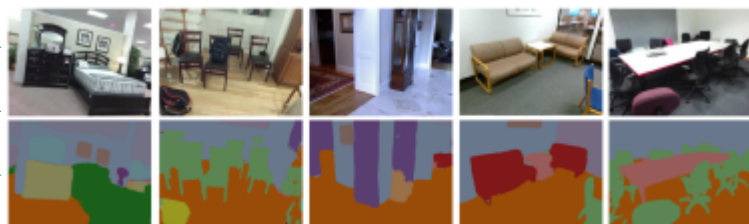


Now, Discussion On Semantic Segmentation. //

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

Example:



Before
v.s.
After.

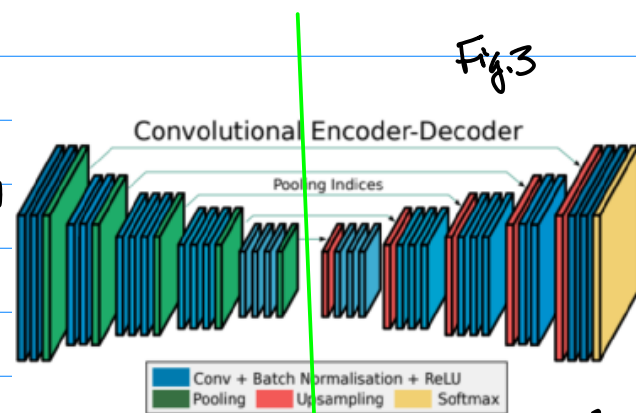


Fig.3

Deep Convolutional Neural Network:

Decoder:

Encoder:

Feature Extraction — Convolutions
Classification — Feedforward NN

To get Pixel by pixel

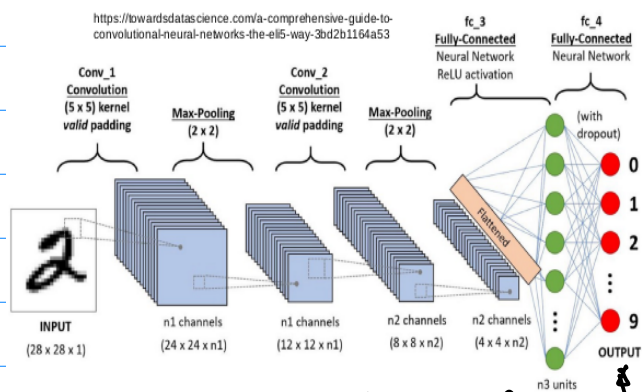
Recognition of Objects
E.g. Segmentation

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.

Illustration of A CNN for Digits Recognition



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

Improve with pixel by pixel Object Recognition

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 as the input image).

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".

Fig.1.

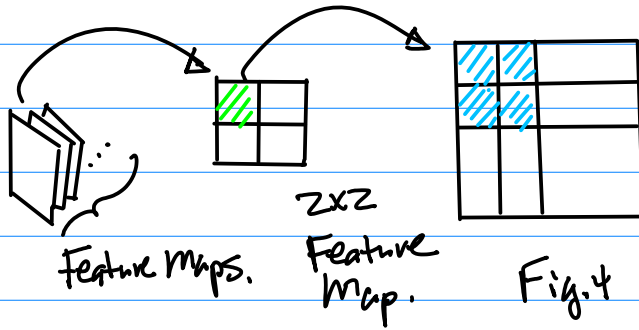


Fig.2

Nov. 10, 22.

53

Design of Example: Up Sampling Techniques



Consider A Design of The Simplest Up Sampling. Duplication of the pixel.

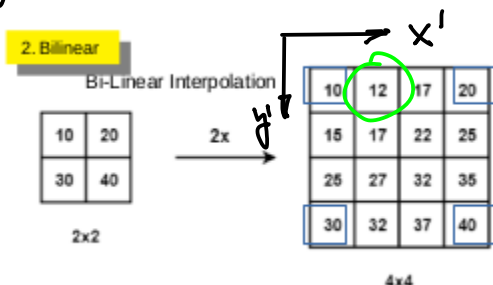
Technique 1.



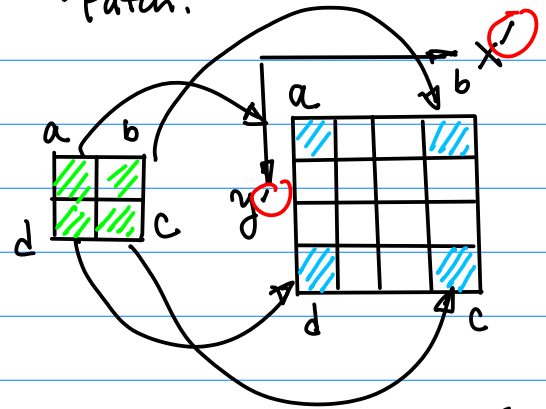
Nearest Neighbour Up Sampling.

