

(A Short Intro to) Large Language Models for Recommendation

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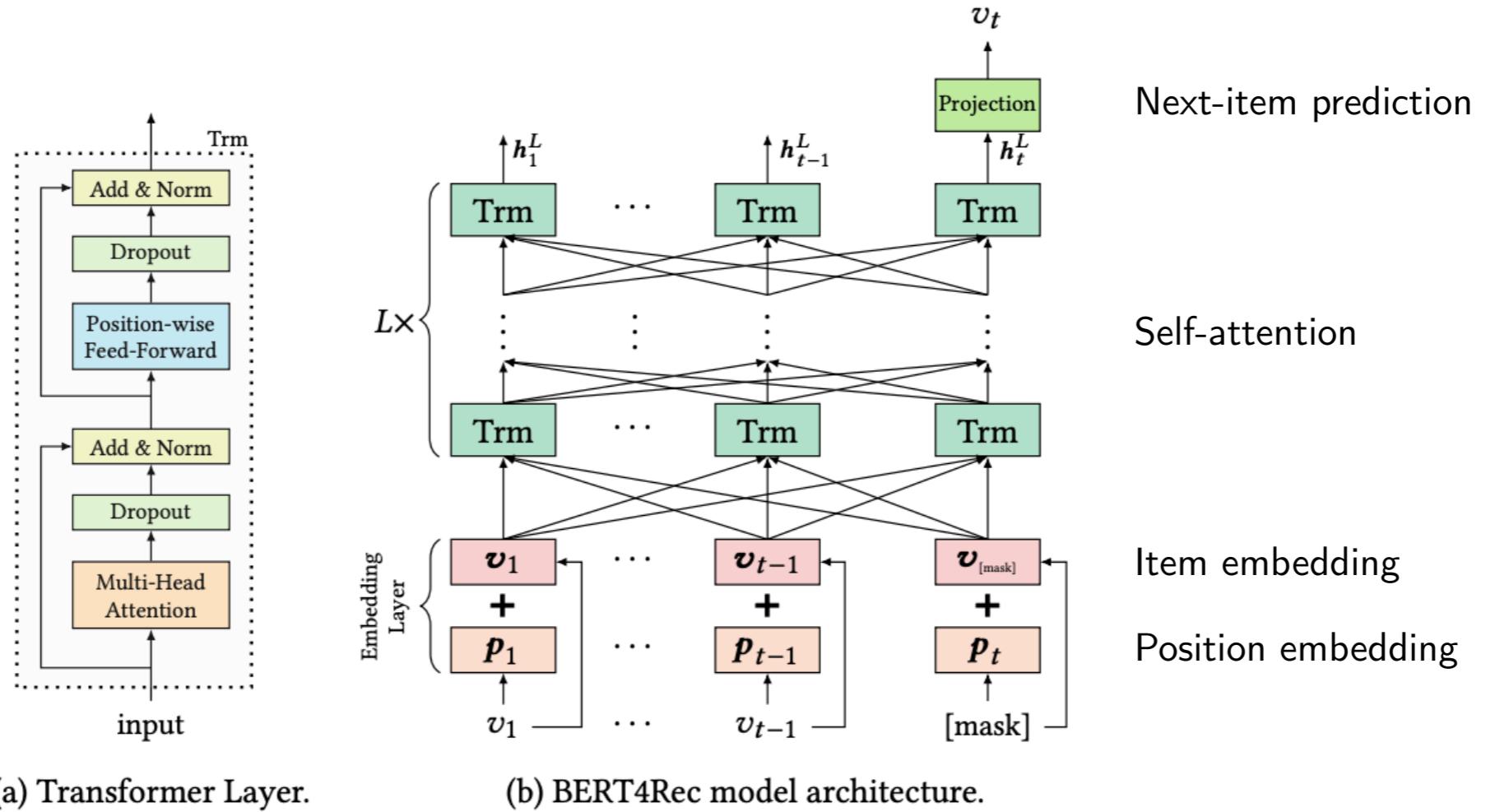
The emergence of Large Language Models (LLMs)

- LLMs emerging as a powerful tool for NLP
- Remarkable abilities in several areas, e.g.,
 - Text completion, summarization, Q&A, translation, among others
- Billions of parameters, trained on a chunk of the internet
- Pretrained models, supports fine-tuning and in-context learning



Generative Models for RecSys

BERT4Rec for sequential recommendation



(a) Transformer Layer.

(b) BERT4Rec model architecture.

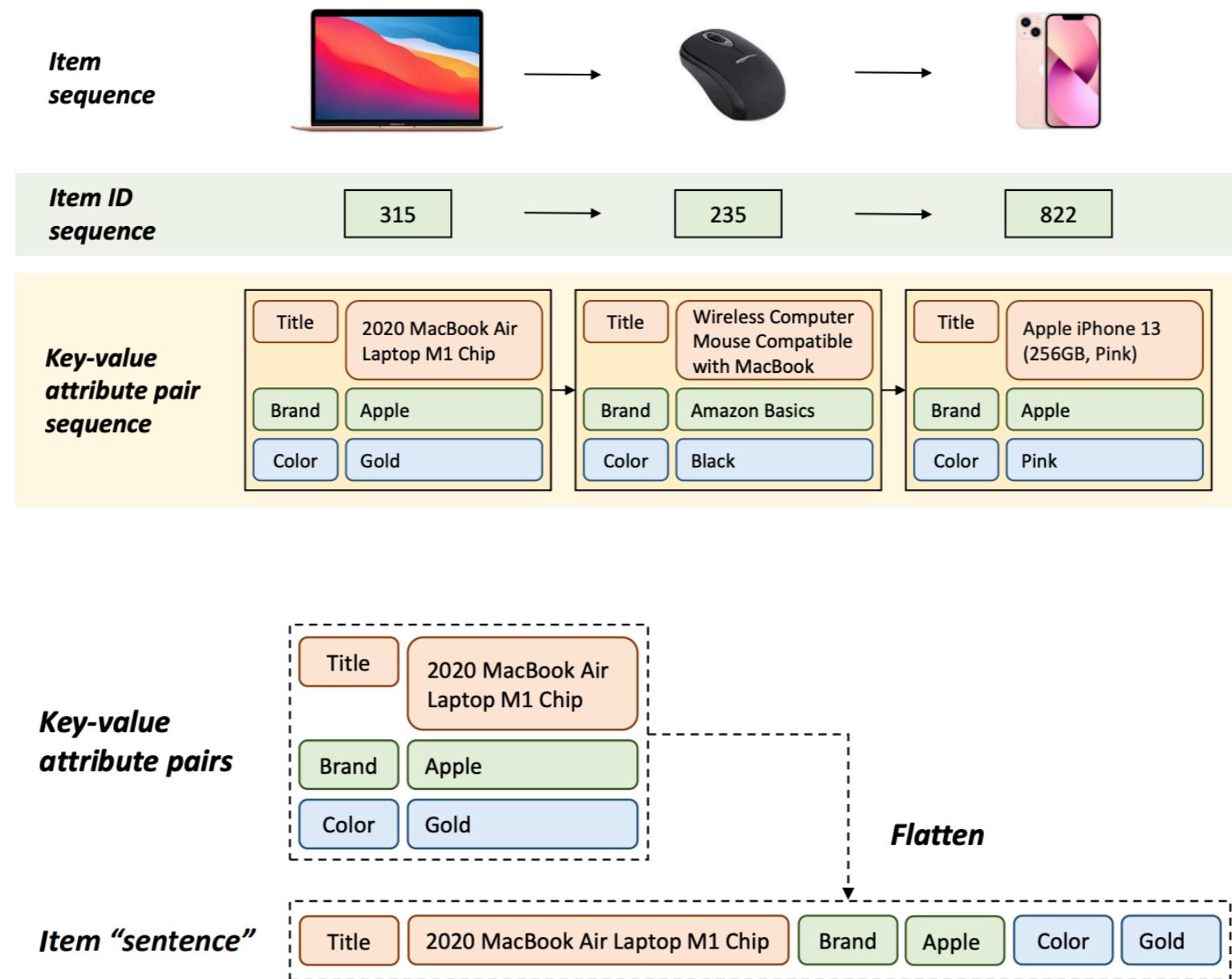
NLP:

