AI-Powered Crypto Risk Dashboard - Software Requirements Specification (SRS)

1. Project Overview

1.1 Purpose

The AI-Powered Crypto Risk Dashboard is a web application that provides real-time portfolio risk analysis for cryptocurrency investments using advanced AI/ML techniques and on-chain data analysis.

1.2 Problem Statement

Current portfolio trackers focus on displaying numbers (prices, gains/losses) but fail to provide actionable risk insights. Most retail crypto investors lack sophisticated risk management tools, leading to poor diversification and exposure to unnecessary volatility.

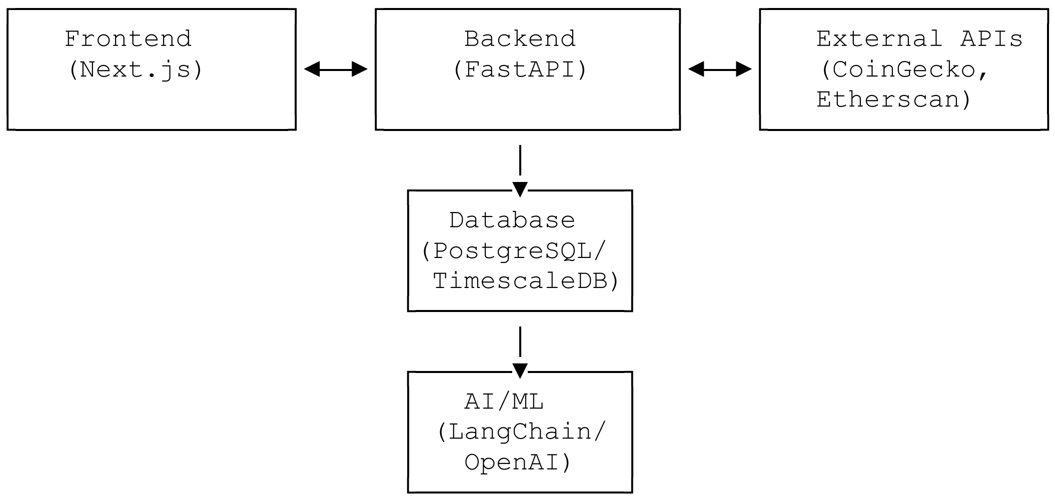
1.3 Solution Overview

A comprehensive dashboard that combines real-time market data with AI-powered analysis to provide:

- Visual risk assessment through interactive heatmaps
- Personalized portfolio insights using LLM technology
- Automated alerts for risk threshold breaches
- Actionable recommendations for portfolio optimization

2. System Architecture

2.1 High-Level Architecture


Frontend (Next.js)
Backend (FastAPI)
External APIs (CoinGecko, Etherscan)
Database (PostgreSQL/ TimescaleDB)
AI/ML (LangChain/ OpenAI)

2.2 Component Architecture

```
Frontend (Next.js + TypeScript)
├── pages/
│   ├── dashboard/           # Main portfolio overview
│   ├── risk-analysis/       # Detailed risk metrics
│   ├── insights/           # AI-generated insights
│   └── alerts/             # Alert management
├── components/
│   ├── charts/             # Risk heatmaps, allocation charts
│   ├── portfolio/          # Portfolio management UI
│   ├── alerts/             # Alert configuration
│   └── common/             # Shared UI components
├── hooks/                  # Custom React hooks
├── utils/                  # Helper functions
└── types/                  # TypeScript definitions

Backend (FastAPI + Python)
├── api/
│   ├── portfolio/          # Portfolio CRUD operations
│   ├── risk/               # Risk calculation endpoints
│   ├── insights/           # AI insights endpoints
│   └── alerts/             # Alert management endpoints
├── core/
│   ├── risk_engine/        # Risk calculation logic
│   ├── ai_engine/          # LangChain integration
│   └── data_fetchers/      # External API integrations
├── models/                 # Database models
├── schemas/                # Pydantic schemas
└── utils/                  # Helper functions
```

3. Functional Requirements

3.1 User Stories

Epic 1: Portfolio Management

- **US-001**: As a user, I want to add cryptocurrencies to my portfolio so that I can track my investments
- **US-002**: As a user, I want to input my holdings (amount, purchase price) so the system can calculate my current position
- **US-003**: As a user, I want to connect my wallet addresses so the system can automatically track my holdings

