Two-Sided Matching: A Study in Game-Theoretic Modeling and Analysis. By Alvin E. Roth and Marilda A. Oliveira Sotomayer. Cambridge: Cambridge University Press, 1991. Cloth, pp. 265, $54.50.

Reading this text on the application of game theory to two-sided matching problems, I relived an experience shared by many readers of this journal—the process known as "resident match." At a prescribed moment, over 90% of senior medical students frantically tear open an envelope that holds the name of the hospital at which they will train. Some go into the resident match kicking and screaming. Others are so trusting of the process (or so weak of conviction) that they let it decide whether they will be internists or surgeons.

Fighting off the vivid image of the great mechanical maw chewing up our preference lists and spitting out one of the more crucial decisions in our lives, some of us sought assurances that the algorithm, named NIMP (the National Intern Matching Program), was fair and just. We were told, or maybe we rationalized, that it was of no use to lie to NIMP. "Gaming" NIMP would not improve our chances of getting into a very good (if not ideal) residency program. We also convinced ourselves that NIMP favors students over hospitals. Having read Roth and Sotomayer's text, I understand that NIMP was neither the mechanical demon we feared nor a panacea.

The truth is that, prior to the use of NIMP, the search for residencies had become so highly competitive that by the mid-1940s many residency programs were accepting students two years in advance. Then NIMP was introduced. Although not developed in a game-theoretic framework, the NIMP algorithm creates a set of student–hospital matches that a game-theorist would call "stable." Here, stable is a technical term referring to the tendency for the parties matched by the algorithm to prefer that match to all alternative matches that could have been achieved without the algorithm. The empirical evidence of that stability in NIMP is found in the high level of participation in the residency match, a level of participation that has been eroded only in recent years by increasing numbers of married couples seeking complementary residencies.

Although NIMP has been a notable improvement over an uncontrolled market, the application of game-theory to the study of NIMP reveals that our two central beliefs (rationalizations?) about the operation of the algorithm were not true. First, students *can* achieve a better matching by highly rating the hospitals reasonably likely to rate them highly. In other words, one can do worse by listing "fliers." Second, the algorithm is designed to be optimal from the perspective of the hospital, not from the perspective of the prospective resident. In fact, from among the set of "stable" matches, the one chosen by NIMP is *least* optimal from the perspective of the students.

In addition to providing some insights into what may have been a traumatic personal experience, this text provides a scholarly and complete treatment of an important class of matching games. Examples of two-sided matching problems include labor markets and auctions. Analyses of these sorts of games may provide insights into medically revelant problems as well. For example, how does the existing incentive-and-formation structure (the "rules" of the game) lead to a given distribution of matches between patients and caregivers, patients and insurers, insurers and providers, and so on. It may also have potential for analysis in matching organ donors and recipients. Examination of these models may allow us to identify the flaws in existing "games" and guide us as we attempt to construct new games with different rules. Will these new games lead to "stable" matches in which participants are satisfied, or a least reasonably so?

Two-Sided Matching is a recent addition to the Econometric Society Monographs Series, which focuses, in part, on theoretical and applied econometrics. Alvin Roth is A. W. Mellon Professor of Economics, Fellow at the Center for Philosophy of Science, and Professor of Business Administration of the Graduate School of Business at the University of Pittsburgh. Marilda Sotomayer is Associate Professor of Mathematics at Pontificia Universidade Catolica do Rio de Janeiro in Brazil and a Research Associate in Economics at the University of Pittsburgh. They have divided their text into three parts, the first treating the simple "marriage model" of one-to-one matching where the structure of the set of stable outcomes and their economic and computational properties is established. Part II explores more complex models where many-to-one matching occurs, while Part III addresses models of one-to-one matching where money is treated as a continuous, rather than discrete, variable.

Many discrete and continuous models are considered, including those with complete or incomplete information, money or barter, single or multiple workers, and simple or complex preferences. A particularly attractive feature of the book is the inclusion at the close of each chapter of a brief historical literature review that provides additional perspective on the particular topics addressed. While the book provides a comprehensive accounting of the history and recent results on this game-theoretic analysis of two-sided matching, it should not be considered a general introduction to the wider field of game theory. For those readers who are interested in a good, general, and readable introduction to game theory, the recent text by Eric Rasmusen[1] may be worth examining.—David B. Matchar, MD, *Center for Health Policy Research and Education, Duke University, Durham, NC*

Reference

1. Rasmusen E. *Games and information: an introduction to game theory*. Cambridge; Cambridge University Press, 1990.

Studying a Study and Testing a Test: How to Read the Medical Literature, 2nd ed. By Richard K. Riegelman and Robert P. Hirsch. Boston: Little, Brown and Company, 1989. Paper, pp. 349, $23.50.

