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$I(x,y)$. Example in the fig. below.

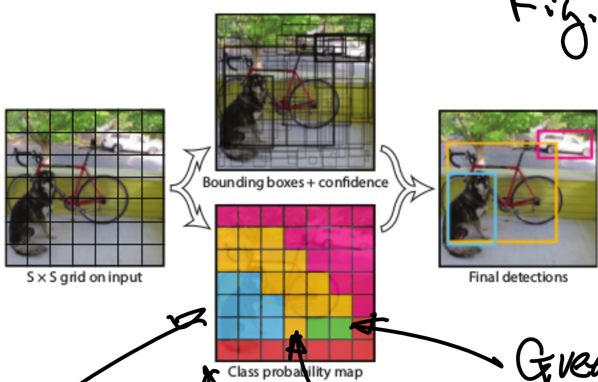

Fig. 1.

Green; Class 4.

Blue: Segmentation for Class 1

Yellow, Class 3

Pink: Segmentation for Class 2

Objective:

To Find/Define Probability Distribution Map for each Class.

$$Prob(class1) = \left(\text{Pixels belong to Class1}\right) \Big/ \text{Total No. of pixels of } I(x,y) \quad \dots (1)$$

from the given Condition in Fig. 1

Since,

$$\left(\text{Pixels belong to Class1}\right) = 8 * \underbrace{(S \times S)}_{\text{pixels One Grid.}} = 8S^2$$

$$\text{Total No. of Pixels of } I(x,y) = 7*7 \times S \times S = 49S^2$$

Hence,

$$Prob(Class1)_{Blue} = \frac{8\cancel{S^2}}{49\cancel{S^2}} = \frac{8}{49}$$

Next,

$$Prob(Class2)_{pink} = \frac{25}{49}$$

$$Prob(Class3)_{yellow} = 14/49$$

$$Prob(Class4)_{green} = 2/49$$

Note: To verify the Calculation, we should have the following property:

$$\sum_{i=1}^{4} Prob(C_i) = 1 \quad \dots (2).$$

from Our Calculation,

$$\sum_{i=1}^{4} Prob(C_i) = Prob(C_1) + Prob(C_2) + \dots + Prob(C_4)$$

$$= (8+25+14+2)/49 = 1.$$

The Next Step for the Probability Distribution Map Calculation: Segmentation, e.g. A Technique to allow us to classify

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Objects into one of the class i.

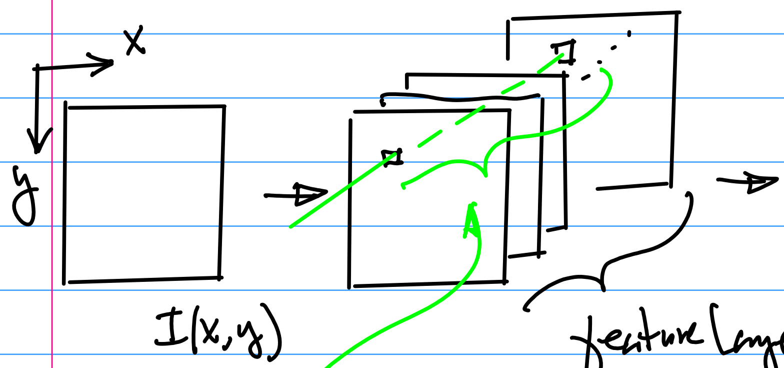
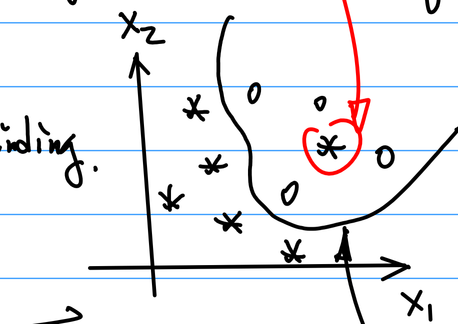


Fig.2a

Cluster Finding.

Fig.2b. mis-classification



$\vec{X}(x_1,x_2)$. Decision Making Function.

Segmentation of the $I(x,y)$

Classification of objects

Form Feature Vector(s)

2022F-101-cmpe258-note-2022-11-1 (4).pdf

$$\vec{X}=(x_1,x_2,\cdots,x_N) \quad \cdots (3).$$

introduce Subscript.

$$\vec{X_i}=(x_{i1},x_{i2},x_{i3},\cdots,x_{iN}) \quad \cdots (3\text{-}b)$$

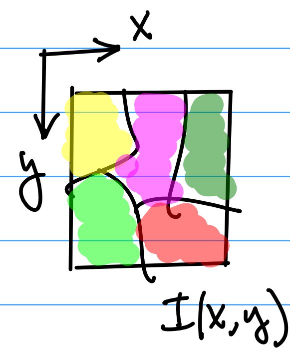


Fig.2c

Ref: for k-mean Cluster Classification.

1. 2022F-101-cmpe258-note-2022-11-1 (4).pdf
2. github, 2022S, Search Keywords "kmean", Two Relevant References
   - PPT. — Formulation.
   - Hand Calculation.

Nov. 7th (Tue).

Note 1. Midterm Exam is scheduled on Next Tuesday (14th). Please Bring Your Laptop Computer to the Class on Monday.
Review and Q&A Session on Thursday.

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Note1. Ref1. General Background → Eqn (1).

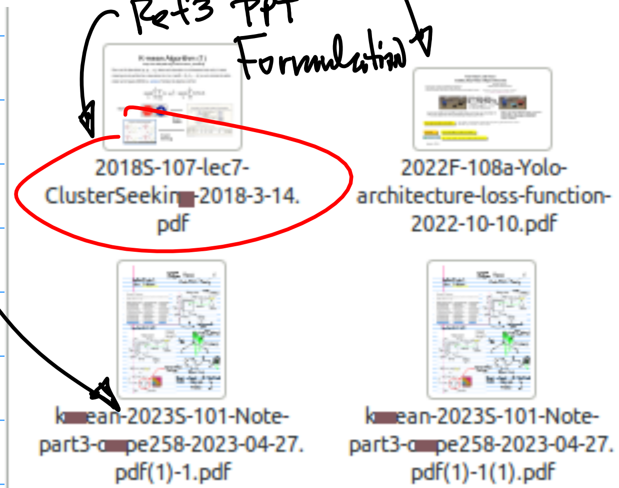
Ref 4, Hand Calculation

Ref2.

