Artificial Intelligence in Recommender systems

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Abstract— Artificial intelligence is a field, which combines computer science with datasets for problem-solving. It combines machine learning and deep learning, which are frequently mentioned in conjunction with artificial intelligence. They are using AI algorithms which seek to create expert systems which make predictions or classifications based on input data. The applications for this technology are growing every day. The goal of creating intelligence has been broken down into sub-problems which consist of capabilities like Reasoning, problem-solving, Knowledge representation, Planning and decision making, Learning, Natural language processing, Perception, Social intelligence. The recommender systems used in the personalised e-services were first established twenty years ago and were developed by employing techniques and theories drawn from other artificial intelligence (AI) fields for user profiling and preference discovery. The past few years have seen a huge increase in successful AI-driven applications. In this paper we covered applications of AI, components of AI, AI process with advantages and disadvantages of AI. along with this we covered how ML based recommender system work. This may help in understanding basics of AI and will lead better research in the field of AI and its use in and recommender systems.

Key words: Artificial Intelligence, Recommender System, Machine Learning, Collaborative Recommender System, Content Based Recommender System, Knowledge Based Recommender System

I. INTRODUCTION

Artificial intelligence is the process of imitating human intelligence processes by computer systems.AI is the general term for the science of artificial intelligence. It uses computers to simulate human intelligent behaviors and it trains computers to learn human behaviors such as learning, judgment, and decision-making.AI is a combination of computer science, logic, psychology, philosophy, and other disciplines. It has applications such as speech recognition, image processing, natural language processing, the proving f automatic theorems, and intelligent robots. AI plays an important role in social development. This results in improving labor efficiency, reducing labor costs, optimizing the structure of human resources, and creating new job demands [8].Various AI techniques have more recently been applied to recommender systems, helping to enhance the user experience and increase user satisfaction.

AI enables a higher quality of recommendation than conventional recommendation methods can achieve.[9]

A. Cognitive Skills

AI programming focuses on cognitive skills that include the following:[5]

1) Learning: Learning focuses on acquiring data and creating rules for how to turn it into actionable information. These rules are called algorithms which provide step-by-step instructions for how to complete a specific task[5].
2) Reasoning: Reasoning focuses on choosing the right algorithm to reach a desired outcome[5].
3) Self-correction: This aspect of AI programming is used to fine-tune algorithms and ensure they provide the most accurate results possible[5].
4) Creativity: Creativity in AI uses neural networks and rule-based systems, statistical methods and other AI techniques to generate new images, new text, new music and new ideas[5].

II. APPLICATIONS OF AI

Artificial Intelligence has a large influence on human lifestyle. AI and machine learning technology is used in most of the essential applications nowadays. some of them are listed here[2].

1) Autonomous Vehicles: Automobile manufacturing companies use machine learning to train computers to think and behave like humans while driving in any environment and detect objects to avoid accidents.
2) Spam Filters: The email that we use today uses AI to filter out spam emails and provide us the filtered emails only.
3) Face Recognition: Our mobiles use face recognition techniques by using face filters to provide secure access. They are also used in high security-related areas in several industries.
4) Recommendation System: Many platforms that we use like e-commerce, entertainment websites, social media, etc., all use the recommendation system to provide customized recommendations to users. This is a very widely used Artificial Intelligence application in almost all industries.
5) Navigation Systems: We use GPS technology which provides users with accurate, timely, and detailed information to improve safety. It is used by Uber and many logistics companies to improve efficiency, analyse road traffic, and optimise routes.
6) Robotics: Robots having AI enabled facilities use real-time updates to sense objects in its path and take directions accordingly.It can be used for Carrying goods in hospitals, factories, and warehouses, and Inventory management too.

7) Human Resource: Artificial Intelligence is used in the hiring process. By using machine learning, we can examine applications based on specific parameters and can be used to scan job candidates' profiles, and resumes.
8) Healthcare: AI can be used in healthcare systems to provide diagnosis and treatment recommendations, patient engagement and adherence, and administrative activities.[3]

III. COMPONENTS OF AI

A. Machine learning: the foundation of AI

Machine learning allows AI systems to learn from data and also need programming and algorithms to process that data and generate meaningful insights. The data we give machine learning tools help AI create data sets to learn how to make decisions and predictions without being programmed to perform specific tasks[4].

B. Neural networks: building blocks of AI

Neural networks are a type of machine learning algorithm that provides the tools to process the information you create based on AI models[4].

C. Data: fuel for AI

Data is the "fuel" for AI systems. Artificial intelligence wouldn't have any functionality without great data sets to train AI models[4].

D. Algorithms: AI's problem-solvers

Algorithms are the backbone of AI. They are mathematical procedures that tell AI how to learn, improve decision-making, and handle problem-solving. Algorithms turn raw data into insights you can use every day[4].

IV. AI PROCESS

Data collection: Data collection is one of the most critical parts of developing an AI system. It's the process of collecting vast amounts of data to train AI systems[4].

