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MODEL OPTIMIZE CONTROL

Data Driven Education and Athletics Outreach

Progress - Q2/5Y

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Affiliate Professor
Brigham Young University

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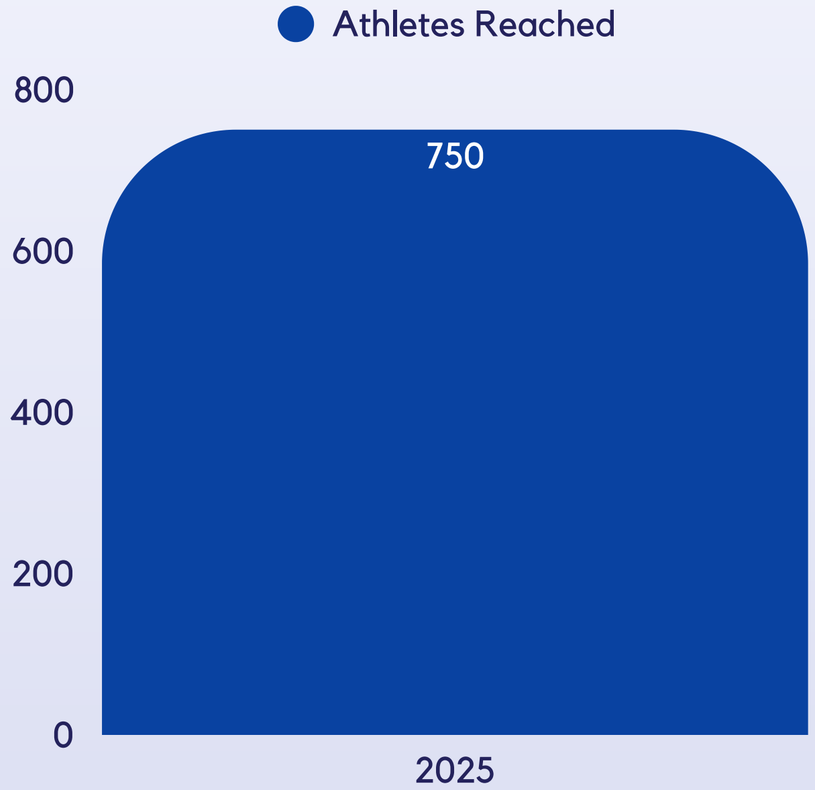
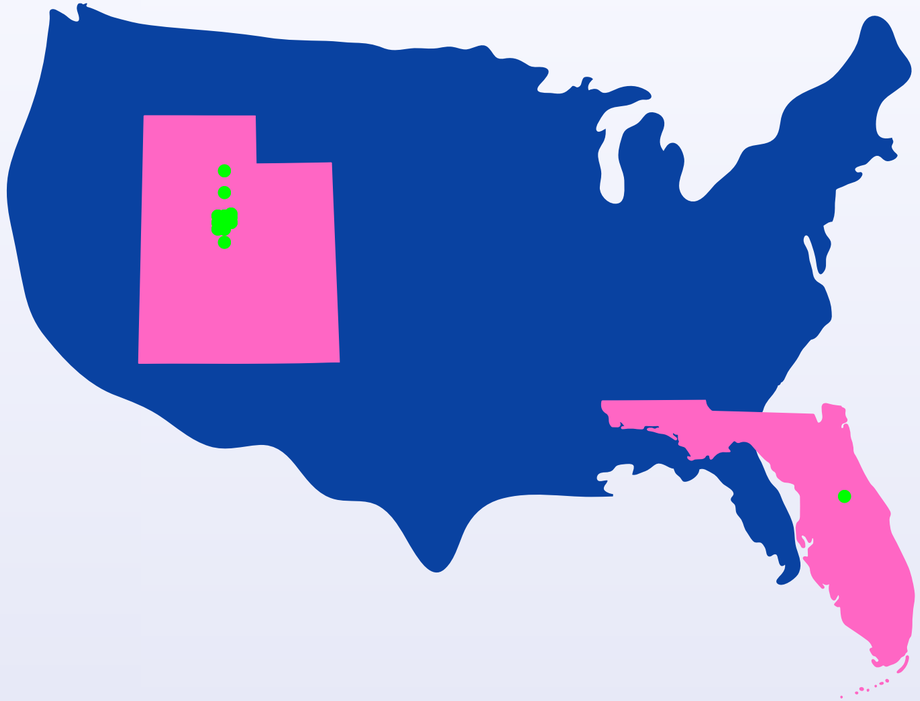
750+ Athletes Reached





19 TEAMS Visited

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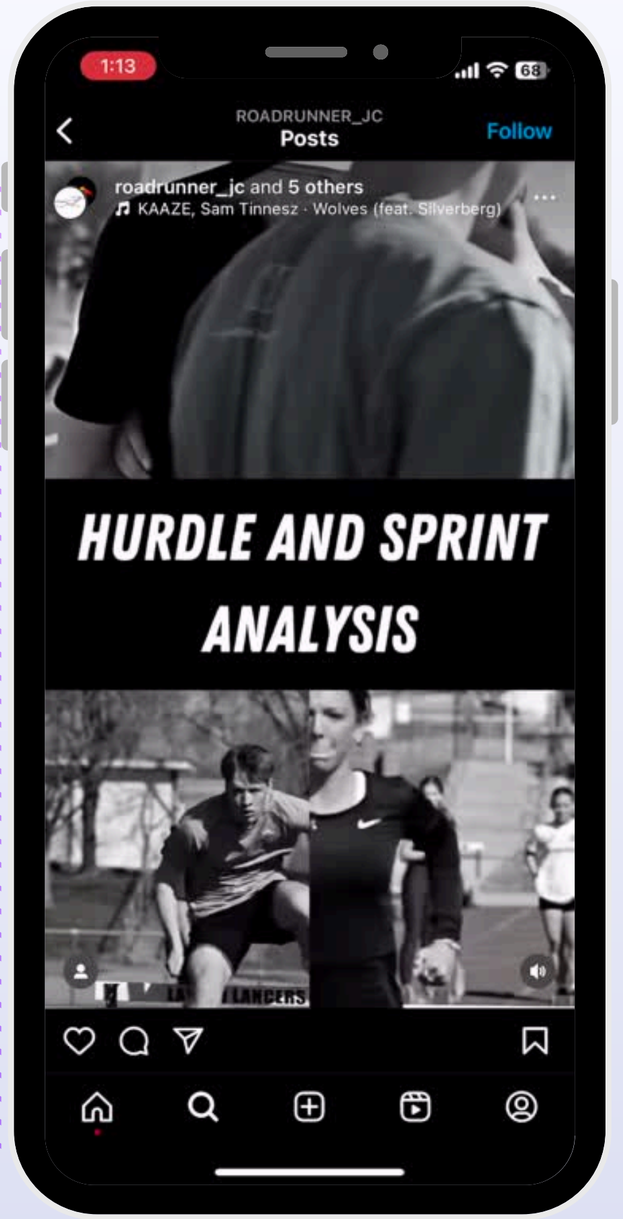

Outreach Program

- Analyze athlete performance videos and data
- Review individual results and insights
- Prepare and present personalized and team recommendations
- Provide data-driven training guidance
- Present on engineering education and career pathways
- Conduct individual athlete performance reviews

Coaches Feedback

“Thank you so much again for all your work and willingness to come help! This information is seriously so beyond valuable and you have such a gift of really wanting to help athletes and coaches get better. A couple of them commented on the time you take to really help explain to them so I just wanted to let you know how much I appreciate. “

-Coach Jamie West

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Distance

McKenna & Nathan

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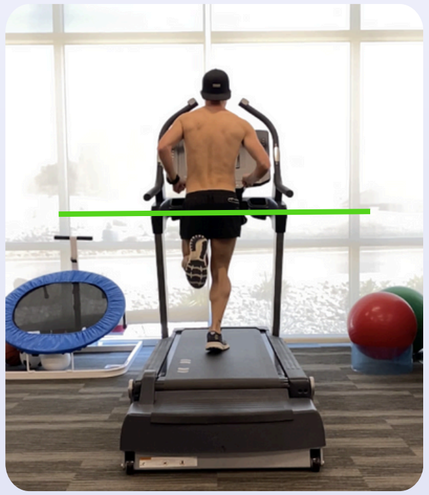
Appropriate (Male = 3-5, Female = 5-7)

Mild Drop

Excessive Drop



Lateral Pelvic Tilt

- Major predictor of injury
- Automated measurement
- Total of 14 feature measurements

