

Mutation Testing for CPSCMS

Users App:

Running Unit tests first to confirm all are passing and ensuring close to 100% coverage in CLI:

```
===== tests coverage =====
----- coverage: platform linux, python 3.10.19-final-0 -----
```

Name	Stmts	Miss	Cover	Missing
users/EmailService.py	27	0	100%	
users/__init__.py	0	0	100%	
users/admin.py	7	0	100%	
users/apps.py	4	0	100%	
users/authentication.py	28	0	100%	
users/forms.py	0	0	100%	
users/migrations/0001_initial.py	11	0	100%	
users/migrations/0002_alter_department_options_and_more.py	4	0	100%	
users/migrations/0003_alter_department_options_and_more.py	5	0	100%	
users/migrations/0004_field_worker_verified_government_authority_verified.py	4	0	100%	
users/migrations/0005_remove_field_worker_worker_name_and_more.py	4	0	100%	
users/migrations/0006_remove_field_worker_assigned_area.py	4	0	100%	
users/migrations/__init__.py	0	0	100%	
users/models.py	31	0	100%	
users/serializers.py	82	8	90%	37, 54-6
0				
users/tests.py	0	0	100%	
users/tests/__init__.py	0	0	100%	
users/tests/test_authentication.py	111	1	99%	31
users/tests/test_email_service.py	126	2	98%	101-103
users/tests/test_models.py	150	0	100%	
users/tests/test_serializers.py	121	0	100%	
users/tests/test_users_auth.py	567	6	99%	283-284, 439-440, 1012-1013
users/tests/test_views_100_coverage.py	86	4	95%	67-74, 108
users/tests/test_views_coverage.py	148	5	97%	115-121
users/urls.py	5	0	100%	
users/views.py	334	10	97%	78, 105, 363-364, 399, 441, 454-455, 466-467
TOTAL	1859	36	98%	

```
===== 156 passed in 39.38s =====
```

Running the Mutpy package for users app utilizing unit tests written in users/tests folder.

```
C:\Users\JAINIL\Desktop\Crowd-Powered-Smart-Complaint-Management-System\Backend>docker compose -f docker-comp
ose.test.yml exec -e DJANGO_SETTINGS_MODULE=CPCMS.mutpy_settings web python /usr/local/bin/mut.py --target us
ers --unit-test users.tests --runner pytest --report-html /test_mutpy/mutpy_report
[*] Start mutation process:
- targets: users
- tests: users.tests
Cloudinary configured successfully
[*] 156 tests passed:
- users.tests.test_authentication [2.23327 s]
- users.tests.test_email_service [0.75432 s]
- users.tests.test_models [8.14093 s]
- users.tests.test_serializers [4.52205 s]
- users.tests.test_users_auth [20.55532 s]
- users.tests.test_views_100_coverage [5.13267 s]
- users.tests.test_views_coverage [3.85445 s]
[*] Start mutants generation and execution:
```

Final mutation score in CLI (Command Line Interface)

```
Id Worker Serializer With department
[*] Mutation score [1204.43021 s]: 100.0%
- all: 183
- killed: 183 (100.0%)
- survived: 0 (0.0%)
- incompetent: 0 (0.0%)
- timeout: 0 (0.0%)
```

Mutation Report:

MutPy mutation report

🕒 24.11.2025 14:08

Target

- users

Tests [156]

- users.tests.test_authentication [2.233 s]
- users.tests.test_email_service [0.754 s]
- users.tests.test_models [8.141 s]
- users.tests.test_serializers [4.522 s]
- users.tests.test_users_auth [20.555 s]
- users.tests.test_views_100_coverage [5.133 s]
- users.tests.test_views_coverage [3.854 s]

Result summary

- 📊 Score - 100.0%
- 🕒 Time - 1204.4 s

Mutants [183]

- 🔴 killed - 183
- 🟡 survived - 0
- 🟠 incompetent - 0
- 🔵 timeout - 0

100.0%

#	Module	Operator	Tests run	Duration	Result	
1		DDL [8]	86	18.752 s	killed	➡
2		DDL [12]	86	19.52 s	killed	➡
3		DDL [24]	86	19.334 s	killed	➡

