Bruno Agent System - Comprehensive Presentation

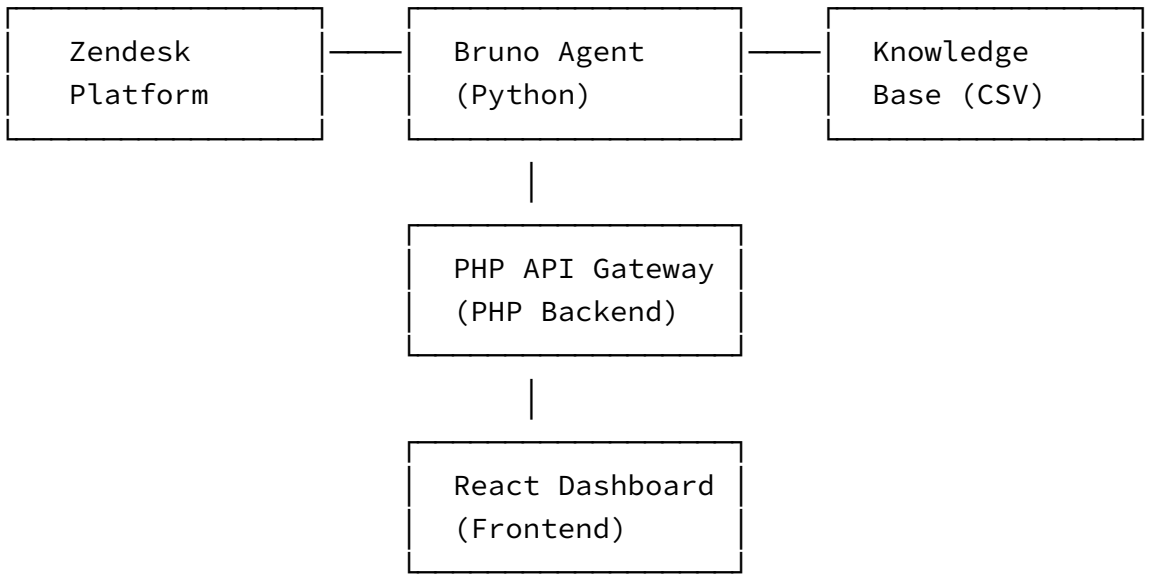
🤖 Executive Summary

Bruno is an advanced AI-powered customer support automation system that seamlessly integrates with Zendesk to provide intelligent, automated responses to customer inquiries. Using cutting-edge Retrieval-Augmented Generation (RAG) technology, Bruno can automatically resolve tickets when possible and intelligently escalate complex issues to human agents.

The system features a sophisticated three-tier architecture with a React-based frontend, a PHP API gateway, and a Python AI processing backend, creating a robust and scalable solution for automated customer support.

🏗️ System Architecture

Core Components



Technology Stack

- **Frontend**: React 18.x with React Router, Bootstrap, and Webpack
- **API Gateway**: PHP 8.x with custom MVC framework

- **AI Processing Backend**: Python 3.x with native HTTP server
- **AI/ML**: OpenAI API (embeddings + GPT models)
- **Data**: Pandas, NumPy for data processing (Python); PDO for database (PHP)
- **HTTP Client**: Axios for API communication (React); cURL for inter-service communication (PHP)
- **Build Tool**: Webpack for bundling React application
- **Integration**: Zendesk API, external business systems

Detailed Architecture Analysis

Multi-Backend Architecture

Frontend Layer (React Application)

- **Location**: `src/` directory contains the React application source code
- **Build Target**: Compiled to `public/` directory via Webpack
- **Routing**: React Router for client-side navigation
- **State Management**: React hooks (useState, useEffect) for component state
- **UI Framework**: Bootstrap CSS for responsive design
- **API Communication**: Axios for HTTP requests to PHP backend

API Gateway Layer (PHP Backend)

- **Location**: `app/` directory contains the PHP API gateway
- **Framework**: Custom MVC framework with routing and dependency injection
- **Purpose**: Acts as an intermediary between React frontend and Python backend
- **Database**: MySQL database for storing ticket history and simulation data
- **Services**: Provides RESTful API endpoints for the React application
- **Communication**: Uses cURL to communicate with Python backend

