# Annexure3b- Complete filing

# INVENTION DISCLOSURE FORM

Details of Invention for better understanding:

**1. TITLE:** Fuzzy Logic for E-commerce Product Recommendations

**2. INTERNAL INVENTOR(S)/ STUDENT(S):** All fields in this column are mandatory to be filled

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1. **DESCRIPTION OF THE INVENTION:**
2. **Purpose**

The fuzzy logic-based recommendation system aims to provide personalized product suggestions by interpreting uncertain, vague, and imprecise user inputs, behaviors, and preferences. This system enhances user experience by delivering more intuitive and accurate recommendations compared to traditional methods. Fuzzy Logic is a way for computers to make smart decisions, even when things are uncertain or not just "yes" or "no." In e-commerce, it helps recommend products based on a customer interests, even if the preferences are not exact.

1. **Core Components of Invention:**

**1. Fuzzy Rule-Based System**  – Defines if-then rules to handle uncertainty in customer preferences. For example, *“*If a user likes sports shoes and casual wear, then suggest running shoes.”

**2. Fuzzy Sets and Membership Functions** – Helps classify customer preferences in a different way, such as highly affordable, moderate priced, instead of fixed price ranges.

**3.Fuzzification** – Converts real-world data like user ratings, purchase history into fuzzy values. For instance, a rating of 3.8 out of 5 may be considered moderate.

**4. Inference Engine** – Processes fuzzy rules and user data to generate recommendations. It determines how well a product matches a customer’s fuzzy preferences.

**5. Defuzzification** – Converts fuzzy values back into a clear and precise result, such as suggesting the top 5 most relevant products for the customer.

1. **Unique Attributes:**

**1.** **Handles Uncertainty and Vagueness** – Unlike traditional recommendation systems that depend on strict rules or fixed categories, fuzzy logic can work with unclear or uncertain data, making it more adaptable to user preferences.

**2.** **Fuzzy Rule-Based System** – Applies a set of if-then rules to determine the best recommendations based on multiple factors, allowing for more flexible and intelligent decision-making.

**3. Membership Functions for Flexibility** – Defines the degree at which a product belongs to a certain category e.g., how "affordable" or "premium" it is, instead of making binary choices.

**4.** **Better User Experience** – Since it understands partial preferences and adjusts to unclear inputs, users get more personalized and meaningful recommendations, enhancing satisfaction.

**PROBLEM ADDRESS BY INVENTION:**

Fuzzy Logic for E-commerce Product Recommendations addresses the problem of **rigid and inaccurate recommendations** caused by traditional rule-based or statistical methods. Conventional recommendation systems often depend on **exact matches** and predefined categories, which fail to capture **uncertain or evolving customer preferences.** Users may have **flexible expectations,** such as a product that is somewhat affordable which is traditional system struggle to handle. Fuzzy logic overcomes this limitation by allowing the system to handle **unclear inputs**, process **verbal variables**, and provide **personalized suggestions** based on degrees of preference rather than fixed criteria. This improves recommendation accuracy, enhances user experience, and increases engagement by suggesting products that **align more closely with customer needs,** even when those needs are not explicitly defined.

**OBJECTIVE OF THE INVENTION**

**1. Improve Recommendation Accuracy** – Provide more relevant product suggestions by handling uncertainty and unclear preferences.

**2**. **Increase Customer Satisfaction** – Deliver recommendations that better match user intent, leading to a more engaging and satisfying shopping experience.

**3**. **Ensure Flexibility and Adaptability** – Continuously improve recommendations based on user interactions, feedback, and behavioral data.

**4**. **Enhance Personalization** – Adapt recommendations to individual users based on

fuzzy logic principles rather than strict rule-based methods.

**5. Overcome Limitations of Traditional Systems** – Overcome the weaknesses of strict rule-based or fully statistical methods recommendation models by allowing for **gradual decision-making.**

**STATE OF THE ART/ RESEARCH GAP/NOVELTY:**

Traditional e-commerce recommendation systems primarily use rule-based filtering, collaborative filtering, or machine learning models. While these methods offer some level of personalization, they struggle with handling **uncertainty, unclear preferences, and evolving user behavior**. Rule-based systems are too rigid, collaborative filtering relies heavily on user similarity, and machine learning models require large datasets for accurate predictions.

