Personal Statement

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1 Introduction

This statement was prepared as part of the materials submitted in support of a proposed merit increase from Professor Step V to Professor Step VI at the University of California, Santa Cruz (UCSC). The period under review since the last personnel action is from 15 Sep 2002 to 17 Oct 2005, although I also include a few accomplishments in the 2001–02 academic year which were inadvertently omitted from the CV I submitted for review last time. Step VI provides an opportunity for the University and the faculty member to take a look not only at progress since the last review but also at the faculty member's entire career, and all personnel actions offer a chance for the person under review to make some remarks about the future. So I've organized these comments into three sections following this introduction: progress since the last review, the big picture, and future plans. This document refers to two other documents: my CV (available for downloading at www.ams.ucsc.edu/∼draper/writings.html), from which this personal statement borrows liberally, and the web page just mentioned.

I was brought to this campus in January 2001 to serve as founding Chair of the newly-forming Department of Applied Mathematics and Statistics (AMS) in the Baskin School of Engineering (SoE), and to provide leadership in research, teaching and service that would encourage the AMS Department to flourish in fulfilling its mission of

(a) excellence in basic research in applied math and statistics, and collaborative research with investigators in the SoE and beyond;

(b) excellence

   (i) in foundational teaching for eventual undergraduate majors and graduate students in applied math and statistics, and

   (ii) in service teaching in applied math and statistics for the SoE and the rest of the campus; and

(c) excellence in service to UCSC, the community, and the professions of applied math and statistics.

Essentially all of my work since January 2001 has related to and been shaped by this mandate, for better and for worse: because there are only so many hours in a day, some of my own personal progress as a scholar has inevitably been lost, but there have also been richly satisfying gains in helping to create an environment in which my colleagues and I can continue to grow, improve and contribute.

2 Progress since the last review

Here is a summary of what's new during this review period, with items listed in the order they appear in the CV.

- **Honors and awards.** 4 new research honors/awards and 4 new teaching honors/awards:
  - Research honors/awards:
    - In 2002 and 2003 I served as President and Past-President of the *International Society for Bayesian Analysis* (ISBA) (This is the premier international research venue for Bayesian work.)
    - In 2003 I presented another discussion paper before the *Royal Statistical Society*. (This is one of the top international research venues for the entire statistics profession. Only a handful of papers per year are singled out for this research honor.)
    - I was chosen as the presenter of the keynote 3–day research short course (on Bayesian hierarchical modeling) given at the *27th Annual Summer Institute of Applied Statistics*, 19–21 Jun 2002, Brigham Young University, Provo UT. (Only one person or set of co-presenters per year receives this research honor.)
    - I was chosen as the co-presenter of the keynote 3–day research short course (on practical Bayesian non-parametric and semi-parametric modeling) given at the *30th Annual Summer Institute of Applied Statistics*, 15–17 Jun 2005, Brigham Young University, Provo UT.
  - Teaching honors/awards:
    - I received an Honorable Mention, 2002–03 *Excellence in Teaching Award*, University of California, Santa Cruz (UCSC); I was nominated for the 2002–03 UCSC *Alumni Association Distinguished Teaching Award*; and I was nominated for the 2002–03 UCSC *STARS Teacher of the Year Award*. (Only a handful of people per year are singled out for these teaching honors.)
    - I received an Honorable Mention, 2003–04 *Excellence in Teaching Award*, University of California, Santa Cruz (UCSC). (Only 7 faculty were chosen for this teaching honor in 2004.)
    - I received an *Excellence in Continuing Education* award, American Statistical Association (ASA; 2004), presented for the research short course *Intermediate/Advanced Bayesian Hierarchical Modeling*, given at the American Statistical Association annual meeting, San Francisco CA, 2003. (The ASA is another premier international research venue in statistics. Only one of these awards is given each year; in 2003 my research short course was chosen from among 34 such courses.)
    - I received an Honorable Mention, 2004–05 *Excellence in Teaching Award*, University of California, Santa Cruz (UCSC); and I was nominated for the 2004–05 UCSC *Alumni Association Distinguished Teaching Award*. (Only a handful of people per year are nominated for these teaching honors.)
- **Grant and contract support.** 8 new grants (totaling $443,000) and 2 new pending grant submissions (totaling an additional $1,790,000; PDF versions of the 2 pending submissions are available in Section II. at the `writings.html` web page):

– (awarded) **Draper D** (2002). *International Workshop on Bayesian Data Analysis.* $88,367 from (among other funders) the US National Science Foundation, the University of California (Santa Cruz), NASA Ames Research Laboratories, and CTB/McGraw-Hill to run an International Workshop on Bayesian Data Analysis in Santa Cruz, 8–10 Aug 2003. This Workshop brought together approximately 160 researchers from 15 countries on 5 continents for 26 invited talks and 75 posters; electronic proceedings are available at `www.ams.ucsc.edu/bayes03`, which has so far been visited more than 11,400 times.

– (awarded) Romano P, **Draper D** (2002). *Perinatal Outcomes for Medical Mothers and Babies.* $27,194 from the California Healthcare Foundation, to perform an empirical analysis of physician- and hospital-level effects as part of the Maternal Outcomes Reporting Initiative, Apr 2003–Mar 2006.

– (awarded) **Draper D**, Krnjajić M (2003). *Cluster Analysis Via Bayesian Nonparametric Density Estimation.* $30,000 from NASA Ames to investigate Bayesian methods for classifying pixels in satellite images on a four-point ordered categorical scale of cloudiness, by applying mixture models with unknown numbers of components in the context of massive data sets, Feb–Sep 2004.

– (awarded) **Draper D** (2004). *Understanding Variations in Death Rates in Veterans Administration Intensive Care Units.* $15,000 from the Department of Veterans Affairs (Palo Alto Health Care System), to perform a hierarchical random-effects logistic regression analysis to explain variations in death rates in intensive care units in VA hospitals around the U.S., Jul 2004–Dec 2005.

– (awarded) **Draper D** (2004). *A Case-Study-Based Contemporary Calculus Course.* $8,088 from the UCSC Center for Teaching Excellence to develop an innovative course, Contemporary Calculus I, which will be case-study based and which will combine traditional paper-and-pencil methodological learning with lab-based numerical and symbolic computing, July 2004–June 2005.

– (awarded) Towbin P, **Draper D** (2004). *Mathematical and Statistical Models of Cooperation and Conflict in Environmental Resource Use.* $162,317 over 4 years from the University of California Institute on Global Conflict and Cooperation, to provide fellowship money for P Towbin's Ph.D. study, July 2004–June 2008.

– (awarded) **Draper D** (2004). *Bayesian Modeling and Inference for Improved Medical Processes and Outcomes.* $50,000 from the Division of Research at Kaiser Permanente, for design and analysis work on a variety of projects (e.g., an innovative method for migrating methods from the intensive care unit to the general wards and emergency room to prevent unnecessary deaths from sepsis), Aug 2004–Aug 2006.

– (awarded) **Draper D** (2004). *Bayesian Modeling and Decision-Making in Industrial Process Control.* $15,000 from the Statistics Group at Pratt & Whitney, for design and analysis work on improved risk assessment in engineering the manufacturing process for jet engines, Nov 2004–Oct 2006.

– (pending) **Draper D**, Gearhart C (2005). *Bayesian statistical modeling of the relationship between air quality and mortality: In pursuit of accurate uncertainty bands and better environmental policy.* $120,000 requested from the University Research Program at Ford

Motor Company, for improved analysis (via Bayesian model averaging and hierarchical modeling) of the relationship between air quality and mortality, Mar 2006–Feb 2008.

– (pending) Escobar G, **Draper D**, et al. (2005). *Sepsis and critical illness in babies* ≥ 34 *weeks gestation*. $1,670,000 requested from the National Institute of Child Health and Human Development (a branch of the National Institutes of Health), January 2006–December 2008. Proposes novel clinical and statistical methods, involving dynamic linear modeling, to take advantage of the Kaiser hospital chain's soon-to-be-available real-time electronic clinical data base to create dynamically-updated severity of illness scores for newborn babies in the first 72 hours of life. I am the lead statistician on this project.

- **Writings and creative activities.** In statistics refereed articles are important, with discussion articles and contributions to the discussion of such articles having particularly high impact (see Section 3.1.2 below); monographs and chapters in monographs also have considerable influence on the research directions taken by the field; and textbooks can be deeply influential for the practice of statistics in the generation following the publication of the text. (One more remark on statistical culture: good single-authored publications are highly valued, as evidence of independent creativity, and good co-authored publications are also highly valued, as evidence of successful collaboration in a field that is largely collaborative by nature.)

  During this review period I made the following contributions to the scientific literature: 5 new refereed articles (4 in print and 1 forthcoming), including 2 discussion articles; 4 new refereed articles submitted; 1 new monograph chapter forthcoming; 6 new invited discussions (5 in print and 1 forthcoming); 1 new refereed article in progress; 1 new monograph in progress; 3 new drafts for each of two books in progress begun earlier (1 monograph, 1 texbook); and 2 refereed letters inadvertently omitted from previous CVs. Numbers in $\boxed{\text{boxes}}$ refer to the sequential publication numbering in Section I. on the `writings.html` web page, where all of these writings may be found in PDF format.

  – (discussion article) Browne WJ, **Draper D**. A comparison of Bayesian and likelihood methods for fitting multilevel models (with discussion). *Bayesian Analysis*, forthcoming. (Demonstrates that Bayesian MCMC-based estimation outperforms likelihood and quasi-likelihood methods in variance components and random-effects logistic regression models with respect to bias of point estimates and coverage and length of interval estimates, and therefore recommends the use of maximum likelihood estimation during the model exploration phase of a multilevel study (for computational speed), and Bayesian estimation using MCMC to produce final publishable results. I was responsible for about 50% of the effort leading to this article.) $\boxed{64}$

  – (discussion article) **Draper D**, Gittoes M (2004). Statistical analysis of performance indicators in UK higher education (with discussion). *Journal of the Royal Statistical Society, Series A*, **167**, 449–474 (context and discussion, 447–448, 497–499; we were not given an opportunity to rejoin). (Attempts to measure the quality with which institutions such as hospitals and universities carry out their public mandates have gained in frequency and sophistication over the last decade. In this paper we examine methods for creating performance indicators (PIs) in multilevel settings (e.g., students nested within universities) based on a dichotomous outcome variable (e.g., drop-out from the higher education system). The *profiling* methods we study involve the indirect measurement of quality, by comparing institutional outputs after adjusting for inputs, rather than directly attempting to measure the quality of the processes unfolding inside the institutions. In the context of an extended case study of the creation of PIs for universities in the UK higher education system, we (a) demonstrate the large-sample functional equivalence between a method based on indirect standardization and an approach based on fixed-effects multilevel modeling, (b) offer simulation results on the performance of the standardization method in null and non-null settings, (c) examine the sensitivity of this method to inadvertent omission of relevant input variables, (d) explore random-effects reformulations and characterize settings in which they are preferable to fixed-effects multilevel modeling in this type of quality assessment, and (e) discuss extensions to longitudinal quality modeling and the overall pros and cons of institutional profiling. Our results are couched in the language of higher education but apply with equal force to other settings with dichotomous response variables, such as the examination of observed and expected rates of mortality (or other adverse outcomes) in the study of the quality of health care. I was responsible for about 65% of the effort leading to this article. **1** citation [December 2004], in statistics, in a journal published in the UK.) $\boxed{61}$

- (article) Hanks B, McDowell C, **Draper D**, Krnjajić M (2004). Program quality with pair programming in CS1. *ACM SIGCSE Bulletin*, **36**, 176–180. (Pair programming transforms what has traditionally been a solitary activity into a cooperative effort. While pair programming, two software developers (the *driver* and the *navigator*, roles which are switched at regular intervals) share a single computer monitor and keyboard. Prior research has shown that compared with students who work alone, students who pair demonstrate increased confidence in their work, and greater success in their first computer science class (CS1); however, these earlier studies were flawed in that paired and solo students were not given the same programming assignments. We use a design that holds assignments constant, and we employ Bayesian methods to quantify the improvement in both process and outcome measures of program quality under pair programming in our stronger experimental design. I was responsible for about 40% of the effort leading to this article. Citation data unavailable.) $\boxed{62}$
- (article) Browne WJ, **Draper D**, Goldstein H, Rasbash J (2002). Bayesian and likelihood methods for fitting multilevel models with complex level–1 variation. *Computational Statistics and Data Analysis*, **39**, 203–225. (In multilevel modeling it is common practice to assume constant variance at level 1 across individuals. In this paper we consider situations where the level–1 variance depends on predictor variables. We examine two cases using a dataset from educational research; in the first case the variance at level 1 of a test score depends on a continuous "intake score" predictor, and in the second case the variance is assumed to be different for different genders. We contrast two maximum-likelihood methods based on iterative generalized least squares with two MCMC methods based on adaptive hybrid versions of the Metropolis-Hastings (MH) algorithm, and we use two simulation experiments to compare these four methods. We find that all four approaches have good repeated-sampling behavior in the classes of models we simulate. We conclude by contrasting raw- and log-scale formulations of the level–1 variance function, and we find that adaptive MH sampling is considerably more efficient than adaptive rejection sampling when the heteroscedasticity is modeled polynomially on the log scale. I was responsible for about 40% of the effort leading to this article. **3** citations [most recent August 2005], in veterinary research and statistics, in journals published in France, the UK and the US.) $\boxed{57}$
- (article) Fouskakis D, **Draper D** (2002). Stochastic optimization: a review. *International Statistical Review*, **70**, 315–349. (We review three leading stochastic optimization methods—simulated annealing, genetic algorithms, and tabu search. In each case we analyze the method, give the exact algorithm, detail advantages and disadvantages, and summarize the literature on optimal values of the inputs. As a motivating example we describe the solution—using Bayesian decision theory, via maximization of expected utility—of a variable selection problem in generalized linear models, which arises

in the cost-effective construction of a patient sickness-at-admission scale as part of an effort to measure quality of hospital care. I was responsible for about 60% of the effort leading to this article. **4** citations [most recent January 2005], in computer science, ecology, and statistics, in journals published in Holland, the UK and the US.) $\boxed{59}$

