAACAAATTCTACCAAGGGATGTTACAACTG ×
TGTGGAAGTTACGTATCATAAGCTACAGGAAAAAAGAAAAAGATTCAGTTACATTGAGTATCTGGCGTCC ×
ATCACCAGATTTATATTCCCTGTTAATAGAAGGAAAGAGATACAGAATCTATCATCTTGCAGCATCACAA ×
TCTAAAAGTAAATCTGGAAAAGCCAACACACAGCTAACAGCAACAAAGAAAACTCAGTACCAGCAACTAC ×
CAGCATCAGATGAAATCCTATCCCAAGTTTATCAGCCAAGGGAACCCCTTTACTTCAACAAACTGTTGGA ×
TCCGGACTTCCAACCACCTTGTTCTGAGGTGGACCTAATAGGATTTGTAGTTTCTGTTGTGAAAAAAATA ×
GGTCTTGCTCCTGTGGTCTATTTGTCAGATGAATGCCATAATTTATTGGCAATAAAGTTCTGGACTGATT ×
TTAATGAAGACATTATTAAACCTTACACATTAATTGCTGCAAGCAACCTCCAGTGGCGACCAGAAGCCAA ×
ATCAGGAATTCCTACTTTATTTGCTGGAGATTTTTCCAGGTTTTCTGCCAGTCCAAAGGAGGAGCATTTT ×
CAAGAGACATTCCACAAAATGAAAAATACTGTTGAGAATATTGGTATGTTTTACAATGATGCAGAAAACA ×
AACTTGTGCATATACTTAATGCAAATGATCCCAAGTTGTCCACCCCGACTAAAGACTATGCTTCAGAGCC ×
ACACACAGCTCAAATAGTCCTTGGCATAGGAAATAAATTTCTGATGTCTTCTCCCAATAATGAGATGAAT ×
TATCAGAGTCCTTTATCACTTTGTAAGCCAAAAGAGAAGTCTGTCCCCATACCTGGATCAACCCAAATGA ×
CTTCAAAGTCTTATTGTAAAGAGGAGAAAGAGATGGATGACCCAAAAACCTGCAAAAAGAGAAGAGCCTT ×
GGACTTTTTGAGTAGAGTGCCTTTACCTCCATCTGTCAGTCCCATTTGTACATTTGTTTCTCCAGCTGCA ×
CAGAAGGCATTTCAGCCACCACGGAGTTGCGGCACCAAATATGAAACACTGATGAAGAAAGAGTTGAATT ×
CTCCACAGATGACTCCACGTAAATTTAATGACCTTTCCCTTTTGGAAAGTGATTCAATAGCAGACGAAGA ×
ACTCGCAATGATAAACACCCAAGCCCTTTTGTTGGGTTCACCAGGAGAACATCAACTTGTGTCTGTCAGT ×
GACTCTACCAGGACTGCTCCCACGAGCTCAAAAGATTATCTTGGACTGAAAAGGCATTCTACTGCACCCG ×
GGGTCAGAGGACCCGAGAGCCCCCAGGCCTGCACCAGGAAGCGGGAGCCCCGTGTACAGAACACAAGTGA ×
TCTGAAAAGGACATCTCTGAGACTGCAGAGGCAACAAACACAAAAATGACAATGAATTGGTGACTGACTC ×
AACCTTTCCAATGTGTGGAAAACACAGCCTCAACCTGTATGTCAAGATGTGCATAATGAGACAAGAAAGA ×
CCACATCCCAAATCTCCTGTGTGCTTGTCTATCTTAGGAAACCTGGCCTATCTCTGTACTGGTCGGTGTA ×
CTTTATTTCAGTTATGTGTCTGAAAATTGTGTATTTATTAGCTAATCAGGAAAAAAAATCTCCTTTAAAC ×
TCTTATGATTGGATATGATCAAGTATATTTTACAAAGTAAACACACTTTTTCTTTAAATTGTGTCCCTAA ×
TTAAATGAAAGTAGGTTTCAAAGTACTGTTATTTTGACTCCTGTAGTTCTTTTTAGGTGACTTGGTTTTG ×
TTTTGTTTTTCGGAGGTAACCTACTATGAACCAGTTTTCCTTAATAAACGTGTTGGTTCTCTTATAGTTG ×
TATCCTGATCAAAAGTCAGGAGGAGTAAGGAACAAACAGCAGTGCTCTCTCTGGACCAGTTCTTTAACCT ×
TACGTCAGCATAAGTGCAAGAAAAACAGAATCCTCAATGTGATTCCTTTTTATGATTCTAGTGTGATTGC ×
TGAATTATTTCAATTAAAAATTCAAATGCTTTTAAAAAAAAAAAAAAAAAGAAAAAAAAAA} // ToString;
```

Process

```
SpecialNote = " ";
```

```
Wgenesample = "BRCA2 mRNA Wolf gene"
(*Lets us know which gene we're dealing with,
used in pdf coding later, so be sure to name it *)
```

```
BRCA2 mRNA Wolf gene
```

```
LetterDNAtoNum[Sample_] := ToExpression[StringReplace[ToString[
    {StringReplace[StringReplace[ToString[{Sample}], {"," → "", " " → "", "{" → "",
        "}" → "", "(" → "", ")" → "", "[" → "", "]" → "", ";" → "", ":" → "", "_" → "",
        "+" → "", "&" → "", "/" → "", "." → "", "RowBox" → "", "Null" → ""}],
      {"0" → "0,", "1" → "1,", "2" → "2,", "3" → "3,", "A" → "0,", "C" → "1,",
       "G" → "2,", "T" → "3,", "a" → "0,", "c" → "1,", "g" → "2,", "t" → "3,"}]}
   ], ",}" → "}"]]
numgenesample = LetterDNAtoNum[lettersample];
Export[StringReplace["GENE_genesample.txt", "GENE_gene" → Wgenesample],
 Flatten[numgenesample]]
```

```
BRCA2 mRNA Wolf genesample.txt
```

```
lengthofgeneitself = Length[Flatten[numgenesample]]
 (*To make sure no base pairs are left out *)
```

```
11190
```

Construction of W

Can compare to W constructen in Python file **W_hat_construction.py** if we want

```
lettersample = {basepairs} // ToString;
LetterDNAtoNum[Sample_] := ToExpression[StringReplace[ToString[
    {StringReplace[StringReplace[ToString[{Sample}], {"," → "", " " → "", "{" → "",
        "}" → "", "(" → "", ")" → "", "[" → "", "]" → "", ";" → "", ":" → "", "_" → "",
        "+" → "", "&" → "", "/" → "", "." → "", "RowBox" → "", "Null" → "", "
       " → "", "
" → ""}],
      {"0" → "0,", "1" → "1,", "2" → "2,", "3" → "3,", "A" → "0,", "C" → "1,",
       "G" → "2,", "T" → "3,", "a" → "0,", "c" → "1,", "g" → "2,", "t" → "3,"}]}
   ], ",}" → "}"]]

numgenesample = LetterDNAtoNum[lettersample];
lengthofgeneitself = Length[Flatten[numgenesample]];
M = numgenesample;

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

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

```
(*numgenesample=LetterDNAtoNum[lettersample];
lengthofgeneitself=Length[Flatten[numgenesample]];
M=numgenesample;
lengthvec[M_]:=Length[M[[1,All]]]
  For[npow=1,npow<1000,npow++,If[lengthvec[M]<(2^(npow)),Break[]];
   FilledSize=2^(npow+1)];
Filler[M_]:=Table[4,{i,1,FilledSize-lengthvec[M]}]
   FilledVec[M_]:=Join[Flatten[M],Filler[M]]
    lengthvec[M_]:=Length[M[[1,All]]]
     Filler[M_]:=Table[4,{i,1,FilledSize-lengthvec[M]}]
      FilledVec[M_]:=Join[Flatten[M],Filler[M]]
      For[npow=1,npow<1000,npow++,If[lengthvec[M]≤(2^npow),Break[]]];
(* gives npow such that  2^npow > lengthvec[M] > 2^(npow -1) *)
FilledSize=2^npow;
FilledM=FilledVec[M];
numrowsW=√Length[FilledM] ;*)
```

W for Human isolate NA19240 chromosome 9 genomic scaffold

Is a “genomic scaffold” a single gene?

Data

Source: GenBank: KZ268583.1

In[ ]:=
```
(*lettersample={}//ToString;*)
```

In[ ]:=
```
lettersample = {TCTTAAGCCAGTCTTTTATTTATATTTTGATTCTGTTTTGTGGAGGACATGCTTCCCTGAATTTTAGGAA ×
GAGGCCAAAAGGTTTGTTCAAGTTTTTACCTGATACATTGGATTAAATTATCTAATGTACACACTTTTAA ×
TTTAAGTCTAGGGGCGACTGTCTACTCTTGATTTTGTATAGTATTATTTTTCTTAACATCCAAGTCCATC ×
TTCATCTATTTGTATAAGATCAATAAAAATATATTTGTCCAGAACCCTGCTTTGGCGGAGTTACTTCTTT ×
CTAAGTAGTAGAGGTAGCAGTTGAGACATGAGCTGGGTTCTGGGTCAGTTTAGAGGGCTGGGCGACATTC ×
CTCCTTTTGGTCTGTATGACTGAATGAATGCAGTTCTTGCTGTCTCGCTCCTCTCCTTAACACATTGAGC ×
CATTGCAGCAGATAAGAAGGAATAATCTTGATCTGCCATTCAGGTGGAACACATGTTCTCTCCAACCACA ×
CCCATAGGTTGTACTCACACTCGGCCAGAAGGTATCCTGTCAATGATATGGAGATGTATCTATCTATCTA ×
GATAGATATCTACTTTGGTTTATGCTCTCTGGTTGCCCGCAAATTATCTCCTTAAATTGAATATCAAAAG ×
AGAGCTTGGTGATGGCAGTGTTATAAAATCCTCAAAATGCAGCACCCATACCCAGAGGAATTTGTAGATT ×
CTGAGATTCTAATTCAGATACCAAACTATATAAAAGGGGAATTGGTCATTGAGGGTTGCTAGGCTCTTTG ×
TTGAGCATATATGCTCTTTTCATGACTTCGAAATTATTTTAAAAATCTAAACTTTTTCTCAGTGTGCTGC ×
AAGATGATTTGATTTGAATGCATAAGCAGTAATTCTCCCCTAAGATTTGTACAATATATTTGCTCTGACA ×
AGCGATAGCCAGCAACTCACTTCACAGCAATTTACAGCGTTTCCATGATAAGTTGAATTATTTTTAACTA ×
GACTCTCTTTGCCTTAATAAAAATATGAAGAAGCAATATACTTGTTCTAATTAGGTTCAAAAGTTGGCAG ×
TCTCTCTCCTGGAAAGAATAGTAAAACTTTTCAGCGGCCTAATATGCATGTATAAACACACAAACACACA ×
CACACACACACACACACACACAAGCACTATTCATAATATTTAAAGCACATTCTGTTCTATGACTTCATTT ×
GTCTAGCACAAAATAAAACGATCTCAGTATATGTCAAGTATCAATTTTTTCGTATGGCCAATTATAGATA ×
TTTTATTTTTTAAAGATTAGAGTGTTCTTGAAGCTCTTTATATTTCTTTGTCAATGAACTAAACATTGGC ×
AAATATGTAGGGTTTCCCACATAAGAACATTATTAACATCAAAATAGAAAGCTGGTGGTAGCAATAATGA ×
```

