COMP9517 Computer Vision
Project, T3 2019

Project Synopsis

The project is worth 45% of the total course marks. Refer to the marking criteria file for detailed information about marking. Submission instructions and demo schedule will be released later.

This project consists of two components:

A. **Individual Component:** This component must be completed individually by each student. (**Individual Component is worth 15% of the total course marks**)

B. **Group Component:** This is the group project component that will be completed by a team of up to 5 students. **(Group Component is worth 30% of the total course marks)**

Project Description

Medical image analysis is one of the leading fields that benefits from Computer Vision, where computer vision techniques help to improve and assist the workflows of medical professionals in multiple tasks, including detection and diagnosis of diseases, guidance for treatment and any post-treatment follow up. Segmentation (also known in many medical fields as contouring) of various organs and anatomical landmarks in medical images improves detection and diagnosis of diseases, and is an ideal task for computer vision-based automation. The Group Component of this project is to perform medical image segmentation of various anatomies, and the Individual component is on segmentation of a specific anatomical part.

There are many public medical imaging datasets available, along with expert ground truth (segmentation masks or diagnostic labels depending on the objective), that help computer scientists develop their Computer Vision algorithms and evaluate their effectiveness before testing on real clinical and surgical datasets. For this project we have selected two popular public retinal image databases, namely IDRiD (Indian Diabetic Retinopathy Image Dataset) [1] and DRIVE (Digital Retinal Images for Vessel Extraction) [2]. Retinal images (images of the back of the eye) are acquired by an ophthalmologist during clinical examination. These images are typically taken with the intention of detecting or excluding potential abnormalities that may relate to different medical conditions or diseases. Some of the visual features that ophthalmologists are interested in include morphological changes to the optic disc, discolouration of the optic nerve and narrowing of the blood vessels in the retina.

Both of the above databases contain multiple subsets of retinal images that are labelled according to a specific objective that could benefit from computer vision and machine learning driven analysis. The tasks we are interested in for the class project are:

1. <u>Individual Component</u>: Optic disc (head of the optic nerve) segmentation in the IDRiD dataset
2. <u>Group Component:</u> This consists of two tasks:

2.1. Segmentation of retinal lesions associated with Diabetic Retinopathy in IDRiD datasets
2.2. Blood vessel segmentation in DRIVE datasets

Individual Component - 15 marks

In this task you will implement a Python solution to segment the optic disc using a set of retinal images from IDRiD database. This task will be **completed individually** by each student and **evaluated for each student separately**.

Task implementation:
For this task you are required to use traditional segmentation algorithms based on image processing along with appropriate pre- and post-processing techniques (without using the dataset for training).

Data Provided:
1. 54 original retinal images in JPG format
2. Corresponding ground-truth segmentation masks in JPG format

Sample images are shown in Fig. 1.

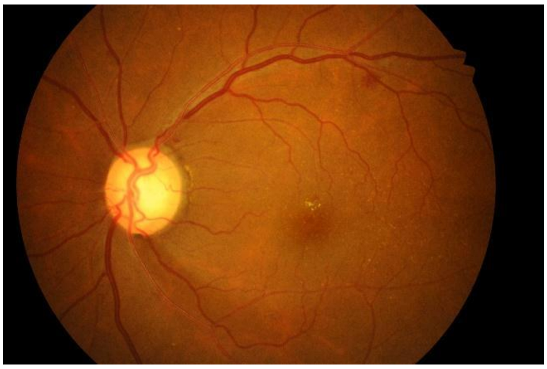
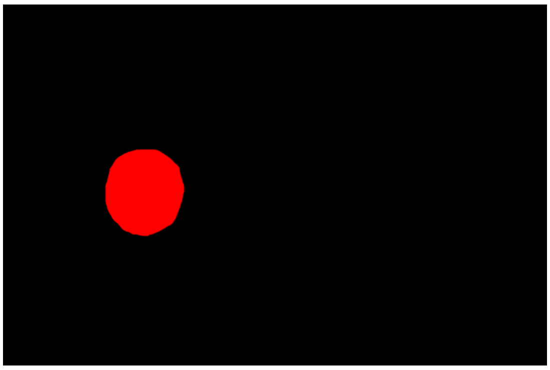



Figure 1: Example retinal image from the IDRiD database (left) and the ground-truth segmentation (right)

Evaluation:
As you are implementing an unsupervised segmentation framework, you can use all original retinal images and their respective ground-truth masks to obtain an appropriate statistical evaluation. However, if you are providing adequate subjective evaluation (via visualised segmentation results and detailed discussion) you may exclude statistical evaluation.

