Instructor
James C. Spall (Research Professor, Dept. of Applied Math and Statistics; Principal Professional Staff, JHU/APL), 443-778-4960 (APL); james.spall@jhuapl.edu; fax 443-778-6661. Web site available at www.mts.jhu.edu/ams/people/joint_research.html.

Homewood Office: Room 200, Whitehead Hall; office hours by appointment at Homewood or APL or drop in from 3:30PM–7:00PM on Tuesdays at the Homewood Campus.

Meeting time/place
Tuesdays, 2:00PM–3:20PM, 1 February 2005–Mid-May 2005 (14 class sessions). Room 303 (AMS Library), Whitehead Hall.

Summary
The focus of this roundtable-format course will be stochastic modeling, especially as related to stochastic search and optimization and Monte Carlo methods in simulation and computation. Methods and algorithms in these areas have tremendous importance in the world at large. It is the aim of this roundtable to explore at a graduate level several aspects of relevant methods and algorithms. Typically, each session will cover an important paper from the literature. In each class session, the instructor, other faculty member, or a student will have the responsibility to lead the discussion. Each student taking the course for credit will be responsible for leading several discussions over the duration of the semester. Discussion leaders will be responsible for preparing a conference-quality presentation as a vehicle for sparking a dialogue about the subject at hand. (Aside from studying the technical material in the course, it is also intended that the roundtable provide a collegial setting for developing presentation skills.) Because course participants will be collectively exploring an advanced topic, the discussion leader need not have a complete grasp of every aspect of the topic being studied; coming to class with pertinent questions and issues for discussion is encouraged as a vehicle for learning.

Prerequisites
Matrix theory and a graduate course in probability and statistics. Experience in data analysis and algorithms will be helpful. Successful completion of 550.760 (spring 2004) or 550.790 (fall 2004) is a sufficient, but not necessary, condition for the course.
Textbook

None. Journal and other readings will be used throughout the course; students will generally be responsible for obtaining copies of the readings online or at the Eisenhower Library. The book *Introduction to Stochastic Search and Optimization* by J. C. Spall (Wiley, 2003) (ISBN: 0-471-33052-3; www.jhuapl.edu/ISSO) is on reserve in the Eisenhower Library. This book may be helpful in “getting up to speed” or reviewing certain topics in preparation for giving a presentation.

Expectations and Grading

The grade of this course is assigned according to the proportions:

1. Presentations (oral delivery and hand-in components): 70%
2. Class participation: 10%
3. Final report: 20%

Each of these components is discussed below. As this is an upper-level course based on collaborative study, grading is not intended to be punitive. I would be happy to give everyone an “A” if possible, but this is not automatic! Students making an honest effort and contributing to the best of their ability should do well in the course.

1. Presentations. For the presentations component of the grade, each student will be evaluated based on the quality and insight of the presentations they are responsible for giving. It is not necessary to prepare “fancy” presentations (i.e., fancy graphics or animations), but I will expect students to adhere to basic principles of effective technical presentations as discussed in class session 1. In preparing a presentation, students are free to discuss among themselves (or others) questions or issues relevant to the paper(s) being reviewed. The presentations must include some overhead (or PowerPoint) slides, and may also include some whiteboard presentation. Students should provide a paper copy of the slides to the instructor and other students. Students may (if desired) provide a *supplementary* one- or two-page summary of the paper; this is not required (the emphasis should be on the presentation).

A tentative schedule is given in the table below. Because of the informal nature of the course, this schedule may adjusted if it is found that more time will be needed to adequately address a specific topic. There is also the possibility of introducing a topic not shown on the current schedule.

While this class is directed at students who are (or will be) carrying out research, the students are not expected to carry out their own research on the ideas being reviewed. For each presentation, it is sufficient to do a thorough review of the paper. In particular, for each presentation, the following questions/issues should be addressed:

1. Basic description of the problem(s) being addressed in the paper, keeping in mind the prerequisites of the course. It is very important that this be done for non-specialists (which may require some thought on the student’s part, as the paper itself may be written for specialists).
2. Summary of the main contribution of the author(s) of the paper (i.e., the “breakthrough” if relevant).
3. Positives and negatives of the basic algorithms, methods, etc.
4. If relevant, connection of the paper to work the student may be aware of in the AMS Department, including by the student him/herself.
5. Summary of numerical results of the author(s) and perhaps others (including any personal experience the student may have, if relevant).
6. The presentation may include published insights and conclusions of others, as published after the paper being reviewed was published (science citation indices may be useful for this; e.g., http://isi02.isiknowledge.com/portal.cgi). All standards of proper attribution and scholarship must apply if the student uses such insights (i.e., provide specific citation information as relevant, including to results appearing only on the Internet).
7. As the course proceeds, make connections (as relevant) to topics that were discussed in earlier weeks.
8. Any other relevant points.

2. Class participation. This is a roundtable course. As such, I expect students other than the discussion leader to at least briefly review the assigned paper prior to class and to be prepared to pose questions or raise issues. The roundtable is intended to be an informal forum for discussion, and will work best if people other than the discussion leader contribute. The discussion leader is also encouraged to raise pertinent questions and issues for discussion, including questions or points of confusion that he/she may have. Do not assume the instructor knows much about many of the papers being studied—he doesn’t and he has as much (or more) to learn as the students about certain topics!

3. Final report. All students will have to write a relatively short final report, summarizing the main points of the weekly discussions and answering several questions that will be posed by the instructor (these questions will be based on the weekly discussions). The report will (tentatively) be on the order of five or six pages; each student will be given one week to write this report. Unlike the weekly discussions, students must work independently on their final reports (i.e., treating them as a take-home exam). More information will be provided near the end of the course.

Tentative Class Schedule (May be adapted as circumstances warrant)

<table>
<thead>
<tr>
<th>Week</th>
<th>Topics</th>
<th>Discussion leader</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(1) Giving technical presentations. (2) Comparative analysis of several algorithms.</td>
<td>Instructor</td>
</tr>
<tr>
<td>2</td>
<td>Stopping an algorithm—when is enough, enough? Yin (1988).</td>
<td>Student</td>
</tr>
<tr>
<td>4</td>
<td>No free lunch theorems. Wolpert and Macready (1997).</td>
<td>Student</td>
</tr>
<tr>
<td>5</td>
<td>Classification and pattern recognition. Cover and Hart (1967) and/or Stone (1977).</td>
<td>Student</td>
</tr>
<tr>
<td>6</td>
<td>Stochastic approximation. Robbins and Monro (1951) and/or Kiefer and Wolfowitz (1952).</td>
<td>Student</td>
</tr>
<tr>
<td>7</td>
<td>Simultaneous perturbation stochastic approximation. Spall (1992) and/or Spall (2000).</td>
<td>Student</td>
</tr>
<tr>
<td>8</td>
<td>Simulated annealing. Kirkpatrick et al. (1983).</td>
<td>Student</td>
</tr>
<tr>
<td>9</td>
<td>Genetic algorithms and convergence. Rudolph (1994).</td>
<td>Instructor</td>
</tr>
<tr>
<td>Page</td>
<td>Text</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Ant colony optimization. Dorigo et al. (1996) and/or Dorigo and Di Caro (1999).</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Expectation–Maximization (EM). Dempster et al. (1977) and/or Wu (1983).</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Automatic differentiation. Paper TBD. (<a href="http://www.autodiff.org">http://www.autodiff.org</a>)</td>
<td></td>
</tr>
</tbody>
</table>

References


