



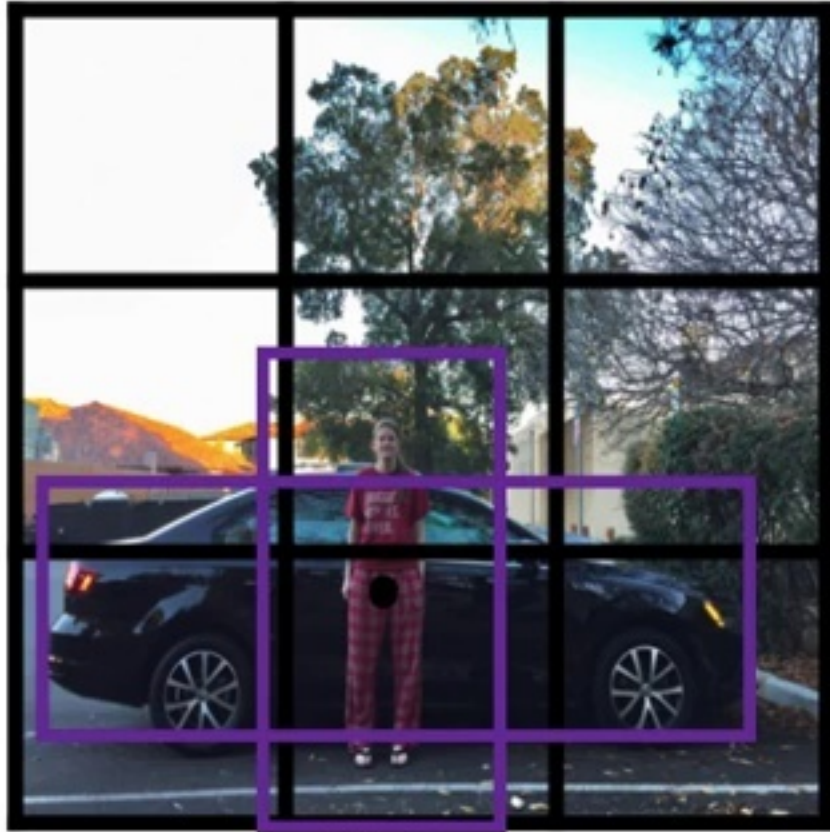
deeplearning.ai



Overlapping objects:

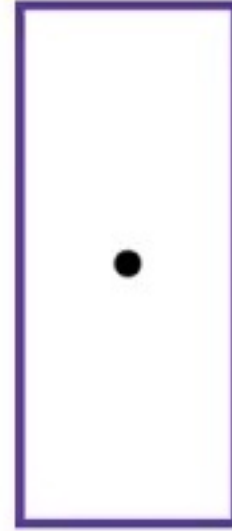


Overlapping objects:

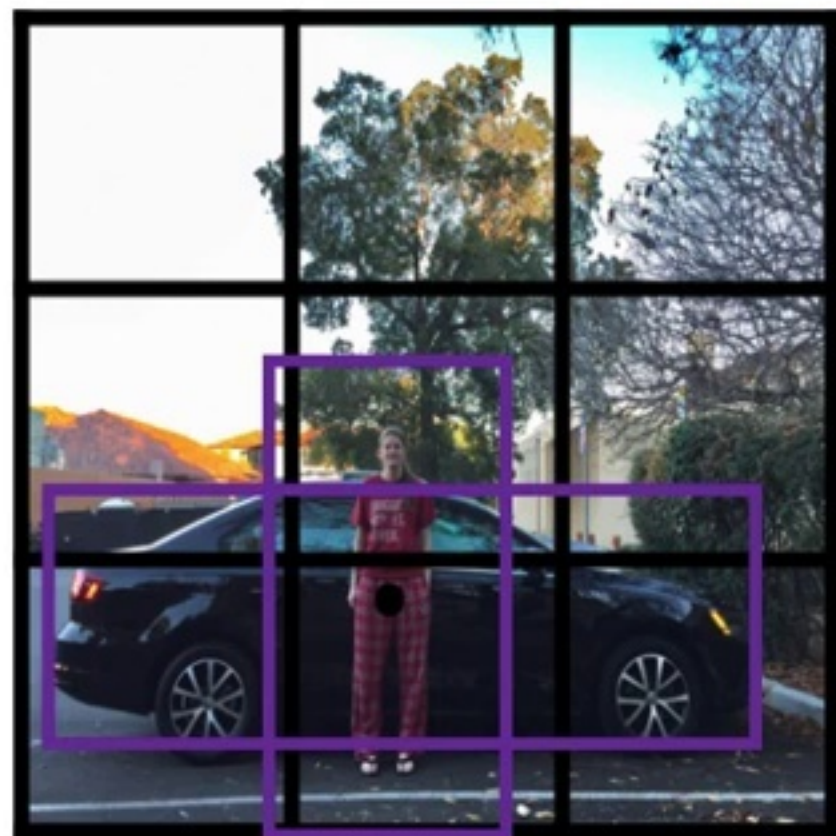


$$y = \begin{bmatrix} p_c \\ b_x \\ b_y \\ b_h \\ b_w \\ c_1 \\ c_2 \\ c_3 \end{bmatrix}$$

