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# Investigation of order picking systems by design and analysis of computer experiments

In the planning of order picking systems, which are characterized by an increasing complexity as well as uncertainties, discrete-event simulation is widely used. It enables investigations of systems using experiments based on executable models. However, the execution of simulation experiments with different parameter configurations (simulation runs) is associated with a high level of effort. This leads us to apply methods from the Design and Analysis of Computer Experiments (DACE). The aim is to create Logistic Operating Curves (LOCs) with uncertainty bands.

Generalized Additive Models for Location, Scale and Shape (GAMLSSs) are considered as meta-models in this contribution as they allow to model the location, scale and shape parameters of a wide class of distributions. Due to this property, GAMLSSs are suitable to adequately model the complexity of order picking systems. They are employed to provide predictions for key performance indicators and can reflect the inherent uncertainties by prediction intervals.

We present an application to an example order picking system modeled with the discrete-event simulation tool AnyLogic. Key performance indicators of interest are e.g. the picking performance, the order picking accuracy and the throughput. The derivation of suitable designs of experiment as well as the development of special cases of GAMLSSs is demonstrated. Results in terms of LOCs with uncertainty bands are visualized.

In the future, GAMLSS-based meta-models will be enhanced for reference models of order picking systems to determine general systemic interdependencies.

## Special/ Invited session

## Classification

Mainly methodology

## Keywords

Design and Analysis of Computer Experiments (DACE), order picking system, Generalized Additive Models for Location, Scale and Shape

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