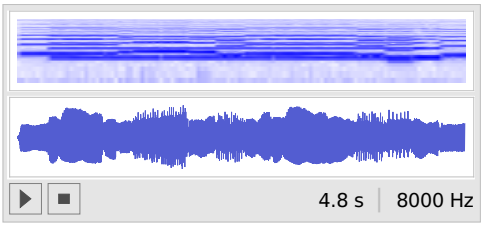
Vectors and Matrices as Data

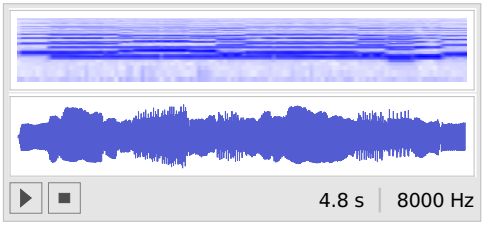
do as fast as possible to test time taken

- Question 1

In[1]:=
```
Sound@
```



Out[1]=



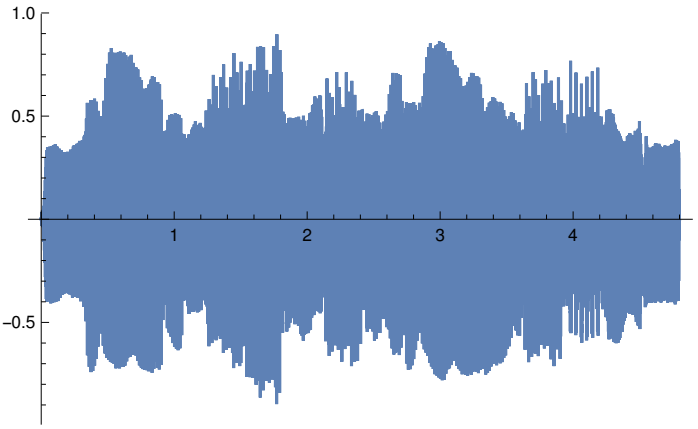
In[2]:=
```
x = Import["/home/nathan/QEA-Homework/module 2/day4/hornCSV.csv"];
x1 = Import[
    "/home/nathan/QEA-Homework/module 2/day4/english_horn.wav", "Data"] // Flatten
```

Out[3]=
```
{0.00466919, 0.010376, 0.00534058, 0.00265503, 0.0039978, 0.00146484,
 -0.00146484, -0.00311279, -0.00344849, -0.00479126, -0.00830078,
 -0.00372314, -0.00210571, 0.00189209, -0.000488281, 0.00527954,
 0.00195313, 0.00344849, ··· 38364 ···, 0.0114136, -0.056427, -0.0945129,
 -0.0944214, -0.0813904, -0.0660095, -0.0410461, -0.0175781,
 -0.0243835, -0.0207825, -0.00665283, -0.00582886, -0.010498,
 -0.00796509, -0.00369263, -0.000457764, 0.000671387, 0.000396729}
```

large output | **show less** | **show more** | **show all** | **set size limit...**

In[4]:=
```
ListLinePlot[x]
```

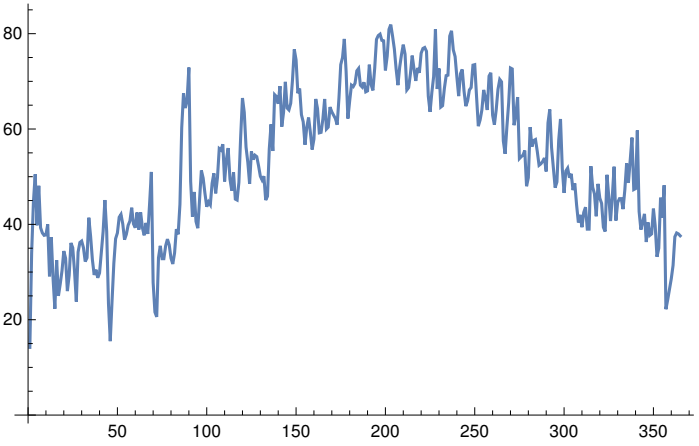
Out[4]=



In[5]:=
```
t = Transpose@
    Import["/home/nathan/QEA-Homework/module 2/day4/1998DailyTempBos.csv"];
```

In[6]:=
```
ListLinePlot[t]
```

Out[6]=



In[7]:=
```
2. Transpose[x1][[1]]
```

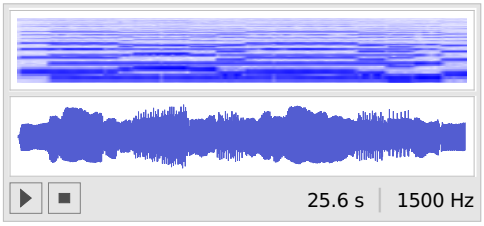
Transpose::nmtx : The first two levels of
{0.00466919, 0.010376, 0.00534058, 0.00265503, 0.0039978, 0.00146484, −0.00146484, −0.00311279, −0.00344849, −0.00479126, −0.00830078, −0.00372314, −0.00210571, 0.00189209, −0.000488281, 0.00527954, 0.00195313, 0.00344849, 0.000915527, 0.0126953, ≪11≫, −0.006073, 0.00119019, −0.00820923, 0.000762939, −0.0027771, 0.00137329, −0.00927734, 0.00558472, −0.000915527, 0.00439453, 0.00830078, 0.0155029, 0.0135193, 0.0136414, 0.0169067, 0.0230713, 0.0341797, 0.0192261, 0.025116, ≪38350≫} cannot be transposed. ≫

Out[7]=
```
{0.00933838, 0.020752, 0.0106812, 0.00531006, 0.00799561, 0.00292969,
 -0.00292969, -0.00622559, -0.00689697, -0.00958252, -0.0166016,
 -0.00744629, -0.00421143, 0.00378418, -0.000976563, 0.0105591, 0.00390625,
 0.00689697, 0.00183105, 0.0253906, ··· 38360 ···, 0.239929, 0.149902,
 0.0228271, -0.112854, -0.189026, -0.188843, -0.162781, -0.132019,
 -0.0820923, -0.0351563, -0.0487671, -0.0415649, -0.0133057, -0.0116577,
 -0.0209961, -0.0159302, -0.00738525, -0.000915527, 0.00134277, 0.000793457}
```

large output | show less | show more | show all | set size limit...

