

Abstracts of CSc. theses in mathematics

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ABSTRACTS OF CSc. THESES IN MATHEMATICS

(Candidatus Scientiarum)

defended recently at Charles University, Prague

TRIMMED ESTIMATES IN THE NONLINEAR REGRESSION MODEL

PROCHÁZKA Bohumír, State Health Institute, Department of Mathematical Statistics and Programming, Šrobárova 48, Prague 10, Czech Republic

(April 5, 1993; supervisor J. Jurečková)

Robust statistical procedures, mainly estimators, became a part of general statistical consciousness. There already exists a host of papers and even monographs devoted to the theoretical and practical aspects of robustness. In the robust literature, a great part is devoted to the robust inference in the regression model, mostly, linear, but also nonlinear. The classical least-square estimator is highly nonrobust.

Among various robust estimators in the linear model, Koener and Basset (*Regression Quantiles*, *Econometrica* **46** (1978), 33–50) introduced a very bright idea of regression quantile and pertaining trimmed least square estimator.

The work extends their idea to the nonlinear regression model and studies the asymptotic behavior of regression quantile and trimmed least-squares estimator.

The regression α -quantiles are defined as a solution of the minimization:

$$\sum \varrho_{\alpha}(y_i - g(x_i\theta)) := \min$$

where function f is

$$\varrho_{\alpha}(z) = \alpha z \text{ for } z \geq 0 \text{ and } \varrho_{\alpha}(z) = (\alpha - 1)z \text{ for } z < 0.$$

The consistency, asymptotic representation and asymptotic normal distribution of regression quantiles under some regularity conditions on the model are derived. Starting with regression quantiles it defines several classes of estimators (an estimator of the Gastwirth type, trimmed least-square estimator) and studies their asymptotic behavior.

The results are illustrated on three groups of real data from the medical research.

SHEAVES OF CONTACT FORMS AND ACYCLIC RESOLUTIONS
ON FINITE JET PROLONGATIONS OF FIBRE BUNDLES

NONG QUOC CHINH, Department of Algebra and Geometry, Faculty of Sciences, Masaryk University, Janáčkovo nám. 2a, 662 95 Brno, Czech Republic

(May 12, 1993; supervisor D. Krupka)

The thesis concerns the study of certain sheafs of differential forms which appear in variational sequences on fibred manifolds. It consists of five parts. In

the third one, the author introduces the basic concepts and statements which are used in the next parts. The sheafs $\Omega_{r(s)}^k$ and $\Theta_{r(s)}^k$ are defined in the 4-th and 5-th parts. It obtains the factor sequence (for each s , $0 \leq s \leq n-1$)

$$(*) \quad \begin{aligned} 0 \rightarrow R \rightarrow \Omega_r^0 \rightarrow \Omega_r^1 \rightarrow \dots \rightarrow \Omega_r^s \rightarrow \Omega_r^{s+1} / \Theta_{r(s)}^{s+1} \rightarrow \dots \\ \dots \rightarrow \Omega_r^P / \Theta_{r(s)}^{P+1} \rightarrow \dots \Omega_r^N \rightarrow 0. \end{aligned}$$

The main results obtained in these parts may be summarized as follows:

- (1) The differential $(k-1)$ -form $\varrho \in \Omega_{r(s)}^{k-1}$ satisfies the condition $d\varrho \in \Omega_{r(s)}^k$ if and only if ϱ admits an expression in the form $\varrho = d\gamma + \beta$, where $\gamma \in \Omega_{r(s)}^{k-2}$ and $\beta \in \Omega_{r(s+1)}^{k-1}$.
- (2) For each s , $0 \leq s \leq n-1$, the sequence

$$0 \rightarrow \Theta_{r(s)}^{s+1} \rightarrow \Theta_{r(s)}^{s+1} \rightarrow \dots \rightarrow \Theta_{r(s)}^{P-1} \rightarrow \Theta_{r(s)}^P \rightarrow 0$$

is exact.

- (3) All sheafs $\Theta_{r(s)}^k$ are soft.
- (4) The factor sequence $(*)$ is an acyclic resolvent of the constant sheaf R over Y .

Finally, the last part is devoted to the study of the acyclic resolvent $(*)$ in the special case $s = 0$. Under this condition, the sequence $(*)$ is a variational sequence. The expression of the class $[\varrho] \in \Omega_r^k / \Theta_{r(0)}^k$, with $\varrho \in \Omega_r^k$, in the special cases $r = 1$ and $r = 2$ is presented.

