KOMPUTASI BIOMEDIK
(PERTEMUAN KE-3)

Thorax : Pneumonia, Normal, Covid-19
MRI : Glioma-Tumor, Meningioma-Tumor, No-Tumor, Pituitary Tumor

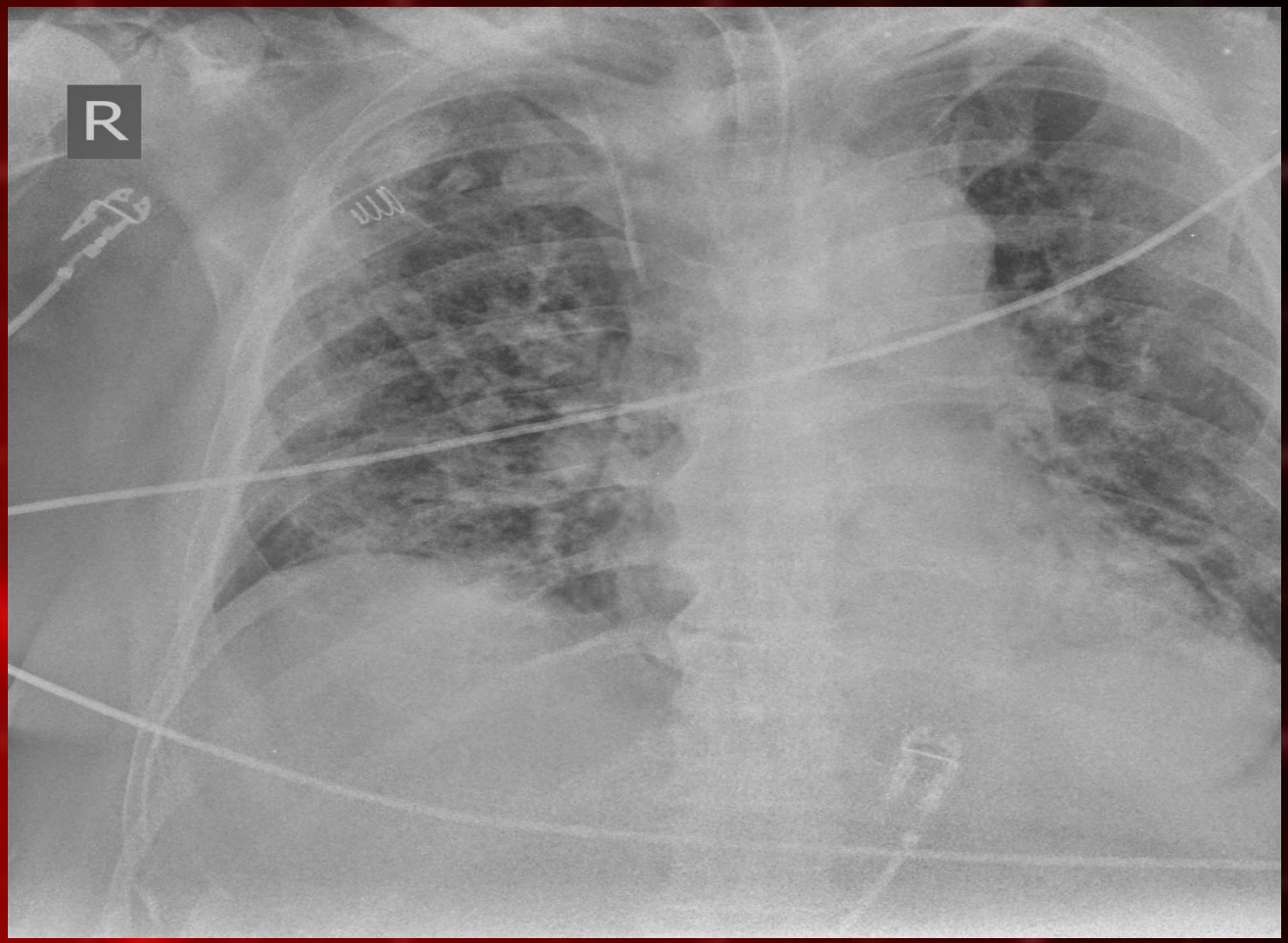
Wiharto

Outline

