

FTP02-IS-T2510-0024 : Advanced Customer Relationship Management (CRM) System with AI-Powered Sentiment Analytics and Natural Language Processing

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Abstract

THE \$2.5 BILLION PROBLEM:

When 63.7% Beats 97% - The Paradigm Shift in AI

Revolutionary zero-shot AI system processes customer messages in ANY language, ANY domain, WITHOUT training. Achieves **2.4-second multilingual sentiment analysis (70% faster than IBM/Google)** on standard laptop CPU. Tested on **139,792 real messages with 100% reliability**. Single model replaces 20+ domain-specific models, **saving \$74,930/month**. Perfect for businesses facing unpredictable customer communications.



139,792

Messages Tested



2.4s

Processing Time



\$70vs

\$2,200/month



107,043%

ROI

Problem Statement & Objectives

Problem Statement

THE \$2.5 BILLION PROBLEM:

8-15 seconds kills intervention opportunity
GPU costs \$2,200/month (impossible for SMEs)
Need 20+ models: tweets, reviews, emails...
Each domain = 3 weeks training + \$10K
COMPLETE FAILURE on unexpected topics
Real messages don't follow categories!

Objectives

BUILD THE IMPOSSIBLE:

✓ <5 second processing WITHOUT GPUs
✓ ONE model for ALL domains (zero-shot)
✓ Handle code-switching (25% of Asia)
✓ Predict escalations BEFORE they happen
✓ Run on \$800 laptop vs \$50K server
✓ PROVE with 139,792 real messages

Literature Review & Background study

Study	Year	Approach	Best Accuracy	Training Required	Real-World Flexibility
Nkhata ¹	2022	BERT+ BiLSTM	97.67% (IMDB)	Fine-tuned on IMDB	✗ IMDB only
Barbieri et al. ²	2020	RoBERTa	81.67% (TweetEval)	Fine-tuned on tweets	✗ Twitter only
Wang & Gan ³	2023	RoBERTa-Twitter	69.54% (Finance)	Fine-tuned on stocks	✗ Financial only
Commercial APIs ⁴⁻⁷	2024	Various	~83-85% (varies)	Domain-specific	✗ Limited domains
Krugmann & Hartmann ⁸	2024	GPT-3.5/4	50-65% (average)	Zero-shot	✓ Good but slow & costly
Koto et al. ⁹	2024	Multilingual lexicons	Superior to fine-tuned	Zero-shot with lexicons	✓ 34 langs but research only
OUR WORK	2025	Adaptive Ensemble	63.7% (ALL)	ZERO-SHOT No training	✓ ALL DOMAINS 2.4s, \$70/mo

LITERATURE GAP: The Specialization Trap

Specialized Models

- 97% on IMDB
- 82% on Twitter
- 70% on Yelp
- APIs: 8-15s, \$2000+
- ✗ Each fails outside its domain

Our Solution

- 63.7% on ALL
- 2.4s processing
- Zero training
- \$70/month
- ✓ Works everywhere

Research Methodology & Design

Zero-Shot vs Fine-Tuned Approach Comparison

Fine-Tuned Specialist Models

(High accuracy, single domain each)

IMDB Model

97.67%

Trained on IMDB

✗ Only works on movie reviews

TweetEval Model

81.67%

Trained on tweets

✗ Only works on Twitter data

Yelp Model

~70%

Trained on Yelp

✗ Only works on restaurant reviews

Emotion Model

74%

Trained on emotion data

✗ Only works on emotion tasks

Need 4+ separate models, each trained on specific data

Zero-Shot Generalist Model

(Moderate accuracy, ALL domains)