In[8]:=
```
audio = Sound[SampledSoundList[x1, 1500]]
```

Out[8]=



In[9]:=
```
Export["low.flac", audio]
```

Out[9]= low.flac

In[10]:=
```
in = Import[
    "/home/nathan/QEA-Homework/module 2/day4/english_horn.wav", "Data"] // Flatten
```

Out[10]=
```
{0.00466919, 0.010376, 0.00534058, 0.00265503, 0.0039978, 0.00146484,
 -0.00146484, -0.00311279, -0.00344849, -0.00479126, -0.00830078,
 -0.00372314, -0.00210571, 0.00189209, -0.000488281, 0.00527954,
 0.00195313, 0.00344849, ··· 38364 ···, 0.0114136, -0.056427, -0.0945129,
 -0.0944214, -0.0813904, -0.0660095, -0.0410461, -0.0175781,
 -0.0243835, -0.0207825, -0.00665283, -0.00582886, -0.010498,
 -0.00796509, -0.00369263, -0.000457764, 0.000671387, 0.000396729}
```

large output | **show less** | **show more** | **show all** | **set size limit...**

■ Question 2

In[11]:=

In[12]:=
```
    1
a = 2;
    3

    3
b = 2;
    1

    3  0  0
d = 0  2  0;
    0  0  1
```

In[15]:=
```
b * a
```

Out[15]=
```
{{3}, {4}, {3}}
```

In[16]:=
```
a.b
```

Dot::dotsh : Tensors {{1}, {2}, {3}} and {{3}, {2}, {1}} have incompatible shapes. >>

Out[16]=
```
{{1}, {2}, {3}}.{{3}, {2}, {1}}
```

In[17]:=
```
a.Transpose[b]
```

Out[17]=
```
{{3, 2, 1}, {6, 4, 2}, {9, 6, 3}}
```

In[18]:=
```
d.a
```

Out[18]=
```
{{3}, {4}, {3}}
```

In[19]:=
```
d.a.Transpose[a]
```

Out[19]=
```
{{3, 6, 9}, {4, 8, 12}, {3, 6, 9}}
```

■ Question 3, 4

In[20]:=
```
Clear["Global`*"]
```

In[21]:=
```
d = Join[
  {Join[{1}, Table[0, 364]]},
  Table[Join[Table[0, i - 1], {1 / 3, 1 / 3, 1 / 3}, Table[0, 363 - i]], {i, 363}],
  {Join[Table[0, 364], {1}]}
 ]
```

Out[21]=
```
{ ··· 1 ··· }
```
large output | show less | show more | show all | set size limit...

In[22]:=
```
t = Import["/home/nathan/QEA-Homework/module 2/day4/1998DailyTempBos.csv"];
```

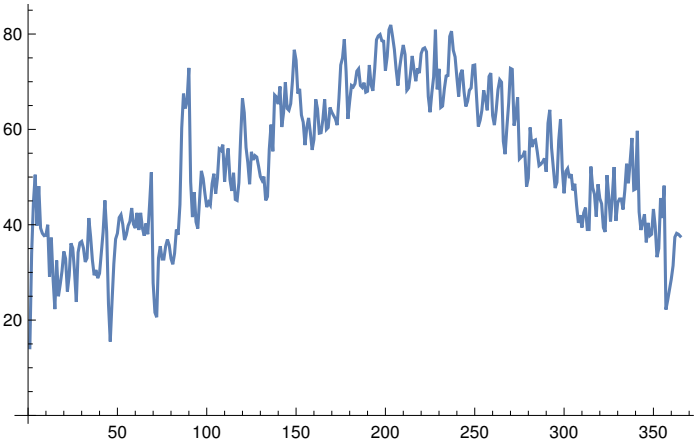
In[23]:=
```
Dimensions[t]
Dimensions[d]
```

Out[23]=
```
{365, 1}
```

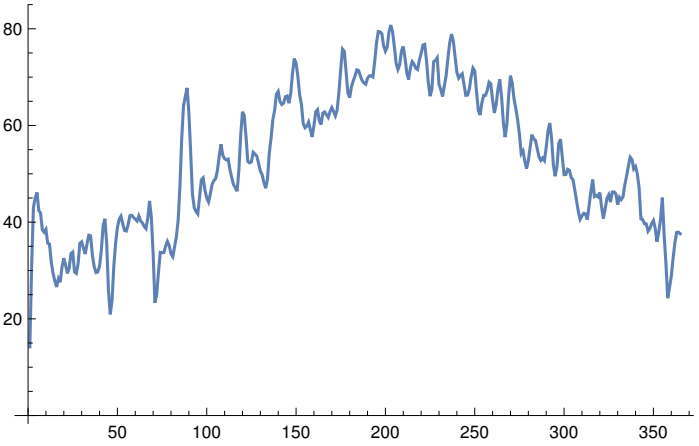
Out[24]=
```
{365, 365}
```

In[25]:=
```
ListLinePlot[Transpose[t]]
ListLinePlot[Transpose[d.t]]
ListLinePlot[Transpose[d.(d.(d.(d.t)))]]
```

