Image Processing in Cross-disciplinary Research

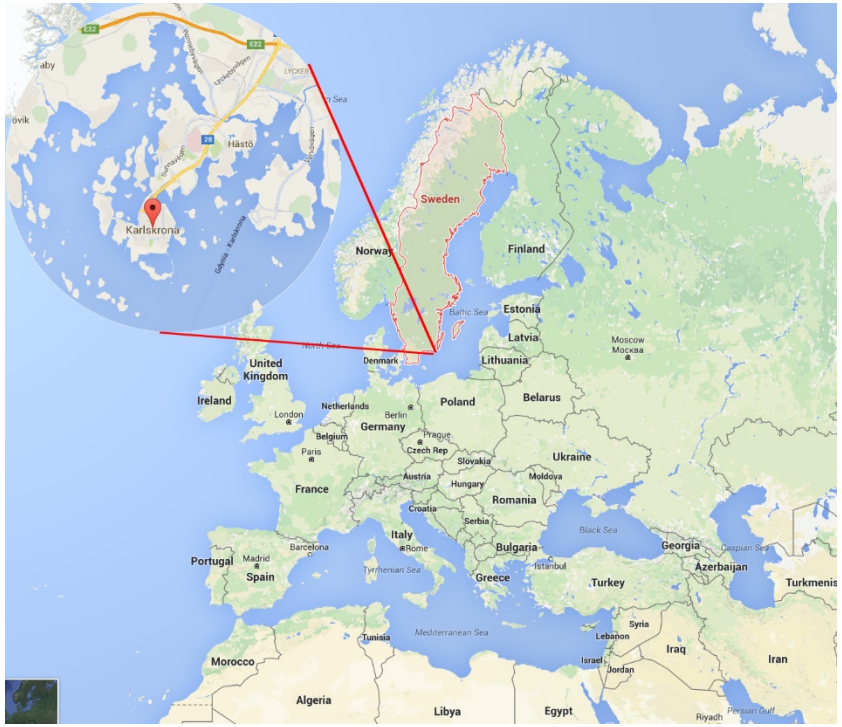
Abbas Cheddad
Associate Professor in Computer Science
& Group Leader (SM IEEE)

Department of Computer Science
Blekinge Institute of Technology
Sweden

Office: +46 4 55-385863
Email: abbas.cheddad@bth.se
Web: http://www.abbascheddad.net

Blekinge Tekniska Högskola

(www.bth.se)



Group Members

-  *Dr. Abbas Cheddad*

Assoc.Prof (Group Leader)

-  *Dr. Huseyin Kusetogullari*

Lecturer

Received his PhD degree from the University of Warwick, UK, in

-  *Florian Westphal*

PhD student

Received his B.Sc. and M.Sc. from the University of Potsdam, Ger 2011.

-  *Siva Krishna Dasari*

PhD student

Pursuing her PhD studies in the Department of Computer Scienc

ArkivDigital

Big data analytics for image processing

- Image classification
- Image restoration
- Pattern recognition

GKN AEROSPACE

SONY

Challenges on the OSNs

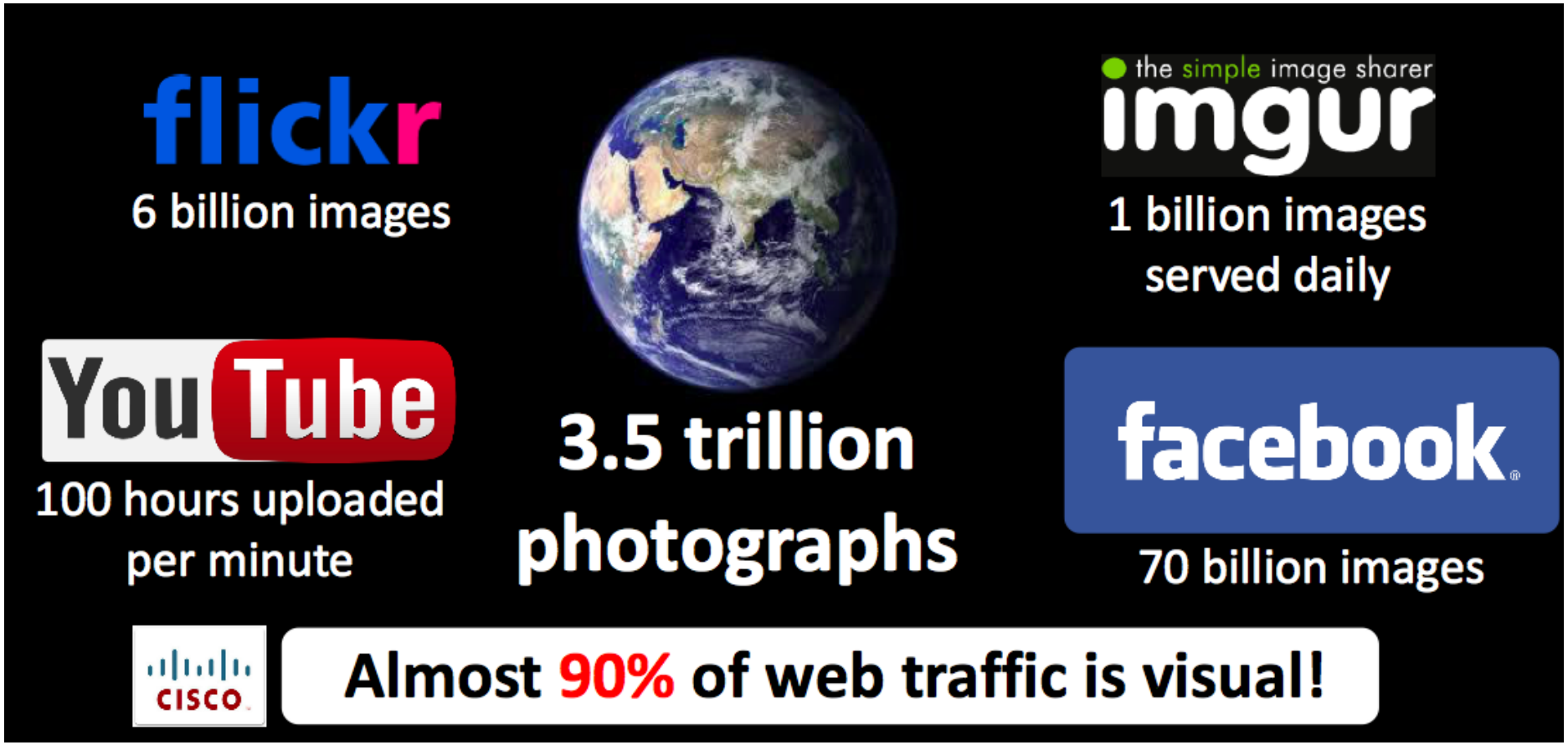
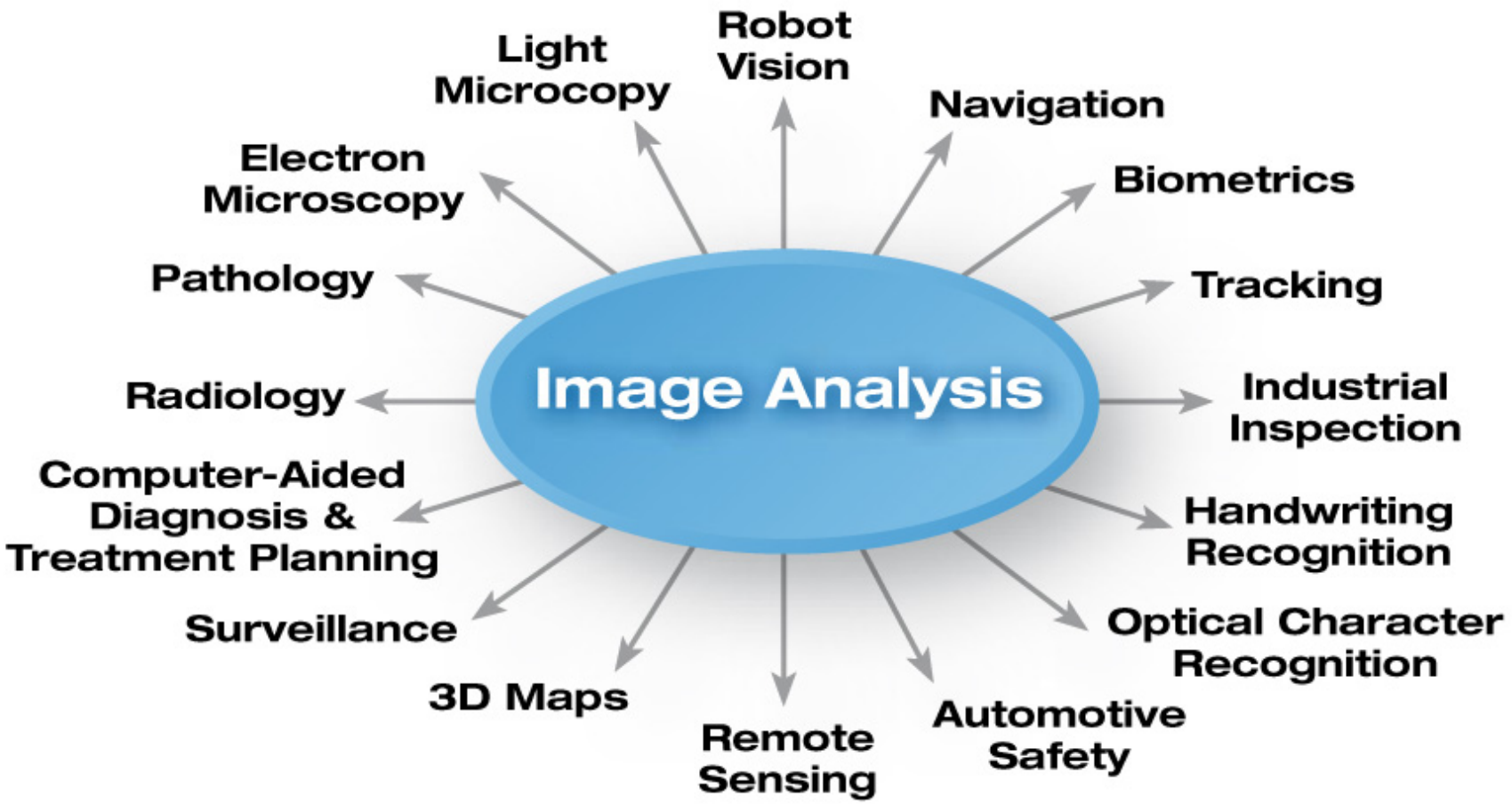