Deliverables for Individual Component:
Each student will submit an individual report with a maximum 3 pages (2-column IEEE format) along with your source code(s) by Nov 22nd, Friday week 10. The report should include the following parts:
1) Introduction and Background – you will briefly discuss your understanding of the task and data and a brief literature review
2) Method (implementation) – in this section you should justify and explain the selection of the techniques you implemented, using relevant references when necessary.
3) Experiment - explain the experiment setup and the evaluation methods and metrics used.

4) Results and Discussion – in this section you should provide some visual results in addition to statistical evaluation, along with a discussion about performance and outcomes.
5) References

Group Component - 30 marks

The group Component **consists of two tasks**, each of which needs to be **completed as a group and will be evaluated ONCE for the whole group**.

Group Task – 1

In this task you will segment retinal lesions of abnormal conditions associated with diabetic retinopathy, namely *microaneurysms*, *haemorrhages*, *hard exudates* and *soft exudates* in IDRiD images.

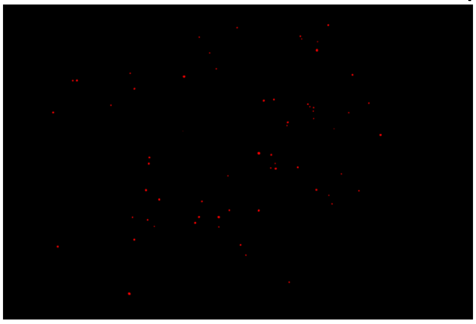
Task Implementation:

You can use any segmentation / classification technique(s) to implement this task. Some of the relevant publications are provided as supplementary materials to this project only as a guidance. You are encouraged to search for other papers and use them as the basis for your implementation.

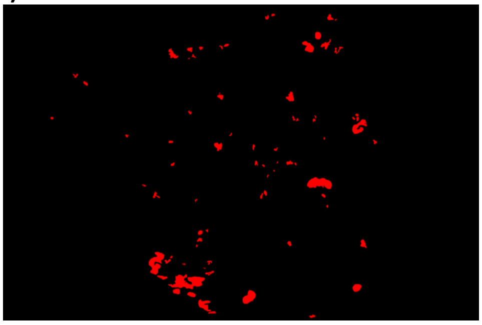
Data Provided:

1. 54 original retinal images in JPG as training images
2. 27 original retinal images in JPG as test images
3. Corresponding ground-truth segmentation masks for each lesion (condition) type in each image (wherever each condition is present)

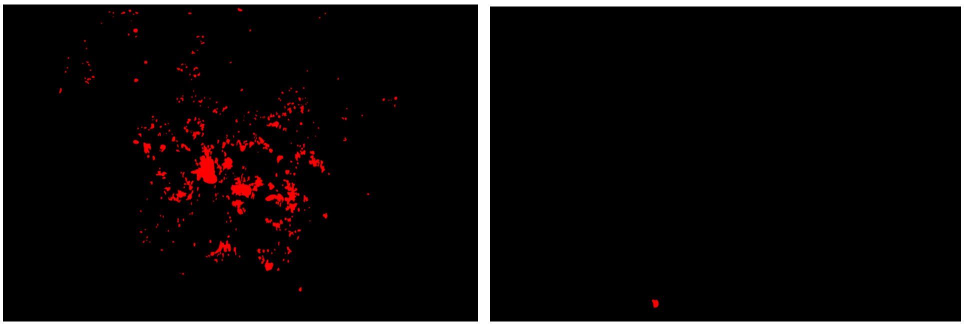
(a)



(b)



(c)



