

An Improved Quantum Software Challenges Classification Approach using Transfer Learning and Explainable AI

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Problems & Ideas

The Challenges

Limited Categorization: Existing Q&A platforms lack fine-grained categorization for QSE.

Developer Frustration: Difficult to find relevant solutions in complex quantum discussions.

Model Limitations: Traditional ML models struggle with quantum jargon without synthetic data.

Proposed Approach

Transfer Learning: Fine-tuned BERT models for context-aware classification of QSE discussions.

Six Challenge Categories: Tooling, Theoretical, Learning, Conceptual, Errors, API Usage.

Explainable AI: Integrated SHAP for model interpretability and validation.

Human-AI Collaboration: Curated dataset via human-ChatGPT negotiation process.

Proposed Workflow for QSE Discussion Classification

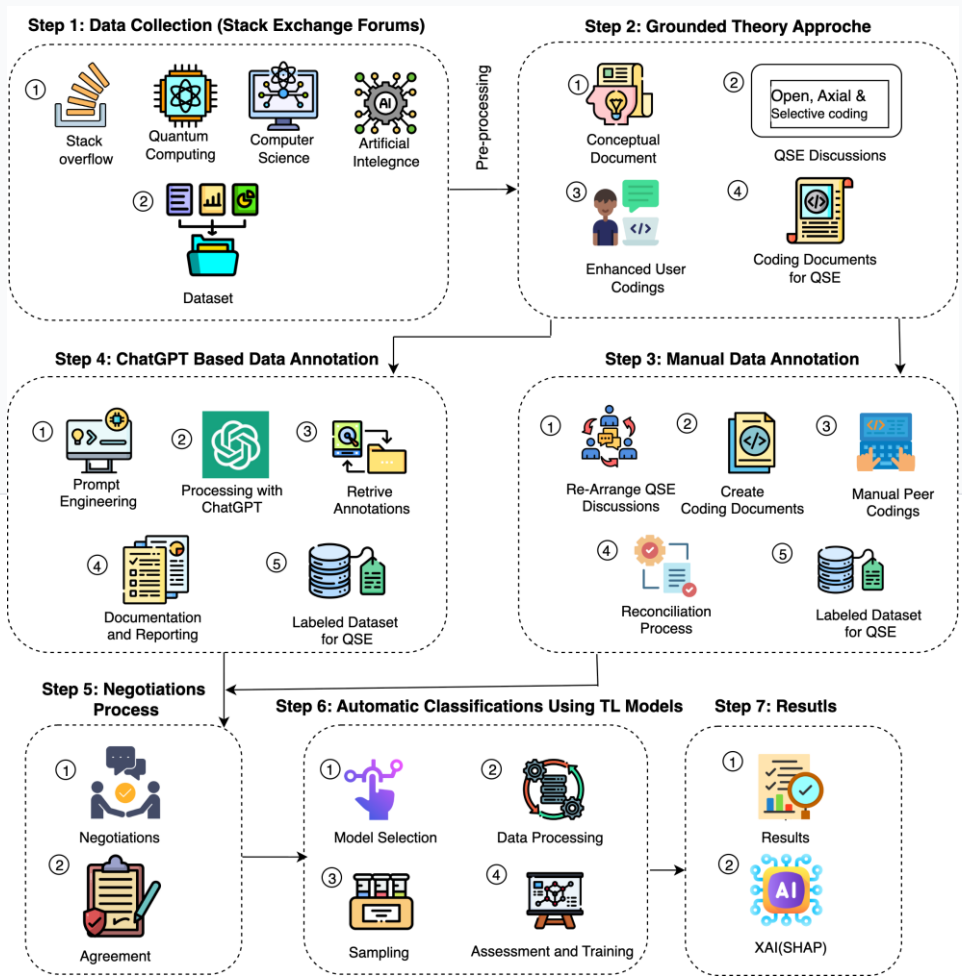


Figure 1: Process from data collection to results with XAI (SHAP)

Main Contributions

Curated Dataset

2,829 QSE discussions curated via human-ChatGPT collaborative negotiation

Conflict-free labeling ensuring high-quality training data

Six challenge categories: Tooling, Theoretical, Learning, Conceptual, Errors, API Usage

Balanced distribution: 16.7% per category

Exceptional Accuracy

95% classification accuracy achieved with fine-tuned BERT/DistilBERT

No synthetic data augmentation required, unlike prior D&ML methods

Significant performance improvement over traditional approaches

Validation accuracy reached 0.98 in 30 epochs

Explainable AI

SHAP integration for global and local model interpretability

Revealed linguistic cues driving classification decisions

Enhanced transparency for trust in AI-driven QSE analytics

Key features: "Programmer", "Register", "Command", "Function"

Confusion Matrix (95% Accuracy)

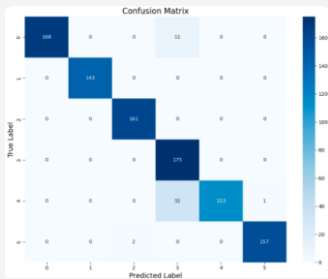


Figure 7: High diagonal values indicate excellent classification performance

SHAP Summary Plot (Interpretability)

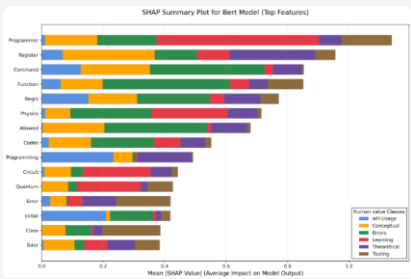


Figure 10: Feature importance across six QSE challenge categories