



# NFL Health and Safety Helmet Assignment & Collision Detection

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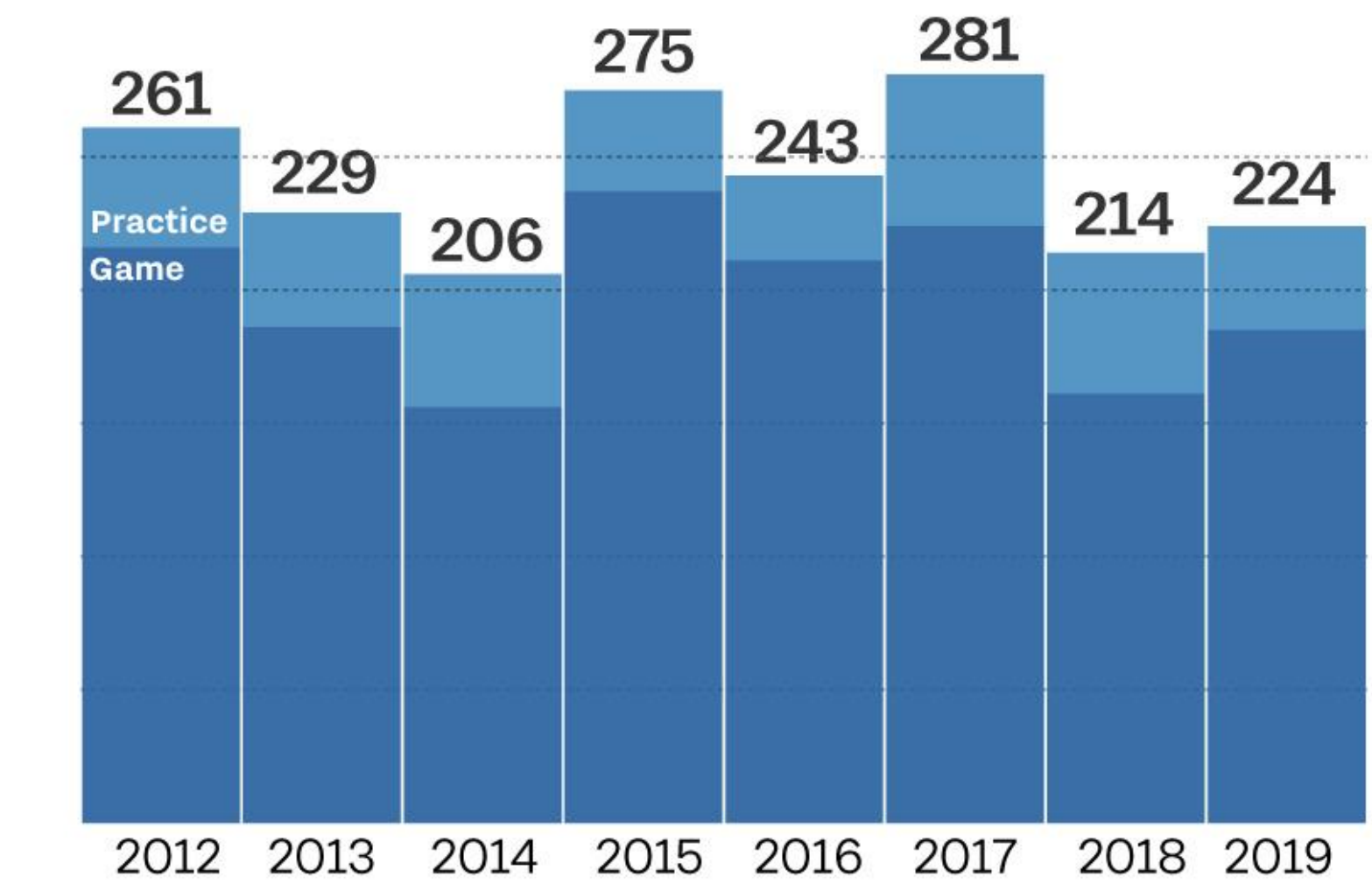


## Background

- The repeated exposure of the human brain to traumatic impacts is shown to significantly increase the likelihood that an individual will develop CTE, Alzheimer's or even dementia.
- In a recent study, the brains of 111 former NFL players were examined, and 110 of those were diagnosed with CTE.
- The goal of this project is to create a preventive analytic algorithm that can aid in the prevention of concussions and potential CTE in players in contact sports such as football.
- This is done through the automatic tracking of helmets and the players to whom they belong to, along with the detection of impacts in a specific game clip