Ref.5.

Ref3 PPT

Formulation



Example: Formulation.

Ref.2. Lecture Notes

Ref.3. Notation

$$\underset{S}{\text{Argmin}} \sum \sum || \vec{x} - \vec{\mu_i} ||^2$$

$$S_i^{(t)} = \{ \vec{x_p} : || \vec{x_p} - \vec{\mu_i} ||^2 \leq || \vec{x_p} - \vec{\mu_j} ||^2, \forall j, \; j = 1, 2, \cdots, K, \text{ and } j \neq i \}$$

$$\vec{x} = \begin{pmatrix} x_1 \\ x_2 \end{pmatrix}, \quad \vec{\mu_i} = \begin{pmatrix} \mu_{i1} \\ \mu_{i2} \end{pmatrix}$$

$$\vec{x} - \vec{\mu_i} = \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} - \begin{pmatrix} \mu_{i1} \\ \mu_{i2} \end{pmatrix} = \begin{pmatrix} x_1 - \mu_{i1} \\ x_2 - \mu_{i2} \end{pmatrix}$$

Check iteration of the Computation.

Convergence. → if converges, then Stop

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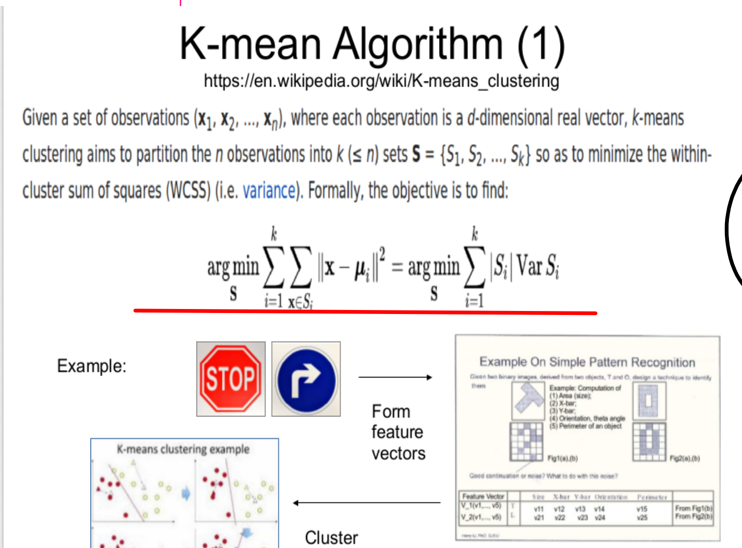

Note 1.

Note 2 → Squared Distance

$$\arg\min_{\mathbf{S}} \sum_{i=1}^{k} \sum_{\mathbf{x}\in S_i} \|\mathbf{x}-\boldsymbol{\mu}_i\|^2 = \arg\min_{\mathbf{S}} \sum_{i=1}^{k} |S_i| \operatorname{Var} S_i \quad \ldots (3)$$

a. "Argmin" minimization

b. "S" Domain, Scope" of the minimization

Example for $\|\vec{x}-\vec{\mu}_i\|^2$,

if $\vec{x}=(x_1,x_2)$, $\vec{\mu}_i=(\mu_{i1},\mu_{i2})$

then

From Ref 2. (my lecture Notes) $\|\vec{x}-\vec{\mu}_i\|^2 = \left(\sqrt{(x_1-\mu_{i1})^2+(x_2-\mu_{i2})^2}\right)^2$

$$= (x_1-\mu_{i1})^2+(x_2-\mu_{i2})^2 \quad \ldots (4)$$

Example: K-mean Cluster Algorithm.

First, Notation.

Note 1. Vectors

Given a set of observations ($\mathbf{x}_1, \mathbf{x}_2, \ldots, \mathbf{x}_n$),

e.g. $\mathbf{X}_1 = (x_{11}, x_{12}, \cdots, x_{1N}) \quad \ldots (1)$

first Observation

For $\underbrace{\mathbf{X}_i}_{\text{Observation } i}$ $\quad x_{ij}$,

Component j for the Observation i

Note: if for d-dimensional vector, then Eqn(1) has its $N=d$

Note 3. "$\sum_{x\in S_i}$" Notation $\sum_{i=1}^{M} x_i$

Summation for each & every x as long as it is from the set S_i

Note 4: from Eqn (3), we have

S_i: Collection of vectors $\mathbf{X}$ belonging to Class i

Note 5: $\sum_{i=1}^{k}$ → to cover the Collection of all Classes.

K-mean

partition the n observations into k (≤ n) sets S = {S1, S2, ..., Sk} $\quad \ldots (2)$

$\{\mathbf{X}_i \mid i=1,2,\cdots,N\}$

K-Classes.

S_i for Class i

Note 6: $\vec{\mu}_i$ ① $\vec{\mu}_i = (\mu_{i1}, \mu_{i2}, \cdots, \mu_{id})$

② Cluster for the Class i

So, with the Objective Function defined, Now Let's take a look at the following Equation for Computation.

$1 \le j \le K$ covers all the different classes.

Hand Calculation Example

Given the following feature vectors use Kmean Algorithm to find the clusters.

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

Ref

20225-114c-Kmean-handCalculation1-c

$$X_1=\begin{pmatrix}0\\0\end{pmatrix} \quad X_2=\begin{pmatrix}1\\0\end{pmatrix} \quad X_3=\begin{pmatrix}0\\1\end{pmatrix} \quad X_4=\begin{pmatrix}1\\1\end{pmatrix}$$
$$X_5=\begin{pmatrix}2\\1\end{pmatrix} \quad X_6=\begin{pmatrix}1\\2\end{pmatrix} \quad X_7=\begin{pmatrix}2\\2\end{pmatrix} \quad X_8=\begin{pmatrix}3\\2\end{pmatrix}$$
$$X_9=\begin{pmatrix}6\\6\end{pmatrix} \quad X_{10}=\begin{pmatrix}7\\6\end{pmatrix} \quad X_{11}=\begin{pmatrix}8\\6\end{pmatrix} \quad X_{12}=\begin{pmatrix}6\\7\end{pmatrix}$$
$$X_{13}=\begin{pmatrix}7\\7\end{pmatrix} \quad X_{14}=\begin{pmatrix}8\\7\end{pmatrix} \quad X_{15}=\begin{pmatrix}9\\7\end{pmatrix} \quad X_{16}=\begin{pmatrix}7\\8\end{pmatrix}$$
$$X_{17}=\begin{pmatrix}8\\8\end{pmatrix} \quad X_{18}=\begin{pmatrix}9\\8\end{pmatrix} \quad X_{19}=\begin{pmatrix}8\\9\end{pmatrix} \quad X_{20}=\begin{pmatrix}9\\9\end{pmatrix}$$

