Human-Centered and Sustainable Recommender Systems

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Abstract

This tutorial explores the intersection of sustainability and recommender systems, focusing on aligning user needs and values with sustainable practices. It emphasizes two dimensions: (1) understanding and modeling users to deliver more sustainable recommendations; and (2) fostering sustainability through system design and functionality. Participants will learn how recommender systems can encourage sustainable behaviors and how to enhance system efficiency while minimizing resource consumption and ethical challenges. Through theoretical insights and hands-on sessions, this tutorial proposes discussion and actionable strategies to design human-centered, sustainable recommender systems, addressing both societal impact and technological responsibility.

Keywords

Recommender Systems, Sustainability, Human-Centered

1 Tutorial Description

The concept of sustainability is defined as a development process capable of "meeting the needs of the present without compromising the ability of future generations to meet their own needs" [4]. It is an increasingly pressing global issue, and technology, including Recommender Systems, has a role to play in addressing it.

Existing approaches dealing with social aspects, ethical issues [3, 6], and environmental aspects [11–13], primarily evaluate the impact of recommender systems by focusing on individual stakeholders' value. Differently from such approaches, in this tutorial, we propose a new and holistic perspective that focuses on integrating environmental, social, and economic considerations [10] into the recommendation process [5, 7]. We analyze the impact of recommender systems in achieving sustainability development goals [1, 9, 14] under a broader sustainable perspective.

Proposing this tutorial on sustainability to the UMAP community has several compelling reasons based on impact, opportunity for innovation, and community engagement.

1.1 Learning Objectives

Participants can gain a comprehensive understanding of the dual role of sustainability in recommender systems. They can explore how these systems can actively promote sustainable behaviors, such as encouraging eco-friendly consumption and supporting educational content on sustainability topics, while addressing societal challenges aligned with the UN's Sustainable Development Goals (SDGs). Also, participants can examine the sustainability of the systems themselves, focusing on strategies to reduce energy consumption and address ethical considerations in system design.

Attendees are able to enhance their knowledge of user modeling techniques to align recommendations with individual needs and societal values, ensuring fairness, diversity, and transparency. They can also learn how to mitigate biases in recommendations and balance personalization with societal objectives, drawing on recent research in fairness and transparency in artificial intelligence.

The tutorial also covers the design of energy-efficient and ethical recommender systems, by proposing strategies to minimize resource usage and carbon footprint while addressing challenges such as algorithmic fairness and responsible AI practices. Furthermore, attendees can discuss integrated approaches that balance societal impact with system efficiency, evaluating trade-offs and identifying opportunities for creating systems that are both user-centered and environmentally responsible.

Finally, through hands-on exercises, participants can acquire practical skills to implement and evaluate sustainable recommender systems using real-world datasets and tools, leveraging state-of-the-art methods to promote sustainability and enhance system efficiency.

1.2 Relevance to ACM UMAP 2025

The topic of sustainability in recommender systems is of critical importance to the ACM UMAP 2025 Conference, reflecting the growing emphasis on ethical, responsible, and impactful AI within the user modeling and personalization community. As societal and environmental challenges intensify, the role of technology in addressing these issues has become a focal point of research and innovation. Sustainable recommender systems embody this shift, offering strategies to align personalization technologies with broader societal goals, such as the SDGs.

In recent years, there has been a growing interest in integrating sustainability into AI systems, as evidenced by the increasing number of publications [8], workshops[1], and special tracks[2] dedicated to this topic at major conferences, including ACM RecSys [2] and ECIR[3]. This tutorial aligns with UMAP's mission to advance user-centered AI by addressing both the societal impact of

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[1]https://sites.google.com/view/ai4s/home
[2]https://ijcai24.org/ai-for-social-good-special-track-accepted-papers/
[3]https://www.ecir2024.org/ir4good/

personalization technologies and the efficiency and responsibility of their implementation. By emphasizing fairness, diversity, and transparency in user modeling while promoting sustainable behaviors and reducing system resource consumption, this topic offers a transformative perspective for the UMAP community. It fosters interdisciplinary dialogue and offers actionable insights to drive meaningful change through recommender systems.

1.3 Target Audience

The tutorial is intended for a beginner or intermediate audience and is open to researchers, industry technologists and practitioners. It covers all the necessary background on sustainability and recommender systems to make it accessible to people without prior knowledge about these topics, which is not assumed. Basic knowledge of Python programming and familiarity with common data science libraries, such as Pandas and NumPy, are preferred. It is worth noticing that, despite the technical aspects, the key concepts illustrated during the tutorial and their applications touch a range of interdisciplinary fields, also making the proposed outline of interest to an interdisciplinary audience. Upon completing this tutorial, the participants gain an understanding of key concepts related to sustainability and recommender systems. They are able to analyze and consider the impact on relevant parties. Additionally, they are able to identify challenges and opportunities in this area.

2 Outline

In the first session of our tutorial, the existing literature and the most recent advances on sustainability in recommender systems are presented. The tutorial covers two different perspectives of this field: (1) understanding and modeling users to deliver more sustainable recommendations; and (2) fostering sustainability through system design and functionality. During the third session, some practical exercises are proposed to keep the audience engaged and make the tutorial interactive.

