**Project Title: Multi-turn Conversational Chatbot with RAG and Tool Integration**

### **Project Aims:**

* Implement multi-turn conversational chatbot with robust state management.
* Develop agentic planning for decision-making and actions.
* Integrate external tools (calculator API, custom FastAPI endpoints).
* Build retrieval-augmented generation (RAG) pipeline with vector-store (FAISS or Pinecone) and Text2SQL.
* Ensure chatbot robustness through handling unhappy flows gracefully.

### **System Architecture Flow:**

User Input  
 │  
 ▼  
Intent & Entity Parsing (LangChain) ────────┐  
 │ │  
 ▼ │  
Conversation State Management (LangChain) ◄─┘  
 │  
 ▼  
Agentic Planning & Controller (LangChain)  
 │  
 ├─────────► Missing Information?  
 │ │  
 │ └─ Yes ──► Clarifying Question (LangChain) ────┐  
 │ │  
 │ ▼  
 │ User Response  
 │ │  
 │◄────────────────────────────────────────────────────────────────┘  
 │  
 ▼  
Select Appropriate Action (LangChain)  
 │  
 ├───────────────────────────┐  
 │ │  
 ▼ ▼  
Calculator API Custom API & RAG Integration (FastAPI)  
Integration (FastAPI) ├─────────┬─────────┐  
 │ │ │ │  
 ▼ ▼ ▼ ▼  
Arithmetic Product Outlets Text2SQL Query  
Calculations Query Query (Outlet DB)  
(FastAPI) (FAISS/Pinecone) (FastAPI) (FastAPI)  
 │  
 ▼  
 SQL Execution (Outlet DB)  
 │  
 ▼  
 Query Results (FastAPI Response)  
 │ │ │ │  
 └───────────┐ │ │ │  
 │ │ │ │  
 Response Parsing (LangChain)│ │  
 │ │ │ │  
 ▼ ▼ ▼ ▼  
 Chatbot Response Generation (LangChain, using Retrieved Information)  
 │  
 ▼  
 Robustness and Error Handling (LangChain & FastAPI)  
 ├─────────┬─────────┐  
 │ │ │  
 ▼ ▼ ▼  
 Missing API Down Malicious  
 Parameters Time Inputs  
 (LangChain) (FastAPI) (FastAPI)  
 │ │ │  
 ▼ ▼ ▼  
Clear Error Graceful Security  
 Message Degradation Response  
(LangChain) (LangChain) (FastAPI)  
 │ │ │  
 └─────────┴─────────┘  
 │  
 ▼  
 Final Response to User (LangChain)

### **Project Timeline and Tasks:**

#### **Day 1: Initial Setup and Planning**

* Planning and Research:
  + Thoroughly read assessment requirements.
  + Setup GitHub repository.
  + Choose frameworks/tools (LangChain, Flowise, FastAPI, FAISS/Pinecone).
* **Deliverables:**
  + Project directory structure initialized.
  + README.md with preliminary architecture description.

#### **Day 2: Sequential Conversation Implementation (Part 1)**

* Define conversational state and memory management.
* Implement state management in LangChain/Flowise.
* Ensure 3-turn conversation flow is demonstrable.
* **Deliverables:**
  + Initial conversation state management system.
  + Automated tests for happy and interrupted conversation paths.

#### **Day 3: Agentic Planning and Tool Integration (Parts 2 & 3)**

* Develop planner/controller logic to parse intents and detect missing info.
* Integrate calculator API for arithmetic operations.
* Handle and test calculator API responses, including failures.
* **Deliverables:**
  + Planner/controller Python module.
  + Calculator integration module and test cases.
  + Short write-up on decision-making logic.

#### **Day 4: Custom API and RAG Setup (Part 4 Preparation)**

* Create FastAPI backend for product knowledge base and outlet SQL DB.
* Scrape and ingest ZUS product data into FAISS/Pinecone.
* Design initial Text2SQL schema for outlets.
* **Deliverables:**
  + FastAPI endpoints (/products, /outlets) skeleton.
  + Data ingestion scripts.
  + Draft OpenAPI spec.

#### **Day 5: Custom API and RAG Integration (Part 4 Completion)**

* Develop AI summarization for /products.
* Build Text2SQL translation mechanism for /outlets.
* Integrate chatbot with both endpoints.
* **Deliverables:**
  + Functional RAG pipeline.
  + Integrated and tested Text2SQL execution.
  + Example chatbot transcripts.

