Introduction

This is an update of the original bibliography for this seminar (which dates from October 1997). It mentions some books published since then. A good bibliography of statistical papers relating to credit scoring has been assembled by the Consumer Credit Research Group at Imperial College, London, directed by Prof. David Hand. It can be found at http://stats.ma.ic.ac.uk/creditgroup/Financelist.html. There is also a reading list at www.defaultrisk.com, but it concentrates primarily on commercial credit risk and credit derivatives.

Gerard Scallan
October 2002

General Credit Scoring Books

MC NAB, H. and WYNN, A. (2001) The Principles and Practice of Consumer Credit Risk Management (CIB Publishing, Canterbury)

An introductory textbook covering many topics credit scoring and behavioral scoring, largely drawing on material from Scoreplus seminars, "Scoring: Making it Work" and "Managing Customer Behavior". The authors are both associates of Scoreplus. This is the textbook for UK professional banking examinations.

LEWIS E.M. (1992) An Introduction to Credit Scoring (1st ed., Athena Publishing, San Rafael CA)

An older overview of credit scoring, this is known as the "Little Red Book". Very thorough on the basics, but somewhat dated in its approach and has quite a lot of misprints. The author, who was a pioneer of credit scoring, died in 1996. Fair Isaac now distribute it. The Institute of Credit Management distribute in the U.K.

MAYS, E. (ed.) (1998) Credit Risk Modeling. Chicago: Glenlake Publishing Company Ltd/Fitzroy Dearborn Publishers

General introduction to topics in building and using credit scoring models. Fourteen papers on topics from the the use of credit bureau information to reject inference, many by well known figures in the scoring field.

MAYS, E. (ed.) (2001) Handbook of Credit Scoring. Chicago: Glenlake Publishing Company Ltd/Fitzroy Dearborn Publishers

An updated version of Elizabeth May's 1998 book. There are eight new chapters, but five have been dropped from the previous book. The additions cover the development of a loss model for home equity loans and comparisons of classed and continuous characteristics, as well as more details on scorecard implementation and strategies. The chapters common with the previous book have been extensively rewritten.

HAND, D.J. and JACKA, S.D. (1998) Statistics in Finance. London: Edward Arnold.

Covers a broad range of applications in insurance and finance as well as credit.

THOMAS, L.C., CROOK, J.N., and EDELMAN, D.B. (Eds.) (1992) Credit Scoring and Credit Control. Oxford: Clarendon Press.

Selection of papers from a conference held at Edinburgh University in 1991. On the frontier of industry and academic practice.

THOMAS, L.C., EDELMAN, D.B. and CROOK, J.N.(2002) Credit Scoring and Its Applications. Philadelphia: SIAM (Society for Industrial and Applied Mathematics).

A text for a master's level course in statistics or operations research. It addresses the mathematical basis for many of the techniques used in credit scoring. It also includes material on the economic background to consumer credit analysis. This is a somewhat more mathematical text than the others in this section.

General Statistics Textbooks

HOGG R.V. and TANIS E.A. (1988) Probability and Statistical Inference (3rd ed., Macmillan, 658pp.)

Good general statistics text, at introductory level. Lots of examples and few proofs, but better structured than many other texts. Discursive style. Useful reference book for statistics used in credit scoring.

PAWITAN, Y. (2001) In All Likelihood. Oxford, Oxford University Press

A good introduction to modeling and the most widely used approach to creating statistical algorithms. Intended as a post-graduate level text book.

SILVEY S.D. (1977) Statistical Inference (2nd ed., Chapman and Hall, 192pp.)

Rigorous statistics text at the graduate level. Very good on the basics of statistical theory, but moves at a rapid pace. Need a good mathematical background. Much more rigorous than HOGG and TANIS.

Session 1: Profit and Risk - Formulating the Problem

See the chapter on "Economic Cycles and Lending and Debt Patterns" in Thomas et al. (2002) in the General section above. Also, Chapter 14 in the same book covers Profit Scoring, Risk-based Pricing and Securitization.

In MAYS (2002), Chapter 6 by Wei Wang is entitled "Going beyond credit score: the development of a loss model for the Home Equity business".

