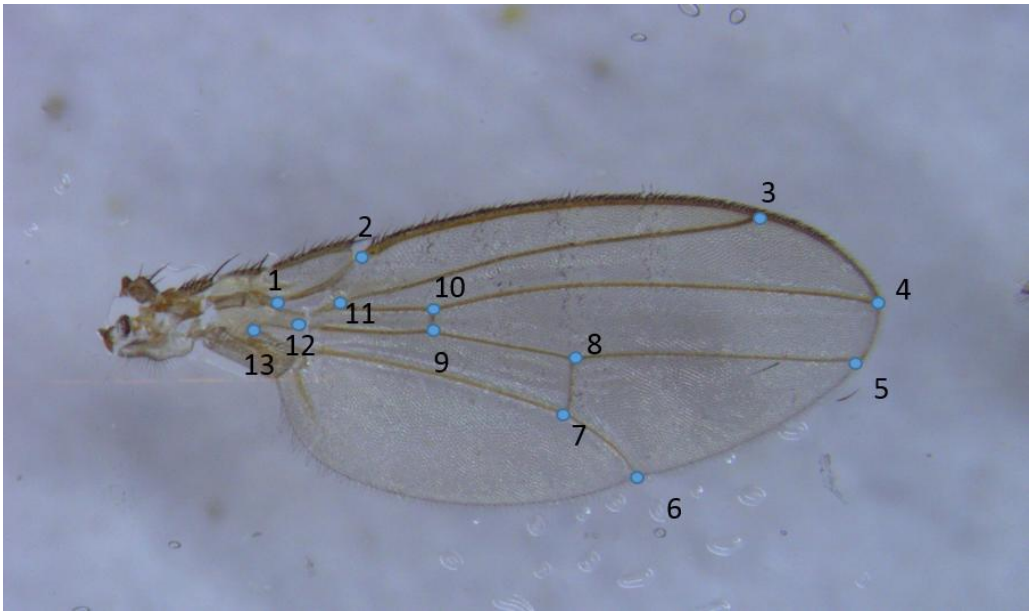
Project: Landmark identification on Drosophila wings

Write a program for automatic landmark detection in digital images of Drosophila wings.

The landmark method is widely used in geometric morphometrics. Landmarks are put (most often) manually on each image of the observed object. A collection of coordinates of biologically definable landmarks is created and used to extract fine differences in size and shape variability between samples for each landmark.

One such image is presented below, together with 13 manually positioned 13 landmarks.



The file wings.zip contains 5 images of drosophila wings. Try to detect 13 landmarks as indicated in the example image, by detecting the characteristic lines (blood vessels and outer contours) and their branching points. Keep the same order of landmarks.

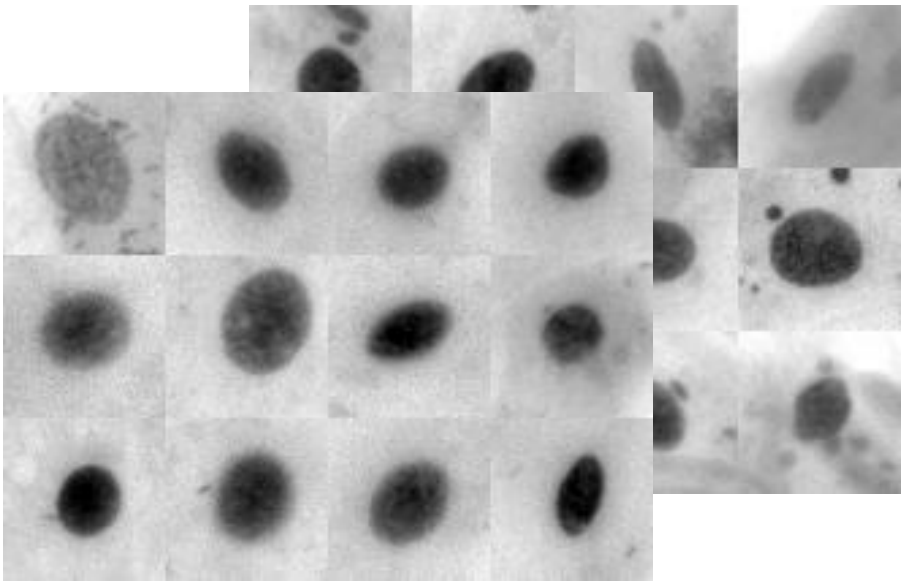
Generate a text file with the XY coordinates for each landmark.