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

Technique 2. Use Interpolation Technique



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



Step 2. Perform Interpolation

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

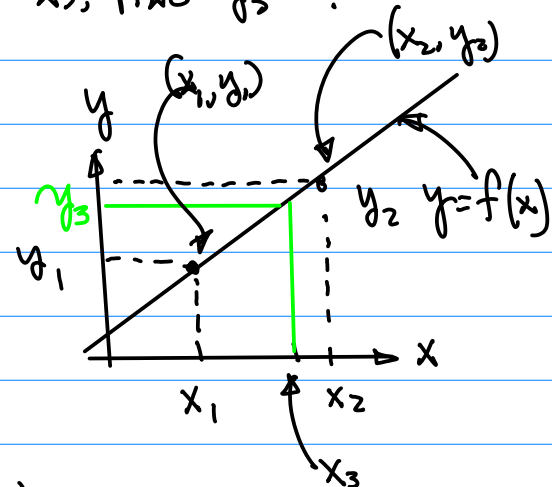


Fig. 7

$$y = f(x), y = ax + b \quad \dots (1)$$

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

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

Solve for a and b in the Above equation

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

$$y = \underbrace{\frac{y_2 - y_1}{x_2 - x_1} x}_a - \underbrace{\frac{y_2 - y_1}{x_2 - x_1} x_1}_b + y_1 \quad \dots (3)$$

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

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

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

$$\text{So } x_1 = 0, y_1 = 10$$

$$x_2 = 3, y_2 = 20$$

Nov. 15 (Tue).

1st Project on Semantic Segmentation.

2022F-104f-project-yolact.pdf

Due on Nov. 27.

11:59 PM;

Reference for the github code Implementation

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

2nd 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)

So! Find $I(x', y')|_{x'=1} = ?$

From Eqn (3), (3-b), and (3-c), $y'=0$

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

$$a = \frac{y_2 - y_1}{x_2 - x_1} \text{ Can be found from the}$$

given condition, e.g.

$$(x_1, y_1) = (0, 10) \text{ See Fig. 5-b.}$$

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

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

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,

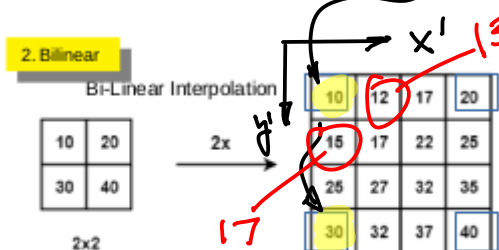


Fig. 1.

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

$$a = \frac{y'_2 - y'_1}{x_2 - x_1} = \frac{20}{3}$$

$$\begin{matrix} \uparrow & \uparrow \\ y'_2 & y'_1 \end{matrix}$$

$$b = -\frac{y'_2 - y'_1}{x_2 - x_1} x_1 + y_1$$

$$= -\frac{20 - 10}{3 - 0} \cdot y'_1 + 10 \Big|_{y'_1 = 0}$$

$$= 10$$

Hence, Eqn (3) Becomes

$$y = ax + b = \frac{20}{3} \cdot x + 10 = \frac{20}{3} \cdot y'_1 + 10$$

$$\begin{aligned}
 y &= ax + b \\
 &= \frac{20}{3} \cdot x + 10 = \frac{20}{3} \cdot y' + 10 \quad | \quad y' = 1 \\
 &= \frac{20}{3} \cdot 1 + 10 \approx 7 + 10 = 17
 \end{aligned}$$

Nov 17 (Thu)

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

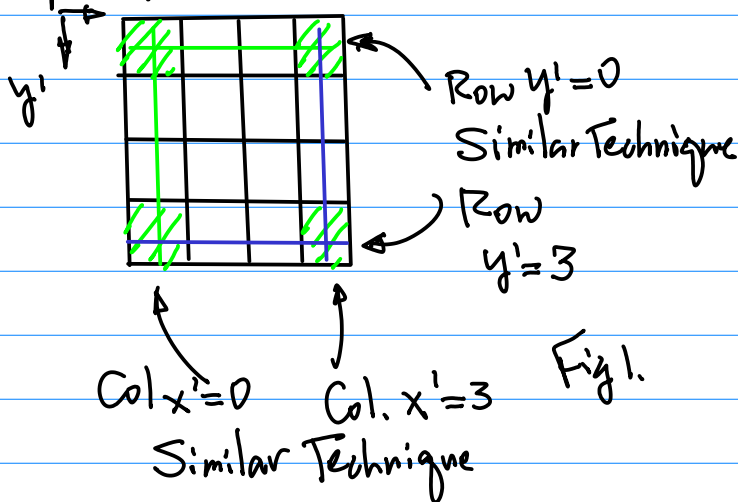
Example: x' 

Fig. 1.

