Table 2 Statistics of used datasets

Datasets	#Users	#Items	#actions	Avg.actions/User	Avg.actions/Item	Sparsity
Beauty	21,849	12,066	19,5141	8.93	16.17	99.93%
Steam	39,626	9,261	177,4231	44.77	191.58	99.52%
ML-1M	6,040	3,416	999,611	163.5	292.63	95.16%

6. Appendix

6.1. Experimental Settings

For some details, the developed video demo, code project, and online supplementary can be found in: https://github.com/Ming209/LANE.

Dateset. The data processing and dataset analysis are as follows:

- **MovieLens:** MovieLens is a classic dataset for movie recommendation systems, created and maintained by the GroupLens Research lab (Harper and Konstan 2015). In this work, we use the version with 1 million user ratings (ML-1M).
- **Amazon:** Amazon is one of the world's largest online retailers, selling a variety of products including cosmetics and books. We used the large-scale Amazon review dataset collected by the McAuley Lab — Amazon Reviews 2014 (McAuley et al. 2015). This dataset is divided into several individual datasets according to top product categories on Amazon. We adopt the Beauty category.
- **Steam:** Steam is one of the world's largest digital game distribution platforms, offering game purchases, social networking, digital rights management, and more. We use the Steam dataset introduced by Kang et al. (Kang and McAuley 2018), which includes user reviews and game information scraped from the Steam platform.

We treat the presence of reviewer ratings as implicit feedback (i.e., user-item interactions) and use timestamps to determine the sequence of actions. To avoid excessive data sparsity and improve recommendation quality, we discard users and items that have fewer than 5 interactions in ML-1M and Beauty datasets, and fewer than 20 interactions in Steam. Additionally, we divide each user's historical sequence S^u into three parts based on their usage: (1). the most recent action $S^u_{|S^u|}$ for testing, (2). the second most recent action $S^u_{|S^u|-1}$ for validation, and (3). all remaining actions for training.

After preprocessing, the statistics of the datasets is shown in Table 2. The Beauty dataset has the fewest average number of interactions per user and per item, making it the sparsest. The Steam dataset follows, while the ML-1M dataset is the densest.

Evaluation Metrics. To accurately evaluate the performance differences between recommendation models, we adopt two common Top-N metrics: HR@10 and NDCG@10. To avoid the computational burden of evaluating all user-item pairs, we follow the evaluation strategies described in (Kang and McAuley 2018) and (He et al. 2017). For each user u, we randomly sample 100 negative items and ranked them alongside the ground truth item. Based on the ranking of these 101 items, we evaluated performance using HR@10 and NDCG@10.

Implementation Details. To ensure a fair comparison, all baseline models and the proposed framework are implemented using the PyTorch framework and optimized with the Adam optimizer. Other hyperparameters and initialization strategies are kept consistent with those in the original papers or provided by the open-source code of the respective models. For the proposed framework, we integrate baseline models as the recommendation model to be explained. Our framework utilizes GPT-3.5 as the large language model for generating multiple preferences and transcribing recommendation reasons. The embedding dimension d is set to 384 (the same as Sentence-BERT), the number of heads h is 4, the hidden size d_k is 384, the number of user preferences m is 5, the learning rate is 0.001, the batch size is 128, and the dropout rate is 0.5. For ML-1M, we set the maximum sequence length n to 200, and for the other two datasets, the maximum sequence length n is set to 50. All other hyperparameters used within baseline models are consistent with those in the original paper.

Baseline. To validate whether the LANE framework can imbue conventional sequential recommendation models with explainability while also enhancing the performance of their final recommendations through the dual-view preference fusion mechanism, we select several **widely-used and efficient online recommendation models to serve as recommender part in our framework for quantitative testing**. If our solution can effectively improve the performance of these most representative recommendation models, it will demonstrate its robustness.

- **GRU4Rec** (Hidasi et al. 2015) based on Gated Recurrent Unit (GRU) architecture, learns representations of user sequence behaviors for personalized recommendations. It possesses the ability to capture long-term dependencies and handle variable-length sequences.
- **BERT4Rec** (Sun et al. 2019) leverages pre-trained BERT to achieve deeper semantic understanding and personalized recommendations by learning representations of behavior sequences.
- **SASRec** (Kang and McAuley 2018) is a sequential recommendation model based on self-attention mechanism. By introducing self-attention mechanism, it effectively captures the correlation between different items in user behavior sequences.

Table 3 Metrics and description problems

Metric	Description Problems
clarity	Is the explanation provided by Model{x} easy to understand?
detail	Is the explanation of Model{x} detailed enough?
effectiveness	Does the explanation of Model{x} help you understand the reason for the recommendation?
relevance	Is the explanation of Model{x} accurate and consistent?
logic	Is the explanation of Model{x} reasonable in structure and logically rigorous?
trust	Do you trust the recommendations provided by Model{x}?
satisfaction	What is your overall satisfaction with Model{x}?

- **DiffuRec** (Li et al. 2023d) is a sequential recommendation method based on a diffusion model. It captures the diverse interests of users by representing items as probability distributions and generates target item representations through noise addition and reverse reasoning.

6.2. Seven Metrics and Their Description Problems in Expert Survey

The seven metrics and their complete description problems are shown in Table 3. In the table, Model{x} represents the number name of each model, where $x \in \{1, 2, 3, 4\}$, and is used to anonymize model information.

6.3. Sample Information and Explanation of Framework Output

In this study, we randomly select a user interaction sequence from the Steam dataset to analyze the explanatory outputs of our framework (Figure 7 in the main text). The full results are detailed in this section. Following the CoT prompt and our standardized response template, the LLM generated text sequentially. The primary objective was to simulate and replicate the recommendation model's process for explanatory purposes.