Epic 2: Risk Analysis

- **US-004**: As a user, I want to see a visual heatmap of my portfolio risk so I can quickly identify high-risk positions
- **US-005**: As a user, I want to see volatility metrics for each holding so I can understand individual asset risk
- **US-006**: As a user, I want to see portfolio-level risk metrics (Sharpe ratio, VaR) so I can assess overall portfolio health
- **US-007**: As a user, I want to see concentration risk analysis so I can identify over-allocation issues

Epic 3: AI Insights

- **US-008**: As a user, I want weekly AI-generated portfolio insights so I can receive personalized recommendations
- **US-009**: As a user, I want AI explanations of risk metrics so I can understand what they mean for my portfolio
- **US-010**: As a user, I want AI-powered rebalancing suggestions so I can optimize my allocation

Epic 4: Alerts & Monitoring

- **US-011**: As a user, I want to set price alerts so I can be notified of significant market movements
- **US-012**: As a user, I want risk threshold alerts so I can be warned when my portfolio becomes too risky
- **US-013**: As a user, I want to receive alerts via email and Telegram so I can choose my preferred notification method

3.2 Acceptance Criteria

Portfolio Heatmap (US-004)

- Display portfolio holdings as colored tiles based on risk level (green=low, yellow=medium, red=high)
- Tile size represents allocation percentage
- Hover shows detailed risk metrics
- Click drills down to individual asset analysis
- Updates in real-time with price changes

AI Weekly Insights (US-008)

- Generate comprehensive weekly portfolio analysis using GPT-4
- Include specific recommendations (e.g., "Consider reducing Bitcoin allocation from 65% to 45%")
- Highlight concentration risks and diversification opportunities
- Compare portfolio performance to market benchmarks
- Provide sentiment analysis based on recent market conditions

4. Database Schema Design

4.1 Core Tables

```sql
-- Users and Authentication
CREATE TABLE users (
    id UUID PRIMARY KEY DEFAULT gen_random_uuid(),
    email VARCHAR(255) UNIQUE NOT NULL,
    password_hash VARCHAR(255) NOT NULL,
    created_at TIMESTAMP WITH TIME ZONE DEFAULT NOW(),
    updated_at TIMESTAMP WITH TIME ZONE DEFAULT NOW()
);
```

```sql
-- Portfolio Management
CREATE TABLE portfolios (
    id UUID PRIMARY KEY DEFAULT gen_random_uuid(),
    user_id UUID REFERENCES users(id) ON DELETE CASCADE,
    name VARCHAR(100) NOT NULL,
    description TEXT,
    created_at TIMESTAMP WITH TIME ZONE DEFAULT NOW(),
    updated_at TIMESTAMP WITH TIME ZONE DEFAULT NOW()
);

CREATE TABLE crypto_assets (
    id UUID PRIMARY KEY DEFAULT gen_random_uuid(),
    symbol VARCHAR(20) UNIQUE NOT NULL,
    name VARCHAR(100) NOT NULL,
    coingecko_id VARCHAR(100),
    contract_address VARCHAR(100),
    created_at TIMESTAMP WITH TIME ZONE DEFAULT NOW()
);

CREATE TABLE portfolio_holdings (
    id UUID PRIMARY KEY DEFAULT gen_random_uuid(),
    portfolio_id UUID REFERENCES portfolios(id) ON DELETE CASCADE,
    asset_id UUID REFERENCES crypto_assets(id),
    quantity DECIMAL(36, 18) NOT NULL,
    average_cost DECIMAL(18, 8),
    created_at TIMESTAMP WITH TIME ZONE DEFAULT NOW(),
    updated_at TIMESTAMP WITH TIME ZONE DEFAULT NOW()
);

-- Time Series Data (TimescaleDB Hypertables)
CREATE TABLE price_history (
    time TIMESTAMP WITH TIME ZONE NOT NULL,
    asset_id UUID REFERENCES crypto_assets(id),
    price_usd DECIMAL(18, 8) NOT NULL,
    volume_24h DECIMAL(20, 2),
    market_cap DECIMAL(20, 2),
    PRIMARY KEY (time, asset_id)
);

SELECT create_hypertable('price_history', 'time');

CREATE TABLE risk_metrics (
    time TIMESTAMP WITH TIME ZONE NOT NULL,
    portfolio_id UUID REFERENCES portfolios(id),
    volatility_30d DECIMAL(8, 4),
    volatility_90d DECIMAL(8, 4),
    sharpe_ratio DECIMAL(8, 4),
    max_drawdown DECIMAL(8, 4),
    var_95 DECIMAL(18, 8),
    concentration_risk DECIMAL(8, 4),
    PRIMARY KEY (time, portfolio_id)
);

SELECT create_hypertable('risk_metrics', 'time');

-- AI Insights
CREATE TABLE ai_insights (
    id UUID PRIMARY KEY DEFAULT gen_random_uuid(),
    portfolio_id UUID REFERENCES portfolios(id) ON DELETE CASCADE,
    insight_type VARCHAR(50) NOT NULL, -- 'weekly', 'alert', 'rebalancing'
    content TEXT NOT NULL,
    risk_score INTEGER CHECK (risk_score >= 1 AND risk_score <= 10),
    recommendations JSONB,
    created_at TIMESTAMP WITH TIME ZONE DEFAULT NOW()
);

-- Alert System
CREATE TABLE alert_rules (
    id UUID PRIMARY KEY DEFAULT gen_random_uuid(),
    user_id UUID REFERENCES users(id) ON DELETE CASCADE,
    rule_type VARCHAR(50) NOT NULL, -- 'price_change', 'risk_threshold',
'portfolio_concentration'
    conditions JSONB NOT NULL,
    notification_channels JSONB NOT NULL, -- ['email', 'telegram']
    is_active BOOLEAN DEFAULT TRUE,
    created_at TIMESTAMP WITH TIME ZONE DEFAULT NOW()
);

CREATE TABLE alert_history (
    id UUID PRIMARY KEY DEFAULT gen_random_uuid(),
    rule_id UUID REFERENCES alert_rules(id) ON DELETE CASCADE,
    triggered_at TIMESTAMP WITH TIME ZONE DEFAULT NOW(),
    message TEXT NOT NULL,
    notification_sent BOOLEAN DEFAULT FALSE
);
```

