Concurrent Task Processor

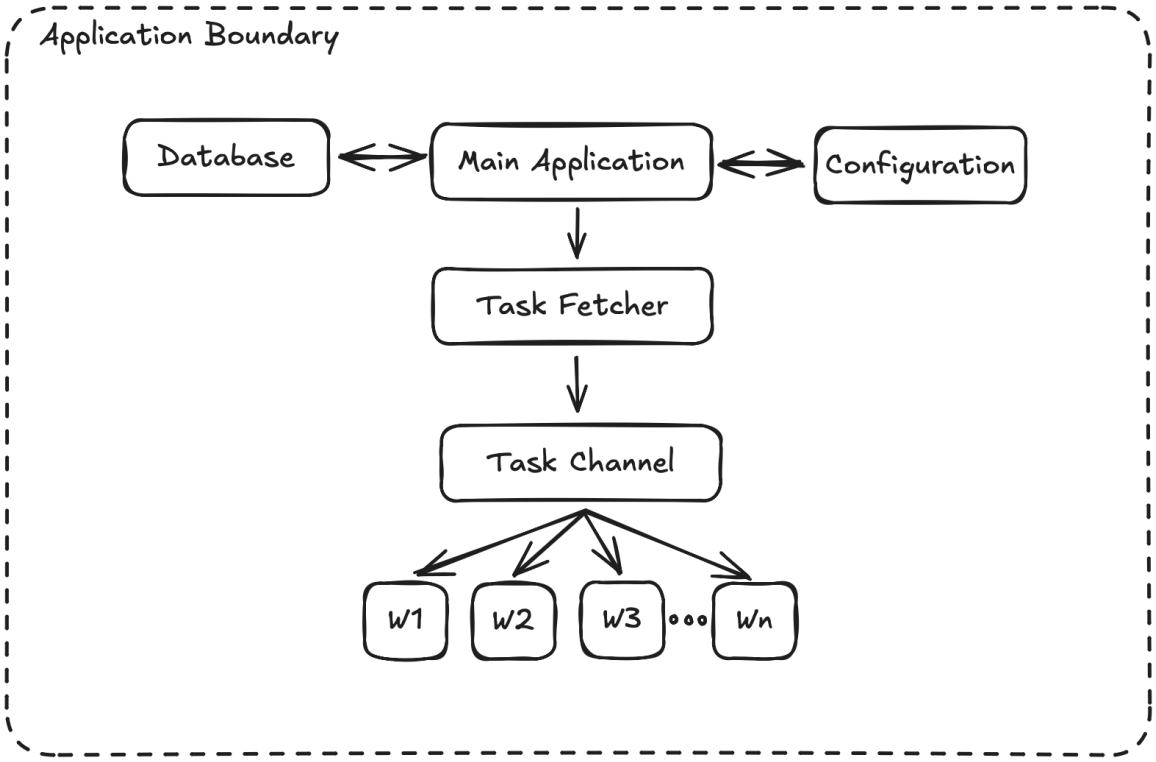
This project is a command-line application written in Go that demonstrates concurrent task processing using a worker pool pattern. The application reads tasks from a PostgreSQL database, processes them in parallel, and updates their status upon completion. It also implements graceful shutdown to ensure all in-progress tasks complete before the application exits.

Architecture

The application follows a modular architecture with the following components:

Core Components

- **Main Application**: Entry point that handles CLI commands
- **Worker Pool**: Manages concurrent task processing
- **Database Layer**: Handles interactions with PostgreSQL
- **Configuration Manager**: Loads settings from environment variables



Workflow

1. Load configuration from **.env** and connect to **PostgreSQL** database.
2. Set env variables: **WORKER_COUNT**=5, **FETCH_INTERVAL**=5s, **FETCH_LIMIT**=10 (default values).
3. Use **migrate** subcommand to run DB migration and create a table (**id**, **payload**, **status**, **result**, **created_at**, **updated_at**).
4. Run seed SQL to insert 20 sample tasks with **pending** status.
5. Use **serve** subcommand to connect to DB and start task processing.

6. Initialize 5 goroutines (workers) to process tasks concurrently.
7. Start fetcher goroutine that runs every 5 seconds (**FETCH_INTERVAL**).
8. Fetch tasks using **FOR UPDATE SKIP LOCKED** to avoid duplicate picks.
9. Update fetched tasks to **in_progress** and send them to workers via channel.
10. Each worker:
    - Receives task from channel.
    - Sleeps 1–4 seconds to simulate processing.
    - Reverses task payload.
    - Randomly fails 1 in 10 tasks.
    - Updates DB with **status=done** and reversed result.
    - If failed, sets **status=error** and error message.
11. App listens for **Ctrl + C** to trigger graceful shutdown.
12. On shutdown: cancels context, waits for workers, exits cleanly.
13. Logs all major actions: DB connect, migrations, fetch, process, shutdown.