TTGGGAACACAGAGTCTCTACTCAACGTTCTAGTTCTGCCATACCATAACTTTGTGATCTCAGGAAATAT ×
CTCTCCATGTTGTCATCTCAAAGTATAGTTCTGTCATTTTTCAATAAGAGCTTTTTGCTTAATTATGAAG ×
TACTAGTTAGTGTAACCATTATTTTGAGCTTCATGTAAATCAAGAACACATGGACTCCACTTGCAAAACA ×
TCGAAAATGTAGTAGGGATTGGGGGCATAAAGCAACACTTTAAAATGTGTAAAGACAATGAGTAAGCAAC ×
AAAGTGTCCAATTTTTTAGGGGAAAGTTGCATACGTTAGGAAAAGGCAGGATTAAGTAACAGAGAATTTG ×
AATGATAACTGGCCAATTGGTGTCATTTACAATTGCAAGTCATACAAATGAAGTTTTCTGTTTTAAAGAG ×
AAAAGGAGTTATTTAGAATGGGTCAACCTATTGGGGAAGCAATGTAGTTAGAAACAATGCCCAAAACCAT ×
GTAAGCAAATGCTCTGTAGAGCACACCCCTGCAATGCTGCCATTGTGAGGCCAAGTCTCTCCTCGTCTTG ×
GTACTGAGCCCTCCGTTCTGCCTCCATCATTGCCACTGTAGCTGCCACAAAATGACCCCTCAACCACCGC ×
TGCCCAGGAACAAAGAAAGAATTCTGTCCTTCCGCGCTCTCAGATCAATTTCCAACATCAGGTGAGCCTT ×
TGATGGGCACTATTCAGTTCCCTTATCCCTGAAATAGATGCAGTAAAAATATAGAAATTGCCTATGTGTT ×
TCCCAATAAGACACATATGGAAGCCTGTTTTCCCACAACAGGAAGGAGTTTGCACAATGGGTGTTCAAAG ×
GAACAATATTCCCTGTAAACCGTACTTTGCCCATATGAAGAAAAGCAATAAGGATTATTTAGTAAATAGA ×
CATGGAAACTCATCCAGGGTTGGCTGATGAGAAGCTGGTTAGCAAGGGGGTCTGCCTTCAGTTAGGACAA ×
GGTTTGTGCTTCCCACGGGTTCTCTCCACAGCAGGAGGGATGCAAACTTCCCTTTCCTCCCCTGCACCTA ×
CCCTCAAATGGCCCAGAGGTCTTCAGGTGCTAGAATTTCTCAATTAATGCTGCACAAAATATCAGACAGC ×
CTTGACTGTCACAGTCTGTTCTCATGAAGCTAGTCTCTGCTCACTACATAAAACAGGAGAGTAAGAACAA ×
GGGTGTTTAACGCTACCCTAGCTCAAACAAGTTTCTCTCTGTATTATGCCAAGAACCTGGGAACCAGTGC ×
ATCTGCTGCTTTCCCTTCTTGGATTCTAGCCCAGACAAAAGAGGCAAGGGGCATTTCTTCAGAGGCCTTG ×
AGCTTCACTACACAATGACCCAGGCTCTACATGCACCCTCTTTATATATTTCTACCTTGAAAAAAAATTT ×
TTATATAATATTAATAATATATATTTTTATATAATAAACACTTTTTTAATAGATAGATATAGATATACAT ×
AGATAAAGATCTCTAGTCAGCCTTTTTTAAGGCTGGGCTGATCGCAGTGCCTCAAAACTATAATCCCAGC ×
ACTTTGGGAGGCCAAGGTGGCCAGATCTCTTGAGTCCAGGAGTTGGAGATCACCCAGGGCAACATGGTGA ×
AACCCCATCTTCACAAAAATTAGCTAGTATGGTATTATGCACCTGCAGTCCCTGCTACTCAGGAGGCTGA ×
GGTGGGAGAATTGCTTGAGCACAGTATGTGAAGGCTTCAGTGAGCTCTAATCACATGACTGCACTCCATC ×
TTGGGTGACAAAGTGAGACCCTCTCTCAAAAATAAAATAAAATAAAAAGGCTACCACCATACTCACAGAT ×
AAGTGTGTCAGGTATATTTGCAGCTATCCTTCCTATATTCTATTTGGTAAAAAAAAAAAAAAGGCAAAGA ×
ACTCTTCTCATTCTAGATTTTTGTATTAATTAGACATTTGAAGTTTATAGCAGAAGAGCTATAATCACTC ×
TATAGACCAGATAGTGCAAACAGATATCAATGCTTTTTAAAAGTATAGAAGGTTATTAGAAATTTTTTAA ×
ACTACTTATAGGTATATATGTATCTAATTGAACTATCAAATGCAAGTAAGATCATTTCCTTAGCGTGTGA ×
AATCCACTCAATTTATTAAAATATTTTCTAATATCTATTACAATAATATTTCTTAATTAGTTAACAAAAG ×
AGGAGTTTTAAGACATTTGTTTATATGTACTTACTAGATTCAAACTCGATTCCACTATTTTCAGAACTCA ×
TACTCTGAGACAAGTCCTTTTTTTATGTAACTATGTTTCTGCCTATATTAAAAGACAGATATGTCAATTT ×
TGCTAGTCATGCTGTTCCAAAGCTCTCCATCCTGATTATTTTTCGGTTTGTTCTAGCAGTCATTCAGAGA ×
CTTACTTATATTCAAATTTCTCTCTAGGTTTAACATTCGTGTATGTCTTGTTGTGGTTTTGTCTATTTTT ×
GCTGTATATAATTTAAGACATTTTATTGACATACACATGCAGAAAAGTACAATGATTAAATATGATAGCT ×
TGATTAATGAAACACATGTATTTGCTTATAGCCATGTACGAAAATAGAACATTATTAAAAATAGTGATAC ×
CTCTCCTGCCCCTTTCCAAACACTAACCCTCATCCTCAATAGTAACAGATTTTTTTTATCATAATTTGGT ×
CTACTTTCAAATTTTTATTAAATAAATCGGAGTATCTACTCTAAGTCTATGTTTATTTCATTGTTGTTAT ×
TTTACTTGTAGTATTTATCTGCTAATGGACATGGTAGATTGAAGACGGCTACATACACATTTTTTAATTA ×
ATAGATTTTTTGAGCACTTTGTGGCTCATGCCTTTAATCCCATCACTTTGGGAGGCTGAGGTGCGTGGAT ×
CATGAGGTCAGGAGATCCAGACAATCCTGGCTAACGTGGTAAAACCCCTTCTCTACTAAAATACAAAAAA ×
TTAGCTGATAGATAACATCAAGATAACATCTGAGTTCTTAGCTGCACTGAGTCAAGCCTACTTACATCTT ×
TGTCTTCTGCTGCACTTTTCCTTCCACATCACCGTCCAGGAATGCCAAGCTCCGTTGGCCTTCTACCCCA ×
TTTCCACTATTGTTCCCCTGCCACCGCGGCTTTTTGCCGCTACCGCCGCGGGTTTTTTGCCTCCGCTGCT ×
TTTTGCCACCGCCGCCGCGGCTTTTTACCCCCAACGCTGGGGCTTTTTGCGGCTCTTTGACCCACCACCG ×
GGGCTTGTTGCCTCTTTTTGCACCCGCCGCCGTGCCTTTTTGCCCCCGCCGCTGCGGCTTTCTCCCCCGC ×
CTCACGGCTTTCTGCCCCCACCGCTGTGGCTTTTCATCACCACTACCGCGGCTTTTTGCCCCCGCCACTG ×
CGGGTTTCTCCCACCGCGGTTTTTGCCCCCGCCGCCGTGGCTTCTTACCCCCGCCGCCATGGCATTTTGC ×
CCCACGTCACCGTGGCTTTTTGCAGCTTTTTGCCGCTGCGGCTCTTTGCCCCTGAAGCCACGGCTTTTTG ×
CCCTTGGCGCCGTGGCTTTTTGCCCCCGCCGCCGCGGCTTTTTGCGGCTTTTTGCCCCCGCCAATACGGC ×