1) Data preprocessing: You shouldn't just input data as you find it. AI systems need accurate, up-to-date, and relevant information for the best results. Without preprocessing your data, there's no guarantee of that happening—especially if you have a large amount of data.
2) Model selection: Model selection is the step of the AI development process where you choose the AI model most suited to the current problem. Many AI models are available—including machine learning algorithms, deep neural networks, or hybrid models using various techniques.
3) Training the model: The training stage comes when you have preprocessed the data and chosen your model.During this phase, you'll split your data into two sets: a training set and a validation set. The training set is what you use to train the model, and the validation (test) set helps you see how well-trained the model is.
4) Testing and evaluation: You shouldn't just count on your AI model to be in a production state after it finishes training. Depending on the data set's quality and how good a job you did at preprocessing, the final model may not give great results.This is where the separate validation data set you created helps. Your validation data set contains input and expected output after it's put into your AI application.
5) Model optimization: Model optimization is the process you go through to improve an AI model's performance. It can mean fine-tuning or modifying your model parameters and using regularization techniques.
6) Fine-tuning means optimizing your model's parameters. You can change the neural network's weights or the AI algorithm used to tune the model.
7) Deployment: Deployment is the final stage of the model development life cycle after you finish training and optimizing your AI model. It's the process of integrating your model into your existing systems or building new computer programs to use your model.
8) Continuous learning: AI models aren't something you train one time. You must regularly train your models on new information to continue seeing accurate output.

You can do this in a couple of ways. The first is to fine-tune your base models. You can generate base models based on initial training data and fine-tune that model based on new data. This gives your AI models updated data to make more accurate predictions.

V. RECOMMENDER SYSTEM MODELS

Recommender systems were first applied in e-commerce to solve the information overload problem caused by Web 2.0, and they were quickly expanded to the personalization of e-government, e-business, e-learning, and e-tourism. Nowadays, recommender systems are an indispensable feature of Internet websites such as Amazon.com, YouTube, Netflix, Yahoo, Facebook, Last.fm, and Meetup[9].g the classical taxonomies of previous research , recommendation techniques fall into three categories: content-based, collaborative filtering (CF)-based and knowledge-based approaches[9].

1) Content-based recommender systems: Content-based recommender systems profile a user's preferences from items in that user's consumption records. The profile usually comprises information about what the user has liked or disliked in the past.

Thus, the profiling process can be seen as a typical binary classification problem, which has been well studied in machine learning and data mining fields. Classic methods such as Naïve Bayes, nearest neighbour algorithms and decision trees are used in this step. These systems typically look at the products that other users with similar preferences have purchased or rated highly and recommend those items to the new user. Based on these variables, a machine learning system consisting of Bayesian classifiers, decision trees, clustering, and other ML techniques analyzes consumers' purchasing histories. It proposes more items with comparable attributes to those previously purchased and positively reviewed[9].

2) Collaborative filtering-based recommender systems :CF-based recommender systems use the utility of an item according to other users' ratings and this technique has been quickly applied in the industry more than 20 years ago. Today, CF is still the most popular technique applied in recommender systems . It means recommender systems in this category will rely on machine learning algorithms (such as clustering models, K-nearest neighbours, matrix factorization, and Bayesian networks) to survey customers' perception of products via user rating, understand who likes what, and offer items already bought by other users with similar tastes[9].
3) Knowledge-based recommender systems: In knowledge-based recommender systems, recommendations are based on existing knowledge or rules about user needs and item functions. Many Artificial intelligent techniques have been introduced and applied to recommender systems. here , we highlight major AI techniques that have enhanced recommender systems[9].

VI. ML POWERED RECOMMENDATION SYSTEM WORKING

A. Data collection and segmentation:

A machine learning system needs large data sets to segment customers, namely categories them into a certain archetype or buyer persona according to their attributes, and target them with suitable suggestions. The system can gather this information via explicit or implicit data collection, while product features can be obtained from the related tags[9].

B. Data storage:

Data sets should be consolidated into a suitable repository depending on the type of data a recommender system needs to analyse. Along with traditional SQL databases designed to efficiently store structured data, you can rely on NoSQL databases that handle complex formats, such as unstructured data[9].

C. Data analysis and decision making:

The recommendation system leverages machine learning algorithms to process data sets, identify patterns and correlations among multiple variables, and build ML models portraying them. For example, algorithms can identify a recurring connection between the age of customers and their preference for one brand over another. Trained models can make predictions on user preferences and recommend the most suitable products or content which companies then base their decisions upon[9].

Example: Now let us first understand the conventional shops' sales strategy[10]. Shopkeepers usually serve known regular customers and offer personalised recommendations. whenever there is a new customers, they need to chat with them initially to learn about their tastes and preferences to recommend relevant products. Shopkeepers segment and group clients into different buyer personas based on their purchasing patterns, interests, gender, and so on, due to which they are able to suggest personalised recommendations.

Recommender Systems are used as digital sales assistants by online e-commerce sites. These systems categorize customers to recommend suitable products. In contrast to human sellers, who recommend based on their intuition and expertise, recommendation engines use machine learning algorithms to evaluate massive datasets containing consumer information, browsing activity, purchase history, and device usage. This enables individual and group client categorization and tailored suggestions, revealing sales dynamics beyond human comprehension.

Machine learning algorithms can use seasonality to better target clients. For example, recommending typical Christmas products to boost winter sales in December or adapting streaming services to recommend family-friendly films and documentaries over the weekend for Christmas [10].

VII. SUMMARY

Recommender systems have established their potential to improve business performance; hence, it is highly likely that the future of recommender Systems will be exciting and innovative. As AI technology advances, we expect several significant recommender system developments. Integrating AI and ML techniques, such as reinforcement learning, has made these systems more accurate and personalized. With the rise of deep learning algorithms and natural language processing, these systems will better understand user preferences, leading to highly precise recommendations [9].

In this paper, we understand fundamentals of AI, introduce their applications in recommender systems, and give directions of possible future research on how AI techniques will be applied in recommender systems. This paper highlights how the recommender system can be enhanced by AI techniques and aims to provide guidance for researchers in the area of recommender systems.

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