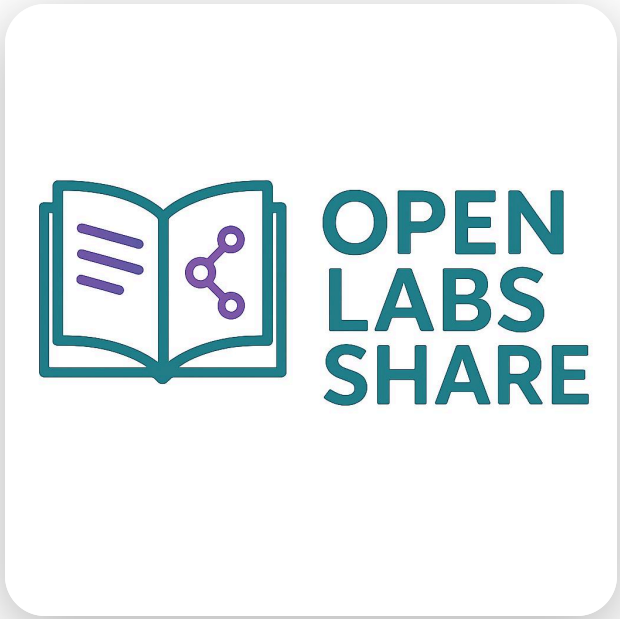


Open Labs Share

Next-Gen Learning Platform: Microservices Meets Education

Kirill Efimovich, Aleliya Turushkina, Mikhail Trifonov, Nikita Maksimenko, Timur Salakhov, Ravil Kazeev, Kirill Shumskiy

🚨 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

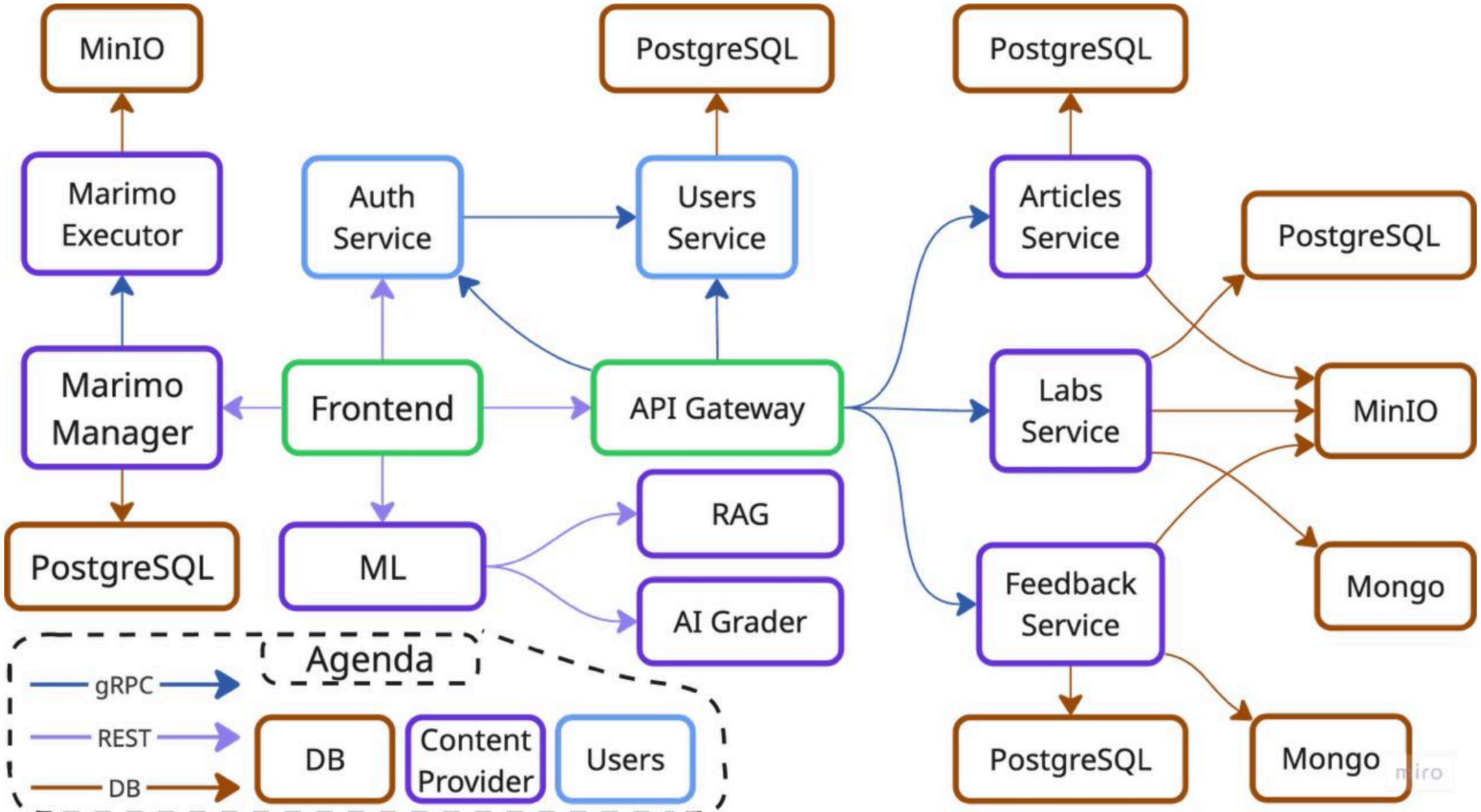
Interactive walkthrough of platform capabilities:

