



Dance Move Classifier

(Originality Never Dies)

LUA YEOW WEN
DSIF-11 Capstone Project

TABLE OF CONTENTS

1

OVERVIEW

2

INTRODUCTION TO DANCE MOVES

3

DATASET

4

EXPLORATORY DATA ANALYSIS

5

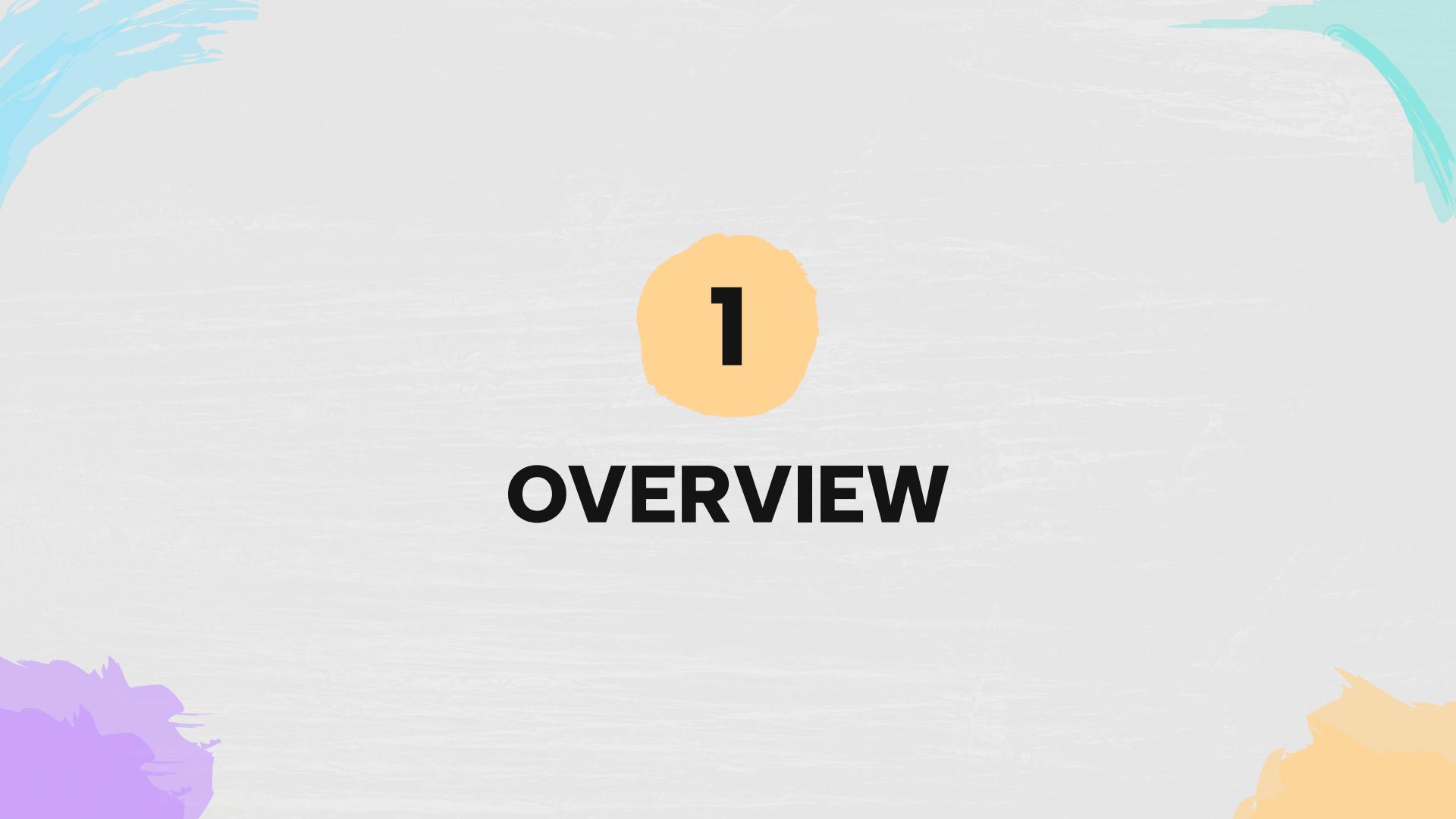
MODELLING AND TUNING

6

DEMO

7

CONCLUSION



1

OVERVIEW

BACKGROUND

Breaking or bboying is a form of dance that has evolved from the battling at the streets of the Bronx into global stage.

Nowadays, winners in dance competitions or events can receive rewards and incentives such as cash prizes, invitations to events, inclusion in an all-star team, or even representation of a country in the 2024 Paris Olympics.



PRIZES FOR OVERSEAS COMPETITIONS



World Breaking Classic 2 vs 2 2024

Top 16: €200

Top 8: €400

Top 4: €1000

2nd Place: €1500

1st Place: €5000



Silverback Open Championships 3 vs 3

Top 32: USD \$50

Top 16: USD \$250

Top 8: USD \$500

Top 4: USD \$1,000

2nd Place: USD \$5000 + silver Silverback medal

1st Place: USD \$15,000 + gold Silverback medal

PRIZES FOR LOCAL COMPETITIONS



Lion City Dance Convention 4 vs 4

3rd Place: SGD \$800

2nd Place: SGD \$1,200

1st Place: SGD \$3,200

Lion City Dance Convention 1 vs 1

1st Place: SGD \$800

OTHER INCENTIVES



Red Bull BC All Star Team

Multiple Bboy sponsorships such as Samsung, Toyota, Alibaba and etc for Paris 2024 Games



Sponsorships like Rimowa, Sony Xperia, G-Shock, and Red Bull

Featured in movie documentary

TOYOTA

SAMSUNG

The WDSF Breaking For Gold series, which is a crucial event where breakers earn points that are essential for qualifying for the 2024 Paris Games

PROBLEM STATEMENT

Over the years, instances have arisen where a bboy's performance closely resembles that of others , leading to an appearance of imitation, a phenomenon known as "Biting" (source) in the breaking community. Given the extensive array of moves within the bboy scene, judges may occasionally overlook instances of "Biting," especially in the fast-paced environment of a bboy battle.

This oversight can consequently lead to potential misjudgment in scoring and decision-making.



WHY SHOULD WE BE CONCERN



It is important to ensure that sponsors support the right Bboy or athlete to maintain the integrity of the sponsorship process.



Addressing potential backlash from the public is essential, as it could become more challenging to attract corporate funding for Bboy events in the future.



Misjudgment could potentially discourage new dancers from participating in dance events or competitions, leading to the deterioration of the Bboy dance scene.

REVENUE MADE IN EVENTS

\$825,000

Breakin tournament that at the world
finals

\$207,000

Breakin Festival held in a city

Deterioration of the Bboy dance scene can
hurt revenues made for such events.

Rough estimations were made by a veteran bboy



INTRODUCTION



Who am I
An advocate bboy data scientist



Stakeholders
Dance event organizers



Secondary Stakeholders
Corporate Sponsors

GOAL



Develop a multi-class classifier that accurately identifies moves, assisting bboy judges in detecting instances of biting.

