Sentiment Analysis Approach in Healthcare Data Assessment

Objective: Convert unstructured patient feedback into structured, high-confidence insights including overall sentiment, domain-specific entity extraction, and entity-level sentiment to improve operational and clinical decision-making.

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Core Techniques

Hybrid Transformer-Based NLP Architecture:

- BioBERT for medical entity recognition
- Clinical NER for healthcare terminology
- Rule-based entity patterns for domain precision
- BERT multilingual sentiment classifier for overall feedback
- FLAN-T5 for aspect-based sentiment analysis
- Zero-shot classification for adaptive entity detection
- Lexicon fallback for robustness

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Entity-level sentiment detection for:

- Doctor
- Nurse
- Facility
- Surgery / Procedure
- Appointment
- Parking

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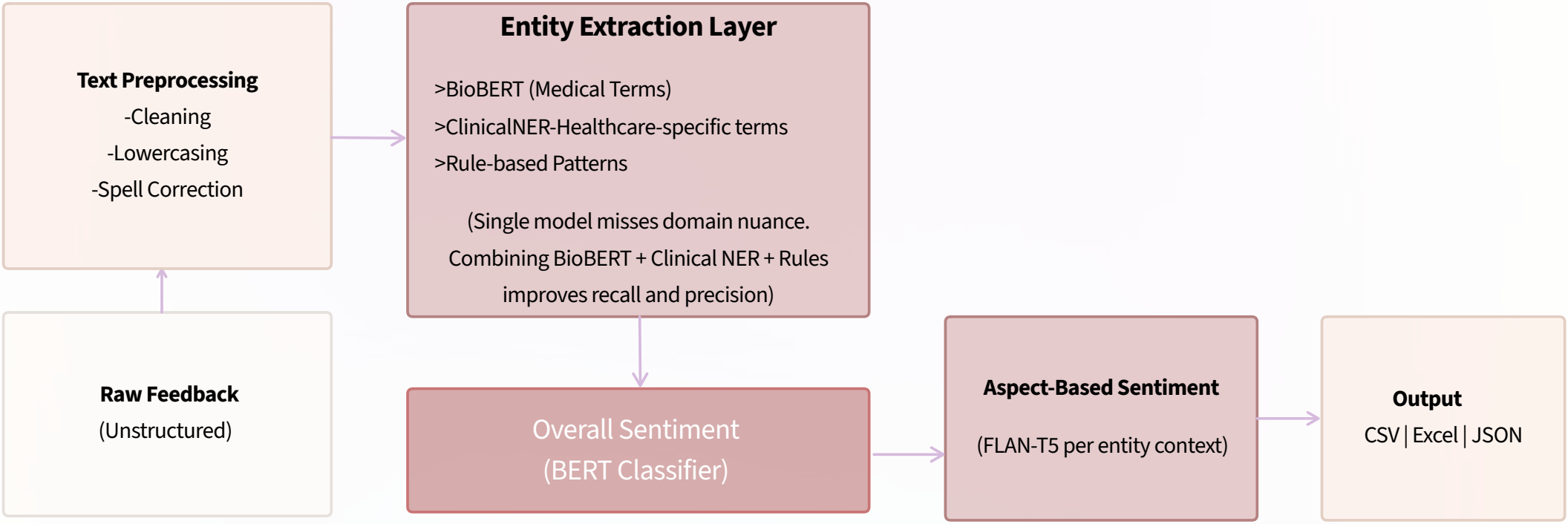
Key Challenges

- No labeled training dataset
- Mixed sentiment within same feedback
- Healthcare terminology variability
- Misspellings
- Overlapping entity mentions
- Need for confidence-aware outputs

System Architecture: NLP Pipeline Flow



Entity Extraction Layer – Hybrid Detection Architecture

BioBERT – Medical Term Recognition

- **What it does**
  Uses BioBERT transformer to detect medical procedures, treatments, and clinical terminology.
- **Why it helps sentiment analysis**
  Ensures clinical entities (e.g., “spinal fusion”, “biopsy”) are correctly identified so sentiment can be linked to the right medical context.
- **Input**
  Preprocessed feedback text
- **Output**
  List of medical entities with type and confidence score