Project: Diagnosing oral cancer

Oral cancer incidence is rapidly increasing worldwide. The most effective way of decreasing cancer mortality is early detection, which makes screening for cancer highly desired. Studies indicate that oral cancer can be tested for with a fast and painless brush sample, possibly done together with your ordinary dental checkup. However, such large scale screening requires computer assisted diagnosis since manual examination is too costly.

Your task is to try to separate individual cut-out cells into the two classes *Cancer* and *Healthy* in the provided annotated data set of ~1000 cells, possibly using texture and/or shape and/or machine learning techniques.

To get access to the data, you should contact Joakim Lindblad, joakim@cb.uu.se



Project: Tracking pedestrian trajectories in outdoor videos

Automatic pedestrian tracking in real time videos is an active research field in computer vision. One of its important applications is in automotive safety system. General and accurate recognition of humans in real time and tracking of their trajectories is a very challenging task, due to the variety of situations, such as different weather conditions, light changes, occluded areas, crowded places, etc., which should be handled.

The task in this project is to ***detect*** pedestrians in videos from outdoor surveillance camera and ***track trajectories*** of the moving objects. A possibility/variation is to include classification of the moving objects (e.g., adult, child, bicycle, car…)

You can make your own dataset (capture video information) to work on, or use some of the publicly available ones.
Some suggestions are
http://homepages.inf.ed.ac.uk/rbf/FORUMTRACKING/
http://cs.binghamton.edu/~mrldata/pets2009.html
https://motchallenge.net/
http://www.vision.caltech.edu/Image_Datasets/CaltechPedestrians/

Project: Binary tomography

Binary tomography is a technique which seeks to reconstruct a binary image (function) defined on the integer grid from its projections (line-sums) along several directions. The main challenge is that practical limitations reduce the number of projections to at most ten (often less). The resulting reconstruction is therefore not unique, and additional constraints are required to reach a good solution.

The task in this project:

Calculate projections of a binary image in a few directions.

Try to reconstruct the original image from its projections (can be done by optimization).

Improve reconstruction quality by using prior knowledge: binary values, homogeneity, structural information.

To make the problem more challenging, consider noisy projection data.

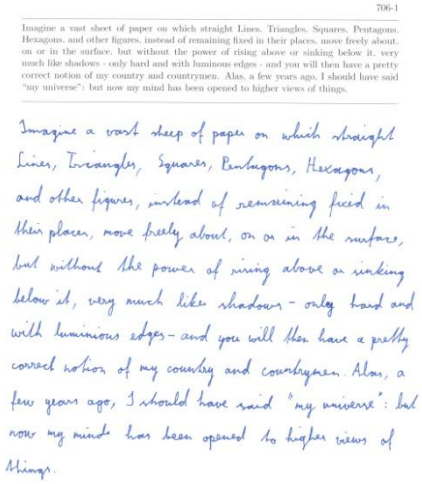
Design your own suitable images/shapes. Some examples of typically used ones in evaluation of binary tomography methods are shown below.

https://ipa.math.uni-heidelberg.de/dokuwiki/Papers/DGCI06.pdf

Project: Writer identification from a handwritten text

In contrast to electronic or printed text, handwritten text carries additional information about the author. Handwriting style of a person is stable enough to make it possible to identify the author of a written text (if a handwritten text from the same author is previously seen).

The need to identify the author of a document may appear in a number of situations: in the court of justice where authenticity of a document has to be concluded, in medicine, where the prescription has to come from an authorized person, or in banks where signatures need to be verified.


706-1

Imagine a vast sheet of paper on which straight Lines, Triangles, Squares, Pentagons, Hexagons, and other figures, instead of remaining fixed in their places, move freely about, on or in the surface, but without the power of rising above or sinking below it, very much like shadows - only hard and with luminous edges - and you will then have a pretty correct notion of my country and countrymen. Alas, a few years ago, I should have said "my universe": but now my mind has been opened to higher views of things.

Imagine a vast sheep of paper on which straight Lines, Triangles, Squares, Pentagons, Hexagons, and other figures, instead of remaining fixed in their places, move freely about, on or in the surface, but without the power of rising above or sinking below it, very much like shadows - only hard and with luminous edges - and you will then have a pretty correct notion of my country and countrymen. Alas, a few years ago, I should have said "my universe": but now my mind has been opened to higher views of things.

The task in this project is to automatically ***identify a writer, based on the handwritten text***.

The CVL-database consisting of images with 7 different handwritten texts (1 German and 6 English) from in total 310 writers, can be used.

