

Task Manager - Final Project Report

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Introduction

The Task Manager project is a comprehensive C++ application designed to manage and organize tasks efficiently. It includes features for adding, updating, deleting, sorting, and searching tasks, among others. It categorizes tasks based on priority, status, and other attributes to provide users with an organized task management experience.

Code Structure

The project is built around the **TaskManager** class and the following key components:

1. TaskManager Class

- Manages all task-related operations.
- Contains methods for adding, updating, deleting, and displaying tasks.

2. Task Struct

- Represents an individual task with attributes like `task_id`, `title`, `description`, `priority`, and `is_completed`.

3. Enums and Helpers

- Priority levels: `LOW`, `MEDIUM`, `HIGH`.
 - Helper methods to format priority and status for user-friendly output.
-

Features and Functionalities

1. Core Operations

- **Add Task:** Adds a new task to the manager with a unique ID.
- **Delete Task:** Deletes a task based on its ID.
- **Update Task:** Updates task attributes like title, description, and priority.

- **Mark as Completed:** Marks a task as completed.

2. Display Features

- **Display All Tasks:** Lists all tasks with key details.
- **Display Task Details:** Shows detailed information about a specific task.
- **Display Completed/Incomplete Tasks:** Categorizes tasks based on completion status.

3. Search and Sorting

- **Search by Title/Description:** Finds tasks containing specific keywords.
- **Sort by Priority/Title:** Sorts tasks for better visibility and management.

4. Advanced Features

- **Count Tasks by Status/Priority:** Provides a count of tasks based on their state.
- **Notify High-Priority Tasks:** Alerts for high-priority tasks.
- **Clear Completed Tasks:** Removes completed tasks from the list.
- **Reset Tasks:** Resets all tasks and counters.

Testing Information

Pre-Testing Process

- Compiled the application using `clang++` with appropriate flags.
- Verified functional correctness with a series of manual inputs.
- Pulled Image using
`docker pull agroce/deepstate_examples_aflpp`
- Mounted project as a volume onto the container
`docker run -it -v /home/arshad/kavya/Assurance/project:/home/user/deepstate/project / agroce/deepstate_examples_aflpp`

```
arshad@Arshad:~/kavya/Assurance/project$ docker run -it -v /home/arshad/kavya/Assurance/project:/home/user/deepstate/project/ agroce/deepstate_examples_aflpp
user@81ba9aac2f90:~/deepstate$ ls
CHacklists.txt README.md bin build_afl build_libfuzzer docs extras mypy.ini push tests
LICENSE Vagrantfile build build_deepstate docker examples fix_reducer project src
user@81ba9aac2f90:~/deepstate$
```

Basic Test Cases

1. **AddTask:** Tests adding a task to the manager and verifies that the task count increases.
2. **FindTask:** Tests finding a task by its ID. It verifies that the correct task is returned for valid IDs, and `nullptr` is returned for invalid IDs.
3. **DeleteTask:** Tests deleting a task from the task manager. It ensures the task count is reduced after deletion.
4. **UpdateTask:** Tests updating a task's details (title, description, and priority) and verifies that the task details are correctly updated and many more.

