ChatGPT

Technical Design Document: Conversational AI Health Assistant

Executive Summary

This document outlines a production-ready architecture for a GenAI-based conversational health assistant that meets all specified requirements: personalized engagement, natural interaction, actionable insights, and extensible architecture using modern AI agent patterns.

Requirements Compliance Checklist

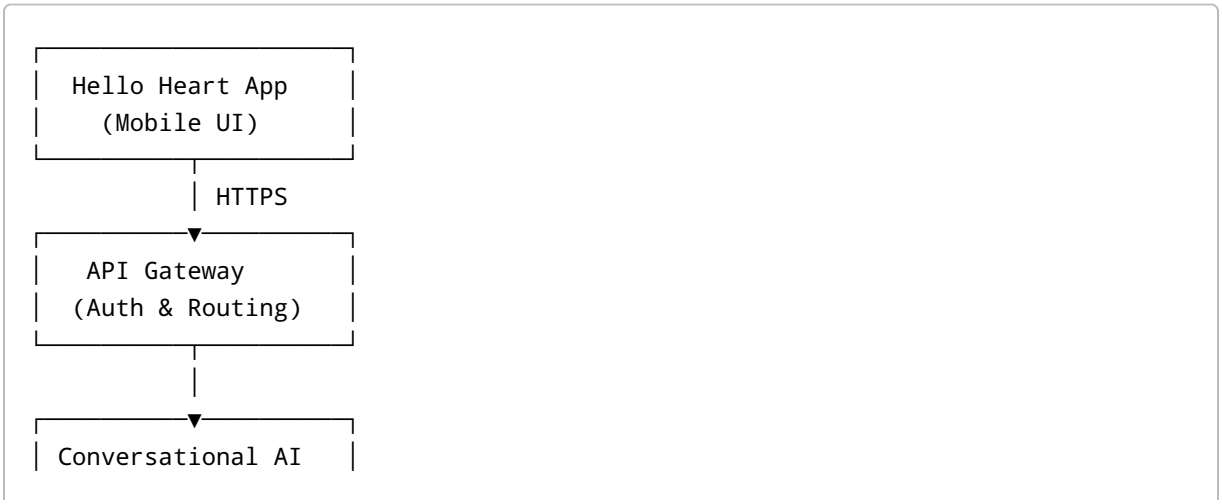
High-Level Architecture: GenAI agents-based system with microservices
LLM Orchestration Framework: LangGraph (with LangChain comparison)
Data Storage Strategy: Multi-tier approach for PRD inputs and conversations
Prompt Strategy & Agent Behavior: Dynamic prompting with safety guardrails
Production Evaluation & Monitoring: Comprehensive metrics and feedback loops