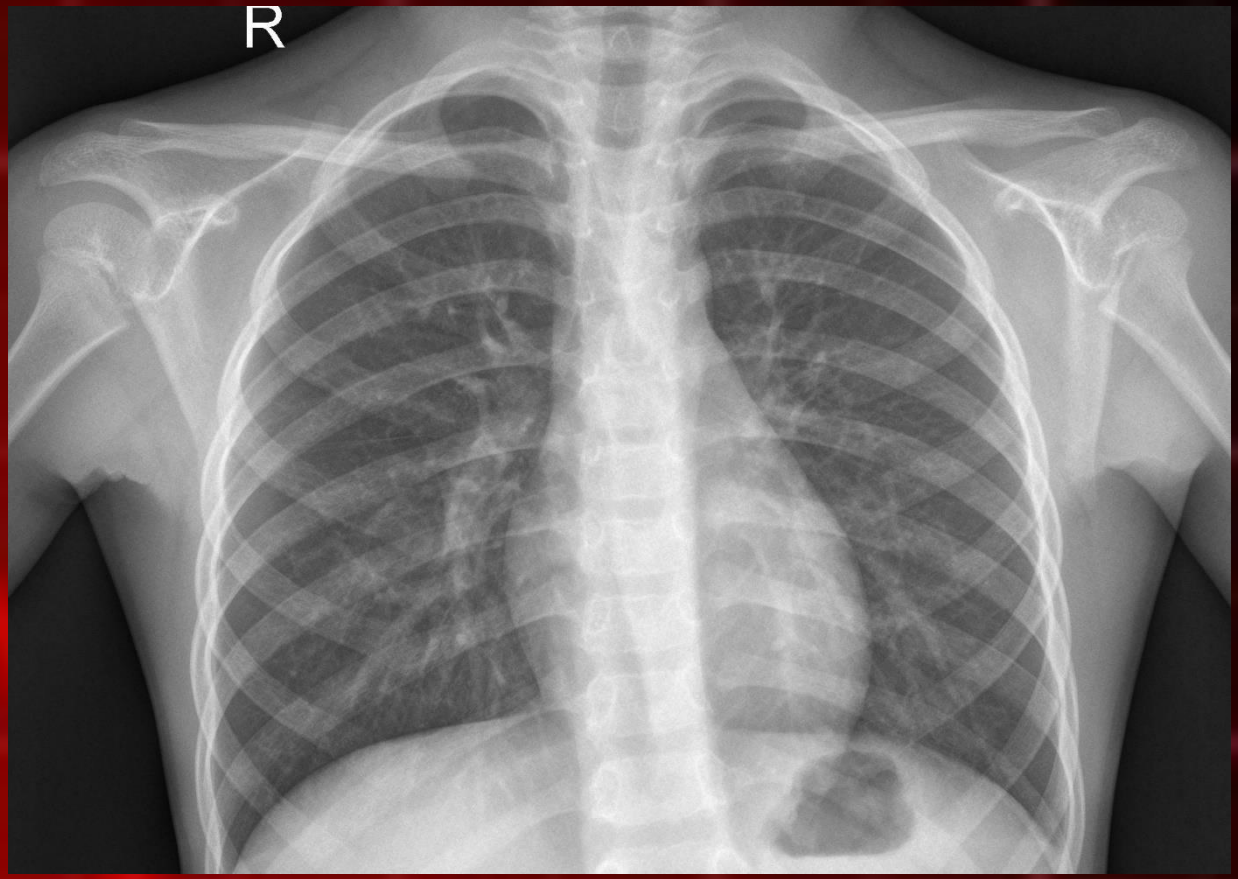
- Image processing citra x-ray paru-paru
- Image Processing MRI
- Metode Pengolahan Preprocessing
- Metode segmentasi
- Metode Feature Extraction
- Metode klasifikasi
- Metode evaluasi Kinerja

