

# Module Interface Specification for SFWRENG 4G06 - Capstone Design Process

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# 1 Revision History

Date	Version	Notes
Date 1	1.0	Notes
Date 2	1.1	Notes

## 2 Symbols, Abbreviations and Acronyms

See SRS Documentation at [SRS Documentation](#).

This section records acronyms and abbreviations for easy reference. Additional terms specific to the Module Interface Specification (MIS) are included below.

Table 1: Symbols, Abbreviations, and Acronyms

Symbol / Acronym	Description
AC	Anticipated Change.
ADT	Abstract Data Type.
AHP	Analytic Hierarchy Process, method for pairwise comparison and ranking of libraries.
AI	Artificial Intelligence.
API	Application Programming Interface, mechanism for data retrieval (e.g., GitHub API, PyPI API).
BWM	Best–Worst Method.
CAS	Computing and Software Department (McMaster University).
CI/CD	Continuous Integration / Continuous Deployment, automated testing and deployment pipeline used in GitHub Actions.
CSV	Comma-Separated Values, used as an export format for datasets.
DAG	Directed Acyclic Graph.
DB	Database, a MySQL instance used for persistent data storage.
Domain	Research Software Domain.
Excel Sheets	Existing manual tools previously used for data collection.
Infrastructure	University-provided resources such as hosting, databases, and servers.
JSON	JavaScript Object Notation, data interchange format used by the system’s APIs.
LLM	Large Language Model.
M	Module.
MG	Module Guide.
MIS	Module Interface Specification (this document).
ML	Machine Learning.
NN	Neural Network.
NNL	Neural Network Libraries.
ORM	Object Relational Mapper, Django ORM used for database interactions.
OS	Operating System.
Packages	Software Packages.
PoC	Proof of Concept, demonstration validating workflow integration.

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<b>Symbol / Acronym</b>	<b>Description</b>
R	Requirement.
REST API	Representational State Transfer API, communication style used between the frontend (React) and backend (Django).
Research Subteam	Student group applying the methodology and writing the research paper.
SC	Scientific Computing.
SFWRENG 4G06	Capstone Design Process.
SRS	Software Requirements Specification.
SSB	Skew-Symmetric Bilinear.
Stakeholders	All individuals involved in or affected by the project (e.g., supervisor, researchers, domain expert).
Supervisor	Faculty member overseeing the project.
Tool	The software being developed to automate data collection, visualization, and storage.
UI	User Interface, front-end component built with React.
UI/UX	User Interface and User Experience.
UC	Unlikely Change.
VnV	Verification and Validation, process of ensuring correctness and meeting stakeholder needs.

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## 3 Introduction

The following document details the **Module Interface Specifications (MIS)** for the **Domain Assessment Tool**, a web-based system that automates data collection, analysis, and visualization to evaluate different research domains. The system enables users to systematically compare libraries, frameworks, or technologies by applying a structured methodology that combines both quantitative metrics and qualitative insights.

This tool is implemented using a **React** frontend and a **Django** backend, with a **MySQL** database managed through the Django Object–Relational Mapper (ORM). Data exchange between system components follows a **REST API** architecture using **JSON** payloads. These technologies were selected based on their stability and are considered **unlikely to change** throughout the project lifecycle.

Complementary documents include the [System Requirements Specification \(SRS\)](#) and the [Module Guide \(MG\)](#). The full documentation and implementation are maintained in the project’s GitHub repository at [DomainX](#).

## 4 Notation

The **Module Interface Specification (MIS)** follows the notation and principles of [Hoffman and Strooper \(1995\)](#), with adaptations from [Ghezzi et al. \(2003\)](#). Mathematical conventions align with Chapter 3 of [Hoffman and Strooper \(1995\)](#) and notations used in **SFWRENG 4G06 – Capstone Design Process**.

### 4.1 General Conventions

- **Assignment:**  $x := e$
- **Conditional rules:**  $(c_1 \Rightarrow r_1 \mid c_2 \Rightarrow r_2 \mid \dots \mid c_n \Rightarrow r_n)$
- **Parameter modes:** `in`, `out`
- **Optional parameter:** `[param]`
- **Exceptions:** functions list `ExceptionName` in an *Exceptions* column; raising an exception denotes a partial function on the exceptional domain.
- **Pre/postconditions:** `requires P / ensures Q`
- **Undefined value / error sentinel:**  $\perp$

### 4.2 Logic and Set Notation

- **Logical operators:**  $\neg, \wedge, \vee, \Rightarrow, \Leftrightarrow$
- **Quantifiers:**  $\forall x \in S \cdot P(x), \exists x \in S \cdot P(x)$

- **Sets:**  $\emptyset$ ,  $\{x \in S | P(x)\}$ , union  $A \cup B$ , intersection  $A \cap B$ , difference  $A \setminus B$ , cardinality  $|S|$
- **Sequences/lists:**  $(a_1, \dots, a_n)$ ; concatenation  $s \| t$ ; length  $|s|$
- **Maps/dictionaries:**  $m : K \rightarrow V$ ; application  $m(k)$ ; update  $m[k \mapsto v]$

### 4.3 Primitive and Derived Types

Data Type	Notation	Description
character	char	Single Unicode character.
integer	$\mathbb{Z}$	Whole numbers in $(-\infty, \infty)$ .
natural number	$\mathbb{N}$	Non-negative integers $(0, 1, 2, \dots)$ .
real	$\mathbb{R}$	Real numbers.
boolean	bool	True or False.
string	string	Finite sequence of characters.
tuple	$(T_1, \dots, T_n)$	Fixed-size, ordered collection, possibly heterogeneous.
list / sequence	list( $T$ )	Variable-size sequence of $T$ .
set	$\mathcal{P}(T)$	Finite subset of $T$ (power-set elements).
dictionary / map	dict( $K, V$ )	Finite mapping from $K$ to $V$ .
option / optional type	Option( $T$ )	Either Some( $T$ ) or None.

Table 2: Primitive and Derived Data Types

### 4.4 Units and Identifiers

- **Timestamps:** use ISO 8601 (e.g., 2025-11-11T09:30:00Z).
- **Durations:** explicit units (e.g., `min`, `hrs`).
- **Identifiers:** `domainID`, `metricID`, and `packageID` are opaque strings unless otherwise specified.

These conventions are used to define interfaces, state variables, environment variables, and access routines throughout the MIS. Derived structures (lists, maps, sets, tuples) represent collections of domain records, configuration parameters, and API payloads. Local functions are defined by their type signatures and input/output relationships.

## 5 Module Decomposition

The following table summarizes the hierarchical organization of modules for the Domain Assessment Tool. Level 1 modules correspond to high-level abstraction layers, while Level 2 modules provide specific functionality within each layer.

Table 3: Module Hierarchy

Level 1	Level 2
Hardware-Hiding Module	Browser Module
Behaviour-Hiding Module	Domains Page Module Application UI Module Data Edit Module User Authentication Module User Role Access Module User Page Module Automated Metrics Module Comparison Module Configuration Module
Software Decision Module	System API Gateway Module Ranking Algorithm Module Graphing Module File Import Module File Export Module Repository API Module Database Persistence Module Logging Module



# 6 Module Interface Specifications

## 6.1 MIS of Browser Module (M2)

### 6.1.1 Module

Provides the runtime container for the React front end. The browser renders HTML/CSS/JS, maintains the page's Document Object Model (DOM), collects user input (mouse, keyboard), and handles network requests to the backend.

### 6.1.2 Uses

None (external, platform-provided).

