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Nicolas Loménie

Histopathology
History, Challenge and Algorithms

A quick review

MASTER
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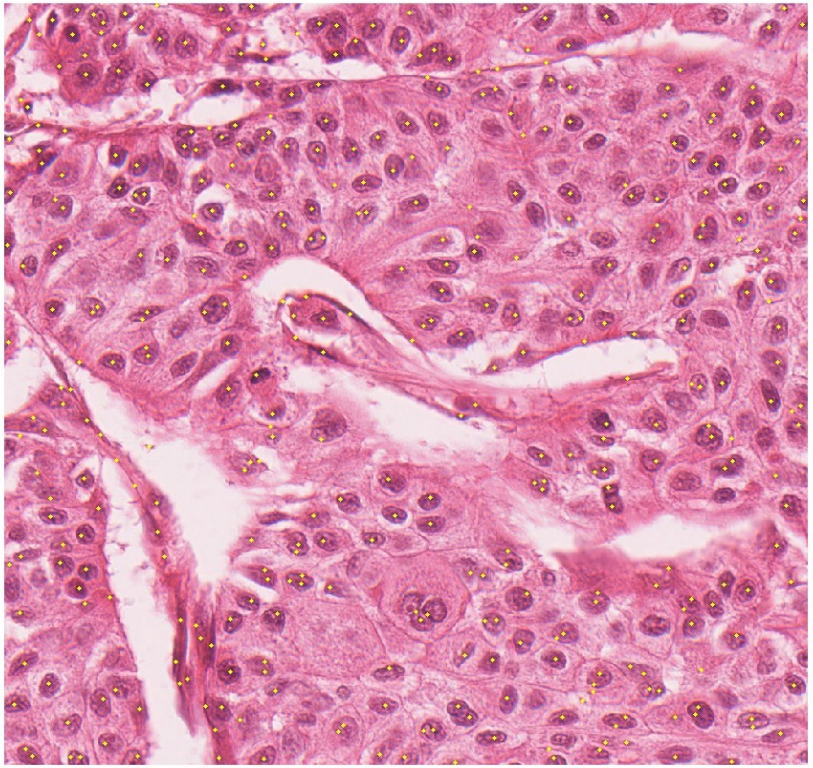
HistoPatho

Nicolas Loménie

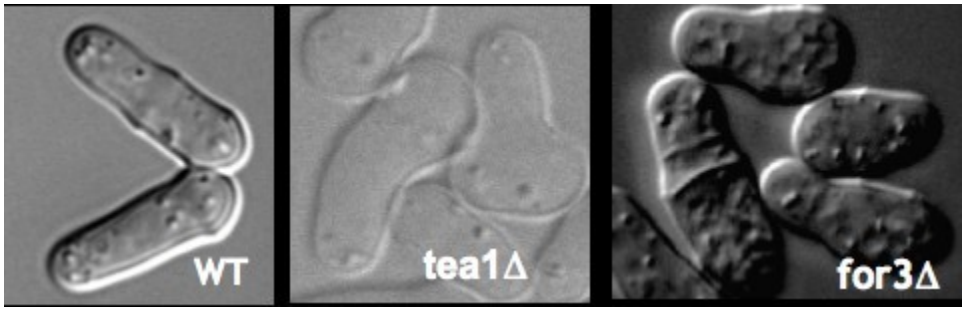
A QUICK TOUR

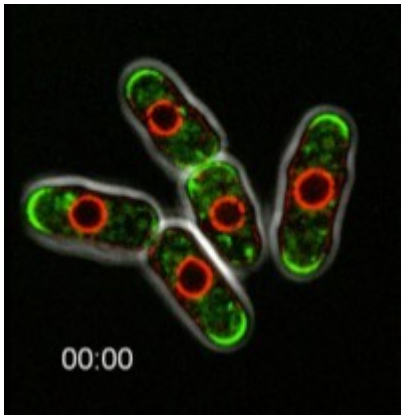
Histopathology :
microscopic examination of tissue in order to study the manifestations of disease (mostly clinical medicine)

https://medium.com/the-physics-arxiv-blog/ghost-imaging-reassembles-images-scattered-by-breast-tissue-e6b4ed85



Histopathology :
Nowadays, can be extended to fundamental biological issues (new devices, softwares that can be applied).



