

A high-contrast, black and white photograph of a person's hands clapping chalk powder over a barbell. The hands are positioned above the barbell, with a large cloud of white powder suspended in the air between them. The barbell is visible as a horizontal line across the lower part of the frame. The background is dark and out of focus, showing parts of a gym setting.

Pose Detection

Logan Lundgren
Data Analytics Capstone Project

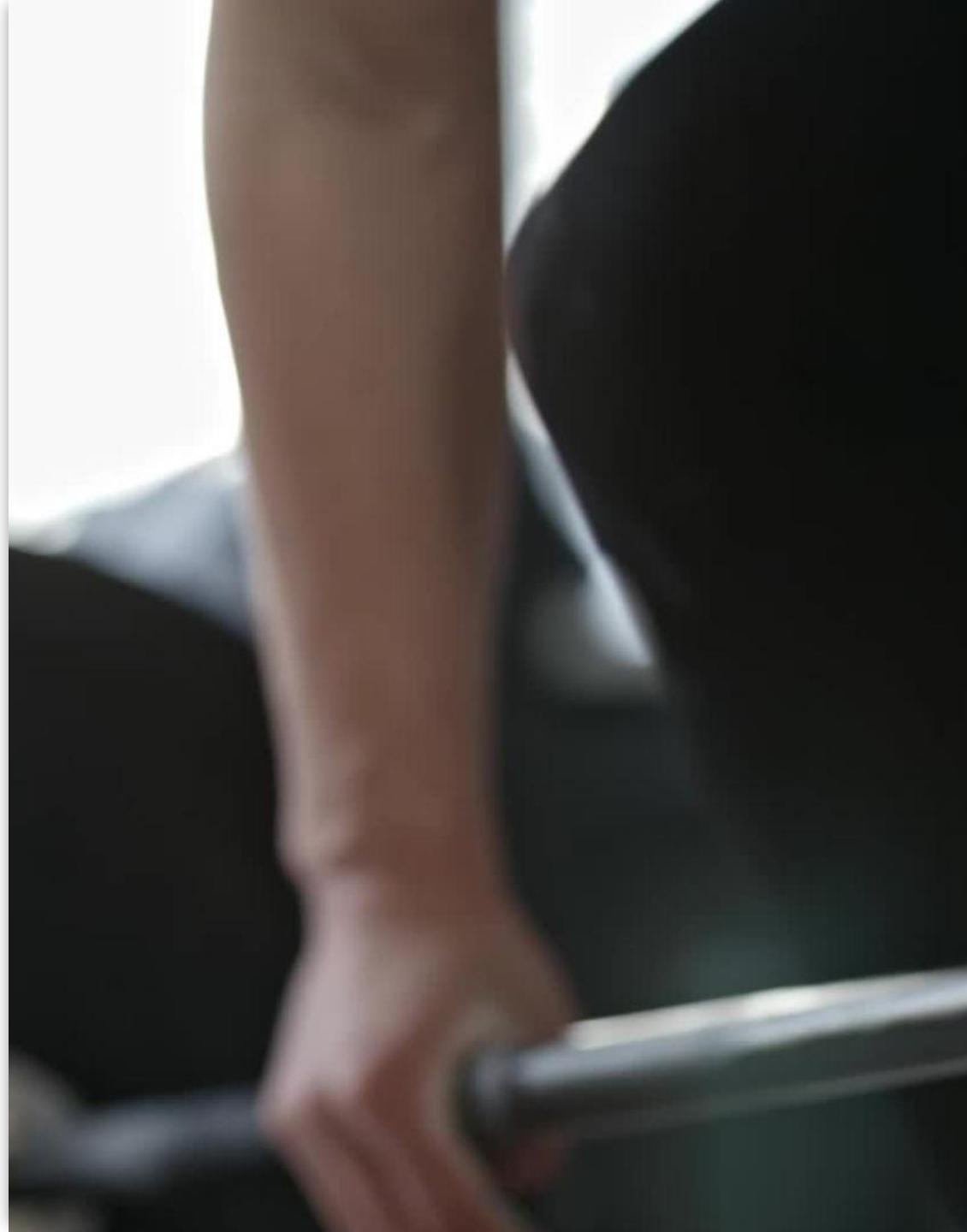
Agenda

- Project Objectives

Project Objectives

Create a ML system that:

- Detect exercises in real-time
- Classify exercise: squat, bench, deadlift, curls, rows (potentially more if time)



Roadmap

Phase	Task	Outcome
1. Data Modeling	Gather exercise videos	Create a clean labeled dataset
2. Pose Detection	Use MediaPipe to detect body movements	Adds labeling to the videos
3. Calculated Variables	joint angles rules	Analyze form
4. Classification Model	Train a LSTM + random forest model to classify exercise	Provide real-time feedback

Dataset: "Workout/Exercises Video"

- **Video data for the following exercises:**

- Bicep Curl
- Barbell Bench
- Squat
- Deadlift
- T Bar Rows
- ...

