



# Open Labs Share

Next-Gen Learning Platform:  
Microservices Meets Education



# The Problem and our Project

Engineering challenges in education technology:

- 🚧 Limited real-world project experience due to academic focus on theory
- 📧 Poor feedback loops between industry needs and educational content

💡 **Our project** is a content creation platform that efficiently connects mentors with young developers throu interactive learning and structured feedback.








## Meet the team

-  Kirill Efimovich (PM/DevOps) - *Project Leadership & DevOps Engineer*
-  Mikhail Trifonov - *Backend Engineer*
-  Nikita Maksimenko - *Backend Engineer*
-  Timur Salakhov - *Backend Engineer*
-  Ravil Kazeev - *Backend Engineer*
-  Kirill Shumskiy - *ML & Backend Engineer*
-  Aleliya Turushkina - *Designer & Frontend Engineer*

# Live Technical Demo: Core Features




Interactive walkthrough of platform capabilities:

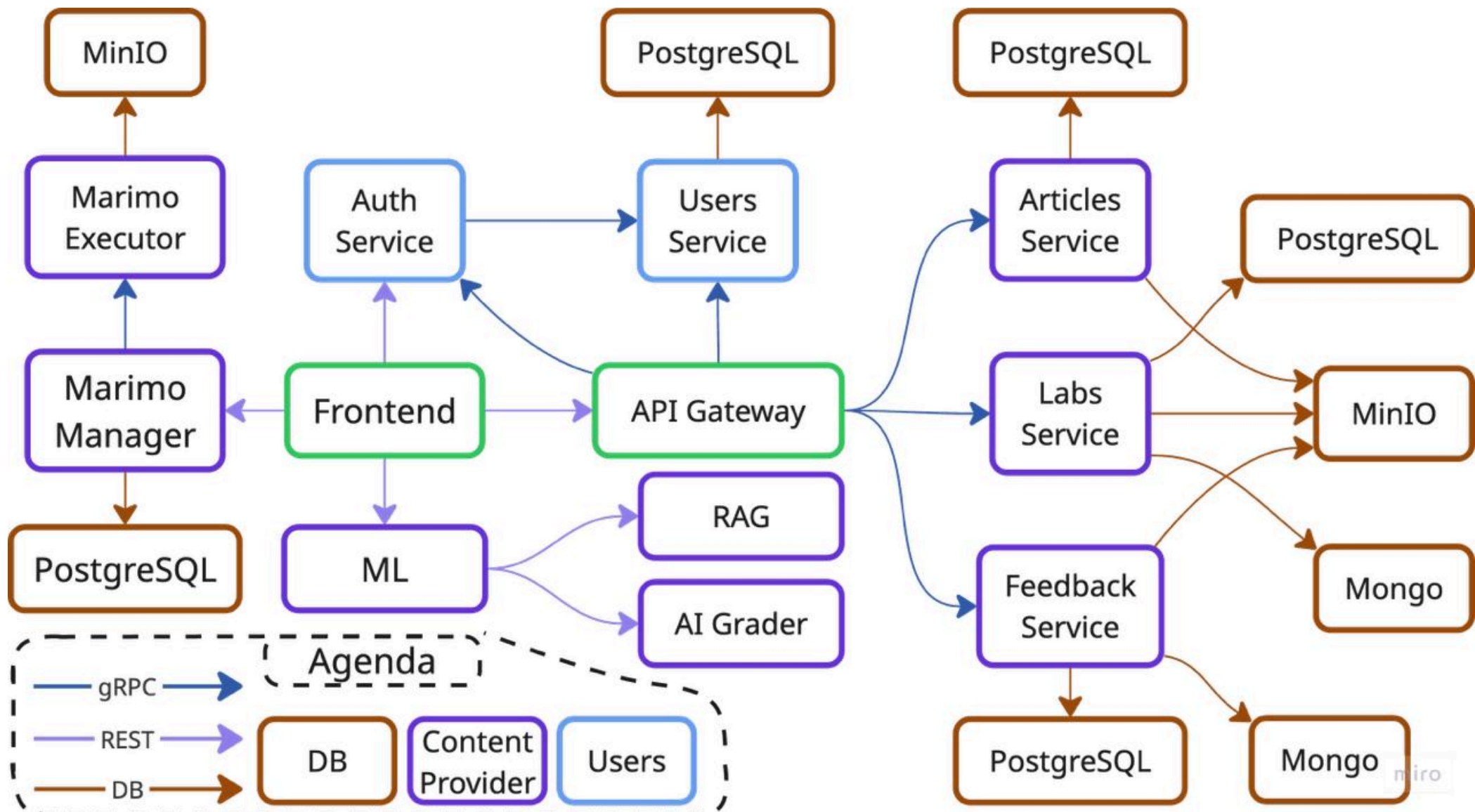
1.  **Secure Authentication:** OAuth2/JWT with multi-factor authentication demo
2.  **Intelligent Lab Discovery:** ML-powered recommendations and search
3.  **Advanced Development Workflow:** Real-time collaboration and submission pipeline
4.  **Intelligent Review Engine:** AI-assisted peer matching and quality scoring
5.  **Analytics Dashboard:** Real-time metrics and performance insights