The new edition of Richard Riegelman's *Studying a Study and Testing a Test: How to Read the Medical Literature* retains much, if not all, of the style and intent of the original edition. In addition, the book has several new features and changes, besides the addition of coauthor Robert Hirsch, who is a biostatistican and epidemiologist, and Associate Chair of the Department of Health Care Sciences at George Washington University, where Dr. Riegelman directs the MPH program and serves as an attending physician in the Department of Medicine at the University Hospital. The book is intended primarily for a statistically unsophisticated audience, such as practicing clinicians who need to intelligently and critically digest and interpret new medical findings to understand their implications, applications, and limitations to pa-

tient care, or medical students who must pass the National Board examinations that include biostatistical and epidemiologic material.

Understanding concepts is emphasized throughout, while more complex statistical calculations purposely are minimized. As with the first edition, the authors hope to "take some of the pain out of the process" by providing a "hands-on," case study approach that includes chapters of "flaw-catching exercises" that consist of summaries of hypothetical journal articles fraught with errors that readers are challenged to discover. In this way readers can self-assess their grasp and depth of understanding of the concepts presented.

A new chapter on controlled clinical trials has been added to Part I (Studying a Study). This is followed by a chapter with two mini-summary "articles" for readers to evaluate, one of which was retained from the first edition, while the second is a new "article" on a controlled clinical trial for a new drug designed to control the transmission of HIV infection through blood transfusions. These types of applied activities and the critiques that follow them are engaging and useful—they not only stimulate active learning and mastery of the material, but are excellent reinforcing and motivating devices. The book successfully avoids much of the dryness and technical complexity that all too frequently accompany presentations of statistical material, which can further estrange the statistically unsophisticated who need a conceptual understanding of these principles and for whom the book is intended.

Much of the material in the chapters comprising both Part II (Testing a Test) and Part III (Rating a Rate) are retained from the previous edition. The authors supplement the clear and informative presentations from the earlier edition, e.g., the discussions of sensitivity, specificity, and positive and negative predictive values, with new information, e.g., on how to evaluate whether using two diagnostic tests is superior to using just one. Use of the lists of "questions to ask" in studying a study, testing a test, and rating a rate that appear at the ends of these three sections alone would do much to increase anyone's ability to read the medical literature more critically and better appreciate the uncertainty that surrounds even the best-designed studies. Also retained from the original edition are the useful glossary of terms and a revised flowchart summary to assist readers in determining whether an appropriate statistical analysis has been used based on the design of a study.

While it is conventional for some statistical texts not to include references and a bibliography, I personally was disappointed that one was not added to this edition. Telling readers that the calculation of confidence intervals for odds ratios and relative risk are "complex" may be appropriate, but not providing the curious and motivated with a reference to consult seems lacking. The footnotes, which were "designed for the statistically oriented reader or for formal classroom use," are helpful, but do not make it possible to easily pursue a topic of interest without conducting one's own literature review. For example, I was intrigued by the *Rule of Three* "that in order to be 95% sure one will observe at least one case of a rare side effect, one needs to treat approximately three times the number of individuals in the denominator" (p. 114). I was motivated to learn more about the derivation and rationale for this rule beyond the authors' description, and would have welcomed a reference or two to help pursue my interest.

One additional minor inconvenience that I hope the authors consider when they get around to preparing the third edition could be corrected by the provision whenever possible of illustrations of statistical procedures that rely on the same set of data. This may allow readers to gain increased insight into how results may vary depending upon the analytic approach taken. For example, the authors could easily have used the same numerical example to illustrate relative risk and the odds ratio, thereby enriching an already excellent presentation of these concepts.

The biggest revision in the current edition is of Part IV, which has been expanded substantially by Dr. Hirsch. This section devotes its major discussions to chapters on "Univariable Analyses," Bivariable Analyses," and "Multivariable Analyses," which focus on what the authors call the three purposes of statistics: "(1) to summarize great numbers of measurements with a manageable few, (2) to make estimates and inferences from samples obtained from large populations, taking into account the influences of chance, and (3) to adjust for the influence of confounding variables on those estimates and inferences." All in all this is a very worthy and readable text for the uninitiated and is to be highly recommended, the minor shortcomings noted not withstanding. The text does accomplish the authors' intention to provide more of a case-based approach to learning how to read the medical literature that truly is compatible with, and thus more likely to be integrated into, the clinical training process.—Fredric M. Wolf, PhD, *Department of Postgraduate Medicine and Health Professions Education, University of Michigan, Ann Arbor, MI*

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