Anchor box 1:



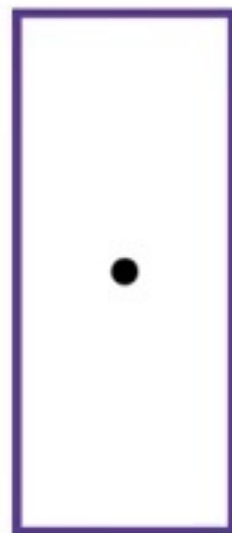
Overlapping objects:



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

A blue curly brace groups the last three elements (c_1, c_2, c_3) of the vector y .

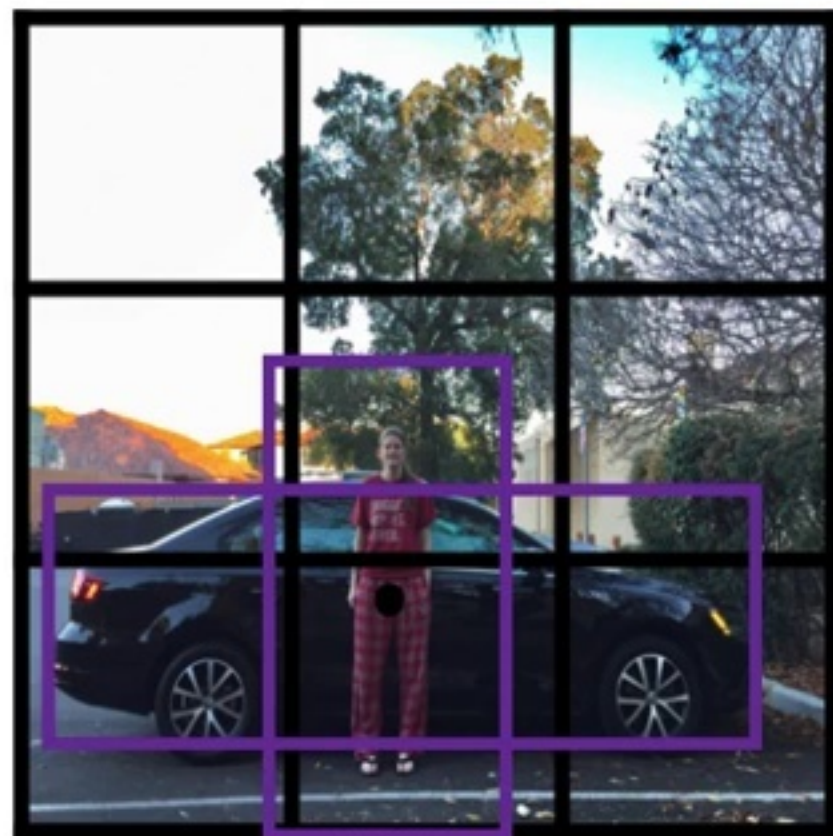
Anchor box 1:



Anchor box 2:

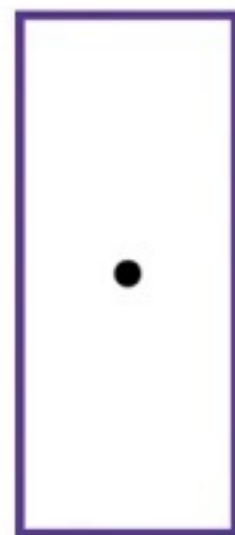


Overlapping objects:



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

Anchor box 1:

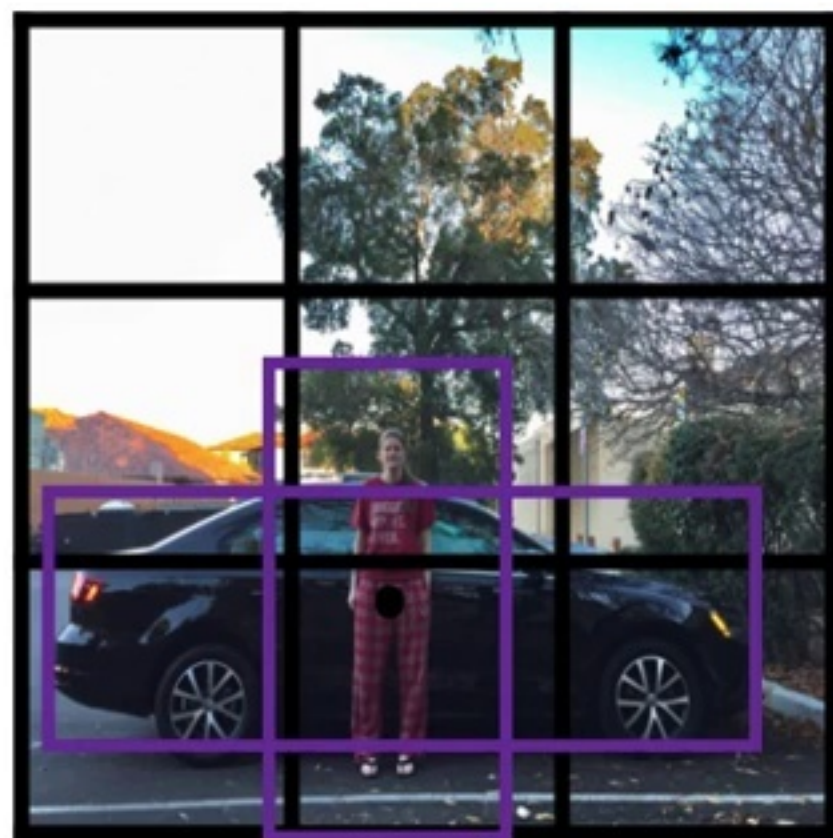


Anchor box 2:



$$y = \begin{bmatrix} p_c \\ b_x \\ b_y \\ b_h \\ b_w \\ c_1 \\ c_2 \\ c_3 \end{bmatrix} \begin{matrix} \left. \begin{matrix} p_c \\ b_x \\ b_y \\ b_h \\ b_w \\ c_1 \\ c_2 \\ c_3 \end{matrix} \right\} \text{Anchor box 1} \\ \left. \begin{matrix} p_c \\ b_x \\ \vdots \\ c_3 \end{matrix} \right\} \text{Anchor box 2} \end{matrix}$$

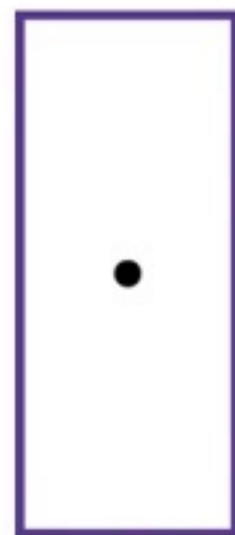
Overlapping objects:



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

Handwritten annotations: A green arrow points from the center of the purple box in the image grid to p_c . A blue arrow points from the left side of the purple box to b_x and b_y . A blue bracket groups c_1, c_2, c_3 .

Anchor box 1:

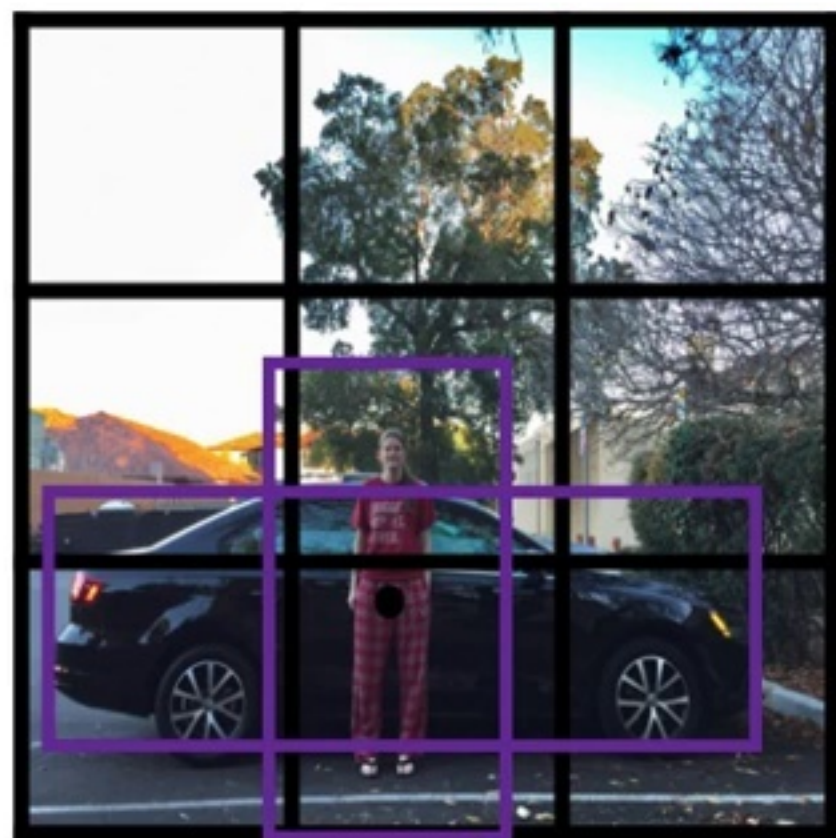


Anchor box 2:



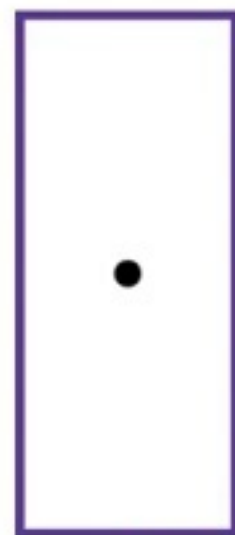
Handwritten annotations: A green box encloses the first five elements of the vector y (p_c, b_x, b_y, b_h, b_w). A blue bracket to the right of this green box is labeled "Anchor box 1". Another green box encloses the last three elements of the vector y (c_1, c_2, c_3). A blue bracket to the right of this green box is labeled "Anchor box 2".

Overlapping objects:



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

Anchor box 1:



Anchor box 2:



$y =$

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

Anchor box 1

Anchor box 2

Anchor box algorithm

Previously:

Each object in training image is assigned to grid cell that contains that object's midpoint.

Anchor box algorithm

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Each object in training image is assigned to grid cell that contains that object's midpoint.

Output y :

$$\underline{3 \times 3 \times 8}$$

Anchor box algorithm

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Each object in training image is assigned to grid cell that contains that object's midpoint.

Output y :

$$\underline{3 \times 3 \times 8}$$

With two anchor boxes:

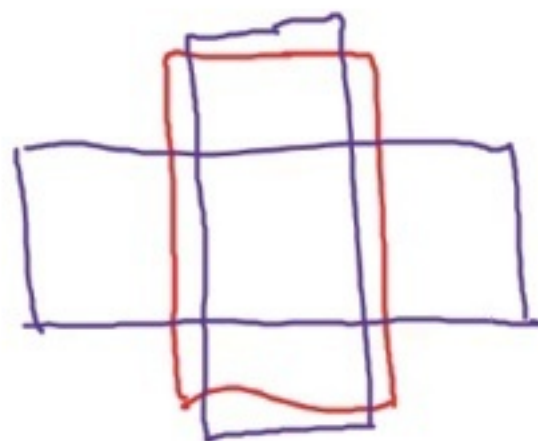
Each object in training image is assigned to grid cell that contains object's midpoint and anchor box for the grid cell with highest IoU.

Anchor box algorithm

Previously:

Each object in training image is assigned to grid cell that contains that object's midpoint.

Output y :
 $3 \times 3 \times 8$



With two anchor boxes:

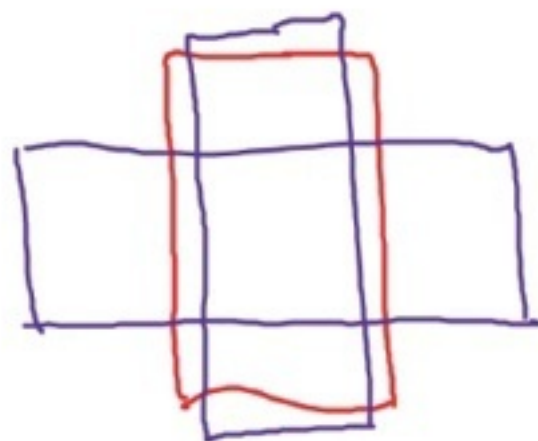
Each object in training image is assigned to grid cell that contains object's midpoint and anchor box for the grid cell with highest IoU.

Anchor box algorithm

Previously:

Each object in training image is assigned to grid cell that contains that object's midpoint.