#### **Day 6: Robustness Testing and Error Handling (Part 5)**

* Implement error handling for edge cases.
* Develop test cases covering robustness (SQL injection, API downtime).
* **Deliverables:**
  + Complete robustness test suite.
  + Summary document on error handling and security.

#### **Day 7: Final Submission and Documentation**

* Finalize and review codebase.
* Host chatbot demo (Heroku/Vercel).
* Prepare documentation.
* **Deliverables:**
  + Public GitHub repository.
  + Live chatbot demo URL.
  + Documentation:
    - Setup and run instructions.
    - Architectural diagrams/screenshots.
    - Detailed API specifications.

### **Final Submission Checklist:**

* ✅ Public GitHub Repo link
* ✅ Hosted Demo URL
* ✅ README.md with setup instructions and architecture
* ✅ API documentation for RAG & Text2SQL endpoints
* ✅ Flow diagrams/screenshots of chatbot interactions

### **Tools & Resources:**

**Frameworks and Tools:**

* LangChain
* Flowise
* FastAPI
* FAISS / Pinecone (vector store)

**Documentation & Tutorials:**

* OpenAPI Specification Guide
* FastAPI Docs
* Heroku Deployment Guide
* Vercel Deployment Guide

**API & Data Sources:**

* ZUS Coffee Product Data
* ZUS Coffee Outlets Data

**Best Practices:**

* Robustness Testing
* Prompt Engineering for Text2SQL

**✅ Prompt Tests for /products (Happy Flows)**

| **Test Case** | **Prompt Example** |
| --- | --- |
| Normal query | Show me the top 3 black drinkware items. |
| Price-based query | Which ZUS tumblers are under RM50? |
| Style-based query | List elegant glass cups for gifts. |
| Ranking-based query | Give me the best 2-selling items in the Accessories category. |

**✅ Prompt Tests for /outlets (Happy Flows)**

| **Test Case** | **Prompt Example** |
| --- | --- |
| Location-specific | Where are ZUS Coffee outlets in Petaling Jaya? |
| Time-specific | Which outlets in Selangor open after 9pm? |
| Feature-specific | List outlets with self-pickup in Kuala Lumpur. |
| Parking-related | Show outlets with parking near Damansara. |

**❌ Prompt Tests for Unhappy Flows**

**1. Missing Parameters**

| **Endpoint** | **Prompt Example** | **Expected Behavior** |
| --- | --- | --- |
| /products | Show products | HTTP 400 with "Query parameter cannot be empty." |
| /products | Calculate | HTTP 400 with "Query parameter cannot be empty." |
| /outlets | Show outlets | HTTP 400 with "Query parameter cannot be empty." |
| /outlets | Where | HTTP 400 with "Query parameter cannot be empty." |
| /chat | { "prompt": "" } | HTTP 400 with "Prompt cannot be empty." |

