Integrating Semantic with Keyword Product search in Online Marketplaces

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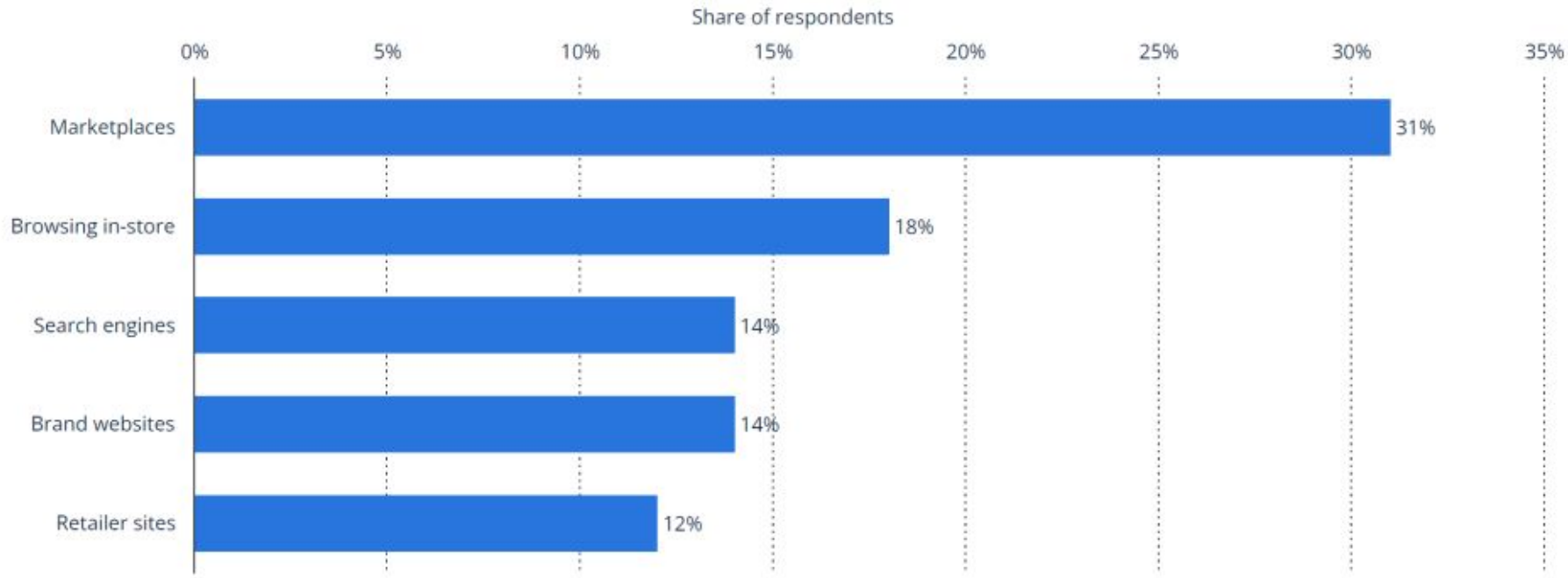
Introduction

Importance of online marketplaces and product search

Introduction | Online Marketplaces

- Online marketplaces are popular platforms for finding products
- *2023 International Trade Administration Survey*: Online marketplaces are the main starting point for product searches worldwide



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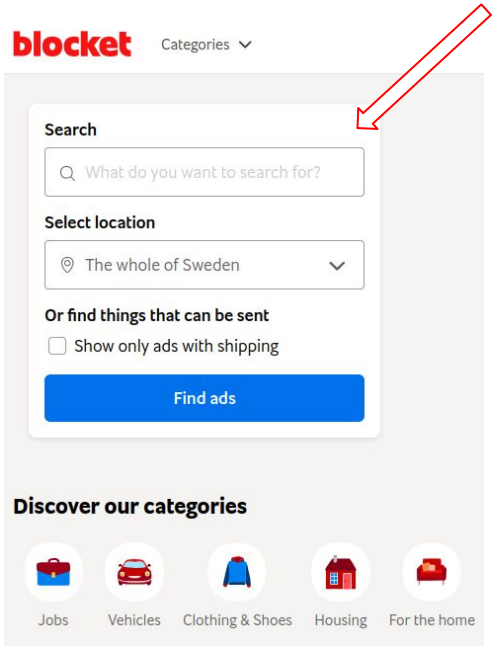
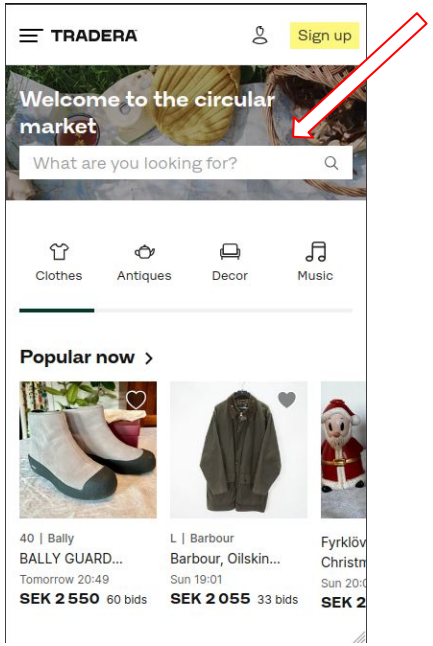
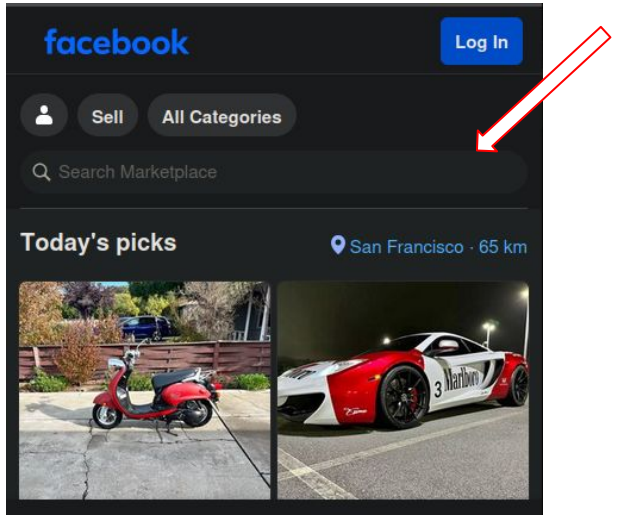
Introduction | Product Search

- The search bar is a widely used tool for finding products
- *2022 Google Survey*: 7 out of 10 shoppers use the search bar as the primary method







