

Sheet 12

Create the directory sheet12 and make it your working directory.

Example 1. a) Go to my homepage and save the files data16.csv and compress.m to your working directory. You are going to use Daubechies wavelets `db2` to compress the signal in the files data16.csv. Load the file and save the first row as the time data `t` and the second row as the signal data `y`. Execute the file and in the command window enter the line `length(t)` to see how many data points are in the signal. Then choose the largest n for which 2^n is less than or equal to the length of `t`. This will be the highest level to which you decompose. Enter the compression rate r , the wavelet family and the level n :

```
r = .75;
fam = 'db2';
n = whatever you figured this should be;
```

Decompose into wavelets, compress and reconstruct:

```
[c,L] = wavedec(y,n,fam);
cc = compress(c,r);
yc = waverec(cc,L,fam);
```

Plot the signal and the compressed signal on the same graph:

```
hold on
plot(t,y,'k','linewidth',4)
plot(t,yc,'r','linewidth',2)
legend('Signal','Compressed')
hold off
```

Finally, compute the relative error:

```
fprintf('Relative Error is %f\n\n',norm(y-yc)/norm(y))
```

Repeat for the compressions 80, 85, 90 and 95%. What is the greatest compression that gives good results? Save this as ex1a.m.

b) Now let's see what the compression did to the DWT: we compare the D_k coefficients for $k = 1, \dots, 6$. Open a new worksheet and save it as ex1b.m. Enter the followings lines—you can copy and paste the lines up to the plotting commands from the previous part, this time using $r = .95$.

Now plot the D_k coefficients ($k = 1, \dots, 6$) for the compressed and uncompressed DWT on same graph:

```

for k = 1:6
    m = sprintf('D_%d Coefficients--Red is Compressed',k);
    dk = detcoef(c,L,k);
    dkc = detcoef(cc,L,k);
    subplot(3,2,k)
    hold on
    plot(dk,'o','color','b','linewidth', 1)
    plot(dkc,'x','color','r','linewidth', 1)
    xlabel(m)
    hold off
end

```

Maximize the plot to get a better view. Repeat for $r = .8, .85, .90$.

Example 2. a) Repeat this analysis for the file data17.csv using the family db4. Find the greatest compression that still gives the spike. This time, compare the D_k coefficients for levels $k = 1, \dots, 8$. You'll need to change the `subplot(3,2,k)` to `subplot(4,2,k)`.

b) How does the family db1 do in terms of removing the spike?

Example 3. Save the data file data5.csv to your working directory. Compress the data using the method of Examples 1 and 2 with the db2 wavelets. Try different compression rates to find the biggest that gives good results. Repeat for the family db4.

Example 4. For the signal in Example 1, compare the 80%, 90% and 95% compressions using db2 wavelets versus the Discrete Fourier Transform (refer back to sheet 7) by plotting them and computing relative errors as follows. Assuming the time variable is t , the original signal is y , the wavelet compression is ycw and the Fourier compression is ycf , enter the following lines:

```

subplot(2,1,1)
hold on
plot(t,y,'k','linewidth',4)
plot(t,ycw,'r','linewidth',2)
legend('Signal','Wavelet')
hold off
subplot(2,1,2)
hold on
plot(t,y,'k','linewidth',4)
plot(t,real(ycf),'r','linewidth',2)

```

```
legend('Signal','Fourier')
hold off
fprintf('Relative Error for Fourier is %f\n',norm(y-ycf)/norm(y))
fprintf('Relative Error for Wavelet is %f\n',norm(y-ycw)/norm(y))
```

The `subplot(m,n,p)` tells Matlab to put m rows and n columns of plots in one plot window. The p gives the placement of the particular plot. What do you conclude?

Example 5. Repeat this for the signal in Example 2.

Sheet 12: Further Exercises

Example 5. Repeat this for the signal in Example 3.