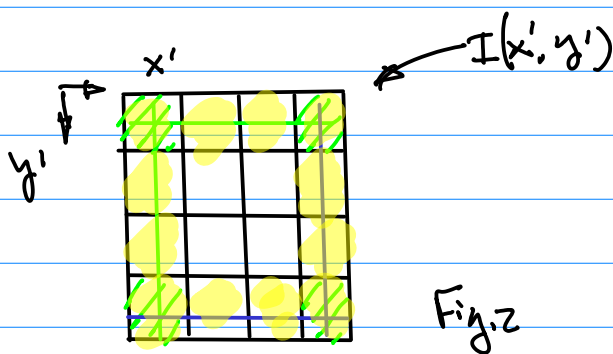


Fig. 2

The Boundary points Can all be Calculated using the Examples from pp 53 - 56.

Now, How about the interior point?

For Example $I(x', y') = ?$ @ $(x', y') = (1, 1)$

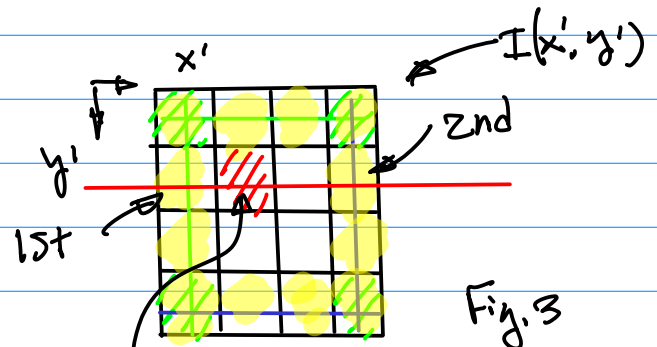


Fig. 3

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

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.

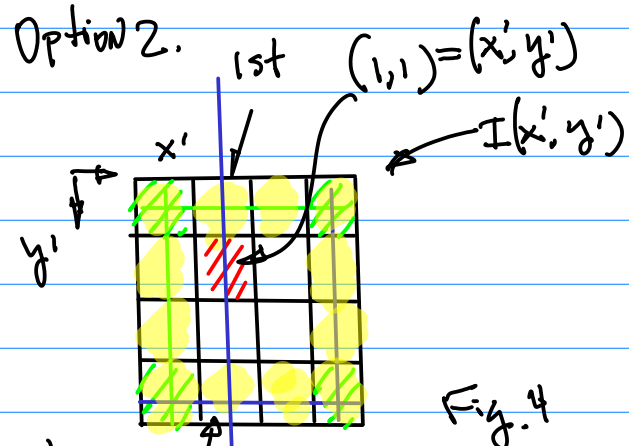
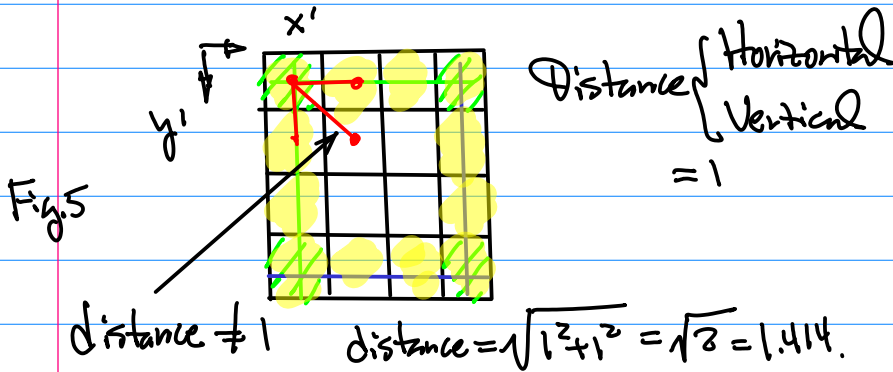


Fig. 4

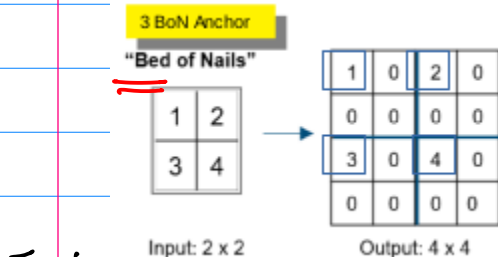
Apply the Same Interpolation Equation Except the independent Variable Changed from x' to y' , Use $I(1, 0)$ as the 1st pt, $I(1, 3)$ for the Interpolation.