Note1: A set of Feature Vectors

$S_i^{(t)}$ ← Captured at Step t
i ← Class id: ith Class

$S_i^{(t)} = \{\vec{X}_p \quad \}$

index, $p = 1, 2, \ldots$
just like Notation i, j, or k

$S_i^{(t)} = \{\vec{X}_p : \quad \}$

Condition

$\|\vec{X}_p - \vec{m}_i^{(t)}\|^2$

Distance (squared) at time (t) to the Cluster of class i

Sol: Step 1. Define K=2 per Heuristics. Expert Knowledge

Note: "0" Initial step.

Let cluster

$\vec{m}_1^0 = \vec{X}_1 = \begin{pmatrix}0\\0\end{pmatrix} \ldots (1)$

$\vec{m}_2^0 = \vec{X}_2 = \begin{pmatrix}1\\0\end{pmatrix} \ldots (2)$

Initial Arbitrary Values

"1" Class 1

And Arbitrarily assign Feature Vectors into 2 Classes.

Step 2. Use Eqn (1) To Compute the distance

$\|\vec{X}_p - \vec{m}_i^{(t)}\|^2$

Now, check the Hand Calculation that I made and posted on the class git, e.g. Ref. 4.

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K-mean Cluster Algorithm

개요

Given the following feature vectors use K-mean Algorithm to find the clusters.

$$X_1=\begin{bmatrix}0\\0\end{bmatrix}\quad X_2=\begin{bmatrix}1\\0\end{bmatrix}\quad X_3=\begin{bmatrix}0\\1\end{bmatrix}\quad X_4=\begin{bmatrix}1\\1\end{bmatrix}$$

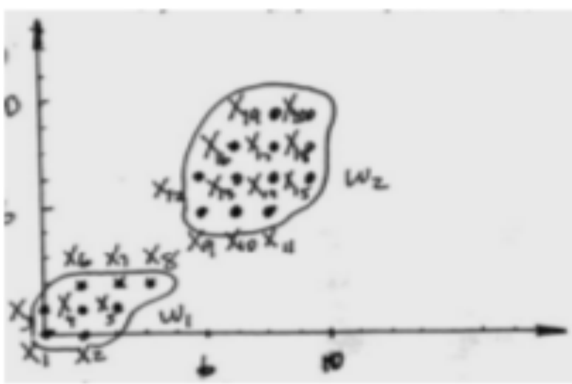
$$X_5=\begin{bmatrix}2\\1\end{bmatrix}\quad X_6=\begin{bmatrix}1\\2\end{bmatrix}\quad X_7=\begin{bmatrix}2\\2\end{bmatrix}\quad X_8=\begin{bmatrix}3\\2\end{bmatrix}$$

$$X_9=\begin{bmatrix}6\\6\end{bmatrix}\quad X_{10}=\begin{bmatrix}7\\6\end{bmatrix}\quad X_{11}=\begin{bmatrix}8\\6\end{bmatrix}\quad X_{12}=\begin{bmatrix}6\\7\end{bmatrix}$$

$$X_{13}=\begin{bmatrix}7\\7\end{bmatrix}\quad X_{14}=\begin{bmatrix}8\\7\end{bmatrix}\quad X_{15}=\begin{bmatrix}9\\7\end{bmatrix}\quad X_{16}=\begin{bmatrix}7\\8\end{bmatrix}$$

$$X_{17}=\begin{bmatrix}8\\8\end{bmatrix}\quad X_{18}=\begin{bmatrix}9\\8\end{bmatrix}\quad X_{19}=\begin{bmatrix}8\\9\end{bmatrix}\quad X_{20}=\begin{bmatrix}9\\9\end{bmatrix}$$

Sol. We can plot these feature vectors below



Step1. Define Number of Cluster $K=2$ Based on Heuristics (the plot of the feature vectors).

Let $K=2$

And make initialization by arbitrarily select 2 points $\vec{x}_1$, $\vec{x}_2$ as the cluster Center

Let cluster

$$\vec{m}_1^0=\vec{x}_1=\begin{pmatrix}0\\0\end{pmatrix}, \quad \cdots (1)$$

$$\vec{m}_2^0=\vec{x}_2=\begin{pmatrix}1\\0\end{pmatrix} \quad \cdots (2)$$

And let Class 1 be

$$C_1 : (\vec{x}_1, \vec{x}_3) \quad \cdots (3)$$

class 2 be

$$C_2 : (x_2, x_4, x_5, \cdots, x_{20}) \quad \cdots (4)$$

Step2, Use Equation

$$\|\vec{x}_p-\vec{m}_i\| \leq \|\vec{x}_p-\vec{m}_j\| \quad \cdots (5)$$

for $\vec{x}_p$ from Class i to regroup feature Vectors in Class i to j if Eqn (5) does not hold. Hence

From Class C_1,

$$\|\vec{x}_1-\vec{m}_1^0\|=\left\|\begin{pmatrix}x_{11}\\x_{12}\end{pmatrix}-\begin{pmatrix}m_{11}\\m_{12}\end{pmatrix}\right\|= \quad m_{11}=x_{11},\ m_{12}=x_{12}$$

$$=\sqrt{(x_{11}-x_{11})^2+(x_{12}-x_{12})^2}=0$$

And

$$\|\vec{x}_1-\vec{m}_2\|=\left\|\begin{pmatrix}x_{11}\\x_{12}\end{pmatrix}-\begin{pmatrix}m_{21}\\m_{22}\end{pmatrix}\right\|= \quad m_{21}=x_{21},\ m_{22}=x_{22}$$

$$=\sqrt{(x_{11}-x_{21})^2+(x_{12}-x_{22})^2}$$

$$=\sqrt{1^2+0^2}=1$$

Continue to Carry Out the Computation, see this 3 page handout, till Converges. → e.g. $m_i^{(t+1)}=m_i^{(t)}$.

then No New Grouping. Stop the Computation.

Nov. 9 (Th).

Example: Hand Calculation of the K-mean.