FRACHOT, A. and GOURIEROUX C. (1995) Titrisation et Remboursements Anticipés (Paris, Economica)

In French. Title translates as "Securitization and Early Repayment". A very good research book on models for early repayment by econometrician who have been closely involved in scoring.

Session 2: What is a Score - Probabilities and Odds

HAND D.J. (1997) Construction and Assessment of Classification Rules (Wiley)

Very good overview of all kinds of techniques. Gives details of non-parametric methods of classification (e.g. kernel estimation). Quite advanced level. The book uses several consumer credit examples. This is a major update to David Hand's book "Discrimination and Classification", which was the standard book in the area (published in 1991).

BREIMAN L., FRIEDMAN J.H., OLSHEN R.A. and STONE C.J. (1984) Classification and Regression Trees (1st ed., Wadsworth, Statistics/Probability Series, 358 pp.)

Introduced the CART method for decision trees. Best introduction to this area and easy to read.

ALTY J.L. and COOMBS M.J. (1984) Expert Systems: Concepts and Examples (1st ed., NCC Publications, Manchester, UK, 209 pp.)

Basic introduction to the ideas of expert systems. Written as a tutorial. Aimed at computer professionals. Lots of examples, mainly from medical applications.

MC CULLAGH P. and NELDER J.A. (1989) Generalized Linear Models (2nd ed., Chapman and Hall, 511pp.)

Classic overview of the general theory of linear models, including logit and probit approaches and much more besides. Directed at an audience of statisticians and researchers.

Session 3: Populations and Population Flow

Session 4: Defining the Data - the Sample

COCHRANE W.J. (1977) Sampling Techniques (3rd ed., Wiley, 428pp.)

Classic introduction to sampling and the topics such as ratio estimators. First edition published in 1953. Also a useful discussion of non-response. Mathematical level is not difficult, but requires concentration.

Session 5: Acquiring the Data - Sources and Quality

THOMAS et al. (2002), Chapter 13, discusses credit bureau information in the US and in the UK. Credit bureau characteristics are discussed in Section 8.5.

In MAYS (2002), Chapter 3 (by Maria T. Pincetich and Kristin M. Tobin) covers US credit bureau information.

EVERITT B.S. (1980) Cluster Analysis (2nd ed., Gower Halstead, 136pp.)

Elementary introduction to cluster analysis techniques written for social scientists and medics. Easy to read and to understand. Very little mathematics.

Session 6: Measuring Scorecard Effectiveness

See HAND (1981) in Session 6 above for ideas on measuring the performance of any classification rule. Also, Chapter 7 in THOMAS et al. (2002) covers scorecard performance measurement. Chapter 13 in MAYS (2002) is a more elementary account of some validation measures by Timothy Lee.

KULLBACK S. (1959) Information Theory and Statistics (1st ed., Wiley, 395pp.)

Introduces the ideas of Divergence and Information Value. A useful chapter on contingency tables. Not easy reading.

WILKIE A.D. (1992) Measures for comparing scoring systems (in Credit Scoring and Credit Control, ed. L.C. Thomas, J.N. Crook, D.B. Edelman, pp123-140, Oxford University Press)

Overview of different measures. Based on a general discussion at a conference.

READ T.R.C. and CRESSIE N.A.C. (1988) Goodness of Fit Statistics for Discrete Multivariate Data (1st ed., Springer Verlag, 211pp.)

Proposes a general family of statistics, "Power Divergence Statistics", for testing hypotheses in contingency tables. This family includes Pearson and Log-likelihood Chi² statistics. All statistics in the family can be shown to have an asymptotic Chi² distribution. It also discusses Divergence and Information Value.

HOADLEY B. and OLIVER R.M. (1995) Business Measures of Scorecard Benefit (Fair Isaac Technical Paper, 15pp.)

Paper which looks at the use of expected loss measures for scorecard performance and attempts to avoid making arbitrary assumptions about unit profit and loss. Well written.

GAYLER, R.W. (1999): Signal Detection for Credit Scoring Practitioners. In Proceedings of Credit Scoring & Credit Control VI, The University of Edinburgh, Edinburgh, Scotland.

