

Contraction theory for posterior distributions and their variational approximations - STAT 689 (Spring 2019)

Blocker 411, TR 9:35-10:50 am

Dates: Feb 19, 21, 26, 28; March 5, 7, 19, 21, 26; April 2

Course description: This one-credit course will take a condensed tour through the key ideas and techniques for theoretical validation of modern Bayesian procedures involving high-dimensional and non-parametric models. Leveraging on recent work by the instructors, some of the key ideas will be introduced through the treatment of tempered or fractional posteriors, where the theoretical analysis surprisingly simplifies, which will subsequently lead to the classical theory of posterior concentration and its connection with Birge-Lécam theory of testing. In addition to discussing general ideas, emphasis will be provided on discussing applications of the general theory to a broad variety of statistical models. The course will also cover very recent advances in the understanding of properties of variational Bayesian procedures. Time permitting, the course will touch upon frequentist validity of Bayesian uncertainty characterizations in semi/non-parametric problems.

Prerequisites: STAT 632 or its equivalent. Students concurrently taking STAT 632 will have the necessary background by the time the course begins.

Instructor Information: Dr. Anirban Bhattacharya & Dr. Debdeep Pati

- Email: anirbanb@stat.tamu.edu, debdeep@stat.tamu.edu (*When you send either of us an e-mail, use subject-line “[STAT689]”*)
- Office: Blocker 401C/D, Ph: (979) 845-3141
- Office Hours: Thursday 10:50-11:50 am for the above-mentioned dates (*If you are unable to meet at these times, then schedule an appointment with the instructor for an alternative time.*)
- No Teaching Assistants are assigned for this course. Feel free to ask questions anytime by email or schedule appointment for meeting.

Course Webpage:

- **Class website:** http://stat.tamu.edu/~debdeep/689_s19.html.
- The class web site will have important information about the course.
- **Ecampus:** To access the blackboard site go to <http://ecampus.tamu.edu> and login using your NetID and password.

Textbooks (Recommended): The lectures will be self-contained. A core collection of research papers relevant to the course will be shared when the course is in session. A recent book closely aligned with the course description is

- *Ghosal and van der Vaart*. Fundamentals of nonparametric Bayesian inference.

Course objective: The primary objective of the course is to enable the graduate students involved in research with a Bayesian/probabilistic modeling focus to obtain a broad picture of where the literature currently stands as well as getting sufficient working knowledge to obtain theoretical guarantees for their own projects.

Course topics & calendar of activities: Tentatively, we will cover following topics:

1. Overview and background review (concentration inequalities, minimaxity etc). Analysis of tempered posteriors and their variational approximations. (Week 1)
2. General theory for posterior contraction. Applications to nonparametric problems. (Week 2)
3. High-dimensional applications. Model selection consistency. (Week 3)
4. RKHS theory and contraction of Gaussian process posteriors (Week 4)
5. Frequentist coverage of Bayesian procedures beyond parametric problems. Illustration with Gaussian process regression (Week 5)

Grading policies: Satisfactory / Unsatisfactory (S/U) grades will be awarded. Your grade will be based on attendance, in-class participation and the homework score.

Homeworks:

- There will be one homework assignment. To receive credit for the homework you must show **all** work neatly, write in blue or black pen or pencil (never in red), clearly **label** each problem, **circle** your final answers (if applicable), **staple** your entire assignment together in the correct order with your **full name printed** (as appeared in the blackboard) on the first page. Assignments written in latex are also acceptable. Any homework violating any of these rules will receive a grade of **zero** for the entire assignment.
- You are allowed to work with other students on the homework problems, however, verbatim copying of homework is absolutely forbidden and constitutes a violation of the Honor Code. Therefore, each student must ultimately produce his or her own homework to be turned in and graded.

Homework give out dates:

- Homework 1: End of third week.