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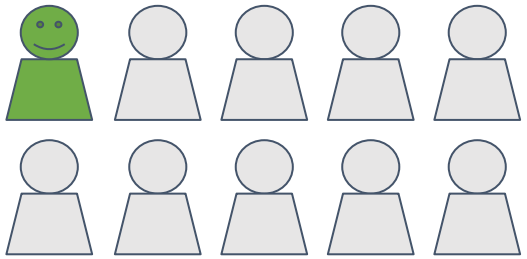
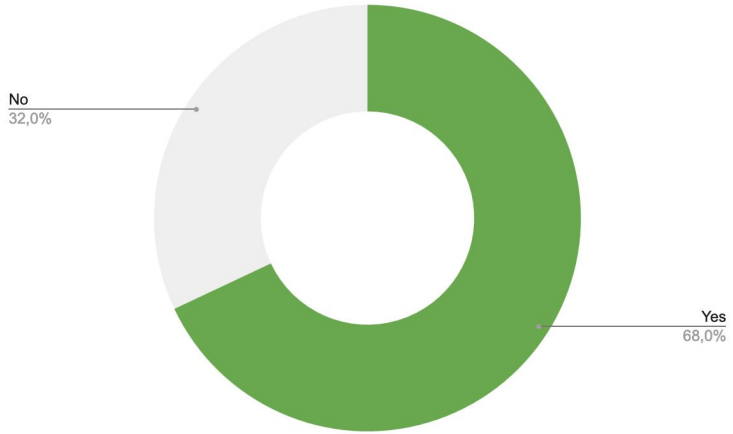
Introduction

Current state and challenges of product search

Introduction | Current State

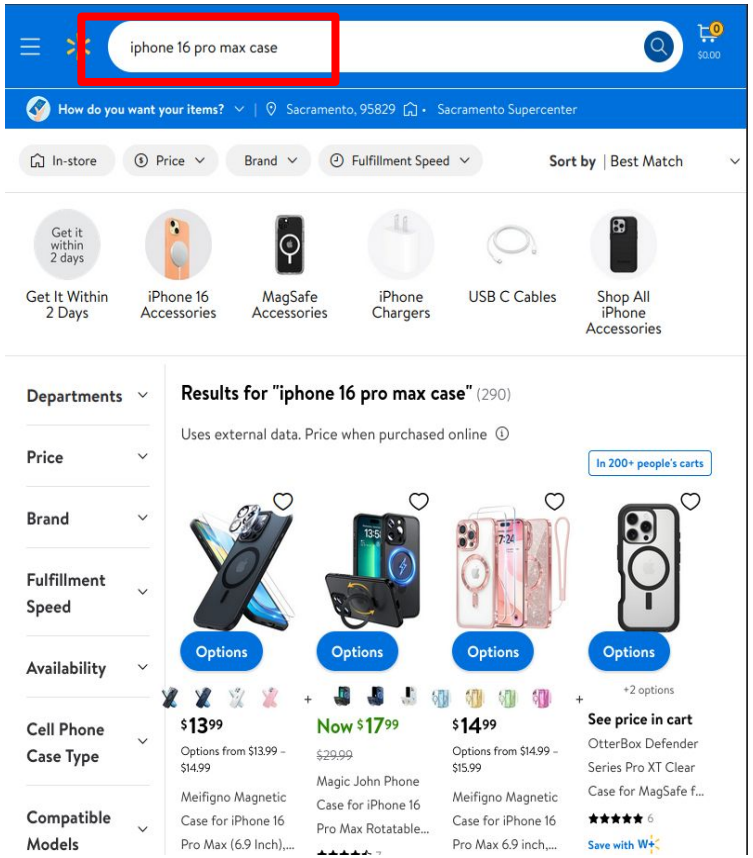
- There is widespread dissatisfaction with search results among shoppers
- *2022 Google Survey*: Only 12% of shoppers find exactly what they are searching for when using the search bar
  - Results in $2 trillion in annual losses globally
- *2024 Constructor Survey*: 68% of shoppers want improved search results

