

TuniMaqam API

Digital Guardian of Tunisian Maqam Heritage

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Our Vision

Leverage technology to **preserve**, **teach**, and **promote** Tunisian maqam music (*Tbu'a*) while respecting its cultural authenticity.

Mission Pillars

- ✓ **Preserve** rare maqamat
- ✓ **Educate** through engaging learning
- ✓ **Connect** generations globally

What is a Maqam?

A **modal framework** defining scales and emotional expressions in Arab music. Tunisia's tradition (*Tab'*/*Tbu'*) is one of the most sophisticated.

Production-Ready

RESTful API ▪ Containerized ▪ Documented ▪ Secure

The Challenge

Why This Matters

Tunisia's maqam tradition has accompanied weddings, celebrations, and spiritual gatherings for centuries—yet this living heritage faces the erosion of time.

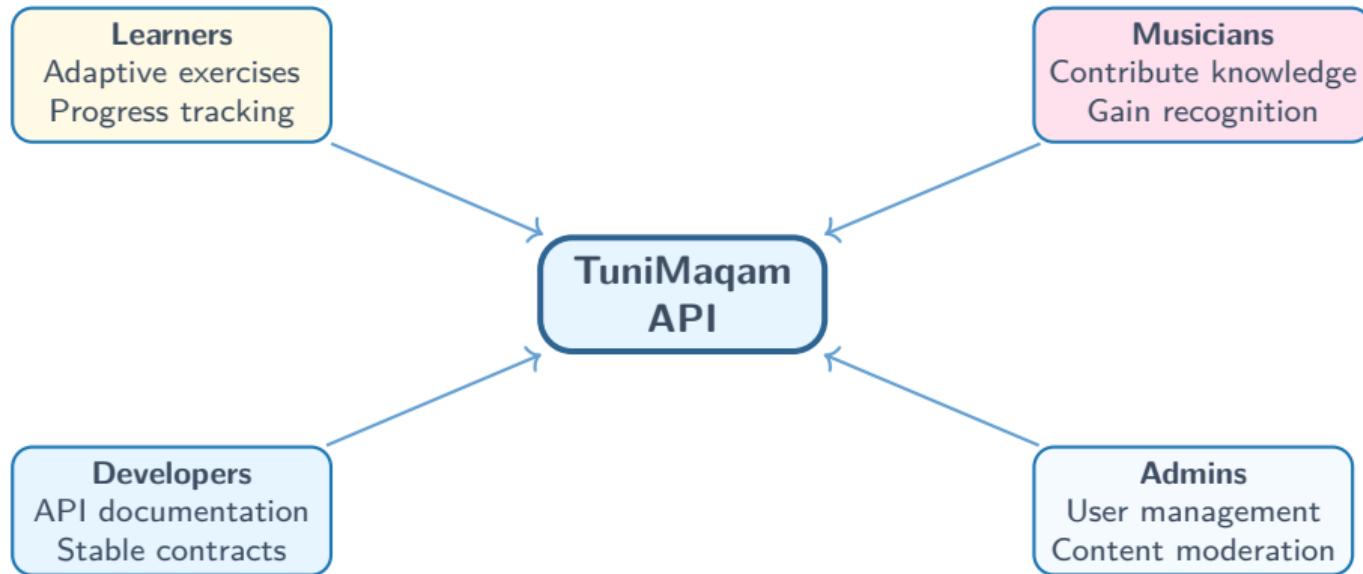
Current Challenges

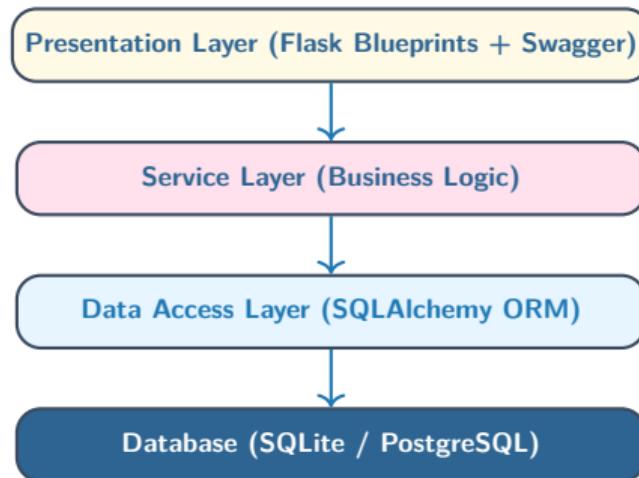
- ▶ **Fragmented Knowledge** — Scattered sources
- ▶ **Learning Barriers** — Years of apprenticeship
- ▶ **Identification Difficulty** — Rare maqamat

Research Gap

- No existing system combines:
- ▶ Structured Tunisian maqam knowledge
 - ▶ Adaptive learning tools
 - ▶ Intelligent analysis & recommendations
- ...in an accessible API format.