ЗДЕСЬ ДОЛЖНО БЫТЬ ДЕМО



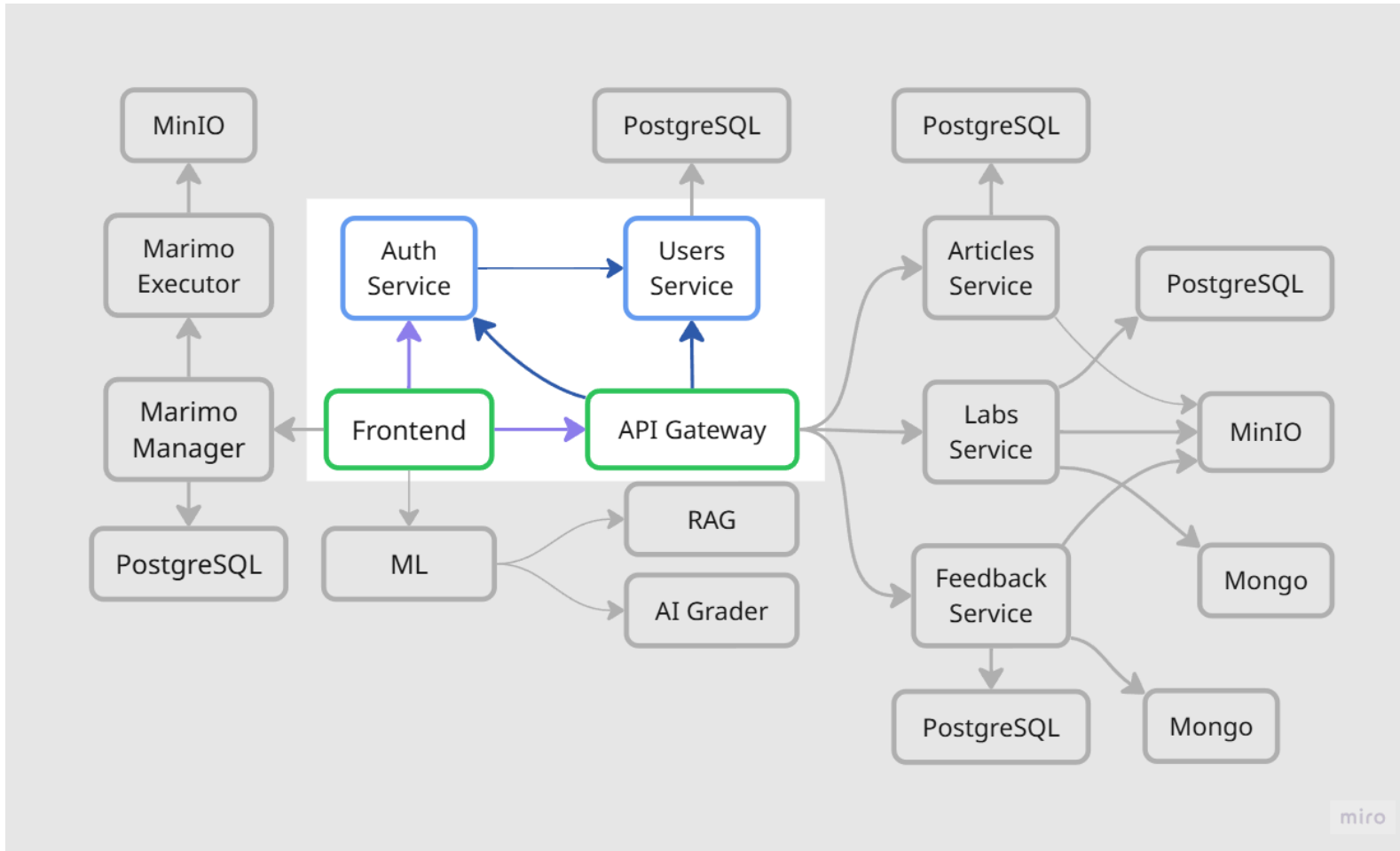
# Frontend: Tech Stack & Connections

-  **Frontend:** React, Vite, Tailwind CSS, React Router
-  **Component Libraries:** React PDF Viewer, Markdown/KaTeX
-  **API Integration:**
  - Communicates with backend via REST API through the API Gateway
  - Auth, Labs, Articles, Submissions, Feedback, and ML services
  - Real-time and file download support from MinIO





# Authentication Service



# Authentication Service: Primary Use Case

Handles all authentication flows and token lifecycle management for secure access control 🔑

- 🔑 **User Authentication:** `sign-in/sign-up` with users-service gRPC calls 👤
- 🗑️ **JWT Generation:** Creates access & refresh `tokens` with user claims 🔒
- ✅ **Token Validation:** `Verifies` signatures, expiration, and blacklist status 🛡️
- 📄 **Session Management:** Logout with token `blacklisting` for security ☠️
- 🛡️ **Security Gateway:** Validates all API requests for `protected` resources 🦊