- Token sequence
- Inter-token correlations

RecSys:

- ID sequence
- Inter-item correlations

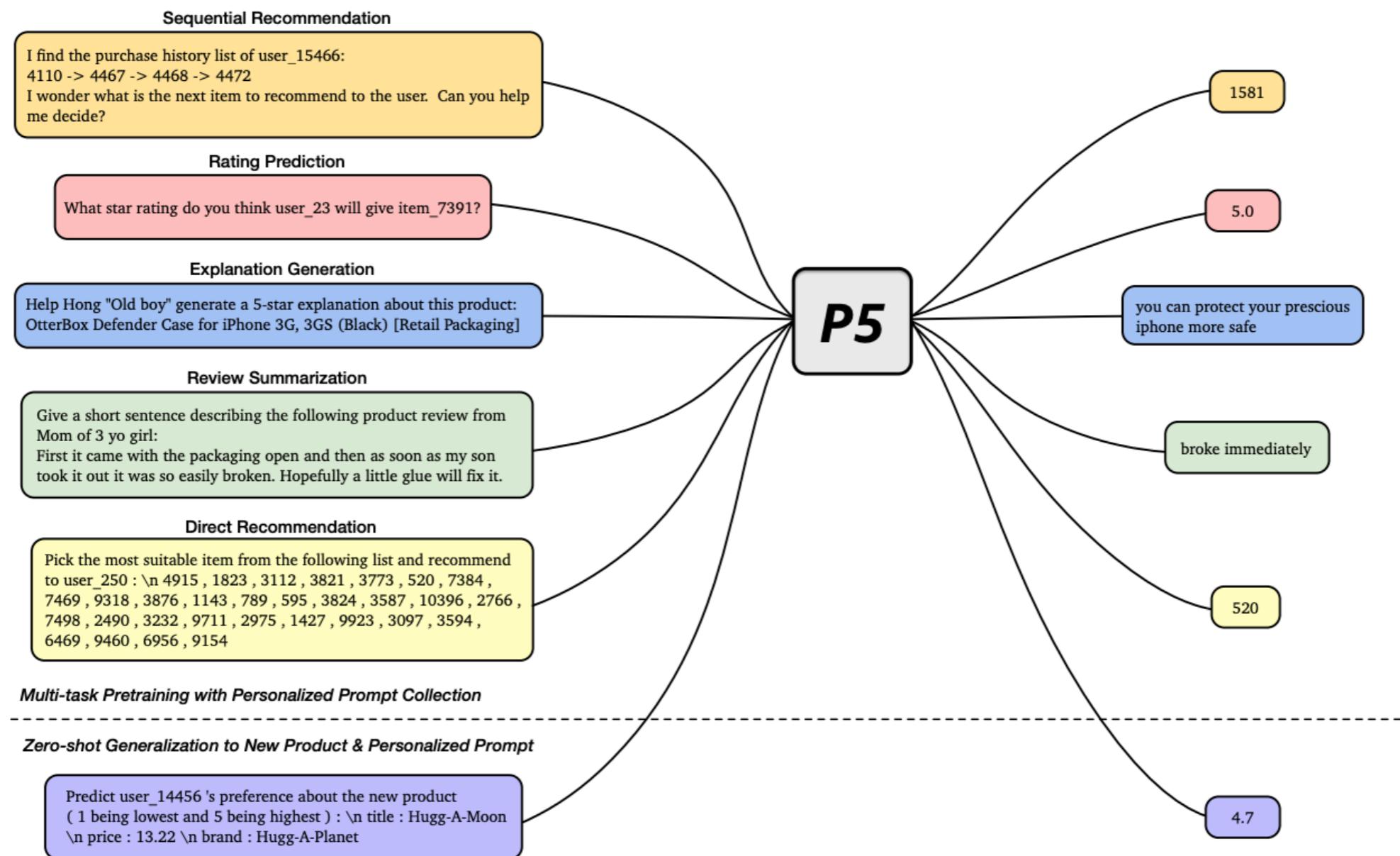
RecFormer - Text is all you need



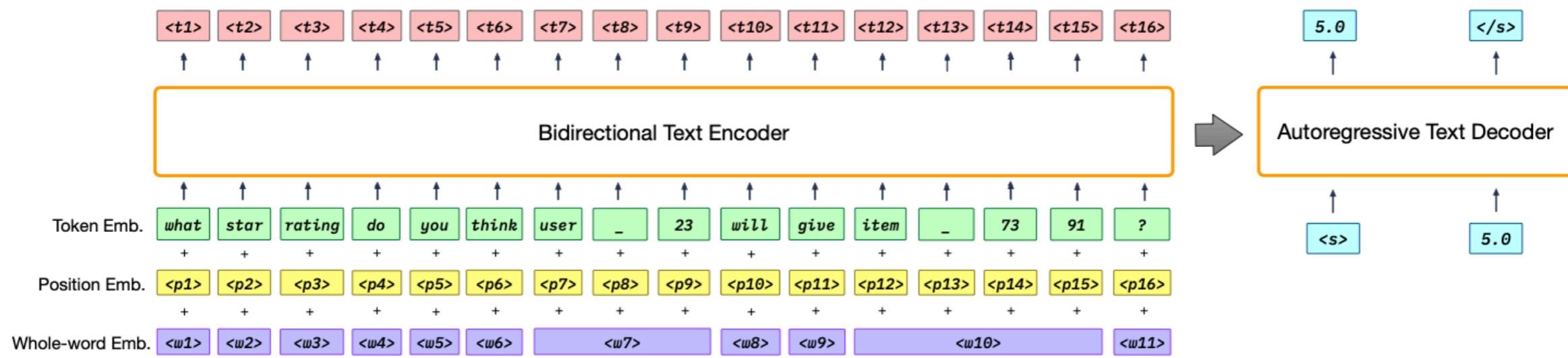
Li et al., "Text Is All You Need: Learning Language Representations for Sequential Recommendation", KDD 2023

