Introduction to Wavelets in Scilab

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Introduction

- The word WAVELET literally means small wave.
- Wavelets are localised waves and they extend not from - ∞ to $+\ \infty$ but only for a finite duration of time.

Introduction

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- Since waves extend over the entire space, they do not need any shift parameter.
- Thus, a Fourier Transform maps 1-D time signals to 1-D frequency signals, whereas
- The wavelet transform maps 1-D time signals to 2-D scale(frequency) and shift parameter signals.

Example1

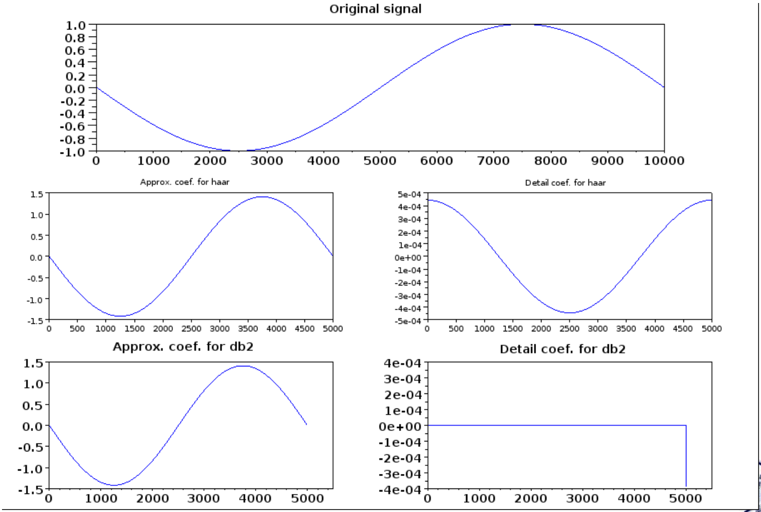
Example1

- Let us see a program which finds out the approximate coefficients and detailed coefficients of a given signal.

Example1:dwt.sce

In this Example:

1. `x=linspace(-%pi,%pi,10000);`
2. `s=sin(x);` //Constructs and Elimentary sine wave signal
3. `[ca1,cd1] = dwt(s,'haar');` // Perform single-level discrete wavelet transform of "s" by "haar".
4. The Graph of Apporoximate co-efficients(cA) and Detailed co-efficient(cD) is Plotted using the plot() command
5. The above procedure is repeated for "db2" type of wavelet.

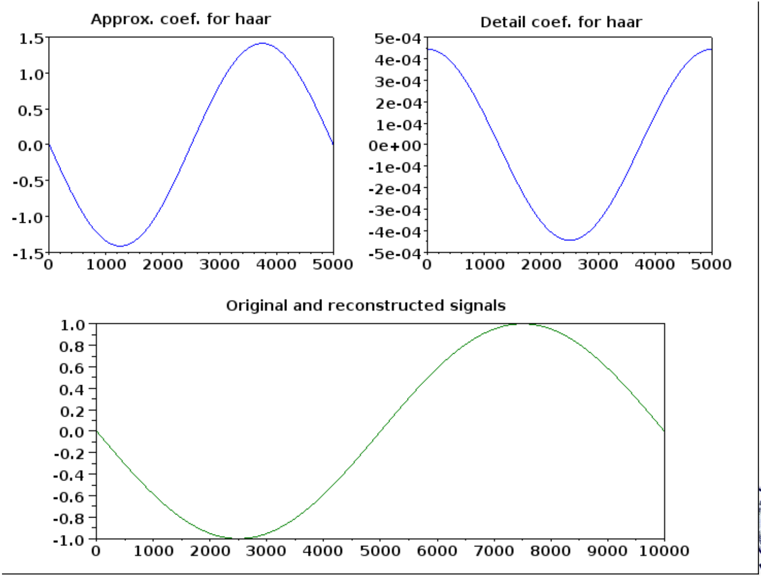

Original signal
Approx. coef. for haar
Detail coef. for haar
Approx. coef. for db2
Detail coef. for db2

Example2:idwt.sce

Example2:idwt.sce

In this Example:

1. Steps 1,2 and 3 are same as above.
2. `ss = idwt(ca1,cd1,'haar');` //Perform single-level inverse discrete wavelet transform, illustrating that idwt is the inverse function of dwt.
3. The Graph of Apporoximate co-efficients(cA) and Detailed co-efficient(cD) is Plotted using the plot() command


Approx. coef. for haar
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
0
1000
2000
3000
4000
5000
Detail coef. for haar
5e-04
4e-04
3e-04
2e-04
1e-04
0e+00
-1e-04
-2e-04
-3e-04
-4e-04
-5e-04
0
1000
2000
3000
4000
5000
Original and reconstructed signals
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000

Commands : `dwt & idwt`

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→ `dwt:Discrete Fast Wavelet Transform`

- dwt is for discrete fast wavelet transform with the signal extension method optional argument.
- As output it gives values of cA : Approximate co-efficients and
  cD : Detailed co-efficients

- For Syntax Detailed help see type "`help dwt`"

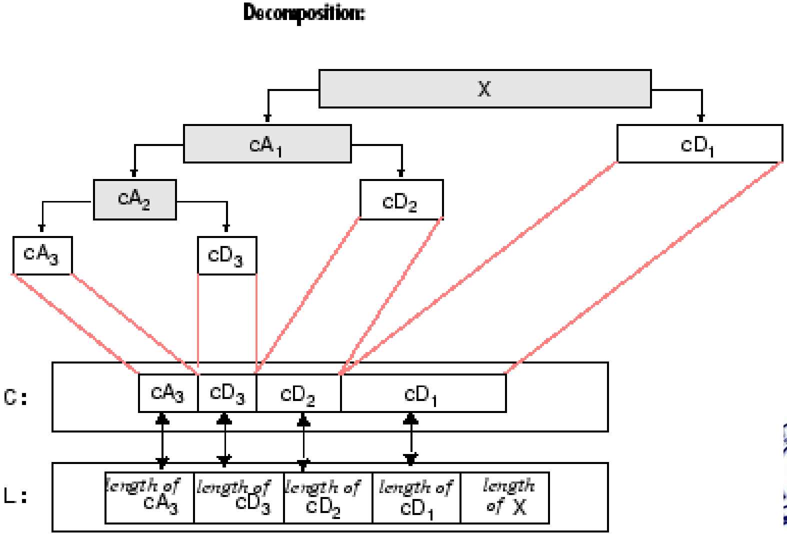
→ `idwt:Inverse Discrete Fast Wavelet Transform`

- idwt is for inverse discrete fast wavelet transform.
- Coefficent could be void vector as '[]' for cA or cD.
- As output it gives a Reconstructed Vector

- For Syntax Detailed help see type "`help idwt`"

Example3:wavelet.sce

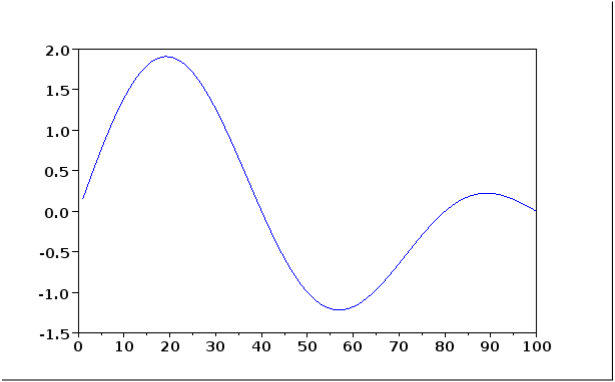
Let us Revise the Decomposition Diagram for the wavelets:



Example3:wavelet.sce

In this Example:

1. `s=[1:100];`
2. `l_s = length(s)`
3. `a = sin(2*%pi*s/100)+sin(3*%pi*s/100);` //Constructs and Elimentary sine wave signal



Example3:wavelet.sce

The coefficients of all the components of a third-level decomposition (that is, the third-level approximation and the first three levels of detail) are returned concatenated into one vector, C.

Vector L gives the lengths of each component.