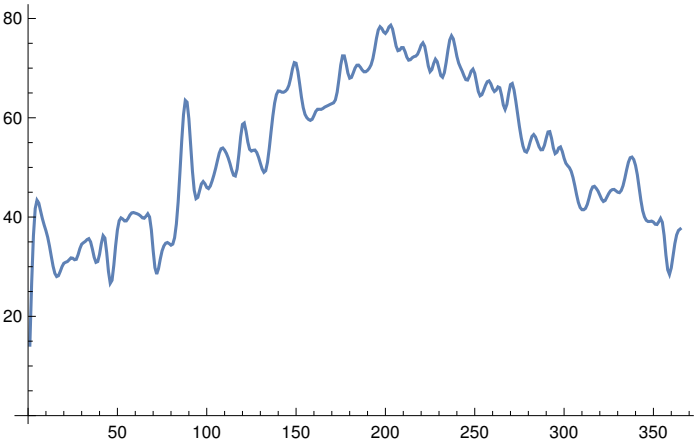
Out[25]=



Out[26]=

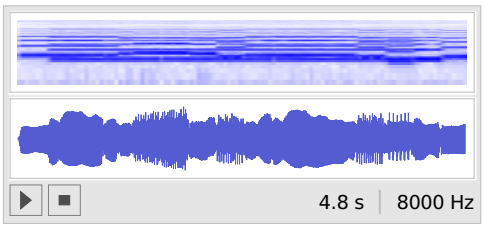


Out[27]=



- Question 7, 8

```
Clear["Global`*"]
soundData = Import[
   "/home/nathan/QEA-Homework/module 2/day4/english_horn.wav", "Data"] // Flatten
Sound[SampledSoundList[soundData, 8000]]
   1 / 3
d = 1 / 3
   1 / 3
soundDatad = ListConvolve[d^T[[1]], soundData]
Sound[SampledSoundList[soundDatad, 8000]]
```



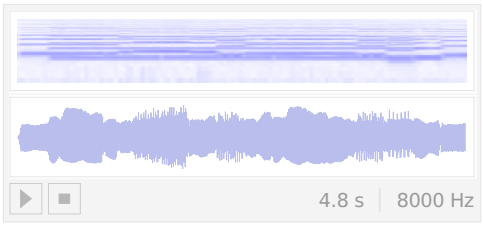

```
ListLinePlot[{soundData, soundDatad}]
```

Out[29]=

```
{0.00466919, 0.010376, 0.00534058, 0.00265503, 0.0039978, 0.00146484,
 -0.00146484, -0.00311279, -0.00344849, -0.00479126, -0.00830078,
 -0.00372314, -0.00210571, 0.00189209, -0.000488281, 0.00527954,
 0.00195313, 0.00344849, ··· 38364 ···, 0.0114136, -0.056427, -0.0945129,
 -0.0944214, -0.0813904, -0.0660095, -0.0410461, -0.0175781,
 -0.0243835, -0.0207825, -0.00665283, -0.00582886, -0.010498,
 -0.00796509, -0.00369263, -0.000457764, 0.000671387, 0.000396729}
```

large output | show less | show more | show all | set size limit...

Out[30]=



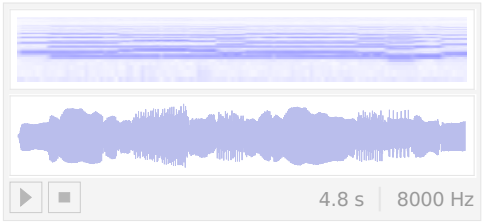
Out[31]= $\left\{\left\{\frac{1}{3}\right\}, \left\{\frac{1}{3}\right\}, \left\{\frac{1}{3}\right\}\right\}$

Out[32]=

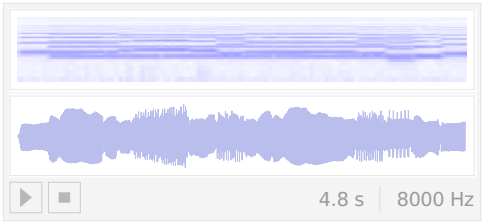
```
{0.00679525, 0.00612386, 0.0039978, 0.00270589, 0.0013326, -0.0010376,
 -0.00267537, -0.00378418, -0.00551351, -0.00560506, -0.00470988,
 -0.00131226, -0.000233968, 0.00222778, 0.00224813, 0.00356038,
 ··· 38366 ···, -0.0465088, -0.0817871, -0.0901082, -0.0806071, -0.0628153,
 -0.0415446, -0.0276693, -0.0209147, -0.0172729, -0.0110881, -0.00765991,
 -0.00809733, -0.00738525, -0.00403849, -0.00115967, 0.000203451}
```

large output | show less | show more | show all | set size limit...

