



$$F(a, b) = \frac{1}{\sqrt{a}} \int_{-\infty}^{+\infty} f(t) \psi^* \left( \frac{t-b}{a} \right) dt$$

# Approximations of Wavelet and Scaling Functions

Shouke Wei, Ph.D. Professor

Email: shouke.wei@gmail.com

## Objective

- talk about the approximations of wavelet and scaling functions and their visualization

```
In [26]: # import the required packages
import pywt
import matplotlib.pyplot as plt
```

## 1. Discrete Wavelet and Scaling Functions

`Wavelet.wavefun(level)` : used to calculate approximations of scaling function  $\varphi(t)$  (phi) and wavelet function  $\psi(t)$ (psi) at the given level of refinement

### (1) Orthogonal wavelets

For orthogonal wavelets returns approximations of scaling function and wavelet function  $\psi(t)$  with corresponding x-grid coordinates:

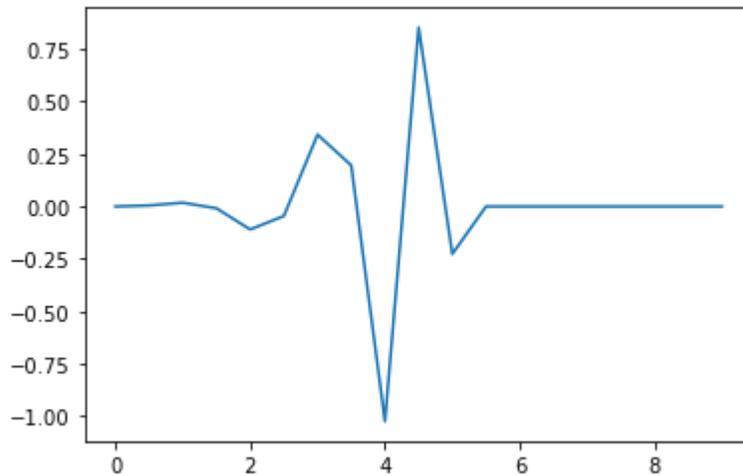
```
In [34]: orwavelet = pywt.Wavelet('db5')
[phi, psi, x] = orwavelet.wavefun(level=1)
```

```
In [32]: psi
```

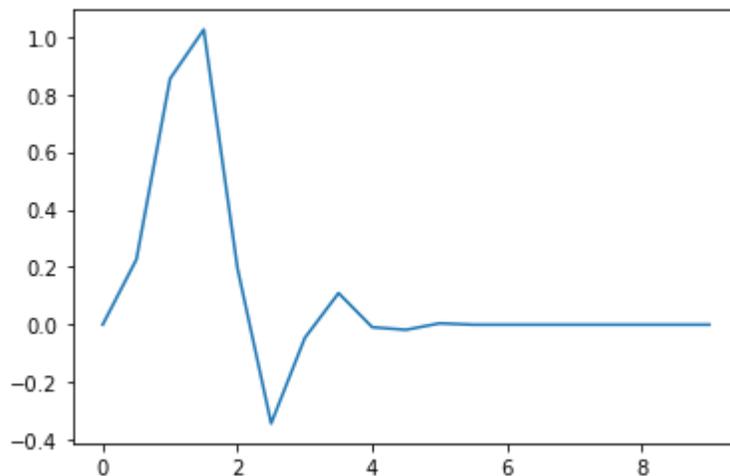
```
Out[32]: array([0.00000000e+00, 1.43911373e-07, 5.42764508e-07, ...,  
0.00000000e+00, 0.00000000e+00, 0.00000000e+00])
```

## Visualization of Wavelet and Scaling Functions

```
In [35]: # wavelet function  
plt.plot(x,psi)  
plt.show()
```



```
In [36]: # Scaling Function  
plt.plot(x,phi)  
plt.show()
```



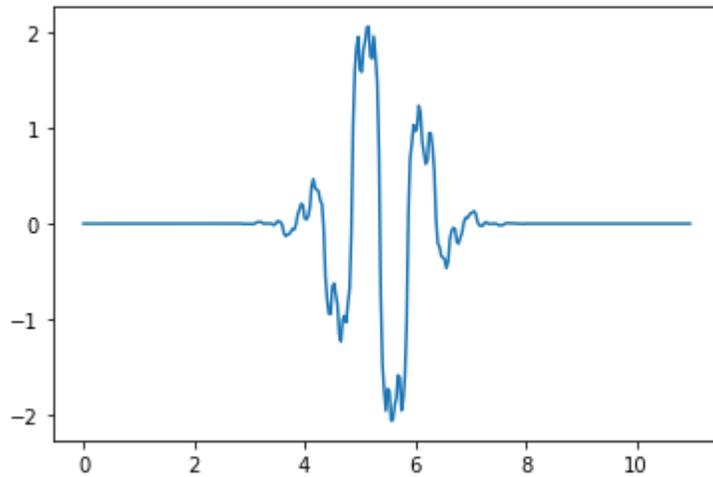
## (2) Other wavelets

For other (biorthogonal but not orthogonal) wavelets returns approximations of scaling function  $\varphi(t)$  and wavelet function  $\psi(t)$  both for **decomposition** and **reconstruction** and corresponding x-grid coordinates:

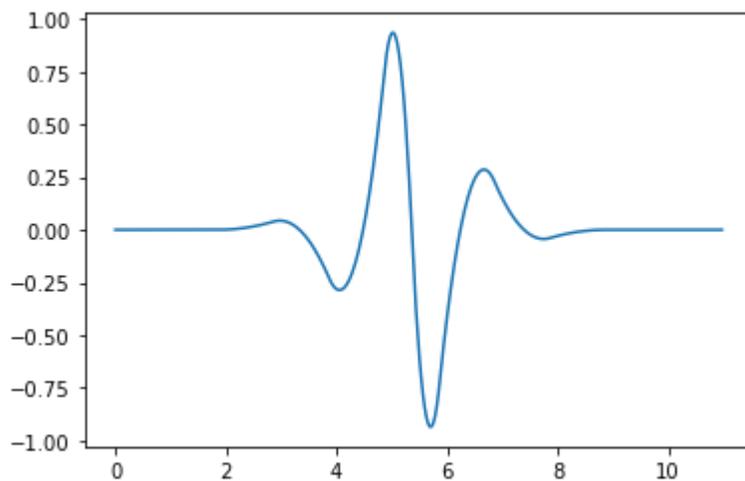
```
In [37]: biwavelet = pywt.Wavelet('bior3.5')
[phi_d,psi_d,phi_r,psi_r,x] = biwavelet.wavefun(level=5)
```

## Visualization of Wavelet and Scaling Functions

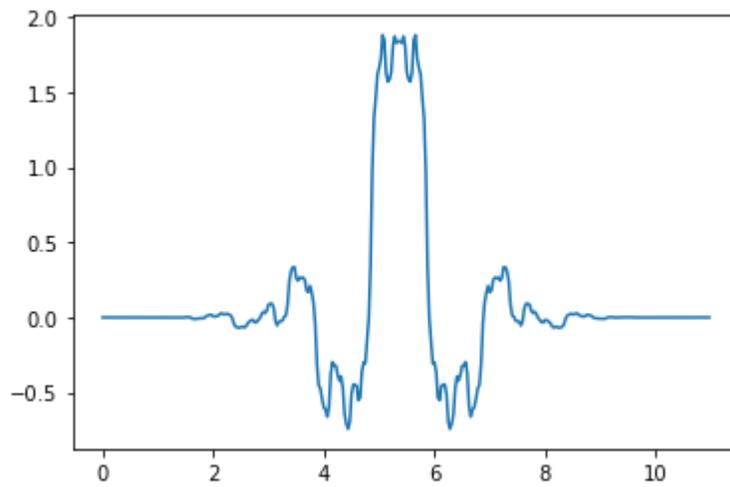
```
In [38]: # Wavelet Function of decomposition
plt.plot(x,psi_d)
plt.show()
```



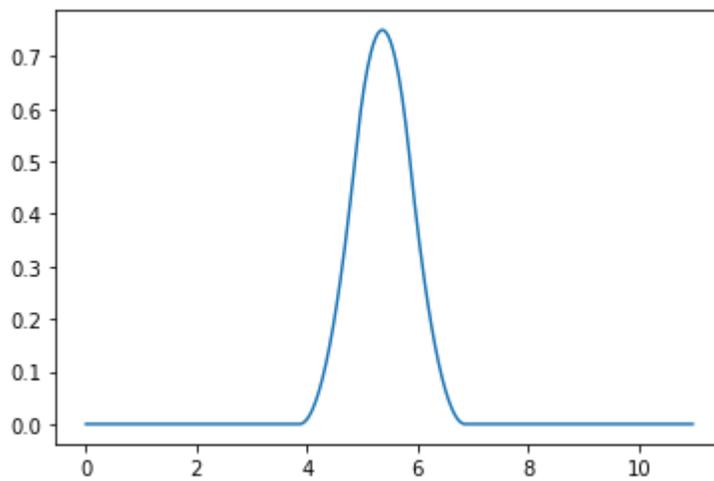
```
In [40]: # wavelet function of reconstruction
plt.plot(x,psi_r)
plt.show()
```



```
In [41]: # scaling functions of decomposition  
plt.plot(x,phi_d)  
plt.show()
```



```
In [42]: # Scaling function of reconstruction  
plt.plot(x,phi_r)  
plt.show()
```



## 2. Continuous Wavelet Functions

ContinuousWavelet.wavefun(level, length = None)

- The `wavefun()` method can be used to calculate approximations of wavelet function  $\psi(t)$  with grid (x).
- The vector length is defined by  $2^{**}\text{level}$  if length is not set.

```
In [45]: Wavelet = pywt.ContinuousWavelet('gaus2')  
[psi,x] = Wavelet.wavefun(level=5)
```

## Visualization of continuous wavelet functions

```
In [46]: plt.plot(x,psi)  
plt.show()
```