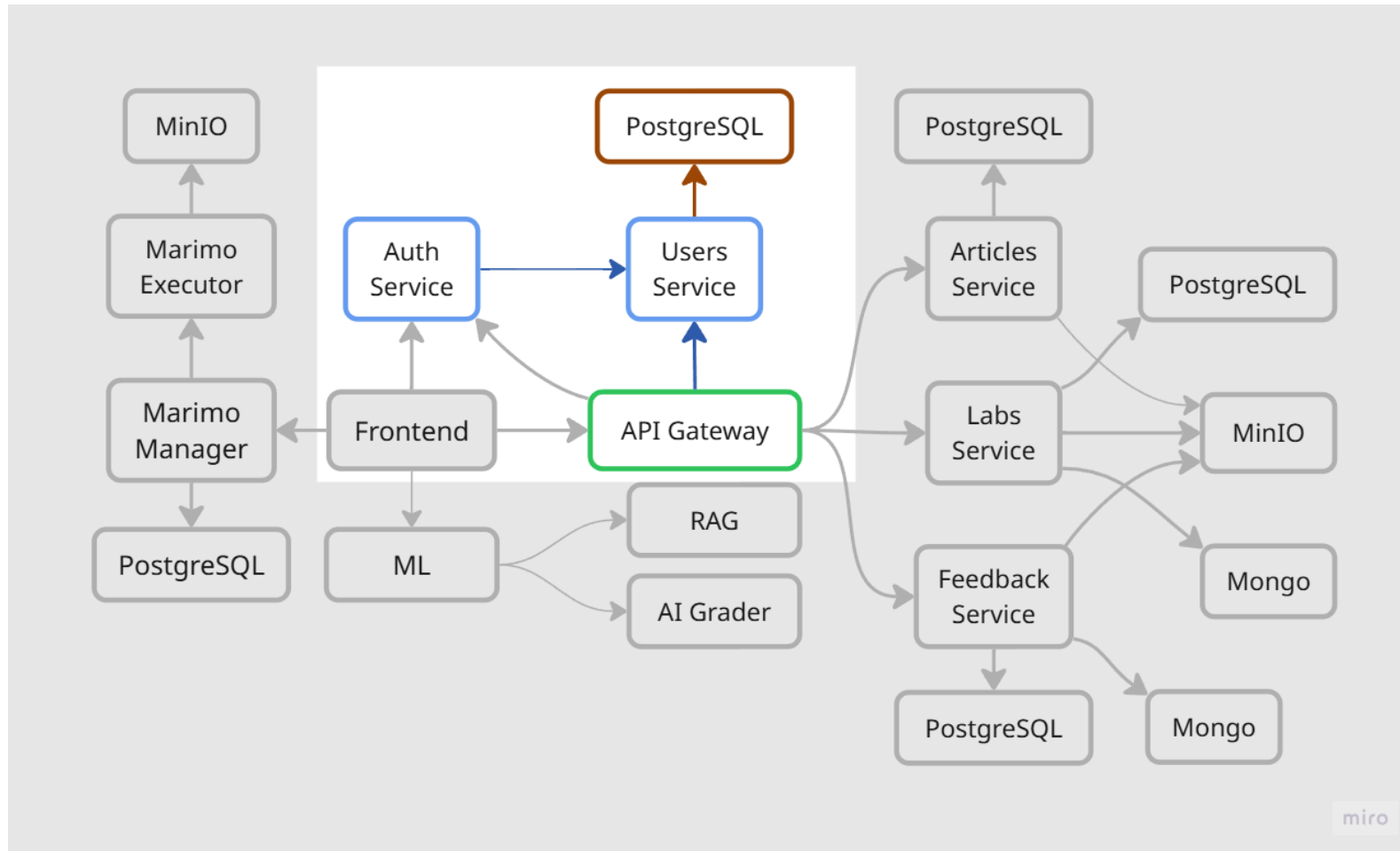


# Authentication Service: Tech Stack & Connections

Java Spring with gRPC communication and no database 😎






- 🏗️ **Java 21 + Spring Boot 3.5:**
  - ↳ REST controller for endpoints
- 🔒 **Spring Security + JWT:**
  - ↳ Token generation with signing and validation, refresh token support
- 🚀 **gRPC Server/Client:**
  - ↳ High-performance calls to Users Service and token validation for API Gateway
- 💾 **In-Memory Blacklist:**
  - ↳ Storage for invalidated tokens for logout functionality
- 📖 **OpenAPI Docs:** Auto-generated REST API documentation
  - ↳ Interactive API documentation for frontend integration and testing

# Users Service







# Users Service: Primary Use Case

Manages all user data, credentials, and points for solving & reviewing labs 🎯

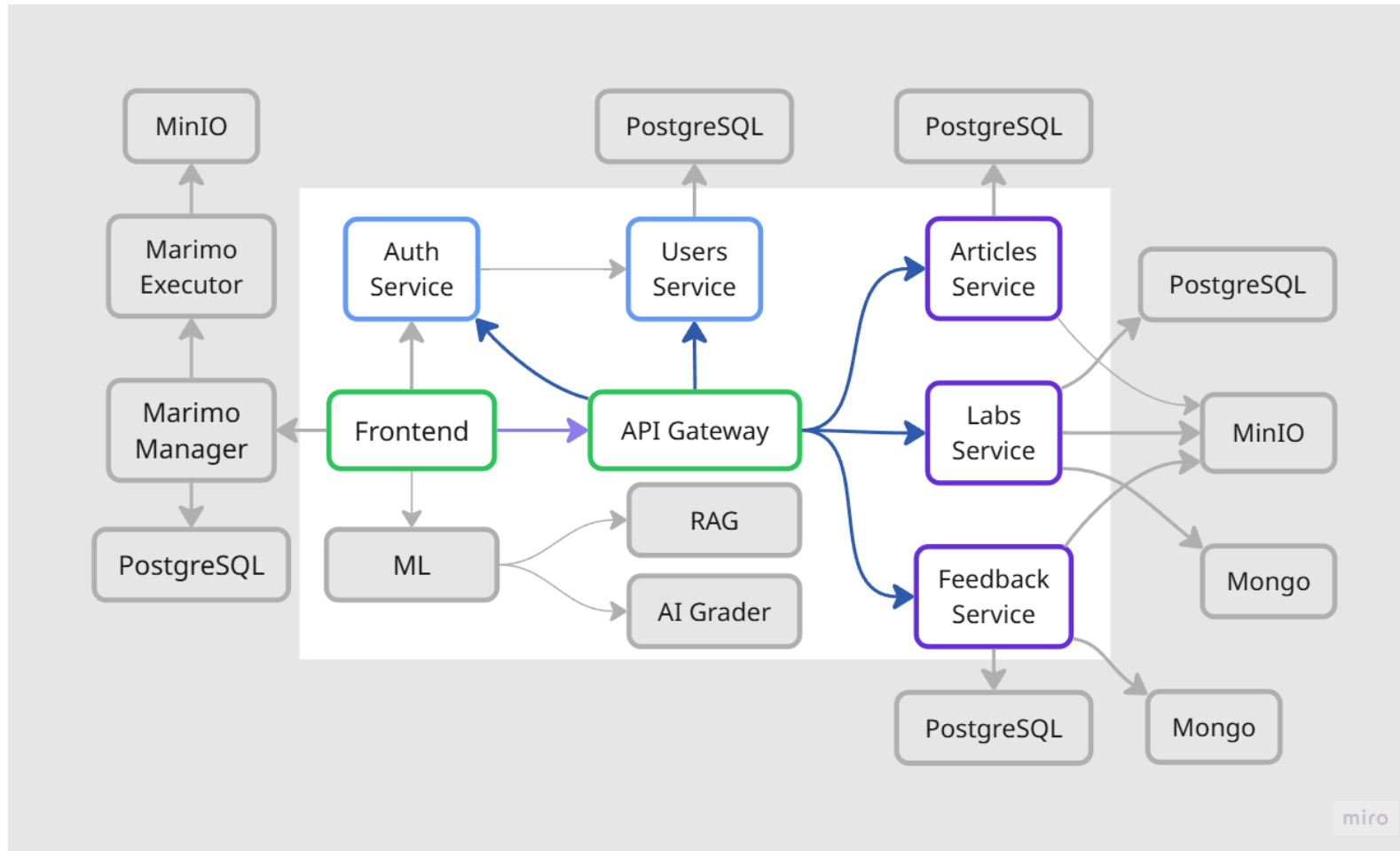
-  **User Registration:** Creates new user accounts 👤
-  **Credential Management:** Stores bcrypt-hashed passwords, validates username/email and password
-  **Profile Operations:** CRUD for user profiles ✎
-  **Points System:** Tracks labs solved/reviewed counts & points balance 💵💰💳
-  **Data Integrity:** Single source of truth for all user-related information 🐟