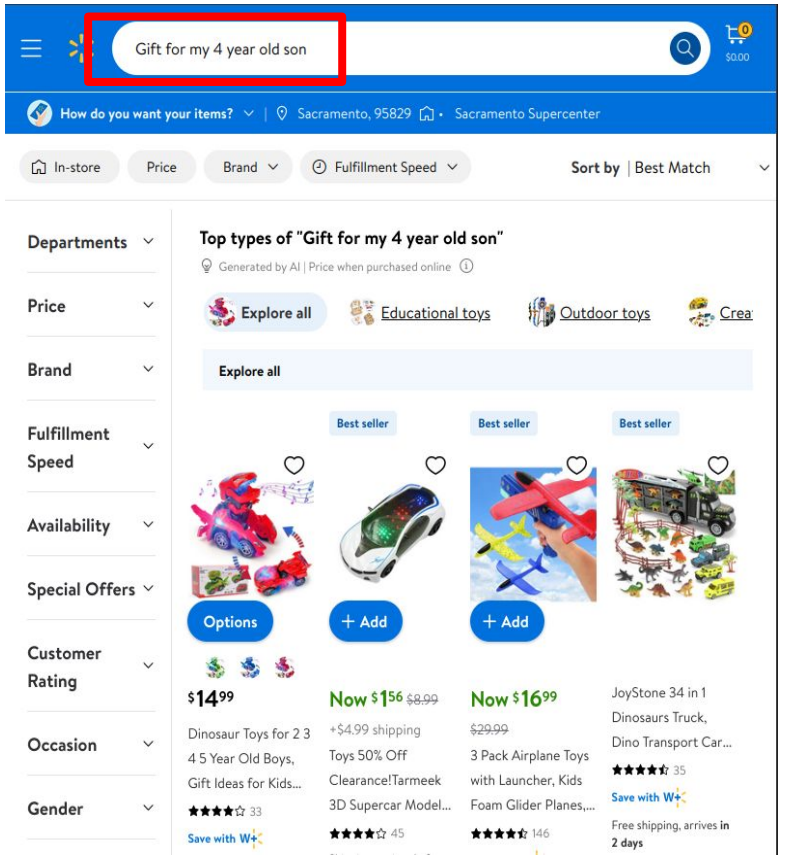




Introduction | Challenges

- Diverse user intentions

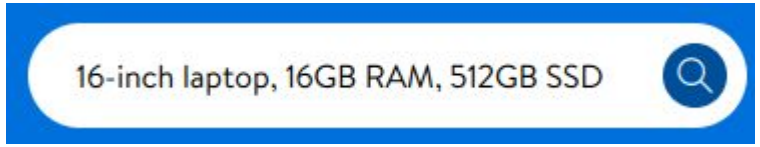




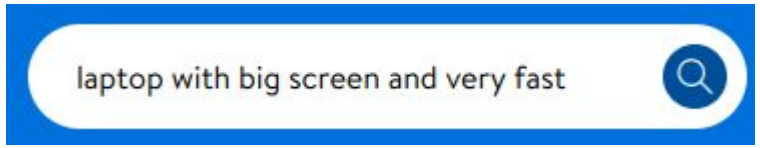
Introduction | Challenges

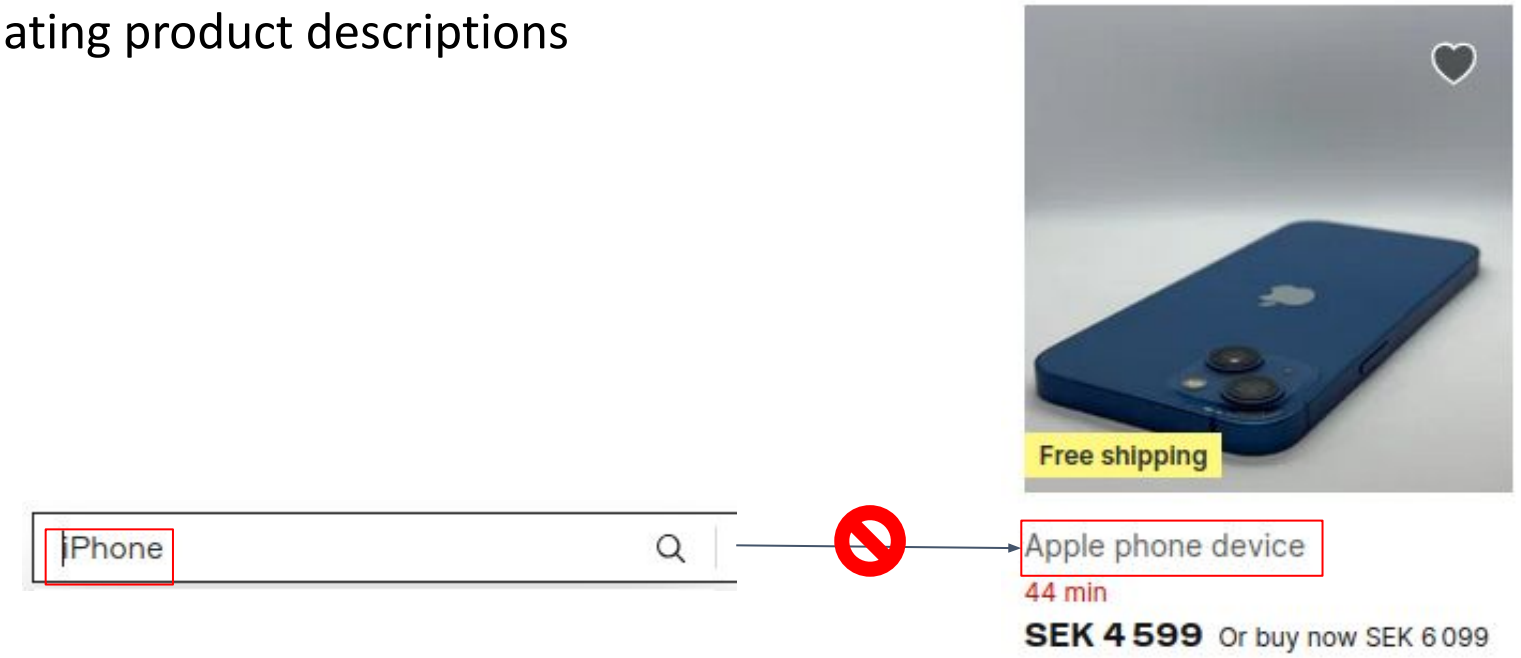
- Diverse user base
  - Language and culture
  - Backgrounds and expertise
- Formulating queries
- Formulating product descriptions

Experienced computer user



Inexperienced computer user





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Introduction

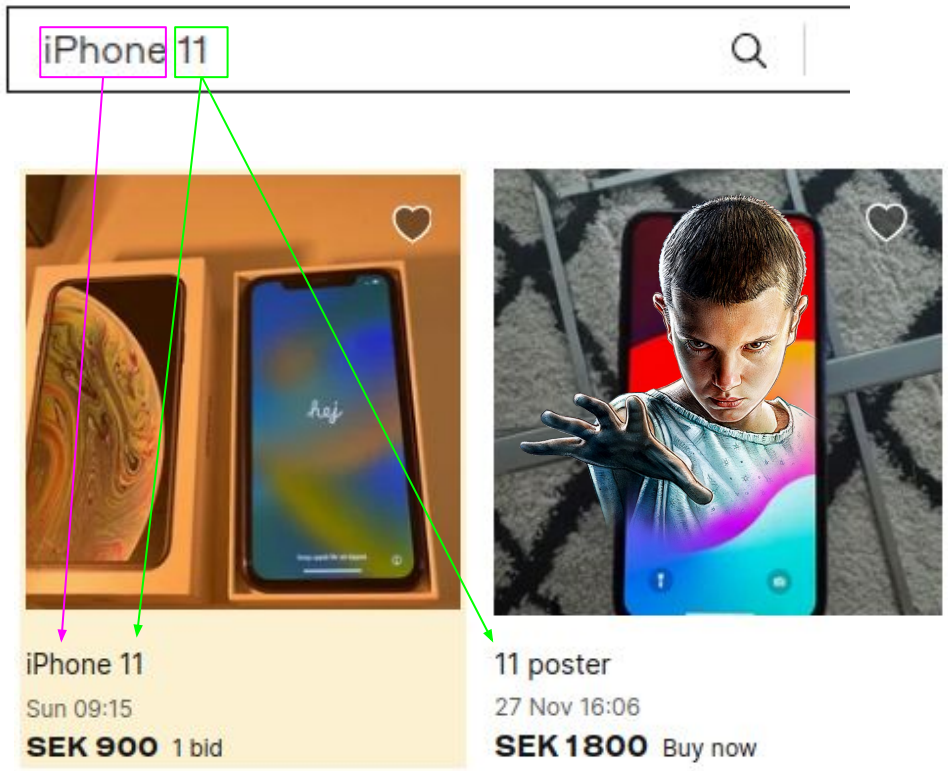
Common product search systems: keyword-based, semantic-based, and hybrid