Note 1. Calculation of A Cluster.

Suppose we have Cluster μ_i defined as

$$\mu_i = \frac{1}{M}\sum_{j=1}^{M} \vec{X}_{ij} \quad \ldots (1)$$

Suppose

$$\vec{X}_i = (x_{i1}, x_{i2}, x_{i3}, \ldots, x_{ip})$$

P-dimension.

$$\mu_i = \frac{1}{M}\left(\vec{X}_{i1} + \vec{X}_{i2} + \cdots + X_{ip}\right)$$

$$= \frac{1}{M}\left[\begin{pmatrix} X_{i11} \\ X_{i12} \end{pmatrix} + \begin{pmatrix} X_{i21} \\ X_{i22} \end{pmatrix} + \cdots + \begin{pmatrix} X_{ip1} \\ X_{ip2} \end{pmatrix}\right] \quad \ldots (1\text{-}b)$$

↓ for C_i, Class i, drop the Sub "i" for the simplicity

$$= \frac{1}{M}\left[\begin{pmatrix} X_{11} \\ X_{12} \end{pmatrix} + \begin{pmatrix} X_{21} \\ X_{22} \end{pmatrix} + \cdots + \begin{pmatrix} X_{\cancel{p}1} \\ X_{\cancel{p}2} \end{pmatrix}\right]$$

M

$$= \frac{1}{M}\begin{pmatrix} X_{11} + X_{21} + X_{31} + \cdots + X_{\cancel{p}1} \\ X_{12} + X_{22} + X_{32} + \cdots + X_{\cancel{p}2} \end{pmatrix}$$

M

$$= \begin{bmatrix} \dfrac{X_{11} + X_{21} + X_{31} + \cdots + X_{\cancel{p}1}}{M} \\ \dfrac{X_{12} + X_{22} + X_{32} + \cdots + X_{\cancel{p}2}}{M} \end{bmatrix}$$

M M

for P=2 ↓

$$\mu_i = \begin{pmatrix} \dfrac{X_{11} + X_{21}}{2} \\ \dfrac{X_{12} + X_{22}}{2} \end{pmatrix} \quad \ldots (1\text{-}c)$$

Note 2. Per Heuristics / Human Expert Knowledge, K is defined Accordingly.

Note 3. Initialization that Requires $\vec{\mu}_i$, for $i = 1, 2, \ldots, K$

select $\vec{\mu}_i$ By Heuristics.

Then, Calculation Based on the following formula,

$$S_i^{(t)} = \{ \quad \}$$

↓

$$\{\vec{X}_p : \underbrace{\text{Conditions}} \}$$

↓

$$\{\vec{X}_p : \|\vec{X}_p - \vec{\mu}_i\|^2 \le \|\vec{X}_p - \vec{\mu}_j\|^2, \; \forall j, \; j = 1, 2, \ldots, K\} \quad \ldots (2)$$

Now, Check the convergeme.
By Comparing

$$\underline{\vec{\mu}_i^{(t+1)} = \mu_i^{(t)}}$$ ← Step at t

for $i = 1, 2, \ldots K$

from the given condition & Our Initialization,
e.g. we have

$$C_1 = (\vec{X}_1, \vec{X}_3)$$

$$\mu_1' = \frac{1}{M} \sum_{i=1}^{M} \vec{X}_i \Big|_{M=2}$$

$$= \frac{1}{2}(\vec{X}_1 + \vec{X}_2) \quad \ldots (3)$$

where $\vec{X}_1$ is equal to the 1st feature vector in C_1
$\vec{X}_2$ is the 2nd feature vector.

Hence,

$$\mu_1' = \frac{1}{2}\left[\begin{pmatrix}0\\0\end{pmatrix} + \begin{pmatrix}0\\1\end{pmatrix}\right]$$

$$= \frac{1}{2}\begin{pmatrix}0\\1\end{pmatrix} = \begin{pmatrix}0\\\frac{1}{2}\end{pmatrix}$$

Now, Check

$$\|\vec{X}_p - \mu_1'\|_{p=1} = \left\|\begin{pmatrix}0\\0\end{pmatrix} - \begin{pmatrix}0\\1/2\end{pmatrix}\right\|^2 \quad \ldots (4)$$

$$= \left\|\begin{pmatrix}0\\1/2\end{pmatrix}\right\|^2 = \sqrt{0^2 + \left(\tfrac{1}{2}\right)^2}^{\,2} = \frac{1}{2} \quad \ldots (4\text{-}b)$$

And

$$\|\vec{X}_p - \vec{\mu}_j\|^2_{j=2} \quad \ldots (5)$$

where

$$\vec{\mu}_2 = \frac{1}{M} \sum_{i=1}^{M} \vec{X}_i \Big|_{M=18}$$

$$= \frac{1}{18} \sum_{i=1}^{18} \vec{X}_i$$ Sub "i" match the Class C_2

$$= \frac{1}{18}\left[\vec{X}_2 + \vec{X}_4 + \vec{X}_5 + \vec{X}_6 + \cdots + \vec{X}_{20}\right]$$

$$= \begin{pmatrix}5.67\\5.33\end{pmatrix}$$

Hence

$$\|\vec{X}_p - \vec{\mu}_2\|^2_{p=1}$$

$$= \|\vec{X}_1 - \vec{\mu}_2\|^2 =$$

$$= \left\|\begin{pmatrix}0\\0\end{pmatrix} - \begin{pmatrix}5.67\\5.33\end{pmatrix}\right\|^2 \quad \ldots (6)$$

Therefore
Eqn (4-b) < Eqn (6)

Similarly, $\vec{X}_3$ Can be verified to Satisfy Eqn (2), → Stays in C_1.

Nov. 17th (Th)

Road map for the 2nd half of the semester:

Semantic segmentation to move from YOLO bounding boxes based DCNN technique to Pixel by Pixel based DCNN called Yolact.

If time permits, we will discuss LSTM (Long Short Term Memory) technique, based on the mathematical formulation of Markov Processes.

Note 1. PPT, introduction

Note 1. Ref. on ChatGPT fine tuning.