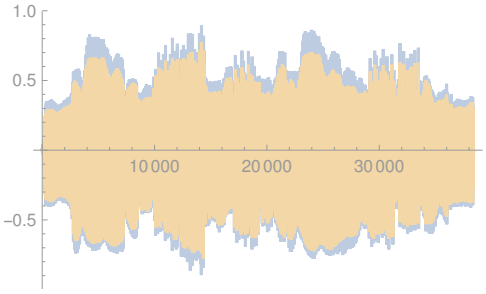
Out[33]=



Out[34]=



Out[35]=



In[36]:=

Question 10

Out[36]= 10 Question

In[37]:=
```
h = {-1, 1, 0}
```

Out[37]= {-1, 1, 0}

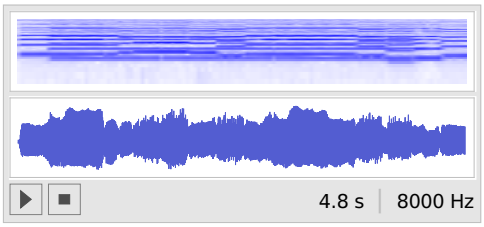
In[38]:=
```
soundDatah = ListConvolve[h, soundData]
```

Out[38]=
```
{0.0050354, 0.00268555, -0.00134277, 0.00253296, 0.00292969, 0.00164795,
 0.000335693, 0.00134277, 0.00350952, -0.00457764, -0.00161743,
 -0.0039978, 0.00238037, -0.00576782, 0.00332642, -0.00149536,
 0.00253296, -0.0117798, ··· 38362 ···, 0.0635376, 0.0678406, 0.0380859,
 -0.0000915527, -0.013031, -0.0153809, -0.0249634, -0.023468,
 0.00680542, -0.00360107, -0.0141296, -0.000823975, 0.00466919,
 -0.00253296, -0.00427246, -0.00323486, -0.00112915, 0.000274658}
```

large output | **show less** | **show more** | **show all** | **set size limit...**

In[39]:=
```
Sound[SampledSoundList[soundDatah, 8000]]
```

Out[39]=

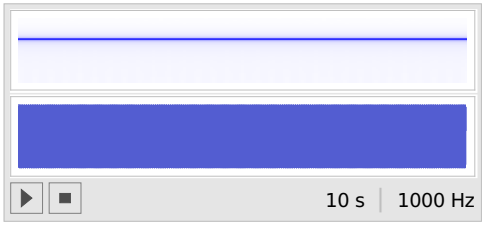


In[40]:=
```
xhf = Table[Cos[1000 t], {t, 0, 10, 10. / 10 000}];
xlf = Table[Cos[10 t], {t, 0, 10, 10. / 10 000}];
```

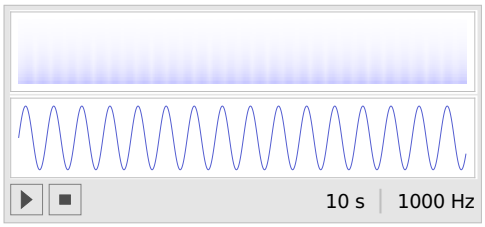
In[42]:=
```
hfSound = ListConvolve[h, xhf];
lfSound = ListConvolve[h, xlf];
```

In[44]:=
```
"High Frequency + High Pass = " Sound[SampledSoundList[hfSound, 1000]]
"Low  Frequency + High Pass = " Sound[SampledSoundList[lfSound, 1000]]
```

Out[44]= High Frequency + High Pass =

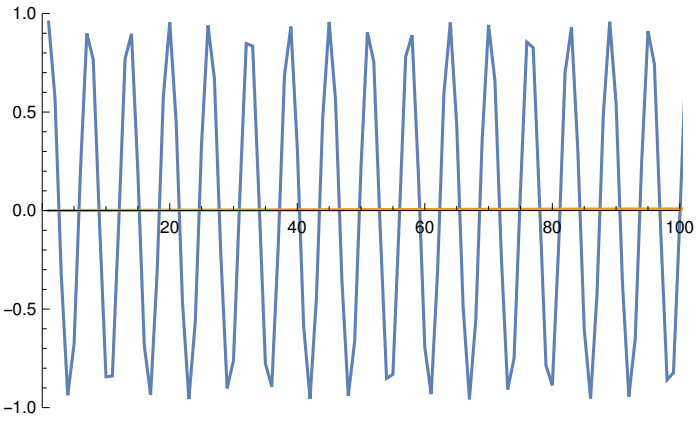


Out[45]= Low Frequency + High Pass =



In[46]:=
```
ListLinePlot[{hfSound, lfSound}, PlotRange → {{0, 100}, {-1, 1}}]
```

Out[46]=



- Question 11

```
Clear["Global`*"]
soundData = Import[
   "/home/nathan/QEA-Homework/module 2/day4/english_horn.wav", "Data"] // Flatten
h2 = {1 / 5, 1 / 5, 1 / 5, 1 / 5, 1 / 5}
soundDatah = ListConvolve[h2, soundData]
xhf2 = Table[Cos[1000 t], {t, 0, 10, 10. / 10 000}];
xlf2 = Table[Cos[10 t], {t, 0, 10, 10. / 10 000}];
hfSound2 = ListConvolve[h2, xhf2];
lfSound2 = ListConvolve[h2, xlf2];
"High Frequency + High Pass = " Sound[SampledSoundList[hfSound2, 1000]]
"Low  Frequency + High Pass = " Sound[SampledSoundList[lfSound2, 1000]]
ListLinePlot[{hfSound2, lfSound2}, PlotRange → {{0, 100}, {-1, 1}}]
```

Out[48]=
```
{0.00466919, 0.010376, 0.00534058, 0.00265503, 0.0039978, 0.00146484,
 -0.00146484, -0.00311279, -0.00344849, -0.00479126, -0.00830078,
 -0.00372314, -0.00210571, 0.00189209, -0.000488281, 0.00527954,
 0.00195313, 0.00344849, ··· 38 364 ···, 0.0114136, -0.056427, -0.0945129,
 -0.0944214, -0.0813904, -0.0660095, -0.0410461, -0.0175781,
 -0.0243835, -0.0207825, -0.00665283, -0.00582886, -0.010498,
 -0.00796509, -0.00369263, -0.000457764, 0.000671387, 0.000396729}
```

large output | show less | show more | show all | set size limit...

