Pollen grain identification using semantic image segmentation

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It is estimated that the prevalence of allergic rhinitis in the European population is 25% [1], with pollen species and an individual's age also determining their susceptibility to illness [2]. Since some of the effects of allergic rhinitis are symptoms such as asthma attacks, developing a sensor that is able to determine both the species and the amount of pollen within a person's vicinity, could allow that individual to avoid high pollen counts and even allow identification of species with which they are most vulnerable. At present, one of the main methods for determining the pollen count in a region is to collect pollen grains via Burkard traps [3], whereupon the collected sample is analyzed daily in a laboratory using a microscope.

In order for individuals to be able to determine levels within their vicinity, a sensor with a small footprint that can work in real-time would be advantageous. In addition, such a sensor might be required to determine the species of pollen grains present, even from within mixtures that contain non-pollen particulates. A small footprint sensor capable of such a task could be developed via lensless imaging. As such, images of pollen grains could be generated by illuminating them with a laser beam and processing their scattering patterns using deep learning neural networks [4]. However, additional methods need to be used to determine the species from the images, including images of mixtures of pollen species.

Here, we use semantic image segmentation (colour labelling of pixels in images) [5], to identify pollen grains in images generated from their scattering patterns. More specifically, we train a neural network on non-mixtures of species and test on mixtures of species, and importantly, only experimental images (not generated images) were used in training and testing the segmentation neural networks, meaning that previously unseen experimental pollen (and thus unseen scattering patterns) could be identified from their generated images.

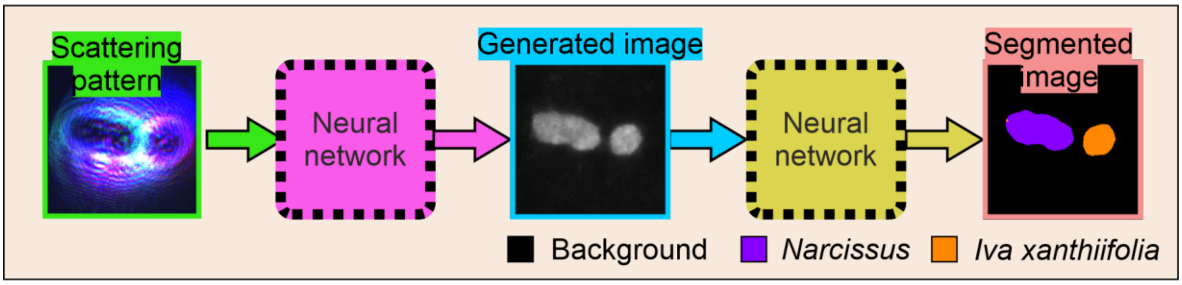

Fig. 1. Concept showing the process of transforming an experimental scattering pattern from pollen grains illuminated with laser light, and converting it to an image, then using a second neural network to segment that image via colour labelling of different pollen grains, including the background. In this example, background is coloured black, *Narcissus* pollen grain is labelled purple and *Iva xanthiifolia* pollen is coloured orange.

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