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An Unsupervised Machine Learning Pipeline to study the shape of solar WINQSEs

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The perplexing mystery of what maintains the solar coronal temperature at about a million K, while the visible disc of the Sun is only at 5800 K, has been a long standing problem in solar physics. A recent study by Mondal et al. (2020, ApJ, 895, L39) has provided the first evidence for the presence of numerous ubiquitous impulsive emissions at low radio frequencies from the quiet sun regions, which could hold the key to solving this mystery. These Weak Impulsive Narrowband Quiet Sun Emissions (WINQSEs) occur at rates of about five hundred events per minute, and their strength is only a few percent of the background steady emission. Based on earlier work with events of larger flux densities and theoretical considerations, WINQSEs are expected to be compact in the image plane. To characterise the spatial structure of WINQSEs, we have developed a pipeline based on an unsupervised machine learning approach. We first identify the boundaries of the radio sun using edge detection techniques, and detect peaks within the solar boundary. Density-Based Spatial Clustering of Application with Noise (DBSCAN), an unsupervised machine learning algorithm, is used to classify the peaks as isolated or clustered. It is also used to find the optimal hyper-parameters for peak-fitting. The peaks are then fit with Gaussian models, and statistical and heuristic filtering criteria are used to obtain robust fits for a subset of these WINQSEs . We find that the vast majority of WINQSEs can be described by well behaved compact Gaussians. By its very design, this approach is focused on morphological characterisation of these weak features and is better suited for identifying them than earlier attempts. We present here our first results of the observed distributions of intensities, sizes and axial ratios of the Gaussian models for WINQSEs arrived at from analysis of multiple independent datasets.