Soccer Player Tracking

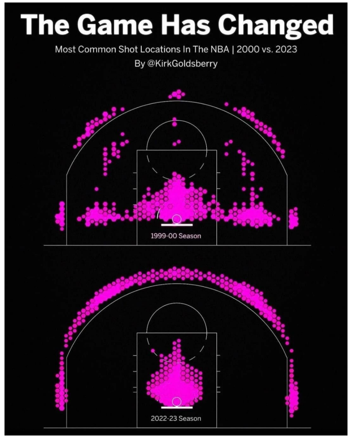
Olivia Tchilibou (axt619), Colin Chenoweth (cwc63), and Thomas Bornhorst (thb34)

Project Description and Goal

- Problem to solve: Getting data on position of all players in a game as they move around in a game of soccer.
- Goal: Track players throughout a game using a neural network model with bounding boxes or general locations
    - Identify players from frame to frame
    - Be able to chart players movement across a game
    - Work with a given camera angle

Why is it important? Growing use of and realized importance of data in sports

- Huge movement in baseball in early 2000s shifted perspectives on the sport (Moneyball)
- Advanced analytics in basketball used more and more (i.e. DARKO)
  - By looking at efficiency of shots from different spots, how the game is played has fundamentally changed
- Soccer teams like Manchester City using it to win league
- Teams using analytics get an advantage over competitors
- Being able to track your players and the ball along with results can allow for deep and more automated analysis of a team that was not possible before
  - Trending use of microchips and trackers in the sports world but these can be expensive, intrusive, disruptive, etc.



Paper: [Player-Tracking Technology]

Related Work

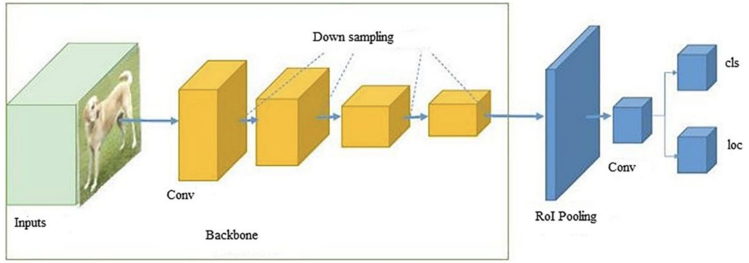


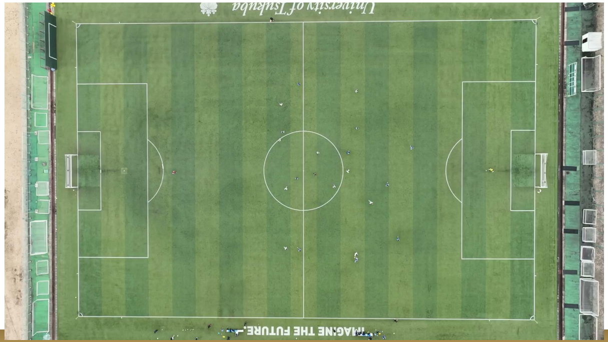
Fig. 2 Basic architecture of one stage detector [1]

- Multi-object detection and tracking is a deep field
  - Some different detectors used: R-CNN variants, YOLO versions, Single-shot detector
  - For tracking: Deep network MOT, End-to-end Deep Learning MOT, RNN-based MOT
- Methods in a sports context
  - YOLO v5 detection with additional processing for object tracking (Kalman Filter)
  - Going from 2D tracking to a 3D tracking of body positions
  - Constraining a model using context and assumptions and then a random decision forest
  - Tracking a ball in sports using multiple camera angles with use of Kalman Filter, Particle Filter, Trajectory Based approach, and others

Papers: 3D Pose Tracking, SoccerTrack, Context-Conditioned Models, Ball Tracking, Tracking Players, MOD, MOT

Dataset

- 60 videos, each 30 seconds or 900 frames, with their corresponding annotations from the top view.
    - Soccer Track Dataset: https://www.kaggle.com/datasets/atomscott/soccertrack
- Annotations in csv format with coordinates of bounding boxes
- Dataset also contains wide_view angles of video that were not used as well as GNSS coordinates of each player