What is MediaPipe

MediaPipe is an open-source library by Google for **real-time pose estimation**.

Pre-trained movement detection Model: No need for large-scale training
Tracks 33 Keypoints: More detailed than other open source models



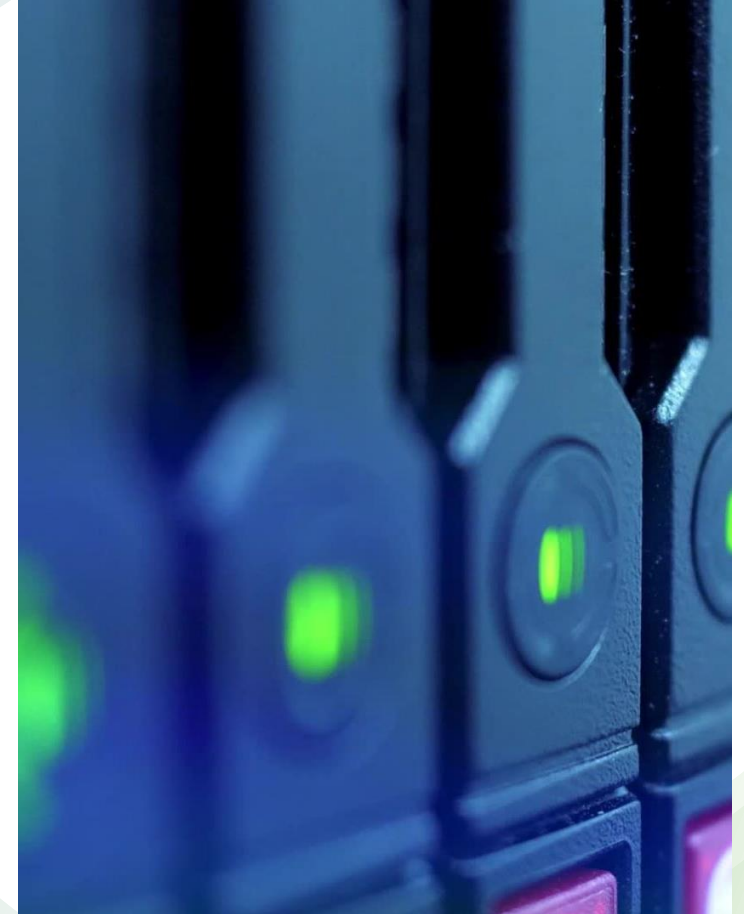
Data Modeling

Data Preprocessing

- Sources:
 - 22 folders, 250+ videos
 - Extracted keypoint data from videos using MediaPipe

Key Data Processing Steps:

