

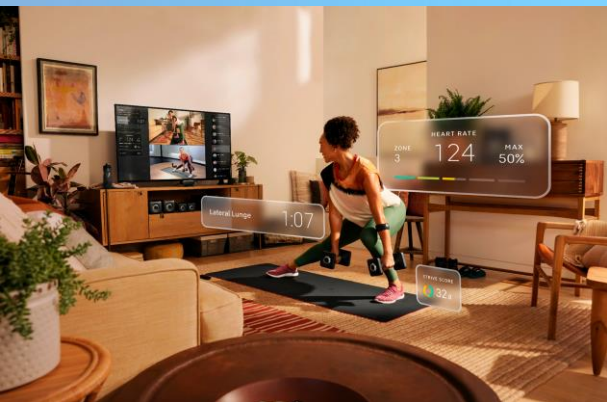


Developing an Embedded Vision AI Powered Fitness System

Sanjay Nichani

VP, Artificial Intelligence & Computer Vision

Peloton Interactive

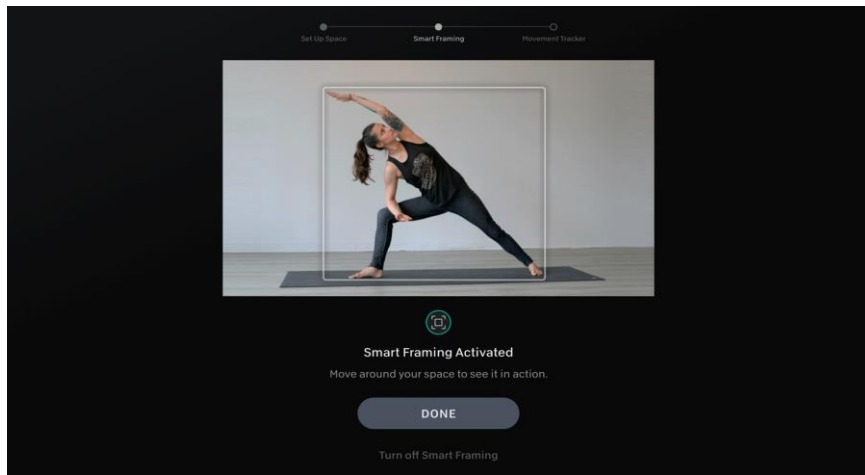


The Peloton Guide

*Transform any television in your home into
an immersive boutique fitness studio
powered by AI*

