CS-591, Spring 2018

Challenges in Cyber-Physical Systems

Tuesday & Thursday, 11.00 am - 12.15 pm, CAS B23

Webpage: `http://cs-people.bu.edu/rmancuso/courses/cs591-sp18/`

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This syllabus represents a guideline on the intended pace of the course. As such it is subject to unpredictable yet moderate changes throughout the semester.

1   Course Description

We do not always realize it, but we live surrounded by machines that augment our abilities by shaping the physical world around us at the press of a button. What supports our modern society and ordinary life is a computing infrastructure (cyber-) that is strongly intertwined with the real world (-physical). Cyber-physical systems are the focus of this course. From toasters to defibrillators; from laundry machines to fighter jets; from elevators to a Mars lander. We are going to explore the formidable challenges that arise when the results of computation immediately affect humans and their environment. We will touch on robustness, fault-tolerance and recovery, certification of safety-critical systems, worst-case performance analysis, and challenges in sense-control-actuate loops. At some point we may end up into ethical discussions of the type: "the fact that we can, does it mean we should?".
You will be asked to read and critically judge seminal and/or recent research-level results on Cyber-Physical Systems. You will also be in charge of accomplishing tangible progress on a research-grade project. Reading, understanding and actively participating to the discussion on papers, as well as demonstrating that you have approached a meaningful challenge in CPS, and that you have made serious progress toward a solution will determine your grade for this course. In summary, you will be asked to: read, discuss, present, and build.

Prerequisite(s):

1. CAS CS-210: Programming and basic software/hardware interface concepts.

2. CAS CS-350: Basics of system modeling and performance analysis; understanding of resource scheduling.

3. Please contact the instructor(s) ahead of time if you do not satisfy any of these prerequisites.

Credit Hours: 4

Course Material: *Paper Reading List.* The paper reading list is your best friend for this course. It groups a list of papers that will be explored throughout this course. As we assign speakers to papers, the list will also record which paper was/will be presented by which student. The list will be made available before the semester starts, and you will have a few weeks to propose changes to the list. Changes can include: the order in which we cover topics/papers; the papers to read; the speaker(s) for a certain paper.

Course Objectives: The typical know-how that students are expected to acquire with this course should allow them to:

1. reading a research paper and summarizing its content;
2. critically determining the contribution of a research paper;
3. identifying strengths and weaknesses of a research work;
4. being able to present the results of a refereed publication;
5. sustaining a peer-review discussion about the validity of proposed publications;
6. identifying a research challenge and possible approaches to tackle it;
7. presenting achieved progress on independent research work;
8. independently overcoming obstacles as they present themselves during the research process;

2 Grading

Research is always tough to grade. For this course, expect to be graded according to how much you will prove to be proactive in the way you conduct research. The grade will be determined according to three main factors:

1. How well you have been reading the papers in the reading list and how insightful your contribution has been to the online and in-class discussions.

2. How well you have metabolized the paper assigned to you for in-class presentation.

3. What progress you have made, together with your teammates, on the research project outlined at the beginning of the semester.

There are no midterms, and there is no final. However, given the weight that the project has on the final grade, the midterms will be replaced by two graded project status updates. Instead of the final we will hold a final project presentation session, which may include a demo session.
In many cases, you will be asked to express a feedback on your peers. This has an impact on yours and theirs grade. The ability to promptly follow in-class procedures and deadlines will be accounted.
An instructor is not allowed to give W (withdrawal) grades. One can get such a grade only by dropping this class by the deadline specified by the registrar office for withdrawals with or without a W grade (check the registrar's office calendar for the exact date). Also, an instructor is not allowed to give an I (incomplete) grade except if a student misses completing assignments and/or misses taking tests due to circumstances beyond their control.

Grade Distribution:

Participation to online and in-class paper discussion	25%
Presentation of research papers in class	25%
Project status update #1	10%
Project status update #2	10%
Final project presentation	30%

3   Course Policies

The following is a summary of the main course policies.