AI Processing Layer (Python Backend)

- **Location**: Root directory contains the Python AI processing services
- **Server**: Native Python HTTP server with threading support
- **Controllers**: MVC pattern in `Controller/` directory
- **Configuration**: Centralized in `chatbot_config.py`
- **Logging**: Comprehensive logging system with rotation
- **AI Integration**: Direct integration with OpenAI API for embeddings and responses

- **Zendesk Integration**: Direct communication with Zendesk API to update tickets

MVC (Model-View-Controller) Pattern

Frontend Model Layer (React)

- **Component State**: React hooks manage component-specific state
- **Local Storage**: Persistent storage for user preferences and chat history
- **API Services**: Service layer in `src/services/` handles API communication

Frontend View Layer (React)

- **React Components**: Modular UI components in `src/components/`
- **CSS Styling**: Bootstrap integration with custom styles in `app.css`
- **SPA Architecture**: Single-page application with client-side routing

Frontend Controller Layer (React)

- **React Hooks**: Custom hooks for business logic
- **Routing Logic**: React Router handles navigation and URL parameters
- **Event Handlers**: Component methods handle user interactions

PHP Backend Model Layer

- **Data Models**: `app/src/Models/User.php` handles data access and business logic
- **Database Integration**: PDO for MySQL database operations
- **CSV Processing**: Direct file operations for knowledge base management
- **External API Calls**: cURL integration with Python backend

PHP Backend View Layer

- **Templates**: PHP views in `app/src/Views/` for API responses
- **JSON Responses**: Structured data responses for React frontend
- **Error Handling**: Consistent error response formatting

PHP Backend Controller Layer

- **API Controllers**: `app/src/Controllers/UserController.php` handles HTTP requests

- **Business Logic**: Orchestrates between models and external services
- **Request Processing**: Validates and processes incoming API requests

Python Backend Model Layer

- **Data Models**: CSV files (`helpdesk_final.csv`, `helpdesk_training.csv`) containing pre-computed embeddings
- **Embedding Storage**: Vector representations of knowledge base entries stored as arrays
- **Configuration Model**: `chatbot_config.py` centralizes all system settings, API credentials, and model parameters
- **Data Access Objects**: Functions in `chatbot_functions.py` handle data retrieval and processing

Python Backend Controller Layer

- **Main Controller**: `chatbot_zendController.py` handles Zendesk webhook requests
- **Embedding Controller**: `embedding.py` manages knowledge base CRUD operations
- **Email Templates Controller**: `emailVorlagen.EmailVorlagen` handles template management
- **Utility Controllers**: Various controllers for specific functions (upload, training, etc.)

Routing System

Frontend Routing (React Router)

- **Client-Side Navigation**: `/`, `/ticket/:id`, `/embedding/:id`, `/embedding`, `/email-vorlagen`
- **Component-Based**: Each route renders specific React components
- **State Persistence**: Local storage maintains UI state across sessions

PHP Backend Routing (Custom Router)

- **API Endpoints**: `/api/v1/ticket/bruno`, `/api/v1/tickets`, `/api/v1/embeddings`, etc.
- **Request Mapping**: Maps HTTP requests to appropriate controller methods
- **Parameter Handling**: Extracts and validates URL parameters

Python Backend Routing (Custom Router) The system implements a custom routing mechanism in `chatbot_server.py`:

```
routes = {
    '/': HomeController,
    '/upload.html' : HomeController,
    '/api/v1/embedding' : embedding.Embedding,
    '/api/v1/emailvorlagen' : emailVorlagen.EmailVorlagen
}
```

Supported HTTP Methods

- **GET**: Homepage, dashboard, and API data retrieval
- **POST**: Creating new embeddings and submitting tickets
- **PUT**: Updating existing embeddings and email templates
- **DELETE**: Removing embeddings from the knowledge base
- **OPTIONS**: CORS preflight requests

Dynamic Route Matching

- **ID-based Routes**: `/api/v1/embedding/<id>` for specific resource operations
- **Regex Pattern Matching**: Uses `re.match()` for dynamic route parsing
- **Method-Based Dispatch**: Different controllers for different HTTP methods

