Data Driven Computer Animation

HKU COMP 7508

Tutorial 4: Real-time Character Control

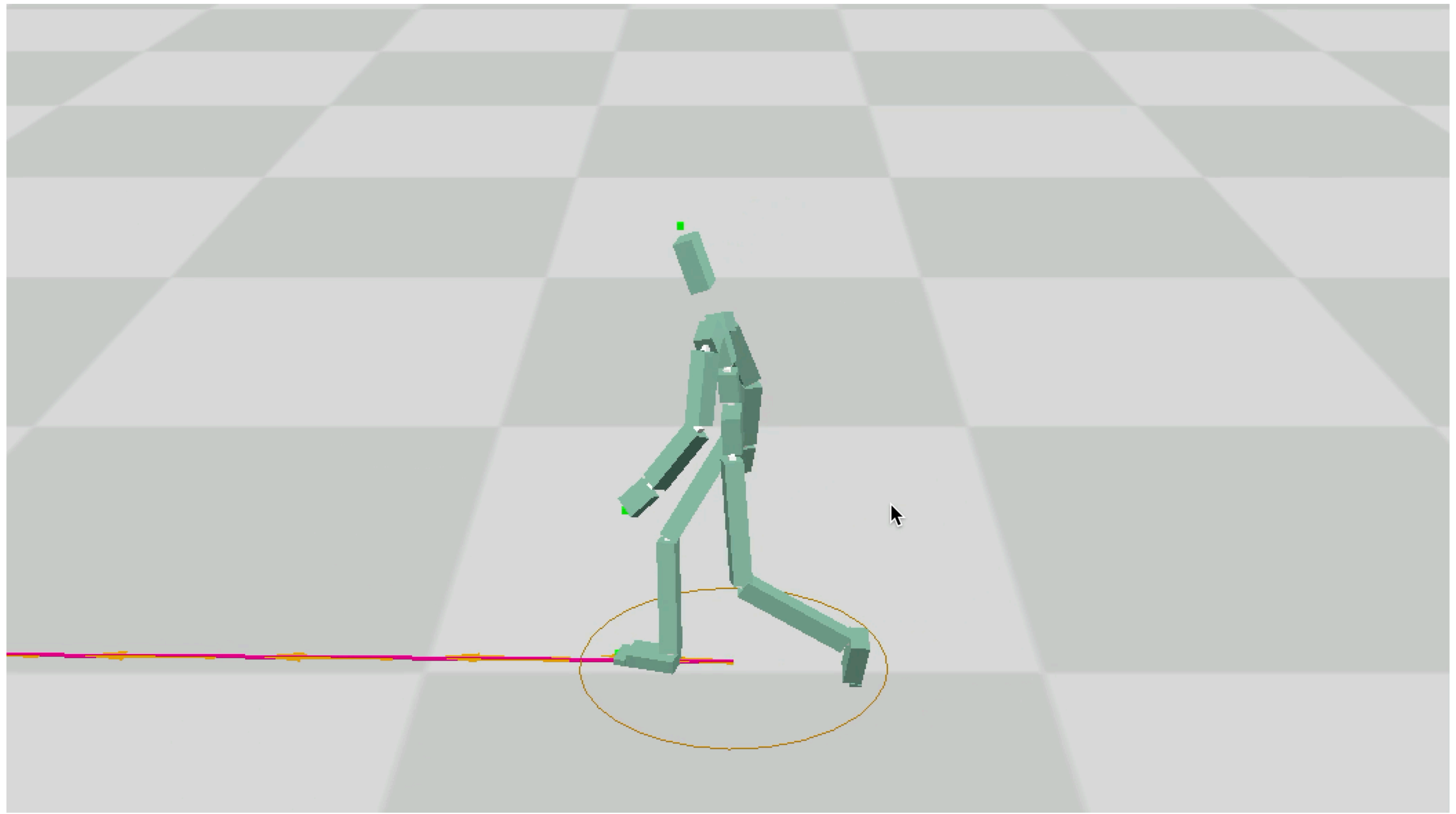
Prof. Taku Komura

TA: Shi Mingyi (myshi@cs.hku.hk), Zhouyingcheng Liao (zliao@connect.hku.hk)

SECTION 2A, 2023

Agenda

1. The overview of real-time character control
2. State machine
3. Motion matching



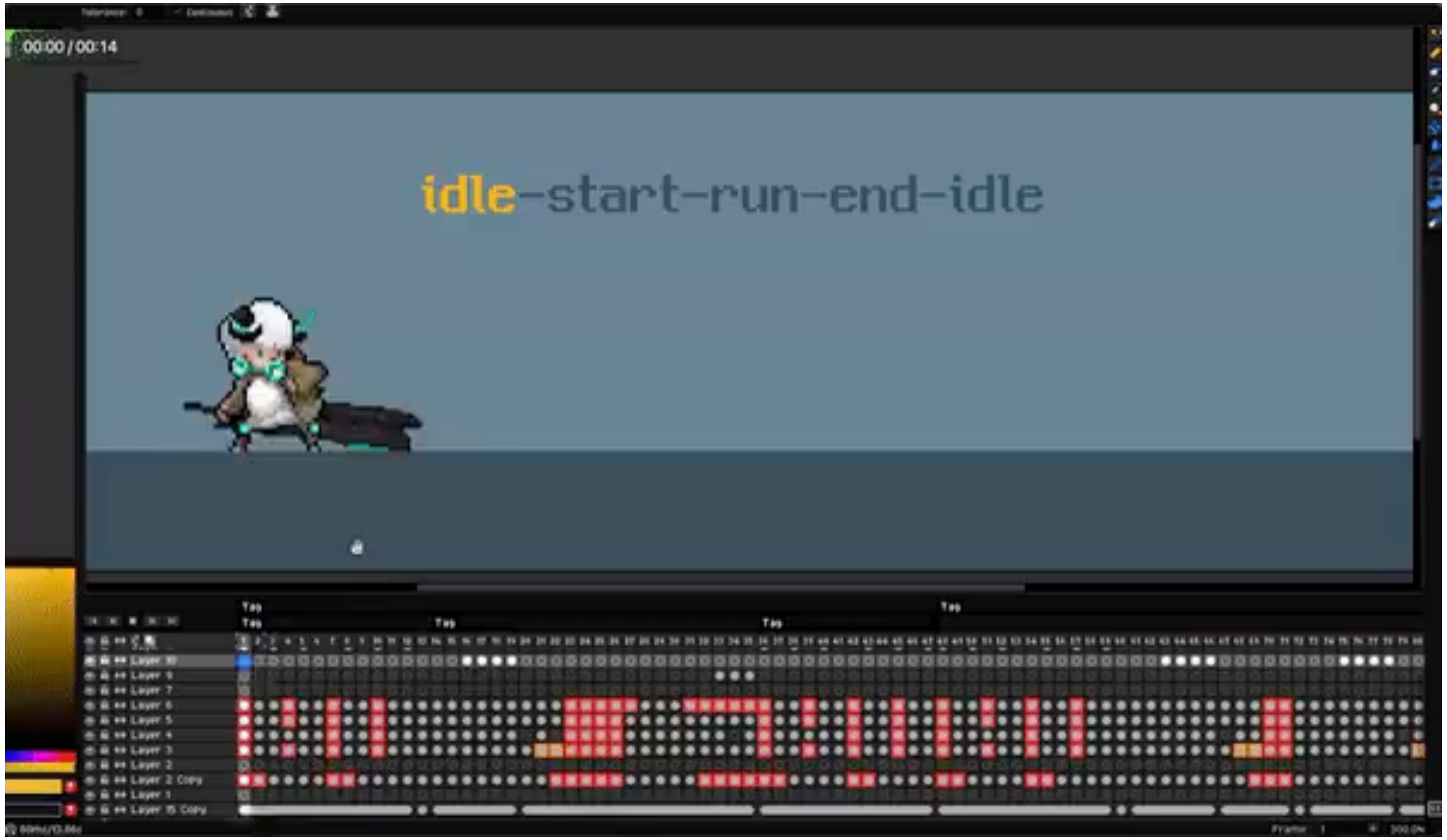
Some materials are from:

Game Developers Conference (GDC)

1. https://www.gdcvault.com/play/1026968/-Genshin-Impact-Building-a
2. https://www.gdcvault.com/play/1025389/Character-Control-with-Neural-Networks

Animation

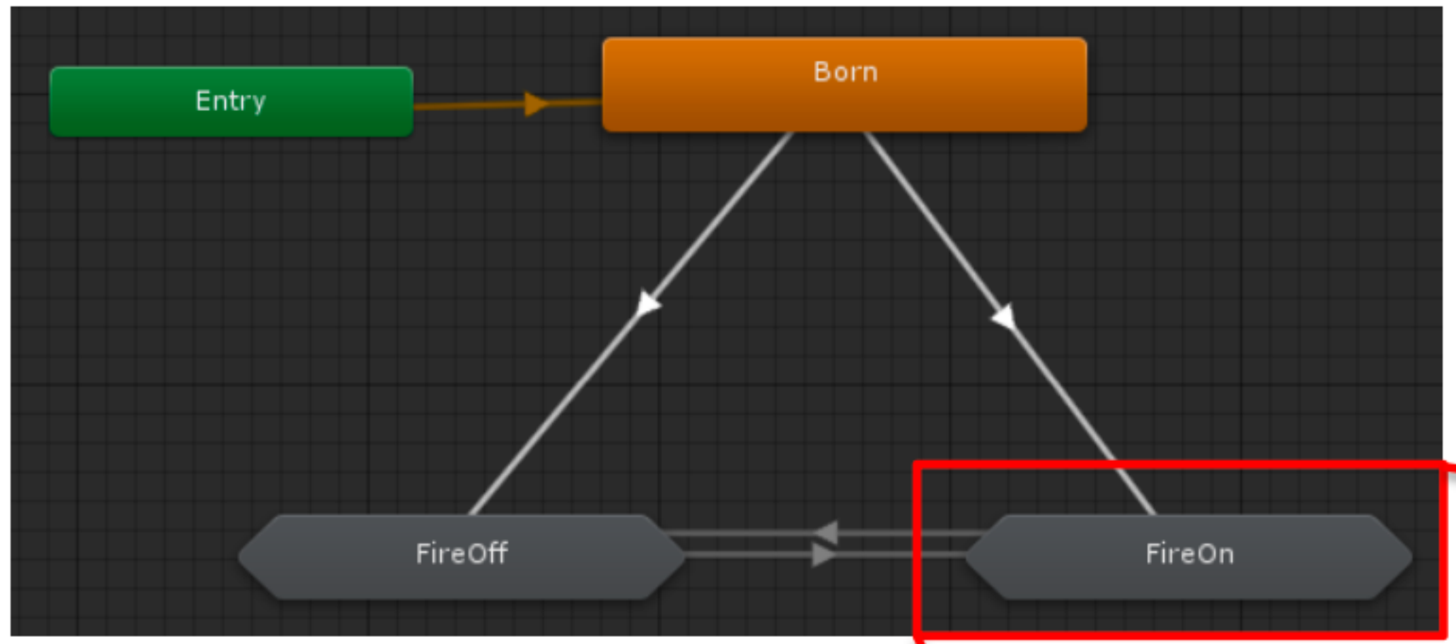
We captured motion clips, label them, and play them in different order



How to make the animation to be controllable?

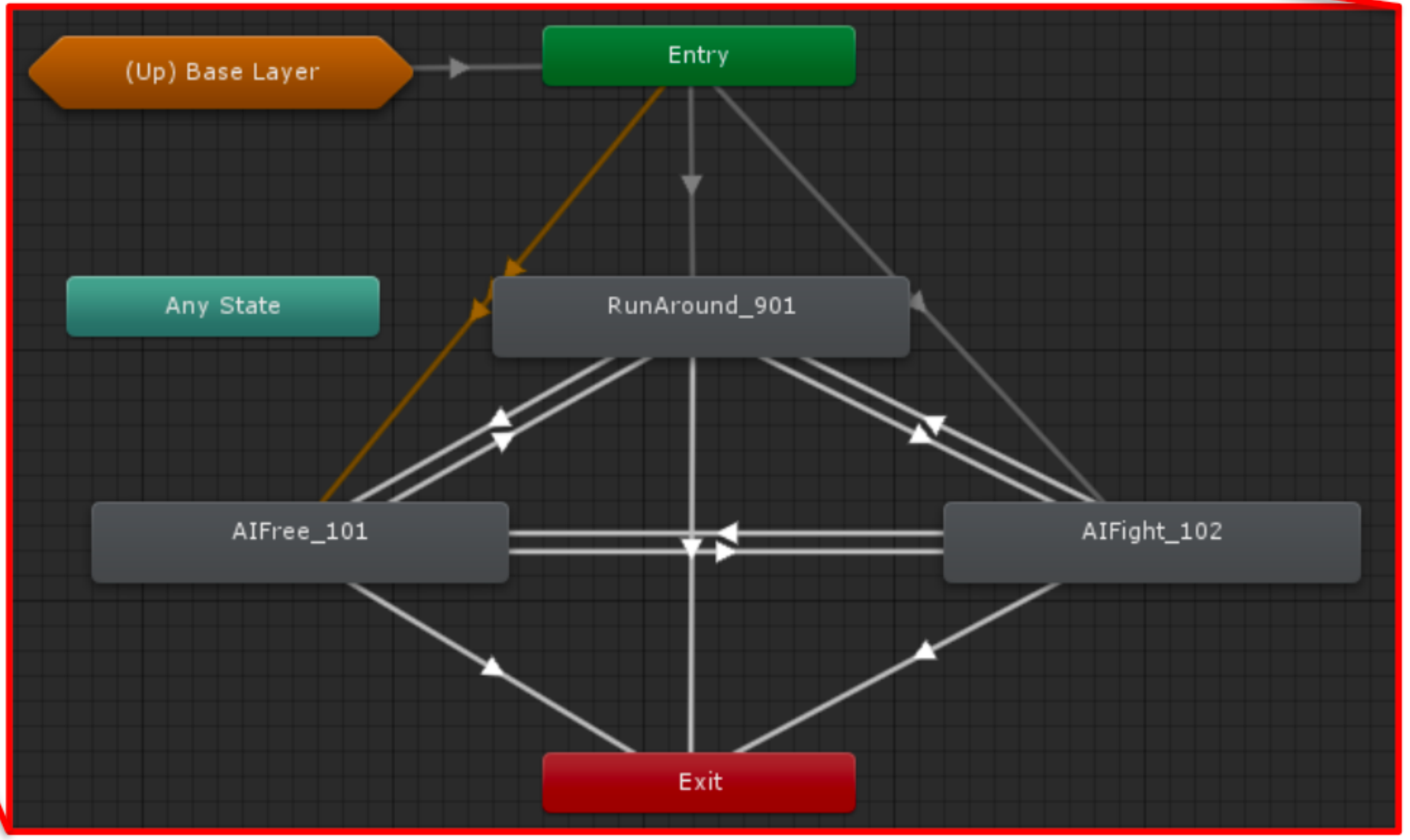
The character should reflect to different control signals
- from keyboard
- gamepad

