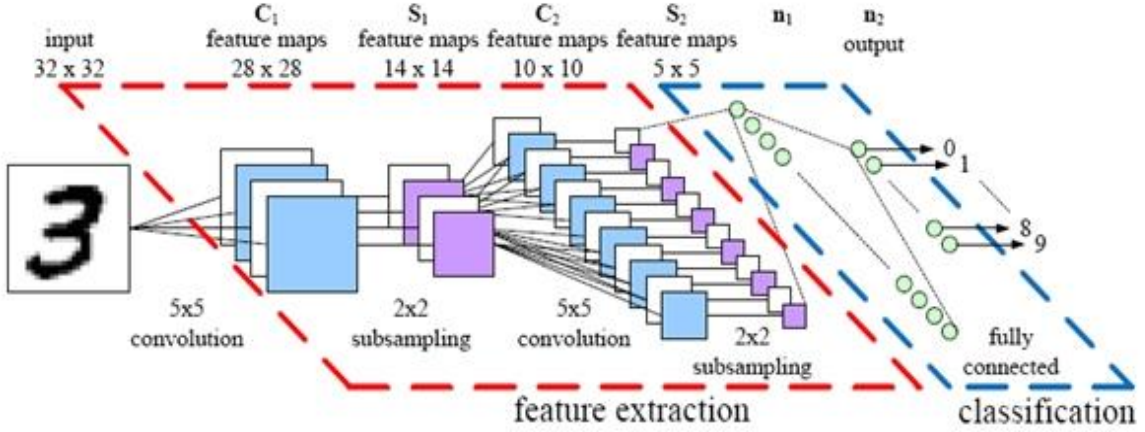
GRAPH SCATTERING CONVOLUTIONAL NETWORK

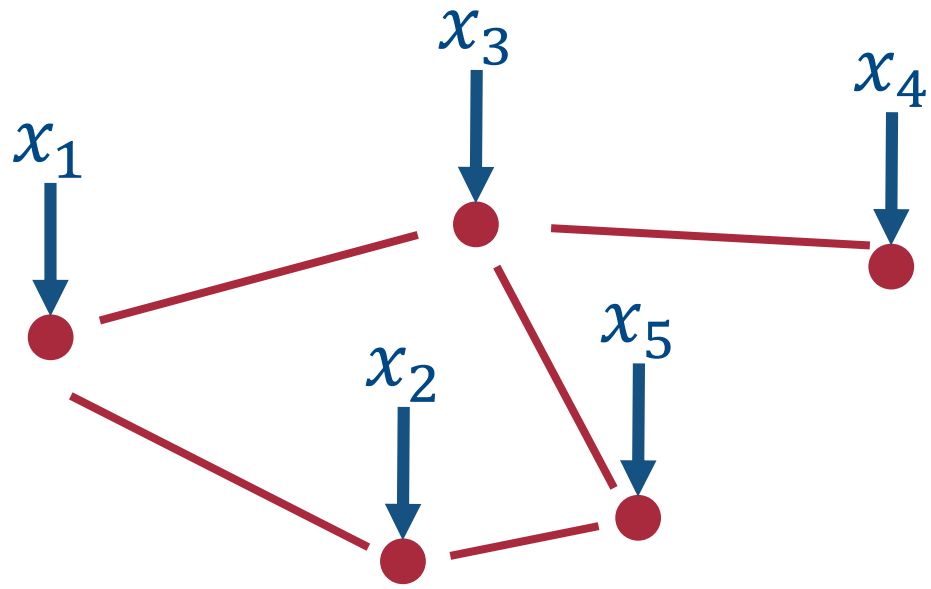
Damian Owerko, Fernando Gama, Alejandro Ribeiro

Motivation

- **Convolutional neural networks** have demonstrated outstanding image processing performance
- Modern signals have an irregular **structure** (unlike images) ⇒ **graph signals**
  - Sensor networks, weather measurements
- Extend CNNs to operate on graph signals
  - Generalize the convolution operation
- Determine power grid brownout using weather measurements