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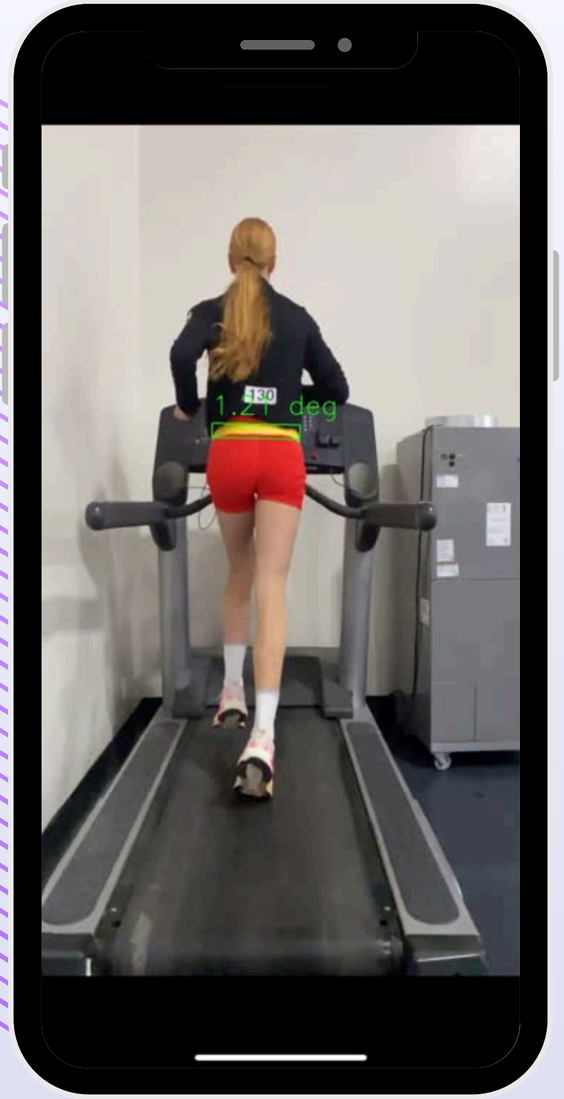

Hip Dip Analysis

- Detects colored band
- Near-real time mobile processing

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Discus

Heather & Creed

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Discus Throw Stages

Preparation

Single Support Entry

Zero Support/ Flight

Single Support Transition

Double Support Delivery

Reverse Out

Exit

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Discus Analysis Roadmap

Completed

Research

Literature review and choose feature measurements

App & Methods

Calculate trunk angle at entry point (X and Z angles)

In Progress...

Multi-Camera System

Catch covered areas from camera view

Finalize Methods

Orbit path, hip depth, seperation/torsion

Display in Applicaiton

Data display, interactive framework, AI integration

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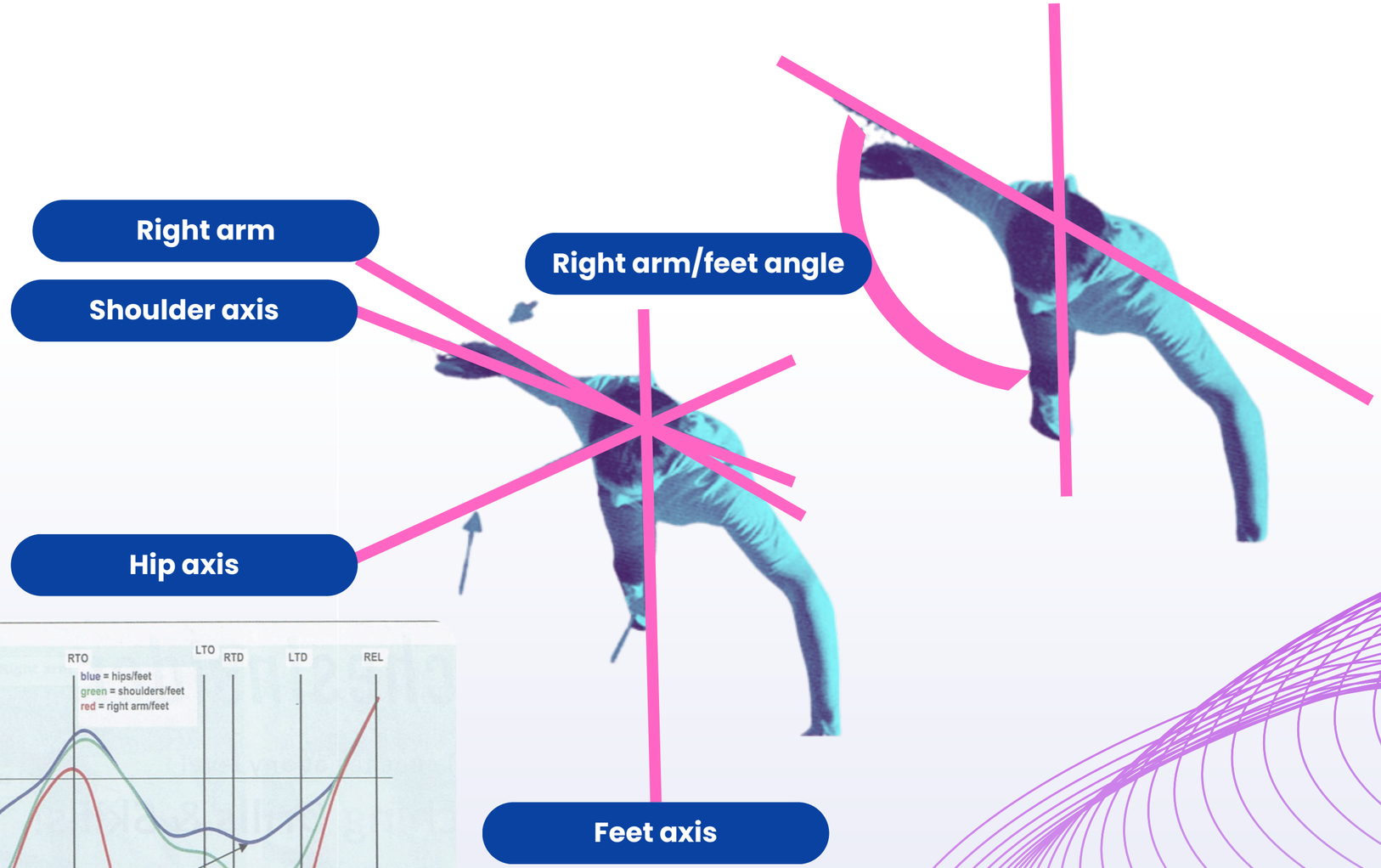
Discus - Future Metrics

“To throw the discus far you have to understand the concept of separation between the upper and lower body.” – Elite Throws Coach Brian Bedard



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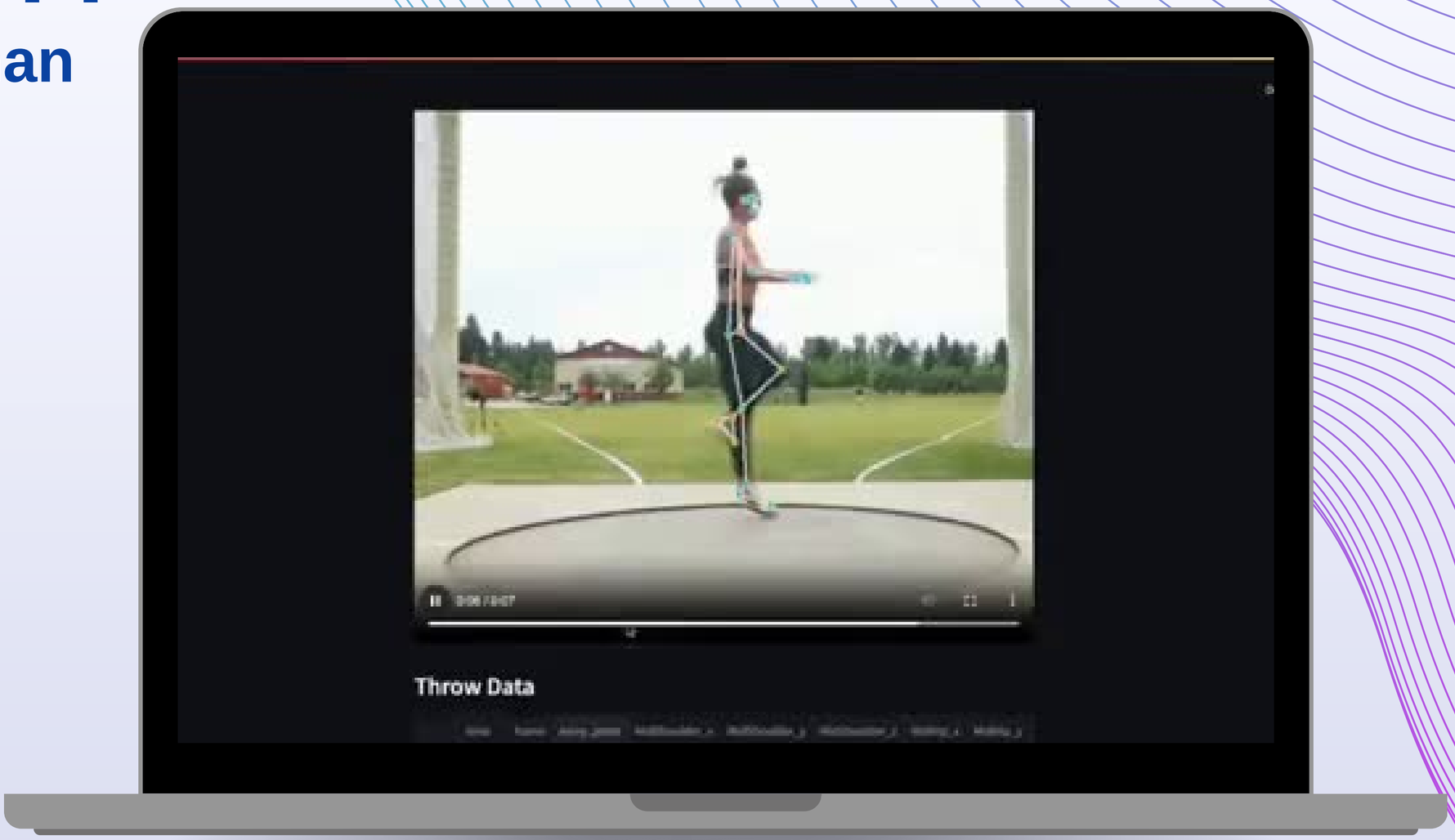
Discus App