(d) **(e)**

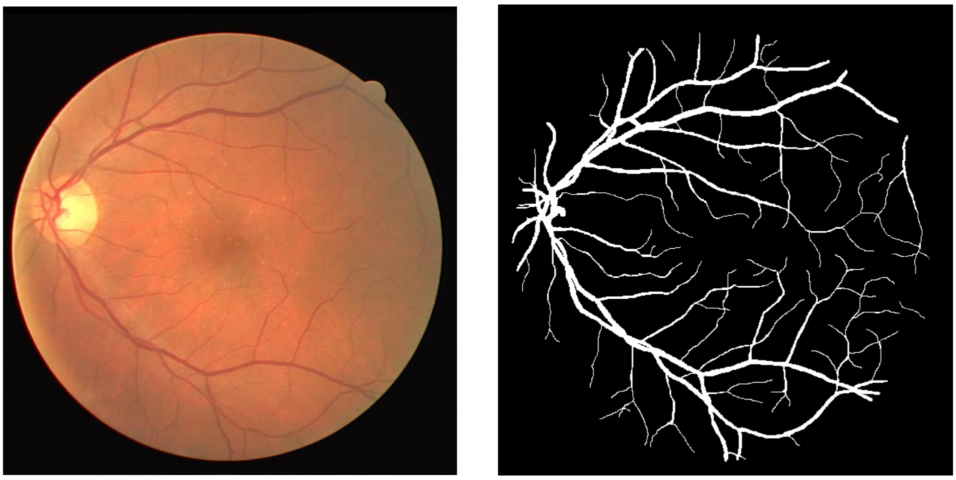
Figure 2: Example retinal image from the IDRiD database (a) with the ground-truth segmentation masks for Microaneurysms (b), Haemorrhages (c), Hard Exudates (d) and Soft Exudates (e).

Evaluation:
You should utilise the training datasets and their labels for designing and training the segmentation algorithms. You should then evaluate the segmentation results on the test datasets and ground-truth provided. You should also investigate and use appropriate evaluation metric(s).

Group Task – 2
In this task you will implement a Python solution to segment blood vessels in retinal images, using a subset of the **DRIVE database**.

Task implementation:
For this task, you may employ a wide range of supervised and unsupervised segmentation techniques and their hybrids, along with appropriate pre- and post-processing techniques. Some of the relevant publications are provided as supplementary materials to this project only as a guidance.

Data Provided:
1. 40 original retinal images in TIF format, divided into 20 training images and 20 test images
2. Corresponding ground-truth segmentation masks for both training and test
3. Background masks – the background (black) around the retinal image is given as a mask and you may use this mask to separate the background (for both training and test subsets)



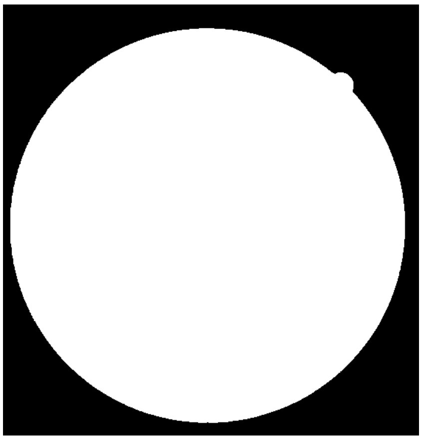


Figure 3: Example retinal image from the DRIVE database (top-left), the ground-truth blood vessel segmentation (top-right), the background mask (bottom)

Evaluation:
You should utilise the training images and their labels for designing the algorithm and training of the supervised segmentation algorithms. You should then evaluate the segmentation results on the test images and the ground-truth provided. You should also investigate and use appropriate evaluation metric(s).

Deliverables for Group Component:
On Nov 19th Tuesday week 10, each group will make a 15-minute demo/presentation to one tutor and one assessor. This should include a slide show presentation demonstrating your methods and results, followed by questions from the assessors/audience. The tutor and assessor will provide feedback during this session.