### 6.1.3 Syntax

**Exported Constants** None.

**Exported Access Programs** None.

### 6.1.4 Semantics

#### State Variables

- **domTree**: the in-memory Document Object Model for the current page.
- **cookieStore**: key-value cookie storage scoped to the site.
- **localStorage/sessionStorage**: Web Storage used by the UI for small client-side state.
- **cache**: HTTP/resource cache managed by the browser.

#### Environment Variables

- Display surface and window manager (screen, viewport, device DPI).
- Network stack (HTTP/HTTPS, TLS).

#### Assumptions

- A modern standards-compliant browser (Chromium/Chrome, Firefox, Safari).
- Supports HTML5, ECMAScript 2020+, Fetch API, CORS, and Web Storage.
- Site is served over HTTPS; backend endpoints expose JSON over REST.

**Access Routine Semantics** Not applicable (no routines exported by this module in our system).

**Local Functions** Not applicable.

## 6.2 MIS of Application UI Module (M3)

### 6.2.1 Module

Provides the React-based front-end shell (routing, layout, and common UI state) that renders all pages and components of the DomainX app, and wires user interactions to the rest of the system.

### 6.2.2 Uses

Browser Module (M2)

System API Gateway Module (M10)

Graphing Module (M12)

File Import Module (M13)

File Export Module (M14)

Repository API Module (M15)

### 6.2.3 Syntax

#### Exported Constants

- **APP\_TITLE** = “DomainX”
- **DEFAULT\_ROUTE** = “/domains”
- **TOAST\_DURATION\_MS** = 4000

#### Exported Access Programs

Name	In	Out	Exceptions
initAppShell	none	mountedRoot	RenderError
navigateTo	routeID, [params]	renderedView	RouteNotFound
renderComponent	componentID, props	renderedFragment	RenderError
handleUserAction	actionType, payload	dispatchResult	ActionError
showNotification	message, severity	successFlag	None

## 6.2.4 Semantics

### State Variables

- **currentRoute**: the active route (path and params).
- **uiState**: global UI model (loading flags, toasts, modal state).
- **sessionContext**: authenticated user + role snapshot for conditional rendering.

### Environment Variables

- Browser DOM (document, window, viewport).
- React runtime (React 18) and router (e.g., React Router) in a SPA environment.

### Assumptions

- Implemented with React (per MG); routes are client-side (SPA).
- Network I/O occurs through M10; UI does not embed backend endpoints directly.
- Graphs are rendered via M12; file workflows are delegated to M13/M14.

#### Access Routine Semantics `initAppShell()`:

- transition: mounts the React root, initializes router and global providers (theme, session).
- output: `mountedRoot`.
- exception: `RenderError` if bootstrap fails.

#### `navigateTo(routeID, [params]):`

- transition: updates `currentRoute`; triggers route component render.
- output: `renderedView`.
- exception: `RouteNotFound` if routeID unknown.

#### `renderComponent(componentID, props):`

- transition: none (pure render of a component into the view tree).
- output: `renderedFragment`.
- exception: `RenderError` if component fails to render.

#### `handleUserAction(actionType, payload):`

- transition: may update `uiState`; may delegate to M10/M12/M13/M14/M15 via callbacks.
- output: `dispatchResult` (ack/nack).
- exception: `ActionError` on invalid action/payload.

`showNotification`(message, severity):

- transition: enqueues a toast into `uiState` for `TOAST_DURATION_MS`.
- output: `successFlag`.
- exception: none.

## Local Functions

- `guardByRole()` — checks `sessionContext` to gate routes/components.
- `bindGraphHandlers()` — wires chart events (M12) to UI callbacks.
- `confirmBeforeLeave()` — prompts on unsaved changes before navigation.

## 6.3 MIS of Data Edit Module (M4)

### 6.3.1 Module

Handles user-initiated edits to domain, package, and metric data. Provides client-side validation and coordination of save/delete operations through the System API Gateway.

### 6.3.2 Uses

Application UI Module (M3)  
User Authentication Module (M5)  
User Role Access Module (M6)  
System API Gateway Module (M12) [Django REST / JSON]  
Metrics Storage Module (M7)

### 6.3.3 Syntax

#### Exported Constants

- `MAX_EDIT_BATCH` = 50
- `UNDO_STACK_LIMIT` = 10

## Exported Access Programs

Name	In	Out	Exceptions
addMetric	metricData	successFlag	SchemaError
editMetric	metricID, newValue	successFlag	ValidationError
deleteMetric	metricID	successFlag	NotFoundError
undoLastEdit	–	successFlag	StackEmptyError
validateEdit	candidateChange	Boolean	ValidationError
commitBatch	changeList	successFlag	NetworkError

### 6.3.4 Semantics

#### State Variables

- **editBuffer**: pending changes not yet committed.
- **undoStack**: most recent operations up to UNDO\_STACK\_LIMIT.

#### Environment Variables

- Browser runtime and React state for form fields and UI feedback.
- Network transport to backend via M12 (Django REST over HTTPS, JSON).

#### Assumptions

- The user is authenticated (M5) and authorized (M6) for the requested action.
- Requests and responses use JSON and follow the schemas exposed by M12.
- Persistent storage of edits is performed by M7 behind M12.

#### Access Routine Semantics `addMetric(metricData)`:

- transition: validate `metricData`; stage in `editBuffer`; send create request via M12 to M7 on commit.
- output: `successFlag` = true if accepted by backend.
- exception: `SchemaError` if required fields are missing or malformed.

#### `editMetric(metricID, newValue)`:

- transition: stage field updates in `editBuffer`; mark record dirty.
- output: `successFlag` = true on commit acknowledgement.

- exception: `ValidationException` if new value violates schema or business rules.

`deleteMetric(metricID):`

- transition: stage delete action in `editBuffer`.
- output: `successFlag` = true if deletion is confirmed by M7.
- exception: `NotFoundException` if the metric does not exist.

`undoLastEdit():`

- transition: revert the most recent staged or committed change if reversible; update `undoStack`.
- output: `successFlag` = true if an action was undone.
- exception: `StackEmptyError` if there is nothing to undo.

`validateEdit(candidateChange):`

- transition: none (local validation only).
- output: Boolean indicating whether `candidateChange` satisfies client-side checks.
- exception: `ValidationException` if checks fail.

`commitBatch(changeList):`

- transition: send up to `MAX_EDIT_BATCH` staged changes via M12; clear successful items from `editBuffer`; push entries to `undoStack`.
- output: `successFlag` = true if all changes are acknowledged by M7.
- exception: `NetworkError` if API calls fail or time out.

## Local Functions

- `coerceTypes()` – cast user input to expected types.
- `diffRecords()` – compute minimal patch for update requests.
- `throttleSaves()` – coalesce frequent edits before commit.

## 6.4 MIS of User Authentication Module (M5)

### 6.4.1 Module

Manages user registration, login, logout, and session validation. Provides secure handling of credentials and tokens, ensuring that only authorized users can access protected data and functionality in the DomainX web application.

#### 6.4.2 Uses

System API Gateway Module (M12) [Django REST Framework, JSON]  
User Role Access Module (M6)  
Database Module (M8) [Django ORM]  
Application UI Module (M3)

#### 6.4.3 Syntax

##### Exported Constants

- **TOKEN\_EXPIRY\_HOURS** = 24
- **MAX\_LOGIN\_ATTEMPTS** = 5
- **PASSWORD\_MIN\_LENGTH** = 8

##### Exported Access Programs

Name	In	Out	Exceptions
registerUser	email, password, role	authToken	ValidationError
loginUser	email, password	authToken	AuthError
logoutUser	authToken	successFlag	SessionError
validateSession	authToken	Boolean	TokenError
refreshToken	oldToken	newToken	TokenExpiredError
hashPassword	password	hashedPassword	None

#### 6.4.4 Semantics

##### State Variables

- **activeSessions**: map of valid tokens to user IDs and expiry timestamps.
- **failedAttempts**: counter tracking consecutive failed login attempts.