Output y :
 $3 \times 3 \times 8$



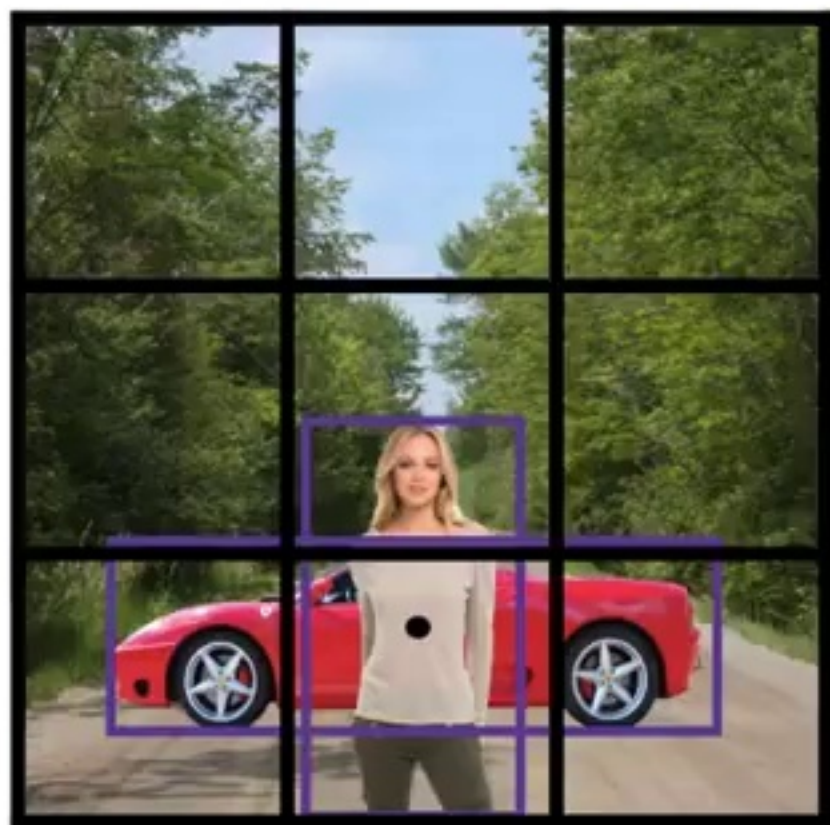
With two anchor boxes:

Each object in training image is assigned to grid cell that contains object's midpoint and anchor box for the grid cell with highest IoU.

(grid cell, anchor box)

Output y :
 $3 \times 3 \times \underline{16}$
 $3 \times 3 \times \underline{2} \times \underline{8}$

Anchor box example

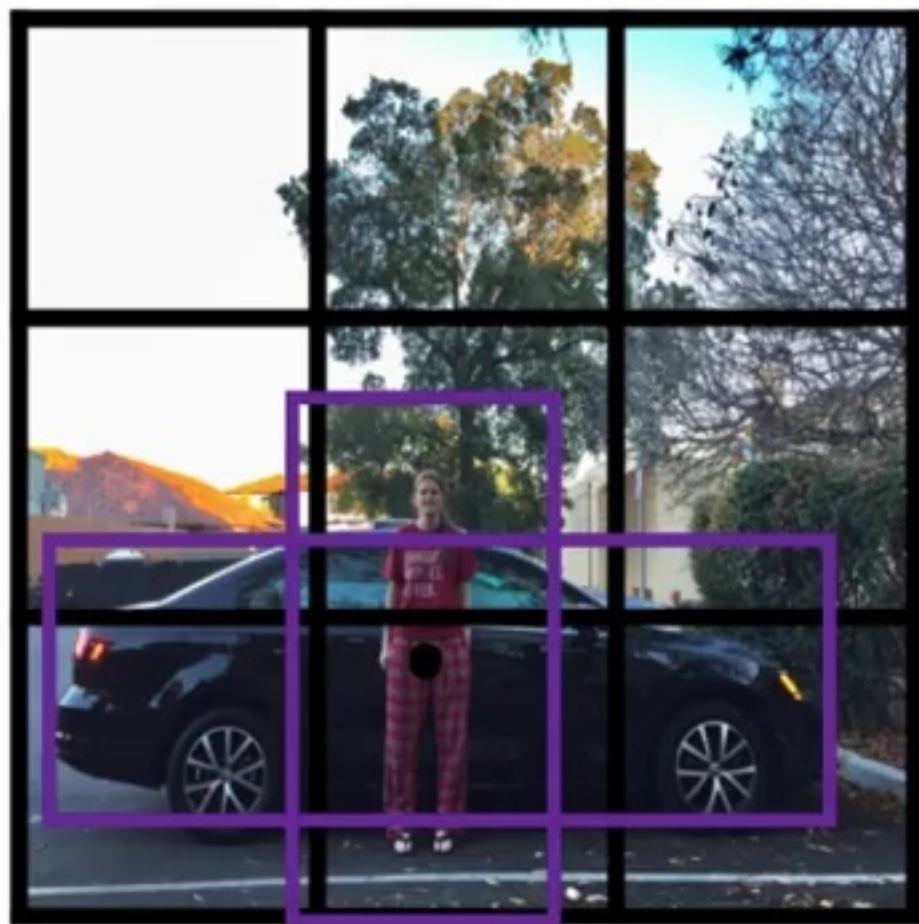


Anchor box 1: Anchor box 2:

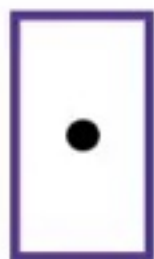


$$y = \begin{bmatrix} p_c \\ b_x \\ b_y \\ b_h \\ b_w \\ c_1 \\ c_2 \\ c_3 \\ p_c \\ b_x \\ b_y \\ b_h \\ b_w \\ c_1 \\ c_2 \\ c_3 \end{bmatrix}$$

Anchor box example

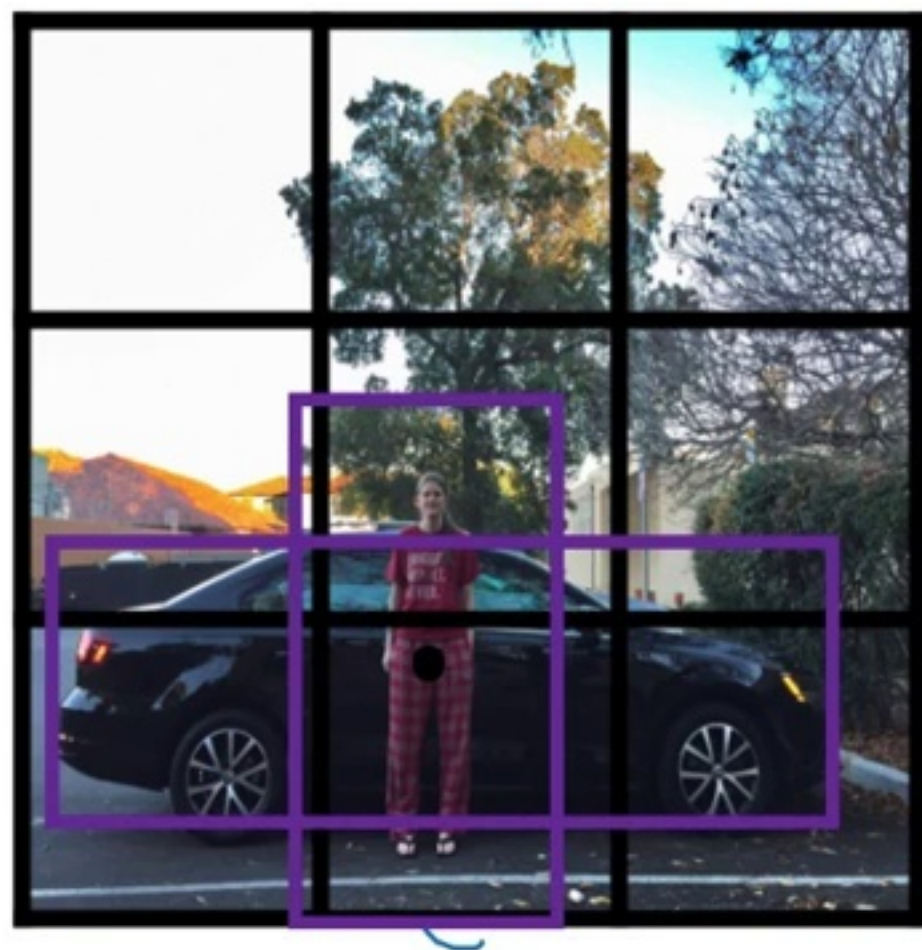


Anchor box 1: Anchor box 2:

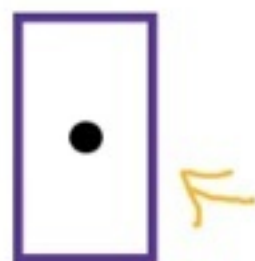


$$y = \begin{bmatrix} p_c \\ b_x \\ b_y \\ b_h \\ b_w \\ c_1 \\ c_2 \\ c_3 \\ p_c \\ b_x \\ b_y \\ b_h \\ b_w \\ c_1 \\ c_2 \\ c_3 \end{bmatrix}$$

Anchor box example



Anchor box 1: Anchor box 2:

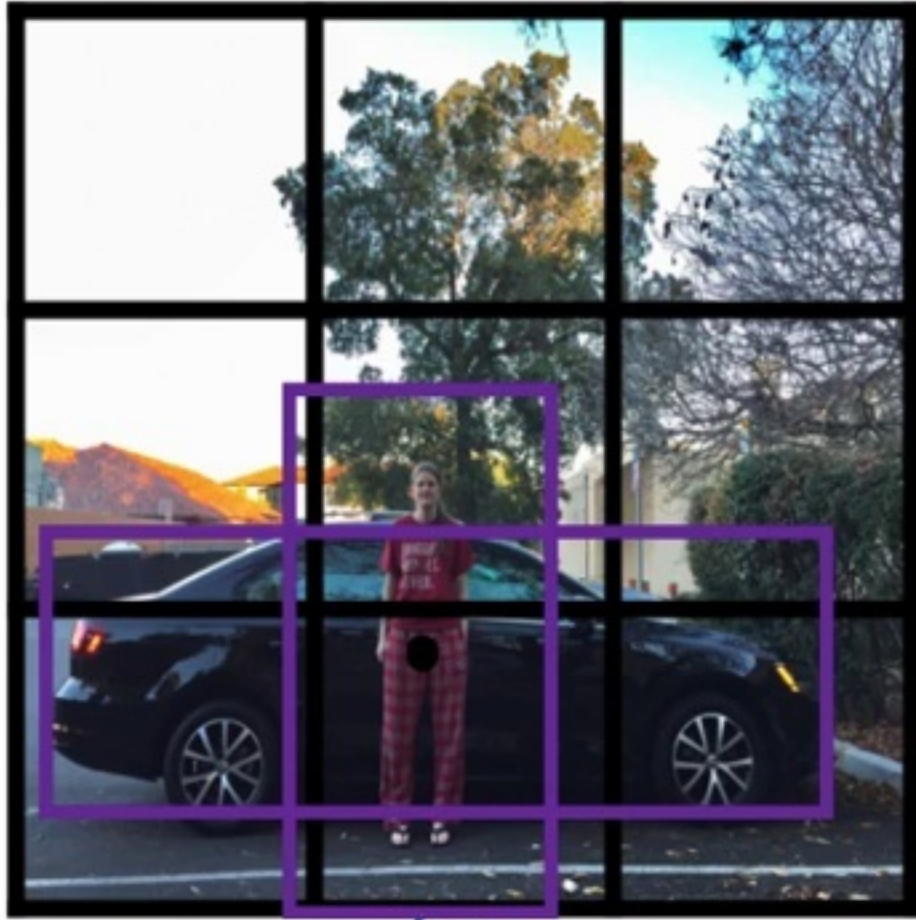


$$y = \begin{bmatrix} p_c \\ b_x \\ b_y \\ b_h \\ b_w \\ c_1 \\ c_2 \\ c_3 \\ p_c \\ b_x \\ b_y \\ b_h \\ b_w \\ c_1 \\ c_2 \\ c_3 \end{bmatrix}$$

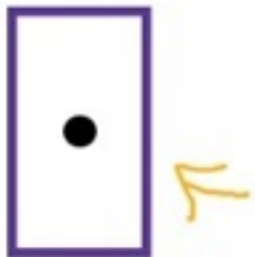
Handwritten annotations in yellow:

- 1 (next to p_c)
- b_x (next to b_x)
- b_y (next to b_y)
- b_h (next to b_h)
- b_w (next to b_w)
- 1 (next to c_1)
- 0 (next to c_2)
- c (next to c_3)

Anchor box example



Anchor box 1: Anchor box 2:



$y =$

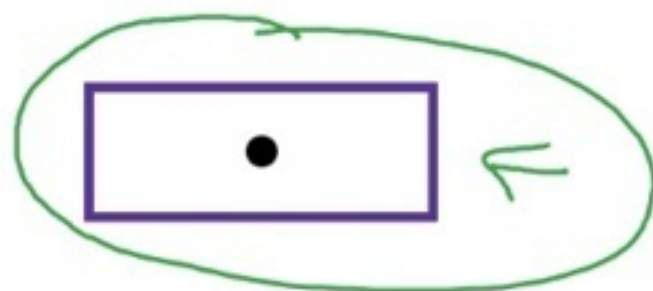
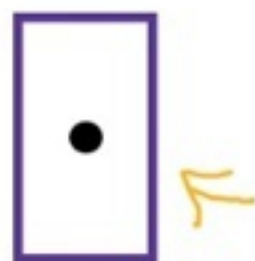
$$\begin{bmatrix} p_c \\ b_x \\ b_y \\ b_h \\ b_w \\ c_1 \\ c_2 \\ c_3 \\ p_c \\ b_x \\ b_y \\ b_h \\ b_w \\ c_1 \\ c_2 \\ c_3 \end{bmatrix}$$

$$\begin{bmatrix} 1 \\ b_x \\ b_y \\ b_h \\ b_w \\ 1 \\ 0 \\ 0 \\ 1 \\ b_x \\ b_y \\ b_h \\ b_w \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