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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PostgreSQL
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Marimo Executor
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Users Service
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API Gateway
Labs Service
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PostgreSQL
ML
RAG
AI Grader
Feedback Service
Mongo
Agenda
gRPC
REST
DB
DB
Content Provider
Users
PostgreSQL
Mongo
miro

🔐 Authentication & Users Service 👥

Mikhail Trifonov (Backend Engineer)

🔐 Authentication Service

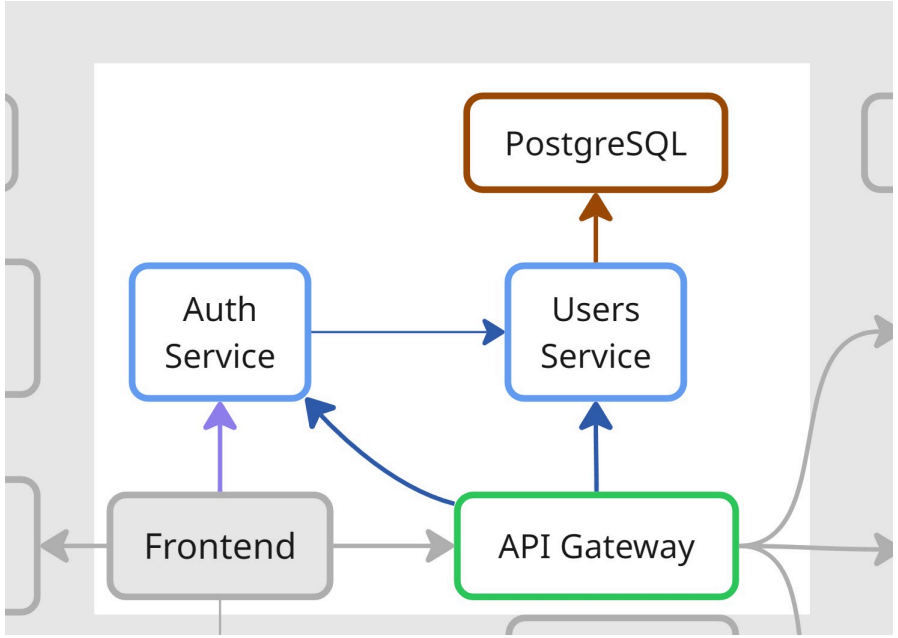
Handles all authentication flows and token lifecycle management for secure access control 🔑

👫 Users Service

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

☕ Tech Stack:

Java 21 + Spring Boot 3.5, Spring Security + JWT, Flyway



Authentication Service: Primary Use Case

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

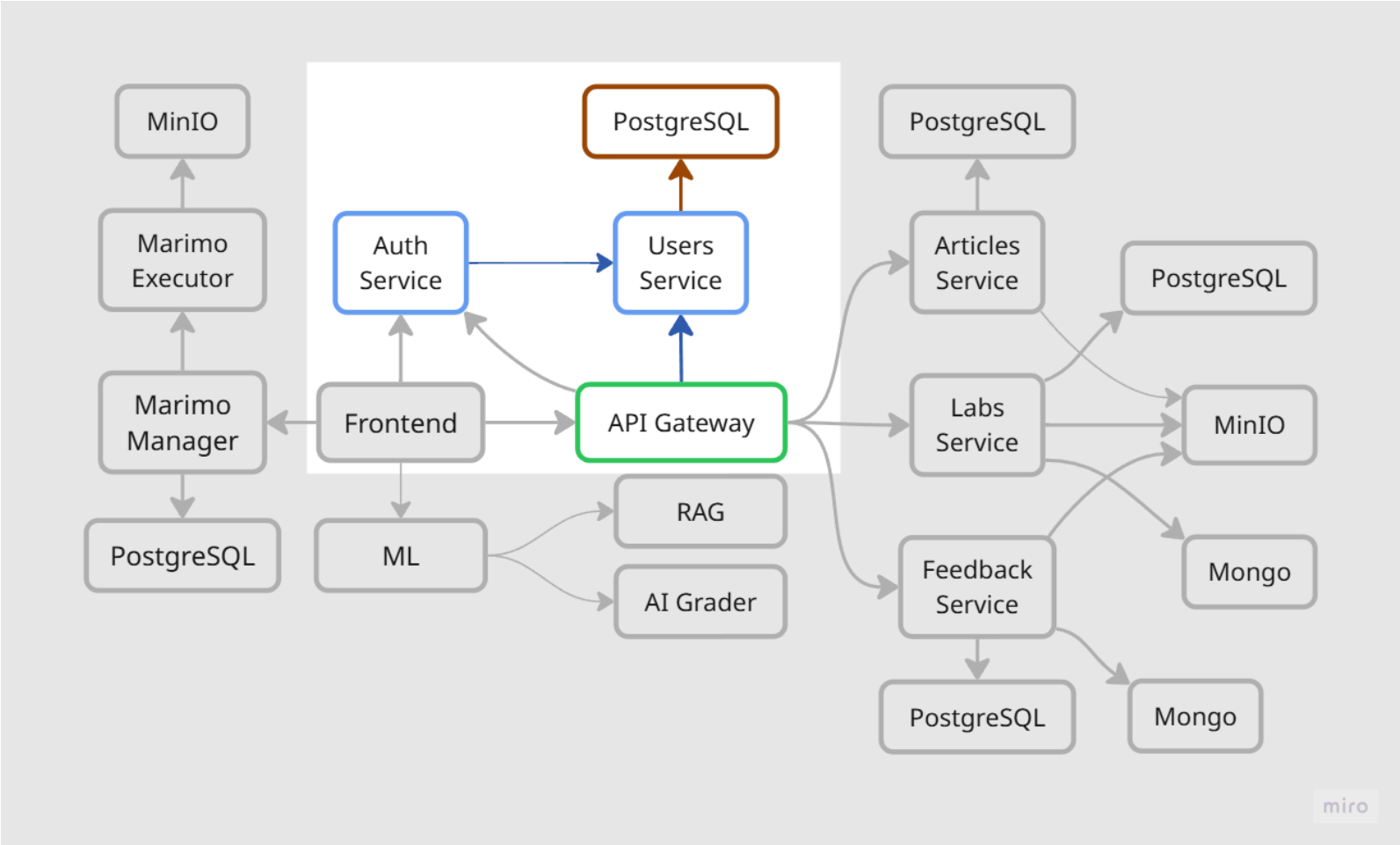
- 🔑 **User Authentication:** `sign-in/sign-up` with users-service gRPC calls 👤
- 🎟️ **JWT Generation:** Creates access & refresh `tokens` with user claims 🔐
- ✅ **Token Validation:** `Verifies` signatures, expiration, and blacklist status 🛡️
- 🚪 **Session Management:** Logout with token `blacklisting` 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