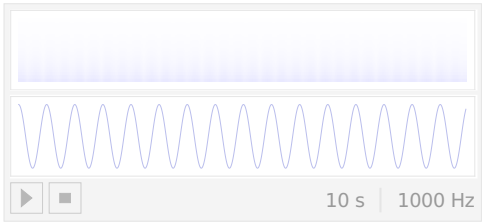
Out[49]= $\left\{\frac{1}{5}, \frac{1}{5}, \frac{1}{5}, \frac{1}{5}, \frac{1}{5}\right\}$

Out[50]=
```
{0.00540771, 0.00476685, 0.00239868, 0.000708008, -0.000512695, -0.00227051,
 -0.00422363, -0.00467529, -0.00447388, -0.00340576, -0.00254517,
 0.000170898, 0.00130615, 0.00241699, 0.00222168, 0.0048584, 0.00710449,
 ··· 38 363 ···, 0.0110779, -0.0317993, -0.0630676, -0.0785522, -0.0754761,
 -0.0600891, -0.0460815, -0.03396, -0.0220886, -0.0150452, -0.0136292,
 -0.0103455, -0.00692749, -0.00568848, -0.00438843, -0.00220947}
```

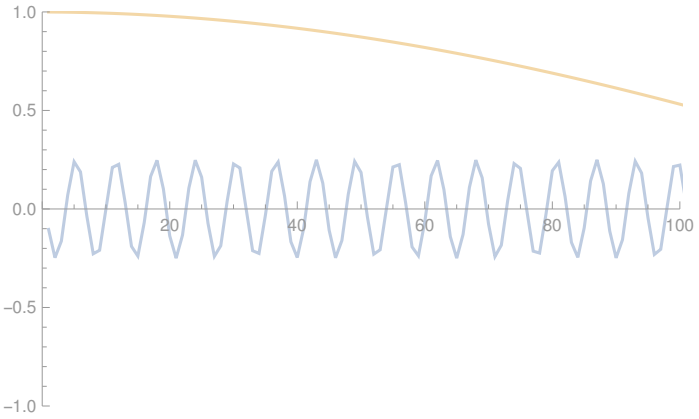
large output | show less | show more | show all | set size limit...

Out[55]= High Frequency + High Pass =

Out[56]= Low Frequency + High Pass =



Out[57]=



■ Question 12

In[58]:=
```
Clear["Global`*"]
soundData = Import[
   "/home/nathan/QEA-Homework/module 2/day4/english_horn.wav", "Data"] // Flatten
N@Length[soundData] / 8000
h = Join[{1 / 2}, Table[0, 8000], {1 / 2}];
soundData[[1 ;; 4000]];
soundData[[Length[soundData] - 4000 ;; Length[soundData]]];
SoundDatah = ListConvolve[h, soundData]
soundDatahFull = Join[(1 / 2) * soundData[[1 ;; 4000]], ListConvolve[h, soundData],
   (1 / 2) * soundData[[Length[soundData] - 4000 ;; Length[soundData]]]];
Sound[SampledSoundList[soundData, 8000]]
Sound[SampledSoundList[SoundDatah, 8000]]
Sound[SampledSoundList[soundDatahFull, 8000]]
```

Out[59]=
```
{0.00466919, 0.010376, 0.00534058, 0.00265503, 0.0039978, 0.00146484,
 -0.00146484, -0.00311279, -0.00344849, -0.00479126, -0.00830078,
 -0.00372314, -0.00210571, 0.00189209, -0.000488281, 0.00527954,
 0.00195313, 0.00344849, ··· 38364 ···, 0.0114136, -0.056427, -0.0945129,
 -0.0944214, -0.0813904, -0.0660095, -0.0410461, -0.0175781,
 -0.0243835, -0.0207825, -0.00665283, -0.00582886, -0.010498,
 -0.00796509, -0.00369263, -0.000457764, 0.000671387, 0.000396729}
```

large output | show less | show more | show all | set size limit...

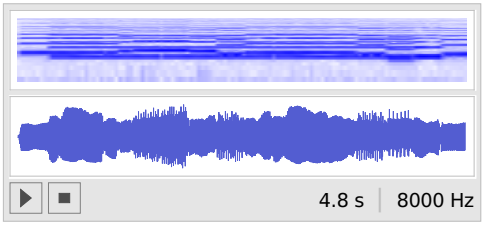
Out[60]= 4.8

Out[64]=

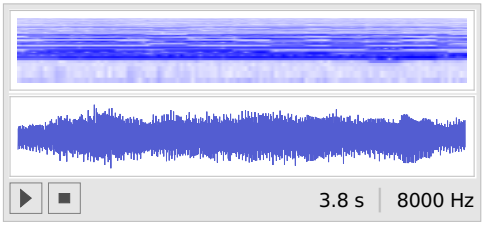
{-0.017395, 0.0696106, 0.087738, -0.00112915, -0.0913849, 0.00312805, 0.169266, 0.196487, 0.103409, 0.0485229, 0.0703888, 0.0362549, -0.0126953, -0.0113678, 0.0381165, -0.0157776, ··· 30 367 ···, -0.0193329, 0.0280914, 0.0890961, 0.14505, 0.151718, 0.110992, 0.0236359, -0.0655518, -0.0870361, -0.0253754, 0.0202484, -0.0189972, -0.0376587, -0.015152, -0.0569, -0.0821228}

large output | show less | show more | show all | set size limit...

