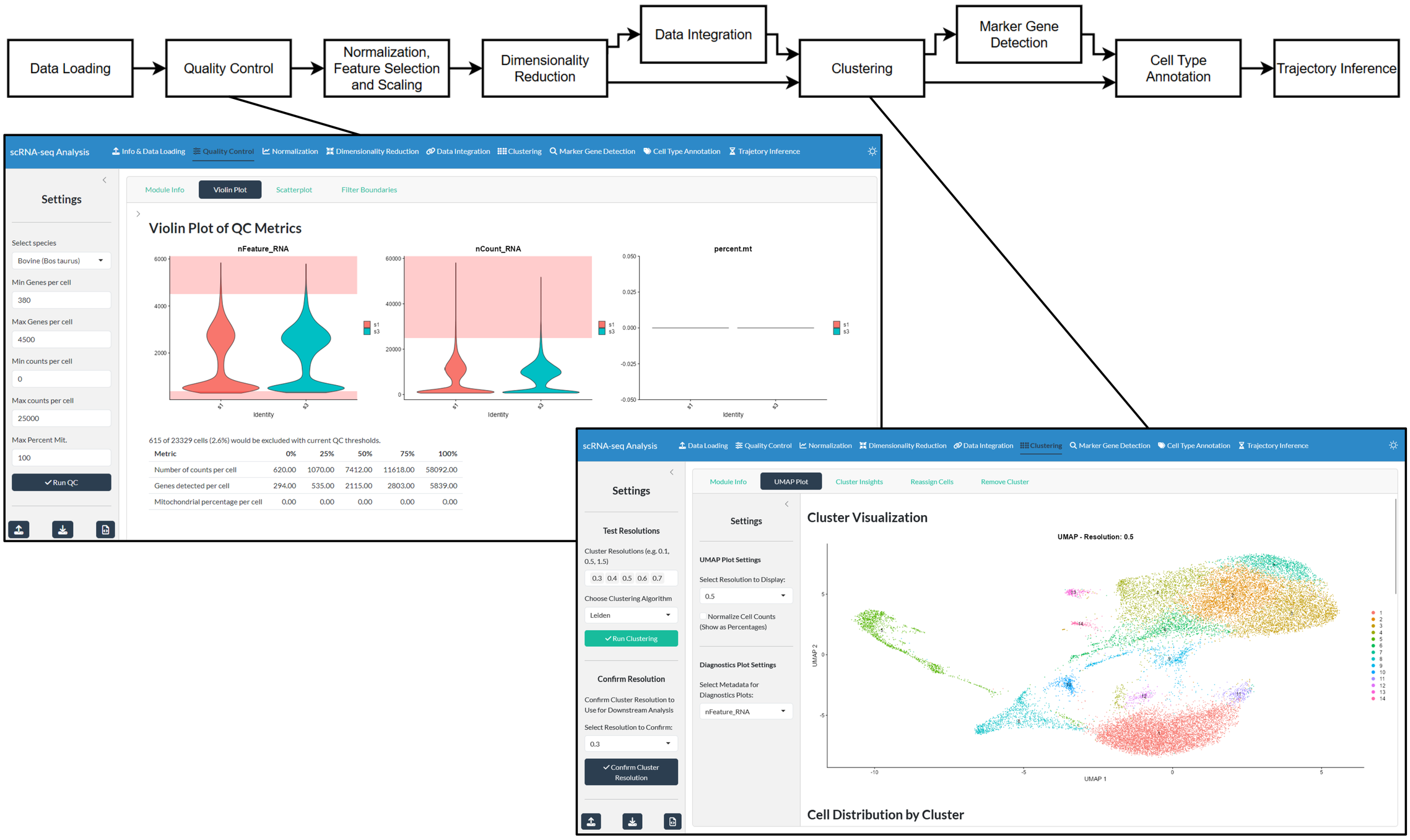
HSLU Hochschule Luzern

Technik & Architektur

Master-Thesis Data Science

Interactive Web App for Single-Cell Data Analysis

Single-Cell RNA Sequencing Analysis Workflow



Problem Statement

Twelve years ago, single-cell RNA sequencing (scRNA-seq) was named "Method of the Year" by *Nature Methods*. Since then, it has become a key technology for analyzing gene expression at the cellular level, enabling researchers in many different fields to gain a better understanding of cellular heterogeneity in organisms.
However, analyzing scRNA-seq data typically requires proficiency in programming languages such as R or Python, which presents a significant barrier for many researchers, particularly those from a non-computational background. This highlights the need for user-friendly tools that enable effective analysis without requiring advanced programming skills.

Proposed Solution

To address this barrier, this thesis presents an interactive web application developed with R Shiny. It features a graphical user interface that removes the need for prior programming experience, making scRNA-seq analysis accessible to a broader range of researchers. Additionally, it promotes reproducibility by enforcing a standardized, step-by-step analysis workflow.

Results

The developed Shiny application implements a complete scRNA-seq analysis pipeline through nine individual modules, covering all major steps from data upload to trajectory inference. Each module is interactive, configurable, and designed to guide users through the workflow without requiring prior programming knowledge. Multiple methods and tunable parameters are available within each module, allowing users to tailor the analysis to their specific dataset and research objectives.
Throughout the workflow, a range of visualizations supports informed decision-making at each step.

To validate the implemented workflow, an scRNA-seq analysis was performed using only the Shiny application's functionality, and the results were compared to a previously published analysis to assess similarity and identify potential differences.

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