Faculty of
Computer Science

Data Science and Business Analytics

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Development of an Interactive Platform or Catalog Analysis and Visualization of Galaxy Clusters with AI Support

Presented By

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About this project

Technical overview and resources

Project Type: Interactive astronomical research platform

Core Technologies:

- Backend: Python, FastAPI, asyncio
- Frontend: JavaScript, TailwindCSS
- AI: Large Language Models (LLM)

Deployment: Docker, Nginx

Data Sources: SIMBAD, VizieR, NASA ADS, arXiv

Repository: https://github.com/gcluster-tech

Development Period: 2025 academic year

Our Project Logo

Problem Statement

What's wrong with current workflow?

Current Manual Workflow

- Search SIMBAD -> manually copy coordinates
- Search VizieR -> manually cross-reference object IDs
- Search ADS -> manually filter by object name
- Search arXiv -> manually validate relevance

Our Automated Solution

- One search -> All databases simultaneously with intelligent cross-referencing, coordinate validation, and AI-powered literature filtering.

Project Overview and System Architecture

What is this platform?

Unified astronomical research platform combining multiple data sources

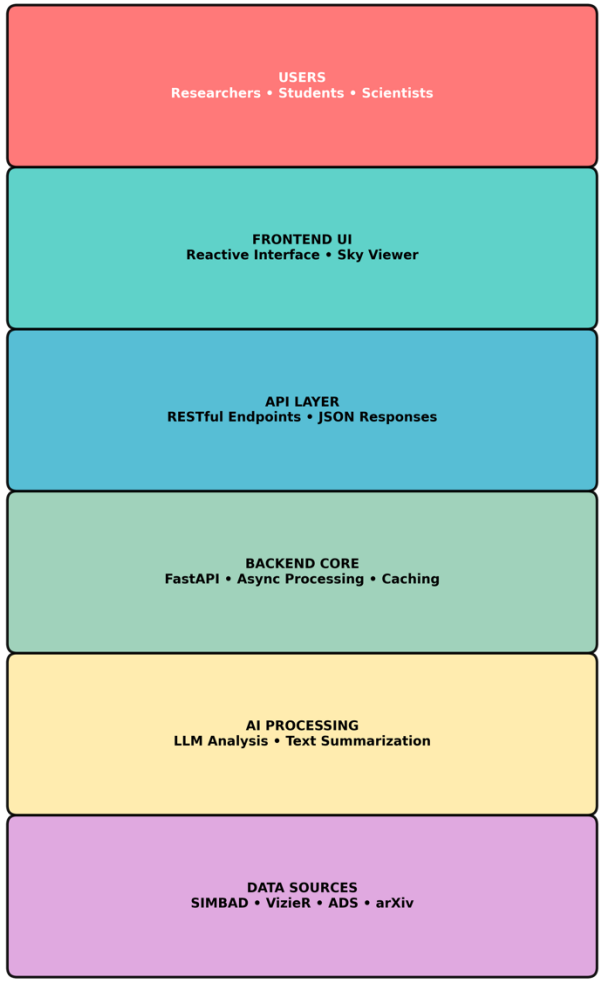
FastAPI backend with async/await architecture, database integrations and LLM processing for literature

Web-based solution with modern UI/UX design based on TailwindCSS with multi-language support and Aladin Lite sky viewer

Real-time integration with leading astronomical databases:

- SIMBAD - object database with identifiers & measurements
- VizieR - various astronomical catalogs
- NASA ADS - astrophysics literature search
- arXiv - preprint server for astronomy

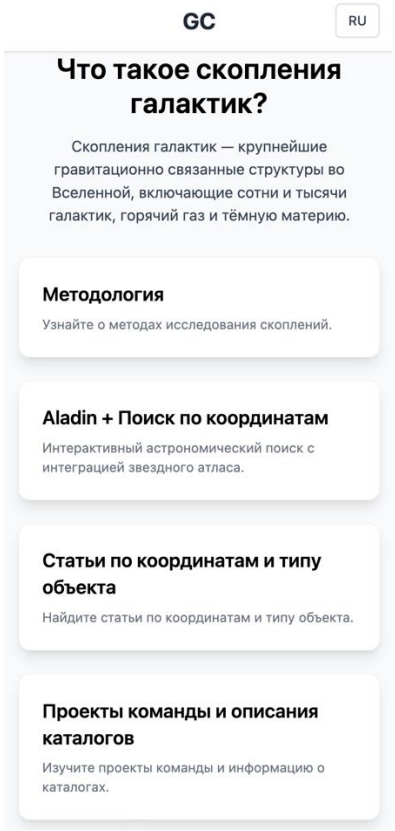
AI-powered literature summarization using LLM