Introduction | Keyword Search

- Word matching

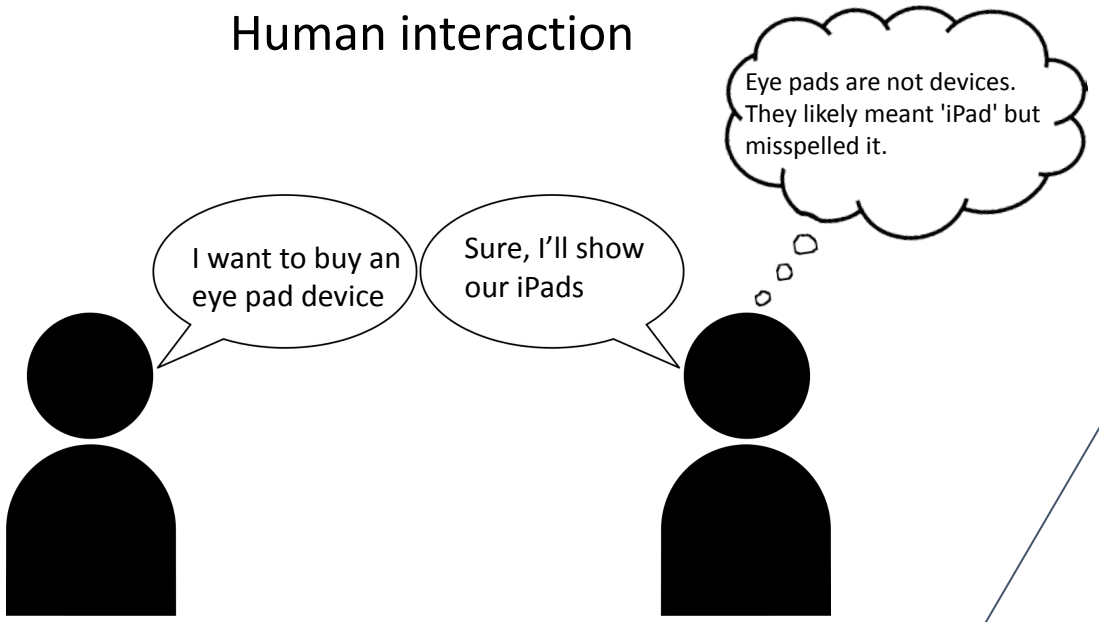
- **Main strength**: Precise matching (e.g., model numbers and brand names)

- **Limitations**:
  - Lacks understanding of context and underlying intent
  - Struggles with vocabulary gaps (e.g., misspellings and synonyms)