# Users Service: Tech Stack & Connections

Java with PostgreSQL persistence and gRPC API  

-  **Java 21 + Spring Boot 3.5:**
  - ↳ **REST** controllers and JPA repositories for user management
-  **PostgreSQL:**
  - ↳ Stores user data, credentials, points, and labs solved/reviewed counts
-  **Flyway:**
  - ↳ Database schema versioning and **migration** management
-  **gRPC Server:**
  - ↳ Provides **API** for user validation, data retrieval, and points updates to other microservices

# API Gateway



# API Gateway: Primary Use Case

Centralized entry point and request orchestration for all client interactions 🌐

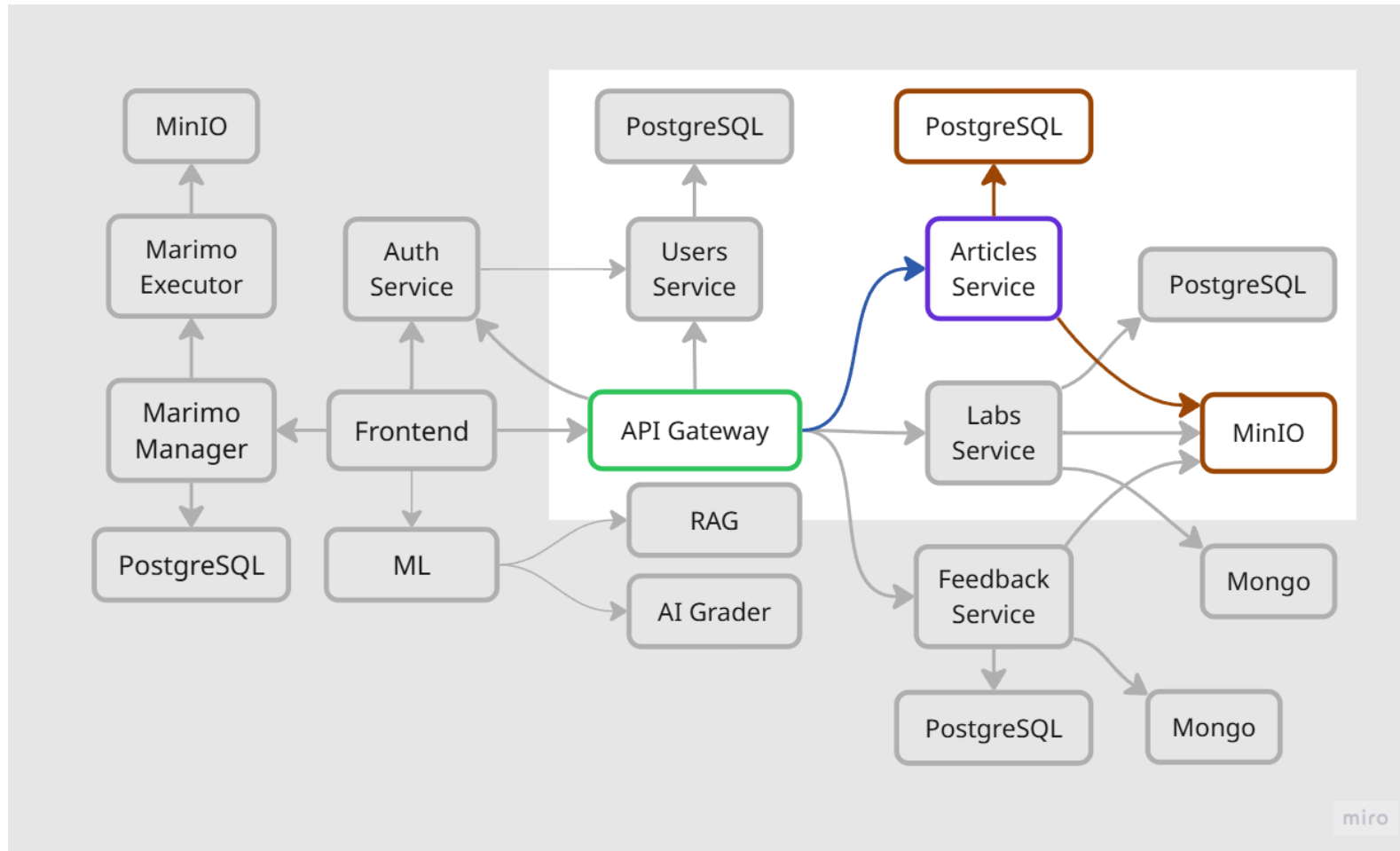
- 🌐 **Centralized Entry Point:** Serves as the unified access layer for all client REST API requests
- 🔄 **Request Routing:** Directs incoming requests to the appropriate microservice ( `auth` , `user` , `article` , `lab` ) via gRPC
- 🔒 **Authentication & Security:** Validates JWT tokens and user's permissions
- 📝 **Cross-Cutting Concerns:** Handles logging, request tracing, and error handling for all API traffic
- 🧠 **Business Logic Execution:** Aggregating data and enforcing business rules beyond simple routing