Image Analysis at the Macro-level



Outline

IP – Risk Prediction of Breast Cancer

IP – Molecular Medicine – OPT –

IP – Diabetic Retinopathy

IP – Handwritten Recognition

IP – Aerospace Engineering

IP – Multimedia Security

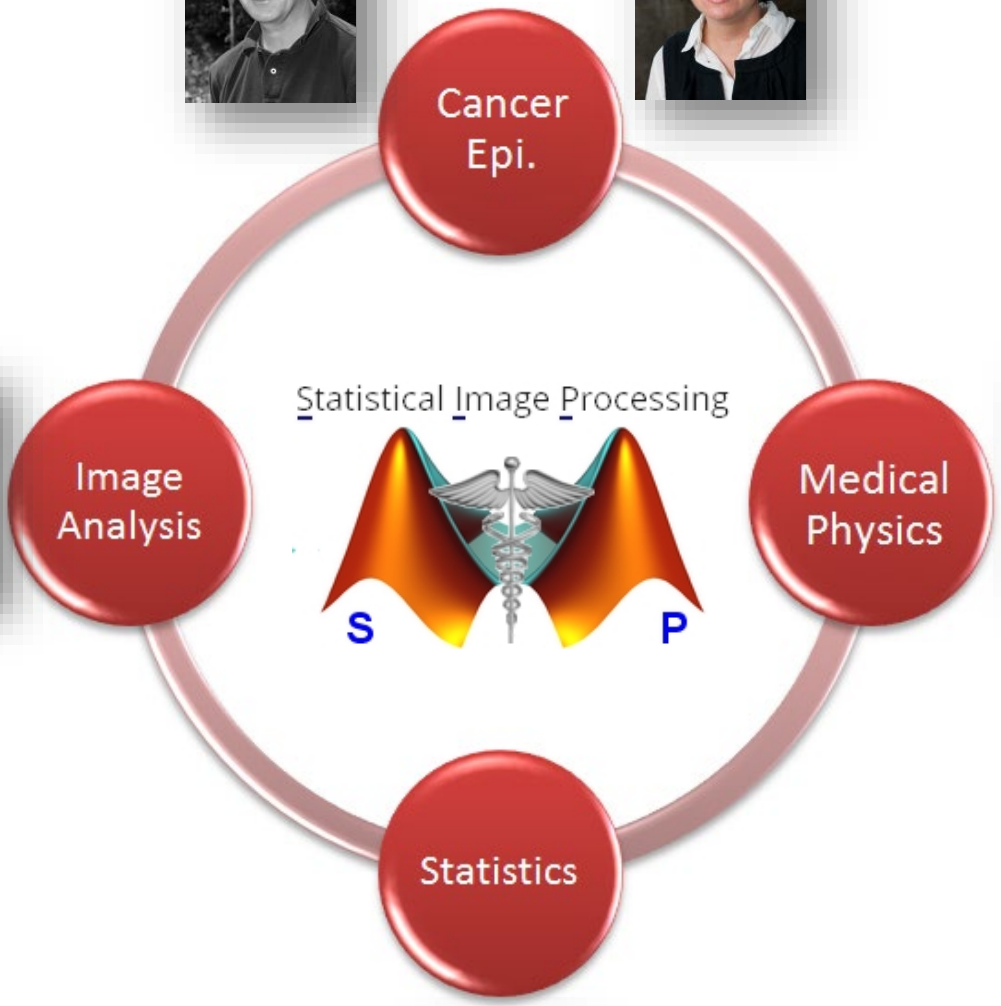
IP – Deep Learning-Generative Adversarial Networks (GANs)

IP – Risk Prediction of Breast Cancer

Karolinska Institutet





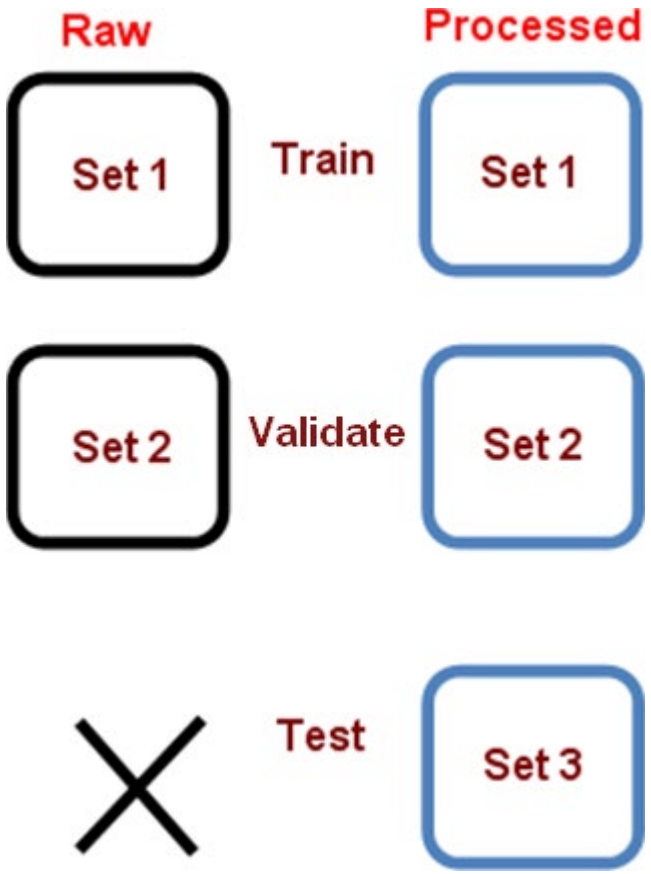


2012 - 2015 Research on statistical image analysis:

Extraction of Area and volumetric density and other features from X-ray images for breast cancer risk prediction

Area and Volumetric Density Measurement

- **Approach 1:** Combine features and acquisition parameters (processed images) to predict Volpara (corresponding raw images) – training using *Random Forests*.



- **Approach 2:** Area PD – directly segmenting dense, breast and pectoral muscle regions

CASAM-Vol current supported models

Machine code	Manufacturer	Manufacturer model name	Station name
0	GE MEDICAL SYSTEMS	Senographe Essential VERSION ADS_53.40	GEMAM-KLN1
1	GE MEDICAL SYSTEMS	Senographe Essential VERSION ADS_53.40	GEMAM-SCR2
2	GE MEDICAL SYSTEMS	Senographe Essential VERSION ADS_53.40	HBGMG03
3	GE MEDICAL SYSTEMS	Senographe Essential VERSION ADS_53.10.10	HBGMG03
4	GE MEDICAL SYSTEMS	Senographe Essential VERSION ADS_53.40	LKAMG01
5	GE MEDICAL SYSTEMS	Senograph DS VERSION ADS_53.40	SCR1
6	Sectra Imtec AB	L30	BDCHK1
7	Sectra Imtec AB	L30	SECTRA_MDM_1
8	Sectra Imtec AB	MDM 1.5	BDCHK2
9	Sectra Imtec AB	MDM 1.5	BDCHK3
10	Philips Digital Mammography Sweden AB	L30	BDCHK1
11	Philips Digital Mammography Sweden AB	L30	BDCHK2
12	Philips Digital Mammography Sweden AB	L30	BDCHK3
13	Philips Digital Mammography Sweden AB	L30	BDCHK4
14	Philips Digital Mammography Sweden AB	L30	SECTRA_MDM_1

Linear Regression

- To evaluate association between each of the automated PD measures and genotypes of the SNP rs10995190 in the gene ZNF365 (coded 0/1/2, treated as continuous variable), we fitted linear regression models using PD measures one at a time as outcome variables and carried out Wald tests.

Table Effect estimates for *rs10995190* on automated measures of mammographic density.

Outcome	Estimate (95%CI)	p-value
Volpara (raw)	−0.138(−0.191, −0.085)	4×10^{-7}
CASAM-Area (Processed)	−0.254(−0.353, −0.155)	6×10^{-7}
CASAM-Vol (Processed)	−0.113(−0.158, −0.068)	9×10^{-7}

Point estimates, interval estimates and p-values (Wald tests) are based on estimated coefficients for the SNP in linear regression models with PD measures as outcomes, adjusting for potential confounding variables (n = 1011).
doi:10.1371/journal.pone.0110690.t002

Logistic Regression with Cancer Status as Outcome

Table Effect estimates for automated measures of mammographic density on case-control status, n = 1058 (Cases 47, Controls 1011).

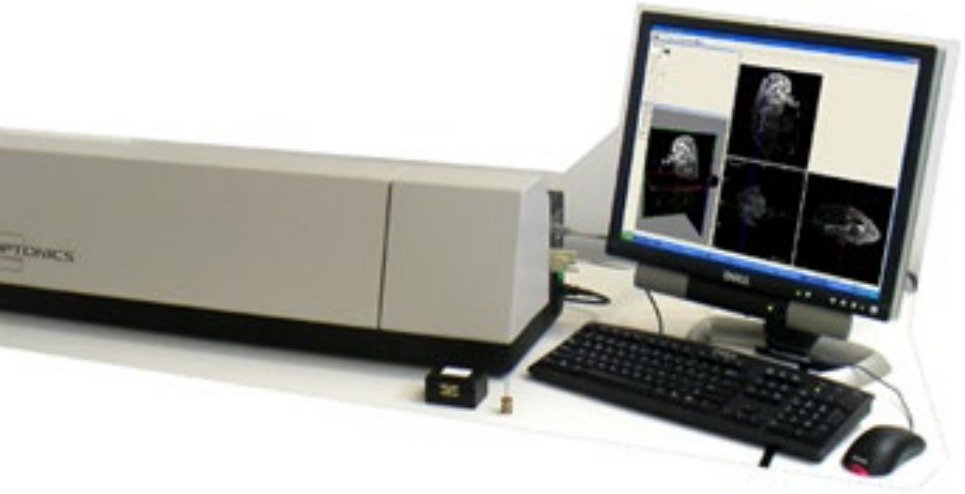
Covariate	Estimate (95%CI)	p-value
(a)		
Volpara(raw)	0.978 (0.300, 1.660)	0.005
CASAM-Area (Processed)	0.483 (0.112, 0.862)	0.012
CASAM-Vol (Processed)	0.926 (0.124, 1.730)	0.023
(b)		
Volpara(raw)	0.961 (0.239, 1.706)	0.010
CASAM-Area (Processed)	0.467 (0.071, 0.879)	0.023
CASAM-Vol (Processed)	0.813 (–0.041, 1.691)	0.065

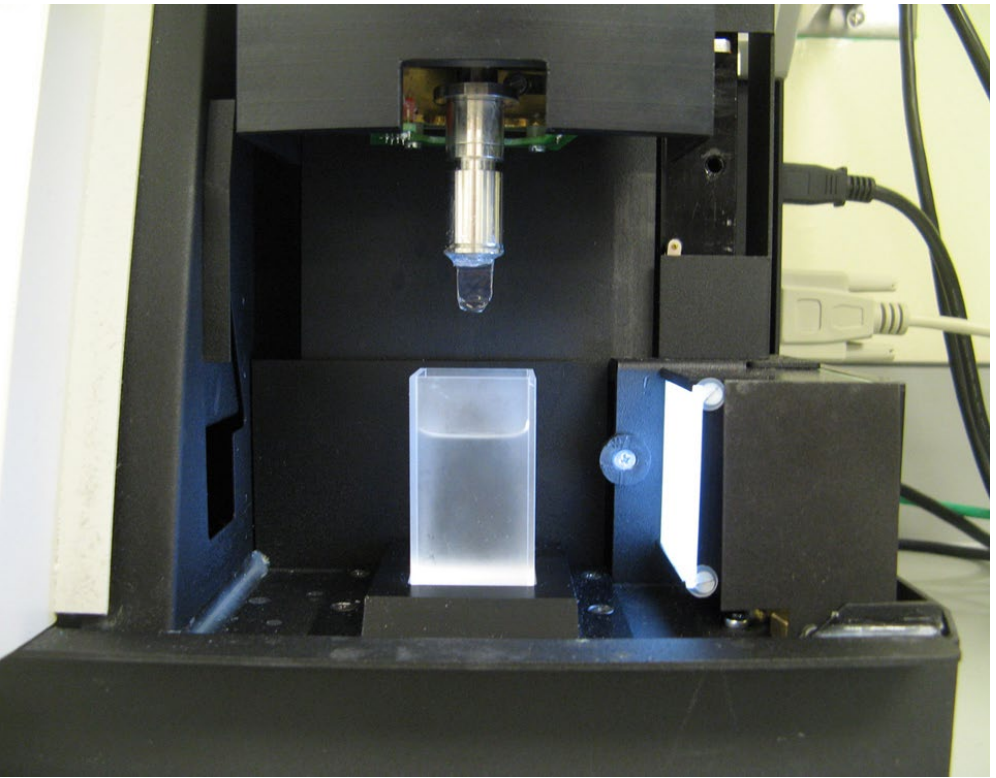
Point estimates, interval estimates and p-values (Wald tests) are based on estimated coefficients for PD in logistic regression models with case-control status as outcome. (a) with partial adjustment (age and BMI), (b) with full adjustment (age, BMI, menopausal status, HRT use, parity and age at first birth).
doi:10.1371/journal.pone.0110690.t004

