Documentation: Context-Aware Testing System Using Generative AI

Overview

This document describes the architecture and process for implementing context-aware system testing using Generative AI. The system dynamically generates test scenarios based on contextual inputs to simulate real-world usage and edge cases effectively.

System Components

1. Web Form (Context Collector)

- Purpose: Serves as the user interface for gathering essential test context.
- Inputs Collected:
- GitHub Repository URL
- Deployment/Live API URL
- Optional user-defined context (e.g., app domain, expected behaviours, user personas)
- Outcome: Initializes the testing session with relevant environment and application details.

2. File Reader (GitHub Crawler)

- Purpose: Traverses the given GitHub repository and fetches file contents using the GitHub API.
- Functionality:
- Recursively parses all directories and submodules.
- Reads each file (mainly `.js`, `.ts`, `.py`, etc.) and extracts code blocks for analysis.
- Outcome: Prepares the raw code base for functional mapping and analysis.

3. Function Description & API Mapping Engine

- Purpose: Uses Generative AI (Gemini) to understand the structure and behaviour of the codebase.
- Functionality:
- Creates function descriptions for each function as a json which contains different fields(name, description ,parameters).
- Reference:(Gemini function calling)
- Identifies and maps API routes (from Express.js, Flask, FastAPI, etc.) to their corresponding function implementations.
- Outcome: Generates an OpenAPI-style map linking endpoints to underlying logic.

4. BDD Scenario Generator

- Purpose: Uses Gemini to create Behavior-Driven Development (BDD) test scenarios from the provided context.
- Functionality:
  - Converts user context + API behavior into Given-When-Then structured test cases.
  - Accounts for edge cases, conditional flows, and user roles.
- Outcome: Produces a comprehensive set of BDD test cases tailored to real-world usage.

5. Function Call Generator

- Purpose: Translates BDD scenarios into executable API function calls.
- Functionality:
  - Converts "When" steps into HTTP requests (GET, POST, etc.) with appropriate headers, payloads, and parameters.
  - Embeds expected outcomes from the "Then" clauses.
- Outcome: A structured test suite ready for automated execution

6. Test Execution Engine (Executioner)

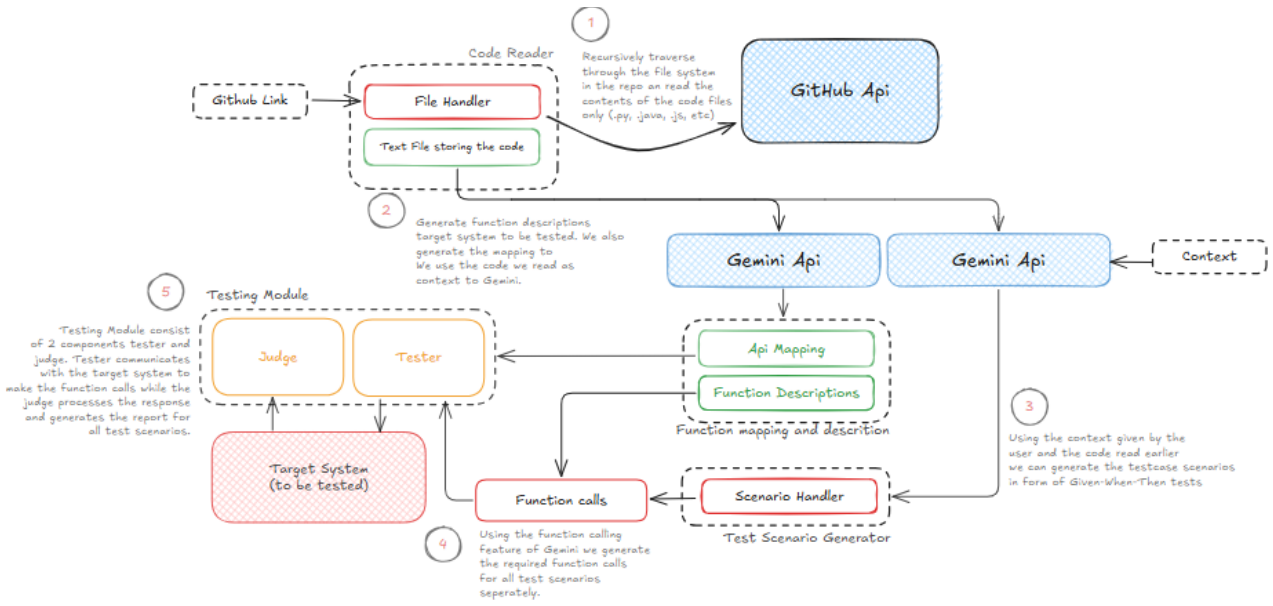
- Purpose: Automatically executes the generated test cases against the live API.