In-Context Learning/LLMs for RecSys

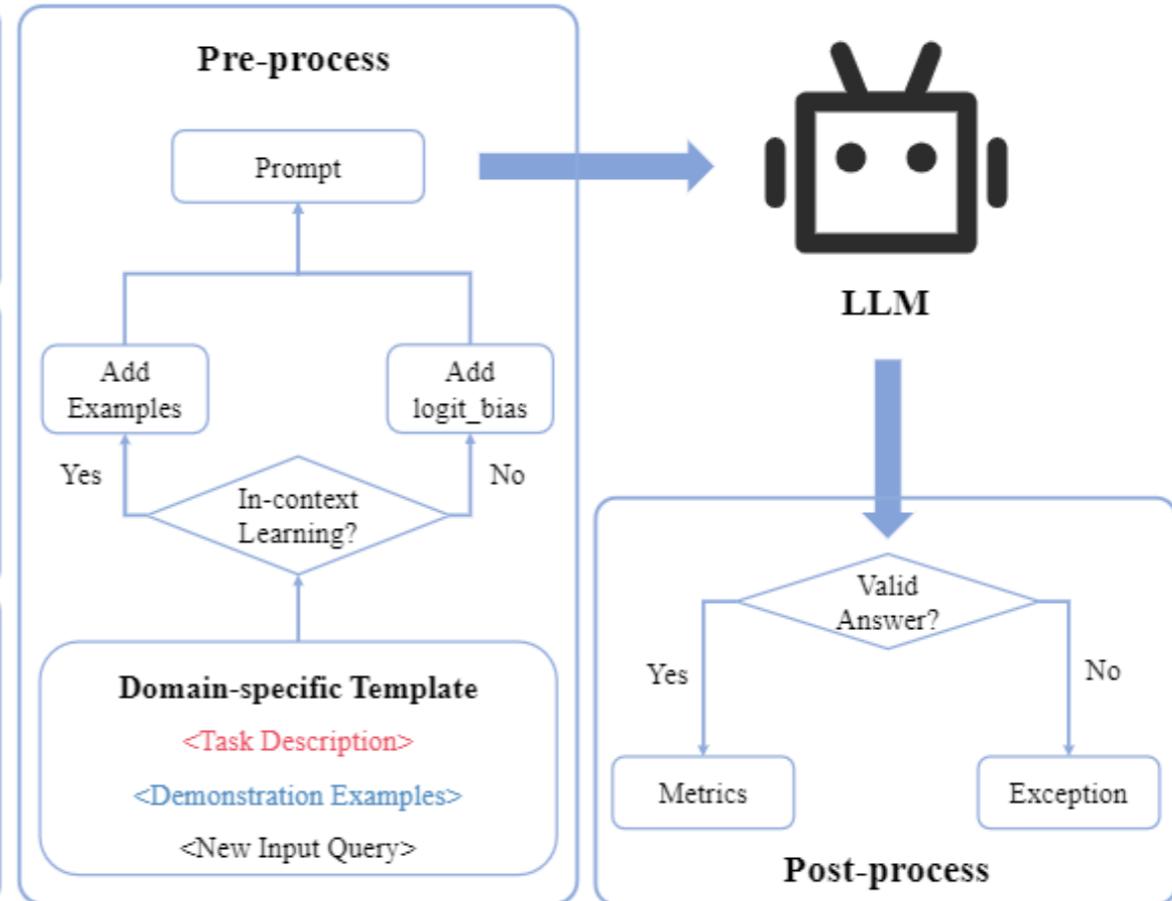
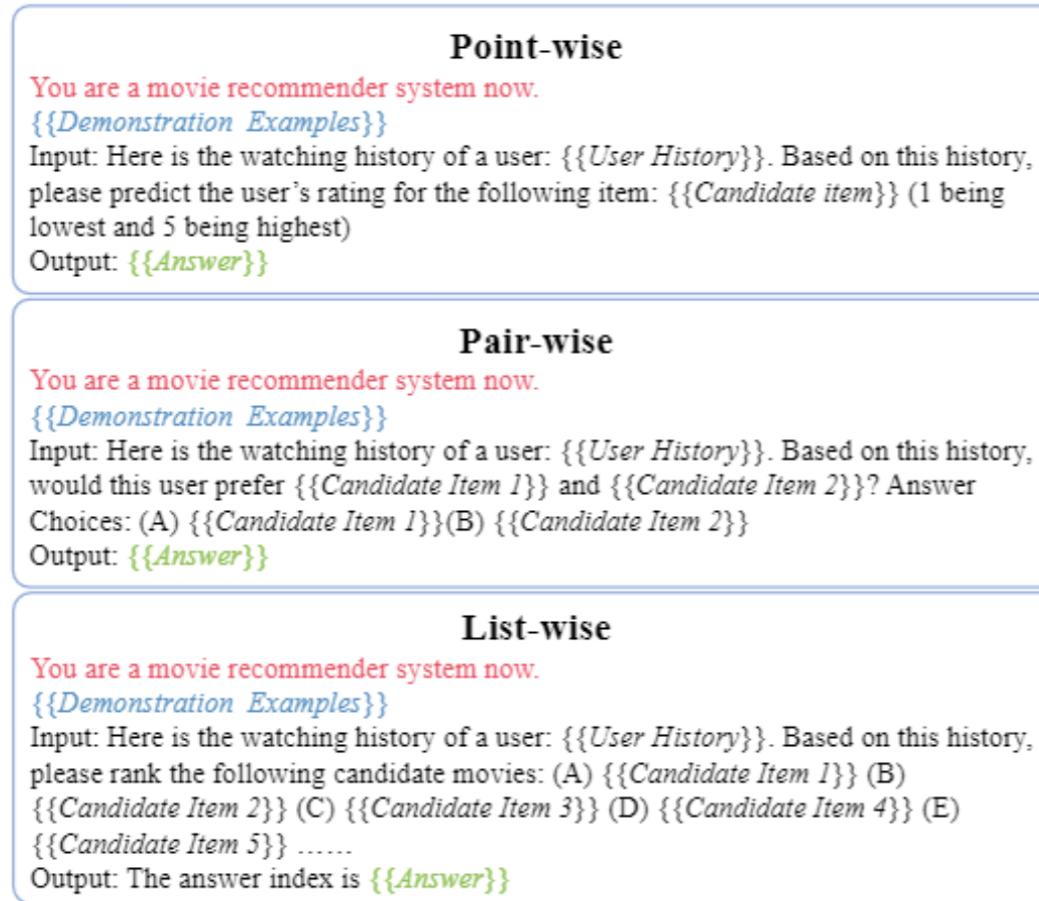
Recommendation as language processing