Notifications App:

Running Unit tests first to confirm all are passing and ensuring 100% coverage in CLI:

```
C:\Users\JAINIL\Desktop\Crowd-Powered-Smart-Complaint-Management-System\Backend>docker compose run --rm web p
yttest --cov=notifications --cov-report=term-missing notifications/tests
[+] Creating 1/1
  ✓ Container redis  Running 0.0s
===== test session starts =====
platform linux -- Python 3.10.19, pytest-9.0.1, pluggy-1.6.0
django: version: 5.2.7, settings: CPCMS.settings_test (from ini)
rootdir: /code
configfile: pytest.ini
plugins: cov-7.0.0, anyio-4.11.0, langsmith-0.4.43, django-4.11.1
collected 33 items

notifications/tests/test_models.py ..... [ 39%]
notifications/tests/test_views.py ..... [100%]

===== tests coverage =====
----- coverage: platform linux, python 3.10.19-final-0 -----
Name                                                    Stmts  Miss  Cover   Missing
-----
notifications/__init__.py                                0      0  100%
notifications/admin.py                                   1      0  100%
notifications/apps.py                                    4      0  100%
notifications/migrations/0001_initial.py                 7      0  100%
notifications/migrations/__init__.py                     0      0  100%
notifications/models.py                                  14      0  100%
notifications/serializers.py                             7      0  100%
notifications/tests/__init__.py                          0      0  100%
notifications/tests/test_models.py                       86      0  100%
notifications/tests/test_views.py                      184      0  100%
notifications/urls.py                                    3      0  100%
notifications/views.py                                   59      0  100%
-----
TOTAL                                                    365      0  100%
===== 33 passed in 17.03s =====
```

The initial Mutpy run for notifications:

```
C:\Users\JAINIL\Desktop\Crowd-Powered-Smart-Complaint-Management-System\Backend>docker compose -f docker-compose.test.
yaml exec -e DJANGO_SETTINGS_MODULE=CPCMS.mutpy_settings web python /usr/local/bin/mut.py --target notifications.views
notifications.urls notifications.serializers notifications.models --unit-test notifications.tests --runner pytest --re
port-html /test_mutpy_notifications --show-mutants --debug
[*] Start mutation process:
  - targets: notifications.views, notifications.urls, notifications.serializers, notifications.models
  - tests: notifications.tests
Cloudinary configured successfully
[*] 33 tests passed:
  - notifications.tests.mutpy_tests [0.98995 s]
  - notifications.tests.test_models [4.78646 s]
  - notifications.tests.test_views [4.84026 s]
[*] Start mutants generation and execution:
```

Almost all mutants survived

```
[8.70819 s] survived
[*] Mutation score [202.88496 s]: 4.3%
- all: 23
- killed: 1 (4.3%)
- survived: 22 (95.7%)
- incompetent: 0 (0.0%)
- timeout: 0 (0.0%)
```

MutPy mutation report

🕒 26.11.2025 13:35

Target

- notifications.views
- notifications.urls
- notifications.serializers
- notifications.models

Tests [33]

- notifications.tests.mutpy_tests [0.99 s]
- notifications.tests.test_models [4.786 s]
- notifications.tests.test_views [4.84 s]

Result summary

- 📊 Score - 4.3%
- 🕒 Time - 202.9 s

Mutants [23]

- 🟢 killed - 1
- 🟠 survived - 22
- 🟡 incompetent - 0
- 🔴 timeout - 0



#	Module	Operator	Tests run	Duration	Result	
1		COD [100]	33	8.662 s	survived	➡
2		COI [100]	33	8.643 s	survived	➡
3		COL [108]	33	8.425 s	survived	➡

The only killed mutant:

Mutation #22

Details

- module -
- **killed** by `notifications/tests/test_views.py::TestNotificationListAPIView::test_list_notifications_authenticated`
- duration - 1.093 s
- tests run - 1