- Functionality:
    - Sends real HTTP requests created by Gemini
- Outcome: Collects actual system behaviour data for comparison.

7. Test Evaluator (Judge)

- Purpose: Evaluates the accuracy of API behaviour against expected outcomes.
- Functionality:
    - Performs pass/fail analysis with optional semantic comparison using LLM.
    - Logs discrepancies, anomalies, and unexpected side effects.
- Outcome: Provides a structured, verdict-based test report with actionable insights.

Architecture


1
Code Reader
Recursively traverse through the file system in the repo an read the contents of the code files only (.py, .java, .js, etc)
GitHub Api
Github Link
File Handler
Text File storing the code
2
Generate function descriptions target system to be tested. We also generate the mapping to We use the code we read as context to Gemini.
Gemini Api
Gemini Api
Context
5
Testing Module
Testing Module consist of 2 components tester and judge. Tester communicates with the target system to make the function calls while the judge processes the response and generates the report for all test scenarios.
Judge
Tester
Api Mapping
Function Descriptions
Function mapping and descrition
3
Using the context given by the user and the code read earlier we can generate the testcase scenarios in form of Given-When-Then tests
Target System (to be tested)
Function calls
Scenario Handler
Test Scenario Generator
4
Using the function calling feature of Gemini we generate the required function calls for all test scenarios seperately.

Architecture for context aware testing system

Workflow

1. Context Acquisition

Example:

```json
{
  "githubRepo": "PSAK02/test",
  "context": "Login",
  “deploymentLink”:” https://www.screener.in”
}
```

2. Generation of functional_description

Example:

```
{
  "name": "authUser",
   "description": "Authenticates a user or creates a new user if one doesn't
exist.",
   "parameters": {
     "type": "object",
     "properties": {
       "email": {
         "type": "string",
         "description": "User's email address"
       },
       "password": {
         "type": "string",
         "description": "User's password"
       }
     },
     "required": [
       "email",
       "password"
     ]
   }
 }
```

3.BDD Generation:

Example:

"BDD": "```gherkin Feature: User Login Scenario: Successful login with valid credentials   Given a user is on the login page   And the user enters a valid username \"testuser\"   And the user enters a valid password \"password123\"   When the user clicks the \"Login\" button   Then the user should be redirected to the home page   And a welcome message should be displayed ``` "

4. API Mapping

Example:

```
{
"authUser": {
        "api": "/user/login",
        "request_type": "post",
        "header": {
            "Content-Type": "application/json"
        }
    }
```

```
}
```

5.Execution & Evaluation

Output is evaluated using rule-based or LLM-assisted validation.

Sample Test Report

```
[
 {
   "passes": 1,
   "reason": ""
 },
 {
   "passes": 1,
   "reason": ""
 },
 {
   "passes": 0,
   "reason": "The test case expects an error message indicating an invalid
username and for the user to remain on the login page. However, the response
shows a successful authentication with an access token. This indicates the login
was successful, contradicting the expected outcome."
 },
 {
   "passes": 0,
   "reason": "The test case failed because the expected outcome was an error
message indicating an invalid password on the login page. However, the actual
response from the authUser API call returned \"{\"email\":\"error\"}\", which
does not directly indicate an invalid password.  This could represent a different
error state, or the front-end may not be properly handling or displaying the
specific error reason returned by the API.  More information is needed to
```

understand the context of this \"error\" and how it relates to invalid password scenarios."

  }

]

Benefits:

- Dynamic adaptability to context changes .
- Improved coverage for edge cases and complex scenarios.
- Human-like reasoning using LLMs to validate real-world conditions.

Limitations:

- Requires strict prompt engineering for deterministic results.
- Model hallucination risks—test outputs must be validated.
- May need fine-tuning or system constraints for production testing.

Tools & Technologies:

- React js
- Flask
- Python
- Gemini API