



Aalborg Universitet

AALBORG UNIVERSITY  
DENMARK

**3rd Edition of knowledge-aware and conversational recommender systems (KaRS) & 5th Edition of recommendation in complex environments (ComplexRec) joint workshop**

Anelli, Vito Walter; Basile, Pierpaolo; Di Noia, Tommaso; Donini, Francesco Maria; Musto, Cataldo; Narducci, Fedelucio; Zanker, Markus; Abdollahpouri, Himan; Bogers, Toine; Mobasher, Bamshad; Petersen, Casper; Pera, Maria Soledad

*Published in:*  
CEUR Workshop Proceedings

*Creative Commons License*  
CC BY 4.0

*Publication date:*  
2021

*Document Version*  
Publisher's PDF, also known as Version of record

[Link to publication from Aalborg University](#)

*Citation for published version (APA):*

Anelli, V. W., Basile, P., Di Noia, T., Donini, F. M., Musto, C., Narducci, F., Zanker, M., Abdollahpouri, H., Bogers, T., Mobasher, B., Petersen, C., & Pera, M. S. (2021). 3rd Edition of knowledge-aware and conversational recommender systems (KaRS) & 5th Edition of recommendation in complex environments (ComplexRec) joint workshop. *CEUR Workshop Proceedings*, 2960(9).

**General rights**

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal -

# 3rd Edition of Knowledge-aware and Conversational Recommender Systems (KaRS) & 5th Edition of Recommendation in Complex Environments (ComplexRec) Joint Workshop

Vito Walter Anelli<sup>1</sup>, Pierpaolo Basile<sup>2</sup>, Tommaso Di Noia<sup>3</sup>, Francesco Maria Donini<sup>4</sup>, Cataldo Musto<sup>5</sup>, Fedelucio Narducci<sup>6</sup>, Markus Zanker<sup>7</sup>, Himan Abdollahpouri<sup>8</sup>, Toine Bogers<sup>9</sup>, Bamshad Mobasher<sup>10</sup>, Casper Petersen<sup>11</sup> and Maria Soledad Pera<sup>12</sup>

<sup>1</sup>Polytechnic University of Bari

<sup>2</sup>University of Bari Aldo Moro

<sup>3</sup>Polytechnic University of Bari

<sup>4</sup>University of Tuscia

<sup>5</sup>University of Bari Aldo Moro

<sup>6</sup>Polytechnic University of Bari

<sup>7</sup>Free University of Bozen-Bolzano

<sup>8</sup>Spotify

<sup>9</sup>Aalborg University, Copenhagen

<sup>10</sup>DePaul University

<sup>11</sup>Sampension

<sup>12</sup>Boise State University

## Abstract

This is the preface for the joint workshop between KaRS and ComplexRec: two workshops co-located with the 15th ACM RecSys 2021 conference.

## Keywords

Recommender Systems, Workshop, Proceedings

## 1. Introduction

In this volume, we include the contributions presented at the Joint KaRS & ComplexRec Workshop, co-located with the 15<sup>th</sup> edition of the ACM Conference on Recommender Systems (RecSys) in Amsterdam.

This joint workshop adopted a hybrid format aligned with the goal of this year's main conference – congregating to continue to build community around recommender systems research and development. In this joint workshop, we merged the main objectives envisioned for the 3<sup>rd</sup> Edition of the KaRS Workshop and the 5<sup>th</sup> edition of the Workshop on Recommendation in Complex Environments:

- Providing an interactive venue for discussing approaches to recommendation in complex envi-

ronments that have no simple one-size-fits-all solution. In particular, we envisioned deepening the community understanding on *complex inputs*—e.g., active user inputs (interaction), implicit user inputs (task, context, preferences), item inputs (features or attributes), domain inputs (eligibility, availability)—and *complex outputs*—e.g., package recommendation, composite items, interface complexity, constraint-based recommendation.

- Providing a meeting forum for stimulating and disseminating research in Knowledge-aware and Conversational Recommender Systems, where researchers can network and discuss their research results in an informal way. In particular, we aimed to expand community understanding on *knowledge-aware recommenders*—from models and feature engineering issues to beyond accuracy recommendation quality with a particular focus on real-world applications—and *conversational recommenders*—from the design of a conversational agent and its interface to the user modeling problems and evaluation issues.

