Mission & Goals
Teach students biological concepts including:
• Cancer is the result of cumulative genetic mutations.
• Personal risk factors and environmental mutagens influence DNA expression and the cell cycle.
• Benign, malignant, and metastatic tumor development and characteristics.

Expose students to practical applications of computer vision in biomedical imaging by:
• Conducting LDCT-based analysis of metastatic nodules using 3D-Slicer.
• Facilitating student understanding of convolutional neural networks in CAD, and the implications of deep learning in medical imaging.

Background

• Lung cancer represents 14% of all new cancer diagnoses, and is the leading cause of cancer death (26%) in the US.
• As baby boomers age, a 52% increase in diagnoses is expected by 2030. (Smith, et al. 2009)
• Diagnosis usually occurs late, reducing treatment success. False negative rates using x-ray screening are as high as 25%. (Stapley, et al. 2006)
• Use of LDCT screening is associated with a 15-20% reduction in mortality risk compared with chest X-rays. (NLST, et al. 2011). Annual screening via LDCT may reduce cancer deaths as diagnosis rates increase.
• Traditional secondary biology introductory courses spend little to no time on medical imaging. As diagnoses are expected to increase, so should our preparation of the next generation of medical and technical professionals.

Lesson Prep:

Flipped Session (90 min.)
1. Dr. Bert Vogelstein discusses how cumulative genetic mutations lead to tumor growth and spread in the HHMI Lecture: “Putting the Brakes on Cancer”.
2. Download and install 3D slicer and patient data.

Class Day 1: (90 min.)
1. Meet Laura McCracken: 30 yr. old non-smoker, vlogs about her Stage 4 SCLC diagnosis in 2008 (Fig. 3)
2. Lung Cancer Basics: statistics & epidemiology (Fig.4), compare and contrast detection technologies including X-rays, MRIs, PET, and LDCT.
3. 2D Diagnostic: Simulate x-ray screening using static LDCT scans to assess nodule characteristics (size, shape, margin, density, est. volume) (Fig. 5) and stage. (Fig. 6).

Evidence of Learning:
• Meet Laura Reflection Log
• Nodule 2D Diagnostic Results

Class Day 2: (90 min.)
1. Check in with Laura: Laura vlogs about her progress.
3. 3D Diagnostic: Re-analyze nodule using segmentation and volume rendering in 3D slicer (Fig.7) and compare with 2D Diagnostic results.
4. Meet Sir Geoffrey: Video bio of Geoffrey Hinton, the “father of deep learning”, and how AI is used in the real world.

Evidence of Learning:
• Meet Laura Reflection Log
• Nodule 3D Diagnostic Results

Class Day 3: (90 min.)
1. Computer Vision Presentation: Focuses on the concepts of edge detection, segmentation, deep learning, neural networks, and how these concepts are used in CAD.
2. Computer Vision Assignment Choice:
   • Draw, label, explain how a convolutional neural network might work for lung nodule detection. (Fig. 8)
   • Write a short essay on deep learning in medical imaging using the MDL 2018 Panel discussion & other resources.
   • Conduct 3 additional nodule analyses using 3D slicer and compare results with a partner
4. Saying Goodbye to Laura: Read Laura’s posts revealing her terminal diagnosis after 7 yrs in remission. Reflection on her story, including how early diagnosis with CAD may have changed her outcome.

Evidence of Learning:
• Meet Laura Reflection Log
• Computer Vision Assignment Choice (deadline extended)

References

Acknowledgements
Special thanks to:
Dr. Jose Urbina for his guidance and subject expertise;
Dr. Nicole Lobo for his administration of the program, and advice as co-principal investigator; Dr. Ulas Bagci for his technical expertise; Dr. Mubarak Shah for his oversight as principle investigator.
Funding for this project was provided through the National Science Foundation, grant #1542439.