# API Gateway: Tech Stack & Connections

Java Spring Boot with REST-to-gRPC translation ☕️🔄

- 🧑🏻 Java 21 + Spring Framework:
  - ↳ REST API, gRPC, Jackson Validators, Spring AOP
- 📥 REST API:
  - ↳ REST is the simplest and most widely supported method for web communication
- 🛡️ Security Layer:
  - ↳ Intercept incoming REST requests for authentication and authorization
- 🔄 gRPC Client:
  - ↳ gRPC provides high-speed, type-safe, and scalable service-to-service communication
- 📤 Response Handling:
  - ↳ Centralizes response handling and error management over the whole backend





# Articles Service







# Articles Service: Primary Use Case

Manages all articles & assets metadata 




-  **Articles Operations:** Provides CRUD for articles details
-  **Content Management:** Handles articles assets in independent storage system
-  **Metadata Management:** Organizes and updates metadata for articles and its assets
-  **Searching:** Provides articles searching based on its title and abstract

# Articles Service: Tech Stack & Connections

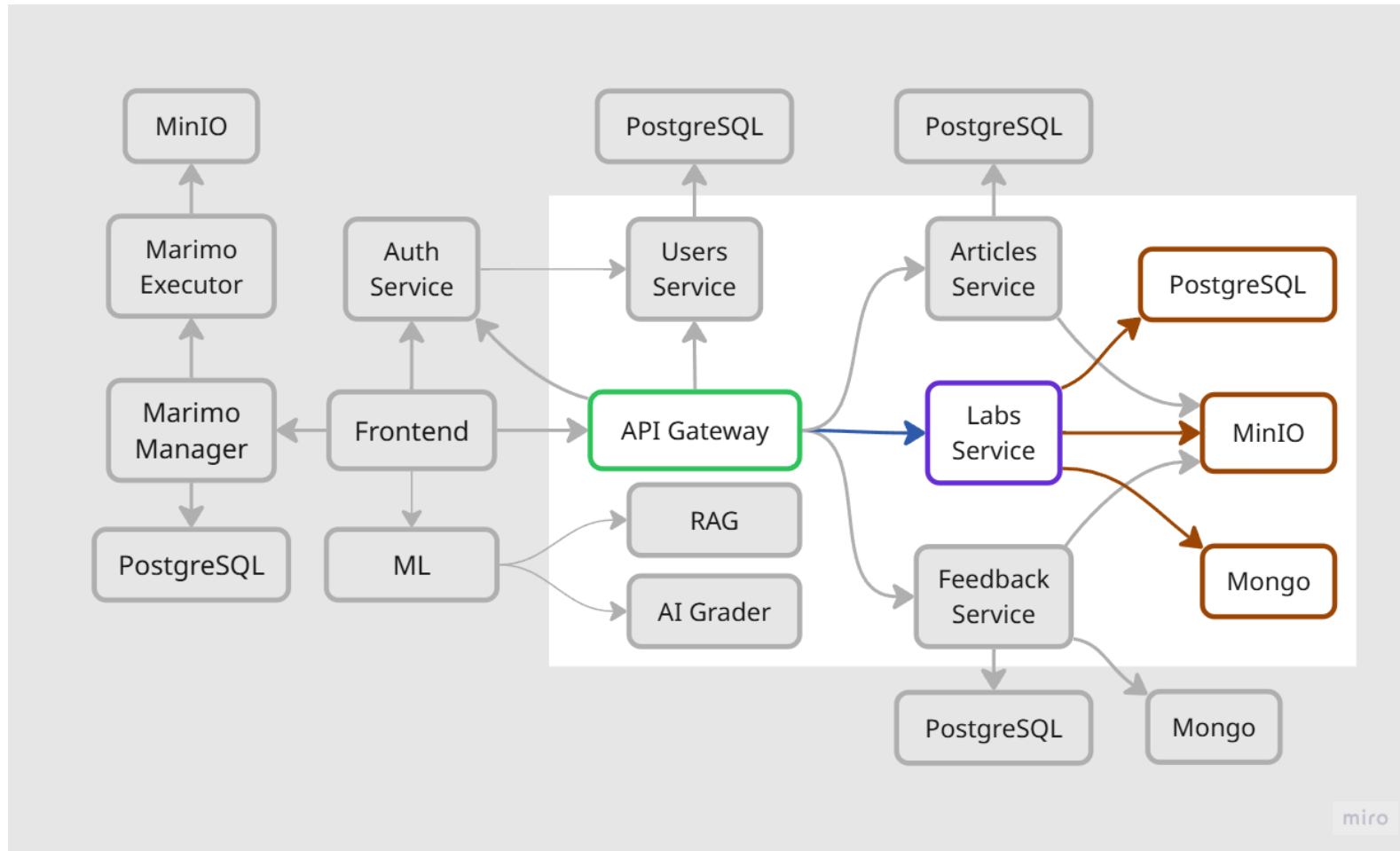
Python-based microservice with PostgreSQL and MinIO storage 

-  Programming Language: Python 3.12
-  Inter-service Communication: gRPC

Service Integrations:

-  API Gateway: Receive and return data in gRPC format
-  PostgreSQL Database: Store all articles and its assets metadata
-  MinIO Storage System: Store all articles assets

# Labs Service



# Labs Service: Primary Use Case

Manages all labs, submissions & educational content 📁

- 📖 **Labs Operations:** Provides CRUD for lab assignments with tags
- 📁 **Submissions Management:** Handles submissions with text content and file assets
- 🏷️ **Tag System:** Organizes labs with flexible tagging and search capabilities
- 📊 **Grading System:** Tracks submission status and grade workflow

