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Are digital workflow and AI implementation under regulation?

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European School of Oncology

ESO-ESP Digital Pathology Seminar

ONLINE COURSE

European Society of Pathology

Agenda

- Digital imaging. Now, pathology
  - Some figures of digital pathology
- Why we need digital pathology and AI regulation
- Some specific regulations in pathology
- Application of AI in pathology
- Conclusions

Pathology, a most valuable source of information

- Since 1990's all pathology departments are custodians of well structured and organized specimens and data: descriptions (gross/micro), final diagnosis, comments, techniques, coding (topography/morphology).
- Some figures in a 47 million inhabitants country (Spain):
  - 4.5 million pathology reports in one year
  - 6.5 million paraffin blocks in one year
  - 10 million histology slides in one year
  - 1,200 surgical pathologists

Anatomic Pathology in Andalucía. Some figures: 36 hospitals

	Seville	Málaga	Cádiz	Granada	Córdoba	Almería	Jaén	Huelva
Popul.	2 M	1,6 M	1,3 M	0,9 M	0,8 M	0,7 M	0,6 M	0,5 M
Hospit	6	7	5	4	4	3	4	3
Pathol.	43	40	27	23	20	16	16	12
Techn.	70	56	32	28	23	20	19	14
Citotec	16	6	3	5	4	2	0	1
Slides	411,000	337,000	189,000	253,000	208,000	218,000	96,000	88,000
Blocks	281,000	237,000	123,000	146,000	117,000	120,000	65,000	50,000

Total in Andalucía: **25% of surgical pathology** is related to **Dermatopathology**.

197 Pathologists, 262 Histotech, 37 Citotech.

1.800.000 slides / year

1.150.000 paraffin blocks / year (**17%** are related to Dermatopathology)

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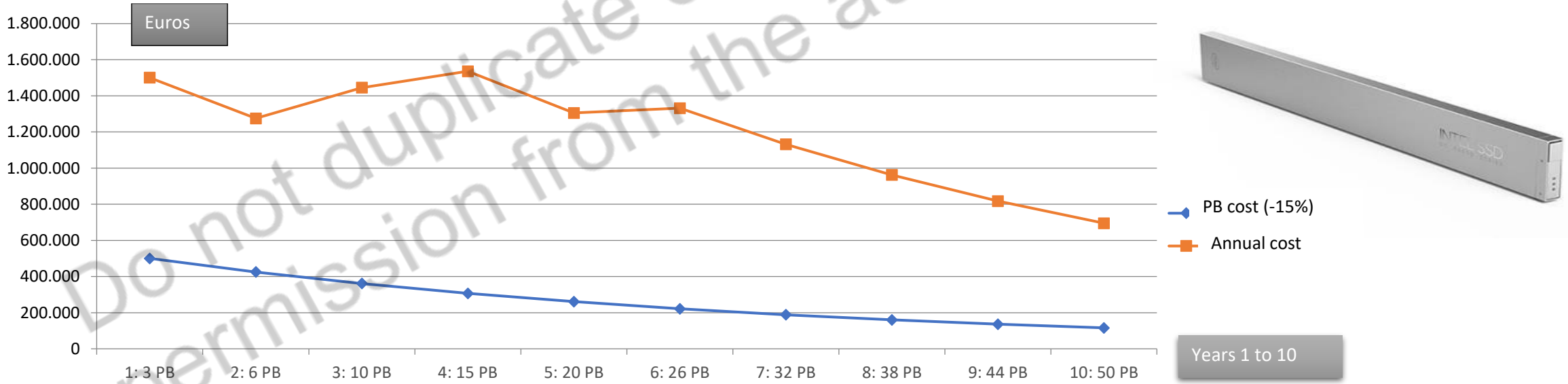
Storage

- Temporary. High performance: 250,000 slides.
  - 1,25 PB (5 GB/ slides). Annual growth : 5%
- Permanent. Larger capacity. 1.800.000 slides / year
  - Growth: 5 PB / year (3 GB/ slide). **€ 12 million in 10 years**



Author's elaboration

System Maturity Matrix

	Level 1	Level 2	Level 3	Level 4	Level 5
Image acquisition	*	*	*	*	*
Storage	*	*	*	*	*
Image distribution	*	*	*	*	*
Image presentation	*	*	*	*	*
Basic tasks redesign	*	*	*	*	*
Manual process optimization		*	*	*	*
PACS process redesign		*	*	*	*
Starting integration with other systems		*	*	*	*
Hospital level image distribution			*	*	*
Patient folder management			*	*	*
Image access based clinical decision			*	*	*
HIS/PACS/LIS integration			*	*	*
Workflow management			*	*	*
E-learning/Teleconferencing			*	*	*
Statistical control				*	*
Decision making assistance				*	*
Enterprise PACS interchange				*	*
PACS/medical record integration				*	*
Data Mining				*	*
Clinical collaboration				*	*
Continuous clinical optimization					*
PACS process innovation					*
Full integration in Medical Record					*

http://dehesa.unex.es/bitstream/handle/10662/4242/TDUEX_2016_Alejo_Gonzalez.pdf;jsessionid=5551678C3783681891 4C13A6AFE859A9?sequence=1 (2015)