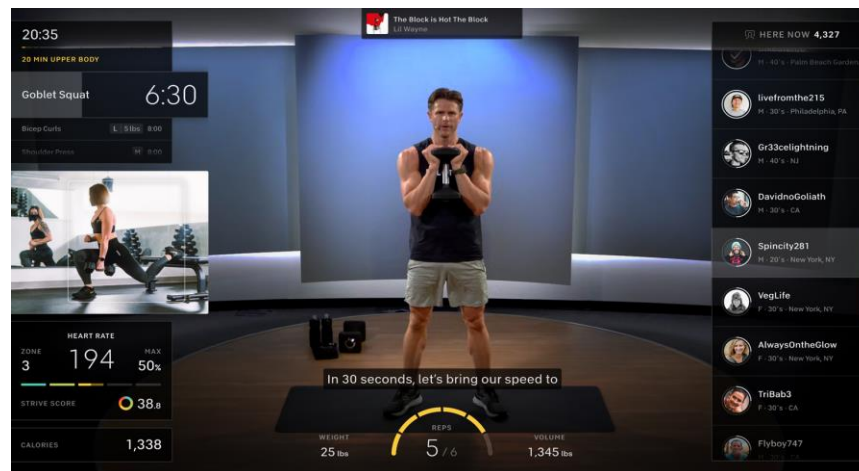


Computer Vision Features



Smart Framing and Self Mode

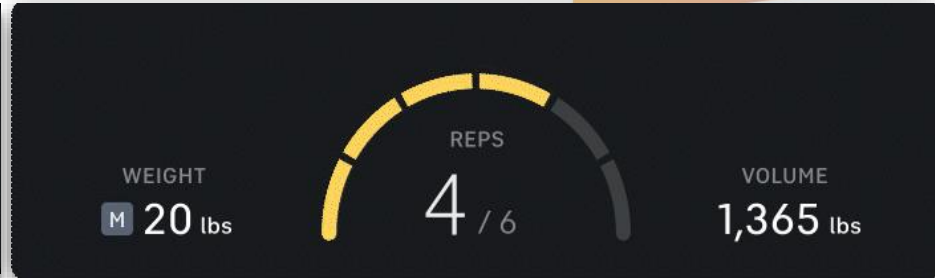
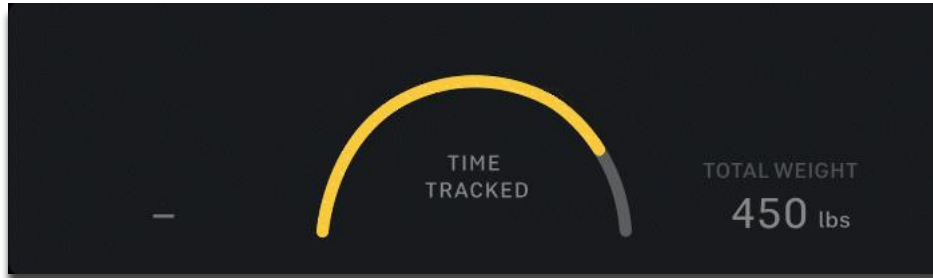
Guide digitally pans and zooms so you can see yourself on screen and compare your form to the instructor's form.



Activity Recognition and Movement Tracker

Tracks members and recognizes their activity, as they follow along with instructors to complete moves in the class.

Computer Vision Features



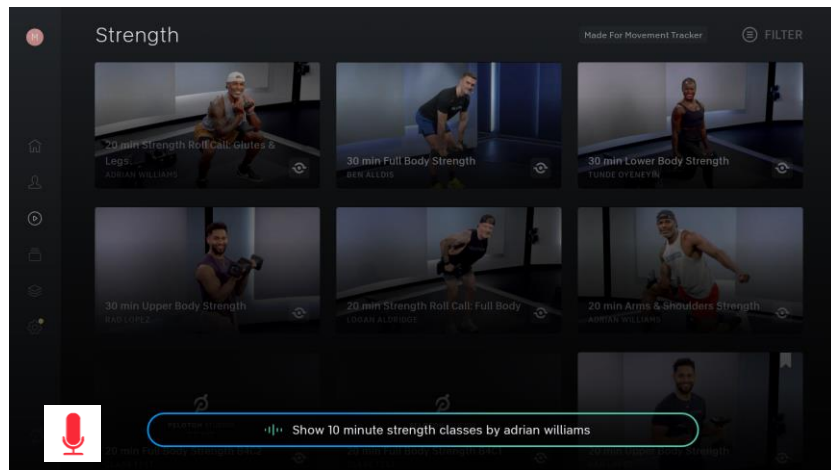
Time Tracked Moves

Allows user to follow exercise led by instructor and receive real-time credit for completing movement.