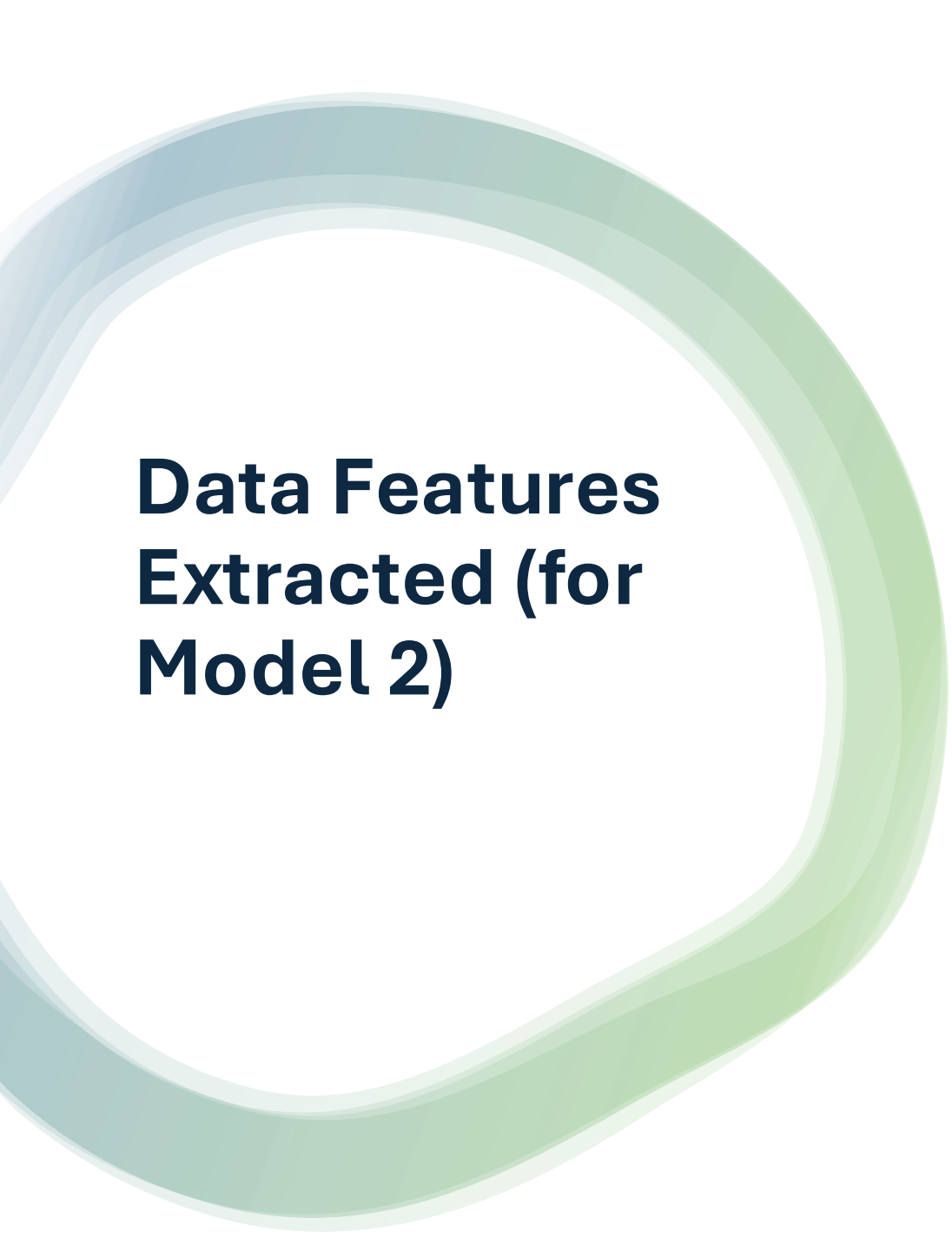
- Store Data in Google Drive
- Extracted pose keypoints (X, Y, Z, visibility) from each frame
Stored pose data in **CSV format** for model training
- Setup / Design Supabase Database
- Import data into Supabase



Challenges in Data Processing

- Challenges
 - Processing power (90 + minutes to run the script)
 - Troubleshooting the script to iterate through the folders correctly
 - Uploading the data to supabase



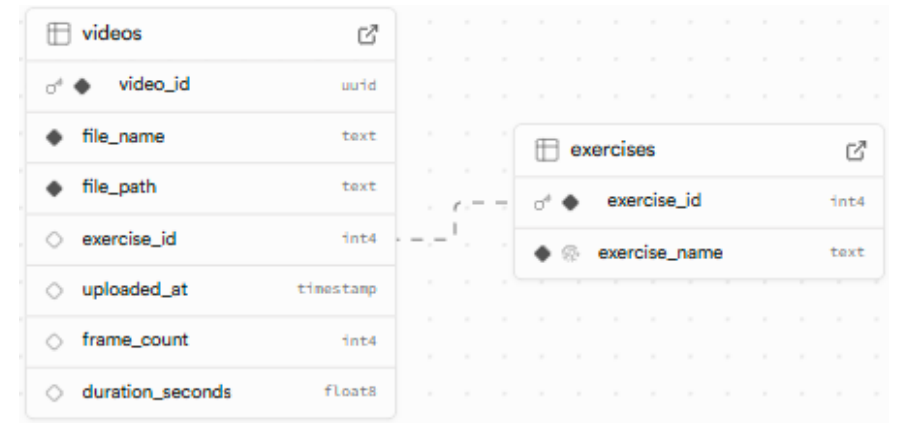


Data Features Extracted (for Model 2)

- **Pose Landmark Data (CSV Format):**
 - **33 landmarks per frame** (X, Y, Z coordinates + visibility)
 - Key joint movements tracked: **shoulders, elbows, knees, wrists**
- **Feature Engineering Plan:**
Compute joint angles

Database (Supabase)

- CREATE TABLE
- video_frames
- (frame_id SERIAL PRIMARY KEY,
- video_id UUID REFERENCES videos(video_id) ,
- frame_number INT NOT NULL,
- timestamp_seconds FLOAT NOT NULL,
- x0 FLOAT, y0 FLOAT, z0 FLOAT, visibility0 FLOAT,
-
- x32 FLOAT, y32 FLOAT, z32 FLOAT, visibility32 FLOAT,



