ECE 66300 Compiler Code Generation, Optimization and Parallelization  
(a.k.a. Advanced Compilation and Automatic Programming)

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Office Hours: Mondays 11:30-12:30

Course Information  
Spring 2018  
WMF 10:30-11:20  
EE 224  
Credit Hours: 3

https://engineering.purdue.edu/~xqiu/  
https://engineering.purdue.edu/~ee663/

Course Description

This course presents the concepts needed to design and implement production quality code generators for any of the more popular languages and families of computer architecture (including various pipelined, superscalar, and macro-parallel machines). Flow analysis, concurrency detection, loop and irregular code optimization/parallelization, as well as automation of these tasks using program synthesis techniques, are covered in detail. Each student will complete a project implementing a simple optimizer/parallelizer/synthesizer.

Prerequisites

ECE-56500, CS-50200 or ECE-46800 or ECE-573000 (or equivalent); or contact the instructor.

Course Requirements

The achievement of course objectives will be assessed through a combination of problem sets, paper presentation and course project.

Grading: Grades will be assigned as follows:

- 10% — Problem sets
- 20% — Paper presentation
- 70% — Project
  - 3% — Team formed by deadline
  - 10% — 1-page project proposal
  - 7% — Proposal presentation
  - 20% — Project presentation
  - 30% — Project final report

Your course grade will be determined using an absolute scale: 97–100: A+; 91–97: A; 88–91: A-; and continuing down.

Problem sets: There will be 3-4 problem sets covering the core techniques.

Paper presentation: You are expected to present a technique based on a research paper from a list prepared by the instructor.
**Project:** You are expected to learn one particular technique in detail, and use it in a concrete project, giving a theoretical or practical contribution. Projects are expected to be done either individually or in groups of two. Project will hopefully be at the level of a conference publication.

There will be four milestones for the project:

- The first milestone consists simply of informing the instructor who your teammate is, or letting us know if you plan to do an individual project.
- The second milestone is a 1-page project proposal and a short presentation where you explain what you plan to do for your project and why you think it’s a good idea. You should elaborate on the following: what are you proposing to do, why is it interesting or important, what are the expected challenges, how does it relate to the state of the art, what evidence do you have so far to suggest this may work. It is expected that for this milestone you will have already done some work towards the project, so it is advised that you seek help early on if you have questions about the suitability of your intended project.
- The third milestone will be a presentation describing your project; the exact length of the presentations will depend on the number of projects that are submitted.
- Finally, you are expected to submit a final report describing your project. The report should be at least 3 pages in length in SIGPLAN format. The report should read like a short paper, so it should make it clear what you did, why you did it, and what you learned from doing it.

Overall, projects will be judged in terms of quality of execution, originality and scope.

**Class Schedule**

Below is the tentative schedule of this course, and a rough estimate of how long we will spend on each.

<table>
<thead>
<tr>
<th>Component</th>
<th>Topics</th>
<th>#Week</th>
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<tbody>
<tr>
<td>Program Verification and Synthesis</td>
<td>Intro to logic, FOL, compactness, Gödel’s theorems, decidability, RE, the Bernays-Shönfinkel-Ramsey class</td>
<td>1</td>
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<tr>
<td></td>
<td>Theories, decision procedures for various theories, Nelson-Oppen theorem, quantifier elimination, SMT</td>
<td>1</td>
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<td>Floyd-Hoare verification, Hoare rules, inductive invariants, termination</td>
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<td></td>
<td>Inductive synthesis, explicit search, CEGIS</td>
<td>1</td>
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<tr>
<td>Static Analysis</td>
<td>Abstract interpretation, Galois connections, numerical domains</td>
<td>1</td>
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<tr>
<td></td>
<td>Invariant synthesis, widening and narrowing, Craig’s interpolation</td>
<td>1</td>
</tr>
<tr>
<td>Reactive Programs</td>
<td>Intro to automata theory, MSO, some finite model theory, MONA</td>
<td>1</td>
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<tr>
<td></td>
<td>Infinite words, LTL, Büchi automata, Vardi-Wolper theorem</td>
<td>1</td>
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<tr>
<td></td>
<td>Reactive synthesis, Büchi games, Pnueli-Rosner theorem, GR(1) games</td>
<td>1</td>
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<tr>
<td>Project proposal</td>
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<tr>
<td>Paper presentation</td>
<td></td>
<td>3</td>
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<tr>
<td>Project presentation</td>
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<td>2</td>
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Policies

Academic Dishonesty

“As a boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do. Accountable together - we are Purdue.” – Purdu Honors Pledge

We hope (and assume) that you are all honest and have no intentions of cheating. Cheating ruins the experience for everyone and we will pursue appropriate penalties if we catch someone cheating. Please don't -- it’s not worth it, both for you and for us. You can find Purdue’s student guide for academic integrity at https://www.purdue.edu/odos/academic-integrity/.

If we do catch someone cheating for the first time, the following penalties will be applied:
- On a midterm exam: zero for the exam.
- On the final exam: failure in the course.
- On a homework: zero on the assignment. Moreover, we will subtract 10% from your final average in the course, or reduce your letter grade by one category (e.g., B to B-), whichever results in the lower grade.

