



Reinforcement Learning

나는 강화학습으로 축구한다

Google Research와 Manchester City F.C.의
인공지능 축구 프로젝트를 대한민국에서
재조명하고 직접 구현해보는 캠프



4

SESSION

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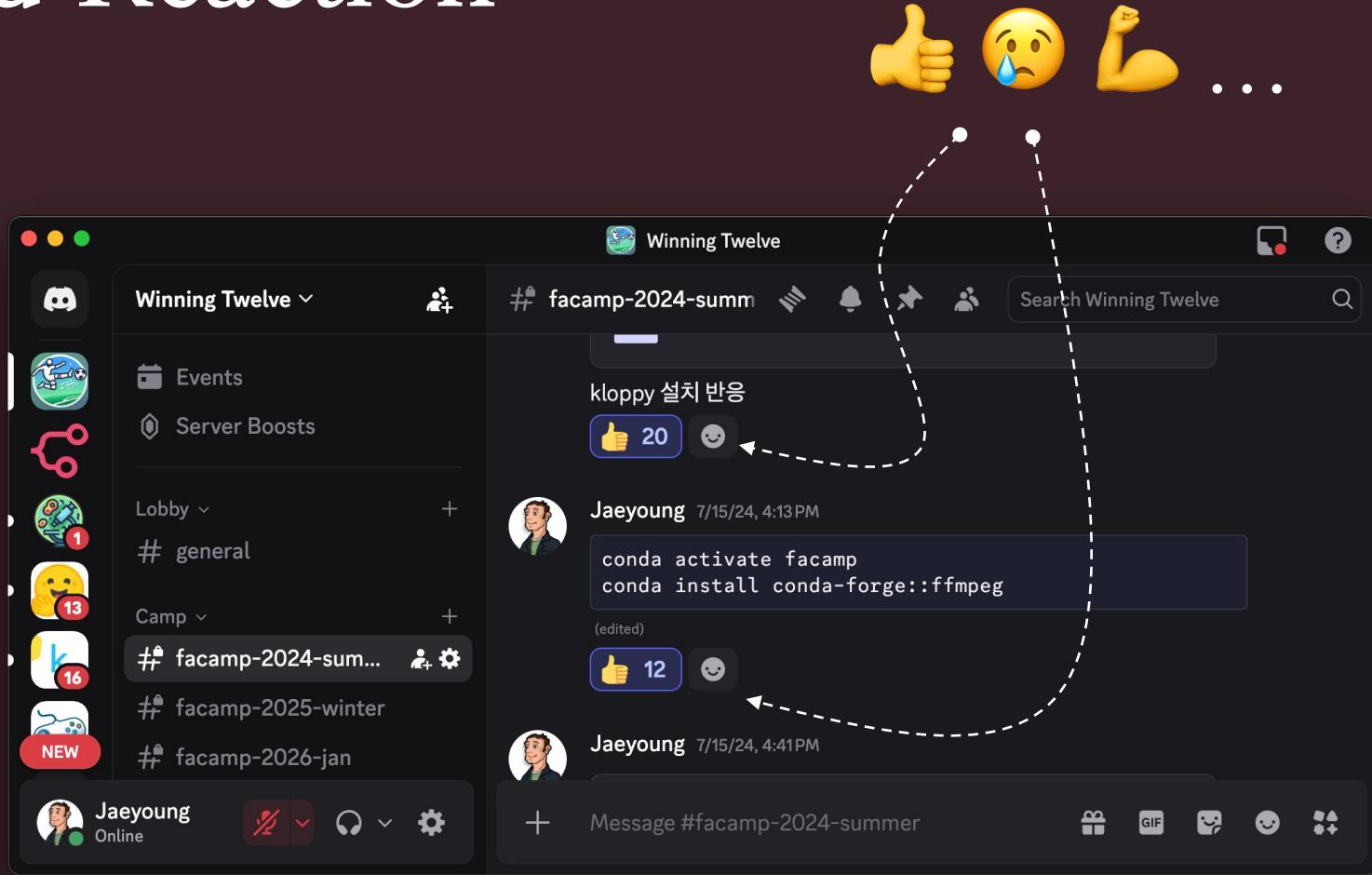
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Agenda