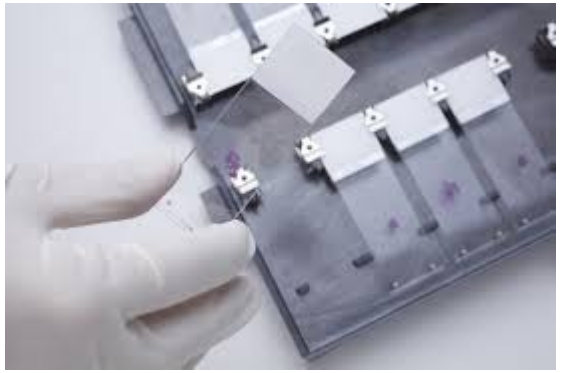


Various observations/acquisitions of fission yeast evolutions (IJM)
https://www.youtube.com/watch?v=7uLjh-yecoM

Spatial Organisation and Micro-Tumoral Environment
https://www.youtube.com/watch?v=Xp8hhwwnE68&list=UU_ClFrngi6A2J4s8FrUdq8g&index=54

Histopathology :

From Gustave Roussy to..... GE Healthcare....but still Gustave Roussy at the hospital :-(Still static and traditional but it is changing slowly



[Roussy25] Roussy G. (1925) L'anatomie pathologique : science biologique, Leçon Inaugurale du 4 Mai 1925, Chaire d'anatomie pathologique, Faculté de Médecine de Paris, *Presse médicale* Pub. 6 Mai 1925.

GUSTAVE ROUSSY
CANCER CAMPUS
GRAND PARIS

GEHC-White-Papers-Digital_Pathology.pdf

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Molecular Med TRI-CON 2015

February 15-20, 2015
Moscone North Convention Center
San Francisco, CA

Cambridge Healthtech Institute's Third Annual

Digital Pathology

Transforming Medicine in a Digital World

February 16-18, 2015 | Moscone North Convention Center | San Francisco, CA
Part of the 22nd Annual Molecular Medicine Tri-Conference

The field of pathology is being reshaped by advances in digital imaging techniques, systems for analyzing data and the increased demand for access. This conference will look at the present and future of digital pathology from many different aspects, including market projections and trends, to technical progress in imaging techniques, and approaches to mining and storage of big data. For digital imaging and molecular technologies to be utilized in routine practice, many factors influencing adoption should be evaluated, including regulation, standards, and validation of imaging methods. Learn how digital pathology is creating advanced diagnoses for the future.

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Day 1 | **Day 2** | **Day 3** | **Download Brochure**

Monday, February 16

10:30 am Conference Program Registration

DIGITAL PATHOLOGY PREDICTIONS: MARKET ANALYSIS & TRENDS

11:50 Chairperson's Opening Remarks
Speaker to be Announced, Definiens

12:05 pm Mobile Industry: Exploiting Smartphones for Digital Pathology
Douglas J. Hartman, M.D., Assistant Professor, Pathology, University of Pittsburgh Medical Center

Market analysis and trends:

Definiens, mHealth, Smartphones, Regulatory Environment for Digital Imaging...

In Vivo Microscopy: *non destructive advanced imaging technique, real time histology → emerging imaging technologies*

Large Scale Deployment:

Color rendering from acquisition to display → WSI, D.P. growing but slowly, towards integrated clinical care, patented activities, telepathology and WSI

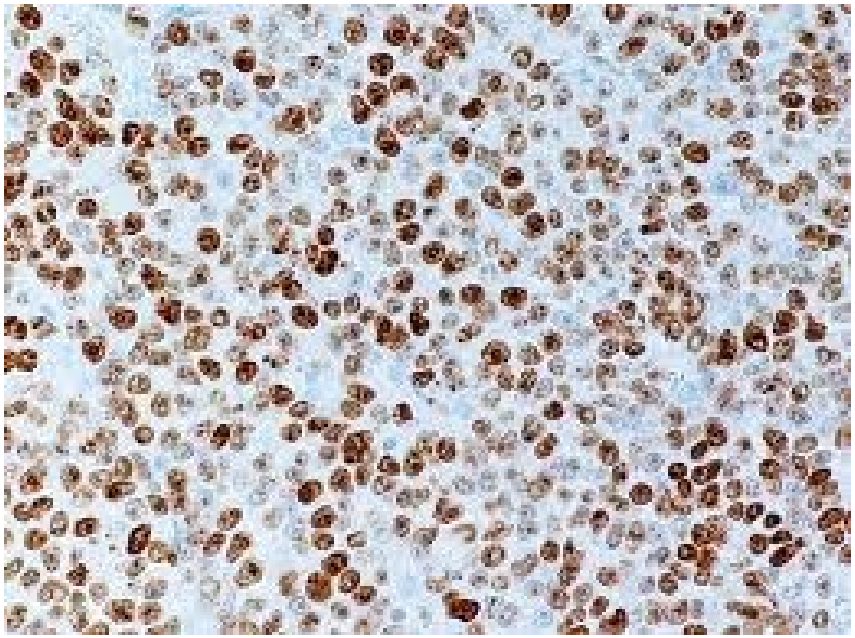
Quantitative Detection of Biomarkers for Next Generation Immunology: *PACS-LIS interoperability*