Rep Tracker

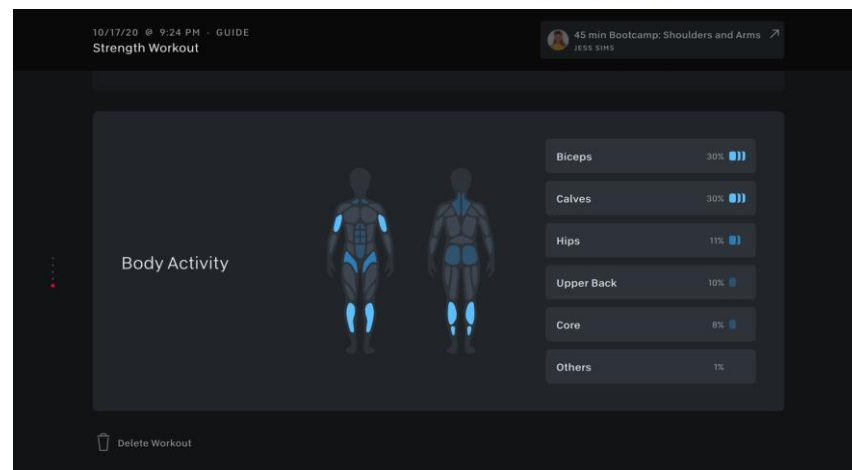
Rep Tracking not only checks that user is performing the correct exercise, but also counts how many reps are done.

Other Machine Learning Features



Voice Control

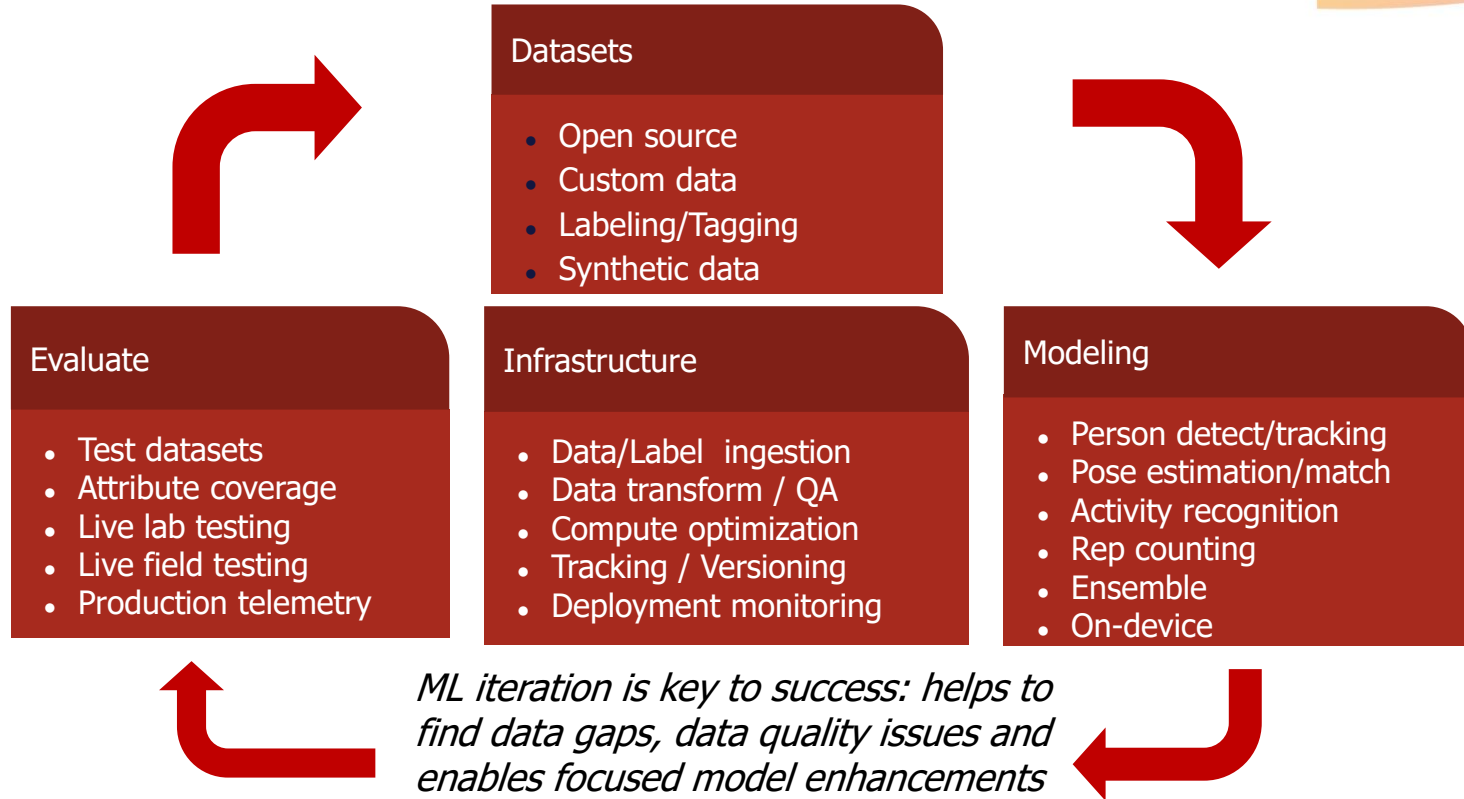
Help members easily navigate content, find classes, control weights and manage their workouts with voice → fast and hands free.