IP- Molecular Medicine – OPT –

UMEÅ UNIVERSITET

2010 - 2012 Research on 3D visualization of B-cell mass in molecular medicine: *Correction of Optical Distortions in OPT Scanners*

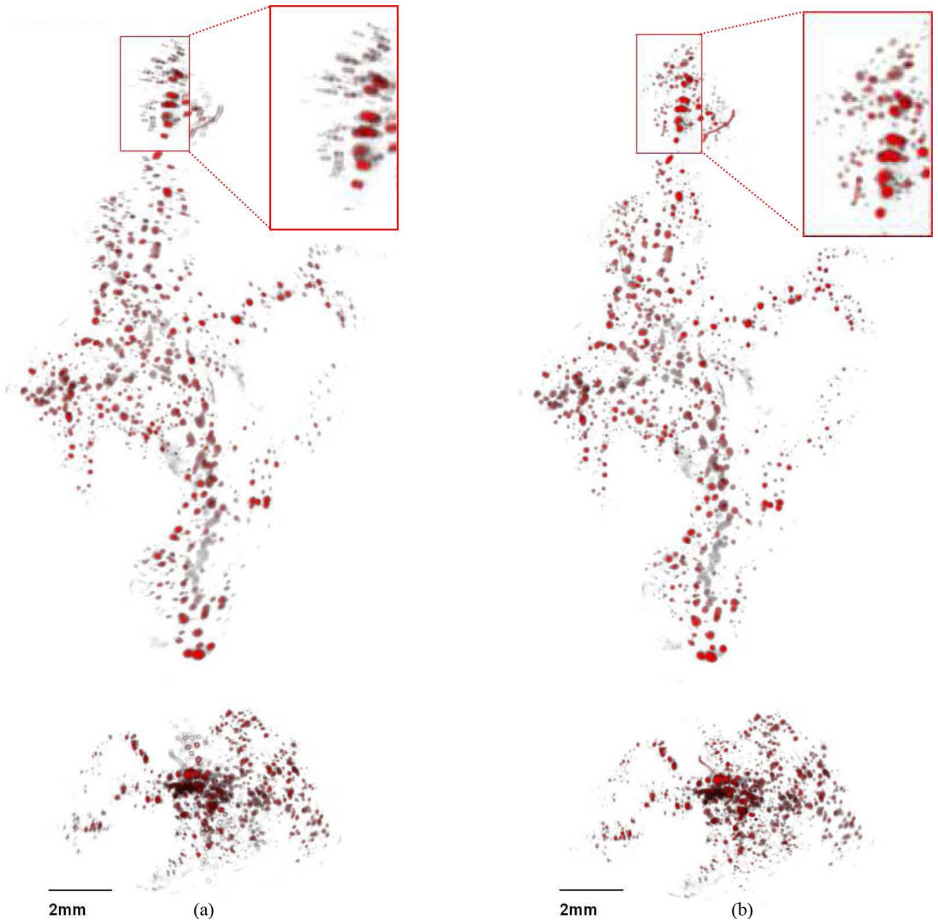


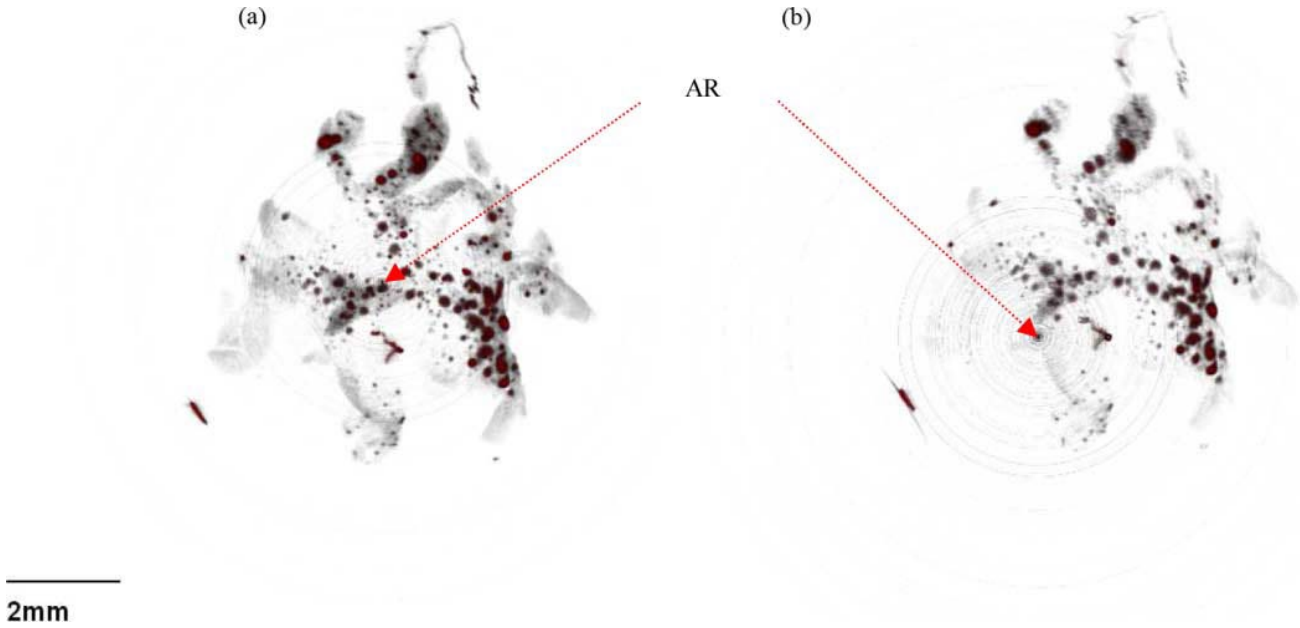


OPT Scanner

- Small animal organ is mounted manually on the rotating motor
- Submerge it into a cuvette filled with BABB clearing solution
- Sample is not precisely mounted around AoR
- Scan post-alignment correction (scattering, depth of focus)

OPT Scan Optimization





Abbas Cheddad, Christoffer Svensson, James Sharpe, Fredrik Georgsson and Ulf Ahlgren,(2012),"Image Processing Assisted Algorithms for Optical Projection Tomography", *IEEE Transactions on Medical Imaging*, Volume: 31 Issue:1, pp:1-15.