##### Environment Variables

- Django authentication middleware and token management system.
- Encrypted database storage via M8 (using Django ORM).
- HTTPS communication channel for login and registration requests.

## Assumptions

- Authentication relies on Django's built-in `AbstractUser` model and REST Framework's token authentication.
- All credential transmissions occur via HTTPS to prevent interception.
- The UI (M3) handles local validation before requests are sent.
- Tokens follow the JWT format and expire after `TOKEN_EXPIRY_HOURS`.

**Access Routine Semantics** `registerUser`(email, password, role):

- transition: create a new user record in M8 with hashed password and assigned role.
- output: `authToken` if registration succeeds.
- exception: `ValidationError` if email exists or password fails complexity checks.

`loginUser`(email, password):

- transition: validate credentials; create new session token and add to `activeSessions`.
- output: `authToken`.
- exception: `AuthError` if credentials are invalid or account is locked.

`logoutUser`(`authToken`):

- transition: invalidate token; remove from `activeSessions`.
- output: `successFlag` = true if successful.
- exception: `SessionError` if session not found.

`validateSession`(`authToken`):

- transition: none.
- output: Boolean indicating if token exists and is unexpired.
- exception: `TokenError` if malformed or tampered.

`refreshToken`(`oldToken`):

- transition: invalidate old token; issue new one with reset expiry.
- output: `newToken`.
- exception: `TokenExpiredError` if token already expired.

`hashPassword`(password):

- transition: none (pure function using Django's `make_password()`).
- output: securely hashed string.
- exception: none.

## Local Functions

- `verifyPassword()` – compares plaintext input to stored hash.
- `generateToken()` – issues signed JWT using Django secret key.
- `rateLimitLogin()` – blocks login after `MAX_LOGIN_ATTEMPTS`.

## 6.5 MIS of User Role Access Module (M6)

### 6.5.1 Module

Defines, stores, and enforces user permissions and access levels across the DomainX web application. This module ensures that users can only view or modify data permitted by their assigned roles, using the role-based access control (RBAC) mechanism built on Django's authorization framework.

### 6.5.2 Uses

User Authentication Module (M5)

System API Gateway Module (M12) [Django REST Framework, JSON]

Database Module (M8) [Django ORM]

Application UI Module (M3)

### 6.5.3 Syntax

#### Exported Constants

- `DEFAULT_ROLE` = “Viewer”
- `ROLE_HIERARCHY` = [“Viewer”, “Editor”, “Admin”]
- `PERMISSIONS_CACHE_TTL` = 300 (*seconds; cached client-side for performance*)

#### Exported Access Programs

Name	In	Out	Exceptions
assignRole	userID, roleName	successFlag	InvalidRoleError
getUserRole	userID	roleName	NotFoundError
verifyAccess	userID, actionPerformed	Boolean	PermissionError
updateRolePermissions	roleName, newPermissions	successFlag	ConfigError
listAllRoles	–	roleList	None

### 6.5.4 Semantics

#### State Variables

- **rolesTable**: mapping of role names to permission sets (read, write, delete, admin).
- **userRoleMap**: dictionary mapping user IDs to assigned roles.
- **permissionsCache**: temporary in-memory store of validated permissions for current session.

#### Environment Variables

- Django's `auth.Group` and `Permission` models manage role bindings in the database.
- Requests validated through Django REST middleware for permission checks.
- Front-end access (M3) conditionally renders UI components based on allowed actions.

#### Assumptions

- All users are authenticated before accessing role-based resources (via M5).
- Role hierarchy is static and unlikely to change during this version.
- Permissions are fetched from the backend via JSON and cached for `PERMISSIONS_CACHE_TTL` seconds.

#### Access Routine Semantics `assignRole(userID, roleName)`:

- transition: updates `userRoleMap` and backend table with new role.
- output: `successFlag` = true if update is stored.
- exception: `InvalidRoleError` if `roleName` not found in `ROLE_HIERARCHY`.

#### `getUserRole(userID)`:

- transition: none.
- output: the user's current role as a string.
- exception: `NotFoundError` if user not found in table.

#### `verifyAccess(userID, actionType)`:

- transition: none.
- output: Boolean — true if role's permissions include the requested `actionType`.

- exception: `PermissionError` if unauthorized.

`updateRolePermissions(roleName, newPermissions):`

- transition: modifies `rolesTable` for the given role and syncs to backend.
- output: `successFlag` = true if successfully updated.
- exception: `ConfigError` if update fails or backend schema mismatch.

`listAllRoles():`

- transition: none.
- output: list of available roles and descriptions.
- exception: none.

## Local Functions

- `hasPermission(userID, action)` – returns true if user's role allows the action.
- `invalidateCache()` – clears cached permissions on role update or logout.
- `syncWithBackend()` – pushes updates to Django ORM via M12.

## 6.6 MIS of User Page Module (M7)

### 6.6.1 Module

Implements the interactive user settings page in the DomainX web interface. This module displays and updates user account details such as display name, email, password, and notification preferences, integrating with the backend through M12.

### 6.6.2 Uses

User Authentication Module (M5)  
User Role Access Module (M6)  
System API Gateway Module (M12) [Django REST Framework, JSON]  
Database Module (M8) [Django ORM]  
Application UI Module (M3)

### 6.6.3 Syntax

#### Exported Constants

- `MAX_DISPLAY_NAME_LEN` = 50
- `SESSION_REFRESH_INTERVAL` = 15 (*minutes*)

## Exported Access Programs

Name	In	Out	Exceptions
fetchUserProfile	authToken	userProfile	AuthError
updateUserProfile	authToken, updatedData	successFlag	ValidationError
changePassword	authToken, oldPwd, newPwd	successFlag	PasswordError
toggleNotifications	authToken, preferenceFlag	successFlag	ConfigError
deleteAccount	authToken	successFlag	PermissionError

### 6.6.4 Semantics

#### State Variables

- **userProfile**: object storing current session's user info (name, email, role, preferences).
- **localCache**: stores recently loaded profile data to reduce repeated API calls.

#### Environment Variables

- React front-end components rendering forms and interactive settings UI.
- Network communication with Django REST API via M12 (HTTPS, JSON payloads).
- Persistent user data stored in database via M8 (Django ORM).

#### Assumptions

- User is authenticated through M5 before accessing the page.
- Profile updates require valid session tokens for backend verification.
- Password strength and validation follow rules enforced by M5.

#### Access Routine Semantics `fetchUserProfile(authToken)`:

- transition: none.
- output: returns `userProfile` containing user's data.
- exception: `AuthError` if token invalid or expired.

#### `updateUserProfile(authToken, updatedData)`:

- transition: updates local and backend profile data via M12.
- output: `successFlag` = true on confirmation.
- exception: `ValidationError` if new data violates constraints.

**changePassword(authToken, oldPwd, newPwd):**

- transition: validates old password; updates to `newPwd` via M5 backend call.
- output: `successFlag` = true on success.
- exception: `PasswordError` if old password incorrect or new one too weak.