*3rd Edition of Knowledge-aware and Conversational Recommender Systems (KaRS) & 5th Edition of Recommendation in Complex Environments (ComplexRec) Joint Workshop co-located with the 15th ACM Conference on Recommender Systems (RecSys 2021)*



© 2021 Copyright for this paper by its authors. Use permitted under Creative Commons License Attribution 4.0 International (CC BY 4.0).  
CEUR Workshop Proceedings (CEUR-WS.org)

Overall, we accepted 17 contributions: 11 long papers, 3 short papers, and 3 position papers. Each presentation was peer-reviewed by at least 3 program committee (PC) members. The presentations of the accepted contributions, along with the two keynote addressed by Edward C. Malthouse (during the virtual component) and Gerard de Melo (during the in person workshop component), sparked interactions among attendees and fostered ideas to continue to advance research focused around the topics of the joint workshop.

As KaRS & ComplexRec co-organizer, we want to thank the RecSys 2021 workshop co-chairs, for their support regarding hybrid workshop organization. Last, but not least, we would like to thank all authors and presenters, as well as the members of the program committee who selflessly shared their time and expertise in providing feedback to workshop authors. Finally, the workshop proceedings shall be submitted to CEUR-WS.org for on-line publication.

## 2. Workshop of Knowledge-aware and Conversational Recommender Systems

### 2.1. Background and Goals

In the last few years, a renewed interest of the research community on conversational recommender systems (CRSs) is emerging. This is probably due to the great diffusion of Digital Assistants (DAs) such as Amazon Alexa, Siri, or Google Assistant that are revolutionizing the way users interact with machines. DAs allow users to execute a wide range of actions through an interaction mostly based on natural language messages. However, although DAs are able to complete tasks such as sending texts, making phone calls, or playing songs, they are still at an early stage on offering recommendation capabilities by using the conversational paradigm.

In addition, we have been witnessing the advent of more and more precise and powerful recommendation algorithms and techniques able to effectively assess users' tastes and predict information that would probably be of interest to them. Most of these approaches rely on the collaborative paradigm (often exploiting machine learning techniques) and do not take into account the huge amount of knowledge, both structured and non-structured ones, describing the domain of interest of the recommendation engine. Although very effective in predicting relevant items, collaborative approaches miss some very interesting features that go beyond the accuracy of results and move in the direction of providing novel and diverse results as well

as generating an explanation for the recommended items. Furthermore, this side information becomes crucial when a conversational interaction is implemented, in particular for the preference elicitation, explanation, and critiquing steps.

The 3rd Knowledge-aware and Conversational Recommender Systems (KaRS) Workshop focuses on all aspects related to the exploitation of external and explicit knowledge sources to feed and build a recommendation engine, and on the adoption of interactions based on the conversational paradigm. The aim is to go beyond the traditional accuracy goal and to start a new generation of algorithms and approaches with the help of the methodological diversity embodied in fields such as Human-Computer Interaction, Conversational Recommender Systems, Semantic Web, and Knowledge Graphs. Consequently the focus lies on works improving the user experience and following goals such as user engagement and satisfaction or customer value.

The aim of this third edition of KaRS is to bring together researchers and practitioners around the topics of designing and evaluating novel approaches for recommender systems in order to:

- Share research and techniques, including new design technologies and evaluation methodologies
- Identify next key challenges in the area
- Identify emerging topics in the field

### 2.2. Program

The program of the half-day workshop (part virtual, part in-person) consists of:

- An invited keynote by Professor Gerard de Melo from the Hasso Plattner Institute for Digital Engineering and the University of Potsdam, Germany.
- The presentation of the selected research papers,

### 2.3. Website & Proceedings

All workshop material including schedule and news will be found on the 2021 workshop website at <https://kars-workshop.github.io/2021/>.

### 2.4. Program Committee

We thank the members of the PC for their thorough reviews and their detailed feedback they gave to the authors. The PC consisted of the following international experts.

