Soccer Game State Reconstruction

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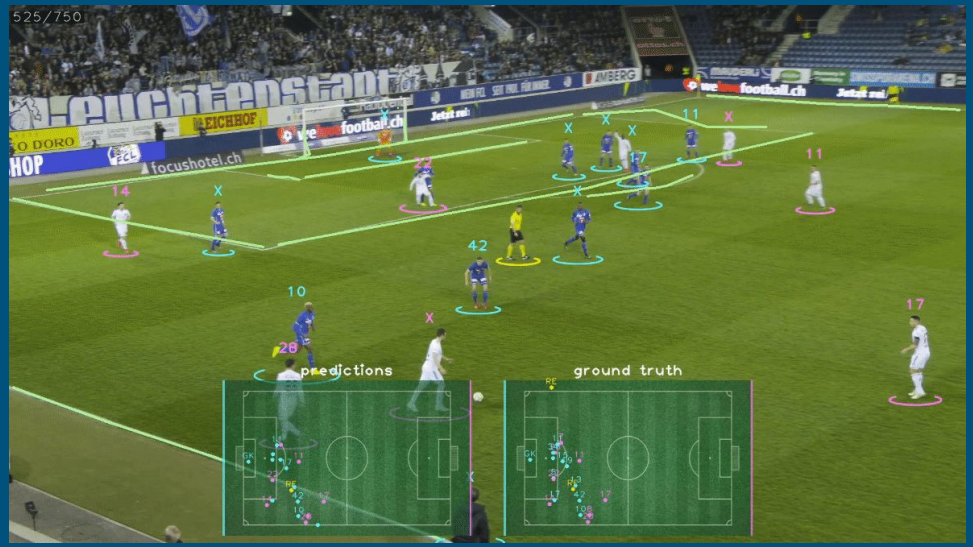
Objective

- Tracking and identification of players, ball, etc. to construct a 2D minimap
- Novel + Challenging: combination of multiple computer vision tasks, moving camera.
- Applications: Data-driven performance insights for sports analysis + broadcast



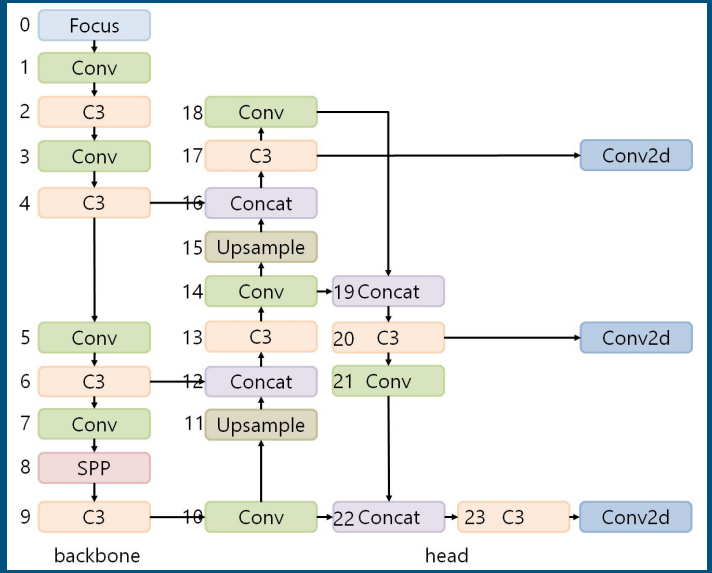
SoccerNet GSR example output

Data + 3V’s

- SoccerNet GSR dataset:
  - https://www.soccer-net.org/data
  - 30s single camera broadcast clips of games in 1080p
  - Labels for jersey number, team, object types, coordinates, etc.
- Velocity
  - Different stages (e.g. players identification, pitch localization) can be processed in parallel
  - GPU acceleration
- Veracity
  - Measure accuracy by comparing our 2D mapping to ground truth
  - Produce reasonable output videos with 25 fps, over 30s videos.
- Volume
  - Large dataset
  - Utilize HuggingFace, Google Cloud Storage Buckets, and a VM to handle storage volume.