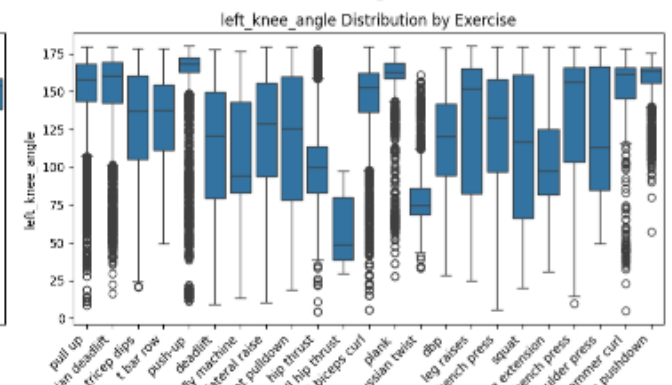
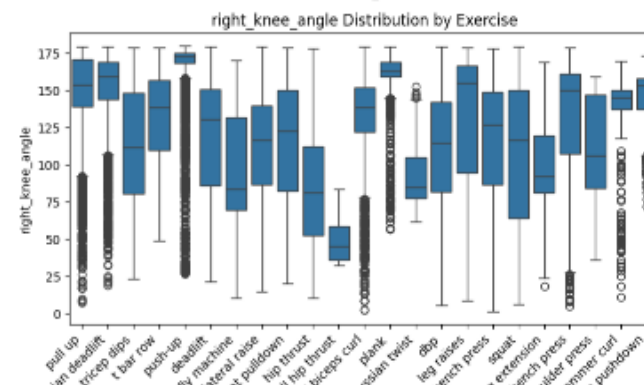
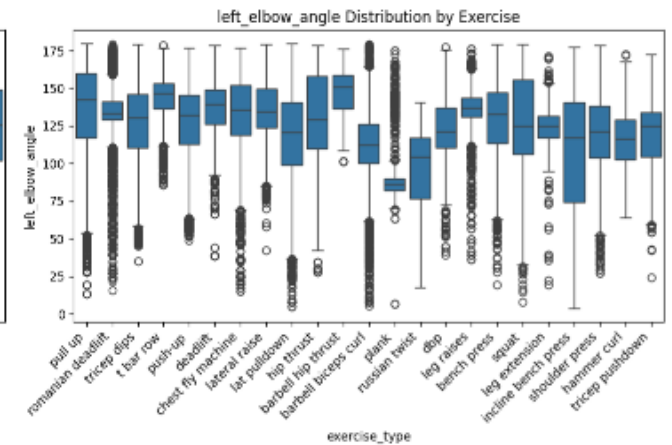
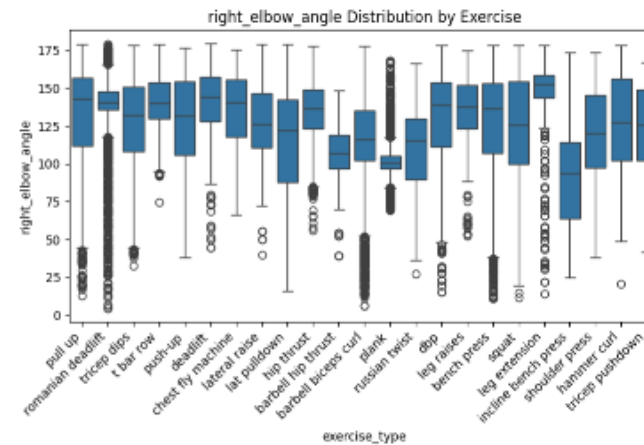
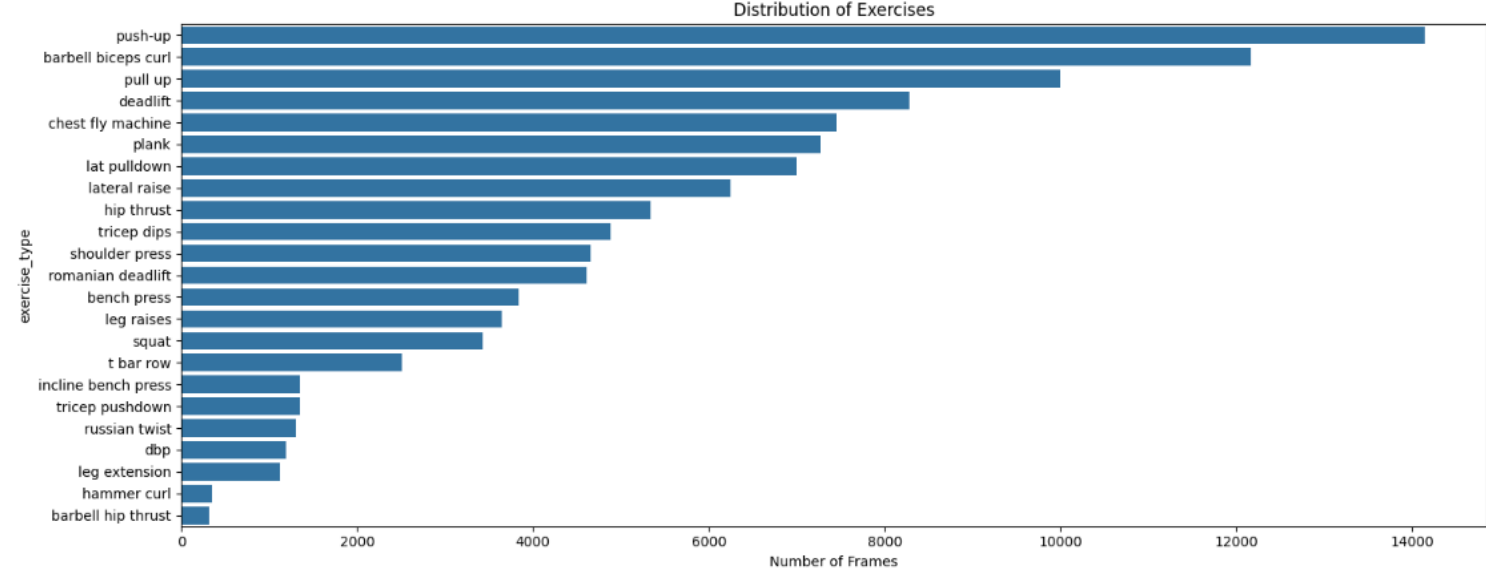
Exploratory Data Analysis (By Frame)