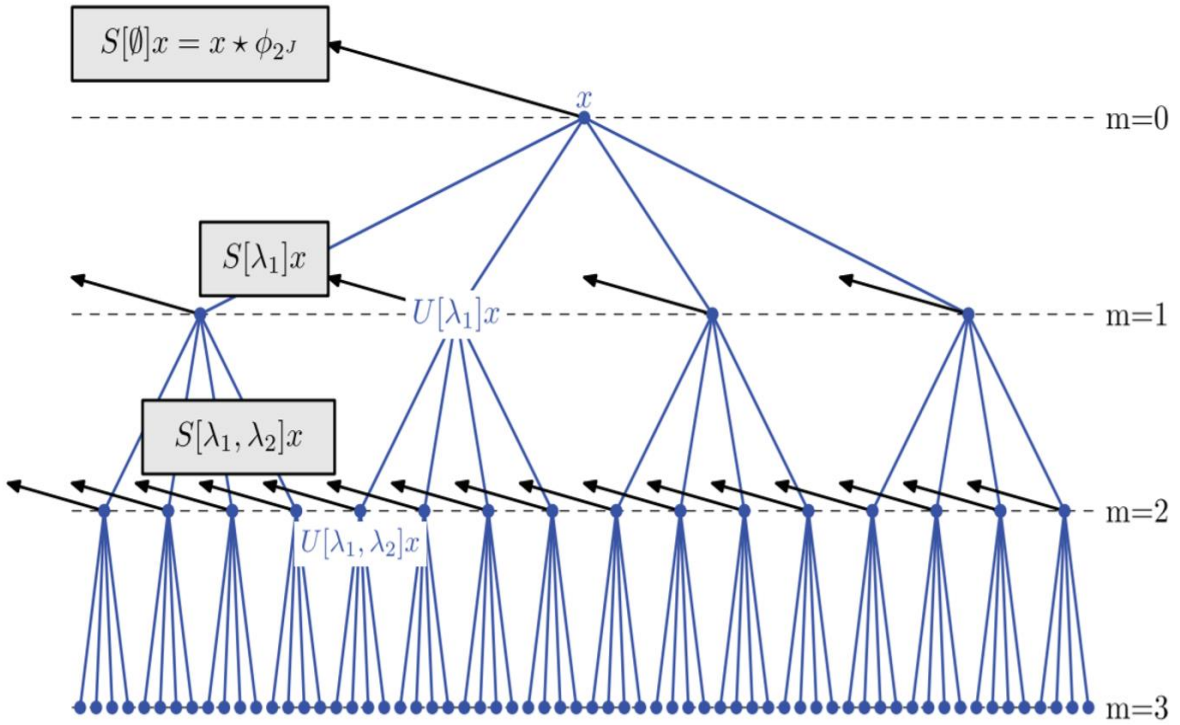


Yan Xu, PhD, Scientist at PROS Follow. "Convolutional neural network." LinkedIn SlideShare. May 20, 2017. Accessed October 22, 2017.