We need to regulate:

1. Digital pathology
2. Computational pathology

Pathologists: Diagnosis, Treatment evaluation and Prognosis

- Until now:

https://www.rcpi.ie/faculties/faculty-of-pathology/

- Nowadays: **DIGITAL PATHOLOGY**

https://www.leicabiosystems.com/digital-pathology/scan/

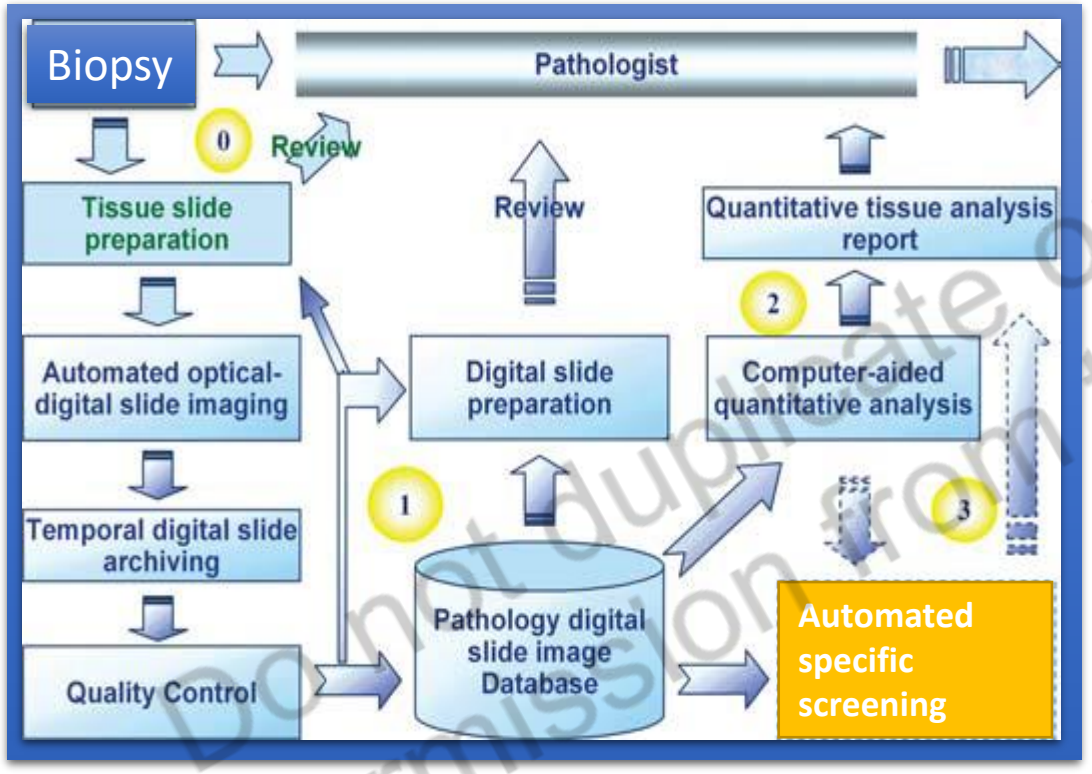
https://usdiagnostics.roche.com/en/tissue/research-platforms-reagents/ventana-dp-200-slide-scanner.html