Clinical NER – Healthcare Entity Detection

- **What it does**
  Uses a healthcare-specific NER model to detect structured entities like Doctor, Facility, Procedure, Treatment.
- **Why it helps sentiment analysis**
  Separates operational entities (e.g., facility, staff) from clinical terms, enabling aspect-level sentiment analysis.
- **Input**
  Preprocessed feedback text
- **Output**
  Structured healthcare entities with entity type labels

Rule-Based Pattern Layer – Precision Capture

- **What it does**
  Applies regex and keyword patterns to detect domain-specific phrases such as “Dr. Name”, “appointment rescheduled”, “parking was difficult”.
- **Why it helps sentiment analysis**
  Captures short operational complaints that transformer models may miss, improving recall and interpretability.
- **Input**
  Preprocessed feedback text
- **Output**
  High-precision domain entities

Entity Merging & Deduplication (Ensemble Layer)

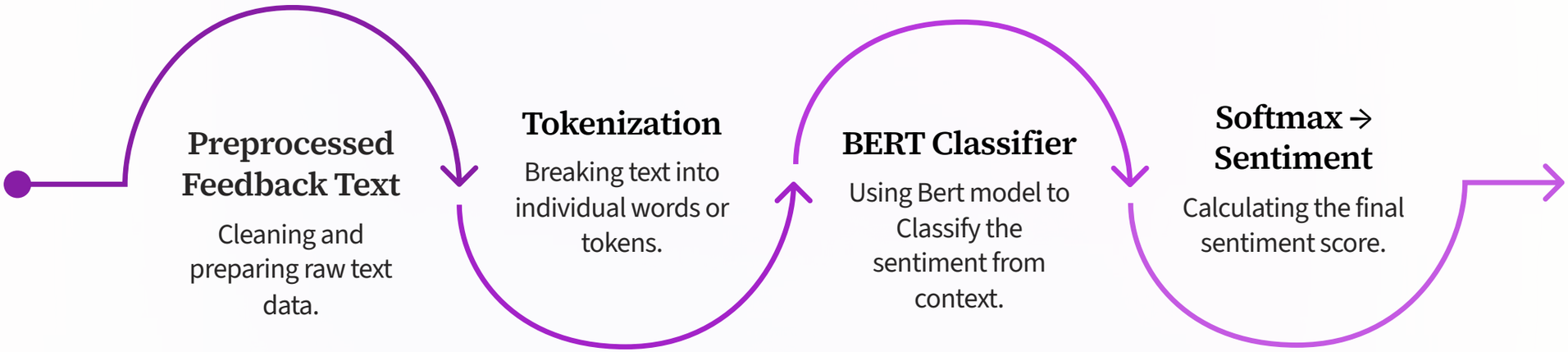
- **BioBERT, Clinical NER, and Rule-Based detectors run independently in parallel** on the same input text.
  Their outputs are aggregated in this layer.
- **What is does**
  Combines entities from all detectors and Removes duplicates and overlaps
  by Normalizing entity names
  and Assigning confidence scores
- **Why it matters:**
  Improves recall through ensemble detection
  Reduces redundancy before sentiment scoring
- **Input**
  Entity lists from three independent detectors
- **Output**
  Unified, deduplicated, confidence-aware entity set

Overall Sentiment Layer (Transformer-Based)

Uses a pretrained BERT-based sequence classification model to analyze the full feedback text and predict overall sentiment.

What happens here:

Preprocessed text → Tokenization → BERT classifier → Softmax probabilities → Sentiment label (Positive / Neutral / Negative) with confidence score



Why it matters

- Captures global emotional tone of the feedback
- Handles contextual language (e.g., “handled professionally despite delays”)
- Provides probability-based confidence score