1. 축구 전에 경기장, 용어, 규칙 등에 대한 이해
2. 그리고 나서 규칙 기반 플레이
3. 그리고 나서 강화학습 기반 플레이



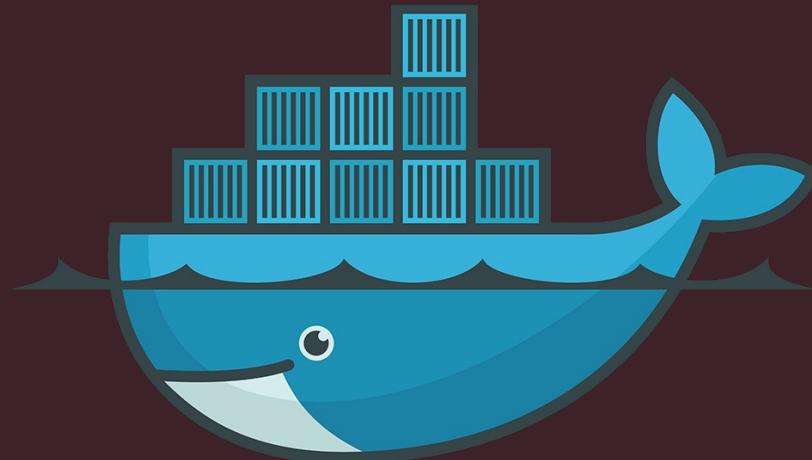
Discord Reaction



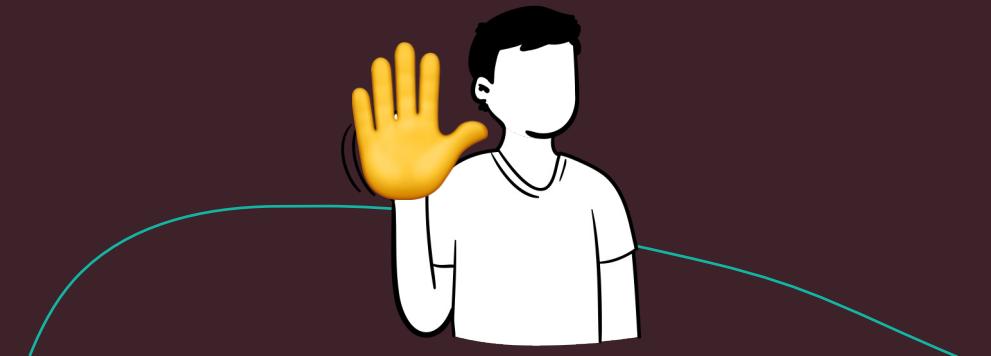


Lab 01

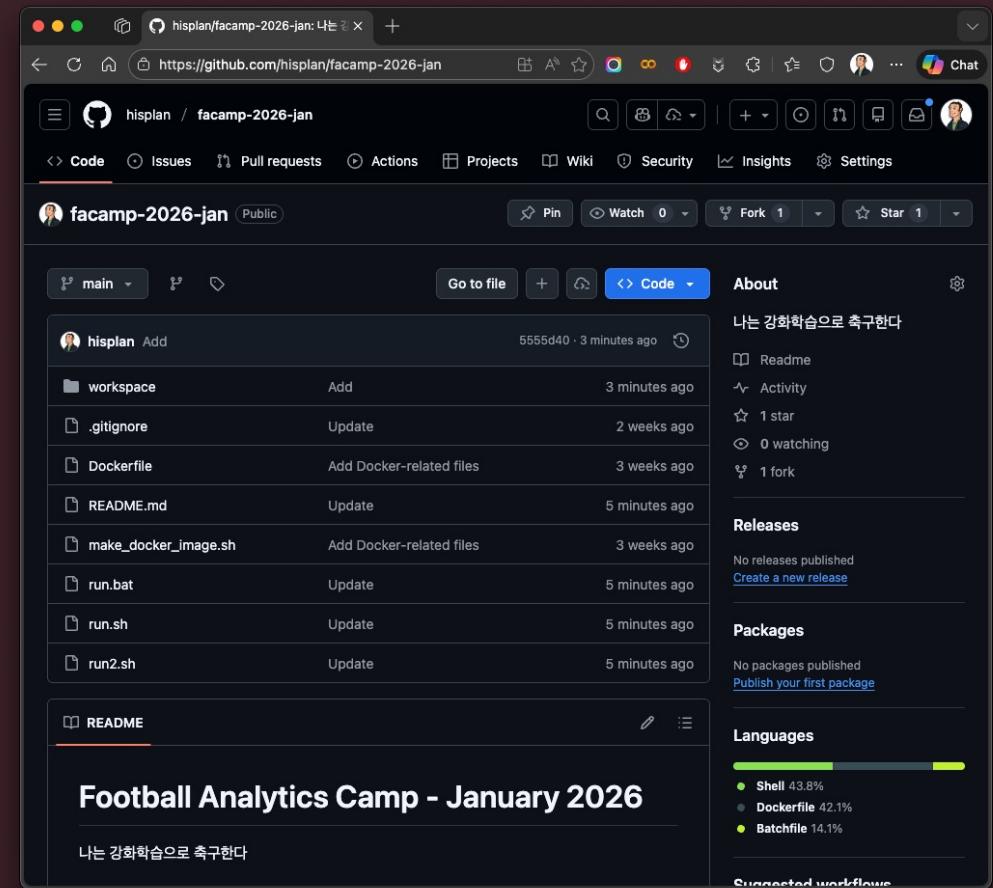
Docker 설치 및 환경 설정



1. Docker 설치 완료
2. Docker 이미지 다운로드 완료
3. VS Code 설치 완료
4. Discord #facamp-2026-jan 채널 접속 완료



GitHub Repository



<https://github.com/hisplan/facamp-2026-jan>

Directory Structure

```
.  
| ...  
| Dockerfile  
| make_docker_image.sh  
| README.md  
| run.bat  
| run.sh  
+-- workspace  
    +-- lab-01  
    |   00_smoke_test.py  
    |   01_random_play.py  
    |   02_make_video.sh  
    |   03_env.py  
    |   04_env_raw.py  
    |   05_env_simple115v2.py  
    |   06_env_simple115v2_stacked.py  
    |   demo-random-play.gif  
    |   demo-random-play.mp4  
    |   README.md  
    |   stacked  
    +-- lab-02  
        01_docker_video.py  
        02_docker_video.sh  
        03_local_video.py  
        04_local_video.sh
```

OpenAI Gym / Farama Foundation Gymnasium



<https://www.gymlibrary.dev/> or <https://gymnasium.farama.org/>

Google Research Football (GRF)

