CMPE258 PART II

Nov. 10, 22

Now, Discussion On Semantic Segmentation. //

Bounding Box Based Object Recognition (YOLO) → Pixel Based Object Recognition

Example:

Before v.s. After.

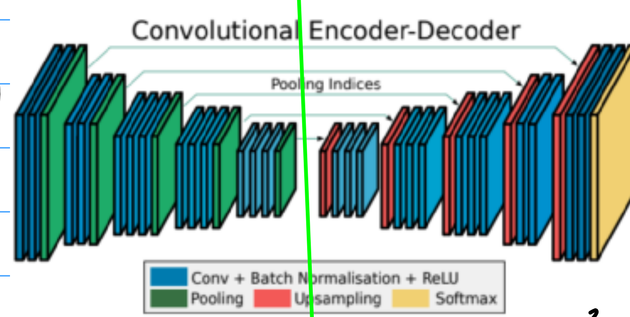


Fig.3

Deep Convolutional Neural Network:

Decoder:

Encoder:

Feature Extraction — Convolutions
Classification — Feedforward NN

To get Pixel by pixel Recognition of Objects e.g. Segmentation

2022F-109-semantic-seg-part1-HL-2022-11-10.pdf

Nov.10 (Th). Deep Convolution Neural Networks for Semantic Segmentation.

Objectives: Object Recognition On pixel-by-pixel Basis.

Note: The Design tasks for us to achieve this goal is to project feature maps Back to higher resolution, eventually to its original size (Same Resolution of the input image).

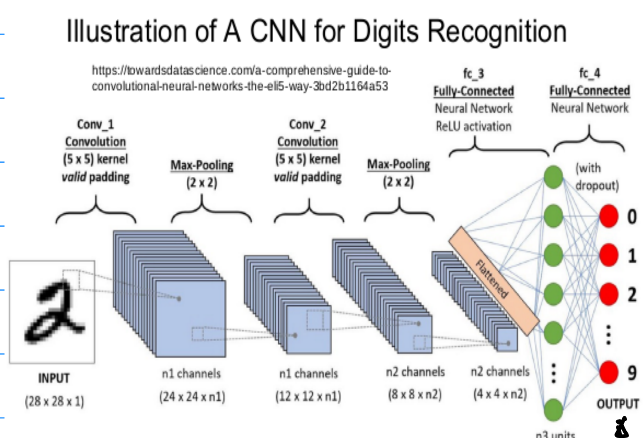


Fig.1.

The process of moving from Lower Resolution feature maps to higher Resolution feature map, eventually to the Resolution of the original image is what we called "upsampling".

Outputs are Numerical Values. in Case of YOLO CNN, the outputs are the Bounding Boxes.

Improvement with Pixel by pixel Object Recognition

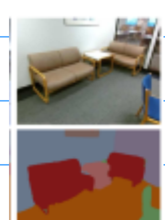


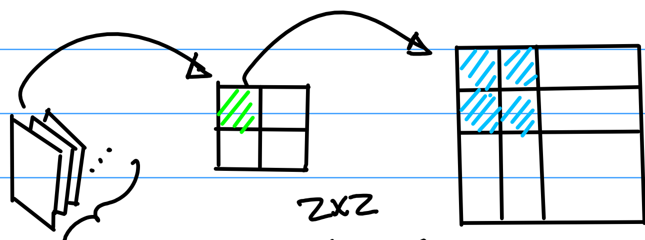
Fig.2

CmpE258

Nov. 10, '22.

53

Example: UpSampling Techniques (Design of)



Feature maps. 2x2 Feature Map. Fig. 4

Consider A Design of The Simplest UpSampling. Duplication of the pixel.

Technique 1.

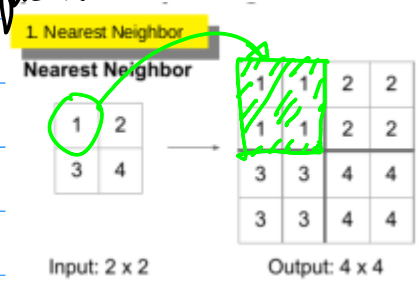


Fig. 5

NN

Nearest Neighbour Upsampling.