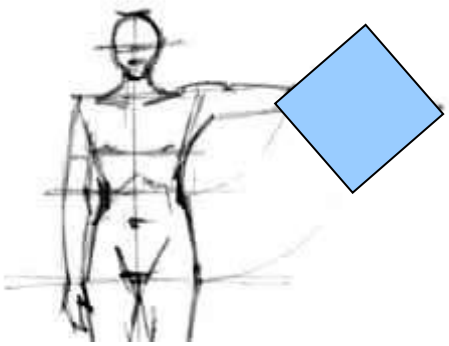
https://cvl.tuwien.ac.at/research/cvl-databases/an-off-line-database-for-writer-retrieval-writer-identification-and-word-spotting/

Project: Hand gesture recognition

Write a program that recognizes 8 different hand gestures. You will need a web cam for this project.

Set up the web cam so that it sees your upper body. Your program should obtain a series of images from the web cam, and recognize the motion of one or both of your hands. This should be relatively easy if the only moving things the camera sees are your hands. Your program should not depend on a uniform background, but rather look for motion by comparing subsequent frames. Additional complexity can be added by allowing other moving things. For example, try to distinguish whether the moving object is a hand or a head.

Your program should be able to recognize 8 different commands. You can choose yourself what different motions can be considered commands. For example: left hand up, left hand down, right hand up, one hand up while the other goes down, moving hand left to right, opening and closing of hand, etc.

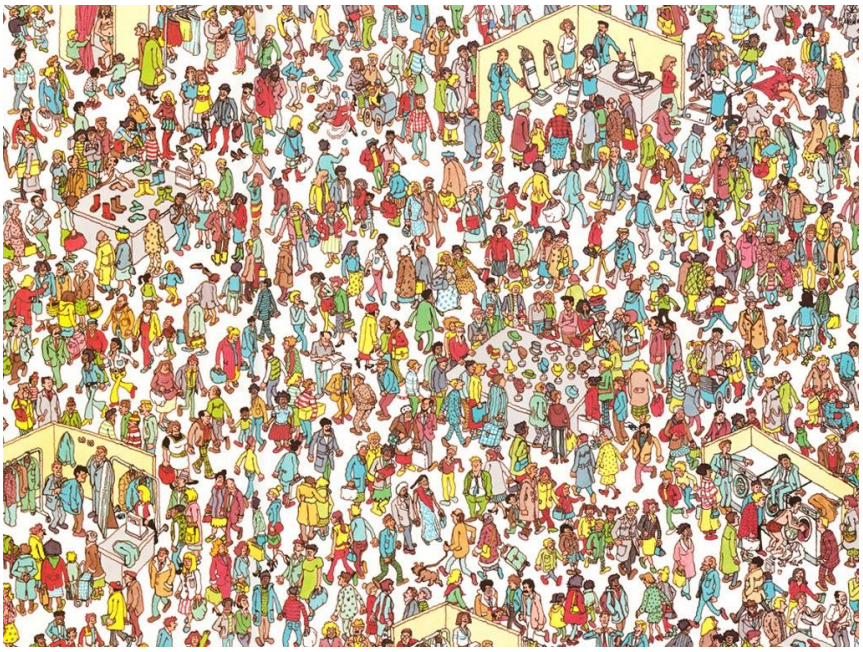


Project: Find Waldo

Can you write a program that does what a 5-year-old can?

Your program should be able to find the Waldo character in an image of any page of a “Where is Waldo” book. There are many different ways to go about this, e.g. using the known colour and pattern of his shirt and hat, or by template matching.

The program should work on all five of the images in Waldo.zip. Feel free to find more!



Project: Identifying hand pose using active shape models

In this project you will be experimenting with active shape models.

Download the active shape model toolbox at the File Exchange: http://www.mathworks.com/matlabcentral/fileexchange/26706 . Disregard the example, it does not correspond with this project.

First you will be taking a sequence of photographs of the same hand, open and palm down on the table. Use a uniform, dark background. Explore the range of motion of the fingers, such that each photograph captures the hand in a different pose. You are aiming at something similar to the drawing below, taken from the Cootes et al. paper that first introduced active shape models (Computer Vision and Image Understanding 61(1):38-59, 1995). Now train the model with this data. Examine the various parameters of the model: How does each affect the shape? Are they independent? Does the average shape represent a possible shape?

Next, take a new image, one that wasn't used in creating the model, and fit the model to it. Is the fit dependent on initialisation? Does the model generalize well? If the hand in the photograph is in a pose not earlier seen by the model, is the model able to adapt? What happens if you change the background to a different colour? And a less uniform background?

