Welcome / Bienvenidos

Prof. Dr. Steffen Härtel

www.scian.cl / www.cimt.cl / www.cens.cl / www.bni.cl / www.rsdue.cl

Laboratory for Scientific Image Analysis (SCIAN-Lab)
Centro de Informática Médica y Telemedicina (CIMT)
Centro Nacional en Sistemas de Información en Salud (CENS)
Biomedical Neuroscience Institute (BNI)
Red de Salud Digital de Universidades del Estado (RSDUE)
Institute of Biomedical Sciences (ICBM)
Núcleo Milenio de AutoOrganización y Mecánica de Tejidos (SELFO)

Facultad de Medicina, Universidad de Chile

Welcome

I. Image Acquisition
Ia|-> Fundamentals of confocal microscopy
Ib|-> Fundamentals of fluorescence
II. Deconvolution
III. Segmentation
IV. Analysis

Literature

- **The Good, the Bad and the Ugly. Helen Pearson. 2007 Nature 447:138-140 https://dx.doi.org/10.1038/447138a**
- **Seeing is believing? A beginners' guide to practical pitfalls in image acquisition.**
  Alison J. North. 2006 The Journal of Cell Biology, 172(1):9-18 https://doi.org/10.1083/jcb.200507103
- **Computational methods for analysis of dynamic events in cell migration**
  V Castañeda, M Cerda, F Santibáñez, J Jara, E Pulgar, K Palma, ... Current Molecular Medicine 14 (2), 291-307
  https://doi.org/10.2174/1566524014666140128113952
- Fluorescence Microscopy, From Principles to Biological Applications.
  Ulrich Kubitscheck (Editor), 2nd Edition, June 2017, Hardcover, ISBN: 978-3-527-33837-5
- https://www.zeiss.com/microscopy/en/resources/insights-hub/life-sciences/basics-of-confocal-microscopy.html
- https://www.microscopyu.com/tutorials
- http://zeiss-campus.magnet.fsu.edu/tutorials/index.html
- **https://zeiss-campus.magnet.fsu.edu/print/livecellimaging/techniques-print.html**
- https://www.leica-microsystems.com/science-lab/tag/basics-in-microscopy
- **https://www.youtube.com/playlist?list=PLG8B8Uyfh7-Azddns5nv_kZU1YQGD4bBg**
- Principles of Fluorescence Spectroscopy, Joseph R. Lakowicz - 4.1 Introduction to Fluorescence
- A global view of standards for open image data formats and repositories
  JR Swedlow, P Kankaanpää, U Sarkans, W Goscinski, G Galloway, ..., Nature Methods, 1-7
  https://doi.org/10.1038/s41592-021-01113-7
- Jonkman, J., Brown, C.M., Wright, G.D. et al. Tutorial: guidance for quantitative confocal microscopy.
  Nat Protoc 15, 1585–1611 (2020) https://doi.org/10.1038/s41596-020-0313-9
- https://www.comicbacterias.com/mini-bactericomics

Children Hospital
Institute of Biomedical Ciences
Nacional Cancer Institute
Faculty of Medicine
Psychatric Clínic
Public Health Institute
University Hospital & Telemedicine
Faculty of Biochemistry & Farmacy
Faculty of Odontology
Psychatric Hospital

Children Hospital
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Faculty of M
Psychatric Clínic
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University Hospital & Telemedicine
Faculty of Biochemistry & Farmacy
Faculty of Odontology
Psychatric Hospital

Latin America Bioimaging

Existing bioimaging technologies in Chile …

FONDEQUIP …

~50 state-funded optical and electronic microscopes FONDEQUIP (2011 →)

https://servicios.conicyt.cl/buscadorequipos/#/search_result/microscopio
La Red de Equipamiento Científico Avanzado: https://redeca.med.uchile.cl

Santiago and public/private universities and institutes concentrate the largest quantity of equipment

- 10 microscopes @REDECA (F-Med, U. de Chile)
- 7 entre CEMC y otras facultades (F-Med, U. de Chile)

- 6 optical microscopes y 2 TEM 2 SEM a @ PUC
- 9 microscopes @ CMA Bio Bio (U. Concepción)
- …

https://globalbioimaging.org

Latin America Bioimaging

...is a network of imaging scientists interested in improving training, education, and access to imaging technologies across the Latin American and Caribbean region.

10 al 12 de noviembre –
Buenos Aires, Argentina

https://labi.lat

...the new Chilean Society of Scientific Imaging (SOChIC) holds its first meeting, 21-22.11.2025, Universidad Austral, Valdivia, Chile.

2022

https://imagenescientificas.cl

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SCIAN-Lab; BNI; REDECA; ICBM; F- Med; U-Chile

OPTOMECHANICAL DESIGN

3D design and printing, Opto-mechanical design, Optical systems.

MICROSCOPY ADVANCED

Conventional Confocal Fluorescence Microscopy, Spinning disk, 4-Lens Light sheet, Super-resolution, Laser ablation, Tissue scanner, Expansion microscopy, Electronic/optical hardware control.