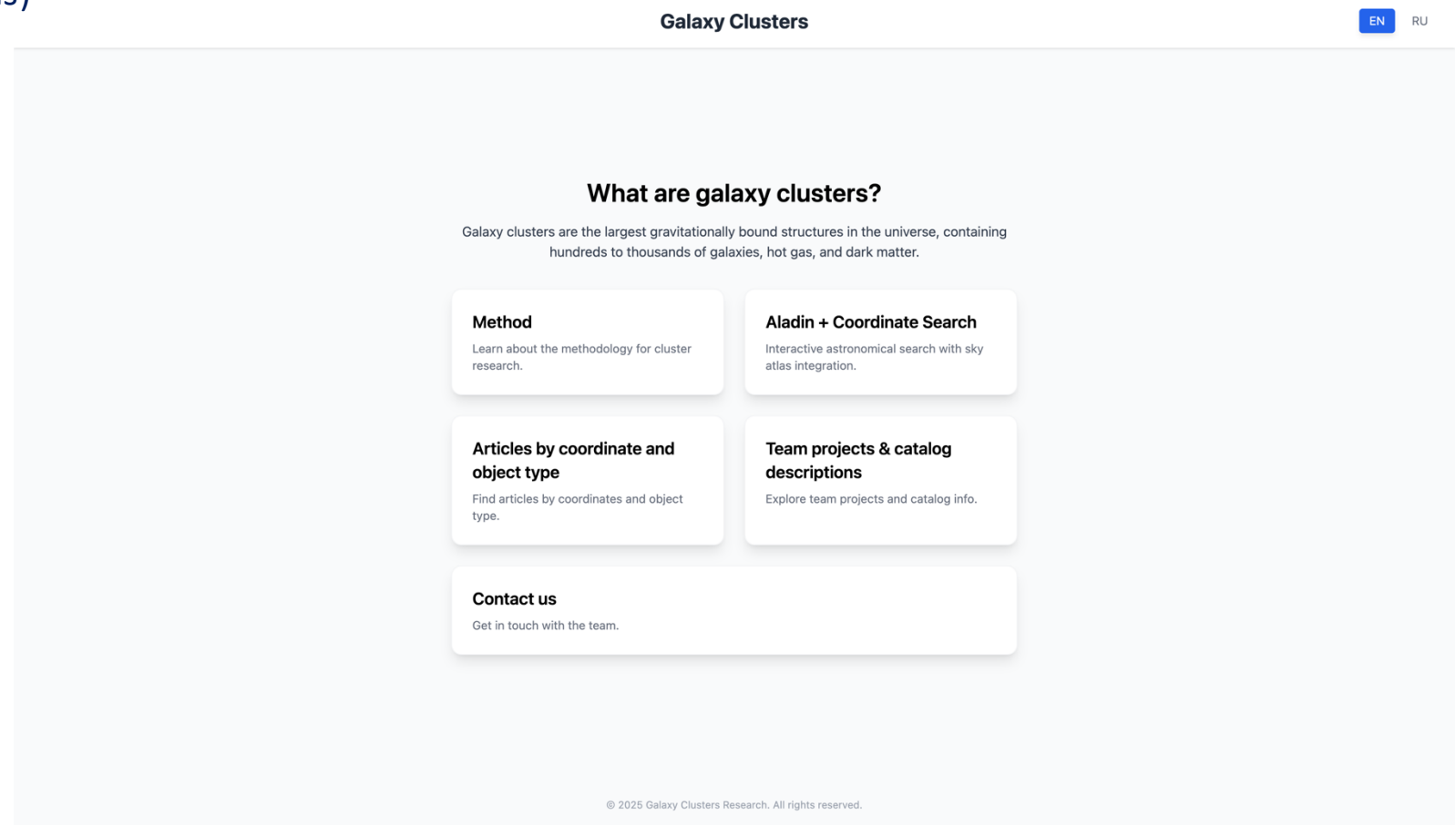


Tower of technologies

Main Interface

Landing page (mobile and desktop versions)