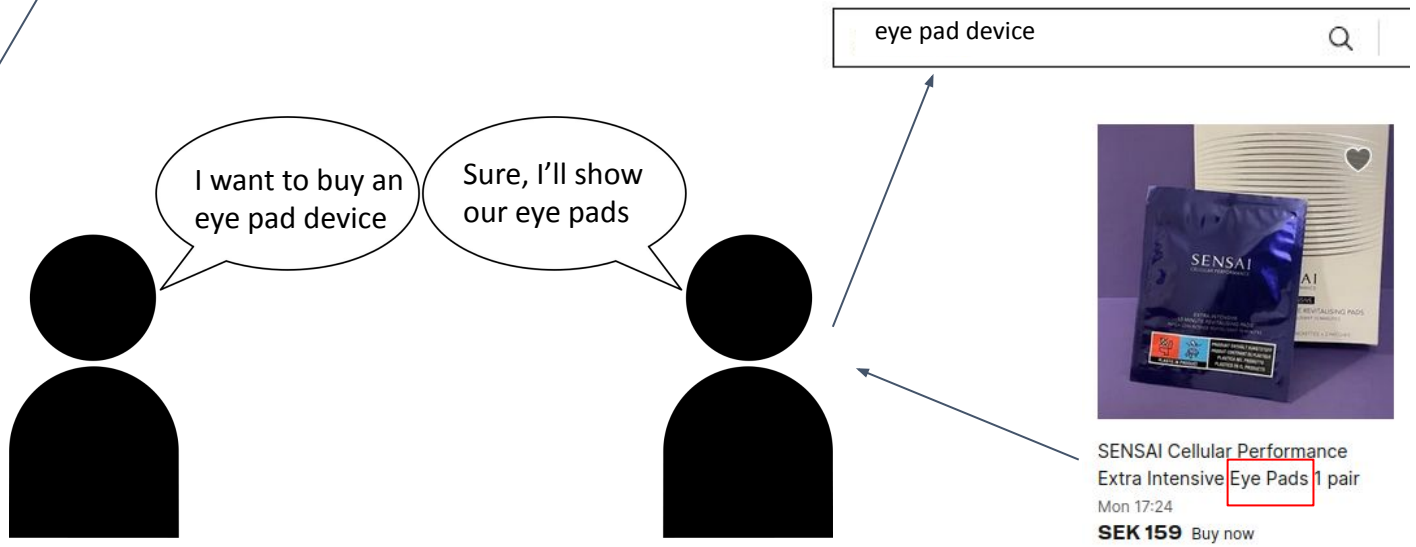


Introduction | Keyword Search

Human interaction

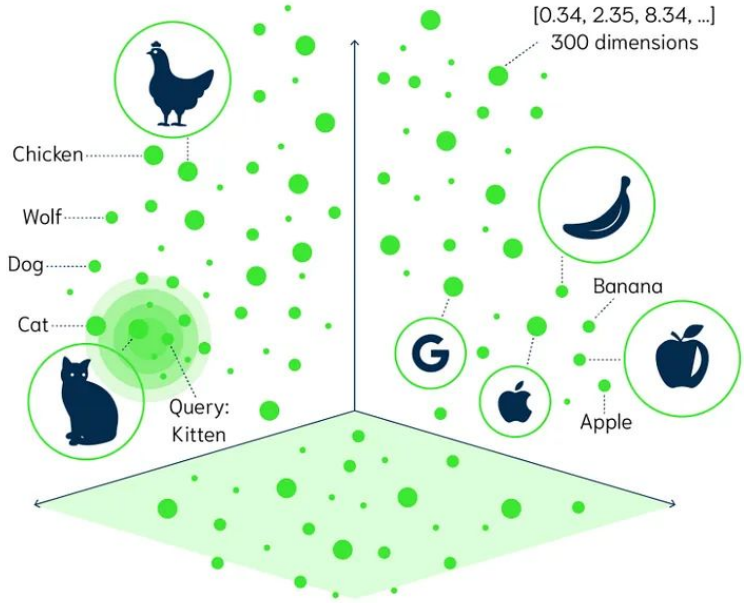


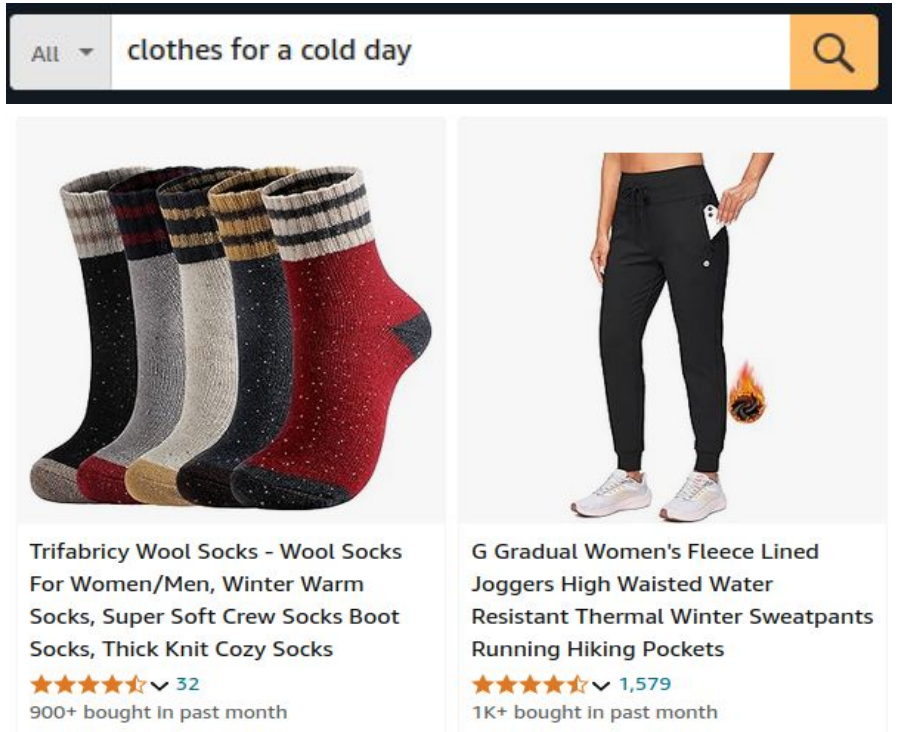
Keyword-based search system



Introduction | Semantic Search

- Matching based on the intent and contextual meaning
- “Product / query” -> Embedding model -> [0, 7, 2, …]
  - Captures semantic meaning
  - Measure distance or similarity
- **Main strength**: Understands the underlying meaning, beyond just words
- **Limitations**:
  - May produce inaccuracies when specific terms are important (e.g., model numbers)
  - Other known limitations, such as negations and units of measurement

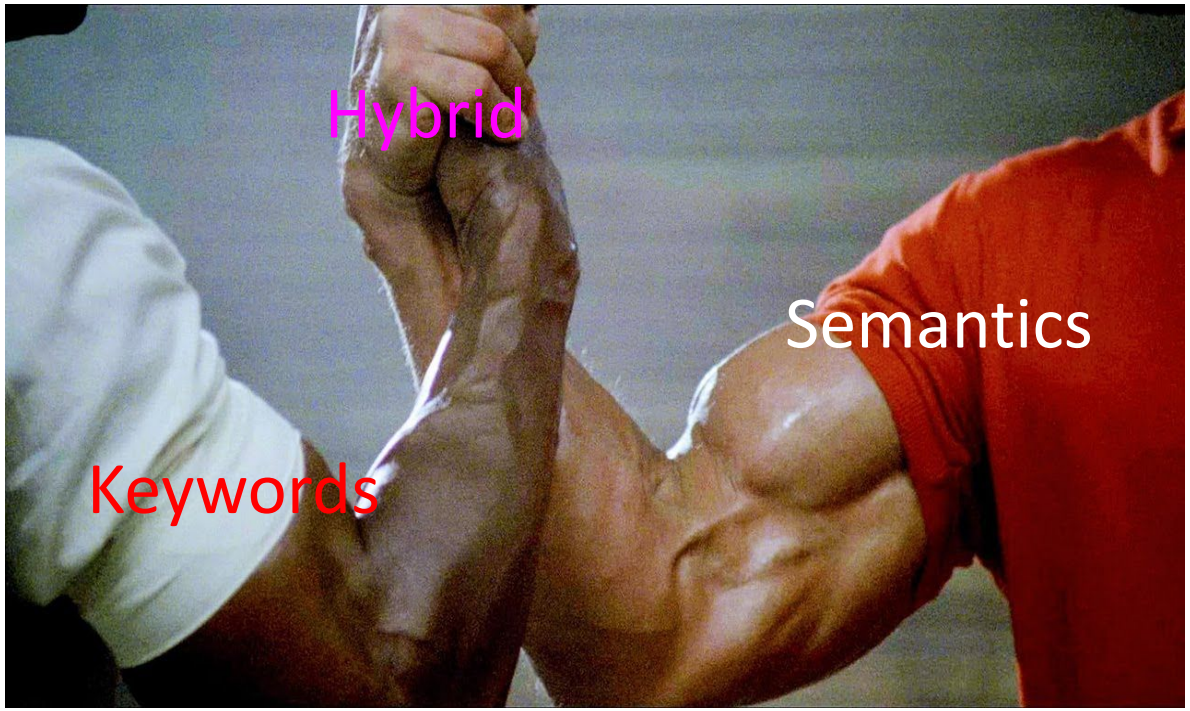




Introduction | Hybrid Search

- Combines keyword and semantic search

- Complementary:
  - Precise term matching
  - Underlying meaning



Introduction

Research Questions

Introduction | Research Questions

- **Hybrid Architectures:** How can hybrid models be implemented to utilize the capabilities of both keyword and semantic models?

- **Hybrid Search Impact on Product Search Results:** What is the impact of hybrid models on product search results compared to keyword and semantic models used independently?