3D volume rendering of a mouse gastro intestinal tract
© Dr. Abbas Cheddad
www.abbascheddad.net

Users of our Enhanced Aquisition Tools for Optical Projection Tomography

Complex of Biomedical Institutes at Krc Prague, Czech Republic

novo nordisk

MONASH University

THE UNIVERSITY of EDINBURGH

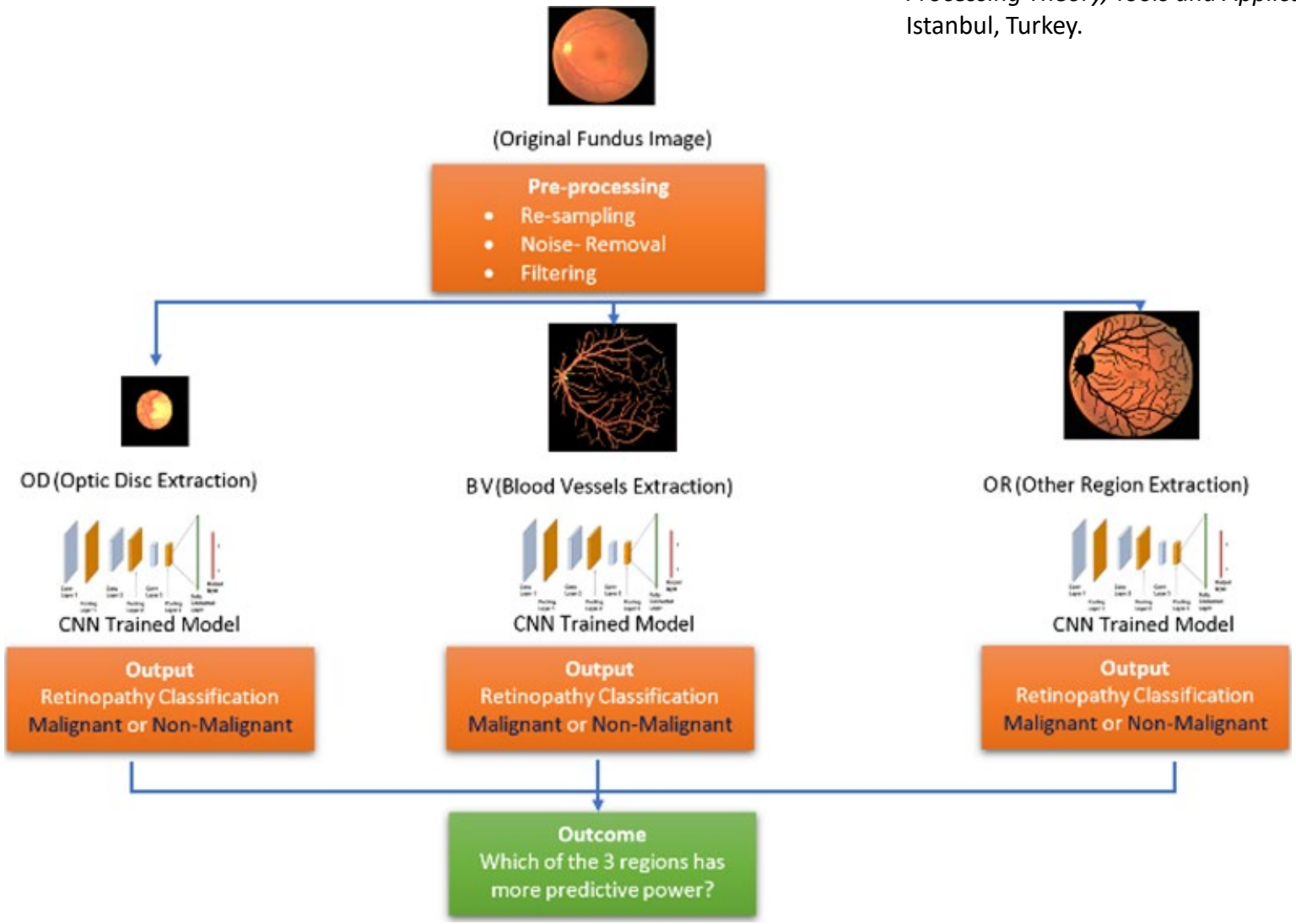
MRC Institute of Genetics & Molecular Medicine
MRC HUMAN GENETICS UNIT

UNIVERSITY OF OULU

Imperial College London

IP- Diabetic Retinopathy

Wu Qian and Abbas Cheddad, "Segmentation-based Deep Learning Fundus Image Analysis," in 9th *International Conference on Image Processing Theory, Tools and Applications* (IPTA 2019). Nov 6-9, 2019, Istanbul, Turkey.



Ophthalmologist @ Tecnológico de Monterrey, Mexico

IP- Handwritten Recognition

SGP (Shape Growth Pattern)

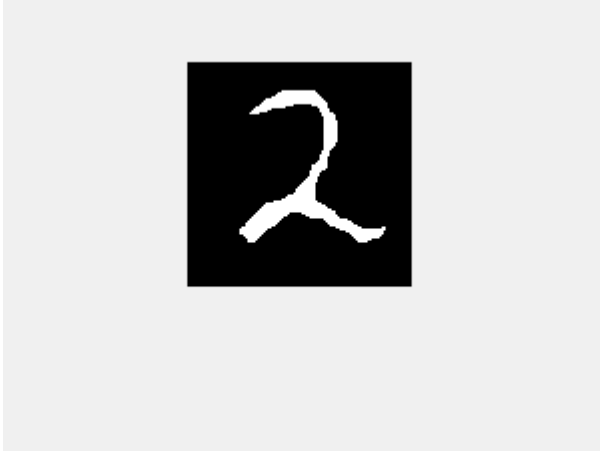
DTBIM: Delaunay **t**riangulation-based **b**inary **i**mage **m**orphing

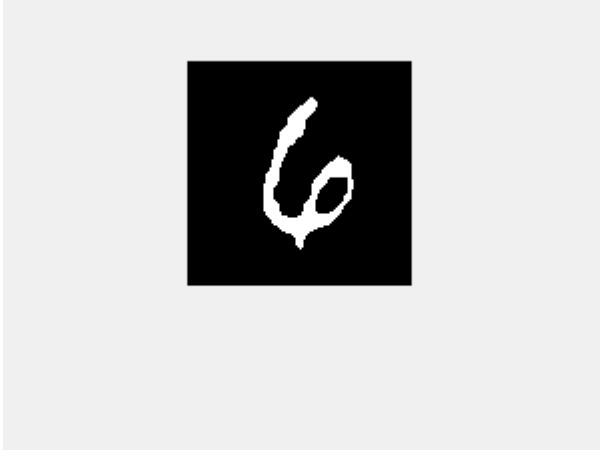
Shape Growth Pattern (SGP)

- Data sets with limited number of samples will deteriorate the success recognition rate in computer vision applications.

- A pre-processing stage is proposed to augment the bank of features that one can retrieve from binary images to help improve the accuracy rate of pattern recognition algorithms.