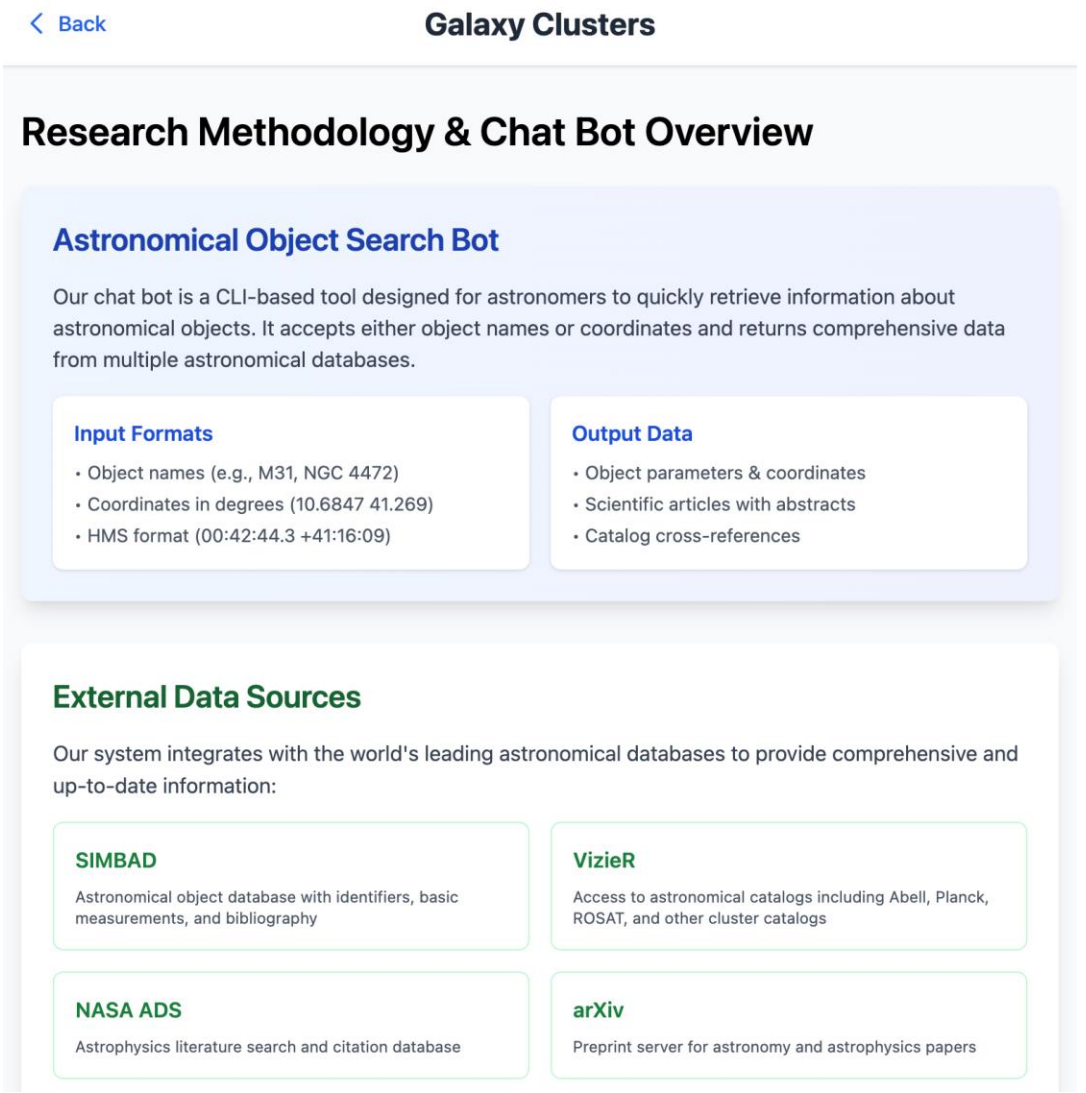




Core Functionality

What makes us different?