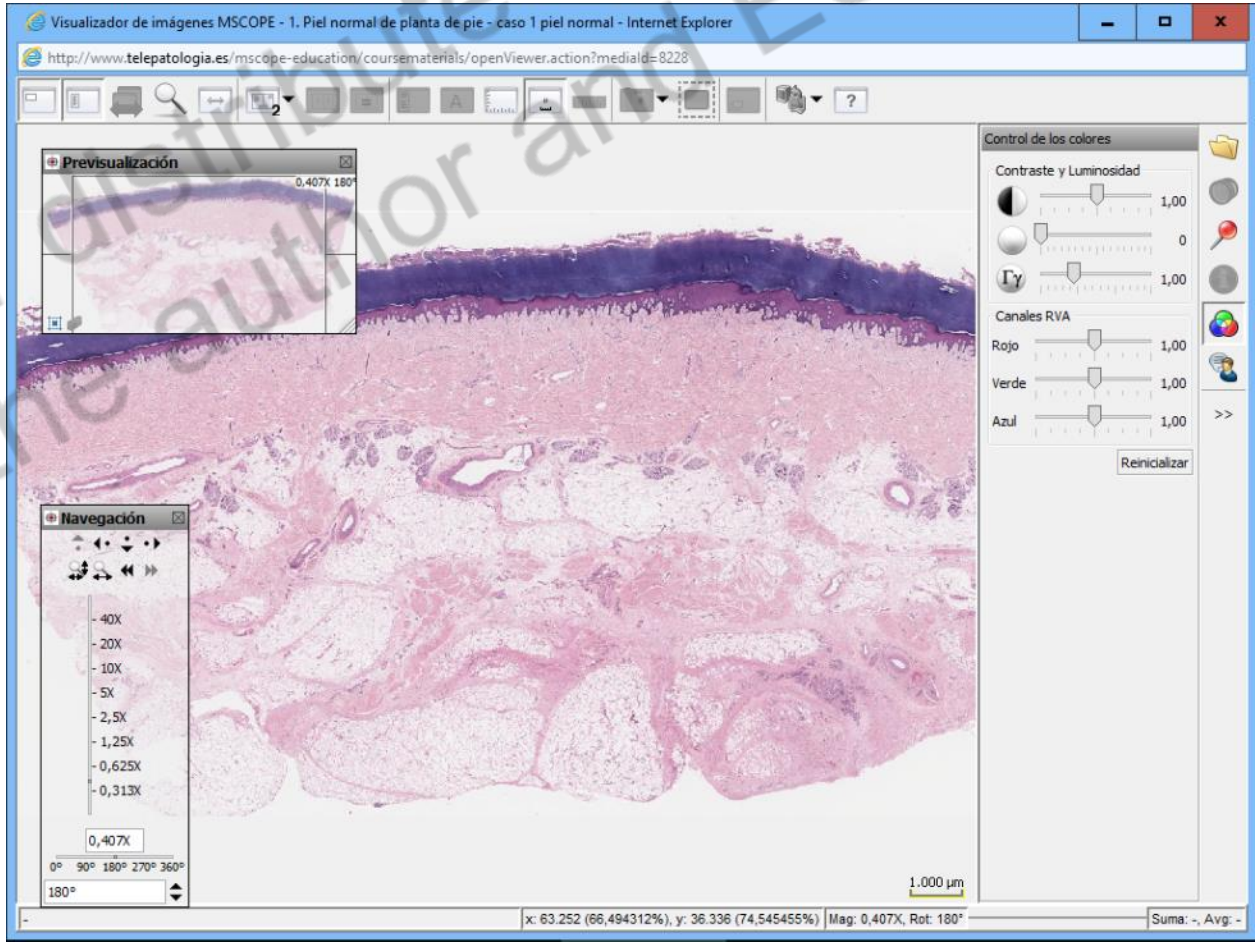
Source: Leica Aperio eSlide Manager

Do we need to digitize all slides?

- Simplify workflows
- To offer the best option to ALL patients:
  - Permanent image that do not deteriorate or get lost
  - Objective quantification
  - Easy data exchange and communication
  - Advanced image analysis (artificial intelligence)
- Avoid digital gap in this specialty: Research, training
- It is a essential part of the Medicine of the future
- It will be a continuous improvement process: more data will be collected, increasing image resolution, multi/hyperspectral, Z-stack…