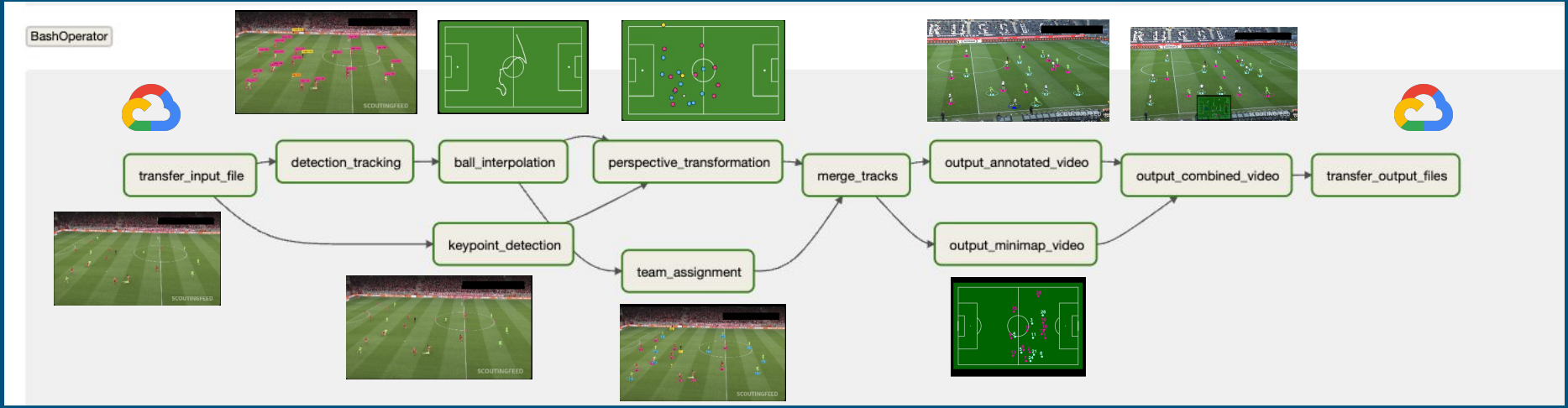
System Overview

- Tech Stack
  - Language: Python
  - Frameworks: OpenCV, Supervision
  - Models: YOLOv5, TVCalib
- Software Architecture
  - Google Colab: model training
  - Google Cloud Platform: VM, airflow, storage buckets