Bootstrap Process

Python Backend Startup Chain

1. `start_supportbot.sh` → Executes `chatbot_bootstrap.py`
2. **Configuration Loading**: `chatbot_config.py` initializes all settings
3. **Server Initialization**: Creates `ThreadingSimpleServer` with custom request handler
4. **Thread Management**: Starts server in a separate thread for concurrent processing
5. **Service Activation**: Begins listening on configured IP and port (default: 0.0.0.0:8000)

PHP Backend Startup

1. **Web Server**: Apache/Nginx configured to serve PHP application
2. **Bootstrap**: `app/src/bootstrap.php` initializes the application
3. **Dependency Injection**: Service container sets up required dependencies
4. **Router Initialization**: Sets up route mappings for API endpoints

Frontend Build Process

1. **Development Server**: `npm start` runs Webpack Dev Server
2. **Production Build**: `npm run build` compiles React app to `public/` directory
3. **Asset Optimization**: Webpack bundles and optimizes JavaScript/CSS assets
4. **Compression**: Optional gzip compression for production builds

Server Architecture

- **Threading Model**: `ThreadingSimpleServer` enables concurrent request handling (Python)
- **Custom Request Handler**: `MyRequestHandler` extends `BaseHTTPRequestHandler` (Python)
- **CORS Support**: Built-in headers for cross-origin resource sharing
- **Signal Handling**: Graceful shutdown with SIGINT handling (Python)

Component Interactions

Complete Zendesk Ticket Processing Flow

```
1. Zendesk Webhook
        ↓
2. Python Backend (AI Processing)
        ↓
3. OpenAI API Interaction
        ↓
4. Response Generation
        ↓
5. Zendesk API Update
        ↓
6. Ticket Status Changed (Solved/Hold)
```

Frontend-Backend Communication

```
1. React Component
        ↓
2. Axios HTTP Request
        ↓
```

```
3. PHP API Endpoint
        ↓
4. PHP Controller Processing
        ↓
5. cURL to Python Backend
        ↓
6. Python Controller Processing
        ↓
7. OpenAI API Interaction
        ↓
8. Response Generation
        ↓
9. JSON Response Chain
        ↓
10. React State Update
```

Module Dependencies

- **Python Backend**: `chatbot_functions` serves as the central processing hub
- **External APIs**: OpenAI, Zendesk, Digistore24, MGB/MOCB integrations
- **Inter-Service Communication**: PHP backend communicates with Python backend via HTTP requests
- **Database Layer**: PHP backend maintains MySQL database for ticket history

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⊠ React Dashboard Analysis

Dashboard Architecture

The system includes a modern React-based dashboard for managing the RAG database and testing the Bruno agent response in real-time. The dashboard communicates with the PHP API gateway, which acts as an intermediary to the Python backend.

Dashboard Components (src/components/)

- **Chat Component**: Interactive interface for testing Bruno responses with custom inputs
- **ListEmbedding Component**: Displays and manages knowledge base entries

- **CreateEmbedding Component**: Form for adding new knowledge base entries
- **EmailVorlagen Component**: Interface for editing email templates
- **Tabs Component**: Navigation between different dashboard sections
- **Header/Footer Components**: Consistent UI layout elements

Dashboard Features

- **Real-time Testing**: Submit custom questions and see Bruno's responses instantly
- **Knowledge Base CRUD**: Full create, read, update, delete operations for knowledge entries
- **Template Management**: Edit both success and fallback email templates
- **Persistent State**: Local storage maintains user preferences and chat history
- **Responsive Design**: Mobile-friendly interface using Bootstrap CSS
- **Loading States**: Visual feedback during API operations with spinners

API Integration The dashboard communicates with the PHP backend through RESTful API endpoints: - `GET /api/v1/tickets` - Retrieve ticket history - `GET /api/v1/embeddings` - Retrieve knowledge base entries - `GET /api/v1/ticket/bruno` - Test Bruno response with custom inputs - `PUT/DELETE /api/v1/ticket/:id` - Update/delete ticket entries - `GET/PUT /api/v1/emailvorlagen` - Manage email templates

PHP Backend API Endpoints The PHP backend provides these endpoints and communicates with the Python backend: - `GET /api/v1/ticket/bruno` - Forwards request to Python backend for Bruno processing - `GET /api/v1/tickets` - Retrieves ticket history from MySQL database - `GET /api/v1/embeddings` - Reads knowledge base from CSV file - `GET /api/v1/embedding/:id` - Retrieves specific knowledge base entry