The Need for Improvement of NN-UpSampling: (1) Sudden Change from One 2x2 Region to its Neighbouring Regions → which produces Visual Artifacts. → propagation till the Output Image; (2) Lack of the consideration of Spatial correlations.

Technique 2. Use Interpolation Technique

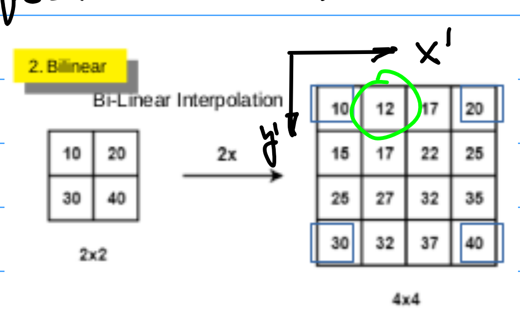


Fig 5-b

Step 1. place "Anchor Points" onto the higher resolution Patch.

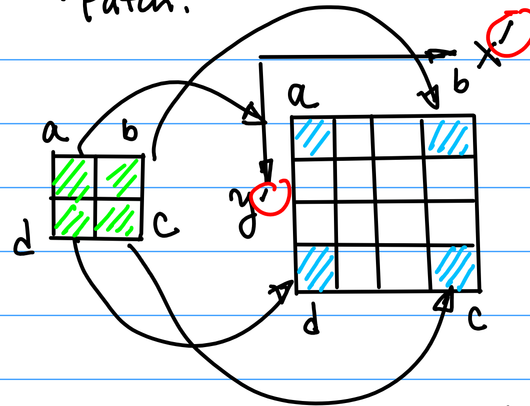


Fig. 6

Step 2. Perform Interpolation

Background: Given (x_1, y_1), (x_2, y_2) and x_3, Find $y_3 = ?$

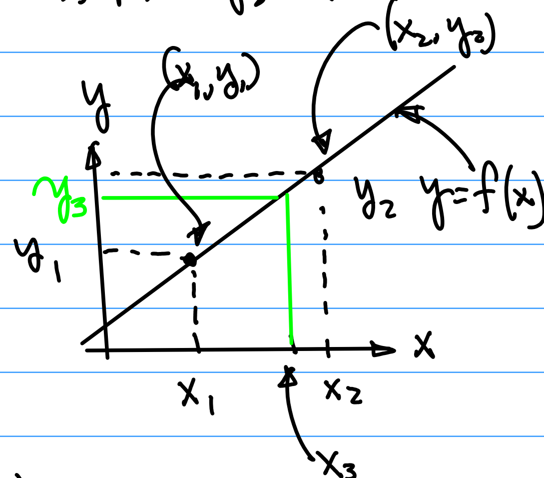


Fig. 7

$y = f(x)$, $y = ax + b$ ... (1)

which is a linear function, (since x is Not in 2nd, 3rd, or higher order).

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{y - y_1}{x - x_1} \quad \ldots (2)$$

Solve for a and b in the Above equation

$$y - y_1 = \frac{y_2 - y_1}{x_2 - x_1}(x - x_1)$$

$$y = \underbrace{\frac{y_2-y_1}{x_2-x_1}}_{a} x \underbrace{- \frac{y_2-y_1}{x_2-x_1} x_1 + y_1}_{b} \quad \ldots (3)$$

$$a = \frac{y_2-y_1}{x_2-x_1} \quad \ldots (3\text{-}b)$$

$$b = -\frac{y_2-y_1}{x_2-x_1} x_1 + y_1 \quad \ldots (3\text{-}c)$$

Let $x = x'$, y equal to the intensity,

So $x_1 = 0$, $y_1 = 10$

$x_2 = 3$, $y_2 = 20$

Nov.15 (Tue).

1° Project on Semantic Segmentation.

2022F-104f-project-yolact.pdf Due on Nov.27.

11:59pm;

Reference for the github Code Implementation

2022F-107-#102n-1a-README-YOLACT-...

2° Team Project: Presentation is scheduled on Nov.29th (Tuesday, In-Class Team Presentation).

