CSE 394: Algorithms and Data Structures for Digital Culture, Spring 2012

“The principle goal of education is to create men who are capable of doing new things, not simply of repeating what other generations have done — men who are creative, inventive and discoverers.” Jean Piaget

1 Basics
Instructor: Prof. Hari Sundaram,
398, Brickyard Building.
Email: hari.sundaram@asu.edu
Home page: http://ame.asu.edu/faculty/hs
Phone: 480-965-2686

TA: Jeffrey Boyd,
390, Brickyard building.
Email: Jeffrey.Boyd@asu.edu

Class Schedule
Mondays and Wednesdays, 1:30-2:45pm, Stauffer B 123.

Office Hours
Instructor: Wednesdays, 3:00-4:00pm, Stauffer B 122.
TA: Mondays, 3:00-4:00pm, Stauffer B 122.
Individual assistance is always available by appointment. I look forward to seeing you during office hours; stop in.

2 Course Description
Today, computing lies at the foundation of many creative projects outside of computer science. The processing project (http://processing.org/) started at the MIT media lab, for example, is one compelling example of how programming has been made accessible to non-CS majors.

Search engines, including Google, have altered our lives over the past ten years. Consider the sequence of operations when you enter a search term like “vacation” on Google. In milliseconds, Google, furnishes web-sites, it considers relevant to the query. Advertisements accompany — typically on a sidebar, or on the top of the page — the websites presented to the user. Algorithms and structures that store data are central characters in this play. Google uses a plethora of data structures, including graphs, to store data about the web. Then, using an elegant algorithm, it ranks the web pages most relevant to the query. The advertisements that are shown are a separate side-show: another algorithm matches the bids made by advertisers on the keyword “vacation” against the slots available to advertise. If you were a new jazz musician, you would like your website to come up, when people search for jazz music. Now, people rarely go beyond the first few pages when they search for something. How would you ensure that your website is highly ranked? Since many consumers will first use search engines to find media, knowledge of algorithms used in retrieval, including web-search, is therefore important.

The aim of this class is at students enrolled in the new digital culture major as well as CS students interested in creative and artistic outcomes. The goal of the course is two-fold: impart knowledge of key
concepts in data structures and algorithms and apply these concepts to real world problems including retrieval.

How will students benefit? The target digital culture major is one with some programming experience (e.g. Processing, Max/MSP). Through this class, you will introduced to “computational thinking”—you will acquire a set of strategies to solve complex problems, and to be prepared to recognize problems that have no simple solution. When you encounter the latter, you will be prepared to approximate, to develop heuristics to solve the problem. Intractable problems, or “hard-to-solve” problems, are often present when we are dealing with enormous data scales. As an example, imagine that you are trying to develop a creative response— an interactive visualization—to all the tweets containing the word “#economy.” Developing an interactive visualization that analyzes, and responds in real-time to billions of daily tweets will be impossible; you will need to develop heuristics first to analyze the data and then to visualize the result. For the CS student, you will be acquainted with key concepts in algorithms and supporting data structures. The focus in this class is a creative outcome — you must not only learn a fundamental idea, but you will need to apply it towards a creative outcome.

![Graph Image]

**Figure 1**: What is the shortest path between nodes s and t? Notice that the graph used here, where nodes represent cities and where edges represent connectivity between a pair of cities, is just a useful abstraction to represent the problem.

### 3 Course Goals and Objectives

Some of the specific skills you will obtain in this course are listed here. All of these will help you to become a critical observer of as well as a participant in digital culture.

**Computational Thinking**: The components of this objective include your knowledge of the:

1. Key algorithms and data structures
2. Ability to evaluate computational strategies and choose an appropriate strategy as part of your solution

I will evaluate your progress toward this goal based on your ability to identify algorithms and data structures that “best” solve the programming assignments. There can be many criteria for optimality, including running time, and algorithm elegance.
Critical thinking: The components of this objective will include your increased tendency to:

1. Refuse to accept assertions based solely on authority
2. Be open to changing your own beliefs based on new information
3. Critically evaluate generalizations
4. Question the evidence and logic behind assertions
5. Express your thoughts clearly when speaking and writing

I will evaluate your progress toward this goal based on your choice of algorithms and data structures used in the assignment.