Exercise types found:

exercise_type	
push-up	14141
barbell biceps curl	12165
pull up	10000
deadlift	8276
chest fly machine	7447
plank	7267
lat pulldown	7000
lateral raise	6245
hip thrust	5337
tricep dips	4885
shoulder press	4654
romanian deadlift	4609
bench press	3835
leg raises	3643
squat	3428
t bar row	2506
incline bench press	1350
tricep pushdown	1346
russian twist	1305
dbp	1189
leg extension	1129
hammer curl	357
barbell hip thrust	313

Name: count, dtype: int64

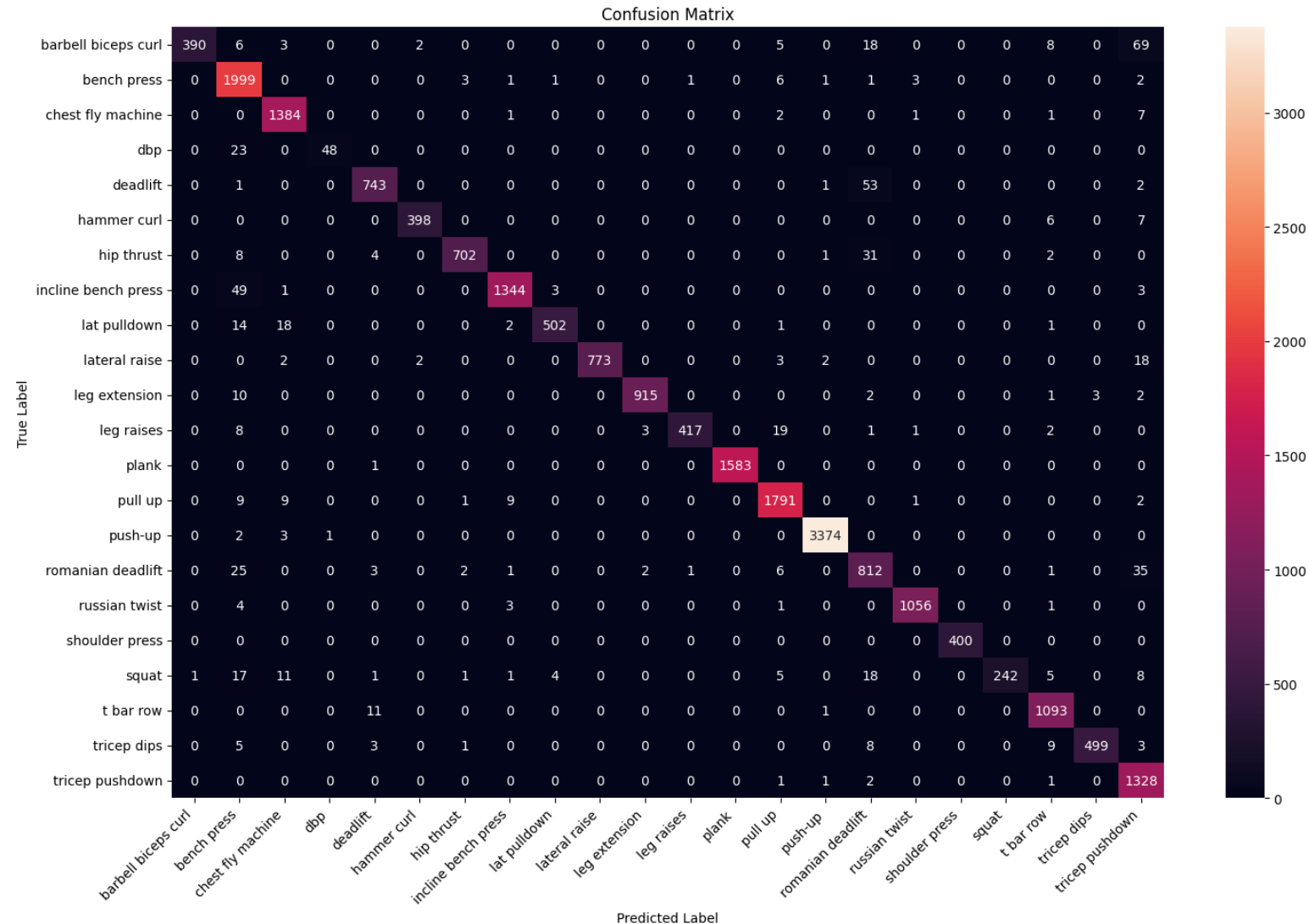
Total frames: 112427
 Number of exercises: 23
 Calculating joint angles...



Model: Random Forest (Frames)

Classification Report:

	precision	recall	f1-score	support
barbell biceps curl	1.00	0.78	0.87	501
bench press	0.92	0.99	0.95	2018
chest fly machine	0.97	0.99	0.98	1396
dbp	0.98	0.68	0.80	71
deadlift	0.97	0.93	0.95	800
hammer curl	0.99	0.97	0.98	411
hip thrust	0.99	0.94	0.96	748
incline bench press	0.99	0.96	0.97	1400
lat pulldown	0.98	0.93	0.96	538
lateral raise	1.00	0.97	0.98	800