Installation

Prerequisites

- Go 1.16+ installed
- PostgreSQL 10+ server
- Git

Steps

1. Clone the repository:
   ```
   git clone https://github.com/yourusername/task-processor.git
   ```

2. Install dependencies:
   ```
   go mod download
   ```

3. Set up your environment variables:
   ```
   cp .env.example .env
   ```

4. Run database migrations:
   ```
   go run main.go migrate
   ```

Configuration

The application is configured using environment variables, which can be loaded from a .env file.

Environment Variable	Description	Default
DATABASE_URL	PostgreSQL connection string	postgres://postgres@localhost:5432/taskprocessor?sslmode=disable
WORKER_COUNT	Number of concurrent worker goroutines	5

FETCH_INTERVAL	Time interval between task fetches (seconds)	5
FETCH_LIMIT	Maximum number of tasks to fetch at once	10

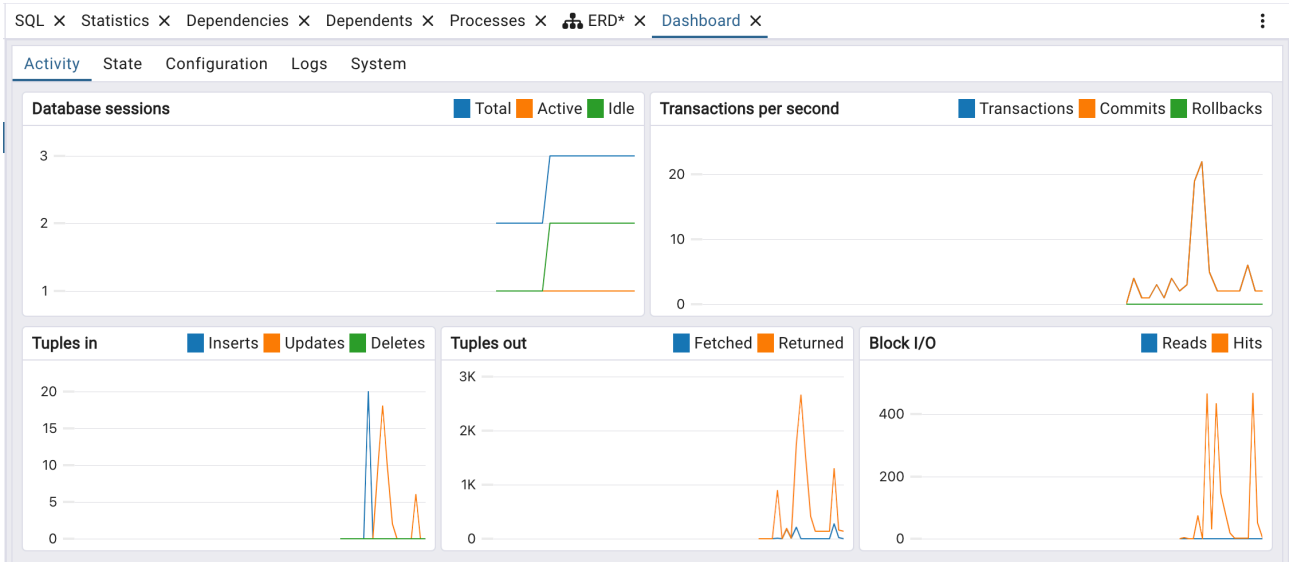
Database Schema

This project uses a PostgreSQL database with a single table to manage and track asynchronous job execution.

ERD (Entity Relationship Diagram)

Column	Type	Description
id	serial PRIMARY KEY	Task ID
payload	text	Task payload/input
status	text	pending' or 'done'
result	text	Result of processing
created_at	timestamp with time zone	Creation timestamp
updated_at	timestamp with time zone	Last updated timestamp

Monitoring with pgAdmin 4



Live pgAdmin dashboard view during task processing. Note the transaction activity, minimal rollbacks, and high cache hit ratio — all indicators of a healthy, responsive PostgreSQL-backed backend.