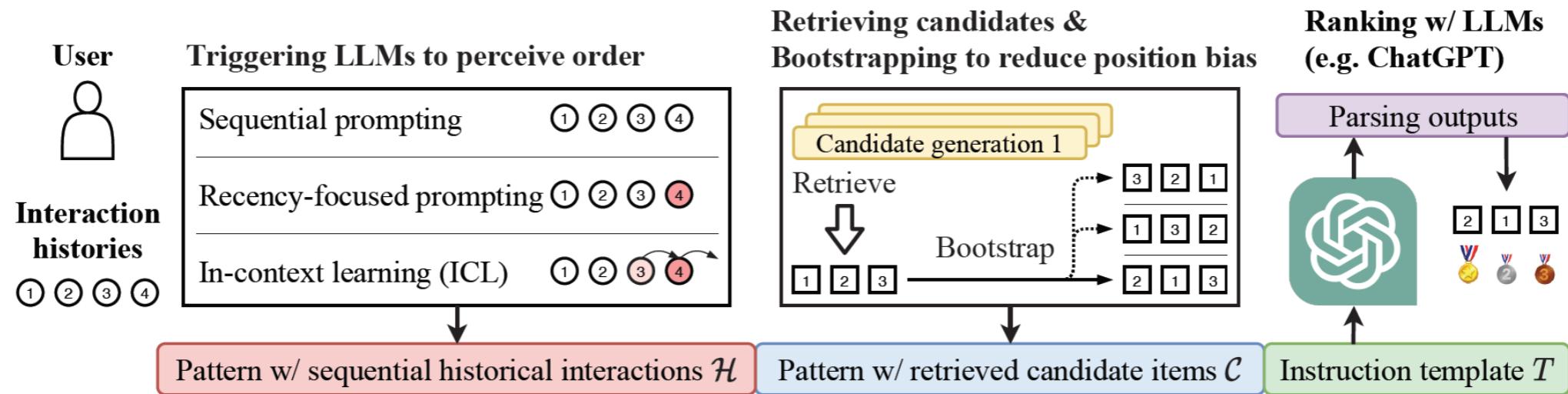
Recommendation as language processing



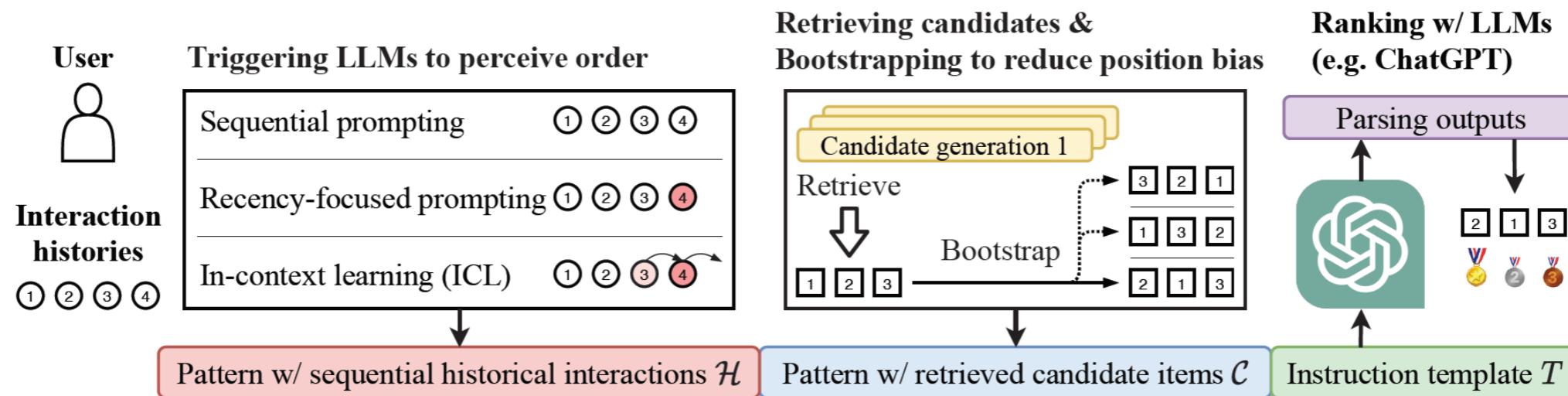
LLMs as a reranker



Addressing position bias



Addressing position bias



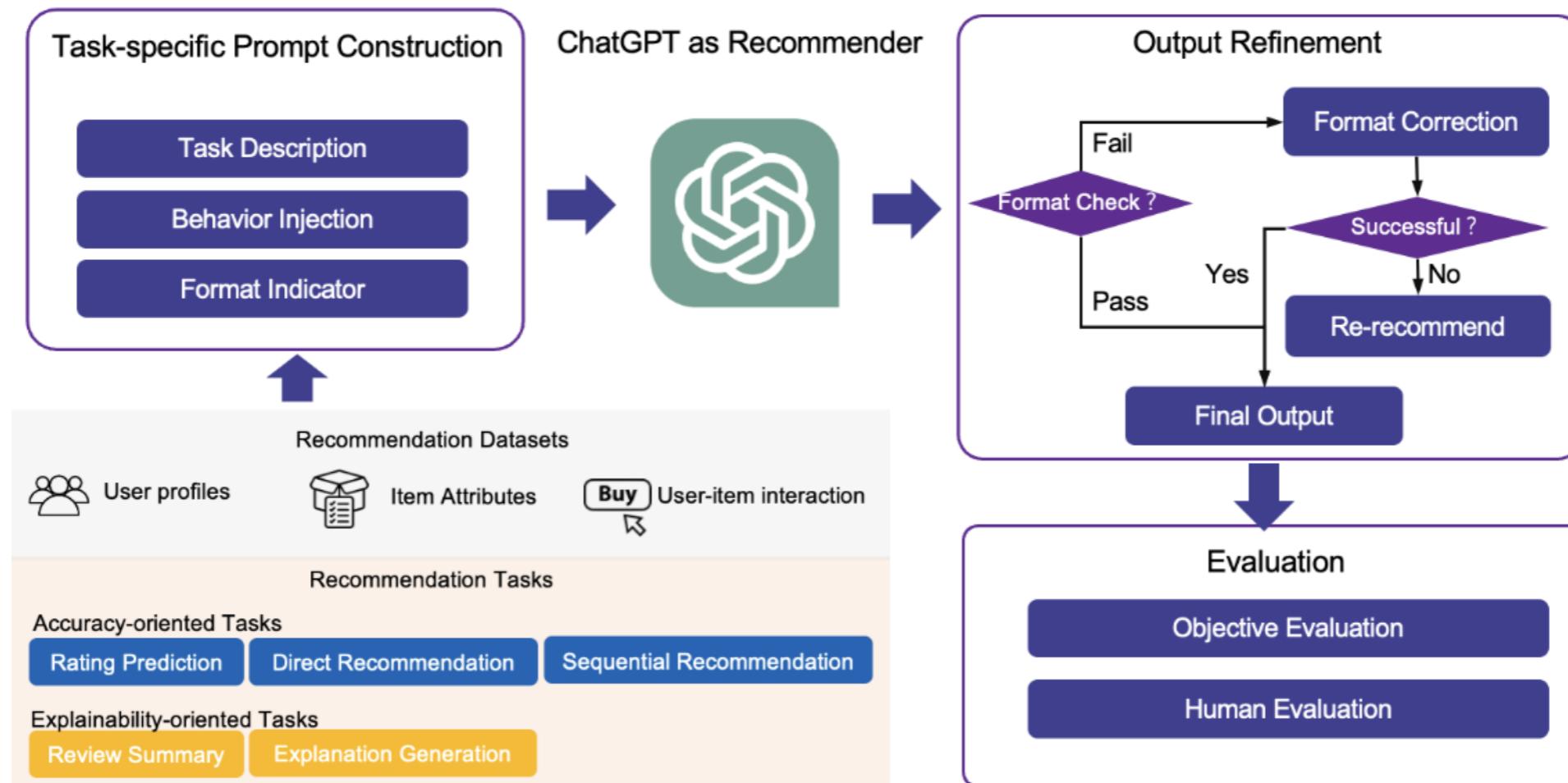
Triggering LLMs to perceive order

- **Sequential prompting**: Historical interactions in their natural order
- **Recency-focused prompting**: “Note that my most recently watched movie is [...]”
- **In-context learning**: “If I’ve watched the following movies in the past in order: [...] then you should recommend [...] to me and now that I’ve watched [...], then:”

Bootstrapping candidates

- Randomly shuffle candidates, use each sample to query the LLM, combine outputs

LLM as a general-purpose recommendation model



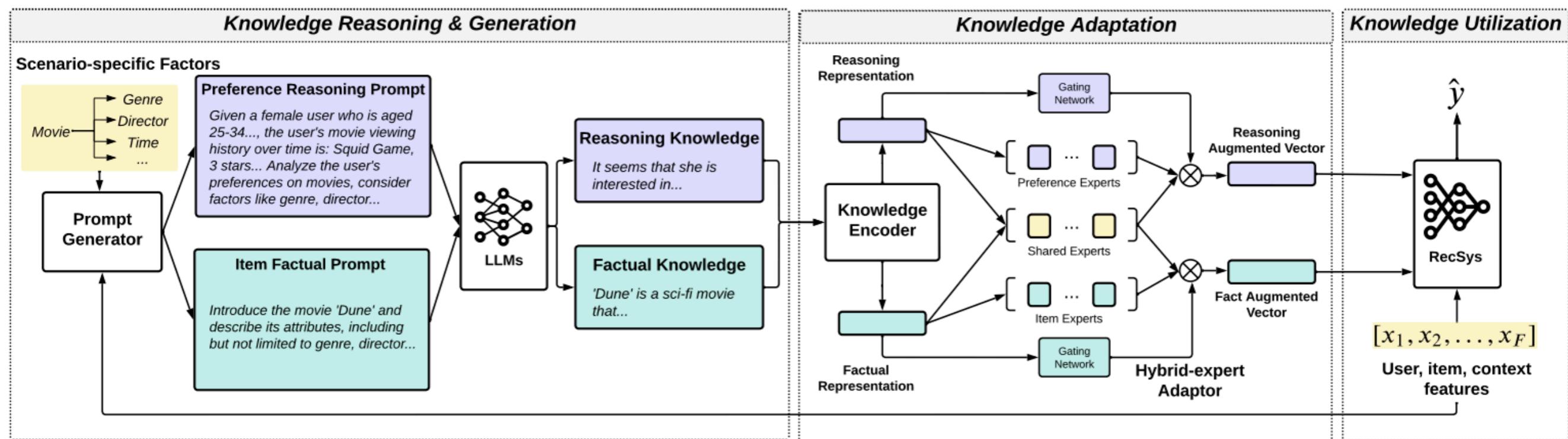
LLM as a general-purpose recommendation model

Rating Prediction	
zero-shot	How will user rate this product_title: "SHANY Nail Art Set (24 Famous Colors Nail Art Polish, Nail Art Decoration)" , and product_category: Beauty? (1 being lowest and 5 being highest) Attention! Just give me back the exact number a result , and you don't need a lot of text.
few-shot	Here is user rating history: 1. Bundle Monster 100 PC 3D Designs Nail Art Nailart Manicure Fimo Canes Sticks Rods Stickers Gel Tips, 5.0; 2. Winstonia's Double Ended Nail Art Marbling Dotting Tool Pen Set w/ 10 Different Sizes 5 Colors - Manicure Pedicure, 5.0; 3. Nail Art Jumbo Stamp Stamping Manicure Image Plate 2 Tropical Holiday by Cheeky®, 5.0 ; 4.Nail Art Jumbo Stamp Stamping Manicure Image Plate 6 Happy Holidays by Cheeky®, 5.0; Based on above rating history, please predict user's rating for the product: "SHANY Nail Art Set (24 Famouse Colors Nail Art Polish, Nail Art Decoration)", (1 being lowest and 5 being highest,The output should be like: (x stars, xx%), do not explain the reason.)
Sequential Recommendation	
zero-shot	Requirements: you must choose 10 items for recommendation and sort them in order of priority, from highest to lowest. Output format: a python list. Do not explain the reason or include any other words. The user has interacted with the following items in chronological order: ['Better Living Classic Two Chamber Dispenser, White', 'Andre Silhouettes Shampoo Cape, Metallic Black', , 'John Frieda JFHA5 Hot Air Brush, 1.5 inch'].Please recommend the next item that the user might interact with.