**toggleNotifications(authToken, preferenceFlag):**

- transition: modifies user's notification preference and syncs to backend.
- output: `successFlag` = true if preference saved.
- exception: `ConfigError` if backend update fails.

**deleteAccount(authToken):**

- transition: issues delete request via M12; user data removed from backend.
- output: `successFlag` = true on completion.
- exception: `PermissionError` if user lacks required authorization.

## Local Functions

- `cacheProfileData()` – stores profile data locally for faster re-rendering.
- `validateEmailFormat()` – ensures valid email syntax before submission.
- `displayConfirmation()` – shows confirmation prompts for irreversible actions.

## 6.7 MIS of Automated Metrics Module (M8)

### 6.7.1 Module

Implements the logic for automated retrieval, calculation, and storage of quantitative metrics associated with repositories or packages. This module interacts with external APIs through M15 to gather data such as stars, forks, downloads, or commit frequency and stores them in the internal database for further ranking and analysis.

### 6.7.2 Uses

Repository API Module (M15) [GitHub API, PyPI API]

System API Gateway Module (M12) [Django REST Framework, JSON]

Database Module (M9) [Django ORM]

Ranking Algorithm Module (M13)

### 6.7.3 Syntax

#### Exported Constants

- **UPDATE\_INTERVAL\_HOURS** = 24
- **MAX\_RETRIES** = 3
- **SUPPORTED\_METRICS** = [“stars”, “forks”, “downloads”, “commits”]

#### Exported Access Programs

Name	In	Out	Exceptions
fetchMetricsFromRepo	packageID	metricsData	APIError
validateMetrics	metricsData	Boolean	ValidationError
storeValidatedMetrics	metricsData	successFlag	WriteError
scheduleAutoUpdate	None	successFlag	SchedulerError

### 6.7.4 Semantics

#### State Variables

- **metricsQueue**: list of repositories scheduled for update.
- **lastUpdateTime**: timestamp of the last successful metric refresh.

#### Environment Variables

- Python `requests` and `cron` utilities used for scheduled API requests.
- Communication with Repository API Module (M15) for fetching data.
- Persistent storage handled through Database Module (M9) using Django ORM.

#### Assumptions

- API rate limits are respected by using cached data or delay-based retries.
- Network failures are retried up to **MAX\_RETRIES**.
- Fetched data conforms to a consistent JSON schema before validation.

**Access Routine Semantics** `fetchMetricsFromRepo(packageID):`

- transition: sends a GET request via M15 to external repository API.
- output: `metricsData` — structured dictionary of retrieved metrics.
- exception: `APIError` if API call fails or response malformed.

`validateMetrics(metricsData):`

- transition: none.
- output: Boolean value indicating if all required metrics are valid.
- exception: `ValidationError` if missing or inconsistent fields.

`storeValidatedMetrics(metricsData):`

- transition: inserts or updates metric entries in M9.
- output: `successFlag` = true if stored successfully.
- exception: `WriteError` if database transaction fails.

`scheduleAutoUpdate():`

- transition: schedules a background task (via Django crontab or Celery) to run every `UPDATE_INTERVAL_HOURS`.
- output: `successFlag` = true if task successfully registered.
- exception: `SchedulerError` if job registration fails.

## Local Functions

- `normalizeMetricValues()` — adjusts different metrics to comparable scales before storage.
- `retryFailedRequests()` — retries failed fetch operations respecting delay intervals.
- `updateLastRunTimestamp()` — records timestamp of most recent completed update.

## 6.8 MIS of Domains Page Module (M9)

### 6.8.1 Module

Implements the logic and presentation layer for displaying all domain-related data within the DomainX platform. This includes the retrieval, organization, and rendering of domains, their associated packages, metrics, and textual descriptions for end users through a React interface connected to the Django backend.

### 6.8.2 Uses

Database Configuration Module (M19) [Django ORM, PostgreSQL]  
System API Gateway Module (M12) [Django REST Framework]  
Graphing Module (M14) [Chart.js / Plotly via React]  
Ranking Algorithm Module (M13) [for displaying domain scores]  
Automated Metrics Module (M8)

### 6.8.3 Syntax

#### Exported Constants

- **DEFAULT\_SORT\_ORDER** = “alphabetical”
- **MAX\_DISPLAYED\_DOMAINS** = 50
- **DEFAULT\_METRIC\_SET** = [“stars”, “forks”, “downloads”]

#### Exported Access Programs

Name	In	Out	Exceptions
fetchAllDomains	filterOptions	domainList	DatabaseError
displayDomainDetails	domainID	renderedView	DataNotFoundError
renderDomainMetrics	domainID, metricType	chartObject	RenderError
searchDomains	searchTerm	filteredList	None

### 6.8.4 Semantics

#### State Variables

- **domainCache**: dictionary storing the most recently viewed domains for quick access.
- **activeFilters**: list of active search or metric filters applied by the user.

#### Environment Variables

- React components (e.g., `DomainList.jsx`, `DomainDetails.jsx`) used to render UI elements.
- Django REST endpoints for retrieving domain and metric data.
- Persistent domain and package data stored in PostgreSQL via Django ORM.

## Assumptions

- Domain data is properly structured and indexed in the database.
- Graph rendering libraries (Chart.js or Plotly) are installed and functional.
- User has appropriate permissions via M6 (User Role Access Module) to view domain data.

**Access Routine Semantics** `fetchAllDomains(filterOptions):`

- transition: none.
- output: list of domain objects matching `filterOptions`.
- exception: `DatabaseError` if ORM query fails.

`displayDomainDetails(domainID):`

- transition: loads the selected domain's details into `DomainDetails.jsx`.
- output: rendered domain view.
- exception: `DataNotFoundError` if the domain ID does not exist.

`renderDomainMetrics(domainID, metricType):`

- transition: retrieves the domain's metric data via M8 and renders a chart through M14.
- output: visualization object.
- exception: `RenderError` if visualization fails.

`searchDomains(searchTerm):`

- transition: updates the domain list view with matching results.
- output: filtered domain list.
- exception: none.

## Local Functions

- `applyFilters()` — applies active filters to retrieved domain list.
- `updateCache()` — refreshes domain cache with recently accessed data.
- `formatMetricData()` — adjusts metric values for standardized display.

## 6.9 MIS of Comparison Module (M16)

### 6.9.1 Module

Implements the logic that defines and manages comparison methods between software packages or domains. This module allows users to compare entities based on quantitative metrics (e.g., stars, forks, commits, downloads) and qualitative attributes (e.g., documentation quality, update frequency). It serves as a bridge between the user interface, ranking algorithm, and metrics data to compute and display meaningful comparisons.

### 6.9.2 Uses

Ranking Algorithm Module (M13) [AHP / BWM weighting methods]

Automated Metrics Module (M8) [metrics retrieval]

Database Module (M9) [Django ORM – metrics and package data]

Graphing Module (M14) [Chart.js / Plotly for visual comparison]

System API Gateway Module (M12) [Django REST Framework]

### 6.9.3 Syntax

#### Exported Constants

- **DEFAULT\_METHOD** = “AHP”
- **SUPPORTED\_METHODS** = [“AHP”, “BWM”, “SSB”]
- **DEFAULT\_VISUALIZATION** = “barChart”

#### Exported Access Programs

Name	In	Out	Exceptions
selectComparisonMethod	methodName	successFlag	InvalidMethodError
computeComparison	domainSet, metricWeights	comparisonTable	ComputationError
fetchComparisonData	domainSet	metricsData	DatabaseError
visualizeComparison	comparisonTable, chartType	chartObject	RenderError

### 6.9.4 Semantics

#### State Variables

- **activeMethod**: string representing the currently selected comparison method.
- **comparisonResults**: cached dictionary holding the most recent comparison output.

