Master Degree Exam Requirements – Applied Informatics
Subject: Mathematical Methods
2024

1. **Measuring uncertainty.** Probability, basic definitions and rules (addition rule for elementary events, conditional probability, multiplication rule, Bayes' Theorem).
2. **Random variable.** Discrete and continuous probability distributions. Most common models of distributions (Bernoulli, binomial, Poisson, uniform, normal, exponential). Parameters of distributions.
3. **Random sampling and statistical inference.** Population and random sample, methods of sampling, sampling distribution, sampling error. Statistical point and interval estimates, the quality of an estimate, confidence interval for mean and proportion.
4. **Principles of statistical hypotheses and tests.** Type I and type II errors, decision rules in statistical tests. Hypotheses about population means and proportions. Hypotheses and use of ANOVA (analysis of variance) method.
5. **Relationships between two quantitative variables.** Correlation, properties of Pearson coefficient of correlation. Univariate and multivariate regression model.
6. **Modelling finite state-space process as Markov chain.** Description of the process, transition probabilities, regular and absorbing chains, properties and long run behaviour, examples.
7. **Statistical models and data.** Knowledge extraction from data, principles and steps in data mining process, methods of data exploration, measures of diversity.
8. **Modelling, simulation and data.** Real world problems, data and simulations of random events. Principles and expected statistical properties of pseudorandom numbers generators. Statistical properties of pseudorandom numbers generators.
9. **Principles of numerical mathematics and approximation of functions**. Arithmetic operations and errors in numerical computations. Interpolation by polynomials, interpolation by spline functions, least square method.
10. **Solution of nonlinear equations and numerical optimization**. Bracketing method for locating roots, methods for finding roots of equations, estimation of error bounds, conditions of convergence. Minimization of function.
11. **Numerical solutions of systems of linear algebraic equations – direct and indirect methods**. Gaussian elimination method, partial pivoting, triangular factorization, ill conditioning. Iterative methods.
12. **Numerical differentiation and integration, solution of ordinary differential equations**. Numerical differentiation, basic formulas. Numerical integrations, basic and composite rules. Euler's method and Runge-Kutta methods.
13. **Graph coloring and its application.** Graph coloring, chromatic number, independent set, independence number, relation between $\chi(G)$ a $\alpha(G)$. Heuristic algorithms determining chromatic number and their practical applications.
14. **Paths in graphs.** Finding the shortest path in various types of ordinary and directed graphs. Topological sort and search for the longest path in the acyclic
15. **Searching of labyrinths and Eulerian graphs**. Algorithms for searching labyrinths and their use. Searching of Eulerian trail in Eulerian graph. Searching of the minimum number of trails containing all edges of the given graph. Chinese postman problem.

References:

Čermák L., Hlavička R.: Numerické metody, Akademické nakladatelství CERM, s.r.o., Brno, 2006.

Demel J.: GRAFY a jejich aplikace, Academia, Praha, 2002.

Hebák P., Kahounová J.: Počet pravděpodobnosti v příkladech. Informatorium, Praha 2005.

Hebák P., Skalská H.: Pravděpodobnost a statistika. Příklady a otázky. Gaudeamus, 2011.

Kučera L.: Kombinatorické algoritmy. SNTL, Praha, 1989.

Míka S., Brandner M.: Numerické metody I. a II., ZČ Univerzita v Plzni, 2000.

Skalská H.: Aplikovaná statistika. Gaudeamus, Hradec Králové, 2013.

Skalská H.: Stochastické modelování. Gaudeamus, Hradec Králové, 2006.

Skalská H.: Přednášky k předmětu Statistické modely a data, elektronická verze, 2014.

English References:

Grinstead Ch., M., Snell J., L.: Introduction to Probability. Chance project publication,

http://www.dartmouth.edu/~chance/teaching_aids/books_articles/probability_book/book.html

http://www.dartmouth.edu/~chance/teaching_aids/books_articles/probability_book/Chapter11.pdf

Groebner D.F., Shannon P.W., Fry P.C., Smith K.D.: Business Statistics. A Decision Making Approach. Prentice Hall, 2008.

Hillier F.S., Lieberman G.J.: Introduction to operations research. McGraw-Hill, 2004

Mathews J.H., Fink K.D.: Numerical Methods Using MATLAB, Pearson Prentice Hall, Upper Saddle River, NJ, 2004.

Roberts, F. S., Tesman, B.: Applied Combinatorics, Second Edition, Pearson Prentice Hall, Upper Saddle River, NJ, 2004.

Tufféry S.: Data Mining and Statistics for Decision Making. Wiley &Sons, Ltd., 2011.