SOLUTION OF THE HEAT-CONDUCTION PROBLEM FOR CONCRETE BLOCKS

ZAHŘÁDKA Ivan, Department of Mathematics, Faculty of Engineering, Czech Technical University, Thákurova 7, Prague 6, Czech Republic
(May 19, 1993; supervisor K. Rektorys)

The thesis arose from a practical problem of determination of the temperature in a gravity dam when inner heat-sources in the dam are acting.

The problem was solved by Prof. K. Rektorys in *Stanovení teploty v přehradě při působení vnitřních zdrojů tepla*, Rozpravy ČSAV **14** (1956), 1–74, by using the Finite Difference Method.

The purpose of the thesis is to modernize and generalize the Rektorys' approach essentially by using the Method of Rothe and in connection with this method to give a mathematical model for the engineers. The problem is formulated in N space dimensions, domains and nonhomogeneous boundary conditions that are considered. Especially, the "problem with an integral condition" is solved

(this is that case when inner heat-sources depend on “the past” of the concrete). The main emphasis lies on the theorems proving that the solution depends on the initial conditions and boundary functions continuously, and new results were obtained.

SLOW VISCOUS INCOMPRESSIBLE FLOW WITH FREE SURFACE

SKALÁK Zdeněk, Institute for Hydrodynamics, Academy of Sciences, Podbabská 13, 166 12 Prague 6, Czech Republic
(June 9, 1993; supervisor J. Stará)

The study deals with the stationary flow of heavy viscous incompressible newtonian fluid with a free boundary. A two dimensional problem is considered which describes the motion of fluid flowing out from a narrow channel and spreading into the infinite halfspace. The author is interested in the existence and uniqueness of the solution — velocity, pressure and free boundary — and in its other properties. At first mathematical formulation of the problem is given. Next, a nonlinear nonhomogeneous problem is studied; it is supposed that the free boundary is known and the author looks for velocity and pressure in a fixed domain. Then he studies the change in the solution of the problem caused by a small change of the free boundary. He gets a precise free boundary of the fluid as a fixed point of a mapping from the space of all possible free boundaries into itself. A solution is reached only in the case of sufficiently small velocity of the fluid in the channel. It is shown that the solutions are smooth hölderian functions with two singularities at the outlet from the channel. The flow in the channel approaches exponentially the Poiseuille flow. The author gets the uniqueness of the solution if a certain simple condition concerning the angles between the free boundary and the fixed wall of the channel is satisfied.

WEAK CONTINUITY AND IDENTIFIABILITY OF M-FUNCTIONALS

MIZERA Ivan, Department of Probability and Statistics, Faculty of Mathematics and Physics, Comenius University, Mlynská dolina, Bratislava, Slovak Republic
(June 24, 1993; supervisor J. Jurečková)

The thesis is devoted to the investigation of weak continuity and identifiability (existence and uniqueness) of M-functionals. These functionals are defined as (possibly multivalued) mappings, which assign to a probability on the sample space a set of values in the parameter space. For the empirical probabilities this set coincides with the set of the values of an underlying M-estimator. Conditions for weak continuity in the general setting are established, separately for M-functionals defined as solutions of minimization problems and those one obtained by solving equations. For the location model, conditions for the uniqueness of the solution of the minimization are formulated, separately for symmetric and for asymmetric population probabilities; the latter case introduces the concept of strong unimodality into this setting. The conditions for weak continuity and

identifiability in the regression problems are obtained, as well for the all known possibilities in the location case. Some other applications and general statements are also considered. In the formulations, nuisance parameters (scale) are included.

MEASURES IN METRIC SPACES

ZINDULKA Ondřej, Mathematical Institute, Faculty of Mathematics and Physics, Charles University, Sokolovská 83, 186 00 Prague 8, Czech Republic

(October 18, 1993; supervisor V. Trnková)

The notion of concentration of Borel measures is introduced to the realm of general metric spaces and examined. A notion of dimension of metric and metrizable spaces is derived from the behavior of concentrations, being compared with various topological and fractal dimensions. As tools, some new real analysis and partition calculus techniques are developed. A unifying theory of fractal dimensions is presented. In the end, various results concerning residual measures are given.