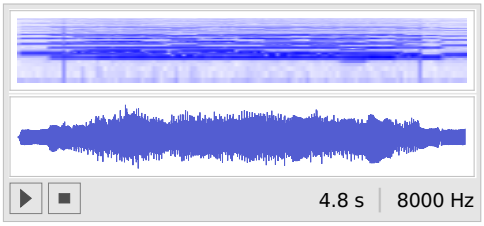
Out[66]=



Out[67]=



Out[68]=



Question 13

In[69]:=
```
Clear["Global`*"]
```

In[70]:=
```
t = Import["/home/nathan/QEA-Homework/module 2/day4/1998DailyTempBos.csv"];
```

In[71]:=
```
h = Table[1 / 5, 5]
```

Out[71]= $\left\{\frac{1}{5}, \frac{1}{5}, \frac{1}{5}, \frac{1}{5}, \frac{1}{5}\right\}$

In[72]:=
```
t1 = ListConvolve[h, t^T[[1]]];
```

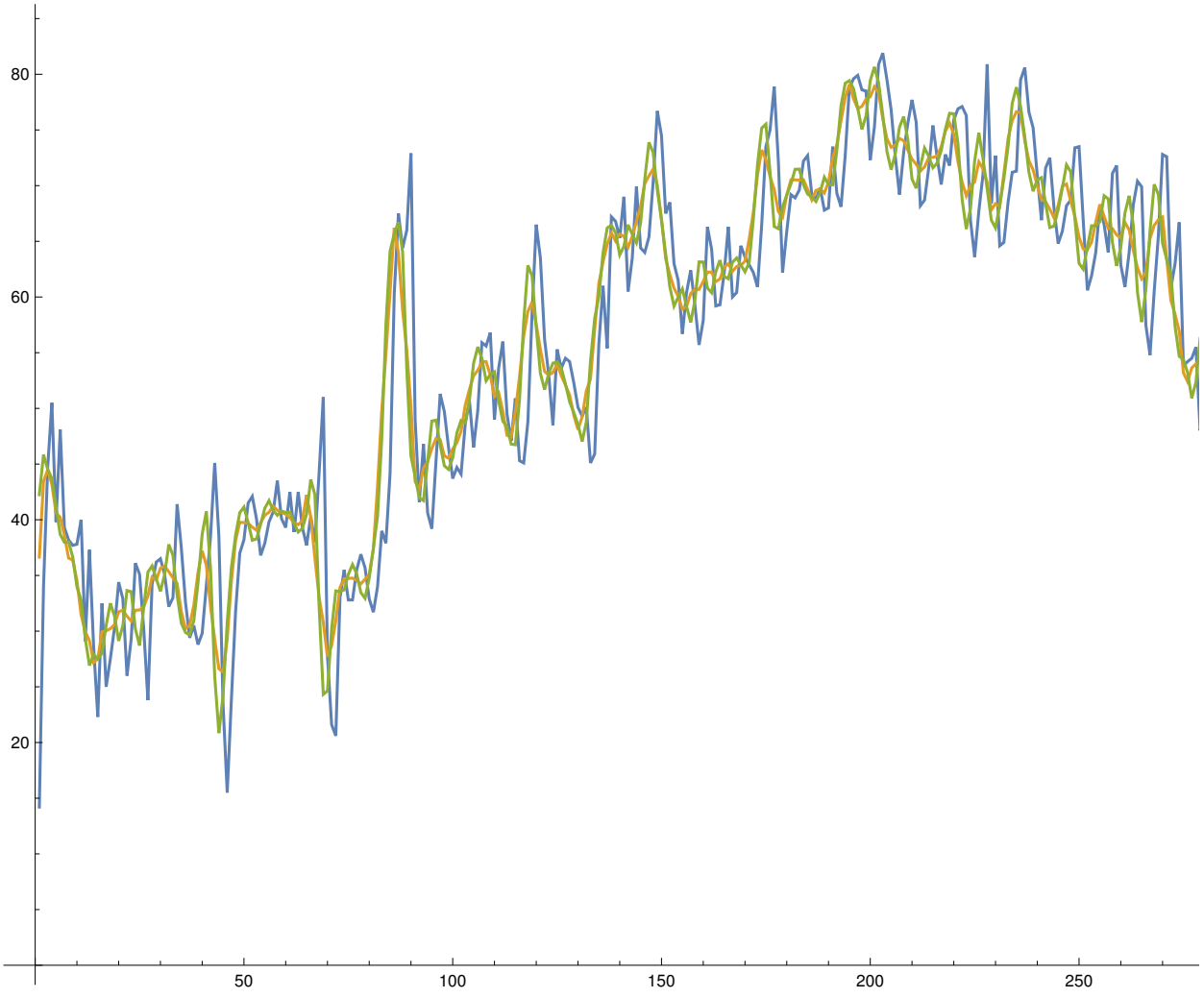
In[73]:=
```
k = {.036, .241, .446, .241, .036}
```