- (article, submitted) **Draper D**. On the relationship between model uncertainty and inferential/predictive uncertainty (submitted; 10 pages). (Demonstrates that increasing the uncertainty in the modeling process by expanding a model hierarchically can lead either to an increase or a decrease in uncertainty about quantities of direct inferential or predictive interest.) $\boxed{69}$
- (article, submitted) **Draper D**, Toland JF. Nonparametric prior specification (submitted; 36 pages). (Shows how to use techniques from functional analysis to compute bounds on Bayes factors in an infinite-dimensional class of prior distributions, as a way to deal more realistically with uncertainty in the process of specifying priors. Other people have dealt in the past with unimodality as a qualitative prior constraint, using Khintchine's characterization of unimodal distributions as mixtures of uniforms; in this paper we use quite different methods to deal with monotonicity and convexity constraints. I was responsible for about 50% of the effort leading to this article.) $\boxed{70}$
- (article, submitted) **Draper D**, Krnjajić M. Bayesian model specification (submitted; 30 pages). (A standard (data-analytic) approach to statistical model specification, practiced with equal vigor in both Bayesian and non-Bayesian approaches to model-building, involves the initial choice, for the structure of the model, of one or another of a variety of standard parametric families, followed by modification of this initial choice - once data begin to arrive - if the data suggest deficiencies in the original specification. In this paper (a) we argue that this approach is formally incoherent, because it amounts to using the data both to specify the prior distribution on structure space and to update using this data-determined prior; (b) we identify two approaches to avoiding (at least in principle, and with a fair amount of data) the incoherence in (a): (1) Bayesian semi-parametric modeling and (2) three-way out-of-sample predictive validation; (c) we provide details on implementing (2); (d) we argue that to make progress in coherent Bayesian model specification in complicated problems You (the modeler) have to either implicitly or explicitly choose a utility structure which defines, for You, when the model currently being examined is "good enough"; (e) we argue that it is best to make this choice explicitly on the basis of real-world considerations regarding the use to which the model will be put; and (f) we contrast model selection methods based on the log score and deviance information criteria (DIC) as two examples of (e) with utilities governed by predictive accuracy. I was responsible for about 50% of the effort leading to this article.) $\boxed{71}$
- (article, submitted) Fouskakis D, **Draper D**. Stochastic optimization methods for cost-effective quality assessment in health (submitted; 53 pages). (Uses Bayesian decision theory to solve the general problem of variable selection in generalized linear models subject to a data collection cost constraint on the predictor variables. The particular case study in which this methodology is developed involves the creation of a cost-effective scale for measuring sickness at admission for hospital patients. We use simulated annealing (SA), genetic algorithms (GA), and tabu search (TS) to find (near-)optimal subsets of predictor variables; the optimization is of a real-valued function of binary $(s_1, \ldots, s_p)$, and in our largest application the space of s-vectors over which we search has $2^{83} \doteq 10^{25}$ elements. We use simulation methods to explore a wide variety of user-defined input settings for the optimization methods we examine, without tuning these methods specifically to the structure of our utility-maximization problem, and we also create a context-specific version (ISA) of simulated annealing (the optimization method whose generic implementation performed most poorly) and document the improvement over its generic counterpart. We

find in our optimization problem that (a) when p is modest (i) genetic algorithms performed relatively poorly for all but the very best user-defined input configurations, and generic simulated annealing also did not perform well, whereas (ii) tabu search had excellent median performance and was much less sensitive to suboptimal choice of user-defined inputs; and (b) for large p the best versions of GA and ISA outperformed TS and generic SA. Our results are phrased in the language of health policy but apply with equal force to other quality assessment settings with dichotomous outcomes, such as the examination of drop-out rates in education, the study of retention rates in the workplace and the creation of cost-effective credit scores in business. This work (1) provides a relatively new perspective on variable selection in generalized linear models, (2) offers new insights into the comparative advantages and flaws of competing stochastic optimization methods, and (3) produces results of direct potential use in quality assessment in health policy and other fields. I was responsible for about 50% of the effort leading to this article.) $\boxed{68}$

- (monograph chapter) **Draper D** (2006). Bayesian multilevel analysis and MCMC. Chapter 3 in *Handbook of Quantitative Multilevel Analysis* (de Leeuw J, editor), New York: Springer (59 pages), forthcoming. (My goal in writing this chapter was to produce a definitive introduction to the Bayesian paradigm and how it is applied in contemporary statistical work to the analysis of multilevel, or hierarchical, models, using Markov chain Monte Carlo methods as the basis of computation. Citation data unavailable.) $\boxed{66}$
- (invited discussion) **Draper D**. Coherence and calibration: comments on subjectivity and "objectivity" in Bayesian analysis. Discussion of "The case for objective Bayesian analysis" by Berger J and "Subjective Bayesian analysis: principles and practice," by Goldstein M, *Bayesian Analysis*, forthcoming (4 pages). (Examines the crucial role of both coherence and calibration in Bayesian analysis, and argues (a) that all Bayesian work is inherently subjective but that (b) "objective" prior distributions play a valuable role in achieving good calibration when (in your judgment) the past and future are exchangeable.) $\boxed{67}$
- (invited discussion) **Draper D** (2005). Discussion of "Local model uncertainty and incomplete-data bias," by Copas J and Eguchi S, *Journal of the Royal Statistical Society Series B*, **67**, 502–503. (Comments upon differences between frequentist and Bayesian approaches to accounting for model uncertainty, and discusses the use of random-effects meta-analytic models to create uncertainty bands that appropriately reflect bias in the measurement process, using estimation of the speed of light in physics in the 20th century as an example. Citation data unavailable.) $\boxed{65}$
- (invited discussion) **Draper D** (2005). Discussion of "Multiple bias modeling for analysis of observational data," by S Greenland, *Journal of the Royal Statistical Society Series A*, **168**, 301. (Offers suggestions on how to perform both process and outcome evaluation of the method proposed by Greenland to judgmentally estimate variance components (a) for nonexchangeability between the observed units in an observational study and units in the population of real scientific interest and (b) for the effects of unmeasured confounders in such studies. Citation data on discussion unavailable; article under discussion cited **5** times.) $\boxed{63}$
- (invited discussion) **Draper D** (2004). Discussion of "Ecological inference for 2×2 tables," by J Wakefield, *Journal of the Royal Statistical Society Series A*, **167**, 435–436. (Emphasizes how violently sensitive inferential answers at the individual level are to assumptions and prior inputs when all that is available is aggregate data, and discusses the relationship between sampling-theory and model-based approaches to ecological inference. Citation data on discussion unavailable; article under discussion cited **3** times.) $\boxed{60}$

– (invited discussion) **Draper D** (2002). Discussion of "Bayesian measures of model complexity and fit," by DJ Spiegelhalter, NG Best, BP Carlin, and A van der Linde, *Journal of the Royal Statistical Society Series B*, **64**, 630–631. (Criticizes the view taken by the authors that model choice can be made in a context-free manner, and advocates a decision-theoretic basis for model selection based on maximization of expected utility. Citation data on discussion unavailable; article under discussion cited **151** times.) $\boxed{58}$

– (invited discussion) **Draper D** (2002). Discussion of "Commissioned analysis of surgical performance by using routine data: lessons from the Bristol inquiry," by DJ Spiegelhalter, P Aylin, NG Best, SJW Evans, and GD Murray, *Journal of the Royal Statistical Society Series A*, **165**, 227. (Emphasizes the value of simulation studies and Bayesian decision theory as a basis for setting practical cutpoints to identify "good" and "bad" institutions in input-output quality assessment. Citation data on discussion unavailable; article under discussion cited **7** times.) $\boxed{56}$

– (article, in progress) Krnjajić M, **Draper D**, Kottas T. Parametric and nonparametric Bayesian model specification: a case study (22 pages). (In this paper, which is about 75% finished, we undertake a simulation study to explore the ability of Bayesian parametric and nonparametric models to provide an adequate fit to count data, of the type that would routinely be analyzed parametrically either through fixed-effects or random-effects Poisson models. The context of the study is a randomized controlled trial with two groups (treatment and control). Our nonparametric approach utilizes several modeling formulations based on Dirichlet process (DP) mixture and mixtures of DP priors. We find that the nonparametric models are able to flexibly adapt to the data, to offer rich posterior inference, and to provide, in a variety of settings, more accurate predictive inference than parametric models.) $\boxed{72}$

– (monograph, in progress) **Draper D**. *Bayesian Modeling, Inference and Prediction.* Contract offered. (I am about 85% finished with this 450–page book, which uses many case studies and mixes theoretical and methodological ideas with symbolic and numerical computing in `Maple` and `R` to create a graduate-level introduction to Bayesian modeling.) $\boxed{75}$

– (letter) Dubois R, Rogers W, **Draper D**, Brook R (1988). Does hospital mortality predict quality? *New England Journal of Medicine*, **318**, 1624. (A further exploration of the relationship between inpatient mortality and hospital quality. I was responsible for about 25% of the effort leading to this letter. Citation data unavailable.) $\boxed{4}$

– (letter) Bennett C, **Draper D**, Kanouse D, Greenfield S (1989). AIDS treatment center: is the concept premature? *Journal of the American Medical Association*, **262**, 2537. (Discusses whether (in 1989) it was clinically appropriate for hospitals to create treatment centers dedicated solely to treating HIV and AIDS patients. I was responsible for about 25% of the effort leading to this letter. Citation data unavailable.) $\boxed{10}$

- **University service: Department of Applied Mathematics and Statistics.**

  As noted in Section 1, I have served as the founding Chair of the Department of Applied Mathematics and Statistics (AMS) since arriving at UCSC in Jan 2001. Quite apart from research and teaching obligations, until recently this has been virtually a full-time job in itself: since I had only two AMS colleagues when I arrived (one of them junior), almost all of the administrative responsibilities for the Department fell to me from Jan 2001 through July 2002 (when my senior colleague Marc Mangel transferred into AMS), and many such responsibilities are still mine today despite a growing faculty who are sharing the burden. Specific accomplishments since Sep 2002 have included, but have not been limited to, the following.

2002–03 ∗ In autumn 2002 I set the *AMS curriculum plan* for 2003–04; curriculum coordination with the Departments of Economics and Mathematics continued.

∗ In spring 2003 joint curriculum planning with the Department of Environmental Toxicology began.

2003–04 ∗ In autumn 2003 I managed *personnel actions* for two of my AMS colleagues (A Kottas and H Lee) and set the *AMS curriculum plan* for 2004–05; curriculum coordination with the Departments of Mathematics and Economics continued.

∗ In 2003–04 I served on the School of Engineering *Committee on Academic Personnel* and the *Undergraduate Studies Committee*.

∗ From Jan to Apr 2004 I organized the successful *recruiting* of a new senior statistician (B Sansó); this involved (among other things) serving as Chair of the *Search Committee*, selecting a short-list of 3 candidates from 45 applications, managing four-day visits by each of the 3 candidates, and negotiating with the successful candidate. I also played an active role in the successful recruiting of two new junior applied mathematicians (P Garaud and J Cortés); this involved detailed discussions with four candidates and negotiating with the two successful candidates.

∗ In the summer of 2004 I compiled the *AMS Annual Report* for 2003–04; this is available in PDF format in Section V. at the `writings.html` web page.

2004–05 ∗ In autumn 2004 I managed a *personnel action* for one of my AMS colleagues (R Prado), participated in a personnel action for another of my AMS colleagues (H Wang), and set the *AMS curriculum plan* for 2005–06; curriculum coordination with the Departments of Mathematics and Economics continued, and curriculum coordination with the Departments of Ecology and Evolutionary Biology, Environmental Studies, and Molecular, Cell, and Developmental Biology began.

∗ In winter and spring 2005, after consultations with many relevant people, I finished a complete rewrite of the *AMS Graduate Program Proposal*; this proposal (246 pages; available in PDF format in Section V. at the `writings.html` web page) is now under review by the campus Graduate Council, and will be submitted to the University of California Office of the President as soon as possible.

∗ In the summer of 2005 I compiled the *AMS Annual Report* for 2004–05 and began work on (a) the AMS contribution to the latest UCSC long-range planning exercise and (b) the formal AMS Departmental proposal.

- **University service: Baskin School of Engineering**.

  – Chair, *Engineering School Space Committee*, Jan 2001–present (this has involved working closely with the Assistant Deans to ensure that all space needs of the Engineering School are addressed as well as they can be, given space constraints).

  – Member, *Dean's Undergraduate Student Advisory Council*, Oct 2002–present; member, *Engineering 2 Building Committee*, Oct 2002–present; member, *Alterations III Planning Committee*, Oct 2002–present.

  – From Dec 2003 through Feb 2004 I wrote the AMS contribution to the *Engineering School strategic futures plan for 2020*.

- From March 2004 to the present I have served on the Engineering School's *Executive Budget Committee*, which is responsible for advising the Dean of Engineering on how to absorb the 2004 budget cuts in a way that does the least harm.