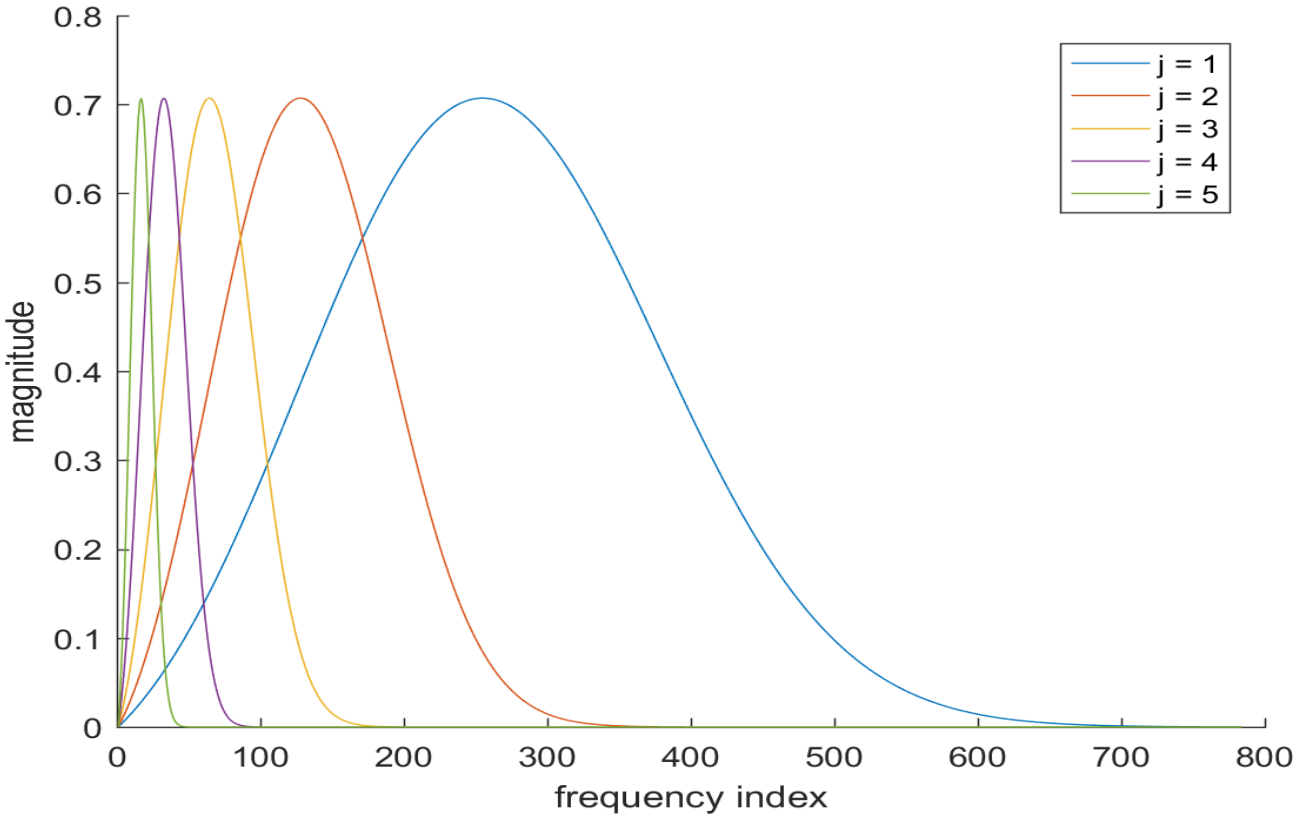
Scattering convolutional network

- There are many CNN architectures ⇒ we choose the SCN
  - Filters pre-specified = **no training**
    - Wavelet filters between layers
  - Tune the degree of **translation invariance**
  - State of the art results on MNIST



J. Bruna and S. Mallat, "Invariant Scattering Convolution Networks," in IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 35, no. 8, pp. 1872-1886, Aug. 2013.

