

DATA-DRIVEN ATHLETICS

AI Athletics & Outreach



[Project Update](#)

[Student Showcases](#)

[Progress Summary](#)



2026: MULTI-SPORT FOCUS AND BROADEN OUTREACH

HOW TO RECORD YOUR RUNNING VIDEO FOR ANALYSIS

1. THE SETUP
3 MIN WARM-UP
SPEED: 8.0 MPH (NOTE THIS!)

2. CAMERA & FRAMING
HD 1080P 60 FPS+ 1x Zoom
Use phone, 60fps+, 1080p rec. Use tripod at hip height. Zoom 1x-3x. Avoid fisheye.

3. ENVIRONMENT & LIGHTING
BRIGHT, NATURAL LIGHT
NO 0.5x FISHEYE

Jog for 3 minutes. Note the exact treadmill speed.

HOW TO RECORD YOUR GOLF SWING VIDEO

1. THE SETUP (Tee Area & Ball Position)
Direction: Right

3. ENVIRONMENT & LIGHTING
BRIGHT, NATURAL LIGHT
CLEAR BACKGROUND & TARGET

HD 1080P 60 FPS+ 1x Zoom

MASTER THE HANDLE. STOP GUESSING. START MEASURING.

Transform Raw Power into Dominant Control with AI Dribbling Analysis. Fixed Form = Instant Buckets.

CURRENT SESSION
POUND: 12.15 hb/s
EYES DOWN: 21% (REDUCE!)

ELITE POTENTIAL
ABOVE HP: 95%
HEADS UP: 100%
BALL TO HAND SWELL TIME: 60% (ELITE CONTROL)

SESSION SUMMARY
DRIBBLES: 4
POUND AVG: 20.27 hb/s (EXPLOSIVE)

AI Dribble Analysis

2700 Active Users
25,000 Actions
130,000 Training Views

JUMP SHOT FORM ANALYSIS: TOP 5

1. TRUNK & POSTURE
TRUNK LEAN: 16°
Maintain optimal forward lean of 10-20 degrees at set point.

2. SET POINT ANGLE
ELEVATION: 44°
ELBOW: 96°
Target a strong set point with optimal elbow flexion (approx 95°) and shoulder elevation. Ensure efficient power transfer with deep knee flex followed by rapid, full hip and knee extension.

3. RELEASE HEIGHT
RELEASE HEIGHT: 9.6 ft
Release the ball at its highest point for clearance and accurate trajectory.

4. FOLLOW-THROUGH CONSISTENCY
FOLLOW-THROUGH ACCURACY: 92%
FOLLOW-THROUGH ACCURACY: 92%
Maintain a consistent and fully extended follow-through to guide the ball.

OVERALL FORM SCORE
FORM SCORE: 85%
NEXT STEPS:
• Focus on trunk lean
• Enhance hip drive
• Enhance hip drive
Composite score based on all form analysis. Improve targeted areas.

4. THE CLIPS (Key Angle: Side Profile)
Outdoor field. Bright daylight. Clear, uncluttered background.
MAX C-SHAPE TENSION (Trunk Tilt & Arm Angle)
RELEASE POINT (Shoulder Angle Target 22-30°)
BLOCK PLANT (Plant Leg Angle: Varies 150-180°)
SIDE PROFILE THROW CLIP (Shot Direction) SIDE PROFILE (Level with hips)

Setup runway & mark plant point. Note the exact start position.

Use phone, 60fps+, 1080p rec. Use tripod at hip height.

HOW TO RECORD YOUR TENNIS SERVE VIDEO FOR ANALYSIS

2. CAMERA & FRAMING
HD 1080P 60 FPS+ 1x 2x Zoom (for framing)
Use phone, minimum 60fps+, 1080p. Position tripod at court level.

3. ENVIRONMENT & LIGHTING
BRIGHT, NATURAL LIGHT
Ensure bright, even light. Backlight is your enemy. Make the server the main subject.

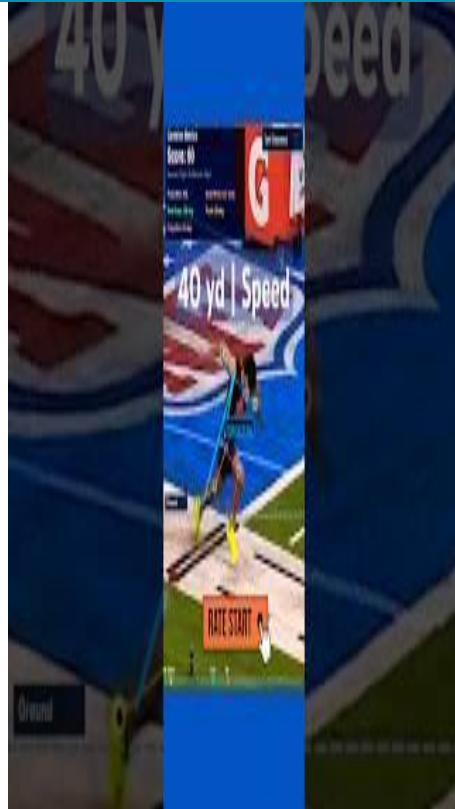
4. THE CLIPS (SINGLE-SERVE MODE)
SIDE PROFILE CLIP
BACK (POSTERIOR) CLIP
Record two sets of 10 separate clips.

Perform 10 serves, aiming for the correct service box.