1. Sample Information

User's interaction sequence: ['Condemned: Criminal Origins', 'BioShock® 2', 'Alan Wake', 'Mortal Kombat Komplete Edition', 'The Dig®', 'World of Goo', 'Mass Effect 2', 'STAR WARS™ Jedi Knight - Mysteries of the Sith™', 'STAR WARS™ Jedi Knight - Jedi Academy™', 'Machinarium', 'Samorost 2', 'Thief', 'Hector: Badge of Carnage - Full Series', 'Antichamber', 'Call of Duty®', 'Assassin's Creed® III', 'Murdered: Soul Suspect', 'Home', 'Crysis 2 - Maximum

Edition', 'Botanicula', 'LISA', 'Home is Where One Starts...', 'Call of Duty®: Black Ops', 'The Novelist', 'STAR WARS™ - The Force Unleashed™ Ultimate Sith Edition', 'Deus Ex: Human Revolution - Director's Cut', 'Borderlands', 'The Talos Principle', 'To the Moon', 'The Typing of The Dead: Overkill', 'Electronic Super Joy', 'BIT.TRIP RUNNER', 'A Story About My Uncle', 'Deadly Premonition: The Director's Cut', 'Deadly Premonition: The Director's Cut', 'Remember Me', 'BIT.TRIP FLUX']

User preferences: {'Action and Adventure Games': 0.3561, 'Sci-Fi Themed Games': 0.3094, 'Indie Games with Unique Storylines': 0.1041, 'Puzzle and Platform Games': 0.108, 'Games with Strong Narrative Elements': 0.1225}

Target item: Far Cry® 2: Fortune's Edition

Rank in candidate: 5/101

2. Explanation of framework output

Step 1:

Preference 1: Action and Adventure Games

Analysis: The user has a strong inclination towards action and adventure games as seen from several titles in their historical interaction sequence, such as 'Mortal Kombat Komplete Edition', 'Call of Duty®', 'Assassin's Creed® III', and 'Crysis 2 - Maximum Edition'. These games offer thrilling experiences with dynamic gameplay and immersive worlds that capture the player's interest. The user likely enjoys the adrenaline rush and engagement provided by these genres.

Preference 2: Sci-Fi Themed Games

Analysis: The user has shown a solid preference for sci-fi themed games, as evidenced by titles like 'BioShock® 2', 'Mass Effect 2', 'STAR WARS™ Jedi Knight - Jedi Academy™', and 'Deus Ex: Human Revolution - Director's Cut'. These games typically feature futuristic settings, advanced technology, and complex plotlines, which suggest that the user finds enjoyment in speculative and imaginative scenarios.

Preference 3: Indie Games with Unique Storylines

Analysis: The user's interest in indie games with unique storylines is evident from their interactions with titles such as 'Antichamber', 'World of Goo', 'Machinarium', and 'To the Moon'. These games often feature distinct art styles and innovative narratives that mainstream games might not offer, indicating the user's appreciation for creativity and original storytelling.

Preference 4: Puzzle and Platform Games

Analysis: The user has shown affinity for puzzle and platform games through their interaction with titles like 'The Talos Principle', 'BIT.TRIP RUNNER', 'World of Goo', and 'A Story About My Uncle'. These games challenge the player's problem-solving skills and often feature platforming elements, which the user seems to enjoy.

Preference 5: Games with Strong Narrative Elements

Analysis: The user appears to have a penchant for games with strong narrative elements, as seen from 'The Novelist', 'Remember Me', 'Murdered: Soul Suspect', and 'The Dig®'. These games focus heavily on storytelling and character development, indicating that the user values a compelling story along with gameplay.

Step 2:

Target item introduction:

'Far Cry® 2: Fortune's Edition' is an open-world first-person shooter game set in a fictional African country embroiled in conflict. The game features a dynamic weather system, realistic fire propagation, and a mission-driven storyline.

Preference Fitness:

(1). **Action and Adventure Games**: 0.9

Reason: 'Far Cry® 2' is a quintessential action and adventure game with open-world exploration, combat, and various missions.

(2). **Sci-Fi Themed Games**: 0.2

Reason: 'Far Cry® 2' is not set in a sci-fi universe and lacks futuristic elements, reducing its appeal based on this preference.

(3). **Indie Games with Unique Storylines**: 0.3

Reason: While 'Far Cry® 2' has a strong narrative, it is not an indie game, nor does it possess a particularly unique storyline compared to the user's indie game preferences.

(4). **Puzzle and Platform Games**: 0.1

Reason: The game does not focus on puzzles or platforming mechanics, making it a poor fit for this preference.

(5). **Games with Strong Narrative Elements**: 0.7

Reason: 'Far Cry® 2' does have a compelling narrative involving mercenaries, war, and survival, providing some level of satisfaction for this preference.

Step 3:

Interaction probability: Medium

Reason: Given the strong alignment with the user's top preferences (Action and Adventure Games with a weight of 0.3561 and a high fitness score of 0.9, and Games with Strong Narrative Elements with a weight of 0.1225 and a fitness score of 0.7), there is a significant probability that the user would interact with 'Far Cry® 2: Fortune's Edition'. The lower fitness scores for Sci-Fi Themed Games, Indie Games with Unique Storylines, and Puzzle and Platform Games reduce overall interaction probability but do not overpower the strong inclinations.

Step 4:

Recommendation: Based on your strong preference for action-packed adventure games and those with compelling narratives, 'Far Cry® 2: Fortune's Edition' aligns well with your gaming tastes. While it may lack the sci-fi elements and unique indie storytelling you're also fond of, the game's immersive open-world experience and engaging missions make it a solid option for your next adventure. Enjoy the exploration and tactical combat in the realistic setting of Far Cry® 2!