Valarie Allman

2x Olympic Gold Medalist



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Hurdles

Violet &
Davin

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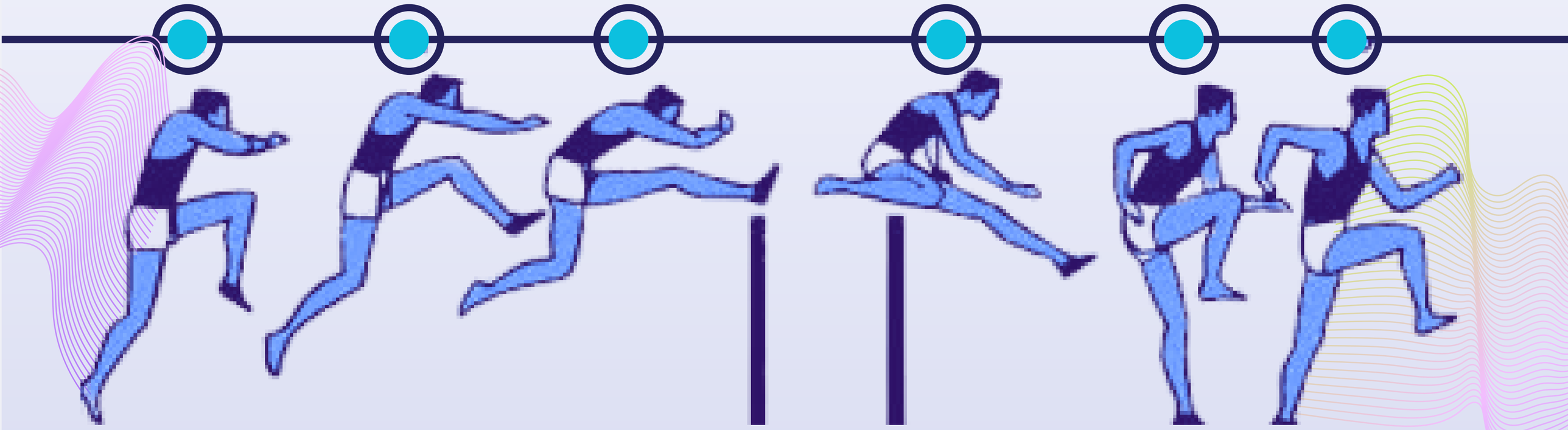
Hurdle Stages

Take off

Hurdle Clearance

Touchdown



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Hurdle Analysis Roadmap

Completed

Streamlit App

Base analysis app adapted to hurdles and hurdle elements researched

Video Analysis

Max knee height recorded and analyzed

In Progress...

Feature Methods

Rank order by importance with guidance from Coach West

Adjust & Improve

Gather feedback from coach and athlete and adjust

Display in Applicaiton

Data display, interactive framework, AI integration

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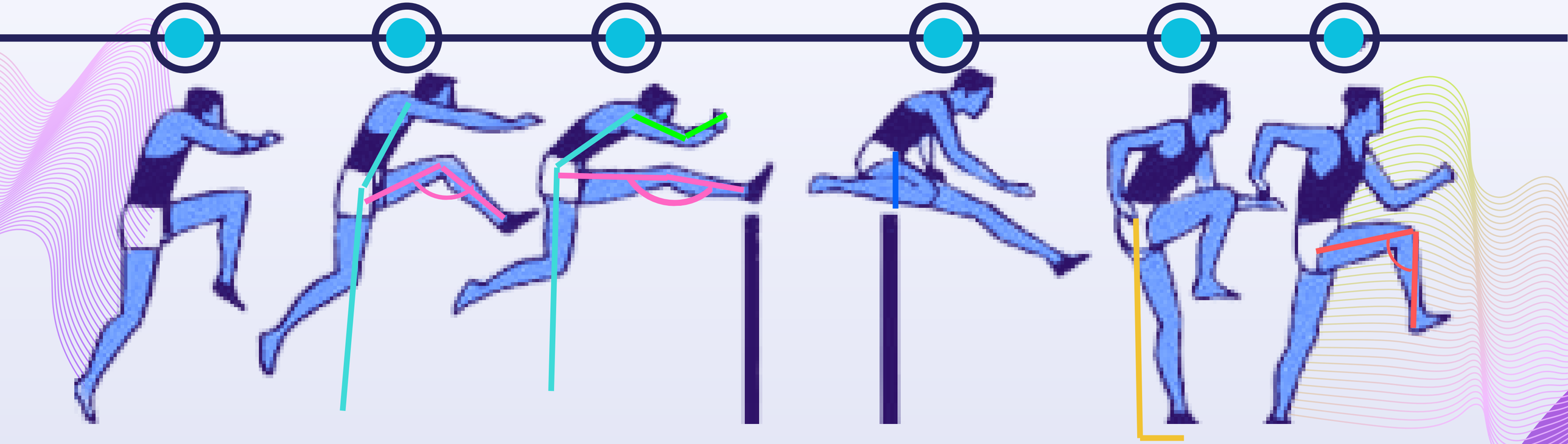
Take off

Hurdle Clearance

Touchdown



Take Off Trunk Angle

Lead Knee Agnle

Lead Elbow Angle

COG Height Above Hurdle

Horizontal Distance From COG to Touchdown

Trail Knee Angle after Touchdown

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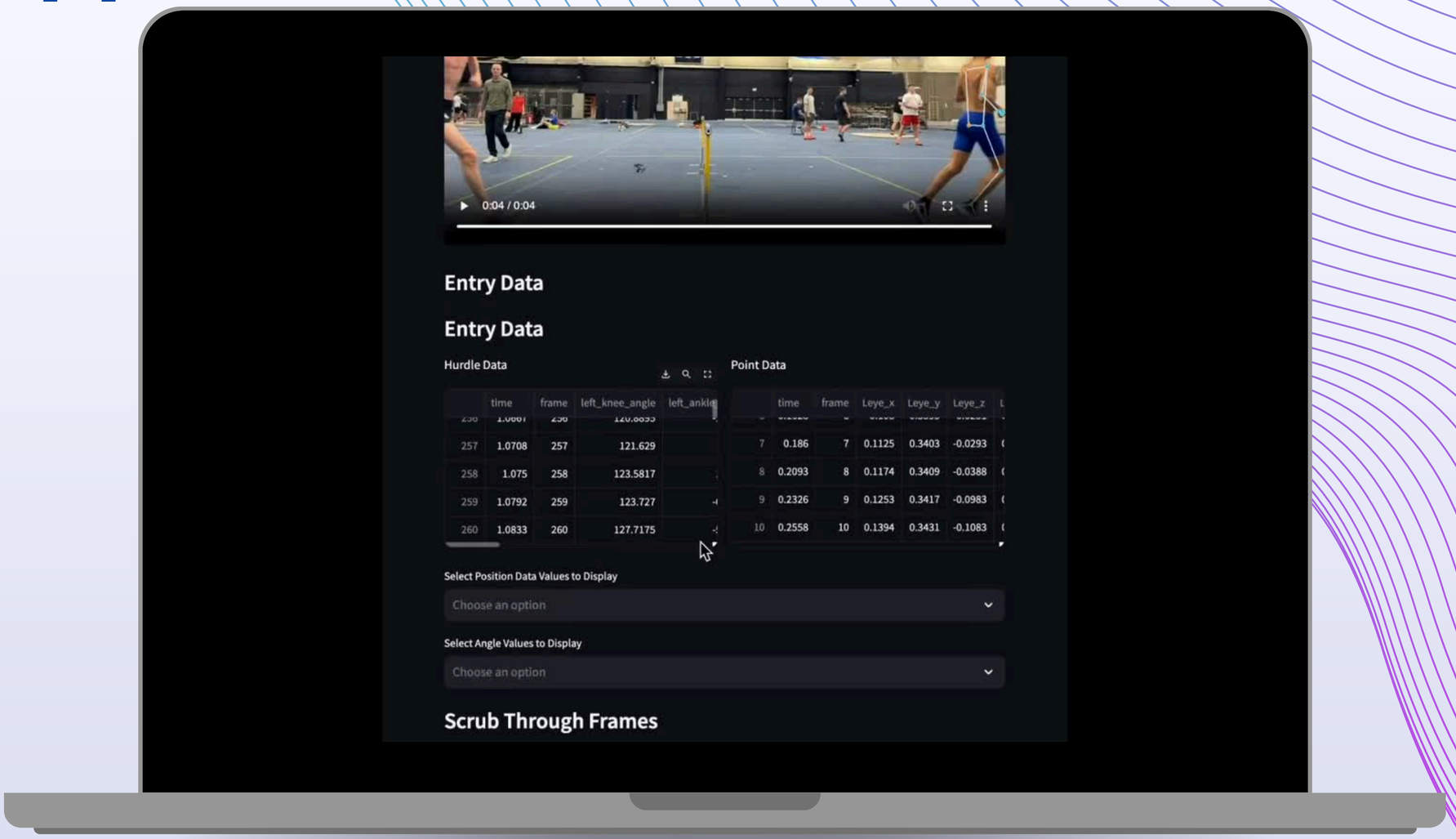
Hurdle App