- **Public lecture or forum participation.** I believe strongly that dissemination of research findings to the broadest possible audience is crucial, and I back up this belief by frequently giving research short courses on Bayesian methods. During this review period I gave 19 new research short courses to a total of about 1,400 participants:

  - *Hierarchical Modeling for Profiling in Health and Education*, International Conference on Health Policy Research, Boston MA, Dec 2001 ($\frac{1}{2}$-day course: 4 hours lecturing; 111 attendees).
  - *Bayesian Hierarchical Modeling*: 27th Annual Summer Institute of Applied Statistics, Brigham-Young University, Provo UT, Jun 2002 (3–day course: 18 hours lecturing; 49 attendees).
  - *Bayesian and Likelihood-Based Methods in Multilevel Modeling*: EpiCentre, Massey University, Palmerston North, New Zealand, Dec 2002 (3–day course: 20 hours lecturing; joint with W Browne, 35 attendees).
  - *Intermediate/Advanced Bayesian Hierarchical Modeling*: American Statistical Association annual meeting, San Francisco CA, Aug 2003 (1–day course: 6 hours lecturing, 50 attendees; average overall effectiveness score 98% based on 43 participant evaluations).
  - *Bayesian Inference and Hierarchical Modeling*: U.S. Centers for Disease Control and Prevention, Atlanta GA, Nov 2003 (2–day course: 12 hours lecturing, 40 attendees).
  - *Intermediate/Advanced Bayesian Hierarchical Modeling*: American Statistical Association LearnSTAT Program, Alexandria VA, Mar 2004 (1–day course: 6 hours lecturing, 39 attendees).
  - *Bayesian Modeling, Inference and Prediction*: Philadelphia Chapter, American Statistical Association, Philadelphia PA, July 2004 (1–day course: 6.5 hours lecturing, 120 attendees).
  - *Bayesian Modeling, Inference and Prediction*: Pratt & Whitney, East Hartford CT, July 2004 (1–day course: 6.5 hours lecturing, 24 attendees).
  - *Intermediate/Advanced Bayesian Hierarchical Modeling*: American Statistical Association annual meeting, Toronto ON, Aug 2004 (1–day course: 6 hours lecturing, 54 attendees; average overall effectiveness score 92% based on 50 participant evaluations).
  - *Bayesian Inference, Prediction and Decision-Making, With Applications to Risk Assessment*: National Veterinary and Food Research Institute of Finland, Helsinki, Oct 2004 (5-day course: 30 hours lecturing and computer lab work, 41 attendees).
  - *Bayesian Statistical Methods and Hierarchical Modeling*: Division of Research, Northern California Kaiser Permanente, Oakland CA, Oct-Dec 2004 (10-week course: 20 hours lecturing and computer lab work, 42 attendees).
  - *Bayesian Modeling, Inference and Prediction*: Biological Sciences, University of California, Berkeley, Berkeley CA, Dec 2004 (1–day course: 6.5 hours lecturing, 138 attendees).

- *Concepts, Trends and Applications of Frequentist and Bayesian Statistics in the Healthcare and Pharmaceutical Industries*: Aventis Pharmaceuticals, Somerset NJ, Dec 2004 (1–day course: 6.5 hours lecturing, 28 attendees).
- *Bayesian Modeling, Inference and Prediction*: Boston Chapter, American Statistical Association, Cambridge MA, Dec 2004 (1–day course: 6.5 hours lecturing, 153 attendees).
- *Bayesian Model Specification and Hierarchical Modeling*: International Conference on Bayesian Statistics and Its Applications, Banaras Hindu University, Varanasi, India, Jan 2005 ($\frac{1}{2}$-day course: 3 hours lecturing, 110 attendees).
- *Bayesian Modeling, Inference and Prediction*: Chicago Chapter, American Statistical Association, Cambridge MA, Mar 2005 (1–day course: 6.5 hours lecturing, 221 attendees).
- *Intermediate Bayesian Modeling, With Applications in Ecology*: Purdue University, West Lafayette IN, Mar 2005 (1–day course: 6.5 hours lecturing, 16 attendees).
- *Practical Bayesian Nonparametric Methods*: 30th Annual Summer Institute of Applied Statistics, Brigham Young University, Provo UT, Jun 2005 (3–day course: 13 hours lecturing, joint with Thanasis Kottas; 40 attendees).
- *Bayesian hierarchical modeling, with applications to provider profiling*: 2005 International Conference on Health Policy Research, Boston MA, Oct 2005 ($\frac{1}{2}$-day course: 4 hours lecturing, 83 attendees).

- **Papers presented at professional meetings.** In statistics, as in other fields, this category is an indication of the extent to which leading researchers view the work of the person invited to speak as important and timely. In the interests of brevity I list only invited, special invited, and plenary talks at major international meetings: during this review period I gave 8 invited talks and 6 plenary presentations.

  - *Stochastic optimization for cost-effective quality assessment in health.* Invited talk, International Conference on Health Policy Research, Boston, MA, 9 Dec 2001.
  - *Nonparametric prior specification.* Invited talk, 7th Valencia International Meeting on Bayesian Statistics, Canary Islands, 3 June 2002.
  - *Statistical foundations of medical provider profiling.* Invited talk, Joint Statistical Meetings, 12 Aug 2002, New York.
  - *Statistical methodology for inverse problems.* Invited talk, SAMSI Workshop on Inverse Problem Methodology In Complex Stochastic Models, 23 Sep 2002, Durham NC.
  - *Strategies for MCMC Acceleration, part I.* Invited talk, SAMSI Workshop on Challenges in Stochastic Computation, 28 Sep 2002, Durham NC.
  - *Statistical analysis of performance indicators in UK higher education.* Invited talk, Royal Statistical Society Meeting on Performance Monitoring and Surveillance, 14 Jan 2003, London.
  - *Strategies for MCMC Acceleration, part II.* Invited talk, Joint Statistical Meetings, 6 Aug 2003, San Francisco.
  - *Strategies for MCMC Acceleration, part III.* Plenary talk, International Workshop on Markov Chain Monte Carlo: Innovations and Applications in Statistics, Physics, and Bioinformatics, 16 Mar 2004, Singapore.

- *Bayesian hierarchical modeling.* Plenary presentation, ISBA (International Society for Bayesian Analysis) 2004 World Meeting, 23 May 2004, Viña del Mar, Chile.
- *Bayesian model specification.* Invited talk, ISBA (International Society for Bayesian Analysis) 2004 World Meeting, 24 May 2004, Viña del Mar, Chile.
- *Statistical methods for performance benchmarking in medicine.* Plenary talk, Analytic Strategies for Nursing Databases: A Collaborative Conference from the National Nursing Quality Database Consortium, 5–6 Nov 2004, Palo Alto CA.
- *Bayesian model specification.* Plenary talk, International Conference/Workshop on Bayesian Statistics and Its Applications, Banaras Hindu University, Varanasi, India, 7 Jan 2005.
- *Bayesian model specification.* Plenary talk, International Seminar on Bayesian Inference in Econometrics and Statistics, 1–2 Aug 2005, St. Louis MO.
- *Bayesian model specification.* Plenary talk, 25th International Workshop on Bayesian Inference and Maximum Entropy Methods in Science and Engineering, 8 Aug 2005, San José CA.

- **Editorial or board service to publications.** During this review period I continued as Associate Editor of the journal *Health Services and Outcomes Research Methodology* (February 1996–present).

- **Other outside creative activity.** During this review period I
  - gave 11 invited talks to statistics departments at leading universities and research laboratories in Finland, Greece, the U.K. and the U.S. (Seattle, Davis, the Naval Postgraduate School, USC, NASA Ames, the Wharton School at the University of Pennsylvania, the RAND Corporation, the University of Helsinki; the University of Bath; the University of California, Santa Barbara; and the National Technical University of Athens);
  - wrote 7 referee reports for leading international journals and NSF;
  - served on 1 NSF site visit panel; and
  - helped to adjudicate the tenure and promotion cases for 5 academic statisticians in the US and Canada.

- **International conferences organized.** 2 new international conferences co-organized:
  - Co-organizer of *International Workshop on Bayesian Data Analysis*, University of California, Santa Cruz, Aug 2003 (see **Grant and contract support** above).
  - Member, Advisory Committee, *International Conference on Bayesian Methods and Applications*, Banaras Hindu University, Varanasi, India, Jan 2005.

- **Graduate students.** During this period I supervised or am supervising 6 graduate students, including 5 students at UCSC and 1 student in Sweden and the U.K. (I successfully supervised 2 M.Phil./M.S. dissertations and 2 Ph.D. dissertations, and I am currently supervising or co-supervising 1 M.S. student and 2 Ph.D. students). Many of these dissertations are available for downloading in PDF format in Section III. at the `writings.html` web page.

- *Functional data analysis: modeling of groundwater contamination.* B Mendes, Department of Mathematical Sciences, University of Bath (M.Phil., 2002). (He is now pursuing postdoctoral studies with me at UCSC.)
- *Uncertainties in modeling groundwater contamination.* B Mendes, Department of Physics, University of Stockholm (Ph.D., 2003; co-advisor with A Pereira).
- *Mirror-jump sampling: a strategy for MCMC acceleration.* S Liu, Department of Computer Science, University of California, Santa Cruz (M.S., 2003). (She is now working toward a Ph.D. in the Department of Biostatistics at the University of Michigan.)
- *Contributions to Bayesian statistical analysis: model specification and nonparametric inference.* M Krnjajić, Department of Applied Mathematics and Statistics, University of California, Santa Cruz (Ph.D., September 2005; co-advisor with Thanasis Kottas). (He now has a post-doctoral position at the Lawrence Livermore National Laboratories.)
- *Bayesian nonparametric modeling for well-calibrated location and scale inferences with skewed and long-tailed data.* J Wallerius, Department of Applied Mathematics and Statistics, University of California, Santa Cruz (M.S. anticipated, 2006).
- *Bayesian estimation of cytonuclear disequilibria under models of immigration and epistatic mating.* R Young, Department of Ecology and Evolutionary Biology, University of California, Santa Cruz (Ph.D. anticipated, 2006; co-advisor with R Vrijenhoek).
- *Mathematical and statistical models of cooperation and conflict in environmental resource use.* P Towbin, Department of Applied Mathematics and Statistics, University of California, Santa Cruz (Ph.D. anticipated, 2008).

• **Postdoctoral research associates.** During this review period I have supervised 1 postdoctoral research associate.

- *Functional data analysis and risk assessment in environmental studies.* Dr. B Mendes, University of California, Santa Cruz, Jan 2003–present.

• **Classroom teaching.** As Chair of AMS I receive one course relief per year, so my normal teaching load is two classes per year. During this review period I taught 10 classes (6 undergraduate, 4 graduate), including 2 Discovery Seminars, to a total of 609 undergraduate and 133 graduate students, and conducted 14 individual graduate student supervisions. (In the tables below L and U denote lower and upper division undergraduate classes and G signifies graduate classes, and F, W, and S stand for fall, winter, and spring quarters, respectively.)

2001–02 (UCSC)

Quarter	Course	Course Title	Enrolled	% Evaluations Returned	Shared?
F	Engineering 5 (L)	Statistics	99	71	no
F	Computer Science 297B (G)	Individual Study	1	—	no
W	Engineering 206 (G)	Bayesian Statistics	30	93	no

2002–03 (UCSC)

Quarter	Course	Course Title	Enrolled	% Evaluations Returned	Shared?
F	Engineering 5 (L)	Statistics	124	82	no
F	Computer Science 299A (G)	Thesis Research	1	—	no
W	Engineering 206 (G)	Bayesian Statistics	39	100	no
W	Computer Science 299B (G)	Thesis Research	1	—	no
W	Computer Science 296 (G)	Masters project	1	—	no
S	Computer Science 299A (G)	Thesis Research	1	—	no

2003–04 (UCSC)

Quarter	Course	Course Title	Enrolled	% Evaluations Returned	Shared?
F	Computer Science 299A (G)	Thesis Research	1	—	no
W	Engineering 206 (G)	Bayesian Statistics	36	75	no
W	Computer Science 299A (G)	Thesis Research	1	—	no
S	Engineering 5 (L)	Statistics	168	79	no
S	Engineering 88A (L)	Thinking About Uncertainty (discovery seminar)	7	86	no
S	Engineering 299A (G)	Thesis Research	1	—	no

2004–05 (UCSC)

Quarter	Course	Course Title	Enrolled	% Evaluations Returned	Shared?
F	AMS 297A (G)	Thesis Research	1	—	no
F	Computer Science 299A (G)	Thesis Research	1	—	no
W	AMS 206 (G)	Bayesian Statistics	28	75	no
W	AMS 297A (G)	Thesis Research	1	—	no
W	AMS 299B (G)	Thesis Research	1	—	no
S	AMS 5 (L)	Statistics	209	71	no
S	AMS 88B (L)	Thinking About Uncertainty (discovery seminar)	2	50	no
S	AMS 297B (G)	Thesis Research	1	—	no
S	AMS 299B (G)	Thesis Research	1	—	no

My teaching evaluations are strong at both the undergraduate and graduate levels. Table 1 summarizes the results of the end-of-quarter instructor evaluation surveys for all of the classes I've taught at UCSC. In these surveys students are asked a number of questions about each course and give their replies on 5–point ordered categorical scales. The standard measures of quality at UCSC are the percentages of responses in the top two categories on the three most important summary questions (noted in the table). The table gives summaries separately for lower-division undergraduate (L), upper-division undergraduate (U), and graduate (G) courses, and overall.

On average, I get a 78% response rate for the surveys in my classes; 92% of the students rate my overall teacher effectiveness as very good (VG) or excellent (E; 62%); 82% give a VG or E to my courses overall as learning experiences; and 84% give one of the top two responses when asked whether they gained a good understanding of the course content. It's worth noting that the course I've mostly been giving at the lower-division level (ENGR/AMS 5; introductory statistics) is not easy to teach (mainly because almost all of the students are in the classroom not because they want to be there but because they have to be there). Note also that my ENGR/AMS 5 enrollments have been steadily increasing, from 99 to 124 to 168 to 209 (a 111% gain in four years). The graduate course I've been teaching, ENGR/AMS 206 (Bayesian statistics), is one of the core offerings for all AMS graduate students (it's also a required course for all bioinformatics graduate students from the Department of Biomolecular Engineering) and has the highest enrollment of all our graduate courses (averaging 30 students each time it's offered).