## Environment Variables

- Django backend provides metric and domain data via REST API endpoints.
- React front-end renders comparison results and visualizations.
- Graphing libraries (Chart.js / Plotly) used for displaying visual comparisons.

## Assumptions

- All metric data used for comparison is already validated by M8.
- User selects a valid comparison method from SUPPORTED\_METHODS.
- Database schema for domains and metrics is consistent with UC1 (structural stability).

**Access Routine Semantics** `selectComparisonMethod(methodName)`:

- transition: updates `activeMethod`.
- output: `successFlag` = true if method is supported.
- exception: `InvalidMethodError` if method not in SUPPORTED\_METHODS.

`computeComparison(domainSet, metricWeights)`:

- transition: executes the selected comparison algorithm using data fetched via M8 and M9.
- output: `comparisonTable` containing ranked and weighted scores.
- exception: `ComputationError` if calculation fails or data incomplete.

`fetchComparisonData(domainSet)`:

- transition: none.
- output: retrieves metric records for all domains in the set.
- exception: `DatabaseError` if ORM query fails.

`visualizeComparison(comparisonTable, chartType)`:

- transition: renders visual representation of results via M14.
- output: chart object displayed in the React UI.
- exception: `RenderError` if graph generation fails.

## Local Functions

- `normalizeWeights()` — ensures weights sum to 1 before calculation.
- `computeAHPMatrix()` — performs pairwise comparisons for AHP method.
- `applyBWM()` — computes ranking scores using Best-Worst Method.

## 6.10 MIS of Configuration Module (M19)

### 6.10.1 Module

Implements the logic for storing, retrieving, and updating configuration data associated with each authenticated user. This includes user preferences such as selected visualization settings, default domain filters, notification preferences, and saved comparison parameters. It interacts with M5 (User Authentication) to identify the active user and with M9 (Database Module) for persistent storage of configuration data.

### 6.10.2 Uses

User Authentication Module (M5) [Django authentication system]

Database Module (M9) [Django ORM / PostgreSQL]

System API Gateway Module (M12) [REST API for data retrieval]

Configuration Constants Module (M20)

### 6.10.3 Syntax

#### Exported Constants

- `DEFAULT_LANGUAGE = "en"`
- `DEFAULT_THEME = "light"`
- `DEFAULT_NOTIFICATION_SETTINGS = {email: true, inApp: true}`

#### Exported Access Programs

Name	In	Out	Exceptions
getUserConfig	userID	configData	DataNotFoundError
updateUserConfig	userID, configData	successFlag	WriteError
resetToDefaults	userID	configData	None
fetchAllConfigs	None	configList	DatabaseError

#### 6.10.4 Semantics

##### State Variables

- **userConfigs**: dictionary mapping each userID to their saved configuration data.
- **defaultSettings**: dictionary storing global default configuration values.

##### Environment Variables

- Django authentication framework for identifying the current user.
- PostgreSQL database accessed through Django ORM for persisting user settings.
- REST API endpoints exposed by M12 for frontend communication.

##### Assumptions

- Each userID exists and is validated through M5 before configuration access.
- Configuration data adheres to a predefined JSON schema.
- Default values are always retrievable from M20 (Configuration Constants Module).

**Access Routine Semantics** `getUserConfig(userID)`:

- transition: none.
- output: returns configuration settings for the given user.
- exception: `DataNotFoundError` if user has no stored configuration.

`updateUserConfig(userID, configData)`:

- transition: updates stored configuration for the given user in the database.
- output: `successFlag` = true if update is successful.
- exception: `WriteError` if database transaction fails.

`resetToDefaults(userID)`:

- transition: resets all stored configuration to default values from M20.
- output: `configData` reflecting the defaults.
- exception: none.

`fetchAllConfigs()`:

- transition: none.
- output: list of all stored configuration records for administrative view.
- exception: `DatabaseError` if ORM query fails.

## Local Functions

- `validateConfigSchema()` — ensures submitted configuration matches the JSON schema.
- `mergeDefaults()` — merges user-provided configuration with global defaults.
- `logConfigChange()` — records modification timestamps for audit purposes.

## 6.11 MIS of System API Gateway Module (M10)

### 6.11.1 Module

Implements the backend REST API layer that governs communication between the Django server, the PostgreSQL database, and the React frontend. This module manages business logic flow, data serialization, and application state across all feature modules. It ensures that frontend requests are authenticated, validated, and routed to the correct Django views or serializers.

### 6.11.2 Uses

Database Module (M9) [Django ORM / PostgreSQL]

User Authentication Module (M5) [Django Auth Middleware]

Automated Metrics Module (M8) [API data collection integration]

Repository API Module (M17) [external API requests]

Configuration Module (M19)

### 6.11.3 Syntax

#### Exported Constants

- `BASE_URL` = “`https://api.domainx.ca/v1/`“
- `REQUEST_TIMEOUT_SEC` = 30
- `MAX_CONNECTIONS` = 100
- `CONTENT_TYPE` = “`application/json`“

#### Exported Access Programs

Name	In	Out	Exceptions
sendRequest	endpoint, method	payload, responseData	NetworkError
authenticateRequest	sessionToken	authorizedHeader	AuthError
handleResponse	rawResponse	parsedResponse	ParseError
routeToService	endpoint, payload	serviceOutput	RouteError

#### 6.11.4 Semantics

##### State Variables

- **activeSessions**: dictionary of authenticated users and tokens.
- **apiRegistry**: mapping of available service endpoints → handler functions.

##### Environment Variables

- Django REST Framework serializers, views, and routers.
- JSON parser and HTTP utilities for request/response handling.
- React frontend consuming REST endpoints via Axios / Fetch API.

##### Assumptions

- All endpoints conform to REST conventions (GET, POST, PUT, DELETE).
- Network connections are encrypted via HTTPS.
- Frontend tokens are validated by M5 (User Authentication Module).

**Access Routine Semantics** `sendRequest(endpoint, payload, method):`

- transition: sends an HTTP request to `endpoint` with `payload`.
- output: `responseData` containing parsed JSON response.
- exception: `NetworkError` if the request fails or times out.

**authenticateRequest(sessionToken):**

- transition: adds authorization header to outgoing requests.
- output: `authorizedHeader`.
- exception: `AuthError` if token is invalid or expired.

**handleResponse(rawResponse):**

- transition: parses JSON and validates response schema.
- output: structured `parsedResponse`.
- exception: `ParseError` if invalid JSON is returned.

**routeToService(endpoint, payload):**

- transition: maps endpoint to corresponding Django service function.
- output: processed response object.
- exception: `RouteError` if endpoint is undefined in `apiRegistry`.

## Local Functions

- `serializeData()` — converts Django models to JSON format for frontend consumption.
- `deserializeRequest()` — validates incoming JSON requests against defined schemas.
- `logTransaction()` — records API request metadata for monitoring and debugging.

## 6.12 MIS of Ranking Algorithm Module (M11)

### 6.12.1 Module

Implements the Analytic Hierarchy Process (AHP) ranking algorithm that computes pairwise comparisons of software packages or domains based on weighted criteria. This module quantifies qualitative assessments and produces normalized ranking scores to determine relative performance or importance. It is implemented using the AHPy library, with extension points for future ranking models such as Best–Worst Method (BWM) or Skew–Symmetric Bilinear (SSB).