Session 7: Basic Algorithms for Scorecard Construction

THOMAS et al. (2002), Chapter 4, gives an overview of the statistical techniques involved.

AGRESTI A. (1990) Categorical Data Analysis (1st ed., Wiley, 558pp.)

Best recent book on topics from log-linear models to logistic regression. Rigorous approach to all levels of binary data analysis. Directed at advanced students and researchers. The author has also"An Introduction to

Categorical Data Analysis" (Wiley, 1996), which covers the same material at a more elementary level.

COLLETT D. (1991) Modeling Binary Data (1st ed., Chapman and Hall, 369pp.)

Good textbook covering all models mentioned and dealing with topics such as over-dispersion and colinearity. Directed at applied statisticians, rather than researchers.

COX D.R. and SNELL E.J. (1989) Analysis of Binary Data (2nd ed., Chapman and Hall, 236pp.)

A major revision of Cox's classic book from 1970 (the first complete overview of logistic regression). Directed at a mathematically sophisticated audience, it gives complete coverage of a broad field in a concise manner. This does not make it easy to read.

HAND D.J. and HENLEY W.E. (1997) Statistical Classification Methods in Consumer Credit Scoring: a Review (in Journal of the Royal Statistical Society, Series A, vol 160, part 3, pp. 523-541)

Overview of credit scoring problem and approaches to solution from a statisticians point of view. Very high level, but contains lots of good references.

HOSMER D.W. and LEMESHOW S. (1989) Applied Logistic Regression (1st ed., Wiley Interscience, 307pp.)

Very basic and methodical introduction to logistic regression. Light on theory, but lots of details of practical issues and interpretation of results. Includes descriptions of SAS and SPSS procedures. It is directed at medical researchers and assumes little mathematical background.

KLEINBAUM D.G. (1994) Logistic Regression: A self-learning text (1st ed., Springer Verlag, 282pp.)

A programmed learning textbook, directed to medical users of logistic regression. Level is similar to Hosmer and Lemeshow.

MENARD S.H. (1995) Applied Logistic Regression Analysis (1st ed., Sage, Thousand Oaks, 98pp.)

A recent and very short textbook, oriented to the use of SAS. Written for social scientists, it has an easy mathematical level, but does not go into much detail. Deals with practical topics such as complete separation and variable selection.

Session 8: Structuring the Data - Classing and Generations

MAYS (2002) contains a discussion of some aspects of this topic (Chapter 4 "Scorecard Modeling with Continuous vs. Classed Variables", by Dennis Ash and Dimitra Vlatsa).

THOMAS et al. (2002) consider the statistical aspects of the problem in Section 8.7.

All the texts mentioned in Session 7 discuss the issues involved in grouping data, in particular AGRESTI (1990 and 1996), and COLLETT (1991). See also MC CULLAGH and NELDER (1989). CRESSIE and READ (Section 5) also supply a much more rigorous statistical framework for this. Three further books are worth mentioning.

BISHOP Y.M.M., FIENBERG S.E. and HOLLAND P.W. (1975) Discrete Multivariate Analysis: Theory and Practice (1st ed., MIT Press, 557pp.)

The classic book on log-linear models and multi-level models for interactions. Difficult notation, but very well written and takes the time to explain the practical significance of results.

EVERITT B.S. (1977) The Analysis of Contingency Tables (1st ed., Chapman and Hall, 128pp.)

Very simple introduction designed for medical researchers and students. Good preparation before tackling more ambitious books such as AGRESTI (1990) or BISHOP et al. (1975). A new edition is in preparation.

GOODMAN L.A. and KRUSKAL W.H. (1979) Measures of Association for Cross-Classification (1st ed., Springer Verlag)

Includes alternatives to the Gini coefficient and gives calculations of variance of estimators.

Session 9: Reject Inference - the Measure of Our Ignorance

MAYS (2001) has an overview of the problem by David Hand (Chapter 11 - "Reject Inference in Credit Operations").

THOMAS et al. (2002) cover reject inference in Section 8.9.

LITTLE R.J.A. and RUBIN D.B. (1987) Statistical Analysis with Missing Data (1st ed., Wiley, 278pp.)