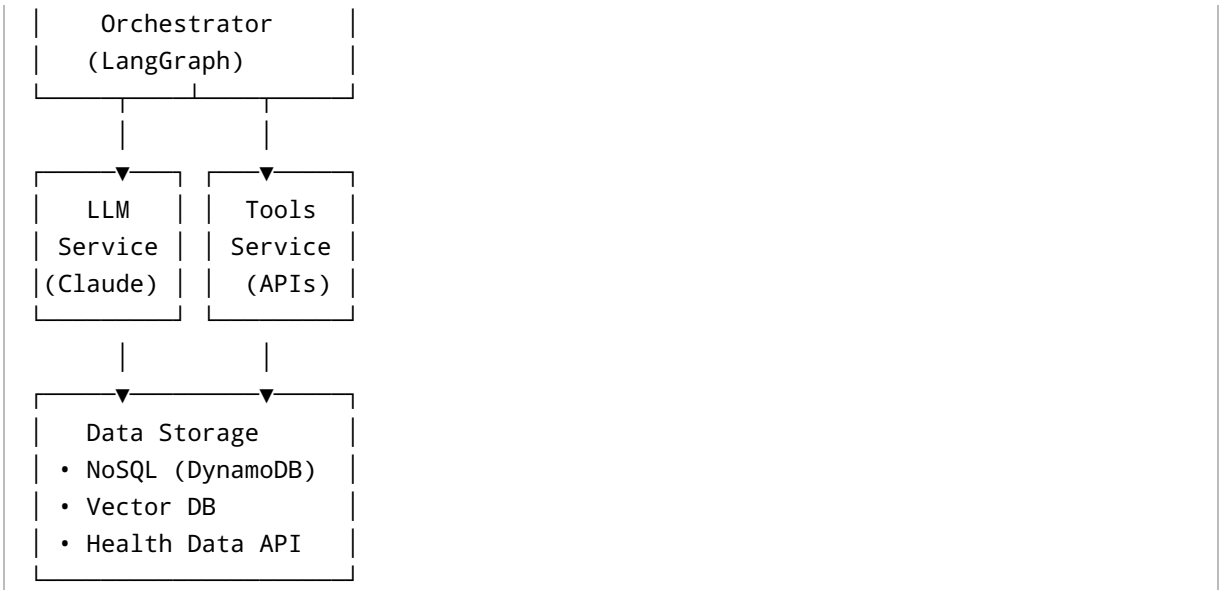
1. High-Level Architecture

System Overview

The conversational AI assistant integrates with the Hello Heart mobile application as a cloud-native microservice, leveraging modern **GenAI agents** architecture to provide personalized health insights and proactive engagement. The system employs a **multi-agent pattern** where specialized agents handle different aspects of health monitoring and user interaction.

Architecture Components





Key Design Principles

- **Event-Driven Architecture**: Supports real-time health data integration and proactive nudges
- **Microservices Pattern**: Separates concerns for scalability and maintainability
- **Serverless-First**: Leverages AWS Lambda/Cloud Functions for automatic scaling
- **Multi-Modal Ready**: Architecture supports future voice/image inputs

2. LLM Orchestration Framework

LangGraph Selection Rationale

We choose **LangGraph** over LangChain for its superior handling of: - **Stateful Conversations**: Explicit state management for complex health dialogues - **Conditional Flows**: Support for medical decision trees and guided interactions - **Cyclic Workflows**: Enables follow-up questions and iterative health assessments - **Multi-Agent Coordination**: Native support for orchestrating multiple specialized agents

Framework Comparison

Feature	LangChain	LangGraph	Decision
State Management	Implicit	Explicit	LangGraph
Cyclic Workflows	Limited	Native	LangGraph
Agent Orchestration	Basic	Advanced	LangGraph
Production Readiness	Good	Excellent	LangGraph

Agent Architecture

```python
# Simplified LangGraph State Definition
class HealthAssistantState(TypedDict):
    messages: List[Message]
    user_health_data: Dict
    current_intent: str
    requires_medical_disclaimer: bool
    conversation_phase: Literal["greeting", "assessment", "advice", "follow_up"]
```

Agent Nodes

1. **Intent Recognition Node**: Classifies user queries (health query, emergency, out-of-scope)
2. **Data Retrieval Node**: Fetches relevant health metrics from user history
3. **LLM Response Node**: Generates personalized insights using Claude
4. **Safety Check Node**: Validates responses against medical guidelines
5. **Follow-up Node**: Determines if proactive nudges are needed

3. Data Storage Strategy

Multi-Tier Storage Architecture

1. Conversation History (DynamoDB)

```
Table: ConversationHistory
PartitionKey: USER#<userId>
SortKey: CONV#<conversationId>#MSG#<timestamp>
Attributes:
  - content: String
  - role: Enum[user, assistant]
  - metadata: JSON
  - ttl: Number (30 days retention)
```

2. Health Metrics (Time-Series)

- Real-time data ingestion via Kinesis/Kafka
- Storage in InfluxDB or TimeStream for efficient queries
- Aggregated daily/weekly summaries in DynamoDB

3. Knowledge Base (Vector Database)

- **Pinecone/Weaviate** for semantic search
- Stores medical guidelines, FAQs, and educational content
- Enables RAG (Retrieval Augmented Generation) for accurate responses

Data Privacy & Security

- End-to-end encryption for PHI (Protected Health Information)
- HIPAA-compliant infrastructure
- Data anonymization for analytics
- User consent management for data usage

4. Prompt Strategy & Agent Behavior

Persona Definition

```
You are a compassionate, evidence-based health coach for Hello Heart.
Your role is to:
- Provide personalized insights based on user health data
- Offer actionable advice in simple, encouraging language
- Maintain a positive, supportive tone
- Never diagnose or prescribe medication
- Redirect medical emergencies to appropriate care
```

Dynamic Prompt Construction

```python
def compose_prompt(user_query: str, health_context: Dict) -> str:
    return f"""
    [System Instructions]
    {PERSONA_PROMPT}

    [User Health Context]
    Recent BP: {health_context['blood_pressure']}
    Weekly Steps: {health_context['step_count']}
    Sleep Quality: {health_context['sleep_score']}
    Heart Rate Variability: {health_context['hrv']}

    [Conversation History]
    {format_recent_messages(last_n=3)}

    [Current Query]
    User: {user_query}

    [Response Guidelines]
    - Start with direct answer
    - Include relevant data insights
    - End with actionable suggestion or follow-up question
    - Maintain encouraging, supportive tone
    """
```