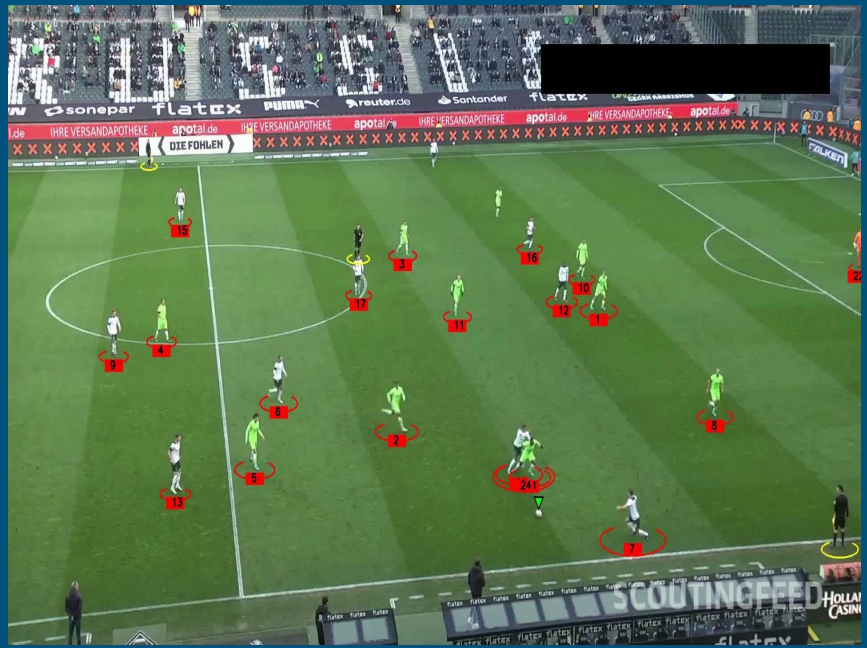
YOLOv5 architecture

System - Airflow

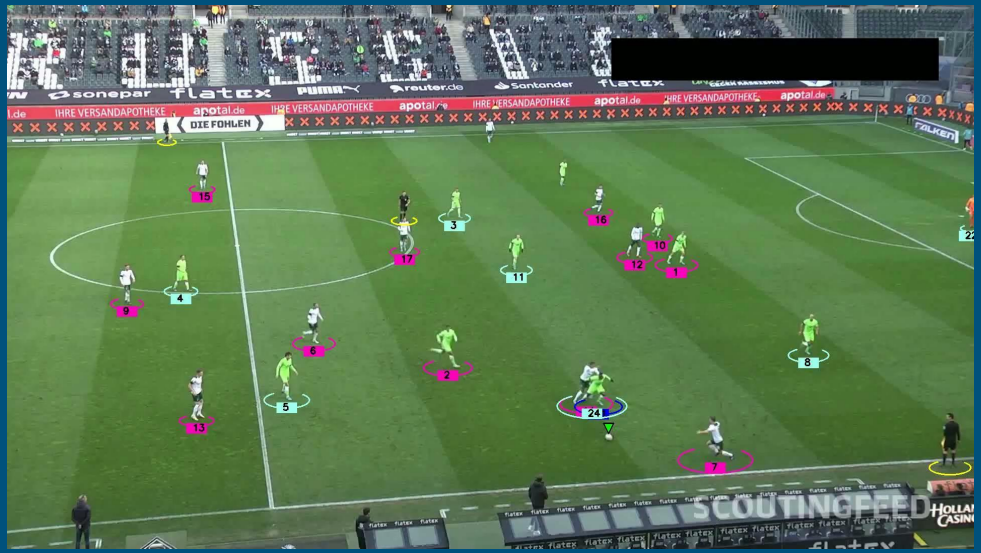


Object Detection/Tracking

- Object Detection: YOLO
  - Fine-tuned to specify object classes (Player, Goalkeeper, Referee, Ball)
- Tracking: Roboflow Supervision
  - Use linear interpolation to estimate ball positions between detections



Player-Team Assignment



- Team colors: K Means
- Goalkeeper's color: heuristics
  - Calculate centroids of both teams
  - Pick the closer one's team color

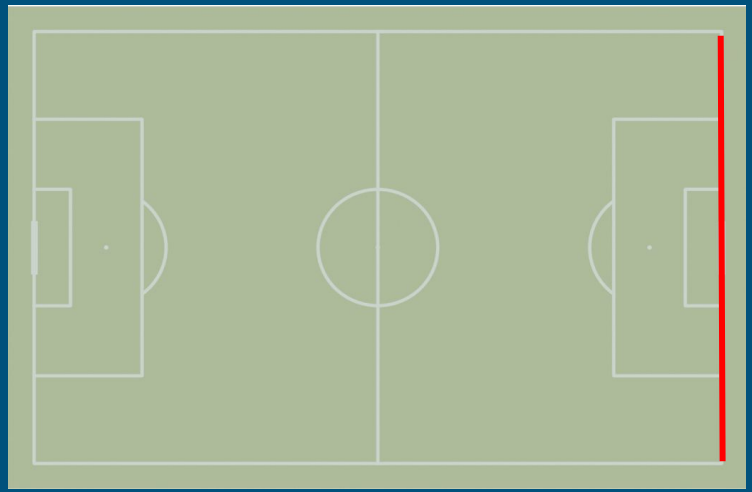
$$C_t = \left(\frac{1}{n_t}\sum_{i}^{n_t} x_i, \frac{1}{n_t}\sum_{i}^{n_t} y_i\right)$$

$$d(C_{goalkeeper}, C_t) = ||C_{goalkeeper} - C_t)||_2$$

Keypoint Detection -> Pitch Localization

“Side line right”

Raw Match Footage

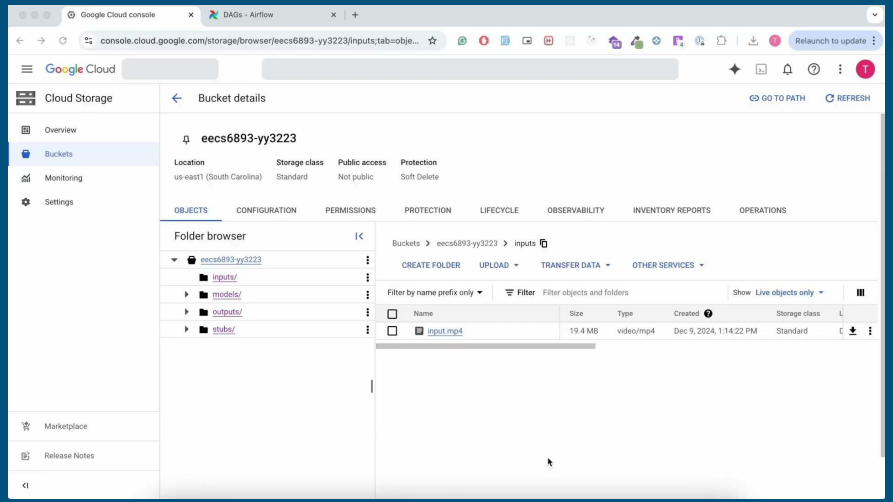


2D Pitch

Perspective Transform

- Given player-tracking bboxes + pitch keypoint detections
  - (optional for visualization: jersey numbers, team, player/ref/gk)