few-shot	Requirements: you must choose 10 items for recommendation and sort them in order of priority, from highest to lowest. Output format: a python list. Do not explain the reason or include any other words. Given the user's interaction history in chronological order: ['Avalon Biotin B-Complex Thickening Conditioner, 14 Ounce', 'Conair 1600 Watt Folding Handle Hair Dryer', , 'RoC Multi-Correxion 4-Zone Daily Moisturizer, SPF 30, 1.7 Ounce'], the next interacted item is ['Le Edge Full Body Exfoliator - Pink']. Now, if the interaction history is updated to ['Avalon Biotin B-Complex Thickening Conditioner, 14 Ounce', 'Conair 1600 Watt Folding Handle Hair Dryer', , 'RoC Multi-Correxion 4-Zone Daily Moisturizer, SPF 30, 1.7 Ounce', 'Le Edge Full Body Exfoliator - Pink'] and the user is likely to interact again, recommend the next item.
Direct Recommendation	
zero-shot	Requirements: you must choose 10 items for recommendation and sort them in order of priority, from highest to lowest. Output format: a python list. Do not explain the reason or include any other words. The user has interacted with the following items (in no particular order): ['Skin Obsession Jessner's Chemical Peel Kit Anti-aging and Anti-acne Skin Care Treatment', 'Xtreme Brite Brightening Gel 1oz', , 'Reviva - Light Skin Peel, 1.5 oz cream']. From the candidates listed below, choose the top 10 items to recommend to the user and rank them in order of priority from highest to lowest. Candidates: ['Rogaine for Women Hair Regrowth Treatment 3-2 ounce bottles', 'Best Age Spot Remover', , 'L'Oreal Kids Extra Gentle 2-in-1 Shampoo With a Burst of Cherry Almond, 9.0 Fluid Ounce'].
few-shot	Requirements: you must choose 10 items for recommendation and sort them in order of priority, from highest to lowest. Output format: a python list. Do not explain the reason or include any other words. The user has interacted with the following items (in no particular order): ['Maybelline New York Eye Studio Lasting Drama Gel Eyeliner, Eggplant 956, 0.106 Ounce', 'L'Oreal Paris Healthy Look Hair Color, 8.5 Blonde/White Chocolate', , 'Duo Lash Adhesive, Clear, 0.25 Ounce']. Given that the user has interacted with 'WAWO 15 Color Professional Makeup Eyeshadow Camouflage Facial Concealer Neutral Palette' from a pool of candidates: ['MASH Bamboo Reusable Cuticle Pushers Remover / Manicure Pedicure Stick', 'Urban Decay All Nighter Long-Lasting Makeup Setting Spray 4 oz', , 'Classic Cotton Balls Jumbo Size, 100 Count'], please recommend the best item from a new candidate pool, ['Neutrogena Ultra Sheer Sunscreen SPF 45 Twin Pack 6.0 Ounce', 'Blink Eyeliner Pencil - Black', , 'Skin MD Natural + SPF15 combines the benefits of a shielding lotion and a sunscreen lotion']. Note that the candidates in the new pool are not ordered in any particular way.

