Monkeying Around: Chaos Engineering and Robust Web Services

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01 Background

Our service, Problem Statement and Goal

Chaos Engineering

Definition:

- Deliberately injecting failures in a controlled manner.

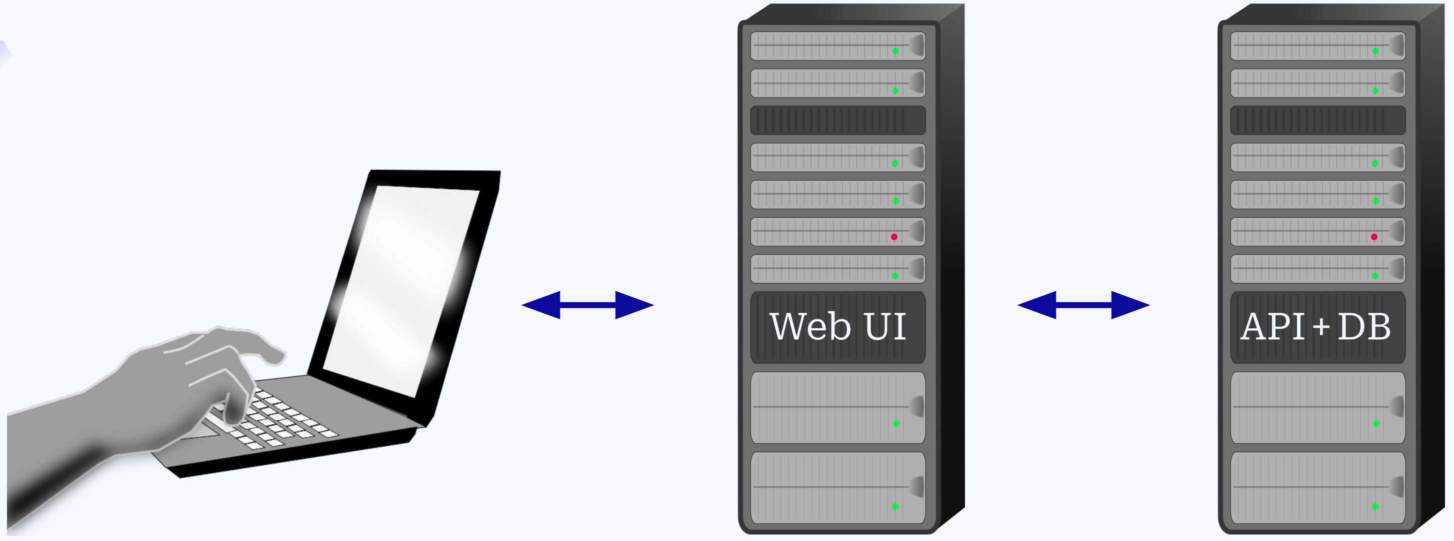
Core Concepts:

- Simulate disruptions (think Netflix's "wild monkey" analogy).
- Ensure continuous service despite unexpected issues.
- Enhance recovery procedures and tooling.

Analogy:

- Like vaccines, controlled exposure builds resilience.

One Move Chess - API Diagram



User

VM2

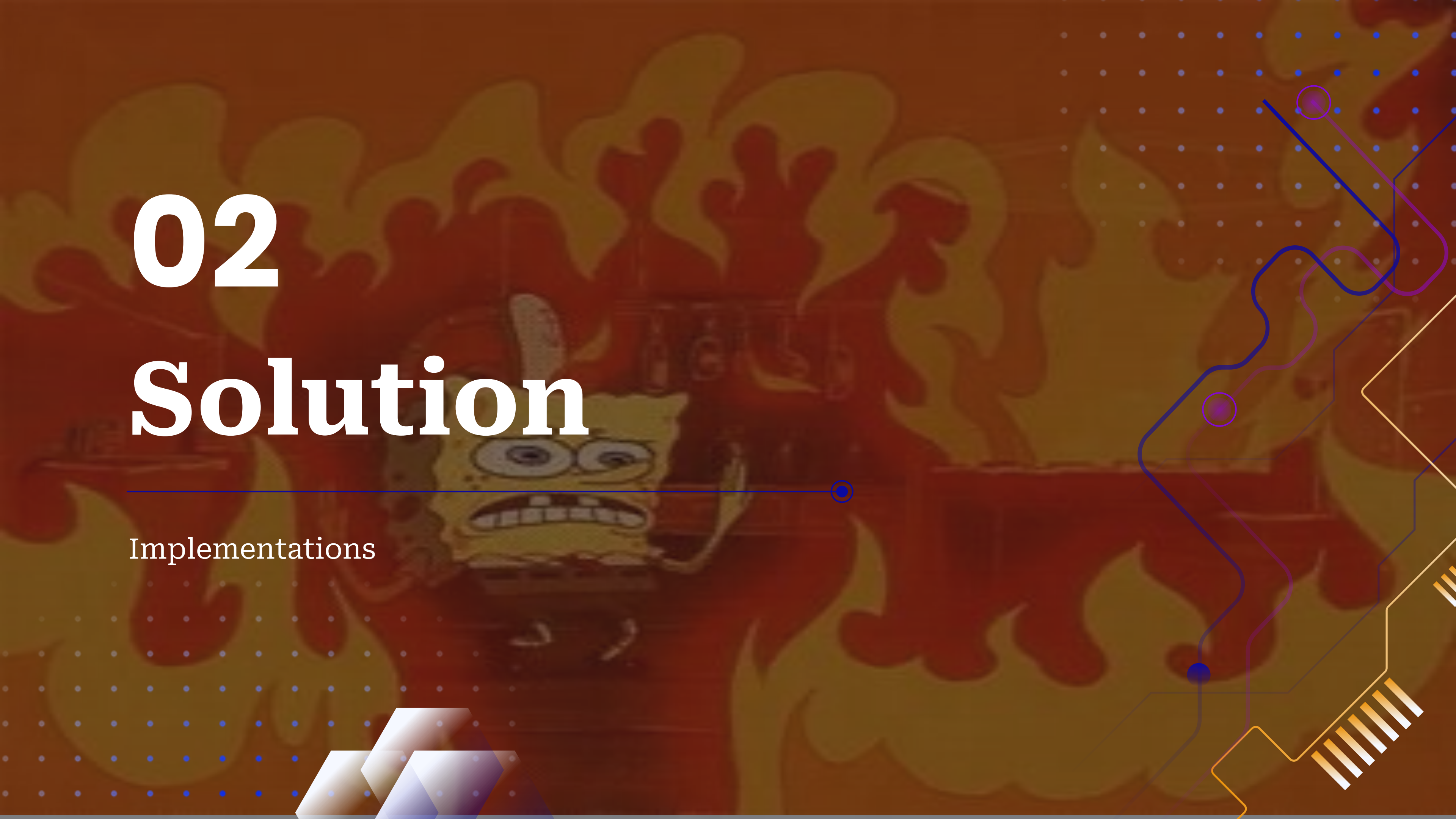
VM1

Problem Statement

We cannot assume that cloud services will always work all of the time. It's much better to practice handling failures in a safe environment rather than when you least expect it.

Our Goal

We aim to achieve graceful degradation, where the system continues to function under stress without crashing. Real-time monitoring of system performance and error rates helps determine whether the system self-heals or requires intervention.