Note: (1) Training & Annotation are encouraged & Required;

(2) modification, enhancement, Experimental Study are encouraged and Carries more Weight

(3) PPT, with Adequate information for Reproducing, Verifying the

Presented; References (Authors. URL Link of the papers, or Publication), github link;

(4) Title page with Authors Names, email, Affiliation, CMPE258 Presentation,

(5) One Slide in PPT with the Table

Team member 1. First, Last Name	Responsibility of the work	Contributions, in the areas of (1) Any coding and the % of the entire project; (2) Testing, Verification; (3) PPT; (4) Executive summary; (5) coordinator; (6) others
Team member 2. First, Last Name	Responsibility of the work	Contributions, in the areas of (1) Any coding and the % of the entire project; (2) Testing, Verification; (3) PPT; (4) Executive summary; (5) coordinator; (6) others
Team member 3. First, Last Name	Responsibility of the work	Contributions, in the areas of (1) Any coding and the % of the entire project; (2) Testing, Verification; (3) PPT; (4) Executive summary; (5) coordinator; (6) others
Team member 4. First, Last Name	Responsibility of the work	Contributions, in the areas of (1) Any coding and the % of the entire project; (2) Testing, Verification; (3) PPT; (4) Executive summary; (5) coordinator; (6) others

Fill out this Table.

Example: Continuation of Up Sampling Using Bi-Linear Interpolation.

Due to the fact that interpolation is carried out in both Row & Col. Direction.

A straight Line $y = ax + b$ to Connect Between 2 Known Points (x_1, y_1), (x_2, y_2)

Find the pixel value at the Next Right pixel location. Assuming x': 0, 1, 2, 3 (Left to Right) and y': 0, 1, 2, 3 (Top Down)

Sol Find $I(x', y')\Big|_{\substack{x'=1 \\ y'=0}} = ?$

From Eqn (3), (3-b), and (3-c),

From the given Condition, we have

$$y = \underbrace{\frac{y_2-y_1}{x_2-x_1}}_{a} x \underbrace{- \frac{y_2-y_1}{x_2-x_1} x_1 + y_1}_{b}$$

where

$a = \dfrac{y_2-y_1}{x_2-x_1}$ Can be found from the given condition, e.g.

$(x_1, y_1) = (0, 10)$ See Fig.5-b.

$(x_2, y_2) = (3, 20)$

Hence $a = \dfrac{y_2-y_1}{x_2-x_1} = \dfrac{20-10}{3-0} = 10/3$

and

$$b = -\frac{y_2-y_1}{x_2-x_1} x_1 + y_1$$

$$= -\frac{20-10}{3-0} \cdot 0 + 10 = 10$$

Therefore, from Eqn(3), we have

$$y = ax+b = \frac{10}{3} \cdot x + 10 \Big|_{x=1} = \frac{10}{3} + 10$$

$$\cong 3.3 + 10 = 13.$$

Note: Round Down 13.3 to 13.

Next, Take Care of the Interpolation of the vertical pair,

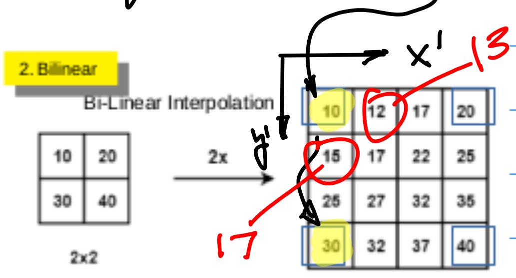


Fig.1.

Apply Eqn(3) Again, from the given condition, if we use the previous independent variable, we have:

$(x_1, y_1) = (0, 10)$

$(x_2, y_2) = (0, 30)$

But we know we are "moving" Top Down. So,

$$a = \frac{y_2-y_1}{x_2-x_1} \neq \frac{30-10}{0}.$$

does not Apply;