- 2023F-104-#190c-9a-chatGPT-API-YZ-HL...
- 2023F-104-2-API_Key (copy).json
- 2023F-104-3-requirements.txt
- 2023F-104-4-test_fine_tuning (copy).py
- 2023F-104-5-train-cti-data (copy).jsonl

Note 2.

json line file to capture the training data.

```
configure_logging()
Terminal:  Local  +
├── GPT_Fine_Tuning
│   ├── API_Key.json
│   ├── CMPE244
│   ├── requirements (copy).txt
│   ├── test_fine_tuning.py
│   ├── train-cti-data.jsonl
│   └── train_fine_tuning.py
├── GPT_Fine_Tuning (1).zip
├── GPT_Fine_Tuningoutput.log
├── hello-the-world
│   ├── API_Key.json
│   ├── chatgpt-2023-10-27.yml
│   ├── ChatHistory.json
│   └── GPTWithHistorySaved.py
├── others
```

NOtethis folder consists of the sample code

```
#-------------------------------------------
# CTI One Corporation
# for Chat-GPT
# Version x0.1
# Coded by: Youran Zheng, 2023-10-27
# Create a Anaconda environment;
# Open a terminal, then
# $ conda env create -f chatgpt-2023-10-27.yml
# Activate the Anaconda environment: $ conda activate chatgpt
#-----------------------------------------
name: chatgpt-2023-10-27

dependencies:
  - python==3.7.1
  - pip
  - pip:
    - openai==0.27.9
~
~
```

Sample example of the .jsonl file as the training data file

From this example, the user is for the part of posting questions, and the asistant is for the part of answer. So, you can modify this sample accordingly to integrate with your Q&A of your training data.

Terminal: Local


```
{"messages": [{"role": "system", "content": "You are Johnny, the CTI One technical support for W100."}, {"role": "user", "content": "Answer the following technical question: What is W100 product?"}, {"role": "assistant", "content": "W100 is a smart walker. It walks up to you when you call it.\n"}]}
{"messages": [{"role": "system", "content": "You are Johnny, the CTI One technical support for W100."}, {"role": "user", "content": "Answer the following technical question: How do I start using W100?"}, {"role": "assistant", "content": "Please first use smart phone to upload your photo to the W100 smart walker.\n"}]}
{"messages": [{"role": "system", "content": "You are Johnny, the CTI One technical support for W100."}, {"role": "user", "content": "Answer the following technical question: How do I set up W100 environment?"}, {"role": "assistant", "content": "Make sure you power up the Wi-Fi router provided in the package and then use your smart phone apps to activate W100 system by initializing it.\n"}]}
{"messages": [{"role": "system", "content": "You are Johnny, the CTI One technical support for W100."}, {"role": "user", "content": "Answer the following technical question:\nSymptom: Battery not charging\nProbable cause: Charger not working"}, {"role": "assistant", "content": "Please replace the charger of W100\n"}]}
{"messages": [{"role": "system", "content": "You are Johnny, the CTI One technical support for W100."}, {"role": "user", "content": "Answer the following technical question:\nSymptom: Battery not charging\nProbable cause: Battery connec
```


Please walk through the sample code, training and testing code as references for your design.
Note: It is mandatroy requirement to have this ChatGPT API capability integrated into your semester long project.

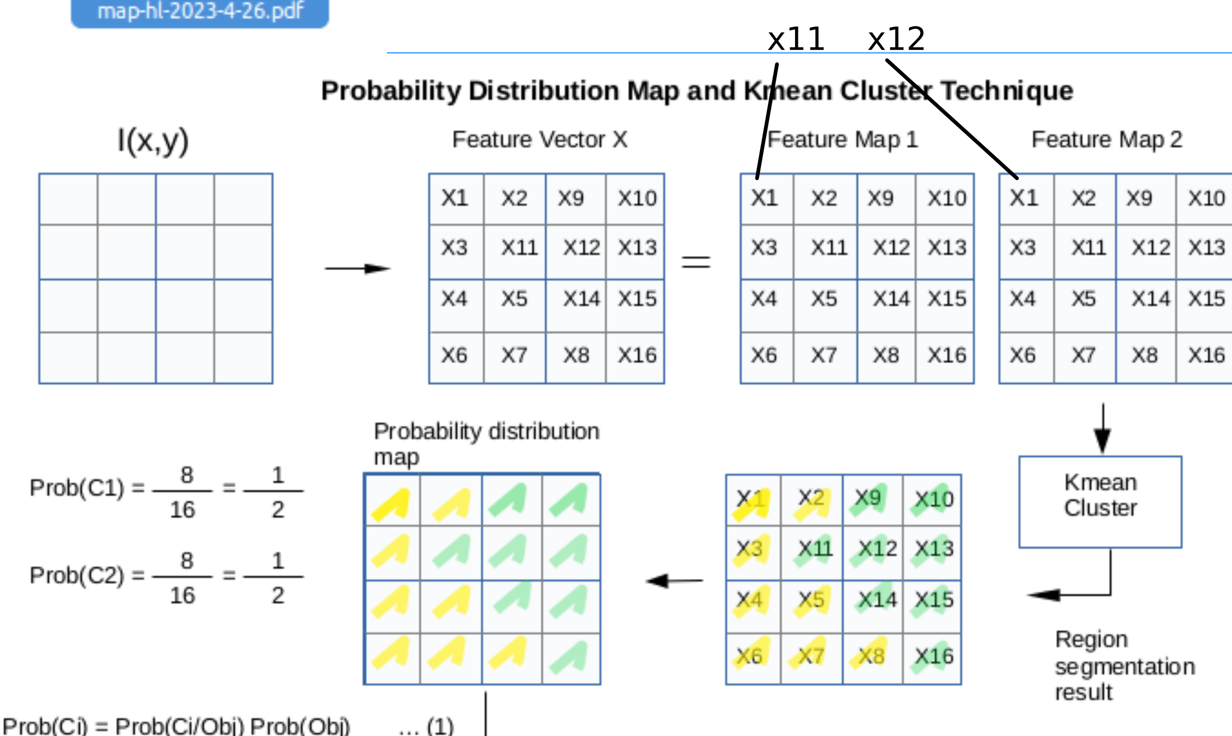
Note: Project assignment for the implementation of Yolact DCNN.

references:
1. Readme on github provides the source github and instructions to build the executable.

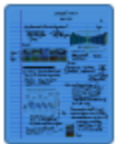
The readme document ID: 2022F-107 ~ on the github.

2. The requirements will be posted on Canvas and it is due on Dec. 3rd (Sunday).

Example: K-mean technique for the probability distribution map calculation.