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Sprints

Dallin & Zarek

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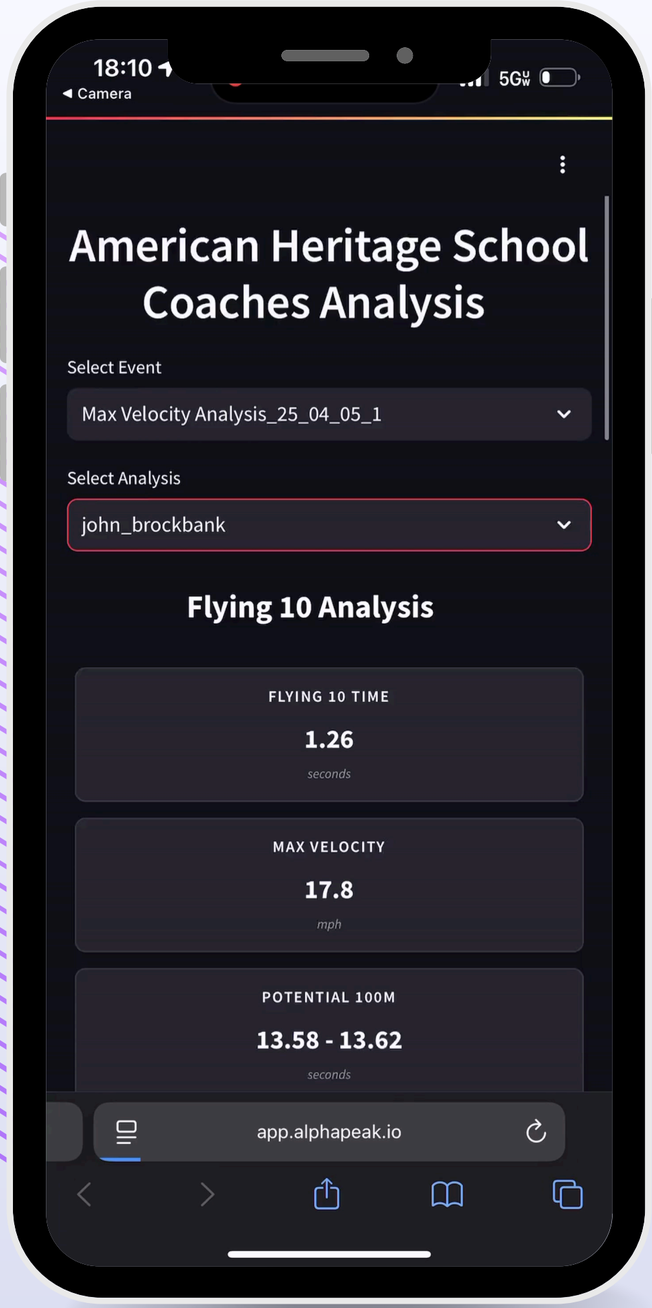

Sprint Analysis

- Biomechanics and Velocity data measured
- Analysis working well
- Processing completely mobile
- Accuracy issues calculating distance/velocities

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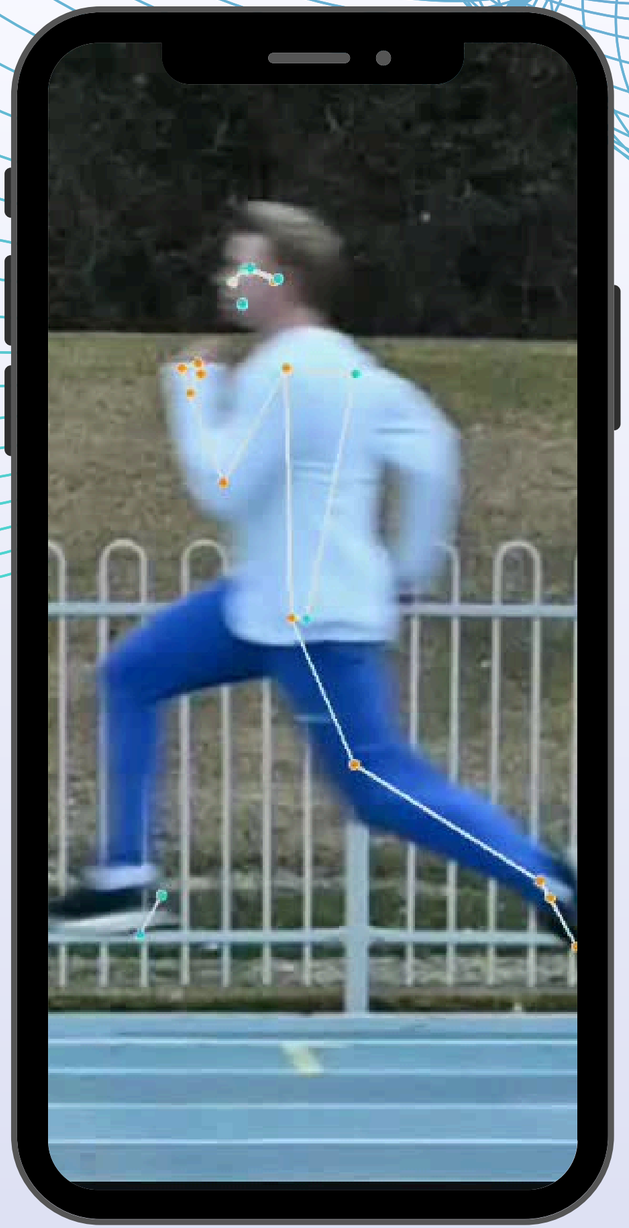
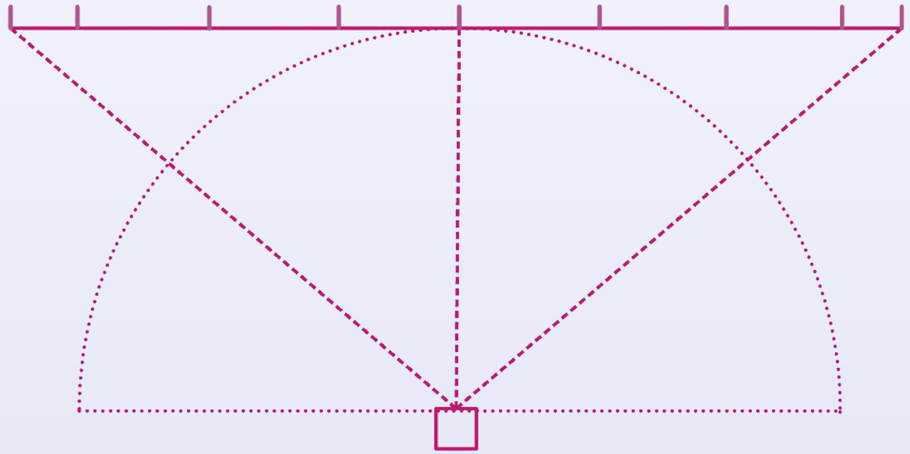


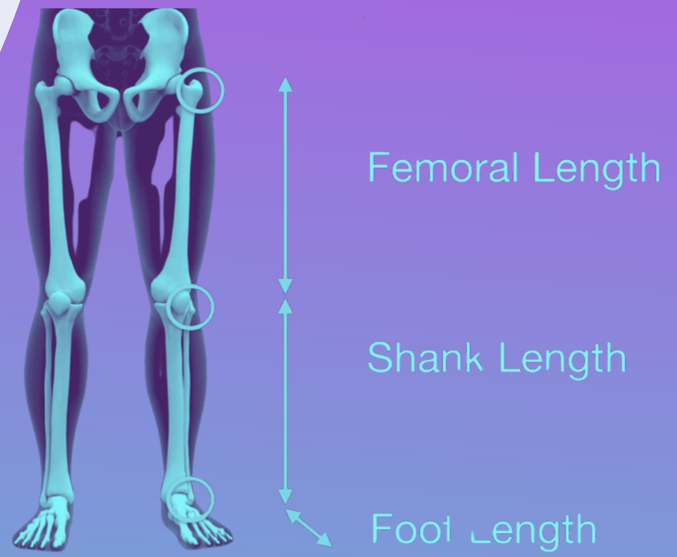


Distance Measurement Method

Using the known distance of the shank, and using a distance-adjustment calculation, we will correct for the added distance.