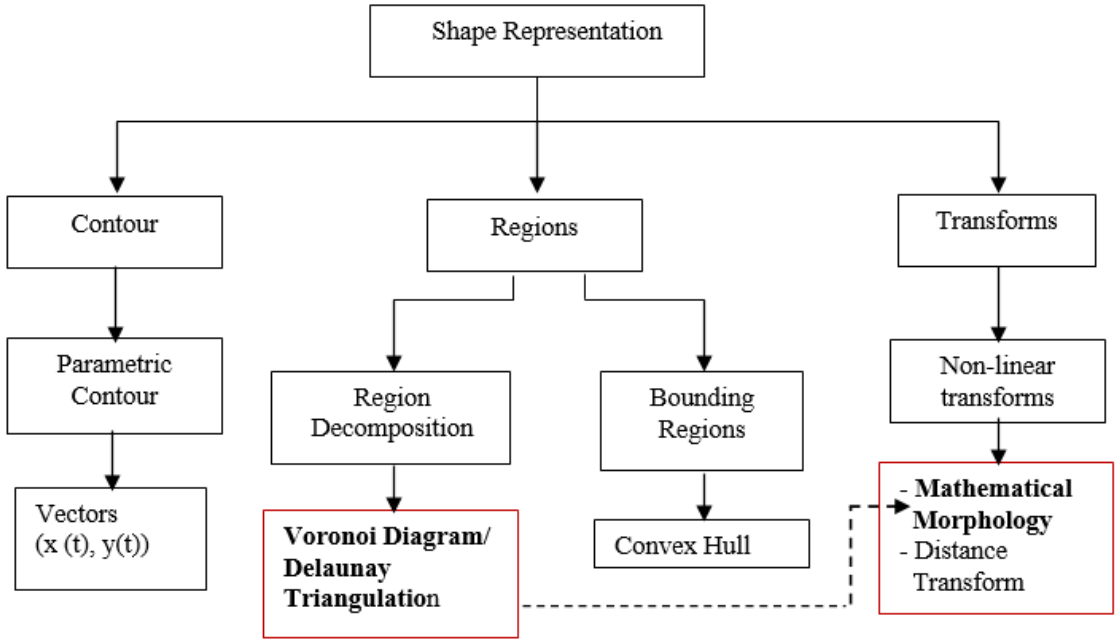
- By having successive dilations applied to a given shape, one can capture a new dimension of its vital characteristics

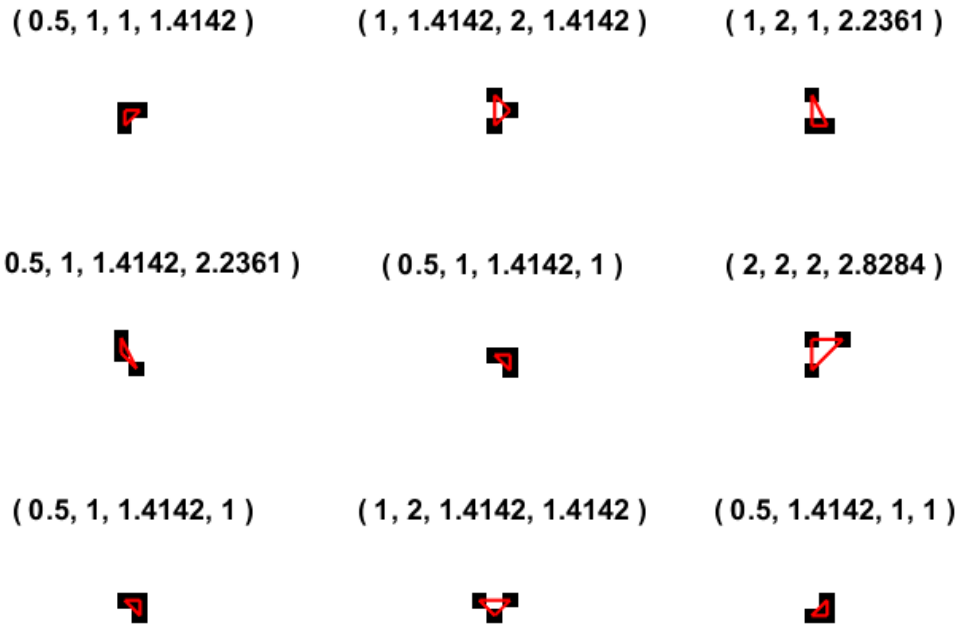




Morphological Dilation

DELAUNAY TRIANGULATION BASED BINARY IMAGE MORPHING (DTBIM)





Cheddad A. "Structure Preserving Binary Image Morphing using Delaunay Triangulation." Pattern Recognition Letters, (2017) 85, pp. 8-14. Elsevier.