Running basic or default tests

```
clang++ task_manager.cpp test.cpp -o test -ldeepstate
./test
```

```
user@81ba9aac2f90:~/deepstate/project$ clang++ task_manager.cpp test.cpp -o test -ldeepstate
user@81ba9aac2f90:~/deepstate/project$ ./test
TRACE: Running: TaskManagementTest_AddTask from test.cpp(9)
Task added successfully.
TRACE: Passed: TaskManagementTest_AddTask
TRACE: Running: TaskManagementTest_FindTask from test.cpp(24)
Task added successfully.
Task added successfully.
TRACE: Passed: TaskManagementTest_FindTask
TRACE: Running: TaskManagementTest_DeleteTask from test.cpp(53)
Task added successfully.
Task added successfully.
Task 1 deleted successfully.
TRACE: Passed: TaskManagementTest_DeleteTask
TRACE: Running: TaskManagementTest_UpdateTask from test.cpp(73)
Task added successfully.
Task added successfully.
Task updated successfully.
TRACE: Passed: TaskManagementTest_UpdateTask
TRACE: Running: TaskManagementTest_MarkTaskCompleted from test.cpp(103)
Task added successfully.
Task 1 marked as completed.
TRACE: Passed: TaskManagementTest_MarkTaskCompleted
TRACE: Running: TaskManagementTest_DisplayTaskDetails from test.cpp(129)
Task added successfully.
TRACE: Passed: TaskManagementTest_DisplayTaskDetails
TRACE: Running: TaskManagementTest_FormatPriority from test.cpp(164)
TRACE: Passed: TaskManagementTest_FormatPriority
TRACE: Running: TaskManagementTest_FormatStatus from test.cpp(185)
TRACE: Passed: TaskManagementTest_FormatStatus
TRACE: Running: TaskManagementTest_DisplayAllTasks from test.cpp(198)
Task added successfully.
Task added successfully.
TRACE: Passed: TaskManagementTest_DisplayAllTasks
TRACE: Running: TaskManagementTest_DisplayCompletedTasks from test.cpp(221)
Task added successfully.
Task added successfully.
Task 1 marked as completed.
TRACE: Passed: TaskManagementTest_DisplayCompletedTasks
TRACE: Running: TaskManagementTest_DisplayIncompleteTasks from test.cpp(245)
Task added successfully.
Task added successfully.
Task 1 marked as completed.
TRACE: Passed: TaskManagementTest_DisplayIncompleteTasks
TRACE: Running: TaskManagementTest_CountTasksByStatus from test.cpp(271)
Task added successfully.
Task added successfully.
Task 1 marked as completed.
TRACE: Passed: TaskManagementTest_CountTasksByStatus
TRACE: Running: TaskManagementTest_ClearCompletedTasks from test.cpp(295)
Task added successfully.
```

Fuzzy test:

`mkdir failures`

```
./test --fuzz --timeout 60 --output_test_dir failures
```

```
[user@81ba9aac2f90:~/deepstate/project$ mkdir failures
[user@81ba9aac2f90:~/deepstate/project$ ./test --fuzz --timeout 60 --output_test_dir failures
INFO: Starting fuzzing
```

Output

```
Task added successfully.
INFO: Done fuzzing! Ran 2188856 tests (36480 tests/second) with 0 failed/2188856 passed/0 abandoned tests
user@81ba9aac2f90:~/deepstate/project$
```

Total 2188856 tests has been ran and all are passed with zero failed tests

Generating mutants

mutate task_manager.cpp

```
[user@81ba9aac2f90:~/deepstate/project$ 
[user@81ba9aac2f90:~/deepstate/project$ 
[user@81ba9aac2f90:~/deepstate/project$ mutate task_manager.cpp
*** UNIVERSALMUTATOR ***
MUTATING WITH RULES: universal.rules, cpp.rules, c_like.rules
```