Attendance: You will get the 25% points for attendance and class participation if you do not miss more than two classes and actively participate in the discussion. Please note that if you miss more, except in very special cases, you will get 0% on attendance. You are strongly encouraged to attend all classes. Regarding the university attendance policy, refer to <http://student-rules.tamu.edu/rule07>.

Make up policy: If an absence is excused, the instructor will either provide the student an opportunity to make up any quiz, exam or other work that contributes to the final grade or provide a satisfactory alternative by a date agreed upon by the student and instructor. If the instructor has a regularly scheduled make up exam, students are expected to attend unless they have a university approved excuse. The make-up work must be completed in a timeframe not to exceed 30 calendar days from the last day of the initial absence. The student is responsible for providing satisfactory evidence to the instructor to substantiate the reason for the absence. Among the reasons absences are considered excused by the university are the following (see Student Rule 7 for details <http://student-rules.tamu.edu/rule07>). The fact that these are university-excused absences does not relieve the student of responsibility for prior notification and documentation. Failure to notify and/or document properly may result in an unexcused absence and the student will get 0% on the attendance. Falsification of documentation is a violation of the Honor Code.

1. Participation in an activity that is required for a class and appears on the university authorized activity list at <https://stuaactonline.tamu.edu/app/sponsauth/index>.
2. Death or major illness in a student's immediate family.
3. Illness of a dependent family member.
4. Participation in legal proceedings or administrative procedures that require a student's presence.
5. Religious holy day. NOTE: Prior notification is NOT required.
6. Injury or illness that is too severe or contagious for the student to attend class.
 - (a) Injury or illness of three or more class days: Student will provide a medical confirmation note from his or her medical provider within one week of the last date of the absence (see Student Rules 7.1.6.1)
 - (b) Injury or illness of less than three class days: Student will provide one or both of these (at instructor's discretion), within one week of the last date of the absence:
 - i. Texas A&M University Explanatory Statement for Absence from Class form available at <http://attendance.tamu.edu>.
 - ii. Confirmation of visit to a health care professional affirming date and time of visit.
 - (c) An absence for a non-acute medical service does not constitute an excused absence.
7. Required participation in military duties.
8. Mandatory admission interviews for professional or graduate school that cannot be rescheduled.

9. Mandatory participation as a student-athlete in NCAA-sanctioned competition.
10. In accordance with Title IX of the Educational Amendments of 1972, Texas A&M University shall treat pregnancy (childbirth, false pregnancy, termination of pregnancy and recovery therefrom) and related conditions as a justification for an excused absence for so long a period of time as is deemed medically necessary by the student's physician. Requests for excused absence related to pregnancy should be directed to the instructor.

Other absences may be excused at the discretion of the instructor with prior notification and proper documentation. In cases where prior notification is not feasible (e.g., accident or emergency) the student must provide notification by the end of the second working day after the absence, including an explanation of why notice could not be sent prior to the class. Accommodations sought for absences due to the observance of a religious holiday can be sought either prior or after the absence, but not later than two working days after the absence.

Statement on Disabilities: The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, currently located in the Disability Services building at the Student Services at White Creek complex on west campus or call 979-845-1637. For additional information visit <http://disability.tamu.edu/>.

Statement on Plagiarism: The handouts used in this course are copyrighted. By "handouts", I mean all materials generated for this class, which include but are not limited to syllabi, quizzes, exams, lab problems, in-class materials, review sheets, and additional problem sets. Because these materials are copyrighted, you do not have the right to copy the handouts, unless I expressly grant permission. As commonly defined, plagiarism consists of passing off as one's own ideas, words, writing, etc., which belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you should have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated. If you have any questions regarding plagiarism, please consult the latest issue of the Texas A&M University Student Rules, under the Section "Honor System Rules." Refer to <http://aggiehonor.tamu.edu> if you have questions or concerns.

Academic Honor System: "An Aggie does not lie, cheat, or steal or tolerate those who do". Academic dishonesty cases will be handled in accordance the University's policies. Please see <http://aggiehonor.tamu.edu> for the complete Honor Council Rules and Procedures.