👥 Users Service



Users Service: Primary Use Case

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

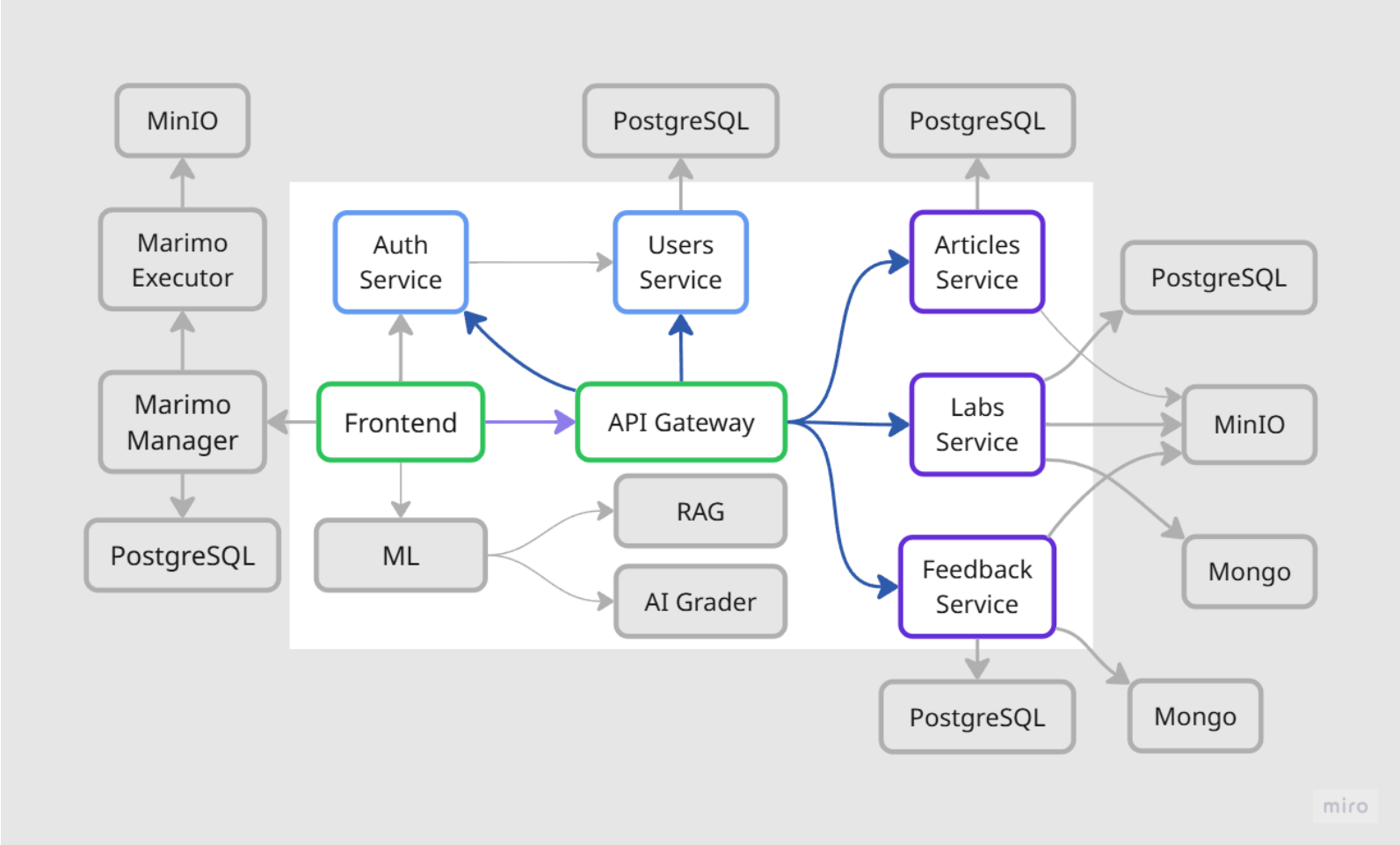
- 🆕 **User Registration:** Creates new user accounts 👤
- 🔐 **Credential Management:** Stores bcrypt-hashed passwords, validates username/email and password
- 👤 **Profile Operations:** CRUD for user profiles ✏️
- 🏆 **Points System:** Tracks labs solved/reviewed counts & points balance 💵💰💳
- 📈 **Data Integrity:** 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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MinIO
PostgreSQL
ML
RAG
AI Grader
Feedback Service
Mongo
PostgreSQL
Mongo
miro

API Gateway: Primary Use Case

Centralized entry point and request orchestration for all client interactions 🌐

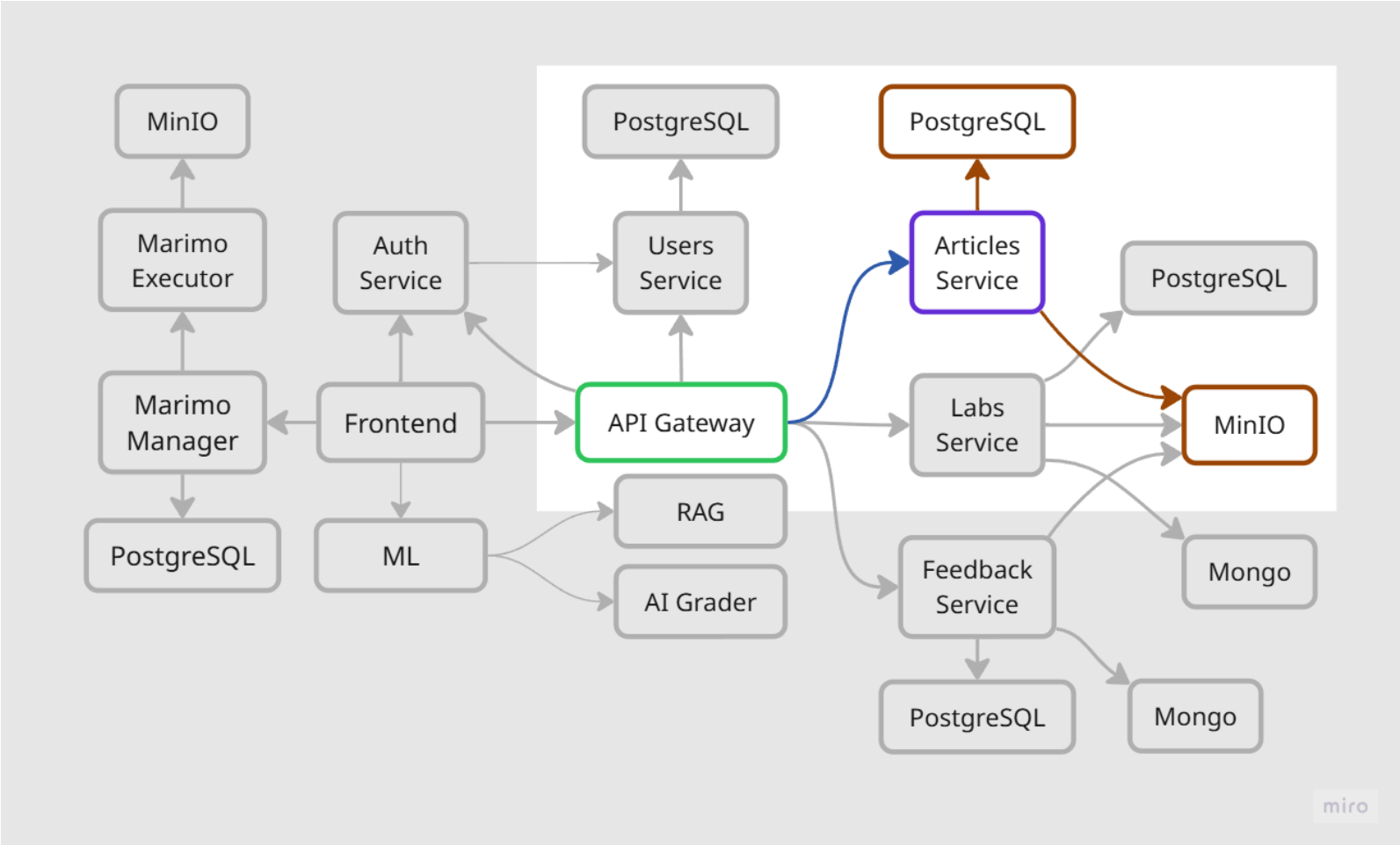
- 🌐 **Centralized Entry Point:** Serves as the unified access layer for all client REST API requests
- 🔀 **Request Routing:** Directs incoming requests to the appropriate microservice (`auth` , `user` , `article` , `lab`) via gRPC
- 🔒 **Authentication & Security:** Validates JWT tokens and user's permissions
- 📝 **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