Agent Design Principles

1. **Modularity**: Each agent handles specific health domains (BP, activity, sleep)
2. **Composability**: Agents can be combined for complex health assessments
3. **Interpretability**: Clear reasoning paths for all health recommendations
4. **Safety-First**: Multiple validation layers before delivering advice

Behavioral Guardrails

- **Medical Disclaimer Triggers**: Automatic disclaimers for symptom-related queries
- **Emergency Detection**: Immediate redirection for critical symptoms (chest pain, severe BP)
- **Scope Boundaries**: Polite deflection for non-health queries
- **Prompt Injection Defense**: Input validation and response filtering

5. Production Evaluation & Monitoring

Comprehensive Metrics Framework

Performance Metrics (Real-time)

- **Response Latency**: p50 < 1s, p95 < 2s, p99 < 3s
- **Throughput**: 1000+ requests/minute capacity
- **API Availability**: 99.9% uptime SLA
- **Token Efficiency**: <500 tokens/response average

Quality Metrics (Daily Analysis)

- **User Satisfaction**: In-app ratings (target: 4.5+/5.0)
- **Conversation Completion**: >80% reach natural conclusion
- **Follow-up Engagement**: >60% respond to proactive nudges
- **Health Outcome Correlation**: Track BP/activity improvements

Business Metrics (Weekly Review)

- **Cost per Conversation**: Target <$0.10
- **User Retention**: 30-day retention >70%
- **Feature Adoption**: New feature usage within 7 days
- **Clinical Accuracy**: Expert review score >95%

Advanced Logging Architecture

```
Logging Strategy:
  Structured Logs:
    - Request/Response pairs with correlation IDs
    - User interactions with anonymized PII
    - System performance metrics
    - Error traces with full context
```

```
  Log Destinations:
    - CloudWatch Logs: Real-time analysis
    - S3: Long-term storage and ML training
    - ElasticSearch: Full-text search capability
    - Datadog: Custom dashboards and alerting
```

Feedback Mechanisms

User Feedback Collection

```python
class FeedbackCollector:
    def collect_feedback(self, conversation_id: str):
        return {
            "satisfaction_rating": 1-5,
            "helpfulness_score": 1-10,
            "would_recommend": boolean,
            "improvement_suggestions": text,
            "health_goal_progress": percentage
        }
```

Clinical Review Process

1. **Automated Flagging**: AI identifies conversations needing review
2. **Expert Queue**: Clinical team reviews flagged interactions
3. **Feedback Loop**: Improvements fed back to prompt engineering
4. **Compliance Tracking**: Ensure medical guideline adherence

Real-time Monitoring Dashboard

```
┌─────────────────────────────────────────────┐
│         Health AI Assistant Monitor         │
├─────────────────────────────────────────────┤
│ System Health                               │
│ ├─ API Status: ● Operational                │
│ ├─ Response Time: 1.2s (↓5%)                │
│ └─ Error Rate: 0.02% (→)                    │
├─────────────────────────────────────────────┤
│ User Metrics                                │
│ ├─ Active Sessions: 3,421                   │
│ ├─ Daily Active Users: 45,234 (↑12%)        │
│ └─ Satisfaction Score: 4.7/5.0              │
├─────────────────────────────────────────────┤
│ Health Outcomes                             │
│ ├─ BP Improvement: 15% of users             │
│ ├─ Activity Increase: 23% avg               │
```

```
│ └─ Sleep Quality: +12% improvement         │
├──────────────────────────────────────────────┤
│ Alerts & Notifications                       │
│ ├─ P1: None                                  │
│ ├─ P2: High token usage - User cluster A     │
│ └─ P3: Slow response - Region us-west        │
└──────────────────────────────────────────────┘
```

Implementation Roadmap

Phase 1 (Months 1-2): Core Infrastructure

- Set up LangGraph orchestration
- Integrate Claude API
- Implement basic health data retrieval

Phase 2 (Months 3-4): Safety & Scale

- Add medical guardrails
- Implement comprehensive monitoring
- Load testing for 100+ concurrent users

Phase 3 (Months 5-6): Intelligence & Optimization

- Deploy RAG for knowledge base
- Implement proactive nudges
- A/B testing framework

Future Considerations

- Multi-modal inputs (voice, images)
- Integration with wearable devices
- Predictive health insights using ML
- Clinical trial participation
