**Abstract:** With recent developments in recording hardware, the processing of neuronal data must keep up with the increasing volumes and complexity by capturing the intrinsic relationships between instances of neuronal activity while remaining invariant to noise. Here, we explore a suite of non-linear manifold feature extraction methods – including t-SNE, UMAP, TriMap – in an attempt to identify the most adequate method for automated spike sorting. Spike sorting is the process of clustering instances of neuronal activity, called spikes, based on similarity. By embedding high-dimensional spike shapes into low-dimensional manifolds that preserve local and global structure, we demonstrate more separable and robust clusters than those obtained via traditional feature extraction methods, such as PCA. We evaluated all feature extraction methods analysed on 95 synthetic datasets spanning a range of cluster counts. Quantitative evaluation using clustering performance metrics (such as Adjusted Rand Index, Silhouette Score, etc.) indicates that several manifold feature extractions outperform other feature extraction methods. Our results suggest that the embeddings obtained by non-linear manifold approaches can offer a powerful, high-precision option in the spike sorting of the next-generation of electrophysiological recordings.