1. **Intelligent Cross-Database Querying**
   - Automatic coordinate conversion between databases
   - Smart object ID resolution across catalogs
   - vs manual copy-paste between sites
2. **Unified Results Correlation**
   - Automatic merging of duplicate entries
   - Distance-based object matching
   - vs separate results from each database
3. **AI-Enhanced Literature Analysis**
   - Context-aware paper filtering by object relevance
   - Automated abstract summarization with key findings
   - vs manual reading of hundreds of abstracts



Core Functionality

What makes us different?

Traditional Approach

Manual Steps (up to 15 min):

1. Open SIMBAD -> search ”Vega”
2. Copy coordinates manually
3. Open VizieR -> paste coordinates
4. Check for catalog matches
5. Open ADS -> search by name
6. Filter papers manually
7. Read abstracts one by one
8. Cross-check object IDs

Error-prone, time-consuming

Our Platform

Automated Workflow (up to 2 min):

1. Type ”Vega” -> press Enter
2. **AI automatically:**
   - Queries all 4 databases
   - Validates coordinates
   - Merges duplicate results
   - Filters relevant papers
   - Summarizes key findings
3. Review unified results

Fast, accurate, comprehensive

Search Result Interface

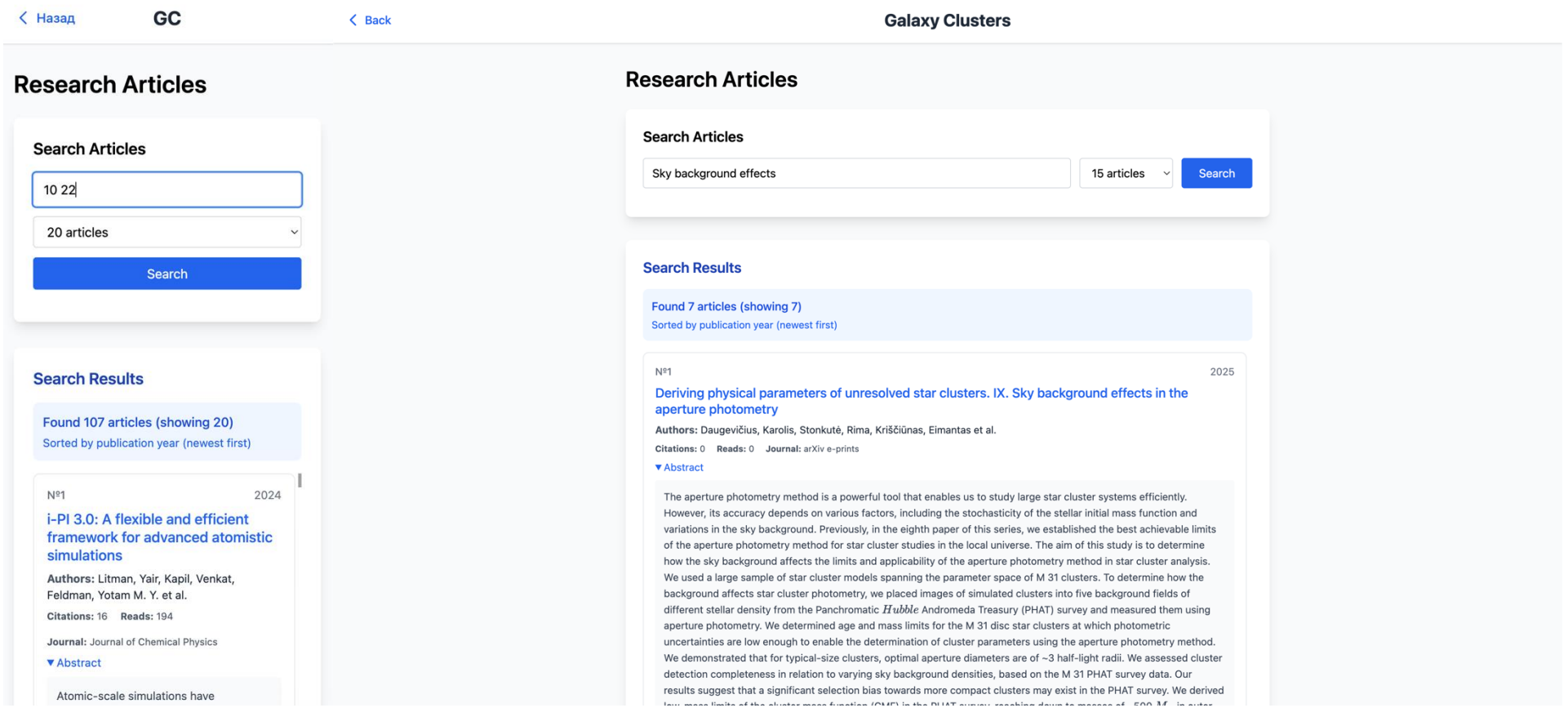
Comprehensive data display (mobile and desktop versions)