Table 1: *Summary of results of instructor evaluation surveys in all the classes I've taught at UCSC.*

ENGR/ AMS Course	Q	n_P/n_E (%)	Instructor's Overall Effectiveness As a Teacher			Course Overall as a Learning Experience			I Gained a Good Understanding of the Course Content		
			VG	E	Total	VG	E	Total	SoA	StA	Total
181 (U)	S01	11/11 (100%)	9%	91%	100%	18%	73%	91%	55%	36%	91%
5 (L)	F01	70/99 (71%)	41%	42%	83%	42%	30%	72%	46%	37%	83%
206 (G)	W02	28/30 (93%)	11%	85%	96%	7%	89%	96%	52%	48%	100%
5 (L)	F02	102/124 (82%)	18%	79%	97%	41%	48%	89%	36%	54%	90%
206 (G)	W03	39/39 (100%)	18%	82%	100%	28%	64%	92%	34%	54%	88%
206 (G)	W04	27/36 (75%)	15%	85%	100%	33%	63%	96%	35%	62%	97%
88A (L)	W04	6/7 (86%)	33%	50%	83%	33%	33%	67%	50%	33%	83%
5 (L)	W04	132/168 (79%)	44%	50%	94%	47%	31%	88%	44%	41%	85%
206 (G)	W05	21/28 (75%)	6%	94%	100%	21%	79%	100%	42%	47%	89%
88B (L)	S05	1/2 (50%)	0%	100%	100%	100%	0%	100%	100%	0%	100%
5 (L)	S05	148/209 (71%)	36%	51%	87%	48%	28%	76%	43%	31%	74%
Mean (L)	[Total]	[459/609 (75%)]	35%	56%	91%	45%	34%	79%	42%	40%	82%
Mean (U)	[Total]	[11/11 (100%)]	9%	91%	100%	18%	73%	91%	55%	36%	91%
Mean (G)	[Total]	[115/133 (86%)]	13%	86%	99%	23%	73%	96%	40%	53%	93%
Mean [Total]		[585/753 (78%)]	30%	62%	92%	40%	42%	82%	42%	42%	84%

Notes: (1) n_E and n_P are the numbers of students enrolled in the class and participating in the instructor evaluation survey, respectively; Q is quarter. (2) VG, E, SoA, and StA stand for Very Good, Excellent, Somewhat Agree, and Strongly Agree, respectively.

- **Other teaching and graduate supervision.** During this review period, in addition to supervising 5 UCSC graduate students (2 M.S., 3 Ph.D.; 1 M.S. and 1 Ph.D. completed; 1 M.S. and 2 Ph.D. ongoing), I served on 1 Ph.D. thesis committee and 5 Ph.D. qualifying exam committees.
  - Ph.D. co-supervisor (with Thanasis Kottas) (2001–2005): M Krnjajić (statistics).
  - Ph.D. co-supervisor (with R Vrijenhoek) (2003–present): R Young (biology).
  - M.Sc. supervisor (2005–present): J Wallerius (statistics).
  - Member, Ph.D. thesis committee (2001–03): R Karchin (bioinformatics).
  - Ph.D. qualifying exam committee (2004): V Kumar (physics).
  - Ph.D. qualifying exam committee (2004): X Shi (computer science).
  - Ph.D. qualifying exam committee (2004): J Masters (computer science).
  - Ph.D. qualifying exam committee (2004): R Gramacy (statistics).
  - Ph.D. supervisor (2004–present): P Towbin (statistics).
  - Ph.D. qualifying exam committee (2005): Weining Zhou (statistics).

3 The big picture

3.1 Research

Since this document will be read by people who are not specialists in my field as well as those who are, I'll start with a basic introduction to my work and will go into technical detail later. As mentioned in the previous section, numbers in $\boxed{\text{boxes}}$ refer to the sequential publication numbering in Section I. on the `writings.html` web page, where all of the writings mentioned here may be found in PDF format.

I'm a statistician interested in developing new theories and methodologies in the context of a wide variety of applications. In contrast to, say, pure mathematics, statistics is an inherently applied field: basic research in statistics is ultimately dedicated to establishing better methods by which to help other people make significant progress on important problems in science, industry and other applied realms. In my work I typically find myself with one foot firmly in methodology and the other firmly in applications; in fact the kind of work I value most highly begins with a substantial applied problem, develops methods useful to solving that problem, solves the problem, and then explores the broader operating characteristics of the method developed in this way. (There will be an echo of this approach in the section on teaching below.)

For me, *statistics* is the study of *uncertainty*: how to measure it, and what to do about it. *Probability* is the part of mathematics (and philosophy) devoted to the measurement of uncertainty, and *decision theory* is the field devoted to making choices in the face of uncertainty. Two main theories of probability have been developed in the last 350 years, the period of time in which uncertainty quantification has been an active part of science: *frequentist* and *Bayesian*.

- The frequentist approach defines probabilities in terms of long-run relative frequencies. This method has the drawback that, strictly speaking, it applies only to phenomena which are inherently repeatable in an independent manner under conditions as close to identical as possible (so-called *IID* sampling), such as spinning a well-balanced roulette wheel or drawing at random with replacement from a finite *population* (a collection of elements about which something of interest is unknown); but this approach has the advantage that it can lead to uncertainty assessments with verifiable levels of accuracy (an example is the familiar interpretation of a 95% *confidence interval* $\left(\hat{\theta}_{\text{lo}}, \hat{\theta}_{\text{hi}}\right)$ for some unknown summary θ of the population of interest: if sampling from the population is repeated in an IID manner and the interval of values on the real line $\left(\hat{\theta}_{\text{lo}}, \hat{\theta}_{\text{hi}}\right)$ is calculated for each sample, in the long run about 95% of these intervals will include θ). This approach appears at first sight to be *objective*, by which I mean that all people reasoning in the frequentist way will arrive at the same probability for a given repeatable *event A*, but in problems of realistic complexity such probabilities can only be computed by constructing a *statistical model* of the real-world situation under study—a statistical model is a mathematical framework for quantifying uncertainty about unknown quantities by relating them to known quantities—and the model-building process turns out in practice to inevitably contain at least some elements of judgment. Thus statistical work is inherently subjective, no matter which definition of probability underlies it.

- The Bayesian approach to quantifying your uncertainty about the truth value of a *proposition* A asks you to specify what odds you would need to give or receive in order to judge a bet about the truth of A to be fair. This method, which is unabashedly subjective, clearly has the advantage that it is, in principle, completely general: your (personal) Bayesian probability of A can be quantified for any A, not just for aspects of a repeatable process. But it also contains a potential drawback: there is no guarantee that the result you get by asking yourself about your betting odds on A will in any sense be "good." As with the frequentist approach, in problems of realistic complexity Bayesian probabilities can typically only be computed on the basis of a statistical model, but in addition to the subjectivity in the model-building process shared by both paradigms a second source of subjectivity arises in the Bayesian approach, as follows. Bayesian uncertainty assessments about an unknown population summary θ are based on conditional probabilities of the form $p(\theta \text{ given } D, \mathcal{A}) = p(\theta|D, \mathcal{A})$, where D is the available data and $\mathcal{A}$ formalizes the background assumptions and judgments on which the uncertainty assessment is based, and—in order for such assessments to be *coherent* (internally logically consistent)—such conditional probabilities mathematically depend on *prior* information $p(\theta|\mathcal{A})$, which quantifies what (if anything) is known about θ external to the collection of the data D. Different investigators may well have different prior information, or their judgments about how this information should be quantified may differ, which creates subjectivity in the process of specifying the prior information as well as in the model-building.

For the past 350 years there has been a (sometimes acrimonious) debate about which of these two paradigms is "best," an approach to framing the problem which forces people to choose between the two approaches. However, if the two definitions of probability are like boxers in a ring, it's an empirical fact that they've been punching it out for centuries and both are still standing. I take this to mean that there must be elements of merit in both paradigms, and that my job as a statistician is not to choose between the approaches but to create a fusion of them that emphasizes their strengths and de-emphasizes their weaknesses. **My personal fusion** involves reasoning in a Bayesian way when formulating my *inferences* and *predictions* (statements about unknown population summaries θ and future data values D^*, respectively) and reasoning in a frequentist way when evaluating the quality of these conclusions, by constructing predictive intervals for data values not used in the modeling process and keeping score about how often these intervals include the actual data values (this is a form of *predictive calibration*). As I put it in publication $\boxed{67}$,

> "I want to be *coherent* in my implementation of Bayes, but coherence by itself is not enough to guarantee that my Bayesian answer is a good answer to a real-world question (I am always free in the coherent Bayesian paradigm to insert extremely strong prior information that is, after the fact, seen to be out of step with the world, and if I do so my Bayesian solution will be poor indeed). This forces me to be guided, not only by coherence, but also by *calibration*: as a consultant I want to use Bayesian methods, because Bayes is the best paradigm so far invented for (a) quantifying all relevant sources of uncertainty in real-world problems and (b) effectively propagating that uncertainty through to the final solution to the problem, but if I want to get invited back to consult again (and again) I had better pay attention to how often I get the right answer (e.g., meteorologists who consistently get it wrong about when it will rain will quickly be ignored, or fired, or both), and this is a fundamentally calibrative activity."

In my research my most general goal is to find a workable fusion of the ideas of coherence and calibration, so that statisticians can use the most flexible approach available for uncertainty quantification—Bayesian—while at the same time having a good idea of how often they get the right answer. How to do this in a fully general and satisfying way in practice is still something of an open problem, even after more than 250 years of Bayesian thinking. Along with other people who are also working in this area, I believe I have made some progress on this problem, as specific details about my work will document in what follows.

3.1.1 A short bio

My path has been a bit non-standard for an academic, and my personal development as a statistician in relation to the frequentist-Bayesian foundational question has also been a bit unusual. After graduate work at Berkeley (1975–81) and a postdoc at the University of Chicago (1981–84), I spent seven years outside of academia at the RAND Corporation (1984–91), working on methods and applications in statistics (with the applications exclusively in medicine and health policy), and I then spent two years as a Visiting Professor at UCLA (1991–93). My first tenure-track-style position was at the University of Bath in England, where I was successively Lecturer (1993–95), Reader (1995–99), and Professor (1999–2001) before coming to UCSC in 2001 at Professor step IV (as noted in my CV, in the British academic system the part of the Lecturer scale I was at was roughly equivalent to an Associate Professor position in the U.S.; the Reader title is roughly equivalent to a junior full Professor; and [British] Professor corresponds roughly to a senior U.S. full Professor).

In the late 1970s and early 1980s Berkeley was a place where the word "Bayes" could not even be uttered out loud (the Statistics Department at Berkeley was founded in the late 1940s by Jerzy Neyman, one of the bastions of the 20th century frequentist paradigm, and he was still a major influence on the Department 25 years ago). I was always interested right from the beginning in the question "Where do statistical models come from, and how can we be honest about the fact that the model itself may also be unknown?", and it turns out that (a) this is an embarrassing question even to ask from the frequentist point of view and (b) it is a quite straightforward question to think about (although in the mid-1980s not to answer, for technical reasons) in the Bayesian paradigm. While at Chicago I began talking with Bayesians, and during the first few years at RAND I spent a lot of time teaching myself how to think like a Bayesian. As a result, although I finished my Ph.D. in 1981, I did not begin publishing until 1987; thus the effective length of my publication career so far is 18 years.

3.1.2 The big picture in writing, so far

To date I am the author or coauthor of 75 contributions to the scientific literature (numbered $\boxed{75}$ back to $\boxed{1}$ in Section I. of the `writings.html` web page), mainly in statistics, medicine and environmental studies: 1 article in progress, 3 books in progress, 4 books and monographs, 31 refereed articles in print or forthcoming, 4 submitted articles, 2 letters, 4 book chapters, 2 book reviews, 1 encyclopedia article, and 23 invited discussions. My work has been highly cited: as of October 2005, according to the `Web of Science`, my articles have been cited at least 2,223 times (mean 79 citations per article, median 56); 3 of my articles have been cited more than 200 times, 5 articles more than 150 times, 11 more than 100 times, and 15 more than 50 times. For comparison, a random sample of `Web of Science` entries indicates that the median number of citations of a paper in a leading statistics journal 10 years after publication is only 4 (95% interval, 0–12); this should not come as much of a surprise, given the sheer volume of published articles. My most highly referenced paper, $\boxed{25}$, has so far been cited 238 times, by researchers working in 44 different fields, in journals published in Australia, Canada, China, France, the Netherlands, New Zealand, Sweden, the U.K. and the U.S.; this paper was one of the founding works for the sub-field of *Bayesian model uncertainty and model averaging*.

A key observation about discussions in statistics and medicine, for those who don't know these fields: open discussion of ideas in the literature plays an incredibly important part in published statistical research, probably because central foundational questions about {Bayesian, frequentist, Bayesian+frequentist} are still being worked out, and also in medical research, probably because there is so much at stake. It's a big honor (a) to have a discussion paper published, as well as (b) to be invited to contribute to the discussion of such a paper; articles of this type are singled out for their importance in methodology (statistics, medicine) and/or clinical and policy implications (medicine).

I have so far authored or co-authored 18 discussion papers:

- 3 ($\boxed{61}$, $\boxed{25}$, $\boxed{21}$) in the *Journal of the Royal Statistical Society*, one of the top publication venues in statistics (not many people have three or more discussion papers in *JRSS*);
- 10 ($\boxed{20}$, $\boxed{18}$, $\boxed{17}$, $\boxed{16}$, $\boxed{15}$, $\boxed{14}$, $\boxed{13}$, $\boxed{12}$, $\boxed{11}$, $\boxed{9}$) in the *Journal of the American Medical Association* and 1 ($\boxed{1}$) in the *New England Journal of Medicine*, arguably the top two medical journals in the U.S. (again, not many statisticians have 11 or more discussion papers in medical journals of this quality); and
- 1 each in *Bayesian Analysis* ($\boxed{64}$), the premier international Bayesian journal (recently founded in 2004); the *IEEE Expert* ($\boxed{37}$), a leading venue for exchange of research ideas in engineering; *Statistical Science* ($\boxed{5}$), one of the top two or three review journals in statistics; and the *Journal of Educational and Behavioral Statistics* ($\boxed{24}$), a leading methodology journal at the interface between education and psychology.

As noted above it has also been my honor to contribute to 23 invited discussions. As anyone who has written one or more of these things knows, it can be at least as much work to do a good job on an invited discussion as finishing one of your own papers. Space is often severely limited in discussions of this type (e.g., *JRSS* often limits people to half a page), but I have contributed original ideas and results from my own unpublished research in many of my invited discussions: publications $\boxed{67}$ (4 pages), $\boxed{51}$ (5 pages), $\boxed{48}$ (4 pages), $\boxed{44}$ (2 pages), $\boxed{41}$ (3 pages), $\boxed{33}$ (3 pages), $\boxed{29}$ (8 pages), $\boxed{27}$ (2 pages), and $\boxed{2}$ (8 pages) are good examples. Citation data on discussion contributions are not available, but an idea of the readership of my discussions can be gained from noting that to date the mean number of citations per paper for the papers on which I have served as an invited discussant is 78.