### 6.12.2 Uses

Database Module (M9) [metrics and domain data via Django ORM]

Automated Metrics Module (M8) [input metric data]

Comparison Module (M16) [for result visualization]

Configuration Module (M19) [for user-defined weights and preferences]

### 6.12.3 Syntax

#### Exported Constants

- `DEFAULT_METHOD = "AHP"`
- `CONSISTENCY_THRESHOLD = 0.1`
- `SUPPORTED_METHODS = ["AHP", "BWM", "SSB"]`

#### Exported Access Programs

Name	In	Out	Exceptions
computeRankScores	metricsTable, userWeights	rankTable	InvalidMetricError
applyAHPWeights	criteriaMatrix	weightedMatrix	MatrixError
normalizeScores	rankTable	normalizedTable	NormalizationError
getTopPackages	normalizedTable, limit	rankedList	None

#### 6.12.4 Semantics

##### State Variables

- **criteriaMatrix**: matrix of pairwise criteria comparisons.
- **normalizedScores**: vector of final ranking results.

##### Environment Variables

- AHPy Python library for performing AHP computations.
- Django backend provides metric input via M9 and M8.
- React frontend retrieves results from M12 through REST endpoints.

##### Assumptions

- Criteria weights are positive and consistent within the threshold.
- All metric inputs are validated prior to ranking.
- The AHP consistency ratio does not exceed 0.1.

**Access Routine Semantics** `computeRankScores(metricsTable, userWeights)`:

- transition: constructs a weighted decision matrix using AHPy.
- output: `rankTable` — ranked list of packages or domains.
- exception: `InvalidMetricError` if metrics missing or inconsistent.

`applyAHPWeights(criteriaMatrix)`:

- transition: applies pairwise weights to compute priority vectors.
- output: `weightedMatrix`.
- exception: `MatrixError` if dimensions invalid or inconsistent.

`normalizeScores(rankTable)`:

- transition: rescales scores so total weight = 1.
- output: normalized score table.
- exception: `NormalizationError` if division by 0 or invalid data.

`getTopPackages(normalizedTable, limit)`:

- transition: none.
- output: top- $n$  ranked packages.
- exception: none.

## Local Functions

- `checkConsistency()` — calculates consistency ratio for AHP matrices.
- `aggregateWeights()` — merges user-defined and default weight sets.
- `normalizeVector()` — scales weight vectors for comparison output.

## 6.13 MIS of Graphing Module (M12)

### 6.13.1 Module

Implements the logic and utilities for generating graphs and data visualizations from processed metric datasets. This module supports visual comparison of domains, packages, and metric trends using the Matplotlib library. It operates as a service module, receiving numerical or categorical data from other modules and outputting visual plots (bar, line, pie, or radar charts) for display or export.

### 6.13.2 Uses

Automated Metrics Module (M8) [provides metric values]  
Database Module (M9) [retrieves stored dataset entries]  
System API Gateway Module (M10) [routes graphing requests]  
Comparison Module (M16) [requests comparative plots]  
Configuration Module (M19) [retrieves user visualization preferences]

### 6.13.3 Syntax

#### Exported Constants

- `DEFAULT_STYLE` = “seaborn-v0\_8-darkgrid“
- `DEFAULT FIGSIZE` = (10, 6)
- `SUPPORTED_CHARTS` = [“bar“, “line“, “pie“, “radar“]
- `EXPORT_FORMAT` = [“.png“, “.svg“, “.pdf“]

#### Exported Access Programs

Name	In	Out	Exceptions
generateGraph	metricData, graphType, config	graphImage	GraphError
updateGraphStyle	styleParams	successFlag	StyleError
exportGraph	graphImage, format, fileName	exportPath	ExportError
renderComparisonPlot	domainMetrics, metric- Type	comparisonImage	DataError

#### 6.13.4 Semantics

##### State Variables

- **currentGraph**: last generated Matplotlib figure object.
- **styleConfig**: dictionary storing current theme and formatting options.

##### Environment Variables

- Python Matplotlib library for visualization.
- NumPy and Pandas libraries for data manipulation.
- REST API (via M10) exposes generated images or data URLs to the React frontend.

##### Assumptions

- Input datasets contain numeric or categorical values compatible with Matplotlib.
- Configuration settings comply with Matplotlib formatting constraints.
- Graph generation occurs on the backend before transfer to the frontend for rendering.

**Access Routine Semantics** `generateGraph(metricData, graphType, config)`:

- transition: constructs a Matplotlib figure according to input type and configuration.
- output: `graphImage` — rendered visualization object.
- exception: `GraphError` if data invalid or plotting fails.

`updateGraphStyle(styleParams)`:

- transition: updates `styleConfig` (color scheme, font, size).
- output: `successFlag` = true if update applied.

- exception: `StyleError` if parameters are unsupported.

`exportGraph(graphImage, format, fileName):`

- transition: saves figure to specified file path in given format.
- output: `exportPath` of saved image.
- exception: `ExportError` if write operation fails.

`renderComparisonPlot(domainMetrics, metricType):`

- transition: overlays multiple data series for comparative visualization.
- output: `comparisonImage` — rendered comparative plot.
- exception: `DataError` if inconsistent metric arrays are provided.

## Local Functions

- `normalizeData()` — ensures all metric values are scaled before plotting.
- `applyTheme()` — applies style configuration globally.
- `cleanTempFiles()` — clears cached images after export.

## 6.14 MIS of File Import Module (M13)

### 6.14.1 Module

Handles ingestion of user-provided data files and converts them into structured datasets for internal use. This module parses, validates, and transforms Excel or CSV files into standardized data frames compatible with the system's metric and domain schema. It ensures type consistency and data integrity before persisting the data to the database.

### 6.14.2 Uses

Database Module (M9) [for data persistence]

System API Gateway Module (M10) [for upload routing and validation]

Configuration Module (M19) [for file-format settings]

Automated Metrics Module (M8) [for synchronization of imported metrics]

### 6.14.3 Syntax

#### Exported Constants

- **SUPPORTED\_FORMATS** = [“.csv”, “.xlsx”]
- **MAX\_FILE\_SIZE\_MB** = 10
- **DEFAULT\_ENCODING** = “utf-8”
- **REQUIRED\_FIELDS** = [“DomainName”, “PackageName”, “MetricName”, “Value”]

#### Exported Access Programs

Name	In	Out	Exceptions
parseFile	filePath, fileType	dataFrame	ParseError
validateImportedData	dataFrame	Boolean	ValidationException
storeImportedData	dataFrame	successFlag	WriteError
getImportSummary	dataFrame	summaryDict	None

### 6.14.4 Semantics

#### State Variables

- **lastImportedFile**: path or identifier of the last processed file.
- **importStatus**: status flag indicating the most recent operation result.

#### Environment Variables

- Python `pandas` library for parsing CSV/Excel files.
- Django REST Framework handles file uploads and passes file references to this module.
- File storage is temporary before validated data is written to the database via M9.

#### Assumptions

- Uploaded files conform to the system’s schema and naming conventions.
- File size and encoding are supported and within defined constraints.
- Invalid rows are filtered out and logged, not silently dropped.

**Access Routine Semantics** `parseFile(filePath, fileType):`

- transition: opens and reads the file using `pandas.read_csv()` or `pandas.read_excel()`.
- output: `dataFrame` containing structured data.
- exception: `ParseError` if the file cannot be opened or parsed.

