Commentationes Mathematicae Universitatis Carolinae

F. Němec

Adaptive methods of numerical quadrature [Abstract of thesis]

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ABSTRACTS OF CSc. THESES IN MATHEMATICS
(Candidatus Scientiarum)
defended recently at Charles University, Prague

MATHEMATICAL AND COMPUTER MODELLING OF MECHANISMS REGULATING BLOOD FLOW AT THE MICROCIRCULATION LEVEL

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(27.2.1989, supervisor M.Malík)

Known mathematical models of blood flow are based on continuous approaches to the description of the flow characteristics and are constructed by the means of differential equations. This thesis introduces a completely new theoretical method. It presents a discrete mathematical theory of the mechanisms of regulating microcirculation. In this theory, the relevant physical laws and relations are introduced in the form of formal axioms.

The created mathematical abstraction has been employed to build computer models of regulating microcirculation. The program implementation is based on asynchronous simulation with event planning.

The results of computer simulation experiments are comparable with the results of direct laboratory measurements. This proves that the created models demonstrate an acceptable degree of equality with the real world.

ON DECIDABILITY OF SKELETAL SETS

NGUYEN XUANG DUNG, Department of cybernetics, University of Hanoi, Hanoi, Vietnam
(27.2.1989, supervisor M.Chytil)

The method of error recovery for parsers of context–free languages introduced by M. Chytil and J. Demner is based on the concept of skeletal set. The quality of recovery depends on the quality of the skeletal set available for given context–free language.

The key problem studied in the dissertation is the question whether a given set of terminal symbols is a skeletal set for the given language. The problem is known to be algorithmically undecidable for general context–free languages. The dissertation deals with important special cases of context–free languages, e.g. regular, linear, and deterministic languages.

ADAPTIVE METHODS OF NUMERICAL QUADRATURE

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(11.4.1989, supervisor I.Marek)

Based on the trapezoidal rule, an adaptive method of construction of a hierarchy of meshes of numerical quadrature is proposed and studied. The purpose

is to obtain a highly effective method of numerical integration of some particular classes of functions whose ranges are split into two parts with essentially different complexities, e.g. peak functions etc.

Useful error bounds are derived and their effectivity checked on some – one and two – dimensional test functions. Also a comparison is made with some stochastic integration methods.

ELIMINATION OF BIAS FOR GENERAL MEASURES OF ASSOCIATIONS

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(12.4.1989, supervisor V.Dupač)

Measures of association have been introduced to detect special statistical dependence of categorical variables. The thesis extends some theoretical results to a large class of measures which are representable as smooth functions of multinomial frequency vectors.

The method for arbitrarily exact approximations of expectations based on the central moments of the multinomial distribution law is formalized in the first part of the thesis. General formulas are applied to the class of logarithmic interactions and to the coefficients of explanatory decomposition power following the D–model for categorical data analysis.

The main results of the thesis are based on the explicit formula for K–th order jackknife transformation, the application of which eliminates all terms up to the order $O(N^{-K})$ in the typical bias expansion of the original estimator. General properties derived for general von Mises differentiable estimators are formalized for the class of association measures. The verification of the asymptotic normality for the basic transformation $J_K(.)$ is a generalization of a result by Parr and Tolley.

The third part of the thesis extends the above results to the situation of S independent random samples. The S–sample jackknife transformation $J_K^S(.)$ is derived from the structure of bias generated by this sample plan. The explicit computational formulas are introduced for $K = 1, \ldots, 4$.

General conclusions from the simulation experiments are illustrated by numerical examples in an appendix.

NUMERICAL MODELLING OF VISCOUS INCOMPRESSIBLE FLOW

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(17.4.1989, supervisors I.Černý, M.Feistauer)

The theme of this work is the mathematical study of one of the classical models of turbulent flow of viscous incompressible fluids. This model generalizes Prandtl's idea of mixing length.

The weak solution of the model is defined and investigated in the theoretical part. The existence of a weak solution for the velocity and the pressure is proved in spaces $\overrightarrow{W}^{1,3}(\Omega)$ and $L_{\frac{3}{2}}(\Omega)$. The nonhomogeneous boundary conditions of Dirichlet's type