Multivariate phase type distributions - Applications and parameter estimation

The best known univariate probability distribution is the normal distribution. It is used throughout the literature in a broad field of applications. In cases where it is not sensible to use the normal distribution alternative distributions are at hand and well understood, many of these belonging to the class of phase type distributions. Phase type distributions have several advantages. They are versatile in the sense that they can be used to approximate any given probability distribution on the positive reals. There exist general probabilistic results for the entire class of phase type distributions, allowing for different estimation methods for the whole class or subclasses of phase type distributions. These attributes make this class of distributions an interesting alternative to the normal distribution.

When facing multivariate problems, the only general distribution that allows for estimation and statistical inference, is the multivariate normal distribution. Unfortunately only little is known about the general class of multivariate phase type distribution. Considering the results concerning parameter estimation and inference theory of univariate phase type distributions, the class of multivariate phase type distributions shows potential for similar great results.

My PhD studies were part of the the work package 3 of the UNITE project. The overall goal of the UNITE project is to improve the decision support prior to deciding on a project by reducing systematic model bias and by quantifying and reducing model uncertainties.

Research has shown that the errors on cost estimates for infrastructure projects clearly do not follow a normal distribution but is skewed towards cost overruns. This skewness can be described using phase type distributions. Cost benefit analysis assesses potential future projects and depend on reliable cost estimates. The Successive Principle is a group analysis method primarily used for analyzing medium to large projects in relation to cost or duration. We believe that the mathematical modeling used in the Successive Principle can be improved. We suggested a novel approach for modeling the total duration of a project using a univariate phase type distribution. The model is then extended to catch the correlation between duration and cost estimates using a bivariate phase type distribution. The use of our model can improve estimates for duration and costs and therefore help project management to make the optimal decisions.

The work conducted during my PhD studies aimed at shedding light on the class of multivariate phase type distributions. This thesis contains analytical and numerical results for parameter estimations and inference theory for a family of multivariate phase type distributions. The results can be used as a stepping stone towards understanding multivariate phase type distributions better. However, we are far from uncovering the full potential of general multivariate phase type distributions. Deeper understanding of multivariate phase type distributions will open up a broad field of research areas they can be applied to.

This thesis consists of a summary report and two research papers. The work was carried out in the period 2010 - 2014.

**General information**

State: Published
Organisations: Department of Applied Mathematics and Computer Science , Statistics and Data Analysis, Department of Transport, Transport policy and behaviour
Projects:

Refinement and application of the method of successive calculations in transport project evaluations

Technical University of Denmark
Period: 01/06/2010 → 02/09/2014
Number of participants: 7
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Financing sources
Source: Internal funding (public)
Name of research programme: 1/3 FUU, 1/3 inst 1/3 Andet
Project: PhD