RPTU Dr. Jürg Spaak
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Rheinland-Pfälzische Technische Universität Kaiserslautern Landau

Landau, 31.01.2025

Certificate for completion of internship

This is to certify that **Mr. Md. Dider Hossain**, born on **February 13, 1994**, successfully completed a compulsory student internship at **Rheinland-Pfälzische Technische Universität (RPTU)** under the **Quantitative Landscape Ecology Working Group** of the **Department of Natural and Environmental Sciences** from **September 20, 2023, to January 23, 2024**.

During the internship, Mr. Hossain was supervised by **Dr. Jürg W. Spaak**, the head of the **Quantitative Landscape Ecology** working group of Department of Natural and Environmental Sciences at Rheinland-Pfälzische Technische Universität (RPTU). In particular, he was able to deepen his existing knowledge of **ecological modelling, machine learning, and data analysis**. The focus is on the translation of python code into R code related to predator-prey interactions model in an ecological food web using body size, temperature effects, and empirical data. The script integrates empirical models with theoretical food web dynamics to study how species interact and persist under different conditions. The translation and the presentation of the results was carried out primarily using the open-source software **"R Studio"**. In another project, he focused on data analysis and machine learning applied to environmental and agricultural datasets, specifically pesticide concentration measurements in soil and water. The statistical analysis and visualization were performed using the open-source python software **"Spyder"**. His area of responsibility included:

Responsibilities and Achievements

1. **Translation of Ecological Models from Python to R**:
    - Analyzed and translated a complex ecological model written in Python into R, ensuring the accuracy and functionality of the translated code.
    - Successfully implemented key mathematical computations, including species interaction matrices and Lotka-Volterra dynamics, in R.
    - Adapted Python-based data structures (e.g., NumPy arrays, SciPy functions) to their R equivalents (e.g., data frames, matrices, and R functions).
    - Recreated numerical simulations and visualizations (e.g., heatmaps, species interaction plots) using R's advanced plotting libraries, such as **ggplot2**.
    - Verified the accuracy of the R code by comparing its outputs with the original Python results, resolving discrepancies to ensure reliable ecological modeling.
2. **Analysis of Pesticide Contamination in Buffer Zones**:
    - Conducted comprehensive data preprocessing and cleaning, including handling missing values and transforming datasets for analysis.
    - Analyzed variations in pesticide concentrations across categorical variables such as **landcover types, crop types, buffer sizes, and sampling positions**.
    - Applied **Principal Component Analysis (PCA)** to reduce dataset dimensionality and identify key chemical components contributing to variance.
    - Performed **ANOVA tests** to assess the significance of categorical variables on pesticide concentrations.
    - Conducted **post-hoc analyses** (e.g., Tukey's HSD) to identify specific group differences and adjusted p-values using **Bonferroni correction**.
    - Summarized findings in clear and concise reports, highlighting the impact of landcover types, buffer sizes, and sampling positions on pesticide concentrations.
    - Provided actionable recommendations based on statistical and machine learning analyses to support environmental decision-making.

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3. **Data Visualization and Reporting**:
    - Created informative plots (e.g., boxplots, clustered heatmaps, and bar plots) to communicate findings effectively.
    - Customized visualizations to highlight significant trends and interactions between variables, ensuring clarity and impact in presentations and reports.

Mr. Hossain demonstrated strong proficiency in **Python programming, R programming, data analysis, and machine learning**. He exhibited a high level of motivation, curiosity, and dedication throughout the internship, consistently seeking opportunities to learn and improve his skills. In addition, Mr. Hossain's behavior towards his superiors and colleagues was exemplary. He maintained a professional attitude, collaborated effectively with team members, and consistently delivered high-quality work.

Mr. Hossain's commitment, technical expertise, and enthusiasm for learning were instrumental in the success of the projects he undertook. We thank him for his dedication and performance during his internship. We wish him continued success in his academic and professional endeavors and are confident that he will achieve great accomplishments in his future career.

Best regards,

Dr. Jürg W. Spaak