



LUDWIG-
MAXIMILIANS-
UNIVERSITÄT
MÜNCHEN



Prof. Dr. Christian L. Müller
Ludwig-Maximilians-Universität München
Institut für Statistik
Ludwigstr. 33
80539 München
christian.mueller@stat.uni-muenchen.de

M.Sc. Thesis Proposal: Analyzing Divergent Growth Outcomes in *B. subtilis* Populations with Varying Initial Cell Densities

Background: Standard bacterial growth curve analysis assumes predictable and reproducible phases (lag, exponential, stationary) across replicates under identical conditions. However, *B. subtilis* populations can exhibit striking heterogeneity in growth outcomes that depends on initial cell density. Under certain density conditions, replicate populations can follow markedly different trajectories despite identical experimental conditions. This phenomenon challenges fundamental assumptions about bacterial growth determinism and reproducibility. The ability to analyze and characterize these heterogeneous outcomes would provide new insights into bacterial population dynamics and the role of initial conditions in determining growth patterns.

Objectives: The purpose of this M.Sc. thesis project is to develop analytical methods for characterizing and predicting divergent growth outcomes in *B. subtilis* cultures based on their initial cell densities. The framework will identify conditions that lead to heterogeneous growth patterns among replicates and quantify the probability of different outcomes. The implementation will combine statistical approaches for analyzing replicate variability with methods for detecting critical density thresholds. These tools will be applied to *B. subtilis* experiments to understand when and why populations diverge into growth versus decline trajectories.

Plan and deliverables: A successful completion of the M.Sc. thesis requires the following computational and scientific advances. Developing analytical methods that can characterize heterogeneous growth outcomes and predict population fate based on initial density, applying these methods to *B. subtilis* experiments showing divergent replicate behaviors. A write-up in thesis form and commented code on GitHub are mandatory deliverables at the end of the thesis.