Promoting Research Collaboration with Open Data Driven Team Recommendation in Response to Call for Proposals

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Introduction

Background:
- We introduce **ULTRA** (**U**niversity **L**ead **T**eam Builder from **R**FPs and **A**nalysis), a novel AI-based system for assisting *team formation* when researchers respond to calls/requests for proposals (RFPs) from funding agencies.
- This is an instance of the general problem of building teams where demand opportunities come periodically and potential members that best fit the criteria and requirements may vary over time.

Broad Objective:
- Build novel methods and useful tools for group recommendation with fairness, and drive different use cases (e.g., meal recommendation).

Use Cases

- **Collaborative team formation.**
- Balanced meal plans for diabetics: recommend meal items (appetizer, main dish, dessert) based on, e.g., dieticians' and doctors' recommendations, calorie count, added sugars/fat grams count, portion sizes, and types of dishes (e.g., vegetables, dairy, poultry, and other meat).
- Recommending an balanced exercise routine/plan.
- Sending relief teams during natural disasters.
- Building surgical teams with factors that maximize a patient's chance of survival and recovery.

Prior and Current Work

- We built ULTRA, a novel AI-based prototype for assisting with ***team formation*** when researchers respond to calls for proposals from funding agencies.
- Using open data, we deployed ULTRA in two universities of varying geographies: ***University of South Carolina (USA)*** and ***Indian Institute of Technology - Roorkee (IIT-R) (India).***
- **Current goals:**
  ○ Scale ULTRA to university-level.
  ○ Evaluate the system for fairness. (E.g., does the system give better team recommendations for those in a certain demographic category?)

Contact Us

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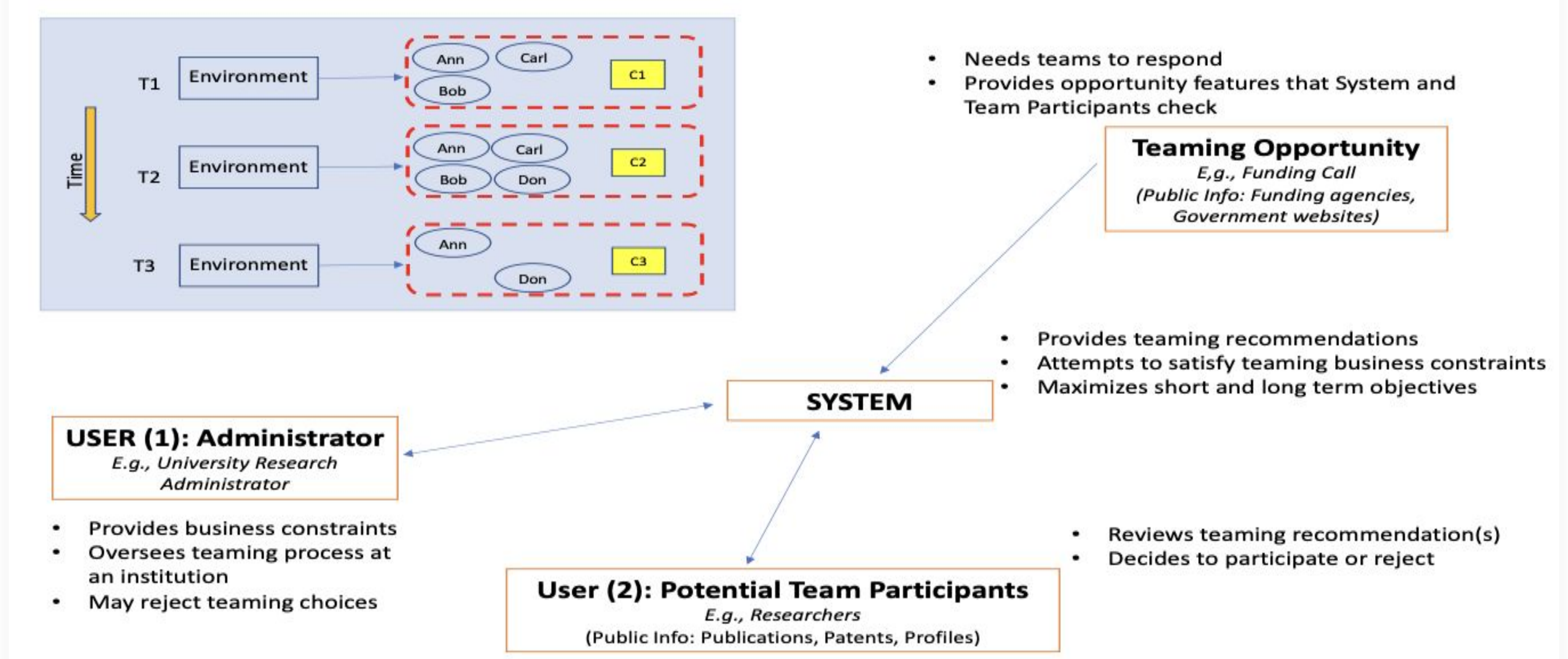- Dr. Biplav Srivastava - biplav.s@sc.edu