The states are managed by ‘node’

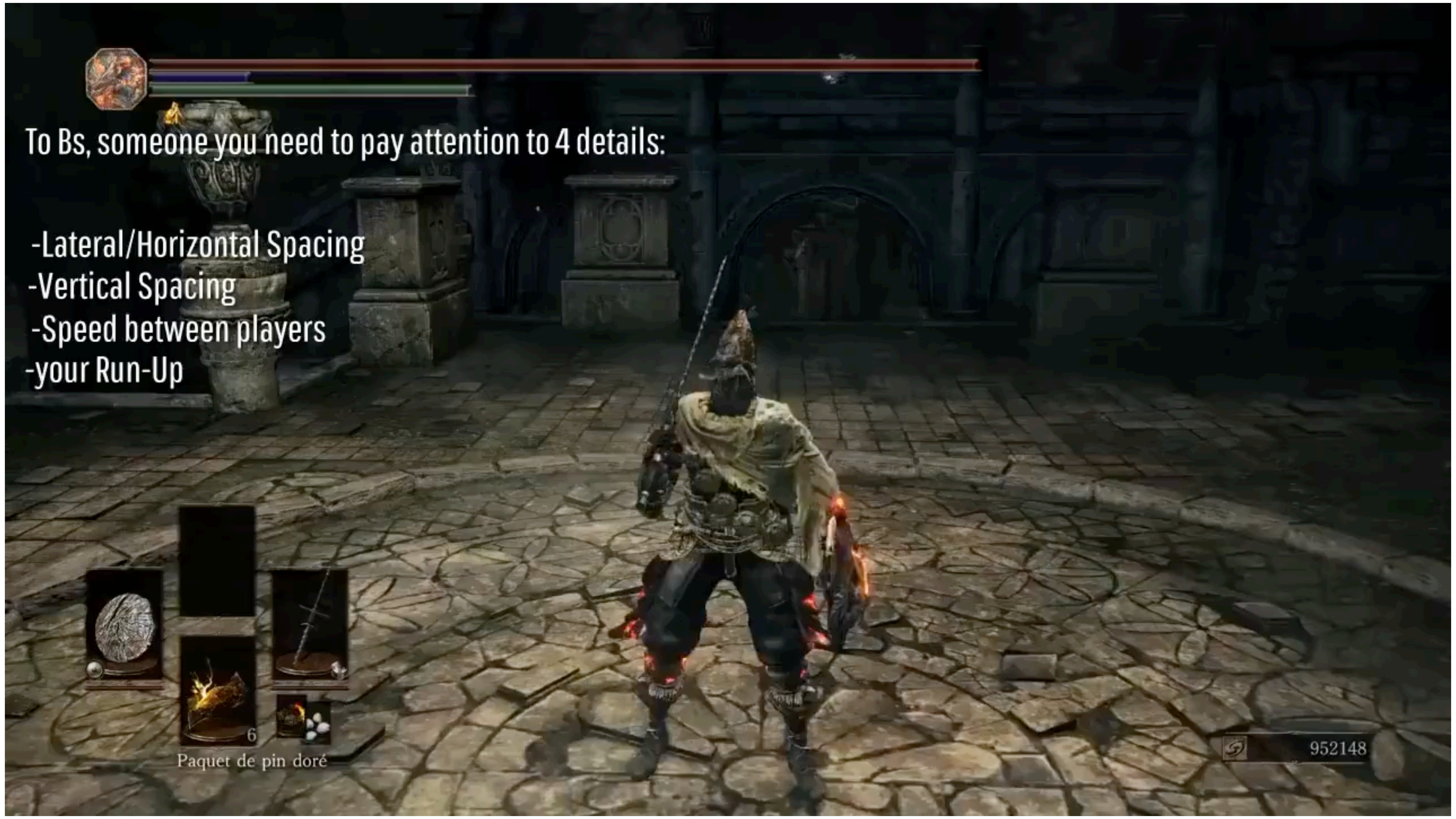


example of fire slime

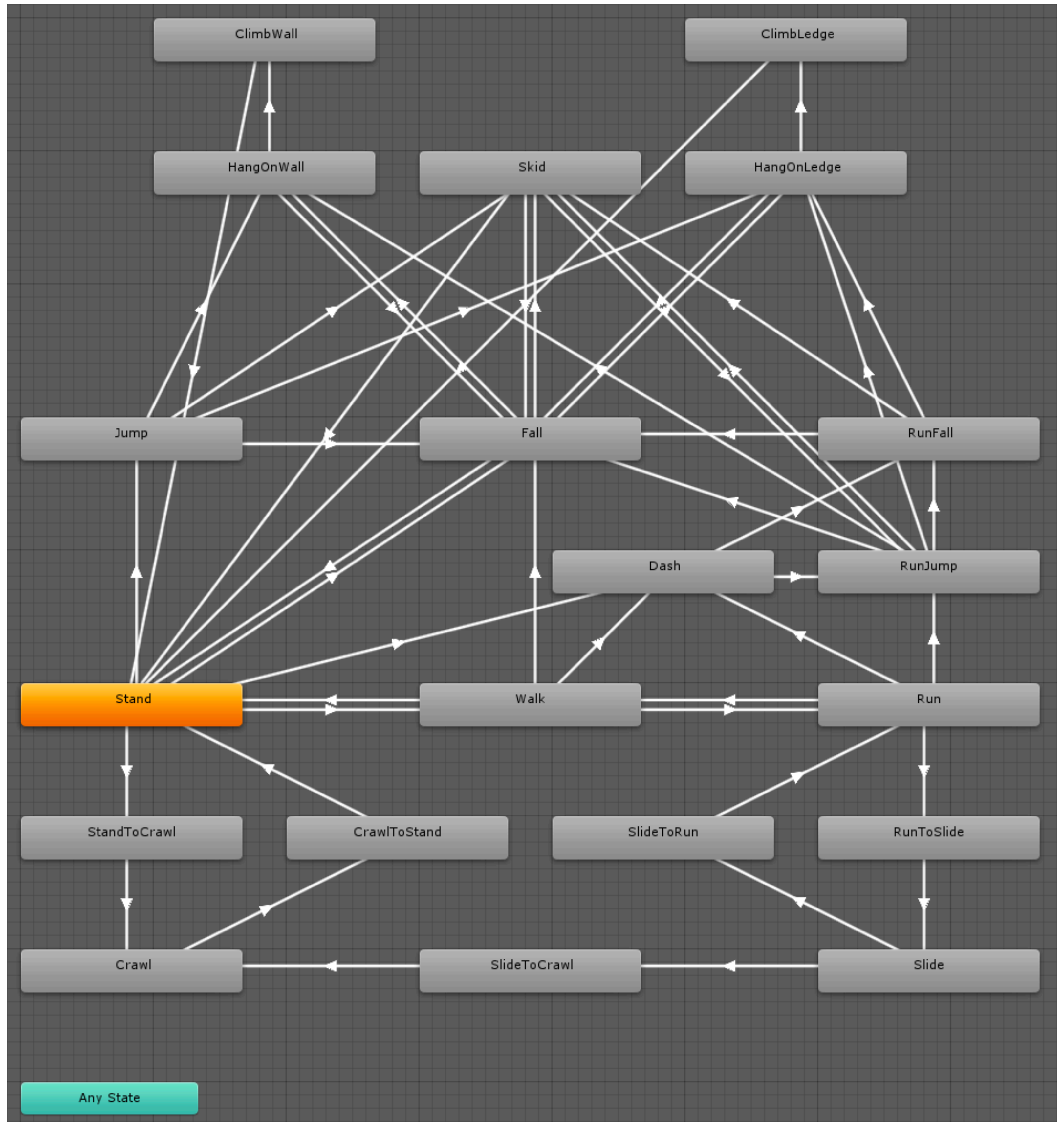
- A Layered System
- Node can be connected to any other node



Node system contains lots of transition



Controlling system is a combination for lots of motion clips