Check y' for the Index, $y' = 0, 1, 2, 3$, therefore, we use y'_1 for x_1, y'_2 for x_2, as a result we have

$$a = \frac{30-10}{3-0} = 20/3$$

y'_2 y'_1

$$b = -\frac{y_2-y_1}{x_2-x_1} x_1 + y_1$$

$$= -\frac{30-10}{3-0} \cdot y'_1 + 10 \Big|_{y'_1=0}$$

$$= 10$$

Hence, Eqn(3) Becomes

$$y = ax + b$$

$$= 20/3 \cdot x + 10 = 20/3 \cdot y' + 10$$

$y = ax + b$

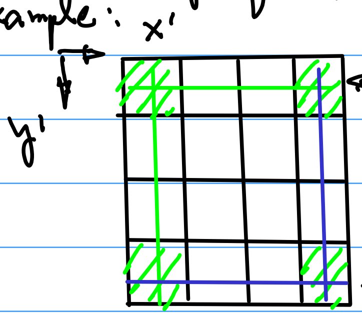
$= \frac{20}{3} \cdot x + 10 = \frac{20}{3} \cdot y' + 10 \Big|_{y'=1}$

$= \frac{20}{3} \cdot 1 + 10 \cong 7 + 10 = 17$

Nov 17 (Thu)

Note: Up-Sampling By Using Bi-Linear Interpolation is required for the design of Semantic Segmentation.

Example:



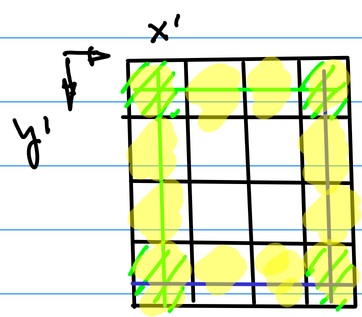
Row $y'=0$ Similar Technique

Row $y'=3$

Col $x'=0$ Col. $x'=3$

Similar Technique

Fig 1.

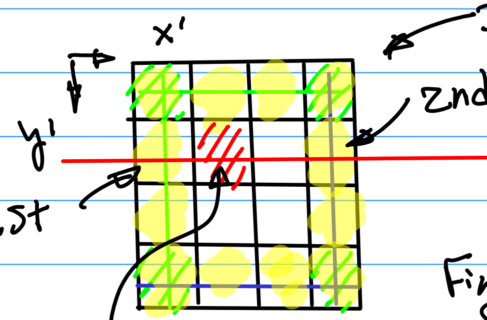


$I(x', y')$

Fig. 2

The Boundary points Can all be Calculated using the Examples from pp53 - 56.

Now, How about the interior Point? For Example $I(x', y') = ?$ @ $(x', y') = (1, 1)$



$I(x', y')$

2nd

1st

Fig. 3

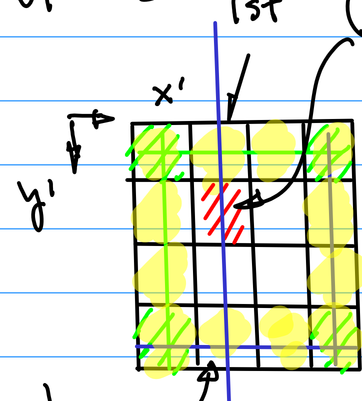
$(x', y') = (1, 1)$, $I(1, 1) = ?$

Option 1: Take the Same Formula for the calculations of the intensity at the Boundary Points, Perform Linear Interpolation with x' as an independent Variable the Known intensity at these Points are $I(x', y') = I(0, 1)$ 1st pt.

$I(x', y') = I(3, 1)$ 2nd pt.

Option 2.

1st $(1, 1) = (x', y')$



$I(x', y')$

2nd

Fig. 4

Apply the Same Interpolation Equation Except the independent Variable Changed from x' to y', Use $I(1, 0)$ as the 1st pt, $I(1, 3)$. for the Interpolation

Conclusion: To find the Up-Sampling Intensity at the interior point, we need first apply interpolation to find the intensities at the boundary points, then, apply the 2nd interpolation using the intensity at the Boundary Points (2 points) to find the intensity at the interior Point.

Why not using diagonal direction for the interpolation ?

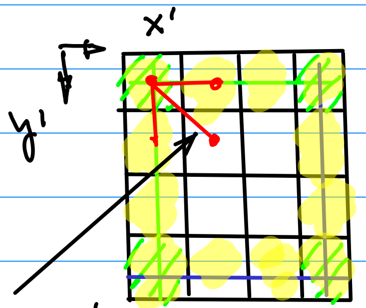


Fig.5

Distance { Horizontal, Vertical } = 1

distance ≠ 1 $\quad$ distance $= \sqrt{1^2+1^2} = \sqrt{2} = 1.414$.