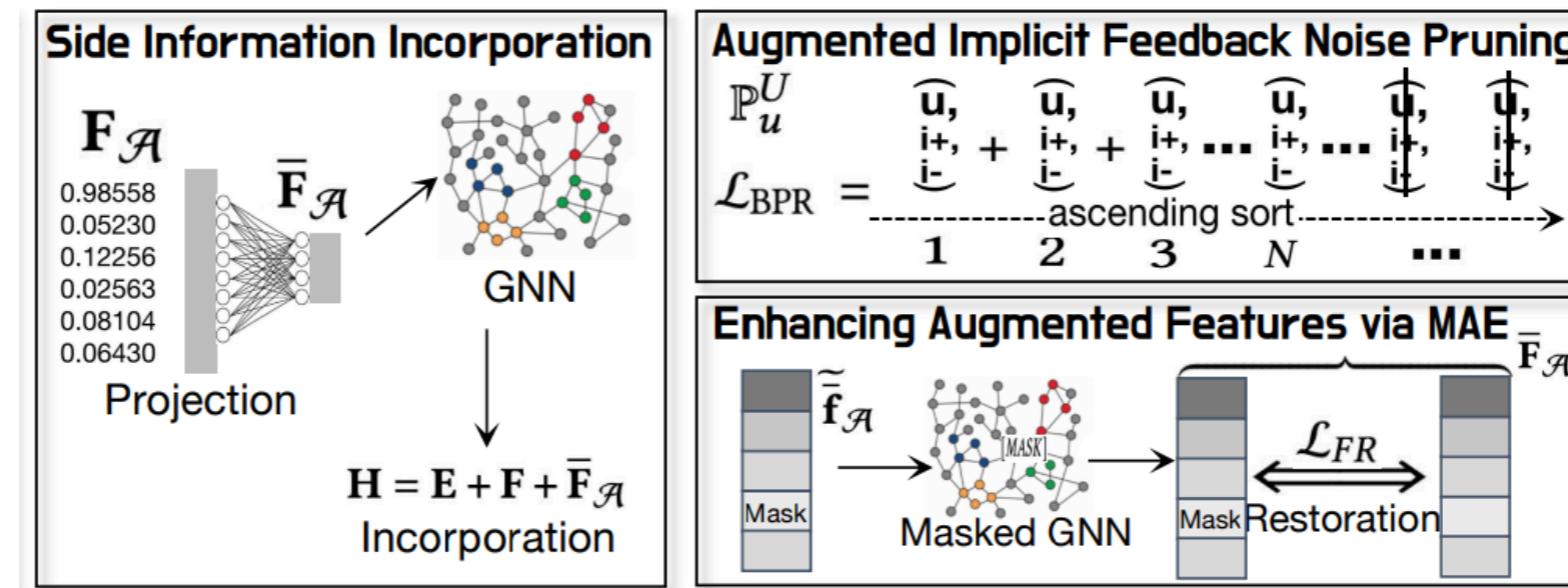
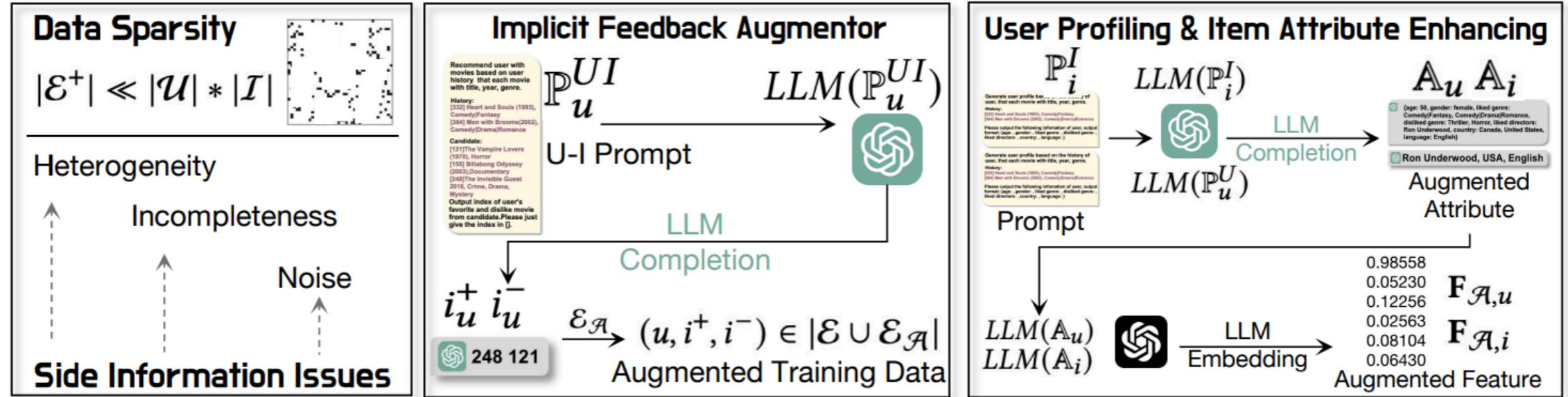
LLM as a general-purpose recommendation model