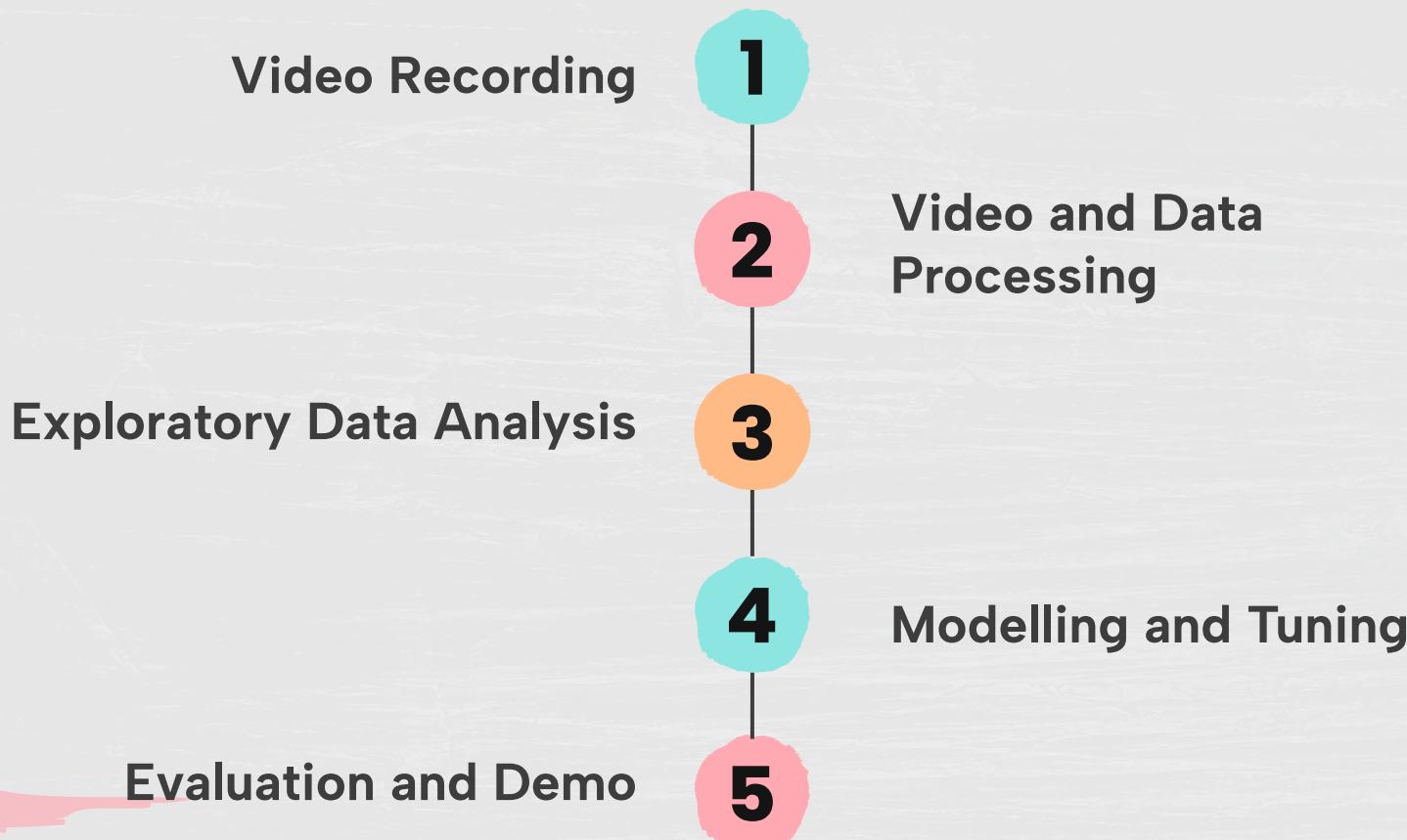


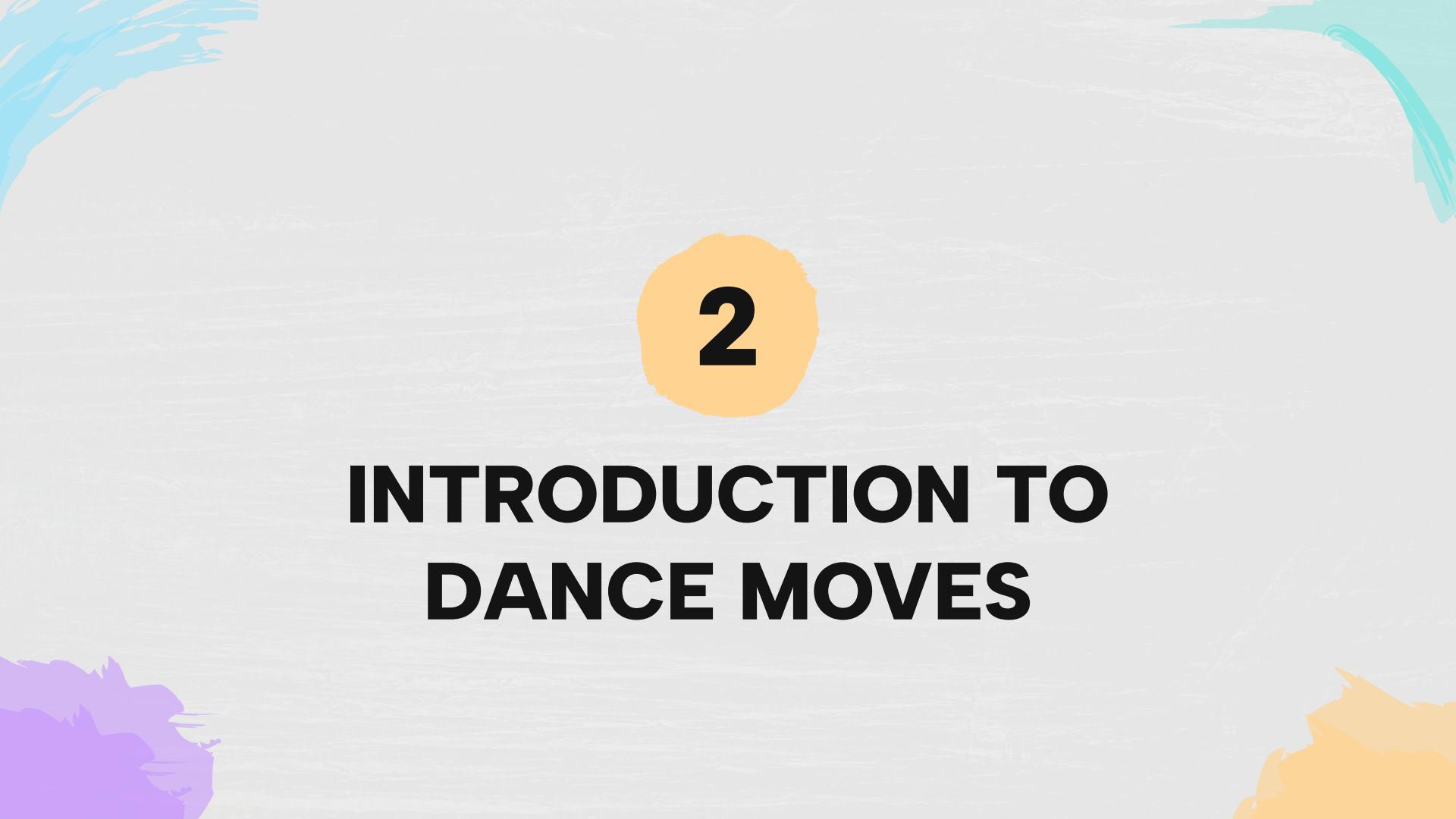
Encourage breakers to create more original moves.



Assisting corporations in selecting the appropriate bboy or bgirl for sponsorship.

PROCESS





2

INTRODUCTION TO DANCE MOVES

CC (Footwork)



- The move is performed by kicking the left leg forward, diagonally whilst twisting the body so that the right upper limb can swing and palm can touch the ground for support.
- The motion is done only once.
- The start pose and mid pose of the move is different.
- End pose is the same as the start pose.

Jackhammer (Powermove)



- The move requires the wrist to turn to the maximum range of movement before each hop.
- The hopping movement is done by bending and extending the knee.
- The body spins as each hop is executed.
- The hopping movement is repetitive and it is in a rotary motion.
- The left upper limb plays a role of balancing the body while spinning and hopping.
- The hopping pace is based on the dancer's level of fatigue.

Handhop (Tricks)



- The move requires the wrist to turn to the maximum range of movement before each hop.
- The hopping movement is done by bending and extending the knee.
- The body spins as each hop is executed.
- The hopping movement is repetitive and it is in a rotary motion.
- The left upper limb plays a role of balancing the body while spinning and hopping.
- The hopping pace is based on the dancer's level of fatigue.



