Carnegie Mellon

The Robotics Institute
Carnegie Mellon University
Pittsburgh, Pennsylvania 15213-3890

Teaching Statement: John M. Galeotti

I have 6+ years of experience integrating teaching and research. I taught my first graduate course in medical image analysis algorithms back in Spring 2008, and my teaching has received two teaching awards and external funding. I have conducted my teaching and my research in mutually beneficial ways, and the synergy has paid off with better equipped students, new research collaborations, more productive students in my own lab, and 2 years of combined research and teaching funding from the National Library of Medicine (NLM) at the National Institutes of Health (NIH). My teaching focus on research and system development requires that I teach not only the theory and application of current techniques, but also that I help my students gain a deep understanding of the big-picture concepts and deficiencies in the field, so that they will become well equipped leaders who can leverage the literature to develop new methods and systems that are actually relevant to medicine and science. Another key component of my teaching is complexity management, ranging from the breakdown of algorithms to the design of real-world systems. Together, these constructs are critical to thinking like a scientist and engineer, and so I explicitly incorporate them as early as possible into students' lives, even at the pre-college level, such as when I teach robotics to underrepresented minorities at Carnegie Mellon University (CMU) in the Summer Academy for Mathematics and Sciences. I am presently advising/supervising the research of two PhD students (one of whom received an NSF GRF for her research with me), one MS student, and one undergraduate researcher. This spring I am also the teaching mentor for an assistant professor through the SYSU-CMU Joint Institute of Engineering. I maximize the public availability of my teaching materials, and for my methods in medical image analysis class I have a complete set of teaching materials available online (http://itk.galeotti.net), including lecture slides, assignments, and professionally produced videos of all my 2012 lectures, which were deliverables for my funding from NLM.

Philosophy & Style: My pedagogical style makes extensive use of class discussions and project work to foster a deep understanding of core concepts and the skills necessary to manage the complexity of modern engineered systems. When I initially present important underlying concepts and theoretical relationships, I prefer to utilize class discussion as the means of presenting the relevant underlying problem, with the goal that students understand (and appreciate!) why they are being presented with yet another algorithm, architecture, etc., before I ever put the details of it in front of them. I guide the discussion as necessary to lead the students naturally from initial understanding of the key aspects of the underlying problem to a critical analysis of potential solutions. My ultimate goal is for the students to pick up and run with the ideas, independently re-deriving the overall theory of what I am about to present in detail, thereby walking students through the process of thinking like an expert scientist or engineer. I typically use quizzes to prompt and assess students' initial comprehension of new material, with follow-on mini-project homework assignments that are typically simplified real-world problems. A large, real-world final project gives students the experience they need to translate their coursework into the real world, using theory, techniques, and tools to identify, formulate, and solve scientific and engineering problems. I prefer projects with an element of interdisciplinary teamwork and collaboration, but with clearly delineated individual goals and responsibilities so that I can fairly evaluate each student. Projects provide a venue for students to begin looking up and teaching themselves the more minute details for their chosen methods, helping jump-start the habits of lifelong learning and literature search. Oral project presentations give students the opportunity (even if just for 5 minutes) to organize, present, and *teach* the key components of their projects, providing them critical experience with conference-style scientific or technical public speaking. I continually modify my course materials to take into account student feedback, new opportunities, and my own perceptions of course deficiencies, paying close attention to what students accomplish for their projects and what they report having learned from them.

Teaching Experience: I teach the longest-standing course on medical image analysis based on the Insight ToolKit (ITK), an open-source toolkit for segmentation, registration, and analysis funded by the NLM. The cross-listed course not only elicits excellent student reviews, but I have also received an Outstanding Teaching Certificate from the University of Pittsburgh (U. Pitt.) School of Engineering for both the 2010-

2011 and 2011-2012 terms, and I was selected to use this class as a mechanism for mentoring teaching at CMU, starting with my first mentee this spring. My public website for this methods in medical image analysis course is sufficiently popular to be one of the first results returned by Google for "medical image analysis," and it has been used as a basis for several similar classes around the world, including at NIH, the University of Iowa, Old Dominion University, Ohio State, Bahcesehir University, Istanbul, University College London, and Mayo Clinic College of Medicine. This graduate course is heavily based on projects that utilize ITK to tackle cutting edge problems in medicine and biomedical research. Class exercises require students to design, build, and run experiments in software to empirically optimize their projects' algorithm architecture and parameter tuning. The course repeatedly stresses the need to always consult the latest scientific literature when seeking to build useful systems, and makes use of current papers for some of the lectures. Students interact with practicing clinicians to learn contemporary practice, workflow, and limitations within the medical and biological communities. As part of course development, I have made numerous contributions to both ITK's source code and to its teaching materials. In addition, the course has afforded me the opportunity to be involved with numerous additional graduate research projects, helping students develop novel methods ranging from segmenting cells in confocal microscopy to Diffusion tensor imaging (DTI)-based neurosurgical path planning. I was also PI on a NLM contract to both update my publicly available course materials to be consistent with the new version 4 of ITK and also to help add real-time video capabilities to v4 of ITK, thereby keeping me actively integrated into its development loop.

I have 4 years of experience teaching a pre-college project-based course in robotics as part of CMU's Summer Academy for Mathematics + Science (SAMS). As a summer program for diversity, SAMS is targeted at underrepresented minorities whom it seeks to prepare for admission to selective STEM programs at colleges and universities. Working in teams and utilizing Lego Mindstorms and Robot C, students learn how to jointly develop a robot platform capable of performing in "real-world" conditions. The teams custom design, build, and program their robots to compete against each other, performing a variety of tasks including line-following, avoiding obstacles, and automatically coloring in figures with markers. When finished, the students have experience with real-world C programming, an initial taste of complexity management for engineering, and the confidence that they can build nontrivial functional systems.

Finally, I have helped advise three Ph.D. students (one at CMU Robotics and two at U. Pitt. Bioengineering), three M.S. students, and multiple undergraduate researchers. The CMU Ph.D. student received an NSF graduate research fellowship based on her research with me, and the U. Pitt. Ph.D. students (both international) are producing work integral to some of my current grant proposals. I have also served on qualifier and thesis committees for other students, primarily those who have taken my methods in medical image analysis course.