Mutation output

```
user@81ba9aac2f90:~/deepstate/project$ mutate task_manager.cpp
*** UNIVERSALMUTATOR ***
MUTATING WITH RULES: universal.rules, cpp.rules, c_like.rules
SKIPPED 15 MUTANTS ONLY CHANGING STRING LITERALS
2461 MUTANTS GENERATED BY RULES
PROCESSING MUTANT: 2: using namespace std; ==> using namespace std;
break;...VALID [written to ./task_manager.mutant.0.cpp]
PROCESSING MUTANT: 2: using namespace std; ==> using namespace std;
continue;...VALID [written to ./task_manager.mutant.1.cpp]
PROCESSING MUTANT: 2: using namespace std; ==> /*using namespace std;*/...VALID [written to ./task_manager.mutant.2.cpp]
PROCESSING MUTANT: 4: TaskManager::TaskManager() : task_counter(0) {} ==> TaskManager::TaskManager() : task_counter(1) {}...VALID [written to ./task_manager.mutant.3.cpp]
PROCESSING MUTANT: 4: TaskManager::TaskManager() : task_counter(0) {} ==> TaskManager::TaskManager() : task_counter(-1) {}...VALID [written to ./task_manager.mutant.4.cpp]
PROCESSING MUTANT: 4: TaskManager::TaskManager() : task_counter(0) {} ==> TaskManager::TaskManager() : task_counter((0+1))...VALID [written to ./task_manager.mutant.5.cpp]
PROCESSING MUTANT: 4: TaskManager::TaskManager() : task_counter(0) {} ==> TaskManager::TaskManager() : task_counter((0-1))...VALID [written to ./task_manager.mutant.6.cpp]
PROCESSING MUTANT: 4: TaskManager::TaskManager() : task_counter(0) {} ==> TaskManager::TaskManager() : task_counter(0) {}
break;...VALID [written to ./task_manager.mutant.7.cpp]
PROCESSING MUTANT: 4: TaskManager::TaskManager() : task_counter(0) {} ==> TaskManager::TaskManager() : task_counter(0) {}
continue;...VALID [written to ./task_manager.mutant.8.cpp]
PROCESSING MUTANT: 4: TaskManager::TaskManager() : task_counter(0) {} ==> /*TaskManager::TaskManager() : task_counter(0) {}*/...VALID [written to ./task_manager.mutant.9.cpp]
PROCESSING MUTANT: 6: void TaskManager::addTask(const string &title, const string &description, Priority priority) ==> void TaskManager::addTask(const string &title, const string &description, Priority priority)...VALID [written to ./task_manager.mutant.10.cpp]
PROCESSING MUTANT: 6: void TaskManager::addTask(const string &title, const string &description, Priority priority) ==> void TaskManager::addTask(const string &title, const string &description, Priority priority)...VALID [written to ./task_manager.mutant.11.cpp]
PROCESSING MUTANT: 6: void TaskManager::addTask(const string &title, const string &description, Priority priority) ==> void TaskManager::addTask(const string &title, const string &description, Priority priority)
break;...VALID [written to ./task_manager.mutant.12.cpp]
PROCESSING MUTANT: 6: void TaskManager::addTask(const string &title, const string &description, Priority priority) ==> void TaskManager::addTask(const string &title, const string &description, Priority priority)
continue;...VALID [written to ./task_manager.mutant.13.cpp]
PROCESSING MUTANT: 6: void TaskManager::addTask(const string &title, const string &description, Priority priority) ==> void TaskManager::addTask ( const string &description,const string &title, Priority priority)...VALID [written to ./task_manager.mutant.14.cpp]
PROCESSING MUTANT: 6: void TaskManager::addTask(const string &title, const string &description, Priority priority) ==> void TaskManager::addTask(const string &title, const string &description, Priority priority,...VALID [written to ./task_manager.mutant.15.cpp]
PROCESSING MUTANT: 6: void TaskManager::addTask(const string &title, const string &description, Priority priority) ==> /*void TaskManager::addTask(const string &title, const string &description, Priority priority)*/...VALID [written to ./task_manager.mutant.16.cpp]
PROCESSING MUTANT: 7: { ==> {
break;...VALID [written to ./task_manager.mutant.17.cpp]
PROCESSING MUTANT: 7: { ==> {
continue;...VALID [written to ./task_manager.mutant.18.cpp]
PROCESSING MUTANT: 8: if (tasks.size() >= MAX_TASKS) ==> if (tasks.size() == MAX_TASKS)...VALID [written to ./task_manager.mutant.19.cpp]
PROCESSING MUTANT: 8: if (tasks.size() >= MAX_TASKS) ==> if (tasks.size() != MAX_TASKS)...VALID [written to ./task_manager.mutant.20.cpp]
```