# Labs Service: Tech Stack & Connections

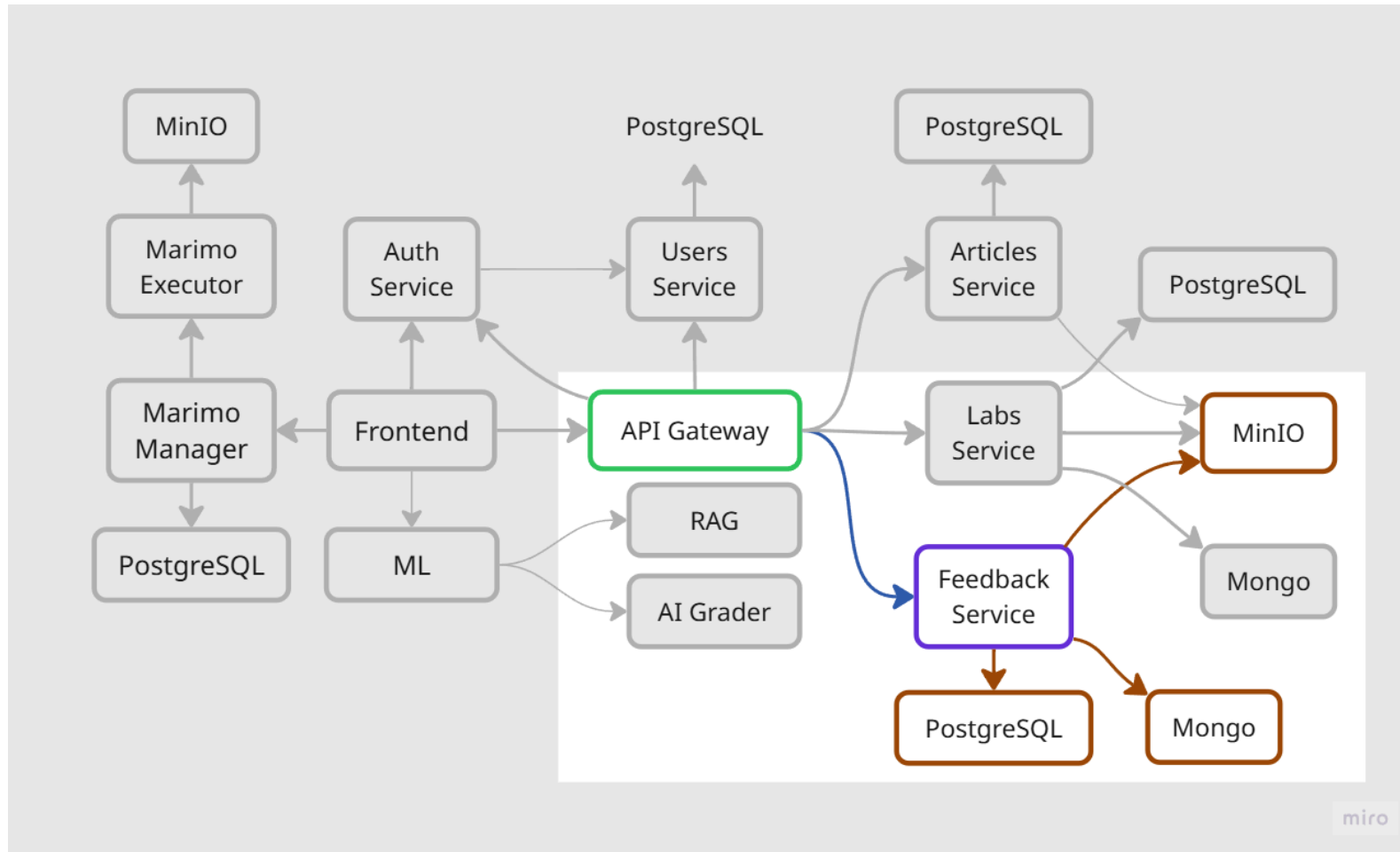
Python with hybrid database architecture and MinIO storage 🐍

- 🐍 Programming Language: Python 3.12
- 🔁 Inter-service Communication: gRPC

Service Integrations:




- 🏠 API Gateway: Single entry point for all requests
- 🗄️ PostgreSQL Database: Store labs, submissions, tags, and assets metadata
- 📄 MongoDB Database: Store submission text content for flexible storage
- ☁️ MinIO Storage System: Store lab and submission assets in organized buckets

# Feedback Service



# Feedback Service: Primary Use Case

Comprehensive feedback and discussion management system 

-  **Comprehensive Feedback System:** Enables reviewers to create, update, and delete detailed feedback on submissions using Markdown for text and code formatting
-  **Organized Discussion Section:** Powers a threaded commenting system for both labs and articles. Nested replies keep conversations structured and easy to follow
-  **Attachment Handling:** Allows multiple file attachments per feedback entry, using efficient gRPC streaming to handle large uploads and downloads without high memory usage

