YOLO for impact detection in Ice Hockey.

Muhammad Sohaib Arif

Problem Description: Concussions in Ice Hockey

Ice Hockey is a very fast game.

Players might be moving at speeds above 30 kilometers per hour

Ice Hockey has the highest rate for concussions in any contact sport

Concussions have become a topic of considerable interest amongst the scientific community, media and general public due to the sensational mechanisms of injury and deleterious consequences they can impart.

Detecting Collisions

Currently, among other methods, collisions are detected using accelerometers and other sensors.

EMU Depart of Health Promotion and Human Performance does research in this topic using sensors.

Current research here involves corroborating impacts detected by sensors using video feeds manually.

This is highly time consuming. How can machine learning help?

Enter Object Detection

Image Processing Tasks:

Image Classification: What is the most prominent object in the image?

Object Detection: What objects are present in the image and what is their general location?

Object Segmentation: What are the exact boundaries of those objects in the image?

Landmark Detection: Detecting coordinates of key points in an image


REHFREW
pepsi
Kroger
Hines Park
HOCKEY

Why Object detection?

Classification doesn’t give information, and is error prone in crowded images.

Classification is also more difficult to verify manually.

Segmentation and landmark detection is too expensive and time consuming to get labelled data.

Additionally, we don’t need something so specific as segmentation or landmark detection for the task of checking collisions

Components of Object Detection: Sliding Window

Train an object classifier on cropped image as a filter

Run the classifier as sliding window over whole image

Change the size of the window and run it again

Repeat

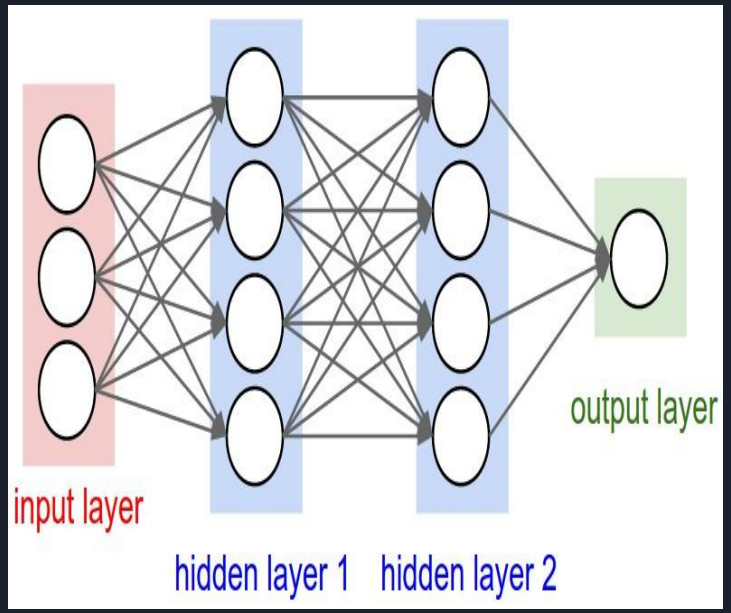
Output the window where the object was found

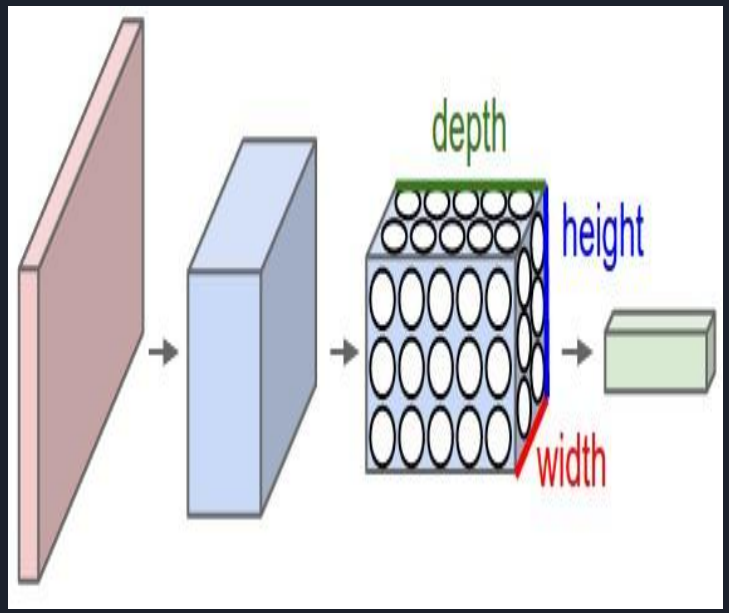
PROBLEMS:

Very computationally intensive

Wasted Computation

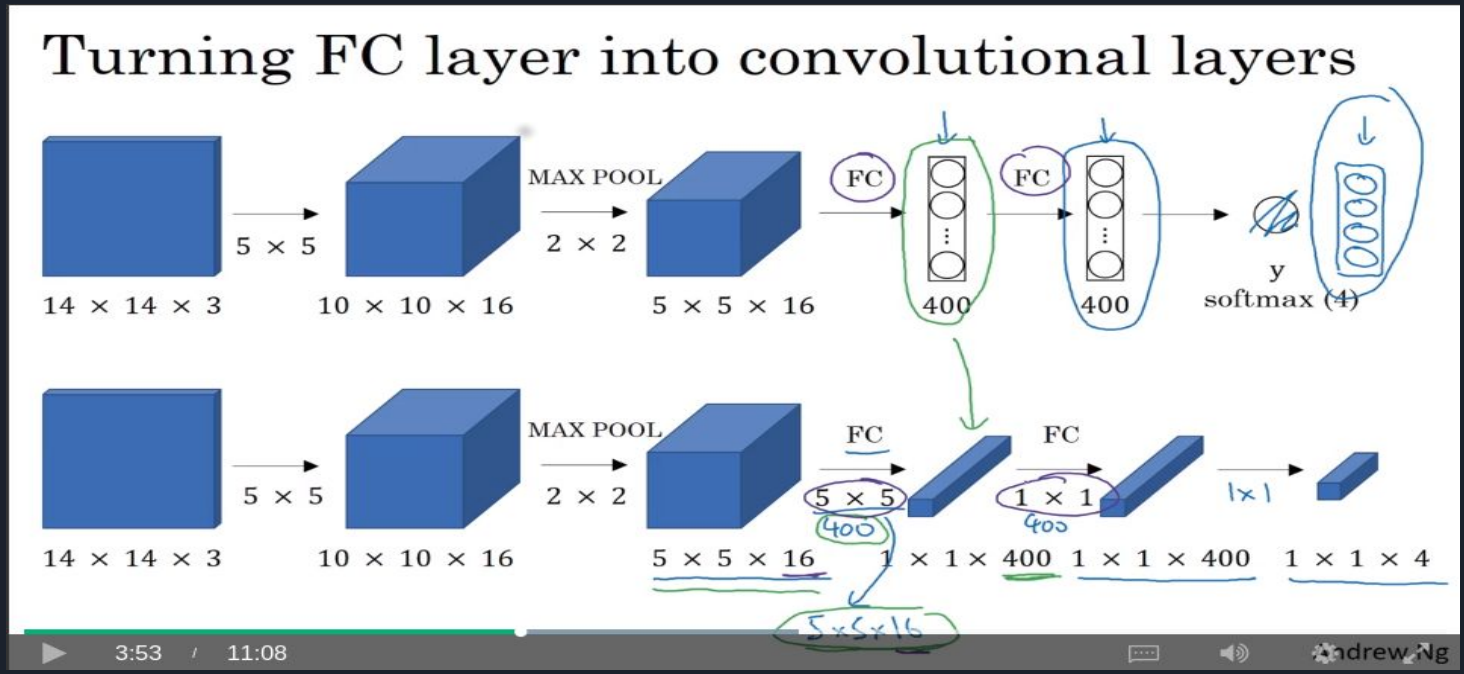
Convolutional Neural Network



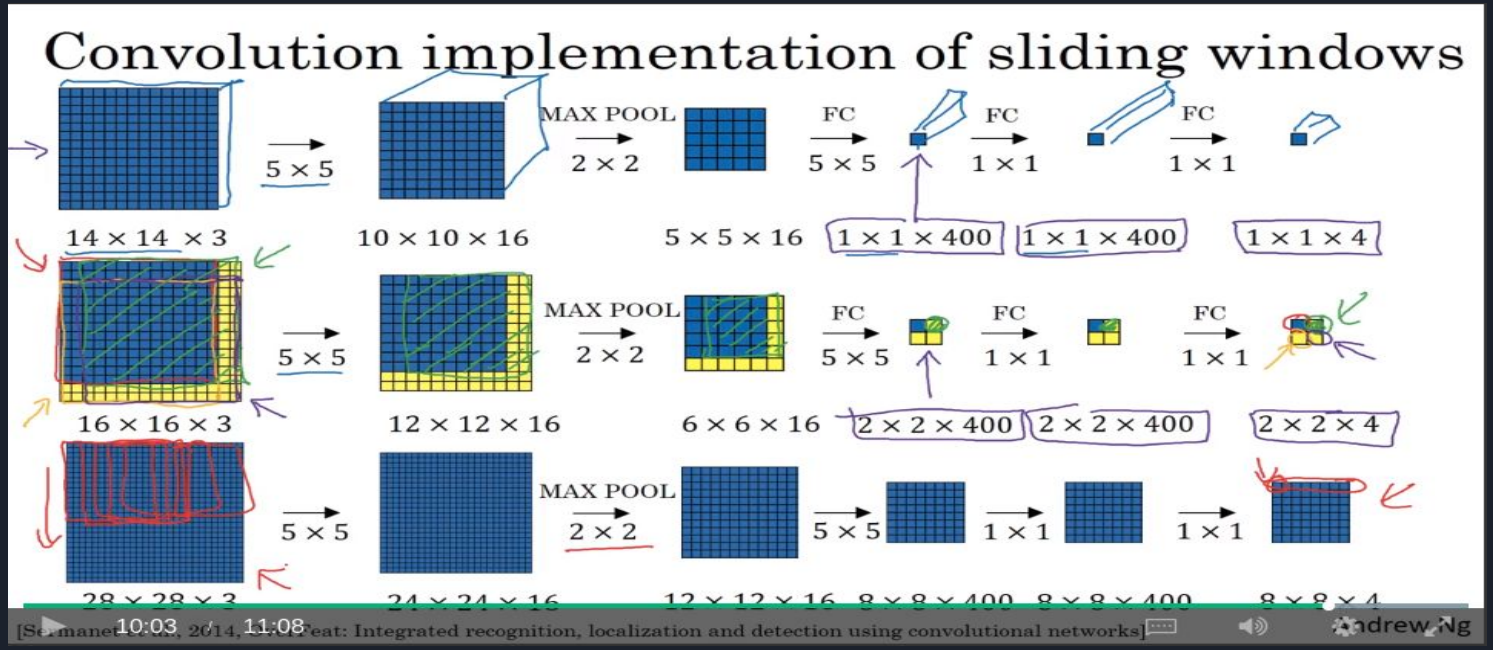


Making Sliding Window Faster

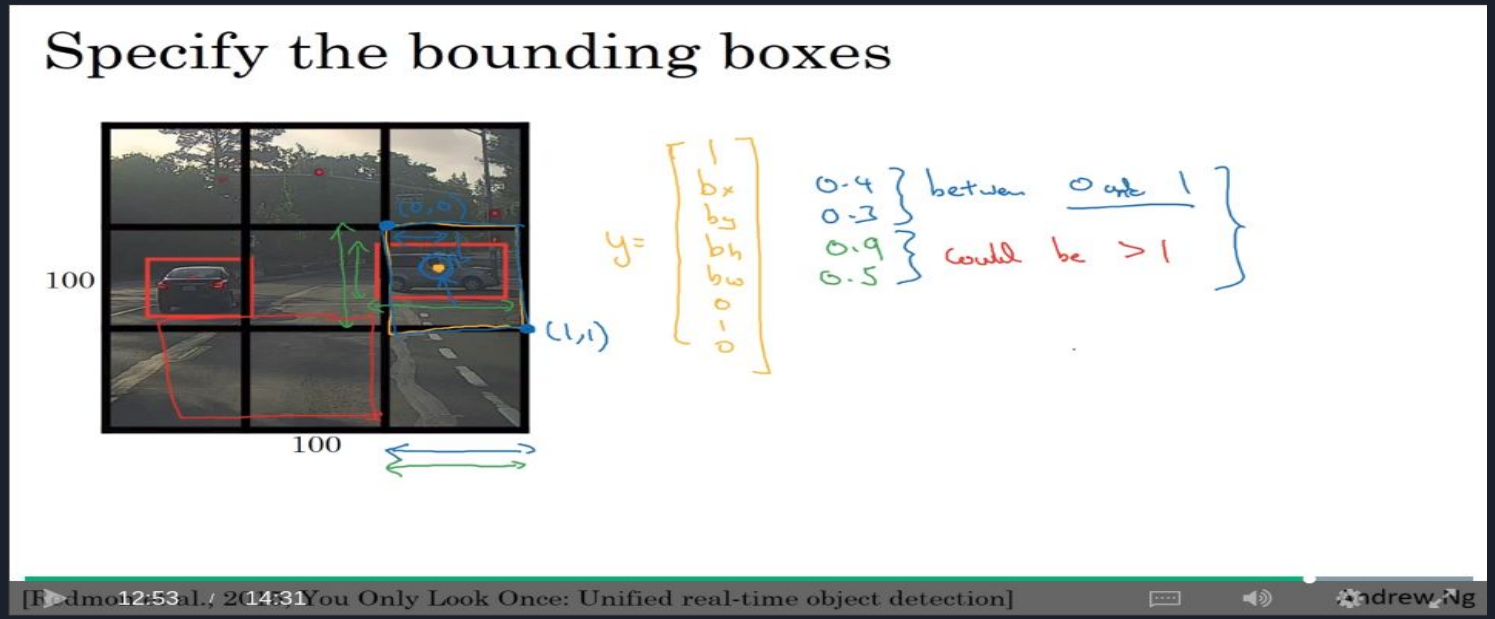
Is there a way to reuse components? (Conv output size =(W - F + 2P)/ S + 1)



Using the convolution to speed up computation



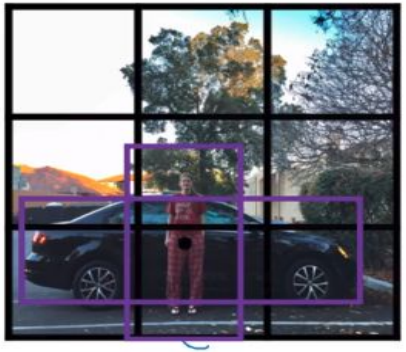
Components of Object Detection: How to specify the object location



Components of Object Detection: Non-Max Suppression

Final Component: Anchor Box

Anchor box example



Anchor box 1: Anchor box 2:

$$y = \begin{bmatrix} p_c \\ b_x \\ b_y \\ b_h \\ b_w \\ c_1 \\ c_2 \\ c_3 \\ p_c \\ b_x \\ b_y \\ b_h \\ b_w \\ c_1 \\ c_2 \\ c_3 \end{bmatrix}$$

Andrew Ng

Getting data and labels for YOLO

Video processing code demo.

Labelling demo.

Training Procedure

Training demo

Verification

Frame number to timestamp conversion

“blink” and approximate matching

Next step

Conclusion

State of project

Other use cases

Possible Improvements

References

Izraelski, Jason. “Concussions in the NHL: A Narrative Review of the Literature.” *The Journal of the Canadian Chiropractic Association* 58.4 (2014): 346–352. Print.

Redmon, Joseph, and Ali Farhadi. "YOLO9000: better, faster, stronger." *arXiv preprint* (2017).

Raval, Siraj. “YOLO Object Detection.” YouTube, YouTube, 15 Nov. 2017, www.youtube.com/watch?v=4eIBisqx9_g.

Ng, Andrew. “Online Courses From Top Universities. Join for Free.” *Coursera*, www.coursera.org/learn/convolutional-neural-networks/home/week/3.

stanfordeng. “Lecture 11 | Detection and Segmentation.” YouTube, YouTube, 11 Aug. 2017, www.youtube.com/watch?v=nDPWywWRIRo

Qiu, Shi. “Puzzledqs/BBox-Label-Tool.” *GitHub*, 12 Sept. 2017, github.com/puzzledqs/BBox-Label-Tool.

AB, Alexey. “AlexeyAB/Darknet.” *GitHub*, github.com/AlexeyAB/darknet.