Each group will also submit a report of maximum 10 pages (2-column IEEE format) along with the source code(s) by Nov 22nd Friday week 10. The report must include the following parts:

1) Introduction - you will discuss on your understanding of the task and data
2) Literature Review – review of relevant techniques in literature, along with any necessary background to understand the techniques you selected. With respect to the literature, you should also justify the techniques you selected.
3) Method (implementation) – in this section you should justify and explain the selection of the techniques you implemented, using relevant references and theories when necessary.
4) Experimental setup - you will explain the experiment setup and evaluation methods.
5) Results – in this section you should provide statistical and visual results.
6) Discussion and Conclusion
7) Contribution of Group Members – in this section you MUST present each group member's contribution in brief. In maximum 3 lines per member, describe the component(s) that each group member contributed to.
8) References

References

[1] Indian Diabetic Retinopathy Image Dataset (IDRiD) Available at: https://idrid.grand-challenge.org/

[2] Hoover, A. "STARE database." Available at: http://www. ces. clemson. edu/~ ahoover/stare (1975)

Supplementary – Some Related Publications

Note: You can find these papers in Google Scholar or through UNSW Library for papers with more restricted.

Individual Component

[1] Dehghani, Amin, Hamid Abrishami Moghaddam, and Mohammad-Shahram Moin. "Optic disc localization in retinal images using histogram matching." *EURASIP Journal on Image and Video Processing* 2012, no. 1 (2012): 19.

[2] Almotiri, J., Elleithy, K. and Elleithy, A., 2018, May. An automated region-of-interest segmentation for optic disc extraction. In *2018 IEEE Long Island Systems, Applications and Technology Conference (LISAT)* (pp. 1-6). IEEE.

[3] Aquino, Arturo, Manuel Emilio Gegúndez-Arias, and Diego Marín. "Detecting the optic disc boundary in digital fundus images using morphological, edge detection, and feature extraction techniques." *IEEE transactions on medical imaging* 29, no. 11 (2010): 1860-1869.

[4] Reza, Ahmed Wasif, Chantra Eswaran, and Kaharudin Dimyati. "Diagnosis of diabetic retinopathy: automatic extraction of optic disc and exudates from retinal images using marker-controlled watershed transformation." *Journal of medical systems* 35, no. 6 (2011): 1491-1501.

Group Component – Task 1

[1] Salamat, Nadeem, Malik M. Saad Missen, and Aqsa Rashid. "Diabetic retinopathy techniques in retinal images: a review." *Artificial intelligence in medicine* (2018).

[2] Sinthanayothin, Chanjira, James F. Boyce, Tom H. Williamson, Helen L. Cook, Evelyn Mensah, Shantanu Lal, and David Usher. "Automated detection of diabetic retinopathy on digital fundus images." *Diabetic medicine* 19, no. 2 (2002): 105-112.

[3] Quellec, Gwenolé, Katia Charrière, Yassine Boudi, Béatrice Cochener, and Mathieu Lamard. "Deep image mining for diabetic retinopathy screening." *Medical image analysis* 39 (2017): 178-193.

[4] Porwal, Prasanna, Samiksha Pachade, Manesh Kokare, Girish Deshmukh, Jaemin Son, Woong Bae, Lihong Liu et al. "IDRiD: Diabetic Retinopathy–Segmentation and Grading Challenge." *Medical Image Analysis* (2019): 101561.

Group Component – Task 2

[1] Budai, Attila, Georg Michelson, and Joachim Hornegger. "Multiscale Blood Vessel Segmentation in Retinal Fundus Images." In *Bildverarbeitung für die Medizin*, pp. 261-265. 2010.

[2] Bilal, Sara, Fatin Munir, and Mostafa Karbasi. "BLOOD VESSELS SEGMENTATION BASED ON THREE RETINAL IMAGES DATASETS." (2006).

[3] Salamat, Nadeem, Malik M. Saad Missen, and Aqsa Rashid. "Diabetic retinopathy techniques in retinal images: a review." *Artificial intelligence in medicine* (2018).

[4] Fraz, Muhammad Moazam, Paolo Remagnino, Andreas Hoppe, Bunyarit Uyyanonvara, Alicja R. Rudnicka, Christopher G. Owen, and Sarah A. Barman. "An ensemble classification-based approach applied to retinal blood vessel segmentation." *IEEE Transactions on Biomedical Engineering* 59, no. 9 (2012): 2538-2548.