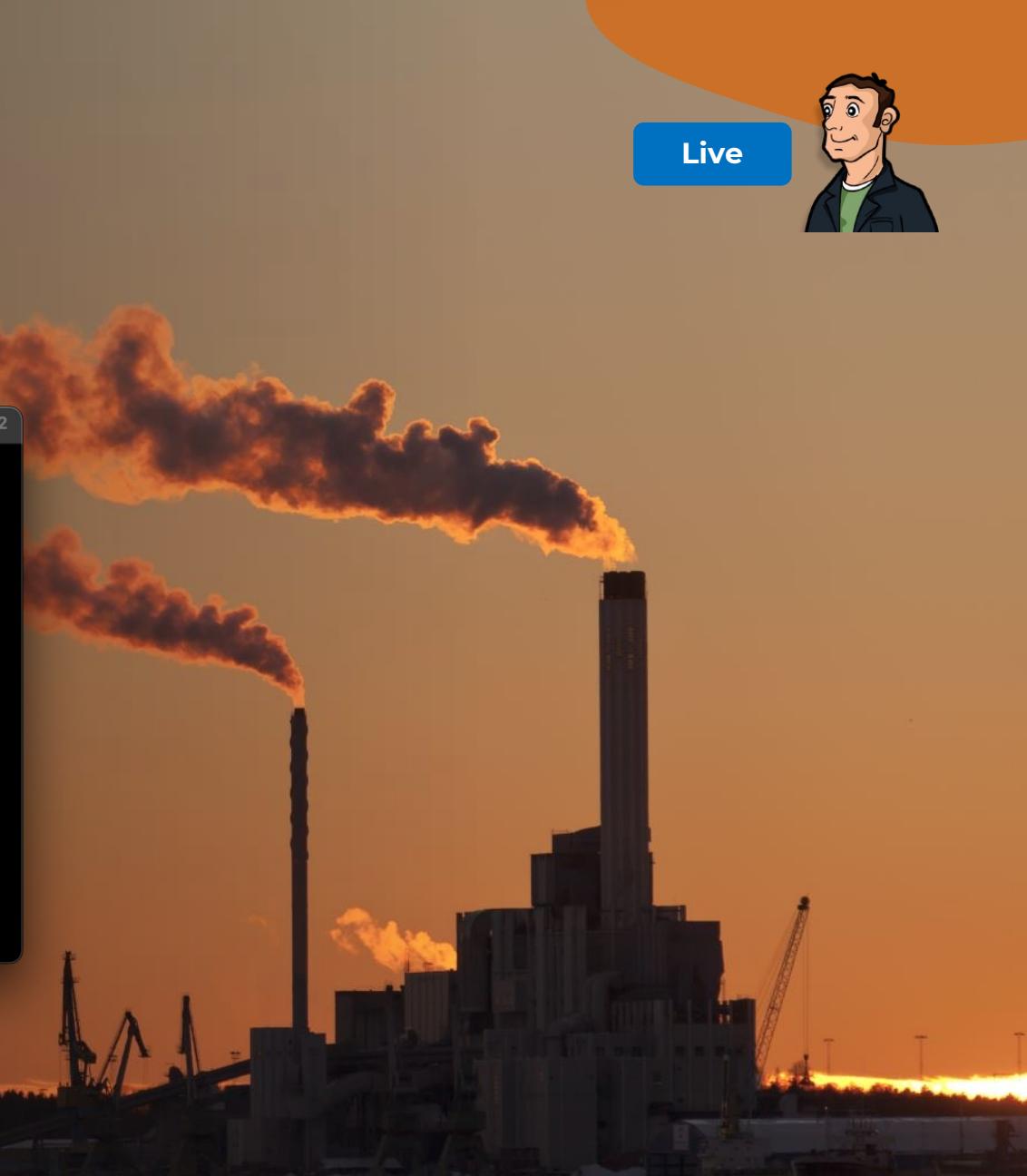
Live

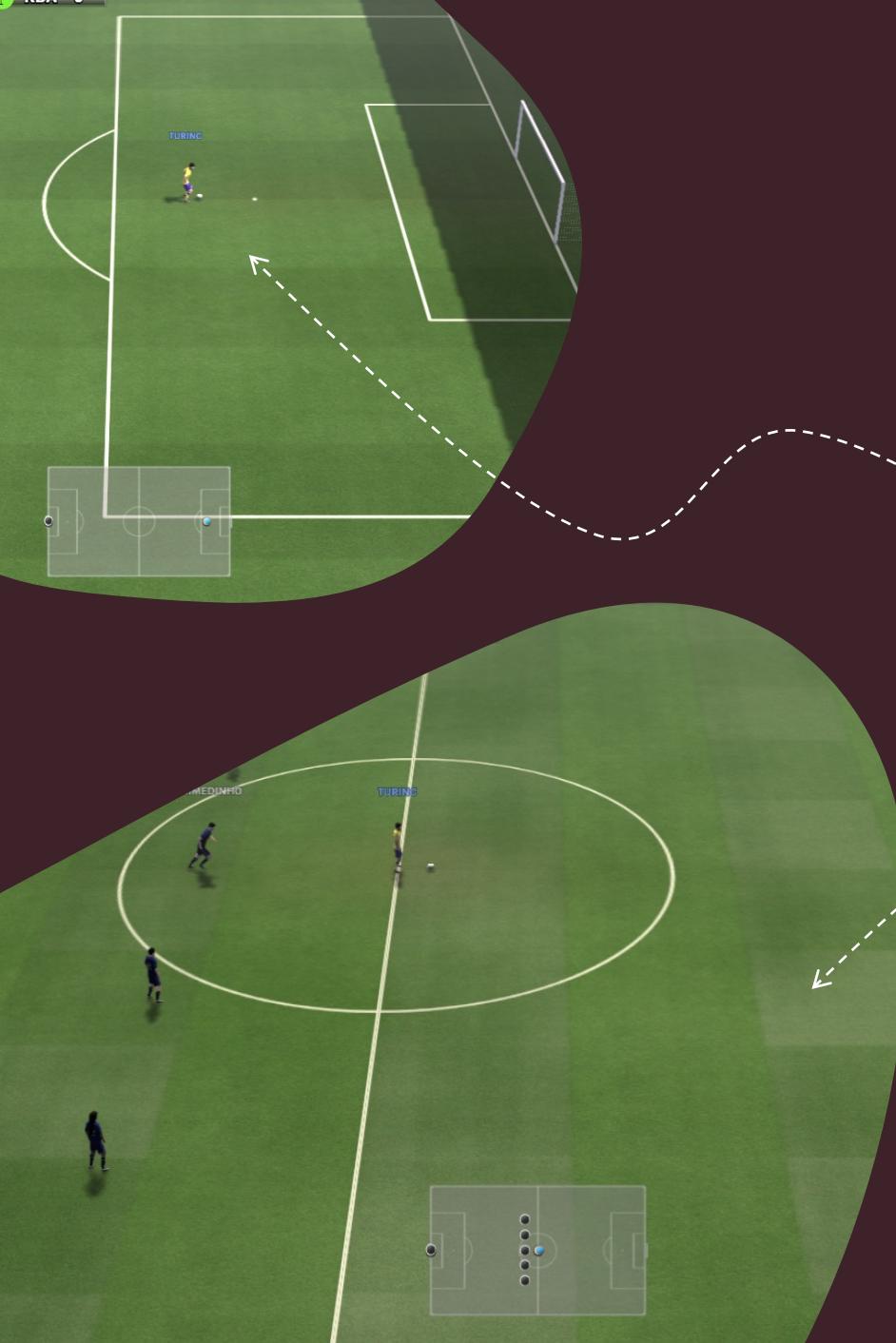


Smoke Test

A terminal window with a black background and white text. The title bar says "root@bb0a05899901: /workspace/lab-01". The window contains the following command-line session:

```
root@bb0a05899901:/# cd /workspace/lab-01/
root@bb0a05899901:/workspace/lab-01# python3 00_smoke_test.py
gfootball env reset OK
root@bb0a05899901:/workspace/lab-01#
```





