# **Developing Features Faster with GitHub Copilot**

## **Real-World Scenario: Implementing a Real-Time Notification & Alert System**

Imagine you’re part of a development team for a SaaS application that requires real-time notifications for users. The application must support different notification types (e.g., system alerts, user messages, scheduled reminders) and must integrate seamlessly with an existing codebase. In this scenario, you are tasked with adding and enhancing a Real-Time Notification module, and you’ll work through a complete lifecycle—from planning and implementation to testing, debugging, refactoring, and deployment preparation—all with GitHub Copilot’s help.

| **Note**: Below prompts are provided solely as examples of effective prompt construction. As participants, we must engage in an iterative process to refine these examples and develop the optimal prompt for the task at hand. |
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## **Step 1: Advanced Project Setup and Workspace Configuration**

**Objective:**Establish a consistent development environment that minimizes configuration issues, using only GitHub Copilot Chat.

**Process and Detailed Prompts:**

**Initialize a Dedicated Workspace:**In Copilot Chat, instruct:

| @workspace: Initialize a new Next.js project named "realtime\_notifications" using create-next-app and open it in VS Code. Ensure that the entire project is scaffolded automatically. |
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| **Note**: Above prompt would help you to generate the required commands. Once commands are created, hover on the commands and click on **Insert into Terminal** option |
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1. This command triggers the creation of the project without any manual terminal commands.

**Configure Workspace Settings:**Next, set up a dedicated workspace configuration file for consistent settings:

| @workspace: Configure this project as a workspace by generating a .code-workspace file with standardized settings for code formatting and linting. |
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| **Note**: Above prompt would help you to generate the required commands. Once commands are created, hover on the commands and click on **Insert into Terminal** option |
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1. The prompt ensures that the workspace has uniform settings to reduce “works on my machine” issues.

**Set Up Version Control:**Create a Git repository and configure a robust .gitignore:

| #git: Generate the Git command to initialize a repository for "realtime\_notifications" and create a .gitignore file that excludes IDE-specific files, build artifacts, and sensitive configuration files. |
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1. This automated setup ensures version control is in place with best practices for ignoring unnecessary files.

**Establish a Multi-Module Structure:**Instruct Copilot Chat to create a well-organized directory structure:

| /start: Generate a project structure for "realtime\_notifications" with the following directories: - src/main/java - src/test/java - config - scripts Ensure the entire structure is created via Copilot Chat. |
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| **Note**: Above prompt would help you to generate the required commands. Once commands are created, hover on the commands and click on **Insert into Terminal** option |
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This prompt is detailed and instructs Copilot to generate all necessary folders automatically.

**Challenges for Step 1:**

* Evaluate if any extra directories (like a dedicated configuration folder for environment-specific settings or a scripts folder for automation tasks) are needed, and refine your prompts until the workspace is perfectly organized.
* Consider how you would structure a more complex, multi-module project using Copilot Chat only, and experiment with refining the structure accordingly.

**Step 2: In-Depth Feature Planning and Design**

**Objective:**Develop detailed feature requirements and a design plan for the real-time notification system using Copilot Chat.

**Process and Detailed Prompts:**

**Document Feature Requirements:**Create a requirements file through Copilot Chat:

| /start: Generate a file named NotificationRequirements.md that outlines the key requirements for a real-time notification system. Include details such as: - Types of notifications (instant alerts, scheduled reminders, user messages) - Delivery channels (in-app notifications, email, push notifications) - Performance constraints (latency targets, scalability) - Security and privacy considerations |
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| **Note**: Above prompt would help you to generate the required commands. Once commands are created, hover on the commands and click on **Insert into Terminal** option |
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1. This prompt directs Copilot to generate a comprehensive requirements document.

**Architectural Design and Component Identification:**Ask for a design outline:

| /start: Generate a detailed design document (DesignDiagram.md) that identifies key components such as NotificationManager, NotificationService, Persistence Layer, and Monitoring Module. Describe the interactions between these components. |
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1. The output should include a high-level diagram or textual description of component interactions.

**Risk Analysis and Trade-Offs:**Request a discussion on design trade-offs:

| /start: Generate a brief analysis of the trade-offs between using WebSockets versus polling for real-time notifications, and outline potential challenges like network latency and data consistency. |
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**Challenges for Step 2:**

* Expand your design document by generating a UML sequence diagram for the notification event lifecycle.
* Create a decision matrix comparing different messaging protocols (e.g., WebSockets, Server-Sent Events, and polling) and justify your choice using iterative prompts.

**Step 3: Implementing the Notification Module Core**

**Objective:**Develop the core functionality of the notification system, including sending instant and scheduled notifications and integrating a persistence layer, using only Copilot Chat.

