Deep Learning–Based Understanding of Customer Reviews for Fitness Equipment Marketing

1. Background and Motivation

Fitness equipment products (e.g., treadmills, dumbbells, and smart fitness devices) receive a large number of customer reviews on e-commerce platforms. These reviews contain valuable information about product quality, functionality, and user experience, which can support marketing decisions.

Traditional machine learning methods rely on handcrafted features and often fail to capture contextual semantics and complex emotions in customer reviews. Recent advances in transformer-based deep learning models provide powerful tools for learning rich textual representations and enable more effective review understanding.

2. Research Questions

This project aims to answer the following research questions:

1. **Do deep learning models outperform traditional machine learning methods in understanding the semantics and sentiment of fitness equipment reviews?**
2. **Can transformer-based text representations reveal key customer concerns and recurring themes useful for marketing insights?**
3. **What are the limitations of deep learning models when analyzing fitness equipment reviews, such as handling neutral or mixed sentiments?**

3. Data

We use public e-commerce review datasets (e.g., Amazon Reviews from Kaggle), focusing on fitness equipment and related product categories.
The dataset includes:

- Review text
- Star ratings
- Product categories

4. Methodology

1. **Baseline Model (for comparison)**
    - TF-IDF + Logistic Regression
2. **Deep Learning Models**
    - Transformer-based language models (e.g., BERT / DistilBERT)
    - Fine-tuning on fitness equipment review data
3. **Semantic Analysis**
    - Generate deep text embeddings
    - Perform semantic clustering to identify major customer concerns
4. **Explainability and Deep Analysis**
    - Attention-based or token-level interpretation
    - Qualitative error analysis to study model limitations

5. Evaluation

- Quantitative metrics: Accuracy, Precision, Recall, F1-score
- Qualitative analysis:
    - Comparison between traditional ML and deep learning models
    - Interpretation of model predictions

6. Expected Outcomes

- Demonstrate the advantages of deep learning in customer review analysis
- Extract marketing-relevant insights from fitness equipment reviews
- Analyze strengths and limitations of transformer-based models in this domain

7. Course Relevance

This project applies modern deep learning techniques, focusing on representation learning, fine-tuning, and experimental comparison, making it well aligned with the objectives of an AI and Deep Learning course and suitable for a semester-long project.