Wavelet Scattering in MATLAB

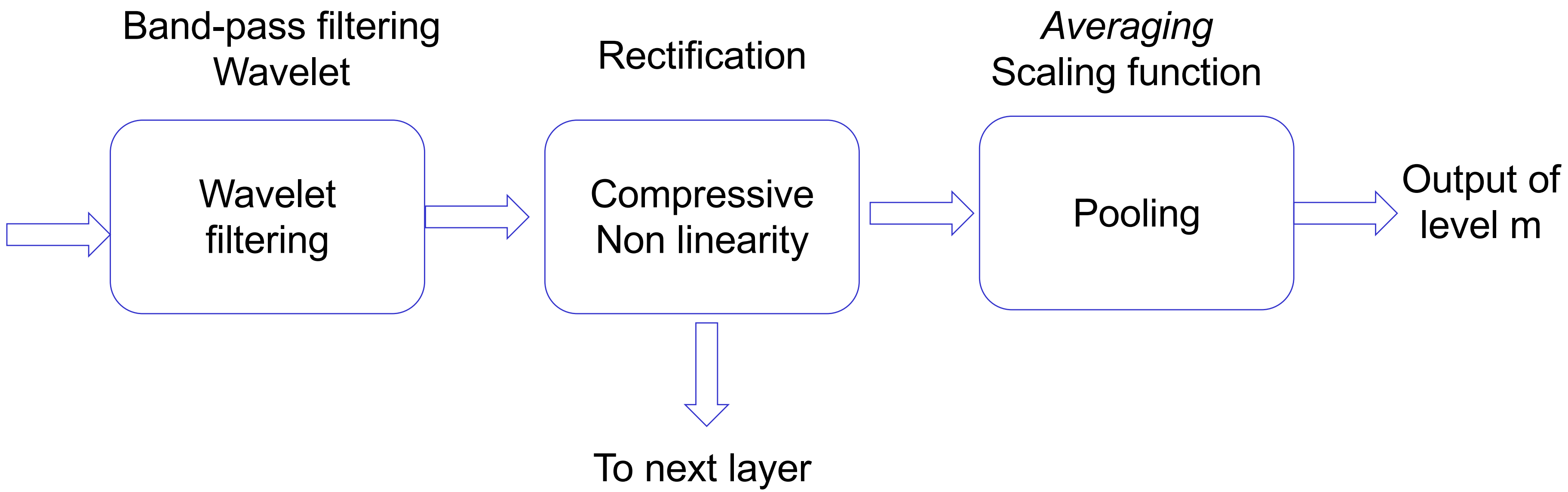
Pragmatic description

- A wavelet scattering framework enables you to derive, with minimal configuration, low-variance features from real-valued time series and image data for use in machine learning and deep learning applications. The features are *insensitive to translations* of the input *on an invariance scale* that you define and are continuous with respect to deformations
- In the 2-D case, features are also *insensitive to rotations*
- The scattering framework uses *predefined wavelet and scaling filters*
- Properties that deep learning architectures possess for extracting useful features from data:
  - Multiscale contractions
  - Linearization of hierarchical symmetries
  - Sparse representations

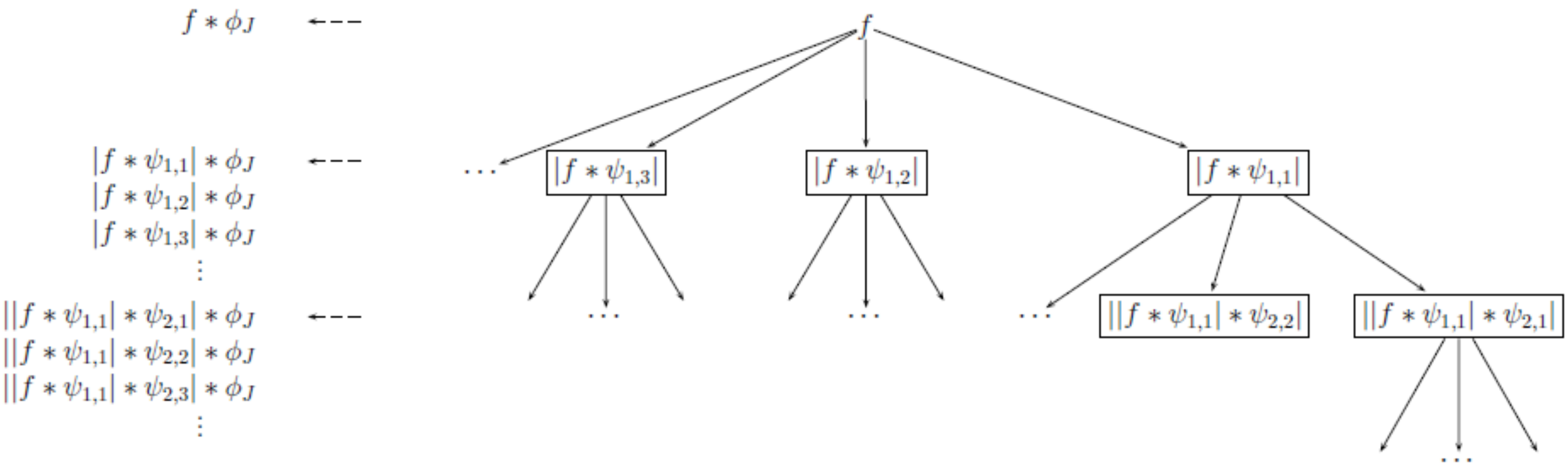
Features of the WST

- The wavelet scattering framework exhibits all these properties. Wavelet scattering transforms linearize small deformations such as dilations by separating the variations across different scales. For many natural signals, the wavelet transform also provides a sparse representation.
- By combining wavelet transforms with other features of the scattering framework described below, the scattering transform produces data representations that minimize differences *within* a class while preserving discriminability *across* classes.
- An important distinction between the scattering transform and deep learning frameworks is that the filters are defined a priori as opposed to being learned.
- Because the scattering transform is not required to learn the filter responses, you can often use scattering successfully in situations where there is a shortage of training data

Wavelet Scattering Transform



SWT


$f * \phi_J$
$|f * \psi_{1,1}| * \phi_J$
$|f * \psi_{1,2}| * \phi_J$
$|f * \psi_{1,3}| * \phi_J$
$||f * \psi_{1,1}| * \psi_{2,1}| * \phi_J$
$||f * \psi_{1,1}| * \psi_{2,2}| * \phi_J$
$||f * \psi_{1,1}| * \psi_{2,3}| * \phi_J$
f
$|f * \psi_{1,3}|$
$|f * \psi_{1,2}|$
$|f * \psi_{1,1}|$
$||f * \psi_{1,1}| * \psi_{2,2}|$
$||f * \psi_{1,1}| * \psi_{2,1}|$