**Process and Detailed Prompts:**

**Generate Core Files and Classes:**Create the main class using:

| #file /new: Create a file named NotificationManager.java in the appropriate directory. /start: Generate a class named NotificationManager that includes methods for sendNotification(), scheduleNotification(), and persistNotifications(). Ensure that the class is structured to handle multiple notification types. |
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| **Note**: Above prompt would help you to generate the required commands. Once commands are created, hover on the commands and click on **Insert into Terminal** option |
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1. This prompt instructs Copilot Chat to create the NotificationManager with core methods.

**Implement Business Logic:**Ask for detailed implementation of the methods:

| /start: Generate code within NotificationManager.java that implements instant notification sending by directly invoking a notification service, and scheduling notifications by queuing messages based on time. |
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1. The prompt guides Copilot to implement essential functionality.

**Integrate JSON Persistence:**To handle persistence, instruct:

| /start: Generate code in NotificationManager.java that uses Gson (or a similar library) to serialize and deserialize notification configurations to a JSON file located in the config directory. |
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1. **Add Robust Error Handling and Logging:**Enhance the code with:

| /start: Update NotificationManager.java to include robust error handling using try-catch blocks, custom exceptions, and SLF4J logging for all critical operations. |
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**Challenges for Step 3:**

* Enhance the notification module to retry sending notifications if an initial attempt fails. Use Copilot Chat to implement asynchronous scheduling and explore thread safety challenges.
* Experiment with prompts to integrate performance optimizations in the persistence layer.

**Step 4: Collaborative Code Quality Enhancement**

**Objective:**Improve code quality and maintainability through refactoring and documentation, solely using GitHub Copilot Chat.

**Process and Detailed Prompts:**

**Refactor Code for Clarity:**Instruct Copilot Chat to simplify complex methods:

| /start: Refactor the sendNotification() method in NotificationManager.java to reduce duplication and improve readability, ensuring it follows DRY principles. |
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1. **Generate Documentation:**Create detailed inline documentation by instructing:

| /start: Generate Javadoc comments for all public methods in NotificationManager.java, detailing the purpose, parameters, and return values. |
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1. **Conduct a Security and Best Practices Review:**Ask for best practice guidelines:

| /start: Generate a brief review of security best practices for handling notification data in transit and at rest, and suggest any improvements for the current implementation. |
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**Challenges for Step 4:**

* Identify redundant code across the module and generate prompts to consolidate it into helper methods.
* Simulate a code review by generating a list of potential code smells and refactoring suggestions, then implement the recommended changes.

**Step 5: Comprehensive Testing, Debugging, and CI/CD Integration**

**Objective:**Develop a comprehensive test suite and integrate your tests into a CI/CD pipeline using GitHub Copilot Chat.

**Process and Detailed Prompts:**

**Create Test Files:**Instruct Copilot Chat to generate test files:

| #file /new: Create a file named NotificationManagerTest.java in the test/ directory. /start: Generate a JUnit 5 test class for NotificationManager, including tests for sendNotification(), scheduleNotification(), and persistNotifications(). Include tests for both normal operations and edge cases. |
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| **Note**: Above prompt would help you to generate the required commands. Once commands are created, hover on the commands and click on **Insert into Terminal** option |
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1. **Integrate Mocks:**Enhance the tests by adding mocks for external dependencies:

| /fix: Enhance NotificationManagerTest.java by generating Mockito-based mocks for external API calls used in sendNotification(). |
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1. **Expand Test Coverage:**Request additional test cases:

| /fix: Add more test cases in NotificationManagerTest.java to handle invalid inputs, failed network calls, and large data sets. |
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1. **CI/CD Workflow Integration:**Automate testing with GitHub Actions:

| /start: Generate a GitHub Actions workflow file (ci.yaml) in the .github/workflows/ directory that sets up the required Java environment, installs Maven dependencies, runs all tests, and reports results. |
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| /fix: Enhance the workflow to include caching for dependencies and trigger on push events to the main branch. |
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**Challenges for Step 5:**

* Develop load tests to simulate high notification volumes and assess system performance.
* Integrate additional quality checks, such as static analysis or code coverage metrics, and refine the CI/CD pipeline accordingly.

**Step 6: Advanced Logging, Observability, and Performance Tuning**

**Objective:**Enhance observability and performance by integrating advanced logging, metrics collection, and resource optimization techniques.

**Process and Detailed Prompts:**

**Integrate Granular Logging:**Instruct Copilot Chat to refine logging:

| /start: Update NotificationManager.java to include granular logging with SLF4J. Ensure that each method logs key events with contextual data (e.g., notification IDs, timestamps). |
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1. **Set Up Dual Output Logging:**Generate configuration for dual logging outputs:

| /start: Generate a logback configuration file that outputs logs both to the console and a file, including patterns and thresholds for different log levels. |
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1. **Integrate Performance Metrics:**Ask Copilot Chat to integrate metrics collection:

| /start: Generate code to integrate a metrics library (such as Micrometer) into NotificationManager.java to track performance metrics like notification dispatch times and queue wait times. |
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1. **Optimize File I/O:**Refine file operations by instructing:

| /explain: Provide suggestions for optimizing JSON file operations in Java to reduce latency under high load. |
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| /fix: Update the persistence logic to use asynchronous file I/O or buffering strategies based on the suggestions. |
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**Challenges for Step 6:**

* Implement a caching mechanism for frequently accessed notification configurations and measure its impact.
* Set up an alerting system that triggers notifications if key performance metrics exceed defined thresholds.