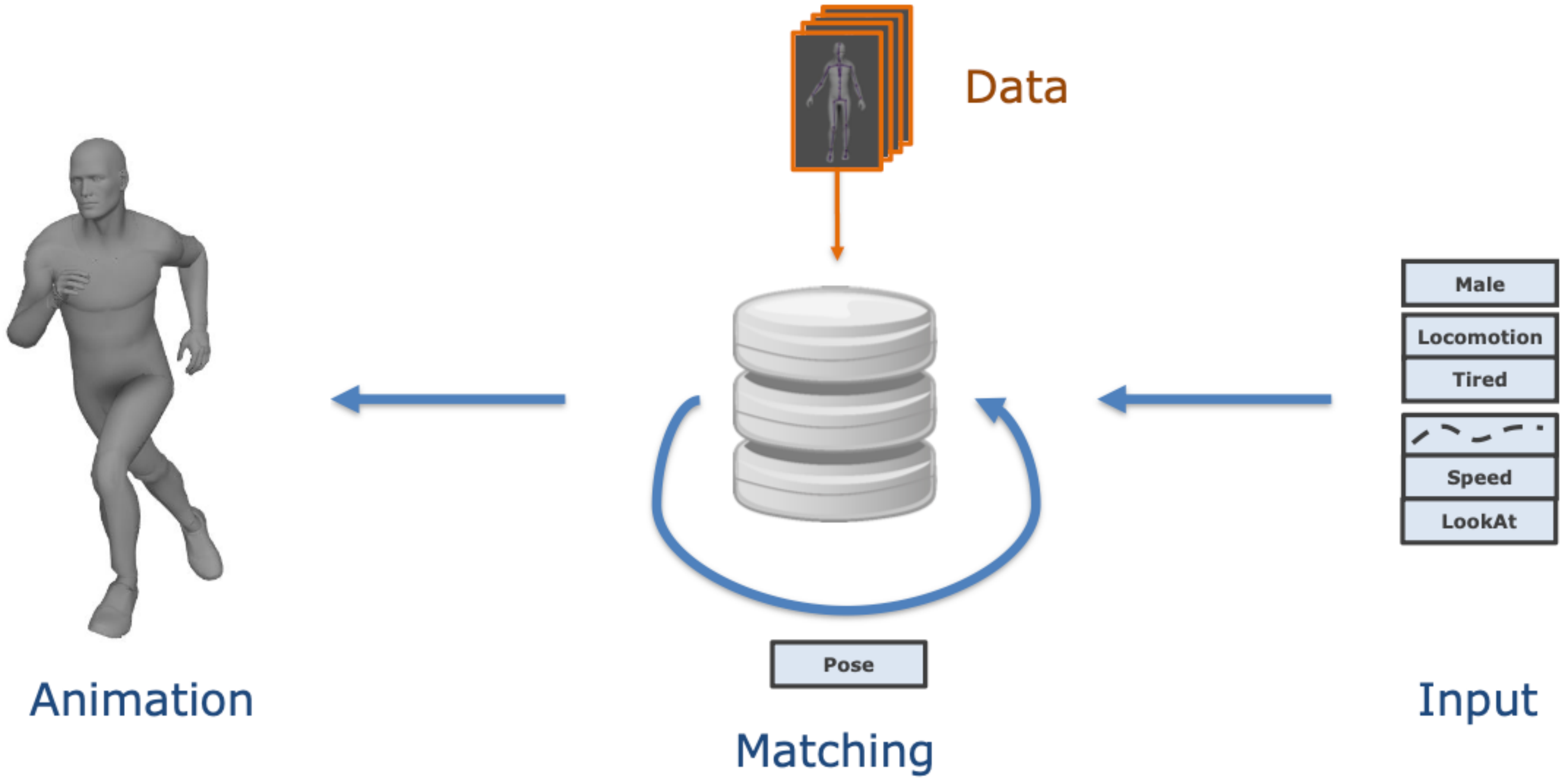
Character State Machine

GDC talk by Daniel Holden

https://www.youtube.com/watch?v=o-QLSjSSyVk

PDF download: https://www.gdcvault.com/play/1025389/Character-Control-with-Neural-Networks

Programming Details



Animation = Query(Dataset, variables)