Creativity: The components of this objective will include your increased tendency to:

1. Apply knowledge of algorithms and data structures, to develop applications. Applications can involve entirely new visual interactions, as well as applications that use existing social media API’s to develop new interactions with existing networks. Applications can include, for example, a new social networking platform, a new way to visualize images from Flickr, a new interface to Twitter, or Facebook, mashups between geo-tagged tweets and Google maps, so that one can search, sort, summarize data for new services.

I will evaluate your progress toward this goal based on the quality of the application. I expect all students to use Processing to develop interactive visual applications.

4 Teaching Philosophy

I appreciate your presence in my class; I recognize that you had a choice in what to study and that you are paying for your time in my class. My job is to facilitate critical thinking on social media. While I can do my best to engage you, I shall not hound you, if you are not here to learn. Why? In my experience, I cannot force students to critically engage with the material, when they are mentally unprepared for engagement.

To teach is, in a sense, to perform. While I shall use humor, compelling narratives and visuals to communicate important ideas, the goal is to engage, not to entertain. While I can come prepared to teach, the choice to learn is yours alone. But, I hope you come to class hungry to learn.

5 Topics

“I can’t understand why people are frightened of new ideas. I’m frightened of the old ones.” John Cage

In each class, we shall discuss algorithms and data structures and connect them to real world problems. How can you best succeed in this course? Engage in material presented in the class. The purpose of the studio discussion is to amplify, explain, and demonstrate key algorithms connected to real world problems. They complement the material in the recommended texts for this class.

You can contribute in many ways. You may, for example, offer insights or observations, ask questions, politely disagree with me or another student (i.e. you can disagree with an idea without discrediting the speaker), help others to articulate their point of view, or follow up on a fellow student’s comments with further insights or evidence. There are usually many valid ways of looking at any issue we study, so, again, don’t worry about being “wrong” — you may be bringing a whole new level of insight into the discussion!
5.1 Textbooks and Software

2. Algorithm Design Jon Kleinberg and Éva Tardos
4. Networks, Crowds, and Markets: Reasoning About a Highly Connected World by David Easley and Jon Kleinberg

I shall use the first two books as the principal reference books for this class. Neither is required, but the first book is highly recommended as a bookshelf reference.

5.2 Class Schedule

<table>
<thead>
<tr>
<th>Dates</th>
<th>Topic</th>
<th>Supplemental reading</th>
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</thead>
<tbody>
<tr>
<td>Jan. 9th / 12th</td>
<td>Introduction; Sorting</td>
<td>Chap. 2, CLRS</td>
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<tr>
<td>Jan. 18th (16th is MLK day)</td>
<td>Stable Matching; Five key computing problems</td>
<td>Chap 1, K&amp;T</td>
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<tr>
<td>Jan. 23rd / 25th</td>
<td>Growth of functions / Tractability</td>
<td>Chap. 3, CLRS, Chap. 2.1-2.4 T&amp;K</td>
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<tr>
<td>Jan. 30th / Feb. 1st</td>
<td>Elementary data structures (lists, stacks, queues, trees) and graphs</td>
<td>Chap 10 CLRS, Chap 22 CLRS, Chap. 3 K &amp; T</td>
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<td>Feb. 6th / 8th</td>
<td>Greedy Algorithms</td>
<td>Chap 16, CLRS, Chap. 4.1-4.5 (skip 4.3) T &amp; K</td>
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<tr>
<td>Feb. 13th / 15th</td>
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<tr>
<td>Feb. 20th / 22nd</td>
<td>Divide and Conquer</td>
<td>Chap. 4, CLRS, Chap. 5.1-5.4 T &amp; K</td>
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<td>Feb. 27th / 29th</td>
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<tr>
<td>Mar. 5th / 7th</td>
<td>Dynamic Programming</td>
<td>Chap. 15, CLRS, Chap. 6.1-6.9 (skip 6.5), T &amp; K</td>
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<td>Mar. 12th / 14th</td>
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<td>Mar. 19th / 21st</td>
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<td>Spring Break</td>
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<tr>
<td>Mar. 26th / Mar. 28th</td>
<td>Network Flow</td>
<td>Chap. 26, CLRS, Chap. 7, T &amp; K</td>
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<td>Apr. 2nd / 4th</td>
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<tr>
<td>Apr. 9th / 11th</td>
<td>Web search, Search markets</td>
<td>Chap. 10, 13 and 14, Easley and Kleinberg</td>
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<td>Apr. 16th / 18th</td>
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<tr>
<td>Apr. 20th</td>
<td>DC Showcase</td>
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<tr>
<td>Apr. 23rd</td>
<td>Review of Topics</td>
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6 Assignments

