Kevin Polisano (LJK, Grenoble University)
Title : On the Shift Invariance of Max Pooling Feature Maps in Convolutional Neural Networks
Abstract : Over the past decade, some progress has been made on understanding the strengths and limitations of convolutional neural networks (CNNs) for computer vision. In particular, the stability properties with respect to small transformations (translations, rotations, scaling, deformations) are only partially understood. In this talk, we study the combined effect of convolution and max pooling layers in generating quasi-invariant representations. This property is essential for classification, since it is expected that two translated versions of the same image are classified in the same way. When trained on datasets such as ImageNet, CNNs tend to learn parameters in the first layer that closely resemble oriented band-pass filters. By leveraging the properties of discrete Gabor-like convolutions, we establish conditions under which the feature maps computed by the subsequent max pooling operator approximate the modulus of complex Gabor-like coefficients, in which case they are stable with respect to small input shifts. We then compute a probabilistic measure of shift invariance for max pooling feature maps. More specifically, we show that some filters, depending on their frequency and orientation, are more likely than others to produce stable image representations. We experimentally validate our theory by considering a deterministic feature extractor based on the dual-tree complex wavelet packet transform, a particular case of discrete Gabor-like decomposition. We demonstrate a strong correlation between shift invariance on the one hand and similarity with complex modulus on the other hand.

Ali Moukadem (IRIMAS, UHA)
Title : The analytic Stockwell transform and its zeros
Abstract : Recently a link between Gaussian analytic functions (GAFs) and some time-frequency transforms of white noises has been established by Bardenet et al. This work was motivated by the earlier work performed by Flandrin on the zeros of the Spectrogram (squared modulus of the Short-Time Fourier Transform-STFT) and their regular distribution which form a point process in the time-frequency plane. In this presentation we extend this work to the Stockwell transform (ST) which is a hybrid version between STFT with Gaussian window and the continuous wavelet transform (CWT). First, we express a generalized version of the ST (GST) that uses an arbitrary window with some admissibility conditions. Then, we define the conditions under which the GST maps to the space of analytic functions what we call the Analytic Stockwell Transform (AST). Moreover, we show numerically that the zeros of the AST applied on white noise coincides with the zeros of hyperbolic GAF

Nicki Holighaus (Acoustics Research Institute, Vienna, Austria)
Title :On the use of quasi-random sets for the decimation of continuous wavelet transforms:
Abstract : Quasi-random sets are deterministic point sets that demonstrate a high level of equidistribution in the sense that they possess low discrepancy. These point sets are successfully used in various applications, in particular in the design of numerical integration schemes. In this talk, I will present some recent results concerning the application of quasi-random sets for the construction of invertible time-frequency filter banks, using wavelet transforms as canonical example. I will shortly introduce low discrepancy sets, and present two approaches for obtaining invertible wavelet transforms from the continuous wavelet transform by decimation with respect to points derived from low discrepancy sets. The mathematical machinery required for proving invertibility of these decimation schemes will be outlined and numerical results presented, alongside some proof-of-concept applications. Finally, I will discuss the integration of invertible, redundant wavelet filter banks in the Large Time-Frequency Toolbox (LTFAT). If time permits, I will mention some further results on wavelet transforms that we obtained in the past.