|  |
| --- |
| **"Show me the top 3 black drinkware items."**  Response body  {  "summary": "\*\*\n\nThe top black drinkware items are:\n\n1. ZUS OG CUP 2.0 With Screw-On Lid 500ml (17oz) in Space Black, priced at RM 55.0. It features a ceramic interior and a screw-on lid for a leak-proof experience.\n\n2. ZUS OG Ceramic Mug (16oz) in Space Black, priced at RM 39.0. It offers a stylish design with an ergonomic handle for comfortable sipping.",  "retrieved\_products": [  {  "name": "ZUS OG CUP 2.0 With Screw-On Lid 500ml (17oz)",  "category": "Tumbler",  "price": 55,  "color": "Thunder Blue, Space Black, Lucky Pink",  "image": "https://shop.zuscoffee.com/cdn/shop/files/10\_af559e6a-677e-40eb-ae59-378af4f12425.png?v=1724744850&width=1080",  "snippet": "Our best-selling drinkware now comes with a twist. Experience OG Cup 2.0 with a Screw-On Lid for the ultimate leak-proof cup that comes with ceramic interior that preserves flavours better, allowing you to taste every note in your daily brew. Have a true ZUS Coffee experience—now embodied in our OG colours. Available in – ⚡️Thunder Blue ⚡️Space Black ⚡️Lucky Pink",  "score": 0.452691227  },  {  "name": "ZUS All Day Cup 500ml (17oz)",  "category": "Tumbler",  "price": 71,  "color": "Creamy Beige, Cherry Blossom, Fresh Mint, Fuzz Peach, Blue Wave",  "image": "https://shop.zuscoffee.com/cdn/shop/files/2\_b7284ad4-1538-4a5d-9bd1-b76bb6c108c5.png?v=1724745300&width=1080",  "snippet": "Refreshed colours for your refreshments.\n\nReady to paint the way you drink with splashes of colours to your all-day routine of sipping on quality brew? Experience effortless style with endless combinations of our All Day Cup - now in extended colours. Choose what screams you and accessorise with the ideal drinking accessory.\n\nAvailable in –\n⚡️Creamy Beige\n⚡️Fresh Mint\n⚡️Blue Wave\n⚡️Fuzz Peach\n⚡️Cherry Blossom\n\nIt’s best for hot or iced – this one’s for All Day, everyday.\nTrust us, your current tumbler will seem boring after this.",  "score": 0.444349587  },  {  "name": "ZUS OG Ceramic Mug (16oz)",  "category": "Tumbler",  "price": 39,  "color": "Thunder Blue, Cloud White, Space Black",  "image": "https://shop.zuscoffee.com/cdn/shop/files/2\_ade9cdc4-083d-4e9c-bff5-dd6231da2ca1.png?v=1728147514&width=1080",  "snippet": "Designed for your cozy moments, our high-quality ceramic mug blends style and practicality effortlessly with an ergonomic handle that makes every sip a comfortable experience.\nWho said sipping from a mug couldn't be stylish? Now available in 3 of your favourite colours: Thunder Blue, Space Black, and Cloud White.",  "score": 0.403642178  }  ]  }  Response headers  content-length: 2522  content-type: application/json  date: Thu,03 Jul 2025 16:40:59 GMT  server: uvicorn |
| **“Which ZUS tumblers are under RM50?”**  Response body  {  "summary": "\*\*\n\nThe provided text does not mention any ZUS tumblers. It only includes information about the ZUS Reusable Straw Kit, which is priced at RM15.9.",  "retrieved\_products": [  {  "name": "ZUS Reusable Straw Kit - Corak Malaysia Collection",  "category": "Accessories",  "price": 15.9,  "color": "",  "image": "https://shop.zuscoffee.com/cdn/shop/files/62\_b565f01c-8f6a-487c-bb5f-241958f9b7ff.png?v=1746778301&width=1080",  "snippet": "Bye-bye single-use straws and hello to sustainable style with the ZUS Reusable Straw Kit! Compact, collapsible, and designed with a carabiner clip, it’s easy to carry wherever you go. Made from food-grade stainless steel with a soft silicone tip to protect your lips and teeth, it’s safe, durable, and simple to clean with the included brush.\n\nWhether at home or on the move, the ZUS Reusable Straw Kit keeps every sip convenient and hassle-free.\n\nCelebrate local heritage with three stunning new Corak Malaysia designs—available now.",  "score": 0.524561763  }  ]  }  Response headers  content-length: 993  content-type: application/json  date: Thu,03 Jul 2025 16:44:37 GMT  server: uvicorn |