MASSIVE CLOUD DATA STORAGE & HPC

OwnCloud @ data backup and storage with high speed access (U. de Chile/REUNA network) and HPC access. Network with dedicated 10Gbps bandwidth.

IMAGE PROCESSING AND BIOSIGNALS

Segmentation of 2D/3D multichannel + time structures, Tracking, Deconvolution, Quantification of morphology, topology & dynamics, Colocalization, Classification.

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SCIAN-Lab; BNI; REDECA; ICBM; F- Med; U-Chile

INNOVATION WITH BIOMEDICAL IMAGE PROCESSING

REGIONAL AND NATIONAL INITIATIVES

BASIC SCIENCE

CEDAI SpA
Centro de Espermiogramas Digitales Asistidos por Internet

DeepPathology
Plataforma de telepatología distribuida

IA-TRAD CHILE
Inteligencia artificial para apoyo diagnóstico y tele-radiología clínica

CPDAI
CENTRO DE PATOLOGIA DIGITAL ASISTIDO POR INTERNET

TRAINING PROGRAMS AND CENTERS

MIM MAGISTER EN INFORMATICA MEDICA

MAKE HEALTH COLOMBIA
Charlas y Talleres de Alto Impacto

CENS - MIT Critical Data
MAKE HEALTH CHILE
HEALTH DATA SCIENCE: CONFERENCE AND WORKSHOPS

CENS Tech Challenge

Collaborations, Associative projects at local and regional level (basic and applied sciences), Summer schools, Postgraduate courses, National and international courses and meetings, Training (*), Service mode (*) Developmental bio., neuroscience, biophysics, microbiology, microbiology, etc.

Spin-offs
Fertility, Digital Pathology, Radiology

Master's Program U. Ch./U. Heidelberg, Summer/Winter Schools, Diplomas, Centers (CIMT, CENS), International Courses and Meetings. Heidelberg, Summer/Winter Schools, Diplomates, Centers (CIMT, CENS), International Courses and Meetings
Medical Inf., Telemedicine, Health Information Systems

Working groups and associative projects in Acquisition, Storage, Processing and Access to biomedical data.
Microscopy, Medical Inf., Telemedicine, Big Data, …

Biomedical Imaging
Confocal / Spinning Disk / Light Sheet / Whole Slide Microscopy
X-Ray / CT
Medical Imaging
Network Data Storage
SASIBA Data Center & NLHPC High Performance Computing
Data Management
2D/3D in vivo & Expansion Microscopy
EVL & Deep Cells
Cancer Cells & Droplets
P. mirabilis Biofilms
Manual Segmentation
AA-HITL Improvement Cycle
ALPACA
AC
IP
AC + IP + ALPACA
Contours & Sections
Expert Algorithm Workflow
& Parameter Corrections
Active
Adjustment (AA)
Quality?
High
Low
Laboratory for
SCIAN
Scientific Image Analysis
Processing Pipeline
Registration & Restoration
Segmentation,
Tracking & Motion Fields
Spatial-Temporal-
Mechanical Attributes
Localization, Shape,
Topology, Organization,
Speed, Persistence,
Motion, Bending, Stress,
Patterns, ...
Local CT Stacks
Multi-Modal International Data Set
MedSAM
Segmentation
AL-HITL Improvement Cycle
Training with
Local Data
Specialist
Final Corrections
Automated Segmentation
of Tumor Lesions
Resident
Initial Corrections
Quality?
High
Low
Active
Learning (AL)

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Laboratory for SCIAN Scientific Image Analysis

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BIOMEDICAL NEUROSCIENCE INSTITUTE

Joaquín Torres García 1874-1949

Richard Feynman (1918-1988)

Mats Gustafson 2006 - 2011

Maria Goeppert-Mayer 1906-1972

René Descartes (1596-1650)

Ernst Abbe 1840- 2005

E Betzig

S Hell

W Moerner

Joaquín Torres García

Uruguayo, painter and thinker,

Montevideo, Barcelona, París, NY …

TO THINK IS TO GEOMETRIZE

Geometry is like a keyboard of languages ...

... curves, regular or not, straight lines, angles, circles, arcs...

... are the few universal elements that can be used to express everything !!!!

morphology

topology

time

UNIVERSALISMO CONSTRUCTIVO

nature > nature methods > comment > article

Comment | Published: 04 May 2021

A global view of standards for open image data formats and repositories

Jason R. Swedlow, Pasi Kankaanpää, Ugis Sarkans, Wojtek Goscinski, Graham Galloway, Leonel Malacrida, Ryan P. Sullivan, Steffen Härtel, Claire M. Brown, Christopher Wood, Antje Keppler, Federica Paina, Ben Loos, Sara Zullino, Dario Livio Longo, Silvio Aime & Shuichi Onami

