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Abstract

Conventional farming practices often result in soil erosion, loss of biodiversity, and pollution of soil and water resources. To mitigate pollution risks, European regulations require the implementation of vegetated buffer strips along watercourses. However, these buffer zones may not always be sufficient, necessitating additional buffer zones with dimensions tailored to each case. The Riverly lab at INRAE has developed the BUVARD tool to determine optimal buffer zone widths based on field data. The initial BUVARD model, which includes the VFSMOD numerical model [7, 5], is complex and requires numerous input variables with both quantitative and qualitative uncertainty, making it challenging for risk management [1].

Previous work has employed a metamodelling approach to simplify the use of BUVARD and aid users in designing buffer strips adapted to specific contexts [6, 4]. Bayesian and non-Bayesian surrogates, such as Polynomial Chaos Expansions (PCE) and Mixed-kriging, have been compared, addressing the mixed variables issue for GP and PCE, but not for Deep Gaussian Processes (DGP). In this work, we explore new surrogate methods for BUVARD with quantitative and qualitative variables: Deep Gaussian Processes (DGP) [2] and Deep Sigma Point Processes (DSPP) [3], which are capable of handling mixed variables. These methods leverage their deep structure to efficiently handle zero value plateaus, given the non-stationary and parsimonious structure of BUVARD data.

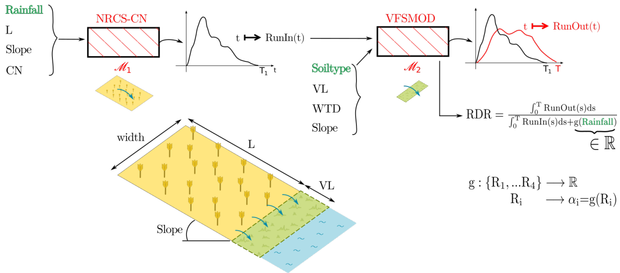

Figure 1: Depiction of the model chain integrated in BUVARD and its meta modelling as a function of only a few input variables, quantitative (black) and qualitative (green).

We examine various approaches for incorporating categorical variables into the DGP and DSPP models, including processing data by pairs of modalities, converting modalities to quantitative values, and using appropriate kernel combinations. Our findings contribute to the development of more accessible and effective buffer zone management tools for the agricultural community, addressing the challenges posed by mixed variables and the complex model chain in BUVARD, while also tackling non-stationarity and zero value plateaus. Furthermore, the metamodel serves as a relevant first guess for pollution reduction device design and provides an effective uncertainty tool for visualizing the impact of parameter uncertainty on filter efficiency in risk analysis and management.

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