Calculating Distances

Due to running parallel to the camera, the distance differs throughout the analysis



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Max Velocity Features

Maximum Hip Angle

Knee Seperation at Touchdown

Maximum Knee Flextion

Stride Rate

Ground Contact Time

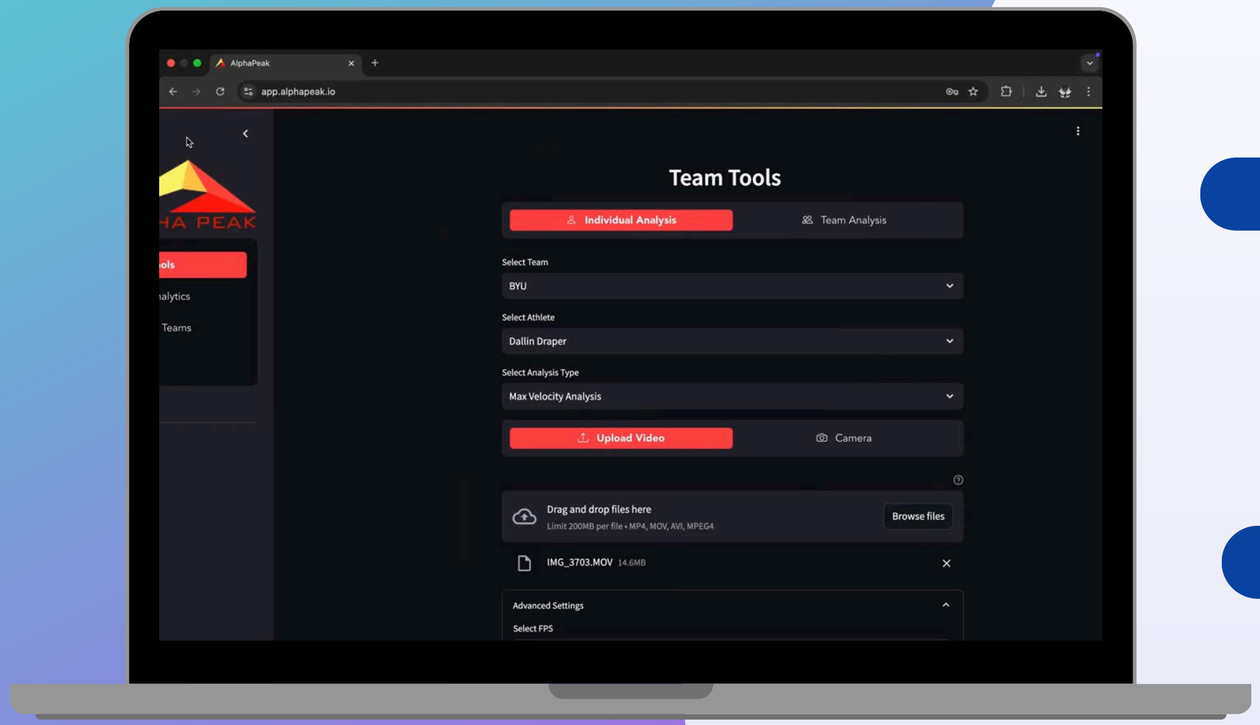
Trunk Angle at Touchdown

Take off Trunk Angle

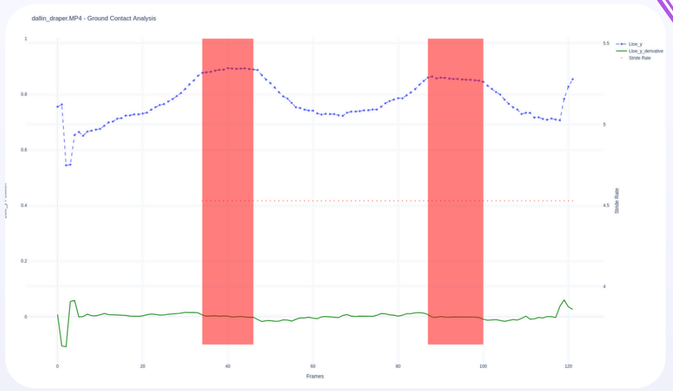
Toe Velocity at Touchdown

Flying 10 Time (seconds)

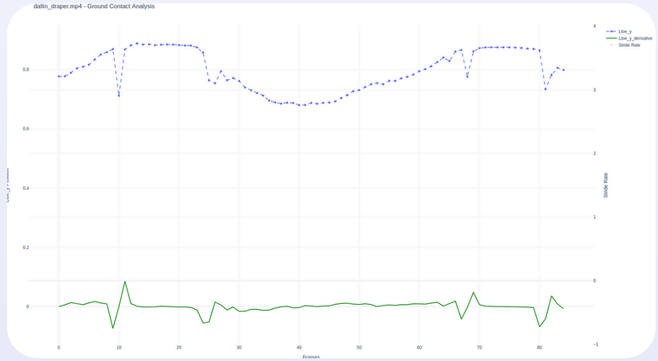
Maximum Velocity (mph)



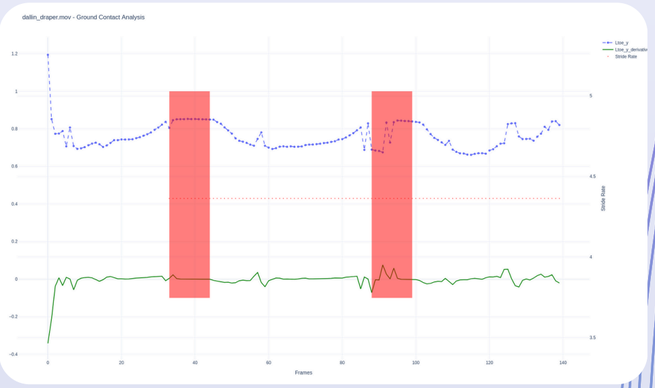
Automated



None Detected



Manual Entry



Whats next:

- Enhanced Metric Accuracy: Developing a model to minimize distortions for more precise measurements.
- Streamlined Data Access: Coaches can easily upload videos and receive real-time sprint metrics for simpler performance analysis.
- Robust Error Management: Users can manually adjust touchdown and takeoff frames to improve data accuracy and reliability.