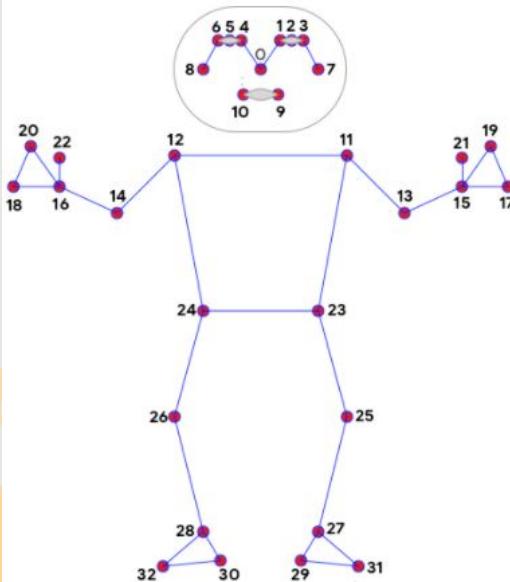
3

DATASET

VIDEO RECORDINGS

- All video attempts were self recorded with Samsung Galaxy S22 (settings: UHD, 30 fps)
- There are 8 videos attempts for each move (7 for training, 1 for validation)
- There are 3 moves in total
- There are 24 video attempts in total for modelling
- 2 seconds /60 frames of data were extracted from each video attempts
- There are also 1 videos attempts for each move for prediction

BODY LANDMARKS SELECTION



- | | |
|--------------------|----------------------|
| 0. nose | 17. left_pinky |
| 1. left_eye_inner | 18. right_pinky |
| 2. left_eye | 19. left_index |
| 3. left_eye_outer | 20. right_index |
| 4. right_eye_inner | 21. left_thumb |
| 5. right_eye | 22. right_thumb |
| 6. right_eye_outer | 23. left_hip |
| 7. left_ear | 24. right_hip |
| 8. right_ear | 25. left_knee |
| 9. mouth_left | 26. right_knee |
| 10. mouth_right | 27. left_ankle |
| 11. left_shoulder | 28. right_ankle |
| 12. right_shoulder | 29. left_heel |
| 13. left_elbow | 30. right_heel |
| 14. right_elbow | 31. left_foot_index |
| 15. left_wrist | 32. right_foot_index |
| 16. right_wrist | |

15 body landmark numbers for x,y,z coordinates and visibility that are extracted with Mediapipe Library:

- p0 : nose
- p9 : mouth_left
- p10 : mouth_right
- p12 : right_shoulder
- p14 : right_elbow
- p16 : right_wrist
- p11 : left_shoulder
- p13 : left_elbow
- p15 : left_wrist
- p24 : right_hip
- p26 : right_knee
- p28 : right_ankle
- p23 : left_hip
- p25 : left_knee
- p27 : left_ankle

DATASET

Move: cc
Video Num: 0
Bboy Name: bboy2
Frame: 1



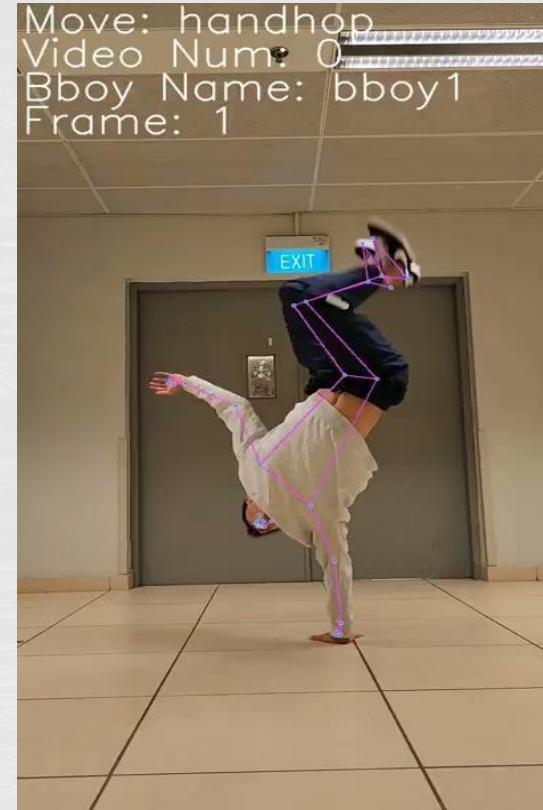
CC

Move: jackhammer
Video Num: 0
Bboy Name: bboy0
Frame: 1



Jackhammer

Move: handhop
Video Num: 0
Bboy Name: bboy1
Frame: 1



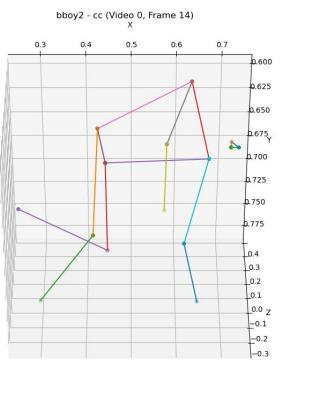
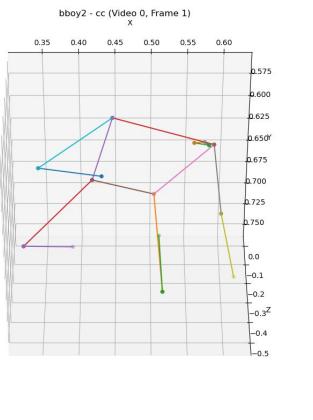
Handhop



4

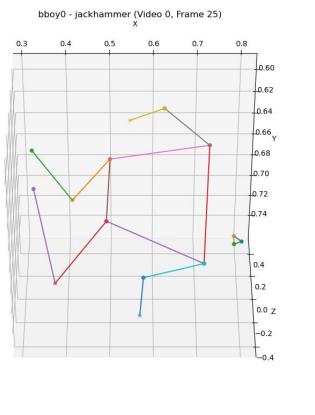
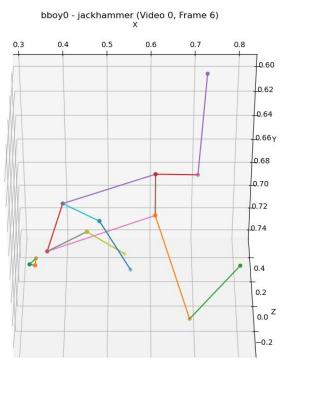
EXPLORATORY DATA ANALYSIS

CC IN 3D PLOT



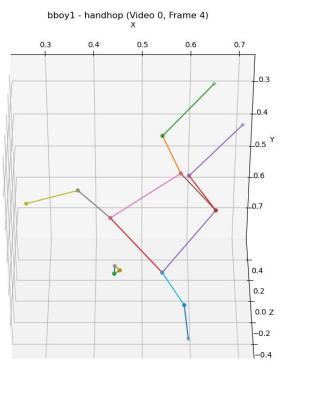
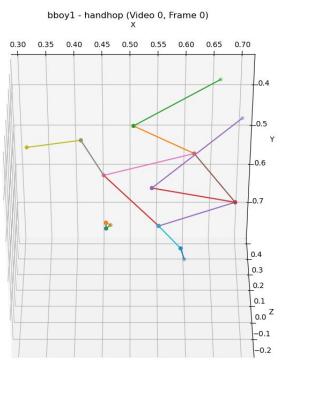
- The landmarks value changes significantly in the x and z axis as the right upper limb and head swung to the left whereas the left lower limb kicked forward and diagonally to the right.
- The change in y axis is observed as the left hand is in contact the ground and right lower limb is bent upwards into a pose.
- The poses in the first and last frame are identical which is the squat position but with different landmark values.