2026: MULTI-SPORT FOCUS

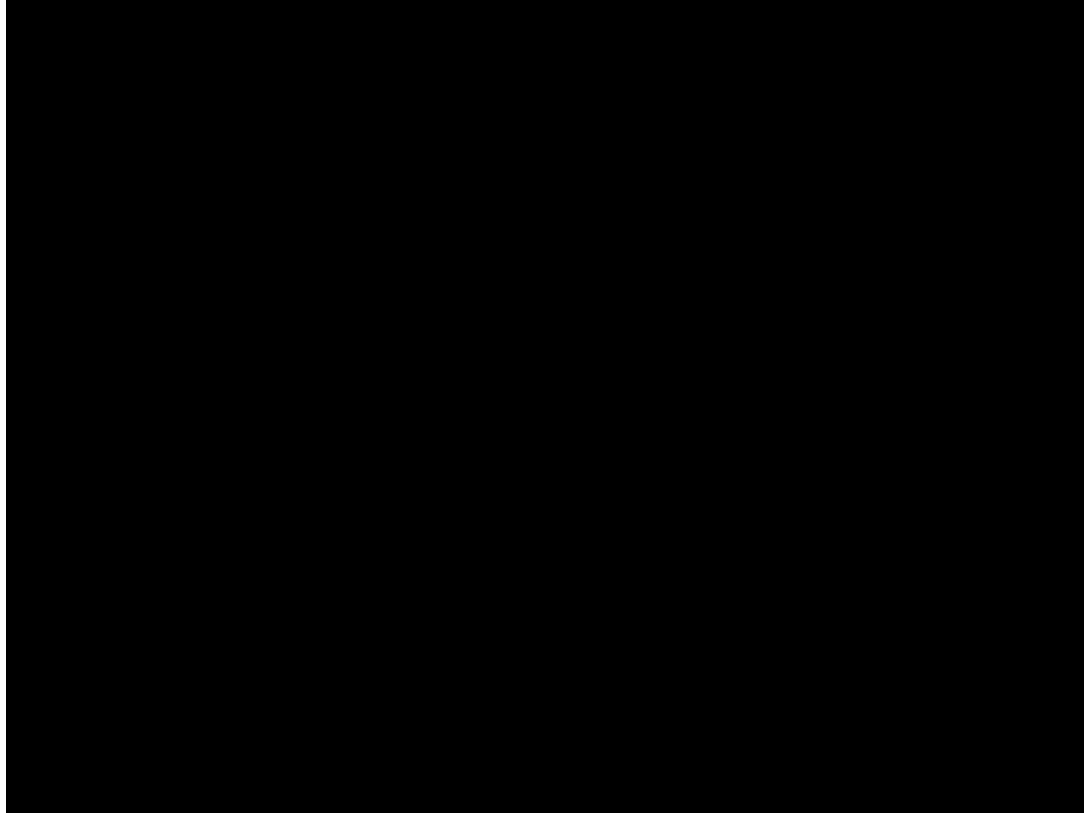




BYU STUDENTS / ATHLETES INTERNSHIPS (2026)



WEBER STATE CASE STUDY — RESULTS



WEBER STATE CASE STUDY — RESULTS



+13%

Boys Top Speed Increase

+22%

Girls Top Speed Increase

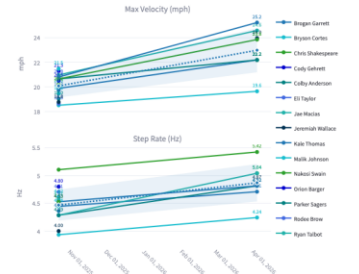
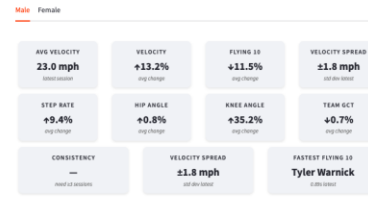
NEW

4x100m School Record

Key Findings

- 6-month tracking window (October – April)
- School record broken in the 4x100m relay
- Fastest sprinters in program history despite being a young team
- Coaches used analysis outputs daily in training planning
- Tool provided fresh perspective coaches had never considered
- Insights integrated into training execution at Weber State

Team Progress Overview



Metrics Over Time





TURN DATA INTO ATHLETE / COACH INSIGHTS



McKenzie Kuchin

Long run spike 21% above baseline long run
5.6 mi long run · 4.7 mi avg

Volume drop 21% below baseline weekly mileage
9.8 mi this week · 12.5 mi baseline

[Open athlete](#) [View results](#)

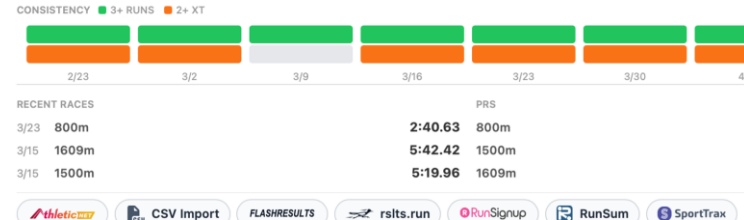
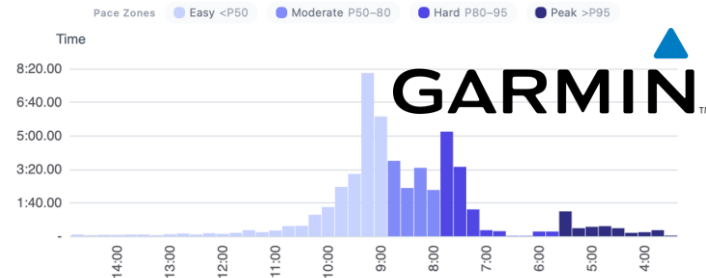
Highlights (38)

Angelina Alder

PR - 800m New personal record at Roadrunner Time Trial
2:12 at Roadrunner Time Trial (Mar 22) · was: 2:14

[Open athlete](#) [View results](#)

PACE DISTRIBUTION





PROPOSAL DEVELOPMENT



BYU ENGINEERING

iR Intermountain Health



Smartphone-Based Wearable Performance Assessment and Injury-Risk Analytics for Military Fitness Readiness

PROBLEM / CAPABILITY GAP

Injury statistics

- High injury rates in running/loading
- Existing tools costly & episodic
- Mobile apps lack validated analytics

PROPOSED SOLUTION

- Waist-mounted smartphone sensor/hub
- Performance assessments for fitness tasks
- Compare phone vs. shoe pod sensing
- Integrates clinical gait data

TECHNICAL AND PROGRAM PLAN

- Year 1:** Build waist sensor & protocols
- Year 2:** Prototype field testing (Camp Williams)
- Year 3:** Validate at Sports Performance Center (BYU)
- Year 4:** Longitudinal injury/performance studies
- Year 5:** Finalize deployment & transition package

EXPECTED IMPACT

- Validated performance assessment platform
- Early injury screening & readiness support
- Evidence on scalable wearables
- Integrated translation pathway (field to clinical)
- Strong USSOCOM mission alignment



CONTRIBUTING DEVELOPMENTS IN PROVO (2027-2028)



BYU



THE TEAM

Marcus Thayer

CV & ML Pipeline Lead — Pole Vault

Nathan Brimhall

Research Lead — Throws & Step Detection

Bradley Greenhalgh

Data & Streamlit App — Pole Vault

Ethan Grundvig

API Frontend — Flutter

Ava Peacock

ML Annotation & Outreach — Pole Vault

Zarek Proffitt

Video Annotation & 3D Research — Throws

Erik Bryant

Discus Annotation & Feature Design

Mark Bryant

Discus Ring & Disc Annotation

Scott Jezik

Outreach — Athlete Data & AI Feedback

McKenna Pouwer

Outreach — Marketing & School Visits

Davin Thompson

API Team — Backend & Infra

Ty Oustrich

API Team — Backend & Infra

Creed Thompson

API Team — Backend & Infra

Heather Thayer

Outreach — Marketing & School Visits

Aaron Thayer

App Engineer — Pole Vault





POLE VAULT ANALYSIS

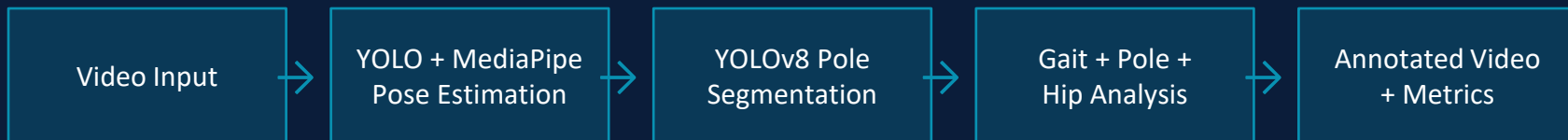
AI powered biomechanical analysis app for pole vault