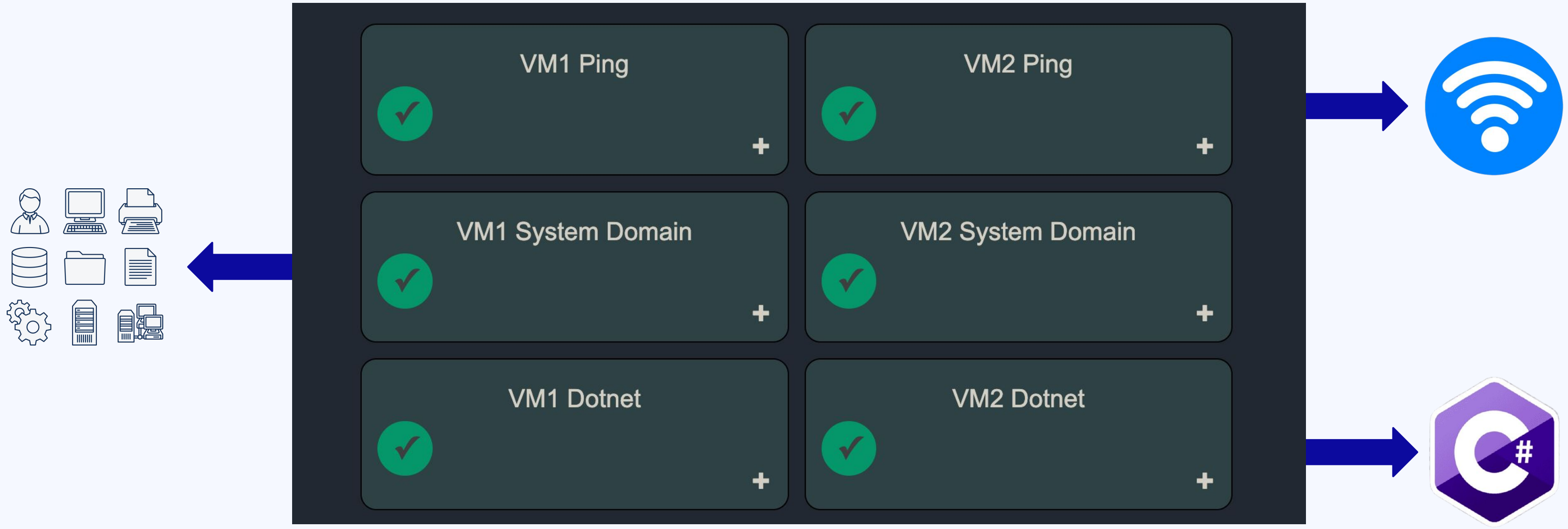
02 Solution

Implementations

Monitoring

Status Page

Status Page - Azure Components



VM1 Ping ✓ +

VM2 Ping ✓ +

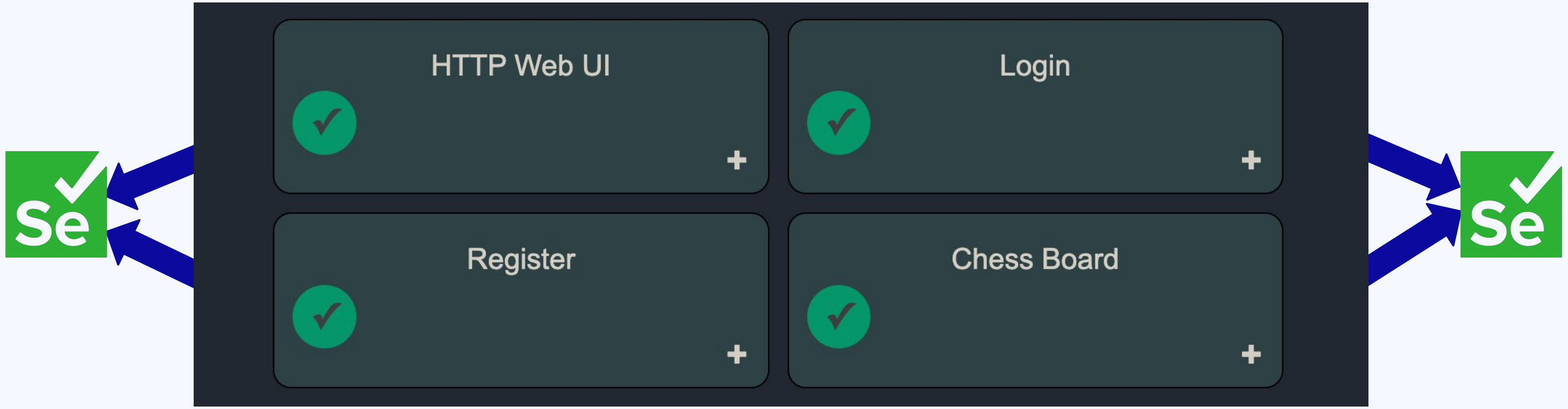
VM1 System Domain ✓ +

VM2 System Domain ✓ +

VM1 Dotnet ✓ +

VM2 Dotnet ✓ +

Status Page - Automated Components



WHY:

- End-to-End (E2E) Testing of User Experience
- Simulating Real User Behavior

Automated Human Interaction

HTTP Web UI

Uses Python HTTP module to check availability of main, login, and registration pages.

Login

Simulates human behaviour to **login** to accounts

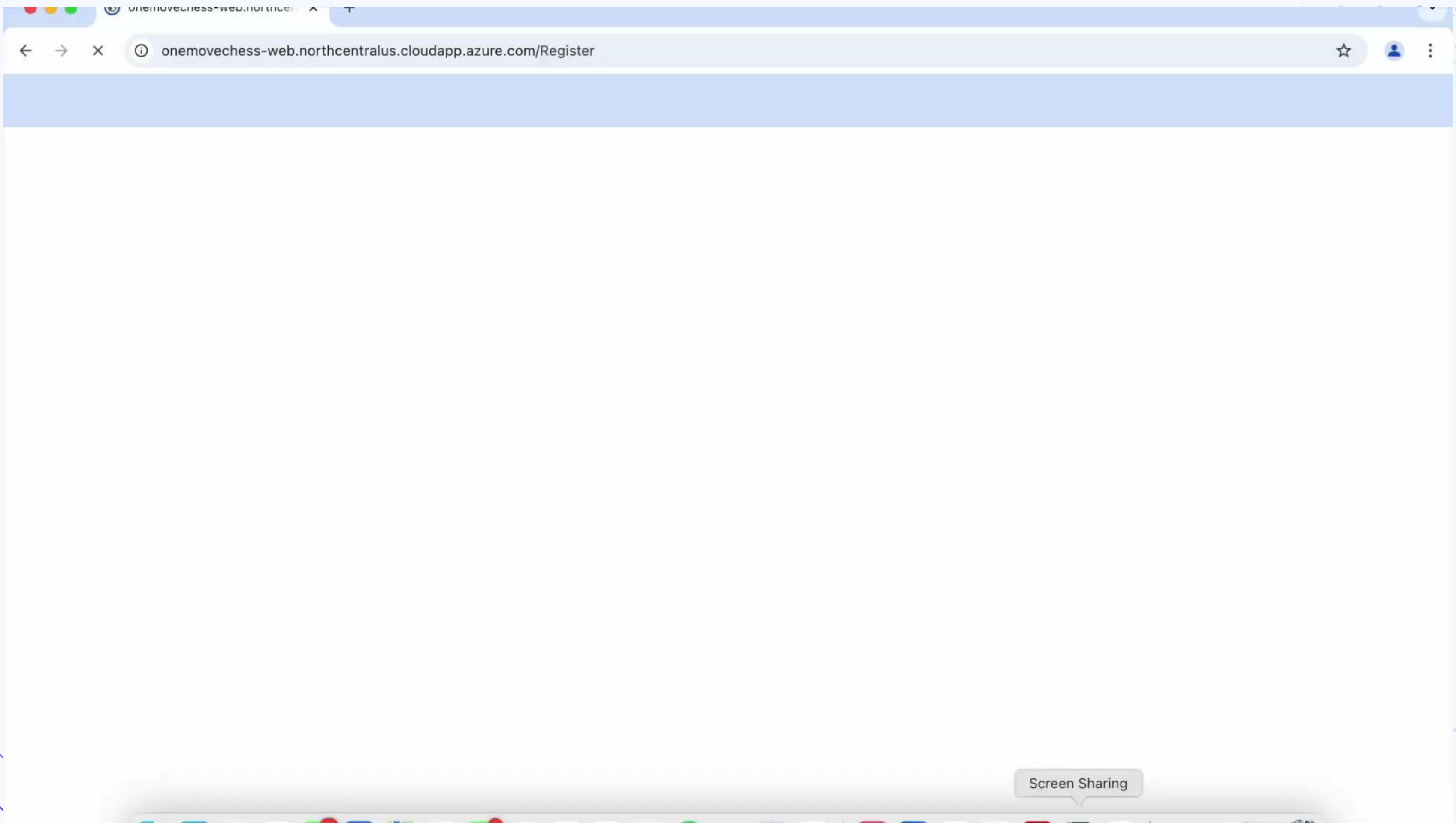
Register

Simulates human behaviour to **register** to accounts

Chess board

Checks board allocation, board availability, and chess piece movement

Demo


onemovechess-web.northcentralus.cloudapp.azure.com/Register

Implementations for effectivity

A	Threading	Runs all components concurrently
B	Immediate	Runs all components every 2 minute
C	Detailed	Clear and concise information on each individual component

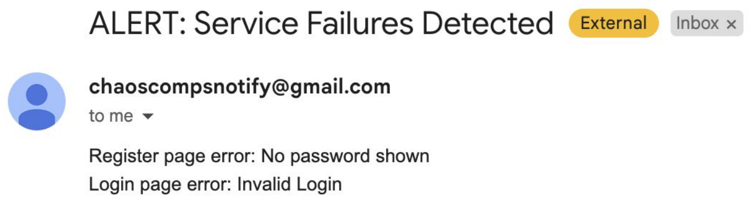
Fault Injection

Fault Injection

Goal: Simulate software and hardware faults to determine our ability to recover & test our monitoring

- Fault-Injection:
  - Kill the API on VM 1
  - Kill the Web UI on VM 2
  - Rename the DB on VM 1
- Fault-Fixer:
  - Restart the API on VM 1
  - Restart the Web UI on VM 2
  - Find the database if it still exists and restore its proper name on VM 1

Notifications



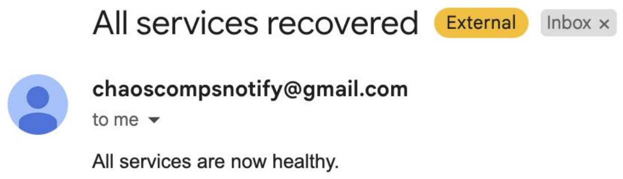
ALERT: Service Failures Detected External Inbox ×

chaoscompsnotify@gmail.com

to me

Register page error: No password shown

Login page error: Invalid Login

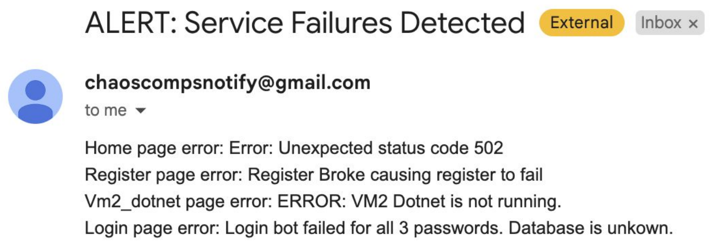


All services recovered External Inbox ×

chaoscompsnotify@gmail.com

to me

All services are now healthy.



ALERT: Service Failures Detected External Inbox ×

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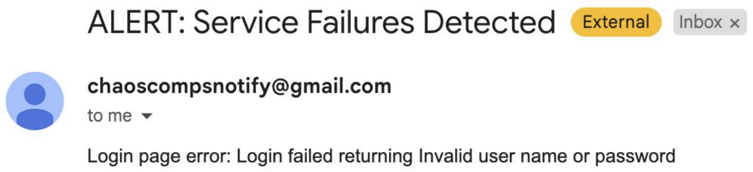
to me

Home page error: Error: Unexpected status code 502

Register page error: Register Broke causing register to fail

Vm2_dotnet page error: ERROR: VM2 Dotnet is not running.

Login page error: Login bot failed for all 3 passwords. Database is unkown.