4.2 Indexes for Performance

```
-- Optimize time-series queries
CREATE INDEX idx_price_history_asset_time ON price_history (asset_id, time
DESC);
CREATE INDEX idx_risk_metrics_portfolio_time ON risk_metrics (portfolio_id,
time DESC);

-- Optimize portfolio queries
CREATE INDEX idx_portfolio_holdings_portfolio ON portfolio_holdings
(portfolio_id);
CREATE INDEX idx_ai_insights_portfolio_created ON ai_insights
(portfolio_id, created_at DESC);
```

5. API Endpoint Specifications

5.1 Portfolio Endpoints

```
GET /api/v1/portfolios
- Get user's portfolios
- Returns: List of portfolios with basic info

POST /api/v1/portfolios
- Create new portfolio
- Body: {name, description}
- Returns: Created portfolio object

GET /api/v1/portfolios/{portfolio_id}
- Get portfolio details with current holdings
- Returns: Portfolio with holdings, current values, allocations

POST /api/v1/portfolios/{portfolio_id}/holdings
- Add/update holding in portfolio
- Body: {asset_symbol, quantity, average_cost}
- Returns: Updated holding object

DELETE /api/v1/portfolios/{portfolio_id}/holdings/{holding_id}
- Remove holding from portfolio
- Returns: Success confirmation
```

5.2 Risk Analysis Endpoints

```
GET /api/v1/portfolios/{portfolio_id}/risk-metrics
- Get current risk metrics for portfolio
- Query params: ?period=30d|90d|1y
- Returns: {volatility, sharpe_ratio, max_drawdown, var_95,
concentration_risk}

GET /api/v1/portfolios/{portfolio_id}/risk-heatmap
- Get data for risk heatmap visualization
- Returns: Holdings with risk scores, colors, allocations

GET /api/v1/portfolios/{portfolio_id}/correlation-matrix
- Get correlation matrix between portfolio holdings
- Returns: Matrix data for visualization
```