Original binary image

Dilation with structuring element 1

Dilation with structuring element 2

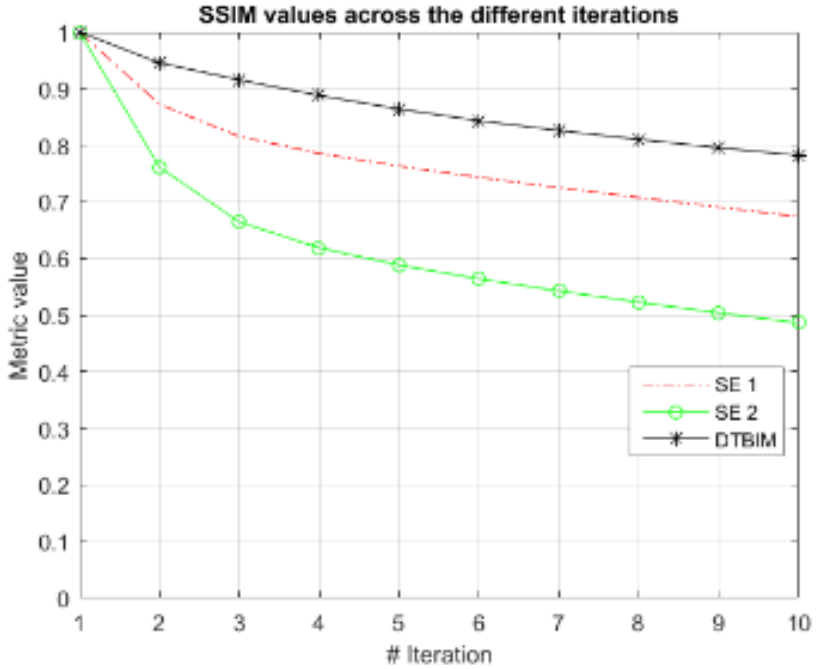
DTBIM

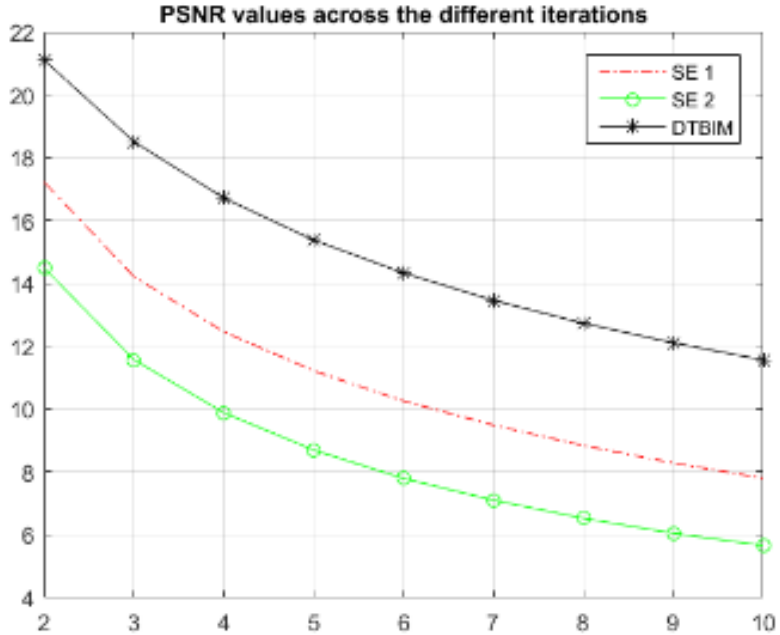
Original binary image

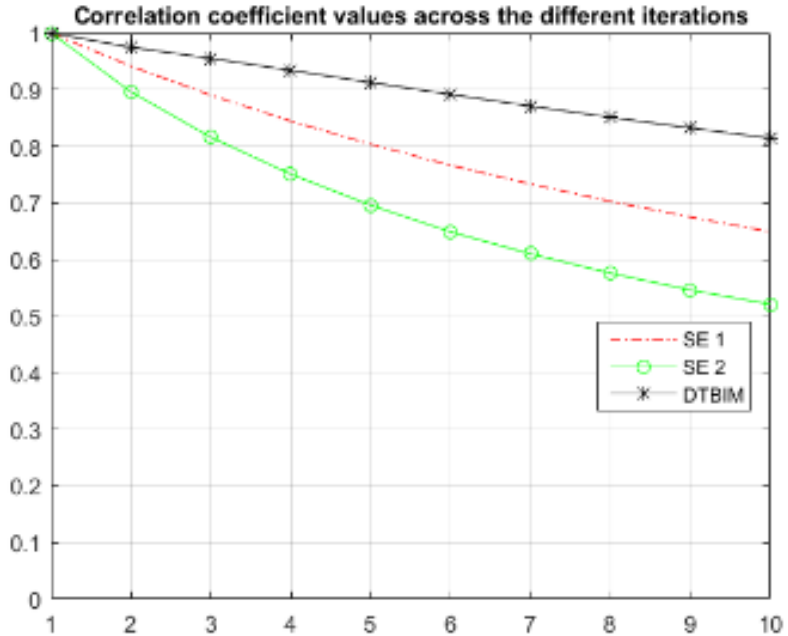
Dilation with structuring element 1

Dilation with structuring element 2

DTBIM

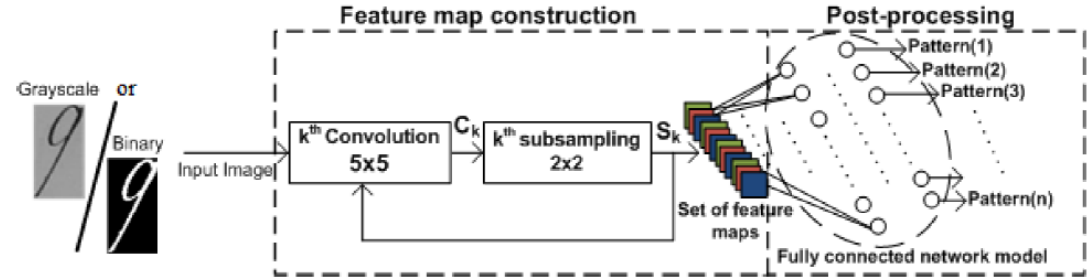




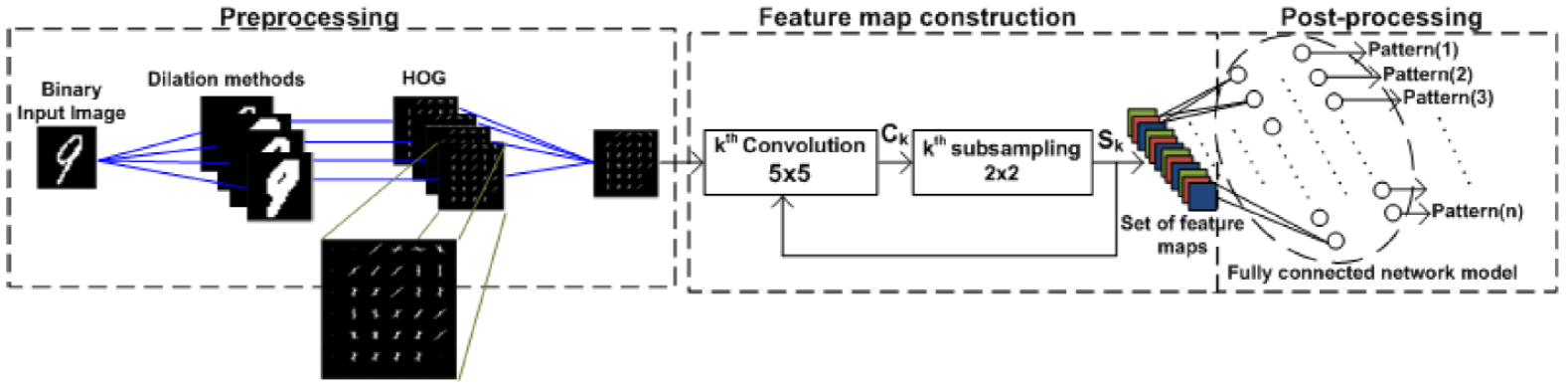


Machine Learning Algorithms

Convolutional Neural Network (CNN)

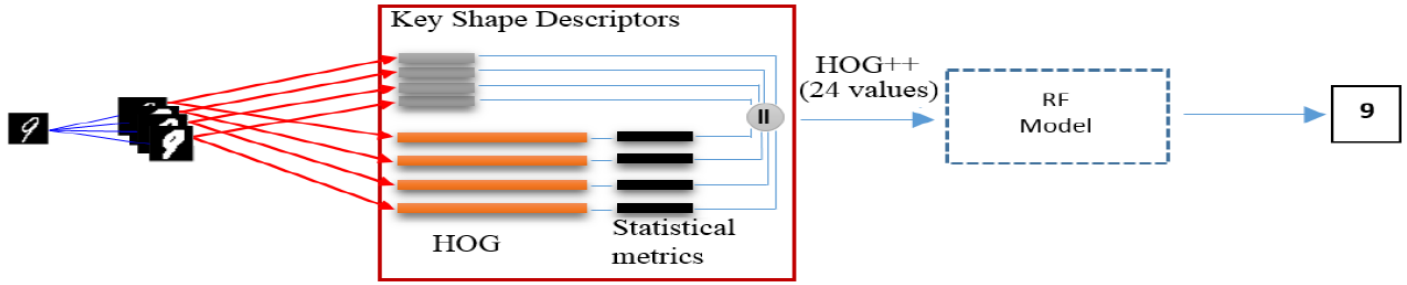


(a)



(b)

Random Forests (500 trees)



(c)

Abbas Cheddad, Huseyin Kusetogullari and Hakan Grahn, (2017). "Object Recognition using Shape Growth Pattern," 10th International Symposium on Image and Signal Processing and Analysis (ISPA 2017). 18-20th September 2017, pp.47-52, Ljubljana, Slovenia.