From conventional microscope to digital slide



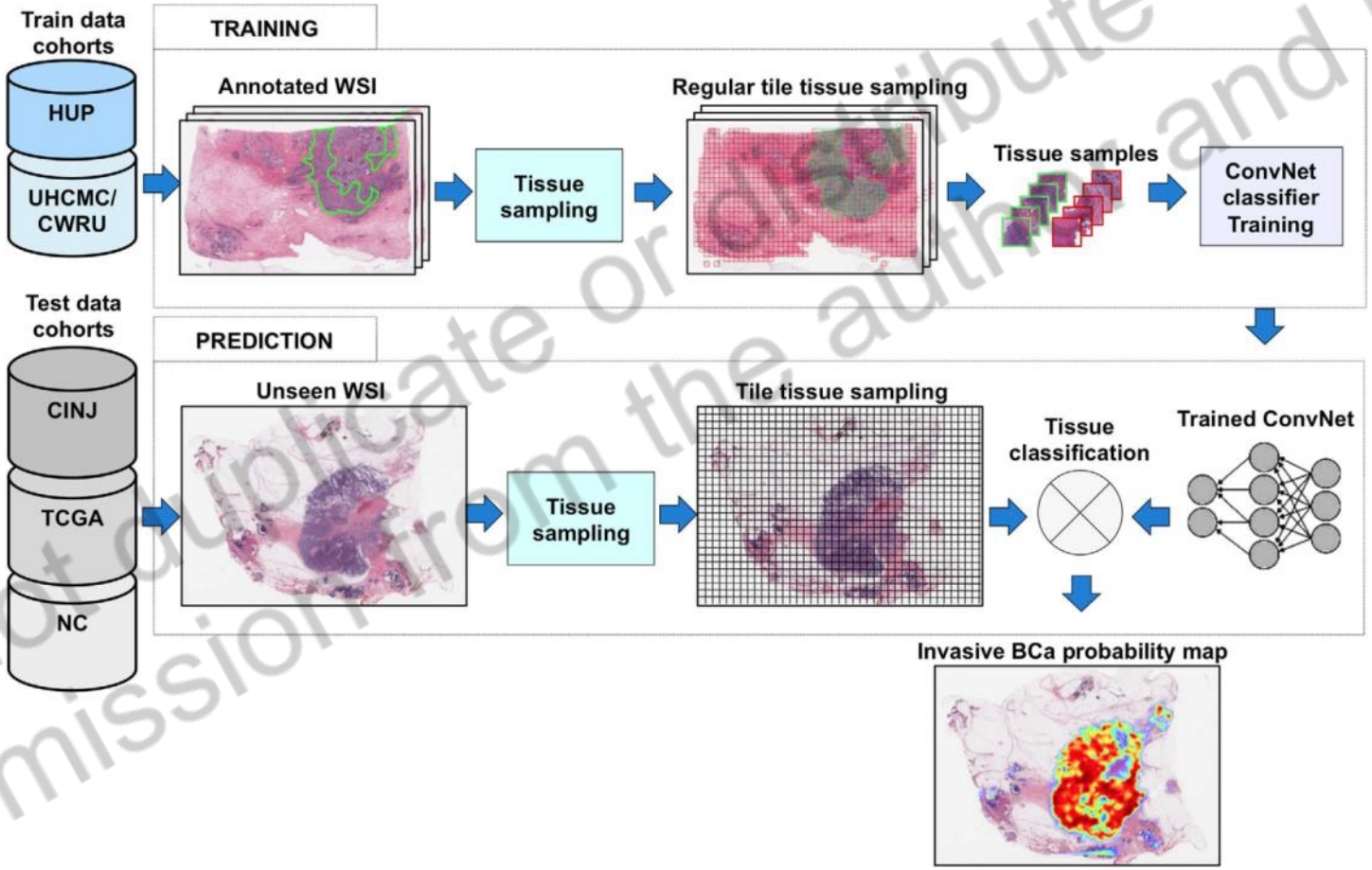


Author's own material

Do we need to keep everything? For how long?

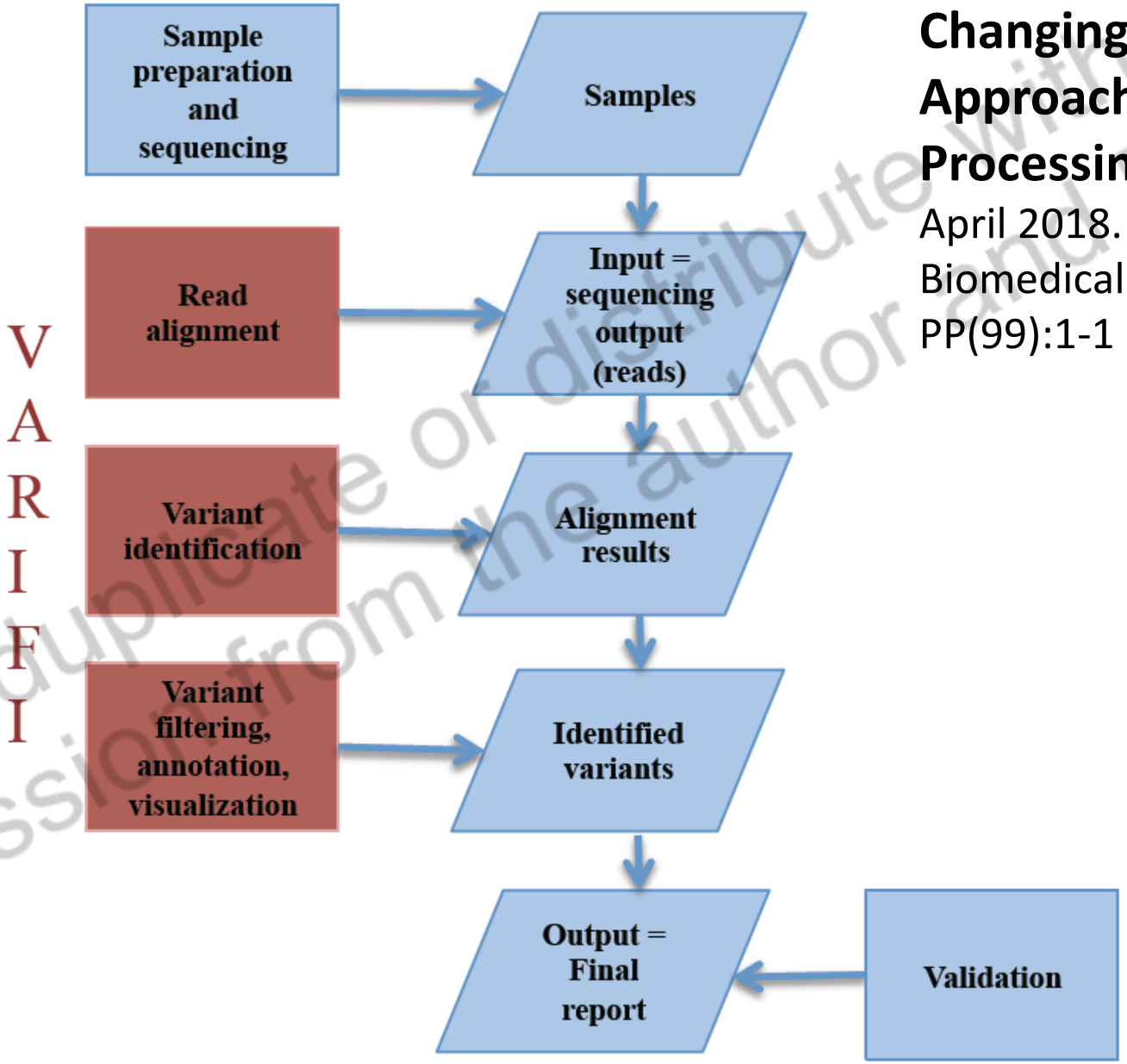
- Training weakly supervised artificial intelligence systems requires thousands of images from al type of diseases and normal tissues
- Long term cohort studies
- We are not able to predict future applications (morphological, molecular or genetic data we will be able to obtain in the future)
- Todays deleting criteria may change tomorrow
- Data storage needs will always be increasing