Out[73]= {0.036, 0.241, 0.446, 0.241, 0.036}

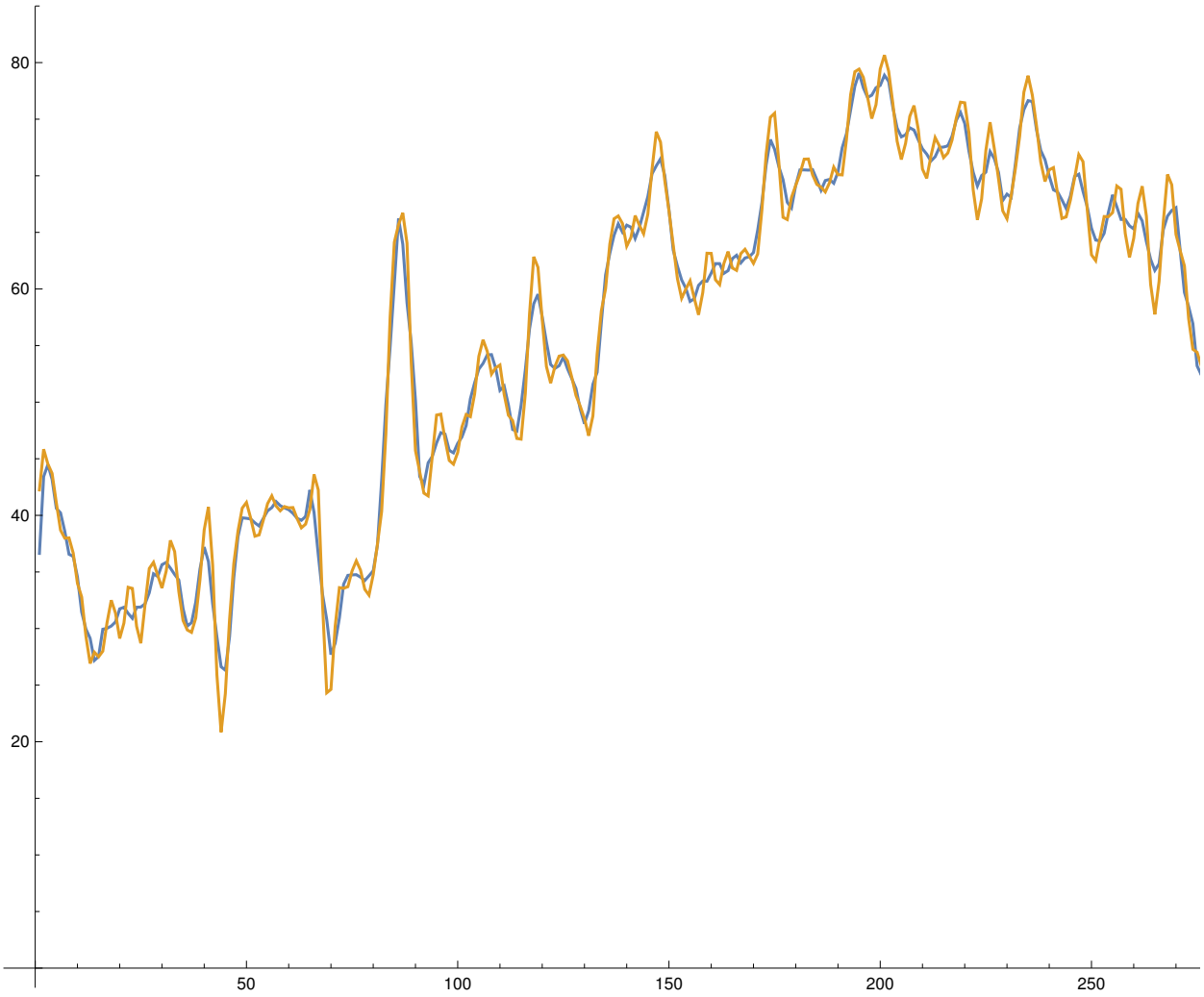
In[74]:=
```
t2 = ListConvolve[k, t^T[[1]]];
```

In[75]:=
```
ListLinePlot[{t^T[[1]], t1, t2}]
ListLinePlot[{t1, t2}]
```

Out[75]=



Out[76]=



Question 14

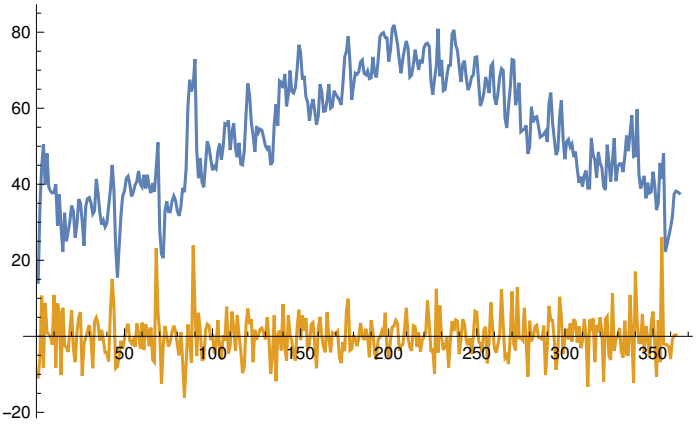
In[77]:=
```
Clear["Global`*"]
```

In[78]:=
```
t = Import["/home/nathan/QEA-Homework/module 2/day4/1998DailyTempBos.csv"];
h = {-1, 1, 0};
t = t^T[[1]];
```

In[81]:=
```
t1 = ListConvolve[h, t];
```

In[82]:=
```
ListLinePlot[{t, t1}]
```

Out[82]=



In[83]:=

Define Kernel

Out[83]=

Define Kernel

In[84]:=
```
Clear["Global`*"]
```

In[85]:=
```
kernel[vec_, kern_] := Join[
  {vec[[1]]},
  Table[Total[vec[[i ;; i + Length[kern] - 1]] * kern],
   {i, 1, 1 + Length[vec] - Length[kern]}], {vec[[-1]]}]
```