Input : Preprocessed full feedback text

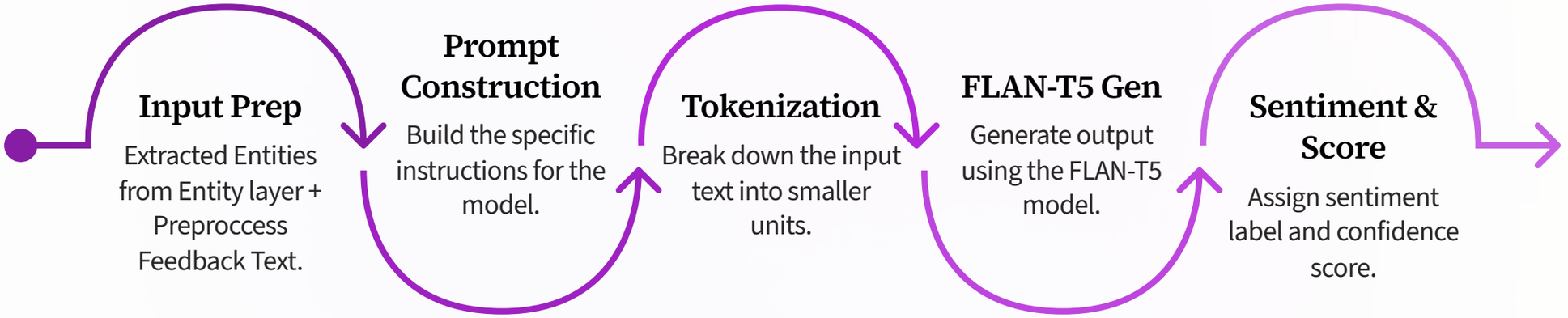
Output : Overall sentiment label + confidence score

Aspect-Based Sentiment Layer(FLAN-T5 Prompt-Based)

Uses a pretrained sequence-to-sequence transformer (FLAN-T5) to assign sentiment to each extracted entity.

What happens here:

Extracted Entities (from Entity Extraction & Merging Layer) + Preprocessed Feedback Text→ Prompt Construction→ Tokenization→ FLAN-T5 Sequence Generation→ Sentiment Label (Positive / Neutral / Negative)→ Confidence Score



Example Prompt: “Analyze the sentiment about Doctor ‘Dr. Riya Patel’ in the following text…”

Why it matters:

- Enables fine-grained entity-level sentiment
- Handles mixed feedback within a single comment
- Works without labeled aspect-based dataset

Output : Entity-level sentiment label + confidence score

Production-Ready & Robust Architecture

Robustness

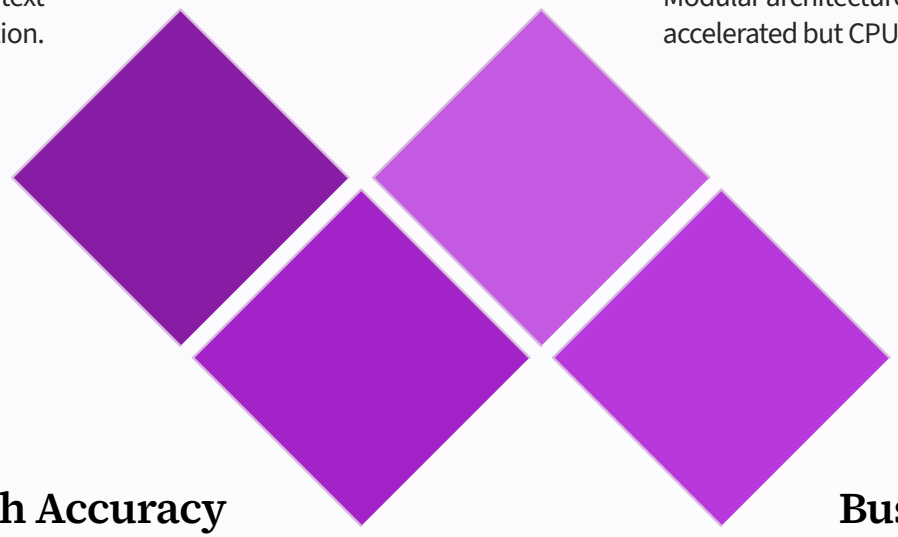
Handles Real-World Variability:

Supports variable input lengths and text normalization.

Operational Ease

Deployment Friendly:

Modular architecture that is GPU-accelerated but CPU-compatible.



High Accuracy

Intelligent & Reliable:

Ensemble entity extraction combining transformers and rule-based logic.

Business Value

Business-Ready Output:

Generates normalized entities with confidence metrics for monitoring.