Course Information:

Instructor: John Galeotti  
Office: NSH A525  
Email: jgaleotti@cmu.edu  
Office Hours: Meets with students after class

Teaching Assistant(s): Ying Ying Wu  
Email Address: yingyingwu@cmu.edu  
Office Hours: TBD

Course Management Assistant: Zara Collier  
Email Address: zcollier@andrew.cmu.edu  
Office Location: HH 1112

Course Description:

Students will gain theoretical and practical skills in medical image analysis, including skills relevant to general image analysis. The fundamentals of computational medical image analysis will be explored, leading to current research in applying geometry and statistics to segmentation, registration, visualization, and image understanding. Students will develop practical experience through projects using the National Library of Medicine Insight Toolkit (ITK), a popular open-source software library developed by a consortium of institutions including Carnegie Mellon University and the University of Pittsburgh. In addition to image analysis, the course will include interaction with clinicians at UPMC. It is possible that a few class lectures may be videoed for public distribution.

Number of Units: 12

Pre-requisites: Knowledge of vector calculus, basic probability, and either C++ or python, including basic command-line familiarity and how to pass arguments to your own command-line programs. Extensive expertise with C++ and templates is not necessary, but some students may find it helpful. Required textbook, "Machine Vision", ISBN: 052116981X; Optional textbook, "Insight to Images", ISBN: 9781568812175.

Course Area: Software Systems and Computer Networking

Class Schedule:

• Lecture:
Tuesday and Thursday, 10:30am to 11:50am, CIC 1201, 3 Lecture Hours


**Optional Textbook:** "Insight to Images", ISBN: 9781568812175

**Brief List of Major Topics Covered:** 2D/3D biomedical image de-noising, restoration, segmentation, registration, shape and feature analysis, morphology, and programming with the Insight Segmentation/Registration Toolkit (ITK library). See course description.

**Course Website:** [http://www.cs.cmu.edu/~galeotti/methods_course/](http://www.cs.cmu.edu/~galeotti/methods_course/)
You should check the course website daily for announcements and handouts.

**Course Blackboard:** To access the course blackboard from an Andrew Machine, go to the login page at: [http://www.cmu.edu/blackboard](http://www.cmu.edu/blackboard). **Note that for most purposes the course website will be used instead of blackboard.**

**Course Wiki:** Students are encouraged to use the ECE wiki to provide feedback about the course at: [http://wiki.ece.cmu.edu/index.php](http://wiki.ece.cmu.edu/index.php).

**Grading Algorithm:**

**Method: The point system**
- Each question or problem in a quiz or homework is assigned a point value
- Your cumulative grade for quizzes [or homeworks] is (the sum of points you earned on all quizzes) divided by (the sum of points you could have earned on all quizzes)
- So, your course grade is equally affected whether you miss 1 point on a 3 point quiz, or you miss 1 point on a 10 point quiz. (This is not the case for the more typical "averaged percentages" method.)

**Attendance: Required**
- Checked using Quizzes
- On some days the quiz may be signing your name on the roll.
- Some days may not have any quiz at all (attendance not checked).

**Quizzes: 20%**
- Not present / not taken = 0
- Lowest 2 are dropped (the 2 on which you missed the most points)
- So, if you are gone for a week-long conference, then the 2 0's won't count.
- In case of extenuating circumstances requiring further absence, talk to me, but I must be fair to the class (i.e. harder on you).

**Homework: 30%**
- Your TA will help you before the assignment is due. When grading, he will **not** try to figure out a non-working mess of code!
- **Late policy: 0%** for code that does not compile, run, and at least perform some part of the assignment. **However,** if you've made a reasonable effort in advance **and** have been working with the TA but still have not been able to get things to
work, then we will be much more generous with partial credit and/or extra time, on a case-by-case basis.

- Also, if you using a different compiler than the TA, then you will be given a brief period of time to fix unforeseen cross-platform incompatibilities.

**Shadow Program: 10%**

- You submit 1 report for each clinical station you visit.
- The first time you miss a station for which you are scheduled (without good reason), you may contact your instructor to reschedule for 50% credit for that station.
- If you do not show up a second time, you will be removed from the Shadow Program, get a 0 for *all subsequent* stations, and your instructor will be very unhappy with you.

**Final Project: 40%**

- ◦ 15% presentation
- ◦ 25% code

**Final Letter Grade**

- While lower cutoffs may be used, the following maximum grade cutoffs are guaranteed:

  >= 93.5 A
  >= 90.0 A-
  >= 87.5 B+
  >= 83.5 B
  >= 80.0 B

**Tentative Course Calendar:**

A tentative course calendar is listed on the course website *(see above)*. The lecture schedule (and some topics) are subject to change, depending in part on class interest and involvement.