JACKHAMMER IN 3D PLOT



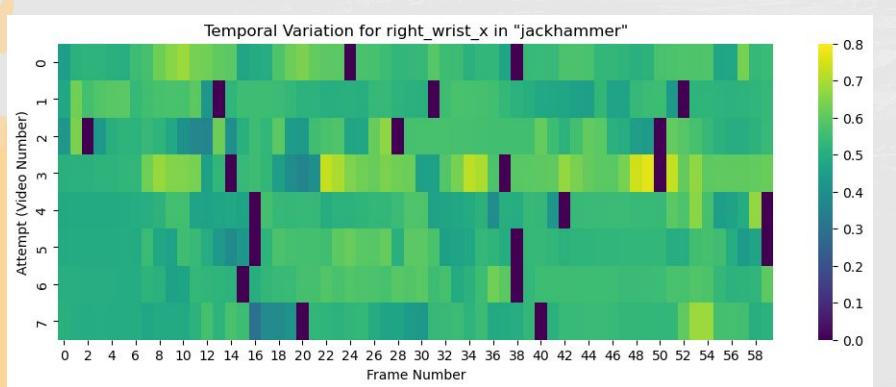
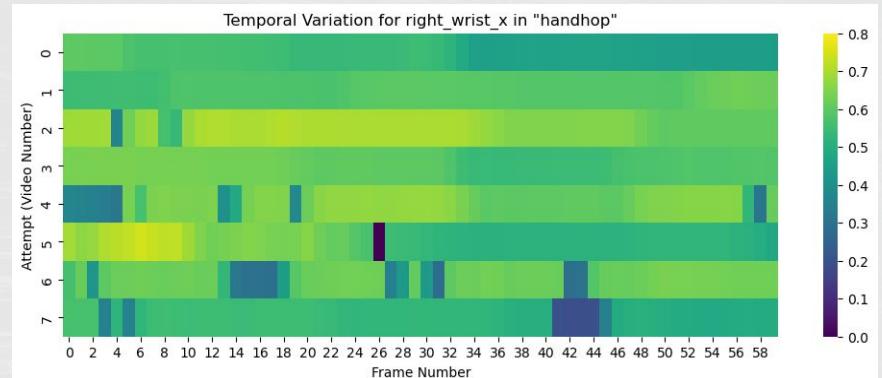
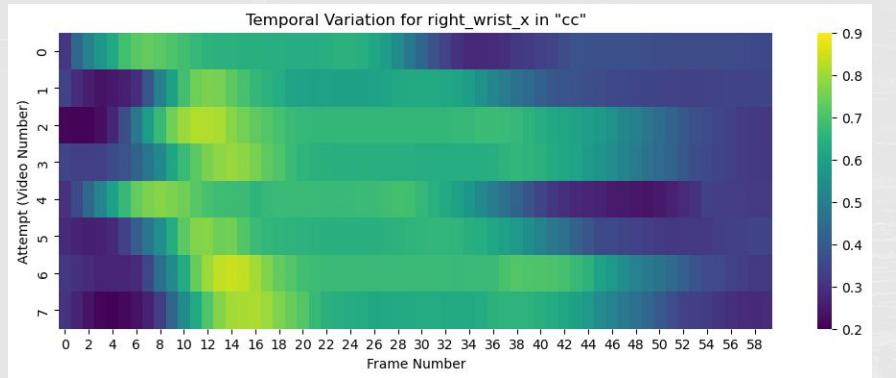
- All the landmarks of x and z axis values varied across the different frames due to the spinning movement of this move along the axis.
- In the last frame where it shows the variations in the y axis when the dancer is in mid air, it is observed that all the landmarks in the y axis increases.

HANDHOP IN 3D PLOT

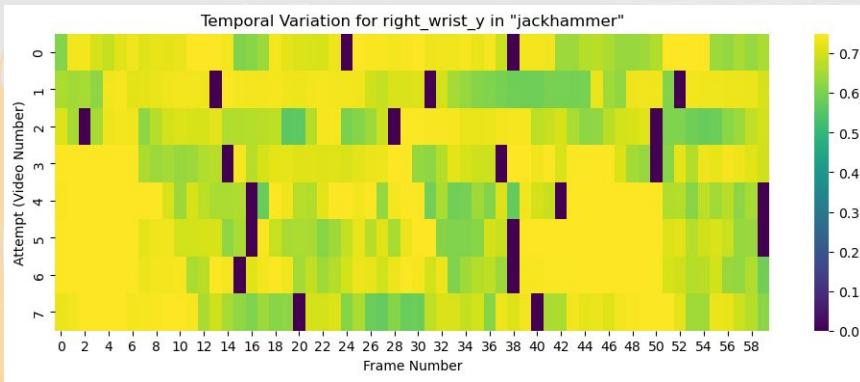
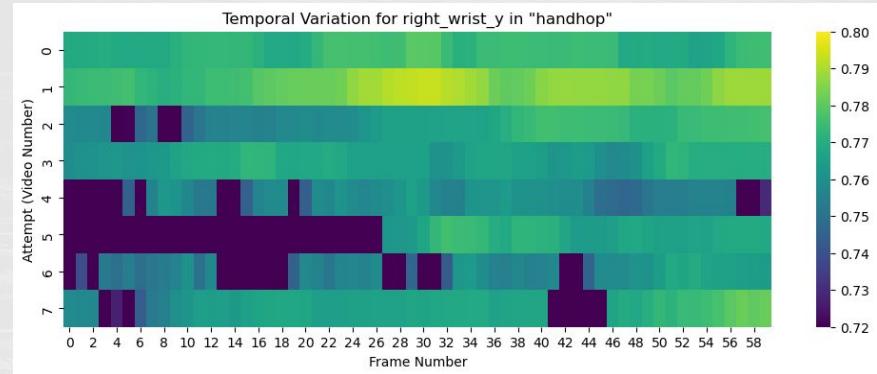
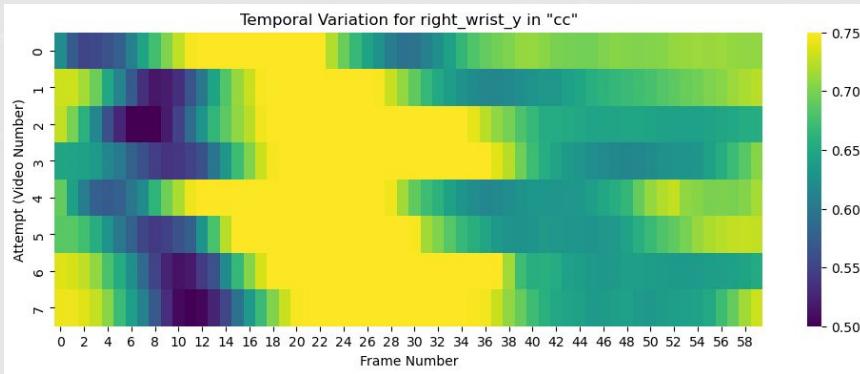


- When the dancer body moves away from the ground, the lower limbs landmark values in y axis are at their maximum before returning to its original pose in the third frame which the knee is bent in preparing for the next hop.
- The landmark values in the x and z axis changes as the dancer lands on different spot after each hop is executed.
- The left upper limb landmark value may vary across the x , y and z axis as the dancer is balancing himself.
- The landmark values in the y axis for mouth is higher than the eyes at all time which signify that the dancer's body is inverted.

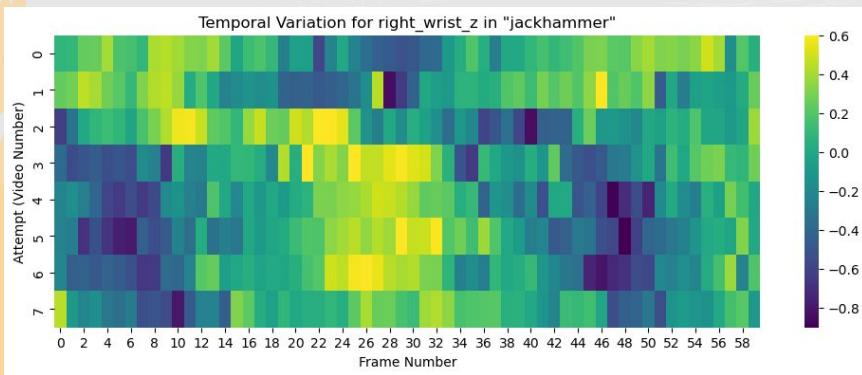
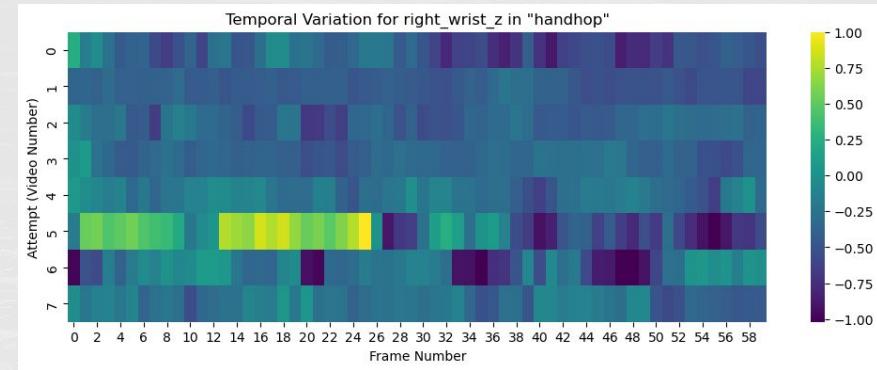
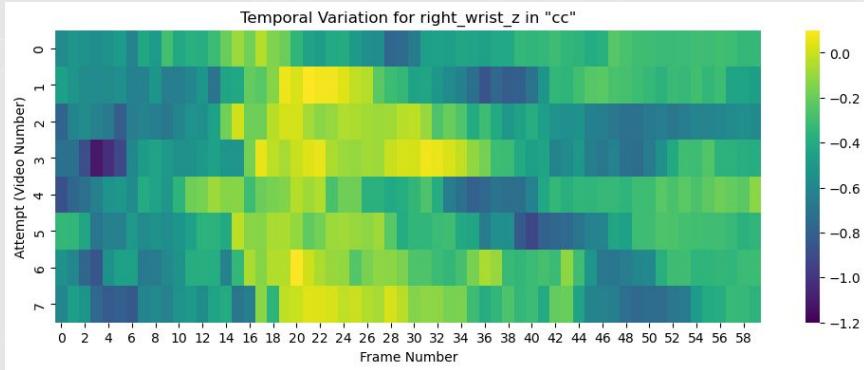
Temporal Variation of right_wrist_x