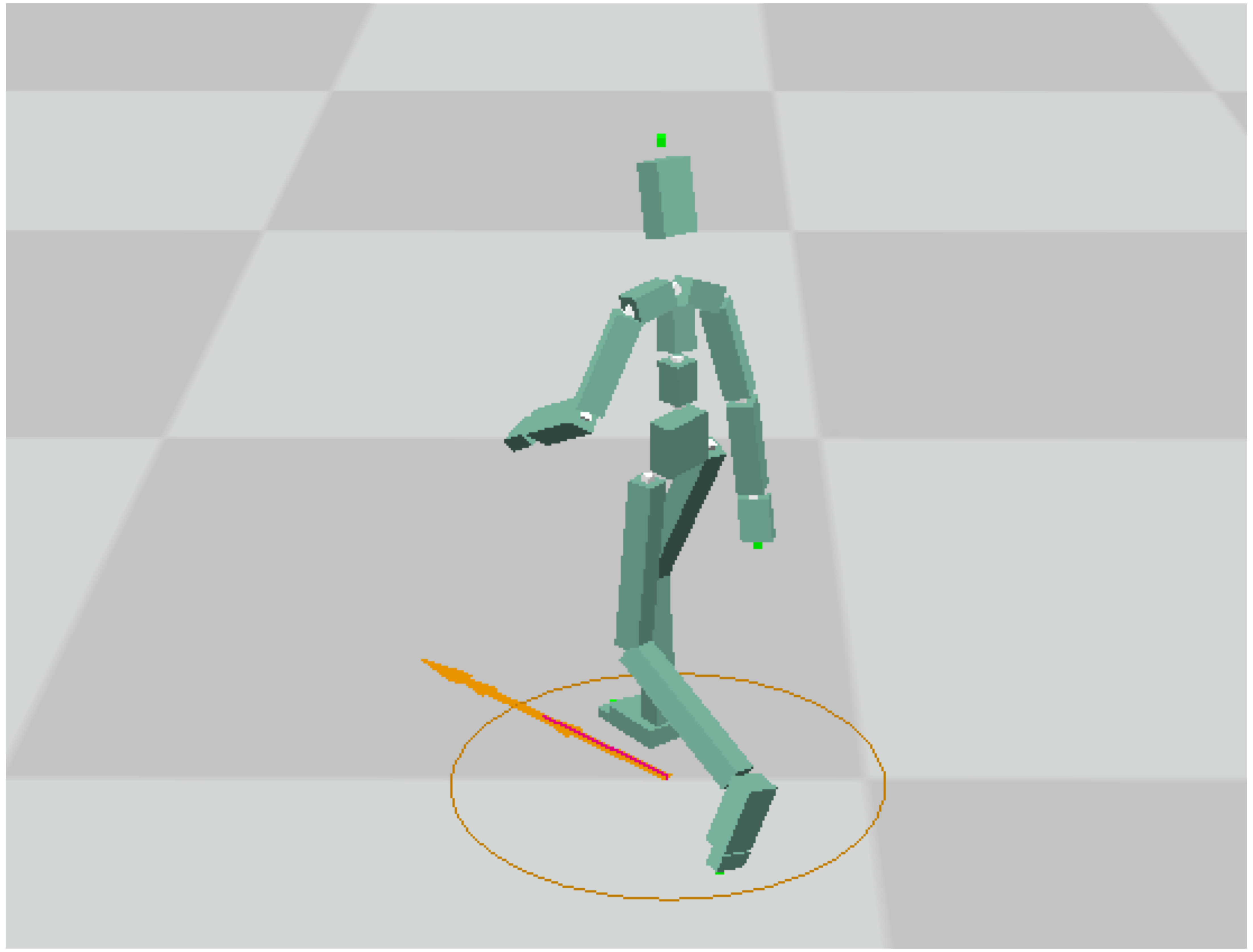
Select animation where variables=xxxxx from dataset

Feature Design

For a motion sequence with n frames

Each frame has its own features:

- Position
- Rotation
- Positional/Angular Velocity
- Future Position/Rotation after 20/40/60 frames