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Pole Vault

Marcus

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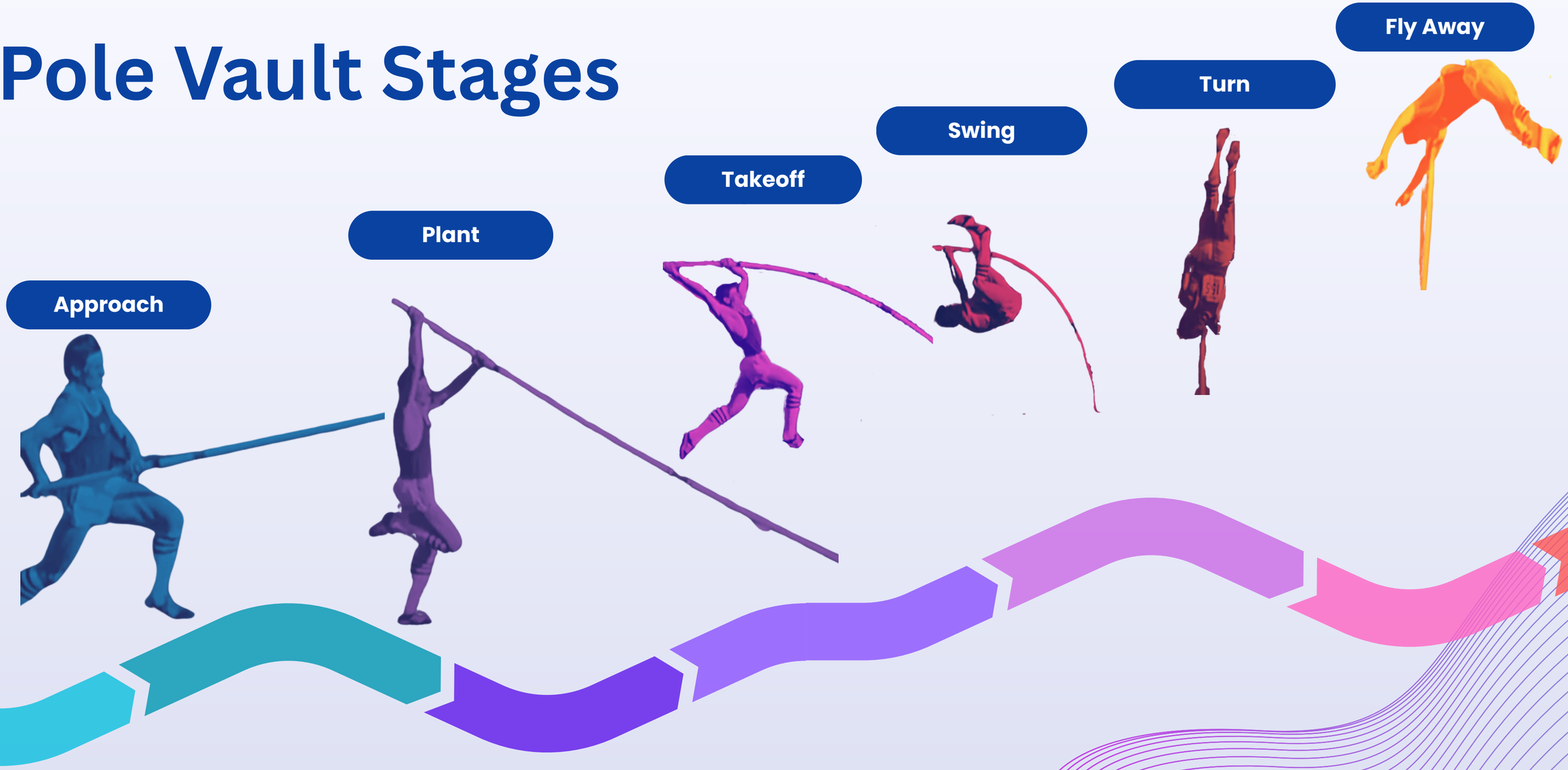
Pole Vault Stages



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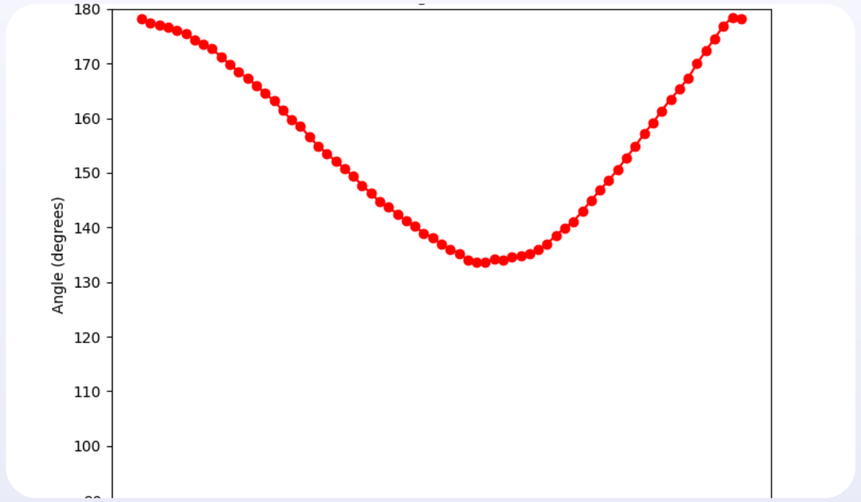
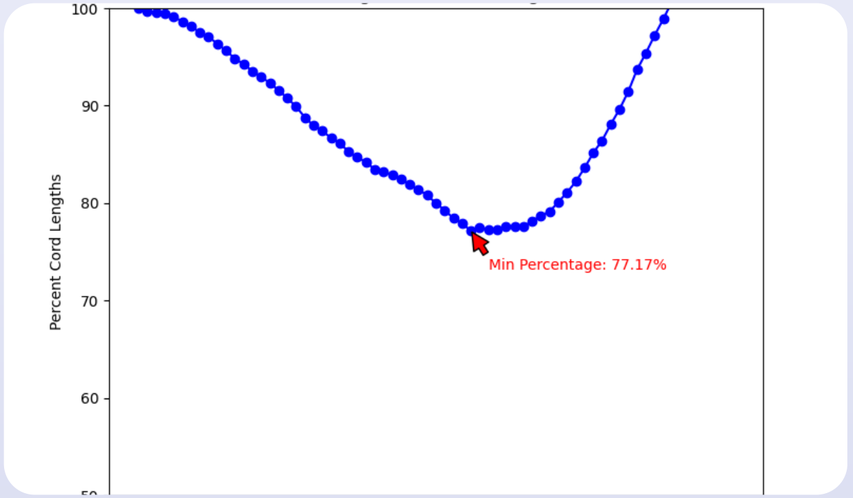
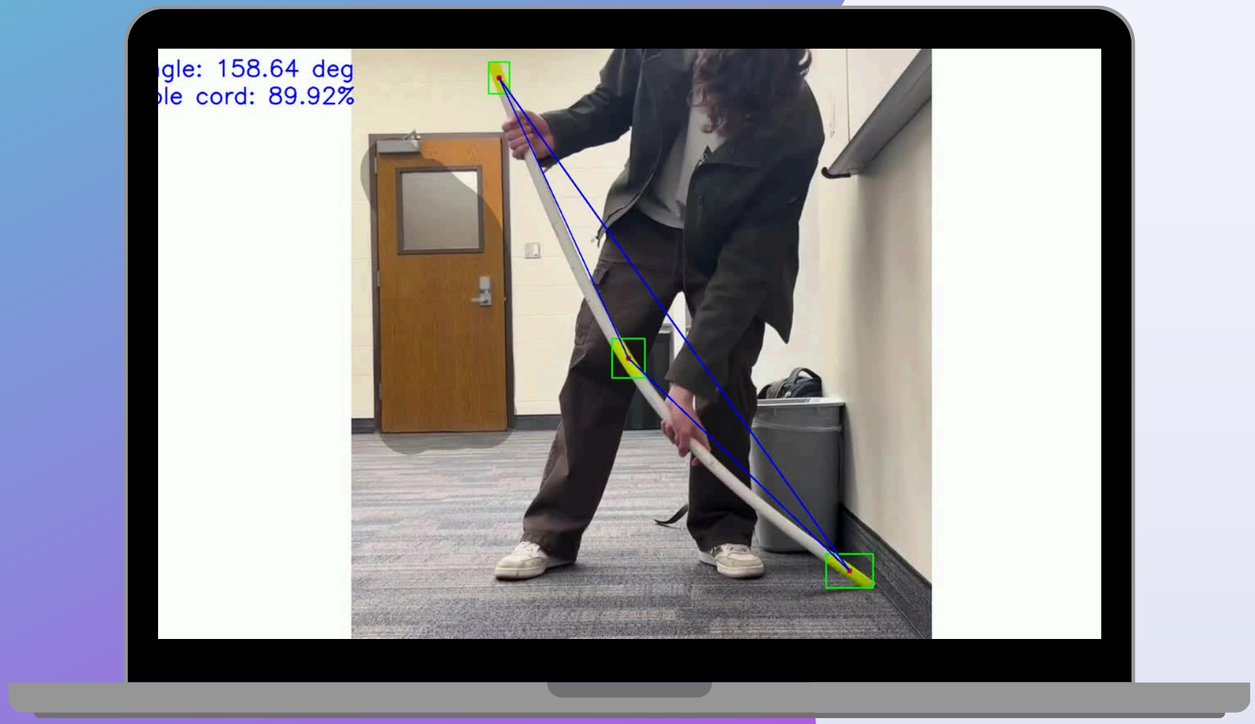
Pole Cord



Max Pole Cord





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Language Models

Oliver

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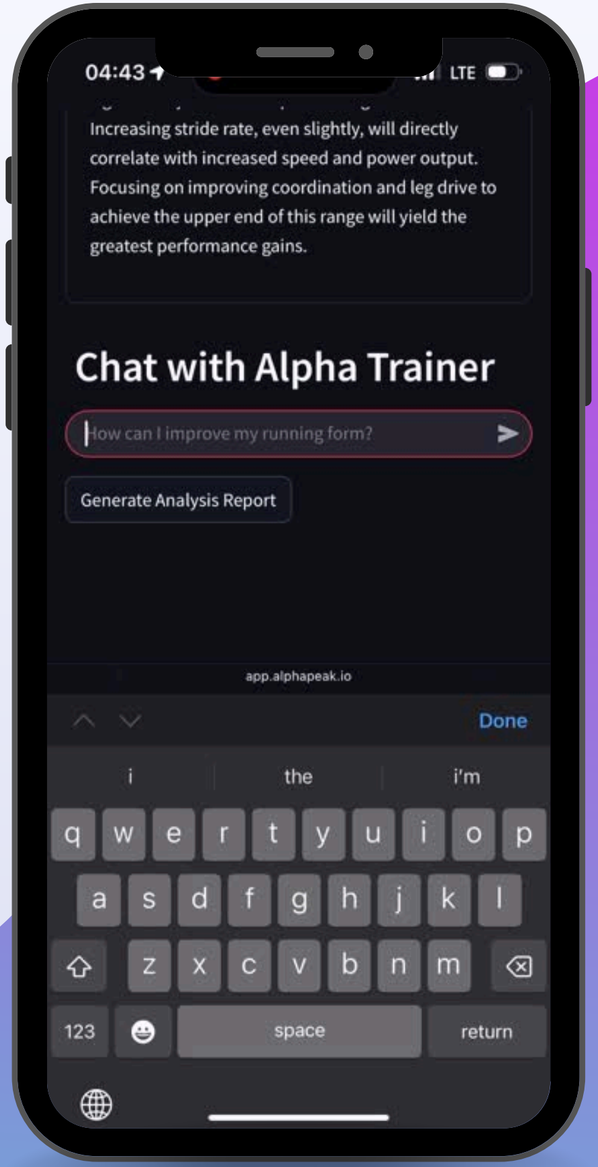
Integrating AI into Biomechanics Data