TTTTTGCCGCTGCGGCTCTTTGCCTCCGAAGCCACGGGTTTTTACCCCCACCGCCACGGGTTTTTGCCCC ×
CGTGGCTTTTTGCTGCCACGGCTTTTTGCCCCCGCCGCCATGGCTTTTTGCTCCTGCCGCTGAGGCTTTT ×
TGCCGCCGCAGTTTTTGCCCCCGCCGCCGCTGCTTTTTGTGGCTTTTTGCCCCCGCAGCTTTCCCCCCCC ×
GTCGCCGCGGGTTTTTGTGGGTTTTTTGCACCCGCTCCCGCTGCTTTTTGCCCCGCCACTACGGCTTTTT ×
GCCGCCTTGGTTTTTTGCCCCCGAAGCCACAGCTTTTTGCCCTCGCCGCCGCGGCTTTTTGTGGCATTTT ×
ACTCTCAGCCACGGTGGCTTTTTGCCCCTGCCACGGCTTTTTATCCCTATCGCCGTCGCCATGGCTTTTT ×
GCAGTCACAGCTTTTTATCCCCACCGCCGCGGCTTTTTGGGCCCACCACCGCGGCCTTTTCAACCGCGGC ×
TTTTTGCCCCCACCACCGTGGCTTTTGGCTCCTGCCACTGAGGCTTTTTGCTGCCGCGGTTTTTGCCCCT ×
GCCGCCGCTGCTTTTTTGCGGCTTTTTGCCCCCCGCCAGGGCGGCTTTTTGCCCCCGTGAATTTTCCCCCC ×
GTCTAAGCGGGATTTTGTGATTTTTTTTGCCCCCGCTCCTGCTGCTTTTTGCCCCCGCCGCCGCAGCTTT ×
TTGCCCCACTGCTACGGTTTTTTGCCACAGTTGCTTTTTGCCCCCGAAGCCACAGCTTTTTACCCTCGAC ×
ACCGCGGCTTTTTGTGGCTTTTCGCCCCTGCCGCTGAGGCTTTTTGCCGCCGCGGTGTTTGTTCCCGCCA ×
CCGCTGCTTTTTTGCGGCTTTTTGCCCCCCACCGCCACGGCTTTTTGCCCCGCCACTACGGCTTTTTGCCG ×
CTGCAGCTTTTTGCCCCCGAAGCCACGGCTTTTTGCCCTCACCGCTGCGGCTTTTTGCACCCACAGCCGG ×
GGCTATTTACCCCCGCTTCCACGGCTTTTTGCCACCGCTGTTTTTTCCCCCACCACCGCGGGTTTTTGCC ×
CCCGCCGCCGTGGGTTTTTGCCGCTGAGGCTTTTTTTTTAACCGCCACCGCCGCGGCTTTTAGTCCCCGC ×
CACCGCGGTTTTTTGCCTCCGCTGCCGAGGCTTTTTGTCCCCACCGCCTTTGCTTTTTGTAGGTTTTCGC ×
CCCCGTCGCTGCAGGTTTTTTGCCCCCTGCCACCACGGCTTTTTCCCCCAGCCGCCGCGGATTTTTGTGT ×
TTTTTTTCCCCCGCTCCCGCTGCTTTTTGCCCCCCCTCAGTGGCTTTTTACCCCCCTCAGCGCGGCTTTT ×
TGCTCCCACCGCCACGTCTTTCTCCAACCGCCACCGTGGCTTTTTGCCCCTGCCGCCACGCCTTTTTGCC ×
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AGACAGAAGCATTCTGATAAACCTGTTTCTGAAGTGTGTACTCAACTATCAGAGTTCAACCTTTCTTTTG ×
ATAGAGCAGTTTTGAAACACACTTTTTGTAGAATCTGAAAGTGGATATTTGGATAGTTTTGAGGATTTCG ×
GTGGAAACACGAGTATCTTCATATAAAATCTAGACAGAAGCATTCTCAGAAACATCTTTGGGATGCTTGC ×
CTTCACATCAGAGAGTTGAACATTCCCTTTCATAGAGCAAGTTTGAAACACTCTTTTTGTGGTATCTGGA ×
AGTGGACATTTTGATCGCTTTGAGGCTCATGGTGAAAAAGGAAATATCTTCGCATAAAAACTAGACAGAA ×
GCATTCTCATAAACCTGTTTGTGATGTGTGTACTCAACTAACAGAGTTGAACCTTTCTTTTGATAGAGCA ×
GTTTTGAAACACTCTTTTTGTAGAATCTGCAAGTGGATATTTTGATAGCTTTGACGGTTTCGTTGGAAAC ×
GGAAATATCTTCATATAAAATCTAGACAGAAGCATTCTCAGAAACATCTCTGTGATGTTTGCATTCAAGA ×
CACATAGTTGAACTTTCTCTTTACTGTAACAGCTTTGAAACACTGATTTTGTAGTATCTGGAACTGGACA ×
TTTCATGTGCATTGGGGCCTATATTGAAAAAGGAAATATCTTCCCATAAAAATTGACAGAAACATTCTCA ×
GAAACTAGTTTGTGATGTGTGTACTCAACTAACACAGTTGAAACTTTCTTTTGATAGAGTAGTTTTGAAA ×
CAGTCTTTTTGTAGAATCTGCAAGTGGATATTTGGATACCTTTGAGGATTTCGTTGCAAACAGGAATATC ×
TTCAGGTAAAATCTACACAGAAGCATTCTCAGAAACATCTTTCGGATGTTTGCATTCAAGTAACAGTGTT ×
GAACATTCCCTTTCTTAGAGCAGGTTTGAAACACTCTTTTTGTAATATCTGGAAGTGGACATTTGGATCG ×
CTTTGAGGTCTGTGGTGAAAAAGAAAGTACCTTGGCATAAAAACTAGACAGAACCATTCTCATAAACTTG ×
TTTGTGATGTGTGTACTCAACTAACAGAGTTGAACCTTTCTTTTGATAGAACAGTTTGAAACAATCTTTT ×
GGTAGAATCTACAAGAGGATATTTGGATAGCTTTGAGTATTTCATCGGAAACGGGAATATGTTTATATAA ×
AATCTAGACAGAAGCATTATCAGAAACATCTTTGTGATGTTTGCAATCAAGTCACAGATTTGAACATTCC ×
CTTTCATAGAGCAGGTTTGAAACACTCTTTTTGTAGTATCTGGAAGTGGACATTTGGATCACTTTGAGGC ×
CTATGGTGTAAAAGGAAATATCTTCGCATAAAAACTAGACAGAAGCATTCTCACAAACTTGTCTGTGATA ×
TGTGTACTCAACTAACAGAGGTGAACCTTTCTTTTGATAGAGCAGTTTTGAAACACTCTTTTTGGAGAAT ×
CTGCAAGTGGGTATTTGGATAGCTTTGAGGATTTCGTTGGAAACGGGAATATCCTAATACAAAATCTAGA ×
AAGAAGCATTCTCAGAAACATATCTGTGATGTTTGCATTCAAGTCACAGGGGTGAATATTCCCTTTTCTG ×
GAGCAGGTTTGAAAAACTGATTTTGTGGTATCTGGAACTGGACATTTCGAGCGCACTGTGGCCTTTATTG ×
AAAAAGGAAATATCTTCCCATAAAAACTAGACAGAAATATTCTCAGAAACTACTTTGTGATGTGTGTACT ×
CAACTATCAGAGTTGAACCTTTCTTTTCATAGAGCAGTTTTGAAACACACTTATTCTAGAATCTGCAAGT ×
GGATATTTGGATAGCTTTGAGGAATTCGGTGGAAACGCGAATATCTTCATATAAATTCTAGACAGAAGCA ×
TTCTCAGAAACATCTTTGGGATGTTTGCCTTCACATCAGACAGTTGAACATTCCCTTTCATAGGGCAGGT ×
TTGAAATACTCTTTTTGTAGTATCTGGAAGTGGACATTTGGAACGGTATCAGGCCTATGGTTAAAAAGGA ×
AATATCTTCCCATAAAAACAAGACAGAAGCACTCTCAGAAACTTATTTCTGATATCTGTCCTCACTTAAC ×
GGACATGAACCTTTCTTTTTATAGAGCACTTTTGAAACACTCTTTTTGTAGTATCTGCAAGTGGATATTT ×
GGATGGCTTTGAGGATTTCGTTGGAAACGGGAATATCTTCCTATAAAATCTAGACAGAAGCATTCTGAGA ×
AACTACTTTGTGATGTTTGCATAAAAGACACAGAGTTGAACATTCCCTGTCATAGAGCAGGTTTGAAACA ×
ATCTTTTTGTAGTATCTGGAAGTGGACACTTCGAACGCTTTCAGGCCTATGGTTAAAAAGGAAACATCTT ×
CTCATATAAAGAAGACAGAAGCATTCTCAGAAACTTATTTGTGATGTGTGTCCTAAACTAACAGACTTGA ×
AACTGTCTTGATACAGCAGTTTTCAAACACTCTTTTTCTAGAATCTGCAAGTGGACATTTGGATAGTTTT ×
GAGGATTTCGTTGCAAACGGGATTACATATAAAAAGTAGACAGCAGCATTCTCAGAAACTTCTTGTGATG ×
TTTGCATTCAAGTCACAGAGTTGAACATTCCCTGTCATAGAGCAGGTTTGAAACAATCTTTTTGTAGTAT ×
CTGGAAGTGGACACTTCGAACGCTTTCAGGCCTATGGTTAAAAACGAAATATCTTCTCATATAAACAAGA ×
CAGAAGCATTCTCAGAAATTTATTTGTGATGTGTGTCCTCAACTAACAGACTTGAACCTGCCTTTTAATA ×
CAGCAGTTTTGAAACACTCTTTTTGTAGAATCTGCAAGTGGACATTTGGACAGCTTTGAGGATTTCGTTG ×
GAAACTGGATTACATATAAAAAGTAGACAGTAGAATTCTCAGAAACTTTTTGTGATGTTTGCATTCAAGT ×
CACAGAGTTGAACATACCCTTTCATAGAGCAGGTTTGATACACTCTTTTTGTAGTATCTGGAAGTGGACA ×
TTTGGAGCGCTTTGTGGCCTACGGTAAAAAAGGAAGTACCCTCCCATAAAAACAACATAGAAGCAATCTC ×
AGAAACTTGTTTATGCTGTATCTACTCAACGAACAGTGTGCAAACTTTCTATTGATAGAGCAGGTGTGAA ×
ACACTCTTTTTTTGGAATCTGCAGGTGCATACTTGGATAGAATTGAGGATTTCGTTGGAAAAGGGATTAC ×

```
TTATAAAAAGTAGACTGCAGCATTCTCAGAAACTTCTTTGTGATGTTTGCATTCAAGTCACAGAGTTGAA ×
CATTCCCTTTCATAGAGCAGGTTTGAAACACTCTTTTTGTAGTATCTGGAAGTGGACATTTCCAACGCTT ×
TCAGGCCTACGGAGAAAAAGGATATATCTTCCCATAAAAACAAGACAGAAGCATTCTCAGAAACTTATTT ×
GTGATGTGTGTCCTCAACTAACGGACTTGAACCTTTCTTTTTATAGAGCACTTTTGAAACACTCTTTTTG ×
TACTATCTGCAAGTGGATAGTTGGATGGCTTTGACGATTTCGTTGGAAACGGGAATATCTTCCTATAAAA ×
TCTACACAGAAGCATTCTCAGAAACTTCTTTGTGATGTTTGCATTCAAGTCACAGAGTTGAACATTCCCT ×
GTCATAGAGCAGGTTTGAAACAATCTTTTTTTAGTATCTGGAAGTGGACACTTCGAACGCTTTCAGGCCT ×
ATGGTTAAAAAGGAAAT} // ToString;
```