Exception traceback

```
self =
client = , user =

def test_list_notifications_authenticated(self, client, user):
    """Test listing notifications for authenticated user"""
    # Create notifications for the user
    Notification.objects.create(
        user=user,
        message="Test notification 1",
        is_read=False
    )
    Notification.objects.create(
        user=user,
        message="Test notification 2",
        is_read=True
    )

    client.force_authenticate(user=user)
    response = client.get(reverse('notification-list'))

    assert response.status_code == status.HTTP_200_OK
> assert len(response.data) == 2
E     AssertionError

notifications/tests/test_views.py:62: AssertionError
```

Problem:

Root cause: the problem was not the test logic itself but import-time binding of Django view callables. MutPy runs tests against a mutated temporary copy of the source, but the Django URLconf imports and binds view callables at module-import time. Tests that use the test client with `reverse()` therefore invoked the already-bound callable from the original import rather than the mutated copy, so MutPy's changes were not exercised.

```
client.force_authenticate(user=user)
    response = client.get(reverse('notification-open',
args=[notif.id]))
```

Solution which i tried:

Using APIRequestFactory() function which comes in rest_framework solely for unit testing purpose. This function directly invokes the view function in the class and this turned out to work properly. Replaced all the tests to use APIRequestFactory() instead to directly call the view and then using reverse proxy to hit the API.

```
factory=APIRequestFactory()
    request=factory.get(reverse('notification-list'))
    force_authenticate(request, user=user)
    response =
notifications_views.NotificationListAPIView.as_view()(request)
```

Running Mutpy again :

```
[*] Mutation score [112.97630 s]: 73.7%
- all: 23
- killed: 14 (60.9%)
- survived: 5 (21.7%)
- incompetent: 4 (17.4%)
- timeout: 0 (0.0%)
```

MutPy mutation report

🕒 26.11.2025 14:00

Target

- notifications.views
- notifications.urls
- notifications.serializers
- notifications.models

Tests [34]

- notifications.tests.mutpy_tests [1.156 s]
- notifications.tests.test_models [4.716 s]
- notifications.tests.test_views [5.18 s]

Result summary

- 📊 Score - 73.7%
- 🕒 Time - 113.0 s

Mutants [23]

- 🟢 killed - 14
- 🟡 survived - 5
- 🟠 incompetent - 4
- 🔴 timeout - 0



#	Module	Operator	Tests run	Duration	Result	
1		COD [100]	15	3.98 s	killed	➔
2		COI [100]	15	4.005 s	killed	➔
3		COL [108]	15	3.944 s	killed	➔

Score improved significantly still some mutants survived.

After adding additional tests for remaining survived mutants finally achieved 100% coverage:

MutPy mutation report

🕒 27.11.2025 12:57

Target

- notifications.views
- notifications.urls
- notifications.serializers
- notifications.models

Tests [42]

- notifications.tests.mutpy_tests [2.838 s]
- notifications.tests.test_models [4.566 s]
- notifications.tests.test_views [4.679 s]

Result summary

- 📊 Score - 100.0%
- 🕒 Time - 174.8 s

Mutants [23]

- 🟢 killed - 23
- 🟡 survived - 0
- 🟠 incompetent - 0
- 🔴 timeout - 0



#	Module	Operator	Tests run	Duration	Result	
1		COD [100]	33	9.001 s	killed	➔
2		COI [100]	33	8.516 s	killed	➔
3		COL [108]	33	8.492 s	killed	➔

The additional tests have been written in **Backend/Notifications/tests/mutpy_tests.py** file.

Complaints App

Initial Mutation Score:

```
erage::test_resolution_image_str
[*] Mutation score [3537.53202 s]: 56.9%
- all: 656
- killed: 369 (56.2%)
- survived: 280 (42.7%)
- incompetent: 7 (1.1%)
- timeout: 0 (0.0%)
```

Since a large number of mutations were generated, I created a configuration file to reduce them and added some additional tests and then obtained the final mutation score.

Final Mutation score:

```
[*] Mutation score [1741.58862 s]: 100.0%
- all: 93
- killed: 62 (66.7%)
- survived: 0 (0.0%)
- incompetent: 31 (33.3%)
- timeout: 0 (0.0%)
PS C:\Users\S540 29IN 8G i5 SSD\Desktop\Crowd-Powered-Smart-Complaint-Management-System\Backend> |
```

The additional tests are in:
Backend/complaints/tests_mut folder.