5.3 AI Insights Endpoints

```
GET /api/v1/portfolios/{portfolio_id}/insights
- Get AI insights for portfolio
- Query params: ?type=weekly|alert|rebalancing&limit=10
- Returns: List of AI-generated insights

POST /api/v1/portfolios/{portfolio_id}/insights/generate
- Trigger new AI insight generation
- Body: {insight_type}
- Returns: Generated insight object

GET /api/v1/portfolios/{portfolio_id}/recommendations
- Get current AI recommendations
- Returns: Structured recommendations with priorities
```

5.4 Alert Endpoints

```
GET /api/v1/alerts/rules
- Get user's alert rules
- Returns: List of configured alert rules

POST /api/v1/alerts/rules
- Create new alert rule
- Body: {rule_type, conditions, notification_channels}
- Returns: Created rule object

PUT /api/v1/alerts/rules/{rule_id}
- Update alert rule
- Body: Updated rule configuration
- Returns: Updated rule object

GET /api/v1/alerts/history
- Get alert history
- Query params: ?limit=50&offset=0
- Returns: Paginated alert history
```

5.5 Market Data Endpoints

```
GET /api/v1/market/prices
- Get current prices for specified assets
- Query params: ?symbols=BTC,ETH,ADA
- Returns: Current prices with 24h change

GET /api/v1/market/assets/search
- Search for crypto assets
- Query params: ?q=bitcoin
- Returns: List of matching assets

GET /api/v1/market/assets/{asset_id}/history
- Get price history for asset
- Query params: ?period=7d|30d|90d|1y
- Returns: Time series price data
```

6. Frontend Component Hierarchy

6.1 Page Components

```
src/
├── app/
│   ├── dashboard/
│   │   └── page.tsx           # Portfolio overview dashboard
│   ├── risk-analysis/
│   │   └── page.tsx           # Detailed risk metrics
│   ├── insights/
│   │   └── page.tsx           # AI insights display
│   ├── alerts/
│   │   └── page.tsx           # Alert management
│   └── layout.tsx             # Root layout with navigation
├── components/
│   ├── dashboard/
│   │   ├── PortfolioOverview.tsx
│   │   ├── AssetAllocation.tsx
│   │   └── QuickStats.tsx
│   ├── charts/
│   │   ├── RiskHeatmap.tsx
│   │   ├── AllocationChart.tsx
│   │   ├── VolatilityChart.tsx
│   │   └── CorrelationMatrix.tsx
│   ├── portfolio/
│   │   ├── HoldingsList.tsx
│   │   ├── AddHolding.tsx
│   │   └── PortfolioSettings.tsx
│   ├── insights/
│   │   ├── WeeklyInsights.tsx
│   │   ├── RecommendationCard.tsx
│   │   └── InsightHistory.tsx
│   ├── alerts/
│   │   ├── AlertRuleForm.tsx
│   │   ├── AlertHistory.tsx
│   │   └── NotificationSettings.tsx
│   └── common/
│       ├── Header.tsx
│       ├── Sidebar.tsx
│       ├── LoadingSpinner.tsx
│       └── ErrorBoundary.tsx
│
```

```
└── hooks/
    ├── usePortfolio.ts
    ├── useRiskMetrics.ts
    ├── useRealTimePrice.ts
    └── useAlerts.ts
```

6.2 State Management Structure

```
// Global State (React Query + Context)
interface AppState {
  user: User | null;
  selectedPortfolio: Portfolio | null;
  realTimePrices: Record<string, number>;
  alerts: Alert[];
}

// Portfolio State
interface Portfolio {
  id: string;
  name: string;
  holdings: Holding[];
  totalValue: number;
  dayChange: number;
  riskScore: number;
}

// Risk Metrics State
interface RiskMetrics {
  volatility30d: number;
  sharpeRatio: number;
  maxDrawdown: number;
  concentrationRisk: number;
  var95: number;
}
```

7. Development Timeline & Milestones

7.1 Phase 1: Foundation (Days 1-2)

Milestone 1.1: Project Setup

- ✅ Repository structure created
- ✅ Development environment configured
- ✅ Database schema implemented
- ✅ Basic FastAPI server running
- ✅ Next.js frontend initialized