Process

In[ ]:=
```
SpecialNote =
  " Not sure if this is a single gene or multiple. Also not sure if this is necessarily
    a set of whole genes or if it's just the DNA sequence corresponding
    to a particular chromosomal structure. In that case it might
    includes only parts of some genes (not the whole genes)";
```

In[ ]:=
```
Wgenesample = "Human chromosome9 scaffold gene"
(*Lets us know which gene we're dealing with,
used in pdf coding later, so be sure to name it *)
```

Out[ ]= Human chromosome9 scaffold gene

In[ ]:=
```
LetterDNAtoNum[Sample_] := ToExpression[StringReplace[ToString[
    {StringReplace[StringReplace[ToString[{Sample}], {"," → "", " " → "", "{" → "",
        "}" → "", "(" → "", ")" → "", "[" → "", "]" → "", ";" → "", ":" → "", "_" → "",
        "+" → "", "&" → "", "/" → "", "." → "", "RowBox" → "", "Null" → ""}],
      {"0" → "0,", "1" → "1,", "2" → "2,", "3" → "3,", "A" → "0,", "C" → "1,",
       "G" → "2,", "T" → "3,", "a" → "0,", "c" → "1,", "g" → "2,", "t" → "3,"}]}
  ], ",}" → "}"]]
numgenesample = LetterDNAtoNum[lettersample];
Export[StringReplace["GENE_genesample.txt", "GENE_gene" → Wgenesample],
 Flatten[numgenesample]]
```

Out[ ]= Human chromosome9 scaffold genesample.txt

In[ ]:=
```
lengthofgeneitself = Length[Flatten[numgenesample]]
 (*To make sure no base pairs are left out *)
```

Out[ ]= 59027

Construction of W

Can compare to W constructen in Python file **W_hat_construction.py** if we want

In[ ]:=
```
LetterDNAtoNum[Sample_] := ToExpression[StringReplace[ToString[
    {StringReplace[StringReplace[ToString[{Sample}], {"," → "", " " → "", "{" → "",
        "}" → "", "(" → "", ")" → "", "[" → "", "]" → "", ";" → "", ":" → "", "_" → "",
        "+" → "", "&" → "", "/" → "", "." → "", "RowBox" → "", "Null" → "", "
       " → "", "
" → ""}],
      {"0" → "0,", "1" → "1,", "2" → "2,", "3" → "3,", "A" → "0,", "C" → "1,",
       "G" → "2,", "T" → "3,", "a" → "0,", "c" → "1,", "g" → "2,", "t" → "3,"}]}
   ], ",}" → "}"]]

numgenesample = LetterDNAtoNum[lettersample];
lengthofgeneitself = Length[Flatten[numgenesample]];
M = numgenesample;

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

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

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

In[ ]:=
```
Dimensions[W]
```

Out[ ]=
```
{256, 256}
```

In[ ]:=
```
ρ = (W.Transpose[W]);
```

In[ ]:=
```
Dimensions[ρ]
```

Out[ ]=
```
{256, 256}
```

```
In[•]:= (*numgenesample=LetterDNAtoNum[lettersample];
lengthofgeneitself=Length[Flatten[numgenesample]];
M=numgenesample;
lengthvec[M_]:=Length[M[[1,All]]]
  For[npow=1,npow<1000,npow++,If[lengthvec[M]<(2^(npow)),Break[]];
   FilledSize=2^(npow+1)];
Filler[M_]:=Table[4,{i,1,FilledSize-lengthvec[M]}]
   FilledVec[M_]:=Join[Flatten[M],Filler[M]]
    lengthvec[M_]:=Length[M[[1,All]]]
     Filler[M_]:=Table[4,{i,1,FilledSize-lengthvec[M]}]
      FilledVec[M_]:=Join[Flatten[M],Filler[M]]
      For[npow=1,npow<1000,npow++,If[lengthvec[M]≤(2^npow),Break[]]];
(* gives npow such that  2^npow > lengthvec[M] > 2^(npow -1) *)
FilledSize=2^npow;
FilledM=FilledVec[M];
numrowsW=√Length[FilledM] ;*)
```

W for PCV1 samples

PCV Type 1 samples

$PCV1_1$ =

```
{{0, 1, 1, 0, 2, 1, 2, 1, 0, 1, 3, 3, 1, 2, 2, 1, 0, 2, 1, 2, 2, 1, 0, 2, 1, 0, 1, 1, 3, 1, 2, 2, 1,
  0, 2, 1, 2, 3, 1, 0, 2, 3, 2, 0, 0, 0, 0, 3, 2, 1, 1, 0, 0, 2, 1, 0, 0, 2, 0, 0, 0, 0, 2, 1, 2, 2,
  1, 1, 1, 2, 1, 0, 0, 1, 1, 1, 1, 0, 3, 0, 0, 2, 0, 2, 2, 3, 2, 2, 2, 3, 2, 3, 3, 1, 0, 1, 1, 1,
  3, 3, 0, 0, 3, 0, 0, 3, 1, 1, 3, 3, 1, 1, 2, 0, 2, 2, 0, 2, 2, 0, 2, 0, 0, 0, 0, 0, 1, 0, 0, 0,
  0, 3, 0, 1, 2, 2, 2, 0, 2, 1, 3, 3, 1, 1, 0, 0, 3, 1, 3, 1, 1, 1, 3, 3, 3, 3, 3, 2, 0, 3, 3,
  0, 3, 3, 3, 3, 2, 3, 3, 3, 2, 1, 2, 2, 0, 2, 0, 2, 2, 0, 0, 2, 2, 3, 3, 3, 2, 2, 0, 0, 2, 0,
  2, 2, 2, 3, 0, 2, 0, 0, 1, 3, 1, 1, 3, 1, 0, 1, 1, 3, 1, 1, 0, 2, 2, 2, 2, 3, 3, 3, 2, 1, 2,
  0, 0, 3, 3, 3, 3, 2, 1, 3, 0, 0, 2, 0, 0, 2, 1, 0, 2, 0, 1, 3, 3, 3, 3, 0, 0, 1, 0, 0, 2, 2,
  3, 2, 0, 0, 2, 3, 2, 2, 3, 0, 3, 3, 3, 3, 2, 2, 3, 2, 1, 1, 1, 2, 1, 3, 2, 1, 1, 0, 1, 0, 3,
  1, 2, 0, 2, 0, 0, 0, 2, 1, 2, 0, 0, 0, 2, 2, 0, 0, 1, 1, 2, 0, 1, 1, 0, 2, 1, 0, 2, 0, 0, 3,
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  3, 0, 2, 1, 1, 2, 0, 2, 1, 0, 2, 3, 3, 1, 1, 1, 3, 2, 3, 0, 0, 1, 2, 3, 0, 3, 2, 3, 2, 0,
  2, 0, 0, 0, 3, 3, 3, 1, 1, 2, 1, 2, 2, 2, 1, 3, 2, 2, 1, 3, 2, 0, 0, 1, 3, 3, 3, 3, 2, 0,
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```

```
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    3, 3, 3, 0, 2, 2, 0, 3, 0, 0, 0, 3, 3, 1, 3, 1, 3, 2, 0, 0, 3, 3, 2, 3, 0, 1, 0, 3, 0, 0,
    0, 3, 0, 2, 3, 1, 0, 2, 1, 1, 3, 3, 0, 1, 1, 0, 1, 0, 3, 0, 0, 3, 3, 3, 3, 2, 2, 2, 1, 3,
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    2, 3, 2, 0, 2, 3, 0, 1, 0, 0, 0, 3, 3, 1, 3, 2, 3, 0, 2, 0, 0, 0, 2, 2, 1, 2, 2, 2, 0, 0,
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    3, 0, 0, 1, 2, 2, 3, 3, 3, 1, 3, 2, 0, 0, 2, 2, 1, 2, 2, 2, 2, 3, 2, 3, 2, 1, 1, 0, 0, 0,
    3, 0, 3, 2, 2, 3, 1, 3, 3, 1, 3, 1, 1, 2, 2, 0, 2, 2, 0, 3, 2, 3, 3, 3, 1, 1, 0, 0, 2, 2,
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    3, 0, 0, 1, 2, 1, 1, 3, 1, 1, 3, 3, 2, 2, 1, 1, 0, 1, 2, 3, 1, 0, 3, 1, 1, 3, 0, 3, 0, 0,
    0, 0, 2, 3, 2, 0, 0, 0, 2, 0, 0, 2, 3, 2, 1, 2, 1, 3, 2, 1, 3, 2, 3, 0, 2, 3, 0, 3, 3}};

PCV1_2 =
  {{0, 1, 1, 0, 2, 1, 2, 1, 0, 1, 3, 3, 1, 2, 2, 1, 0, 2, 1, 2, 2, 1, 0, 2, 1, 0, 1, 1, 3, 1, 2, 2, 1,
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    0, 3, 0, 1, 2, 2, 2, 0, 2, 1, 3, 3, 1, 1, 0, 0, 3, 1, 3, 1, 1, 1, 3, 3, 3, 3, 3, 2, 0, 3, 3,
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    0, 0, 2, 3, 2, 0, 0, 0, 2, 0, 0, 2, 3, 2, 1, 2, 1, 3, 2, 1, 3, 2, 3, 0, 2, 3, 0, 3, 3}};
```

