the learning ideas conference

# Designing Diverse and Balanced Student Teams

## A Hybrid Approach Using Genetic Algorithms and Student Social Network Analysis

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# Outline

- Background & Motivation
- Proposed System Overview
- Hybrid Algorithm Design
- Experimental Evaluation
- Conclusion & Future Work

# Background & Motivation

Team-based learning enhances engagement, critical thinking, and collaboration.

Forming balanced teams is complex—especially in MOOCs.

Current methods lack scalability and personalization.

# Research Gaps

Manual team formation is time-consuming in large classes.

Existing tools rarely consider both skill diversity and social ties.

Lack of scalable, automated solutions for heterogeneous team creation.

# Key Contributions

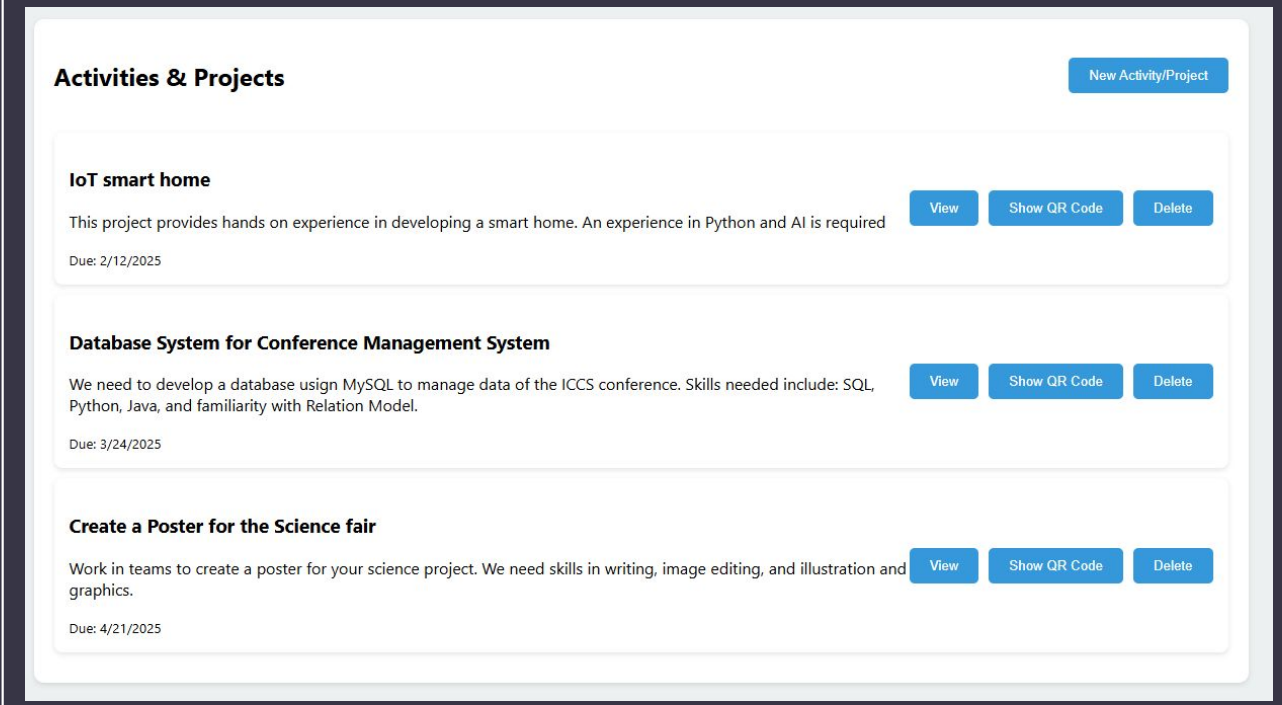
- Hybrid algorithm combining community detection and genetic optimization.
- Web-based platform for teachers and students.
- Validated with synthetic networks (20, 50, 100 students).

# System Overview

- Teachers: define activities, required skills, and team sizes.
- Students: self-rate skills, select preferred teammates.
- System processes data and outputs optimal team assignments.