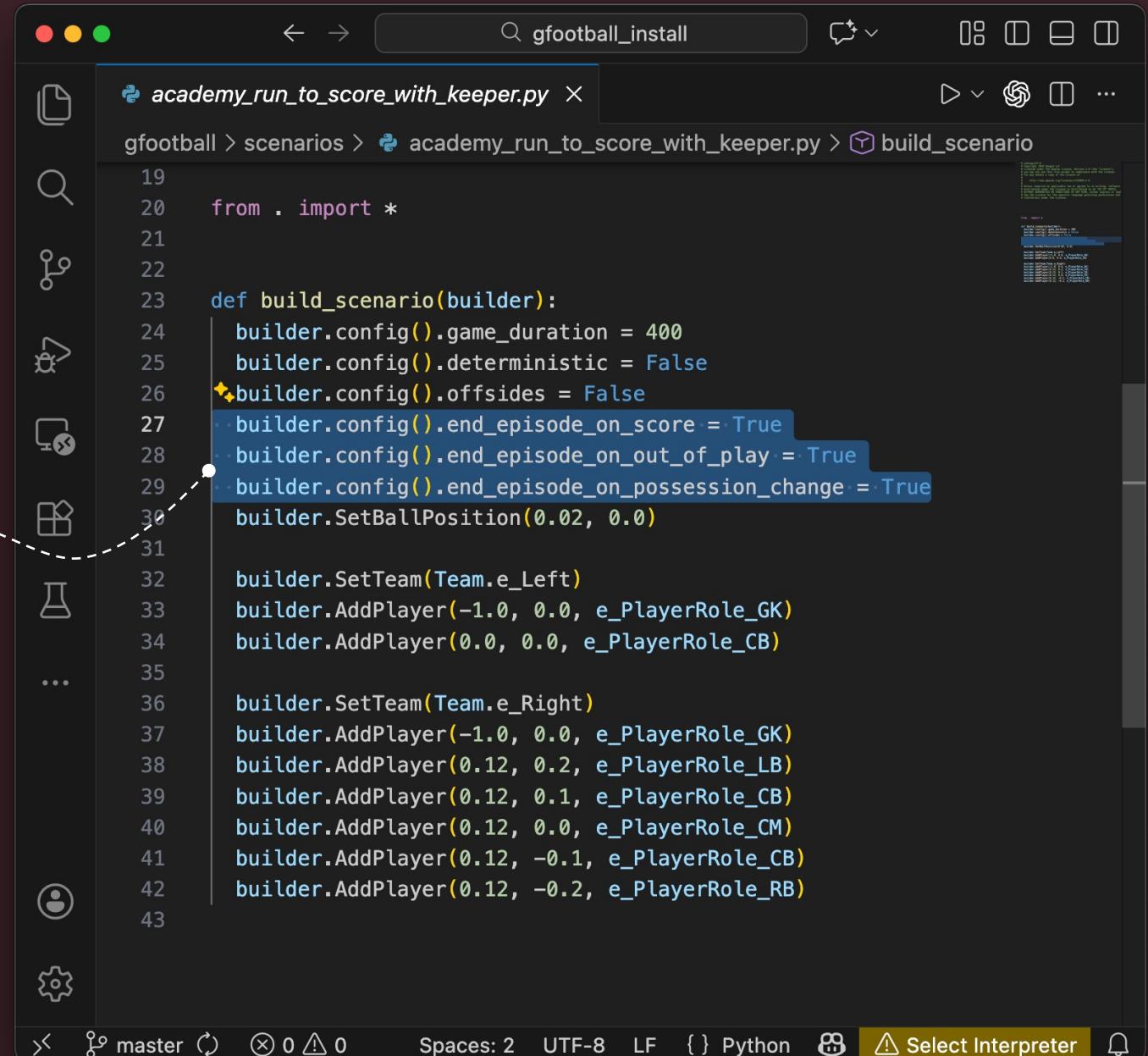
Agent and Environment



Single agent vs. Multi-agent

Termination

시나리오마다
종료 조건이 다 다른



```
gfootball > scenarios > academy_run_to_score_with_keeper.py > build_scenario
19
20     from . import *
21
22
23     def build_scenario(builder):
24         builder.config().game_duration = 400
25         builder.config().deterministic = False
26         builder.config().offsides = False
27         builder.config().end_episode_on_score = True
28         builder.config().end_episode_on_out_of_play = True
29         builder.config().end_episode_on_possession_change = True
30         builder.SetBallPosition(0.02, 0.0)
31
32         builder.SetTeam(Team.e_Left)
33         builder.AddPlayer(-1.0, 0.0, e_PlayerRole_GK)
34         builder.AddPlayer(0.0, 0.0, e_PlayerRole_CB)
35
36         builder.SetTeam(Team.e_Right)
37         builder.AddPlayer(-1.0, 0.0, e_PlayerRole_GK)
38         builder.AddPlayer(0.12, 0.2, e_PlayerRole_LB)
39         builder.AddPlayer(0.12, 0.1, e_PlayerRole_CB)
40         builder.AddPlayer(0.12, 0.0, e_PlayerRole_CM)
41         builder.AddPlayer(0.12, -0.1, e_PlayerRole_CB)
42         builder.AddPlayer(0.12, -0.2, e_PlayerRole_RB)
43
```

Stacked



1



2



3



4



Lab 02

Docker-based vs. Local (No Docker)

No DISPLAY defined, doing off-screen rendering

Step: 0/300 Done: False

Step: 10/300 Done: False

Step: 20/300 Done: False

...