Now, consider Nailing/Anchor Point Based Up-Sampling.

Pack 0's at the rest Locations.

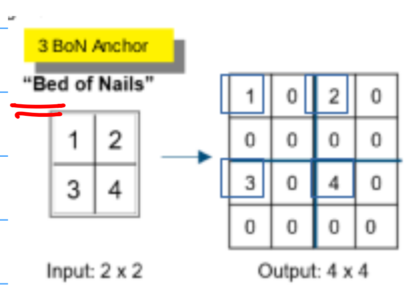
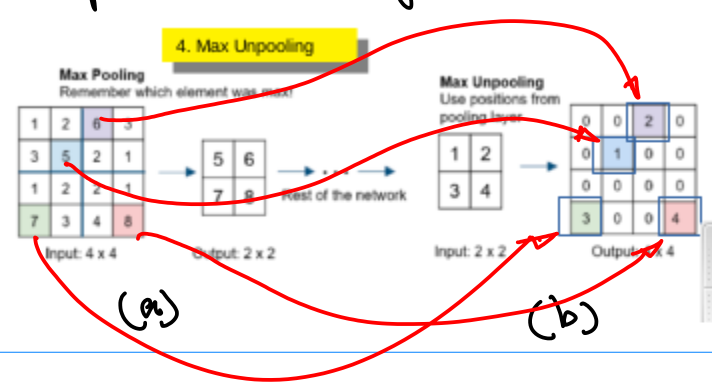


Fig.6

Copy the intensities of the Lower Resolution Feature Layer to 4 Corners of the higher feature Layer as illustrated

Example: Max Unpooling.



Transposed Convolution Up-sampling

Motivations for Convolution Based Up-Sampling:

1. Using Combination of Up-Sampling Techniques with Convolution to Remove artifacts from Up-Sampling alone approach;
2. Make good use of Convolution to extract/Add features when up-Sampling, And the Deep Learning Capability.

Nov. 22nd (Tue)

Note: Last Homework Due Dec. 4th. Check CANVAS.

Note: Yolact Project:

1° Use Tensor Flow;
2° Coco Anotation Tool (On-Line) for Training.
3° Extension of the Due Date to Dec. 5 (Monday)

Example: Transposed Convolution for Upsampling

Ref: see github.

Kernel

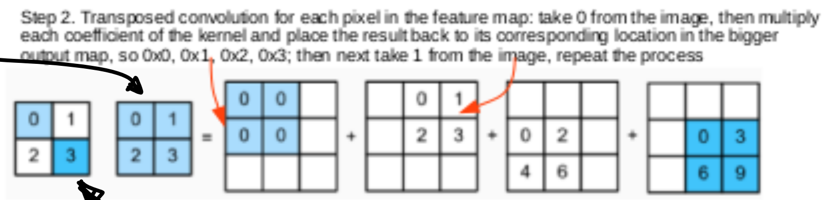


Fig.1

Note: 1. Feature Layer, in the example, is 2x2;

2. Kernel: 2x2

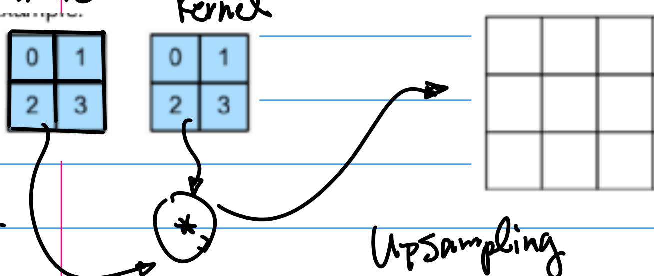


Fig.2

Upsampling

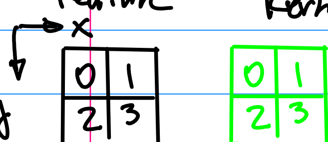
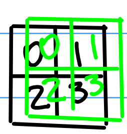


Fig3.

Step1.



1° move the kernel, place it on top of the feature map.