leg extension	0.99	0.98	0.99	933
leg raises	1.00	0.92	0.96	451
plank	1.00	1.00	1.00	1584
pull up	0.97	0.98	0.98	1822
push-up	1.00	1.00	1.00	3380
romanian deadlift	0.86	0.91	0.89	888
russian twist	0.99	0.99	0.99	1065
shoulder press	1.00	1.00	1.00	400
squat	1.00	0.77	0.87	314
t bar row	0.97	0.99	0.98	1105
tricep dips	0.99	0.95	0.97	528
tricep pushdown	0.89	1.00	0.94	1333
accuracy			0.97	22486
macro avg	0.97	0.94	0.95	22486
weighted avg	0.97	0.97	0.97	22486



Exploratory Data Analysis (By Video)

Number of unique videos: 377
Number of unique exercises: 23

Exercise Distribution (number of videos per exercise):

exercise_type	count
push-up	44
bench press	36
incline bench press	33
barbell biceps curl	30
deadlift	29
lat pulldown	26
lateral raise	24
pull up	21
leg extension	16
squat	15
chest fly machine	15
tricep pushdown	14
tricep dips	14
hammer curl	12
leg raises	11
t bar row	8
shoulder press	7
russian twist	5
dbp	5
romanian deadlift	4
hip thrust	4
plank	3
barbell hip thrust	1