**Education Objectives (Relationship of Course to Program Outcomes)**

(a) an ability to apply knowledge of mathematics, science, and engineering: Theoretical and practical lectures are combined with practical and empirical exercises to prepare students for a large-scale science/engineering final project.

(b) an ability to design and conduct experiments, as well as to analyze and interpret data: Class exercises require students to design, build, and run experiments in software to empirically optimize their projects’ algorithm architecture and parameter tuning.

(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability: The final projects require students to build a working system that address a real need, either by providing new computational tools or by making new discoveries. Required interaction with practicing clinicians and class lectures both expose students to the dominant constraints in the various domains of
biomedical image analysis, including matters of usability, patient safety, and legal liability.

(d) an ability to function on multi-disciplinary teams: The entire class is multi-disciplinary, requiring students to interact with clinicians, biologists, and/or engineers. Homework assignments and the final project require engineering approaches to biomedical problems in order to derive clinically/scientifically meaningful results.

(e) an ability to identify, formulate, and solve engineering problems: As a project-based course, students must continually solve engineering problems. The final projects further require students to individually identify relevant biomedical problems, formulate an engineering approach, and then proceed to (at least partially) solve their chosen problems

(f) an understanding of professional and ethical responsibility: Ethical matters of patient safety and legal liability are discussed when relevant to other lecture materials, as part of projects, and when shadowing clinicians.

(g) an ability to communicate effectively: The final projects require individual student presentations, roughly equivalent to an oral conference presentation. Although students are graded primarily on technical content, they are also graded on the clarity, polish, and length of their presentation.

(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context: [see item (c) above regarding economic and societal constraints and impact]

(i) a recognition of the need for, and an ability to engage in life-long learning 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. The textbook was chosen in part due to its extensive references which provide an excellent cross-reference starting point from which relevant current literature can be found.

(j) a knowledge of contemporary issues: Biomedical image analysis is a driving factor for many recent developments in the medical and biological communities. Students are instructed and shown that building useful systems requires knowledge of contemporary practice, workflow, and limitations within these communities, so that the students’ final systems will be both usable and relevant to current research/medicine.

(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice: As a project based course, students are taught and required to use a wide variety of techniques, skills and engineering tools to solve a variety of biomedical image analysis problems.

ECE Academic Integrity Policy (http://www.ece.cmu.edu/programs-admissions/masters/academic-integrity.html):
The Department of Electrical and Computer Engineering adheres to the academic integrity policies set forth by Carnegie Mellon University and by the College of Engineering. ECE students should review fully and carefully Carnegie Mellon University's policies regarding Cheating and Plagiarism; Undergraduate Academic Discipline; and Graduate Academic Discipline. ECE graduate student should further review the Penalties for Graduate Student Academic Integrity Violations in CIT outlined in the CIT Policy on Graduate Student Academic Integrity Violations. In addition to the above university and college-level policies, it is ECE's policy that an ECE graduate student may not drop a course in which a disciplinary action is assessed or pending without the course instructor's explicit approval. Further, an ECE course instructor may set his/her own course-specific academic integrity policies that do not conflict with university and college-level policies; course-specific policies should be made available to the students in writing in the first week of class.

This policy applies, in all respects, to this course.

CMU Academic Integrity Policy (http://www.cmu.edu/academic-integrity/index.html):

In the midst of self exploration, the high demands of a challenging academic environment can create situations where some students have difficulty exercising good judgment. Academic challenges can provide many opportunities for high standards to evolve if students actively reflect on these challenges and if the community supports discussions to aid in this process. It is the responsibility of the entire community to establish and maintain the integrity of our university.

This site is offered as a comprehensive and accessible resource compiling and organizing the multitude of information pertaining to academic integrity that is available from across the university. These pages include practical information concerning policies, protocols and best practices as well as articulations of the institutional values from which the policies and protocols grew. The Carnegie Mellon Code, while not formally an honor code, serves as the foundation of these values and frames the expectations of our community with regard to personal integrity.

The Carnegie Mellon Code

Students at Carnegie Mellon, because they are members of an academic community dedicated to the achievement of excellence, are expected to meet the highest standards of personal, ethical and moral conduct possible.

These standards require personal integrity, a commitment to honesty without compromise, as well as truth without equivocation and a willingness to place the good of the community above the good of the self. Obligations once undertaken must be met, commitments kept.