Our Approach - PyTorch

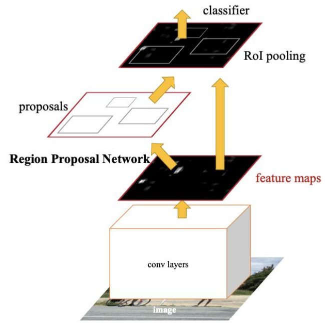


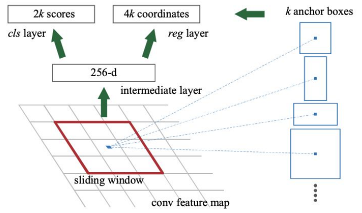
Figure 2: Faster R-CNN is a single, unified network for object detection. The RPN module serves as the 'attention' of this unified network.

Dataset Preprocessing Steps

- Loaded the annotations
- Video frame extractions
- Calculations of Bounding Box coordinates
- Data Split: 70% train, 10% validation, and 20% test.

Training Steps

- Faster R-CNN model with Region Proposal Networks
  - https://arxiv.org/abs/1506.01497
- One class for each player + ball + background
- SGD with lr=0.005, momentum=0.9, weight_decay=0.005
- Plan was to run for many epochs
- Run on Case HPC



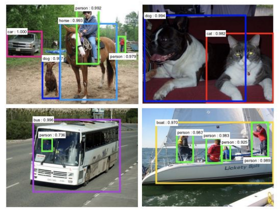


Figure 3: **Left**: Region Proposal Network (RPN). **Right**: Example detections using RPN proposals on PASCAL VOC 2007 test. Our method detects objects in a wide range of scales and aspect ratios.

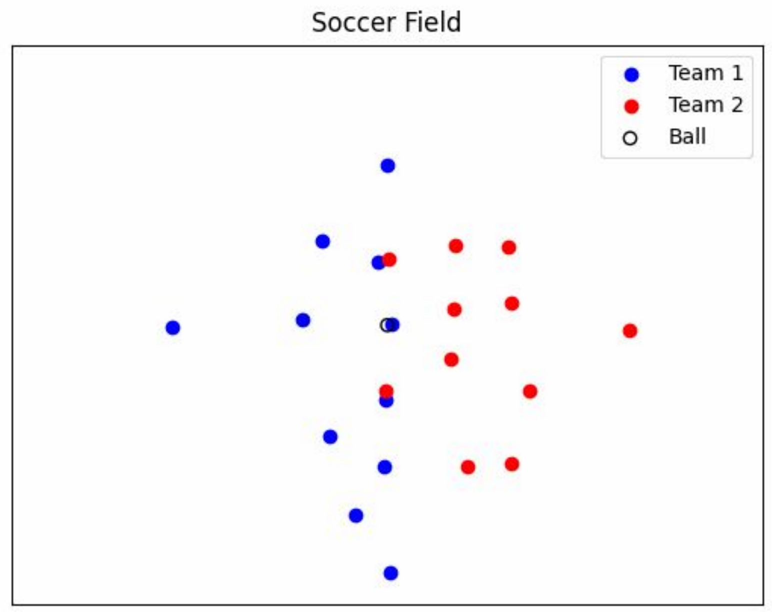
Challenges

- Data
    - 54,000 total frames
        - Takes long time to preprocess extract frames
        - Missing values
- HPC
    - Difficult to debug
    - Takes long time to run a since epoch because large dataset
    - GPU storage limits our usable batch sizes

Results: Data Preprocessing/Faster R-CNN

- Frame extraction
- Drop frames/annotations with missing box annotations
- Implemented Faster R-CNN for 4 classes
    - Background, 2 teams, 1 ball
- Currently training (finally with no errors/nan values appearing, hopefully)

Results: Tracking Algorithm



Next Step

- Try to run on multiple GPUs to speed up training
- Run tracking on the model’s predicted boxes
- Performance metrics
- Attempt to extract more useful information, such as possession or goals.
- If have time, work on identifying individual players, not just teams
    - Can try retraining Faster R-CNN
    - Can try using using previous frame’s boxes

Thank You!