References

1. Valluru, S. L., Srivastava, B., Paladi, S. T., Yan, S., & Natarajan, S. (2024). Promoting Research Collaboration with Open Data Driven Team Recommendation in Response to Call for Proposals. *Proceedings of the Thirty-Sixth Annual Conference on Innovative Applications of Artificial Intelligence (AAAI/IAAI-24).*
2. Srivastava, B., Koppel, T., Paladi, S. T., Valluru, S. L., Sharma, R., & Bond, O. (2022). ULTRA: A Data-driven Approach for Recommending Team Formation in Response to Proposal Calls. *IEEE ICDM Workshop on AI for Nudging and Personalization (WAIN).*
3. Gupta, A., Srivastava, B., Aggarwal, K., & Paladi, S. T. KITE-An Unsupervised, Effective and Inclusive Approach for Textual Content Exploration.

Sample Input Data from University of South Carolina

Faculty Researcher Data

Faculty Name	Research Interests
Agostinelli, Forest	['Artificial Intelligence, Deep Learning, Reinforcement Learning, Search, Bioinformatics']
Bakos, Jason D.	['computer architecture, reconfigurable computing, heterogeneous computing, high performance computing, embedded systems']
Banerjee, Sourav	['Wave Propagation, Ultrasonics, Acoustics, Metamaterials, Biomedical']
Bayat, Mahmoud	['Structural Health Monitoring, Probabilistic Analysis, Nonlinear Vibrations, Machine Learning, Earthquake Eng']

Requests/Calls for Proposals (RFPs) Data

RFP ID	RFP Title	Description
nsf20540	NSF-Simons Research Collaborations on the Mathematical and Scientific Foundations of Deep Learning	The National Science Foundation Directorates for Mathematical and Physical Sciences (MPS), Computer and Information Science and Engineering (CISE), Engineering (ENG), and the Simons Foundation Division of Mathematics and Physical Sciences will jointly sponsor up to two new research collaborations consisting of mathematicians, statisticians, electrical engineers, and theoretical computer scientists. Research activities will be focused on explicit topics involving some of the most challenging questions in the general area of Mathematical and Scientific Foundations of Deep Learning.

ULTRA - System Architecture

- Needs teams to respond
- Provides opportunity features that System and Team Participants check

Teaming Opportunity
E.g., Funding Call (Public Info: Funding agencies, Government websites)

SYSTEM
- Provides teaming recommendations
- Attempts to satisfy teaming business constraints
- Maximizes short and long term objectives

USER (1): Administrator
E.g., University Research Administrator
- Provides business constraints
- Oversees teaming process at an institution
- May reject teaming choices

User (2): Potential Team Participants
E.g., Researchers (Public Info: Publications, Patents, Profiles)
- Reviews teaming recommendation(s)
- Decides to participate or reject