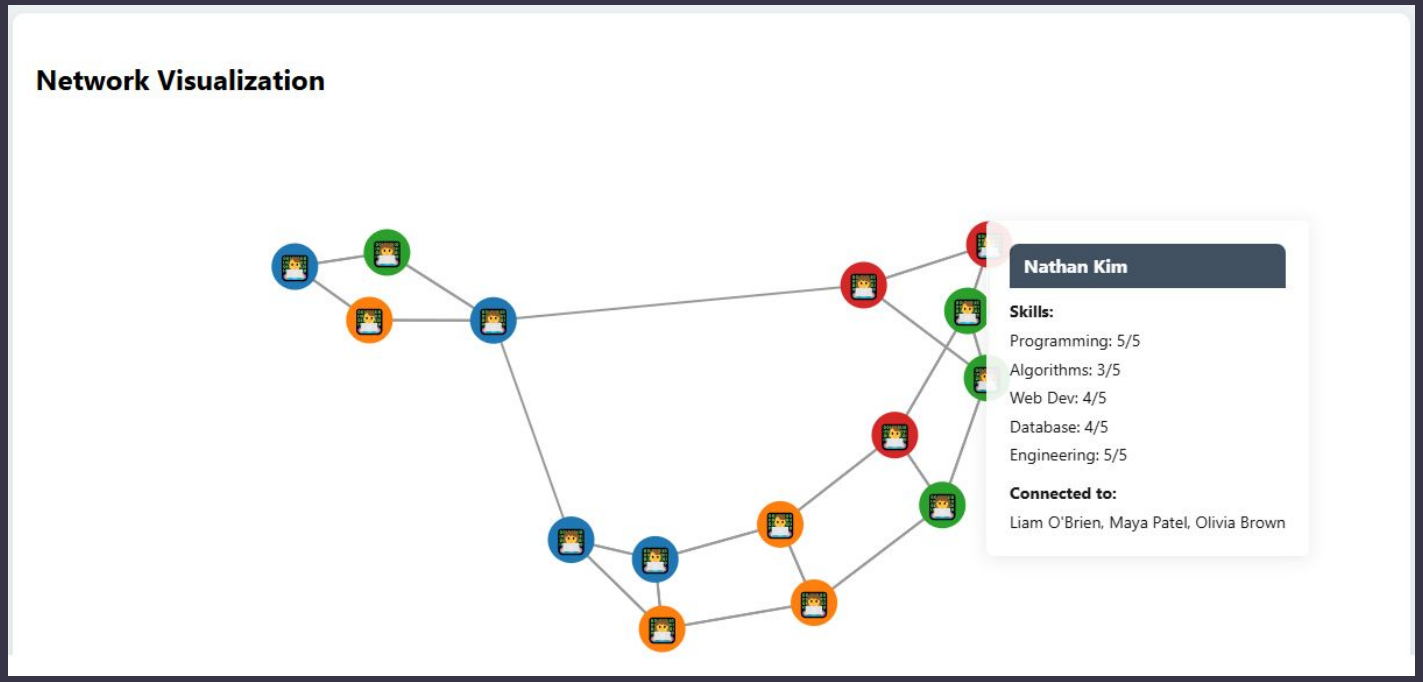
# Teacher Interface

- Activity creation and skill specification.