**validateImportedData(dataFrame):**

- transition: checks for required fields and data-type consistency.
- output: Boolean indicating whether validation succeeded.
- exception: `ValidationError` if mandatory columns are missing or invalid types detected.

**storeImportedData(dataFrame):**

- transition: inserts validated rows into the database through the Django ORM (M9).
- output: `successFlag` = true if all rows stored successfully.
- exception: `WriteError` if a database transaction fails.

**getImportSummary(dataFrame):**

- transition: none.
- output: `summaryDict` — total rows processed, valid, invalid, and stored.
- exception: none.

## Local Functions

- `cleanColumnNames()` — standardizes column names to match system schema.
- `detectDelimiter()` — determines delimiter automatically for CSV files.
- `logImportActivity()` — records metadata of each file import for traceability.

## 6.15 MIS of File Export Module (M14)

### 6.15.1 Module

Handles transformation of system data into exportable formats such as CSV or Excel. This module converts domain, metric, and ranking data from database tables into standardized file outputs compatible with external analysis tools. It ensures that exported files preserve correct formatting, encoding, and schema alignment for interoperability.

### 6.15.2 Uses

Database Module (M9) [retrieves structured data for export]  
System API Gateway Module (M10) [handles export requests and delivery]  
Configuration Module (M19) [provides user-selected export settings]  
Ranking Algorithm Module (M11) [supplies ranking data for export]

### 6.15.3 Syntax

#### Exported Constants

- **SUPPORTED\_FORMATS** = [“.csv“, “.xlsx“]
- **DEFAULT\_ENCODING** = “utf-8“
- **EXPORT\_DIRECTORY** = “/exports/“
- **MAX\_ROWS\_PER\_FILE** = 50,000

#### Exported Access Programs

Name	In	Out	Exceptions
prepareExportData	queryParams, dataType	dataFrame	DataError
exportToCSV	dataFrame, fileName	filePath	WriteError
exportToExcel	dataFrame, fileName	filePath	WriteError
getExportSummary	filePath	summaryDict	None

### 6.15.4 Semantics

#### State Variables

- **exportStatus**: status flag of the latest export operation.
- **lastExportFile**: file name of the most recently generated export.

#### Environment Variables

- Python `pandas` library for writing tabular data to files.
- Django backend provides query data via ORM (M9).
- React frontend triggers export through API endpoints in M10.

## Assumptions

- Data requested for export is already validated and normalized.
- User export requests specify supported formats only.
- The file system path `EXPORT_DIRECTORY` is writable by the application.

**Access Routine Semantics** `prepareExportData(queryParams, dataType)`:

- transition: retrieves records from the database according to filters and data type.
- output: `dataFrame` with processed export data.
- exception: `DataError` if query fails or data unavailable.

`exportToCSV(dataFrame, fileName)`:

- transition: writes data to a comma-separated file using `pandas.to_csv()`.
- output: `filePath` to generated CSV file.
- exception: `WriteError` if file I/O fails.

`exportToExcel(dataFrame, fileName)`:

- transition: writes data to an Excel file using `pandas.ExcelWriter()`.
- output: `filePath` to generated Excel file.
- exception: `WriteError` if Excel writer fails.

`getExportSummary(filePath)`:

- transition: none.
- output: `summaryDict` — includes file name, record count, and format.
- exception: none.

## Local Functions

- `sanitizeFileName()` — ensures export file names are safe and standardized.
- `splitLargeExports()` — divides large datasets into multiple files if row limit exceeded.
- `logExportActivity()` — records export metadata for auditing.

## 6.16 MIS of Repository API Module (M15)

### 6.16.1 Module

Provides an interface for interacting with external repository APIs such as GitHub, GitLab, and PyPI. This module retrieves repository metadata and metric data (e.g., stars, forks, issues, commits) required for domain analysis. It handles authentication, rate limiting, and response parsing before returning validated data to internal modules.

### 6.16.2 Uses

Automated Metrics Module (M8) [for metric retrieval requests]

System API Gateway Module (M10) [for backend communication]

Configuration Module (M19) [for API tokens and environment variables]

Database Module (M9) [for storing fetched data]

### 6.16.3 Syntax

#### Exported Constants

- **GITHUB\_BASE\_URL** = “<https://api.github.com/>“
- **PYPI\_BASE\_URL** = “<https://pypi.org/pypi/>“
- **REQUEST\_TIMEOUT\_SEC** = 30
- **MAX\_RETRIES** = 3
- **RATE\_LIMIT\_THRESHOLD** = 1000

#### Exported Access Programs

Name	In	Out	Exceptions
setAuthToken	token	successFlag	AuthError
fetchRepoMetadata	packageID	repoData	APIError
fetchRepoMetrics	packageID, metricList	metricsData	APIError
handleRateLimit	responseHeaders	delaySeconds	RateLimitError

### 6.16.4 Semantics

#### State Variables

- **authToken**: authentication key for accessing external APIs.
- **lastResponseStatus**: HTTP status code of the most recent request.

## Environment Variables

- Internet connection and access to repository APIs (GitHub, GitLab, PyPI).
- Python `requests` library for sending API requests.
- Django environment variables (via M19) for storing API keys securely.

## Assumptions

- API tokens are valid and refreshed automatically if expired.
- Rate limiting is handled gracefully using `Retry-After` headers.
- JSON responses from external APIs follow their documented schemas.

**Access Routine Semantics** `setAuthToken(token)`:

- transition: sets a new authentication token for subsequent API calls.
- output: `successFlag` = true if token successfully stored.
- exception: `AuthError` if token invalid or missing permissions.

`fetchRepoMetadata(packageID)`:

- transition: sends GET request to GitHub/PyPI API for project metadata.
- output: `repoData` — dictionary of metadata (name, owner, description, license).
- exception: `APIError` if request fails or JSON malformed.

`fetchRepoMetrics(packageID, metricList)`:

- transition: sends API requests for specific metrics (e.g., stars, forks, downloads).
- output: `metricsData` — structured dictionary of metric values.
- exception: `APIError` if any metric endpoint fails or rate-limited.

`handleRateLimit(responseHeaders)`:

- transition: calculates required delay based on rate-limit headers.
- output: `delaySeconds` = integer number of seconds to wait.
- exception: `RateLimitError` if headers missing or malformed.

## Local Functions

- `parseJSONResponse()` — converts JSON responses into Python dictionaries.
- `retryRequest()` — retries failed API calls up to `MAX_RETRIES`.
- `logAPICall()` — records each API interaction for debugging and monitoring.

## 6.17 MIS of Database Persistence Module (M17)

### 6.17.1 Module

Handles all data persistence and retrieval operations between the application and its relational database. This module defines and manages models representing entities such as domains, packages, metrics, and users. It ensures data integrity, schema consistency, and transactional reliability using Django's ORM layer with a MySQL backend.

### 6.17.2 Uses

System API Gateway Module (M10) [for CRUD operations]

Configuration Module (M19) [for connection credentials]

Automated Metrics Module (M8) [for inserting new metric data]

Ranking Algorithm Module (M11) [for reading metric tables during ranking]

### 6.17.3 Syntax

#### Exported Constants

- `DB_NAME` = “domainx\_db”
- `DB_ENGINE` = “django.db.backends.mysql”
- `DB_TIMEOUT_SEC` = 15
- `AUTO_COMMIT` = true

#### Exported Access Programs

Name	In	Out	Exceptions
createRecord	tableName, dataDict	successFlag	WriteError
readRecord	tableName, queryFilters	resultSet	NotFoundError
updateRecord	tableName, recordID, updatedFields	successFlag	WriteError
deleteRecord	tableName, recordID	successFlag	DeleteError
executeRawQuery	queryString	queryResult	QueryError

#### 6.17.4 Semantics

##### State Variables

- **connectionPool**: pool of reusable MySQL database connections.
- **lastTransactionStatus**: Boolean flag indicating success or failure of the last query.