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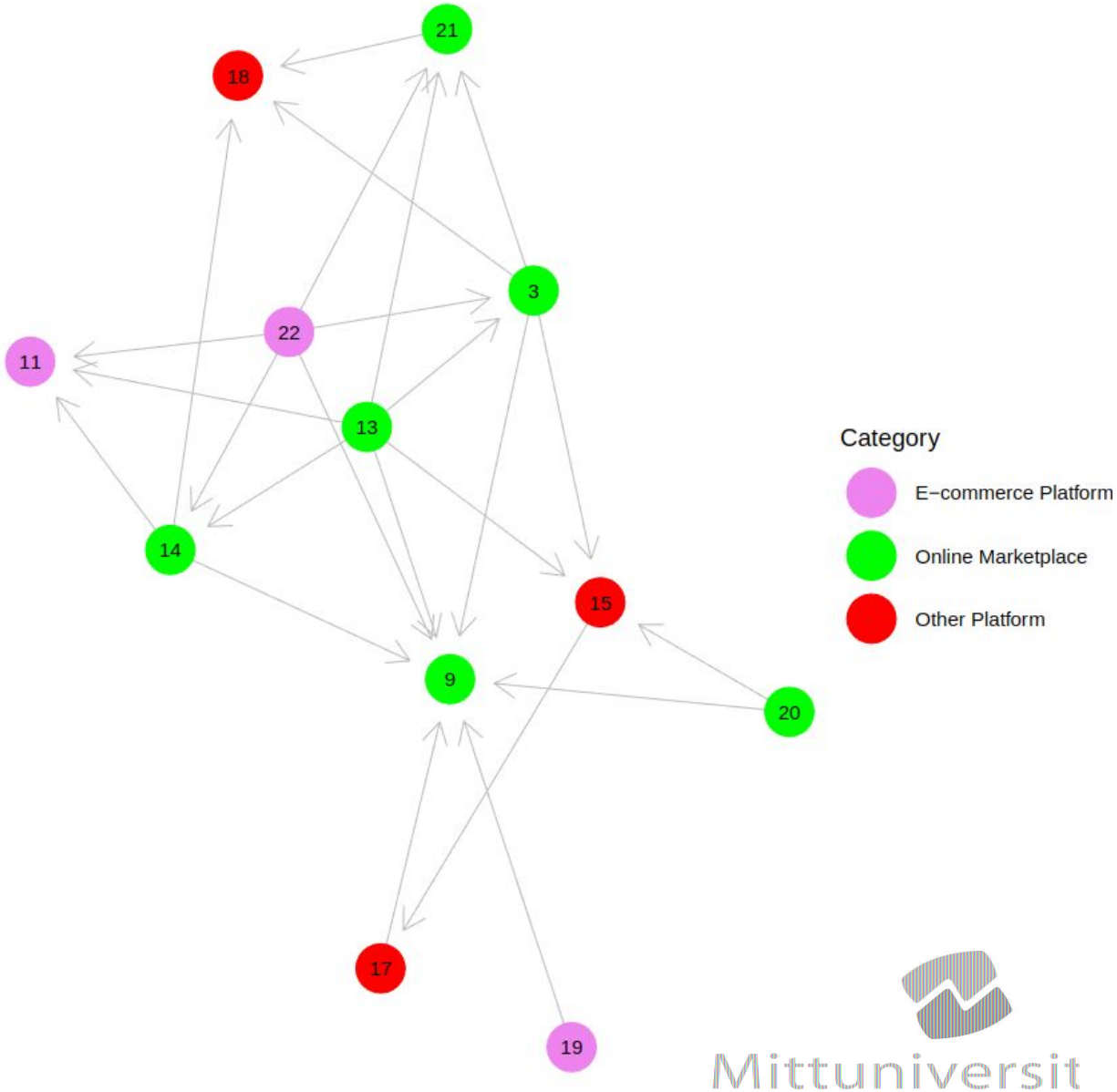
Literature Review

Selected studies, hybrid architectures and their impact on product search results

Literature Review

- Selected studies:
  - 6 online marketplaces
  - 3 e-commerce platforms
  - 3 other platforms
- Includes:
  - Hybrid models
  - Offline and online experiments
- The studies are interconnected



Results and Discussion

Hybrid architectures and their impact on product search results

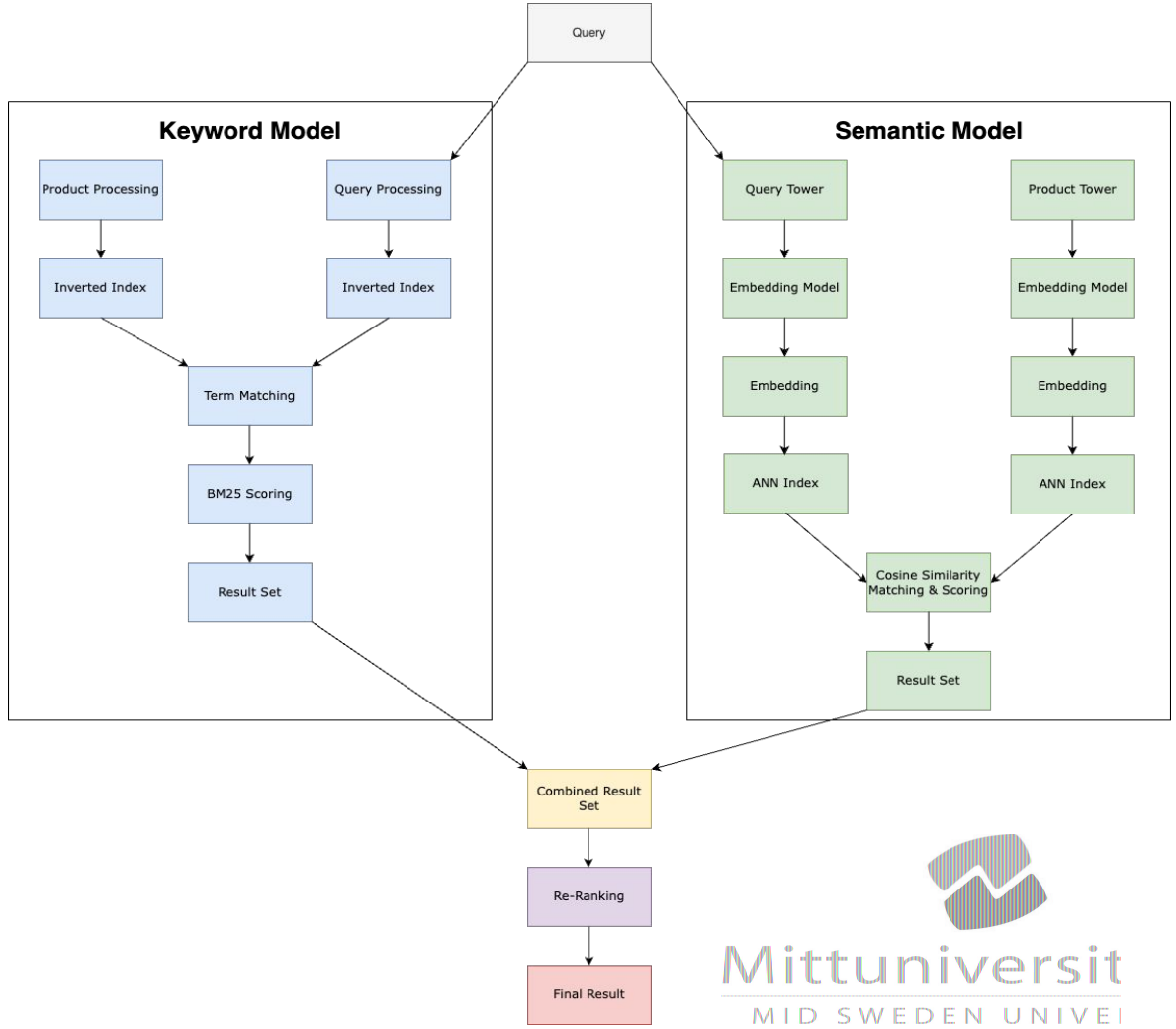
Results and Discussion | Hybrid Architectures

