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Editorial

Guest editorial—Uncertainty and parameter space analysis in visualization

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Uncertainty and parameter space analysis in visualization are becoming increasingly prevalent and play an important role in astronomical, (bio)-medical, industrial, and engineering applications. All these areas require methods and techniques which help domain specialists to understand the processes involved in data generation, the reliability of the data, and the distribution of and reasons for uncertainty. Furthermore, with increasing algorithmic complexity additional the following questions arise:

- How does a slight parameter change modify the result?
- How stable is a parameter?
- In which range is a parameter stable?
- Which parameter set is optimal for a specific problem?

Such questions are frequently neglected when new visualization techniques are introduced. This special section of Computers and Graphics on "Uncertainty and Parameter Space Analysis in Visualization" is a follow up initiative to the guest editors' IEEE VisWeek 2012 tutorial with the same name [1]. The aim of this special section is to promote research which takes into account the various aspects of uncertainty and its influence on the visualization pipeline, as well as algorithmic stability and the exploration of parameters. The authors were invited to submit contributions of all aspects of uncertainty visualization and parameter space analysis. Topics of interest included, but were not limited to uncertainty modeling, statistical visualization, structural uncertainty, visual representations of uncertainty, cognitive and perceptual aspects of uncertainty, visualization of multi-run data, parameter space analysis, visual parameter tuning, and applications. The special section spans two volumes and encompasses a total of 8 papers. The first three papers were already published in volume 39 and volume 41 features the remaining five publications.

We begin the special section with *Uncertainty in medical visualization: towards a taxonomy* by Ristovski et al. [2] who categorize types of uncertainty in an abstract form, describe them mathematically in a rigorous way, and discuss the visualization challenges of each type and the effectiveness of the existing techniques. The aim of this work was to generate a comprehensive understanding of what types of uncertainty exist in medical visualization and what their characteristics in terms of mathematical models are. In *Uncertainty estimation and visualization in probabilistic segmentation* by Al-Taie et al. [3] the authors introduce novel methods for estimating and visualizing uncertainties associated with the results of a probabilistic segmentation. The developed uncertainty measures reflect the degree of uncertainty associated with each voxel's probability vector as a value between 0 and 1 regardless of the number of classes. The visualization methods present the estimated uncertainties with the segmentation result to the user in an intuitive way. *Supporting the integrated visual analysis of input parameters and simulation trajectories* by Luboschik et al. [4] brings together parameter space visualization and multi-scale visualization to give an overview of large parameter spaces and the resulting simulation trajectories for analyzing simulated processes. This approach is demonstrated in the domain of systems biology by a visual analysis of a rule-based model of the canonical Wnt signaling pathway that plays a major role in the embryonic development.

The second part of the special section in this current volume 41 continues with *Visualizing the stability of critical points in uncertain scalar fields* by Mihai and Westermann [5], who derive measures from uncertain scalar ensembles for the likelihood of the occurrence of critical points with respect to both the position and the type of the critical points. These critical points are important indicators of the topology of iso-contours in scalar fields. The authors show that by deriving confidence intervals for the gradient and the determinant and by tracing the Hessian matrix in scalar ensembles, domain points can be classified in locations of critical points and the specific critical point type to be expected. In *Visual analysis of dimensionality reduction quality for parameterized projections*, Martins et al. [6] introduce a set of interactive visualizations for dimensionality reduction algorithms that aim to help users to judge the effectiveness of a projection in maintaining features from the original space, to understand the effect of parameter settings on these results, as well as to perform related tasks such as comparing two projections. These tasks are achieved by revealing the quality of a projection and thus allowing an inspection of parameter choices for dimensionality reduction algorithms. Riveiro et al. [7] show an empirical study that addresses the effects the visualization of uncertainty has on decision-making in their work entitled *Effects of visualizing uncertainty on decision-making in a target identification scenario*. In their investigations the authors focus on an air defense scenario, where the consequences of a late or wrong decision are severe, and where the decision time of the expert operators is limited to a few minutes the shape of the high likelihood region called optimal percentile region projection. This technique facilitates the selection of regions with high likelihood in high-dimensional spaces before projection into a lower-dimensional projection space. Furthermore it allows us to analyze features on the surface of these regions in the projected space and to use a three-dimensional space in order to show features that are not salient in only two dimensions. The final paper of this special section is *Interactive exploration of parameter space in data mining: comprehending the predictive quality of large decision tree collections* by Padua et al. [9]. In this paper the authors demonstrate an interactive approach on a dataset from a telecommunications company to facilitate the comprehension of the predictive power of large collections of decision trees by exploring large portions of the parameter space. The authors developed novel views that allow us to visualize and analyze the predictive quality of hundreds of trees, working together with coordinated multiple views of tree representations, and aggregates of Receiver Operating Characteristic and Lift curves for assessing the predictive quality of the models.

Summing up, we are pleased to have a set of strong papers in this first special section of Computers & Graphics on Uncertainty and parameter space analysis in visualization. We express our gratitude especially to the Editor in Chief Joaquim Jorge for his support when setting up this special section, to Lisa Gordon who was key to keep this process on track as well as to all the anonymous reviewers providing their valuable reviews on time.

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