##### Environment Variables

- MySQL database server (version  $\geq 8.0$ ) hosting all project data.
- Django ORM handles model definitions and query translation.
- Environment credentials managed by M19 (e.g., host, username, password).

##### Assumptions

- Database schema remains stable (UC1).
- All ORM migrations are version-controlled through Django's migration system.
- Connection credentials are valid and not hard-coded.

**Access Routine Semantics** `createRecord(tableName, dataDict):`

- transition: inserts new record into table using Django ORM's `Model.objects.create()`.
- output: `successFlag` = true if commit successful.
- exception: `WriteError` if transaction fails or constraint violated.

`readRecord(tableName, queryFilters):`

- transition: queries table for matching records using `filter()` or `get()`.
- output: `resultSet` = list or object containing retrieved records.
- exception: `NotFoundError` if no results found.

`updateRecord(tableName, recordID, updatedFields):`

- transition: updates record fields and commits changes to the database.
- output: `successFlag` = true if update succeeds.
- exception: `WriteError` if record not found or data invalid.

`deleteRecord(tableName, recordID):`

- transition: deletes a record using ORM's `delete()` method.
- output: `successFlag` = true if deletion succeeds.
- exception: `DeleteError` if record missing or database locked.

`executeRawQuery(queryString):`

- transition: executes custom SQL queries directly via ORM's `raw()` method.
- output: `queryResult` containing query output.
- exception: `QueryError` if query invalid or connection lost.

## Local Functions

- `initializeConnectionPool()` — sets up reusable database connections on startup.
- `rollbackTransaction()` — rolls back failed transactions to preserve integrity.
- `logQueryActivity()` — logs all executed queries for debugging and analytics.

## 6.18 MIS of Logging Module (M18)

### 6.18.1 Module

Provides centralized logging functionality for recording and retrieving events, user activities, and system actions. It captures events from backend services, database operations, and API calls, storing them in structured log files for traceability and debugging. This module helps ensure accountability, auditability, and system reliability throughout DomainX.

### 6.18.2 Uses

System API Gateway Module (M10) [for capturing backend requests and responses]

Database Module (M17) [for storing error logs and event history]

Configuration Module (M19) [for environment-specific logging paths and levels]

### 6.18.3 Syntax

#### Exported Constants

- `LOG_FILE_PATH` = “/var/log/domainx/app.log“
- `DEFAULT_LEVEL` = “INFO“
- `MAX_LOG_SIZE_MB` = 10
- `BACKUP_COUNT` = 5

## Exported Access Programs

Name	In	Out	Exceptions
initLogger	configFilePath	successFlag	ConfigError
logEvent	message, level, context	successFlag	WriteError
getRecentLogs	limit	logsList	FileError
archiveLogs	None	successFlag	ArchiveError

### 6.18.4 Semantics

#### State Variables

- **activeLogger**: configured logger instance handling all writes.
- **logLevel**: current logging verbosity threshold (DEBUG, INFO, WARNING, ERROR).

#### Environment Variables

- Python `logging` package for logging and log rotation.
- File system storage for log persistence.
- Operating environment defined by M19 (development, staging, production).

#### Assumptions

- File system permissions allow append and rotation of log files.
- Log directory structure already exists and is writable by the application.
- Critical events (ERROR, CRITICAL) are monitored through external observability tools if configured.

#### Access Routine Semantics `initLogger(configFilePath)`:

- transition: initializes the logger with parameters defined in the config file.
- output: `successFlag` = true if initialization succeeds.
- exception: `ConfigError` if file invalid or missing keys.

#### `logEvent(message, level, context)`:

- transition: formats and writes a log entry to file and console.
- output: `successFlag` = true if write successful.

- exception: `WriteError` if log file inaccessible or write fails.

`getRecentLogs(limit):`

- transition: reads from log file up to the specified limit of lines.
- output: `logsList` = list of recent log entries.
- exception: `FileError` if log file missing or corrupted.

`archiveLogs():`

- transition: compresses and rotates existing log files once they exceed `MAX_LOG_SIZE_MB`.
- output: `successFlag` = true if archiving succeeds.
- exception: `ArchiveError` if file rotation fails.

## Local Functions

- `formatLogMessage()` — prepends timestamps and log levels to messages.
- `rotateLogs()` — performs log rotation based on file size thresholds.
- `sendCriticalAlert()` — triggers email or console alerts for severe events.

## References

Carlo Ghezzi, Mehdi Jazayeri, and Dino Mandrioli. *Fundamentals of Software Engineering*. Prentice Hall, Upper Saddle River, NJ, USA, 2nd edition, 2003.

Daniel M. Hoffman and Paul A. Strooper. *Software Design, Automated Testing, and Maintenance: A Practical Approach*. International Thomson Computer Press, New York, NY, USA, 1995. URL <http://citeseer.ist.psu.edu/428727.html>.

## Appendix — Reflection

[Not required for CAS 741 projects —SS]

The information in this section will be used to evaluate the team members on the graduate attribute of Problem Analysis and Design.

The purpose of reflection questions is to give you a chance to assess your own learning and that of your group as a whole, and to find ways to improve in the future. Reflection is an important part of the learning process. Reflection is also an essential component of a successful software development process.

Reflections are most interesting and useful when they're honest, even if the stories they tell are imperfect. You will be marked based on your depth of thought and analysis, and not based on the content of the reflections themselves. Thus, for full marks we encourage you to answer openly and honestly and to avoid simply writing "what you think the evaluator wants to hear."

Please answer the following questions. Some questions can be answered on the team level, but where appropriate, each team member should write their own response:

1. What went well while writing this deliverable?

Awurama: We had a clear module hierarchy and strong alignment with the MG, which made structuring each MIS section easier. Collaboration and consistency across modules also improved clarity.

2. What pain points did you experience during this deliverable, and how did you resolve them?

Awurama: Managing LaTeX formatting, especially tables and long text, was time-consuming. We fixed these by using the tabularx package and standardizing our template for all modules.

3. Which of your design decisions stemmed from speaking to your client(s) or a proxy (e.g. your peers, stakeholders, potential users)? For those that were not, why, and where did they come from?

Awurama: Most design choices came from client discussions with Dr. Smith and feedback from peers. For example, decisions on automation scope, ranking algorithms, and database structure came directly from those conversations.

4. While creating the design doc, what parts of your other documents (e.g. requirements, hazard analysis, etc), if any, needed to be changed, and why?

Awurama: We refined sections of the SRS and MG for consistency, mainly updating module responsibilities and interfaces to match the finalized MIS content.

5. What are the limitations of your solution? Put another way, given unlimited resources, what could you do to make the project better? (LO\_ProbSolutions)

Awurama: Limited time and resources meant we couldn't build full scalability or advanced automation. With more resources, we'd expand integration testing, optimize APIs, and improve real-time analytics.

6. Give a brief overview of other design solutions you considered. What are the benefits and tradeoffs of those other designs compared with the chosen design? From all the potential options, why did you select the documented design?

Awurama: We considered using a non-relational database and different frontend frameworks but chose Django/MySQL and React for reliability and maintainability. Alternatives offered flexibility but added complexity and reduced team familiarity.

(LO\_Explores)