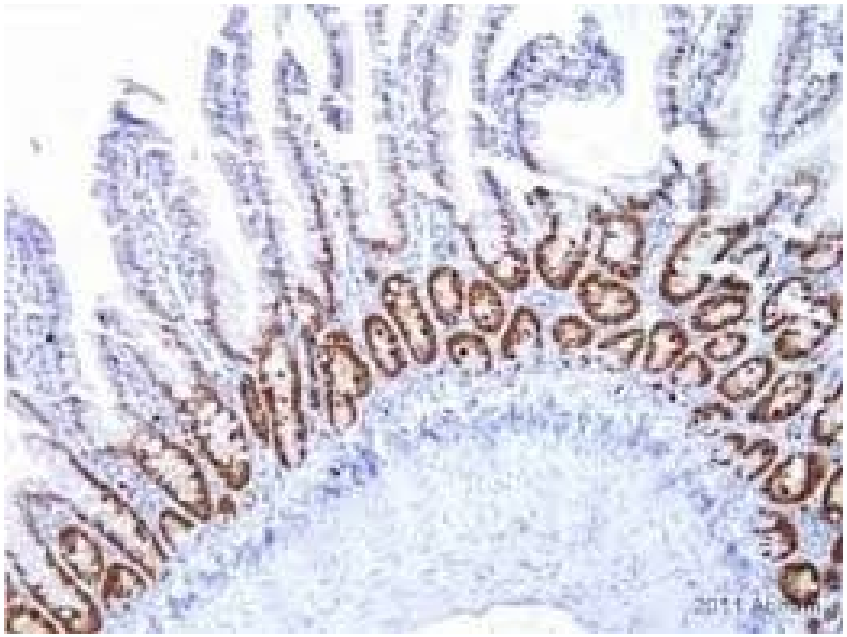
Specialized Adoption of Digital Pathology: *WSI for teaching and diagnosing, image-based diagnoses → visual expertise → eye tracking to optimize presentation of digital image data, high resolution histology 3D for reconstruction & Analysis, GE Healthcare, Google Glass in pathology*

Big Data & The Cloud

WSI – BioImaging & BioInformatics Research: *hot spot detection, from Ki-67 stained slides → Metin Gurcan, challenges of Biomarker targeted therapy*

Next Steps for Integration : Moving Digital Pathology into Real Practice: *Using digital imaging to select tumor cells for next generation sequencing, Computational pathology.*





+ 12th European Congress on Digital Pathology, June 2014, Paris, *ADICAP etc.*

+ HIMA@MICCAI

+ http://visionbib.com/bibliography *or //iris.usc.edu/vision-notes/bibliography*

+ GE Healthcare Report – *White Paper – Public Healthcare issue, Canada, 2012*

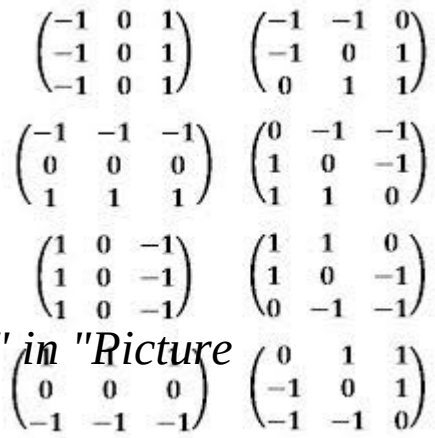
2003 : T.W. Nattkemper et al. / Computers in Biology and Medicine 33 (2003) 31–43 → lack of research works

2007 : Nattkemper going on : *IEEE Trans Med Imag, 26 (7) (2007), pp. 1010–1016 T.W. Nattkemper, T. Twellmann, H. Ritter, W. Schubert Human vs. machine: evaluation of fluorescence micrographs + A. Lehmussola, P. Ruusuvuori, J. Selinummi, H. Huttunen, O. Yli-Harja Computational framework for simulating fluorescence microscope images with cell populations*

2011 : A. Madabhushi et al. / Computerized Medical Imaging and Graphics 35 (2011) 506– 514 → Graph-based technique

2012 : PHD Proposal June 2012 GE

2 teams Paris 13 : Mignonney & Lamy de la Chapelle – Chemistry – Biomarkers – Prof. Frédéric Capron – Hôpital Pitié-Salpêtrière



Tribute to Judith. S. Prewitt *"Object Enhancement and Extraction" in "Picture processing and Psychopictorics",Academic Press,1970*

2009 : Histopathological Image Analysis : a methodological review about histopathological scene understanding :-) **IEEE REVIEWS IN BIOMEDICAL ENGINEERING, VOL. 2, 2009, Metin Gurcan et al.**

CAD technologies for digitized histopathology USA&Europe vs. Radiology, Mammography in early 1990's. Now CAD and pathology → facilitate disease classification → need for quantitative imaging.

