

# Maria Panagiota Fourtouni - Academic Projects Portfolio

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## Survival Analysis & Reliability

- Kaplan–Meier Estimation & Log-Rank Tests — Applied survival analysis methods on a lung cancer dataset, including Kaplan–Meier survival curves, log-rank and Wilcoxon tests, and comparison between PH and AFT models.
- Censored Data Modeling — Developed log-normal regression models with right-censored data; derived likelihood functions, estimated parameters, and implemented analysis in R.
- Nelson–Aalen Estimator of Cumulative Hazard — Implemented the Nelson–Aalen estimator for cumulative hazard functions, studied variance estimation, asymptotic distribution, and constructed confidence intervals.
- Pareto Distribution & Hazard Functions — Derived and analyzed the hazard function of Pareto mixture distributions, examined monotonicity properties, and discussed applications in biomedical reliability.

## Statistical Quality Control (SQC)

- p-Charts for Defect Analysis — Constructed p-charts to monitor defect rates in manufacturing processes; re-estimated control limits after identifying and removing special causes using R.
- EWMA Control Charts — Designed and interpreted Exponentially Weighted Moving Average (EWMA) control charts to detect small process shifts and improve sensitivity compared to Shewhart charts.
- Process Capability Indices (Cp, Cpk) — Evaluated process capability indices for printed circuit board thickness measurements; combined X-bar and R charts with Cp and Cpk calculations to assess quality standards.
- X-bar and R Charts in Industrial Data — Applied X-bar and R charts to assess variability and stability of an industrial production process; demonstrated the effect of subgroup size on detection ability.

## Design of Experiments (DOE)

- Factorial Designs & ANOVA — Conducted statistical analysis of multi-level factorial designs; identified significant factors and interactions using ANOVA, regression modeling, and Pareto charts.
- Yates' Algorithm for  $3^2$  Designs — Implemented Yates' algorithm for  $3^2$  factorial designs; decomposed effects into linear and quadratic components and interpreted contrasts.
- Experimental Designs in Practice — Applied one-way and two-way ANOVA on designed experiments; examined main effects and interactions in industrial and biomedical examples.

## Computational Statistics

- Kernel Regression (Nadaraya-Watson Estimator) — Applied nonparametric regression techniques in R using Gaussian kernels; optimized bandwidth via leave-one-out cross-validation and visualized fitted curves.
- Bootstrap Methods for Extreme Values — Conducted a simulation study of bootstrap resampling for the distribution of sample minima; highlighted limitations of bootstrap when statistics depend on extremes.
- Stochastic Optimization in Regression — Investigated computational algorithms for parameter estimation in nonlinear regression models; compared performance and convergence properties.

## **Generalized Linear Models (GLMs)**

- Logistic Regression for Binary Outcomes — Fitted logistic regression models to biomedical datasets; interpreted odds ratios, significance of predictors, and model goodness-of-fit.
- Poisson Regression for Count Data — Applied Poisson and quasi-Poisson models to analyze count responses; performed overdispersion diagnostics and compared model fit.
- Model Comparison & Selection — Compared nested GLMs using likelihood ratio tests and information criteria (AIC, BIC); discussed implications for model adequacy and parsimony.

## **Probability Theory & Stochastic Processes**

- Measure-Theoretic Probability Proofs — Worked on exercises in advanced probability theory, including convergence theorems (monotone, dominated), uniform integrability, and limit distributions of random variables.
- Random Variable Transformations — Derived distributions of transformed random variables; applied change-of-variable techniques to continuous and discrete cases.
- Law of Large Numbers & Central Limit Theorem — Explored theoretical foundations and provided proofs of LLN and CLT in the context of applied probability.