TUTORIAL

Multi-Agentic Recommender Systems: Foundations, Design Patterns, and E-Commerce Applications — An Industrial Tutorial

REZA YOUSEFI MARAGHEH, Walmart Inc., Bentonville, AR, United States

YASHAR DELDJOO, Polytechnic University of Bari, Bari, BA, Italy

CHI WANG, DeepMind Technologies Limited, London, U.K.

JASON CHO, Walmart Inc., Bentonville, AR, United States

DEREK CHENG, DeepMind Technologies Limited, London, U.K.

Multi-Agentic Recommender Systems: Foundations, Design Patterns, and E-Commerce Applications − An Industrial Tutorial

Reza Yousefi Maragheh
Walmart Global Tech
Sunnyvale, California, USA
reza.yousefimaragheh@walmart.com

Yashar Deldjoo
Polytechnic University of Bari
Bari, Italy
yashar.deldjoo@poliba.it

Chi Wang
Google DeepMind
Redmond, Washington, USA
wangchi@google.com

Jason Cho
Walmart Global Tech
Sunnyvale, CA, USA
jason.cho@walmart.com

Derek Cheng
Google DeepMind
Mountain View, CA, USA
zcheng@google.com

Abstract

The goal of this tutorial is to provide our perspective on the most recent advances in LLM-powered agents for recommender systems. Building on our extensive experience deploying agentic tools in large-scale environments, this tutorial hopes to deepen the understanding of participants with diverse backgrounds on the alphabets that underpin multi-agentic frameworks. Organized by the founders of leading agentic tools, the tutorial will highlight how these frameworks are being applied to create next-generation recommender systems in diverse applications. The examples include context-aware recommendation, dynamic multi-step orchestration, and personalized recommendation systems. To provide a solid foundation, we begin with a brief background on the evolution of recommender systems and how recent breakthroughs in large language models (LLMs) have shifted the paradigm toward more interactive, adaptive, and autonomous systems. The hands-on session will allow participants to directly engage with state-of-the-art techniques, bridging the gap between theoretical concepts and practical implementations.

CCS Concepts

• **Information systems** → *Recommender systems*.

Keywords

Agentic Recommender Systems, Large Language Models, Multi-Agent AI, Industrial Applications, Autonomous Recommendation, Interactive Recommendation, LLM-Powered Agents

1 Tutorial Length, Level, and Audience

We propose a session of approximately **3 hours** (half-day format), including a **hands-on session**.

2 Motivation for Proposing this Tutorial

Despite major breakthroughs in recommender systems, most large-scale and user-facing industrial solutions still follow static or "one-shot" models that produce recommendations with limited interaction or personalization beyond user profiles. As user demands evolve toward more intuitive, interactive, and context-aware experiences, there is an urgent need for these systems to evolve into dynamic autonomous systems capable of reasoning, *multi-step orchestration*, and proactive engagement. Recent developments in LLM enable new capabilities to reason dialogically, maintain longer contexts (memory), query external tools autonomously, and orchestrate *multi-step* workflows [11, 24], paving the way for 'autonomous' or 'agentic' recommender systems.

In short, these *agentic* solutions, or more precisely **multi-agent systems**, can adapt to diverse user behaviors, moving beyond the simple question–response paradigm typical of non-agentic chatbots. They can proactively reason [13, 19, 21, 28], query external APIs [18, 23], refine suggestions based on user and system constraints [3, 9, 25], and even simulate user behavior to evaluate recommendations on broader criteria [26, 29]. However, implementing such advanced pipelines also raises concerns around scalability, reliability, and transparency. Balancing interactive, multi-step reasoning with performance and safety constraints requires best design frameworks and best practices.

Against this backdrop, this tutorial clarifies the core concepts, architectures, and workflows of agentic LLM-based recommender systems. By illustrating the building blocks and showcasing real-world implementation experiences, and providing formal definitions, we aim to equip participants with actionable insights into how these powerful paradigms fundamentally impact the way we think about the design of next wave of (generative) recommender systems.[1]

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[1]It is worth mentioning that the authors are currently preparing a visionary survey paper that expands on the topics discussed in this tutorial. This complementary work will be shared alongside our tutorial materials, including dedicated Colab files and slides, which will be made available on a dedicated GitHub page.