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| --- | --- | --- | --- |
| **Abstract** | **State of the Art** | **Research Gap** | **Novelty** |
| **Recommendation Accuracy** | Rule-based and collaborative filtering provide recommendations based on exact matches or user similarities. | |  | | --- | | Struggles to handle unclear, uncertain, or approximate user preferences. |  |  | | --- | |  | | |  | | --- | | Uses fuzzy sets and membership functions to interpret and process unclear user preferences. |  |  | | --- | |  | |
| |  | | --- | | **Personalization** |  |  | | --- | |  | | |  | | --- | | Machine learning-based models offer some level of personalization. |  |  | | --- | |  | | |  | | --- | | Requires large datasets for effective learning and may not work for new users. |  |  | | --- | |  | | |  | | --- | | Adapts to small datasets and works effectively even with partial or uncertain user input. |  |  | | --- | |  | |
| |  | | --- | | **Decision-Making Process** |  |  | | --- | |  | | |  | | --- | | Traditional models depend on hard thresholds and binary classifications e.g., recommended or not recommended. |  |  | | --- | |  | | |  | | --- | | Lacks flexibility to account for gradual changes in user preferences. |  |  | | --- | |  | | |  | | --- | | Uses verbal variables e.g., moderately priced and if-then fuzzy rules for human-like decision-making. |  |  | | --- | |  | |
| |  | | --- | | **Handling User Uncertainty** |  |  | | --- | |  | | |  | | --- | | Requires users to input precise preferences e.g., price range, specific categories. |  |  | | --- | |  | | |  | | --- | | Fails when user preferences are unclear, evolving, or subjective. |  |  | | --- | |  | | |  | | --- | | Uses fuzzification and defuzzification to interpret approximate preferences and refine recommendations. |  |  | | --- | |  | |
| |  | | --- | | **Adaptability and Learning** |  |  | | --- | |  | | |  | | --- | | Machine learning models require frequent retraining with new data. |  |  | | --- | |  | | |  | | --- | | Struggles to adapt quickly to changing user behavior without extensive retraining. |  |  | | --- | |  | | |  | | --- | | Continuously refines recommendations without requiring large-scale retraining. |  |  | | --- | |  | |

**CONCLUSION**

The fuzzy logic-based recommendation system for e-commerce represents a significant advancement over traditional recommendation models. By incorporating fuzzy sets, membership functions, and rule-based decision-making, the system effectively handles uncertainty, vague preferences, and evolving user behaviors. Unlike conventional methods that rely on exact matches or predefined categories, this approach allows for more flexible, human-like decision-making, making product recommendations more intuitive and personalized.With its ability to process verbal inputs, adapt to changing user preferences, and function efficiently even with limited data, this invention improves recommendation accuracy, enhances user satisfaction, and increases engagement. Furthermore, businesses benefit from higher conversion rates and a competitive edge by offering intelligent, customer-centric suggestions.

In summary, fuzzy logic enhances e-commerce recommendations by bridging the gap between rigid algorithms and human-like reasoning, ultimately creating a more dynamic, efficient, and user-friendly shopping experience.

**4. DETAILED DESCRIPTION:**

E-commerce platforms depends on **recommendation systems** to suggest relevant products to users. Traditional recommendation techniques, such as **rule-based filtering, collaborative filtering, and machine learning models**, often struggle to handle **unclear or evolving user preferences. Fuzzy Logic** addresses these challenges by incorporating **human-like reasoning,** allowing the system to interpret uncertain inputs and provide more personalized recommendations.

**Detail description of the Invention:**

**1. User Input Collection:** Firstlyuser will give in input to system such as Affordable laptop with good battery life ,Highly rated smartphone under ₹20,000, Shoes with moderate price and high comfort. The inputs are not precise by indicate that relative preferences.

**2. Fuzzification :**  The system converts crisp values into fuzzy values using linguistic terms like low, medium, high.