Explanation Generation	
zero-shot	<p>Here is user's interaction history:</p> <ol style="list-style-type: none">1. Prolab Caffeine- Maximum Potency 200 mg 100 Tablets2. DevaCurl Mist-er Right Lavender Curl Revitalizer 12.0 oz3. TIGI Catwalk Curl Collection Curlesque Leave-In Conditioner, 7.27 Ounce4. e.l.f. Pigment Eyeshadow, Naturally Nude, 0.05 Ounce <p>Help user generate a 5.0-star explanation about this product "SHANY Nail Art Set (24 Famouse Colors Nail Art Polish, Nail Art Decoration)" with around 10 words.</p>
few-shot	<p>Here are some recommended products and their corresponding explanations for user:</p> <ol style="list-style-type: none">1. product "TIGI Catwalk Curl Collection Curlesque Curls Rock Amplifier, 5.07 Ounce, Packaging May Vary" and its explanation "One of the few things I have found that work for white people with curly hair"2. product "DevaCurl Mist-er Right Lavender Curl Revitalizer 12.0 oz" and its explanation "it makes my hair greasy and gross" <p>Help user generate a 5.0-star explanation about this product "SHANY Nail Art Set (24 Famouse Colors Nail Art Polish, Nail Art Decoration)" with around 10 words?</p>
Review Sumarization	
zero-shot	<p>Here are some summaries of user:</p> <ol style="list-style-type: none">1. "Loving this sooo muchh"2. "Amazing color"3. ".Hong Kong Collection &lt;3 OPI" <p>Write a short sentence to summarize the following product review from user: "So i was pretty excited that i got this in the mail, but seriously....i think its just the color of mine, i don't know, not good cover stick... Received it sticking to the top...so basically it was broken when i opened it because of the air mail looks very pasty...very white i shall say...im never buying this product ever..". The sentence should be around 4 words.</p>
few-shot	<p>Here are some reviews and their corresponding summaries of user:</p> <ol style="list-style-type: none">1. Review:"After watching kardashian episode back in 2009 kim mentioned OPI my private jet.. and i was like what is that? i looked it up online and LOVED it and i just got it 1 week shipping.. awesomee just love this color its sparkley brown and its turns black sometimes cool!! well for mee looolll LOVE this color &lt;3 on my toes and fingers lol". Summary:"Loving this sooo muchh"2. Review:"I love this and im glad im adding this to my collection! (: a nice top coat or alone very shimmery and very pretty, especially the top brush cap thing its silver than the original black! (: i recommend this". Summary:"Amazing color" <p>Write a short sentence to summarize the following product review from user: "So i was pretty excited that i got this in the mail, but seriously....i think its just the color of mine, i don't know, not good cover stick... Received it sticking to the top...so basically it was broken when i opened it because of the air mail looks very pasty...very white i shall say...im never buying this product ever..". The sentence should be around 4 words.</p>

Knowledge augmentation from LLMs



LLMs with graph augmentation



LLMs with graph augmentation

Recommend user with movies based on user history that each movie with title, year, genre.

History:

[332] Heart and Souls (1993), Comedy|Fantasy
[364] Men with Brooms(2002), Comedy|Drama|Romance

Candidate:

[121]The Vampire Lovers (1970), Horror
[155] Billabong Odyssey (2003), Documentary
[248]The Invisible Guest 2016, Crime, Drama, Mystery

Output index of user's favorite and dislike movie from candidate. Please just give the index in [].

248 121

(a) Implicit Feedback

Generate user profile based on the history of user, that each movie with title, year, genre.

History:

[332] Heart and Souls (1993), Comedy|Fantasy
[364] Men with Brooms (2002), Comedy|Drama|Romance

Please output the following infomation of user, output format: {age: , gender: , liked genre: , disliked genre: , liked directors: , country: , language: }



{age: 50, gender: female, liked genre: Comedy|Fantasy, Comedy|Drama|Romance, disliked genre: Thriller, Horror, liked directors: Ron Underwood, country: Canada, United States, language: English}

(b) User Profile

Provide the inquired information of the given movie.
[332] Heart and Souls (1993), Comedy|Fantasy

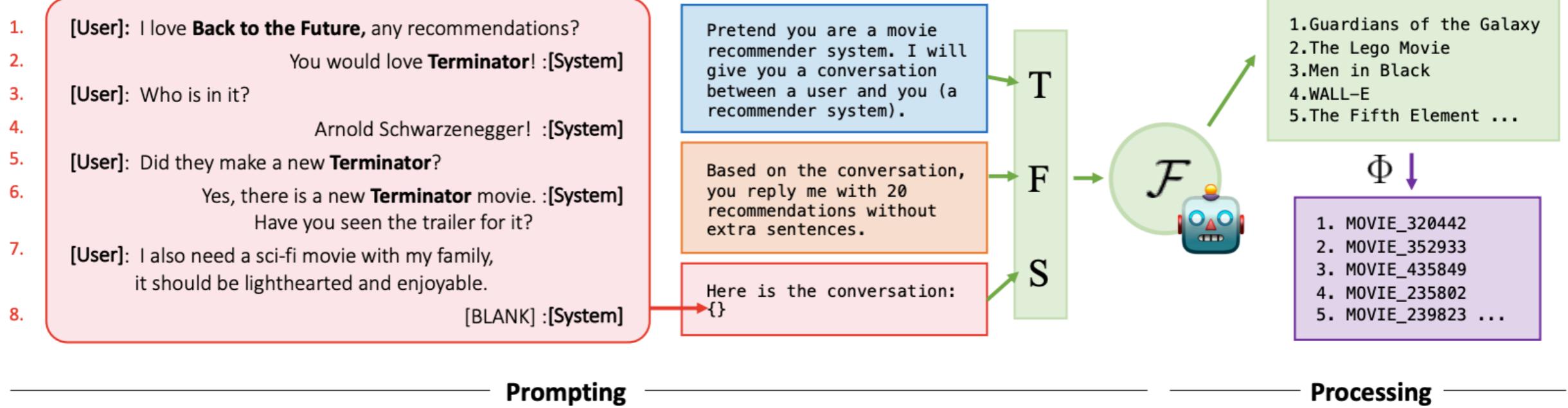
The inquired information is: director, country, language. And please output them in form of: director, country, language



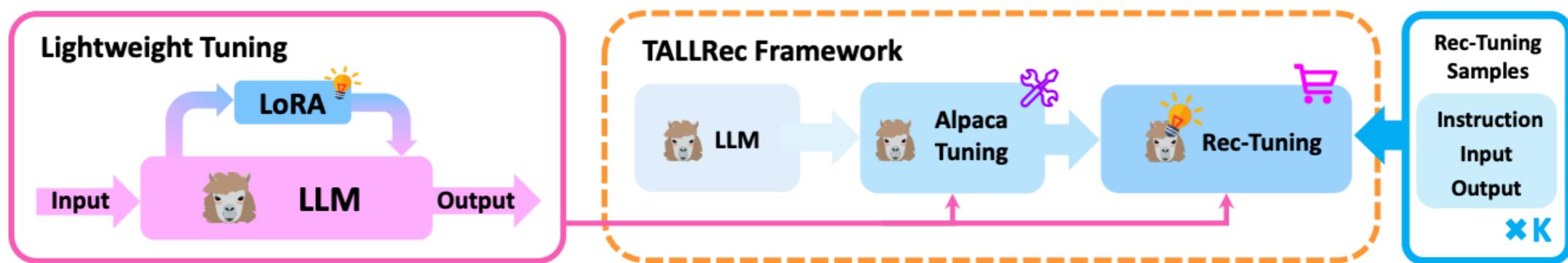
Ron Underwood, USA, English

(c) Item Attribute

LLMs as zero-shot conversational RS



Tuning LLMs for recommendation



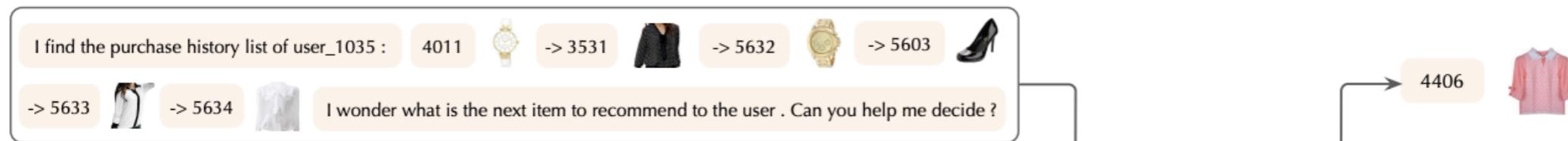
Transforms the recommendation data as instructions used to tune the LLM via an instruction tuning process, e.g.,

