Singular Spectrum Analysis

make test data

In[1]:= `len = 200`

Out[1]= `200`

line

In[2]:= `a1 = Table[N[2 * i / len], {i, len}];`

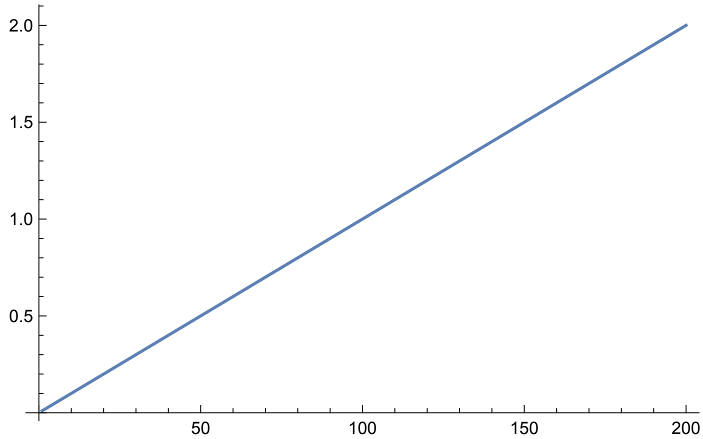
In[3]:= `Export["~/ssa_20211008/graph1.csv", a1, "CSV"]`

Out[3]= `~/ssa_20211008/graph1.csv`

line

In[4]:= `ListPlot[a1, Joined → True]`

Out[4]=



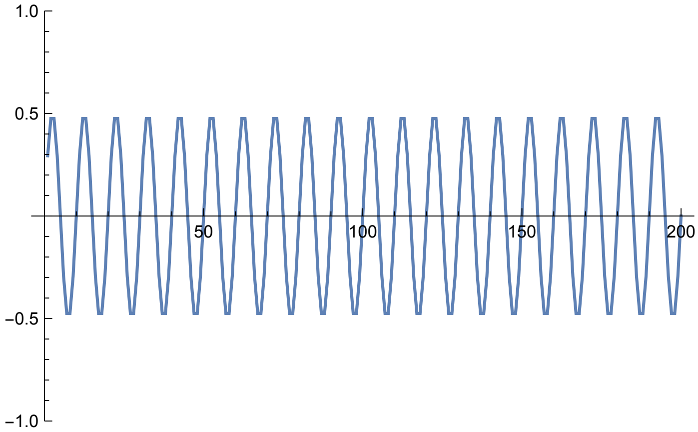
sine wave

In[5]:= `a2 = Table[0.5 * Sin[2 Pi (20 * i / len)], {i, len}];`

In[6]:= `Export["~/ssa_20211008/graph2.csv", a2, "CSV"]`

Out[6]= `~/ssa_20211008/graph2.csv`

In[7]:=
```
ListPlot[a2, Joined → True, PlotRange → {-1, 1}]
```

Out[7]=


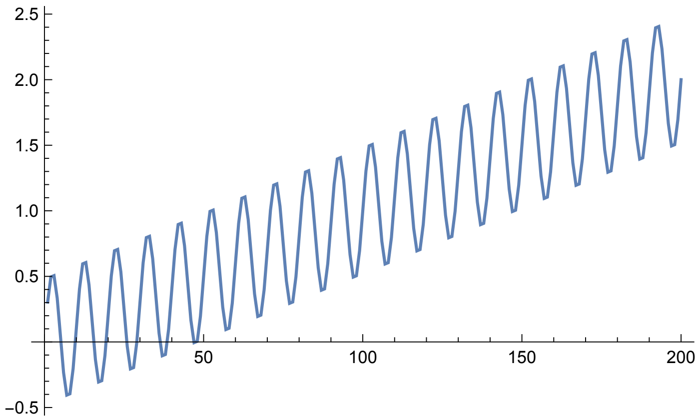
superposition of curves

In[8]:=
```
c = a1 + a2;
```

In[9]:=
```
Export["~/ssa_20211008/graph3.csv", c, "CSV"]
```

Out[9]= ~/ssa_20211008/graph3.csv

In[10]:=
```
ListPlot[c, Joined → True]
```

Out[10]=


decomposition of curve by singular spectral analysis

In[11]:=
```
c[[1]]
```

Out[11]= 0.303893

In[12]:=
```
Length[c]
```

Out[12]= 200

Out[ ]= 200

Out[ ]= 200

Out[ ]= 0

In[13]:= `Dimensions[c]`

Out[13]= {200}

Out[ ]= {200}

Out[ ]= {200}

In[14]:= `m = Length[c]`

Out[14]= 200

In[15]:= `n = Floor[m / 2]`

Out[15]= 100

In[16]:= `m - n + 1`

Out[16]= 101

In[17]:= `% + n`

Out[17]= 201

In[18]:= `x = N[Table[c[[i + j - 1]], {i, m - n + 1}, {j, n}]];`

In[19]:= `Dimensions[x]`

Out[19]= {101, 100}

In[20]:= `? SingularValueDecomposition`

Out[20]=

Symbol

SingularValueDecomposition[m] gives the singular value decomposition for a numerical matrix m as a list of matrices $\{u, w, v\}$, where w is a diagonal matrix and m can be written as $u.w$.Conjugate[Transpose[v]].