Cytology imagery easier because only cells and no glands. With histopathological images we observe the architecture of tissues

Early works in the 1990's overlooked due to computer ressources limitation

2009 : Histopathological Image Analysis : a methodological review about histopathological scene understanding :-) IEEE REVIEWS IN BIOMEDICAL ENGINEERING, VOL. 2, 2009, Metin Gurcan et al.

A. Quantitative Imaging for disease grading : *prostate & breast cancer the most common cancers screened. Standardization of the grading system like Gleason for prostate*

B. Radiology vs. Histopathology

Radiology	Histopathology
< 512x512x512 voxels About 134 Megavoxels	>15 000 x 15 000 pixels About 225 Mpixels x 12-20 → avg 4 Billions pixels
Grey levels	Color / Multispectral

C. H&E staining still for 50 years

+ Immuno-Fluorescence Imaging (locate proteins in tissue)

+ Multimodality : *multichannel imaging methods NEEDS REGISTRATION of the MULTIPLEXED images (ref. 29), Raman spectroscopy, multispectral/Hyperspectral etc.... → Histopathology Scene Understanding Discipline ?*

2009 : Histopathological Image Analysis : a methodological review about histopathological scene understanding :-) **IEEE REVIEWS IN BIOMEDICAL ENGINEERING, VOL. 2, 2009, Metin Gurcan et al.**

COLOR & ILLUMINATION

For both fluorescent & bright field microscopy variations in staining & scanning procedures (ref. 53)

AUTOMATED DETECTION & SEGMENTATION

Histological structures : lymphocytes, cancer nuclei (ref. 73, 74 , glands, lumen (ref. 63), cytoplasm, epithelial, stromal and connective tissue.

FEATURE EXTRACTION

Table 1 : Object level and features used in histopathological images.
Nuclear features + margin and boundary appearance of ductal, stromal, tabular & glandular structures
Automated ? Mainly nuclei, a bit stroma and cytoplasm (ref. PhD 83)

2009 : Histopathological Image Analysis : a methodological review about histopathological scene understanding :-) **IEEE REVIEWS IN BIOMEDICAL ENGINEERING, VOL. 2, 2009, Metin Gurcan et al.**

FEATURE EXTRACTION

> 1000 features for an RGB image

Spatially related features → graph-based representation, 150 features for all graph structures (see Table 2 : The cell-graph paradigm)

Multiscale approach

FEATURE SELECTION/DIMENSIONALITY REDUCTION/MANIFOLD LEARNING

CLASSIFICATION & SUBCELLULAR QUANTIFICATION

Classification accuracy > 90 % in any case :-)

TMA

2009 : Histopathological Image Analysis : a methodological review about histopathological scene understanding :-) **IEEE REVIEWS IN BIOMEDICAL ENGINEERING, VOL. 2, 2009, Metin Gurcan et al.**

TRENDS & NEEDS

1. Technological advances

2. Multimodal data fusion/Registration (ref. 123-126)

3. Correlating histological signatures with protein & gene expression
→ discovering of new proteins/biomarkers

4. Exploratory histopathology image analysis

5. CAD

IEEE TRANSACTIONS ON MEDICAL IMAGING, VOL. 32, NO. 2, FEBRUARY 2013

A Hybrid Classification Model for Digital Pathology Using Structural and Statistical Pattern Recognition

Erdem Ozdemir and Cigdem Gunduz-Demir*, Member, IEEE, 10 pages

AUTOMATED GRADING OF PROSTATE CANCER USING ARCHITECTURAL AND TEXTURAL IMAGE FEATURES, ISBI 2007, 4 pages

IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING, VOL. 61, NO. 5, MAY 2014

Breast Cancer Histopathology Image Analysis: A Review

Mitko Veta∗, Josien P. W. Pluim, Paul J. van Diest, and Max A. Viergever

2020 onwards

https://www.triconference.com/

https://www.triconference.com/Digital-Pathology

https://www.drivendata.org/competitions/67/competition-cervical-biopsy

https://www.drivendata.co/blog/tissuenet-cervical-biopsies-winners/

https://tissuepathology.com/