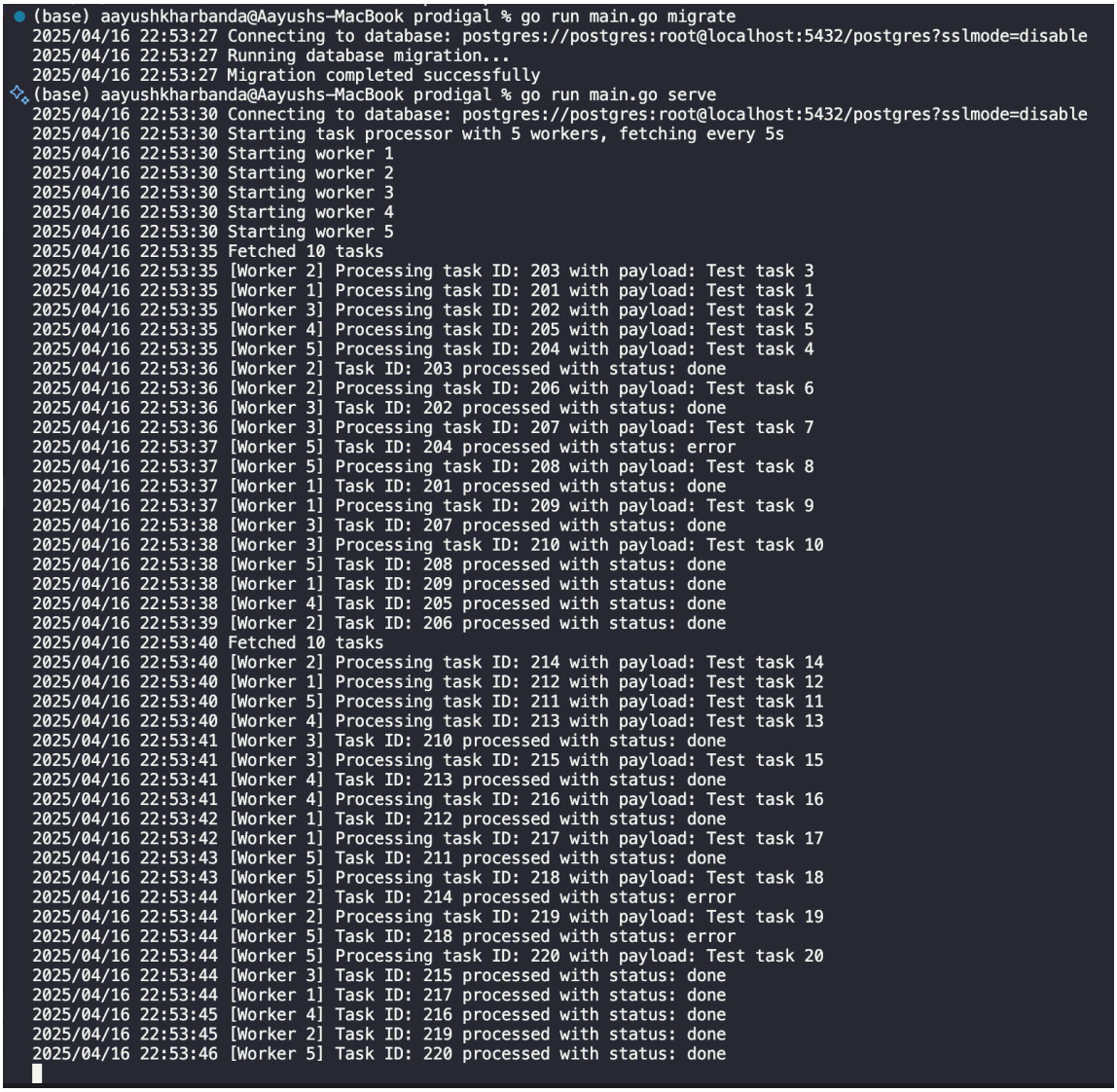
Running the Application

1. Run database migrations:
   ```
   go run main.go migrate
   ```

2. Create sample 20 tasks to test
   ```
   psql "$DATABASE_URL" -f seed/seed_tasks.sql
   ```

3. Start the task processor service:
   ```
   go run main.go serve
   ```

CLI Output Example



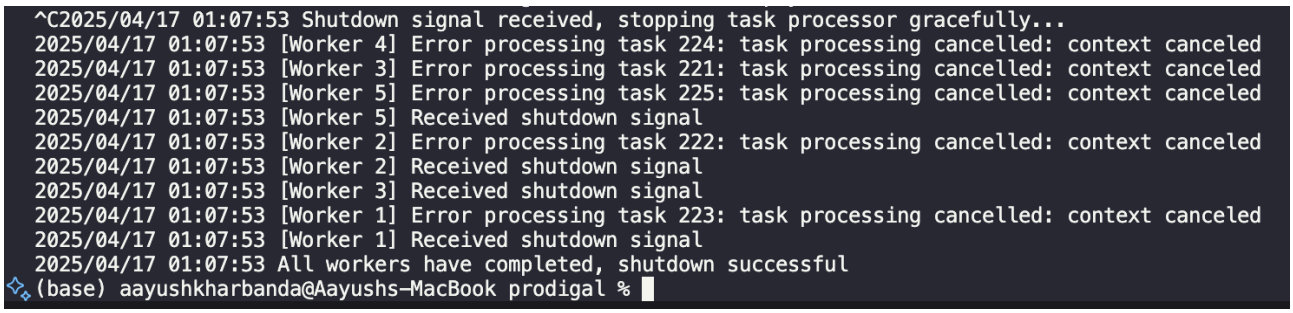
Above screenshot illustrates the task processor running with multiple workers. Each worker fetches tasks from the PostgreSQL database every 5 seconds, processes the payload, and updates the task's status (done or error). The log messages displayed in the CLI provide real-time visibility into task execution, status updates, and concurrency.

Graceful Shutdown Testing

I tested graceful shutdown by:

1. Starting the service with a longer processing time:
   ```
   go run main.go serve
   ```

2. Monitoring the logs while sending termination signals:
   ```
   # Ctrl + c
   ```



Graceful shutdown: signal received, tasks completed, workers exited, application closed cleanly.