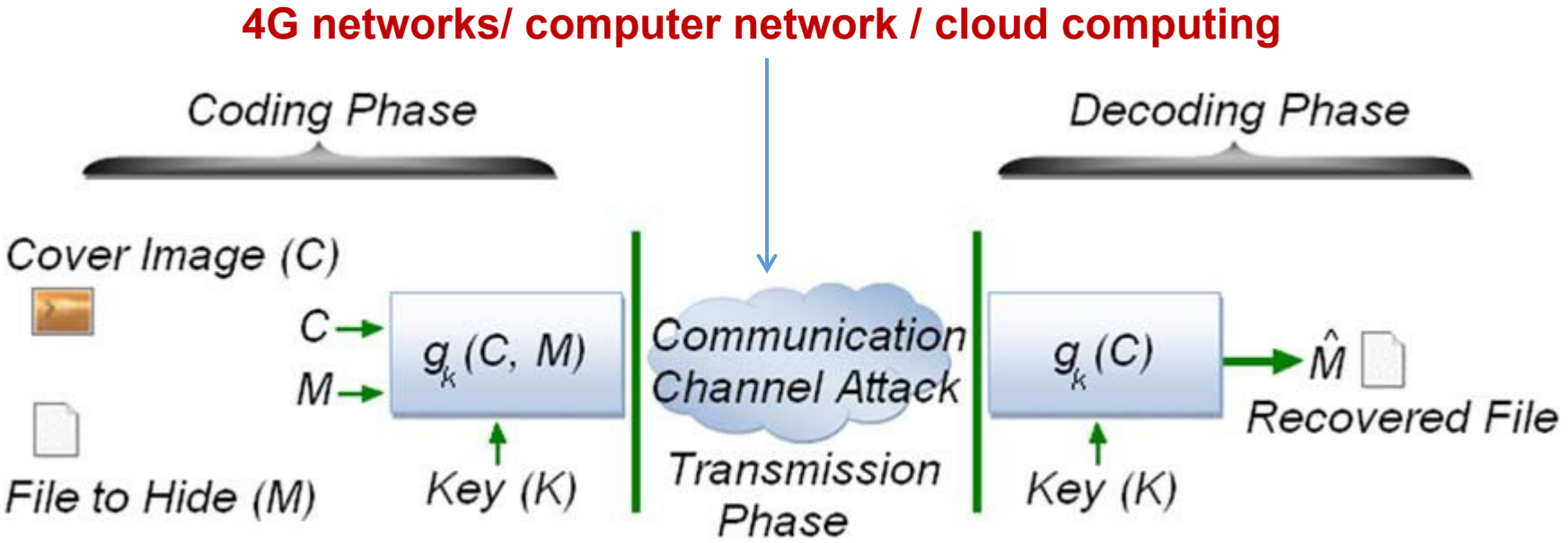
IP- Aerospace Engineering

GKN Aerospace AB

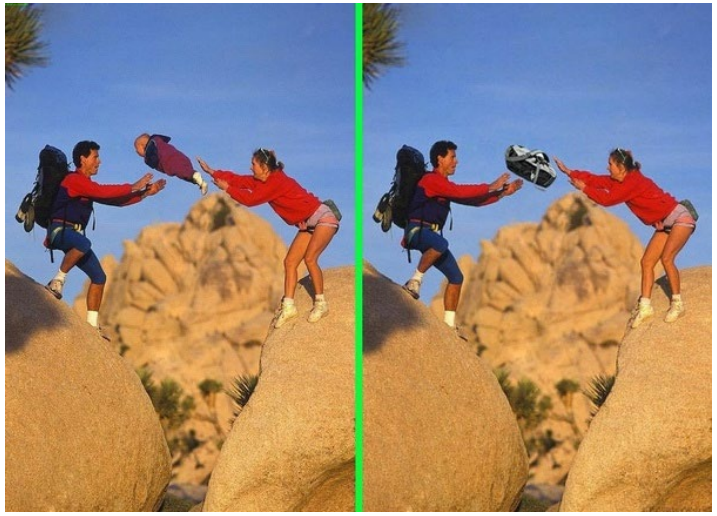
- ML Models to Support Design Space Exploration
- Computer Vision Welding Control

GKN Aerospace, Trollhättan, Sweden

IP- Multimedia Security



Communication-theoretical view of a generic embedding process: C denotes cover file (e.g., image), M denotes the data to hide.

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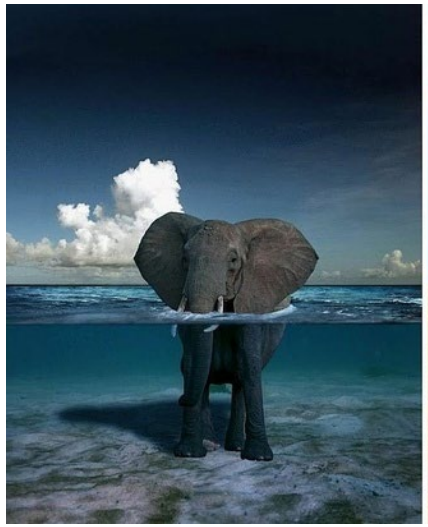
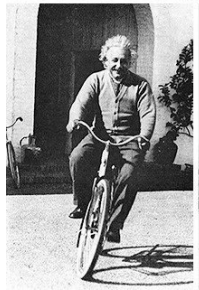



FAKE


FAKE

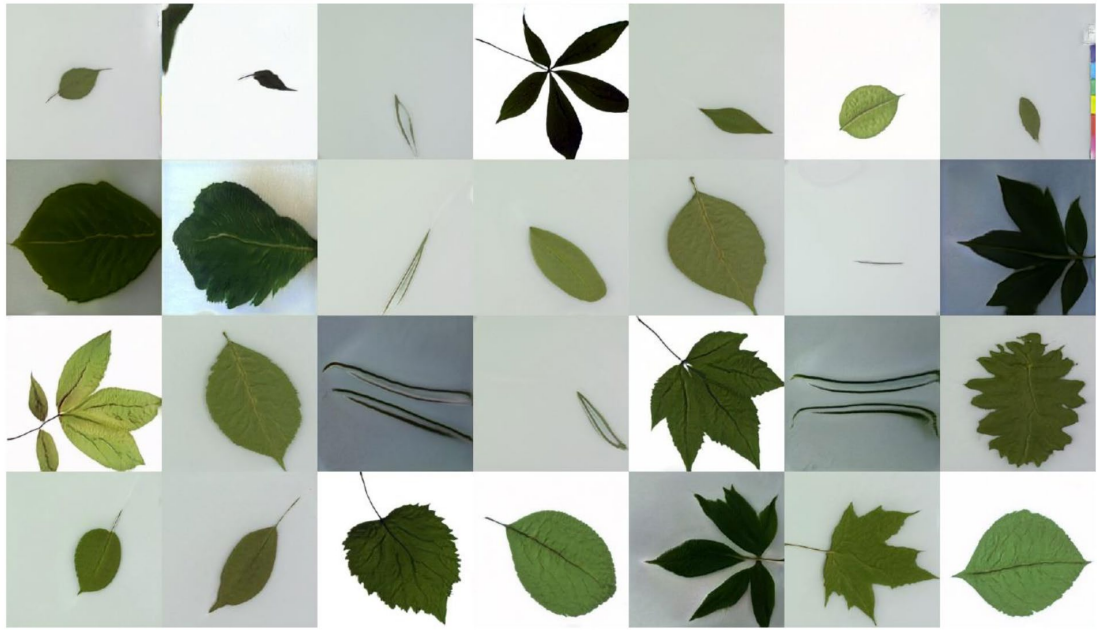



FAKE

DEMO

https://area.autodesk.com/fakeorfoto/

IP- Deep Learning-Generative Adversarial Networks (GANs)



Style GAN generator adapting to the leaf dataset after around 87 ticks with a training time of 192 GPU hours+ and minibatch size of 8

IP- Free Data sets

- **Mini-DDSM:** AI-based age estimation from X-Rays

C.D. Lekamlage, F. Afzal, E. Westerberg and A. Cheddad, "Mini-DDSM: Mammography-based Automatic Age Estimation," in 3rd International Conference on Digital Medicine and Image Processing (DMIP 2020), Kyoto, Japan, November 06-09, 2020.

- **ARDIS:** Handwritten Digits

Huseyin Kusetogullari, Amir Yavaria bdi, Abbas Cheddad, Håkan Grahn and Johan Hall, "ARDIS: A Swedish Historical Handwritten Digit Dataset," Neural Computing and Applications, 32(21)16505-16518, 2020. Springer.

- **SHIBR:** Swedish Historical Birth Records

Abbas Cheddad, Hüseyin Kusetogullari, Mustapha Aouache, Agrin Hilmkil, Lena Sundin, Amir Yavariabdi, Johan Hall, "SHIBR-The Swedish Historical Birth Records: A Semi-Annotated Dataset", under review. (15,000 high-resolution color images of the era between 1800 and 1840)

http://abbascheddad.net/Coda.html

Thank you!

Question?