In[86]:=
```
kernel[{1, 3, 2, -1, 3, 1}, {1 / 2, 1 / 3, 1 / 4}]
```

Out[86]=

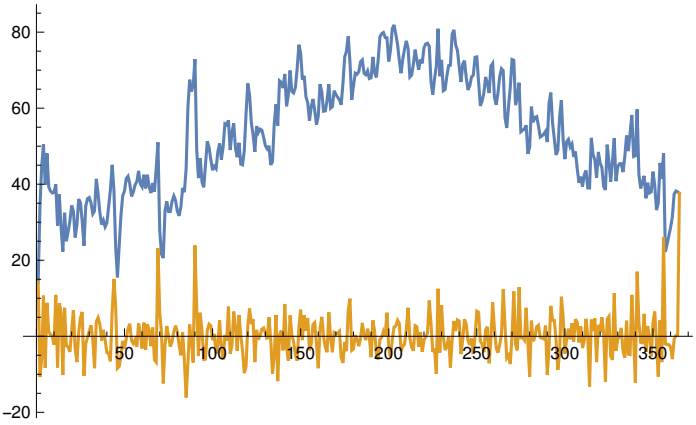
$$\left\{1, 2, \frac{23}{12}, \frac{17}{12}, \frac{3}{4}, 1\right\}$$

In[87]:=
```
t = Import["/home/nathan/QEA-Homework/module 2/day4/1998DailyTempBos.csv"];
k = {0, 1, -1};
t = t^T[[1]];
```

In[90]:=
```
tk = kernel[t, k];
```

In[91]:=
```
ListLinePlot[{t, tk}]
```

Out[91]=



In[92]:=

Define Kernel 2D

Out[92]=

Define Kernel 2D

In[93]:=

```
Clear["Global`*"]
```

In[94]:=

```
a = {{1, 2, 3, 4, 5}, {6, 7, 8, 9, 10},
    {11, 12, 13, 14, 15}, {16, 17, 18, 19, 20}, {21, 22, 23, 24, 25}};
a1 = a
k = (1 / 11) * {{1, 1, 1}, {1, 3, 1}, {1, 1, 1}}
```

Out[95]=

```
{{1, 2, 3, 4, 5}, {6, 7, 8, 9, 10},
 {11, 12, 13, 14, 15}, {16, 17, 18, 19, 20}, {21, 22, 23, 24, 25}}
```

Out[96]=

$$\left\{\left\{\frac{1}{11}, \frac{1}{11}, \frac{1}{11}\right\}, \left\{\frac{1}{11}, \frac{3}{11}, \frac{1}{11}\right\}, \left\{\frac{1}{11}, \frac{1}{11}, \frac{1}{11}\right\}\right\}$$

In[97]:=

```
kernel2D[a_, k_] := Module[{a1},
  a1 = a;
  For[t = 2, t < Length[a], t = t + 1,
   For[z = 2, z < Length[a], z = z + 1,
    a1[[t, z]] =
          k[[1, 1]] a[[t - 1, z - 1]] +
          k[[1, 2]] a[[t - 1, z]] +
          k[[1, 3]] a[[t - 1, z + 1]] +
          k[[2, 1]] a[[t, z - 1]] +
          k[[2, 2]] a[[t, z]] +
          k[[2, 3]] a[[t, z + 1]] +
          k[[3, 1]] a[[t + 1, z - 1]] +
          k[[3, 2]] a[[t + 1, z]] +
          k[[3, 3]] a[[t + 1, z + 1]]]
  ];
  Return@a1]
```

In[98]:=
```
kernel2D[a, k]
```

Out[98]=
```
{{1, 2, 3, 4, 5}, {6, 7, 8, 9, 10},
 {11, 12, 13, 14, 15}, {16, 17, 18, 19, 20}, {21, 22, 23, 24, 25}}
```

In[99]:=
```
house = Import["/home/nathan/QEA-Homework/module 2/day4/house.png", "Data"];
k1 = (1 / 11) * {{1, 1, 1}, {1, 3, 1}, {1, 1, 1}};
k2 = {{0, 1, 0}, {1, -4, 1}, {0, 1, 0}}
k3 = {{-1, -1, -1}, {-1, 9, -1}, {-1, -1, -1}}
houseA = kernel2D[house, k1]
houseB = kernel2D[house, k2]
houseC = kernel2D[house, k3]
```

Out[101]=
```
{{0, 1, 0}, {1, -4, 1}, {0, 1, 0}}
```

Out[102]=
```
{{-1, -1, -1}, {-1, 9, -1}, {-1, -1, -1}}
```

Out[103]=
```
{ ··· 1 ··· }
```
large output | **show less** | **show more** | **show all** | **set size limit...**

Out[104]=
```
{ ··· 1 ··· }
```
large output | **show less** | **show more** | **show all** | **set size limit...**

Out[105]=
```
{ ··· 1 ··· }
```
large output | **show less** | **show more** | **show all** | **set size limit...**

In[106]:=
```
Image[house, "Byte"]
Image[houseA, "Byte"]
Image[houseB, "Byte"]
Image[houseC, "Byte"]
```

Out[106]=

Out[107]=

Out[108]=

Out[109]=

In[110]:=
```
Export["/home/nathan/QEA-Homework/module 2/day4/houseA.png", Image[a1, "Byte"]];
Export["/home/nathan/QEA-Homework/module 2/day4/houseB.png", Image[a2, "Byte"]];
Export["/home/nathan/QEA-Homework/module 2/day4/houseC.png", Image[a3, "Byte"]];
```

Image::imgarray : The specified argument a2 should be an array of rank 2 or 3 with machine–sized numbers. ≫

Image::imgarray : The specified argument a3 should be an array of rank 2 or 3 with machine–sized numbers. ≫