ALERT: Service Failures Detected External Inbox ×

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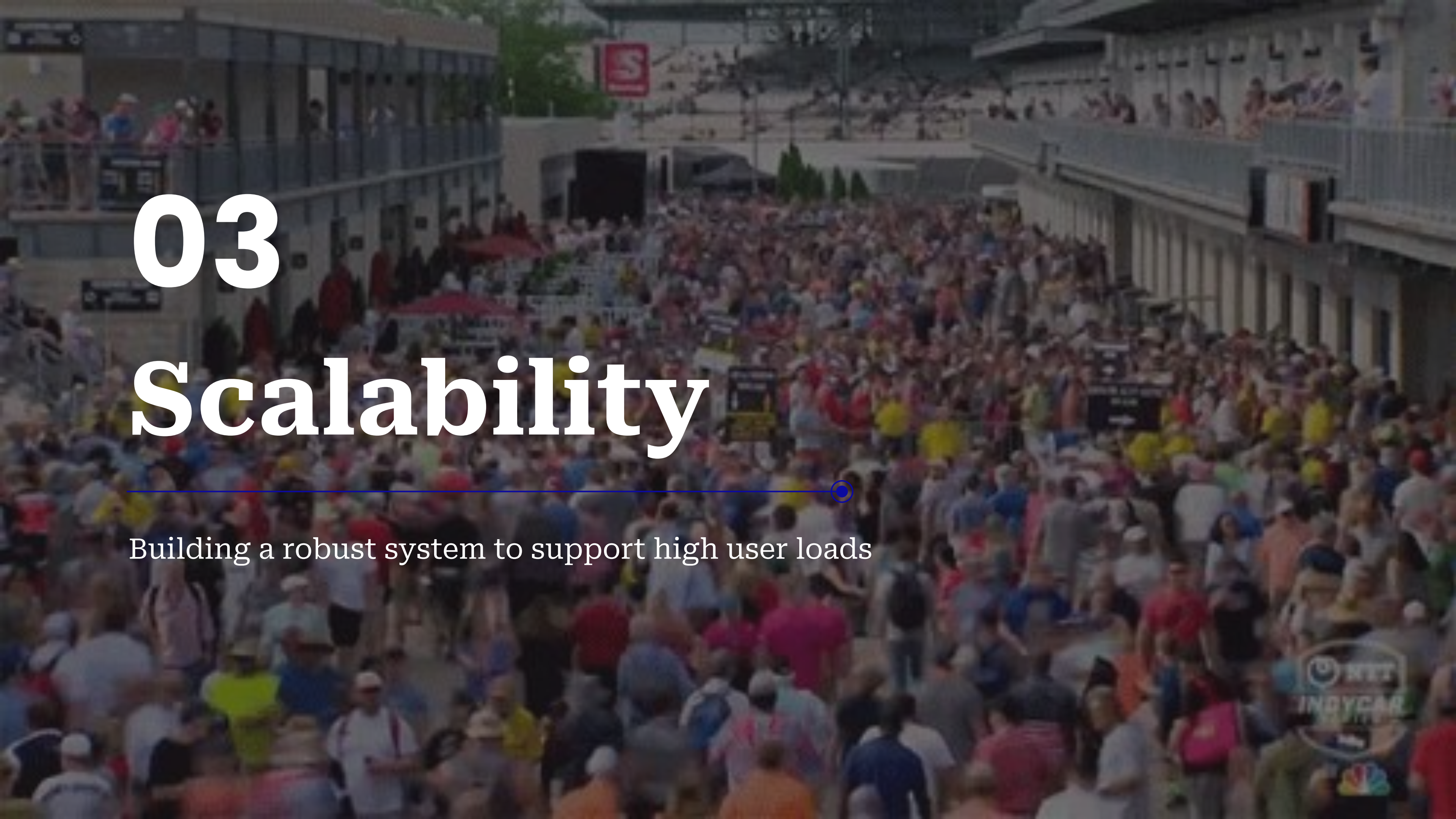
to me

Login page error: Login failed returning Invalid user name or password



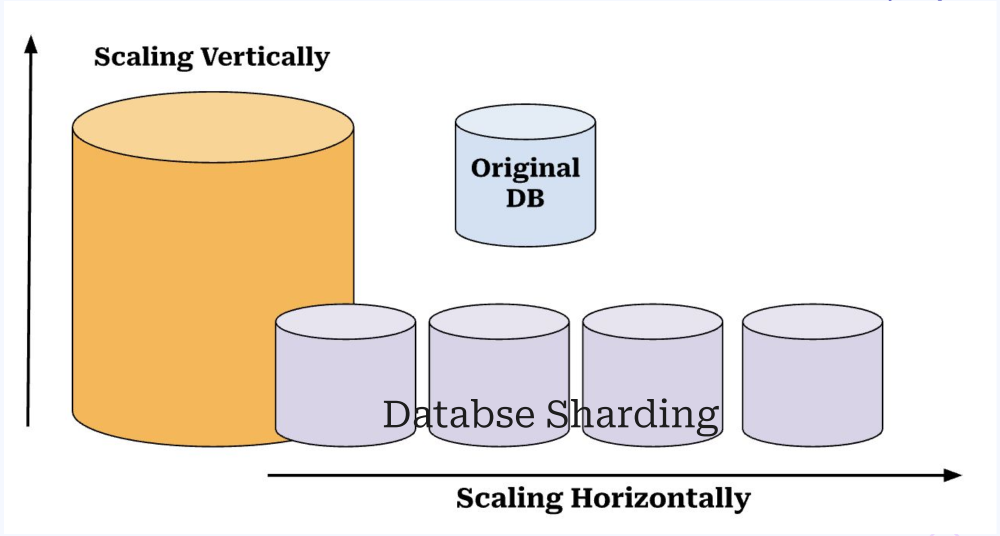
03

Scalability

Building a robust system to support high user loads

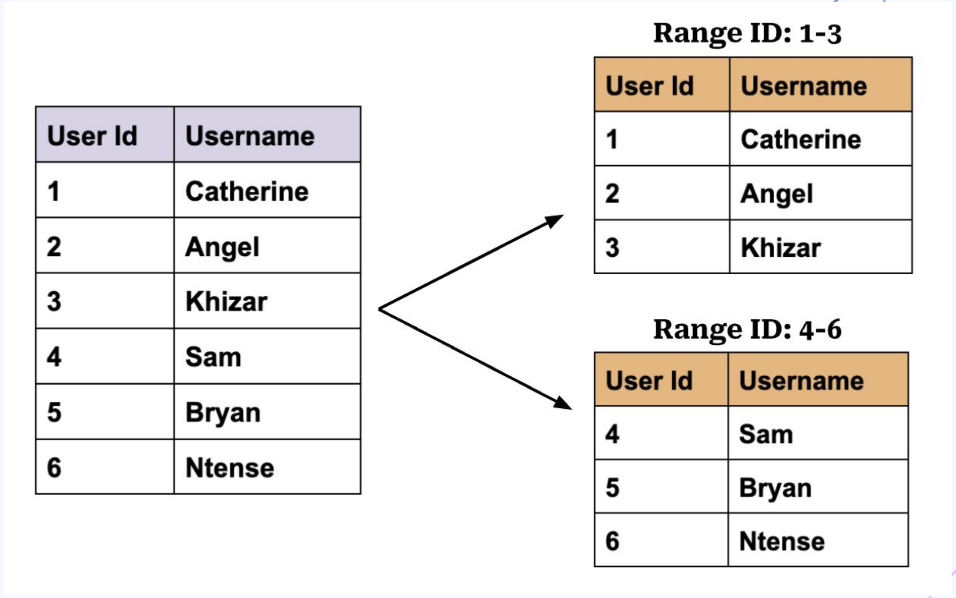
Database Sharding

- What is Database Sharding?
- Why might we want to incorporate Database Sharding?
    - Scalability
    - Cost
    - Performance
    - Fault Tolerance



Database Sharding

- How is Database Sharding Implemented?
  - Geographic Sharding
  - Range-Based Sharding
  - Hash-Based Sharding