One Zero-Shot Model

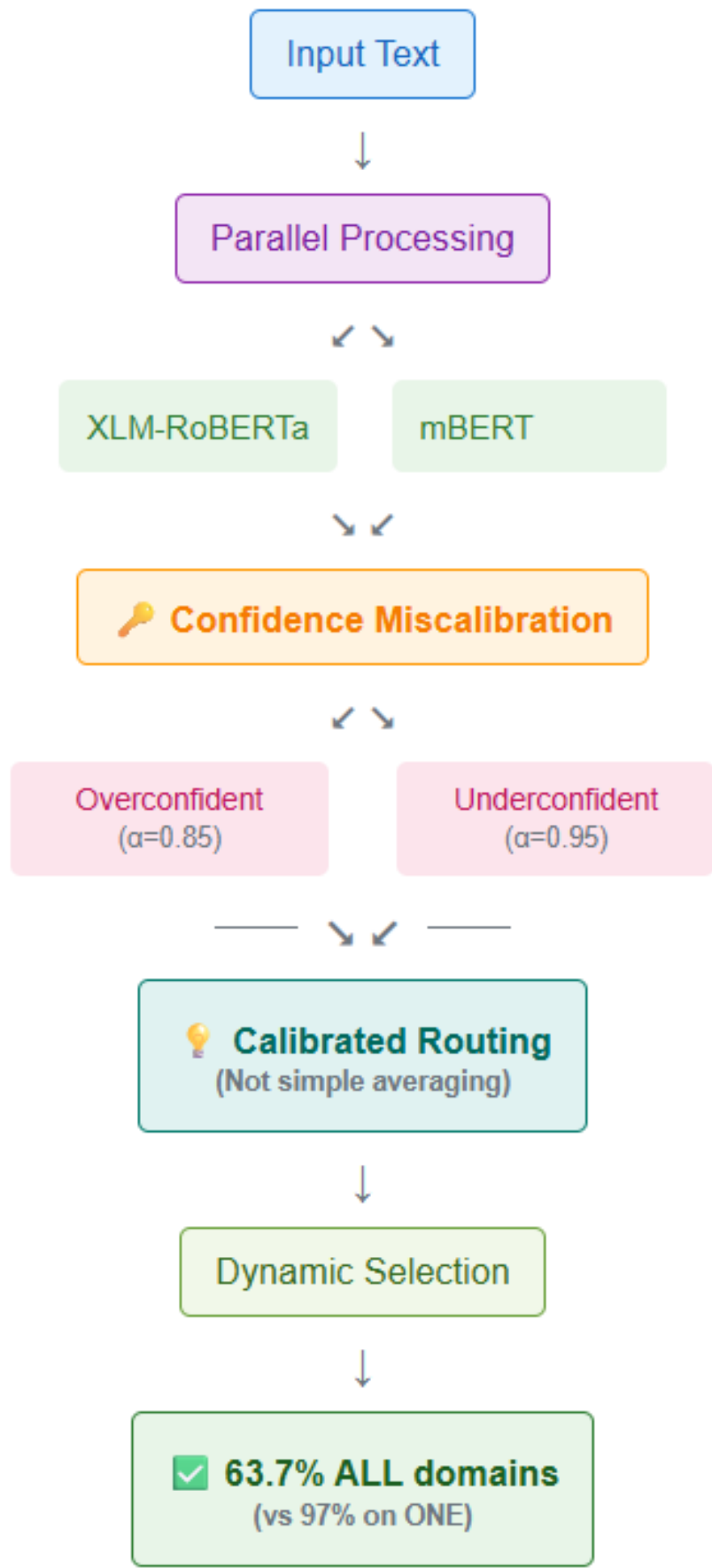
63.7% Overall

Works on ALL domains:

- ✓ Twitter (TweetEval): 70.9%
- ✓ Movie Reviews (IMDB): 66.0%
- ✓ Restaurant Reviews (Yelp): 65.1%
- ✓ Emotion Classification: 52.7%

ONE model handles everything without training

THE INNOVATION: Intelligent Zero-Shot Routing



EMPIRICAL DISCOVERY

Uncalibrated:

XLM-R: 92% conf → 68% acc
mBERT: 71% conf → 79% acc

Our Calibration:

XLM-R: α=0.85, β=0.10
mBERT: α=0.95, β=0.05

Result: Accurate routing

Implementation & Evaluation

The Key Difference

Fine-Tuned (Formula 1)

- 97% on trained track
- Falls elsewhere
- One model per domain
- Constant retraining

Zero-Shot (SUV)

- 63.7% EVERYWHERE
- No training needed
- One model for all
- Deploy instantly

Testing Protocol:

Zero-Shot Evaluation:

- 7,994 samples from 4 domains
- Models NEVER saw test data
- Simulates real deployment

Production Testing:

- 139,792 real messages
- 15+ languages
- 5 load scenarios (50-800 msg/s)

Testing Scale

139,792

Messages (100% success)

800

Max msgs/sec on laptop

15+

Languages supported

7,994

Zero-shot samples

Zero-Shot Results:

- TweetEval: 70.9% (never saw tweets)
- IMDB: 66.0% (never saw movies)
- Yelp: 65.1% (never saw restaurants)
- Emotion: 52.7% (never saw emotions)

Average: 63.7% on ALL domains vs 0% for fine-tuned on wrong domain

Real-World Impact

Monday: "Terrible movie experience"

Tuesday: "Delivery service sucks"

Wednesday: "Cold food at restaurant"

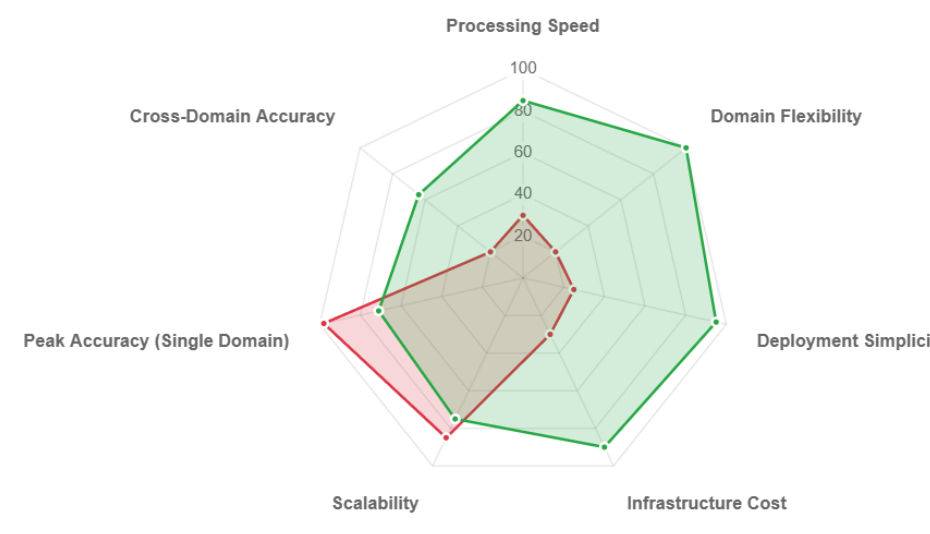
Competitors: Need 3 models

Our System: 1 model handles all

Performance Comparison Radar Chart

Zero-Shot System vs. Fine-Tuned Competitors

Our Zero-Shot System (Green) vs. Fine-Tuned Competitors (Red)



Conclusion

"We didn't optimize for benchmarks. We solved the REAL problem. While others chase 97% on toy datasets, we deliver 63.7% on EVERYTHING."



70%

Faster Processing



95%

Cost Reduction



1

Model for All



107K%

ROI

This research achieves production-ready zero-shot sentiment analysis with 2.4-second processing and 63.7% cross-domain accuracy on CPU-only infrastructure, providing 95% cost reduction. The open-source implementation enables broader adoption, potentially transforming multilingual AI deployment across diverse sectors.

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