Group Recommendation With Teaming as a Use Case: ULTRA UI Prototype for University of South Carolina

http://casy.cse.sc.edu/ultra/DataExplorer/

Ultra Family of Tools

- **Explore Ultra Data** - See Data, See API
  Click on See Data to see the latest extracted proposals, users and awards.
  Click on See API to redirect to Swagger pages and retrieve the content.
- **Explore Text Content** - Unsupervised Text Visualization with KITE
  An Unsupervised, Effective and Inclusive Approach for Textual Content Exploration
- **Text to Classsification Mapper** - Mapper
  Tool that display the code and description from the ACM and JEL tree based on the text we enter
- **See Recommendation for Teaming** - Teaming Under Development

Website Demo – 3 Use Cases (UCs) With 4 Teaming Methods (M#) Each

Ultra Demonstration and Survey

Select a Use Case:

UC1   UC2   UC3

UC1: Names/Method → Proposal/Teams

Given a researcher's name and a matching method, show a list of highest proposals and candidate teams.

Select researcher's name: Agostinelli, Forest
Select method: M3: Boosted Bandit Matching
Number of Results: 5 , Number of teams per proposal: 3

Enter

http://casy.cse.sc.edu/ultra/teaming/

UC2: Proposal/Method → Teams

Given a proposal and a matching method, show a list of highest ranked candidate teams.

Select proposal:

Select method: M3: Boosted Bandit Matching
Number of teams per proposal: 3

Enter

UC3: Research Interests/Method → Proposal/Teams

Given a desired research interest and a matching method, show a list of highest ranked proposals and candidate teams.

Select interest:
Select method: M3: Boosted Bandit Matching

Enter

Use Case 3 - Sample Results

Selected Proposal: **quantum**, Selected Method: **M3: Boosted Bandit Matching**

Index	Skills	Proposal ID	Proposal Name	Recommended Teams	Overall Goodness Score
1	quantum	nsf17548	Ideas Lab: Practical Fully-Connected Quantum Computer Challenge (PFCQC) (2017)	['Chao, Yuh J. ', 'Farouk, Tanvir I.', 'Huang, Xinyu ', 'Rizos, Dimitris', 'Zhang, Bin'] ['Farouk, Tanvir I.', 'Gatzke, Edward P.', 'Huang, Xinyu ', 'Rizos, Dimitris', 'Zhang, Bin'] ['Chao, Yuh J. ', 'Farouk, Tanvir I.', 'Huang, Xinyu ', 'Rizos, Dimitris', 'Zhang, Bin'] ['Farouk, Tanvir I.', 'Gatzke, Edward P.', 'Huang, Xinyu ', 'Rizos, Dimitris', 'Zhang, Bin'] ['Banerjee, Sourav ', 'Farouk, Tanvir I.', 'Huang, Xinyu ', 'Rizos, Dimitris', 'Williams, Christopher'] ['Banerjee, Sourav ', 'Chao, Yuh J. ', 'Huang, Xinyu ', 'Rizos, Dimitris', 'Williams, Christopher']	0.5938 0.5938 0.5938 0.5938 0.5938 0.5938

## Goodness Metric

- We consider *four methods for group recommendation* and the following metrics to evaluate teams. We penalize the first two metrics, and reward the former.

Metric	Definition
Redundancy	Number of skills that a team of researchers commonly have.
Set size	Team size.
Coverage	Number of skills satisfied by a team in response to an RFP.
k-Robustness	Effectiveness of a team if k members are unavailable.