A summary of statistical ideas relating to the imputation of responses and reject inference, by two authorities in the field. Most of the applications relate to non-response in surveys. This is currently a very active topic in statistical research.

HENLEY W. E. (1994) Statistical Aspects of Credit Scoring (Unpublished Ph.D. Dissertation, The Open University, U.K.)

A Ph.D. thesis on reject inference. Main conclusion is that most of the widely used methods add little value. Some unverifiable assumption about the nature of the previous censoring is necessary for all methods. Hence, the outcome is based on a judgment.

HAND D.J. and HENLEY W.E. (1994) Inference about rejected cases in discriminant analysis (in New Approaches in Classification and Data Analysis, ed. E. Diday et al., Springer Verlag, pp. 292-299)

Gives key conclusions from Henley's Ph.D. dissertation. A good statistical overview of the problem.

HAND D.J. and HENLEY W.E. (1993) Can Reject Inference ever work? (IMA Journal of Mathematics Applied to Business and Industry, vol. 5(4): pp. 45-55.

Another version of the conclusions from Henley's Ph.D. thesis.

Session 10: Building the Scorecard - the Practice

See MAYS (2002), Chapter 5, for an overview "The Basics of Scorecard Development and Validation" by Elizabeth Mays.

Session 11: Multiple Scorecards and Splitting

All the texts mentioned in Sessions 7 and 8 are relevant to population splitting and non-linear models. See particularly COLLETT (1991) and BISHOP et al. (1975).

GAYLER, R. (1995) Is the Wholesale Modeling of interactions Worthwhile? (Proceedings of Conference on Credit Scoring and Credit Control, University of Edinburgh Management School, U.K.).

Paper based on review of large number of samples by CCN Asia Pacific. Very good methodology. Concludes that information about interactions adds little strength to scorecards.

Session 12: Small Sample Scorecards

Once again, the texts mentioned in Sessions 7 and 8 provide the best overview.

Session 13: Where is scoring headed?

The starting point for a discussion of linear programming is DANTZIG (1963). In addition, the following references give more recent approaches to the solution of mathematical programs.

GILL P.E., MURRAY W., WRIGHT M.H. (1981) Practical Optimization (1st ed., Academic Press, 401pp.)

Introduction to the methods and practical aspects of non-linear programming, by leaders in the development of optimization software.

CURET N.D. (1994) An Incremental Primal-Dual Method for Generalized Networks (Computers in Operations Research, vol. 21, no. 10, pp. 1051-1059)

Session 14: Managing Scorecard Development

Session 15: Alternative to Scorecards: Neural Nets and Graphical Models

RIPLEY B. (1994) Neural Networks and related methods of classification (with discussion) (Journal of the Royal Statistical Society, London, Series B, vol. 56, no. 3, pp. 409-456

A very good survey paper covering neural nets from a statistical point of view, which has served to formulate this session. It is followed by a discussion which gives a wide variety of viewpoints on the significance of neural nets. Ripley has also written a chapter "Statistical Aspects of Neural Networks" (in O.E. Barndorff-Nielsen, JL Jensen and WS Candle e's., Networks and Chaos: Statistical and Probabilistic Aspects, Chapman and Hall, 1993), which largely covers the same material as this paper, but without the discussion.

TAM K.Y. and KIANG M.Y. (1992) Managerial Applications of Neural Networks: The Case of Bank Failure Predictions (Management Science, vol. 38, No. 7, pp. 926-947)

An excellent introduction to neural nets which presents algorithms very clearly, using the prediction of bank failure in Texas as an example. The best place to start. Also includes a comparison with other techniques, including logistic regression, which is not conclusive.

BEALE R. and JACKSON T. (1990) Neural Computing: An Introduction (1st ed., IOP Publishing, Bristol and Philadelphia, 240pp.)

Introductory textbook at an undergraduate level, which is light on the mathematics.

HECHT-NIELSEN R. (1989) Neurocomputing (1st. ed, reprinted 1991, Addison-Wesley)

A good general text on neural networks, written by the founder of HNC Software, the leading neural net vendor in the credit area.