Marcus Thayer · Aaron Thayer · Ava Peacock · Bradley Greenhalgh



POLE VAULT ANALYSIS OVERVIEW

VaultSense — Video-Based Biomechanical Analysis



CV Pipeline: YOLO segmentation, pole mask skeletonization, multi-frame consensus clustering, chord-length bend tracking with polynomial smoothing

ML Pipeline: 7 classifiers with 5-fold cross-validation, MLP best model, post-processing for discrete alternating step detection



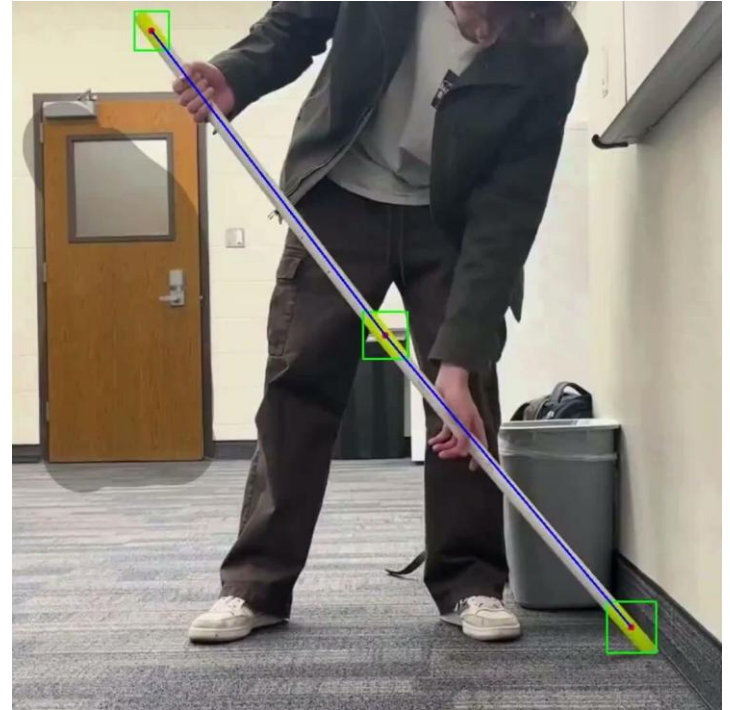
WHERE IT STARTED

Max Pole Bend and Danny Wilkerson

- Danny's mentorship has been invaluable
- He introduced the idea of max pole bend
- First attempt at automation was instructive



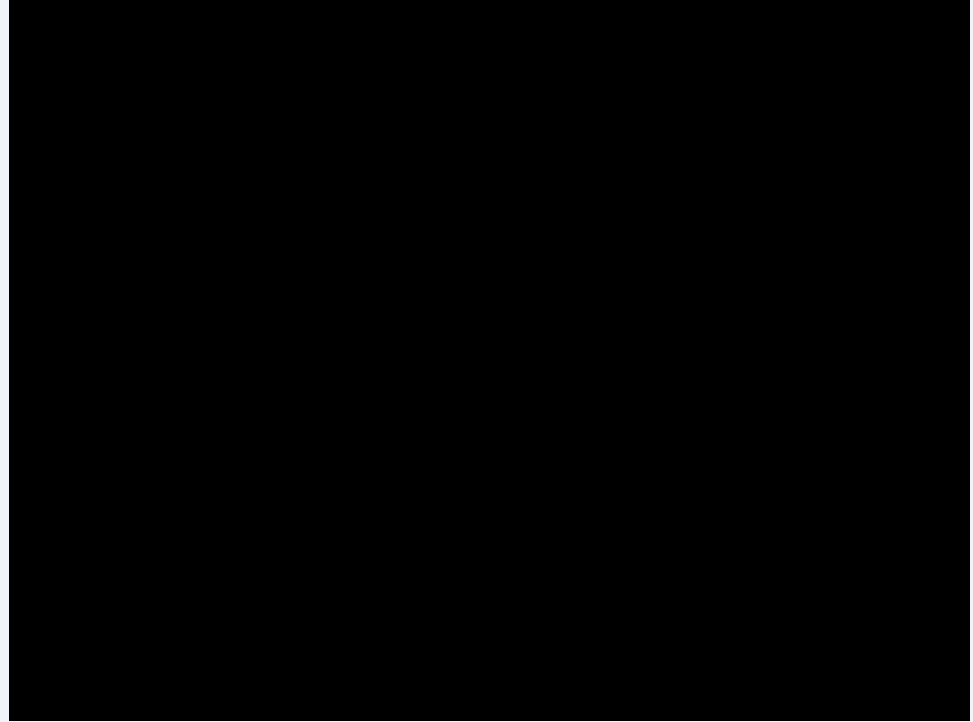
Danny Wilkerson
Head Pole Vault Coach,
Bethel University



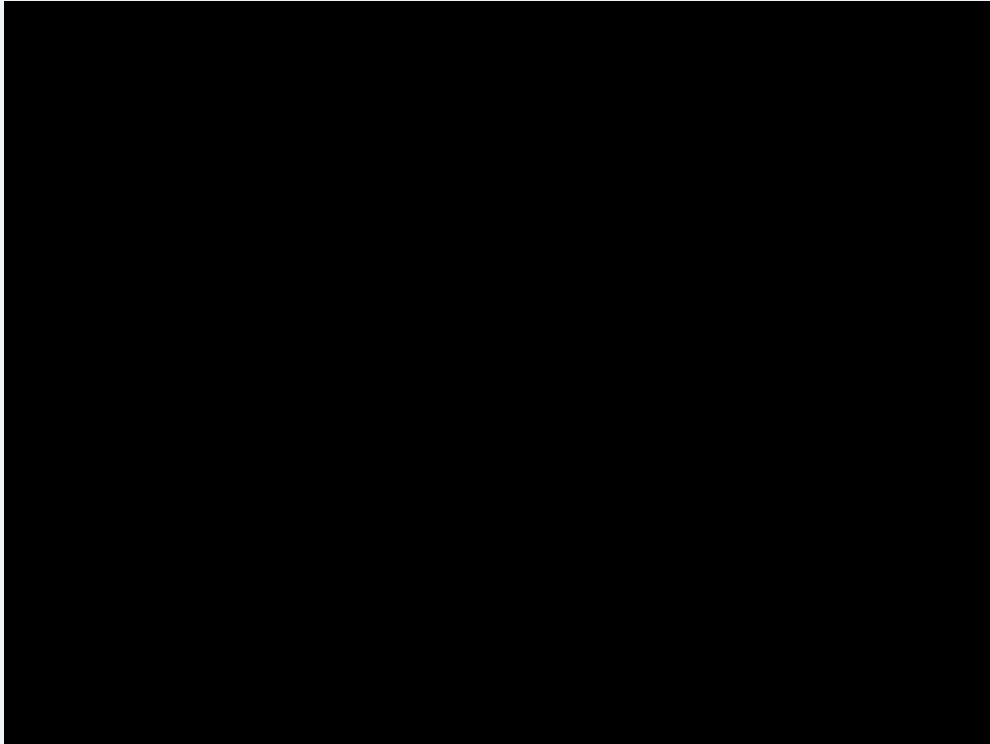
WHERE WE WERE

Dec 2025 Proof of Concept

- Max pole bend and cadence analysis = manual inputs
- We have since made significant breakthroughs in automation