**Step 7: Code Refactoring and Team Collaboration**

**Objective:**Ensure that the codebase is maintainable and that team collaboration is streamlined through effective refactoring and documentation.

**Refactor for Maintainability:**Ask Copilot Chat to identify and refactor redundant code:

| /start: Refactor complex methods in NotificationManager.java to extract common functionality into helper methods, ensuring the code follows DRY principles. |
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1. **Generate Documentation:**Instruct Copilot Chat to create detailed documentation:

| /start: Generate comprehensive Javadoc comments for all methods in NotificationManager.java, explaining the purpose, parameters, return values, and any exceptions thrown/start: Identify potential code smells in NotificationManager.java and suggest refactoring strategies to improve readability and maintainability. |
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1. **Simulate Code Reviews:**Request a review of potential code smells:

| /start: Identify potential code smells in NotificationManager.java and suggest refactoring strategies to improve readability and maintainability. |
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**Challenges for Step 7:**

* Use prompts to simulate resolving merge conflicts and ensuring that commit messages clearly reflect each refactoring decision.
* Refine your documentation until it thoroughly explains all changes and design decisions for the benefit of team members.

**Step 8: Final Integration, Migration, and Deployment Preparation**

**Objective:**Prepare the new notification module for deployment by integrating it with the existing system and setting up deployment automation.

**Integrate the Module:**Instruct Copilot Chat to merge the new notification module with the existing codebase:

| /start: Integrate the notification module into the main application, ensuring that all APIs and data flows are correctly wired. |
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1. **Resolve Merge Conflicts Automatically:**Use a prompt to help resolve conflicts:

| #git /start: Generate commands to resolve merge conflicts for the integration of the notification module. |
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1. **Prepare Deployment Scripts:**Generate a Dockerfile and a GitHub Actions workflow for deployment:

| /start: Generate a Dockerfile that compiles and runs the notification service in a Java 17 environment. |
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| /start: Generate a GitHub Actions workflow file that automates the build, test, and deployment process for the notification system. |
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1. **Implement Rollback Strategies:**Ask for strategies to handle failed deployments:

| /start: Generate guidelines and code for implementing rollback procedures if the deployment fails, including health-check endpoints. |
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**Challenges for Step 8:**

* Validate the integration by running side-by-side tests on the new module and the existing system.
* Refine your deployment scripts until they include automated rollback procedures and health checks.

**Step 9: Post-Deployment Monitoring, Documentation, and Future Enhancements**

**Objective:**Ensure the system is monitored post-deployment, documentation is updated, and plans for future improvements are in place.

**Set Up Live Monitoring:**Generate configuration for monitoring tools:

| /start: Generate configuration files to integrate monitoring tools like Grafana and Prometheus, so that performance metrics and logs can be visualized in real time. |
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1. **Configure Automated Alerting:**Ask Copilot Chat:

| /start: Generate code to configure alerts that notify the team via email or messaging apps if notification dispatch latency exceeds defined thresholds. |
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1. **Update Documentation:**Ensure all changes are well documented:

| /start: Generate a detailed update for the README.md and API documentation that reflects the modernized notification module, including architectural diagrams and configuration details. |
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1. **Plan Future Enhancements:**Ask for a roadmap:

| /start: Generate a roadmap document (Roadmap.md) that outlines potential future enhancements based on observed performance metrics and user feedback. |
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**Challenges for Step 9:**

* Develop an incident response plan using prompts that detail steps for critical failures in the notification system.
* Create a detailed feedback mechanism to collect user input and translate it into feature improvements.

**Additional Advanced Challenges**

* **Implement Update Functionality:**Generate an API route with a PUT endpoint for updating notification details and integrate it into the system.
* **Integrate a Global Error Boundary:**Create a custom error boundary component for your React-based notification UI to catch exceptions and display fallback interfaces.
* **Refactor State Management with Context:**Migrate shared state (if applicable) to React Context for global management and create a custom hook for accessing notification data.
* **Automate Deployment with GitHub Actions:**Refine your CI/CD pipeline to support parallel test execution and automatic rollback on failures by generating an advanced GitHub Actions workflow.

## **Conclusion**

By working through this highly detailed exercise, you’ll tackle authentic development challenges, from environment setup and detailed architectural planning to robust coding, comprehensive testing, integration, and deployment readiness. Throughout each step, GitHub Copilot’s powerful inline suggestions and chat commands will simulate a collaborative, real-world environment, preparing you to handle both expected and unforeseen challenges in modern software development.

**Happy coding** and continuous learning with GitHub Copilot!