# Developing an LLM-Powered Customer Support Chatbot for Medical Technology Company

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# Problem Statement

In the highly specialized medical equipment industry, delivering exceptional customer service, particularly in the areas of sales and technical support, can be the determining factor in securing a successful sale and fostering long-term customer loyalty. This problem is exacerbated by the complexity of medical equipment, where customers require detailed product information, compatibility guidance, and technical troubleshooting assistance. Moreover, as businesses grow and expand their product offerings, relying solely on traditional customer service channels, such as phone lines and email, makes it increasingly difficult and resource-intensive to maintain a highly trained and knowledgeable support staff.

By leveraging the latest advancements in natural language processing and large language models (LLMs), the development of an intelligent and user-friendly chatbot presents a promising solution to enhance customer experience, improve operational efficiency, and position the business as a technology-driven leader in the medical ultrasound equipment industry.

# Context

2D Imaging is a small, family-owned business specializing in the sale, repair, and refurbishing of ultrasound imaging equipment. Despite its success built on exceptional service, industry knowledge, and a loyal customer base, the company has traditionally relied on word-of-mouth marketing, local hospital contracts, and phone/fax-based transactions.

However, the highly specialized nature of the ultrasound equipment industry and the limited availability of online product information pose challenges for scaling operations and facilitating online sales. Customers frequently require detailed product information, compatibility guidance, and technical troubleshooting assistance that can only be acquired through extensive hands-on experience with various ultrasound machines and probes.

As 2D Imaging aims to expand its reach and increase online sales to individual customers, the company recognizes the need for a robust online presence, including a comprehensive product catalog and an innovative customer service solution. The development of an intelligent and user-friendly chatbot presents an opportunity to enhance customer experience, streamline operations, and position the business as a technology leader in the medical ultrasound equipment industry.

# Criteria for Success

1. **Accuracy/Relevance**:
   1. The chatbot should achieve an accuracy rate of at least 90% in providing correct and relevant responses to customer inquiries related to ultrasound product information, compatibility, and technical troubleshooting.
   2. The chatbot's responses should be consistent with the expertise and knowledge of the company's subject matter experts.
2. **Integration/Scalability:**
   1. The chatbot should seamlessly integrate with the company's existing website, product catalog, and inventory management system.
   2. The chatbot's architecture should be modular and extensible, allowing for easy updates and expansion to accommodate new product lines or additional functionalities in the future.

# Scope of Solution Space

1. **Natural Language Processing (NLP) and Language Model Integration:**
   * Evaluate and select suitable large language models (LLMs) for natural language understanding and generation.
   * Develop or integrate NLP components for intent recognition, entity extraction, and context management.
   * Implement techniques for handling ambiguity, clarification prompts, and multi-turn conversations.
2. **Knowledge Base Development:**
   * Capture and structure the company's existing domain knowledge, including product information, compatibility data, troubleshooting guides, and industry expertise.
3. **Modular and Extensible Architecture**
   * Design a modular architecture that separates the core LLM components, NLP pipelines, and conversational interfaces from the domain-specific knowledge base and business logic.
   * Develop domain-agnostic NLP components (intent recognition, entity extraction, context management) that can be trained on diverse datasets.
   * Implement transfer learning techniques to fine-tune the NLP components for specific domains using labeled data from the target industry or business.

# Constraints

1. **Knowledge Acquisition and Structuring:**
   * Capturing and structuring the existing domain knowledge, product information, compatibility data, and troubleshooting guides from subject matter experts may be time-consuming and challenging, especially for a small business like 2D Imaging.
   * Ensuring the accuracy and completeness of the knowledge base is crucial for the chatbot's performance.
2. **Computational and Data Management Resources**
   1. Powerful GPU acceleration is often required for training and inference of large language models
   2. Sufficient RAM (e.g., 32GB or more) may be needed on servers hosting the chatbot solution. Dedicated GPU resources or optimized inference engines may be required to ensure acceptable response times and throughput for customer interactions
   3. Storing and managing large datasets, knowledge bases, and conversation logs can require significant storage capacity, potentially necessitating data warehousing or distributed storage solutions

# Stakeholders

1. 2D Imaging owners and web-development team
2. Customers
3. Other small-businesses looking to integrate a customer service chat bot with their domain knowledge-base

# Data Sources

The data for this project will have to be created and will consist of:

1. 2D Imaging’s product catalog
2. Compatibility matrices and guides for ultrasound probes and systems
3. Customer interaction data (aggregated customer inquiries and complaints through various channels)