Analyzing the mutants

analyze_mutants task_manager.cpp project

```
user@081ba9aac2f90:~/deepstate/project$ analyze_mutants task_manager.cpp project
ANALYZING task_manager.cpp
COMMAND: ** ['project'] **

=====
#1: [0.0s 0.0% DONE]
RUNNING ./task_manager.mutant.2184.cpp...
./task_manager.mutant.2184.cpp KILLED IN 0.0030994415283203125 (RETURN CODE 127)
RUNNING SCORE: 1.0
=====

#2: [0.0s 0.04% DONE]
RUNNING ./task_manager.mutant.2212.cpp...
./task_manager.mutant.2212.cpp KILLED IN 0.0027098655700683594 (RETURN CODE 127)
RUNNING SCORE: 1.0
=====

#3: [0.01s 0.08% DONE]
RUNNING ./task_manager.mutant.1273.cpp...
./task_manager.mutant.1273.cpp KILLED IN 0.0024881362915039062 (RETURN CODE 127)
RUNNING SCORE: 1.0
=====

#4: [0.01s 0.12% DONE]
RUNNING ./task_manager.mutant.1074.cpp...
./task_manager.mutant.1074.cpp KILLED IN 0.0527653694152832 (RETURN CODE 127)
RUNNING SCORE: 1.0
=====

#5: [0.07s 0.16% DONE]
RUNNING ./task_manager.mutant.427.cpp...
./task_manager.mutant.427.cpp KILLED IN 0.005495548248291016 (RETURN CODE 127)
RUNNING SCORE: 1.0
=====

#6: [0.08s 0.2% DONE]
RUNNING ./task_manager.mutant.680.cpp...
./task_manager.mutant.680.cpp KILLED IN 0.05289769172668457 (RETURN CODE 127)
RUNNING SCORE: 1.0
=====

RUNNING ./task_manager.mutant.1414.cpp...
./task_manager.mutant.1414.cpp KILLED IN 0.05239605903625488 (RETURN CODE 127)
RUNNING SCORE: 1.0
=====

#2453: [120.29s 99.63% DONE]
RUNNING ./task_manager.mutant.2270.cpp...
./task_manager.mutant.2270.cpp KILLED IN 0.052583932876586914 (RETURN CODE 127)
RUNNING SCORE: 1.0
=====

#2454: [120.35s 99.67% DONE]
RUNNING ./task_manager.mutant.105.cpp...
./task_manager.mutant.105.cpp KILLED IN 0.0030755996704101562 (RETURN CODE 127)
RUNNING SCORE: 1.0
=====

#2455: [120.35s 99.72% DONE]
RUNNING ./task_manager.mutant.864.cpp...
./task_manager.mutant.864.cpp KILLED IN 0.0024280548095703125 (RETURN CODE 127)
RUNNING SCORE: 1.0
=====

#2456: [120.35s 99.76% DONE]
RUNNING ./task_manager.mutant.1926.cpp...
./task_manager.mutant.1926.cpp KILLED IN 0.0022377967834472656 (RETURN CODE 127)
RUNNING SCORE: 1.0
=====

#2457: [120.36s 99.8% DONE]
RUNNING ./task_manager.mutant.1508.cpp...
./task_manager.mutant.1508.cpp KILLED IN 0.05222916603088379 (RETURN CODE 127)
RUNNING SCORE: 1.0
=====

#2458: [120.41s 99.84% DONE]
RUNNING ./task_manager.mutant.347.cpp...
./task_manager.mutant.347.cpp KILLED IN 0.004331111907958984 (RETURN CODE 127)
RUNNING SCORE: 1.0
=====

#2459: [120.42s 99.88% DONE]
RUNNING ./task_manager.mutant.313.cpp...
./task_manager.mutant.313.cpp KILLED IN 0.0027723312377929688 (RETURN CODE 127)
RUNNING SCORE: 1.0
=====

#2460: [120.42s 99.92% DONE]
RUNNING ./task_manager.mutant.822.cpp...
./task_manager.mutant.822.cpp KILLED IN 0.051857709884643555 (RETURN CODE 127)
RUNNING SCORE: 1.0
=====

#2461: [120.48s 99.96% DONE]
RUNNING ./task_manager.mutant.1570.cpp...
./task_manager.mutant.1570.cpp KILLED IN 0.053565263748168945 (RETURN CODE 127)
RUNNING SCORE: 1.0
=====

MUTATION SCORE: 1.0
user@081ba9aac2f90:~/deepstate/project$
```

