Earthquakes can be classified as either primary events (main shocks) or as secondary events (aftershocks). The difference is that secondary events are caused by previously occurring events, whereas primary events are not. Seismic occurrences over a spatial and temporal window can be regarded as a point process with some degree of clustering. Of interest to researchers in the field of seismology are the relationships between characteristics of earthquakes and characteristics of their aftershocks. However, until Model Independent Stochastic De-clustering (MISD) was developed (Marsan and Lengline, 2008), pairwise classification of aftershocks and the earthquakes that caused them was unreliable. One of the key assumptions to MISD is spatial homogeneity of primary events. Changes have been proposed for MISD by (Nichols and Schoenberg, 2014) to allow for a spatially dependent background rate. Classification accuracy of MISD in its various forms is difficult to compute using real data as classification accuracy can't be assessed without knowing a priori which previously occurring event triggered a secondary event. This article focuses on a detailed approach for creating and using synthetic earthquake catalogs with sufficient complexity to evaluate classification accuracy for MISD and for MISD with a spatially dependent background rate.