Basic themes in my research. Looking across the arc of my entire career to date, my work falls into one or more of 17 basic themes, 14 methodological and 3 applied. (Numbers in $\boxed{\text{boxes}}$ refer as usual to the publication numbers in Section I. of the `writings.html` web page; Gx and Dy refer to item x under the numbered grants list in my CV and item y in Section III. at the web page just mentioned; and Hz refers to item z in the list of honors and awards in the relevant section of the CV, if they were numbered in the order in which they appear on pp. 2–3 of the CV.)

- Methodology:
  - **Bayesian hierarchical/multilevel modeling** ($\boxed{75}$, $\boxed{74}$, $\boxed{66}$, $\boxed{64}$, $\boxed{57}$, $\boxed{53}$, $\boxed{52}$, $\boxed{51}$, $\boxed{42}$, $\boxed{34}$, $\boxed{24}$, $\boxed{23}$, $\boxed{5}$, $\boxed{3}$, G6, D7, D3, D2, H8, H10, H12). With a number of my Ph.D. students from Bath and UCSC I have made a variety of contributions to the basic literature on Bayesian hierarchical/multilevel modeling. The best way to ensure that your ideas get used in science is to give people software embodying those ideas; for example, my Bath Ph.D. student William Browne and I are the co-developers of the MCMC capabilities in the hierarchical/multilevel modeling package `MLwiN`, which currently (October 2005) has a user base of more than 3,000 people worldwide (more on MCMC below). Browne and I have also recently demonstrated ($\boxed{64}$) in a discussion paper that a popular frequentist method for fitting a particular form of hierarchical/multilevel model (random-effects logistic regressions) can be poorly calibrated, whereas the Bayesian fitting of such models is almost perfectly calibrated.
  - **Bayesian methods for institutional quality assessment in medicine, education, and business** ($\boxed{61}$, $\boxed{56}$, $\boxed{50}$, $\boxed{47}$, $\boxed{46}$, $\boxed{33}$, $\boxed{20}$, $\boxed{19}$, $\boxed{18}$, $\boxed{17}$, $\boxed{16}$, $\boxed{15}$, $\boxed{14}$, $\boxed{13}$, $\boxed{12}$, $\boxed{11}$, $\boxed{10}$, $\boxed{9}$, $\boxed{8}$, $\boxed{7}$, $\boxed{6}$, $\boxed{4}$, $\boxed{1}$, G13, G12, G9, G7, G5, D9). From my earliest days at RAND I have been deeply interested in how to measure the quality with which a hierarchical institution such as a hospital, a university, or a company carries out its public or private mandate.
    - I was a member of a team at RAND in the late 1980s and early 1990s that did pioneering work on the measurement of quality of hospitalized health care ($\boxed{1}$, $\boxed{4}$, $\boxed{6}$, $\boxed{7}$, $\boxed{8}$, $\boxed{9}$, $\boxed{10}$, $\boxed{11}$, $\boxed{12}$, $\boxed{13}$, $\boxed{14}$, $\boxed{15}$, $\boxed{16}$, $\boxed{17}$, $\boxed{18}$, $\boxed{19}$, $\boxed{20}$). One of our biggest projects was the *DRG Quality of Care Study*, a five-year $7,500,000 study examining the quality of care offered to elderly patients by hospitals in the U.S. before and after a major change in governmental reimbursement method, which was suspected of causing a decrease in quality of care.
    - I was co-PI on a major grant (G5; $547,420 over 1 year) from Eurostat to advise the European Community on best-practice methodology in the design and analysis of complex sample surveys in business ($\boxed{46}$, $\boxed{47}$, $\boxed{50}$).
    - From 1998 to the present I have served as a statistical advisor to the U.K. Higher Education Funding Council for England (HEFCE). In this capacity I have provided guidance on the creation and appropriate calibration of *performance indicators for higher education*, which are measures of process and outcome for U.K. universities (such as student dropout rates) which help the U.K. government judge the extent to which these universities carry out their public educational mandate successfully. My Bath Ph.D. student Mark Gittoes and I developed methods for properly calibrating the discrepancies between observed and expected dropout rates, which HEFCE have been using since 2000 in their annual publications documenting the performance of all

of the U.K.'s universities (see `www.hefce.ac.uk/pubs` for details). This work led to a major discussion paper at the *Journal of the Royal Statistical Society* (61).

- **Bayesian methods for risk assessment in environmental studies and medicine** (55, 43, 40, 25, 13, 8, 7, 6, 1, G14, G9, G7, G3, D11, D10).
  - While at Bath I served as co-PI on another major grant (G3; $558,327 over 3 years), this one from the European Commission to perform model uncertainty and sensitivity analysis calculations in risk assessment studies of groundwater contamination from nuclear waste repositories. My colleagues from Italy, Spain, and Sweden and I developed new methods for calculating the contribution to the overall uncertainty arising from lack of knowledge about the *scenario* under which the underground nuclear storage facility might fail; these methods have had a significant influence on how the European Union plans its nuclear waste risk assessment studies (25, 40, 43, 55). My post-doctoral research associate Bruno Mendes and I continue to work on this topic today.
  - While at RAND I was part of a team that developed improved methodology for assessing the risk of death within 30 days of admission for elderly hospitalized patients as a function of how sick they were on admission to the hospital; this work was fundamental to efforts at the Health Care Financing Administration (HCFA), the part of the U.S. government that ran the Medicare system until the late 1990s, to measure the appropriateness (or lack thereof) of hospital-level mortality rates as an indirect marker of quality of care (1, 6, 7, 8, 13). Since these early efforts a Ph.D. student and I have developed improved methods of measuring admission sickness that take account of data collection costs (see the items below on Bayesian decision theory and stochastic optimization).
- **Markov chain Monte Carlo (MCMC) methods** (75, 66, 57, 52, 41, 37, 36, 34, G6, D12, D7, D5). The Bayesian approach to inference and prediction in complicated problems has a core technical difficulty: the accurate approximation of high-dimensional integrals. In the late 1980s the statistics profession discovered that what are now called *Markov chain Monte Carlo* (MCMC) algorithms, developed by physicists and chemists in the 1940s, could be used to solve this computational problem, and this discovery came at a moment when computers finally became fast enough for MCMC methods to be practical. The confluence of these two key developments has created a revolution in Bayesian statistical practice. As mentioned above, my Bath Ph.D. student William Browne and I have equipped `MLwiN`, a widely-used package for hierarchical/multilevel modeling, with MCMC capabilities; we did this by implementing an adaptive hybrid Metropolis-Gibbs MCMC strategy and demonstrating (52, 57, 66) its superiority in Monte Carlo efficiency to other MCMC algorithms.
- **Model uncertainty and Bayesian model averaging** (75, 69, 65, 51, 35, 32, 27, 25, G14, G6, G2). As mentioned above, I was one of the founders (25) of the contemporary sub-field of assessment and propagation of uncertainty in the statistical model itself, via a technique called *Bayesian model averaging*, and I continue to work in this field (69). The practical bottom-line in paying attention to model uncertainty is better-calibrated uncertainty assessments that more fully take account of all relevant sources of uncertainty, and this translates into better decision-making because people are

better able to hedge against the real uncertainty they face (see **Bayesian decision theory** below).

- **Bayesian nonparametric modeling** ($\boxed{75}$, $\boxed{72}$, $\boxed{71}$, $\boxed{70}$, $\boxed{48}$, G8, G6, G4, D14, D13, D4, H14). In the Bayesian paradigm uncertainty about something not fully known by you is expressed by means of probability distributions, which quantify the possible values of the unknown thing and how plausible each of those values is. Bayesian statistical work in the 18th, 19th, and 20th centuries was characterized by progress in uncertainty quantification when the unknown thing is a number, or a vector, or a matrix, but for greatest realism in scientific applications it's necessary to make a quantum leap in sophistication by placing probability distributions on entire functions (curves). This is the field of Bayesian nonparametric (BNP) modeling, and I believe (along with a number of other statisticians) that it will be one of the most important topics[1] in 21st century statistics. I have made several contributions ($\boxed{48}$, $\boxed{70}$, $\boxed{71}$, $\boxed{72}$) to understanding the practical limitations and implementation difficulties of BNP modeling, including jointly supervising (with my colleague Athanasios Kottas) the AMS Department's first completed Ph.D. dissertation on this topic, which was recently completed by Milovan Krnjajić.
- **Bayesian decision theory** ($\boxed{75}$, $\boxed{71}$, $\boxed{68}$, $\boxed{59}$, $\boxed{54}$, $\boxed{49}$, $\boxed{31}$, $\boxed{29}$, G6, D8, D3). In addition to providing the most complete account of how to quantify uncertainty, the Bayesian paradigm offers the only approach to rational decision-making so far developed: *Bayesian decision theory*, which is based on quantifying the relative value to you of the uncertain consequences of your actions through a *utility function* and choosing the best action by *maximizing expected utility* (MEU). As noted above, a Bath Ph.D. student, Dimitris Fouskakis, and I have developed a method based on Bayesian decision theory for constructing, in a cost-effective fashion, a numerical scale that measures the sickness at admission of hospital patients; this method holds significant promise to improve care and save money at hospitals in the U.S. and abroad ($\boxed{54}$, $\boxed{59}$, $\boxed{68}$).
- **Bayesian model specification** ($\boxed{75}$, $\boxed{72}$, $\boxed{71}$, $\boxed{58}$, $\boxed{29}$, $\boxed{26}$, G6, D13). In any given applied problem there will be a variety of possible statistical models expressing the relationship between known and unknown quantities, and one of the key problems of Bayesian statistical work is specifying a particular choice for a model in a way that is both coherent and well-calibrated. It is my view that model specification is a decision-theoretic activity that should therefore be approached via maximizing expected utility. I have written several articles on this topic, including recent work ($\boxed{71}$, $\boxed{72}$) that I will continue to emphasize and develop.
- **Fusion of coherence and calibration** ($\boxed{75}$, $\boxed{67}$, $\boxed{44}$, $\boxed{37}$, $\boxed{29}$, G6). As noted in Section 3.1, I believe that a central challenge in any applied Bayesian analysis is to find an appropriate fusion of the ideas of coherence (internal consistency of probability assessments) and calibration (external validity of such assessments). $\boxed{67}$ contains my most recent published thinking on this point.
- **Causal inference and analysis of observational data** ($\boxed{63}$, $\boxed{61}$, $\boxed{60}$, $\boxed{39}$, $\boxed{33}$, D9). One of the key goals of much scientific work is the determination of valid causal

[1]It was part of my founding vision for the Statistics Group in AMS that one of our research specializations should be in Bayesian nonparametric methods, and my colleagues agree with me in this emphasis; in 2002 we hired a steller junior statistician who specializes in this field, Athanasios Kottas, and we plan several more hires in this area.

relationships: did this drug *cause* this patient's blood pressure to fall, or was this the effect of some other cause? **Randomized controlled trials** (RCTs), in which experimental subjects are randomly assigned to treatment and control groups, are the "Rolls Royce" of experimental design in many scientific fields, but it's not always possible, for ethical or other reasons, to run an RCT; an example arises in studying the relationship between smoking and adverse health outcomes such as lung cancer and heart disease in humans (it will always be unethical to assign people to a treatment group in which they're forced to smoke to see what will happen to their health). In such situations the best we can do is *observational studies*, in which subjects assign themselves to the treatment and control groups. Arriving at valid causal conclusions from observational data is, even today, after more than 100 years of thinking about it, a challenging statistical problem, because other variables may *confound* (get in the way of your understanding of what's really causing what). I've made several contributions to the literature in this field, including ([61]) the work mentioned above with HEFCE on identifying "good" and "bad" universities on the basis of their dropout rates (data of this type are inevitably observational).

- **Design and analysis of complex sample surveys** ([50], [47], [46], [41], [12], G5). The first challenging problem I undertook at RAND was to design the sampling plan for the *DRG Quality of Care Study* (described above under **Bayesian methods for institutional quality assessment**). The hierarchical design we eventually chose involved multi-stage cluster sampling with stratification and yielded a nationally representative data set with approximately 17,000 patients from 297 hospitals. I have had a continuing interest in how to design and analyze complex sample surveys of this type, and I have made some contributions to this field ([12], [46], [47], [50]), including ([41]) an examination of how MCMC methods can be used for finite-population inference.

- **Stochastic optimization** ([68], [59], [54], [45], D8). I argued above that rational decision-making is based on maximizing expected utility. However, the set over which this maximization must be performed can sometimes be enormous; for example, in the work with Dimitris Fouskakis described above on creating a cost-effective admission sickness scale, the space over which we needed to maximize had $2^{83} \doteq 10^{25}$ elements. Brute-force examination of all possibilities is not feasible with present computing power in problems of this type; instead, a promising approach involves the use of *stochastic optimization* techniques, which use randomness to guide your wandering around in the space over which you're maximizing in a way that makes it likely you will find a good (near-optimal) solution in a reasonable amount of computer time. Fouskakis and I have made several contributions to this field ([45], [54], [59], [68]).

- **Exchangeability** ([38], [22], [21], [2]). An utterly basic judgment in Bayesian modeling arises when you recognize that your uncertainty about two or more unknown quantities is similar. For example, if I'm trying to predict the mortality status (within 30 days of admission) of the next 400 patients, starting from 1 Jan 2006, at the Dominican Hospital in Santa Cruz with admission diagnoses of heart attack, and if I have no other information about these patients, I recognize that my uncertainty about the outcome for patient 24 is the same as for patient 42, and indeed if someone were (behind my back) to relabel the order in which the patients arrive in my data set, my combined uncertainty about all of them would remain the same. A great statistician, Bruno de Finetti, called this a judgment of *exchangeability* of (my uncertainty about) these patients. Exchangeability has profound consequences for Bayesian modeling, and indeed a remarkable result proved by de Finetti implies the inevitability of Bayesian nonparametric modeling under exchangeability. I have made several contributions to this field ([2], [22], [38]), including ([21]) a prominent discussion paper read before the Royal Statistical Society.