User Id	Username
1	Catherine
2	Angel
3	Khizar
4	Sam
5	Bryan
6	Ntense

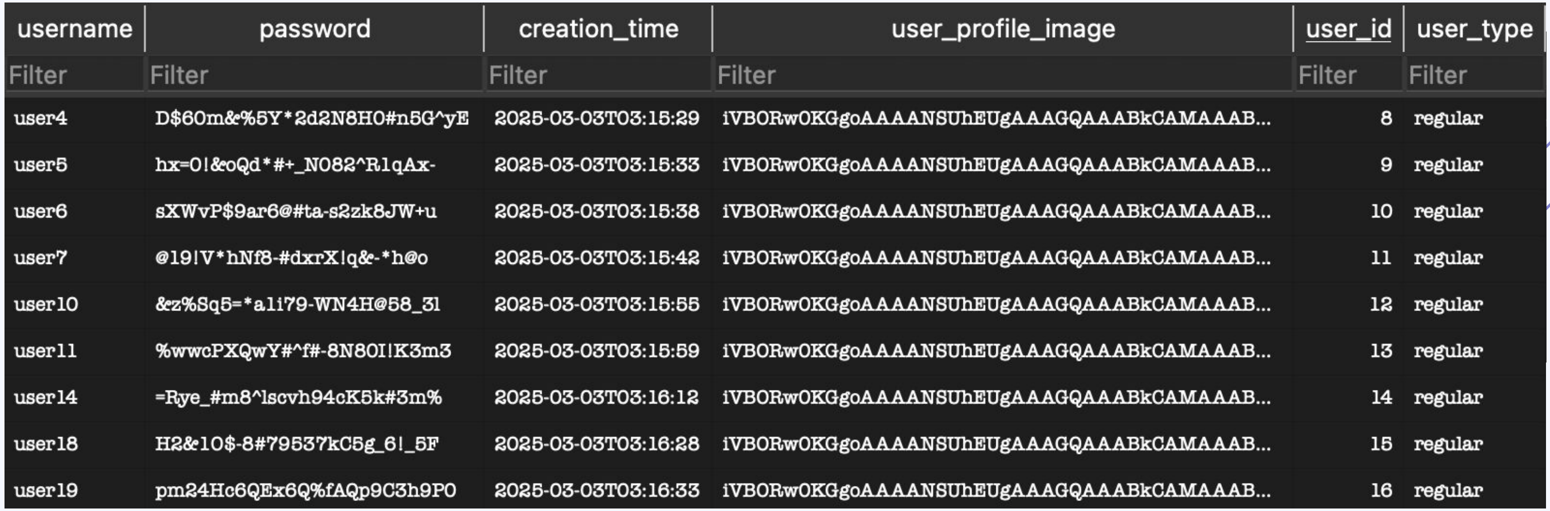
Range ID: 1-3

User Id	Username
1	Catherine
2	Angel
3	Khizar

Range ID: 4-6

User Id	Username
4	Sam
5	Bryan
6	Ntense

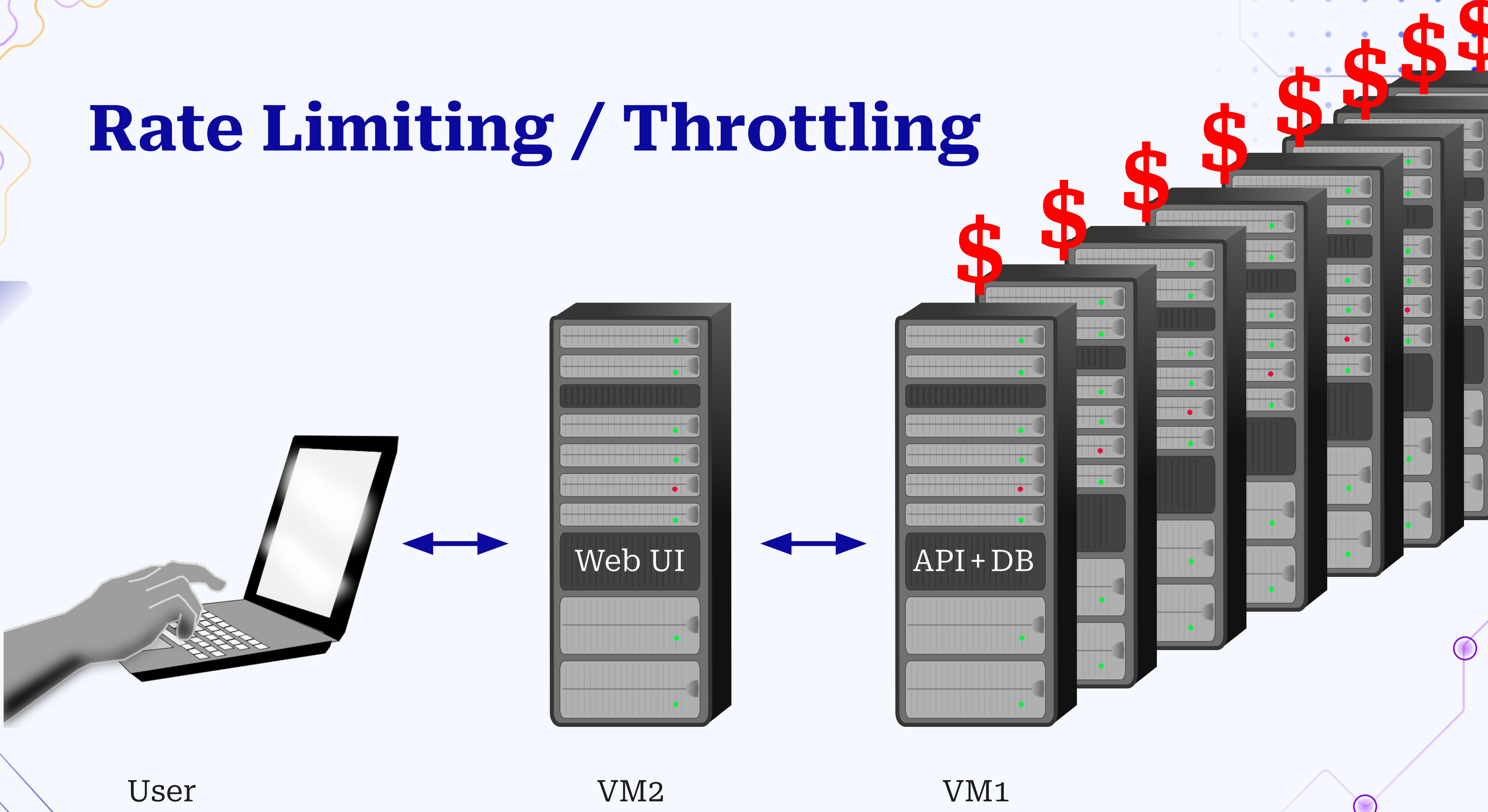
Sharding by Username



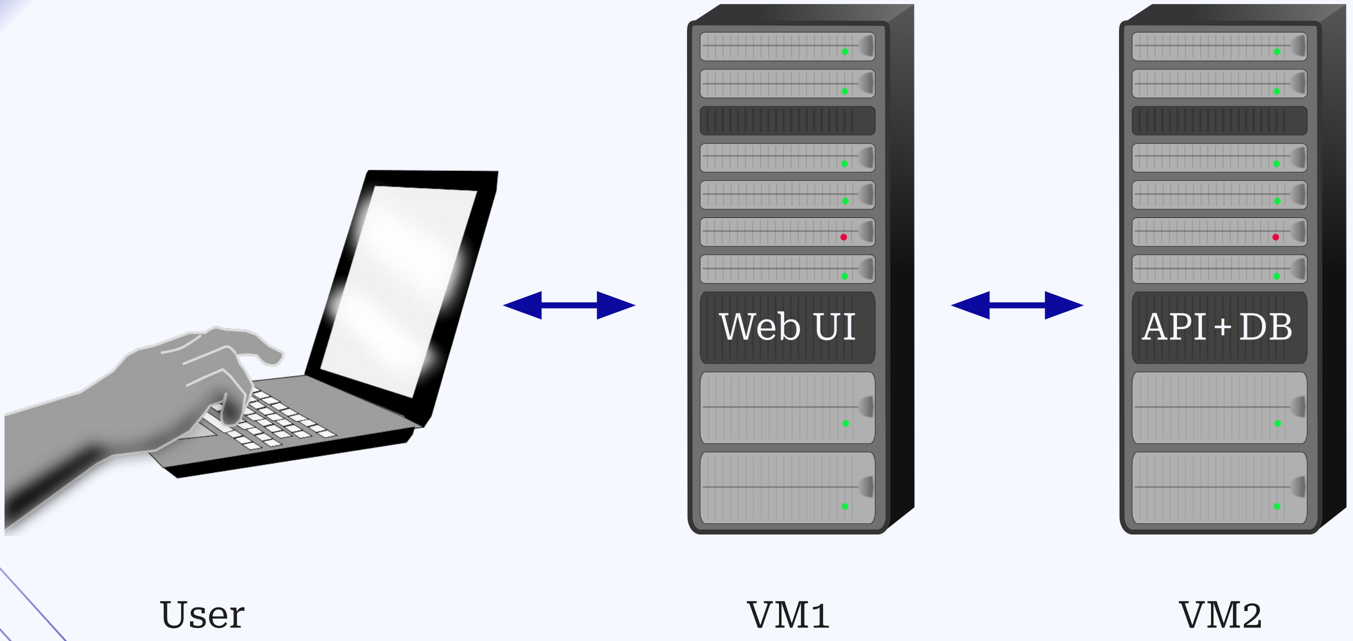
username	password	creation_time	user_profile_image	user_id	user_type
Filter	Filter	Filter	Filter	Filter	Filter
user4	D$60m&%5Y*2d2N8H0#n5G^yE	2025-03-03T03:15:29	iVBORw0KGgoAAAANSUhEUgAAAGQAAABkCAMAAAB...	8	regular
user5	hx=0!&oQd*#+_N082^R1qAx-	2025-03-03T03:15:33	iVBORw0KGgoAAAANSUhEUgAAAGQAAABkCAMAAAB...	9	regular
user6	sXWvP$9ar6@#ta-s2zk8JW+u	2025-03-03T03:15:38	iVBORw0KGgoAAAANSUhEUgAAAGQAAABkCAMAAAB...	10	regular
user7	@19!V*hNf8-#dxrX!q&-*h@o	2025-03-03T03:15:42	iVBORw0KGgoAAAANSUhEUgAAAGQAAABkCAMAAAB...	11	regular
user10	&z%Sq5=*a1i79-WN4H@58_3l	2025-03-03T03:15:55	iVBORw0KGgoAAAANSUhEUgAAAGQAAABkCAMAAAB...	12	regular
user11	%wwcPXQwY#^f#-8N80I!K3m3	2025-03-03T03:15:59	iVBORw0KGgoAAAANSUhEUgAAAGQAAABkCAMAAAB...	13	regular
user14	=Rye_#m8^lscvh94cK5k#3m%	2025-03-03T03:16:12	iVBORw0KGgoAAAANSUhEUgAAAGQAAABkCAMAAAB...	14	regular
user18	H2&10$-8#79537kC5g_6!_5F	2025-03-03T03:16:28	iVBORw0KGgoAAAANSUhEUgAAAGQAAABkCAMAAAB...	15	regular
user19	pm24Hc6QEx6Q%fAQp9C3h9P0	2025-03-03T03:16:33	iVBORw0KGgoAAAANSUhEUgAAAGQAAABkCAMAAAB...	16	regular