SingularValueDecomposition[$\{m, a\}$] gives the generalized singular value decomposition of m with respect to a.

SingularValueDecomposition[m, k] gives the singular value decomposition associated with the k largest singular values of m.

SingularValueDecomposition[m, UpTo[k]] gives the decomposition for the k largest singular values, or as many as are available.

SingularValueDecomposition[$\{m, a\}$, k] gives the generalized singular value decomposition associated with the k largest singular values.

In[21]:= `uu = SingularValueDecomposition[x];`

In[22]:= `Dimensions[uu]`

Out[22]= {3}

In[23]:= `u = uu[[1]];`

In[24]:= `w = uu[[2]];`

In[25]:= `v = uu[[3]];`

In[26]:=
```
Dimensions[u]
```
Out[26]=
```
{101, 101}
```

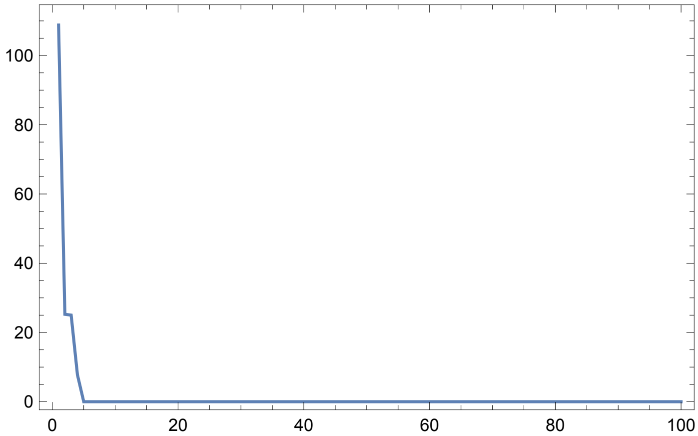
In[27]:=
```
Dimensions[w]
```
Out[27]=
```
{101, 100}
```

In[28]:=
```
Dimensions[v]
```
Out[28]=
```
{100, 100}
```

In[42]:=
```
Print[n]
```
```
100
```

distribution of singular values

In[43]:=
```
ListPlot[Table[{i, w[[i, i]]}, {i, n}],
 Joined → True, PlotRange -> All, Axes → False, Frame → True]
```
Out[43]=



In[30]:=
```
sn[xx_] := Module[{i, j, k, n, n1, x, sum}, x = {};
  {n1, n} = Dimensions[xx];
  j = 0; sum = 0;
  Do[Do[If[k ≤ n, sum = sum + xx[[i - k + 1, k]]; j = j + 1], {k, i}];
   x = Append[x, sum / j]; sum = 0; j = 0, {i, n1}];
  j = 0; sum = 0;
  Do[Do[If[k ≤ n1, sum = sum + xx[[n1 - k + 1, k + i - 1]];
      j = j + 1], {k, n - i + 1}];
   x = Append[x, sum / j]; sum = 0; j = 0, {i, 2, n}];
  Return[x]]
```

0

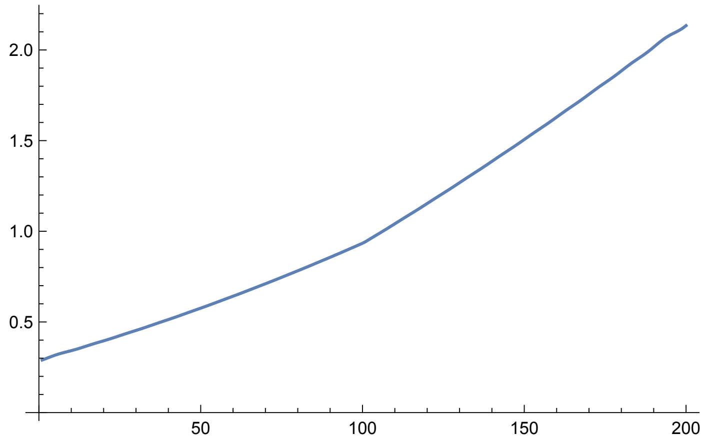
trend

In[31]:=
```
xx = Sum[w[[i, i]] × Outer[Times, Transpose[u][[i]], Transpose[v][[i]]], {i, 1}];
```

In[32]:=
```
y1 = sn[xx];
```

In[33]:=
```
ListPlot[y1, Joined → True, PlotRange → All]
```

Out[33]=



elements except trend

In[34]:=
```
xx = Sum[w[[i, i]] × Outer[Times, Transpose[u][[i]], Transpose[v][[i]]], {i, 2, 3}];
```

In[35]:=
```
y1 = sn[xx];
```

In[36]:=
```
ListPlot[y1, Joined → True]
```

Out[36]=