- **General**

  - Attending lectures is mandatory and will account for a large portion of the final grade.
  - Students are responsible for all missed work, regardless of the reason for absence. It is also the absentee's responsibility to get all missing slides/materials.
  - Reading the research paper at hand before the corresponding class is mandatory. You are expected to come to class knowing the content of paper for the day. Failure to do so will impact your grade.
  - **There is no justification for lack of progress in your project.** If you expect to have a busy class schedule for the term and you are not sure if you will be able to commit for the project, do not take this course. If your project turns out to be too hard, you will have to prove that you have made an important attempt at solving it.
  - The final project presentation may require more time than the normally allocated time in the official exam matrix. Be ready to arrange additional time for the final presentation session. Even if you do not have to present, you are still being asked to provide a feedback to your colleagues. Hence, you are expected to attend the session(s) entirely.

- **Grades**

  - You will earn the grade that is directly proportional to your performance. Since this course is not based on exercises and quizzes, there is no curve.
  - In general, if you are following the guidelines on how to be on top of the course duties, you will get a high grade for this course.

- **Short Reviews**

  - You will be asked to post a short review for the research paper that will be discussed in class **at least 2 hours before the corresponding class starts**. A template for the review will be provided.
  - You can still post a review after the assigned deadline, but no points will be given for this. In other words, the review deadline is a firm deadline.
  - Online discussion and paper review submission will be performed via Piazza.

- **Project**

- You will be expected to work in team on the course project. The teams will be composed of no less than three members, and no more than four members. Exceptions to this rule can be made, but the significance of the project at hand needs to be clearly supported in this case.
- Project assignment will be performed within the first 2 weeks of the course. Project bidding will be open on the first day of class.
- As your teammates will rely on your help to make progress on the project, it is important that you communicate your intention to drop the course (if any) early enough for them to reorganize the work.
- You will be asked to anonymously rank the performance of your teammates in correspondence of the first and second progress update, and at the time of the final presentation.
- Failure to attend and participate to progress updates and final project presentation will not be excused.

- **In-class Presentations**
  - Each student will be asked to present a research paper from the reading list. Depending on the class size, some of the papers may be presented by more than one student, typically two.
  - The rest of the class is expected to provide anonymous feedback on the presenter.
  - If you are scheduled to present a paper but a conflict arises, changes to the schedule can be made, as long as this is communicated at least three full lectures ahead of time. For instance, if your presentation is on Tue, April 10, the instructor and the class need to be aware of the conflict by the time the lecture on Thu, March 29 has started.
  - A no-show without proper communication will not be excused.

4   Interaction with Course Staff

In the context of this course, there are three main ways to interact with the course staff:

1. Lectures;

2. Office Hours;

3. Piazza Online Platform.

4.1   Lectures

As mentioned above, attendance to lectures and active participation to the in-class discussions is mandatory and they contributes to 25% of the final grade. Attendance may be sampled during the lectures.

The length of each class is about 1 hour and 15 minutes. The first part of the class will be dedicated to the presentation for the paper at hand. For solo presentations, we will allocate 35 minutes. For duo presentations we will allocate 45 minutes.

In the second part of the class, we will run a moderated discussion about the presented paper. During this phase, you can ask questions to the presenter or the audience, respond to outstanding

questions on the paper, or express an opinion on the work. Any contribution is strongly encouraged. The discussion will take about 35 minutes for solo presentations and 25 minutes for duo presentations.

In the last 5 minutes, you will be asked to submit a final recommendation for the paper. Recommendations will be submitted online in class. So you are expected to bring any web-enabled device to class (e.g. a laptop, a smartphone, or a tablet).

4.2   Office Hours

Office hours are meant to answer specific questions about the papers and/or to receive directions on how to progress on your course project. Bear in mind that since you are dealing with research-grade challenges, the instructor does not typically know how to address specific issues about your project. You are also welcomed to share with the course staff your plan for an incoming paper presentation.

