RoboEireann Open Research Challenge –
Video Analysis/Statistics
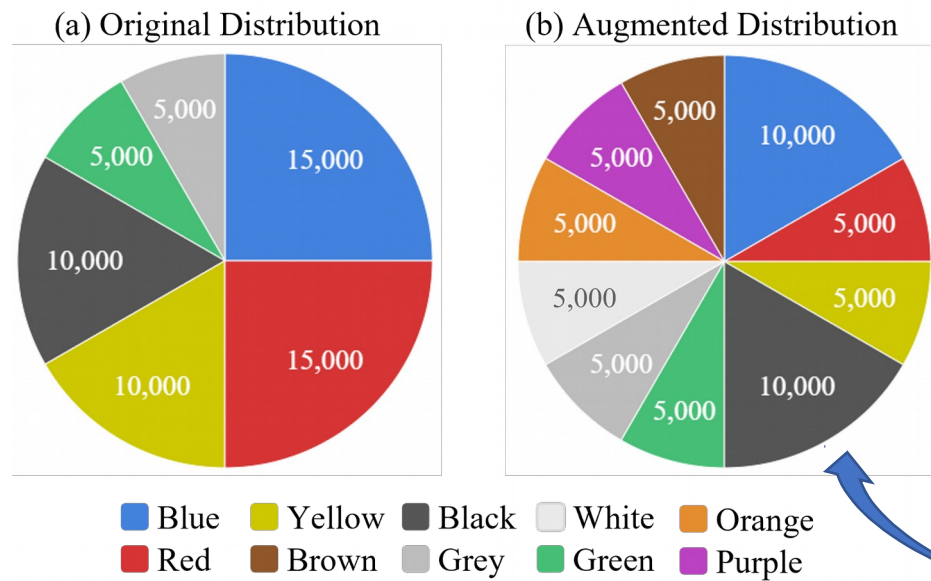
RoboCup 2022 Standard Platform League

Maynooth University
National University
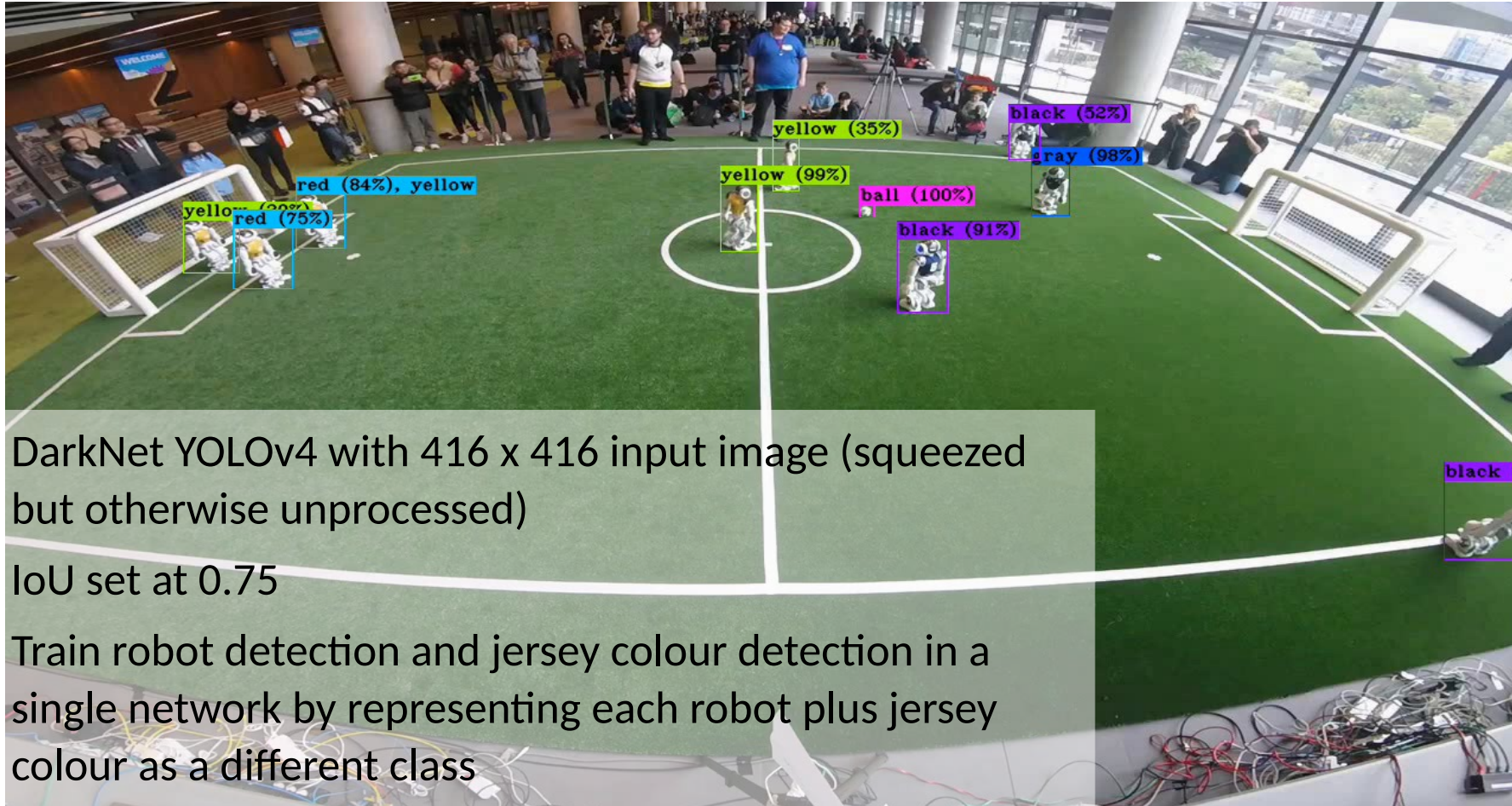of Ireland Maynooth