DATA AND LABELING



**A peek into the
Roboflow dataset
annotation process...**

Aggregated and labeled
images using Roboflow
to create a custom data
set and train a pole
detection model



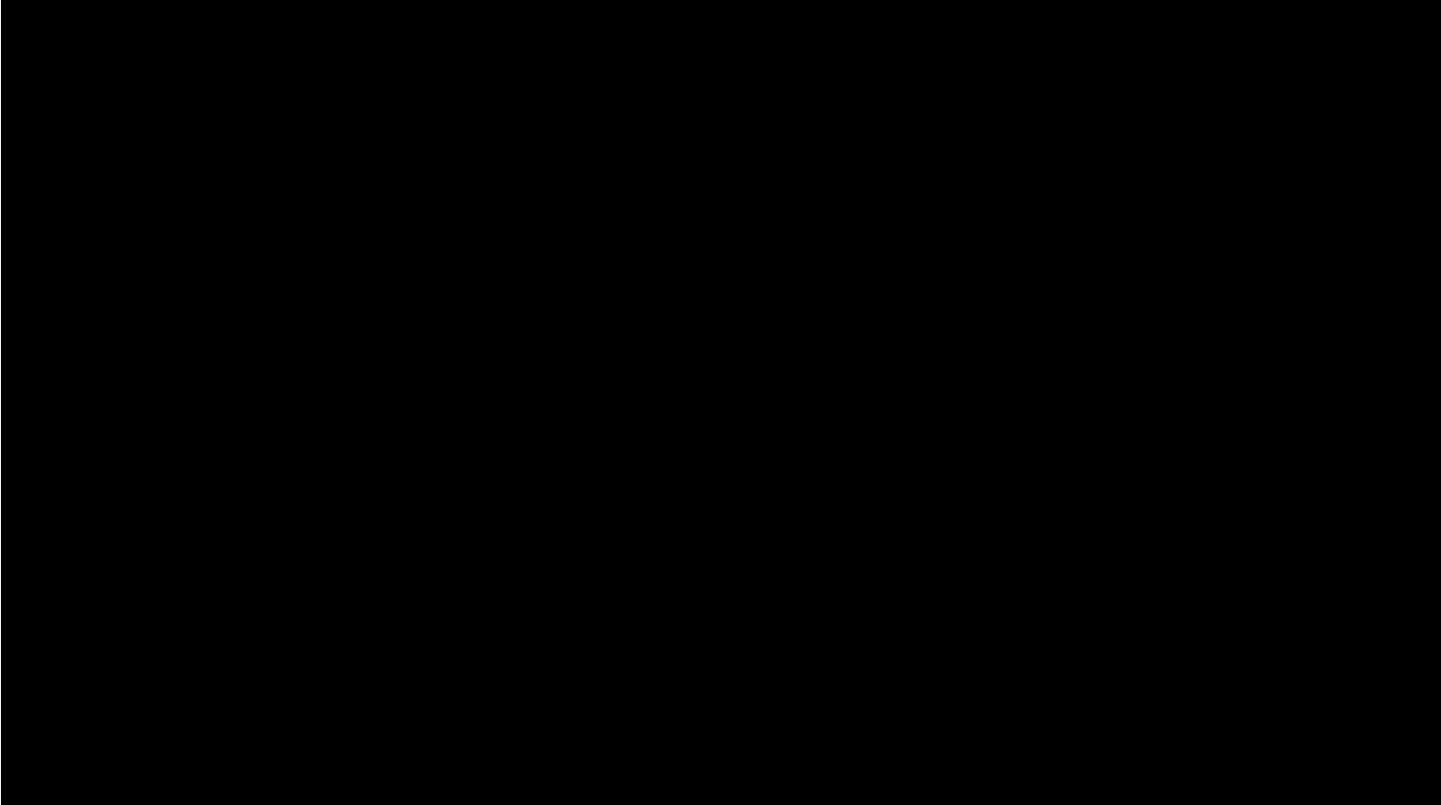
DATA AND LABELING



1200+ images
100+ hours
1 of 1 dataset



CURRENT STATE OF ANALYSIS



AARON THAYER – POLE VAULT APP ENGINEER

Key Accomplishments

- Developed **pixel-to-meters calibration** by having athletes input their height
- Built initial **step-detection algorithm** that displays athlete's steps
- Leveraged step detection to calculate **steps-per-minute** and **stride length**
- Implemented **max hip height** measurement



POLE VAULT — BRADLEY GREENHALGH & AVA PEACOCK

Bradley Greenhalgh

Data Collection, Annotation & Streamlit App

- 1+ hour of pole vault training clips
- Created initial version of the Streamlit app
- Created frame extraction script at 30 fps for Roboflow input
- Annotated 300+ frames in Roboflow for pole tracking model

Ava Peacock

ML Support & Outreach

- Annotated 200+ frames in Roboflow for pole tracking model
- Helped at the indoor track outreach events
- Researching Streamlit and AI tools for the project
- Provided general support wherever additional help was needed



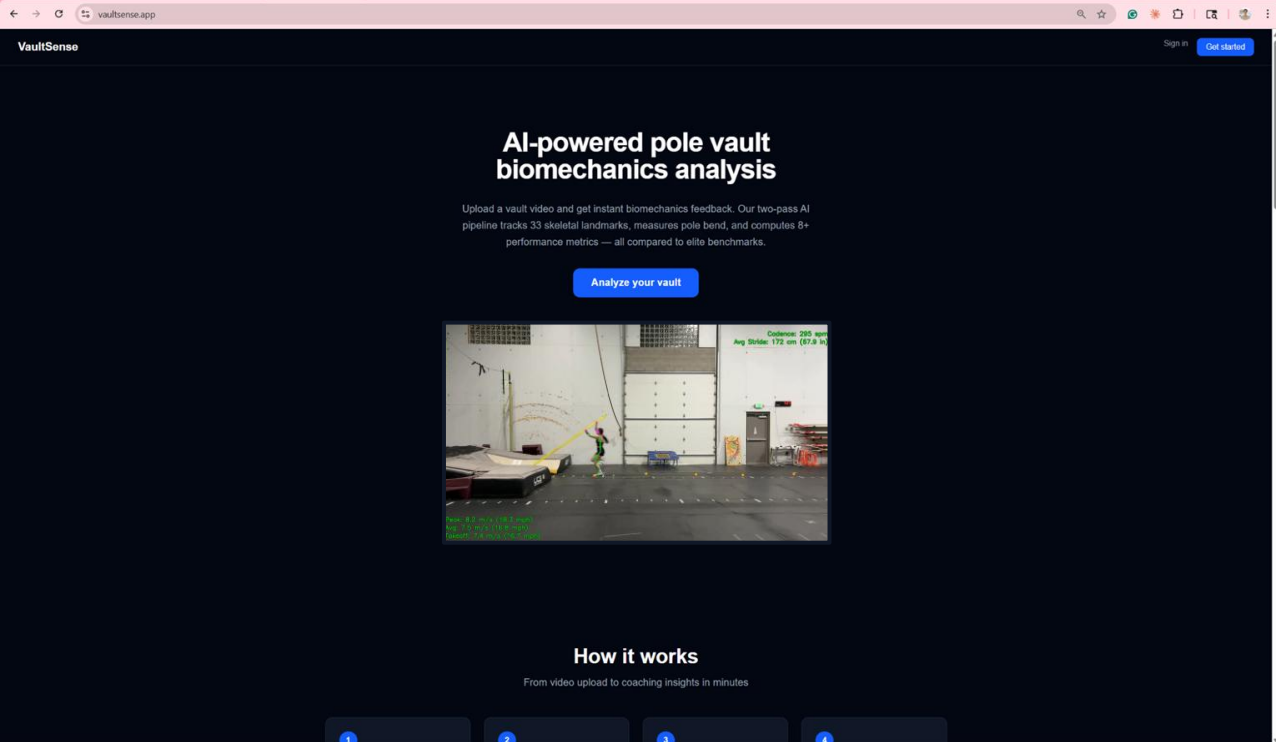
STEP DETECTION

- Algorithmic based solutions weren't working
- Trained a custom step detection machine learning model
- Implemented into greater analysis pipeline