Demo


Google Cloud console
DAGs - Airflow
console.cloud.google.com/storage/browser/eecs6893-yy3223/inputs;tab=obje...
Relaunch to update
Google Cloud
Cloud Storage
Overview
Buckets
Monitoring
Settings
Marketplace
Release Notes
Bucket details
GO TO PATH
REFRESH
eecs6893-yy3223
Location
us-east1 (South Carolina)
Storage class
Standard
Public access
Not public
Protection
Soft Delete
OBJECTS
CONFIGURATION
PERMISSIONS
PROTECTION
LIFECYCLE
OBSERVABILITY
INVENTORY REPORTS
OPERATIONS
Folder browser
Buckets > eecs6893-yy3223 > inputs
CREATE FOLDER
UPLOAD
TRANSFER DATA
OTHER SERVICES
Filter by name prefix only
Filter
Filter objects and folders
Show Live objects only
eecs6893-yy3223/
inputs/
models/
outputs/
stubs/
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Size
Type
Created
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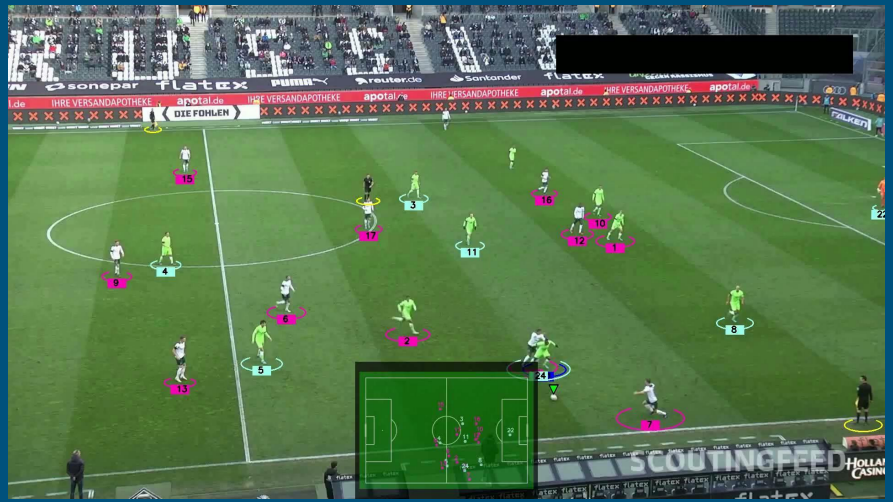
input.mp4
19.4 MB
video/mp4
Dec 9, 2024, 1:14:22 PM
Standard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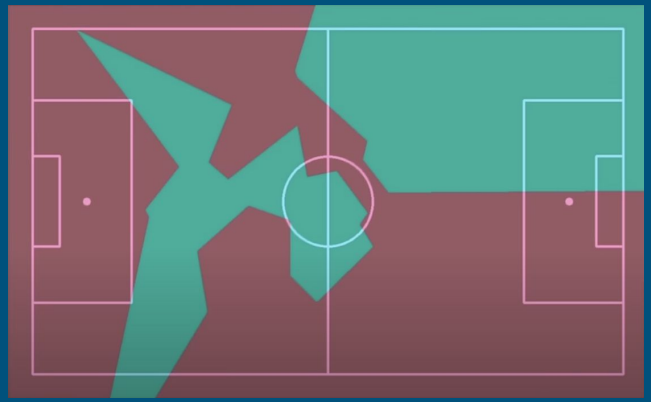
SCOUTINGFEED

Future Work

- Tracking: Tracklet assignment using jersey number, player names
- Perspective Transformation: Post-transform position smoothing
- Visualizations: Heatmap, speed estimator, voronoi plots
- Airflow: Having its own backend to parallelize the pipeline



Q&A