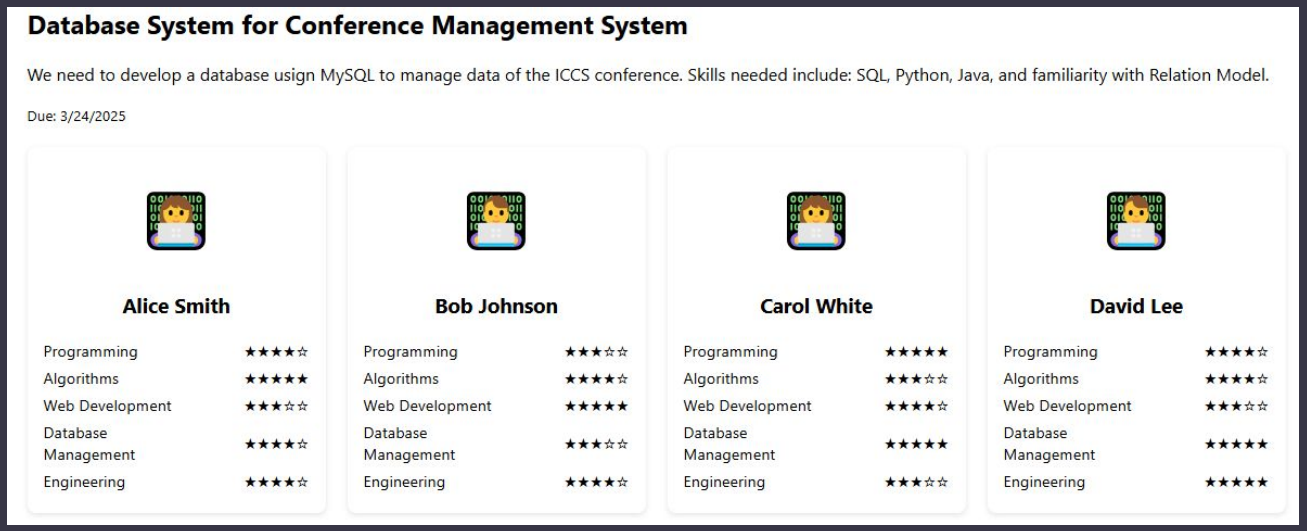

# Teacher Interface

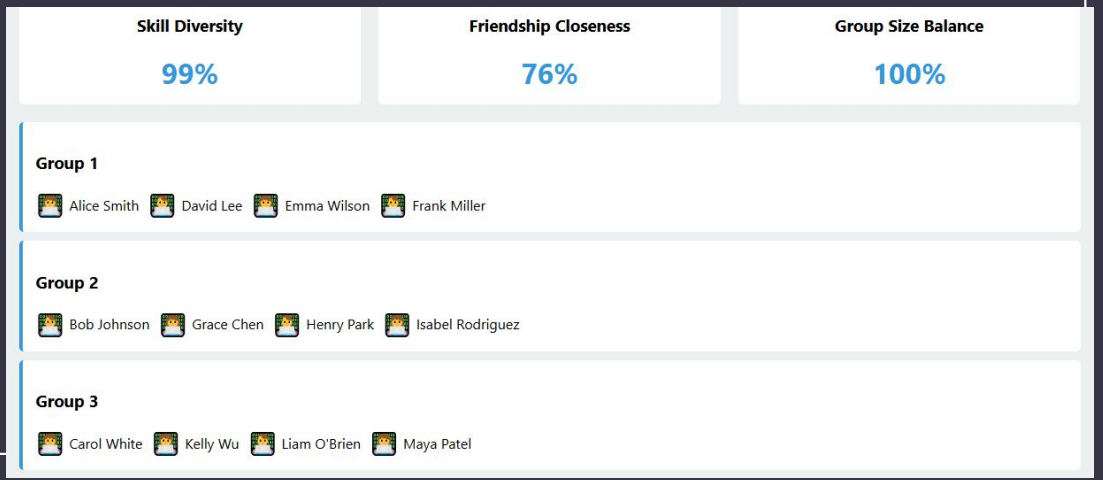
- Visualization of student networks.