Temporal Variation of right_wrist_y

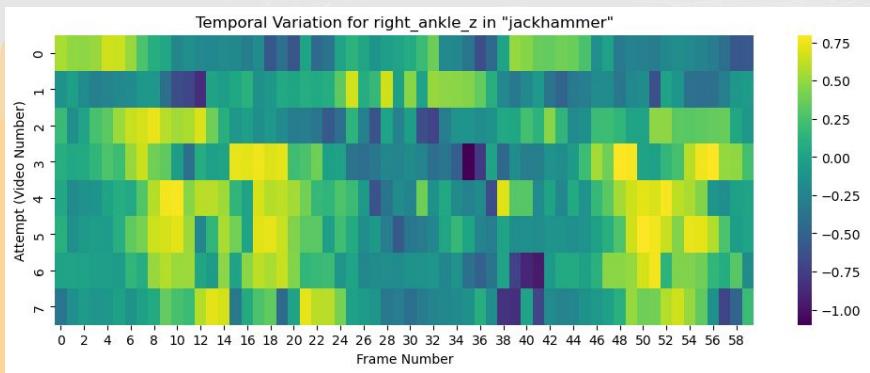
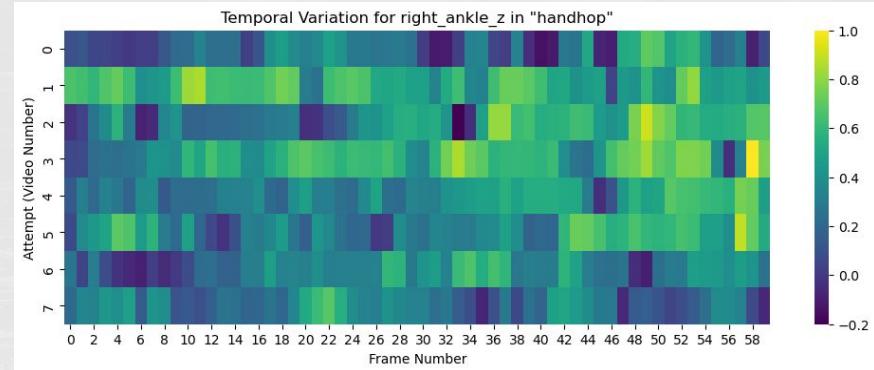
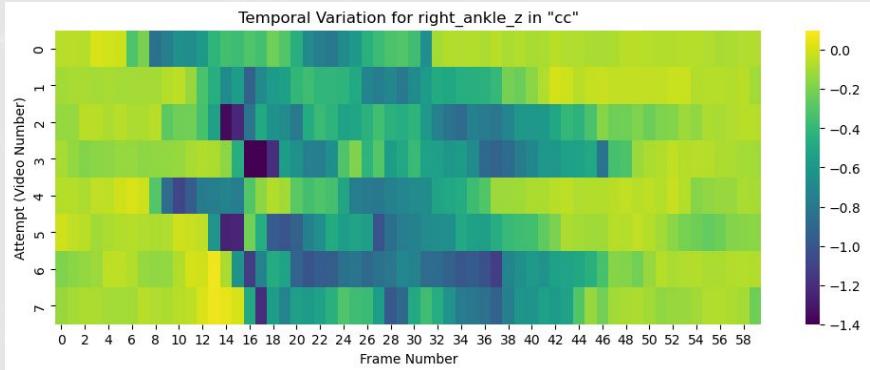


Temporal Variation of right_wrist_z

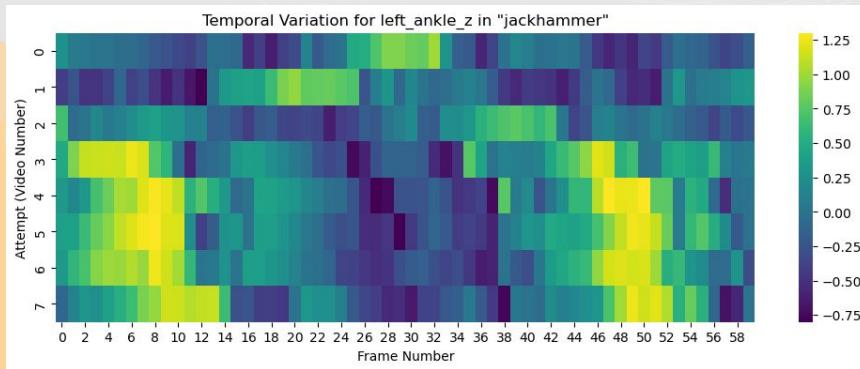
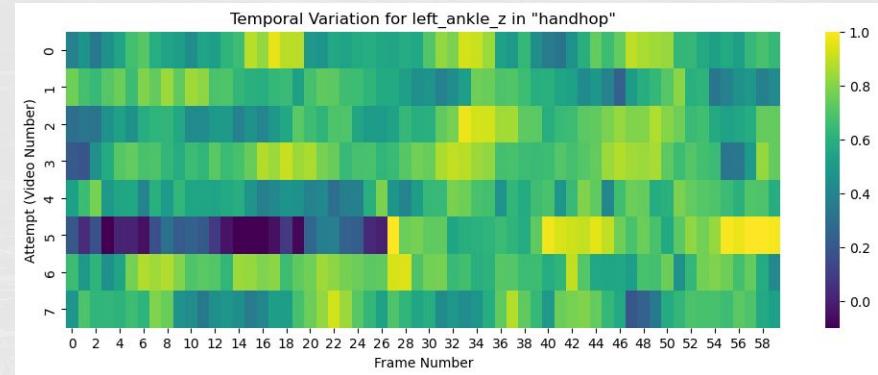
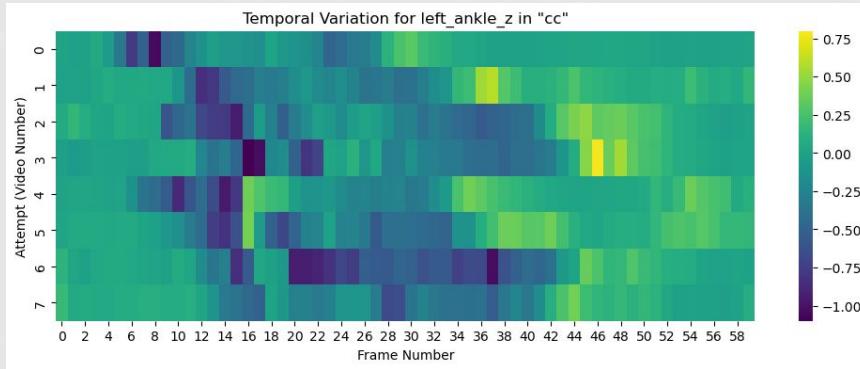


The unique temporal fluctuations of right_wrist_x, right_wrist_y and right_wrist_z in the 3 moves may improve models that identify sequential patterns.