4.3   Piazza

In the context of this course, we will use Piazza as the official platform to extend the in-class interaction outside the scheduled lectures and office hours. Students are welcome to establish other ways to interact with each other online outside of Piazza. However, they should expect the instructor to interact only on Piazza posts.

Piazza will be used to post various course resources, including the most up-to-date version of this document, as well as the official paper reading list and presentation schedule. Short paper reviews due before the corresponding class will also have to be posted on Piazza.

On top of that, Piazza will be used to communicate important announcements, post supplemental material, post lengthy answers to questions that were not completely addressed in class, and the like. As such, every student is strongly encouraged to regularly check the official CS-591 Piazza page.

Although constructive opinions about the lectures and the material are welcomed, everyone should make an effort in keeping the discussion on a professional tone and to the point.

4.4   In-class Discussion

A prerequisite for good research is the ability to critically judge someone else's work. During the in-class discussion, you will be asked to express your judgment on the paper at hand, and/or to express/address specific concerns about the work. You can tell that you are doing a poor job during in-class discussions if you are not intervening. Ideally, I would like all the students to participate to all the discussions, but due to time constraints this may not always be possible. Nonetheless, **you should always actively seek your opportunity to intervene**.

If you believe that your question is silly, ask! You will be surprised to know how many other students were wondering about the same thing; if you think that your question has a trivial answer, *ask!* You will be amazed by the depth of the answer; if you think that your question will require a lengthy response, *ask!* The instructor will do his best to provide a sketch of the answer and will use Piazza to answer more in detail; Basically, if you have any question, *ask!*

5   Short Reviews

It is fundamental that you come to class with a clear idea in mind about the content of the paper being discussed. For this reason, you will be asked to submit a short review for the paper being

discussed, before the corresponding class starts. Specifically, **your review should be submitted at least 2 hours before the class starts**.

The submission process will be performed on Piazza, and your review will be visible to everyone, albeit your identity may not. A Piazza thread will be created by the course staff to collect all the reviews for each given paper.

The rough structure of a short review should be:

1. Short summary. One or two paragraphs briefly describing the content of the paper.

2. Points in favor. An itemized list of aspects to the paper that you deem positive.

3. Points against. An itemized list of characteristics of the paper that you did not like.

4. Contribution. A short paragraph that explains why the paper is novel in your opinion.

5. Other comments. A space to provide additional arguments and explanations to support your judgment about the paper.

6. Questions. A non-empty list of questions for the audience or the presenter to be addressed in class.

6 Presentations

At the beginning of the semester, you will be asked to "bid" for a paper. In other words, you will be asked to pick which paper out of the reading list you would like to present during the semester. Papers will be assigned on a FIFO basis. So you are encouraged to promptly choose a paper to present. You will be randomly assigned a paper after the paper bidding phase is over.

You are encouraged to propose changes to the reading list, if there is a paper related to cyber-physical systems that you would like to read and present. These changes need to be proposed early on, to have the rest of the class fully on-board. The class may be polled to commit to a change, especially if proposed late in the semester.

Prepare a presentation targeting 35 minutes for solo presentations. For duo presentations, the two students should extensively interact to prepare a combined presentation of 45 minutes total. Both students are expected to present an even portion of the content. Both students are expected to know the content of the other student's part.

All the presentations should conclude trying to address some of the questions posted by other students in their short reviews for the paper. For this, consider that some questions may be posted as late as 2 hours before the class. The presenter(s) have the freedom to decide which questions they would like to address. Moreover, they can identify some of these questions as a good starting point for the in-class discussion.

Practice your presentation thoroughly! You will be ranked by the other students based on your performance on the stage. The considered criteria are:

1. Clarity of presentation;

2. Understanding of the paper;

3. Level of engagement;

4. Ability to address questions;

5. Overall talk organization;

7   Course Project

The project is a crucial part of this course, and hence it has a heavy weight on the final grade. I expect that you will be able to demonstrate that you have spent some serious time trying to solve the problem at hand.

