



Reykjavík University Project Report, Thesis, and Dissertation Template

by

Sigurður Helgason

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Examining Committee:

Yngvi Björnsson, Supervisor
Professor, Reykjavík University, Iceland

Tough E. Questions, Examiner
Associate Professor, Massachusetts Institute of Technology, USA

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December 2019

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December 2019

Abstract

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Titll verkefnis með þöæéíó

Sigurður Helgason

desember 2019

Útdráttur

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Important!!! Read the Instructions!!!

If you have not already done so, \LaTeX the `instructions.tex` to learn how to setup your document and use some of the features. You can see a (somewhat recent) rendered PDF of the instructions included in this folder at `instructions-publish.pdf`. There is also more information on working with \LaTeX at <http://samvinna.ru.is/project/htgaru/how-to-get-around-projects-publish.pdf>. This includes common problems and fixes.

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I dedicate this to my spouse/child/pet/power animal.

Acknowledgements

So long, and thanks for all the fish.

Acknowledgements are optional; comment this chapter out if they are absent Note that it is important to acknowledge any funding that helped in the work This work was funded by 2019 RANNIS grant “Survey of man-eating Minke whales” 1415550. Additional equipment was generously donated by the Icelandic Tourism Board.

Preface

This dissertation is original work by the author, Sigurður Helgason.

The preface is an optional element explaining a little who performed what work. See https://www.grad.ubc.ca/sites/default/files/materials/thesis_sample_prefaces.pdf for suggestions.

List of publications as part of the preface is optional unless elements of the work have already been published. It should be a comprehensive list of all publications in which material in the thesis has appeared, preferably with references to sections as appropriate. This is also a good place to state contribution of student and contribution of others to the work represented in the thesis.

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List of Abbreviations

MSc	Masters of Science
DR	Diabetic Retinopathy
ML	Machine Learning
AI	Artificial Intelligence

Part I

The First Part

Introduction to the first part.

Chapter 1

Introduction

State the objectives of the exercise. Ask yourself: Why did I design/create the item? What did I aim to achieve? What is the problem I am trying to solve? How is my solution interesting or novel?

In the year 2017 the approximate amount of adults with diabetes was 425-million people [1], this number is projected to rise to 629-million people by the year 2045. The rate of people that are diagnosed with diabetes is 1 in every 2. Secondly of all people with diabetes 1 in every 3 develop diabetic retinopathy (DR)[2].

Diabetic retinopathy is a symptom of both type 1 and type 2 diabetes and is now the leading cause of blindness amongst adults today. DR is diagnosed by two major technologies, firstly there is the fundus imaging method, where a photograph is taken of the fundus (back) of the patients eye, an example of this can be seen in Figure 1.1. Secondly ophthalmologists examine Optical Coherence Tomography (OCT) scans of human retina, an example of this can be seen in Figure 1.2. The work in this paper does not focus on the latter. The diagnosis of DR is costly and as the statistic indicate the amount of work is going to increase.

Patients that have DR are grouped into four different stages[3]:

1. *Mild Nonproliferative Retinopathy* - This is the earliest stage of diabetic retinopathy, and it's characterized by balloon-like swelling in the retina's blood vessels. These are called microaneurysms, and these vessels can leak into the eye.



Figure 1.1: Example of Fundus image

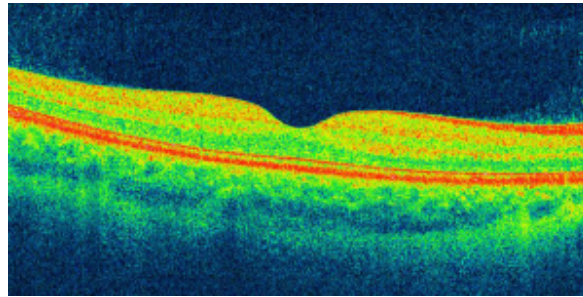


Figure 1.2: Example of OCT on Retina

2. *Moderate Nonproliferative Retinopathy* - During this stage, the blood vessels nourishing the retina swell and may even become blocked. This can contribute to diabetic macular edema (DME) which is a build-up of fluid in the macula region of the retina.

3. *Severe Nonproliferative Retinopathy* - At this stage, an increasing number of blood vessels nourishing the eye have become blocked. As a result, the retina is signaled to grow new blood vessels.

4. *Proliferative Diabetic Retinopathy* - This is the final stage of diabetic retinopathy. New blood vessels proliferate, growing inside the retina and into the vitreous gel, which is the fluid that fills the eye. Because these blood vessels are delicate, they may begin to leak and bleed. As a result, scar tissue may form, causing retinal detachment, the pulling away of the retina from underlying tissue. Retinal detachment may cause spotty vision, flashes of lights, or severe vision loss.