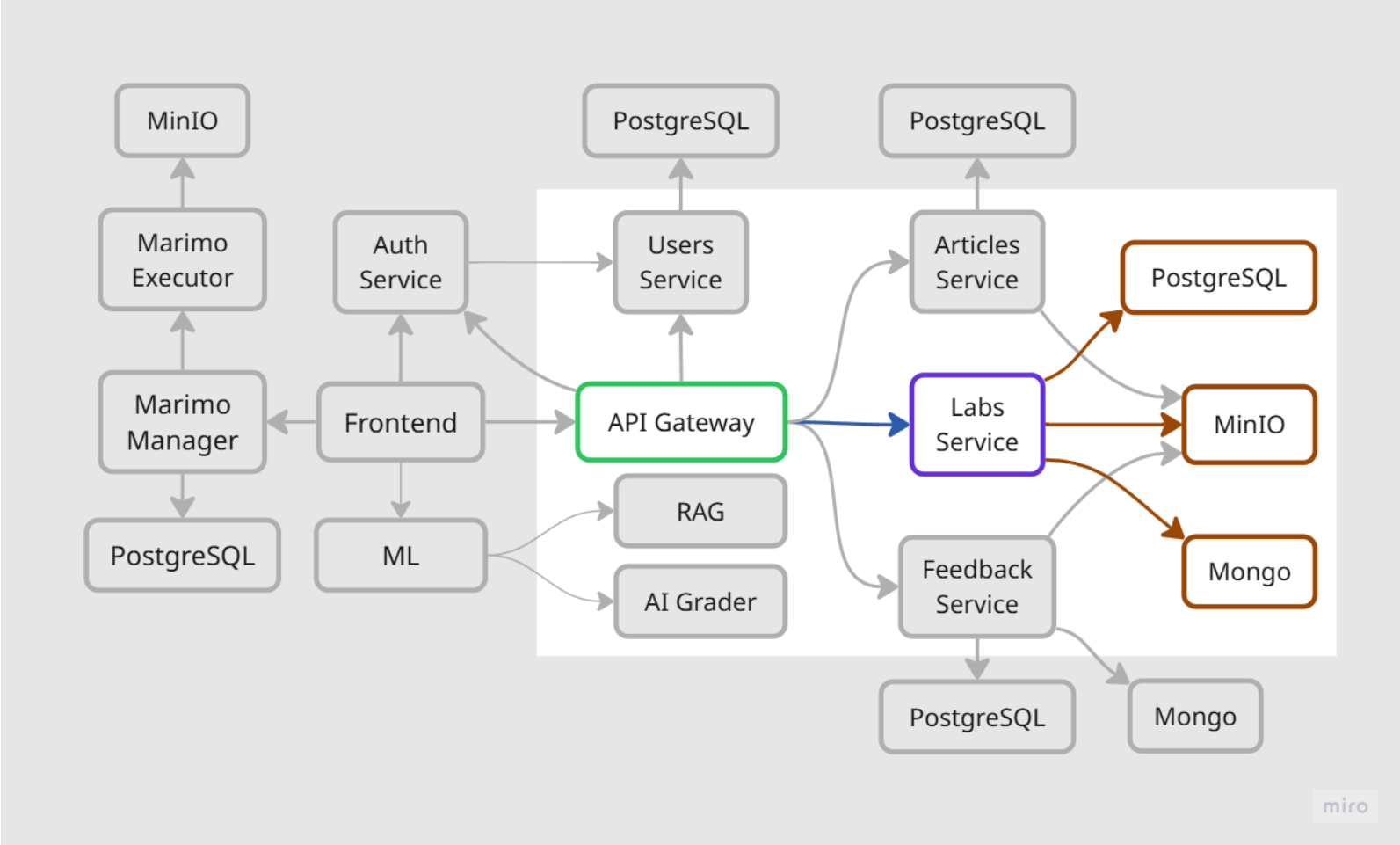
Python-based microservice with PostgreSQL and MinIO storage 🐍