Temporal Variation of right_ankle_z



Temporal Variation of left_ankle_z



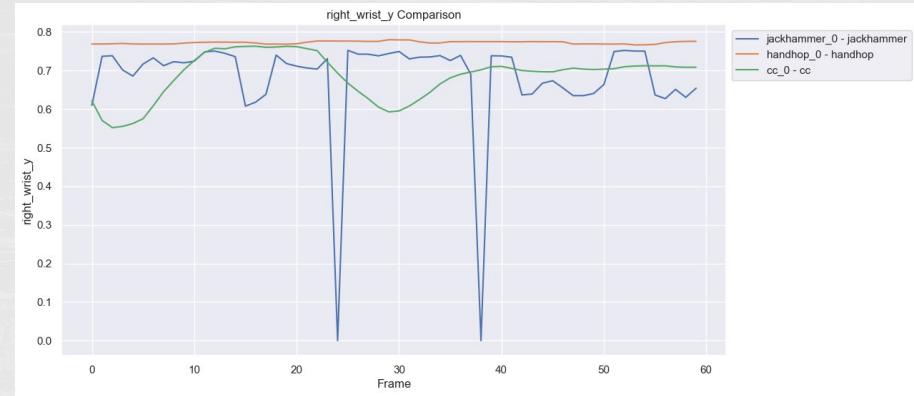
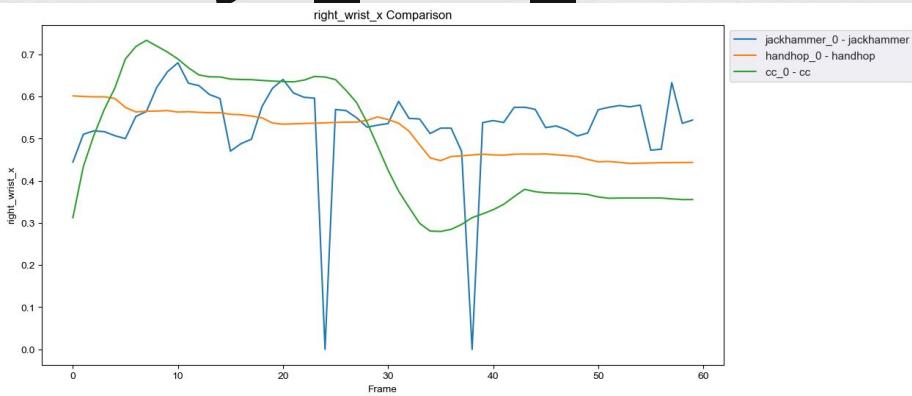
The unique temporal fluctuations of right_ankle_z and left_ankle_z in the three dances may improve models that identify sequential patterns.

Temporal Variation Insights

The unique temporal patterns among the different landmarks and moves can be used as an advantage for models that can utilize these patterns to differentiate between dance moves.

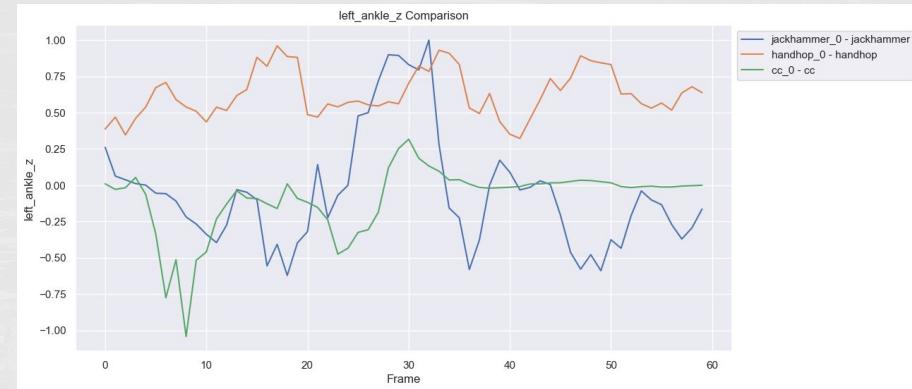
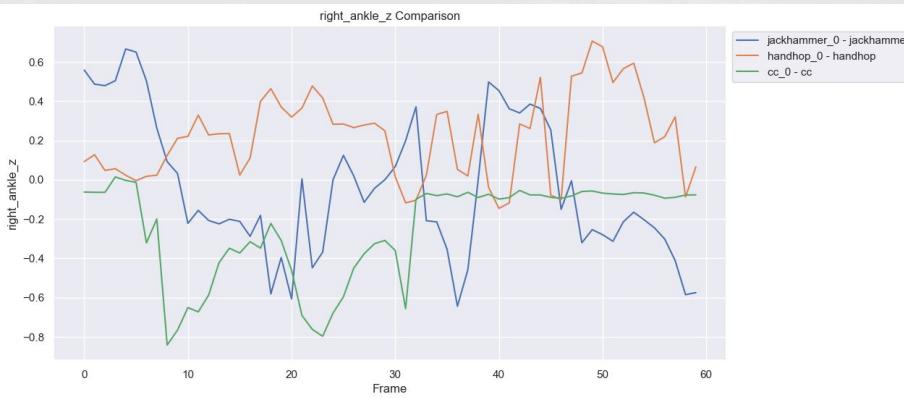
This is because they are considering the full context of the movement, not just isolated positions.

Line Plot for 'right_wrist_x', 'right_wrist_y', 'right_wrist_z'



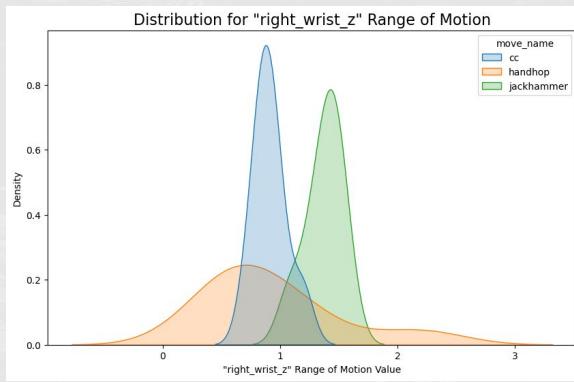
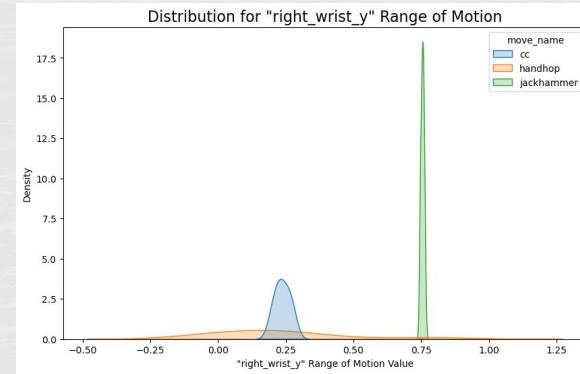
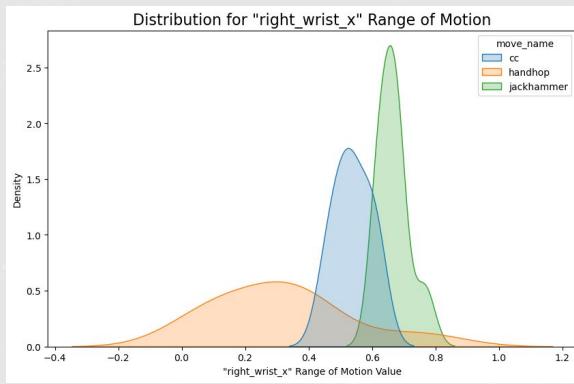
The unique temporal fluctuations of right_ankle_z and left_ankle_z in the three dances may improve models that identify sequential patterns.

Line Plot for 'right_ankle_z', 'left_ankle_z'

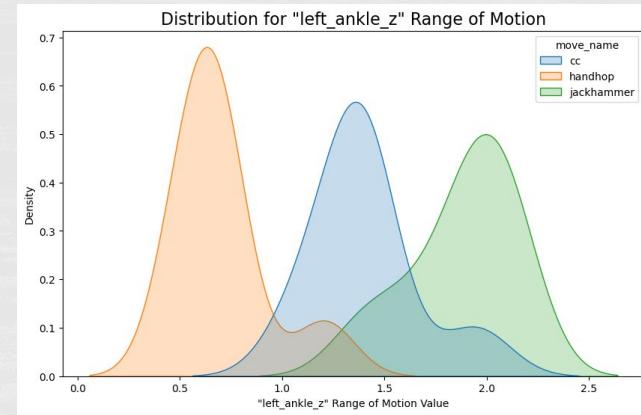
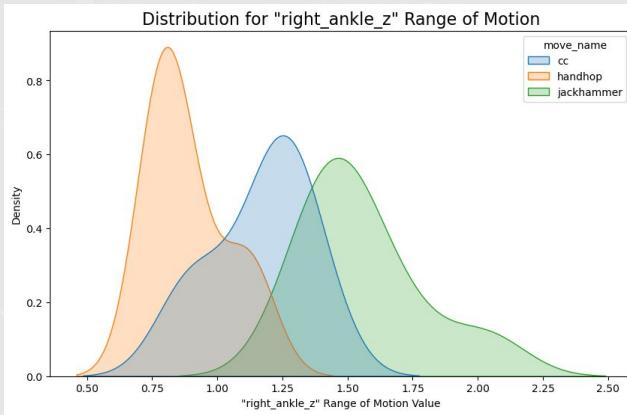


- Jackhammer demonstrates the greatest variation, indicative of active and varied ankle movements.
- Handhop shows less fluctuation than Jackhammer but is more varied than CC.
- CC is relatively stable, suggesting less movement of the right ankle in the vertical plane.
- The increased in the value at frame 30 onwards indicates that the right lower limb that kicked towards the camera stabilizes after hitting the pose.