Deep learning classifiers



Cruz-Roa, et al. Scientific Reports volume 7, Article number: 46450 (2017)

DeepVariant: A convolutional neural network to study NGS variants.



Why Deep Learning Is Changing the Way to Approach NGS Data Processing: a Review
April 2018. IEEE Reviews in Biomedical Engineering PP(99):1-1

Some specific regulations

In clinical practice

- Personal data protection
- Patient right and obligations
- Electronic medical record
- In vitro diagnosis (IVD) Regulation
- Cybersecurity
- Electronic signature
- Digital administration
- Artificial intelligence

In research and training

- Personal data protection
- Biomedical research law
- Intellectual property
- Artificial intelligence
- Biomedical ethical principles

Pathology in the Electronic Health Record

- Elements:
  - Pathology Information System (traceability)
  - Digital slide management system (viewers, local and central repositories)
  - Teleconsultation and remote diagnosis
  - Image analysis and artificial intelligence tools
- Patient access to personal health data and images
- Promoting international standards (IHE, HL7, CDA, DICOM, SNOMED CT)

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6459377/

Artificial intelligence in Pathology regulation

- CLIA (USA): Developing algorithms prior to validation and implementation.
- American Medical Association (AMA): patient privacy and confidentiality
- Questions:
  - Validation and safety (how much is needed?); privacy
  - Resulting unemployment
  - To whom the responsibility falls
  - Balance between ethical guidance and avoiding AI development delay
  - Industry self-regulation is not enough → peer regulation? (CAP, Societies)

Allen TC. Regulating Artificial Intelligence for a Successful Pathology Future. Arch Pathol Lab Med (2019) 143 (10): 1175–1179. https://doi.org/10.5858/arpa.2019-0229-ED

New methods of regulatory guidance in Pathology

- “Flexibility” allowing for temporary, experimental regulation.
- “Regulatory sandboxes”: Industry can test new ideas with less rigid rules
- “Anticipatory rulemaking” Stakeholder feedback → regulations that are timely and relevant
- Regulation based on increased use of data analysis
- Adaptation of common law rules to AI whenever possible
- “Legal foresight”: proactively explore potential future legal developments
- “Multistakeholder councils”: to overcome uncertainty and information deficits
- A strong opportunity for “enterprise liability”

Allen TC. Regulating Artificial Intelligence for a Successful Pathology Future. Arch Pathol Lab Med (2019) 143 (10): 1175–1179. https://doi.org/10.5858/arpa.2019-0229-ED

