# APPLIED MATHEMATICS DIVISION

MACHINE LEARNING

As a branch of Artificial Intelligence, Machine Learning enables systems to extract patterns and dependencies in data without being told explicitly how to do so. It combines areas of mathematics, probability theory, statistics, optimisation, algorithms and scientific computing.

In Applied Mathematics we use Machine Learning as a modelling tool to solve and analyse many different problems in robotics, image recognition and computer vision, biometric identification, computational linguistics, climatology, resource managements, nature conservation, and medicine. Some examples of projects include:

- Modelling and predicting flow in the lower Orange River, to support improved release scheduling at the Vanderkloof Dam
- Estimating and predicting water quality from measured variables
- Detecting and counting elephants in aerial photographs
- Assisting a Zoology study on population dynamics of great white sharks, by identifying specimens from dorsal fin images
- Identifying Protea species from images, for crowed-sources surveying and conservation
- Automating question answering on a digital helpdesk for pregnant and breastfeeding mothers in rural areas of South Africa
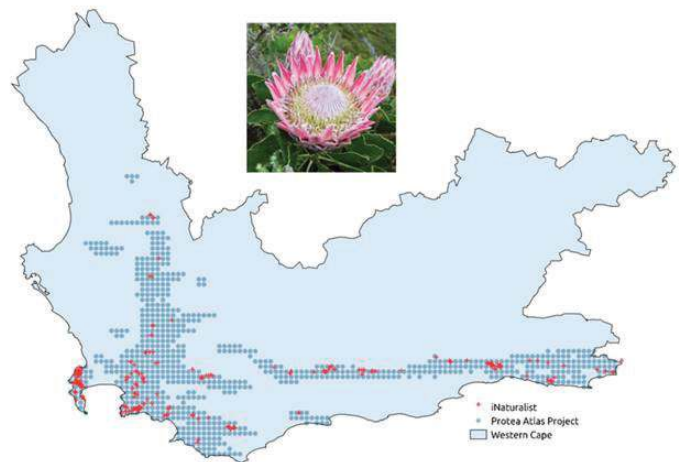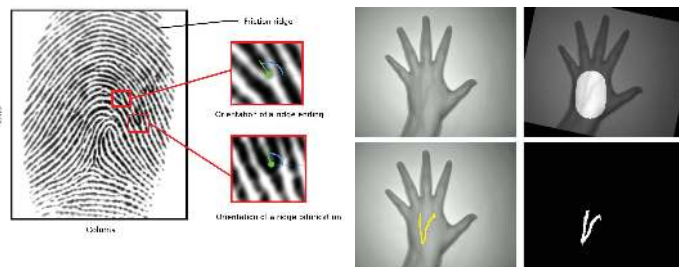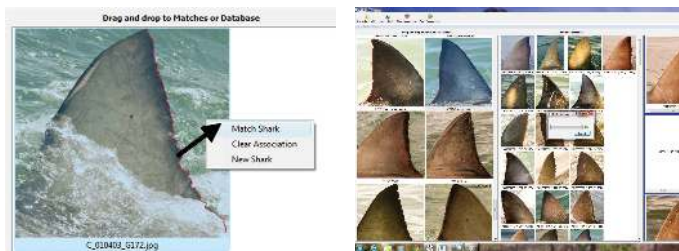
BIOMETRIC RECOGNITION

The field of biometric recognition involves the authentication of an individual based on one or more behavioural or physical characteristics by means of suitable pattern recognition or machine learning techniques. The feasibility of the following modalities have been investigated on previous occasions:

- Handwritten signature verification
- Fingerprint matching
- Hand vein-based authentication
- Ear-based recognition

DIGITAL IMAGE PROCESSING

Digital Image Processing makes use of mathematically based computer applications to perform various actions on digital images. Examples are:

- Edge detection (extracting, joining or enhancing edges)
- Motion and focus deblurring (sharpening, and undoing the effect of blur)
- Image registration (matching features in different images)
- Image segmentation (extracting meaningful patches from images)
- Image enhancement (contrast, colour, noise removal)

Blurred image Estimated sinogram Deblurred image