Rate Limiting and Throttling

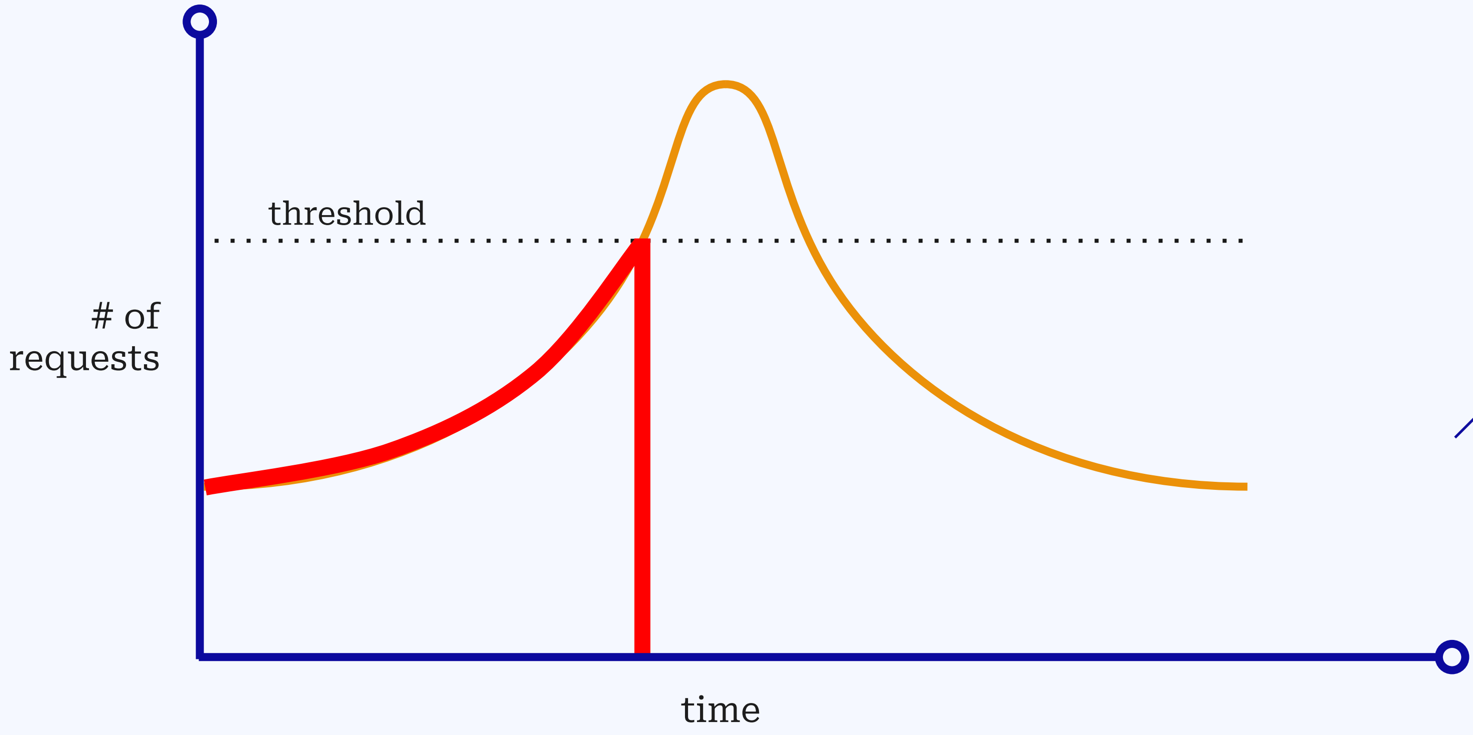
Rate Limiting / Throttling



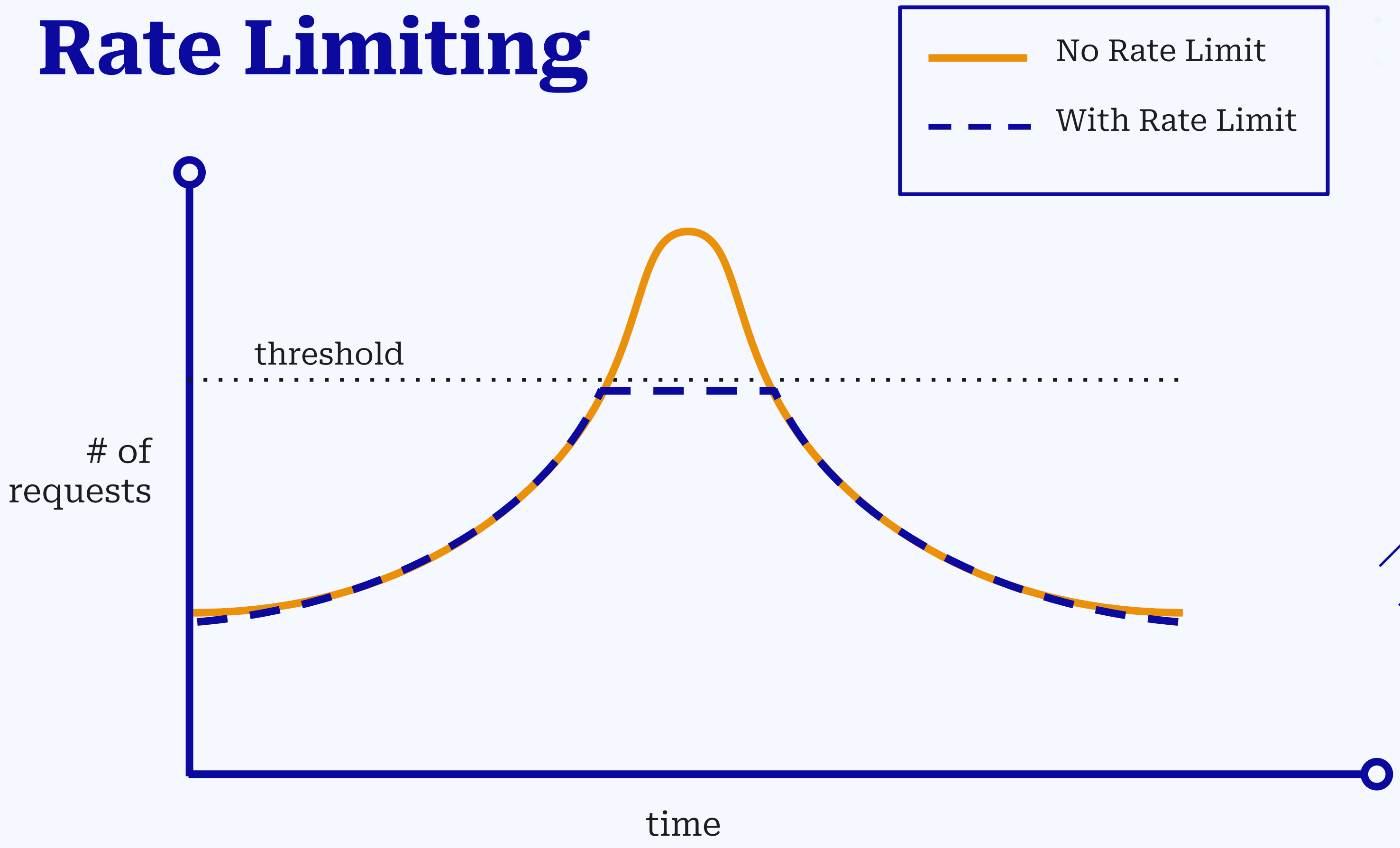
Rate Limiting / Throttling



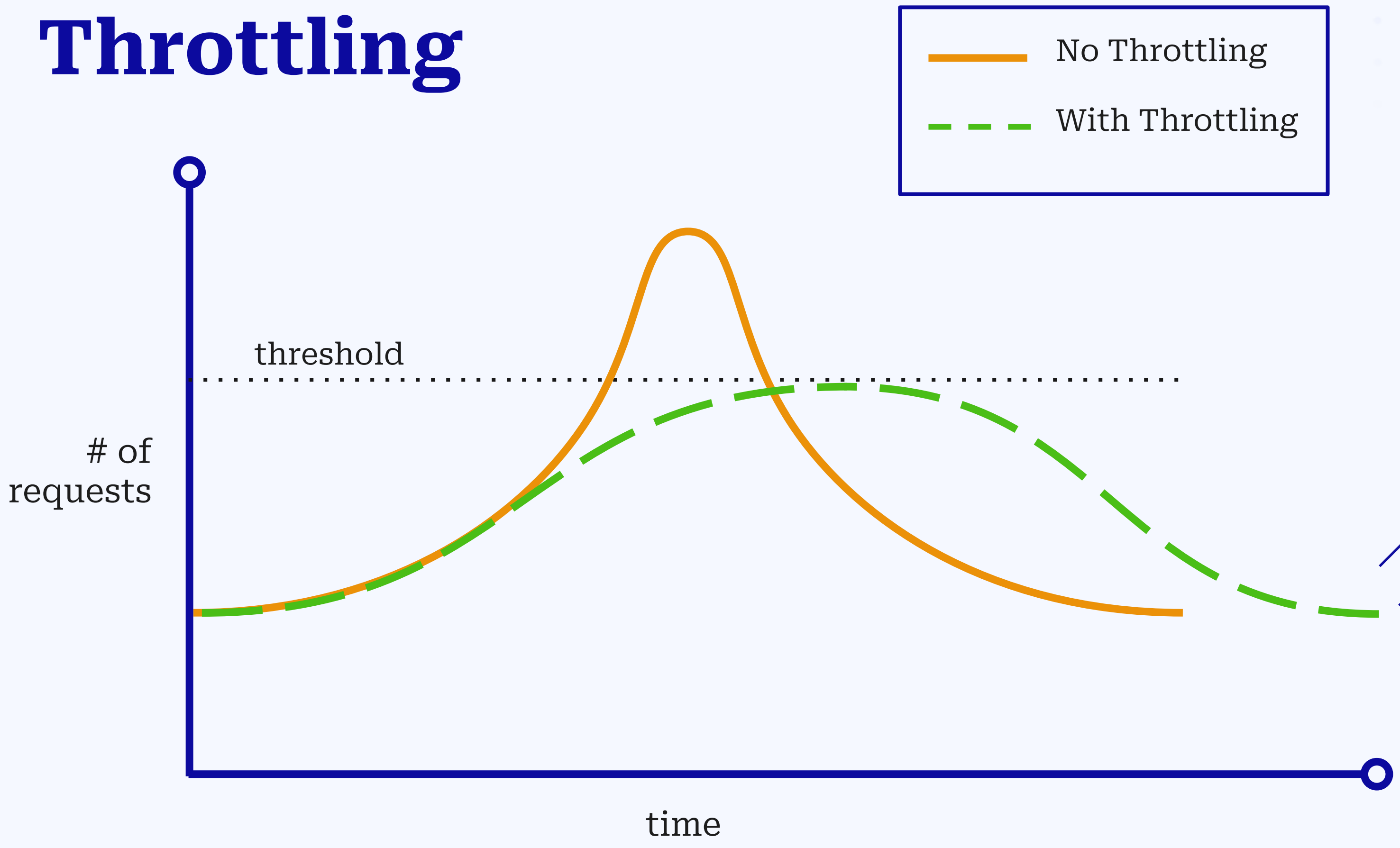
Rate Limiting



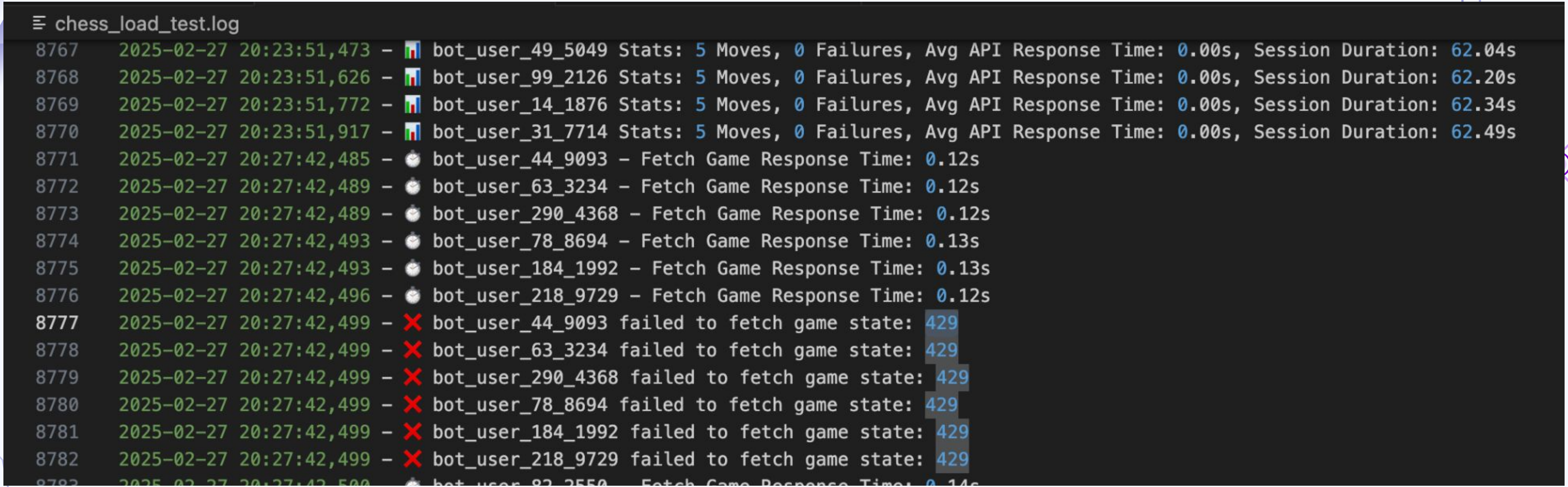
Rate Limiting



Throttling



Rate Limiting / Throttling



chess_load_test.log

```
2025-02-27 20:23:51,473 - 📊 bot_user_49_5049 Stats: 5 Moves, 0 Failures, Avg API Response Time: 0.00s, Session Duration: 62.04s
2025-02-27 20:23:51,626 - 📊 bot_user_99_2126 Stats: 5 Moves, 0 Failures, Avg API Response Time: 0.00s, Session Duration: 62.20s
2025-02-27 20:23:51,772 - 📊 bot_user_14_1876 Stats: 5 Moves, 0 Failures, Avg API Response Time: 0.00s, Session Duration: 62.34s
2025-02-27 20:23:51,917 - 📊 bot_user_31_7714 Stats: 5 Moves, 0 Failures, Avg API Response Time: 0.00s, Session Duration: 62.49s
2025-02-27 20:27:42,485 - ⏱ bot_user_44_9093 - Fetch Game Response Time: 0.12s
2025-02-27 20:27:42,489 - ⏱ bot_user_63_3234 - Fetch Game Response Time: 0.12s
2025-02-27 20:27:42,489 - ⏱ bot_user_290_4368 - Fetch Game Response Time: 0.12s
2025-02-27 20:27:42,493 - ⏱ bot_user_78_8694 - Fetch Game Response Time: 0.13s
2025-02-27 20:27:42,493 - ⏱ bot_user_184_1992 - Fetch Game Response Time: 0.13s
2025-02-27 20:27:42,496 - ⏱ bot_user_218_9729 - Fetch Game Response Time: 0.12s
2025-02-27 20:27:42,499 - ❌ bot_user_44_9093 failed to fetch game state: 429
2025-02-27 20:27:42,499 - ❌ bot_user_63_3234 failed to fetch game state: 429
2025-02-27 20:27:42,499 - ❌ bot_user_290_4368 failed to fetch game state: 429
2025-02-27 20:27:42,499 - ❌ bot_user_78_8694 failed to fetch game state: 429
2025-02-27 20:27:42,499 - ❌ bot_user_184_1992 failed to fetch game state: 429
2025-02-27 20:27:42,499 - ❌ bot_user_218_9729 failed to fetch game state: 429
2025-02-27 20:27:42,500 - ⏱ bot_user_82_2550 - Fetch Game Response Time: 0.14s