For second cheating offense of any kind, you will fail this course.

Attendance

You are expected to be present for every meeting of the classes in which they are enrolled. When conflicts or absences can be anticipated, such as for many University sponsored activities and religious observations, you should inform the instructor of the situation as far in advance as possible. For unanticipated or emergency absences when advance notification to an instructor is not possible, you should contact the instructor as soon as possible by email. If you are unable to do so, or in cases of bereavement, contact the Office of the Dean of Students (ODOS). If you notice major problems with our schedule (e.g. our midterm conflicts with an exam in another course that many of you are taking), please tell us promptly so that we have the best chance to fix it. If you have a disability or other special circumstance which may require special accommodations, please speak to us.

CAPS Information

Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at (765)494-6995 and http://www.purdue.edu/caps/ during and after hours, on weekends and holidays, or through its counselors physically located in the Purdue University Student Health Center (PUSH) during business hours.

Disclaimer

This syllabus is subject to change.
EMERGENCY PREPAREDNESS LECTURE

1. Prior to the first day of class, obtain a copy of the building emergency plan for each building in which you will be teaching. Note the evacuation route and assembly area, as well as the shelter in place locations. BEPs are located on the Emergency Preparedness website http://www.purdue.edu/ehps/emergency_preparedness/

2. On the first day of class, the following information is required to be presented to students:

As we begin this semester I want to take a few minutes and discuss emergency preparedness. Purdue University is a very safe campus and there is a low probability that a serious incident will occur here at Purdue. However, just as we receive a “safety briefing” each time we get on an aircraft, we want to emphasize our emergency procedures for evacuation and shelter in place incidents. Our preparedness will be critical IF an unexpected event occurs!

Emergency preparedness is your personal responsibility. Purdue University is actively preparing for natural disasters or human-caused incidents with the ultimate goal of maintaining a safe and secure campus. Let’s review the following procedures:

• For any emergency call 911.
• There are nearly 300 Emergency Telephone Systems throughout campus that connect directly to the Purdue Police Department (PUPD). If you feel threatened or need help, push the button and you will be connected to the PUPD.
• If we hear a fire alarm we will immediately evacuate the building and proceed to_______________ (location).
  ° **Do not use the elevator.**
  ° Go over evacuation route...see specific Building Emergency Plan.
• If we are notified of a Shelter in Place requirement for a tornado warning we will shelter in the lowest level of this building away from windows and doors. Our preferred location is ________________.
• If we are notified of a Shelter in Place requirement for a hazardous materials release we will shelter in our classroom shutting any open doors and windows.
• If we are notified of a Shelter in Place requirement for an active threat such as a shooting we will shelter in a room that is securable preferably without windows. Our preferred location is ________________.
  **(NOTE: Each building will have different evacuation & shelter locations. The specific Building Emergency Plan will provide specific locations and procedures)**

Attached to the syllabus is an “Emergency Preparedness for Classrooms” sheet that provides additional preparedness information. Please review the sheet and the Emergency Preparedness website for additional emergency preparedness information.
EMERGENCY PREPAREDNESS SYLLABUS ATTACHMENT

EMERGENCY NOTIFICATION PROCEDURES are based on a simple concept – if you hear a fire alarm inside, proceed outside. If you hear a siren outside, proceed inside.

• **Indoor Fire Alarms** mean to stop class or research and immediately **evacuate** the building.
  - Proceed to your Emergency Assembly Area away from building doors. **Remain outside** until police, fire, or other emergency response personnel provide additional guidance or tell you it is safe to leave.

• **All Hazards Outdoor Emergency Warning Sirens** mean to immediately seek shelter (**Shelter in Place**) in a safe location within the closest building.
  - “Shelter in place” means seeking immediate shelter inside a building or University residence. This course of action may need to be taken during a tornado, an active threat including a shooting or release of hazardous materials in the outside air. Once safely inside, find out more details about the emergency*. **Remain in place** until police, fire, or other emergency response personnel provide additional guidance or tell you it is safe to leave.

*In both cases, you should seek additional clarifying information by all means possible...Purdue Emergency Status page, text message, Twitter, Desktop Alert, Albertus Beacon, digital signs, email alert, TV, radio, etc....review the Purdue Emergency Warning Notification System multi-communication layers at http://www.purdue.edu/ehps/emergency_preparedness/warning-system.html

EMERGENCY RESPONSE PROCEDURES:

• Review the **Emergency Procedures Guidelines**
  https://www.purdue.edu/emergency_preparedness/flipchart/index.html

• Review the **Building Emergency Plan** (available on the Emergency Preparedness website or from the building deputy) for:
  - evacuation routes, exit points, and emergency assembly area
  - when and how to evacuate the building.
  - shelter in place procedures and locations
  - additional building specific procedures and requirements.

EMERGENCY PREPAREDNESS AWARENESS VIDEOS

• "**Run. Hide. Fight.®**" is a 6-minute active shooter awareness video that illustrates what to look for and how to prepare and react to this type of incident. See: https://www.youtube.com/watch?v=5mzI_5aj4Vs (Link is also located on the EP website)

MORE INFORMATION
Reference the Emergency Preparedness web site for additional information:
https://www.purdue.edu/ehps/emergency_preparedness/