Search Results Features:

- **Interactive tables** with sorting
- **Literature links** to papers
- **Article abstracts**

Real Example

Search for ”10 22” returns cleared data from NASA ADS



AI-Powered Research Assistant

Beyond simple database queries

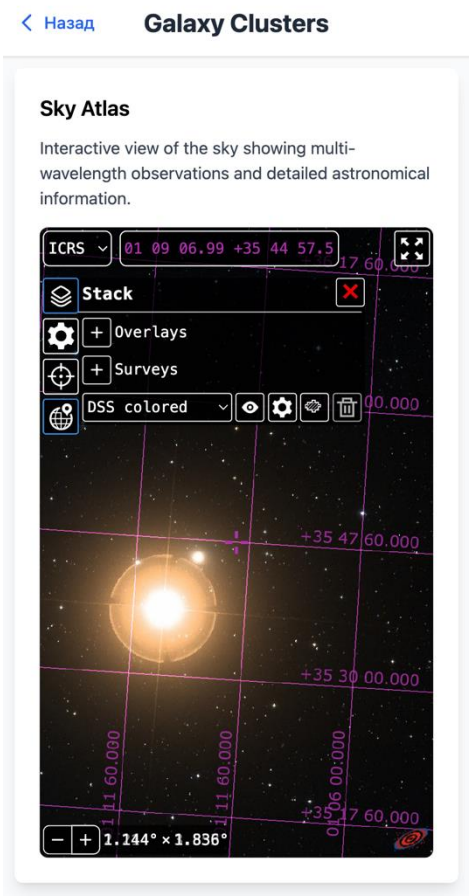
Unique AI Capabilities:

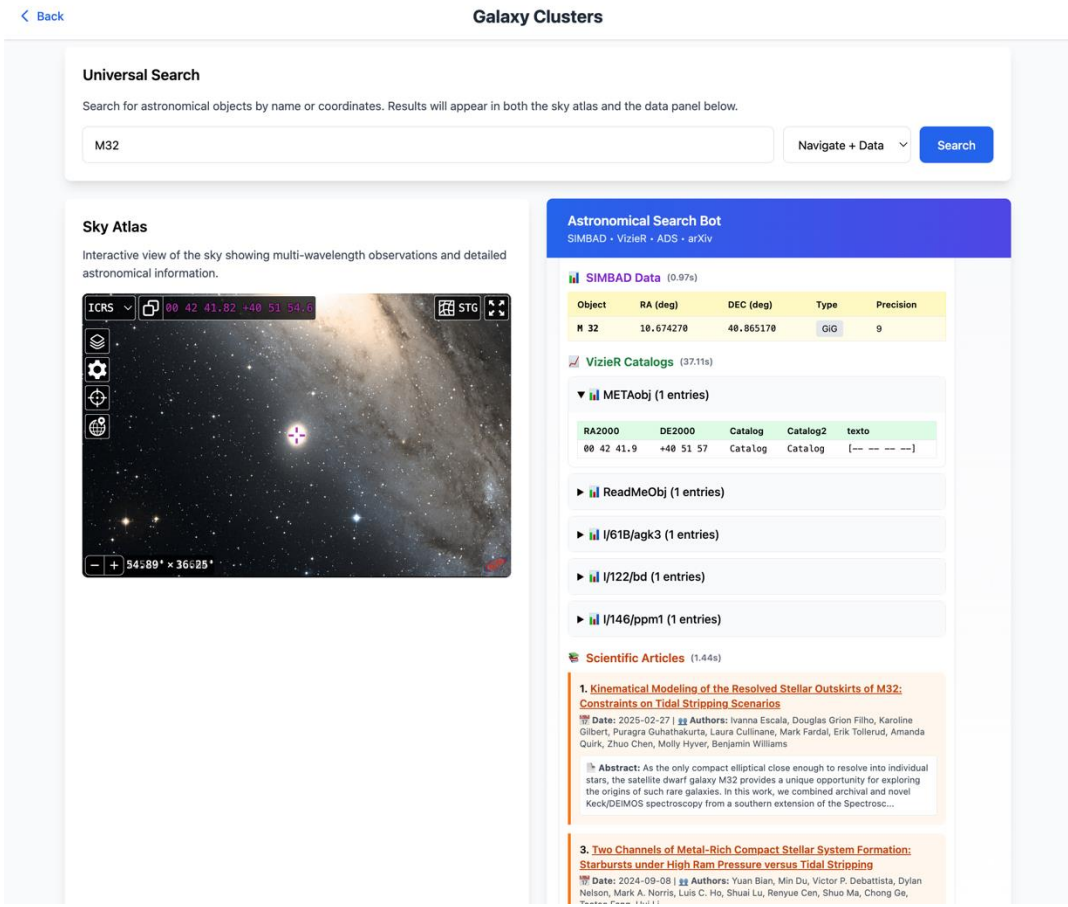
- **Contextual Understanding** – Knows when ”M31” and ”Andromeda” refer to the same object
- **Smart Paper Filtering –** Distinguishes relevant papers from noise
- **Research Gap Detection** – Identifies understudied aspects of objects