The expected outline, including the description of the practical session, is briefly illustrated below.

(1) Introduction to Sustainability in Recommender Systems
- Overview of sustainability: SDGs and Agenda 2030.
- RecSys and Sustainability: Definition of recommender systems and their societal impact.
- The dual role of sustainability in RecSys: RecSys for Sustainability and Sustainability of RecSys
- Why Sustainability Matters in RecSys: Social, environmental, and economic implications.
- Key questions guiding the session.
(2) RecSys for Sustainability
- Defining RecSys for Good: Using recommendations to promote sustainable behaviors and social well-being.
- Role of User Modeling in RecSys for Good: Balancing personalization with societal objectives; avoiding biases and ensuring fairness and transparency; promoting sustainable behavior and consumption.
- Real-world examples and strategies (e.g., eco-friendly products, educational content).
(3) Sustainability of RecSys
- Defining Sustainability of RecSys: Enhancing system efficiency and reducing environmental impact.
- Case studies and practical approaches: energy-efficient designs and ethical considerations
- Hands-on session: exploring tools and techniques for sustainable recommender systems.
(4) Closing Reflections and Takeaways
- Sustainable RecSys: integration of both perspectives.
- Actionable strategies for researchers and practitioners.
- Discussion on the role of User Modeling in RecSys for Good.
- Sustainability in recommender systems is a shared responsibility and an opportunity to drive meaningful change.

Participants can explore tools and datasets to evaluate sustainable recommender systems. The session includes:

- Evaluating system efficiency and ethical considerations
- Case studies using state-of-the-art tools and frameworks

All the slides, Jupyter notebooks, reference lists, pre-processed datasets, and any source code used during the tutorial will be published on our webpage[4].

3 Organizers

Allegra De Filippo is an Assistant Professor at the Department of Computer Science and Engineering at the University of Bologna. She received her Ph.D. in Computer Science and Engineering at the University of Bologna (2020). Her research focuses on decision support systems, stochastic optimization, and methods for integrated offline/online optimization under uncertainty in complex systems. Her doctoral thesis was identified as being of exceptional quality during the evaluation process of the EurAI 2021 PhD Thesis Award.

Allegra has deepened her knowledge of the aspects of artificial intelligence and sustainability through various academic and professional experiences, presenting her research results in international events such as the Business Forum AI Italia Canada with a panel on the current state of AI and its impact on the circular economy and sustainability goals. Her recent research activities focus on the environmental sustainability of AI, with particular attention to recommender systems. In 2023 and 2024, she authored two contributions accepted at ACM RecSys Conference (International Conference on Recommender Systems), discussing the interplay between recommender systems and sustainability.

She organized RecSoGood 2024, the First International Workshop on Recommender Systems for Sustainability and Social Good, co-located with ACM RecSys 2024. She has published papers at top-tier international conferences and journals in artificial intelligence (IJCAI and JAIR) and collaborated with research groups, universities, and companies in AI and sustainability, and she is the editor of a volume on "Recommender Systems for Sustainability and Social Good" (Springer, CCIS Series). She is the track chair of the IJCAI 2025 AI, Arts & Creativity special track. She is an editorial board member of the journal ACM Computing Survey and has served in organizational and scientific roles for several events.

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[4]https://giuspillo.github.io/umap25_sustainable_recsys_tutorial/

Ludovico Boratto is an Associate Professor of Computer Science at the University of Cagliari (Italy). His research interests focus on recommender systems and their impact on the different stakeholders, both considering accuracy and beyond-accuracy evaluation metrics. He has authored over 60 papers and published his research in top-tier conferences and journals.

He is editor of the book "Group Recommender Systems: An Introduction", published by Springer. He co-organized RecSoGood 2024, the First International Workshop on Recommender Systems for Sustainability and Social Good, co-located with ACM RecSys 2024. Additionally, he co-created and co-chaired the "IR for Good" track at ECIR 2024 and 2025, which explored social impact, sustainable development, and ethics in information retrieval. He is the editor of a volume on "Recommender Systems for Sustainability and Social Good" (Springer, CCIS Series). He is an editorial board member of the "Information Processing & Management" journal (Elsevier) and "Journal of Intelligent Information Systems" (Springer), and guest editor of several journals' special issues. He is regularly part of the program committees of the main Web conferences, where he received eight outstanding contribution awards.

In 2012, he got his Ph.D. at the University of Cagliari (Italy), where he was a research assistant until May 2016. From May 2016 to April 2021, he joined Eurecat as a Senior Research Scientist in the Data Science and Big Data Analytics research group. In 2010 and 2014, he spent ten months at Yahoo! Research in Barcelona as a visiting researcher. He is a member of ACM and IEEE.

Giuseppe Spillo is a Ph.D. Student at the Computer Science Department, University of Bari. His main research interests include knowledge-aware and multi-modal recommender systems, environmental sustainability of AI models, and natural language processing. During 2023 and 2024, he authored papers for international conferences, including ACM Recommender Systems and User Modeling, Adaptation and Personalization (UMAP); he authored a paper published at UMAP 23 winning the James Chen's Best Student Paper Award. Since 2024, he has served as a program committee member for the ACM Recommender Systems Conference and the User Modeling, Adaptation and Personalization Conference.

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