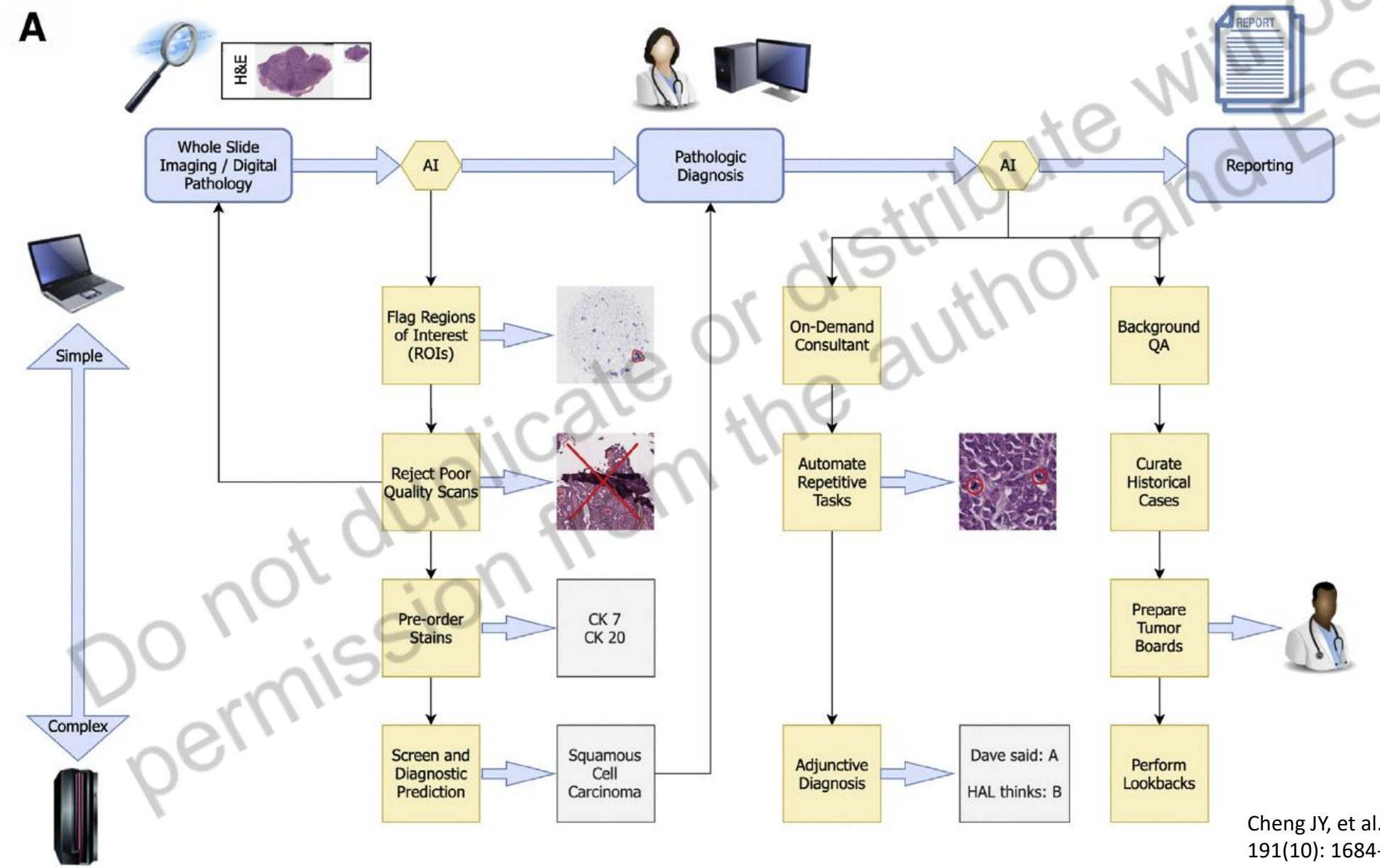
Current scenario on the use of AI in Pathology

- It is unlikely that AI-based tools will wholly replace physicians in the near future. They are designed for very specific problems.
- Repetitive tasks may be suitable for supplemental AI-based assistance
- 71% pathologist indicated that AI tools could increase their diagnostic efficiency
- CAP: Rigorous validation studies before clinical use
- IVD market approval (EU and USA)

https://www.cap.org/member-resources/clinical-informatics-resources/how-to-validate-ai-algorithms-in-anatomic-pathology