Defn of W

```
(*Export["PCV1_1genesample.txt",Flatten[PCV1₁]]
 Export["PCV1_2genesample.txt",Flatten[PCV1₂]]
 Export["PCV1_3genesample.txt",Flatten[PCV1₃]]
 Export["PCV1_4genesample.txt",Flatten[PCV1₄]]*)
(*^These give the DNA data in the form we need in python *)
```

We costructed the W for `M = {Join[PCV1₁[[1]], PCV1₂[[1]]};` in python (**DensityMatrixREcalc.py**)

Only used two genes because this particular choice has length 4096 = 2^(12) after filling i.e. b is even, which helps make the algorithm a bit simpler

```
SpecialNote = " We use 2 samples of PCV1 Genes here
    so that we have an even b, 2^b = Length of the filled data set ";

lengthofgeneitself = Length[Flatten[{Join[{PCV1₁[[1]], PCV1₂[[1]]}]}]]
 (*To make sure no base pairs are left out *)
```

```
3518
```

```
Wgenesample = "(2 sample) PCV1 gene"
(*Lets us know which gene we're dealing with,
used in pdf coding later, so be sure to name it *)
```

```
(2 sample) PCV1 gene
```

```
W = {{0, 0, 1, 1, 1, 1, 0, 0, 2, 2, 1, 1, 2, 2, 1, 1, 0, 0, 1, 1, 3, 3, 3, 3, 1, 1, 2, 2, 2, 2, 1, 1,
    0, 0, 2, 2, 1, 1, 2, 2, 2, 2, 1, 1, 0, 0, 2, 2, 1, 1, 0, 0, 1, 1, 1, 1, 3, 3, 1, 1, 2, 2, 2, 2},
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    0, 0, 2, 2, 0, 0, 2, 2, 2, 2, 3, 3, 2, 2, 2, 2, 2, 2, 3, 3, 2, 2, 3, 3, 3, 3, 1, 1, 0, 0, 1, 1},
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{1, 1, 0, 0, 0, 0, 2, 2, 3, 3, 3, 3, 2, 2, 2, 2, 3, 3, 2, 2, 2, 2, 0, 0, 2, 2, 2, 2, 2, 2, 2, 2,
 2, 2, 3, 3, 3, 3, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 2, 2, 3, 3, 3, 3, 2, 2, 2, 2, 1, 1, 0, 0, 3, 3},
{1, 1, 1, 1, 0, 0, 0, 0, 2, 2, 0, 0, 3, 3, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 1, 1, 0, 0, 2, 2, 3, 3,
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{3, 3, 2, 1, 0, 0, 3, 3, 3, 3, 0, 0, 2, 2, 0, 0, 2, 2, 2, 2, 3, 3, 2, 2, 0, 0, 3, 3, 2, 2, 2, 2,
 2, 2, 2, 2, 3, 3, 1, 1, 3, 3, 1, 1, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 3, 3, 0, 0, 0, 0, 0, 0, 0, 0},
{3, 3, 3, 3, 1, 1, 0, 0, 3, 3, 0, 0, 3, 3, 3, 3, 3, 3, 0, 0, 2, 2, 1, 1, 1, 1, 3, 3, 3, 3, 3, 3,
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{2, 2, 2, 2, 0, 0, 0, 0, 0, 0, 2, 2, 2, 2, 3, 3, 0, 0, 2, 2, 2, 2, 2, 2, 2, 2, 3, 3, 0, 0, 2, 2,
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{2, 2, 0, 0, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 0, 0, 2, 2, 2, 2, 0, 0, 0, 0, 1, 1, 3, 3,
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{2, 2, 0, 0, 2, 2, 2, 2, 3, 3, 0, 2, 2, 2, 3, 3, 3, 3, 0, 0, 0, 0, 1, 1, 0, 0, 3, 3, 3, 2, 1, 1,
 1, 1, 0, 0, 0, 0, 2, 2, 0, 0, 3, 3, 2, 2, 2, 2, 1, 1, 3, 3, 2, 2, 1, 1, 2, 2, 3, 0, 2, 2, 3, 3},
{0, 0, 3, 3, 1, 1, 1, 1, 3, 3, 1, 1, 1, 1, 3, 3, 3, 3, 3, 3, 3, 3, 0, 0, 3, 3, 2, 2, 2, 2, 3, 3,
 2, 2, 0, 0, 2, 2, 3, 3, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 3, 3, 3, 3, 1, 1, 3, 3, 2, 1, 3, 3, 0, 0},
{2, 2, 0, 0, 0, 0, 0, 0, 2, 2, 2, 2, 1, 1, 2, 2, 2, 2, 2, 2, 0, 0, 0, 0, 3, 3, 3, 3, 2, 2, 0, 0,
 0, 0, 2, 2, 0, 0, 3, 3, 0, 0, 1, 1, 1, 1, 1, 1, 2, 2, 3, 3, 1, 1, 3, 3, 3, 3, 3, 3, 1, 1, 2, 2},
{2, 2, 1, 1, 2, 2, 1, 1, 1, 1, 0, 0, 3, 3, 1, 1, 3, 3, 2, 2, 3, 3, 0, 0, 0, 0, 1, 1, 2, 2, 2, 2,
 3, 3, 3, 3, 3, 3, 1, 1, 3, 3, 2, 2, 0, 0, 0, 0, 2, 2, 2, 2, 1, 1, 2, 2, 2, 2, 2, 2, 2, 2, 3, 3},
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{1, 1, 1, 1, 0, 0, 0, 0, 2, 2, 2, 0, 3, 3, 2, 2, 2, 2, 1, 1, 3, 3, 2, 2, 1, 1, 2, 2, 2, 2, 2, 2,
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{2, 2, 1, 1, 2, 2, 2, 2, 3, 3, 0, 0, 0, 0, 1, 1, 2, 2, 1, 1, 1, 1, 3, 3, 1, 1, 1, 1, 3, 3, 3, 3,
 2, 2, 2, 2, 1, 1, 1, 1, 0, 0, 1, 1, 2, 2, 3, 3, 1, 1, 0, 0, 3, 3, 1, 1, 1, 1, 3, 3, 0, 0, 3, 3},
{0, 0, 0, 0, 0, 0, 0, 0, 2, 2, 3, 3, 2, 2, 0, 0, 0, 0, 0, 0, 2, 2, 0, 0, 0, 0, 2, 2, 3, 3, 2, 2,
 1, 1, 2, 2, 1, 1, 3, 3, 2, 2, 1, 1, 3, 3, 2, 2, 3, 3, 0, 0, 2, 2, 3, 3, 0, 0, 3, 3, 3, 3, 4, 4},
{4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4,
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{4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4,
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{4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4,
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{4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4,
 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4},
{4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4,
 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4},
```

```
{4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4,
 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4},
{4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4,
 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4},
{4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4,
 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4}};
```