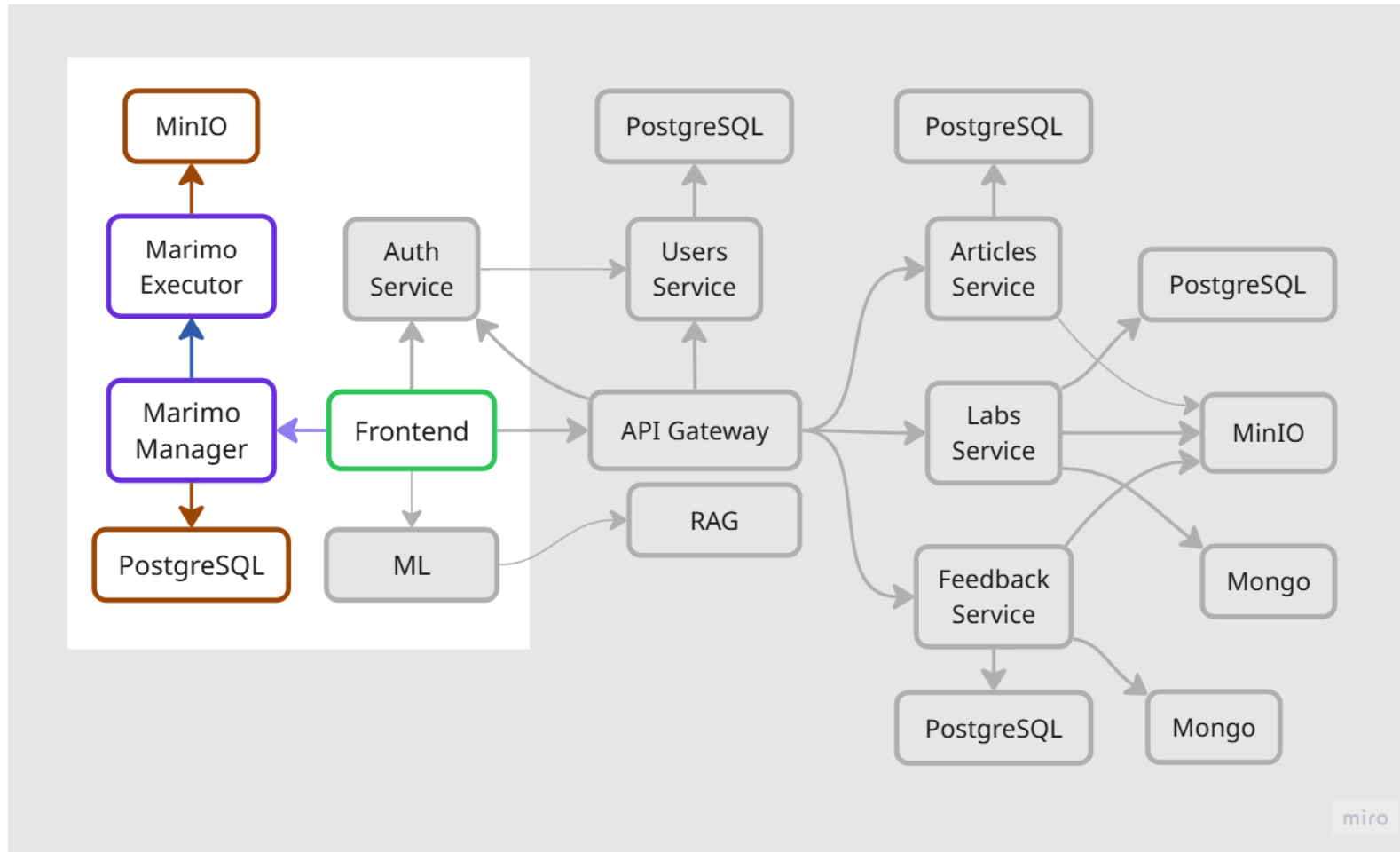
# Feedback Service: Tech Stack & Connections

Go with a multi-storage backend and gRPC API 🐭💾

- 🐭 Go 1.24:
  - ↳ High-performance, concurrent service ideal for I/O-heavy tasks
- 🗣️ gRPC Server:
  - ↳ Provides a typed API for feedback, comments, and file streaming
- 🗄️ Multi-Storage Backend:
  - ↳ PostgreSQL: Stores structured feedback metadata
  - ↳ MongoDB: Stores unstructured comments and feedback content
  - ↳ MinIO: Object storage for all file attachments















# Marimo Service



# Marimo Service: Primary Use Case

Interactive code execution and data visualization through cells with Python code 

-  **Notebook Management:** CRUD operations for marimo components linked to labs/articles 
-  **Session Orchestration:** Start/stop interactive Python sessions with TTL 
-  **Code Execution:** Real-time cell execution with output capture and error handling 
-  **Asset Management:** Upload/download datasets and files for notebook use 
-  **Interactive Widgets:** Set of basic Marimo input widgets which value can be used in code (sliders, switchers, text fields, etc.) 
-  **Cross-cells state memory:** Variables and modules from executed cells are available in other cells 

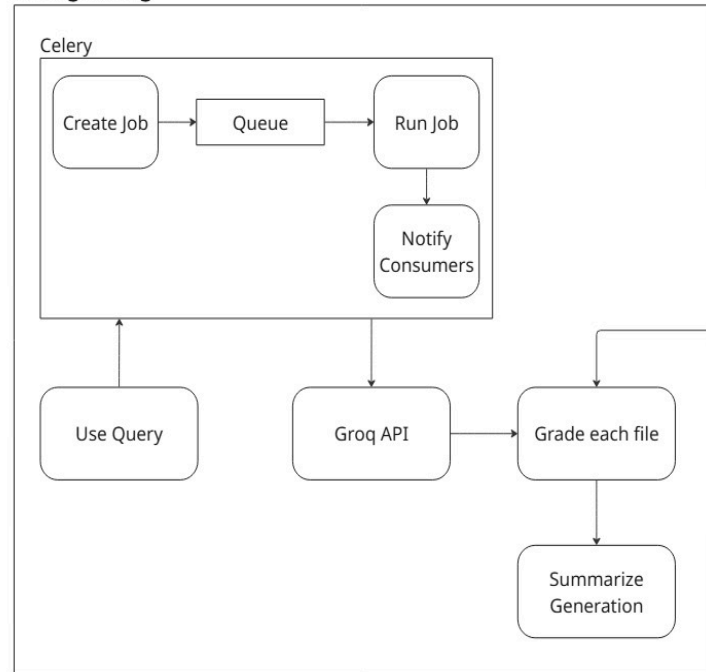
# Marimo Service: Tech Stack & Connections