User Experience

- **Modern SPA**: Smooth navigation without page reloads
- **Immediate Feedback**: Real-time response to user actions
- **Error Handling**: Clear error messages for failed operations
- **Persistent Preferences**: Settings maintained across sessions

⚙ Key Features

1. Automated Ticket Processing

- **Real-time Webhook Integration**: Instantly receives new ticket notifications
- **Intelligent Classification**: Determines if tickets can be auto-resolved
- **Context-Aware Responses**: Generates relevant answers using RAG
- **Status Management**: Automatically updates ticket status in Zendesk

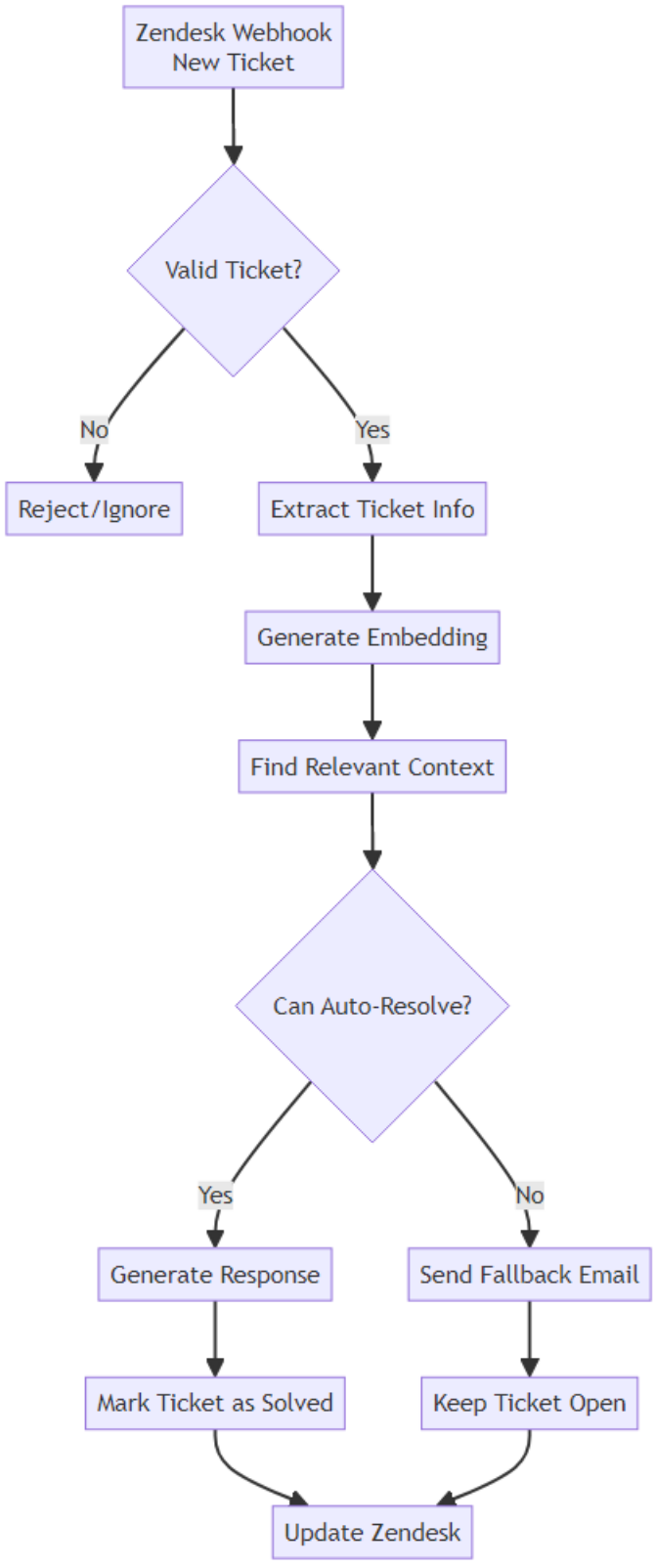
2. RAG-Powered Intelligence

- **Semantic Search**: Uses OpenAI embeddings for contextual understanding
- **Dynamic Context Building**: Retrieves most relevant knowledge base entries
- **Multi-Model Support**: Leverages both legacy and modern GPT models
- **Quality Assurance**: Built-in validation to prevent hallucinations