- Vito Walter Anelli, POLITECNICO DI BARI
- Azzurra Ragone, EY BUSINESS AND TECHNOLOGY SOLUTIONS

- Paolo Rosso, UNIVERSITAT POLITÈCNICA DE VALÈNCIA
- Andrea Iovine, UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO
- Fedelucio Narducci, POLITECNICO DI BARI
- Adir Solomon, BEN-GURION UNIVERSITY
- Maurizio Ferrari Dacrema, POLITECNICO DI MILANO
- Diego Antognini, ECOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE
- Marco Polignano, UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO
- Tommaso Di Noia, POLYTECHNIC UNIVERSITY OF BARI
- Iván Cantador, UNIVERSIDAD AUTÓNOMA DE MADRID
- Marco de Gemmis, UNIVERSITY OF BARI ALDO MORO
- Raffaele Perego, ISTI-CNR
- Claudio Gennaro, ISTI-CNR
- Gianmaria Silvello, UNIVERSITY OF PADUA
- Cataldo Musto, DIPARTIMENTO DI INFORMATICA - UNIVERSITY OF BARI
- Davide Di Ruscio, UNIVERSITÀ DEGLI STUDI DELL'AQUILA
- Nicola Tonello, UNIVERSITY OF PISA
- Pierpaolo Basile, UNIVERSITY OF BARI
- Alejandro Bellogin, UNIVERSIDAD AUTÓNOMA DE MADRID
- Chiara Renso, ISTI-CNR, PISA, ITALY
- Pablo Sánchez, UNIVERSIDAD AUTÓNOMA DE MADRID
- Benjamin Heitmann, RWTH AACHEN UNIVERSITY
- Maria Maistro, UNIVERSITY OF COPENHAGEN
- Olga Marino, UNIVERSIDAD DE LOS ANDES
- Francesco M. Donini, UNIVERSITA' DELLA TUSCIA
- Dietmar Jannach, UNIVERSITY OF KLAGENFURT
- Cristina Gena, UNIVERSITY OF TORINO
- Giorgio Maria Di Nunzio, UNIVERSITY OF PADUA
- Federica Cena, UNIVERSITY OF TORINO
- Markus Zanker, FREE UNIVERSITY OF BOZEN-BOLZANO
- Ludovico Boratto, UNIVERSITY OF CAGLIARI
- Franco Maria Nardini, ISTI-CNR
- Alain Starke, WAGENINGEN UNIVERSITY & RESEARCH
- Toine Bogers, AALBORG UNIVERSITY
- Francesco Ricci, FREE UNIVERSITY OF BOZEN-BOLZANO

- Giovanni Semeraro, UNIVERSITY OF BARI
- Nourah Alrossais, UNIVERSITY OF YORK
- Nicola Ferro, UNIVERSITY OF PADOVA
- Yashar Deldjoo, POLITECNICO DI BARI
- Claudio Pomo, POLITECNICO DI BARI
- Antonio Ferrara, POLITECNICO DI BARI

### 3. Workshop on Recommendation in Complex Environments

#### 3.1. Background and Goals

During the past decade, recommender systems have rapidly become an indispensable element of websites, apps, and other platforms that seek to provide personalized interactions to their users. As recommendation technologies are applied to an ever-growing array of non-standard problems and scenarios, researchers and practitioners are also increasingly faced with challenges of dealing with greater variety and complexity in the inputs to those recommender systems. For example, there has been more reliance on fine-grained user signals as inputs rather than simple ratings or likes. Applications require more complex domain-specific constraints on inputs to the recommender systems. Likewise, the outputs of recommender systems are moving towards more complex composite items, such as package or sequence recommendations. This increasing complexity requires smarter recommender algorithms that can deal with this diversity in inputs and outputs.

For the past four years, the ComplexRec workshop series has offered an interactive venue for discussing approaches to recommendation in complex scenarios that have no simple one-size-fits-all solution. For the fifth edition of ComplexRec we have narrowed the focus of the workshop and contributions to the workshop about topics related to one of the two main themes on complex recommendation: complex inputs and complex outputs.

For the past four years [1, 2, 3, 4], the ComplexRec workshop series has offered an interactive venue for discussing approaches to recommendation in complex scenarios that have no simple one-size-fits-all solution. For the fifth edition of ComplexRec we have narrowed the focus of the workshop and contributions to the workshop about topics related to one of the two main themes on complex recommendation: complex inputs and complex outputs. ComplexRec 2021 will take place as a joint workshop with KARS 2021.