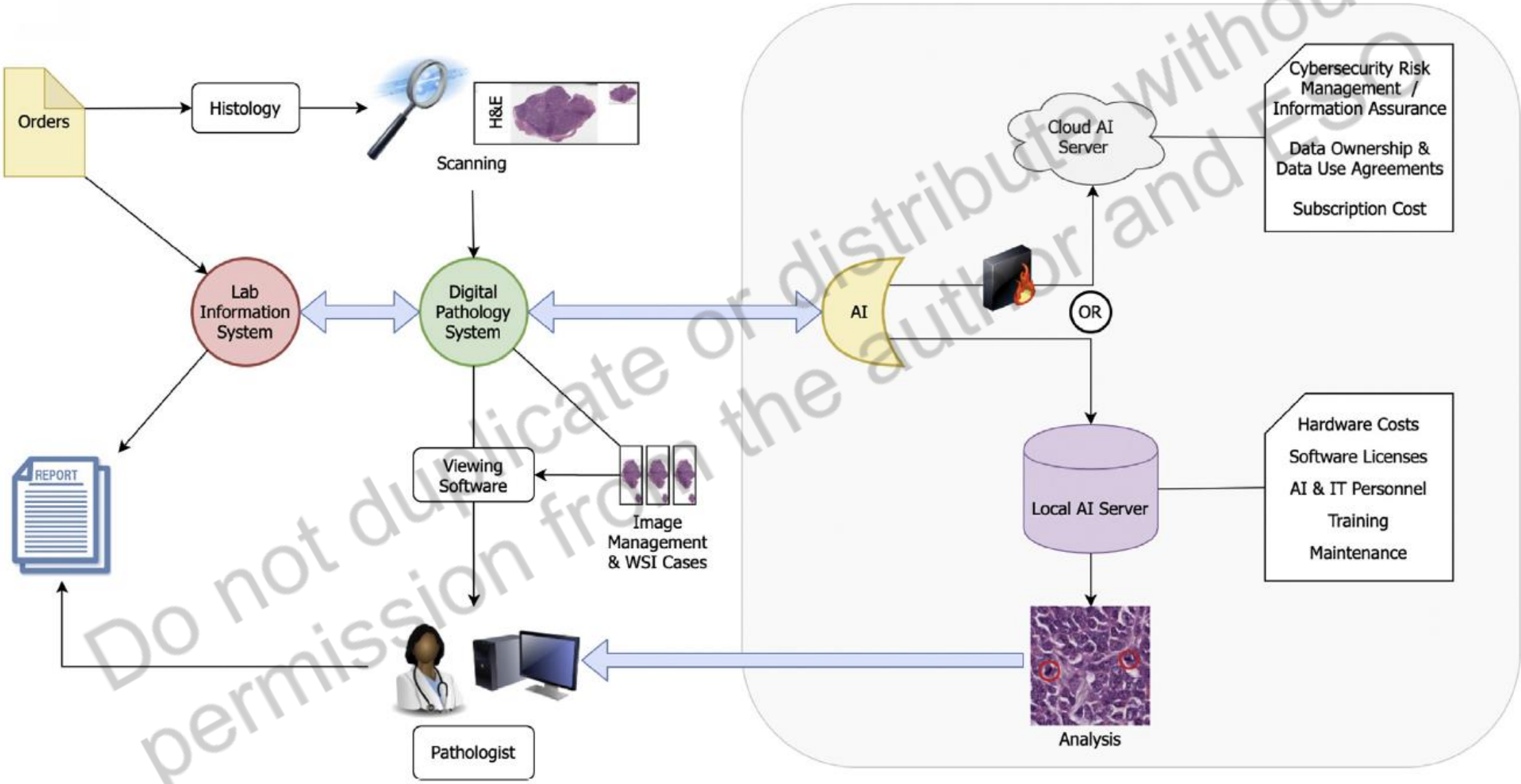
Cheng JY, Abel JT, Balis UGJ, McClintock DS, Pantanowitz L. Challenges in the Development, Deployment, and Regulation of Artificial Intelligence in Anatomic Pathology. The American Journal of Pathology, 2021; 191(10): 1684-1692. https://doi.org/10.1016/j.ajpath.2020.10.018.

