AAPM 2013 Session in Memory of Charles E. Metz, Ph.D.

Past, Present, and Future Roles of ROC Analysis in Medical Imaging and Quantitative Image Analysis

Maryellen Giger, The University of Chicago

Alicia Toledano, Biostatistics Consulting

Kyle Myers, FDA

Yulei Jiang, The University of Chicago

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Maryellen Giger, Ph.D.

A.N. Pritzker Professor of Radiology,

Medical Physics, and the College

The University of Chicago

Charles E. Metz, Ph.D. 1942-2012

Professor of Radiology & Medical Physics, The University of Chicago

- True scientist, educator, & mentor, of the highest caliber
- Graduated with honors in 1964 from Bowdoin College with a bachelor's degree in physics; from University of Pennsylvania with a master's degree in 1966 and the Ph.D. degree in 1969
- Came to University of Chicago in 1969
  - Full Professor in 1980
  - Director of the Graduate Program in Medical Physics at the University from 1979 to 1986.
  - Over 250 scientific papers

Charles E. Metz, Ph.D.
1942-2012
Professor of Radiology & Medical Physics, The University of Chicago

- Died from pancreatic cancer on July 4 at his home in Burr Ridge, Illinois. He was 69 years old.
- Survived by his daughters
  - Daughter, Becky Metz Mavon of Western Springs, Illinois
  - Daughter, Molly Metz of Seattle, Washington
  - Grandchildren Charlie, Avery and Oni
  - Former wife, Maryanne Metz of Chicago
- Established the Charles E Metz, Ph.D. Memorial Fund that hosts a Special Topics Course within the Medical Physics Graduate Program at the University of Chicago

Charles E. Metz, Ph.D.

- Fellow of the American Association of Physicists in Medicine in 2004
- Paul C. Hodges Alumni Society's Excellence Award in 2004
- L.H. Gray Medal by the International Commission on Radiation Units and Measurements in 2005—cited for his “fundamental contributions to basic and applied radiation science.”

Charles E. Metz, Ph.D.
1942-2012

- A pioneer in image science and was instrumental in elucidating the mathematical foundations of imaging science.
- Contributed to nuclear medicine imaging and reconstruction methods, and developed the Metz filter, an image processing filter that concurrently enhances resolution and suppresses noise in nuclear medicine images.

Professor Metz and ROC Analysis

- Best known for extending the mathematical foundations of receiver operating characteristic (ROC) analysis to the medical imaging field
- His paper, “Basic principles of ROC analysis”, which was published in 1978, has been cited nearly 3,000 times.
- Provided, free of charge, an extensive package of computer software to more than 15,000 registered users worldwide.
- http://metz-roc.uchicago.edu

Professor Metz and Students

- Extraordinary teacher to both students and colleagues.
- Advised over 38 doctoral students, many of whom now are leading figures in the field.
- Received twice the "Kurt Rossmann Award of Excellence in Teaching", in its inaugural year and after the "limit one" rule was removed .

Professor Metz and WWII Airplanes

- Humble leader in other areas including the model airplane world, having amassed an impressive collection of books and models of WWII airplanes
- Now donated to the Pritzker Military Library in Chicago

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Introduction

- Receiver Operating Characteristic (ROC) analysis has been a mainstay of many research developments as well as various clinical studies/trials.
- It has provided medical physicists with a way to objectively measure:
  - how data are presented in an image
  - how people perceive those images
  - how one can compare different observers or different imaging modalities with each other.
- ROC analysis plays an important role in both technology assessment and clinical decision-making, especially as various aspects of imaging biomarkers and personalized/precision medicine are evaluated.

Introduction

- Over the past five years, on average, almost 40 papers/year that were published in MEDICAL PHYSICS utilized ROC analysis.
- The challenges and opportunities in ROC analysis research and in its application in various tasks are active areas, including
  - ROC analysis theory
    - Expanding the mathematical formulation for multiple lesions per image
    - Location-based sensitivity
    - Evaluation without ground truth
  - Applications of ROC analysis
    - Expanding role in imaging biomarker validation
    - Assessing response to therapy
    - Theranostics
    - Image-based phenotyping with genomics

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