# CS680: Compiler Optimization for High Performance Computing

August 2016

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| **Instructor:** | Bin Ren | **Time:** | M/W 3:30 – 4:50pm |
| **Email:** | bren[at-sign]wm.edu | **Place:** | Tucker Hall 220 |
| **Office:** | McGlothlin-Street Hall, 116 | | |

**Course Page:**
This course is managed by Blackboard system, and please check periodically for updates.

**Office Hours:**
M/W 5:00 – 6:00pm (After class) or by appointment.

**Important Date:**
add/drop deadline: Sept. 2; withdraw deadline: Oct. 21; final exam: Dec. 12 9:00-12:00

**Course Description:**
This topic course will explore the cutting edge research of improving both the performance and productivity by leveraging compiler optimization techniques in high performance computing area. First, it will introduce the basic and important notions in this area, such as compiler analysis, code transformation, code optimization, instruction parallelism, multicore parallelism, cache management, modern parallel architectures, programming models and so on. Second, students need to present and criticize related papers from the course paper list given by the lecturer. These papers are either classic research work or from leading conferences in this field recently. Finally, all students are required to finish a course project, write a related report, present their project and take a final exam. The ultimate goal of this class is to prepare students with the necessary knowledge of conducting graduate level research in this area.

**Prerequisites:**
There is no specific prerequisite course for this research topic class, however, it will be helpful if you have a good understanding of basic/undergraduate level compiler, C programming and computer architecture. Please feel free to talk to the instructor, if you are not sure whether you have enough background knowledge to take this class.

**Tentative Course Outline:**
- Introduction to compiler
- Control flow analysis
- Data flow analysis
- Compiler optimizations
- Data locality analysis
- Vectorization
- GPU programming
- Paper presentations
- Project presentations

**Reference Books:**
   **NOTE:** All textbooks are optional. All required contents are covered by our slides and papers.

- Engineering a Compiler, Keith D. Cooper and Linda Torczon, 2nd Edition
- Optimizing Compilers for Modern Architectures, Randy Allen and Ken Kennedy, 1st Edition
- Compilers: Principles, Techniques, and Tools, Alfred V. Aho, Monica S. Lam, Ravi Sethi, and Jeffrey D. Ullman, 2nd Edition

**Grading Policy:**
- Class participation: 10%
- Research paper presentation: 20%
- Paper critiques and homeworks: 20%
- Research project: 30% (Proposal: 10%, Report: 10%, Presentation: 10%)
- Final exam: 20%
- Extra credit: 10%

**Final grades:**
- 95% - 110% A;
- 90% - 94% A−;
- 85% - 89% B+;
- 80% - 84% B;
- 75% - 79% B−;
- 70% - 74% C+, etc

**Class participation:**
   For regular lectures, class participation is checked by random pop quizzes; and for presentations, all listeners are required to submit a brief evaluation to summarize the key points learned from the presentation, and problems with the presenting.

**Research paper presentation:**
   Each student is expected to present two papers from the paper list provided by the instructor. During the presentation, please be prepared to answer any questions from the instructor and other students. Each presentation should last around 45 minutes: 15 minutes for background and introduction, 20 minutes for design and implementation, 10 minutes for evaluation, conclusion and related works. Before presenting, the presenter is allowed to schedule a dry run with the instructor to improve her/his slides and presentation skills.

**Paper critiques and homework:**
   There are two homework assignments related to the regular lectures, and each one takes up 4% of the total credit. There are four paper critiques for each student, and each one takes up 3% of the total credit. Please follow this format to write your critiques:

- Summary: overall topic, main contributions, evaluation results
- Overall pros. and cons.: novelty, significance, organization, writing style, technical soundness
- Detailed concerns and questions

These critiques are going to be discussed intensively after each presentation.

**Research project:**

Each student is expected to perform a semester-long research project. All projects need to be approved by the instructor. Please contact the instructor early to brainstorm potential project ideas. For each project, students are required to submit a proposal with at least two pages, and a final report with at least eight pages, which are in IEEE format. At the end of the semester, students need to present their report in class.

**Final exam:**

All contents in the final exam are covered by our slides and papers. The instructor will highlight the scope of final exam in the last class.

**Extra credit:**

An extra credit opportunity is available for students who would like to improve their final grade of this class.

**Late Policy:**

The homeworks and project related codes/documents are due by 11:59 pm on the due day. No exceptions will be made to this deadline: if you submit at 12:00 am, your submission will be considered to be late. The time stamp on the electronic submission will be used to determine the submission time. A reduction of 10% per day will be applied to late submissions. Submissions more than three days late will not be accepted. Paper presentation slides and critiques are due immediately before the presentation. Late submissions will not be accepted.

**Academic Accommodations:**

It is the policy of The College of William and Mary to accommodate students with disabilities and qualifying diagnosed conditions in accordance with federal and state laws. Any student who feels s/he may need an accommodation based on the impact of a learning, psychiatric, physical, or chronic health diagnosis should contact Student Accessibility Services staff at 757-221-2509 or at sas@wm.edu to determine if accommodations are warranted and to obtain an official letter of accommodation.

**Academic Honesty:**

Students are required to follow the Honor System of the College of William and Mary.