Consider Semantic Segmentation
ref 1. on the github

1- 
2022F-101-cmpe258-note-part2-2022-12-6 (3).pdf

CMPE258 Part II

Nov.10,22

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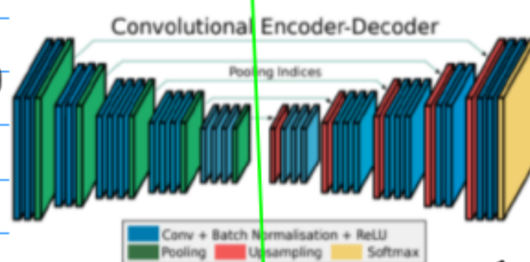
Now, Discussion On Semantic Segmentation.

Fig.3

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



Example:

Before v.s. After.

Deep Convolutional Neural Network:

Decoder:

Encoder:

Nov.21st (Tuesday).

Note 1. Semester Long Project Presentation. Nov. 30th (Thur). and Dec. 5 (Tue) Scheduled for the team/individual Project. Presentation

Note 2. Mandatory Requirement: To integrate ChatGPT APIS in your Project.

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

Example: Architecture of the DCNN, esp. Decoder

Ref 1. From the YoLact Paper

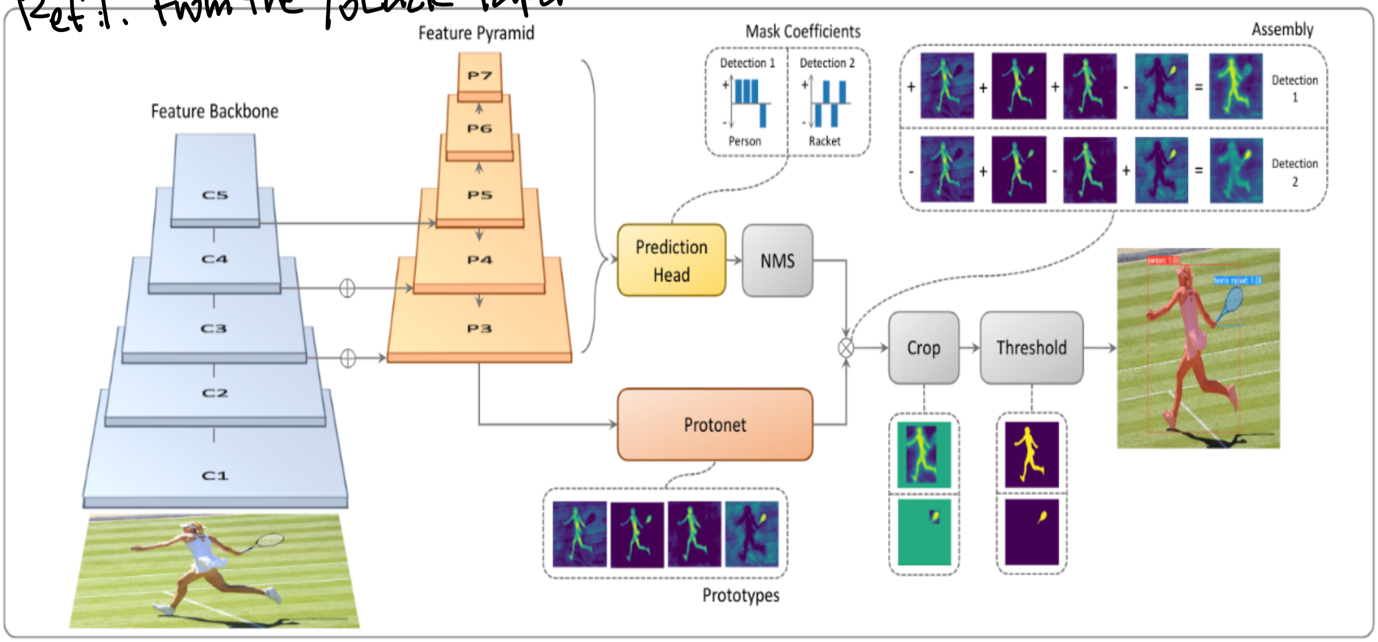


Figure 2: **YOLACT Architecture** Blue/yellow indicates low/high values in the prototypes, gray nodes indicate functions that are not trained, and $k = 4$ in this example. We base this architecture off of RetinaNet [27] using ResNet-101 + FPN.

Ref 2. Lecture Notes

1- 

Nov. 1

Example: Design of UpSampling Techniques

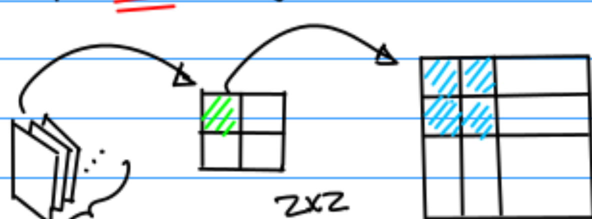


Fig. 4

Note 1. from the Ref.
Technique 1.

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

Technique 1.

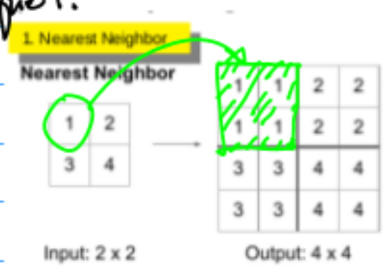
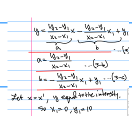


Fig. 5

NN



Continued from the Ref. Technique 2.

Bi-Linear Interpolation

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

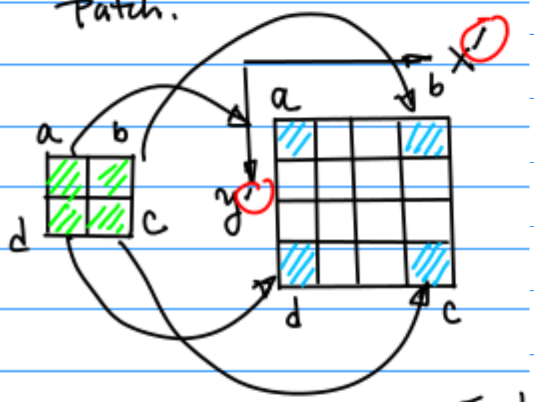


Fig.1

Step 2. Perform Interpolation

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

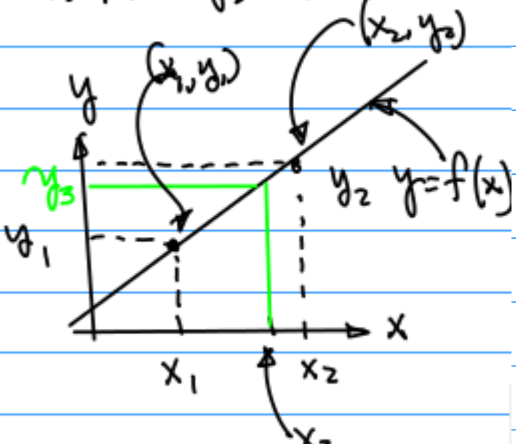


Fig.7

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

After the Math. manipulation, we have the formula Eqn (3)

