**Software Requirements**

**Development Environment**

1. Operating System: Windows 10/11, macOS (10.15 or later), or any Linux distribution (e.g., Ubuntu 20.04+).
2. Node.js: Version 18.x or 20.x (LTS) for the Express backend.
3. Python: Version 3.11+ for the AI engine with Flask, scikit-learn, and TensorFlow.
4. MongoDB: Version 7.0+ (via MongoDB Atlas cloud service) for the NoSQL database.
5. Git: Version 2.50+ for version control.
6. Visual Studio Code: Version 1.101.0+ with extensions (ESLint, Python, MongoDB).
7. npm: Version 10.x+ (bundled with Node.js).
8. Postman: For API testing and development, ensuring endpoint functionality.

**Runtime Environment (Server-Side)**

1. Node.js with Express: For backend API, handling requests and database interactions.
2. Flask: For the AI recommendation engine.
3. MongoDB Atlas: Cloud-hosted database: storing user data, recipes, and feedback.
4. Edamam Recipe Search API: Real-time recipe data, requiring an app\_id and app\_key (using-Developer tier, 500 calls/month limit). It is free to use.

**Additional Tools**

1. bcrypt: For secure password hashing in user authentication.
2. jsonwebtoken: For JWT-based session management.
3. axios: For HTTP requests to the Edamam API and Flask server.
4. node-cache: For caching API responses to optimize performance.
5. nltk: For natural language processing in the AI engine.
6. scikit-learn: For TF-IDF and cosine similarity in recommendations.
7. TensorFlow: For collaborative filtering.

**Hardware Requirements**

**Development Machine**

**Minimum**:

1. Processor: Intel Core i5 (8th Gen) or equivalent (e.g., 2.0 GHz dual-core).
2. RAM: 8 GB to handle Node.js, Python, and MongoDB Atlas client.
3. Storage: 256 GB SSD for project files, virtual environment, and dependencies.
4. Display: 1920x1080 resolution for coding in VS Code.
5. Network: High-speed internet (10 Mbps+) for API calls and GitHub sync.

**Recommended**

1. Processor: Intel Core i7 (10th Gen) or equivalent (2.5 GHz quad-core) for smoother multitasking.
2. RAM: 16 GB to support multiple servers (Express, Flask) and debugging tools.
3. Storage: 512 GB SSD for larger datasets and future scalability.
4. Display: 1920x1080 or higher (e.g., 2560x1440) with a 15-17 inch screen for dual-monitor setups.
5. Network: 20 Mbps+ with low latency for real-time API testing.

**Server (Deployment)**

**Minimum** (for MVP on a cloud service: Heroku or Vercel):

1. CPU: 1 vCPU (virtual CPU) for handling basic API requests.
2. RAM: 512 MB to run Node.js and Flask concurrently.
3. Storage: 1 GB SSD for MongoDB Atlas data and cached responses.
4. Network: 10 Mbps bandwidth for user traffic.

**Recommended** (when scaling to more users will be done):

1. CPU: 2 vCPUs for handling increased concurrent requests.
2. RAM: 2 GB to support caching and AI computations.
3. Storage: 5 GB SSD for larger recipe datasets and user growth.
4. Network: 50 Mbps bandwidth with low latency for global access.

**User Device Requirements**

**Minimum**:

1. Operating System: Windows 10/11, macOS 10.15+, or any Linux distribution (two latest versions supported), or iOS 14+/Android 10+ for mobile browsers.
2. Processor: 1.5 GHz single-core or equivalent.
3. RAM: 4 GB to handle modern browsers.
4. Storage: 100 MB free space for browser cache and temporary files.
5. Display: 1280x720 resolution for responsive design.
6. Network: 5 Mbps internet connection for video conferencing (if integrated later) and API calls.
7. Browser: Chrome 87+ or Chromium-based (e.g., Edge), Firefox 78+, Safari 14+, supporting HTML5 and JavaScript.

**Recommended**:

1. Operating System: Windows 11, macOS 12+, Ubuntu 22.04+, iOS 16+, or Android 12+ for the latest features.
2. Processor: 2.0 GHz dual-core or equivalent.
3. RAM: 8 GB for smoother multitasking with multiple tabs.
4. Storage: 1 GB free space for future app enhancements.
5. Display: 1920x1080 resolution for optimal UI experience.
6. Network: 10 Mbps+ with low latency for real-time updates.
7. Browser: Latest Chrome, Firefox, or Safari with developer tools enabled.
8. Other: External webcam/microphone for potential video features, backup drive for user data.