ULTRA - Human Study Evaluation and Computational/Qualitative Feedback

Human Study Responses for USC (28 Days, 212 Responses)
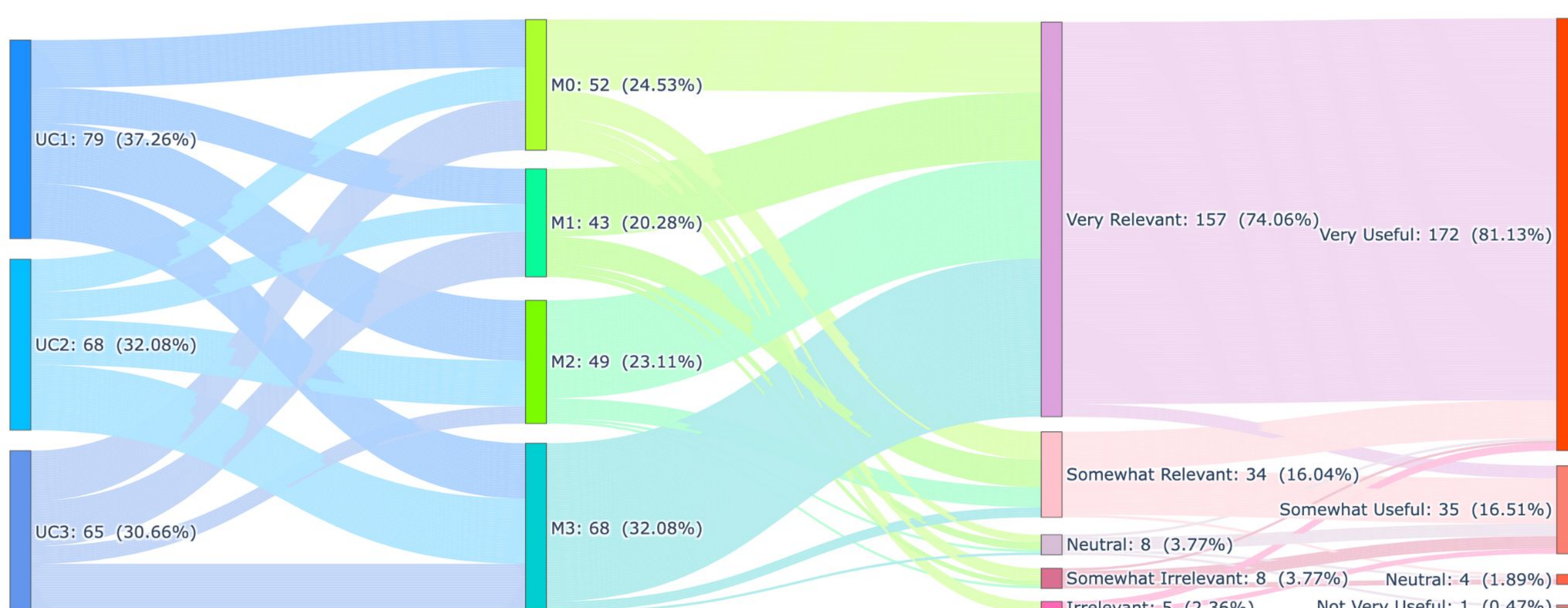
Qualitative Feedback

- An IRB-approved user study was conducted in May 2023, where participants were asked to interact with ULTRA and provide feedback:
  ○ *"This is incredible and has a lot of potential. Can't wait for this to be in real time!"*
  ○ *"Very well thought out! Great resource to the university"*

Average Goodness Scores and Quality of Teaming Results for 2 Universities

Method	Average Quality	Average Volume
M0	0.0879 ± 0.0290	10
M1	0.3673 ± 0.1569	10
M2	0.4097 ± 0.1313	9
M3	0.5295 ± 0.0816	6

Method	Average Quality	Average Volume
M0	0.0896 ± 0.0006	10
M1	0.4218 ± 0.0011	8
M2	0.4292 ± 0.0017	7
M3	0.5835 ± 0.0203	1

We created and implemented AI methods using string, taxonomy, and more advanced contextual boosted bandits in ULTRA. *(Please refer to our paper for more details.)*

Across two different settings in the **US (top)** and **India (bottom)**, as recommendation methods become more data-informed, they improve teaming quality while reducing team size.