3 Instructors

- Dr. Reza Yousefi Maragheh (ryousefimaragheh@acm.org), Staff Data Scientist, Walmart Global Tech, Sunnyvale, USA,
- Dr. Yashar Deldjoo (deldjooy@acm.org), Senior Researcher and Associate Professor, Polytecyhnic University of Bari, Italy
- Dr. Chi Wang (wangchi@google.com), Senior Staff Research Scientist, Google DeepMind,
- Dr. Jason Cho (jhdcho@gmail.com), Director of Data Science and ML, Walmart Global Tech, Sunnyvale, USA,
- Dr. Derek Cheng, (zcheng@google.com), Senior Staff Research Scientist, Google DeepMind.

Collectively, the instructors have presented tutorials at international venues (RecSys, KDD, WWW), authored refereed articles on LLM-based recommender systems, and developed industrial-scale agentic AI pipelines [1, 2, 2, 4–8, 10, 12, 14–17, 20, 22, 27]. *At least one instructor from each institution (Walmart Global Tech, Google DeepMind, and Polytechnic University of Bari) will attend and present in person.*

4 Outline

We structure this 3-hour tutorial into five modules:

A. **Introduction and Background (15 minutes)**
   - Core properties of modern RecSys: accuracy, policy alignment, context awareness, scalability (cost efficiency, development time efficiency)
   - Temporal view of how evolving LLM-oriented technique address or fail to address the above goals (LLM Vanilla prompting, Chain of Thought, Self-Refine, prompt chaining, single agent frameworks, multi-agent frameworks)
   - Motivating scenario (e.g., **a personalized birthday-planner**) illustrating multi-step, autonomous workflows.

B. **Alphabets of Multi-Agentic-AI (45 minutes)**
   - **Memory Moderation & Retrieval Mechanisms:** Discussion of different memory types and how/when to retrieve them
   - **Function Calling & Tool Usage:** Extending LLM pipelines with external APIs, databases, and knowledge bases
   - **Model Context Protocols:** The standardization of the orchestrations.
   - **Reasoning Load Balancing:** Splitting complex tasks into manageable segments for efficient model usage, mainstream industrial orchestrations.
   - **Revisiting the Running Example**: System Design and how it can be improved using above components.

C. **Industrial Agentic RecSys Implementations (60 minutes)**
   - Prominent tasks and design patterns:
     - (i) Conversational Recommendation
     - (ii) Context-Aware Autonomous Recommendation
     - (iii) Recommendation Evaluation and User Behavior Simulation
     - (iv) Explanation Generation
   - Best practices for large-scale agentic pipelines: standards, pitfalls, and optimization

D. **Hands-On Demonstration (30–45 minutes)**
   - Overview of open-source or industrial frameworks: AG2,[2] LangChain/LangGraph,[3] CrewAI,[4] Agent Development Kit (ADK)[5]
   - Live demonstration of a multi-step recommendation scenario (e.g., "Personalized Birthday Planner") in a shared notebook environment
     - System Components
     - System and Architecture Design
     - Initial Implementation
     - Debugging and failure point diagnoses
     - Refinement

E. **Challenges & Future of Agentic AI for RecSys (15 minutes)**
   - Common pitfalls: communication complexity and protocol, scalability, hallucinations, error propagation, fairness, and bias
   - Privacy/fairness/unintended behavior concerns and possible mitigation strategies
   - Future directions: multi-agent synergy, advanced memory systems, self-improving agentic systems.

5 Relevance and Target Audience

Relevance. Agentic AI represents an emerging, rapidly evolving field that has attracted substantial research attention due to its potential to shape the future of recommender systems. Given this growing significance, our tutorial aims to equip the community with practical knowledge and proven techniques drawn from both industry and academia. The instructors collectively bring extensive experience in agentic architectures, including contributions to foundational open-source frameworks and deployments in industrial-scale applications. Our goal is to ensure that attendees gain insights from leading research in the field.

Target Audience and Prerequisites: The tutorial is positioned between intermediate and advanced levels, with content prepared at an **intermediate level** to ensure accessibility. We believe the tutorial will benefit a wide audience, including PhD researchers exploring this emerging topic, senior researchers with experience in generative LLM models, and industry practitioners seeking practical, scalable solutions.

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[2]https://ag2.ai/

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