Bringing highly trained AI-assisted coaching to every athlete — instantly and affordably

- data interpretation
- question/answer interface
- form analysis



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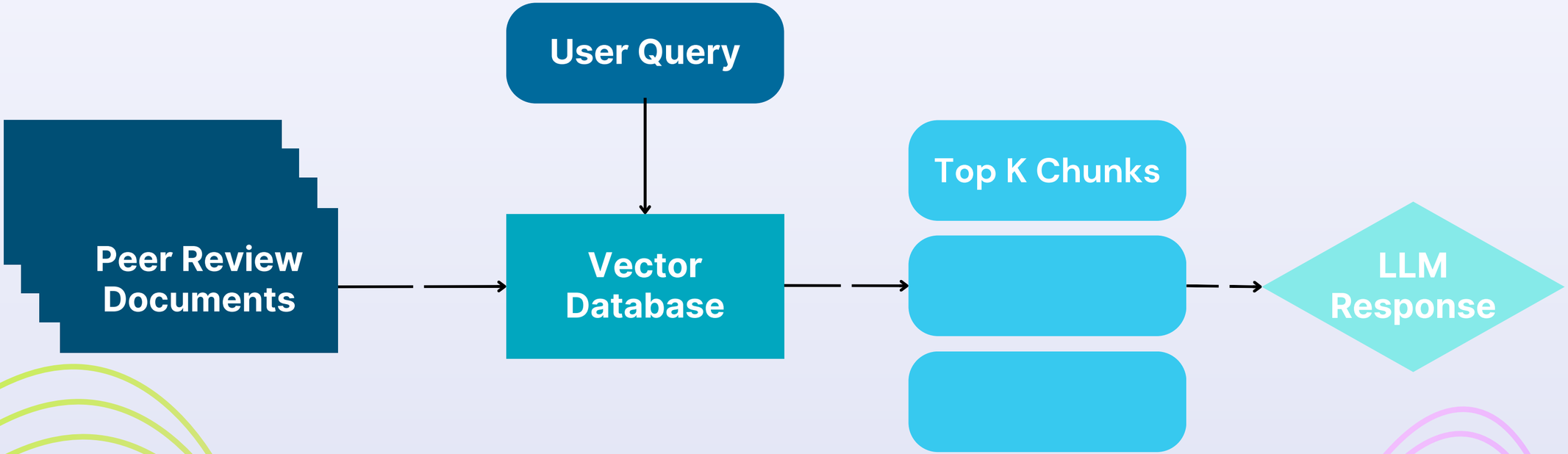
RAG Pipeline (Retrieval Augmented Generation)



- Detailed collection of verified, peer reviewed information
- Provides context for AI Assistance to answer questions

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Knowledge Base and Model Testing

Distance Running Posterior View Context_Contralateral H

Distance Running Posterior View Context: Contralateral Hip Dip Many distance run
associated with excessive pelvic drop and hip adduction. These biomechanical iss
tendinopathy, gluteus medius or minimus muscle strain, and Greater Trochanter P
adduction amplify the compressive loads at the distal insertion of the gluteal tend
This pain is often exacerbated during activities like lying on the affected side, clim
—especially uphill. For men, the optimal hip drop (hip angle) during running is less
deviation beyond these thresholds increases injury risk. Biomechanically, the glute
lateral hip stability during the stance phase of running gait, preventing excessive p
maximus, tensor fascia latae (TFL), oblique abdominal muscles, and quadratus lum
maintaining proper alignment. When lateral stability is compromised, the pelvis dr

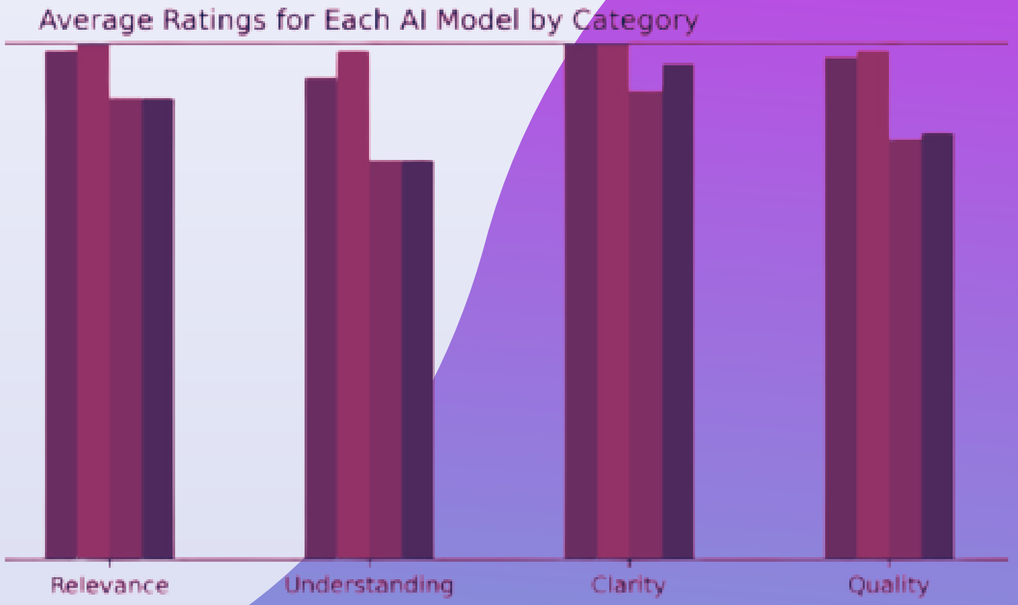
```
import time

# Write to CSV with response time instead of timestamp
#Change file name accordingly depending on model
with open(r"C:\Users\olive\OneDrive\Attachments\Knowledge Base\distance_running_QA_gemma3:27b.csv", mode="w", newline="", encoding="utf-8") as file:
    writer = csv.writer(file)
    writer.writerow(["question_number", "question", "answer", "model", "response_time_seconds"])

    for i, question in enumerate(questions, 1):
        print(f"Processing Question {i}...")

        start_time = time.time()
        answer = chat_with_collection(t, m, question, c_id)
        end_time = time.time()

        response_time = round(end_time - start_time, 2)  # in seconds
        writer.writerow([f"question_{i}", question, answer, m, response_time])

        time.sleep(1)

print("All Q&A saved with response times logged.")
```

[6] ✓ 6m 14.5s

```
Processing Question 1...
Processing Question 2...
Processing Question 3...
Processing Question 4...
Processing Question 5...
Processing Question 6...
Processing Question 7...
Processing Question 8...
Processing Question 9...
```

```
mma327b = pd.read_csv(r"C:\Users\olive\OneDrive\Attachments\Knowledge Base\distance_running_QA_gemma3
mma327b
```

er	question	answer	model
_1	What is considered an ideal stride rate for mo...	Research suggests that a step frequency of aro...	gemma3:27b
_2	How can increasing stride rate reduce injury r...	Increasing stride rate can reduce injury risk ...	gemma3:27b
_3	What is the minimum stride rate increase neede...	According to the provided text, a 10% increase...	gemma3:27b
_4	How does stride rate affect step length?	There is a strong inverse relationship between...	gemma3:27b
5	What does a more plantar-flexed ankle at conta...	The provided context does not directly address...	gemma3:27b



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Full Integration & Performance Insights

- Precision Metrics – Improved model accuracy for more reliable measurements
- Effortless Data Access – Coaches upload videos, get real-time sprint metrics
- Continuous Improvement – Expanding knowledge base & refining model performance
- Integrated Support – API-powered expert guidance for athletes & coaches
- Holistic Development – Training, nutrition, recovery, & injury prevention

"The goal is to turn data into information, and information into insight."

Whats Next?