- 🐍 **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

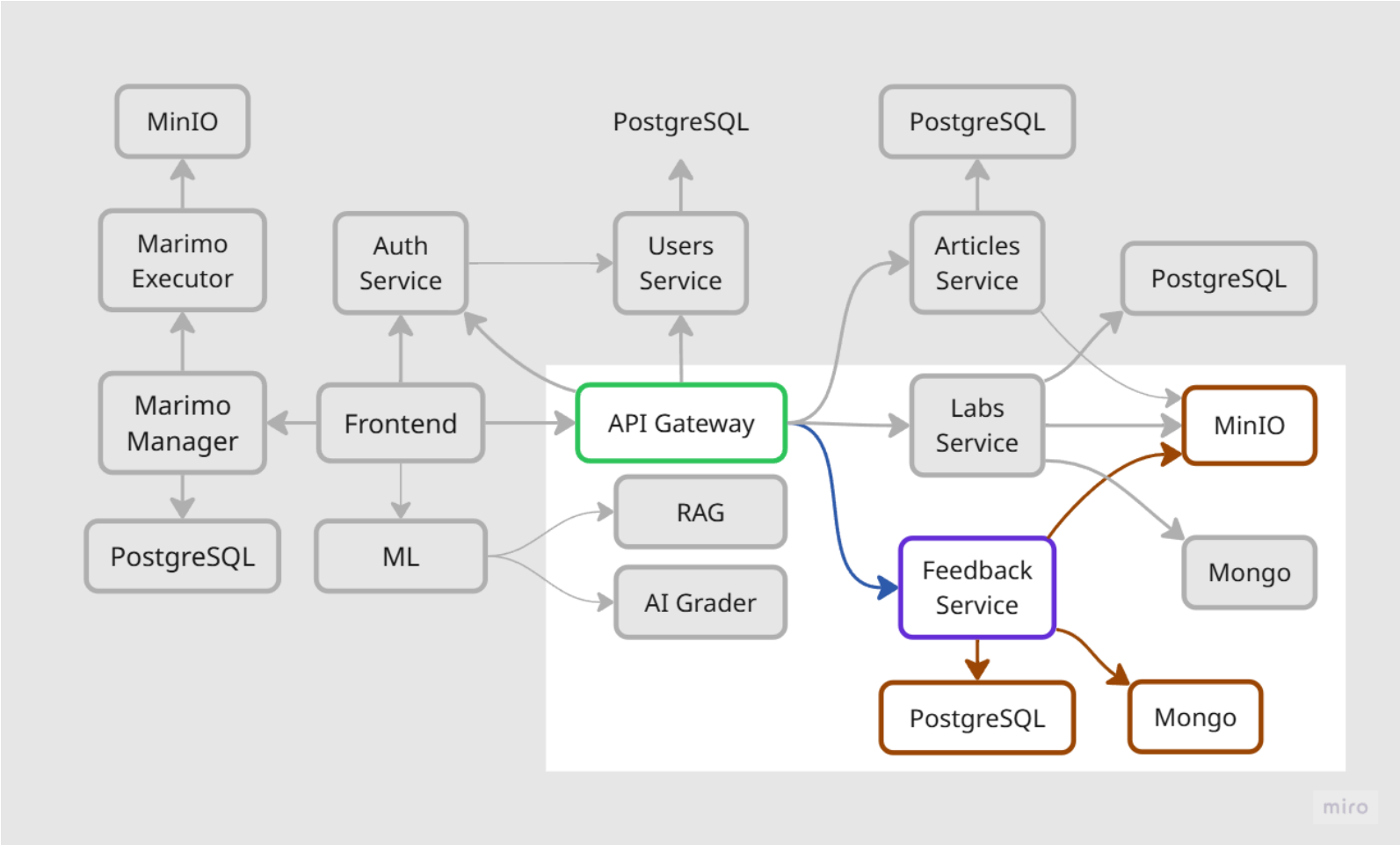
Python with hybrid database architecture and MinIO storage 🐍