Step: 240/300 Done: False

Step: 250/300 Done: False

Step: 260/300 Done: False

Step: 270/300 Done: False

Step: 280/300 Done: False

Step: 290/300 Done: False

Finished 300



A

Headless 실행 → 프레임 이미지 → 영상 → 확인

B

실행과 동시에 확인

Lab 03

```
import gfootball.env as football_env

env = football_env.create_environment(
    env_name="5_vs_5"
)

obs = env.reset()

done = False

while (not done):

    action = model.predict(obs)
    obs, reward, done, info = env.step(action)

env.close()
```

- Environment
- Scenario
- Episode
- Step
- Observation
- Action
- Reward
- Termination



Actions

<https://github.com/google-research/football/blob/master/gfootball/doc/observation.md#default-action-set>

The screenshot shows a GitHub browser interface with the following details:

- Repository:** football/gfootball/doc/observatio... (partially visible)
- Branch:** master
- Path:** football / gfootball / doc / observation.md
- Content Section:** Actions
- Section Header:** Default action set
- Description:** The default action set consists of 19 actions:
- Idle actions:**
 - `action_idle` = 0, a no-op action, sticky actions are not affected (player maintains his directional movement etc.).
- Movement actions:**
 - `action_left` = 1, run to the left, sticky action.
 - `action_top_left` = 2, run to the top-left, sticky action.
 - `action_top` = 3, run to the top, sticky action.
 - `action_top_right` = 4, run to the top-right, sticky action.
 - `action_right` = 5, run to the right, sticky action.
 - `action_bottom_right` = 6, run to the bottom-right, sticky action.
 - `action_bottom` = 7, run to the bottom, sticky action.
 - `action_bottom_left` = 8, run to the bottom-left, sticky action.
- Passing / Shooting:**
 - `action_long_pass` = 9, perform a long pass to the player on your team. Player to pass the ball to is

Observation

Environment exposes following `raw` observations:

- Ball information:
 - `ball` - [x, y, z] position of the ball.
 - `ball_direction` - [x, y, z] ball movement vector.
 - `ball_rotation` - [x, y, z] rotation angles in radians.
 - `ball_owned_team` - {-1, 0, 1}, -1 = ball not owned, 0 = left team, 1 = right team.
 - `ball_owned_player` - {0..N-1} integer denoting index of the player owning the ball.
- Left team:
 - `left_team` - N-elements vector with [x, y] positions of players.
 - `left_team_direction` - N-elements vector with [x, y] movement vectors of players.
 - `left_team_tired_factor` - N-elements vector of floats in the range {0..1}. 0 means player is not tired at all.
 - `left_team_yellow_card` - N-elements vector of integers denoting number of yellow cards a given player has (0 or 1).
 - `left_team_active` - N-elements vector of booleans denoting whether a given player is playing the game (False means player got a red card).
 - `left_team_roles` - N-elements vector denoting roles of players. The meaning is:
 - 0 = `e_PlayerRole_GK` - goalkeeper,
 - 1 = `e_PlayerRole_CB` - centre back,
 - 2 = `e_PlayerRole_LB` - left back,
 - 3 = `e_PlayerRole_RB` - right back,
 - 4 = `e_PlayerRole_DM` - defence midfield

<https://github.com/google-research/football/blob/master/gfootball/doc/observation.md#raw-observations>