Generally without intervention patients advance from one stage to the next eventually leading to permanent vision impairment, however with intervention by an ophthalmologist this advancement can be prevented [4].

This paper focuses on applying machine learning methods to patient information and Fundus images of those patients to assess the likelihood (risk) of those patients DR developing into SDR.

In this paper we will apply machine learning methods to patients information and fundus images of patients that has been collected a period of time to examine a patients likelihood to advance from one stage of DR to the next, attempting to predict the timeline the patient has to seek medical help.

1.1 Machine learning methods in Ophthalmology

Applying machine learning to fundus images and patient information has been done before very successfully researchers[5], this work generally focuses on applying image recognition on the images to identify which stage of DR the eye has reached.

1.2 Background

Provide background about the subject matter (e.g. How was morse code developed? How is it used today?). This is a place where there are usually many citations. It is suspicious when there is not. Include the purpose of the different equipment and your design intent. Include references to relevant scientific/technical work and books. Applying statistics to medical data in order to better understand a patients evolution from DR to SDR has been done previously by a company called RetinaRisk, a significant contributor to this paper, but RetinaRisk's solution does not apply machine learning but a specialists field knowledge and a handcrafted formula. RetinaRisks formula has been used to significantly reduce costs to health organizations as when patients following their recommendations for doctor checkups come in less often but at time that are more critical. im just writing something so that it looks like I'm writing something

Chapter 2

Methods

This section discusses the various machine learning methods utilized throughout this project and discusses their applicability.

I'm a little teapot

I'm a smaller teapot

Chapter 3

Results

In this section you discuss any issues that came up while developing the system. If you found something particularly interesting, difficult, or an important learning experience, put it here. This is also a good place to put additional figures and data.ello world

Chapter 4

Discussion

Here I will discuss the myriad of fields research like this can help for instance for health organizations, patients, taxpayers, and pharmaey

4.1 Summary

summarize the workey

4.2 Conclusion

conclude the work, discuss the significance of the workey

Bibliography

- [1] I. D. Foundation. (). Facts & figures, [Online]. Available: <https://www.idf.org/aboutdiabetes/what-is-diabetes/facts-figures.html>.
- [2] J. W. Yau, S. L. Rogers, R. Kawasaki, E. L. Lamoureux, J. W. Kowalski, T. Bek, S.-J. Chen, J. M. Dekker, A. Fletcher, J. Grauslund, S. Haffner, R. F. Hamman, M. K. Ikram, T. Kayama, B. E. Klein, R. Klein, S. Krishnaiah, K. Mayurasakorn, J. P. O'Hare, T. J. Orchard, M. Porta, M. Rema, M. S. Roy, T. Sharma, J. Shaw, H. Taylor, J. M. Tielsch, R. Varma, J. J. Wang, N. Wang, S. West, L. Xu, M. Yasuda, X. Zhang, P. Mitchell, and T. Y. Wong, "Global prevalence and major risk factors of diabetic retinopathy", *Diabetes Care*, vol. 35, no. 3, pp. 556–564, 2012, ISSN: 0149-5992. DOI: 10.2337/dc11-1909. eprint: <https://care.diabetesjournals.org/content/35/3/556.full.pdf>. [Online]. Available: <https://care.diabetesjournals.org/content/35/3/556>.
- [3] P. of Blindness Society of Metropolitan Washington. (). What is diabetic retinopathy, [Online]. Available: <http://www.youreyes.org/eyehealth/diabetic-retinopathy>.
- [4] A. N. Kollias and M. W. Ulbig, "Diabetic retinopathy: Early diagnosis and effective treatment", *Deutsches Arzteblatt International*, vol. 107, no. 5, 75–83; quiz 84, Feb. 2010, ISSN: 1866-0452. DOI: 10.3238/arztebl.2010.0075.
- [5] V. Gulshan, L. Peng, M. Coram, M. C. Stumpe, D. Wu, A. Narayanaswamy, S. Venugopalan, K. Widner, T. Madams, J. Cuadros, R. Kim, R. Raman, P. C. Nelson, J. L. Mega, and D. R. Webster, "Development and Validation of a Deep Learning Algorithm for Detection of Diabetic Retinopathy in Retinal Fundus

Photographs”, *JAMA*, vol. 316, no. 22, pp. 2402–2410, Dec. 2016, ISSN: 0098-7484. DOI: 10.1001/jama.2016.17216. eprint: <https://jamanetwork.com/journals/jama/articlepdf/2588763/joi160132.pdf>. [Online]. Available: <https://doi.org/10.1001/jama.2016.17216>.