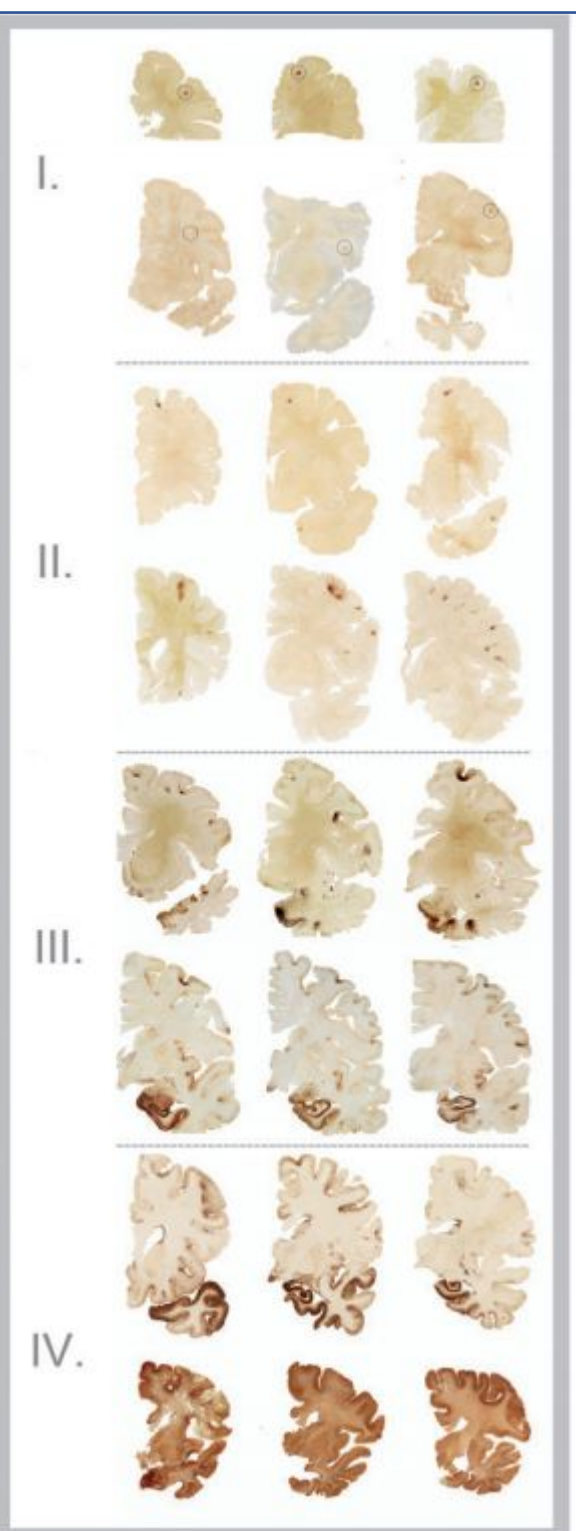
## Concussions in the NFL by year

Preseason and regular season



Source: NFL

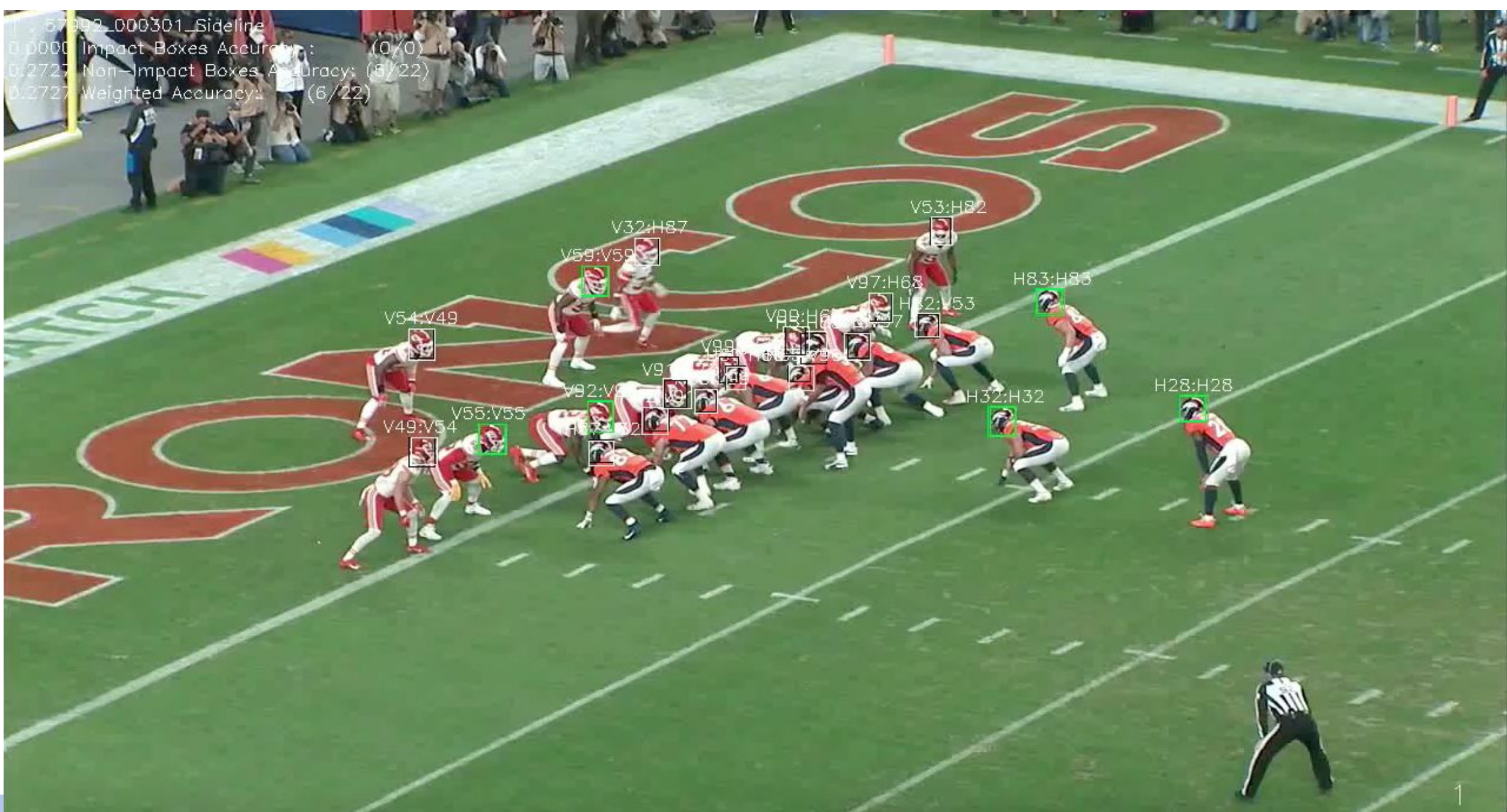
Vox



## Methods

- Employed DeepSort which is a machine learning model for tracking and assigning IDs
  - Computed bounding boxes using YOLO v5
  - Uses sorting and the identification model to link bounding boxes and tracks
- Parameters to tuning DeepSort to receive better accuracy in video output
  - MAX\_DIST: Threshold to determine similarity in ID model
  - MIN\_CONFIDENCE: Minimum confidence algorithm has in prediction
  - MAX\_IOU\_DISTANCE: How much boxes should overlap to determine ID
  - MAX\_AGE: Number of frames unallocated tracks will be deleted after
  - N\_INIT: Number of frames newly allocated tracks will be activated after
  - NN\_BUDGET: Previous number of frames to retain for each track

| video_frame             | label | left | width | top | height |
|-------------------------|-------|------|-------|-----|--------|
| 57992_000301_Sideline_1 | V49   | 346  | 22    | 286 | 28     |
| 57992_000301_Sideline_1 | H83   | 879  | 24    | 250 | 24     |
| 57992_000301_Sideline_1 | H32   | 838  | 24    | 355 | 27     |
| 57992_000301_Sideline_1 | H82   | 790  | 18    | 186 | 25     |
| 57992_000301_Sideline_1 | V53   | 776  | 21    | 272 | 21     |
| 57992_000301_Sideline_1 | H68   | 737  | 20    | 254 | 26     |
| 57992_000301_Sideline_1 | V97   | 716  | 22    | 290 | 24     |
| 57992_000301_Sideline_1 | H65   | 683  | 18    | 288 | 18     |
| 57992_000301_Sideline_1 | V90   | 669  | 21    | 319 | 22     |