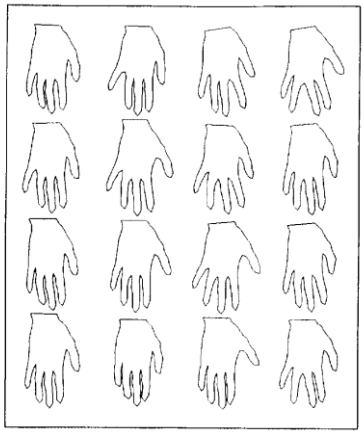


FIG. 13. Training set of hand shapes, each defined by 72 points

Project: Monitoring leaves length

Write a program that detects the leaves and measures their length in the images given.

The file plants.zip contains 8 photographs of young plants, taken from the side. Each plant is composed of a single leaf. Note that the red background gives excellent contrast with the green leaves if you use the proper colour space.

You program should detect all the leaves in one image, measure their length, and return the data in a form you find suitable. Note that leaves can cross each other in the image. Try to design your program such that these can be separated. The program should work without modification on all the images provided.

Project: Detecting and measuring cells in a Pap smear

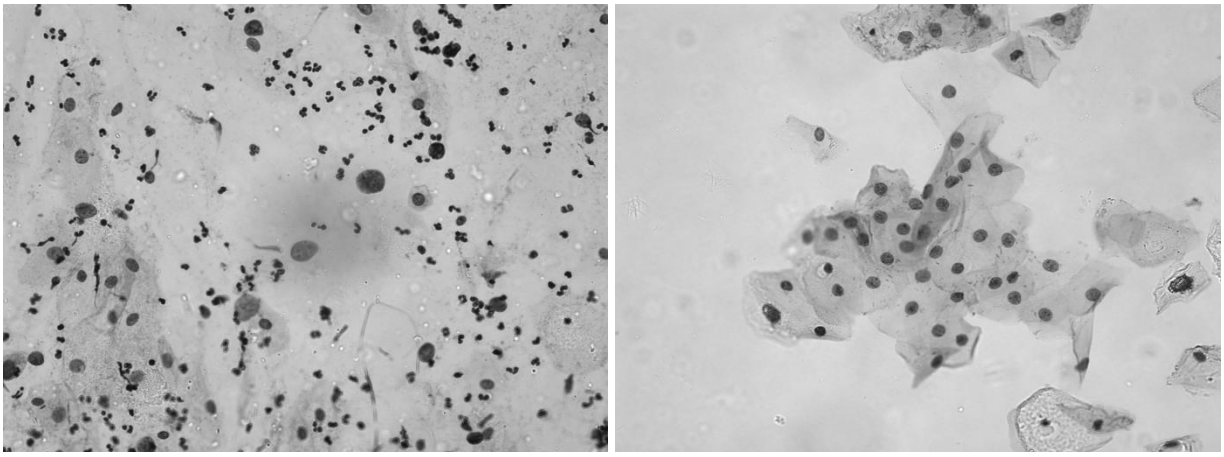
Automating the assessment of Pap smears has been attempted since the 1950's. It is still not a fully solved problem. But in this project we won't be as demanding as the real-world medical application.

A Pap smear is a collection of cells from the cervix, and can be used for early detection of cervical cancer. The problem is that manual evaluation of a smear can take up to 20 minutes. A person needs to look at every single cell on the whole slide, looking for the few odd cells among 100 000 cells. No wonder there's such a strong interest in automation!

Your task is to write a program that detects and delineates the cell nuclei. These are the larger, dark, round shapes seen in both images. Note that the smaller, darker shapes, which are very common in the left image, are blood cells and should be ignored.

The areas with intermediate grey value around the nuclei are the cell cytoplasms. Try to distinguish these from the unoccupied background also.

The images are in papsmear.zip

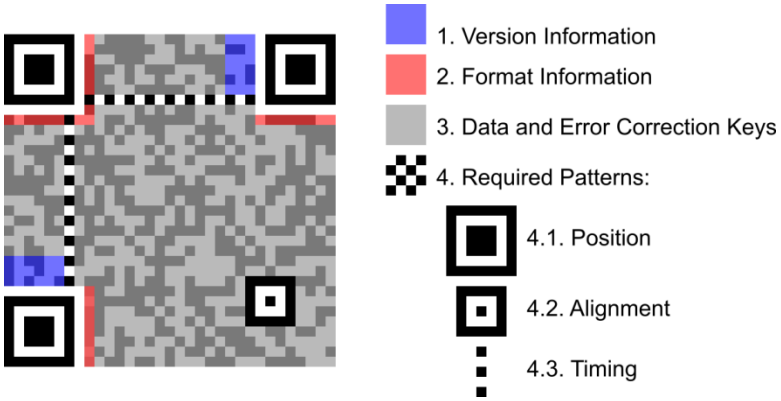


Project: 2D bar code reading

QR codes are increasingly common 2D bar codes. Most modern cell phones can take a photograph of such a bar code and give the user the information encoded in it, for example a web URL, an email address, a vcard, etc.