Other Features:

- **Touch-optimized** interface
- **Responsive tables** with horizontal scroll
- **Simplified navigation** for small screens
- **Fast loading** on mobile networks
- **Gesture support** for sky viewer

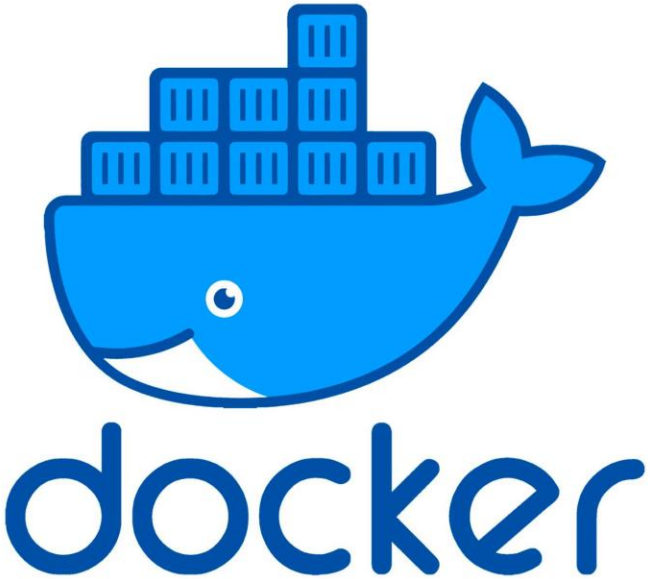
Fully cross-platform – Works seamlessly on desktop, tablet, and
mobile devices with adaptive UI.





Deployment & Scalability

Production-ready solution



Infrastructure

- **Docker containerization** for consistent deployment
- **Nginx reverse proxy** for load balancing
- **SSL/TLS encryption** for secure connection
- **Health monitoring** with automated checks
- **Log aggregation** for debugging & analytics

Scalability Features:

Horizontal scaling ready: Load balancer + multiple backend instances

Database optimization by applying caching layer that reduces API usage

Conclusion

Key Achievements

Theorem (Project Success)
Successfully created a **unified platform** *that integrates major astronomical databases with AI-powered analysis, reducing research time and improving data accessibility.*

Technical Metrics:

- **Over 10,000 objects** accessible via unified search
- **AI-powered** literature summarization in seconds
- **Real-time cross-database** queries (SIMBAD, VizieR, ADS, arXiv)
- **Fully responsive** interface for desktop and mobile

Live Demo: gclusters.tech

Questions and Discussion

Thank you for your attention!

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