```

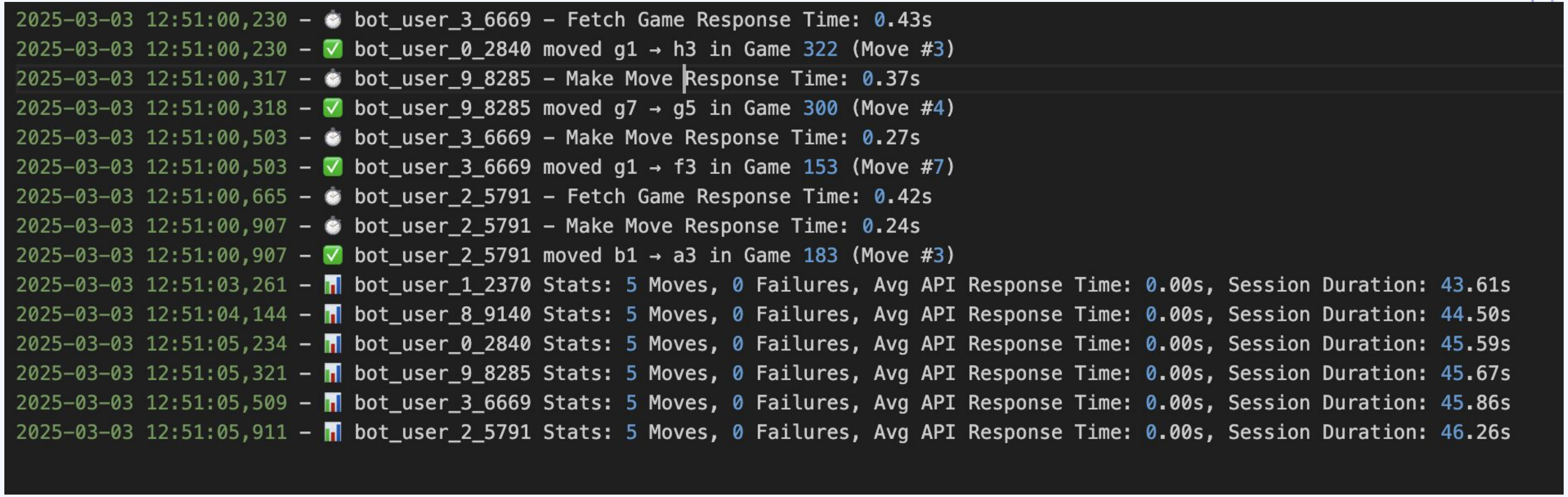
Load Testing

Load Testing

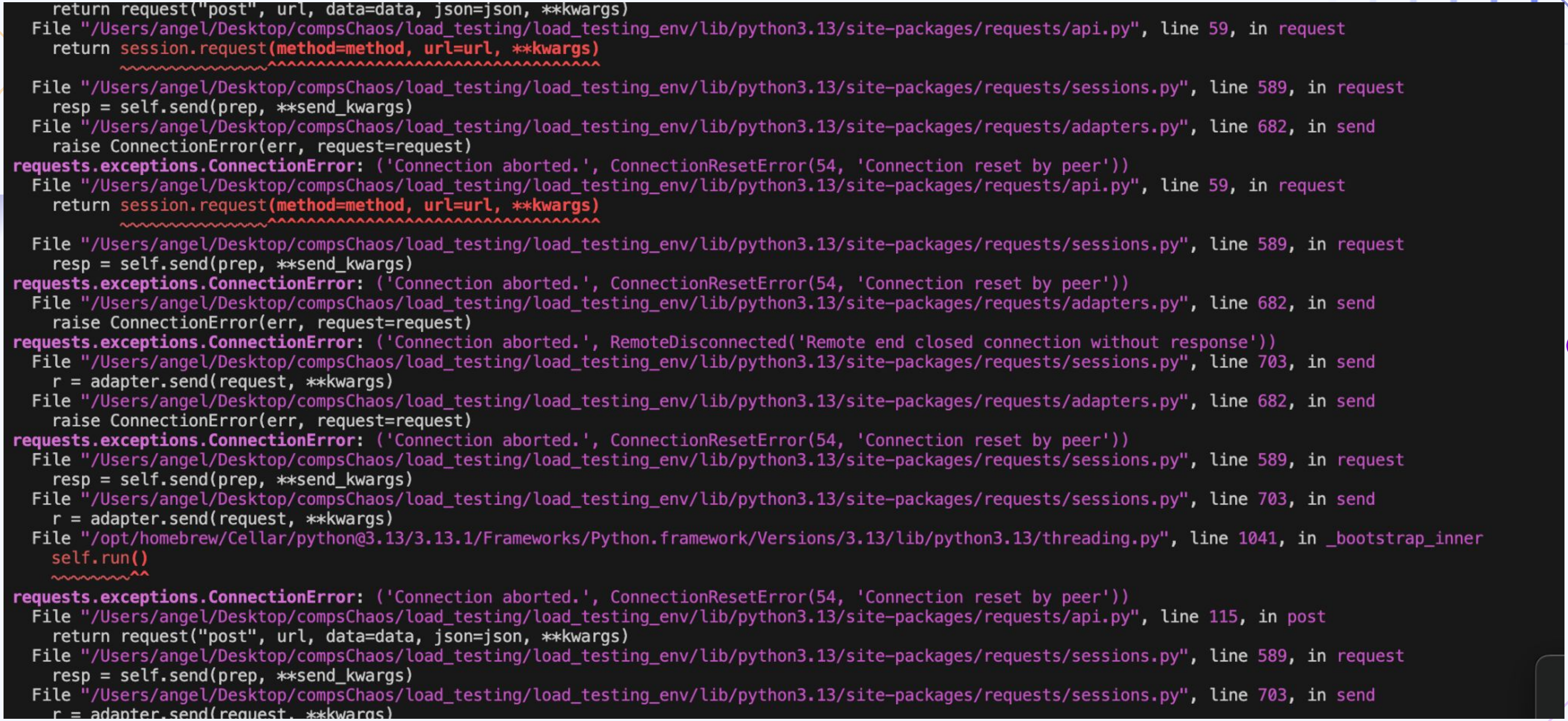
- What is Load Testing?
  - Simulating high traffic to evaluate system performance.

- Why we want to incorporate Load Testing?
  - Scalability
  - Stability
  - Performance

- How is Load Testing implemented?
  - Created bot users to simulate thousands of players making moves.



```
2025-03-03 12:51:00,230 - ⏱ bot_user_3_6669 - Fetch Game Response Time: 0.43s
2025-03-03 12:51:00,230 - ✅ bot_user_0_2840 moved g1 → h3 in Game 322 (Move #3)
2025-03-03 12:51:00,317 - ⏱ bot_user_9_8285 - Make Move Response Time: 0.37s
2025-03-03 12:51:00,318 - ✅ bot_user_9_8285 moved g7 → g5 in Game 300 (Move #4)
2025-03-03 12:51:00,503 - ⏱ bot_user_3_6669 - Make Move Response Time: 0.27s
2025-03-03 12:51:00,503 - ✅ bot_user_3_6669 moved g1 → f3 in Game 153 (Move #7)
2025-03-03 12:51:00,665 - ⏱ bot_user_2_5791 - Fetch Game Response Time: 0.42s
2025-03-03 12:51:00,907 - ⏱ bot_user_2_5791 - Make Move Response Time: 0.24s
2025-03-03 12:51:00,907 - ✅ bot_user_2_5791 moved b1 → a3 in Game 183 (Move #3)
2025-03-03 12:51:03,261 - 📊 bot_user_1_2370 Stats: 5 Moves, 0 Failures, Avg API Response Time: 0.00s, Session Duration: 43.61s
2025-03-03 12:51:04,144 - 📊 bot_user_8_9140 Stats: 5 Moves, 0 Failures, Avg API Response Time: 0.00s, Session Duration: 44.50s
2025-03-03 12:51:05,234 - 📊 bot_user_0_2840 Stats: 5 Moves, 0 Failures, Avg API Response Time: 0.00s, Session Duration: 45.59s
2025-03-03 12:51:05,321 - 📊 bot_user_9_8285 Stats: 5 Moves, 0 Failures, Avg API Response Time: 0.00s, Session Duration: 45.67s
2025-03-03 12:51:05,509 - 📊 bot_user_3_6669 Stats: 5 Moves, 0 Failures, Avg API Response Time: 0.00s, Session Duration: 45.86s
2025-03-03 12:51:05,911 - 📊 bot_user_2_5791 Stats: 5 Moves, 0 Failures, Avg API Response Time: 0.00s, Session Duration: 46.26s
```