The Mutation Score is 1

Code Coverage

Code coverage (deleted all the mutant files before checking the coverage)

```
clang++ task_manager.cpp test.cpp -o test -ldeepstate --coverage
```

```
./test
```

```
[user@81ba9aac2f90:~/deepstate/project$ clang++ task_manager.cpp test.cpp -o test -ldeepstate --coverage
[user@81ba9aac2f90:~/deepstate/project$ ./test
TRACE: Running: TaskManagementTest_AddTask from test.cpp(9)
Task added successfully.
TRACE: Passed: TaskManagementTest_AddTask
TRACE: Running: TaskManagementTest_FindTask from test.cpp(24)
Task added successfully.
Task added successfully.
TRACE: Passed: TaskManagementTest_FindTask
TRACE: Running: TaskManagementTest_DeleteTask from test.cpp(53)
Task added successfully.
Task added successfully.
Task 1 deleted successfully.
TRACE: Passed: TaskManagementTest_DeleteTask
TRACE: Running: TaskManagementTest_UpdateTask from test.cpp(73)
Task added successfully.
Task updated successfully.
TRACE: Passed: TaskManagementTest_UpdateTask
TRACE: Running: TaskManagementTest_MarkTaskCompleted from test.cpp(103)
```

llvm-cov-9 gcov task_manager.cpp

```
[user@81ba9aac2f90:~/deepstate/project$ llvm-cov-9 gcov task_manager.cpp
File './task_manager.h'
Lines executed:100.00% of 1
./task_manager.h:creating 'task_manager.h.gcov'

File '/usr/bin/../lib/gcc/x86_64-linux-gnu/7.5.0/../../../../include/c++/7.5.0/bits/alloc_traits.h'
Lines executed:100.00% of 10
/usr/bin/../lib/gcc/x86_64-linux-gnu/7.5.0/../../../../include/c++/7.5.0/bits/alloc_traits.h:creating 'alloc_traits.h.gcov'

File '/usr/bin/../lib/gcc/x86_64-linux-gnu/7.5.0/../../../../include/c++/7.5.0/bits/allocator.h'
Lines executed:100.00% of 1
/usr/bin/../lib/gcc/x86_64-linux-gnu/7.5.0/../../../../include/c++/7.5.0/bits/allocator.h:creating 'allocator.h.gcov'
```

```
Lines executed:5.00% of 20
/usr/bin/../lib/gcc/x86_64-linux-gnu/7.5.0/../../../../include/c++/7.5.0/bits/stl_uninitialized.h:creating 'stl_uninitialized.h.gcov'

File '/usr/bin/../lib/gcc/x86_64-linux-gnu/7.5.0/../../../../include/c++/7.5.0/bits/stl_vector.h'
Lines executed:98.00% of 52
/usr/bin/../lib/gcc/x86_64-linux-gnu/7.5.0/../../../../include/c++/7.5.0/bits/stl_vector.h:creating 'stl_vector.h.gcov'

File '/usr/bin/../lib/gcc/x86_64-linux-gnu/7.5.0/../../../../include/c++/7.5.0/bits/vector.tcc'
Lines executed:82.98% of 47
/usr/bin/../lib/gcc/x86_64-linux-gnu/7.5.0/../../../../include/c++/7.5.0/bits/vector.tcc:creating 'vector.tcc.gcov'

File '/usr/bin/../lib/gcc/x86_64-linux-gnu/7.5.0/../../../../include/c++/7.5.0/ext/new_allocator.h'
Lines executed:92.31% of 13
/usr/bin/../lib/gcc/x86_64-linux-gnu/7.5.0/../../../../include/c++/7.5.0/ext/new_allocator.h:creating 'new_allocator.h.gcov'

File '/usr/bin/../lib/gcc/x86_64-linux-gnu/7.5.0/../../../../include/c++/7.5.0/iostream'
Lines executed:100.00% of 1
/usr/bin/../lib/gcc/x86_64-linux-gnu/7.5.0/../../../../include/c++/7.5.0/iostream:creating 'iostream.gcov'

File 'task_manager.cpp'
Lines executed:81.38% of 188
task_manager.cpp:creating 'task_manager.cpp.gcov'

user@81ba9aac2f90:~/deepstate/project$
```

- Unit testing ensured approximately **82% code coverage**, with focus on all major functionalities.