Milestone 1.2: Data Integration

- ✅ CoinGecko API integration working
- ✅ Price data fetching and storage
- ✅ Basic CRUD operations for portfolios
- ✅ Database seeded with sample data

7.2 Phase 2: Core Features (Days 3-4)

Milestone 2.1: Portfolio Management

- ✅ Portfolio creation and editing
- ✅ Holdings management (add/edit/remove)
- ✅ Real-time portfolio valuation
- ✅ Basic portfolio dashboard

Milestone 2.2: Risk Engine

- ✅ Risk calculation algorithms implemented
- ✅ Volatility and Sharpe ratio calculations
- ✅ Risk metrics API endpoints
- ✅ Risk heatmap visualization

7.3 Phase 3: AI Integration (Days 4-5)

Milestone 3.1: LangChain Setup

- ✅ LangChain integration configured
- ✅ GPT-4 prompt engineering completed
- ✅ AI insight generation working
- ✅ Structured output parsing

Milestone 3.2: Frontend Polish

- ✅ Interactive charts implemented
- ✅ Real-time data updates
- ✅ Responsive design completed
- ✅ Error handling and loading states

7.4 Phase 4: Advanced Features (Days 5-6)

Milestone 4.1: Alert System

- ✅ Alert rule configuration
- ✅ Email notification system
- ✅ Telegram bot integration
- ✅ Alert history tracking

Milestone 4.2: Performance & Polish

- ✅ Performance optimization
- ✅ Caching implementation
- ✅ UI/UX improvements
- ✅ Mobile responsiveness

7.5 Phase 5: Deployment (Days 6-7)

Milestone 5.1: Production Setup

- ✅ Frontend deployed to Vercel
- ✅ Backend deployed to Railway/Render
- ✅ Database hosted (Supabase/PlanetScale)
- ✅ Domain and SSL configured

Milestone 5.2: Documentation & Demo

- ✅ Complete documentation written
- ✅ Demo video recorded
- ✅ Portfolio presentation prepared
- ✅ Performance monitoring setup

8. Technical Specifications

8.1 Performance Requirements

- **Page Load Time**: < 2 seconds for initial load
- **Real-time Updates**: < 500ms latency for price updates
- **API Response Time**: < 200ms for portfolio operations
- **Database Queries**: < 100ms for risk calculations
- **Concurrent Users**: Support 100+ concurrent users

8.2 Security Requirements

- JWT-based authentication
- Input validation and sanitization
- Rate limiting on API endpoints
- Secure password hashing (bcrypt)
- CORS configuration
- Environment variable management

8.3 Scalability Considerations

- Horizontal scaling for FastAPI backend
- Database connection pooling
- Redis caching for frequent queries
- CDN for static assets
- Background job processing for heavy calculations

9. Success Metrics

9.1 Technical Metrics

- ✅ 100% uptime during demo period
- ✅ < 2s average page load time
- ✅ All API endpoints responding < 200ms
- ✅ Real-time updates working smoothly
- ✅ Mobile-responsive design

9.2 Feature Completion

- ✅ Portfolio management fully functional
- ✅ Risk heatmap displaying accurate data
- ✅ AI insights generating meaningful recommendations
- ✅ Alert system sending notifications
- ✅ Professional documentation and demo

9.3 Portfolio Readiness

- ✅ Live deployed application
- ✅ Professional GitHub repository
- ✅ Comprehensive documentation
- ✅ Demo video showcasing features
- ✅ Technical blog post written

10. Risk Assessment & Mitigation

10.1 Technical Risks

Risk: API rate limiting from external services **Mitigation**: Implement caching, multiple API sources, graceful degradation

Risk: Real-time data synchronization issues **Mitigation**: WebSocket fallback, local state management, error boundaries

Risk: AI API costs exceeding budget **Mitigation**: Response caching, request batching, usage monitoring

10.2 Timeline Risks

Risk: Complex risk calculations taking longer than expected **Mitigation**: Start with basic calculations, iterate and improve

Risk: AI integration complexity **Mitigation**: Begin with simple prompts, expand gradually

Risk: Deployment issues **Mitigation**: Deploy early and often, have backup hosting options

This comprehensive SRS provides the foundation for building a production-ready crypto risk dashboard. Each component is designed to work together seamlessly while maintaining modularity for easier development and testing.