# Development of pattern recognition and classification models for the detection of vibro-acoustic emissions from codling moth infested apples

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## Abstract

Codling moth (CM) is the most devastating global pest of apples with a huge potential impact on the post-harvest quality and yield of the product. Due to the small size of its larvae and potentially hidden behavior, simple visual inspection is ill-suited for accurate infestation detection. The characteristic vibro-acoustic signals of multiple behaviors of CM larvae such as chewing and boring were identified in a previous study. In this study, two different approaches were proposed to build on this previous work: multi-domain feature extraction with machine learning to show basic classification potential, and matched filter-aided classification to show the effects of preprocessing using the larval behavior templates. Additionally, low-intensity heat stimulation was applied to improve classification results by increasing the larvae's hidden activity rate. The results indicated that the first approach led to accuracies as high as 97.47 % for an acoustic signal duration of 10 s, with heat stimulation improving classification rates to 98.96 % for the same interval. Finally, the matched filter-aided classification approach improved upon the heat stimulated results even further to obtain a 100 % accuracy on classifying the test set for a signal duration of 5 s. These findings suggest that the vibro-acoustic technique can be an adaptable tool for detecting CM infestation in apples and improve post-harvest classification quality in fruit.