# Teacher Interface

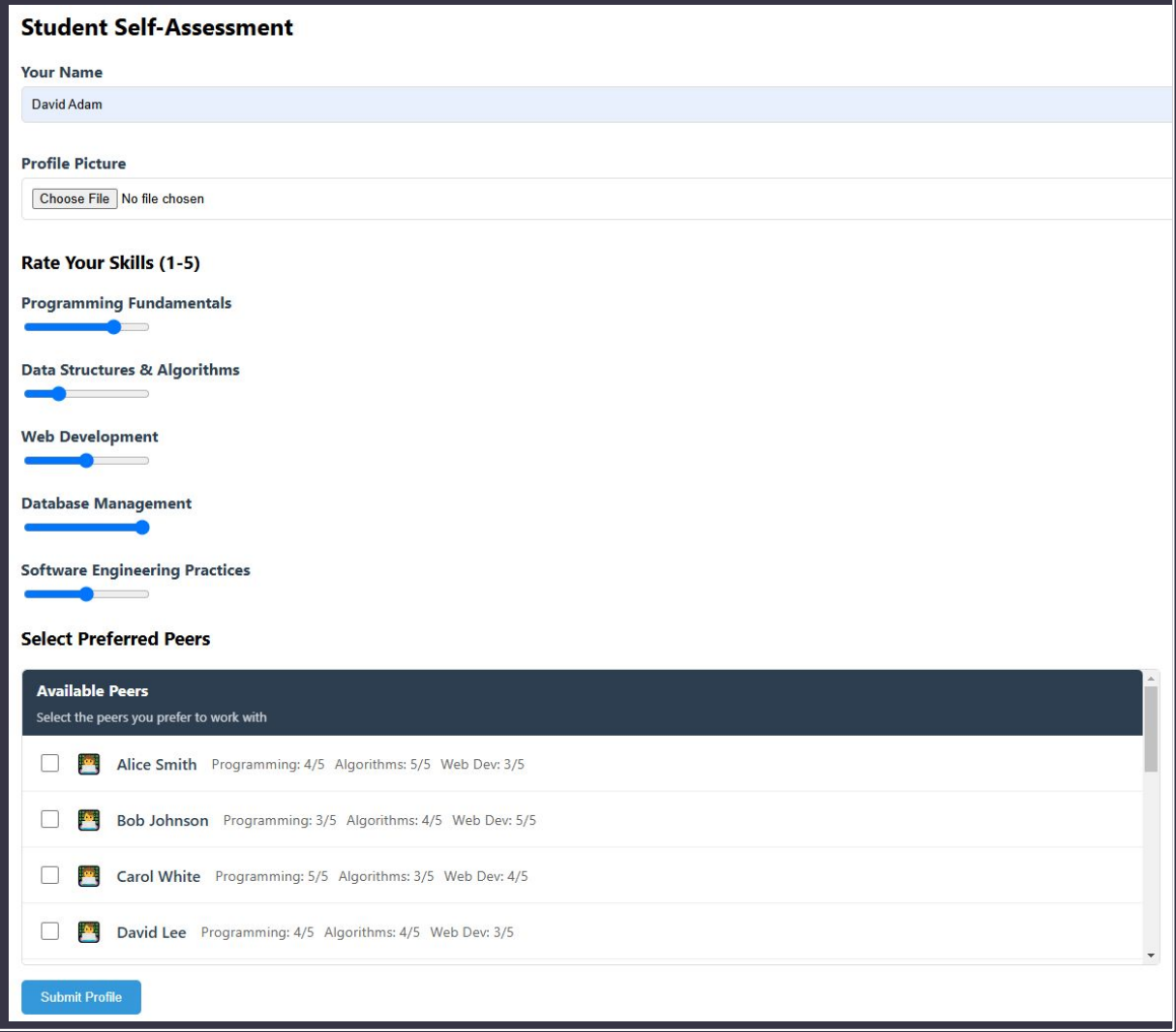
- Review of student ratings and preferences.



# Student Interface

- Likert-scale self-rating on required skills.
- Peer selection enhances autonomy and satisfaction.
- Submits responses via QR code or link.



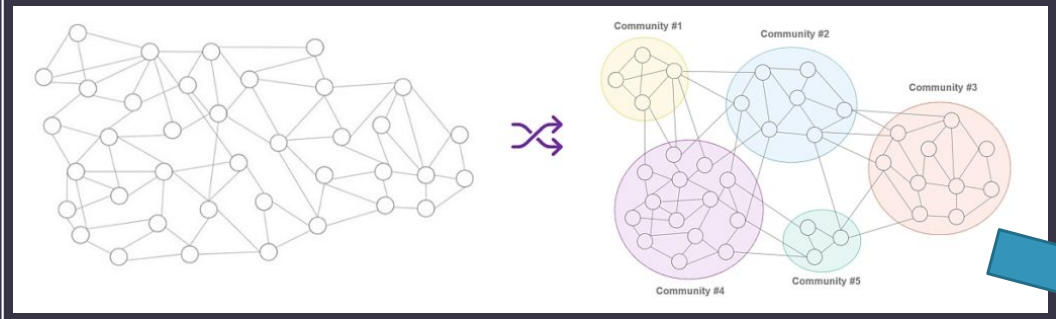
# Backend System

- Builds weighted social graph from preferences.
- Handles computational complexity efficiently.
- Supports large-scale classrooms and MOOCs.

