

# Modularity-based Community Detection in Bacterial and Viral Networks

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## **Abstract**

This paper investigates community structure in bacterial and viral protein similarity networks using modularity-based community detection methods. We compare several algorithms and perform a sensitivity analysis on the resolution parameter using Adjusted Rand Index and Adjusted Mutual Information.



# 1 Introduction

## 1.1 Motivation

## 1.2 Definition of a Network

## 1.3 Mathematical Representation

## 1.4 What Can We Do with Networks?

# 2 Network Summary Statistics

## 2.1 Basic Metrics

## 2.2 Degree Distribution

## 2.3 Centrality Measures

# 3 Similarity Measures for Community Comparison

## 3.1 Rand Index

## 3.2 Adjusted Rand Index

## 3.3 Adjusted Mutual Information

## 3.4 Comparison of ARI and AMI

# 4 Community Detection Methods

## 4.1 Modularity

## 4.2 Edge Betweenness (Girvan–Newman)

## 4.3 Louvain Method

## 4.4 Leiden Method

# 5 Data Description

## 5.1 Data Source

## 5.2 Network Structure

## 5.3 Preprocessing

# 6 Experimental Setup

## 6.1 Implementation

## 6.2 Hyperparameters

## 6.3 Evaluation Criteria

# 7 Results

## 7.1 Descriptive Comparison of Bac and Vir

## 7.2 Method Comparison

## 7.3 Hyperparameter Sensitivity Analysis

## 7.4 Interpretation of Results

# 8 Discussion

# 9 Conclusion