Example: Price 15,000 is Moderate price , Temperature 10degree is consider as cold, Customer rating 1 out of 5 is Low rating.

**3. Fuzzy Rule-Based Processing:**  The system applies a set of If-Then rules to determine product suitability.

Example fuzzy rules:

* IF price is "affordable" AND rating is "high," THEN recommend product.
* IF price is "moderate" AND battery life is "long," THEN recommend with priority.
* IF price is "high" AND rating is "low," THEN do not recommend.

**4. Defuzzification:** The system converts fuzzy outputs into numerical ranking scores. Example: Laptop A: 85% match, Laptop B: 78% match, Laptop C: 60% match.

**5.** **Final Recommendation:** The system shows a ranked list of recommended products, ensuring that the most relevant ones appear first. The user receives recommendations that feel more natural and aligned with their needs.

**FLOW CHART FOR FUZZY LOGIC:**

**Input User**

**Defuzzification**

**Display Recommended Product**

**END**

Generate Crisp Value

Use Defuzzification Method

**Aggregation**

Calculate Rule Strength

Apply fuzzy operations

**Rule Base**

**Define Membership function for product**

Calculate Membership degrees for user and product

Define Membership function for user

**FUZZIFICATION**

**Product Data**

START

5.RESULTS OF INVENTION:

1. **More Accurate Product Recommendations** :The system suggests products that better match user preferences by handling uncertainty and vague inputs.
2. **Enhanced User Satisfaction**: Customers receive recommendations that align more closely with their needs, leading to a better shopping experience and higher engagement.
3. **Improved Decision-Making Process**: By using fuzzy logic, the system makes intelligent, flexible, and context-aware decisions rather than relying on rigid rules.
4. **Better Handling of Unclear Inputs**: Unlike traditional recommendation systems, this invention processes approximate user preferences (e.g., “somewhat affordable” or “highly rated”) instead of requiring exact values.
5. **Increased Adaptability** : The system continuously refines recommendations based on changing user behaviors, feedback, and interactions without requiring frequent retraining.
6. **Higher Conversion Rates for E-Commerce Platforms**: More relevant recommendations lead to increased purchases, boosting revenue for online stores.
7. **Efficient Performance with Limited Data**:The system can generate effective recommendations even when user data is incomplete or sparse, making it useful for new users and smaller datasets.
8. **Competitive Advantage for Businesses** :Implementing a fuzzy logic-based recommendation system helps e-commerce platforms stand out by offering more personalized and human-like product suggestions.

Advantages Of Invention:

1. **Handles Uncertainty and Vague Preferences** – Unlike traditional systems that require precise user inputs, fuzzy logic processes unclear or subjective preferences to provide more personalized recommendations.
2. **Improves Recommendation Accuracy** – By considering degrees of preference instead of rigid categories, the system offers more relevant product suggestions, leading to better user satisfaction and engagement.
3. **Enhances Personalization** – The system adapts recommendations based on fuzzy rules and user behavior, ensuring that suggestions align with individual preferences even if they are not explicitly defined.
4. **More Human-Like Decision Making** – Using linguistic variables and fuzzy rule-based processing, the system mimics human reasoning, making recommendations feel more natural and intuitive.
5. **Requires Less Data for Effective Performance** – Unlike machine learning models that need large datasets for accuracy, this system works well even with limited data, making it more efficient for new users or niche markets.
6. **Handles Uncertainty and Vague Preferences** – Unlike traditional systems that require precise user inputs, fuzzy logic processes unclear or subjective preferences to provide more personalized recommendations.
7. **Improves Recommendation Accuracy** – By considering degrees of preference instead of rigid categories, the system offers more relevant product suggestions, leading to better user satisfaction and engagement.
8. **Enhances Personalization** – The system adapts recommendations based on fuzzy rules and user behavior, ensuring that suggestions align with individual preferences even if they are not explicitly defined.
9. **More Human-Like Decision Making** – Using linguistic variables and fuzzy rule-based processing, the system mimics human reasoning, making recommendations feel more natural and intuitive.
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