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

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

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

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

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

$x_2 = 3$, $y_2 = 20$

Applying the Eqn to the top line of the feature plan. Eqn (3-b):

$$\underset{(\text{slop})}{a} = \frac{\text{feature @ pt b.} - \text{feature @ pt. a}}{\text{Index Coordinate @ b} - \text{Index Coordinate @ a}}$$

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

So, for the offset from Eqn (3-C)

$$\underset{(\text{offset})}{b} = -\frac{10}{3} \cdot x_1 \Big|_{x_1 = 0} + y_1 \Big|_{y_1 = 10}$$

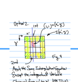
$= 10$

therefore

$$y = ax + b = \frac{10}{3} x + 10$$

Find the feature @ (1, 0), hence,

$$y = \frac{10}{3} x \Big|_{x=1} + 10 = \frac{10}{3} + \frac{30}{3} = 40/3$$



Once the interpilations along x-axis all Done, then Move to the interpolations along y-axis.

Note: from the Lecture Notes, Ref. 2.

We Can Carry out the 2nd Dimension interpolation as illustrated Below. pp.56.

Option 2.

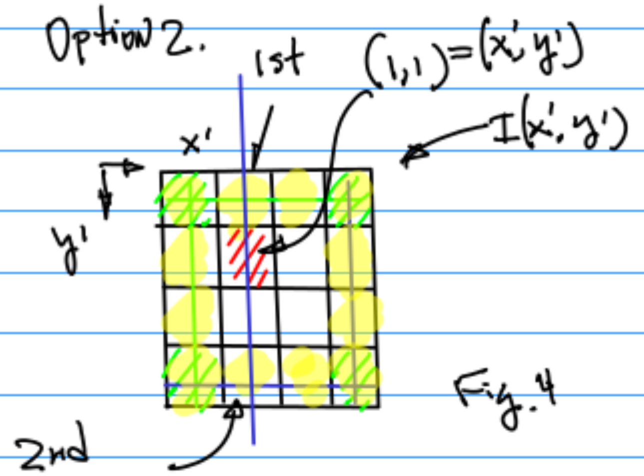


Fig. 4

Apply the Same Interpolation Equation Except the independant Variable Changed from x' to y', Use I(1,0) as the 1st pt, I(1,3) for the Interpolat Technique for UpSampling, Ref. 3

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

Nov. 28 (Tue).

Note 1. Presentation + Demo + Code Walk-Through Starts ON Thursday (Nov. 30).
Submission Starts ON Thursday

Note. 2 Final Exam Schedule ON Dec. 8th Friday 2:45-5:00 p.m. In the Same Classroom. Please Bring Your Laptop With MNIST, Yolo, Yolact Code Ready;

Note 3. Please Bring a USB webCAM, You may need it in the exam.

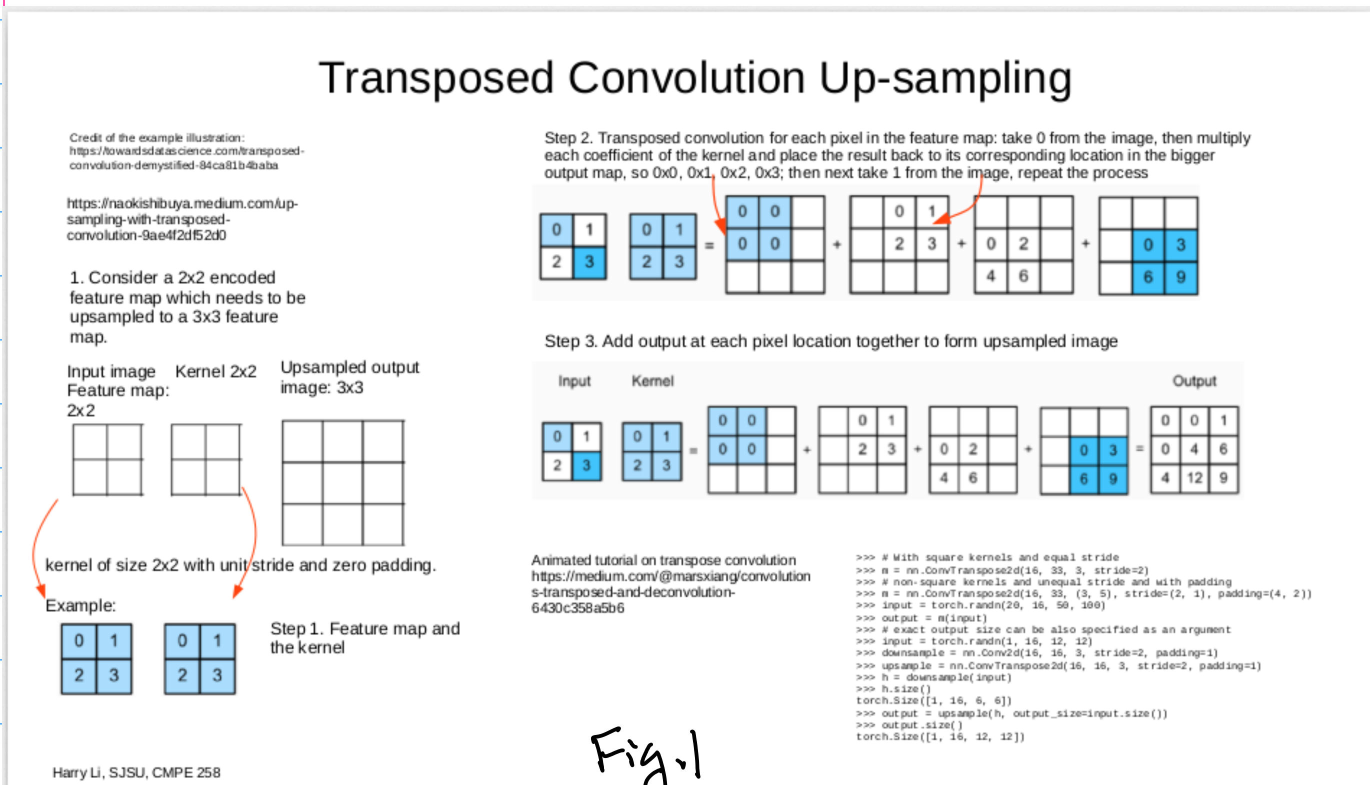


Fig.1

Ref:

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Example: Transposed Convolution for Upsampling

Continue this process for the rest of the Kernel Coefficients,

Ref: See github.

