# Solution Requirements

## Diabetic Retinopathy Detection System

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## FUNCTIONAL REQUIREMENTS

### 1. User Management

**FR-1.1: User Registration** - Allow new users to create accounts with name, email, password - Validate email format and password match - Verify email uniqueness in database - Priority: MUST HAVE

**FR-1.2: User Login** - Authenticate users with email and password - Create secure session upon successful login - Priority: MUST HAVE

**FR-1.3: User Logout** - End user session securely - Clear session data - Priority: MUST HAVE

### 2. Image Upload & Processing

**FR-2.1: Image Upload** - Accept retinal fundus images (PNG, JPG, JPEG) - Validate file format and size (max 16MB) - Secure filename handling - Priority: MUST HAVE

**FR-2.2: Image Preprocessing** - Resize images to 299x299 pixels - Normalize pixel values (0-1 range) - Convert to model input format - Priority: MUST HAVE

### 3. DR Classification

**FR-3.1: DR Prediction** - Classify DR severity into 5 classes: 1. No_DR, 2. Mild, 3. Moderate, 4. Severe, 5. Proliferate_DR - Load trained Xception model - Perform inference and extract probabilities - Priority: MUST HAVE

**FR-3.2: Confidence Score Display** - Display prediction confidence as percentage (0-100%) - Show probabilities for all 5 classes - Priority: MUST HAVE

### 4. Results Management

**FR-4.1: Prediction Display** - Show DR classification, confidence, uploaded image, timestamp - User-friendly result presentation - Priority: MUST HAVE

**FR-4.2: Prediction History Storage** - Store predictions in database with user, result, confidence, timestamp - Enable future retrieval - Priority: SHOULD HAVE

### 5. Navigation & Interface

**FR-5.1: Responsive Design** - Adapt interface to desktop, tablet, mobile - Touch-friendly on mobile devices - Priority: SHOULD HAVE

## NON-FUNCTIONAL REQUIREMENTS

### Performance

**NFR-1.1: Prediction Speed** - ≤ 5 seconds per image (HIGH)
**NFR-1.2: Page Load Time** - < 3 seconds (MEDIUM)
**NFR-1.3: Concurrent Users** - Support minimum 10 users (MEDIUM)

### Accuracy

**NFR-2.1: Classification Accuracy** - ≥ 85% overall (CRITICAL)
**NFR-2.2: Class-wise Performance** - F1-score ≥ 0.80 per class (HIGH)
**NFR-2.3: False Negative Rate** - Minimize for severe cases (CRITICAL)

### Reliability

**NFR-3.1: System Availability** - 99% uptime (HIGH)
**NFR-3.2: Error Handling** - Graceful with user-friendly messages (HIGH)
**NFR-3.3: Data Integrity** - No data loss, regular backups (HIGH)

### Security

**NFR-4.1: Authentication** - Secure session-based auth (CRITICAL)
**NFR-4.2: Data Privacy** - Protected user data, HIPAA considerations (CRITICAL)
**NFR-4.3: Secure File Upload** - Validate and sanitize files (HIGH)
**NFR-4.4: Password Security** - Bcrypt hashing for production (CRITICAL)

### Usability

**NFR-5.1: User Interface** - Intuitive for non-technical users (HIGH)
**NFR-5.2: Accessibility** - WCAG 2.1 guidelines (MEDIUM)
**NFR-5.3: Error Messages** - Clear, actionable, non-technical (MEDIUM)

### Compatibility

**NFR-6.1: Browser Support** - Chrome, Firefox, Safari, Edge (latest 2 versions) (HIGH)
**NFR-6.2: Operating System** - Windows, macOS, Linux, iOS, Android (HIGH)
**NFR-6.3: Screen Resolutions** - 320px to 1920px+ (MEDIUM)

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## DATA REQUIREMENTS

### Training Data

- Minimum 3,000 labeled fundus images (Actual: 3,662)
- All 5 DR severity levels represented
- High-quality PNG images

### User Data

- User information: Name, email, password, registration date
- Prediction records: User, prediction, confidence, timestamp, image name
- Storage: JSON documents in IBM Cloudant

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## INTERFACE REQUIREMENTS

### User Interface

- Registration Form: Name, Email, Password, Confirm Password
- Login Form: Email, Password
- Prediction Interface: File upload, submit button, result display

### API Interface

- Model Inference API: Input (image array) → Output (class probabilities)
- Database API: CRUD operations via Cloudant REST API

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## CONSTRAINTS

**Technical:** Python 3.8+, TensorFlow 2.x, JavaScript-enabled browser, internet connection
**Resource:** 4-6 week timeline, 1-3 developers, minimal budget
**Regulatory:** Medical device regulations, data privacy laws (HIPAA, GDPR)

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## ASSUMPTIONS

1. Users have basic computer literacy
2. Retinal images are properly captured
3. Internet connectivity available
4. Modern web browser installed
5. IBM Cloud account for Cloudant
6. Training data properly labeled

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## ACCEPTANCE CRITERIA

✅ Users can register and login
✅ Users can upload retinal images
✅ System classifies DR with ≥85% accuracy
✅ Predictions display within 5 seconds
✅ Results show class and confidence
✅ Predictions stored in database
✅ Interface is responsive

✅ System handles errors gracefully
✅ Security measures implemented
✅ Documentation complete

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## OUT OF SCOPE (Future Versions)

Mobile app, batch processing, PDF reports, email notifications, EHR integration, multi-language support, heatmap visualization, admin dashboard, analytics