VAULTSENSE.APP

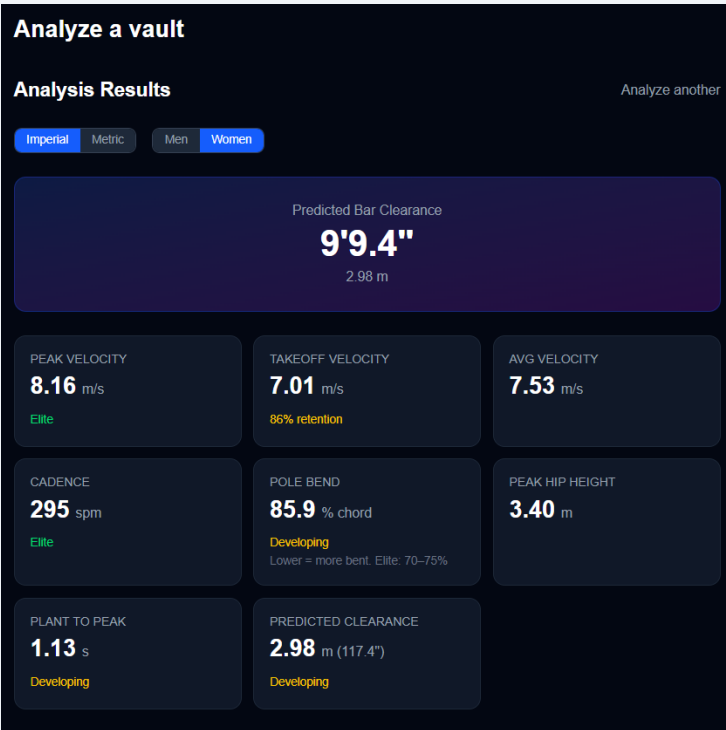
- Live and publicly accessible
- No install, just a browser
- Upload a vault, get results



The screenshot shows the VaultSense website interface. At the top, the browser address bar displays "vaultsense.app". The website header includes the "VaultSense" logo on the left and "Sign in" and "Get started" buttons on the right. The main content area features a large heading: "AI-powered pole vault biomechanics analysis". Below this heading is a descriptive paragraph: "Upload a vault video and get instant biomechanics feedback. Our two-pass AI pipeline tracks 33 skeletal landmarks, measures pole bend, and computes 8+ performance metrics — all compared to elite benchmarks." A prominent blue button labeled "Analyze your vault" is centered below the text. Underneath the button is a video player showing a pole vaulter in action. The video has green text overlays: "Cadenza: 295 mm" and "Avg Stride: 172 cm (67.8 in)" in the top right corner, and "Time: 4.2 s (1.18 s jump)" and "Pole: 1.2 m (3.94 ft)" in the bottom left corner. Below the video player is a section titled "How it works" with the subtext "From video upload to coaching insights in minutes". At the bottom of the page, there are four numbered navigation tabs (1, 2, 3, 4) with the first tab highlighted.



VAULT METRICS VIA WEB APP



AI POLE VAULT COACH

The screenshot displays the AI Pole Vault Coach interface. It features four video frames showing a pole vaulter in action, each with specific annotations and a 'Download' button:

- Top Left:** Max Bend: Projected Tip (blue) vs Top Hand (red)
- Top Right:** Phase 1: Ground Tip to Bottom Hand
- Bottom Left:** Plant Frame: Reconstructed Tip (blue dot)
- Bottom Right:** Phase 2: Top Hand to Tip

Below the frames, the 'Jump Height' section displays two key metrics:

Metric	Value
Peak Hip Height	11'1.8" (3.40 m)
Predicted Clearance	9'9.4" (2.98 m)

At the bottom, there is an 'AI Coach' button and a 'Click to generate' link.

- Integrated AI coach powered by Anthropic's Claude
- Breaks down metrics into actionable steps for coaches and athletes
- Offers expert-level, feedback with drills and exercise suggestions





DISCUS THROW ANALYSIS

Computer vision for discus ring detection and throw technique analysis

Training AI models to recognize the discus and discus ring from multiple angles.
Automating technique analysis for the most vital mechanics for performance results





DISCUS ANALYSIS

AlphaForm — Video-Based Biomechanical Analysis

96.1%

Step Detection
Model Score

76.3%

Discus Detection
Model Score

94.5%

Discus Ring Detection
Model Score

ANNOTATED FRAMES



Overview:

- From only an idea to reality
- Collection → Annotation → Training → Testing
- Importance of data preparation



NATHAN BRIMHALL: RESEARCH LEAD, THROWS

Key Accomplishments

- Organized team efforts on annotating discus and discus ring detection frames
- Developed a custom tool to extract step detection frames
- Cleaned data and engineered features for model training
- Trained and fine-tuned 3 machine learning models
- Incorporated discus analysis into main app pipeline



Research Paper

Conference submission demonstrating the novelty and impact of the biomechanical CV pipeline

Next Steps

- Diversify datasets
- Begin discus throw outreach
- Incorporate LLM AI feedback
- Expand to include other features





DISCUS ANALYSIS

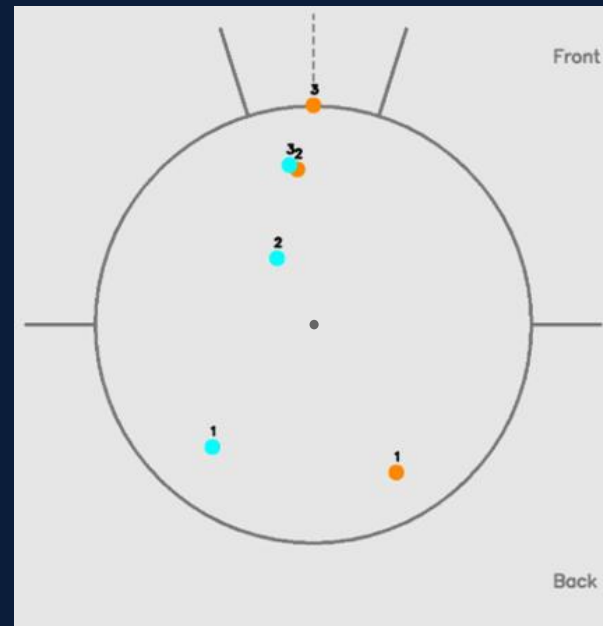
Discus Step Detection Map - Demo



Machine Learning Training:

- First iterations of models
- Improve dataset for discus release angle
- Incorporate metrics

STEP DETECTION MAP



THROWS TEAM: ZAREK, ERIK, & MARK

Zarek Proffit

Annotation & 3D Research

- Annotated discus throw videos and ring models
- Researched multi-video syncing.
- Exploring multi-angle 3D position data for accurate biomechanics

Erik Bryant

Annotation & Feature Design

- Filmed and uploaded discus throw videos.
- Annotated discus throw videos and ring models
- Consulted with throws coach to identify vital mechanics and features

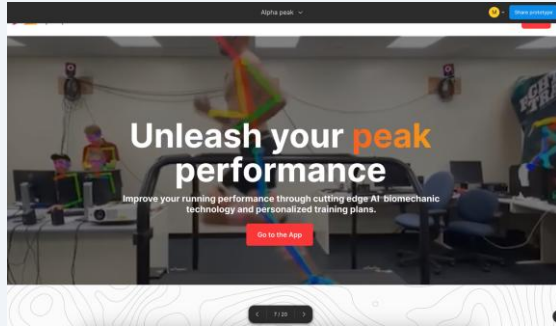
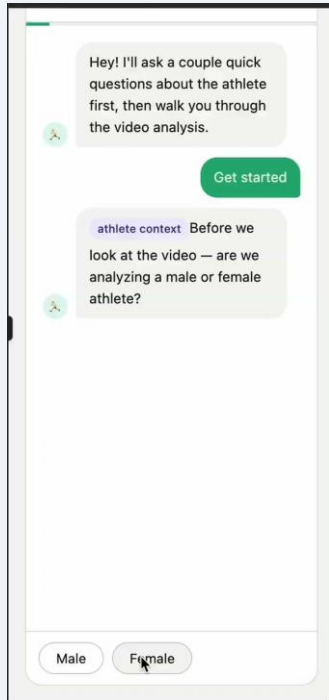
Mark Bryant

Discus Ring & Disc Annotation

- Filmed and uploaded discus throw videos.
- Annotated discus throw videos and ring models
- Identified vital mechanics and features



OUTREACH: MCKENNA POWWER



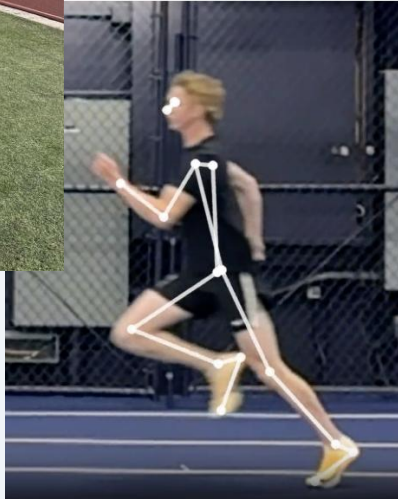
10 Visits · 4 Schools · 4 Open Analysis

Progress for 2026

- Contacted coaches for outreach visits.
- Social media and online presence.
- Technical analyses to high schools
- Data processing of videos, communicating errors and helping refine the process.
- Thursday night open outreach visits.
- AI Trainer script for automated coaching



OUTREACH: MCKENNA POWWER



Personal Progress

- Developed management skills related to events, team projects, and product management.
- Built content creation and design skills.
- Exposure to product development, research, and coding.
- Relationship building and marketing/outreach strategies.



OUTREACH: SCOTT JEZIK

Team Role

- Marketing and personal athlete connection
- Athlete data processing
- Feedback collection and implementation
- Developing script for actionable feedback alongside data analysis

Personal Progress

- Client-facing engineering skills
- Ability to incorporate feedback to development process
- Learned to present technical information to non-technical audiences

alphapeak

FREE RUNNING FORM ANALYSIS

Getting into running?
Recovering from an injury?
We're offering a free running form analysis every week!

**THURSDAY NIGHTS
@ 7 PM
BYU INDOOR TRACK**

Register Now

Our analysis is being built by a research team of BYU engineer and health students.

Questions?

