2026-T3 Droplets: A Marker Design for Enhancing Cluster Associations

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T3A. S B Interactive Prototype

The Droplets in their current form are generated from a Python implementation which export the result as SVG. An interactive browser-based prototype should be implemented as a frontend, to showcase the design, test-out different parameter settings, and compare to alternative methods.

Functional Requirements

FR1 **Baseline framework** Web-frontend with SVG container for showing the Droplets of a concrete sample. Hyperparameters of the visualization should set through respective input forms. Connection to a backend in Python to support binding the respective package, (re)computation when parameters are changed. User should be able to select from a set of default use cases (e.g., through a respective dropdown).

- FR1a **Support for Typescript implementation (optional)** Recently the Droplets have also been implemented in Typescript. Also compute the desings using this implementation. Swithing between them should be realized through a toggle option.

FR2 **User Upload** A user should be able to upload arbitrary input data in the form of a data file plus an optional background image.

FR3 **Support for reference visualizations** The application should allow for additional "reference" visualizations, which are computed in the backend and displayed as well.

- FR3a **Baseline methods** Support the baseline methods pie charts, bar charts, stacked bar charts, which are already supported by the given Python package.
- FR3b **Advanced methods (optional)** Support and implement additional "more advanced" methods such as spider charts.

T3B. B M Extension to 3D

The Droplets design has been developed for two-dimensional maps, but for some applications – e.g., fMRI images – support for 3D volume data could be of interest. The idea is to have a slices viewer (similar to the orthogonal slices used in brain visualization), which allows to step through the volume by adjusting the respective X, Y, Z coordinates.

Research Questions

RQ1 In how far are users capable to perceive three dimensional homogenity structures through a respective adaptation of the Droplets marker?

Functional Requirements

FR1 **Support for 3D volume data** Adjust code to support 3D volume data. This is relatively straightforward, as an additional column for Z values can be added to the extttpositions.csv. Based on that, it should differentiate between 2D and 3D inputs.

FR2 **Methodological adjustments** Certain parts of the pipeline need to be adapted to support 3D. In particular the collision detection and the drawing.

- FR2a For the collision, all positions in the vicinity of a cut-plane can be projected onto the plane, where the de-collision can be solved in 2D.
- FR2b As the directivity vector can "stick out" of the plane to some extent, this needs to be visualized by altering the appearance of the Droplets' tails, such as fade out in order to indicate a three-dimensionality.

  Optional alternative: render the Droplets completely in 3D by generating respective shapes. Export, e.g., as triangle mesh with colors.

T3C. S B Use Case Compilation, Quantitative Analysis

To date, sociodemographic properties such as land usage, biomedical use cases such as spatial transcriptomics, and high-dimensional data such as feature embeddings have been tested. But any data combining proportional relations with a spatial embedding can be visualized with the Droplets.

Research Questions

RQ1 What are potential use cases for the Droplets glyph?

RQ2 What are existing methods to quantitatively comapare the effectiveness and efficiencies of markers such as the Droplets glyph?

Preparatory Requirements

PR1 Find (at least) one reasonable type of dataset to visualize with the Droplets.

PR2 Survey related works on perceptual evaluation from the field of both glyph design and scatter plot visualization.

Functional Requirements

FR1 **Use Case Compilation**

- FR1a Implement a pipeline for acquiring a sample of the chosen data type. E.g., through scraping of corresponding web servies.
- FR1b Apply the Droplets to the obtained data sample and evaluate their performance.

FR2 **Quantitative Anslysis**

- FR2a Implement one or multiple metrics for the quantitative comparison of alternative visualizations.
- FR2b Evaluate the performance of the Droplets in contrast to alternate methods using the implemented evaluation metrics.
- FR2c **Advanced methods (optional)** Support and implement additional "more advanced" methods such as spider charts.