### 3.2. Complex inputs

An important source of complexity comes from the various types of inputs to the system beyond users and items, such as features, queries and constraints. There are active user inputs (interaction), implicit user inputs (task, context, preferences), item inputs (features or attributes) and domain inputs (eligibility, availability). In group-based recommendation, the user input can be a combination of inputs for multiple individual users as well as group aspects such as the composition of the group and how well they know each other. An additional challenge is providing users with ways to have control over the inputs. For instance by selecting and weighting or ranking user and item features, providing interactive queries to steer the recommendation, or deal with longer narrative statements that require natural language understanding.

### 3.3. Complex outputs

Another type of complexity that we wish to focus on in ComplexRec 2020 is the complexity of the outputs of a recommender system to move away from a straightforward ranked list of items as output. An example of such complex output is package recommendation: suggesting a set or combination of items that go well together and are complementary on dimensions that matter to the user. In many domains the sequence in which items are recommended is also important. Moreover, different users may want different information about items, so the output complexity goes beyond ranking and also manifests itself in how the interface should allow the user to view the type of information that is most relevant to them. Another example of complexity in recommender systems output are environments where the system's goal is to create new, composite items that must satisfy certain constraints (such as menu recommendation, or recommendations for product designs).

### 3.4. Program

The program of the half-day workshop (completely virtual) consists of:

- An invited keynote by Edward C. Malthous, Erasmus Otis Haven Professor at Northwestern University, Illinois, United States.
- The presentation of the selected research papers,

### 3.5. Website & Proceedings

All workshop material including schedule and news will be found on the 2021 workshop website at <https://complexrec2021.aau.dk/>.

### 3.6. Program Committee

The ComplexRec 2021 organizers would like to thank the members of the program committee for their time and effort to provide timely and constructive reviews of the submitted papers.

- Panos Adamopoulos, EMORY UNIVERSITY
- Ludovico Boratto, EURECAT
- Christine Bauer, UNIVERSITY OF UTRECHT
- Alejandro Bellogin, UNIVERSIDAD AUTÓNOMA DE MADRID
- Iván Cantador, UNIVERSIDAD AUTÓNOMA DE MADRID
- Tommaso Di Noia, POLITECNICO DI BARI
- Mehdi Elahi, UNIVERSITY OF BERGEN
- Fabio Gasparrini, ROMA TRE UNIVERSITY
- Pasquale Lops, UNIVERSITY OF BARI "ALDO MORO"
- Mirko Marras, EPFL
- Cataldo Musto, UNIVERSITY OF BARI "ALDO MORO"
- Fedelucio Narducci, UNIVERSITY OF BARI
- Markus Schedl, JOHANNES KEPLER UNIVERSITY
- Peter Dolog, AALBORG UNIVERSITY
- Cristina Gena, UNIVERSITA' DEGLI STUDI DI TORINO
- Hanna Schäfer, UNIVERSITÄT KONSTANZ
- Marco De Gemmis, UNIVERSITY OF BARI
- Bei Yu, SYRACUSE UNIVERSITY

## References

- [1] T. Bogers, M. K. B. Mobasher, A. Said, A. Tuzhilin, Complexrec 2017, in: Proceedings of the First Workshop on Recommendation in Complex Scenarios, volume 1892, CEUR-WS, 2017, pp. 1–28.
- [2] T. Bogers, M. Koolen, B. Mobasher, C. Petersen, A. Said, Complexrec 2018, in: Proceedings of the Second Workshop on Recommendation in Complex Scenarios, 2018, pp. 1–37. URL: <http://toinebogers.com/workshops/complexrec2018/resources/proceedings.pdf>.
- [3] M. Koolen, T. Bogers, B. Mobasher, A. Tuzhilin, Complexrec 2019, in: Proceedings of the Third Workshop on Recommendation in Complex Scenarios, volume 2449, CEUR-WS, 2019, pp. 1–39.
- [4] T. Bogers, M. Koolen, C. Petersen, B. Mobasher, A. Tuzhilin, O. S. Shalom, D. Jannach, J. A. Konstan, Recommendation in complex scenarios and the impact of recommender systems 2020, in: Proceedings of the Workshops on Knowledge-aware and Conversational Recommender Systems and Recommendation in Complex Scenarios, volume 2697, CEUR-WS, 2020, pp. 1–67.