Storage & High Performance Computing

REDECA

Advanced Data & Health

SASIBA Data Center

300 TB
192x3 GB ram

BioMed-HPC
REUNA
NLHPC

10 Gbps

Scientific Image & Data Processing

Registration & Restoration

Segmentation

Motion Estimation
Tracking | Motion Fields

Shape, Topology, Organization | Speed, Persistence, Motion Patterns

SPATIAL DESCRIPTORS

TEMPORAL DESCRIPTORS

Physical-Computational Modelling

Microscopy & Physical Manipulation

REDECA

Advanced Microscopy

Optical Tweezers

Droplets

FRET

Laser Ablation

ALPACA Shape Analysis

Miguel Concha
Biología del Desarrollo

V Castañeda, M Cerda, F Santibáñez, J Jara, E Pulgar, K Palma, ...
Computational methods for analysis of dynamic events in cell migration,
Current molecular medicine 14 (2), 291-307

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Biomedical Neuroscience Institute

Very Large Telescope (VLT), 4 Telescopes, 8m, 2600 m

Atacama Large Millimeter/submillimeter Array (ALMA), 66 Antenna, 5000 m

E-ELT European Extremely Large Telescope, 39 m, 3000 m

NASA World Wind screenshot

Extraterrestrial Monster Science produces:
TeraB, PetaB, ExaB, ZettaB, YottaB

… Tera is a unit prefix in the metric system denoting multiplication by 10E12 or 1.000.000.000.000 !

… Tera is derived from Greek τέρας (teras), meaning “monster”.

… Tera was confirmed for use in the SI in 1960…. Wiki !

Metric prefixes

Prefix	Symbol	1000^m	10^n	Decimal	English word[n 1]	Since[n 2]
yotta	Y	1000^8	10^{24}	1 000 000 000 000 000 000 000 000	septillion	1991
zetta	Z	1000^7	10^{21}	1 000 000 000 000 000 000 000	sextillion	1991
exa	E	1000^6	10^{18}	1 000 000 000 000 000 000	quintillion	1975
peta	P	1000^5	10^{15}	1 000 000 000 000 000	quadrillion	1975
tera	T	1000^4	10^{12}	1 000 000 000 000	trillion	1960
giga	G	1000^3	10^9	1 000 000 000	billion	1960
mega	M	1000^2	10^6	1 000 000	million	1960
kilo	k	1000^1	10^3	1 000	thousand	1795
hecto	h	$1000^{2/3}$	10^2	100	hundred	1795
deca	da	$1000^{1/3}$	10^1	10	ten	1795
		1000^0	10^0	1	one	–
deci	d	$1000^{-1/3}$	10^{-1}	0.1	tenth	1795
centi	c	$1000^{-2/3}$	10^{-2}	0.01	hundredth	1795
milli	m	1000^{-1}	10^{-3}	0.001	thousandth	1795
micro	µ	1000^{-2}	10^{-6}	0.000 001	millionth	1960
nano	n	1000^{-3}	10^{-9}	0.000 000 001	billionth	1960
pico	p	1000^{-4}	10^{-12}	0.000 000 000 001	trillionth	1960
femto	f	1000^{-5}	10^{-15}	0.000 000 000 000 001	quadrillionth	1964
atto	a	1000^{-6}	10^{-18}	0.000 000 000 000 000 001	quintillionth	1964
zepto	z	1000^{-7}	10^{-21}	0.000 000 000 000 000 000 001	sextillionth	1991
yocto	y	1000^{-8}	10^{-24}	0.000 000 000 000 000 000 000 001	septillionth	1991

The Scale of the Universe https://htwins.net/scale2

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redeca.med.uchile.cl

Welcome to REDECA

REDECA provides technological support, access and accompaniment in the use of advanced services and equipment. Institutional and external users can request assistance in the selection of services or equipment suitable for their experimental challenges, storage and analysis of their data.

REDECA... do science with us !

|-> Perkin Elmer Spinning Disk with laser ablation

|-> Deconvolution

|-> Deconvolution

box model

box length

box hight

box width

box elongation

box flatness

box entropy

|-> Perkin Elmer Spinning Disk

Austrolebias Nigripinnis, Microinyección mRNA para la expresión de LifeAct-GFP (actina). migración de Deep Cells (DC) a través del Enveolpping Layer (EVL). (G.Reig)

Ulrich Kubitscheck
Bonn

Pulgar, Keller, Concha, unpublished

Figure 1 | Four-lens SPIM setup

Jan Huisken
Dresden

Pulgar, Keller, Concha, unpublished

What about large-scale connectivity in high resolution?

If you cannot improve your optics, enlarge the sample.

Expansion Microscopy can magnify the zebrafish brain by factor 4.

Juan Eduardo Rodríguez
Kubitscheck-Lab
Bonn University

Karina Palma
Leo/SCIAN
U-Chile

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U-Chile

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Zebrafish: Pineal complex

Video of a 3D view comprising 1687 slices. Volume size 1133 x 954 x 954 µm³ (~113 GB)

Video of a 3D view comprising 1687 slices. Volume size 1133 x 954 x 954 μm³ (~113 GB)

Dante Castagnini,
Biochemist

MSc Nicole Canales,
T. Médico, Microbiología

Canales et al. *2025, Microbial Pathogenesis*

Dante Castagnini,
SCIAN-Lab, Bioquímico

Castagnini et al. 2025, JoVE, 2024 J. of Microbiological Methods

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