KDE Plot for 'right_wrist_x', 'right_wrist_y', 'right_wrist_z'



KDE Plot for 'right_ankle_z', 'left_ankle_z'



- The distributions suggest that some moves have specific, characteristic movements that could be key in identifying them.
- The overlap in distributions for some moves means that a single coordinate movement might not be sufficient for classification, and combining multiple coordinates or landmarks might be necessary.



5

MODELLING AND TUNING

RECURRENT NEURAL NETWORK (RNN) ARCHITECTURE



Gated Recurrent Unit (GRU)

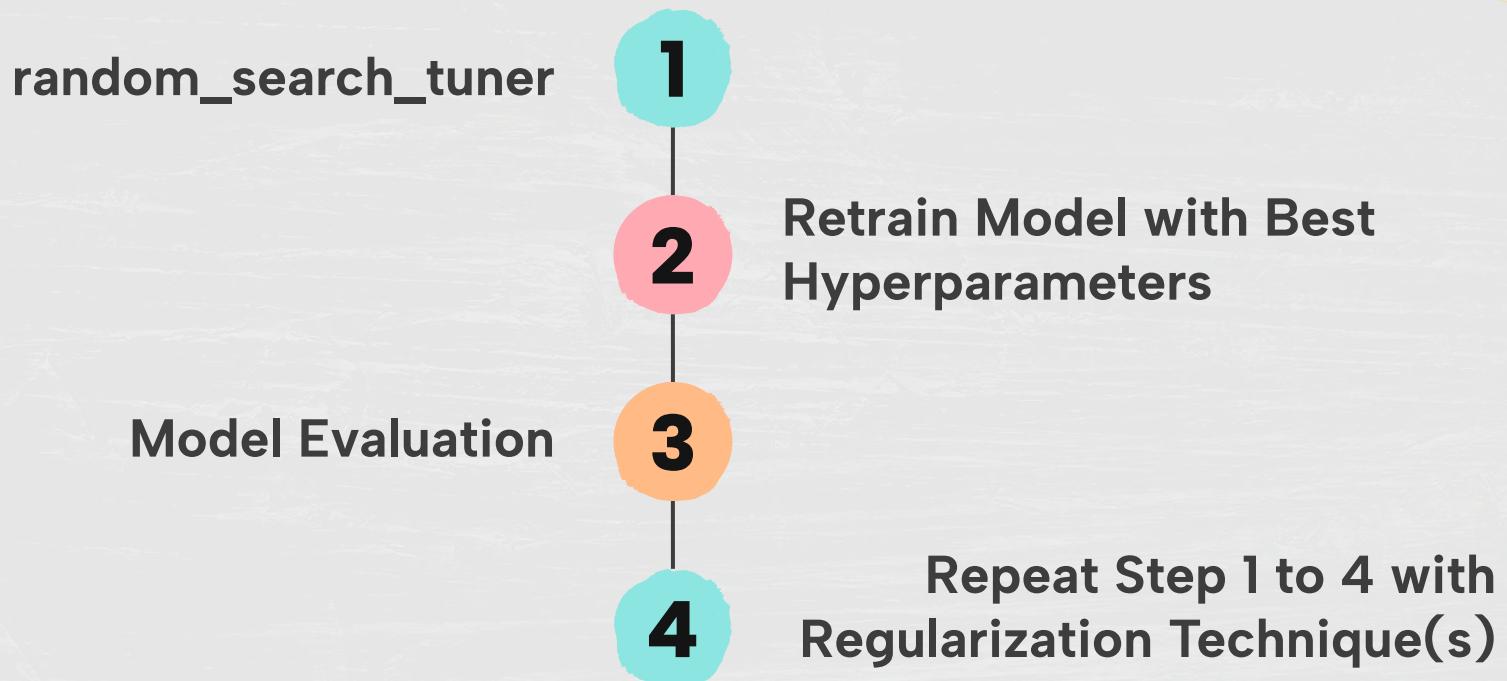
Outperforms with smaller datasets, and offers quicker training times on larger datasets



Long Short-Term Memory (LSTM)

Capable to handle complex architecture compared to GRU

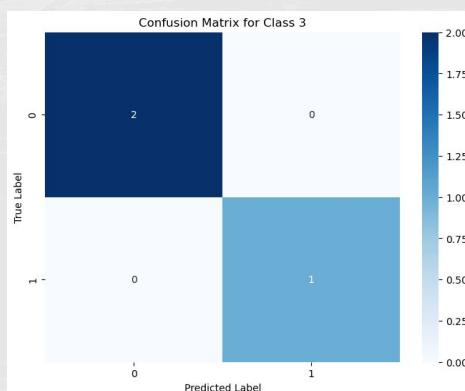
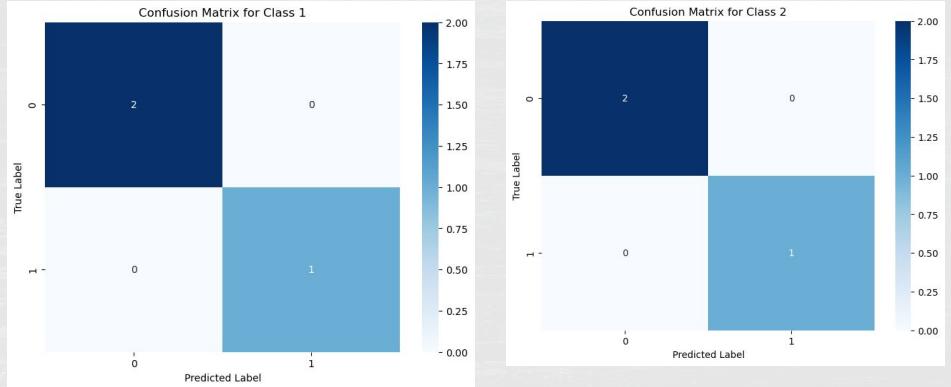
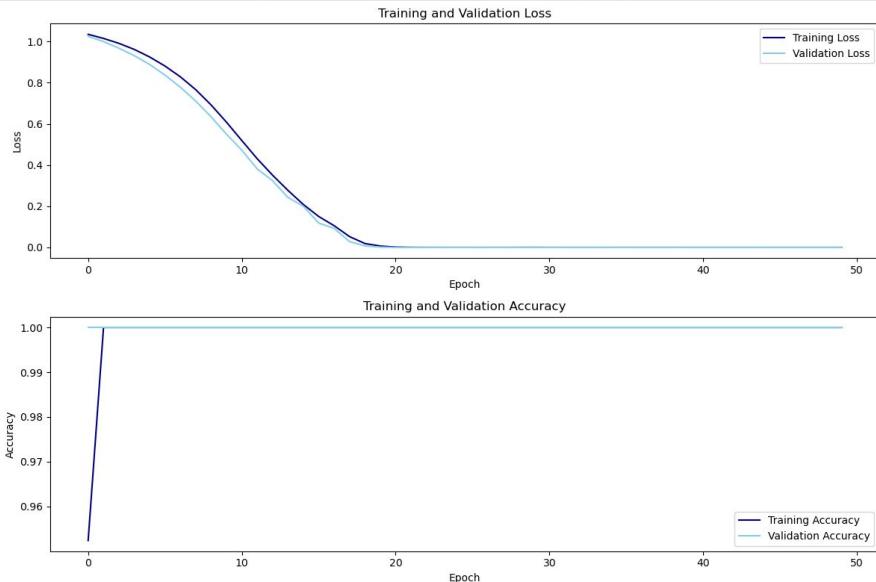
MODELLING STAGES