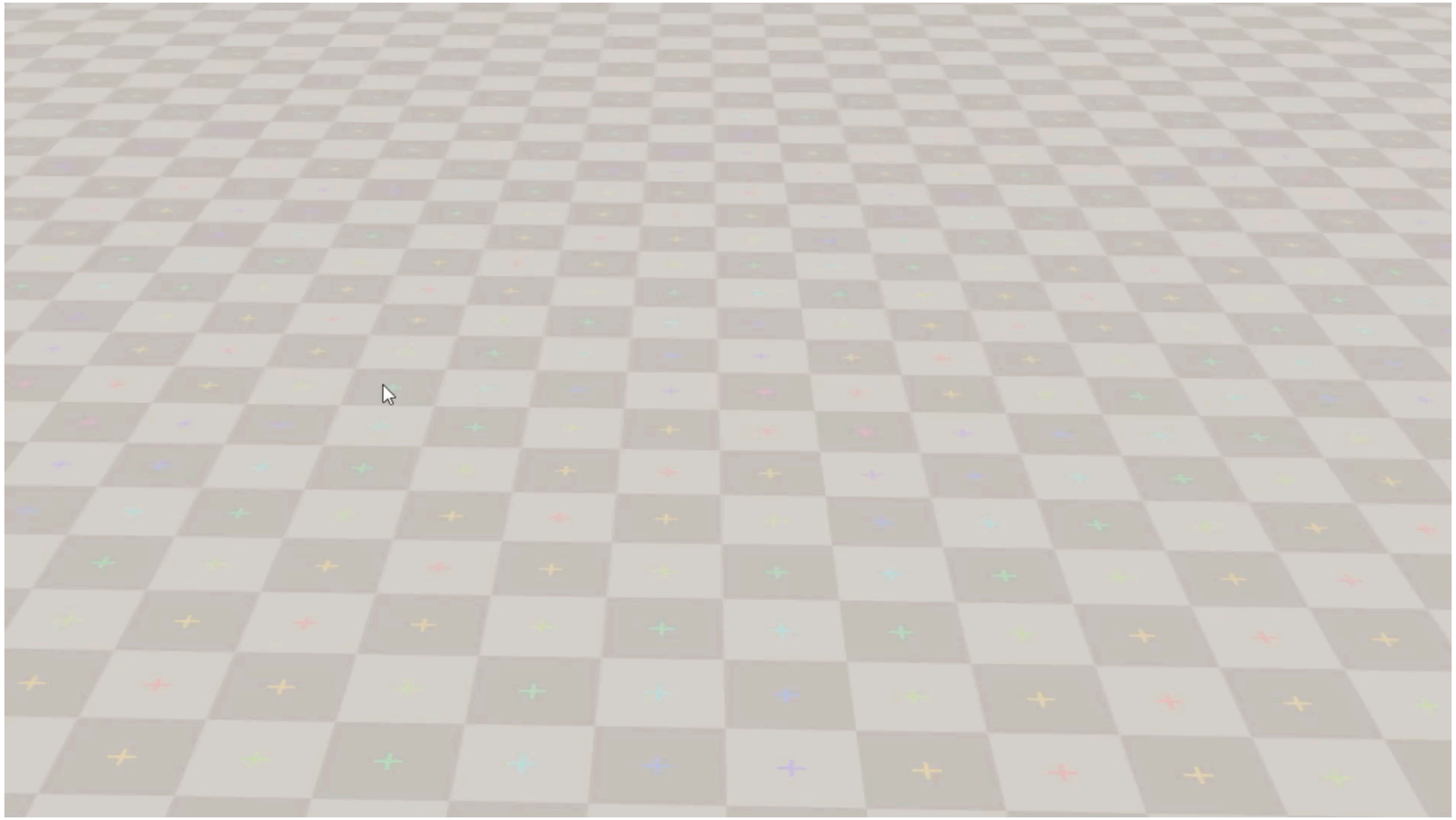


When we control the character

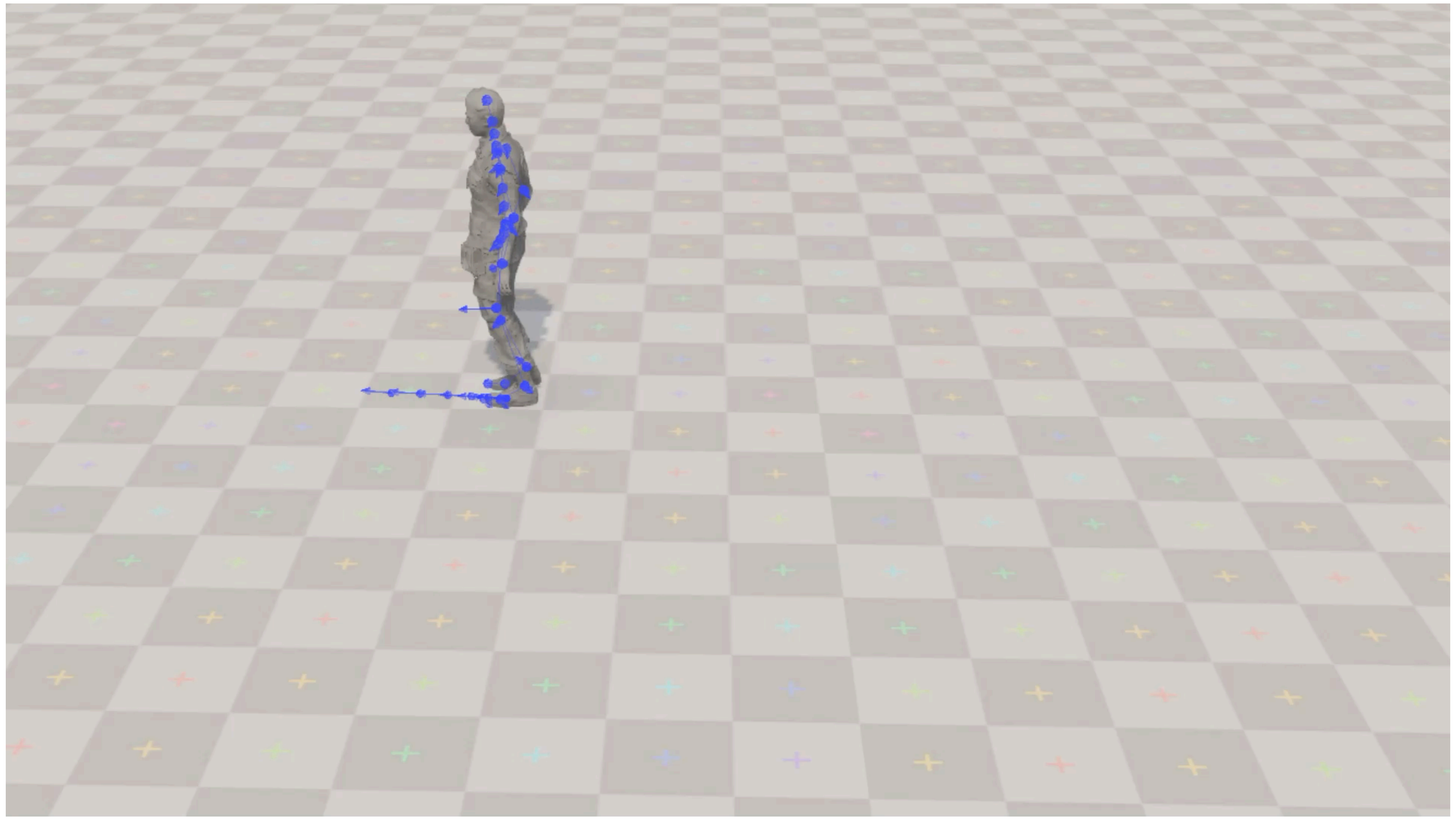
Each frame also has its own features:

- Position
- Rotation
- Positional/Angular Velocity
- Future Position/Rotation after 20/40/60 frames (decided by controller)

Step1: Give control signals



Step2: Analyze the motion data



```
# Extract the data terms
pos, rot = forward_kinematics_with_channel(self.joint_parent, self.joint_channel, sel
rot = align_quat(rot, False)
vel = np.zeros_like(pos)
vel[1:] = (pos[1:] - pos[:-1])/self.dt
vel[0] = vel[-1]
avel = np.zeros_like(vel)
avel[1:] = quat_to_avel(rot, self.dt)
avel[0] = avel[-1]
```

We know:

1. Joint position
2. Joint velocity
3. Joint rotations
4. Joint angular velocity

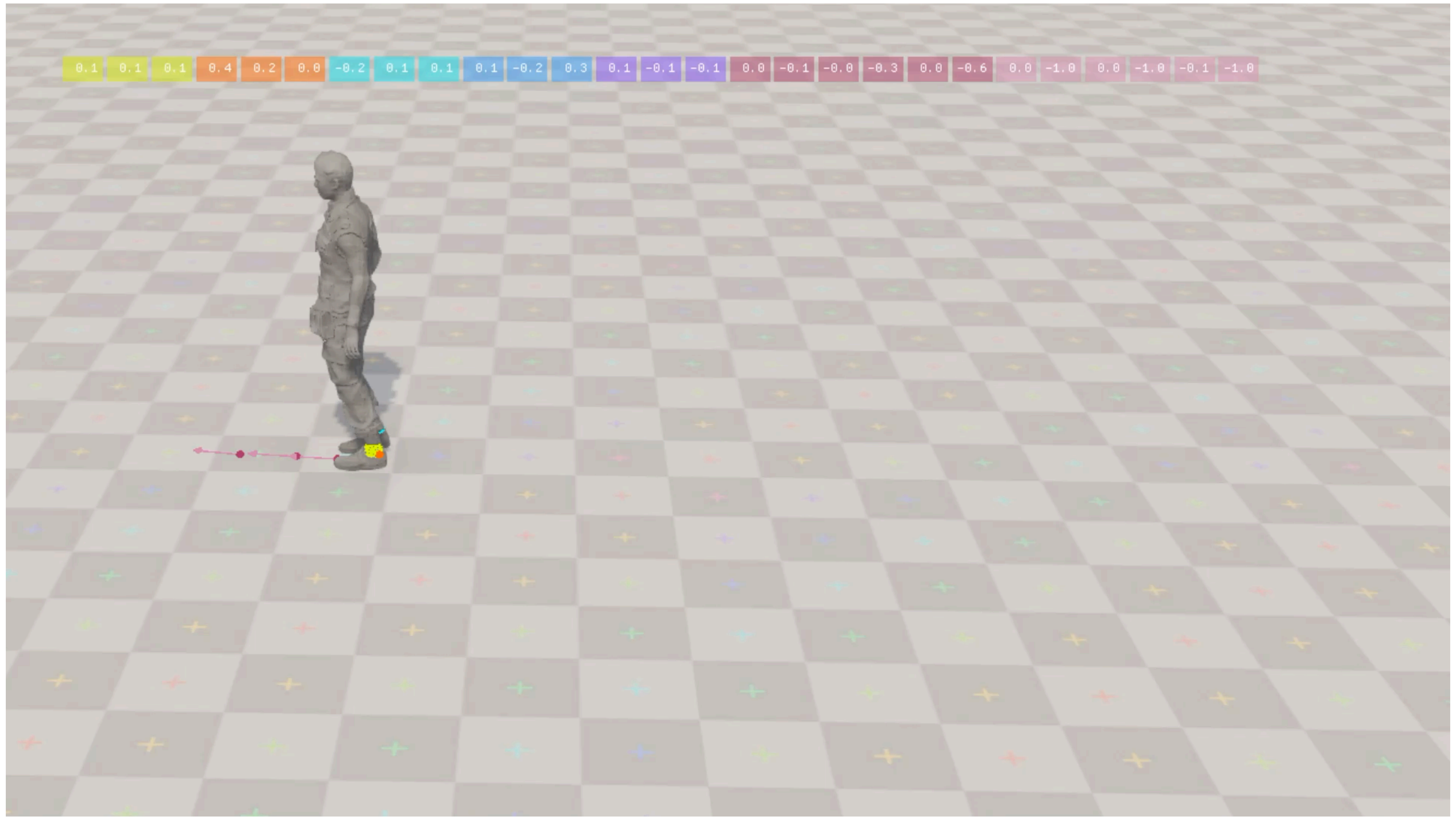
…

relative position

waving timing

…

Step3: Design the matching variables



```
    How can we use these data to match the motion?
    '''
    feature_mapping = {
        'lFootPos': 3,
        'rFootPos': 3,
        'lFootVel': 3,
        'rFootVel': 3,
        'lFootRot': 3,
        'rFootRot': 3,
        'rKneeAVel': 3,
        'lKneeAVel': 3,
        'lHandPos': 3,
        'lHandVel': 3,
        'rHandPos': 3,
        'rHandVel': 3,
        'rKneeAVel': 3,
        'lKneeAVel': 3,
        'rHipPos': 3,
        'lHipPos': 3,
        'rHipVel': 3,
        'lHipVel': 3,
        'hipVel': 3,
```

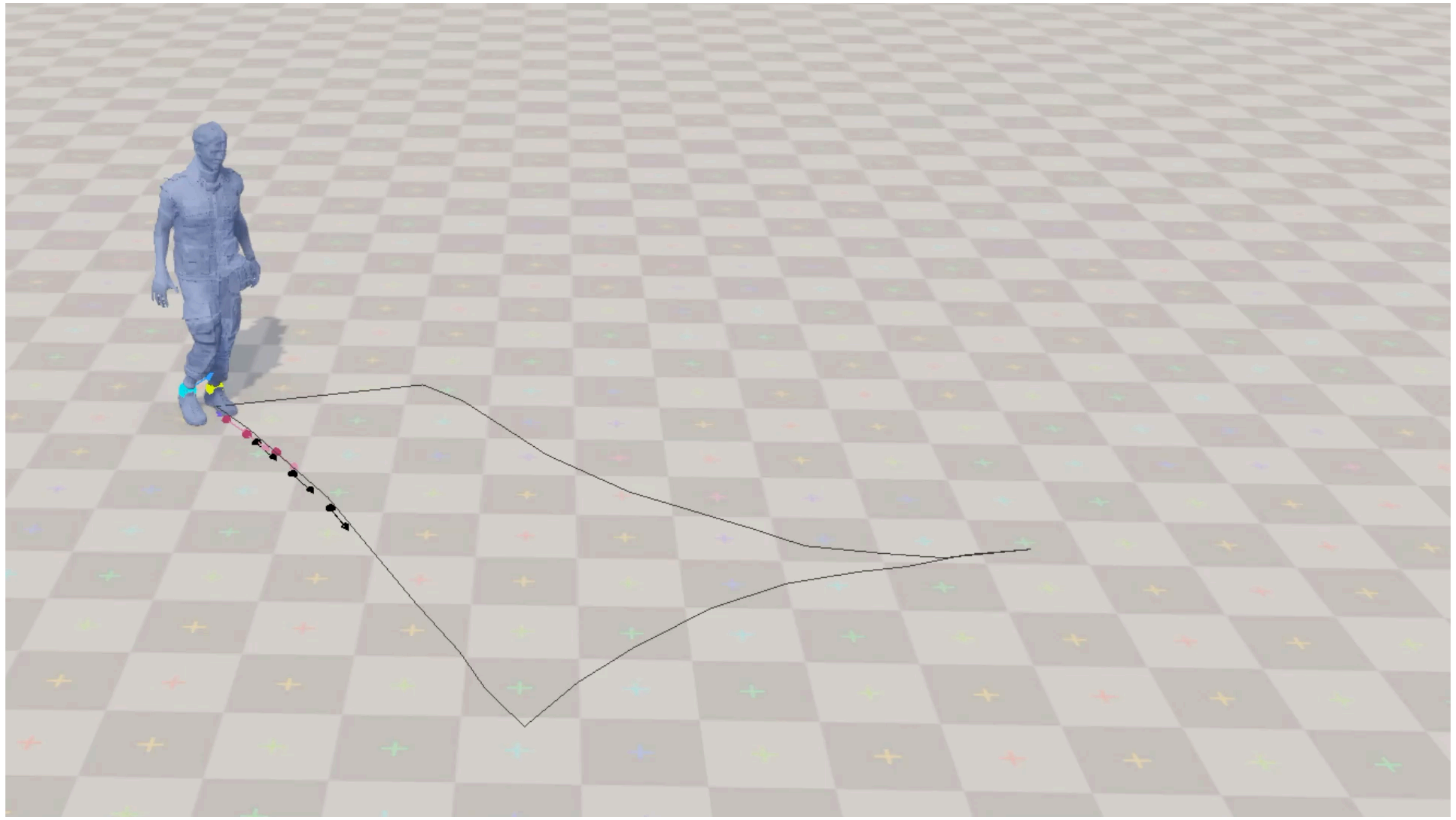
```
        for feature_name in self.feature_names:
            '''
            Extract the position:
                features.append(self.extract_offset(roo
            Extract the rotation:
                features.append(self.extract_rotation(r
            Extract the velocity:
                features.append(self.extract_vel(root_r
            Extract the future position:
            '''
            ##### Code Start #####

            if feature_name == 'lFootPos':
                features.append()
            elif feature_name == 'lFootVel':
                features.append()
            elif feature_name == 'trajectoryPos2D':
                features.append()

            ##### Code End #####
```