W for H1A

Define a 1x781 vector H1Avec which contains all the base pair info of the H1A gene

```
H1Avec =
  {{3, 0, 2, 2, 1, 3, 2, 1, 2, 3, 3, 2, 2, 2, 2, 1, 1, 3, 3, 3, 3, 3, 3, 3, 1, 2, 1, 0, 3, 1, 1, 3, 2,
    1, 3, 3, 1, 2, 3, 1, 0, 2, 2, 3, 3, 3, 0, 3, 0, 1, 1, 0, 1, 3, 3, 3, 0, 3, 3, 3, 2, 2, 3, 2, 3,
    2, 1, 3, 2, 3, 2, 3, 3, 0, 2, 3, 1, 0, 1, 1, 0, 3, 2, 3, 1, 3, 2, 0, 0, 0, 1, 0, 2, 3, 2, 1, 1,
    3, 1, 1, 1, 2, 1, 1, 1, 1, 1, 2, 1, 1, 2, 1, 3, 3, 1, 3, 2, 1, 3, 2, 1, 3, 1, 1, 3, 2, 0,
    2, 0, 0, 0, 1, 1, 3, 3, 3, 0, 2, 1, 3, 2, 2, 1, 0, 0, 2, 0, 0, 2, 2, 1, 0, 0, 0, 2, 0, 0,
    0, 1, 1, 3, 2, 1, 3, 0, 0, 2, 2, 1, 3, 2, 1, 0, 2, 1, 0, 2, 1, 1, 3, 1, 1, 0, 0, 2, 0, 0,
    0, 0, 0, 0, 1, 1, 1, 2, 1, 3, 2, 2, 1, 1, 1, 3, 3, 1, 1, 2, 3, 2, 3, 1, 0, 2, 0, 2, 1, 3,
    2, 0, 3, 1, 2, 3, 2, 1, 0, 2, 2, 1, 3, 2, 1, 3, 3, 1, 1, 3, 1, 1, 3, 1, 3, 0, 0, 2, 2, 0,
    2, 1, 2, 3, 2, 2, 3, 2, 2, 3, 2, 3, 2, 3, 1, 2, 3, 3, 2, 2, 1, 0, 2, 1, 3, 1, 3, 3, 0, 0,
    0, 0, 0, 2, 2, 1, 2, 1, 3, 2, 2, 1, 2, 2, 1, 1, 2, 1, 0, 2, 2, 1, 3, 0, 1, 2, 0, 1, 2, 3,
    2, 2, 0, 2, 0, 0, 2, 0, 0, 1, 0, 0, 1, 0, 2, 1, 1, 2, 1, 0, 3, 3, 0, 0, 2, 1, 3, 2, 2, 2,
    1, 0, 3, 3, 0, 0, 2, 0, 2, 1, 1, 3, 2, 2, 3, 0, 0, 2, 1, 0, 0, 2, 2, 2, 0, 0, 1, 2, 3, 3,
    2, 2, 3, 2, 1, 0, 2, 0, 1, 0, 0, 0, 2, 2, 2, 3, 0, 1, 1, 2, 2, 0, 2, 1, 1, 3, 1, 2, 2, 2,
    3, 3, 1, 1, 3, 3, 1, 0, 0, 2, 1, 3, 1, 0, 0, 1, 0, 0, 2, 0, 0, 2, 2, 1, 2, 3, 1, 1, 3, 1,
    1, 2, 3, 2, 2, 0, 0, 0, 1, 1, 0, 0, 2, 1, 1, 1, 2, 2, 1, 2, 1, 1, 3, 1, 0, 0, 0, 2, 2, 3,
    2, 2, 1, 3, 0, 1, 0, 0, 0, 0, 0, 1, 3, 0, 0, 2, 2, 1, 0, 0, 1, 2, 2, 2, 3, 2, 1, 0, 3, 1,
    3, 0, 0, 0, 0, 0, 2, 1, 3, 1, 0, 0, 0, 0, 0, 2, 2, 1, 1, 0, 1, 2, 2, 2, 2, 2, 1, 3, 0, 2,
    1, 0, 0, 0, 0, 0, 2, 0, 2, 1, 2, 3, 1, 0, 0, 2, 0, 1, 3, 1, 1, 2, 0, 0, 0, 0, 0, 2, 2, 1,
    3, 0, 0, 0, 0, 0, 2, 1, 1, 3, 2, 1, 2, 2, 1, 0, 0, 1, 0, 0, 2, 2, 0, 0, 0, 3, 1, 1, 3, 1,
    1, 0, 0, 2, 0, 0, 3, 1, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0, 0, 0, 1, 3, 2, 3, 0, 0, 0,
    2, 1, 1, 1, 0, 0, 2, 0, 0, 0, 2, 3, 0, 2, 1, 3, 0, 0, 0, 0, 2, 1, 1, 1, 3, 2, 1, 3, 0,
    0, 0, 2, 1, 3, 0, 0, 2, 2, 1, 3, 2, 3, 0, 0, 0, 0, 1, 1, 1, 0, 0, 2, 2, 1, 2, 2, 1, 1,
    0, 0, 2, 2, 1, 3, 0, 2, 2, 2, 3, 2, 0, 1, 2, 0, 0, 2, 1, 1, 0, 0, 0, 2, 0, 1, 3, 2, 1,
    1, 0, 0, 0, 1, 1, 1, 0, 0, 2, 0, 0, 0, 2, 1, 2, 2, 1, 0, 1, 1, 1, 0, 0, 2, 0, 0, 0, 0,
    0, 2, 3, 0, 0, 0, 3, 3, 1, 0, 2, 3, 3, 0, 2, 0, 0, 2, 3, 3, 3, 1, 3, 3, 1, 3, 0, 2, 3,
    0, 0, 1, 1, 1, 0, 0, 1, 2, 2, 1, 3, 1, 3, 3, 3, 3, 0, 0, 2, 0, 2, 1, 1, 0, 1, 1, 3, 0}};
```

```
Export["H1A_genesample.txt", Flatten[H1Avec]]
```

```
H1A_genesample.txt
```

```
SpecialNote = " ";
```

```
lengthofgeneitself = Length[Flatten[H1Avec]](*To make sure no base pairs are left out *)
```

```
781
```

```
Wgenesample = "Human H1A gene"
(*Lets us know which gene we're dealing with,
used in pdf coding later, so be sure to name it *)
```

```
Human H1A gene
```

```
W = {{3, 0, 2, 2, 1, 3, 2, 1, 2, 3, 3, 2, 2, 2, 2, 1, 1, 3, 3, 3, 3, 3, 3, 3, 1, 2, 1, 0, 3, 1, 1, 3},
    {2, 1, 3, 3, 1, 2, 3, 1, 0, 2, 2, 3, 3, 3, 0, 3, 0, 1, 1, 0, 1, 3, 3, 3, 0, 3, 3, 3, 2, 2, 3, 2},
    {3, 2, 1, 3, 2, 3, 2, 3, 3, 0, 2, 3, 1, 0, 1, 1, 0, 3, 2, 3, 1, 3, 2, 0, 0, 0, 1, 0, 2, 3, 2, 1},
    {1, 3, 1, 1, 1, 2, 1, 1, 1, 1, 1, 2, 1, 1, 2, 1, 3, 3, 1, 3, 2, 1, 3, 2, 1, 3, 1, 1, 3, 2, 0, 2},
    {0, 0, 0, 1, 1, 3, 3, 3, 0, 2, 1, 3, 2, 2, 1, 0, 0, 2, 0, 0, 2, 2, 1, 0, 0, 0, 2, 0, 0, 0, 1, 1},
    {3, 2, 1, 3, 0, 0, 2, 2, 1, 3, 2, 1, 0, 2, 1, 0, 2, 1, 1, 3, 1, 1, 0, 0, 2, 0, 0, 0, 0, 0, 0, 1},
    {1, 1, 2, 1, 3, 2, 2, 1, 1, 1, 3, 3, 1, 1, 2, 3, 2, 3, 1, 0, 2, 0, 2, 1, 3, 2, 0, 3, 1, 2, 3, 2},
    {1, 0, 2, 2, 1, 3, 2, 1, 3, 3, 1, 1, 3, 1, 1, 3, 1, 3, 0, 0, 2, 2, 0, 2, 1, 2, 3, 2, 2, 3, 2, 2},
    {3, 2, 3, 2, 3, 1, 2, 3, 3, 2, 2, 1, 0, 2, 1, 3, 1, 3, 3, 0, 0, 0, 0, 0, 2, 2, 1, 2, 1, 3, 2, 2},
    {1, 2, 2, 1, 1, 2, 1, 0, 2, 2, 1, 3, 0, 1, 2, 0, 1, 2, 3, 2, 2, 0, 2, 0, 0, 2, 0, 0, 1, 0, 0, 1},
    {0, 2, 1, 1, 2, 1, 0, 3, 3, 0, 0, 2, 1, 3, 2, 2, 2, 1, 0, 3, 3, 0, 0, 2, 0, 2, 1, 1, 3, 2, 2, 3},
    {0, 0, 2, 1, 0, 0, 2, 2, 2, 0, 0, 1, 2, 3, 3, 2, 2, 3, 2, 1, 0, 2, 0, 1, 0, 0, 0, 2, 2, 2, 3, 0},
    {1, 1, 2, 2, 0, 2, 1, 1, 3, 1, 2, 2, 2, 3, 3, 1, 1, 3, 3, 1, 0, 0, 2, 1, 3, 1, 0, 0, 1, 0, 0, 2},
    {0, 0, 2, 2, 1, 2, 3, 1, 1, 3, 1, 1, 2, 3, 2, 2, 0, 0, 0, 1, 1, 0, 0, 2, 1, 1, 1, 2, 2, 1, 2, 1},
    {1, 3, 1, 0, 0, 0, 2, 2, 3, 2, 2, 1, 3, 0, 1, 0, 0, 0, 0, 0, 1, 3, 0, 0, 2, 2, 1, 0, 0, 1, 2, 2},
    {2, 3, 2, 1, 0, 3, 1, 3, 0, 0, 0, 0, 0, 2, 1, 3, 1, 0, 0, 0, 0, 0, 2, 2, 1, 1, 0, 1, 2, 2, 2, 2},
    {2, 1, 3, 0, 2, 1, 0, 0, 0, 0, 0, 2, 0, 2, 1, 2, 3, 1, 0, 0, 2, 0, 1, 3, 1, 1, 2, 0, 0, 0, 0, 0},
    {2, 2, 1, 3, 0, 0, 0, 0, 0, 2, 1, 1, 3, 2, 1, 2, 2, 1, 0, 0, 1, 0, 0, 2, 2, 0, 0, 0, 3, 1, 1, 3},
    {1, 1, 0, 0, 2, 0, 0, 3, 1, 1, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0, 0, 0, 1, 3, 2, 3, 0, 0, 0, 2},
    {1, 1, 1, 0, 0, 2, 0, 0, 0, 2, 3, 0, 2, 1, 3, 0, 0, 0, 0, 2, 1, 1, 1, 3, 2, 1, 3, 0, 0, 0, 2, 1},
    {3, 0, 0, 2, 2, 1, 3, 2, 3, 0, 0, 0, 0, 1, 1, 1, 0, 0, 2, 2, 1, 2, 2, 1, 1, 0, 0, 2, 2, 1, 3, 0},
    {2, 2, 2, 3, 2, 0, 1, 2, 0, 0, 2, 1, 1, 0, 0, 0, 2, 0, 1, 3, 2, 1, 1, 0, 0, 0, 1, 1, 1, 0, 0, 2},
    {0, 0, 0, 2, 1, 2, 2, 1, 0, 1, 1, 1, 0, 0, 2, 0, 0, 0, 0, 0, 2, 3, 0, 0, 0, 3, 3, 1, 0, 2, 3, 3},
    {0, 2, 0, 0, 2, 3, 3, 3, 1, 3, 3, 1, 3, 0, 2, 3, 0, 0, 1, 1, 1, 0, 0, 1, 2, 2, 1, 3, 1, 3, 3, 3},
    {3, 0, 0, 2, 0, 2, 1, 1, 0, 1, 1, 3, 0, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4},
    {4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4},
    {4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4},
    {4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4},
    {4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4},
    {4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4},
    {4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4},
    {4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4}};
```

```
Length[W]
Length[W[[1]]]
Print["This should be 1024 for H1A:   ", Length[W] * Length[W[[1]]]]
```

```
32

32

This should be 1024 for H1A:   1024
```