At the beginning of the semester, we will run a project bidding phase. During this phase, you will be asked to: (1) form a team for your project; and (2) pick an idea and write a short project proposal. The project proposal should state how the project is related to the course and why it is novel. The project proposal is due one week after the end of the paper bidding phase, and it can be as informal as an e-mail CC'd to the course staff and to all the teammates.

During the project bidding phase, you will be given the freedom to select your teammates. You will be randomly assigned teammates if you do not belong to a team by the end of the bidding phase.

The topic of the project is open-ended. Albeit I will provide some ideas and general guidelines to select a project that is a good fit for the class, you are welcomed to propose your own ideas. Each team will work on a different project.

7.1   Project Updates

There will be two project status update presentations.

In the first presentation, you will be asked to: (i) describe the nature of the project being carried out by your team; (ii) describe the main challenges that need to be faced in your project; (iii) detail what preliminary steps you have taken to get started on your project; (iv) comment on any preliminary result you may have; (v) provide an overview of the future intended approach to tackle the challenge at hand; and (vi) define a timeline of the next steps.

In the second presentation, it is expected that you have substantially identified an effective approach to solve the challenge at hand, despite the final results may not be available yet. You are expected to present the positive and negative attempts made to solve the problem at hand. You should provide an overview of the expected results.

You will be asked to express a feedback on your teammates in correspondence of project update presentations.

7.2   Final Project Presentation

The final presentation is the time to showcase your project! Here, the goal is to demonstrate that the original project statement was substantially covered. If the final result is a negative result, you will be asked to detail the reasons that led to the results, and the various unsuccessful attempts made.

You will also be asked to express a feedback on your teammates in correspondence of the final project presentation.

8   Checklist of Course Duties

Here is a summary of what you will be asked to do for this course. Most of these duties are time-critical.

- Form a team to work on your project;

- Identify a project idea/topic, participate to the project bidding phase, and make a proposal to commit to your project;

- Scan the paper reading list and identify which paper you would like to present, then participate to the paper bidding phase to commit to a presentation;

- Before any lecture that involves a paper presentation, read the paper and submit a short review in the appropriate Piazza thread;

- After the class is over, follow the directions of the course staff and submit your evaluation for the speaker(s). As a speaker, you will receive the anonymous feedback submitted by your colleagues.

- Prepare and practice your (or your part) of the assigned paper. Make sure to take a look at the questions submitted by your colleagues in their short reviews;

- Actively participate to the daily in-class discussion and paper evaluation;

- Prepare and practice with your team the three project-related presentations;

- After each project presentation, evaluate your teammates. This evaluation will be used to decide your grade, but it will not be made available, not even in an anonymous form;

- Always check the Piazza page for announcements, updates, and polls.

Please mark the dates for the three project presentations, as well as your paper presentation date on your calendar (and remember them when you make your recess and end-of-semester travel plans!). There will be absolutely no excuse for a no-show to any of these class events. For medical emergencies, you must provide a letter from a doctor, specifying the period of time during which you were unable to attend an exam.

9 Academic Code of Conduct

It is expected that each and every student complies with the directives and regulations provided in the Academic Code of Conduct. The full body of the code is available online at `https://www.bu.edu/academics/policies/academic-conduct-code/`. Hereafter we highlight those portions of the code of which the students should be particularly aware.

9.1 Academic Misconduct

Academic misconduct is conduct by which a student misrepresents his or her academic accomplishments, or impedes other students opportunities of being judged fairly for their academic work. Knowingly allowing others to represent your work as their own is as serious an offense as submitting anothers work as your own.

9.2 Violations of The Code

Violations include, but are not limited to:

- Cheating on examination;

- Plagiarism;

- Misrepresentation or falsification of data presented for surveys, experiments, reports, etc.;

- Theft of an examination;

- Unauthorized communication during examinations;

- Knowingly allowing another student to represent your work as his or her own;

- Forgery, alteration, or knowing misuse of graded examinations, quizzes, grade lists, or official records of documents;

- Theft or destruction of examinations or papers after submission;

- Submitting the same work in more than one course without the consent of instructor;

- Altering or destroying another students work or records, or altering records of any kind;

- Violation of the rules governing teamwork; Unless specifically authorized, the following rules apply to teamwork:

  1. No team member shall intentionally restrict or inhibit another team members access to team meetings, team work-in-progress, or other team activities without the express authorization of the instructor;
  2. All team members shall be held responsible for the content of all teamwork submitted for evaluation as if each team member had individually submitted the entire work product of their team as their own work.

