Task 1: Form Correctness Detection Using Pose Estimation

1. Posture Rules Used

Rule 1: Elbow Angle (Bicep Curl)

- The angle at the elbow is computed using the shoulder–elbow–wrist keypoints.
- Ideal range: **40°–160°**
- < 40° → Over-flexion
- 160° → Locking out elbow

Rule 2: Wrist–Shoulder Alignment (Lateral Raise)

- Wrist y-coordinate must align with shoulder y-coordinate within ±20 pixels.
- Ensures the user lifts arms parallel to the ground.

Rule 3: Back Posture (Spinal Alignment)

- Compares shoulder x-coord with hip x-coord.
- Offset > 25 px indicates leaning or poor posture.

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2. Logic Behind the Rules

Motion biomechanics research shows:

- **Elbow angle** determines bicep load and safety.
- **Wrist–shoulder alignment** ensures shoulder abduction at correct height.
- **Back posture** prevents compensatory leaning which may cause injury.

The system uses:

- **Keypoint estimation → time-series smoothing → angle calculation → rule evaluation → overlay feedback**

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3. Challenges Faced & Solutions

Challenge 1: Noisy Keypoints

- Solution: Implemented **moving average smoothing** over 5 frames.

Challenge 2: Varying Body Positions

- Used relative geometric rules instead of absolute pixel thresholds.

Challenge 3: Multiple Persons in Frame

Problem: MediaPipe returns only one pose (the most prominent).

Solution Options:

1. **Use MediaPipe MultiPose** (still experimental).
2. **Use OpenPose** which supports multi-person detection natively.
3. If multiple bodies are detected:
    - Choose the one closest to camera (largest bounding box).
    - OR detect all people and track IDs using pose embeddings.

You can document that **your current system is single-person only**, but scalable.

Conclusion

This project demonstrates a practical rulase-based exercise form evaluation system using pose estimation and geometric logic. The pipeline can be extended to ML models for automated scoring.