– **Dynamic linear modeling** (G15). I am now working with a physician at Kaiser Research, Dr. Gabriel Escobar, on developing novel clinical and statistical methods, involving *dynamic linear modeling* (a technique from *time series analysis*), to take advantage of the Kaiser hospital chain's soon-to-be-available electronic clinical data base to create dynamically-updated severity of illness scores for newborn babies in the first 72 hours of life. Current best practice involves waiting at least 24 hours after birth and taking the worst value of each clinical variable measured during that period as the basis for constructing the sickness score, but many acutely ill babies are already dead by then, and the point of the scale is to tell doctors how sick these babies are so that therapies that can save them may be implemented. Our idea is to use more dynamic methods of data analysis that permit moment-to-moment updating of the sickness score as new information becomes available. We have written a $1,670,000 grant proposal to the NIH to implement this plan.

- Applications:

  – **Medical applications** ([30], [28], [20], [19], [18], [17], [16], [15], [14], [13], [12], [11], [10], [9], [8], [7], [6], [4], [1], G15, G12, G9, G7, D6, D1). I have been involved in a wide variety of medical applications so far in my career, including

    * a study of the extent to which hospital mortality rates predict hospital quality of care ([1], [4]);
    * a project that measured sickness at admission and predicted death status for elderly (Medicare) patients with one or more of four high-mortality diseases, and used this sickness scale to help identify provisionally "good" and "bad" hospitals ([6], [7], [8]);
    * a study demonstrating that hospitals which treat a higher volume of AIDS patients have better outcomes ([9], [10]);
    * the DRG Quality of Care Study described above ([11], [12], [13], [14], [15], [16], [17], [18], [19], [20]);
    * a project showing that well-chosen subsets of standard instruments for measuring well-being in the elderly can produce scales with good reliability and validity and reduced respondent burden ([28]); and
    * a study that lays the groundwork for a full cost-benefit analysis of three leading methods for detecting osteoporosis, and demonstrates that *radiographic absorptiometry* holds promise as a practical and inexpensive method for screening for this disease ([30]).

  – **Environmental applications** ([55], [43], [40], G11, G3, D16, D11, D10). As noted above, I have also been involved in a project performing risk assessment for a particular method of underground storage of nuclear waste ([40], [43], [55]).

- **Biological applications** (D15, D5). I have recently begun a collaboration with Rob Young, a Ph.D. student in biology at UCSC, on *Bayesian estimation of cytonuclear disequilibria*. Nuclear-cytoplasmic covariances are measures of non-random associations of nuclear alleles or genotypes with cytoplasmic alleles. These covariances are informative about many evolutionary processes including admixture, migration in hybrid zones, genetic drift, selection and endosymbiont transmission. We extend existing frequentist methodology for estimating these covariances by developing a Bayesian algorithm that combines information on allele counts from previous studies with information gained from the current study, and we use a Monte Carlo methodology to estimate disequilibrium measures and to test hypotheses.

3.1.3 Honors and awards

In my career to date I have received a total of 9 honors for scholarship and research (the CV has full details); highlights include

- serving as President-Elect, President, and Past-President of the *International Society for Bayesian Analysis* (ISBA), 2001–2003 (This is the premier international research venue for Bayesian work);
- presenter of three discussion papers before the *Royal Statistical Society* (This is one of the top international research venues for the entire statistics profession. Only a handful of papers per year are singled out for this research honor);
- Fellowship and Chartered Statistician in the *Royal Statistical Society*;
- twice (1998 and 2004) winning the *Excellence in Continuing Education* award from the *American Statistical Association* (ASA) for research short courses on Bayesian hierarchical modeling I've given at ASA annual meetings (The ASA is another premier international research venue in statistics. Only one of these awards is given each year; in 2003 my research short course was chosen from among 34 such courses); and
- being chosen twice (2002 and 2005) as the presenter or co-presenter of the keynote 3–day research short course given at the *Annual Summer Institute of Applied Statistics* run by Brigham Young University, once for Bayesian hierarchical modeling and the second time for Bayesian nonparametric methods. (Only one person or set of co-presenters per year receives this research honor.)

3.1.4 Grants and contracts

So far since 1993 I have been PI or co-PI on a total of 13 grants totaling $1,763,512, and I currently have 2 pending grants totaling an additional $1,790,000 (the CV has details). Highlights include the following.

- (awarded) **Draper D**, Parmigiani G, West M (1995). *International Workshop on Model Uncertainty and Model Robustness.* $41,416 from the UK Engineering and Physical Sciences Research Council (EPSRC), the US National Science Foundation, and the University of Bath, to run an

International Workshop on Model Uncertainty and Model Robustness in Bath, June 30–July 2, 1995. The Workshop brought together 88 researchers from 15 countries for 18 invited talks, 9 invited discussions, and 46 posters;

- (awarded) **Draper D**, Pereira A, Prado P, Saltelli A (1996). ***GESAMAC**: Conceptual and Computational Tools to Assess the Long-Term Risk from Nuclear Waste Disposal in the Geosphere*. \$558,327 over 3 years from the European Commission (for a postdoctoral Research Officer, equipment, and travel), to perform model uncertainty and sensitivity analysis calculations in risk assessment studies of groundwater contamination from nuclear waste repositories, Jan 1996–Dec 1998;

- (awarded) Chambers R, **Draper D**, Jones T, Nordberg L, Skinner C (1998). *Model Quality Reports in Business Statistics*. \$547,420 over 1 year from Eurostat (for a postdoctoral Research Officer, equipment, and travel), to advise the European Community on best-practice methodology in the design and analysis of complex sample surveys, Jan–Dec 1998;

- (awarded) **Draper D** (2002). *International Workshop on Bayesian Data Analysis*. \$88,367 from (among other funders) the US National Science Foundation, the University of California (Santa Cruz), NASA Ames Research Laboratories, and CTB/McGraw-Hill to run an International Workshop on Bayesian Data Analysis in Santa Cruz, 8–10 Aug 2003. This Workshop brought together approximately 160 researchers from 15 countries on 5 continents for 26 invited talks and 75 posters; electronic proceedings are available at `www.ams.ucsc.edu/bayes03`, which has so far been visited more than 11,400 times;

- (pending) **Draper D**, Gearhart C (2005). *Bayesian statistical modeling of the relationship between air quality and mortality: In pursuit of accurate uncertainty bands and better environmental policy*. \$120,000 requested from the University Research Program at Ford Motor Company, for improved analysis (via Bayesian model averaging and hierarchical modeling) of the relationship between air quality and mortality, Mar 2006–Feb 2008; and

- (pending) Escobar G, **Draper D**, et al. (2005). *Sepsis and critical illness in babies* $\geq$ 34 *weeks gestation*. \$1,670,000 requested from the National Institute of Child Health and Human Development (a branch of the National Institutes of Health, January 2006–December 2008. Proposes novel clinical and statistical methods, involving dynamic linear modeling, to take advantage of the Kaiser hospital chain's soon-to-be-available electronic clinical data base to create dynamically-updated severity of illness scores for newborn babies in the first 72 hours of life. I am the lead statistical consultant on this project.

3.1.5 Outside professional activities

Public lecture or forum participation. As noted in Section 2, I believe strongly that dissemination of research findings to the broadest possible audience is crucial, and I back up this belief by frequently giving research short courses on Bayesian methods. From 1994 to the present I have given 26 such courses to a total of about 1,800 participants in Brazil, Canada, Finland, India, New Zealand, Switzerland, the U.K. and the U.S. These courses vary in length from 6 to 30 hours of material, and have included the following (highlighted presentations are underlined).

- *Bayesian modeling, inference and prediction* (University of Bern, Switzerland (1994); Philadelphia Chapter, American Statistical Association, Philadelphia PA (2004); Pratt & Whitney, East Hartford CT (2004); Biological Sciences, University of California, Berkeley, Berkeley CA (2004); Boston Chapter, American Statistical Association, Cambridge MA (2004); Chicago Chapter, American Statistical Association, Cambridge MA (2005));

- *Bayesian hierarchical modeling* (American Statistical Association annual meetings (1997, 1998); 32nd Symposium on the Interface: Computing Science and Statistics, New Orleans LA (2000); Pfizer UK Ltd, Sandwich, England (2000); 7th School of Linear Models, São Carlos, Brazil (2001); 27th Annual Summer Institute of Applied Statistics, Brigham Young University, Provo UT (2002));

- *Intermediate and advanced Bayesian hierarchical modeling* (ASA annual meetings (1998, 2003, 2004); American Statistical Association LearnSTAT Program, Alexandria VA (2004));

- *MCMC methods in multilevel modeling* (University of London (1998));

- *Hierarchical modeling for profiling in health and education* (International Conference on Health Policy Research, Boston MA (2001, 2005));

- *Bayesian and likelihood-based methods in multilevel modeling* (EpiCentre, Massey University, New Zealand (2002));

- *Bayesian inference and hierarchical modeling* (U.S. Centers for Disease Control and Prevention, Atlanta GA (2003));

- *Bayesian inference, prediction and decision-making, with applications to risk assessment* (National Veterinary and Food Research Institute of Finland, Helsinki (2004));

- *Bayesian statistical methods and hierarchical modeling* (Division of Research, Northern California Kaiser Permanente, Oakland CA (2004));

- *Concepts, trends and applications of frequentist and Bayesian statistics in the healthcare and pharmaceutical industries* (Aventis Pharmaceuticals, Somerset NJ (2004));

- *Bayesian model specification and hierarchical modeling* (International Conference on Bayesian Statistics and Its Applications, Banaras Hindu University, Varanasi, India (2005));

- *Intermediate Bayesian modeling, with applications in ecology* (Purdue University, West Lafayette IN (2005)); and

- *Practical Bayesian nonparametric methods* (30th Annual Summer Institute of Applied Statistics, Brigham Young University, Provo UT (2005)).

Papers presented at professional meetings. As noted in Section 2, in statistics, as in other fields, this category is an indication of the extent to which leading researchers view the work of the person invited to speak as important and timely. Since 1993 I have given a total of 45 invited, special invited, and plenary talks (28 invited, 4 special invited, 13 plenary) at major international statistics meetings in Brazil (3), China (1), Chile (2), Czechoslovakia (1), Denmark (1), Germany (1), Greece

(2), Holland (2), India (1), Italy (2), Portugal (1), Spain (3), Switzerland (1), Singapore (1), the U.K. (11) and the U.S. (12); details are given in the CV.

The 11 broad topics on which I've been invited to speak at international meetings have been as follows (some talks covered more than one topic; highlight talks are underlined).

- *Model uncertainty*: International Workshop on Hierarchical Modeling (1993, Brazil); International Workshop on Bayesian Modeling (1994, Spain); International Society of Bayesian Analysis (ISBA) World Meeting (1994, Spain); European Meeting of Statisticians (1995, Denmark); International Workshop on Stochastic Modeling in Meteorology (1996, U.K.); International Workshop on Statistical Modeling (1997, Switzerland); International Conference on Sensitivity Analysis of Model Output (SAMO98) (1998, Italy);

- *Bayesian nonparametric methods*: Highly Structured Stochastic Systems (HSSS) International Workshop on Variable-Dimension MCMC Methods (1997, U.K.); International Statistical Symposium (1998, Taiwan); 4th Conference of the International Chinese Statistical Association (1998, China); Highly Structured Stochastic Systems (HSSS) International Workshop on Graphical Modeling (1998, Italy); International Workshop on Statistical Modeling (1998, U.K.); International Workshop on Bayesian Nonparametric Methods (1999, U.K.); International Society for Bayesian Analysis (ISBA), Sixth World Meeting (2000, Greece); 7th School of Linear Models (2001, Brazil); European Meeting of Statisticians (2001, Portugal); 7th Valencia International Meeting on Bayesian Statistics (2002, Spain);

- *Bayesian hierarchical modeling*: International Workshop on Hierarchical Modeling (1993, Brazil); International Meeting on Multilevel Modeling (1999, Holland); 3rd European Conference on Principles and Practice of Knowledge Discovery in Databases (PKDD '99) (1999, Czechoslovakia); International Society for Bayesian Analysis (ISBA), Sixth World Meeting (2000, Greece); 7th School of Linear Models (2001, Brazil); International Society for Bayesian Analysis (ISBA), 2004 World Meeting (2004, Chile);

- *Bayesian model specification*: International Meeting on Model Selection (1993, Mathematisches Forschungsinstitut Oberwolfach (Germany)); International Society for Bayesian Analysis (ISBA), 2004 World Meeting (2004, Chile); International Conference/Workshop on Bayesian Statistics and Its Applications (2005, India); International Seminar on Bayesian Inference in Econometrics and Statistics (2005, U.S.); 25th International Workshop on Bayesian Inference and Maximum Entropy Methods in Science and Engineering (2005, U.S.);

- *Markov chain Monte Carlo methods*: Joint Statistical Meetings (1996, U.S.); COMPSTAT 2000 (2000, Holland); SAMSI Workshop on Challenges in Stochastic Computation (2002, U.S.); Joint Statistical Meetings (2003, U.S.); International Workshop on Markov Chain Monte Carlo: Innovations and Applications in Statistics, Physics, and Bioinformatics (2004, Singapore);

- *Risk assessment*: Highly Structured Stochastic Systems (HSSS) International Workshop on Graphical Modeling (1998, Italy); Interface 2000 (2000, U.S.); EPSRC International Workshop on Statistical Analysis of Computer Code Output (2000, U.K.); International Society for Bayesian Analysis (ISBA), Sixth World Meeting (2000, Greece); Interface 2001 (2001, U.S.); SAMSI Workshop on Inverse Problem Methodology In Complex Stochastic Models (2002, U.S.);

- *Institutional quality assessment*: Royal Statistical Society Social Statistics Section (2000, U.K.); International Conference on Health Policy Research (2001, U.S.); Joint Statistical Meetings (2002, U.S.); Royal Statistical Society Meeting on Performance Monitoring and Surveillance (2003, U.K.); Analytic Strategies for Nursing Databases: A Collaborative Conference from the National Nursing Quality Database Consortium (2004, U.S.);

- *Causal inference*: Royal Statistical Society Research Conference (1996, U.K.); Royal Statistical Society Research Conference (1998, U.K.);

- *Bayesian decision theory*: 3rd European Conference on Principles and Practice of Knowledge Discovery in Databases (PKDD '99) (1999, Czechoslovakia); International Conference on Health Policy Research (2001, U.S.);

- *Stochastic optimization*: Joint Statistical Meetings (1998, U.S.); International Conference on Health Policy Research (2001, U.S.); and

- *Bayesian methods in the social sciences*: International Meeting on Statistics in the Social Sciences (1996, U.K.).