5 vs 5 : One Game



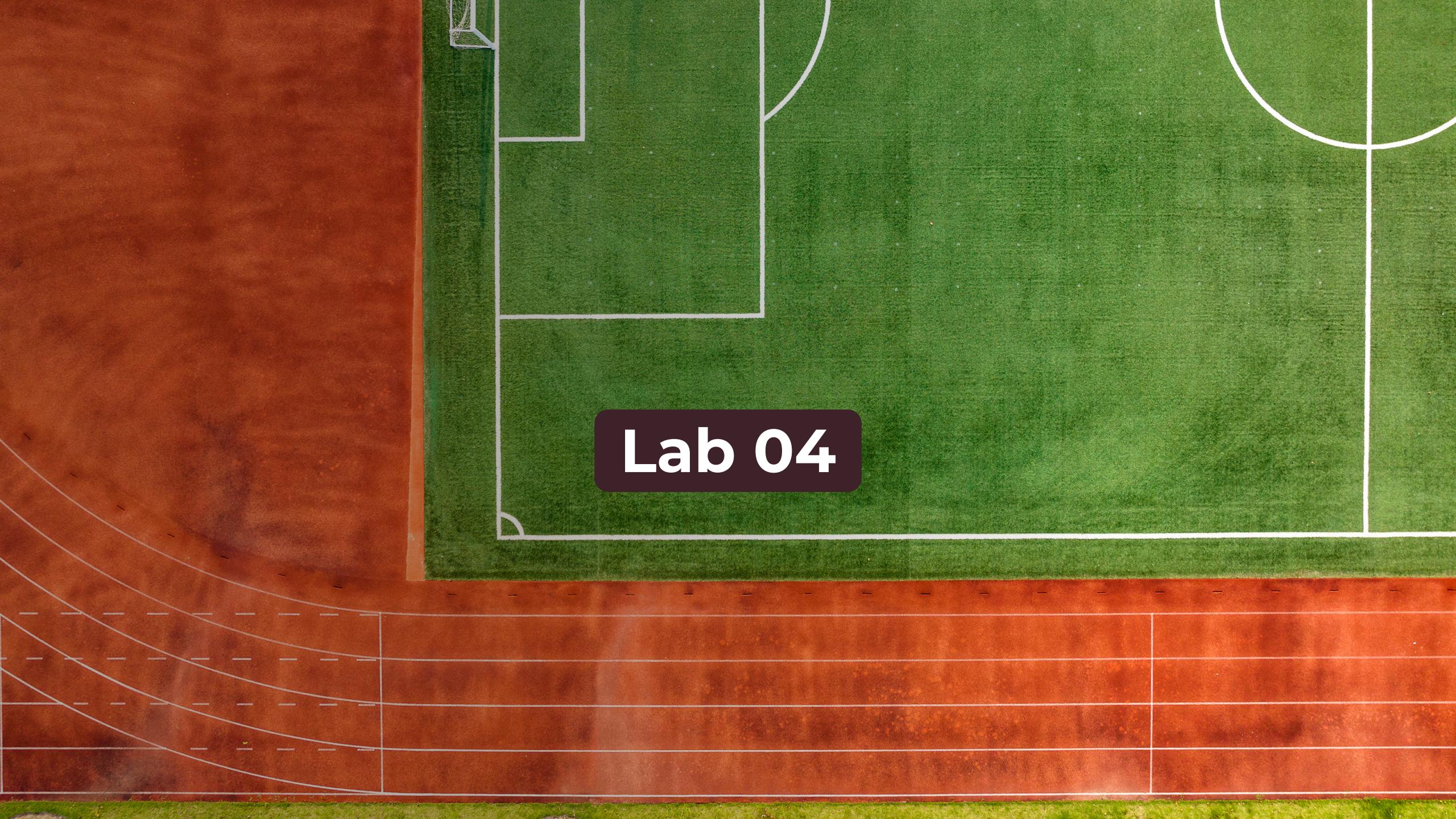
90

minutes

3500

steps

(*) No half-time

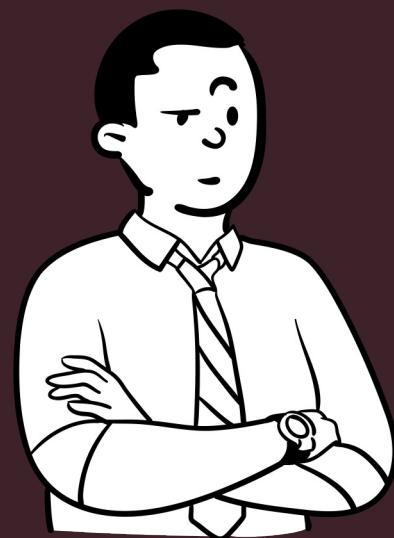


Lab 04

Coordinates



90분 동안 총 몇 바퀴 정도 돌 수 있나?



A man with a beard and mustache, wearing a yellow and orange long-sleeved shirt and black shorts, is kicking a soccer ball against a grey brick wall. He is wearing white sneakers. A dark red rectangular overlay contains the text "Lab 05".

Lab 05