Name: count, dtype: int64

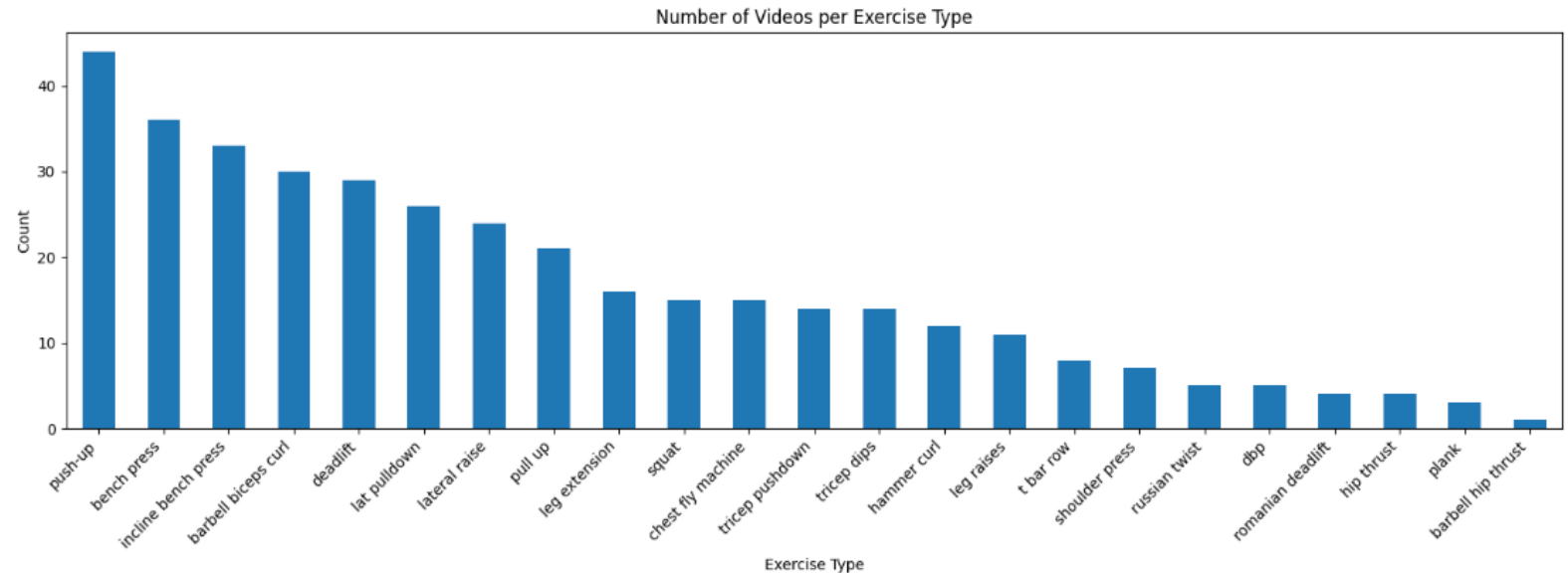
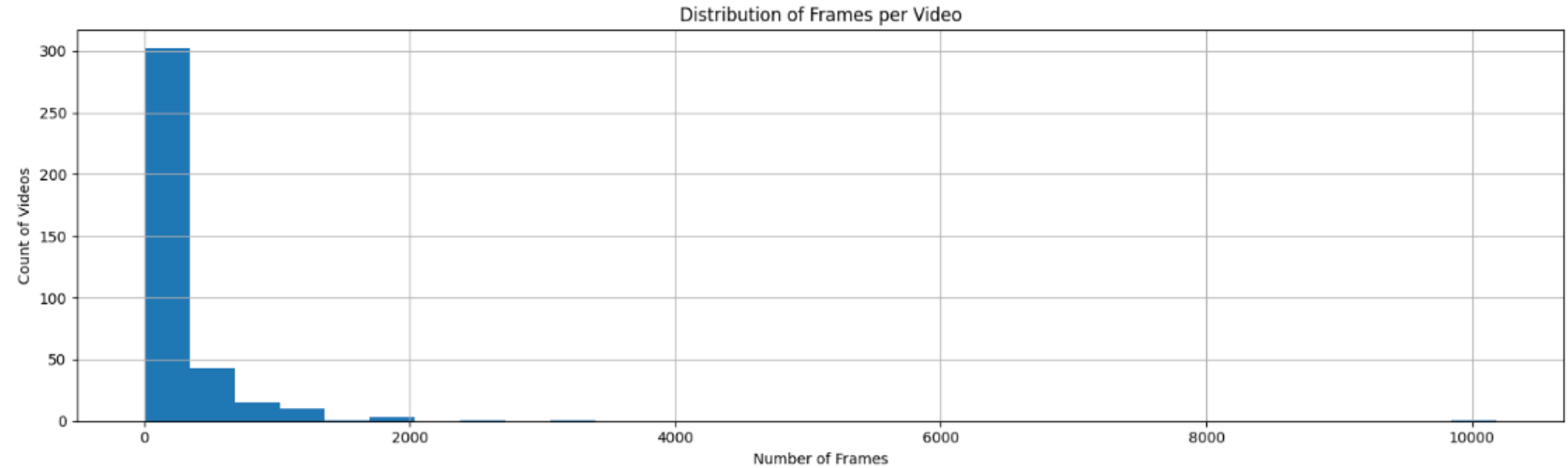
Frames per Video Statistics:

count	377.000000
mean	298.214854
std	613.627944
min	3.000000
25%	93.000000
50%	162.000000
75%	292.000000
max	10182.000000