McKenna Pouwer
(348)3679078
pouwer@byu.edu

Scott Jezik
(808)8007441
scottjez@byu.edu



OUTREACH: HEATHER THAYER

**OUTREACH
VISITS**

**CROSS-TEAM
COORDINATION**

**BRIDGING DATA
& ATHLETES**



Looking Ahead

Repeated Athlete Tracking

Video capture with high school athletes during summer training



Metrics & Injury Analysis

Partner with API team to apply new metrics and study injury patterns over time



Online Marketing

Social media posts and short-form video content showcasing athlete results





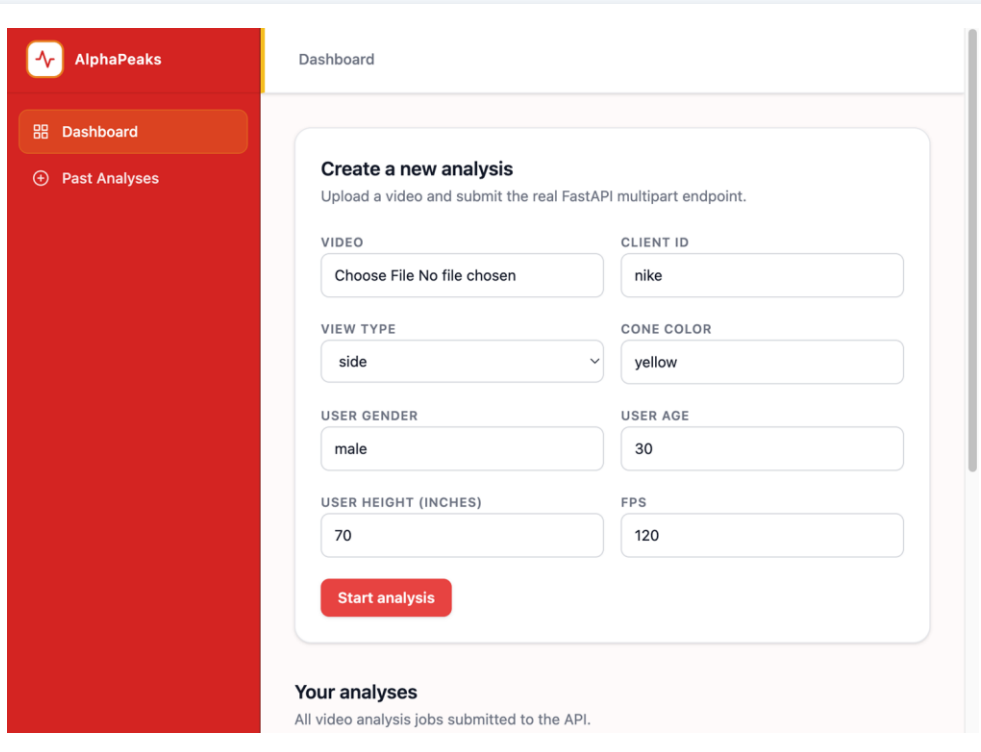
VIDEO ANALYSIS API

FastAPI · YOLO · MediaPipe · PostgreSQL · Celery · Docker

Davin Thompson · Ty Oustrich · Creed Thompson · Ethan Grundvig



API — SYSTEM ARCHITECTURE & ENDPOINTS



The screenshot shows the AlphaPeaks dashboard. On the left is a red sidebar with the logo and navigation links for 'Dashboard' and 'Past Analyses'. The main content area is titled 'Dashboard' and features a 'Create a new analysis' section. This section includes a sub-header 'Create a new analysis' and a description: 'Upload a video and submit the real FastAPI multipart endpoint.' Below this are several input fields: 'VIDEO' (a file upload button showing 'Choose File No file chosen'), 'CLIENT ID' (a text input with 'nike'), 'VIEW TYPE' (a dropdown menu with 'side' selected), 'CONE COLOR' (a text input with 'yellow'), 'USER GENDER' (a text input with 'male'), 'USER AGE' (a text input with '30'), 'USER HEIGHT (INCHES)' (a text input with '70'), and 'FPS' (a text input with '120'). A red 'Start analysis' button is positioned below the inputs. At the bottom of the dashboard, there is a 'Your analyses' section with the text 'All video analysis jobs submitted to the API.'

System Architecture

API Layer	FastAPI endpoints with validation
Data Layer	PostgreSQL + SQLAlchemy + Alembic
Processing	Celery workers for async video processing
Storage	Structured storage for videos & CSV outputs
Containers	Docker Compose: API, Redis, Postgres, workers

API Endpoints

GET /health – system health check

POST /api/v1/analysis/ – upload & create job

GET /api/v1/analysis/ – list analyses

GET /api/v1/analysis/{id} – retrieve results

PATCH /api/v1/analysis/{id} – update metadata

DELETE /api/v1/analysis/{id} – remove analysis



API — KEY ACCOMPLISHMENTS & CODE MIGRATION

Key Accomplishments

- Built full end-to-end performance analysis platform
- Researched best practices for building a B2B API
- Integrated FastAPI, PostgreSQL, SQLAlchemy, and Alembic
- Designed and re-designed the database schema
- Implemented asynchronous processing with Celery
- Connected YOLO and MediaPipe CV pipeline to API
- Containerized full environment with Docker Compose
- Built automated system and endpoint verification tests

Code Migration

Migrated, refactored & cleaned:

```
distance_speed_analysis
zoom_preprocess
ap_form
ap_ang
ap_dist_sag
gather_distance_metrics
```

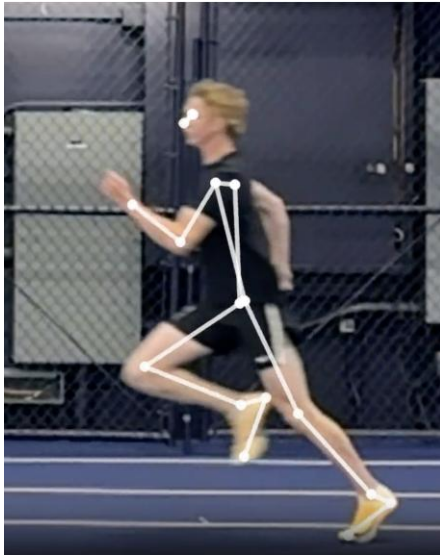
Ethan Grundvig — Flutter Frontend

- Built Flutter frontend mockup for the API
- Exposed bugs in the API through testing
- Working on processed video retrieval flow



API – DATA RETURN

PROCESSED VIDEO - WIREFRAME VIDEO FOR ALL ATHLETES



DATA- METRICS, ANGLES, POSITIONS

```
{  
  "frame": 1,  
  "time_sec": 0.008,  
  "left_knee_angle_deg": 162.4,  
  "right_knee_angle_deg": 158.9,  
  "hip_flexion_deg": 34.2,  
  "ankle_dorsiflexion_deg": 11.7  
},
```

Insights

EX. Your left knee flexes 5° less than your right knee



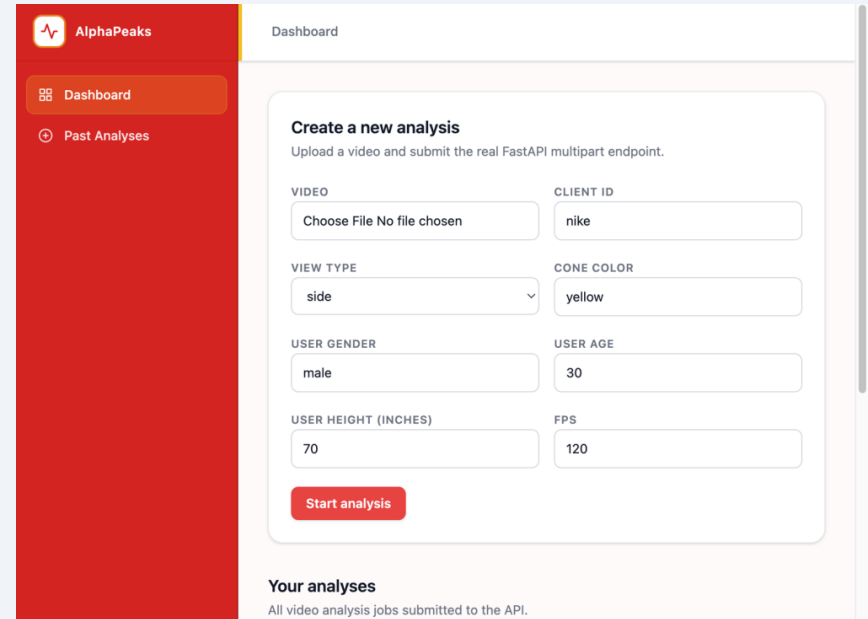
API: TYLER OUSTRICH

API progress

- Celery/Redis task broker
- Docker containerization
- End to end testing

Personal Progress

- AI development skills
- Production grade standards
- Collaboration



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AlphaPeaks

Dashboard

Dashboard

Past Analyses

Create a new analysis

Upload a video and submit the real FastAPI multipart endpoint.