- 🐍 **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 💬

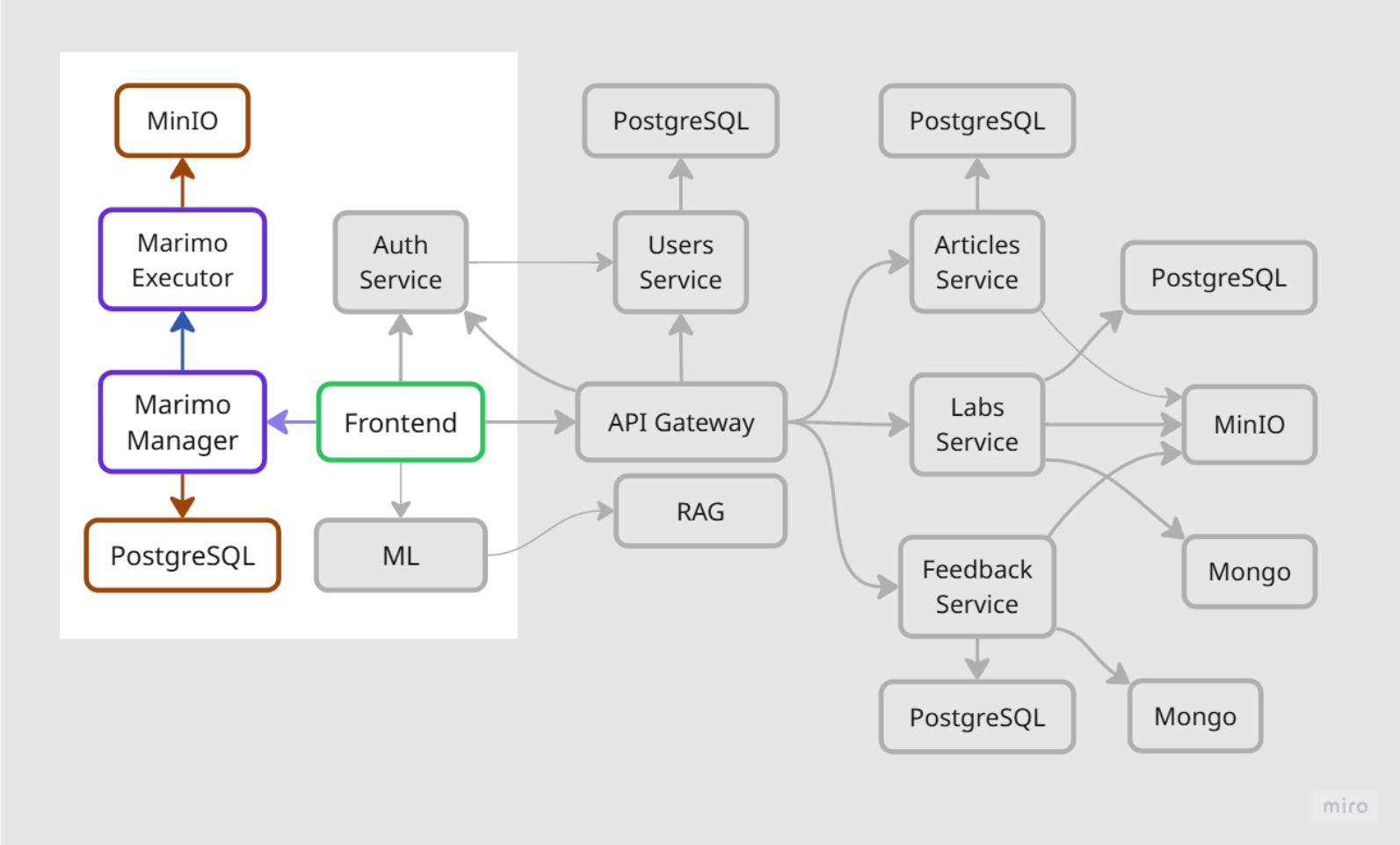
- 📝 **Comprehensive Feedback System:** Enables reviewers to create, update, and delete detailed feedback on submissions using Markdown for text and code formatting
- 💬 **Organized Discussion Section:** Powers a threaded commenting system for both labs and articles. Nested replies keep conversations structured 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 🔬