I would like to foster critical thinking and creativity — so there are no exams in this class. Instead, there are four programming assignments and one final project. Each programming project is an individual exercise, while the project can have at most two people in each group. All assignments and the final project must be completed within the Processing environment. This will allow you to take advantage of existing libraries and features that come part of the package, to develop complex creative outcomes.

The weight for each programming assignment is 15% and the weight for the final project is 30%.

<table>
<thead>
<tr>
<th>Name</th>
<th>Date Assigned</th>
<th>Date Due</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignment 1</td>
<td>Feb 1st</td>
<td>Feb. 15th</td>
<td>15%</td>
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<tr>
<td>Assignment 2</td>
<td>Feb. 15th</td>
<td>Feb. 29th</td>
<td>15%</td>
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<tr>
<td>Assignment 3</td>
<td>Feb. 29th</td>
<td>Mar. 14th</td>
<td>15%</td>
</tr>
<tr>
<td>Assignment 4</td>
<td>Mar. 14th</td>
<td>Mar. 29th</td>
<td>15%</td>
</tr>
<tr>
<td>Final Project</td>
<td>First discussion on Feb. 29th; finalized by Mar. 14th</td>
<td>Apr. 18th</td>
<td>30%</td>
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<tr>
<td>Class Participation</td>
<td></td>
<td></td>
<td>10%</td>
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</tbody>
</table>

There is a public showing of all group projects on Apr. 20th at the end of semester digital culture festival. The project is deliberately open-ended to give you the opportunity to think deeply and then upon an idea that fascinates you. The outcome of your exploration: a working prototype. Applications can involve entirely new social interactions, as well as applications that use existing social media API's to develop new interactions with existing networks. Applications can include, for example, a new social networking platform, a new interface to Twitter, or Facebook, mashups between geo-tagged tweets and Google maps, so that one can search, sort, summarize data for new services.

You will present a demonstration of the application, in class, on April 18th.

For each assignment, as well as the final project, I will evaluate your work in terms of its reasoning — including the methods used to solve the problem — and how you argue for the correctness of the results. Please explain in a 2 page write-up how you approached the problem, any problems that you encountered, how you overcame them. If you need an extra page to explain your reasoning, that is fine. The write-up shall be in 10point font, with 1 inch margins, double-column, and single spaced. Include any references. Append the code in a zipfile. The TA should be able to run the code within the Processing environment without any error.

Send the assignments / project as an email to by the due date to the TA, Jeffrey Boyd: Jeffrey.Boyd@asu.edu.

6.1 Academic Integrity

You are expected to maintain the utmost level of academic integrity in the course. Any violation of the code of academic integrity will be penalized severely.
You are allowed to collaborate on the assignments to the extent of formulating ideas as a group. However, you must develop solutions to each assignment completely on your own, and understand what you are writing. You must also list the names of everyone with whom you discussed the assignment.