- Failure to sit in a specifically assigned seat during examinations.

- Attempting improperly to influence the award of any credit, grade, or honor.

- Intentionally making false statements to the Academic Conduct Committee or intentionally presenting false information to the committee.

- Failure to comply with the sanctions imposed under the authority of this code.

9.3   Authorship

The student must clearly establish authorship of a work. Referenced work must be clearly documented, cited, and attributed, regardless of media or distribution. Even in the case of work licensed as public domain or Copyleft, (See: http://creativecommons.org/) the student must provide attribution of that work in order to uphold the standards of intent and authorship.

9.4   Declaration

Online submission of, or placing one's name on an exam, assignment, or any course document is a statement of academic honor that the student has not received or given inappropriate assistance in completing it and that the student has complied with the Academic Honesty Policy in that work.

9.5 Consequences

According to the Academic Code of Conduct, sanctions may be imposed on the student that has been deemed in violation of the code. Sanctions may vary depending upon the gravity of the misconduct. For minor violations, any of the instructors may require to: (i) redo a homework assignment; (ii) complete a different assignment than what originally given; assign a grade of zero or "F" for a single assignment or for the course. Major and/or repeated violations can result in official reprimands, disciplinary probation, suspension, or expulsion in agreement with the official code of conduct.

9.6 Personal Takeout

The whole point is: do your best to be a good student. You are here to learn, but in the meantime also to become a better citizen of the world.

10 Tentative Course Outline

The weekly coverage might change to adapt to the progress of the class, and to react to unforeseen circumstances. Hence, the table below may not reflect the latest changes to the course schedule. Please refer to the reading list available on the course webpage for the most up to date course schedule.

Lecture	Unit	Paper/Topic	Presenter	Remarks
Thu 1/18	Cyber-physical Systems	Introduction and Course Overview	Renato	
Tue 1/23	Cyber-physical Systems	The Class of Cyber-physical Systems	Renato	
Thu 1/25	Cyber-Physical Systems	Summary of Challenges in CPS	Renato	Paper Assignments Due
Tue 1/30	System Models	Paper #1	TBA	
Thu 2/01	System Models	Paper #2	TBA	Project Proposals Due
Tue 2/06	System Models	Paper #3	TBA	
Thu 2/08	Security in CPS	Paper #4	TBA	
Tue 2/13	Security in CPS	Paper #5	TBA	
Thu 2/15	Security in CPS	Paper #6	TBA	
Thu 2/22	Security in CPS	Paper #7	TBA	
Thu 2/27	WCET	Paper #8	TBA	
Tue 3/01	**Progress Update**	**Progress Update #1**		
Tue 3/13	WCET	Paper #9	TBA	
Thu 3/15	WCET	Paper #10	TBA	
Tue 3/20	IoT	Paper #11	TBA	
Thu 3/22	Human in the Loop	Paper #12	TBA	
Tue 3/27	Human in the Loop	Paper #13	TBA	
Thu 3/29	Power Management	Paper #14	TBA	
Tue 4/03	Power Management	Paper #15	TBA	
Thu 4/05	Architectures	Paper #16	TBA	
Thu 4/10	**Progress Update**	**Progress Update #2**		
Tue 4/12	Architectures	Paper #17	TBA	
Tue 4/17	RT on Multicore	Paper #18	TBA	
Thu 4/19	RT on Multicore	Paper #19	TBA	
Tue 4/24	RT on Multicore	Paper #20	TBA	
Thu 4/26	Applications	Paper #21	TBA	
Tue 5/01	Applications	Paper #22	TBA	
Tue 5/10	**Progress Update**	**Final Project Presentation**		