| **“List elegant glass cups for gifts.”**  Response body  {  "summary": "Unfortunately, the provided text does not contain information about elegant glass cups for gifts. It only describes a ceramic mug, which does not match your request.",  "retrieved\_products": [  {  "name": "ZUS OG Ceramic Mug (16oz)",  "category": "Tumbler",  "price": 39,  "color": "Thunder Blue, Cloud White, Space Black",  "image": "https://shop.zuscoffee.com/cdn/shop/files/2\_ade9cdc4-083d-4e9c-bff5-dd6231da2ca1.png?v=1728147514&width=1080",  "snippet": "Designed for your cozy moments, our high-quality ceramic mug blends style and practicality effortlessly with an ergonomic handle that makes every sip a comfortable experience.\nWho said sipping from a mug couldn't be stylish? Now available in 3 of your favourite colours: Thunder Blue, Space Black, and Cloud White.",  "score": 0.434219539  }  ]  }  Response headers  content-length: 789  content-type: application/json  date: Thu,03 Jul 2025 16:47:07 GMT  server: uvicorn |
| **“Give me the best 2-selling items in the Accessories category”**  Response body  {  "summary": "\*\*\n\nThe provided text does not include information about the best-selling items in the Accessories category. The text only describes tumblers, which are not specified as part of the Accessories category.",  "retrieved\_products": [  {  "name": "ZUS OG CUP 2.0 With Screw-On Lid 500ml (17oz)",  "category": "Tumbler",  "price": 55,  "color": "Thunder Blue, Space Black, Lucky Pink",  "image": "https://shop.zuscoffee.com/cdn/shop/files/10\_af559e6a-677e-40eb-ae59-378af4f12425.png?v=1724744850&width=1080",  "snippet": "Our best-selling drinkware now comes with a twist. Experience OG Cup 2.0 with a Screw-On Lid for the ultimate leak-proof cup that comes with ceramic interior that preserves flavours better, allowing you to taste every note in your daily brew. Have a true ZUS Coffee experience—now embodied in our OG colours. Available in – ⚡️Thunder Blue ⚡️Space Black ⚡️Lucky Pink",  "score": 0.246561512  },  {  "name": "ZUS All Day Cup 500ml (17oz)",  "category": "Tumbler",  "price": 71,  "color": "Creamy Beige, Cherry Blossom, Fresh Mint, Fuzz Peach, Blue Wave",  "image": "https://shop.zuscoffee.com/cdn/shop/files/2\_b7284ad4-1538-4a5d-9bd1-b76bb6c108c5.png?v=1724745300&width=1080",  "snippet": "Refreshed colours for your refreshments.\n\nReady to paint the way you drink with splashes of colours to your all-day routine of sipping on quality brew? Experience effortless style with endless combinations of our All Day Cup - now in extended colours. Choose what screams you and accessorise with the ideal drinking accessory.\n\nAvailable in –\n⚡️Creamy Beige\n⚡️Fresh Mint\n⚡️Blue Wave\n⚡️Fuzz Peach\n⚡️Cherry Blossom\n\nIt’s best for hot or iced – this one’s for All Day, everyday.\nTrust us, your current tumbler will seem boring after this.",  "score": 0.243169725  }  ]  }  Response headers  content-length: 1790  content-type: application/json  date: Thu,03 Jul 2025 17:02:25 GMT  server: uvicorn |
| **"Where are ZUS Coffee outlets in Petaling Jaya?"**  Response body  {  "summary": "ZUS Coffee outlets in Petaling Jaya are located at:\n\n1. Damansara Perdana: 12-1 (Ground floor), Jalan PJU 8/5E, Bandar Damansara Perdana, 47820 Petaling Jaya, Selangor. [Map](https://maps.app.goo.gl/Hj1Gu2MMHGabTZXb9)\n\n2. Uptown Damansara: 44-G (Ground Floor), Jalan SS21/39, Damansara Utama, 47400 Petaling Jaya, Selangor. [Map](https://maps.app.goo.gl/SGuUWhHHEBNd8mFWA)\n\n3. Dataran Glomac, Kelana Jaya: C-G-05 (Ground Floor), Jalan SS 6/5b, Dataran Glomac, 47301 Petaling Jaya, Selangor. [Map](https://maps.app.goo.gl/PbdUfc36FVxXzXz76)",  "sql\_query": "SELECT name, address, link FROM outlets WHERE address LIKE '%Petaling Jaya%' LIMIT 3;",  "executed\_sql\_result": [  [  "ZUS Coffee – Damansara Perdana, Petaling Jaya",  "12-1 (Ground floor), Jalan PJU 8/5E, Bandar Damansara Perdana, 47820 Petaling Jaya, Selangor.",  "https://maps.app.goo.gl/Hj1Gu2MMHGabTZXb9"  ],  [  "ZUS Coffee – Uptown Damansara, Petaling Jaya",  "44-G (Ground Floor), JALAN SS21/39, DAMANSARA UTAMA, 47400 PETALING JAYA, SELANGOR",  "https://maps.app.goo.gl/SGuUWhHHEBNd8mFWA"  ],  [  "ZUS Coffee – Dataran Glomac, Kelana Jaya",  "C-G-05 (Ground Floor), Jalan SS 6/5b, Dataran Glomac, 47301 Petaling Jaya, Selangor.",  "https://maps.app.goo.gl/PbdUfc36FVxXzXz76"  ]  ]  }  Response headers  content-length: 1233 content-type: application/json date: Fri,04 Jul 2025 09:02:31 GMT server: uvicorn |