# Data Simulation

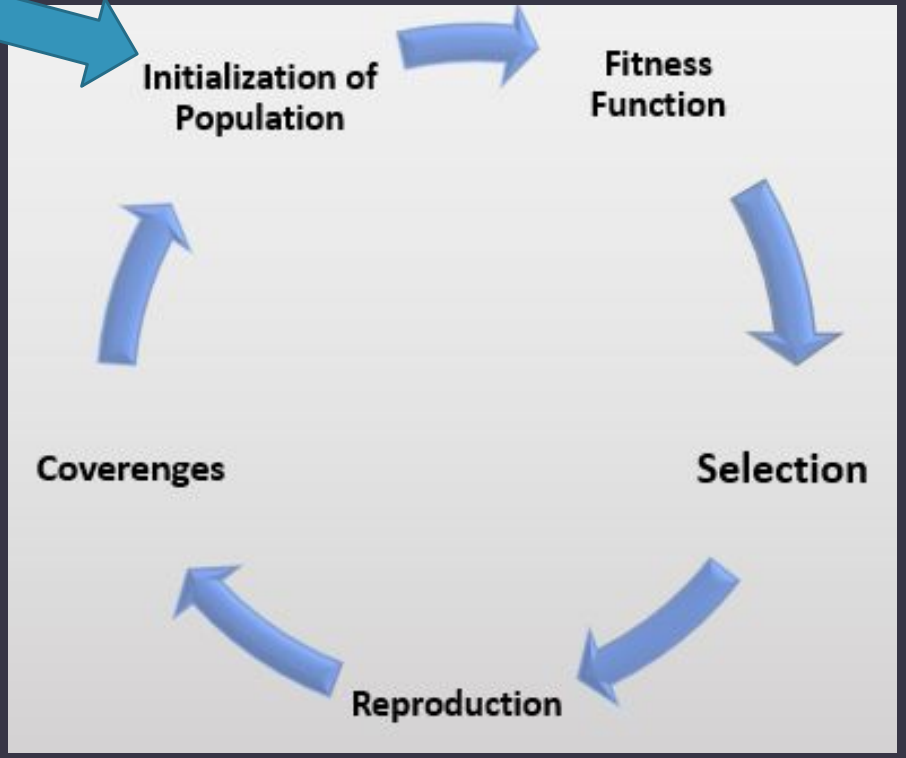
- Synthetic data: 20, 50, 100 students (5 instances each).
- Randomized skill vectors and social edge weights.
- Captures realistic classroom diversity.

# Hybrid Algorithm Design




Phase 1: Community Detection (Louvain method).

Chromosome = team assignment; fitness = skill diversity, closeness, size balance.




Phase 2: Genetic Optimization.

# Hybrid Algorithm Design

- Phase 1: Community Detection (Louvain method).
- Phase 2: Genetic Optimization.
- Chromosome = team assignment; fitness = skill diversity, closeness, size balance.

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Input: G = (V, E): Social network graph
       S: Skill vectors for each student
       k: Desired number of groups

Output: G_k = {G_1, G_2, ..., G_k}: Partitioned student groups

Initialisation:
    Perform community detection on G to obtain initial group assignments G_k^(0)
    Encode initial assignments as chromosome c^(0)

Process:
1: Initialise population P with chromosome c^(0) and random chromosomes
2: for t = 1 to T (max generations) do
3:     Evaluate fitness F(c) for all chromosomes in P
4:     Select parent chromosomes using tournament selection
5:     Perform crossover to generate offspring
6:     Apply mutation to offspring with probability p_mut
7:     Replace least-fit individuals in P with offspring
8: end for