Run this for output and pdf

In[•]:=
```
EigensofW = Eigenvalues[W] // N
```

Out[•]=
```
{483.848, 19.8583 + 6.96768 i, 19.8583 - 6.96768 i, -4.00531 + 18.8576 i, -4.00531 - 18.8576 i,
 0.780021 + 18.5963 i, 0.780021 - 18.5963 i, -14.8901 + 11.0216 i, -14.8901 - 11.0216 i,
 -17.4194 + 4.58851 i, -17.4194 - 4.58851 i, 13.727 + 11.6623 i, 13.727 - 11.6623 i,
 5.50844 + 17.0659 i, 5.50844 - 17.0659 i, 17.907, 16.802 + 5.88984 i, 16.802 - 5.88984 i,
 -17.6938 + 1.52994 i, -17.6938 - 1.52994 i, 2.7767 + 17.3978 i, 2.7767 - 17.3978 i,
 -15.8433 + 6.40316 i, -15.8433 - 6.40316 i, -10.4457 + 13.3045 i, -10.4457 - 13.3045 i,
 11.7951 + 11.9015 i, 11.7951 - 11.9015 i, 8.85116 + 14.2089 i, 8.85116 - 14.2089 i,
 -4.3147 + 16.16 i, -4.3147 - 16.16 i, -3.34967 + 16.183 i, -3.34967 - 16.183 i,
 -11.2547 + 11.7013 i, -11.2547 - 11.7013 i, -8.99223 + 13.3767 i, -8.99223 - 13.3767 i,
 13.0153 + 9.36275 i, 13.0153 - 9.36275 i, 15.8232 + 1.46337 i, 15.8232 - 1.46337 i,
 14.2088 + 7.0725 i, 14.2088 - 7.0725 i, 5.87228 + 14.5199 i, 5.87228 - 14.5199 i,
 -12.3893 + 9.41411 i, -12.3893 - 9.41411 i, -14.9914 + 3.96472 i, -14.9914 - 3.96472 i,
 -2.08969 + 15.229 i, -2.08969 - 15.229 i, 14.5249 + 4.83292 i, 14.5249 - 4.83292 i, -15.1298,
 -4.34439 + 14.2896 i, -4.34439 - 14.2896 i, 1.26689 + 14.7232 i, 1.26689 - 14.7232 i,
 14.7278, -14.6933, 10.356 + 10.331 i, 10.356 - 10.331 i, -6.1602 + 13.1693 i,
 -6.1602 - 13.1693 i, 8.80256 + 11.5068 i, 8.80256 - 11.5068 i, 4.07596 + 13.747 i,
 4.07596 - 13.747 i, -11.9787 + 7.8384 i, -11.9787 - 7.8384 i, 4.78932 + 13.2623 i,
 4.78932 - 13.2623 i, -7.12071 + 12.1164 i, -7.12071 - 12.1164 i, 13.8338 + 0.49743 i,
 13.8338 - 0.49743 i, 12.1535 + 6.27809 i, 12.1535 - 6.27809 i, -10.567 + 8.64602 i,
 -10.567 - 8.64602 i, -12.7852 + 4.75438 i, -12.7852 - 4.75438 i, -13.3918,
 -12.9044 + 3.56866 i, -12.9044 - 3.56866 i, 10.5261 + 8.1339 i, 10.5261 - 8.1339 i,
 11.0537 + 7.32294 i, 11.0537 - 7.32294 i, -8.04821 + 10.4704 i, -8.04821 - 10.4704 i,
 -2.78767 + 12.7516 i, -2.78767 - 12.7516 i, 12.9311, 2.04162 + 12.7079 i, 2.04162 - 12.7079 i,
 -0.586609 + 12.7444 i, -0.586609 - 12.7444 i, -11.9498 + 4.14973 i, -11.9498 - 4.14973 i,
 8.13711 + 9.52736 i, 8.13711 - 9.52736 i, -8.5541 + 9.0017 i, -8.5541 - 9.0017 i,
 11.9562 + 2.80519 i, 11.9562 - 2.80519 i, -5.41773 + 10.9764 i, -5.41773 - 10.9764 i,
 -10.3646 + 6.09143 i, -10.3646 - 6.09143 i, 6.88196 + 9.72759 i, 6.88196 - 9.72759 i,
 -3.73646 + 11.2323 i, -3.73646 - 11.2323 i, -2.39128 + 11.5907 i, -2.39128 - 11.5907 i,
 -2.90984 + 11.3502 i, -2.90984 - 11.3502 i, -11.6004, 5.48515 + 10.1858 i,
 5.48515 - 10.1858 i, -0.961992 + 11.3353 i, -0.961992 - 11.3353 i, 8.53358 + 7.47957 i,
 8.53358 - 7.47957 i, 11.194, 10.7642 + 2.96244 i, 10.7642 - 2.96244 i, 2.70555 + 10.786 i,
 2.70555 - 10.786 i, -10.4185 + 2.96466 i, -10.4185 - 2.96466 i, -8.50841 + 6.68741 i,
 -8.50841 - 6.68741 i, 9.78122 + 4.44744 i, 9.78122 - 4.44744 i, 6.97967 + 8.07633 i,
 6.97967 - 8.07633 i, 3.83441 + 9.86985 i, 3.83441 - 9.86985 i, -6.23061 + 8.37987 i,
 -6.23061 - 8.37987 i, -10.1229 + 1.89246 i, -10.1229 - 1.89246 i, 10.1699 + 1.11161 i,
 10.1699 - 1.11161 i, 0.48782 + 10.1037 i, 0.48782 - 10.1037 i, -3.91686 + 9.20553 i,
 -3.91686 - 9.20553 i, -8.74962 + 4.26766 i, -8.74962 - 4.26766 i, 1.98637 + 9.31578 i,
 1.98637 - 9.31578 i, -5.85892 + 7.403 i, -5.85892 - 7.403 i, 5.99014 + 7.18589 i,
 5.99014 - 7.18589 i, 7.61044 + 5.33771 i, 7.61044 - 5.33771 i, -7.25101 + 5.51437 i,
 -7.25101 - 5.51437 i, -8.32108 + 3.00497 i, -8.32108 - 3.00497 i, 8.11617 + 2.96488 i,
 8.11617 - 2.96488 i, -6.10965 + 6.00601 i, -6.10965 - 6.00601 i, 6.52477 + 5.54903 i,
 6.52477 - 5.54903 i, -3.38787 + 7.49355 i, -3.38787 - 7.49355 i, -0.343758 + 7.88408 i,
 -0.343758 - 7.88408 i, -7.86774, 7.62836 + 0.690443 i, 7.62836 - 0.690443 i,
 -7.25496 + 1.26918 i, -7.25496 - 1.26918 i, 6.80626 + 2.08624 i, 6.80626 - 2.08624 i,
 -5.04238 + 5.02122 i, -5.04238 - 5.02122 i, 6.20929 + 3.09539 i, 6.20929 - 3.09539 i,
 -6.42482 + 2.48272 i, -6.42482 - 2.48272 i, 2.83363 + 6.23469 i, 2.83363 - 6.23469 i,
```

```
-6.71164, 6.6399, 3.87266 + 5.13629 i, 3.87266 - 5.13629 i, -1.72771 + 6.09027 i,
-1.72771 - 6.09027 i, 1.01831 + 6.22568 i, 1.01831 - 6.22568 i, -2.81882 + 5.07466 i,
-2.81882 - 5.07466 i, 0.531217 + 5.67403 i, 0.531217 - 5.67403 i, 2.96922 + 4.73358 i,
2.96922 - 4.73358 i, 4.41708 + 3.22761 i, 4.41708 - 3.22761 i, 5.20508 + 0.629525 i,
5.20508 - 0.629525 i, -0.994286 + 4.96347 i, -0.994286 - 4.96347 i, -4.99116,
3.94534 + 2.8691 i, 3.94534 - 2.8691 i, -3.50634 + 3.26777 i, -3.50634 - 3.26777 i,
-3.97785 + 1.5185 i, -3.97785 - 1.5185 i, -0.315041 + 3.45147 i, -0.315041 - 3.45147 i,
2.86769 + 1.7442 i, 2.86769 - 1.7442 i, -2.90289 + 1.53675 i, -2.90289 - 1.53675 i, 2.94837,
-0.432635 + 1.78757 i, -0.432635 - 1.78757 i, 0.986795 + 1.50386 i, 0.986795 - 1.50386 i,
-1.41842 + 0.451695 i, -1.41842 - 0.451695 i, 1.34406, 0.0554687, 0., 0., 0.,
0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.}
```

