New Course Request SEP 0 2 2009 **Indiana University** Indianapolis Campus

Check Appropriate Boxes: Undergraduate credit ☐ Graduate credit ☒ Professional credit ☐ 98

1. School/Division Science, Biostatistics 2. Academic Subject Code BIOS
3. Course Number S621 (must be cleared with University Enrollment Services) 4. Instructor J. Harezlak
5. Course Title Advanced Statistical Computing

   Recommended Abbreviation (Optional) ______

   (Limited to 32 Characters including spaces)

6. First time this course is to be offered (Semester/Year): Fall 2009
7. Credit Hours: Fixed at 3.0 or Variable from ______ to ______
8. Is this course to be graded S-F (only)? Yes ___ No X
9. Is variable title approval being requested? Yes ___ No X
10. Course description (not to exceed 50 words) for Bulletin publication: P: STAT 52100; experience with R/Splus programming. This course covers selected computational techniques useful in advanced statistical applications and statistical research, such as methods for solving linear equations, numerical optimization, numerical integration, Bayesian methods, bootstrap methods, and stochastic search algorithms.
11. Lecture Contact Hours: Fixed at 3 or Variable from ______ to ______
12. Non-Lecture Contact Hours: Fixed at ______ or Variable from ______ to ______
13. Estimated enrollment: 5-10 of which 100 percent are expected to be graduate students.
14. Frequency of scheduling TBD (new program) Will this course be required for majors? Yes
15. Justification for new course: Required course for new biostatistics Ph.D. program
16. Are the necessary reading materials currently available in the appropriate library? Yes
17. Please append a complete outline of the proposed course, and indicate instructor (if known), textbooks, and other materials.
18. If this course overlaps with existing courses, please explain with which courses it overlaps and whether this overlap is necessary, desirable, or unimportant.
19. A copy of every new course proposal must be submitted to departments, schools, or divisions in which there may be overlap of the new course with existing courses or areas of strong concern, with instructions that they send comments directly to the originating Curriculum Committee. Please append a list of departments, schools, or divisions thus consulted.

Submitted by:

[signature] Date 3/17/09

Department Chairman/Division Director

______ Date ______

Dean of Graduate School (when required)

[signature] APPROVED JUN 8/09 BS

IUPUI Curriculum Sub-Committee 2009

Approved by:

[signature] Date 4/17/2009

Dean

[signature] Date 8/10/09

Chancellor/Vice-President

______ Date ______

University Enrollment Services

After School/Division approval, forward the last copy (without attachments) to University Enrollment Services for initial processing, and the remaining four copies and attachments to the Campus Chancellor or Vice-President.

UPS 724

University Enrollment Services Final—White; Chancellor/Vice-President—Blue; School/Division—Yellow; Department/Division—Pink; University Enrollment Services Advance—White

BIOS S621 (3 cr.)
Advanced Statistical Computing

Syllabus

A. Instructors

Jarosław Harezlak, PhD, Assistant Professor
Samiran Ghosh, PhD, Assistant Professor
Xiaochun Li, PhD, Associate Professor

Contact information:
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B. Course description:
This course will cover selected computational techniques useful in advanced statistical applications and statistical research. Topics to be covered include methods for solving linear equations, numerical optimization, numerical integration, Bayesian methods, bootstrap methods and stochastic search algorithms. The course is part of the Biostatistics Ph.D. curriculum.

C. Prerequisites:
STAT 52100; experience with R/Splus programming

D. Course Description for Bulletin:
P: STAT 52100; experience with R/Splus programming. This course covers selected computational techniques useful in advanced statistical applications and statistical research, such as methods for solving linear equations, numerical optimization, numerical integration, Bayesian methods, bootstrap methods, and stochastic search algorithms.

E. Educational objectives:
During the course students will:
1. develop computational skills required in modern statistical modeling
2. acquire knowledge necessary to implement new statistical methods

F. Meeting times:
Lectures twice per week

G. Course outline:

Lectures 1- 2. Computer arithmetic, computing sample moments.

Lectures 3-6. Solving systems of linear equations, LU, Choleski, QR, and singular value decompositions. Computing quantities related to least squares regression. Condition numbers, estimating accuracy of solutions, iterative refinement.
Lectures 7-12. Numerical optimization, maximum likelihood, and generalized estimating equations. One dimensional problems, Newton's method, quasi-Newton algorithms, derivative-free algorithms, solution methods for nonlinear systems of equations.

Lectures 13-14 Linear and quadratic programming.

Lectures 15-16. EM and related algorithms.

Lectures 17-19. Laplace approximations and numerical quadrature. Romberg integration, Gaussian quadrature, nested evaluation of multi-dimensional integrals.

Lectures 20-22. Basic simulation methods. Generating uniform pseudo-random numbers, transformation methods, accept-reject methods, importance sampling, control variates, antithetic sampling.

Lecture 23. Numerical integration via importance sampling in Bayesian applications.

Lectures 24-25. Markov chain Monte Carlo. Metropolis-Hastings algorithm, Gibbs sampling.

Lectures 26-28. Bootstrap methods. Resampling methods for variance estimation, bias reduction, hypothesis testing, and confidence intervals; iterated bootstrap; use of control variates, importance sampling and antithetic sampling to improve efficiency.

Lectures 29-30 . Stochastic search algorithms

H. **Textbooks**
Required and Recommended: None--Lecture notes will be available on course web page

Supplemental references:
Lange K (1999). *Numerical Analysis for Statisticians*. Springer.
Press WH, Teukolsky SA, Vetterling WT, and Flannery BP (1992). *Numerical Recipes in C: The Art of Scientific Computing. Second Edition*. Cambridge University Press.
Press WH, Teukolsky SA, Vetterling WT, and Flannery BP (1992). *Numerical Recipes in Fortran: The Art of Scientific Computing. Second Edition*. Cambridge University Press.
Robert CP and Casella G (1999). *Monte Carlo Statistical Methods*. Springer.
Thisted RA (1988). *Elements of Statistical Computing*. Chapman and Hall.

I. **Evaluation and Grading:** Students will be evaluated based on their performance on the homework assignments (60%), and take home final exam (40%). Letter grades for the course are assigned using the following scale: A: 90-100; B: 80-89; C: 70-79; D: 60-69; F: less than

60. Within each letter grade, "+" and "-"will be assigned if the numeric score is in the top and bottom quintiles, respectively.

J. Cheating and Plagiarism:
Academic misconduct will *not* be tolerated and all cases will be reported. Examine the IU Code of Student Rights, Responsibilities, and Conduct at http://www.iupui.edu/code and in particular examine the rules regarding academic misconduct at http://www.iupui.edu/code/#P2_G. Violations of these rules will result in a grade of "F" (or 0%) for the assignment in question, and may result in an "F" for the course or even expulsion from the university (see http://life.iupui.edu/rights/undergrad/sanctions.html).

K. Americans with Disabilities Act
If you need any special accommodations due to a disability, please contact Adaptive Educational Services at (317)-274-3241. Joseph T. Taylor Hall (UC), Room 137.