As members of the Carnegie Mellon community, individuals are expected to uphold the standards of the community in addition to holding others accountable for said standards.
It is rare that the life of a student in an academic community can be so private that it will not affect the community as a whole or that the above standards do not apply.

The discovery, advancement and communication of knowledge are not possible without a commitment to these standards. Creativity cannot exist without acknowledgment of the creativity of others. New knowledge cannot be developed without credit for prior knowledge. Without the ability to trust that these principles will be observed, an academic community cannot exist.

The commitment of its faculty, staff and students to these standards contributes to the high respect in which the Carnegie Mellon degree is held. Students must not destroy that respect by their failure to meet these standards. Students who cannot meet them should voluntarily withdraw from the university.

_this policy applies, in all respects, to this course._

Carnegie Mellon University's Policy on Cheating ([http://www.cmu.edu/academic-integrity/cheating/index.html](http://www.cmu.edu/academic-integrity/cheating/index.html)) states the following:

According to the University Policy on Academic Integrity, cheating "occurs when a student avails her/himself of an unfair or disallowed advantage which includes but is not limited to:

- Theft of or unauthorized access to an exam, answer key or other graded work from previous course offerings.
- Use of an alternate, stand-in or proxy during an examination.
- Copying from the examination or work of another person or source.
- Submission or use of falsified data.
- Using false statements to obtain additional time or other accommodation.
- Falsification of academic credentials."

This policy applies, in all respects, to this course.

Carnegie Mellon University's Policy on Plagiarism ([http://www.cmu.edu/academic-integrity/plagiarism/index.html](http://www.cmu.edu/academic-integrity/plagiarism/index.html)) states the following:

According to the University Policy on Academic Integrity, plagiarism "is defined as the use of work or concepts contributed by other individuals without proper attribution or citation. Unique ideas or materials taken from another source for either written or oral use must be fully acknowledged in academic work to be graded. Examples of sources expected to be referenced include but are not limited to:

- Text, either written or spoken, quoted directly or paraphrased.
- Graphic elements.
- Passages of music, existing either as sound or as notation.
- Mathematical proofs.
- Scientific data.
• Concepts or material derived from the work, published or unpublished, of another person."

This policy applies, in all respects, to this course.

Carnegie Mellon University’s Policy on Unauthorized Assistance (http://www.cmu.edu/academic-integrity/collaboration/index.html) states the following:

According to the University Policy on Academic Integrity, unauthorized assistance "refers to the use of sources of support that have not been specifically authorized in this policy statement or by the course instructor(s) in the completion of academic work to be graded. Such sources of support may include but are not limited to advice or help provided by another individual, published or unpublished written sources, and electronic sources. Examples of unauthorized assistance include but are not limited to:

• Collaboration on any assignment beyond the standards authorized by this policy statement and the course instructor(s).
• Submission of work completed or edited in whole or in part by another person.
• Supplying or communicating unauthorized information or materials, including graded work and answer keys from previous course offerings, in any way to another student.
• Use of unauthorized information or materials, including graded work and answer keys from previous course offerings.
• Use of unauthorized devices.
• Submission for credit of previously completed graded work in a second course without first obtaining permission from the instructor(s) of the second course. In the case of concurrent courses, permission to submit the same work for credit in two courses must be obtained from the instructors of both courses."

This policy applies, in all respects, to this course.

Carnegie Mellon University’s Policy on Research Misconduct (http://www.cmu.edu/academic-integrity/research/index.html) states the following:

According to the University Policy For Handling Alleged Misconduct In Research, “Carnegie Mellon University is responsible for the integrity of research conducted at the university. As a community of scholars, in which truth and integrity are fundamental, the university must establish procedures for the investigation of allegations of misconduct of research with due care to protect the rights of those accused, those making the allegations, and the university. Furthermore, federal regulations require the university to have explicit procedures for addressing incidents in which there are allegations of misconduct in research.”

The policy goes on to note that “misconduct means:
• fabrication, falsification, plagiarism, or other serious deviation from accepted practices in proposing, carrying out, or reporting results from research;

• material failure to comply with Federal requirements for the protection of researchers, human subjects, or the public or for ensuring the welfare of laboratory animals; or

• failure to meet other material legal requirements governing research.”

“To be deemed misconduct for the purposes of this policy, a ‘material failure to comply with Federal requirements’ or a ‘failure to meet other material legal requirements’ must be intentional or grossly negligent.”

To become familiar with the expectations around the responsible conduct of research, please review the guidelines for Research Ethics published by the Office of Research Integrity and Compliance.

This policy applies, in all respects, to this course.