Body Activity

Body Activity shows the users various muscles worked out and provides personalized full body workout suggestions.

Machine Learning Flywheel



Real-world datasets

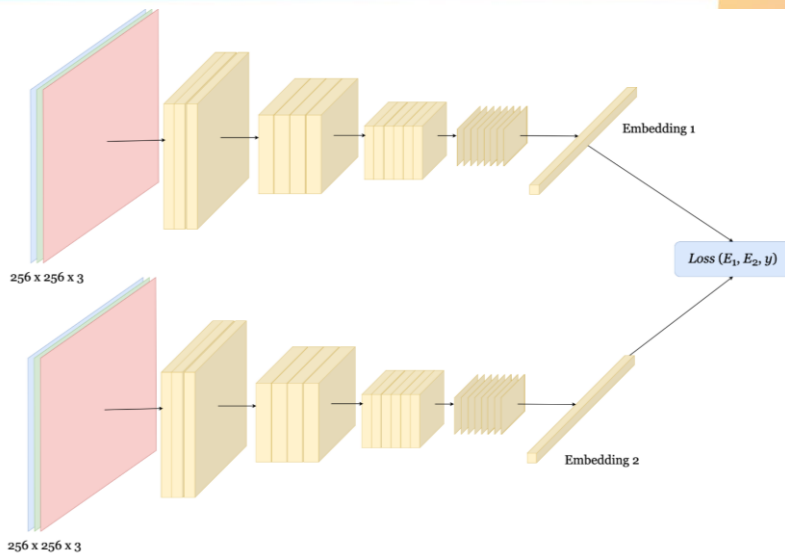


Synthetic datasets



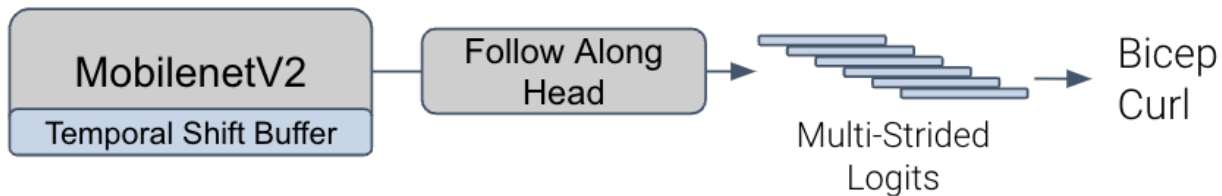
Deep Match

Template matching using metric learning



Deep Move

Action recognition with temporal shift buffers



Diversity Attributes for Metrics

01

Environmental attributes

- Background: walls, flooring, furniture, windows
- Lighting, shadows, reflections
- Other people, animals in the field of view
- Occlusion
- Equipment (mat, dumbbells)