AI in Pathology. Possible applications

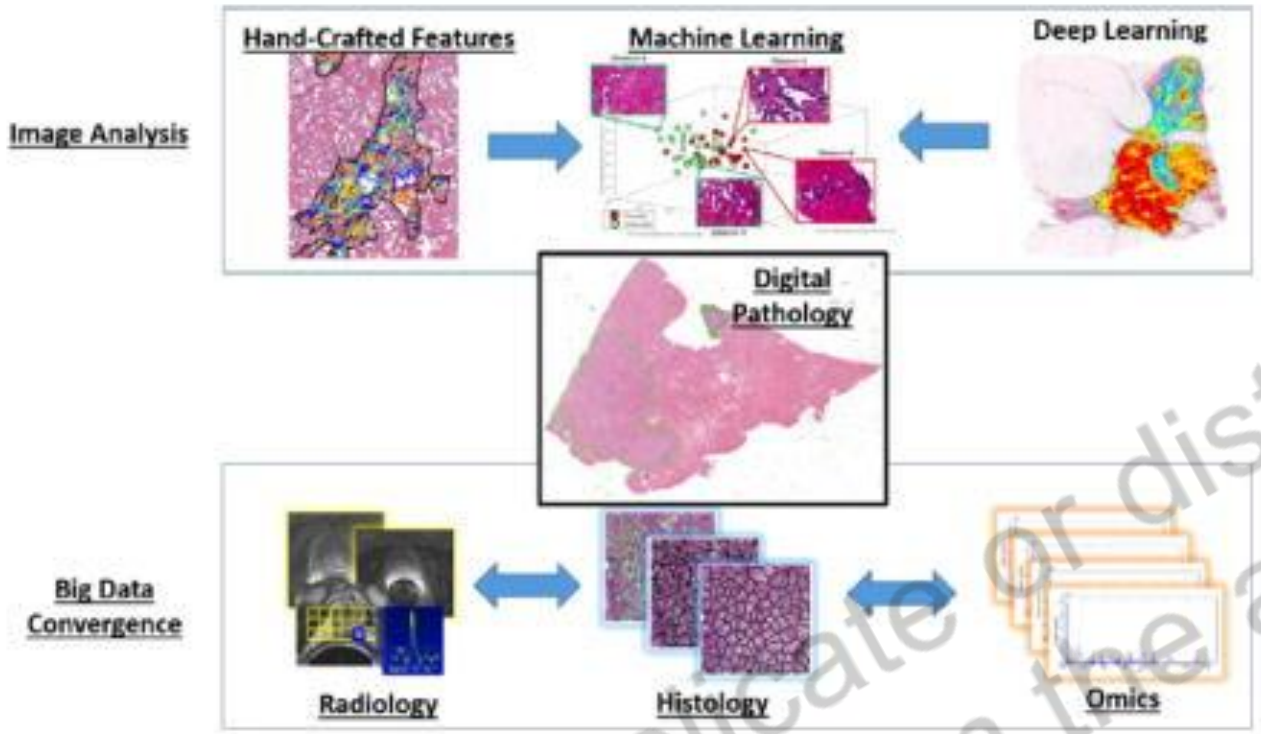


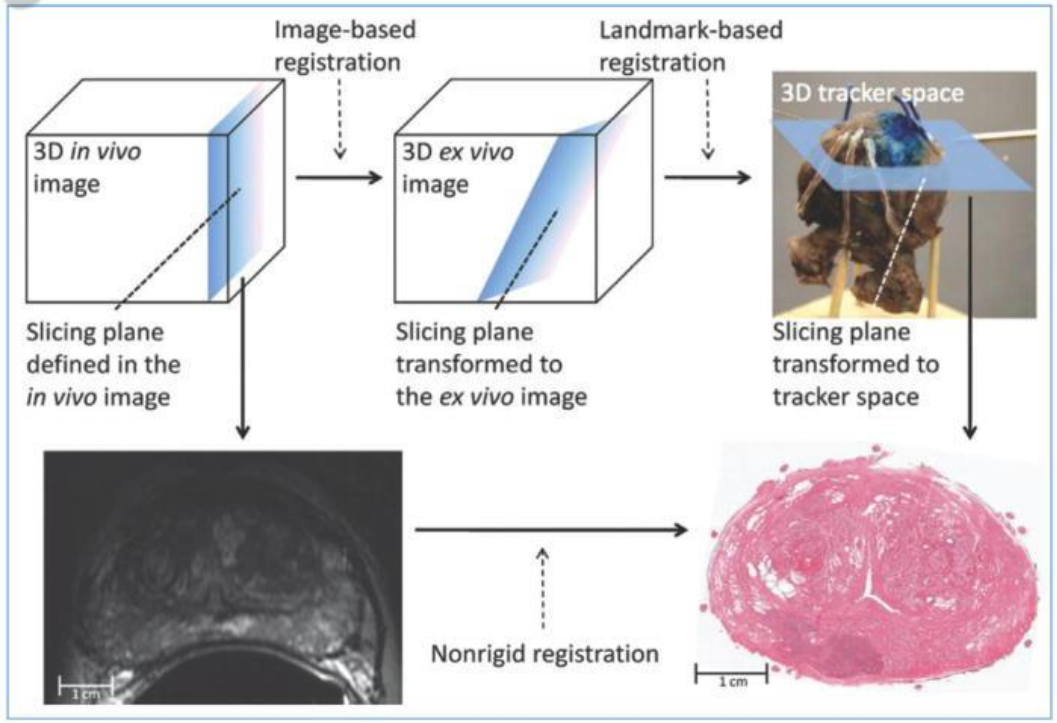
Cheng JY, et al. Am J Pathology, 2021; 191(10): 1684-1692. 8.

AI in Pathology. Implementation



Cheng JY, et al. Am J Pathology, 2021; 191(10): 1684-1692. 8.





Madabhushi A, Lee G. Image analysis and machine learning in digital pathology: Challenges and opportunities. Medical Image Analysis 2016; 33: 170-175.
https://www.sciencedirect.com/science/article/pii/S1361841516301141

Conclusions

- Digital pathology affects general workflow in pathology department
- Unprecedent large amount of data is being generated. Their efficient use requires normalization and regulation
- AI demands new regulatory scenarios, also in pathology
- Some commercial AI products have been cleared (FDA, CE-IVD) in pathology, but they are focussed only on specific problems
- Validation is encouraged before AI is implemented in clinical practice
- AI implementation should consider the integration of multiple data sources

Muchas gracias

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