3. Knowledge Base Management

- **CRUD Operations**: Full management of knowledge base entries
- **Category Filtering**: Product-specific response customization
- **Web Interface**: User-friendly dashboard for content management
- **Auto-Embedding**: Automatic vector generation for new content

⚙️ Workflow Process



⚙ Advanced Capabilities

Smart Filtering & Categorization

- **Product Categories**: Different response strategies per product line
- **Domain Filtering**: Intelligent sender validation
- **Duplicate Detection**: Prevents multiple responses to same issue
- **Autoresponder Blocking**: Ignores system-generated messages

Quality Control System

- **Multi-layer Validation**: Ensures factual accuracy
- **Contact Info Verification**: Prevents fabricated information
- **Previous Contact Check**: Avoids conflicting responses
- **Response Confidence Scoring**: Measures certainty levels

Personalization Engine

- **Name Extraction**: Automatically identifies and uses customer names
- **Contextual Awareness**: Considers customer history and purchases
- **Brand Consistency**: Maintains professional tone and branding
- **Link Preservation**: Maintains important hyperlinks in responses

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⚙ Management Dashboard

Features

- **Live Testing Interface**: Real-time response testing
- **Template Management**: Customizable email templates
- **Knowledge Base Editor**: Easy content updates
- **Performance Monitoring**: Activity and success metrics

API Endpoints

```
GET    /api/v1/embedding     # Retrieve knowledge base entries
POST   /api/v1/embedding     # Add new knowledge base entry
PUT    /api/v1/embedding/:id # Update specific entry
DELETE /api/v1/embedding/:id # Remove entry
PUT    /api/v1/emailvorlagen # Update email templates
```

🔒 Security & Validation

Input Sanitization

- **Content Filtering**: Removes malicious or inappropriate content
- **Format Validation**: Ensures proper ticket structure
- **Rate Limiting**: Prevents system overload
- **Authentication**: Secure API access controls

Business Logic Validation

- **Permission Checks**: Ensures appropriate response authority
- **Information Accuracy**: Validates all provided details
- **Policy Compliance**: Follows company response guidelines
- **Escalation Rules**: Properly routes complex issues

📊 Performance Metrics

Success Indicators

- **Resolution Rate**: Percentage of tickets auto-resolved
- **Response Time**: Average time to first response
- **Accuracy Score**: Quality of generated responses
- **Customer Satisfaction**: Post-interaction feedback

Monitoring Features

- **Comprehensive Logging**: Detailed activity tracking
- **Error Detection**: Automatic failure identification
- **Performance Analytics**: System efficiency metrics
- **Alert System**: Proactive issue notification

✅ Benefits

For Business

- **Cost Reduction**: Decreases manual support workload
- **24/7 Availability**: Continuous customer service
- **Consistency**: Uniform response quality
- **Scalability**: Handles increased volume without staff increase

For Customers

- **Instant Responses**: Immediate acknowledgment
- **Accurate Information**: Reliable, up-to-date answers
- **Personalized Service**: Tailored to individual needs
- **Reduced Wait Times**: Faster resolution of common issues

🔮 Future Enhancements

Planned Improvements

- **Advanced Analytics**: Deeper insights into customer needs
- **Multi-Language Support**: Global customer reach
- **Voice Integration**: Phone support automation
- **Predictive Assistance**: Proactive issue resolution

■ Conclusion

Bruno represents a sophisticated implementation of AI-powered customer service automation, combining modern machine learning techniques with contemporary web development practices. The system delivers measurable improvements in efficiency while maintaining high standards of customer service quality.

Key Success Factors: - Robust RAG implementation for accurate responses - Comprehensive validation and quality control - Flexible architecture supporting various business needs - Modern React-based management interface - Seamless Zendesk integration - Sophisticated three-tier architecture with PHP API gateway

The Bruno agent system demonstrates how AI can enhance rather than replace human customer service, creating a hybrid approach that maximizes both efficiency and quality. The multi-backend architecture with its separation of concerns between frontend, API gateway, and AI processing allows for scalable growth and maintenance.