- Differences between hybrid models, but similar foundation

- **Core Keyword Models:**
  - Inverted index term matching
  - BM25 scoring

- **Integration of Semantic Models:**
  - Two-tower architecture with query and product embeddings
  - Approximate Nearest Neighbor (ANN) search with cosine similarity for matching and scoring

- **Hybridization:**
  - **Merging:** Combines results from both models into a unified match set
  - **Re-ranking:** Following this merging, refines and ranks matches based on relevance (limited re-ranking details available across studies)



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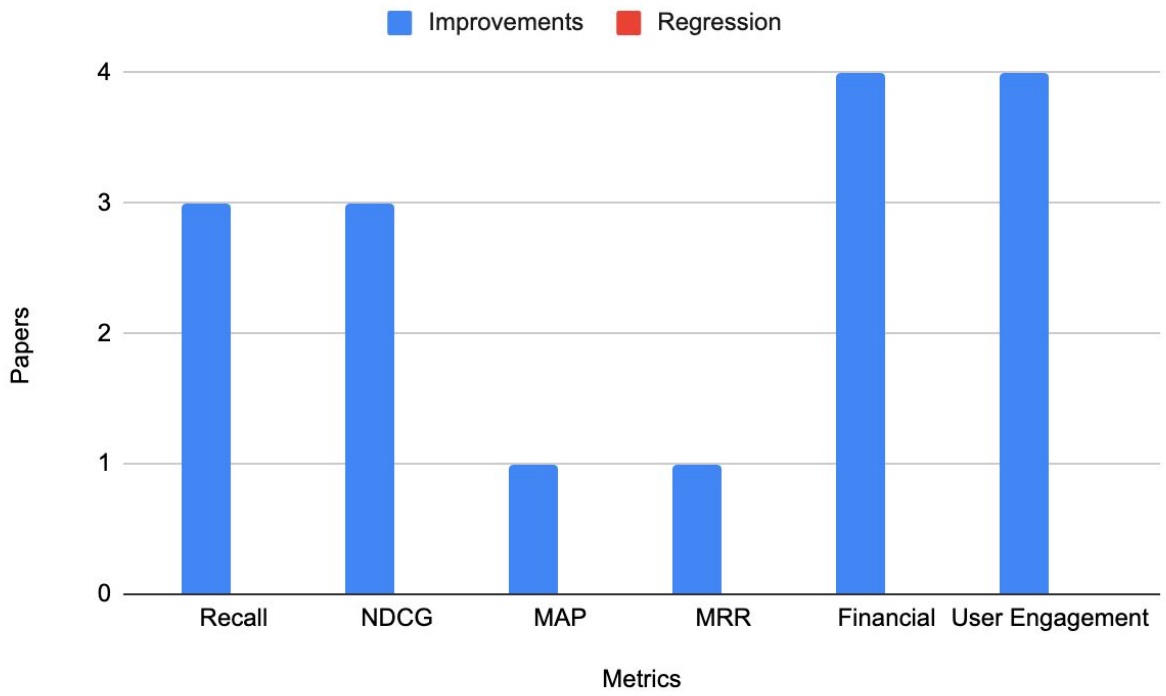
Results and Discussion | Impact

- Significant improvements in product search result metrics when compared to standalone models
- Improved coverage, ranking quality and business performance



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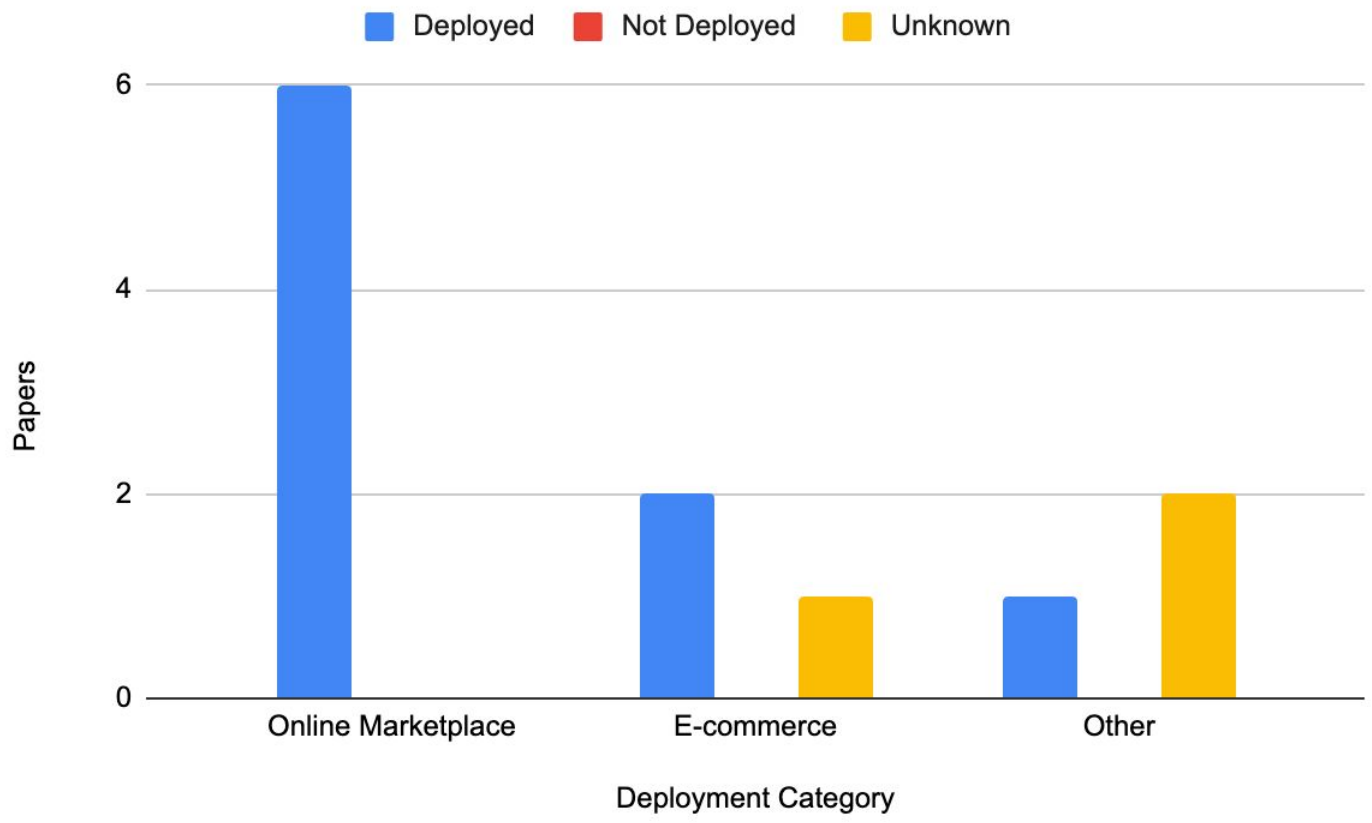
Results and Discussion | Impact