| **"Which outlets in Selangor open after 9pm?"**  Response body  {  "summary": "The outlets in Selangor that open after 9pm are:\n\n1. ZUS Coffee – Temu Business Centre City Of Elmina\n - Address: No 5 (Ground Floor), Jalan Eserina AA U16/AA Elmina, East, Seksyen U16, 40150 Shah Alam, Selangor\n - Link: [Google Maps](https://maps.app.goo.gl/XduXnuUs4E2a1VE56)\n\n2. ZUS Coffee – Spectrum Shopping Mall\n - Address: Lot CW-5 Cafe Walk, Ground Floor Spectrum Shopping Mall Jalan Wawasan Ampang, 4, 2, Bandar Baru Ampang, 68000 Ampang, Selangor\n - Link: [Google Maps](https://maps.app.goo.gl/XPhXh6bgSb4pPaSz7)\n\n3. ZUS Coffee – Giant Shah Alam Stadium\n - Address: A14 – A16, Ground Floor, Giant Shah Alam Stadium, Persiaran Sukan, Seksyen 13, 40100 Shah Alam, Selangor\n - Link: [Google Maps](https://maps.app.goo.gl/V6jaEgHy2qcw1DJh6)",  "sql\_query": "SELECT name, address, link FROM outlets WHERE address LIKE '%Selangor%' AND opens\_at LIKE '%9:%' LIMIT 3;",  "executed\_sql\_result": [  [  "ZUS Coffee – Temu Business Centre City Of Elmina",  "No 5 (Ground Floor), Jalan Eserina AA U16/AA Elmina, East, Seksyen U16, 40150 Shah Alam, Selangor",  "https://maps.app.goo.gl/XduXnuUs4E2a1VE56"  ],  [  "ZUS Coffee – Spectrum Shopping Mall",  "Lot CW-5 Cafe Walk, Ground Floor Spectrum Shopping Mall Jalan Wawasan Ampang, 4, 2, Bandar Baru Ampang, 68000 Ampang, Selangor",  "https://maps.app.goo.gl/XPhXh6bgSb4pPaSz7"  ],  [  "ZUS Coffee – Giant Shah Alam Stadium",  "A14 – A16, Ground Floor, Giant Shah Alam Stadium, Persiaran Sukan, Seksyen 13, 40100 Shah Alam, Selangor",  "https://maps.app.goo.gl/V6jaEgHy2qcw1DJh6"  ]  ]  }  Response headers  content-length: 1546  content-type: application/json  date: Fri,04 Jul 2025 09:16:42 GMT  server: uvicorn |
| **"List outlets with self-pickup in Kuala Lumpur."**  Response body  {  "summary": "The outlets with self-pickup in Kuala Lumpur are:\n\n1. ZUS Coffee – Bandar Menjalara\n - Address: 37, Jalan 3/62a, Bandar Menjalara, 52200 Kuala Lumpur, Wilayah Persekutuan Kuala Lumpur\n - Link: [Google Maps](https://maps.app.goo.gl/SoxNpkV3iGxmd4Rr7)\n\n2. ZUS Coffee – Sri Rampai, Setapak\n - Address: No.39 (Ground Floor), Jalan 45/26 Taman Sri Rampai, 53300 Kuala Lumpur\n - Link: [Google Maps](https://maps.app.goo.gl/UFPhAXiUpmb2v9X57)\n\n3. ZUS Coffee – Cheras Leisure Mall\n - Address: Lot L1-24, Leisure Mall, Jalan Manis 6, Taman Bukit Segar, 56100 Kuala Lumpur, Wilayah Persekutuan Kuala Lumpur\n - Link: [Google Maps](https://goo.gl/maps/kZMrsniabj6ajf7w8)",  "sql\_query": "SELECT name, address, link FROM outlets WHERE address LIKE '%Kuala Lumpur%' AND services LIKE '%pickup%' LIMIT 3;",  "executed\_sql\_result": [  [  "ZUS Coffee – Bandar Menjalara",  "37, Jalan 3/62a, Bandar Menjalara, 52200 Kuala Lumpur, Wilayah Persekutuan Kuala Lumpur",  "https://maps.app.goo.gl/SoxNpkV3iGxmd4Rr7"  ],  [  "ZUS Coffee – Sri Rampai, Setapak",  "No.39 (Ground Floor), Jalan 45/26 Taman Sri Rampai, 53300 Kuala Lumpur.",  "https://maps.app.goo.gl/UFPhAXiUpmb2v9X57"  ],  [  "ZUS Coffee – Cheras Leisure Mall",  "Lot L1-24, Leisure Mall, Jalan Manis 6, Taman Bukit Segar, 56100 Kuala Lumpur, Wilayah Persekutuan Kuala Lumpur",  "https://goo.gl/maps/kZMrsniabj6ajf7w8"  ]  ]  }  Response headers  content-length: 1374  content-type: application/json  date: Fri,04 Jul 2025 09:19:11 GMT  server: uvicorn |
| **Show outlets with parking near Damansara.**  Response body  {  "summary": "I couldn't find any relevant outlets based on your query. Please try a different query.",  "sql\_query": "SELECT name, address, link FROM outlets WHERE services LIKE '%parking%' AND address LIKE '%Damansara%' LIMIT 3;",  "executed\_sql\_result": []  }  Response headers  content-length: 252  content-type: application/json  date: Fri,04 Jul 2025 09:21:41 GMT  server: uvicorn |