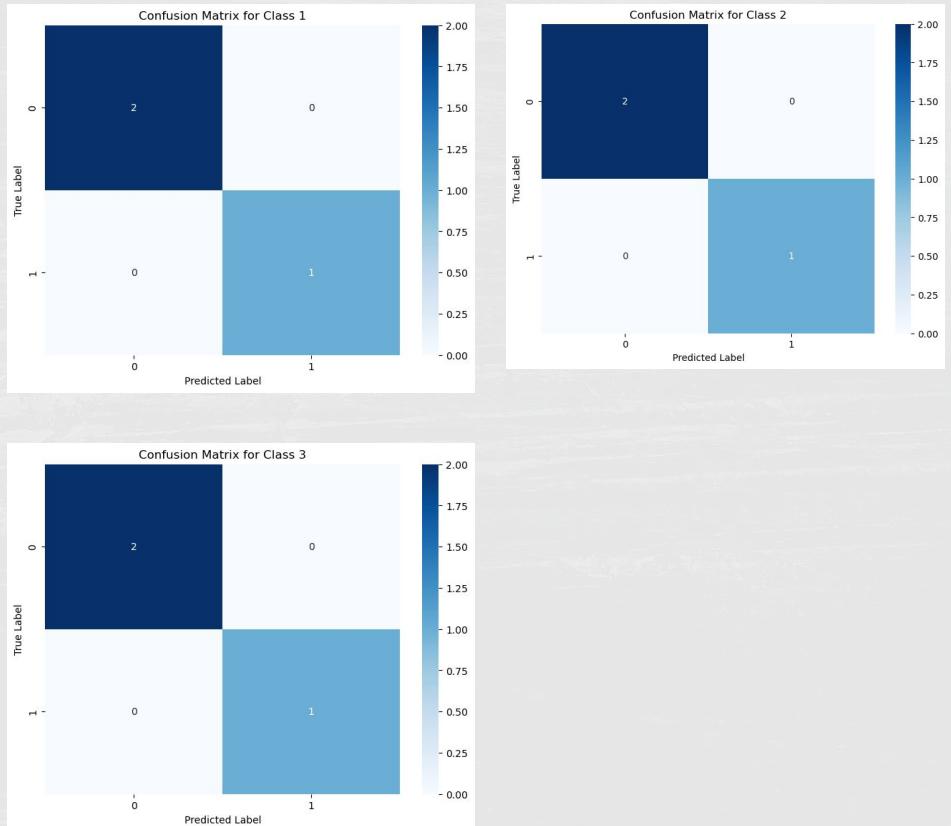
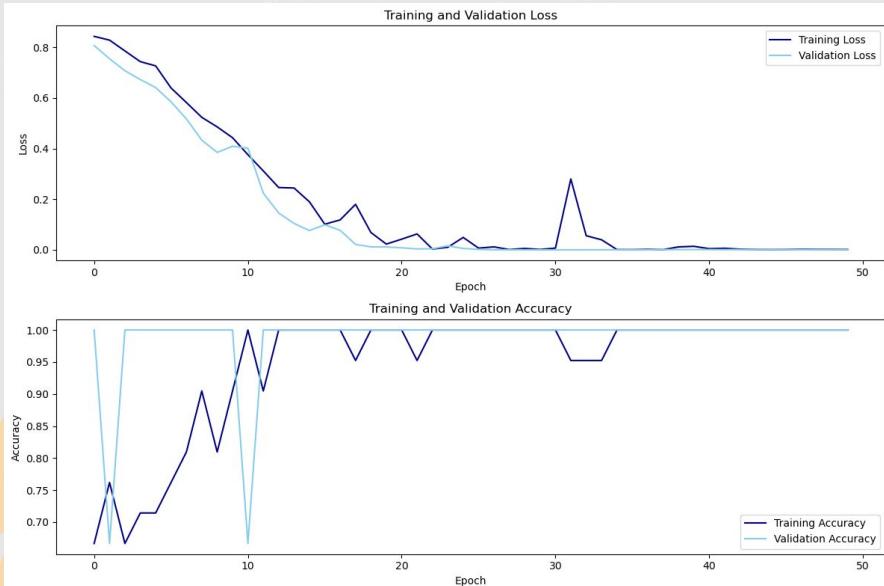
MODEL COMPARISON

| Model | Accuracy Score | Run Time HH:MM:SS |
|------------------------|----------------|----------------------|
| GRU Model (base model) | 100% | 0:03:40 |
| LSTM Model | 33.33% | 0:03:35 |
| GRU Model DO | 100% | 0:02:53 |
| LSTM Model DO | 66.67% | 0:03:03 |
| GRU Model ES | 100% | 0:04:00 |
| LSTM Model ES | 66.67% | 0:04:17 |
| GRU Model DO and ES | 100% | 0:03:19 |
| LSTM Model DO and ES | 100% | 0:03:17 |

GRU Model (base model)



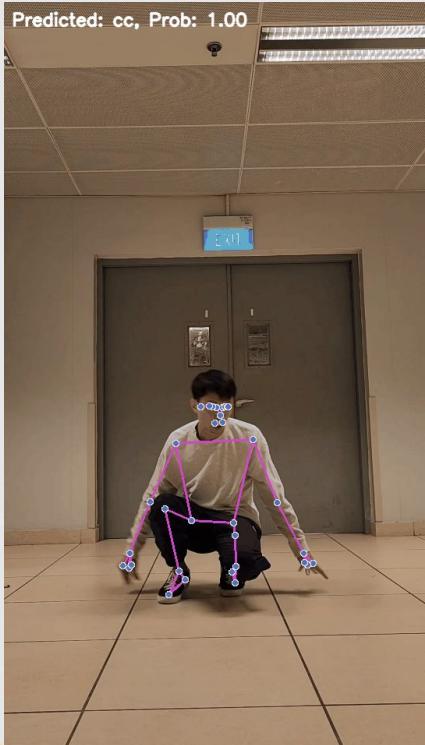
GRU Model with Dropout Regularization



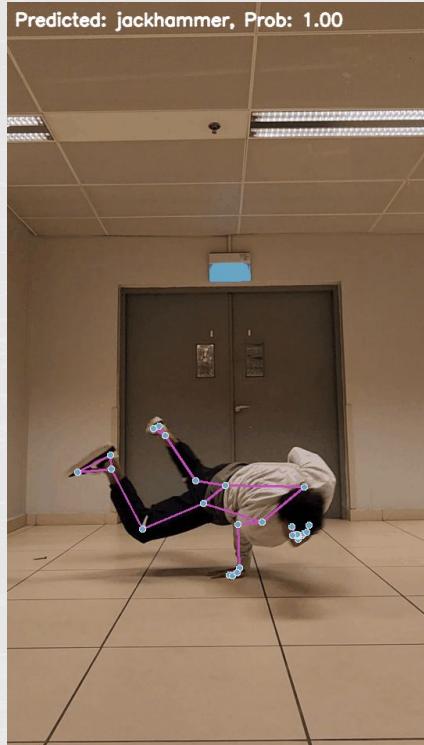
6

DEMO

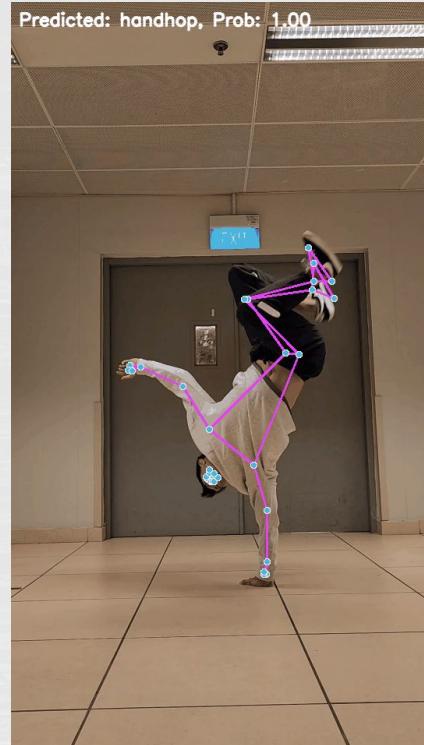
DEMO



CC



Jackhammer



Handhop



7

CONCLUSION RECOMMENDATION FURTHER IMPROVEMENTS

Conclusion



The model accurately identifying moves to help bboy judges detect instances of biting



This will assist corporations in selecting the right bboy or bgirl for potential sponsorship



The fairness and rewarding incentives will encourage bboys and bgirls to create more original moves

RECOMMENDATION



Event Organizers

Dance competitions and events can utilize this model to provide judges with valuable insights, helping them assess the originality of performances. Just like VAR system in soccer matches to detect fouls.



Corporate Sponsors

The marketing team of a company can utilize this model to identify dancers with exceptional originality for potential sponsorship opportunities.

FURTHER IMPROVEMENTS



Incorporate videos captured from various angles



Diversify move durations during execution



Extend the dance moves database to encompass various hip-hop styles, including popping and locking



Develop a user-friendly app for bboys and bgirls, encouraging the creation of original dance moves

THANK YOU!

Questions?