Final Step:
9: Return best chromosome c* representing the optimized groups G_k
```

# Fitness Function Details

- Skill Diversity: entropy of team skills.
- Friendship Closeness: avg. social edge weights.
- Group Size Balance: penalizes unequal team sizes.

# Results Overview

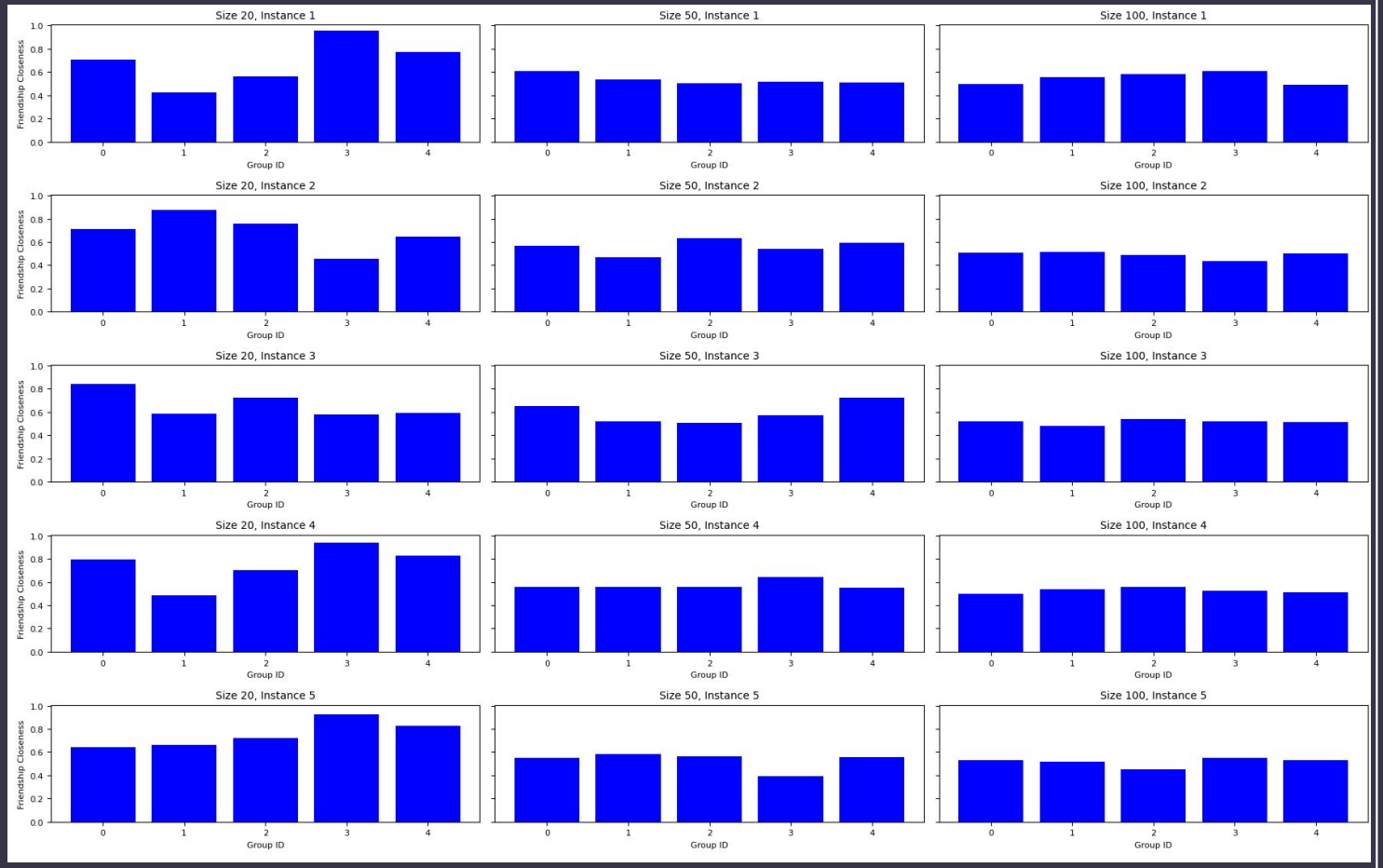
- Metrics: Skill diversity, friendship closeness, group size.
- Consistent performance across 20, 50, 100 nodes.
- System shows robustness and scalability.

# Skill Diversity Results

- Uniform high skill diversity across all team instances.
- Maintained balance in large networks (e.g., 100 students).
- High entropy = broad range of skills.

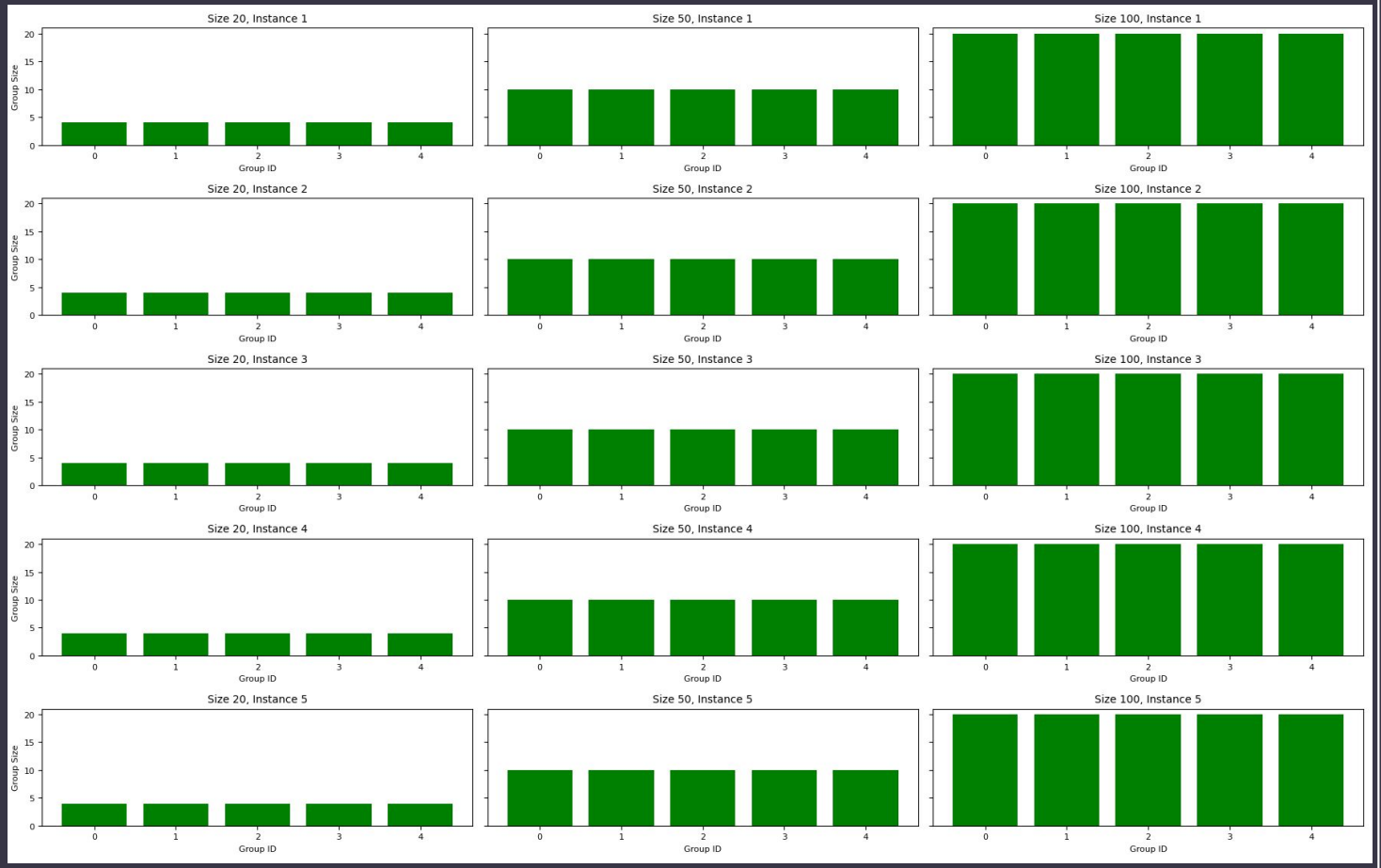
# Friendship Closeness

- Measured by average edge weights.
- Smaller networks = more variance.
- Larger networks = uniform closeness.



# Group Size Balance

- Near-perfect team sizes across all cases.
- Effective in both small (20) and large (100) networks.
- Reduces educator workload.



# Strengths of the System

- Scalable and automated.
- Personalized: considers both skills and preferences.
- Supports visual analytics and teacher overrides.

# Future Work

- Deploy with real student datasets.
- Integrate cognitive and learning preferences.

# Conclusion

- Presents a novel, robust algorithm and system for team formation.
- Combines AI with social network analysis.
- Applicable across face-to-face, hybrid, and MOOC settings.

# Thank You

- Questions Please

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