VIDEO: Choose File No file chosen

CLIENT ID: nike

VIEW TYPE: side

CONE COLOR: yellow

USER GENDER: male

USER AGE: 30

USER HEIGHT (INCHES): 70

FPS: 120

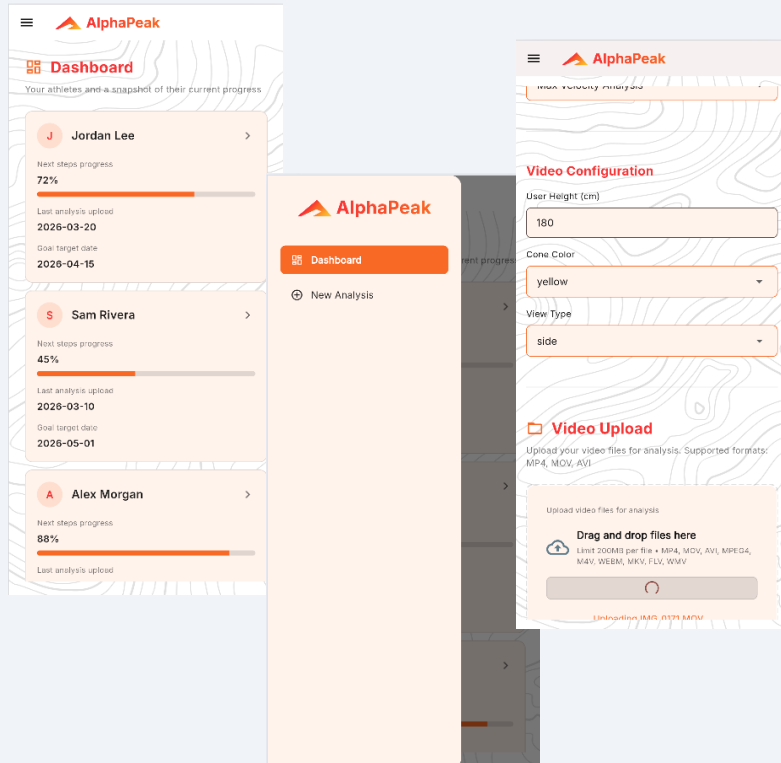
Start analysis

Your analyses

All video analysis jobs submitted to the API.



FLUTTER FRONTEND: ETHAN GRUNDTVIG



Project Progress

- Debugged and tested API, particularly the processed video retrieval flow
- Flutter frontend for coaches

Personal Progress

- Learned flutter/dart
- Real-life coding experience on a team (GitHub workflow)
- Preparation for standard industry practice with agentic programming



PRODUCTION APPLICATION



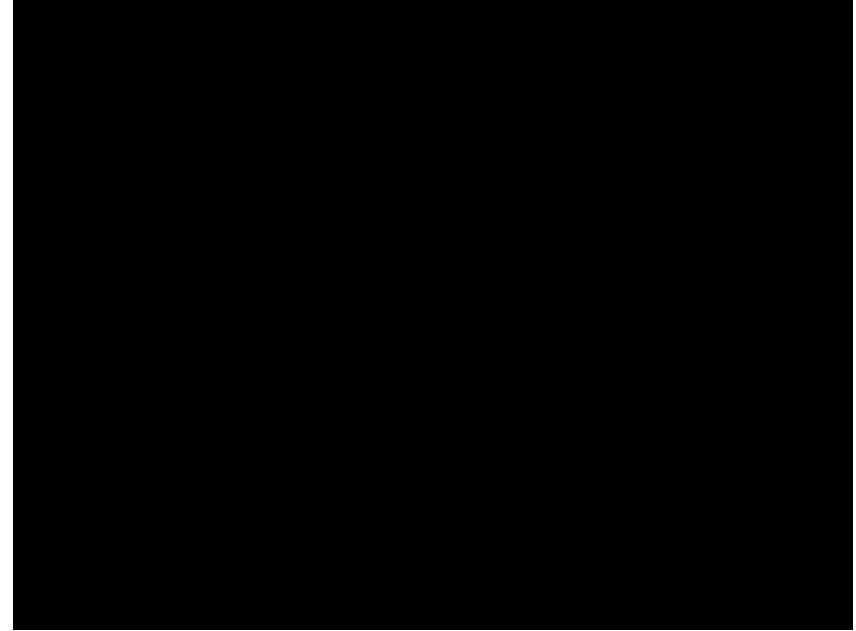
Web App



iOS



Android



What's Changing

- Takes the proven outreach prototype to full production
- **Beta launch**
- Releasing to 50+ physical therapists this summer
- Longitudinal tracking built in — monitor progress over time
- Built on 4 analysis types already proven in the field, adding more as development progresses





Sports Performance Assessments

Provo City
SCHOOL DISTRICT
Welcome • Educate • Inspire

Intermountain Health

BYU ENGINEERING



LOOKING AHEAD

School Partnerships

Partner with local school to have a more longitudinal approach

Professional Partnerships

BYU Athletics, Intermountain Health, United State Military

Student Development

Students have deeper interactions with athletes and the technology

Training Optimization

Expand scope of technology to more than form analysis

Public Available Tools

Through apopt and Alpha Peak, release tool front he lab that can be publicly used

Real Impact

Focus on longitudinal impact that is measurable



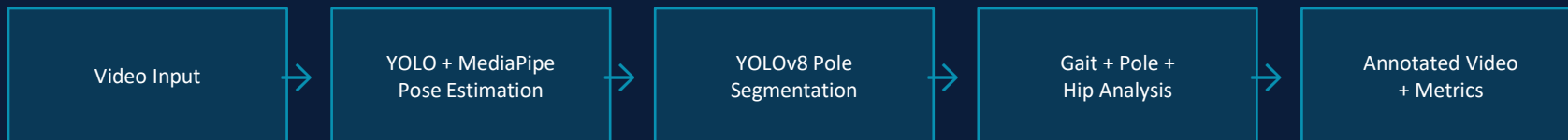
ADDITIONAL SLIDES





POLE VAULT ANALYSIS

AlphaForm — Video-Based Biomechanical Analysis



96.9%

Step Detection Accuracy

0.993

ROC AUC Score

1,000+

Annotated Images

165

Biomechanical Features / Foot

6.6 MB

YOLOv8 v3 Model Size

CV Pipeline: YOLO segmentation, pole mask skeletonization, multi-frame consensus clustering, chord-length bend tracking with polynomial smoothing

ML Pipeline: 7 classifiers with 5-fold cross-validation, HistGradientBoosting best model, post-processing for discrete alternating step detection



MARCUS — POLE VAULT PIPELINE LEAD

Key Accomplishments

- Spearheaded training dataset expansion to 1,000+ annotated images; refined in RoboFlow
- Trained YOLOv8 segmentation model v3 — 72% smaller (6.6 MB vs 23 MB), more accurate
- Built pole analysis pipeline: length calibration via skeletonization, bend % via chord-length ratios
- Created full step-detection ML pipeline from scratch: 165 features, 7 classifiers, 96.9% accuracy
- Built unified analysis pipeline tying together pose, pole, stride, hip droop, and max hip height
- Streamlit UI for configurable analysis, annotated video export, stride plots, and CSV data

Next Steps

- Expand step detection dataset across more athletes & conditions
- High school outreach for diverse video data
- Coach & pro research for benchmark metric values
- LLM-based natural-language coaching feedback
- Continuously evaluate new biomechanical metrics



STEP DETECTION – ML PIPELINE DEEP DIVE

Data & Labeling

- Custom labeling tool for ground-contact annotation
- Extracts 165 biomechanical features per foot from MediaPipe landmarks
- Feature engineering: lags, leads, and derived metrics per frame
- Step-detection review index to locate exact ground-contact frames

Model Training

- Compared 7 classifiers with stratified 5-fold cross-validation
- Best: HistGradientBoosting at 96.9% accuracy
- Balanced dataset for robust evaluation
- Cadence (SPM), stride length, per-stride progression metrics
- Height-based pixel calibration

Output & Post-Processing

- Post-processing cleans raw predictions into discrete alternating steps
- Annotated output video with metric overlays
- Stride plot visualizations and CSV data export
- Configurable analysis parameters via UI