In[ ]:=
```
Abs[EigensofW]
```

Out[ ]=
```
{483.848, 21.0452, 21.0452, 19.2783, 19.2783, 18.6126, 18.6126, 18.5254, 18.5254, 18.0136,
18.0136, 18.0122, 18.0122, 17.9328, 17.9328, 17.907, 17.8044, 17.8044, 17.7598, 17.7598,
17.618, 17.618, 17.0883, 17.0883, 16.9151, 16.9151, 16.7562, 16.7562, 16.7403, 16.7403,
16.7261, 16.7261, 16.5261, 16.5261, 16.2354, 16.2354, 16.1182, 16.1182, 16.0331,
16.0331, 15.8907, 15.8907, 15.8717, 15.8717, 15.6624, 15.6624, 15.5602, 15.5602,
15.5068, 15.5068, 15.3717, 15.3717, 15.3079, 15.3079, 15.1298, 14.9354, 14.9354,
14.7776, 14.7776, 14.7278, 14.6933, 14.6279, 14.6279, 14.5389, 14.5389, 14.4876,
14.4876, 14.3385, 14.3385, 14.3154, 14.3154, 14.1006, 14.1006, 14.0539, 14.0539,
13.8427, 13.8427, 13.6793, 13.6793, 13.6534, 13.6534, 13.6406, 13.6406, 13.3918,
13.3888, 13.3888, 13.3026, 13.3026, 13.2593, 13.2593, 13.2062, 13.2062, 13.0527,
13.0527, 12.9311, 12.8709, 12.8709, 12.7579, 12.7579, 12.6498, 12.6498, 12.5293,
12.5293, 12.4179, 12.4179, 12.2809, 12.2809, 12.2407, 12.2407, 12.022, 12.022, 11.9158,
11.9158, 11.8375, 11.8375, 11.8348, 11.8348, 11.7173, 11.7173, 11.6004, 11.5688,
11.5688, 11.3761, 11.3761, 11.3475, 11.3475, 11.194, 11.1645, 11.1645, 11.1201, 11.1201,
10.8321, 10.8321, 10.8219, 10.8219, 10.7449, 10.7449, 10.6744, 10.6744, 10.5885,
10.5885, 10.4424, 10.4424, 10.2983, 10.2983, 10.2305, 10.2305, 10.1155, 10.1155,
10.0042, 10.0042, 9.73492, 9.73492, 9.5252, 9.5252, 9.44094, 9.44094, 9.35515, 9.35515,
9.2957, 9.2957, 9.10963, 9.10963, 8.84705, 8.84705, 8.64075, 8.64075, 8.56738, 8.56738,
8.56529, 8.56529, 8.2238, 8.2238, 7.89157, 7.89157, 7.86774, 7.65954, 7.65954, 7.36514,
7.36514, 7.11882, 7.11882, 7.11606, 7.11606, 6.93807, 6.93807, 6.88783, 6.88783,
6.84842, 6.84842, 6.71164, 6.6399, 6.43264, 6.43264, 6.33059, 6.33059, 6.30841,
6.30841, 5.80499, 5.80499, 5.69884, 5.69884, 5.58775, 5.58775, 5.47066, 5.47066,
5.24301, 5.24301, 5.06208, 5.06208, 4.99116, 4.87826, 4.87826, 4.79299, 4.79299,
4.25783, 4.25783, 3.46582, 3.46582, 3.35646, 3.35646, 3.28457, 3.28457, 2.94837,
1.83918, 1.83918, 1.79871, 1.79871, 1.48861, 1.48861, 1.34406, 0.0554687, 0., 0.,
0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.}
```

```
Wgenesample
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[Sum[(set[[i]])^α, {i, 1, n}]] // N
H0 = Log[n] // N ;(* H0 = Hartley Entropy*)
H1 = -Sum[((set[[i]]) (Log[set[[i]]])), {i, 1, n}] // N; (* H1 = Shannon Entropy*)
H2onward = Table[H[a], {a, 2, 20}] // N ;(* H2 onward *)
RenyiEntropyofEigenvalues = Join[{H0}, {H1}, H2onward];
```

Out[ ]= Human chromosome9 scaffold gene

In[ ]:=
```
Abs[rhoEigens]
```

Out[ ]=
```
{266021., 3806.06, 3389.28, 2450.78, 1912.6, 1773.95, 1645.93, 1562.73, 1421.38, 1393.77,
 1338.46, 1279.79, 1258.53, 1237.62, 1202.43, 1147.59, 1134.25, 1117.5, 1091.67,
 1042.43, 1004.17, 993.133, 975.255, 952.125, 932.025, 923.146, 894.656, 871.752,
 856.101, 848.158, 837.193, 827.084, 802.064, 789.353, 782.585, 764.194, 759.974,
 744.507, 733.538, 727.8, 709.079, 696.459, 683.526, 669.329, 660.707, 650.239, 648.121,
 630.997, 621.876, 620.126, 610.721, 605.601, 594.97, 588.609, 581.376, 562.353,
 553.969, 548.08, 530.752, 520.77, 515.185, 504.421, 498.906, 491.608, 481.472, 473.282,
 471.475, 462.801, 458.669, 448.371, 444.36, 434.536, 429.254, 421.526, 414.627, 404.69,
 402.189, 392.587, 385.249, 376.745, 374.051, 361.052, 357.922, 353.906, 346.076,
 340.597, 337.628, 331.13, 326.501, 319.903, 317.057, 314.908, 308.495, 307.951,
 298.837, 298.009, 293.027, 286.488, 281.229, 274.199, 272.686, 267.677, 261.447,
 255.358, 244.996, 242.571, 233.2, 231.124, 229.491, 225.681, 224.051, 221.124, 218.349,
 216.522, 211.058, 204.307, 201.943, 195.608, 191.972, 190.154, 187.058, 185.029,
 181.413, 175.733, 174.211, 168.877, 167.461, 164.878, 158.908, 158.374, 155.961,
 154.325, 148.703, 145.967, 145.18, 142.788, 142.085, 139.663, 135.557, 129.041,
 125.922, 122.917, 121.442, 120.44, 117.932, 115.184, 112.394, 110.399, 107.631,
 105.408, 103.149, 99.939, 98.7483, 94.5576, 92.5514, 89.7287, 88.9743, 85.5292,
 84.2914, 82.9885, 80.7292, 79.1281, 76.2596, 72.9578, 71.1938, 68.4218, 66.5738,
 64.591, 63.4024, 62.9802, 60.479, 59.559, 57.5124, 54.9998, 53.9055, 52.8349, 50.2557,
 49.1445, 47.7769, 45.0571, 44.2219, 41.9247, 41.4539, 40.8924, 40.0632, 37.5205,
 36.0087, 35.5347, 34.1811, 32.6806, 32.5248, 29.3879, 28.2356, 27.6005, 26.9967,
 24.4664, 23.2797, 22.5026, 21.8369, 21.2764, 19.8888, 18.8483, 17.3046, 15.8729,
 15.5208, 14.2935, 13.7374, 13.1778, 12.4535, 12.0886, 11.3875, 10.6453, 9.54106, 8.9693,
 8.82021, 8.41967, 7.65915, 6.62035, 5.99868, 5.08291, 4.55845, 4.44252, 4.31448,
 3.77024, 2.98685, 2.77102, 2.42774, 2.00658, 1.73301, 1.60463, 1.11771, 0.830514}
```

In[ ]:=
```
RenyiEntropyofEigenvalues
```

Out[ ]=
```
{5.44674, 2.52786, 0.82095, 0.617115, 0.548553, 0.514268, 0.493697,
 0.479984, 0.470188, 0.462841, 0.457127, 0.452556, 0.448816, 0.445699,
 0.443062, 0.440801, 0.438842, 0.437128, 0.435615, 0.434271, 0.433068}
```

In[ ]:=
```
button =
  Button["Click here for output and pdf", Print[Style[Wgenesample, Black, Bold, 28]] ×
```

```
Print[Style["The ", Blue, Italic, 18], Style[Wgenesample, Black, Italic, 18],
 Style["  has  ", Blue, Italic, 18], Style[lengthofgeneitself, Black, Italic, 18],
 Style["   base pairs   ", Blue, Italic, 18]] ×
If[StringLength[SpecialNote] > 3, Print[Style["(Special Note): ", Black, Bold, 16],
  Style[SpecialNote, Black, Italic, 12]], Print["  "]] ×
Print[Style["W is a   ", Blue, Italic, 18], Style[Length[W], Black, Italic, 18],
 Style["  by  ", Blue, Italic, 18], Style[Length[W[[1]]], Black, Italic, 18],
 Style["   matrix with   ", Blue, Italic, 18],
 Style[Length[W] * Length[W[[1]]], Black, Italic, 18],
 Style[" = 2^b elements", Blue, Italic, 18], Style["  for b = ", Blue, Italic, 18],
 Style[Log[2, Length[W] * Length[W[[1]]]], Black, Italic, 18]] ×
If[(Length[W] * Length[W[[1]]]) == (Length[W])^2,
 Print[Style["(If statement safecheck):  ", Black, Bold, 12],
  Style[Length[W], Black, Italic, 12], Style["  times  ", Red, Italic, 12],
  Style[Length[W[[1]]], Black, Italic, 12],
  Style["   equals   ", Red, Italic, 12], Style[(Length[W]^2), Black, Italic, 12],
  Style["  W is of the right size, you may proceed ", Red, Italic, 12]],
 Print[Style["(If statement safecheck):  ", Black, Bold, 12],
  Style["Warning!!!", Red, Italic, 28],
  Style["   W is of wrong size, STOP and check W ", Red, Italic, 12]]] ×
Print["The number of nonzero eigenvalues is  =   ", 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[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["The approximate linearity of the above plot tells us
   that the eigenvalues decrease exponentially. If it's
   nowhere near linear try adjusting the plot range. "]
×
Print["  "] ×
Print[Style[
  "[redacted]", 18]] ×
Print["  "]
×
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]] ×
If[Total[set] == 1, Print[Style["(If statement safecheck):  ", Black, Bold, 12],
  Style["Total[set] = ", Red, Italic, 12], Style[Total[set], Black, Italic, 12],
```

```
      Style[" = 1, so the Eigenvalue set is properly normalized", Red, Italic, 12]],
     Print[Style["(If statement safecheck):  ", Black, Bold, 12],
      Style["Warning!!!", Red, Italic, 28], Style["  Total[set] = ", Red, Italic, 12],
      Style[Total[set], Black, Italic, 12], Style[" ≠ 1, ", Red, Italic, 12],
      Style[" so the Eigenvalue set is NOT properly normalized.", Red, Italic, 12],
      Style[" This will render the entropies invalid. Fix it. ", Red, Italic, 12]]]
    ×
    Print["  "] ×
    Print[Style[
      "[redacted]", 18]] ×
    Print["  "]
    ×
    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}]
      ]]] ×
    Export["rhoEigenEntropies.pdf", EvaluationNotebook[]] ×
    NotebookSave[EvaluationNotebook[], "rhoCalcOutput"];
   SystemOpen["rhoEigenEntropies.pdf"]
   (*DeleteFile[StringReplace["rhoEigenEntropies.pdf","rho"→ Wgenesample]]
    RenameFile["rhoEigenEntropies.pdf",
     StringReplace["rhoEigenEntropies.pdf","rho"→ Wgenesample]]
    SystemOpen[StringReplace["rhoEigenEntropies.pdf","rho"→ Wgenesample]]*)
   , Background → Green];
nb = CreateDocument[];
Paste[nb, button]
NotebookEvaluate[nb];
```

Possible Issues

Be sure that W contains only integer values (e.g. 0, 1, 2, 3, 4).
Including floats (e.g. 0.0, 1.0, 2.0, 3.0, 4.0) may incorrectly make some of the eigenvalues negative or imaginary because of how mathematica handles floats differntly than it handles integers.