2° Start the first pixel at Top left Corner (Feature map)

F(0,0)=0, then for each Kernel Coefficient, we have

F(0,0) x K(0,0) = 0x0 = 0, place it at the output Layer.

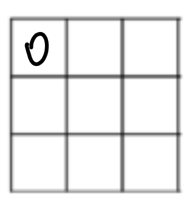


Fig.4

Continue this process for the rest of the kernel coefficients,

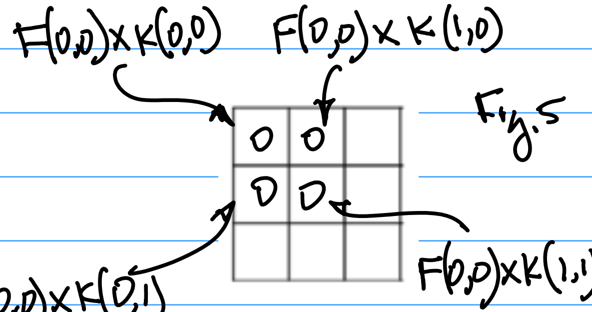


Fig.5

Step2.

F(1,0)x K(0,0) = 1 x 0

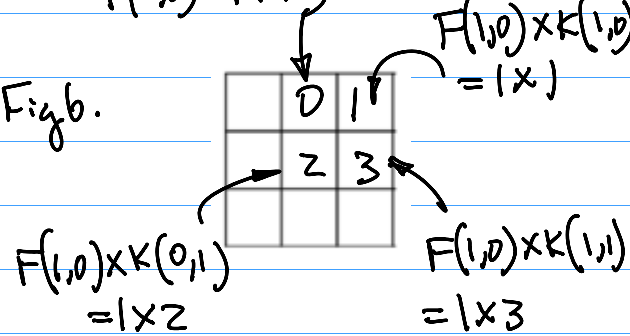
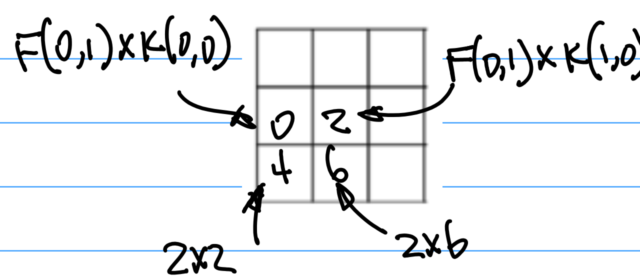


Fig6.

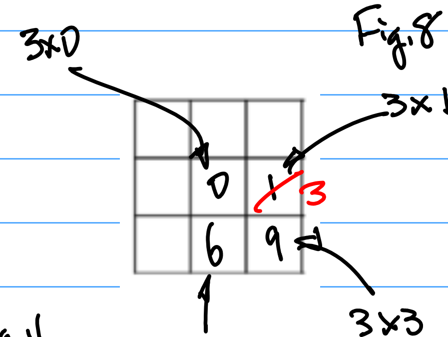
Step3.

Fig.7



Step4.

Fig.8



CMPE258

Nov. 22, 22

Hence, we have 4 Layers as an intermmediate Result:

$$\underbrace{\begin{array}{|c|c|c|}\hline 0 & 0 & \\ \hline 0 & 0 & \\ \hline & & \\ \hline\end{array} + \begin{array}{|c|c|c|}\hline & 0 & 1 \\ \hline & 2 & 3 \\ \hline & & \\ \hline\end{array} + \begin{array}{|c|c|c|}\hline & & \\ \hline 0 & 2 & \\ \hline 4 & 6 & \\ \hline\end{array} + \begin{array}{|c|c|c|}\hline & & \\ \hline & 0 & \cancel{1}\ 3 \\ \hline & 6 & 9 \\ \hline\end{array}}_{1/4}$$

$$\frac{1}{4}\begin{array}{|c|c|c|}\hline 0 & 0 & 1 \\ \hline 0 & 4 & 6 \\ \hline 4 & 12 & 9 \\ \hline\end{array} = \begin{array}{|c|c|c|}\hline 0 & 0 & 1/4 \\ \hline 0 & 1 & 3/2 \\ \hline 1 & 3 & 9/4 \\ \hline\end{array} \quad //$$

Dec 6. Last Day of Class
Review. Final

Note: 1. Please Take Care of OnLine Class Survey.