Instruction Input	
Task Instruction:	Given the user's historical interactions, please determine whether the user will enjoy the target new movie by answering "Yes" or "No".
<hr/>	
Task Input:	User's liked items: GodFather. User's disliked items: Star Wars. Target new movie: Iron Man
<hr/>	
Instruction Output	
Task Output:	No.

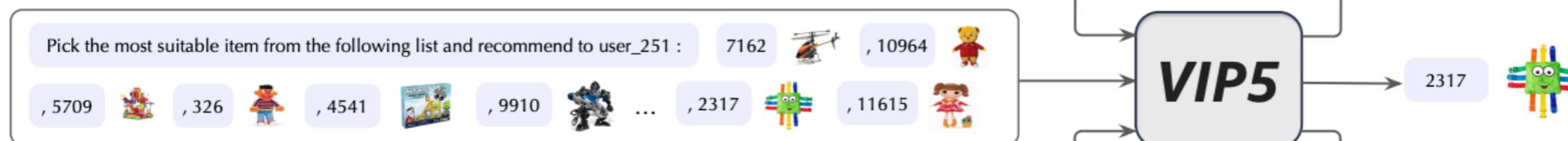
Multimodal RecSys

Multimodal foundation models for recommendation

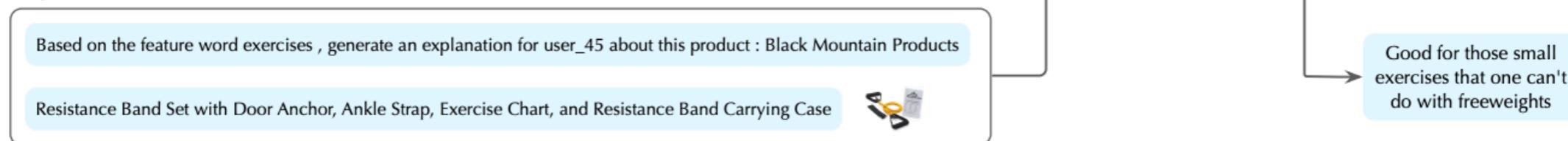
Sequential Recommendation



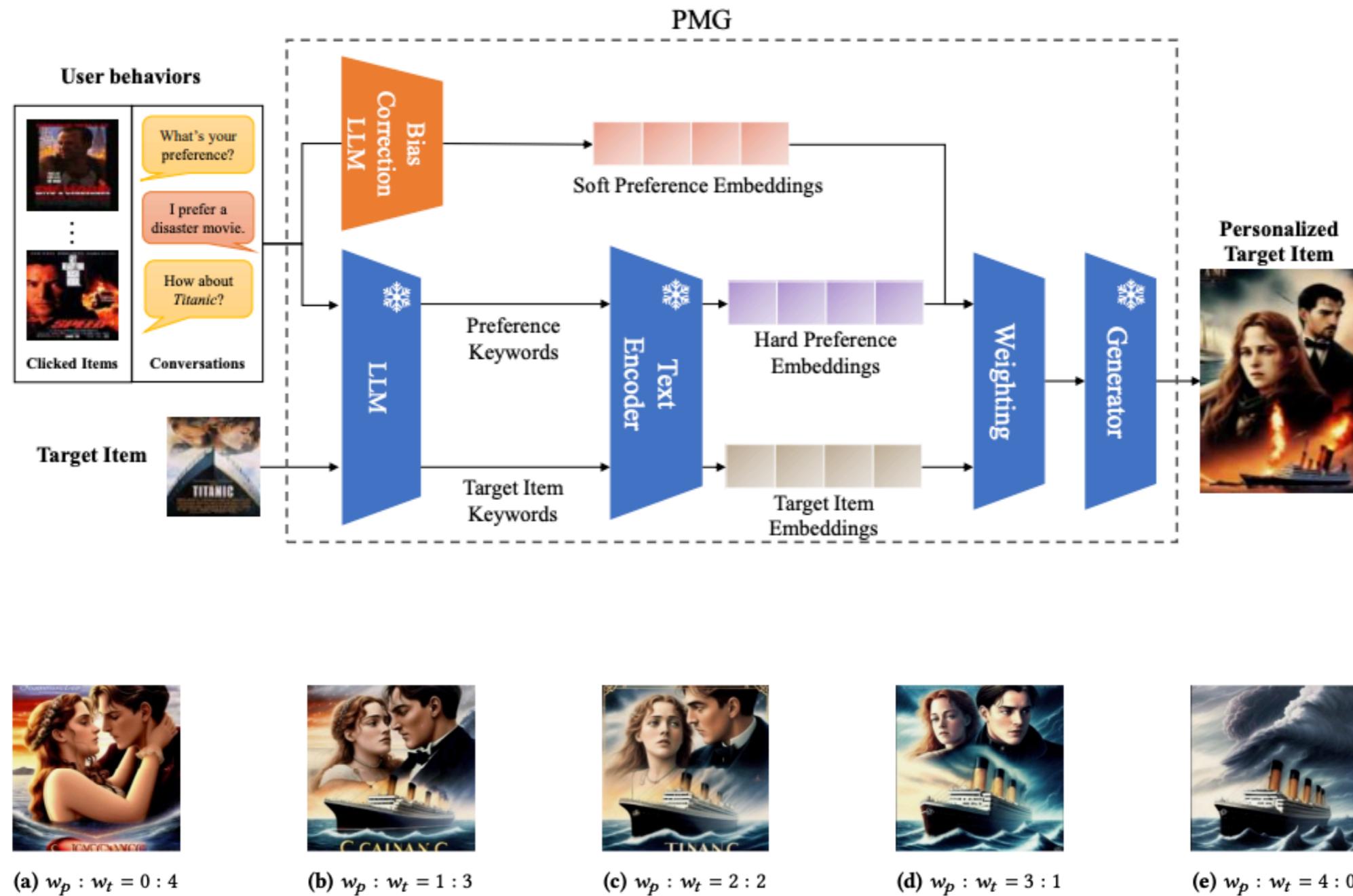
Direct Recommendation



Explanation Generation



Personalized multimodal generation with LLMs



Conclusion