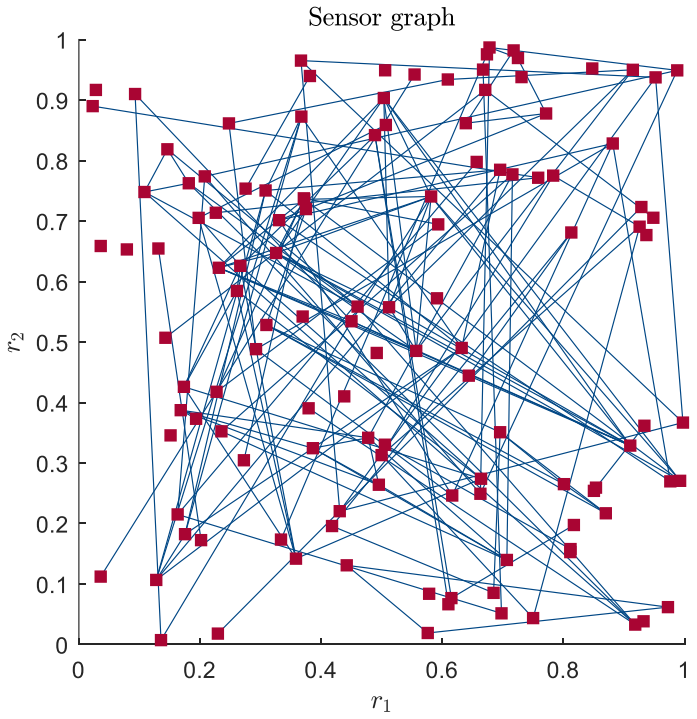
Filters can be defined on a graph

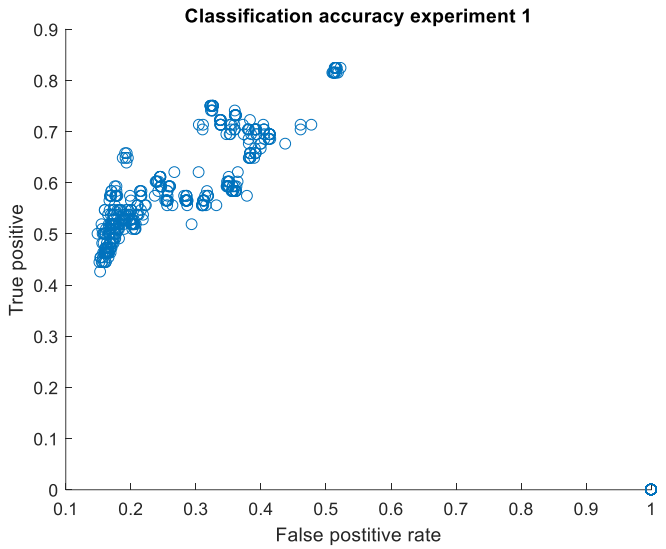


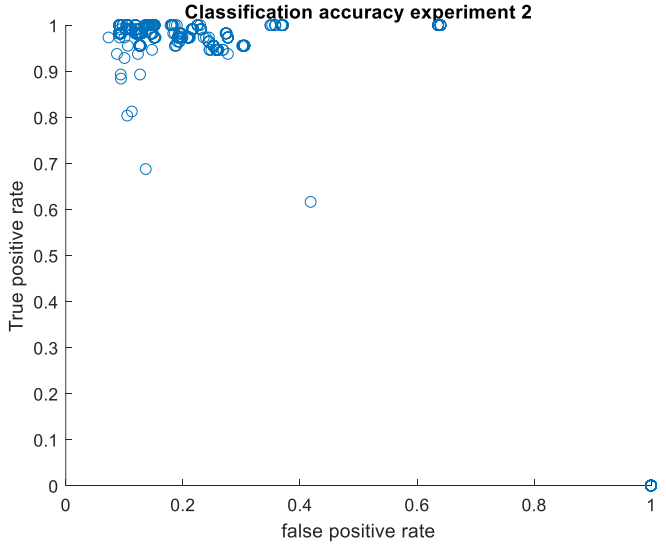
- Use **frequency response** of wavelet filter
- $H(\boldsymbol{h}) = V\mathrm{diag}(\boldsymbol{h})\mathrm{V}^H$
  - V is the frequency basis of the underlying graph support
  - **h** is the frequency response $\Rightarrow$ H(**h**) is the graph filter

Building the graph support

- Graph support that relates the data values
  - Weather measurements
  - Nodes in the graph are weather stations
- Compute distances between stations
  - Nearby stations have similar measurements
  - Apply gaussian kernel to great-circle distance
- Use 25 nodes (stations)







Preliminary results and future work

- Using Earth Networks NYC weather data and EIA reliability data for NY between 2011-2013
- Used two Earth Networks dataset fields
  - 1. temperature – **84.2% accuracy**
  - 2. sea-level pressure – **94.56% accuracy**
- Much better performance with pressure data
  - Likely a better storm predictor
- Optimally combine different weather measurements
- Try other graph CNN architectures

We extend the SCN to graph signals