2. Final Exam. Dec 8th, Thursday 2:45–5:00 pm.

Group II Classes

Group II classes are those classes which meet TR, T, R, TWR, MTR, TRF, MTRF, MTWR, TWRF, RF, TF,TRS.

Regular Class Start Times	Final Examination Days	Final Examination Times
7:00 through 8:25 AM	Monday, December 12	7:15-9:30 AM
8:30 through 9:25 AM	Wednesday, December 14	7:15-9:30 AM
9:30 through 10:25 AM	Friday, December 9	9:45 AM-12:00 PM
10:30 through 11:25 AM	Tuesday, December 13	9:45 AM-12:00 PM
11:30 AM through 12:25 PM	Thursday, December 8	9:45 AM-12:00 PM
12:30 through 1:25 PM	Monday, December 12	12:15-2:30 PM
1:30 through 2:25 PM	Wednesday, December 14	12:15-2:30 PM
2:30 through 3:25 PM	Friday, December 9	2:45-5:00 PM
3:30 through 4:25 PM*	Tuesday, December 13	2:45-5:00 PM
4:30* through 5:25 PM*	Thursday, December 8	2:45-5:00 PM

*Classes with start time between 4:25 through 5:25 PM, which meet only once per week

CmpE258

Dec 6th, 22

60

Zoom OnLine Based Final.

1. Zoom from 2:45 ~ 5:00pm

Closing Time, One Extension.

2. Questions for the Final Exam.

Similar Format as the midterm Exam.

① Basic Concepts. Theoretical Analysis.

② Design Related Questions with Hand Calculation

③ Homeworks & Projects.

Note: Please Bring Printer Papers. Write your first, Last Name, with 4 Digists of your SID. on the top of each page

Note: Arrange your Submission Paper in Sequential order!

Note: please make sure your Computer is ready, there will be questions Related to the Execution of Computer Programs.

3. 80% ± material in the Final Exam will be the newer material Since the midterm.

4. K-mean Cluster Technique for Deep Learning Application, e.g. for Segmentation of Images for further Applications By DCNN for Object Classification.

2022F-101-cmpe258-note-2022-11-1.pdf

Oct. 25, 22 Objective Function 43

2022S-114c-KmeanCluster-v3-2022-4-19.pdf

$$\arg\min_{S} \sum_{i=1}^{k} \sum_{x\in S_i} \|x-\mu_i\|^2 = \arg\min_{S} \sum_{i=1}^{k} |S_i| \operatorname{Var} S_i \quad \ldots(1)$$

Formula for Calculation

pp.44

Oct. 27, 22

b. t Iteration

$$S_i^{(t)} = \{x_p : \|x_p - m_i^{(t)}\|^2 \le \|x_p - m_j^{(t)}\|^2 \ \forall j, 1 \le j \le k\} \quad \text{if} \quad \ldots(2)$$

a. $\{S_i \mid i = 1, 2, \cdots, K\}$ Classes / Group.

Preprocessing Techniques.

Binary Image Analysis

CANNY Edge

Contours

CmpE258

Dec.6,22

61.

Motivation: Build Bounding Boxes → ROI (Region of Interests) To Crop the Image + Further Processing

OpenCV Implementation for Contour Analysis.

a. EXTERNAL

b. TREE

Note: Requirements to Be Able to Apply these in your design.