Anchor box example



Anchor box 1: Anchor box 2:



$y =$

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

Handwritten values for the first vector (orange and green):

$$\begin{bmatrix} 1 \\ b_x \\ b_y \\ b_h \\ b_w \\ 1 \\ 0 \\ 0 \\ 1 \\ b_x \\ b_y \\ b_h \\ b_w \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

Handwritten values for the second vector (green), with a blue bracket on the right labeled "Anchor box 2":

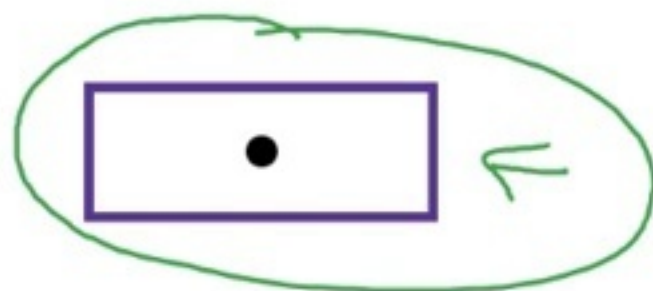
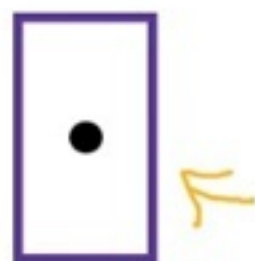
$$\begin{bmatrix} 1 \\ b_x \\ b_y \\ b_h \\ b_w \\ 0 \\ 1 \\ 0 \end{bmatrix}$$

Car only?

Anchor box example



Anchor box 1: Anchor box 2:



$y =$

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

Handwritten values for the first vector (orange and green):

$$\begin{bmatrix} 1 \\ b_x \\ b_y \\ b_h \\ b_w \\ 1 \\ 0 \\ 0 \\ 1 \\ b_x \\ b_y \\ b_h \\ b_w \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

Handwritten values for the second vector (blue and green), with a bracket labeled "car only?" above the first part:

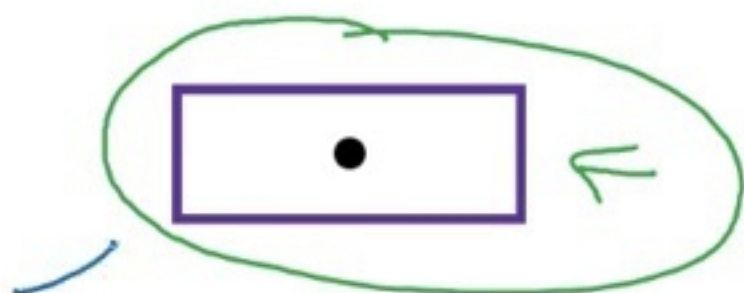
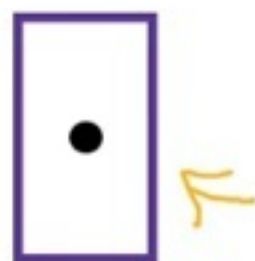
$$\begin{bmatrix} 0 \\ ? \\ ? \\ ? \\ ? \\ ? \\ ? \\ ? \\ 1 \\ b_x \\ b_y \\ b_h \\ b_w \\ 0 \\ 1 \\ 0 \end{bmatrix}$$

Labels on the right: "anchor box 1" (bracketed next to the first 8 elements) and "anchor box 2" (bracketed next to the last 8 elements).

Anchor box example



Anchor box 1: Anchor box 2:



$y =$

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

Handwritten values for the first vector (orange and green):

$$\begin{bmatrix} 1 \\ b_x \\ b_y \\ b_h \\ b_w \\ 1 \\ 0 \\ 0 \\ 1 \\ b_x \\ b_y \\ b_h \\ b_w \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

Handwritten values for the second vector (green):

$$\begin{bmatrix} 0 \\ ? \\ ? \\ ? \\ ? \\ ? \\ ? \\ ? \\ 1 \\ b_x \\ b_y \\ b_h \\ b_w \\ 0 \\ 1 \\ 0 \end{bmatrix}$$

Annotations: "car only?" at the top, "anchor box 1" for the first 8 elements, and "anchor box 2" for the last 8 elements.