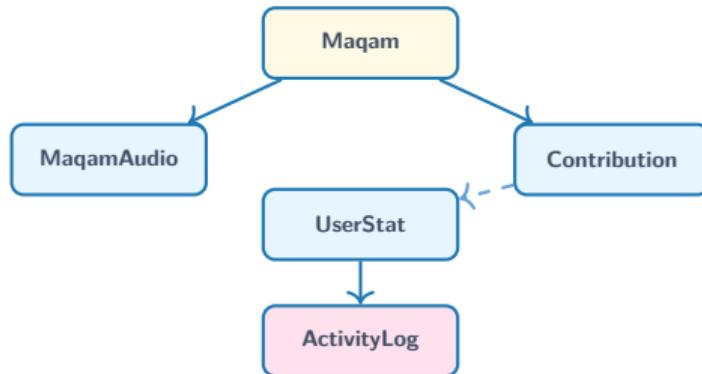
Stakeholders & Their Needs





Tech Stack

- ▶ **Flask 3.x** — Web Framework
- ▶ **SQLAlchemy** — ORM
- ▶ **Marshmallow** — Validation
- ▶ **PyJWT + Authlib** — Auth
- ▶ **Flasgger** — API Docs
- ▶ **Docker** — Deployment



Key Features

- ▶ **Bilingual** names (Arabic/English)
- ▶ **Ajnas** stored as JSON
- ▶ **Emotion weights** for mood queries
- ▶ **Contribution workflow** with audit

Maqam Attributes

Name ▪ Region ▪ Emotion ▪ Difficulty ▪ Rarity ▪ Usage ▪ Related

Four Core Services

Knowledge

- Maqam repository
- Community contributions
- Audio management

Learning

- 8 exercise types
- Adaptive difficulty
- Progress tracking

Analysis

- Note-to-maqam
- Audio-to-maqam
- Confidence scoring

Recommend

- Context-aware
- Heritage boost
- Multi-factor scoring

Integrated Platform

All services work together: Analysis identifies maqamet → Learning creates quizzes → Recommendations suggest next steps → Knowledge preserves contributions.

API Endpoints

GET /knowledge/maqam
GET /maqam/{id}
GET /maqam/by-name/{n}
POST /maqam (admin)

Audio Management

- ▶ Upload MP3, WAV, OGG
- ▶ Validation & secure storage

Contribution Workflow

1. User submits contribution
2. Status: pending
3. Expert/Admin reviews
4. accepted or rejected

Contribution Types

new_maqam ■ correction ■ addition ■ audio

8 Exercise Types

Flashcards

MCQ Quiz

Mixed Quiz

Matching

Audio Recog.

Clue Game

Order Notes

Odd-One-Out

Adaptive Difficulty

Learner level computed dynamically:

Advanced: score $\geq 75\%$ & 10+ activities

Intermediate: score $\geq 50\%$ or 5+

Beginner: otherwise

Pedagogy

Active Recall ▪ Spaced Repetition ▪ Immediate Feedback

Gamification

Points ▪ Streaks ▪ Leaderboard ▪ Progress

First Jins Focus

The **first jins** contains the tonic and characteristic intervals—the “DNA” of the maqam.

Confidence Formula

$$\text{Conf} = \text{Base} \times \text{Mult}$$

$$\text{Base} = 0.7 \cdot \frac{|C|}{|I|} + 0.3 \cdot \frac{|C|}{|M|}$$

I = input, M = maqam notes, C = common

Match Multiplier

Matches	Mult
1	0.50
2	0.70
3–4	0.85–0.95
5+	1.00

Audio Pipeline

Upload → AssemblyAI → Extract Notes → Analyze → Return Candidates

Recommendation Engine

Multi-Factor Scoring

$$S_m = \sum_i w_i \cdot f_i(m)$$

Score for maqam m based on weighted factors.

Scoring Factors

Factor	Max
Mood alignment	+1.0
Event match	+0.25
Region match	+0.20
Heritage boost	+0.20

Heritage Preservation

Rare and endangered maqamat receive a **+20%** boost for cultural preservation.

Example Request

```
{"mood": "joy", "event": "wedding",  
"region": "tunis"}
```

Returns ranked suggestions with rationale.

Role-Based Access Control

Learner

Expert

Admin

Hierarchical permissions

JWT Authentication

- ▶ Industry-standard tokens
- ▶ Role embedded in claims
- ▶ Configurable expiration

Security Features

- ✓ Google OAuth 2.0
- ✓ Rate limiting (Flask-Limiter)
- ✓ Input validation (Marshmallow)
- ✓ CORS & RESTful errors

Knowledge

GET /maqam
POST /contributions
PUT/DELETE maqam

Learning

POST /quiz/start
GET /flashcards
GET /leaderboard

Analysis

POST /notes
POST /audio
Confidence scores

Recommend

POST /recommend
Context-aware
Heritage boost

Interactive Docs

Swagger UI at /apidocs — auto-generated

RESTful Design

Standard HTTP verbs ▪ JSON ▪ Consistent errors

Testing & Deployment

Test Suite

Pytest covers all core services:

- ▶ `test_auth.py`
- ▶ `test_learning.py`
- ▶ `test_analysis.py`
- ▶ `test_recommendations.py`

Code Quality

PEP 8 ▪ Modular blueprints ▪ Separation of concerns

Containerization

- ✓ Dockerfile + Docker Compose
- ✓ Render.yaml for deployment
- ✓ SQLite (dev) / PostgreSQL (prod)
- ✓ Environment variables for secrets

Production Ready

Gunicorn ▪ Health checks ▪ Logging

Impact & Future Work

Cultural Impact

TuniMaqam **democratizes access** to maqam knowledge—bridging heritage and technology for future generations.

Achievements

- ✓ Complete REST API platform
- ✓ 4 integrated services
- ✓ Production-ready deployment
- ✓ Comprehensive documentation

Future Roadmap

- ▶ **Audio Corpus** — Expand recordings
- ▶ **ML Models** — Deep learning on audio
- ▶ **Mobile Apps** — iOS/Android clients
- ▶ **Broader Scope** — Pan-Arab maqamat

Vision

Algorithmic cultural preservation at scale.

Thank You!

TuniMaqam API

Preserve ▪ Educate ▪ Connect

Production-ready REST API with cultural empathy

Questions Welcome!