Approach

- Focus on object detection, dataset wrangling, some coordinate mapping, basic statistics
- Did not attempt automatic estimation of camera extrinsics

416x416

Object detector (YOLOv4)

Evaluated

Coordinate mapping

Partial

Filter + heuristics statistics

Basic

Dataset augmentation

(a) Original Distribution

(b) Augmented Distribution

Blue · Yellow · Black · White · Orange
Red · Brown · Grey · Green · Purple

Object detection

- DarkNet YOLOv4 with 416 x 416 input image (squeezed but otherwise unprocessed)
- IoU set at 0.75
- Train robot detection and jersey colour detection in a single network by representing each robot plus jersey colour as a different class

Object detection results

Object detector performance
AP @ IoU 0.75

⚽	ball, ap = 51.24%	(TP = 1499, FP = 1004)
🔴	red, ap = 97.60%	(TP = 1994, FP = 58)
🟡	yellow, ap = 96.28%	(TP = 2410, FP = 104)
⚫	black, ap = 97.52%	(TP = 4724, FP = 151)
⚪	white, ap = 93.75%	(TP = 2332, FP = 169)
🟢	green, ap = 97.77%	(TP = 1523, FP = 37)
🟠	orange, ap = 95.42%	(TP = 2277, FP = 113)
🟣	purple, ap = 95.23%	(TP = 2267, FP = 117)
🟤	brown, ap = 94.89%	(TP = 2270, FP = 72)
⚫	grey, ap = 97.96%	(TP = 1466, FP = 34)
🔵	blue, ap = 95.54%	(TP = 4528, FP = 242)

Average inference time 43.1 ms (23.2 Frames/sec) on
i7-8750H with NVIDIA GeForce GTX 1060

- Ball AP is very small in the image and small localisation errors make a difference
  - At IoU 0.5, the ball AP is close to 80%
- The AP results are reasonable but some colour errors occur
  - Better augmentation likely needed
  - Prior knowledge (which two jersey colours to expect) could be integrated
  - Jersey classifier could be separated (but prefer not to)