Editorial or board service to publications. So far in my career I have served as Associate Editor for a number of the top methodology and applications journals in statistics:

- Associate Editor (Theory and Methods), *Journal of the American Statistical Association*, 1988–1991.

- Associate Editor (Applications and Case Studies), *Journal of the American Statistical Association*, 1988–1994.

- Member, Editorial Board, *ASA-SIAM Series on Statistics and Applied Probability*, 1993–1995.

- Member, *Royal Statistical Society Research Section Committee* (responsible for editorial decisions on Discussion Papers), 1995–1998.

- Associate Editor, *Journal of the Royal Statistical Society, Series B*, 1995–1997.

- Associate Editor, *Health Services and Outcomes Research Methodology*, February 1996–present.

I have not been able to agree to many duties of this type while serving as founding Chair of AMS, but I look forward to resuming editorial duties in the future once my term as Chair finishes.

Outside creative activity. These fall into three categories: invited talks at leading statistics departments, service on NSF research review panels, and international conferences organized.

- From Oct 1993 to the present I gave 66 invited talks to statistics departments, Royal Statistical Society gatherings, and other leading statistical organizations in the UK, US, Austria, Germany, Spain, and Israel (Bristol (3), Manchester (2), Seattle (2), Newcastle, Vienna, Kent, Graz, Dundee, Glasgow, Aberdeen, Edinburgh (2), Leeds (2), Southampton, Berlin, Warwick, Oxford (4), Birmingham, Avon, Cambridge (2), Madrid, Geneva, Leicester, Exeter, UCLA, the RSS Medical Section, Imperial College (2), Jerusalem (2), Haifa, Tel Aviv, University College London, AEA Technologies plc, the RSS Environmental Statistics Study Group, Durham, Stanford (2), Santa Cruz, Nottingham, Bath (2), Open, UCAS/HESA, Lancaster, the RSS Social Statistics Section, Berkeley, Sandia National Laboratories, CTB/McGraw-Hill, Seattle, Davis, the Naval Postgraduate School, USC, NASA Ames, the Wharton School at the University of Pennsylvania, the RAND Corporation, the University of Helsinki; the University of California, Santa Barbara; and the National Technical University of Athens), wrote 63 referee reports for leading international journals and book publishers based mainly in the US and UK, refereed 12 EPSRC and NSF grant applications, and helped to adjudicate the tenure and promotion cases for 11 academic statisticians in the US and Canada.

- Participation in research review panels for the National Science Foundation (NSF):

  - In November 2001 I was one of eight experts chosen to serve on an NSF site visit panel to evaluate a $10 million proposal by researchers at Duke University, the University of North Carolina (Chapel Hill), and North Carolina State University to found the Statistical and Mathematical Sciences Institute (SAMSI), which was funded (see `www.samsi.info` for details).

- International conferences organized to date:

IC1 Co-organizer of *International Workshop on Model Uncertainty and Model Robustness*, Bath (UK), June-July 1995 (see **Grant Support** above).

IC2 Organizer of half-day Royal Statistical Society Research Section meeting on *Design and Analysis of Complex Sample Surveys*, London, May 1997.

IC3 Co-organizer of *International Workshop on Stochastic Model-Building and Variable Selection*, Duke University, October 1997.

IC4 Co-organizer of *Bayesian Nonparametrics International Workshop*, University of Michigan, July 2001.

IC5 Co-organizer of *International Workshop on Bayesian Data Analysis*, University of California, Santa Cruz, Aug 2003 (see **Grant Support** above).

IC6 Member, Advisory Committee, *International Conference on Bayesian Methods and Applications*, Banaras Hindu University, Varanasi, India, Jan 2005.

I am particularly proud of IC1 (which helped to put both the Statistics Group at the University of Bath and the research topic of Bayesian model uncertainty on the map) and IC5 (which similarly greatly increased the visibility of the Statistics Group within AMS in the Bayesian world). Both of these conferences were my idea, and I was responsible for getting most or all of the grant money to make them happen.

Graduate students. To date I have supervised or co-supervised 13 graduate dissertations (7 Ph.D., 6 M.S./M.Sc./M.Phil.), of which 2 have been at UCSC (1 Ph.D., 1 M.S.), and I currently am supervising or co-supervising an additional 3 graduate dissertations (2 Ph.D., 1 M.S.), all 3 of which are at UCSC.

- *Health and social support in the elderly.* K Raube, RAND Graduate School of Policy Studies (Ph.D., 1991). (She is now Adjunct Professor and Executive Director of the Graduate Program in Health Management at the Haas School of Business in the University of California, Berkeley.)

- *Topics in hierarchical modeling.* W Browne, Department of Mathematical Sciences, University of Bath (M.Sc., 1995, with distinction); recipient, James Duthie Prize for best M.Sc. Dissertation, University of Bath, 1995. (He is now a Lecturer (equivalent to an Assistant Professor in the US) in the Division of Statistics within the School of Mathematical Sciences at the University of Nottingham (UK).)

- *Variable selection via hierarchical modeling and utility*, D Fouskakis, Department of Mathematical Sciences, University of Bath (M.Sc., 1996, thesis with distinction). (He is now a Lecturer in the Department of Mathematics at the National Technical University of Athens (Greece).)

- *Fixing the broken bootstrap.* C McKail, Department of Mathematical Sciences, University of Bath (M.Sc., 1997). (He now works at a leading software company in the London area.)

- *Markov chain Monte Carlo methods for inference on family trees.* R Cheal, Department of Mathematical Sciences, University of Bath (Ph.D., 1997). Internal and external examiners: C Jennison and W Gilks (respectively). (He is now a postdoc in the Statistics Group within the Department of Mathematical Sciences at the University of Bath (UK).)

- *Cardiac mortality and dietary risk factors: Survival analysis with time-varying covariates.* D Kounali, Department of Mathematical Sciences, University of Bath (M.Sc., 1998). (She is currently finishing a Ph.D. in statistics at the University of Southampton (UK).)

- *Applying MCMC methods to multi-level models.* W Browne, Department of Mathematical Sciences, University of Bath (Ph.D., 1999). Dr. Browne's dissertation was nominated for the 1999 Savage Award for best Bayesian Ph.D. dissertation in the world. Internal and external examiners: A Robinson and D Spiegelhalter (respectively).

- *Stochastic optimization for cost-effective quality assessment in health.* D Fouskakis, Department of Mathematical Sciences, University of Bath (Ph.D., 2000). Dr. Fouskakis was short-listed for the 1999 Ede and Ravenscroft Research Prize at the University of Bath, and his dissertation was nominated for the 2001 Savage Award and the 2003 Lefkopouleion Award for the best statistics Ph.D. dissertation in Greece. Internal and external examiners: M Hurn and S Richardson (respectively).

- *Statistical analysis of performance indicators in UK higher education.* M Gittoes, Department of Mathematical Sciences, University of Bath (Ph.D., 2001). Internal and external examiners: A Robinson and H Goldstein (respectively). (He is now a Member of the Technical Staff at the Higher Education Funding Council for England (HEFCE) in Bristol (UK).)

- *Functional data analysis: modeling of groundwater contamination.* B Mendes, Department of Mathematical Sciences, University of Bath (M.Phil., 2002). (He is now pursuing postdoctoral studies with me at UCSC.)

- *Uncertainties in modeling groundwater contamination.* B Mendes, Department of Physics, University of Stockholm (Ph.D., 2003; co-advisor with A Pereira).

- *Mirror-jump sampling: a strategy for MCMC acceleration.* S Liu, Department of Computer Science, University of California, Santa Cruz (M.S., 2003). (She is now working toward a Ph.D. in the Department of Biostatistics at the University of Michigan.)

- *Contributions to Bayesian statistical analysis: model specification and nonparametric inference.* M Krnjajić, Department of Applied Mathematics and Statistics, University of California, Santa Cruz (Ph.D., September 2005; co-advisor with Thanasis Kottas). (He now has a post-doctoral position at the Lawrence Livermore National Laboratories.)

- *Bayesian nonparametric modeling for well-calibrated location and scale inferences with skewed and long-tailed data.* J Wallerius, Department of Applied Mathematics and Statistics, University of California, Santa Cruz (M.S. anticipated, 2006).

- *Bayesian estimation of cytonuclear disequilibria under models of immigration and epistatic mating.* R Young, Department of Ecology and Evolutionary Biology, University of California, Santa Cruz (Ph.D. anticipated, 2006; co-advisor with R Vrijenhoek).

- *Mathematical and statistical models of cooperation and conflict in environmental resource use.* P Towbin, Department of Applied Mathematics and Statistics, University of California, Santa Cruz (Ph.D. anticipated, 2008).

Postdoctoral research associates. To date I have supervised 3 postdoctoral research associates, 2 at the University of Bath and 1 at UCSC (in progress).

- *Model uncertainty and sensitivity analysis in risk assessment studies of groundwater contamination from nuclear power plants (GESAMAC).* Dr R Cheal, University of Bath (UK), Jan 1996–Dec 1998.

- *Measuring quality of uncertainty assessments in complex sample surveys.* Dr R Bowater, University of Bath (UK), Jan–Dec 1998.

- *Functional data analysis and risk assessment in environmental studies.* Dr B Mendes, University of California, Santa Cruz, Jan 2003–present.

3.1.6 Research: concluding comments

- I believe it's fair to say that I have good taste in knowing what the important problems and developments are in my field, and I'm able to bring this to bear when choosing collaborations, offering graduate students problems to work on, and providing leadership, both (a) in my Department and University and (b) nationally and internationally in my profession.

- I write slowly, with many drafts; this is probably both a strength and a weakness. My goal is extreme clarity, with each point inevitably following from what came before, and I like to take on big problems (such the basic process of Bayesian model specification, and properly accounting for uncertainty in the modeling process) rather than chipping away at smaller problems. This makes my production in terms of paper count lower than it might otherwise be, but my papers tend to be both longer and more widely cited as a result. I have had some success at framing and solving important problems, and I look forward to building on this success in the future.

3.2 Teaching

3.2.1 Accomplishments

Courses taught. From 1980 to the present I have taught more than 3,140 undergraduate and 580 graduate students (more than 3,730 students overall) in 55 classes (33 undergraduate, 22 graduate) and 14 individual graduate student supervisions at 8 universities in Switzerland, the U.K. and the U.S. (the University of California, Berkeley; the University of Chicago; the RAND Graduate School of Policy Studies; the University of Washington; the University of California, Los Angeles; the University of Bath; the University of Neuchâtel; and the University of California, Santa Cruz); my CV provides details on the courses not already detailed in Section 2 above.

Quality of teaching evaluations. This was summarized for my UCSC teaching in Table 1 of Section 2 above. I've always received strong teaching evaluations everywhere I've taught; in fact, I've won or been nominated for major teaching awards at every institution in which I've been on faculty.

Teaching honors. Overall to date I've received 8 teaching honors:

- Recipient, *Llewellyn John and Harriet Manchester Quantrell Award for Excellence in Undergraduate Teaching*, University of Chicago, 1984. (This is a major teaching award, given each year at the University of Chicago to only two or three people.)
- Nominated for graduate teaching excellence awards at the RAND Graduate School of Policy Studies (1990, 1991).
- Nominated for the *Mary Tasker Award* for excellence in undergraduate teaching at the University of Bath (1997, 1999).
- *Excellence in Continuing Education* award, American Statistical Association (1998); presented for the research short course *Bayesian Hierarchical Modeling*, given at the American Statistical Association annual meeting, Anaheim CA, 1997. (Only one of these awards is given each year; in 1997 my research short course was chosen from among 19 such courses.)
- Honorable Mention, 2002–03 *Excellence in Teaching Award*, University of California, Santa Cruz (UCSC); nominated for the 2002–03 UCSC *Alumni Association Distinguished Teaching Award*; nominated for the 2002–03 UCSC *STARS Teacher of the Year Award*. (Only a handful of people per year are singled out for these teaching honors.)
- *Excellence in Continuing Education* award, American Statistical Association (2004); presented for the research short course *Intermediate/Advanced Bayesian Hierarchical Modeling*, given at the American Statistical Association annual meeting, San Francisco CA, 2003. (Only one of these awards is given each year; in 2003 my research short course was chosen from among 34 such courses.)
- Honorable Mention, 2003–04 *Excellence in Teaching Award*, University of California, Santa Cruz (UCSC). (Only 7 faculty were chosen for this teaching honor in 2004.)
- Honorable Mention, 2004–05 *Excellence in Teaching Award*, University of California, Santa Cruz (UCSC); nominated for the 2004–05 UCSC *Alumni Association Distinguished Teaching Award*. (Only a handful of people per year are nominated for these teaching honors.)

Teaching publications. I have an undergraduate textbook ($\boxed{73}$) and two research monographs ($\boxed{74}$, $\boxed{75}$) in progress, and I have used all three of these books in my teaching at UCSC since 2001: $\boxed{73}$ (*Thinking About Uncertainty: An Introduction to Probability and Statistics*) has been one of the two texts I use in AMS 5 (a lower-division undergraduate introductory statistics course); $\boxed{75}$ (*Bayesian Modeling, Inference and Prediction*) has essentially been the text in AMS 206 (a graduate introduction to Bayesian methods); and $\boxed{74}$ (*Bayesian Hierarchical Modeling*) has provided supplementary reading in AMS 206.