4. `[C,L] = wavedec(a,3,'haar');`

Example3:wavelet.sce

To extract the level 3 approximation coefficients from C, type:

5. `cA3 = appcoef(C,L,'haar',3);`

To extract the levels 3, 2, and 1 detail coefficients from C, type

6. `cD3 = detcoef(C,L,3);`
7. `cD2 = detcoef(C,L,2);`
8. `cD1 = detcoef(C,L,1);`

The above can be written in one command as:

9. `[cD1,cD2,cD3] = detcoef(C,L,[1,2,3]);`

Example3:wavelet.sce

To reconstruct the level 3 approximation from C, type

```
10. A3 = wrcoef('a',C,L,'haar',3);
```

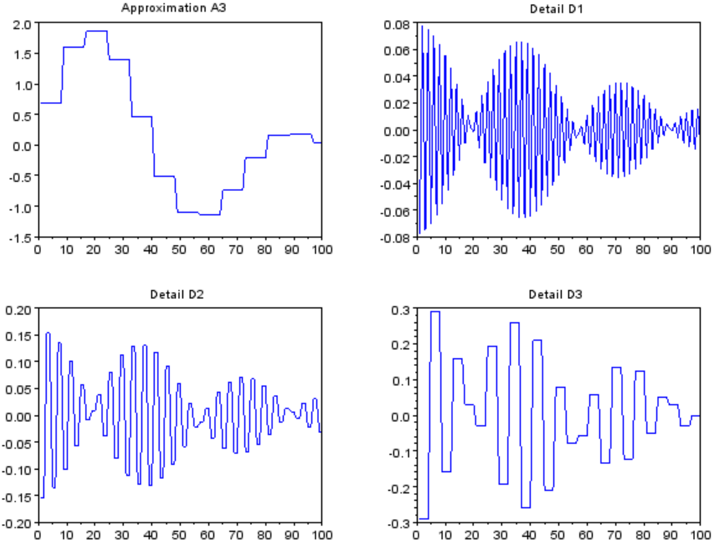
To reconstruct the details at levels 1, 2, and 3, from C, type

```
11. D1 = wrcoef('d',C,L,'haar',1);
12. D2 = wrcoef('d',C,L,'haar',2);
13. D3 = wrcoef('d',C,L,'haar',3);
```

Example1:wavelet.sce

Example1:wavelet.sce

Display the results of a multilevel decomposition



To reconstruct the original signal from the wavelet decomposition structure, type

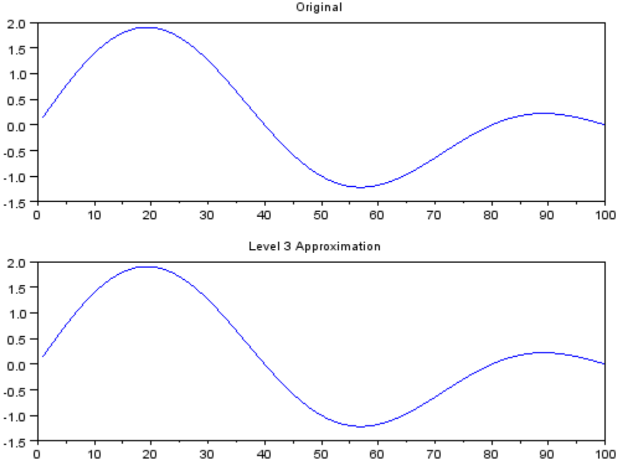
```
14. A3 = waverec(C,L,'haar');
```

Of course, in discarding all the high-frequency information, we've also lost many of the original signal's sharpest features.

Original Vs Approximate

Original Vs Approximate

To compare the approximation to the original signal, type



Commands Used

Commands Used

The commands used in the Multi-level Decomposition and Construction of Approximate and Detailed Coefficients are:

- ⋆ `wavedec`: Multiple Level Discrete Fast Wavelet Transform
- ⋆ `waverec`: Multiple Level Inverse Discrete Fast Wavelet Transform
- ⋆ `appcoef`: One Dimension Approximation Coeffcent Reconstruction
- ⋆ `detcoef`: One Dimension Detail Coeffcent Extraction
- ⋆ `wrcoef`: Restruction from single branch from multiple level

Help

Help

Please type **help command_name** to see the Usage, Description and Examples for that particular command.

Further Exploration

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Optimal de-noising requires a more subtle approach called thresholding.

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This involves discarding only the portion of the details that exceeds a certain limit.

Thank You!!

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