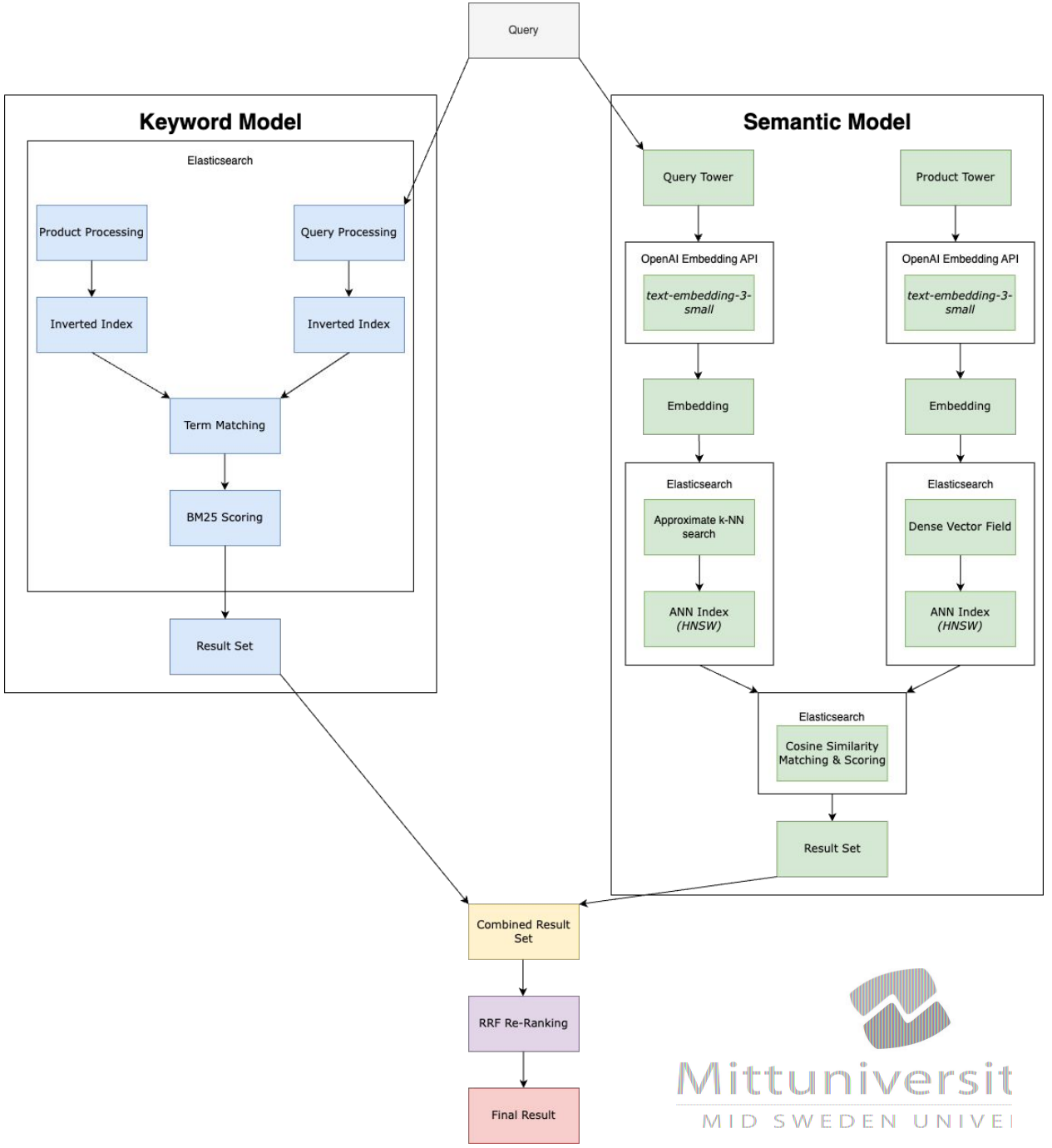
- A majority of hybrid models were deployed in production



Proposed Solution

Proposed Solution

- Hybrid models provide better product search results
- Hybrid models can be complex to implement
  - Requires expertise and resources
- **Proposed solution:** A simplified hybrid model for broader adoption
  - Inspired by models in the review
  - Lightweight and flexible
  - Codebase



Conclusions and Future Recommendations

Conclusions and Future Recommendations

- Discussed different hybrid architectures and identified a similar foundation across the literature
- Multiple studies, with various experiments and metrics, verified that hybrid models significantly enhance product search results
- We proposed a simplified hybrid model as a starting point
- Suggest further exploration of the overall hybrid model impact:
  - Complexity and maintenance
  - Resource requirements
  - Cost implications
  - Latency
  - Pagination

Questions