3.2.2 Teaching methods and philosophy

I've thought carefully about how the disciplines of applied mathematics and statistics can be most successfully taught. It's my view that at all levels of material, from the very first lower-division course to the most advanced graduate seminar, the key is a **case-study** orientation, as in the following four-step paradigm (which I'll describe in the context of statistics teaching):

(1) An interesting real-world science or engineering problem is introduced and described in sufficient contextual detail that the students fully understand its practical significance;

(2) Statistical methods are developed/introduced to solve the problem in step (1);

(3) The real-world implications and limitations of the solution in step (2) are examined; and

(4) The general properties of the methods "invented" in step (2) are explored.

Step (1) in this four-step process serves to illustrate the wide applicability of mathematical and statistical thinking and to show that many good mathematical ideas or methods were in practice invented while trying to solve a real-world problem, and step (2) focuses on the crucial problem-formulation process. If the class demonstrates its openness to a not-just-note-taking approach to learning (almost all classes do, typically quite eagerly), I undertake steps (2) and (4) in an interactive way, by asking the students to suggest ideas for how progress might be made in solving the problem in (1), developing the methods adaptively based on the suggestions they give me, and interactively exploring the general attributes of the methods we've "created."

When someone suggests an idea that's only partially successful I lead us down the indicated path until we hit a brick wall, and then we figure out together how to climb over the wall; this reinforces the important fact about the mathematical discovery process that most good ideas and methods are arrived at through a process of successive refinement of partially-flawed ideas and methods (many people are mystified about how a now-standard mathematical concept was developed until they see in action that the way to proceed is to scratch something down, figure out what's wrong with it, and then figure out how to fix the flaw).

This approach has the added advantage that the instructor can weave many details of the history of mathematics/statistics (and of science) into the narrative; by this device the interest of the students is maintained, and they increase their appreciation for the crucial context in which ideas and methods arise. In my 25 years of teaching I've used this approach successfully in classes ranging in size from

1 to 500, and at levels ranging from first-year undergraduate courses to the most advanced graduate seminars.

An abbreviated example of a case study in a calculus course is available in PDF format in Section IV of the `writings.html` web page, and my three books-in-progress ($\boxed{73}$, $\boxed{74}$, and $\boxed{75}$ in Section I. on that web page) all contain a number of examples of the use of case studies in statistics employing the four-step paradigm described here.

New course development. I have been involved in course development work (launching new courses or revamping old ones) for 8 courses at UCSC: AMS 5, 15A, 15B, 15M, 15N, 7, 181, and 206.

- The first time I taught AMS 5 (fall 2001) I redesigned it in a case-study orientation (following the four-step method outlined above), and I've been improving the case studies ever since.

- Since arriving at UCSC in 2001 I've been approached by a number of faculty in the School of Engineering and the Division of Physical and Biological Sciences who have expressed dissatisfaction with some of the mathematics teaching on campus and who have asked the AMS Department to consider offering more satisfactory courses in applied math; the specific complaints have been about there being little emphasis on problem formulation and insufficient motivation of the mathematical methods covered as tools for solving real-world problems. In response to these concerns I applied for and received a course-relief grant from the UCSC Center for Teaching Excellence to develop an innovative two-quarter sequence, Contemporary Calculus I and II, which will be case-study based (following the four-step method outlined above) and which will combine traditional paper-and-pencil methodological learning with lab-based symbolic, graphical and numerical computing. I'm currently developing the case studies for these courses, which will be called AMS 15A (Contemporary Calculus I; 5–credit course covering differential calculus of functions of one variable and applications), 15M (2–credit computing lab associated with 15A), 15B (Contemporary Calculus II; 5–credit course covering integral calculus of functions of one variable and applications), and 15N (2–credit computing lab associated with 15B); these courses will first be offered at UCSC in 2006–07.

- AMS 7 (introductory lower-division biostatistics) is not working well for the audience it's meant to serve: undergraduate majors in MCD Biology, EE Biology, Environmental Studies, and Environmental Toxicology. I'm currently working with people from those four Departments to completely revamp AMS 7 and relaunch it in 2006–07 as AMS 7 (statistics for the biological sciences, a 5–credit course covering statistical methods in the context of a series of biologically-motivated case studies) and AMS 7L (a 2–credit lab associated with AMS 7 in which students will gain hands-on computing experience in data analysis).

- Before I arrived there were no courses offered at UCSC on Bayesian statistics. In the spring of 2001 I developed and offered a new course, ENGR 181 (an upper-division introduction to Bayesian methods). It quickly became clear that the real demand for a course of this kind was at the graduate level, so in winter 2002 I redeveloped the course and offered it as ENGR 206 (graduate Bayesian statistics). I've been improving this course steadily over the past three years, and in 2006 I will hand the course over to one of my colleagues, Herbie Lee, as an essentially finished product.

3.2.3 Teaching: concluding comments

- It turns out that I'm able to remember what it was like not to know something, and to share with other people the organic process of getting from {not knowing this thing} to {knowing it}. This observation may sound facile, but I believe that it's a key to teaching success: it helps people learn about the discovery process. This is a crucial contemporary skill: most of what we use in our daily work is composed of ideas and methods we've taught ourselves since leaving school. Thus the real emphasis in teaching should be on *helping people learn how to teach themselves*.

- The main complaint I get about my teaching is that my handwriting is terrible (which is true; I've tried to improve it, but I don't know how much better it will get under in-class conditions, when I need to write quickly in lectures). One possible solution to this problem is to prepare written lecture notes and make them available to the students; the drawback to this solution is loss of spontaneity, the value of which should not be underestimated in the classroom. I deal with this problem as follows.

  - In my graduate teaching (AMS 206) I provide hardcopy of the lecture notes before each lecture, supplemented by in-class notes written onto sheets of paper projected on a screen with a document camera; these written real-time class notes are then scanned and the resulting PDF files are posted quickly (ideally within an hour after the class finishes) on the course web page (please see `www.cse.ucsc.edu/classes/ams206/Winter05` for a thorough example of this).
  - In my undergraduate teaching (AMS 5), for part of the quarter I provide a version of hardcopy of the lecture notes before each lecture, by making the draft of my textbook for the course ($\boxed{73}$) available to the students. I used to write on the black- or white-board for real-time lecture notes, but lower-division students complained bitterly about lack of clarity (with reason), so recently I've developed a new approach:

    (1) As with AMS 206, I now "lecture" not at the board but at the document camera, and I scan the resulting real-time class notes and post the resulting PDF files quickly on the course web page; and

    (2) As early in the course as possible I identify three or four sharp students with good handwriting who take good notes, and I pay them as reader/tutors to take high-quality lecture notes in class each day; these supplemental notes are also scanned in and posted on the course web page, and students are encouraged to (i) look at all available notes for a few lectures (including mine), (ii) choose one or two sources they like the best, and (iii) use them as lecture notes that supplement their own in-class notes.

    This worked really well the last time I gave AMS 5 (spring 2005), and I intend to use this plan again in the future (please see `www.cse.ucsc.edu/classes/ams005/Spring05` for a good example of this).

3.3 Service

I concentrate here on major components of my service to the AMS Department, the Baskin School of Engineering, and the UCSC campus; my service to the profession (through such things as Associate Editorships on leading journals, organization or co-organization of major international research conferences, and offering frequent research short courses internationally on a variety of topics in Bayesian methods), together with lesser components of service at UCSC (e.g., membership and Chair duties on a variety of committees, and so on), have been covered in various places above.

If approached perfectionistically, the founding Chair position is an essentially impossible job: simultaneously getting everything done that needs doing in administrative work and teaching, while pursuing the same research agenda as one would without the Chair duties, is not possible. I recently took careful notes on how my time was spent during a typical week: 55 hours worked, 40 of them on administrative matters, and another 10 on development of case studies for the courses mentioned above; and not a moment of discretion in how the time was spent: the 50 hours of work just mentioned *had* to be done *right then* to avoid falling behind in crucial Department initiatives. Having said this, there have been some successes.

3.3.1 Accomplishments

- I was almost solely responsible for the AMS part of the School of Engineering 10–year plan in 2001, in which (subject to budgetary constraints) the campus committed to a plan under which AMS will grow to 17 faculty by the end of the decade (this has recently been revised to 16, 8 each in applied mathematics and statistics).

- Through a series of hires of excellent people, I have helped the AMS Department grow from a faculty size of 3 (counting myself) in January 2001 when I arrived to 9 at present, plus one open senior position in applied math which we're filling this year. As an example of the excellence of the new hires, I have been told repeatedly by people in good position to know that both in 2001–02 (when we hired Raquel Prado and Bruno Sansó) and 2002–03 (when we hired Athanasios Kottas and Herbie Lee) we hired the best Bayesian statistics people on the market in the country.

- I'm proud to have been able to propose and gain approval for five Curriculum and Leave Plans, from 2001–02 to 2005–06, under which AMS overall enrollments have grown from 860 in 2000–01 to a projected figure of $\boxed{\textbf{2,982}}$ in 2005–06, a 247% increase (i.e., multiplying the 2000–01 figure by almost 3.5) in only five years. This enrollment growth has involved significant joint curriculum planning on my part with the Departments of Economics and Mathematics.

- I'm also proud to have been the main author (building on an excellent earlier draft by Marc Mangel) of an AMS proposal for graduate degrees in Statistics and Stochastic Modeling, which was submitted to campus in April 2005. Our vision is to offer an innovative graduate program that provides students with a fusion education, in which they learn significant aspects (a) of both statistical/stochastic modeling and applied mathematical modeling and (b) of both Bayesian and frequentist statistical methods, and with all of this playing out in the context of solving an important problem in science or engineering. This proposal received wonderful support letters from leading statisticians in the U.S. (see Appendix H in the proposal, which may be obtained in PDF format from Section V. of the `writings.html` web site). I look forward to revising and resubmitting the graduate proposal once comments on it from the Graduate Council and the Committee on Planning and Budget are received, and I anticipate that the resubmission will occur before the end of the 2005 fall quarter.

While we've been planning our graduate program, we've not been idle in graduate education: a number of Departments on campus have been kind enough to admit AMS students on a temporary basis, with the idea that they will be transferred to AMS once the graduate program is formally approved. I'm also very proud of the fact that since I arrived in early 2001 we have used this facility to grow our graduate program from 0 students to 20 (almost all of these people are Ph.D. students; please see `www.ams.ucsc.edu` for details).

3.3.2 Service: concluding comments

- I'm a good leader and motivator. The trick with administrative leadership is of course to look for win/wins, and I seem to be good at that. When it's not possible for everybody to get their first choice (e.g., as the AMS Curriculum and Leave Plan becomes more complicated), I seem to be able to work well with people to get everyone either their first or second choice in a way that leaves most or all of us pretty happy.

- Early in my time as Chair I could not delegate tasks very much because there were few people to delegate them to, and my colleagues in the early days did not have much administrative/service experience. In recent years, as the Department has grown, I've tried to share the burden with my colleagues as much as possible, but I think it's fair to say that it took me longer than it should have to learn how to delegate optimally (there is of course an art to it: some things absolutely must be done by the Chair; with some other things I'm pretty sure I would do the best job of all of us on that particular task, but there's only so many hours in the day, and person X will be able to do it 95% as well as I could, so that's one I can let go of ...).

4 Future plans

I'll conclude with some thoughts on future plans in research, teaching and service. Subject to the approval of the Dean, the dominant future structural event for me in the next several years is that I'm scheduled to rotate out of the Chair duties in the fall of 2007, when Marc Mangel (Head of the Applied Mathematics Group) is scheduled to assume the AMS Chair. I hope to take a partial or full sabbatical year in 2007–08 to recharge my batteries in a variety of ways.

- **Research.**

  - I look forward to expanding the collaboration I've begun with investigators at Kaiser Research in Oakland, on topics in measuring quality of health care and improving care for hospitalized patients. Once significant grant money starts to flow, this should be an interesting and valuable source of applied problems for AMS statistics graduate students.

- I hope to finish $\boxed{75}$ (the monograph on *Bayesian Modeling, Inference and Prediction*) in 2006–07, and if this is not possible the sabbatical leave in 2007–08 should certainly permit it to be finished. Among other potentially exciting developments, this book will have the first accessible treatment of Bayesian nonparametric methods in a research monograph aimed at graduate students.
- In the statistics part of AMS faculty research and graduate training we emphasize Bayesian methods, for reasons given in Section 3.1, but all AMS statistics faculty are equally well versed in frequentist methods and all graduate students will receive a thorough grounding in methods from both paradigms. In order to share the value of this sort of statistical fusion with the rest of the campus, I intend in the next year or two to organize a one-day workshop for all interested UCSC faculty on the relationship between frequentist and Bayesian statistical methods and the advantages of being well-versed in both paradigms.
- In the next several years I expect to finish a large backlog of partially-completed articles (on topics as disparate as (a) exploring the practical advantages and disadvantages of Dirichlet process mixture models and Pólya trees [two leading Bayesian nonparametric methods] in a series of case studies, (b) "In sharp dispraise of (sharp-null) hypothesis tests," and (c) "Hierarchical modeling, variable selection and utility") that only await sufficient release time for their successful completion.

• **Teaching.** I intend to pencil myself in for an adventurous change in my teaching duties in 2006–07: since we'll be offering AMS 15A/M and 15B/N and the newly-revised version of AMS 7/7L for the first time that year, it's only fair that I shoulder the main burden of teaching these new courses myself, so I expect to teach at least AMS 7/7L and AMS 15A/M (and if the Department is willing to arrange a trade under which I teach an extra course in 2006–07 in return for a reduction of one course in the future, I'll also teach AMS 15B/N). After these courses are established I look forward to handing them off to others and to teaching some of the graduate statistics courses AMS offers that I've never given (such as the course on Bayesian nonparametric methods), along with my usual share of lower-division statistics teaching.

• **Service.** I'm nearly finished with the *AMS proposal for formal Departmental status*, which will be submitted to campus by the end of the 2005 fall quarter. Once our graduate program and formal departmental status are approved, the main structural tasks I was brought to UCSC to accomplish administratively will have finished, and the leadership of the AMS Department will simplify to the usual annual cycle of recruiting, developing the Curriculum and Leave Plan, and performing the myriad daily tasks that underpin the running of a successful academic unit.