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Pathomics, Radiomics and AI Will Enable Informed Cancer Care (if...)

Session 4: Computational Onc & Integrated Diagnostics: Ops for New Tech to Improve Dx Info and Inform Cancer Care
Disclaimers (SFCOI and COI)

• Significant Conflicts of Interest (SFCOI)
  – I have a startup company SpIntellx™ in the computational pathology AI space (founder equity)

• Conflicts of Interest (COI)
  – I am funded by three NCI sources – CCSG, ITCR, SPORE (federal grants) & CDC, NCATS, NHGRI and NLM.
  – I consult for several cancer centers and biotechnology companies (consulting fees and honoraria)
Major Points - Objectives

• Pathomics and Radiomics will fundamentally change diagnostics for precision oncology
• Pathology and Radiology need to partner to accomplish this for Oncology
• Data sharing is key enabler for this transformation
Pathomics: A Definition

• First appeared in mid-2000’s attributed to Lawrence Livermore Lab – “…high throughput diagnostics to understand the molecular basis of disease…”

• Today=Computational Pathology (Louis, 2014 & 5)

Computational Pathology

An Emerging Definition

David N. Louis, MD; Georg K. Gerber, MD, PhD; Jason M. Baron, MD; Lyn Bry, MD, PhD; Anand S. Dighe, MD, PhD; Carl Getz, PhD; John M. Higgins, MD; Frank C. Kuo, MD, PhD; William J. Lane, MD, PhD; James S. Michaelson, PhD; Long P. Le, MD, PhD; Craig H. Merrel, MD, PhD; John R. Gilbertson, MD; Jeffrey A. Golden, MD

Computational Pathology

A Path Ahead

MD; Michael Feldman, MD, PhD; Alesha B. Carter, MD; Anand S. Dighe, MD, PhD; John D. Pfefer, MD, PhD; Jindrich Brand, MD, PhD; Jindrich Brand, MD, PhD; Jonathan Braum, MD, PhD; John F. Ponsaskevich, MD; MD; John H. Simard, MD, PhD; Georg K. Gerber, MD, PhD, MPH; Stephen J. Galli, MD; Jeffrey A. Golden, MD; MD; Jeffrey A. Golden, MD

Pathomics: Final Report


December 13, 2006

Louis, et. al. 2015, Arch Path Lab Med
Radiomics: A Definition

- **Radiomics** is a field of medical study that aims to extract large amount of quantitative features from medical images using data-characterization algorithms. These features, termed *radiomic* features, have the potential to uncover disease characteristics that fail to be appreciated by the naked eye.

Deep Learning Research in Radiology
Pathomics + Radiomics = Dx Power

• Both Pathomics and Radiomics are making great strides in combining Genomics in computational algorithms for Dx, Px and Prediction
  – Pathogenomics and Radiogenomics are key
• Validation: Industry AI Rad/Path startups booming!
  – Pathomics Funding - Paige.AI (Fuchs) = $25M, PathAI = $15M, Fimmic = $11M
  – Radiomics Funding – Zebra Medical Vision = $20M, Arterys = $14M, AiDoc Medical = $11M, plus 30 radiology AI companies at RSNA in 2017
  
https://medium.com/@DrHughHarvey/the-a-z-guide-to-radiology-ai-companies-showcasing-at-rsna-2017-8c9976db90df

From Genomic Standards and Knowledge Bases for Decision Support = Jeremy Warner M.D., M.S.
Precision Oncology at Scale
Leverages Computation (AI)

• Imaging data is multidimensional (complex) and multi-modal (weighted images, tracers, color, fluorescence, etc...)

• Deeper understanding of imaging data is facilitated by AI to see what is not visible by human cognition alone (e.g. “fundamental theorem” Friedman, et al.)

![Image: Figure 1. A “Fundamental Theorem” of informatics.](image)
Data Sharing is key to get there

- Data sharing will be key to AI for Oncology
- Needed for R&D, validation and implementation
- Training sets for the next generation of pathologists and radiologists – need to get involved
- FAIR data (Findable, Accessible, Interoperable and Reusable) and Academic/Industry partnership is key!

Data Sharing Consortiums and Large Datasets to Inform Cancer Diagnosis - Amy Abernethy, M.D.
Building Data Sharing Platforms
Pathology and Radiology Can Share

• Text Information Extraction System (TIES) Cancer Research Network (TCRN) shares de-identified pathology and radiology reports and images which are searchable and FAIR
• Supported by NCI’s Information Technology for Cancer Research (ITCR) program and links to The Cancer Image Archive (TCIA)
• Soon supporting datathons and hackathons

From “Computational Pathology” Fuchs, 2017
Conclusions

• Pathomics and Radiomics will fundamentally change diagnostics for precision oncology

• Pathology and Radiology need to partner to accomplish this for Oncology

• Data sharing is key enabler for this transformation
Questions to Address

• How will artificial intelligence (AI) and machine learning change the practice of radiology, pathology, and other forms of diagnostic imaging?
• How should clinical training be transformed so future physicians are prepared to use AI and machine learning systems in daily practice?
• As we adopt AI, machine learning, and other information systems to improve diagnostic information and inform cancer care, what are the opportunities and challenges?
• What practice model is likely to derive the most benefit from AI and machine learning? (e.g. academic vs. community care setting, or urban vs. rural setting)
Questions to Address

• Is artificial intelligence and machine learning more likely to bring radiology and pathology together as a single specialty, or to keep them as separate disciplines?

• What role can AI, machine learning, and other information technologies play in enhancing radiology reports, pathology reports, and other forms of physician/patient communication?

• What are the best methods to produce large datasets that inform cancer diagnosis? What are the challenges in creating and using such data sets?