Java for metadata management with Python native code execution 🍲🐍

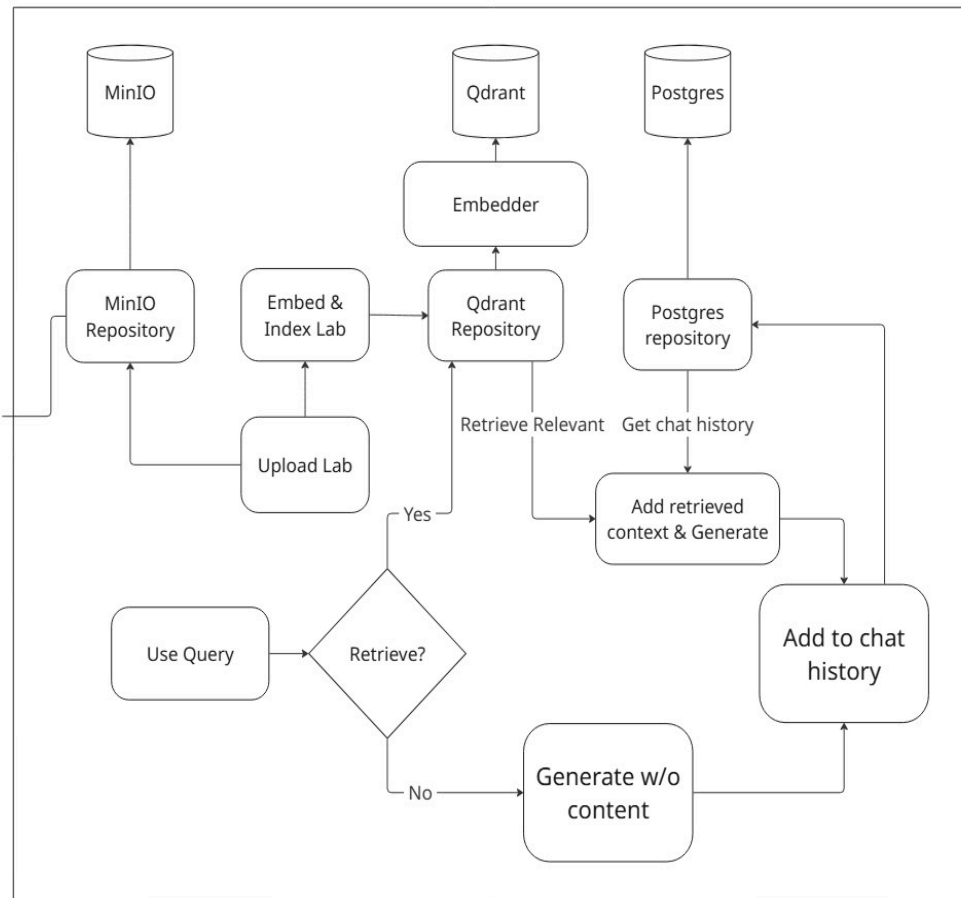
- 🛠️ **Java Manager + Python Executor:**
  - ↳ Java handles `REST API` and `metadata` while Python `executes` notebooks
- 🗄️ **PostgreSQL:**
  - ↳ Tracks notebook metadata, user sessions, and execution trails with TTL cleanup
- 📦 **MinIO:**
  - ↳ Object storage for notebook `files` and user-uploaded `assets`
- 🔗 **gRPC:**
  - ↳ Java Manager ← `execute requests, session management` → Python Executor
- 🐍 **Marimo:** Interactive notebook execution with widgets
  - ↳ Interactive notebook execution with ✨ `widgets` ✨

# ML Service

## Autograding



## AI Assistant



# ML Service: Primary Use Case

Two powerful AI enhancements for the learning platform 🧠

- 🔍 **AI RAG Assistant:** Context-aware code and documentation helper, leveraging Retrieval-Augmented Generation (RAG) to deliver accurate, real-time support to students
- ✅ **Autograding:** Automated code assessment system for evaluating submissions instantly — ideal for learning platforms

# ML Service: Tech Stack & Connections

FastAPI backend with specialized AI models and infrastructure 🐍🤖

## 🤖 AI RAG Assistant

- Qwen2.5-Coder-1.5B-Instruct (local inference)
- Qdrant vector store
- BAAI/bge-small-en-v1.5 embeddings

## ✅ Autograding

- deepseek-r1-distill-llama-70b (groq inference)
- Menagerie dataset: Graded CS1 Assignments for evaluation

## Core Architecture:

🐍 FastAPI-based backend with three-layer structure

🌿 Celery for asynchronous tasks

📦 Redis for caching and message broker






# DevOps & Infrastructure



DevOps Infrastructure Architecture Diagram

# DevOps: Primary Use Case

Automated deployment pipeline and infrastructure management 

-  **Accelerate Delivery:** Fully automate the build, test, and deployment lifecycle
-  **Ensure Stability:** Create reproducible environments with Docker for development and production
-  **Team help tools** to automate issues managing and PR notifiers to keep the team perfectly synchronized





# DevOps: Tech Stack & Connections

Key GitHub Actions Workflows: 🌟

- 🛠️ **Compilation Validation:** Ensures all services compile
- 🔪 **Test Execution:** Runs unit & integration tests
- 🐳 **Docker Build Validation:** Builds, validates and pushes images to GHCR
- 🚀 **Deployment Automation:** Handles the Blue-Green deployment logic



# DevOps: Infrastructure

## ● Green-Blue Strategy ●

- **0 Zero Downtime:** Updates are seamless
- **Workflow:**
  - i. Deploy new version (Green) alongside Production (Blue)
  - ii. Test Green environment internally
  - iii. Switch HAProxy to route traffic to Green
  - iv. Keep Blue for instant rollback



## Server & Networking

- **Host:** Self-managed server on Ubuntu 24.04
- **Specs:** 6-Core CPU, 16GB RAM, 240GB SSD
- **Proxy:** NGINX & HAProxy
- **Access:** CloudPub for public NAT traversal
- **Monitoring:** cAdvisor for container metrics

# Communication Problems

✗ Problems	✓ Solutions
✗ Problems in task setting and communication between people	✓ Create clear GitHub rules for issue creation, assignment workflows, and collaborative development processes
✗ Too many services that use the same data model	✓ Create scripts that automatically check data model consistency across all services

# Implementation Problems

✗ Problems	✓ Solutions
✗ A single database was inefficient for managing varied data types.	✓ Used the best database for each job: PostgreSQL for metadata, MongoDB for comments, and MinIO for file attachments.
✗ University network NAT blocked access to self-hosted server.	✓ After issues with Cloudflare, we successfully used <b>CloudPub</b> to create a secure tunnel for public access.

# Thank you!

We're glad to hear your questions! 🛒 😊 🎸