02

Member attributes

- Gender, skin tone
- Body type
- Fitness level
- Disabilities
- Clothing

03

Geometric attributes

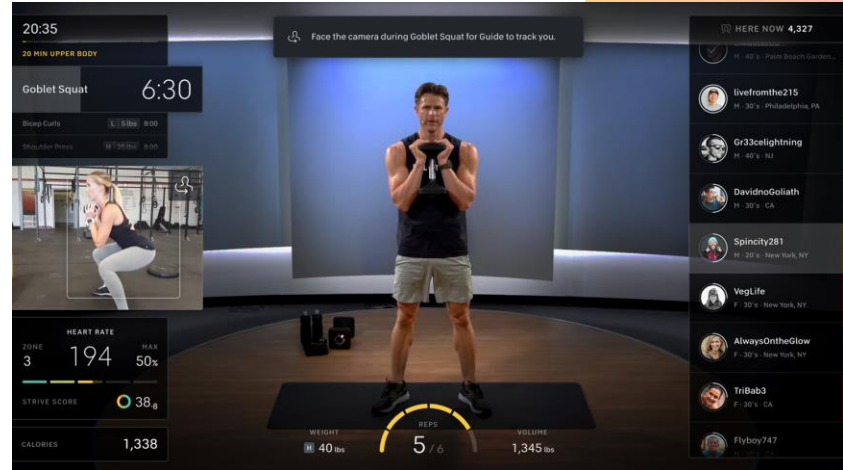
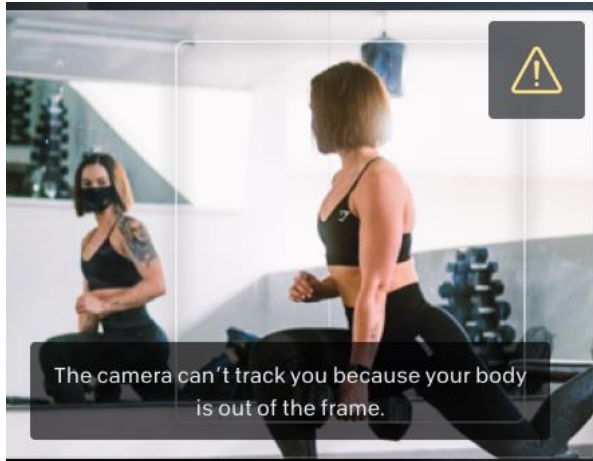
- Camera/Member relative placement
- Camera mounting Height
- Camera tilt
- Member orientation
- Member distance

Fairness Metric

Equality of opportunity: For a preferred label (specific exercise is being performed) and a given attribute, a classifier predicts that preferred label equally well for all values of that attribute. True Positive Rates are shown in table below.

Exercise	Median	Attribute: Body Type			Fitzpatrick Skin Tone			Gender	
		Underweight	Average	Overweight	1-2	3-4	5-6	Man	Woman
Crossbody Curl	97%	100%	100%	97%	100%	98%	100%	100%	98%
Squat	99.7%	100%	100%	100%	100%	100%	100%	100%	100%
Dumbbell Swing	96%	100%	96%	98%	98%	100%	97%	97%	100%

Robustness Driven through UI and Nudging



Edge cases nudging:

- Brightness
- Occlusion
- Camera tilt, distance
- Multiple people

Orientation nudging occurs in all time-based and rep tracking workouts to minimize inaccuracies due to occlusion.

Conclusion

- Rapid ML iteration helps find data gaps, data quality issues and enable focused model enhancements
- Diversity attributes are important to ensure balanced training, but also key to slice and dice performance
- ML and UI work together to ensure that member has a robust experience without introducing friction
- Both objective metrics focused on worst case performance + subjective metrics measurements are necessary to drive improvements



[The Peloton Guide](#)

[Peloton AI principles](#)

[Blazepose](#)

[Temporal shift module](#)

[Early stage recommender systems](#)

[Context aware recommender systems](#)

[User experience platform for connected fitness](#)