Not all the variables is needed
Find a balance between speed and accuracy

Step4: Matching



```
normalized_query = self.db.normalize_features(query_feature)

# Do the query
idx = self.db.query_tree.query(normalized_query.reshape(1,-1), k=1)[1][0]
```

Because we only use small dataset
We also store it with OC-tree
So the searching is fast

Programming Details

Prepare:

- A motion dataset
  - Oc-tree to accelerate the searching
- A set of feature variables
- A animation system to play the animation

The dataset and animation are prepared in this assignments

you only need to care the variables design

What you need to do:

Design the matching feature and its weights

```python
def main():
    viewer = SimpleViewer()
    controller = Controller(viewer)

    selected_feature_names = ['trajectoryPos2D', 'trajectoryRot2D']
    selected_feature_weights = [1, 1]

    # selected_feature_names = ['lFootPos', 'rFootPos']
    # selected_feature_weights = [1, 1]

    assert len(selected_feature_names) == len(selected_feature_weights)

    character_controller = CharacterController(viewer, controller, selected_feature_names, selected_feature_weights)
    task = InteractiveUpdate(viewer, controller, character_controller)
    viewer.addTask(task.update)
    viewer.run()
    pass
```

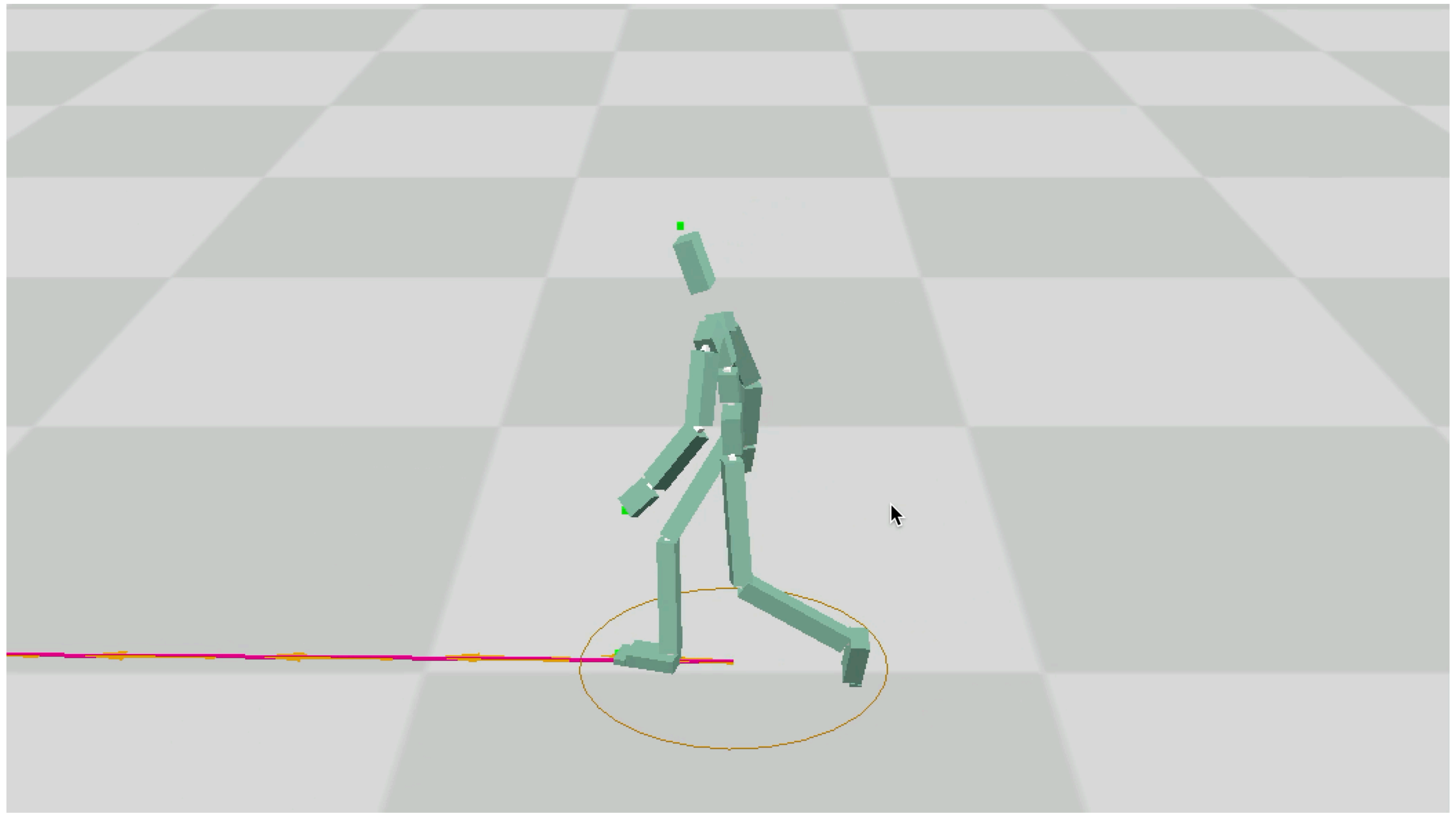
- Some features are pre-defined. (L11~L35, L135~L197)

- If you want to add you new features, update the code around (L11~L35, L135~L197)

Desired Results

1. Less variables, and better performance (total 15%, 22% - your_variable_num)

2. System analyzation (10%) about variable selection, future frame range, etc.



Overview, Due: March.20th(Wed)

- part1_key_framing (30%)
    - - Linear interpolation (10%); Slerp Interpolation (15%)
    - - Report the different performance by giving different numbers (5%)
- part2_concatenate (35%)
    - - Define the search window (10%); Calculate the sim_matrix (10%); Find the real_i and real_j (10%); The shifting on the root joint position (5)
- part3_motion_matching (25%)
    - variable terms (15% <- 22% - your_variable_num) + System analyzation (10%)
- Report (8%) + 2 videos (2%)
    - Including necessary experiment results by different parameters (4%) and your thinking(4%) for how to produce high quality motions