- Translate insights into actionable strategies
- Enhance user experience & engagement
- Expand outreach & refine recommendations

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Wearables

Luke

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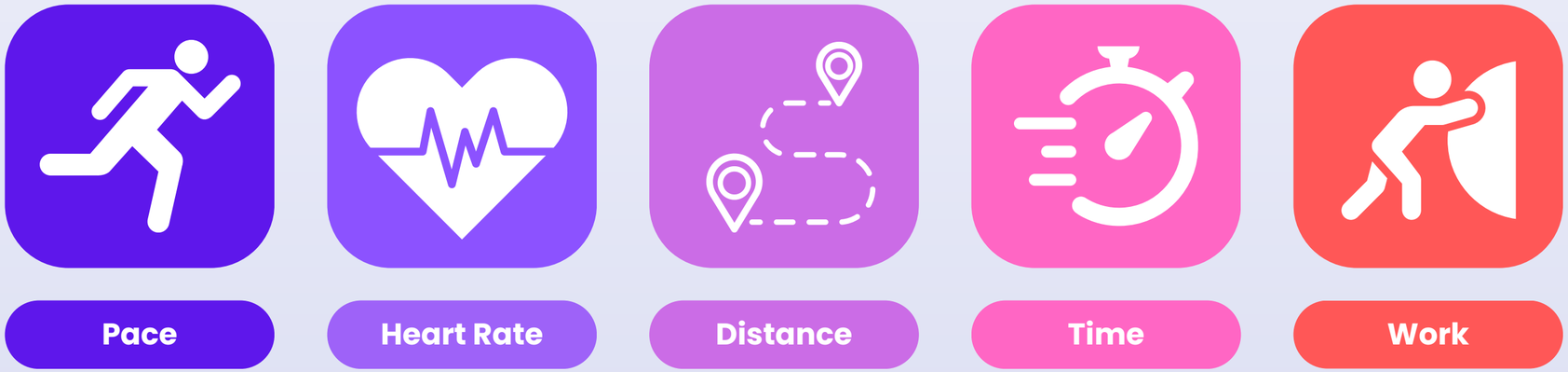
Development Progress

I built a Streamlit web app that analyzes Garmin FIT files, helping athletes and coaches track performance. It extracts key running metrics—date, week number, distance, time, and heart rate—storing them in a DuckDB database for efficient analysis. Users can upload FIT files, manage athlete data, and visualize performance trends with interactive mileage and effort plots. Color-coded mileage charts highlight percentage changes, while effort plots show heart rate trends.

Current Features



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Garmin App Roadmap

Completed

File Upload

Users upload individual or multiple FIT files for analysis.

Garmin API

The Garmin API alerts us of a new file.

Process File

Our system extracts running and heart rate data from FIT files.

In Progress...

Pull Metrics

Athlete and team performance data is stored into our database.

Display Data/Coaches Access

Streamlit and Matplotlib create interactive charts, allowing coaches to track athlete performance easily.

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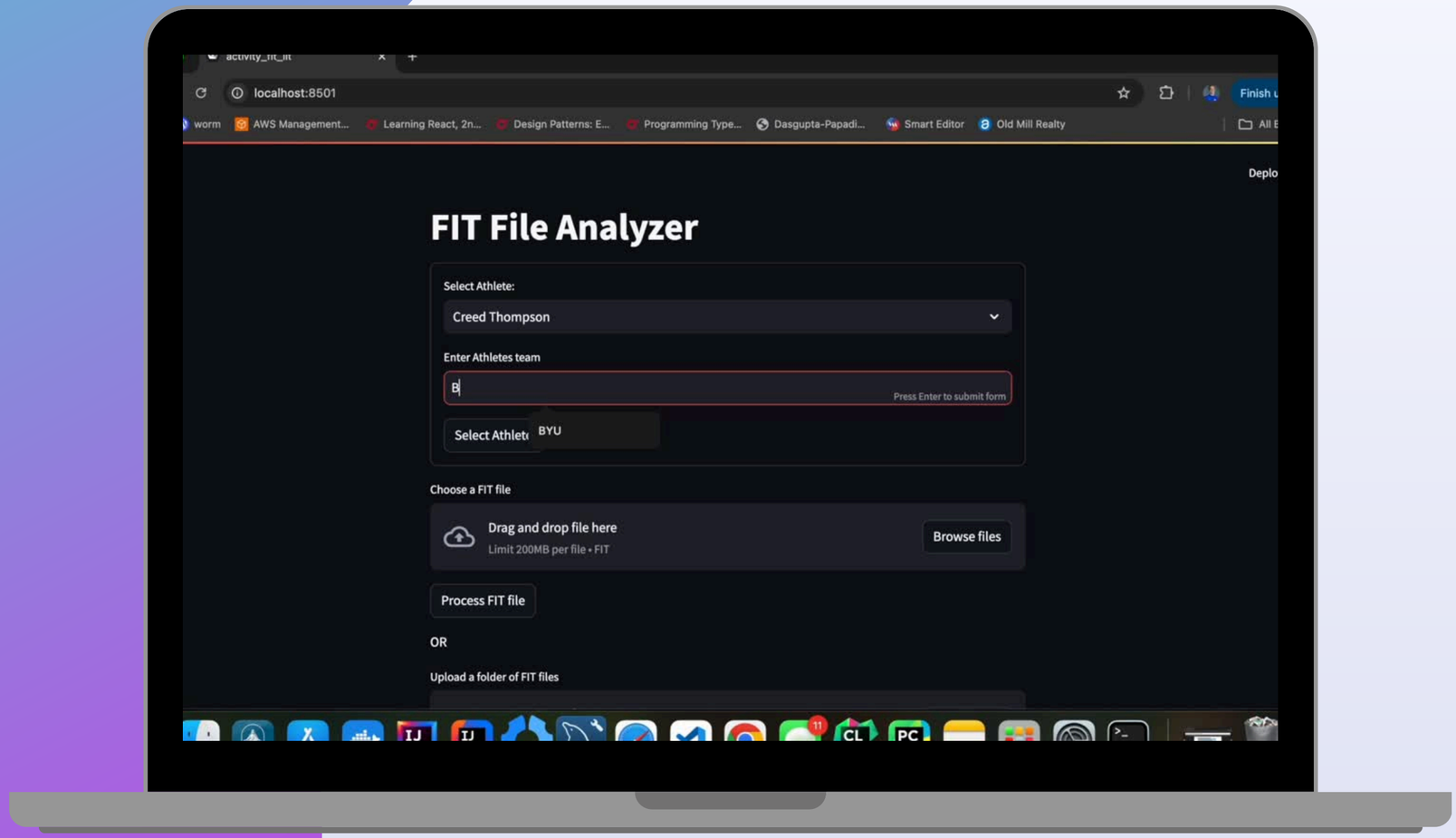
FIT File Analyzer



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Project Overview

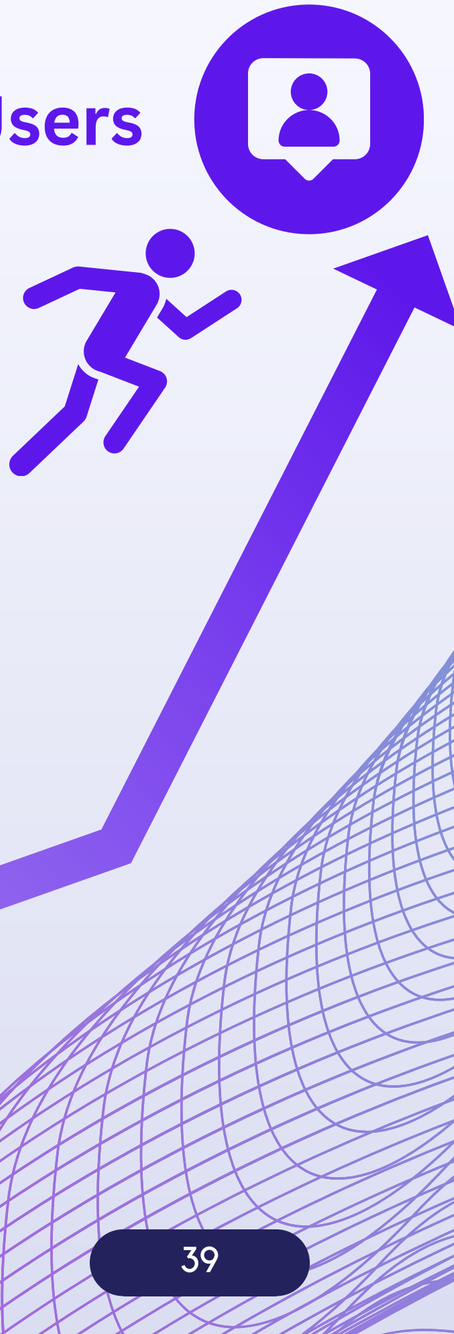
2400 Active Web Users

750+ Athletes Reached

52 Grad Students Apps

11 Undergraduate Researchers

4 World Class Coach Mentors



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Questions?

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