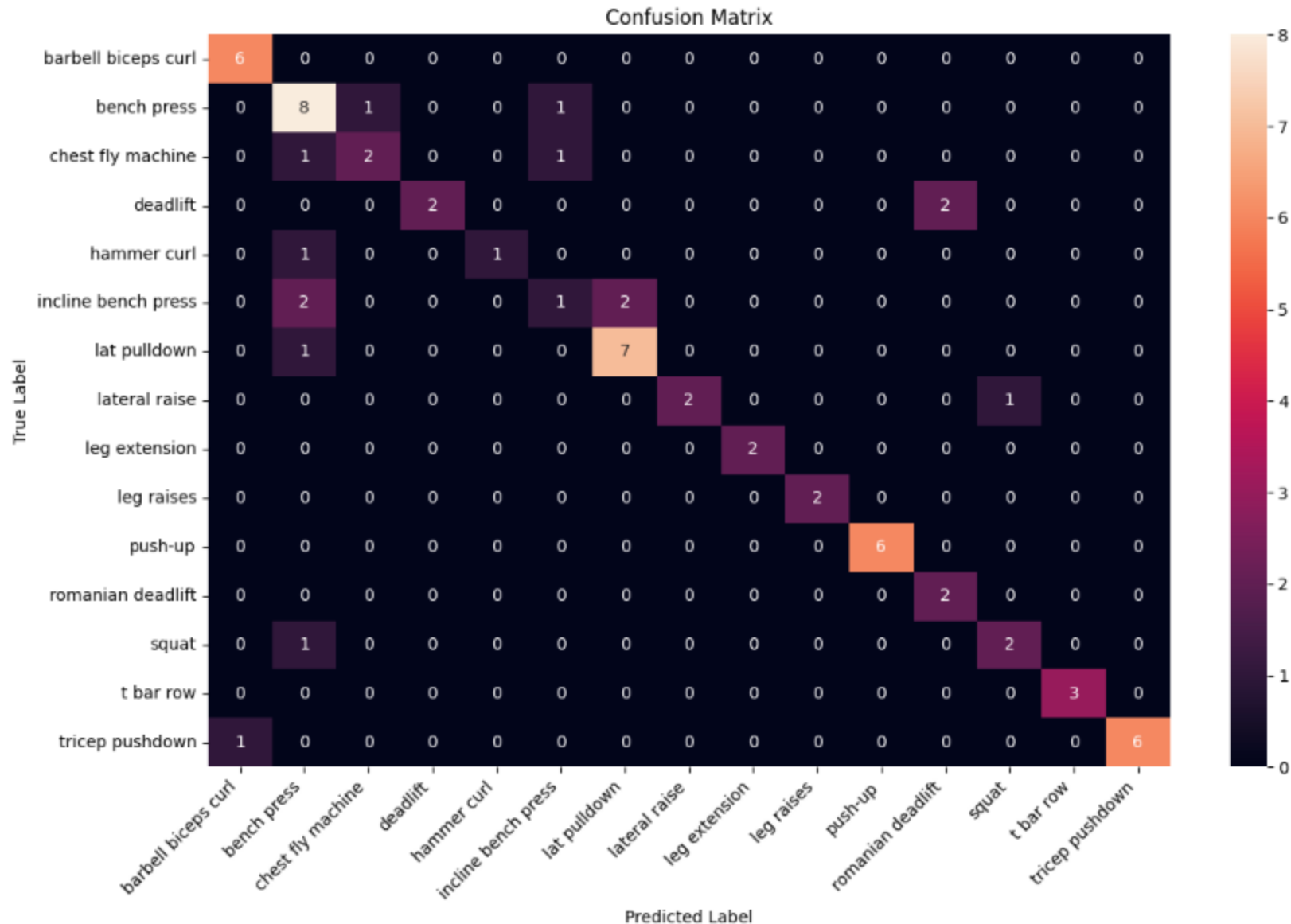
dtype: float64

Number of coordinate columns: 133

Number of visibility columns: 33



Random Forest (Full Video)



CNN Model Output (Fail)

- Not good
- This would require more data
- Could work frame by frame, but random forest already worked

Powerbi // tableau