Plagiarism deserves special mention. It is an academic violation to copy, to include text from other sources, including online sources, without proper citation. To get a better idea of what constitutes plagiarism, please consult the ASU policy on student obligations: http://provost.asu.edu/academicintegrity/policy. This is a serious violation: evidence of plagiarism, will likely result in failing the course.

7 Attendance and Class Participation

“Eighty percent of success is showing up.” Woody Allen.

You should attend every class. I understand that extenuating circumstances arise that can make this difficult, but please let me know before class if you cannot attend. If circumstances make you miss more than 3 classes during the semester, you may have overextended yourself and you should consider dropping the class. Absenting yourself from this class will negatively affect your grade. For every class missed beyond three, you will lose half a letter grade. If you show up for class with a highly contagious illness (e.g., flu, cold), I will ask you not to attend and it will count as an absence, so do NOT drag yourself out of a sick bed — it won’t do you any good.

I hope you actively participate in this course. I say this because I found it is the best way to engage you in learning the material (and it makes the lectures more fun). I welcome your comments, thoughts, questions, and hope you take an active role in the in class demonstrations. If the class is too quiet, I may call on a student to share his or her thoughts. Please note that if I do so, I am not “picking” on that student. I’m hoping to make the lecture a little more lively and interesting. If you are not prepared, please let me know before class, so we can all avoid feeling uncomfortable.

8 Civil Classroom Behaviors

It is the responsibility of college faculty to create and maintain a civil classroom atmosphere in which members of their classes treat each other with mutual respect. One crucial outcome of this type of atmosphere is the establishment of a classroom in which attention and energy is focused on teaching and learning, rather than on frustration, conflict, and distrust. Students do not like to be taught by teachers who disrespect them, and teachers do not enjoy teaching students whose behavior is disrespectful to them or to their fellow students.

I have always treated my students with dignity, respect, and fairness. I do not play favorites, I do not belittle my students, I show up for my classes on time, and I am always prepared when I arrive for class. I hold all my students in high esteem, regardless of how well they perform in my classes, and I try my best to communicate this to them through both my words and my actions. I do everything in my power to conduct myself in the manner of a professional educator because I realize that I serve as a role model for many of my students who seek digital media as their profession.

Two of my most important duties as a college professor are (1) to give my students a clear idea of the types of behaviors that can interfere with the teaching and learning process in my classroom and (2) to make a sincere effort to decrease or eliminate these behaviors whenever possible. Research in psychology over the past 15 years has identified the following set of student behaviors that can have a detrimental effect upon my ability to teach and your ability to learn. I want you to know what these behaviors are so you will avoid engaging in them. I also want you to know that if you decide to engage in these behaviors, it will be my responsibility to ask you to stop doing them.

- Allowing your cell phone to ring in class or, worse yet, answering it and engaging in a telephone conversation during class.
• Texting during class
• Participating in social networks during class: **if you are present on Facebook or Twitter during class, you are considered absent in class!**
• Talking to your fellow students during class about things that are not related to the official topic of discussion.
• Arriving at class late or leaving class early.
• Packing up your books before the class is over.
• Failing to comprehend and/or follow instructions due to a lack of attention.
• Making distracting noises or movements.
• Sitting in the back of the classroom when there are seats available in the front.
• Behaving as if you are bored by or uninterested in the class material (e.g., slouching in your seat or falling asleep).
• Coming to class unprepared (i.e., without completing the assignment that is due).
• Exhibiting academically dishonest behaviors (e.g., cheating or plagiarizing).
• Intentionally refusing to participate in classroom activities.
• Doing things in class other than what is expected (e.g., surfing the web or doing homework for another class).
• Asking questions that are off the topic or that have already been answered.
• Treating your fellow students or instructor with disrespect (e.g., with insults, sarcastic remarks, or disrespectful facial expressions).

9 Learning Resources
We've all needed help in something at some point in our lives. If you find yourself not understanding the assigned readings, lectures and assignments, please set up an appointment with me. You can drop by during my office hours or arrange a mutually convenient time if you can’t make my office hours.