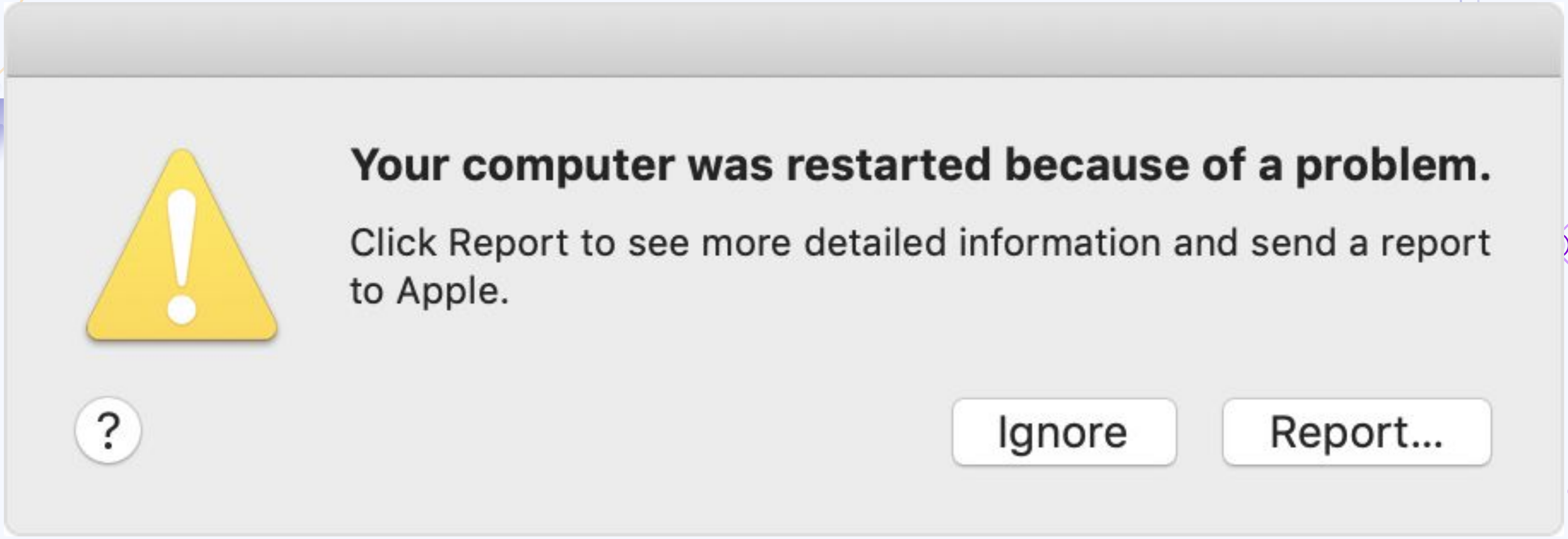


```
    return request("post", url, data=data, json=json, **kwargs)
  File "/Users/angel/Desktop/compsChaos/load_testing/load_testing_env/lib/python3.13/site-packages/requests/api.py", line 59, in request
    return session.request(method=method, url=url, **kwargs)
           ~~~~~~~~~~~~~~~^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^

  File "/Users/angel/Desktop/compsChaos/load_testing/load_testing_env/lib/python3.13/site-packages/requests/sessions.py", line 589, in request
    resp = self.send(prep, **send_kwargs)
  File "/Users/angel/Desktop/compsChaos/load_testing/load_testing_env/lib/python3.13/site-packages/requests/adapters.py", line 682, in send
    raise ConnectionError(err, request=request)
requests.exceptions.ConnectionError: ('Connection aborted.', ConnectionResetError(54, 'Connection reset by peer'))
  File "/Users/angel/Desktop/compsChaos/load_testing/load_testing_env/lib/python3.13/site-packages/requests/api.py", line 59, in request
    return session.request(method=method, url=url, **kwargs)
           ~~~~~~~~~~~~~~~^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^

  File "/Users/angel/Desktop/compsChaos/load_testing/load_testing_env/lib/python3.13/site-packages/requests/sessions.py", line 589, in request
    resp = self.send(prep, **send_kwargs)
requests.exceptions.ConnectionError: ('Connection aborted.', ConnectionResetError(54, 'Connection reset by peer'))
  File "/Users/angel/Desktop/compsChaos/load_testing/load_testing_env/lib/python3.13/site-packages/requests/adapters.py", line 682, in send
    raise ConnectionError(err, request=request)
requests.exceptions.ConnectionError: ('Connection aborted.', RemoteDisconnected('Remote end closed connection without response'))
  File "/Users/angel/Desktop/compsChaos/load_testing/load_testing_env/lib/python3.13/site-packages/requests/sessions.py", line 703, in send
    r = adapter.send(request, **kwargs)
  File "/Users/angel/Desktop/compsChaos/load_testing/load_testing_env/lib/python3.13/site-packages/requests/adapters.py", line 682, in send
    raise ConnectionError(err, request=request)
requests.exceptions.ConnectionError: ('Connection aborted.', ConnectionResetError(54, 'Connection reset by peer'))
  File "/Users/angel/Desktop/compsChaos/load_testing/load_testing_env/lib/python3.13/site-packages/requests/sessions.py", line 589, in request
    resp = self.send(prep, **send_kwargs)
  File "/Users/angel/Desktop/compsChaos/load_testing/load_testing_env/lib/python3.13/site-packages/requests/sessions.py", line 703, in send
    r = adapter.send(request, **kwargs)
  File "/opt/homebrew/Cellar/python@3.13/3.13.1/Frameworks/Python.framework/Versions/3.13/lib/python3.13/threading.py", line 1041, in _bootstrap_inner
    self.run()
    ~~~~~~~~^^

requests.exceptions.ConnectionError: ('Connection aborted.', ConnectionResetError(54, 'Connection reset by peer'))
  File "/Users/angel/Desktop/compsChaos/load_testing/load_testing_env/lib/python3.13/site-packages/requests/api.py", line 115, in post
    return request("post", url, data=data, json=json, **kwargs)
  File "/Users/angel/Desktop/compsChaos/load_testing/load_testing_env/lib/python3.13/site-packages/requests/sessions.py", line 589, in request
    resp = self.send(prep, **send_kwargs)
  File "/Users/angel/Desktop/compsChaos/load_testing/load_testing_env/lib/python3.13/site-packages/requests/sessions.py", line 703, in send
    r = adapter.send(request, **kwargs)
```



Your computer was restarted because of a problem.

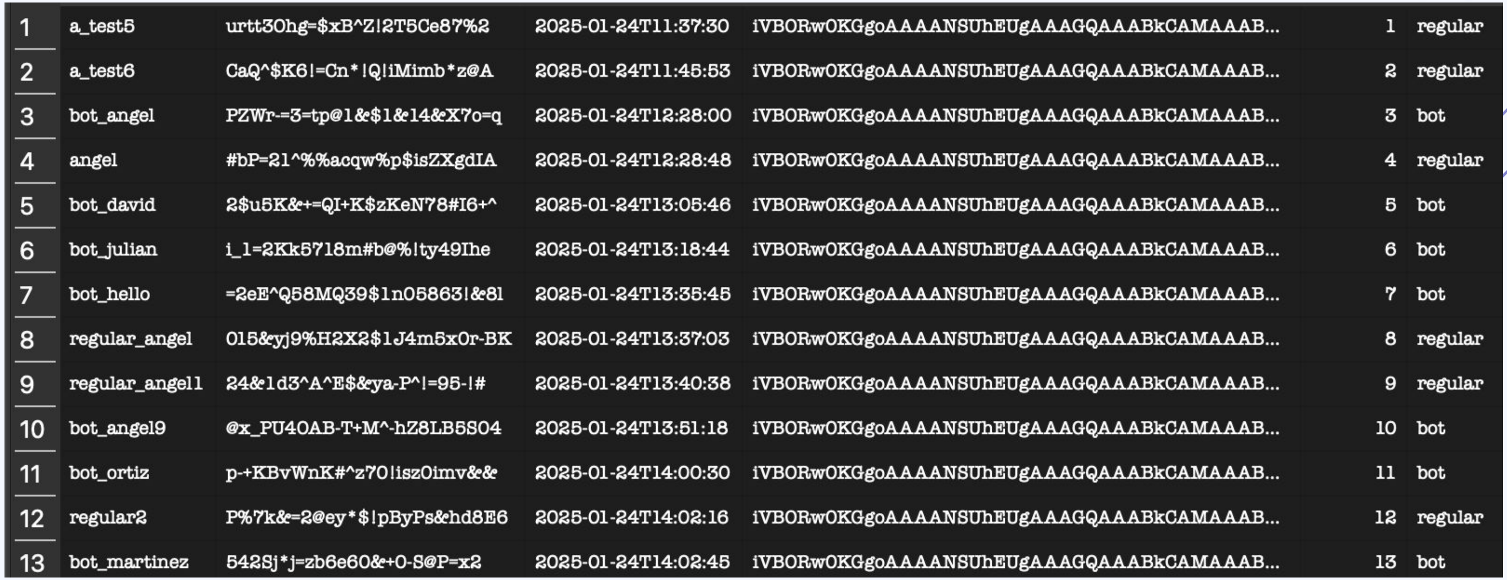
Click Report to see more detailed information and send a report to Apple.

User-Game Types

- What happens when we create these load testing bots?
  - Bots simulate thousands of users making real-time moves.
  - Generate high-traffic scenarios to test system performance.

- How can we prevent diminishing user experience?
  - Classified separately from real users in the database.
  - Tagged under a bot-specific user type to keep them isolated.