Your task is to write a program that detects the QR code in an image, corrects it for rotation and perspective, finds the top-left corner and the grid spacing, and reads the code as a matrix of ones and zeros. Decoding the QR code is optional.

See http://en.wikipedia.org/wiki/QR_Code and http://www.swetake.com/qr/qr1_en.html .



Project: Road detection in satellite images

A common problem is to detect roads in satellite images. The image below is taken from http://maps.google.com/ . Get some screen shots from that site and write a program that detects the roads. Warning: this problem is not as easy as it looks!

Project: Registration

I found a bunch of images of the main building of MIC online. The first two images are from Google Street View, and are exactly the same photograph, but with different distortions to make it look like a different point of view. The other two images are taken from different perspectives, and under very different conditions. Write a program that matches these images, and warps them all to a common geometry. The difference in colours, shadows, background, and plants make this task complicated. There are two different approaches to this task:

- Compare the pixel values directly, using a suitable error measure. Find a geometric transformation that minimizes the error measure.
- Find relevant landmarks in one image, then search for those same landmarks in the second one. Find a geometric transformation that matches these landmarks as well as possible.

Evaluate both approaches.

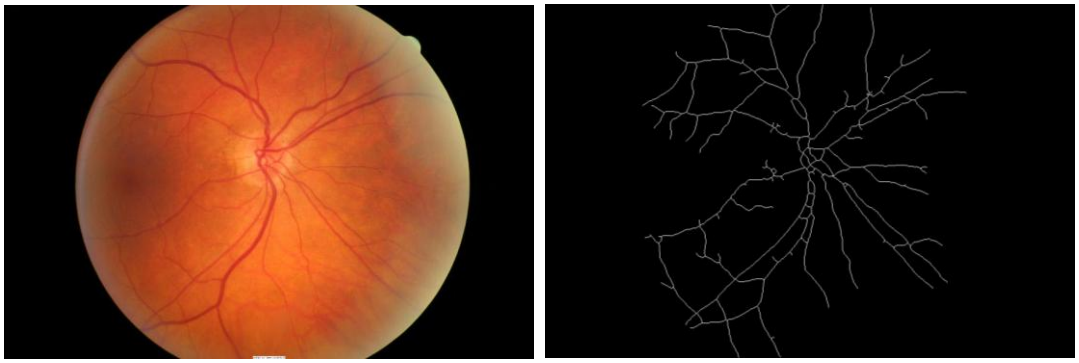
You can find the images in MIC.zip, or you can use images of a different object to work on.

Project: Blood vessel segmentation in retinal images

Diabetic retinopathy (DR) is one of the leading disabling chronic diseases, and one of the leading causes of preventable blindness in the world. Fundus imaging has an important role in diabetic retinopathy detection and monitoring because eye fundus is sensitive to vascular diseases. The goal of this project is to develop a method for segmentation of blood vessels in retinal images.

You can download 20 fundus images, and two sets of manual expert annotation images of the vessel network at: http://www.ces.clemson.edu/~ahoover/stare/probing/index.html

(7-zip can unpack the files for you on Windows.) The manual annotations can be used for algorithm development and algorithm evaluation. Use 15 of the images for training and testing, and save 5 images for final algorithm evaluation.



Project: Keys

Take an image with a number of different keys. Examples are shown below. Take another (reference) image, with only one of the keys.

Try to find the reference key in the collection. Label/delineate the correct match.

You will need to segment and align the object. Consider use colour information and arrangement of feature points. The order processing is not obvious, is it better to first find a plausible object and then to delineate it, or first to segment all objects and then to identify the key?

Try with different arrangements of the objects and viewing angles, increasing difficulty of detection!

Project: Licence plate recognition

Take a number of images of cars, so that the licence plate is visible. Try to recognize the licence (letters and numbers).

It is good to decompose the task in three steps: plate detection, character segmentation and character recognition. Use colour and shape information for plate detection. Character segmentation can be relatively simple, in good imaging conditions. Discuss the challenges!

Character recognition should lead to the decoded content of the licence plate.

An example is illustrated below:

Add difficulty to the task by considering images of the plates of the moving cars. You will have to determine motion and correct for the blur. You may discuss the speed limit for your algorithm to work.