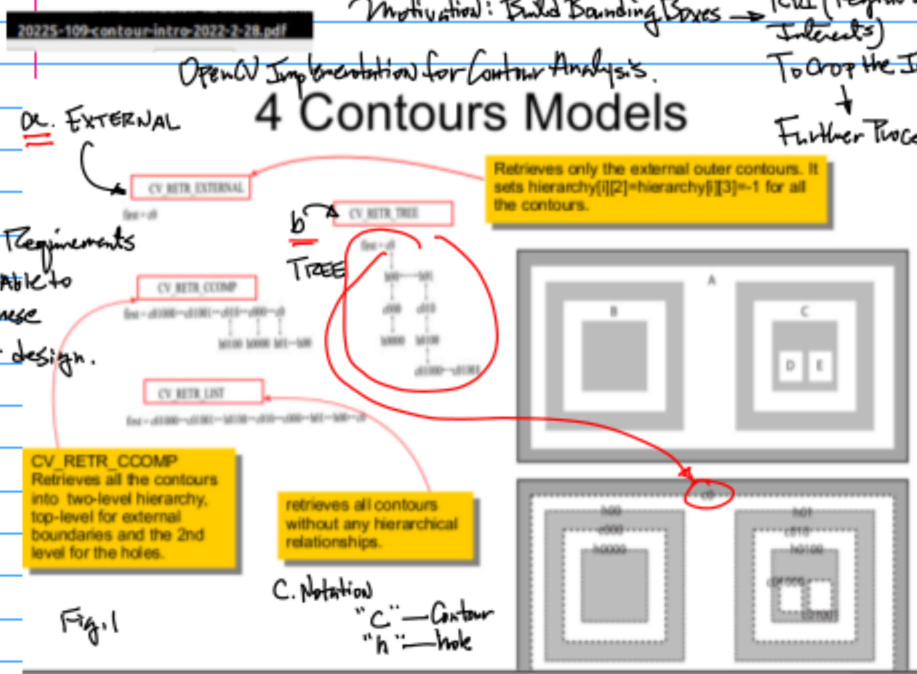
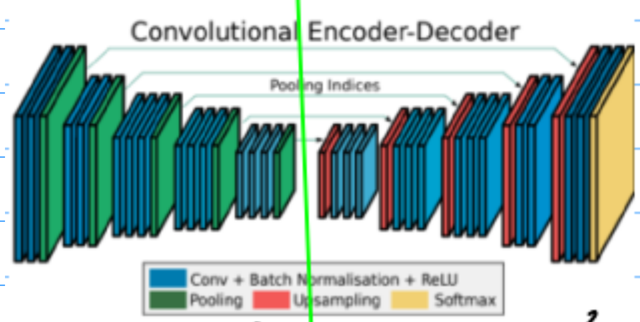


Fig.1

C. Notation
"C" — Contour
"h" — hole

5. Semantic Segmentation

Fig.3



Deep Convolutional Neural Network:

Decoder: { Upsampling Techniques / Transpose Convolution }
Spatial Information (e.g. Features)

UpSampling Techniques.

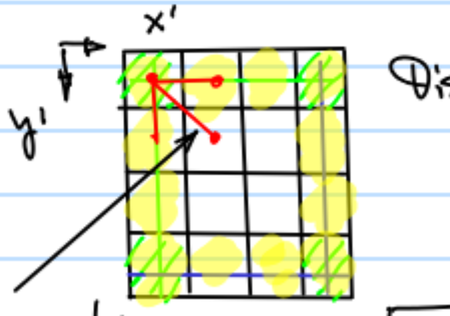


Fig. 5

distance $\neq 1$ distance $= \sqrt{1^2 +}$

Bi Linear Interpolation.

"Twice" Linear Interpolation

To find the interior points.

Example: Transposed Convolution for Upsampling

Ref: See github.

Kernel

Step 2. Transposed convolution for each pixel in the feature map: take 0 from the image, then multipl each coefficient of the kernel and place the result back to its corresponding location in the bigger output map, so 0x0, 0x1, 0x2, 0x3; then next take 1 from the image, repeat the process

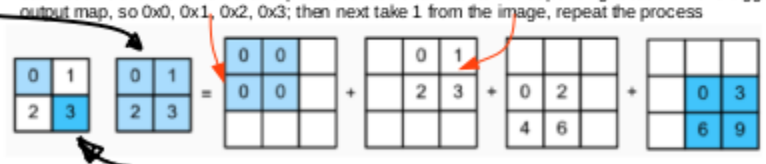


Fig. 1

Note: 1 Feature Layer in the example

6. Projects / Homeworks. YOLO, YOLACT.

Note: One Page Formula Sheet is allowed.

Note: Please make sure Video Cam is on During the Entire Session of the Final. Also Video Recording will be on During the Final.