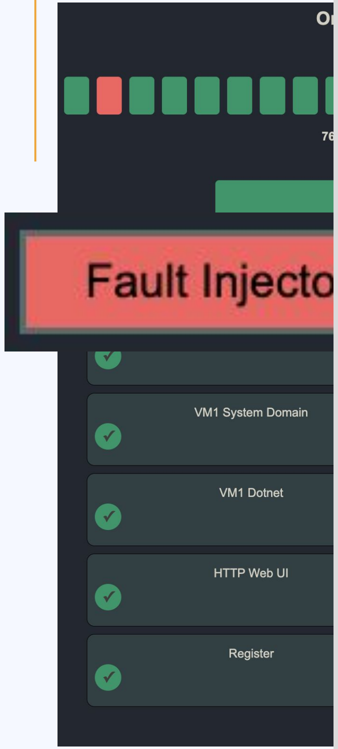
User Enhancements



1	a_test5	urtt3Ohg=$xB^Z!2T5Ce87%2	2025-01-24T11:37:30	iVBORw0KGgoAAAANSUhEUgAAAGQAAABkCAMAAAAB...	1	regular
2	a_test6	CaQ^$K6!=Cn*!Q!iMimb*z@A	2025-01-24T11:45:53	iVBORw0KGgoAAAANSUhEUgAAAGQAAABkCAMAAAAB...	2	regular
3	bot_angel	PZWr-=3=tp@1&$1&14&X7o=q	2025-01-24T12:28:00	iVBORw0KGgoAAAANSUhEUgAAAGQAAABkCAMAAAAB...	3	bot
4	angel	#bP=21^%%acqw%p$isZXgdIA	2025-01-24T12:28:48	iVBORw0KGgoAAAANSUhEUgAAAGQAAABkCAMAAAAB...	4	regular
5	bot_david	2$u5K&+=QI+K$zKeN78#I6+^	2025-01-24T13:05:46	iVBORw0KGgoAAAANSUhEUgAAAGQAAABkCAMAAAAB...	5	bot
6	bot_julian	i_1=2Kk5718m#b@%!ty49Ihe	2025-01-24T13:18:44	iVBORw0KGgoAAAANSUhEUgAAAGQAAABkCAMAAAAB...	6	bot
7	bot_hello	=2eE^Q58MQ39$1n05863!&8l	2025-01-24T13:35:45	iVBORw0KGgoAAAANSUhEUgAAAGQAAABkCAMAAAAB...	7	bot
8	regular_angel	015&yj9%H2X2$1J4m5x0r-BK	2025-01-24T13:37:03	iVBORw0KGgoAAAANSUhEUgAAAGQAAABkCAMAAAAB...	8	regular
9	regular_angel1	24&1d3^A^E$&ya-P^!=95-!#	2025-01-24T13:40:38	iVBORw0KGgoAAAANSUhEUgAAAGQAAABkCAMAAAAB...	9	regular
10	bot_angel9	@x_PU40AB-T+M^-hZ8LB5S04	2025-01-24T13:51:18	iVBORw0KGgoAAAANSUhEUgAAAGQAAABkCAMAAAAB...	10	bot
11	bot_ortiz	p-+KBvWnK#^z70!isz0imv&&	2025-01-24T14:00:30	iVBORw0KGgoAAAANSUhEUgAAAGQAAABkCAMAAAAB...	11	bot
12	regular2	P%7k&=2@ey*$!pByPs&hd8E6	2025-01-24T14:02:16	iVBORw0KGgoAAAANSUhEUgAAAGQAAABkCAMAAAAB...	12	regular
13	bot_martinez	542Sj*j=zb6e60&+0-S@P=x2	2025-01-24T14:02:45	iVBORw0KGgoAAAANSUhEUgAAAGQAAABkCAMAAAAB...	13	bot

Conclusion

ALERT: Service Failures Detected External Inbox ×



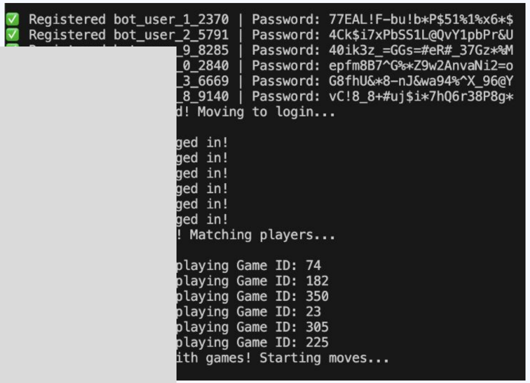
Fault Injecto

VM1 System Domain ✓

VM1 Dotnet ✓

HTTP Web UI ✓

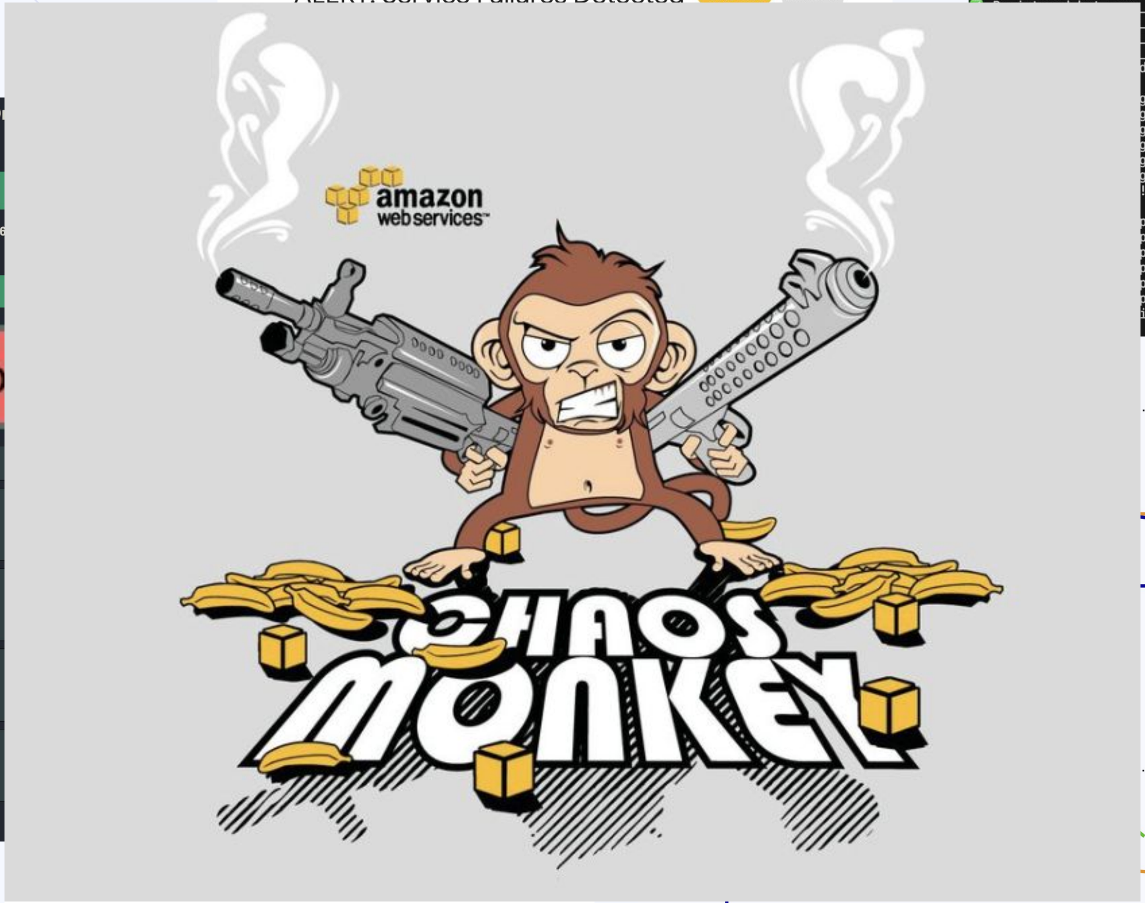
Register ✓

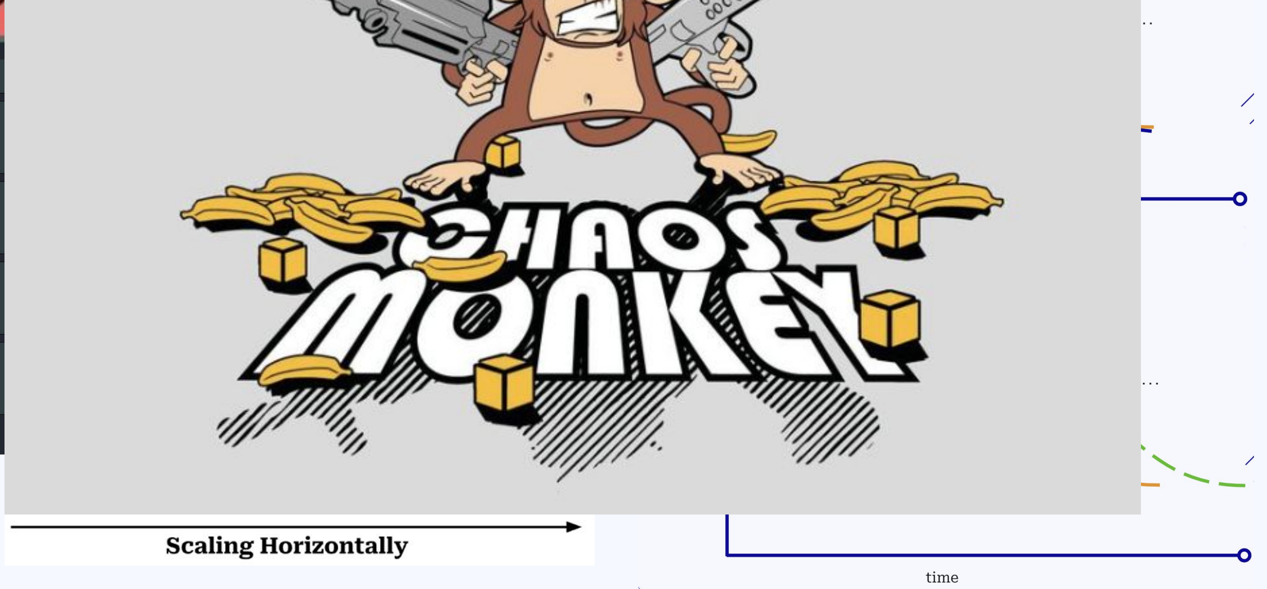


```
✅ Registered bot_user_1_2370 | Password: 77EAL!F-bu!b*P$51%1%x6*$
✅ Registered bot_user_2_5791 | Password: 4Ck$i7xPbSS1L@QvY1pbPr&U
                          _9_8285 | Password: 40ik3z_=GGs=#eR#_37Gz*%M
                          _0_2840 | Password: epfm8B7^G%*Z9w2AnvaNi2=o
                          _3_6669 | Password: G8fhU&*8-nJ&wa94%^X_96@Y
                          _8_9140 | Password: vC!8_8+#uj$i*7hQ6r38P8g*
                          d! Moving to login...

                          ged in!
                          ged in!
                          ged in!
                          ged in!
                          ged in!
                          ged in!
                          ! Matching players...

                          playing Game ID: 74
                          playing Game ID: 182
                          playing Game ID: 350
                          playing Game ID: 23
                          playing Game ID: 305
                          playing Game ID: 225
                          ith games! Starting moves...
```





Questions