AFOSR-TR-97-0673

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	November 1996	Final Technical Report 1 May 95 to 31 Aug 96

4. TITLE AND SUBTITLE
Some Statistical Inference Problems in Data Fusion and Semi-Parametric Regression

5. FUNDING NUMBERS
F4962095-1-0335

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9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
AFOSR/NM
110 Duncan Avenue, Ste B115
Bolling AFB, DC 20332/8050

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
F49620-95-1-0335

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION AVAILABILITY STATEMENT
Approved for public release; distribution unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

The proposal dealt with several problems in the areas of data fusion and semi-parametric regression models. The problems were formulated specifically in the context of linear models, both univariate and multivariate. Some data fusion problems that arise in the area of calibration has been successfully solved. In addition, in the context of the calibration problem, univariate as well as multivariate, several satisfactory confidence regions have been constructed and applied to real data. In the same spirit, confidence regions and tests in some linear functional relationship models have been derived as well.

14. SUBJECT TERMS
combining information (data fusion) calibration, confidence region, multivariate linear model, linear functional relationships.

15. NUMBER OF PAGES
3

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

November 1996

Final Tehnical Report, May 1995 – August 1996

Some Statistical Inference Problems in Data Fusion and Semi-Parametric Regression

(AFOSR F49620-95-1-0335)

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Distribution Unlimited

Abstract:The proposal dealt with several problems in the areas of data fusion and semi-parametric regression models. The problems were formulated specifically in the context of linear models, both univariate and multivariate. Some data fusion problems that arise in the area of calibration has been successfully solved. In addition, in the context of the calibration problem, univariate as well as multivariate, several satisfactory confidence regions have been constructed and applied to real data. In the same spirit, confidence regions and tests in some linear functional relationship models have been derived as well.

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UNCLASSIFIED UNCLASSIFIED UNCLASSIFIED

Research Objectives: The major objectives were to address several statistical inference problems in the context of data fusion and semiparametric regression. Another objective, as stated in an earlier Progress Report (August, 1995) was to complete the work on several problems on calibration, originally included in an earlier proposal *Statistical Inference Problems in Some Multivariate Linear Models With Applications to Multivariate Calibration and Meta-Analysis*, also funded by the AFOSR (AFOSR F49620-93-1-0001), for the period October 1992–September 1994. The above proposal included several problems on the construction of confidence regions for the univariate and multivariate calibration problems, as well as some data fusion problems that can arise in this context.

Status of Effort: Before I describe the status of effort with respect to the above research objectives, it is necessary to give a short outline of the calibration problem, in order to make this report somewhat self-contained. The calibration problem involves a response variable that depends on an explanatory variable, and data are available on both of these variables. This data, referred to as the *calibration data*, can be used to establish the relationship between the response variable and the explanatory variable. Such a relationship is called the *calibration curve*. Now suppose we have another observation on the response variable for which the value of the explanatory variable is unknown. The problem of *calibration*, or *inverse regression*, deals with the estimation of this unknown quantity. If both the response and explanatory variables are scalars, we have the problem of univariate calibration. If at least one of these quantities is a vector, we then have the multivariate calibration problem.

The problems that I have investigated dealt exclusively with the construction of confidence regions. Two types of confidence regions are required in this context: single use confidence regions and multiple use confidence regions. Single use confidence regions are required when the calibration data is used once, in order to obtain a confidence region for a single unknown value of the explanatory variable. On the other hand, the problem of multiple use confidence regions will arise if the calibration data will be used repeatedly in order to construct a sequence of confidence regions for a sequence of unknown values of the explanatory variable. In the same context, one can also encounter the situation where the calibration data comes from several independent sources and an appropriate data fusion strategy is called for in order to construct single use as well as multiple use confidence regions. I have solved most of the above problems successfully, and in most cases, completely. Some computational issues still remain open. Furthermore, the data fusion problem remains open in the multivariate case.

Accomplishments/New Findings: When I started working on calibration, the problems mentioned above were essentially completely open, except for the availability of some single

use confidence regions only, which were somewhat unsatisfactory. In this connection, we have derived a new single use confidence region, based on a natural pivot statistic, and the results are very satisfactory. Also, for the first time, some multiple use confidence regions have been derived for the multivariate calibration problem. The data fusion problem that we solved is for the univariate calibration problem and we have constructed some multiple use confidence regions based on combined information. All the above results are derived under the assumption that the calibration curve is a linear model. Even in this context nonlinearity do arise if the explanatory variable enters the model in a nonlinear fashion. We have tackled this situation as well. Application of our procedures to several real data sets gave some very satisfactory results.

A problem that has some similarity to calibration is that of estimating the parameters in a functional relationship model. For such models, we have derived some confidence regions and tests, applying some of the techniques that we have developed for the calibration problem.

Personnel Supported: None

Publications (submitted or accepted for publication):

1. Mathew, T. and Sharma, M. K. (1996). Multiple use confidence regions based on combined information in univariate calibration. Submitted for publication.

2. Mathew, T. and Zha, W. (1996). Multiple use confidence regions in multivariate calibration. To appear in *Journal of the American Statistical Association.*

3. Mathew, T. and Zha, W. (1996). Some single use confidence regions in a multivariate calibration problem. Submitted for publication.

4. Mathew, T., Sharma, M. and Nordstrom, K. (1996). Conservative multiple use confidence regions in multivariate calibration. Submitted for publication.

5. Kasala, S. and Mathew, T. (1996). Exact confidence regions and tests in some linear functional relationships. To appear in *Statistics and Probability Letters.*

Participation at Meetings: Participated in the annual meeting of the American Statistical Association, Chicago, August, 1996.

Research Transition: None.