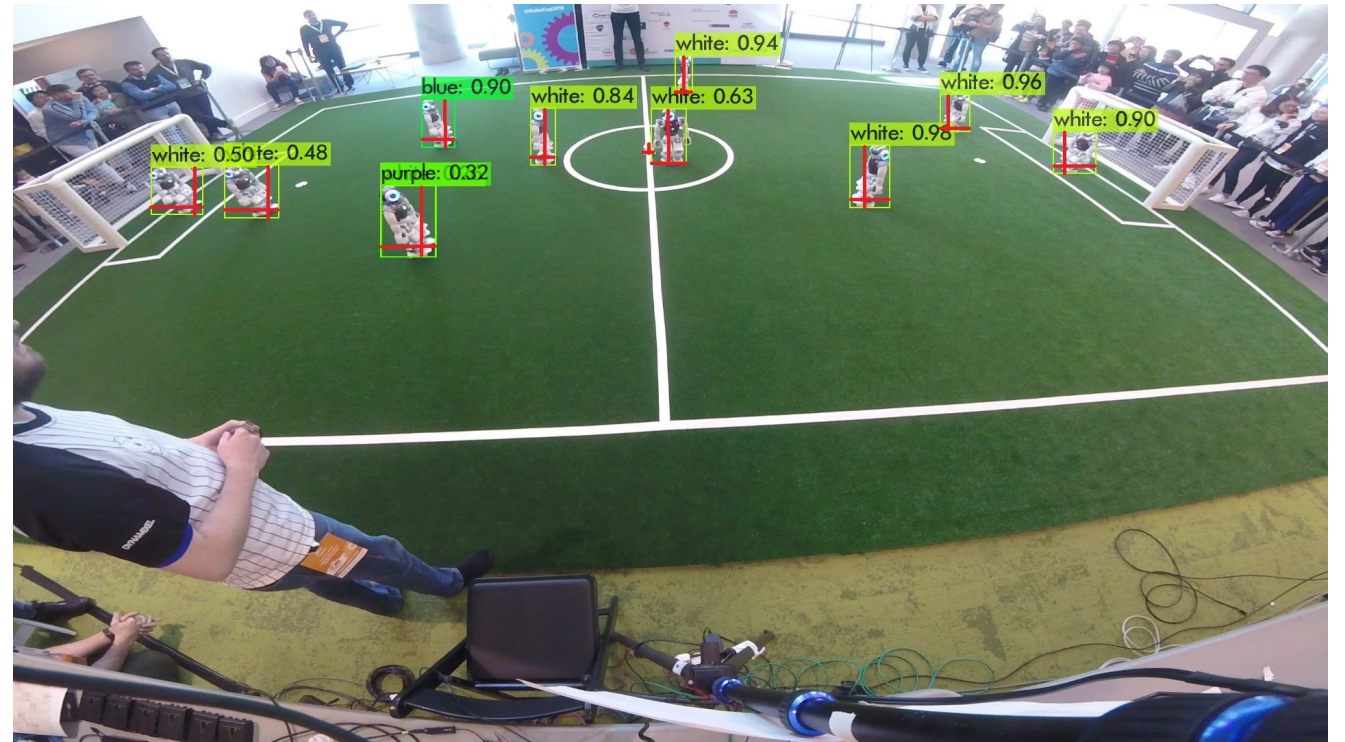# Position estimation
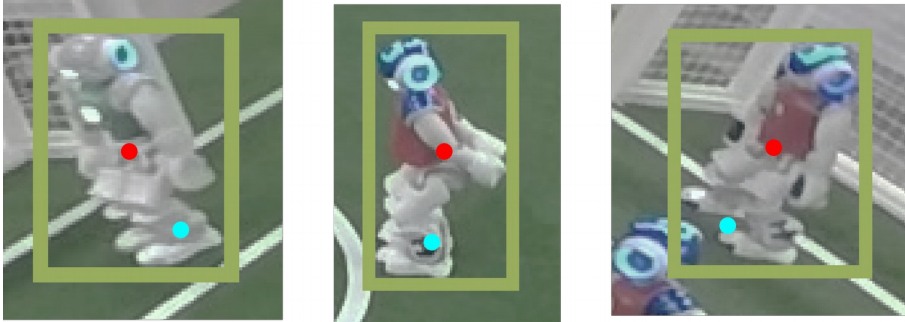
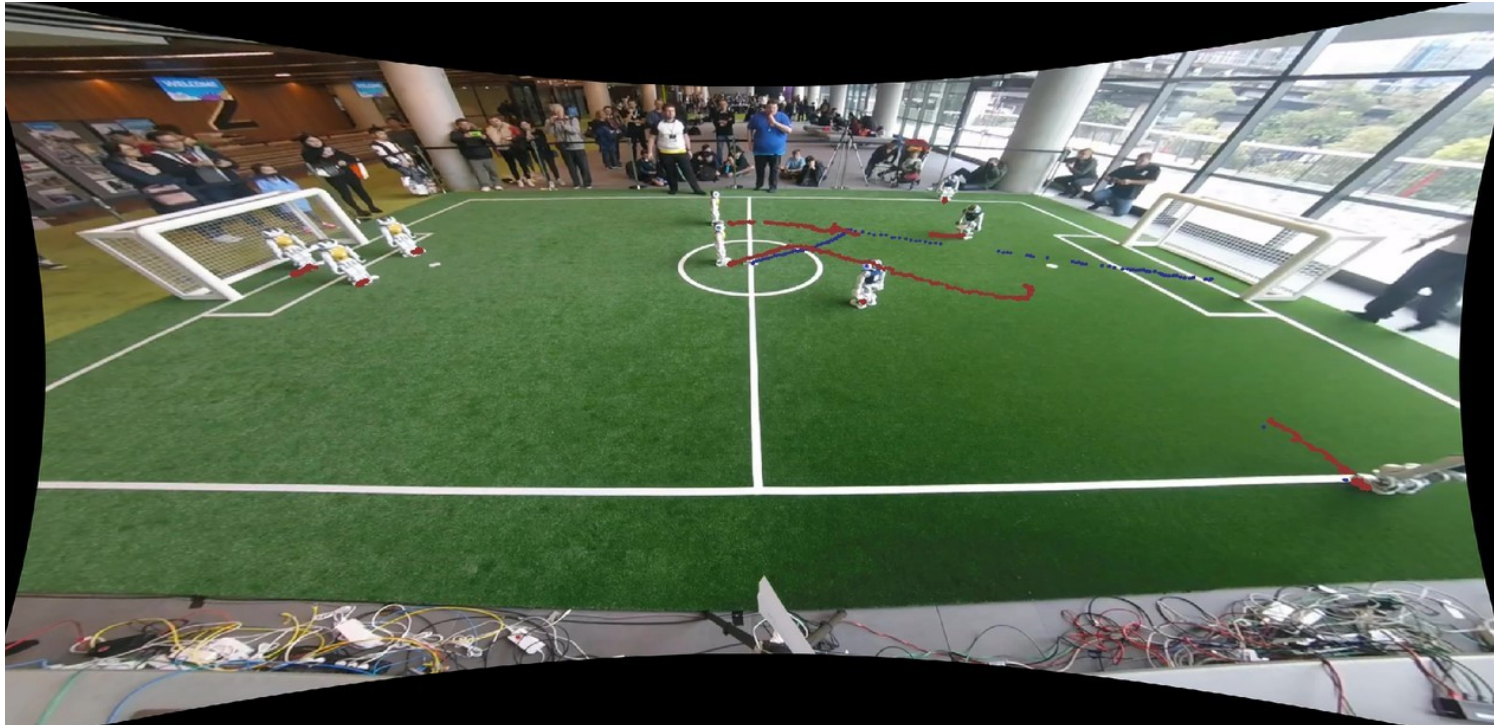● Default Coordinate   ● Desired Coordinate

$$\delta = \frac{0.5I_w - x_c}{0.5I_w}$$

$$x = x_c + \delta(0.4b_w)$$

$$y = y_c + 0.4b_h$$

Tracking and statistics

Kick   Normal Detection   Position after Discontinuity   High Speed Detection

Conclusions

- A standard object detector such as YOLOv4 is likely accurate enough and fast enough to generate the position input for many useful statistics

- Our own approach of detecting colours as object classes is currently not sufficiently accurate, but we have ideas to solve this

- Basic statistics can be derived from the object position data over time using heuristics

- It might be interesting to see whether machine learning should also be applied to identifying events of interest also

- We are not yet convinced that statistics at the player level are relevant and did not invest any time in examining the robot numbers on jerseys (other than during the required labelling task)

- We believe that incorporating statistics into measurement of league progress will help to identify areas for improvement and future rules changes