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?

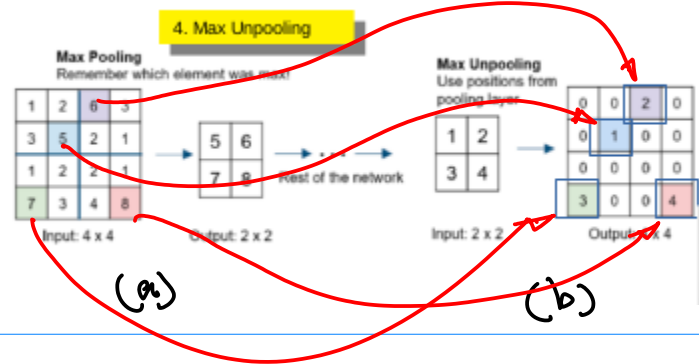


Now, consider Nailing/Anchor Point Based Up-Sampling.



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 Technique 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.

Place 0's at the rest locations.

Copy the intensities of the Lower Resolution Feature Layer to 4

Nov. 22nd (Tue)

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

Note: Yolact Project:

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

Example: Transposed Convolution for Upsampling

Ref: See github.

Continue this process for the rest of the kernel coefficients,

Kernel

Step 2. Transposed convolution for each pixel in the feature map: take 0 from the image, then multiply each coefficient of the kernel and place the result back to its corresponding location in the bigger output map, so 0×0 , 0×1 , 0×2 , 0×3 ; then next take 1 from the image, repeat the process

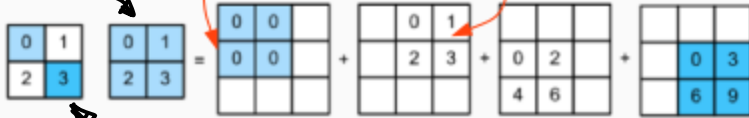


Fig.1

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

Feature

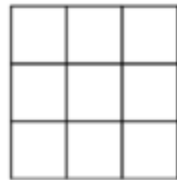
Kernel



Fig.2

*

Upsampling



$F(0,0) \times K(0,0)$ $F(0,0) \times K(1,0)$

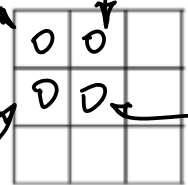


Fig.5

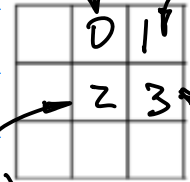
$F(0,0) \times K(0,1)$ $F(0,0) \times K(1,1)$

Step 2.

$$F(1,0) \times K(0,0) = 1 \times 0$$

$$F(1,0) \times K(1,0) = 1 \times 1$$

Fig.6.



$$F(1,0) \times K(0,1) = 1 \times 2$$

$$F(1,0) \times K(1,1) = 1 \times 3$$

Step 3.

Feature

Kernel

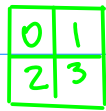
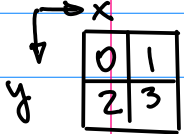
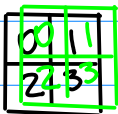


Fig.3.

Step 1.

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

$F(0,0) \times K(0,0) = 0 \times 0 = 0$, place it at the output Layer.

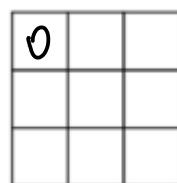


Fig.4

$F(0,1) \times K(0,0)$

$F(0,1) \times K(1,0)$

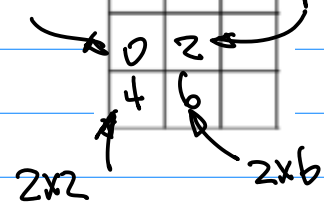


Fig.7

Step 4.

3×0

Fig.8

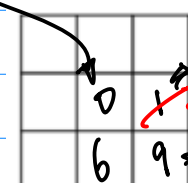


Fig.4

3×2

3×1

3×3

Hence, we have 4 layers as an intermediate Result :

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

$$\underbrace{\hspace{15em}}_{\frac{1}{4}}$$

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