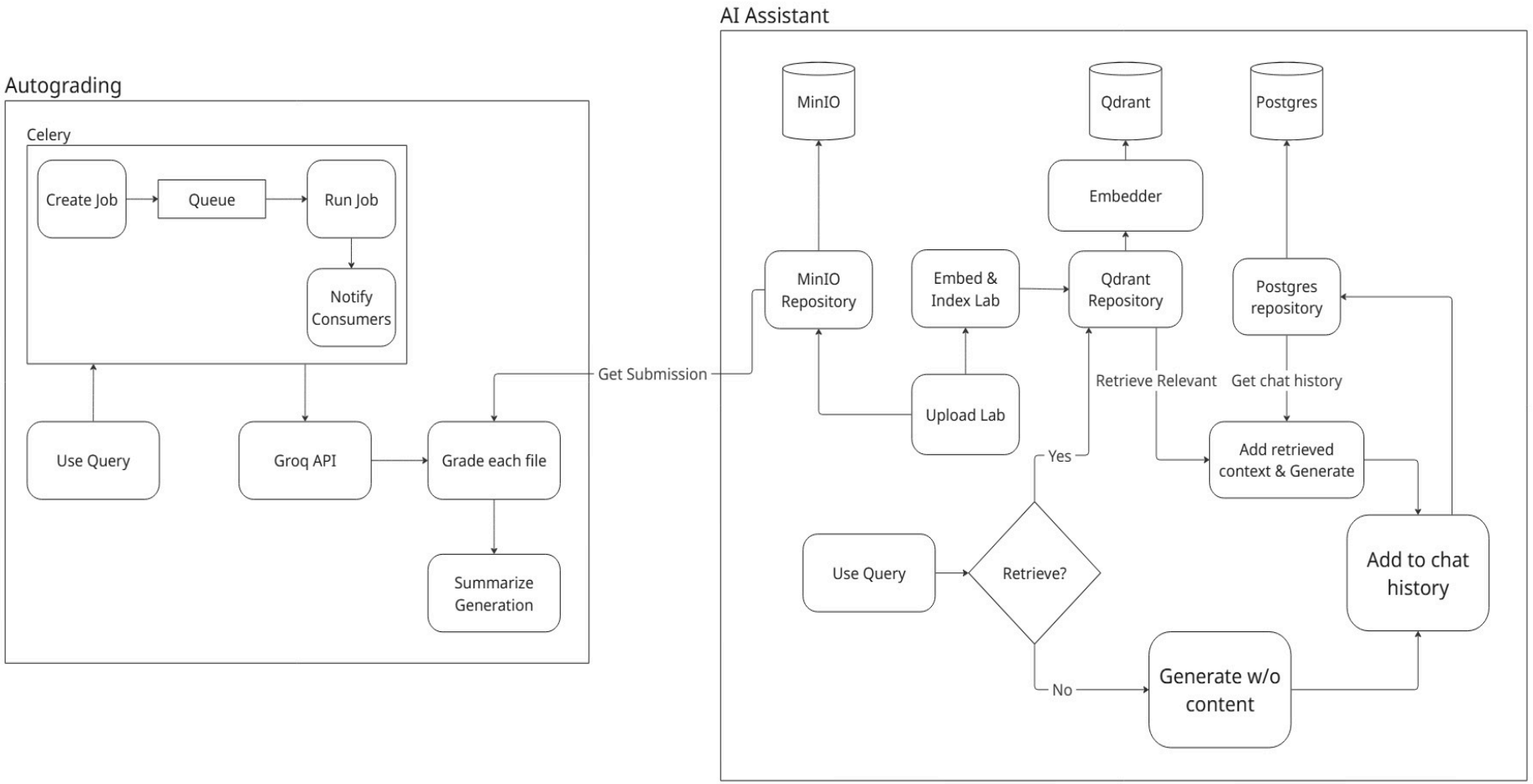
- 📝 **Notebook Management:** CRUD operations for marimo components linked to labs/articles 🔗
- ⏰ **Session Orchestration:** Start/stop interactive Python sessions with TTL 🪦
- 👟 **Code Execution:** Real-time cell execution with output capture and error handling 🖐️
- 📊 **Asset Management:** Upload/download 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
Celery
Create Job
Queue
Run Job
Notify Consumers
Use Query
Groq API
Grade each file
Summarize Generation
Get Submission
AI Assistant
MinIO
Qdrant
Postgres
Embedder
MinIO Repository
Embed & Index Lab
Qdrant Repository
Postgres repository
Upload Lab
Retrieve Relevant
Get chat history
Yes
Add retrieved context & Generate
Use Query
Retrieve?
Add to chat history
No
Generate w/o content

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: 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:** Buillds, validates and pushes images to GHCR
- ✈️ **Deployment Automation:** Handles the Blue-Green deployment logic

🛤️ DevOps: Infrastructure

🔵 Green-Blue Strategy 🟢

- 0️⃣ **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 **CloudPub** to create a secure tunnel for public access.

Thank you!

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