| 57992_000301_Sideline_1 | H60   | 664  | 22    | 284 | 26     |
| 57992_000301_Sideline_1 | H28   | 1001 | 24    | 345 | 24     |



## Results

- A video output with the tracking of player helmets and collisions, for a set of trained NFL video clips.
  - Green boxes signify correct matching of helmet and player number
  - White boxes signify incorrect matching of helmet and player number
  - Yellow boxes signify previously confirmed collisions
  - Red boxes signify detection of collision by our algorithm
- CSV file displaying coordinates of detected boxes to specific players
- Final output of total number of detected collisions in video clip

## Further Applications

- Future applications can be used for both diagnosis and prevention to better improve the lives of not only football players, but other contact sports
- Apply this technology to concussion prone sports or activities (i.e. ice hockey or lacrosse)
- Use this machine learning model to analyze an entire game as opposed to only limitedly timed clips
- Create a web application to allow users to input video and receive a visual output of helmet detection and impact detection
  - The NFL can begin developing this to allow first team access, then sell proprietary use
- Use model to begin detecting impacts in real time to better predict and diagnosis brain injuries
  - Can be used mid competition to not only review play, but if algorithm detects major collision
  - Parameters can be changed depending on sport to signify what an impact is

## Collision Comparison Video



## Project Github



## Endzone Collision Video