Kernel

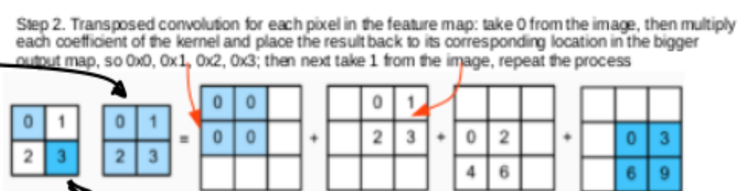

Fig.1

F(0,0)xK(0,0) F(0,0)xK(1,0)

Fig.5

F(0,0)xK(0,1) F(0,0)xK(1,1)

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

Step 2.

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Note: from the Ref Example, the Transposed Convolution UpSampling is performed by multiply each Kernel coefficient to the 2x2 patch, then place the intermmediate Computational Result on to 3x3 Patch using the Kernel coefficient location as reference, See the example on the PPT. (PP66 of this Note, Fig.1)

Example: Given A Small patch from a feature map, and Kernel

α_1	α_2
α_3	α_4

... Fig.2

, use transposed Convolution to perform an UpSampling.

1.5	3
5	9

... Fig.3

Step1. Take 1st coefficient α_1 from the Kernel, then perform

The calculation as follows.

$1.5\alpha_1$	$3\alpha_1$	
$5\alpha_1$	$9\alpha_1$	

Fig.4

2nd step. for α_2

	$1.5\alpha_2$	$3\alpha_2$
	$5\alpha_2$	$9\alpha_2$

Fig.5

3rd Step. α_3

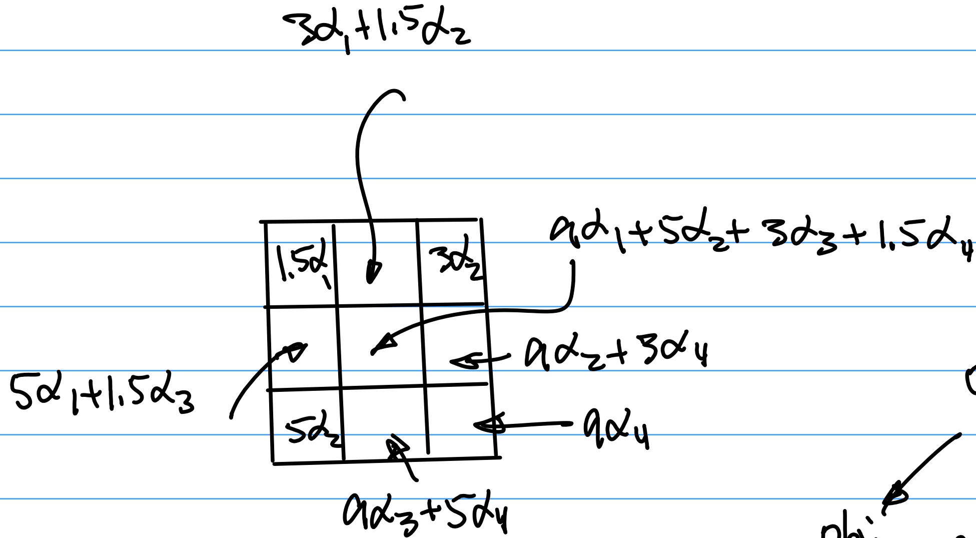
$1.5\alpha_3$	$3\alpha_3$	
$5\alpha_3$	$9\alpha_3$	

Fig.6

4th Step, α_4

	$1.5\alpha_4$	$3\alpha_4$
	$5\alpha_4$	$9\alpha_4$

5th Step Integrate the Above Result togeth.



Objects Appears inside the Bounding Box.

Note 1. Notation for the unit function: $\mathbb{I}^{obj}_{ij} = \begin{cases} 1 & \text{if Obj Detected Inside the BB} \\ 0 & \text{o/w} \end{cases}$

Location of the ROI

Locations

$$\lambda_{\text{coord}} \sum_{i=0}^{S^2} \sum_{j=0}^{B} \mathbb{1}_{ij}^{\text{obj}} \left[(x_i - \hat{x}_i)^2 + (y_i - \hat{y}_i)^2 \right]$$

$$+ \lambda_{\text{coord}} \sum_{i=0}^{S^2} \sum_{j=0}^{B} \mathbb{1}_{ij}^{\text{obj}} \left[\left(\sqrt{w_i} - \sqrt{\hat{w}_i}\right)^2 + \left(\sqrt{h_i} - \sqrt{\hat{h}_i}\right)^2 \right]$$

$$+ \sum_{i=0}^{S^2} \sum_{j=0}^{B} \mathbb{1}_{ij}^{\text{obj}} \left(C_i - \hat{C}_i \right)^2$$

$$+ \lambda_{\text{noobj}} \sum_{i=0}^{S^2} \sum_{j=0}^{B} \mathbb{1}_{ij}^{\text{noobj}} \left(C_i - \hat{C}_i \right)^2$$

$$+ \sum_{i=0}^{S^2} \mathbb{1}_{i}^{\text{obj}} \sum_{c \in \text{classes}} (p_i(c) - \hat{p}_i(c))^2 \qquad (3)$$

Note 2: Loss function in this case:

$f_\Sigma = f_1 + f_2 + \cdots + f_5$

Or, to generalize it,

$f_\Sigma = \sum_i f_i$

for

Note 3. λ_i, $i = 1, 2, \cdots, 5$

$\sum_i \lambda_i = 1$

Geometric Shapes

Note 4. physical meaning of Each loss function.

Class Classification.