Metode pengolahan x-ray

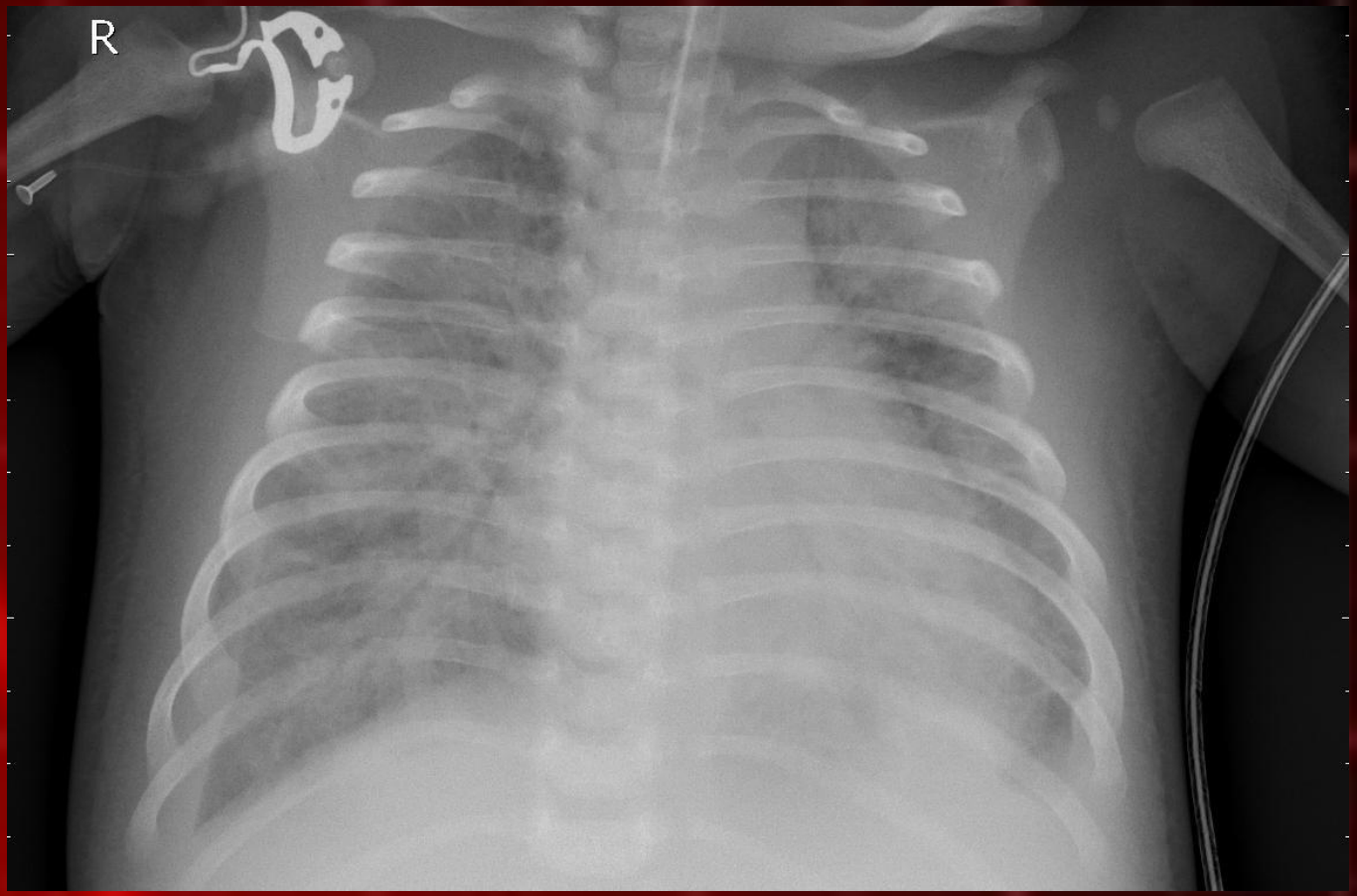
- Covid-19



- Normal

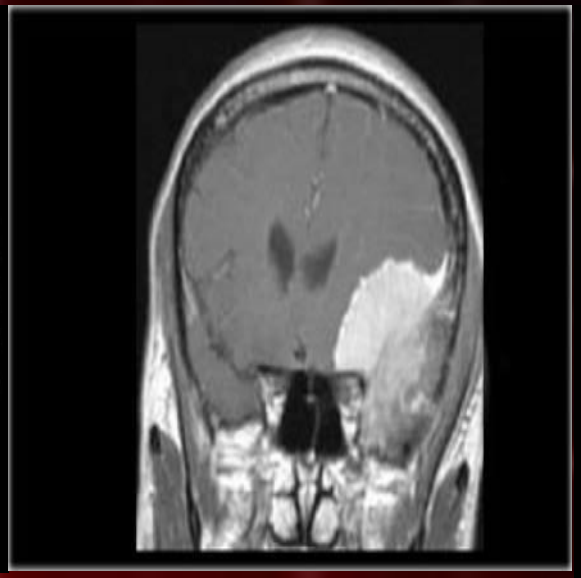


- Pneumonia

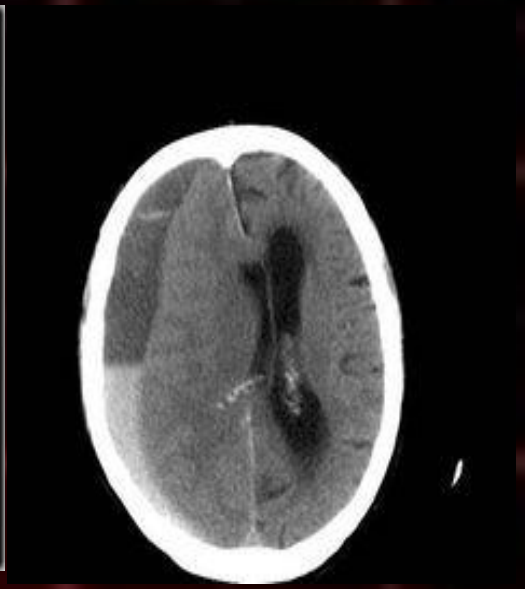


- Dataset lengkap : Thorax
  - Normal
  - Covid-19
  - Penumonia
- https://www.kaggle.com/prashant268/chest-xray-covid19-pneumonia?select=Data

Glioma-Tumor



Meningioma-Tumor



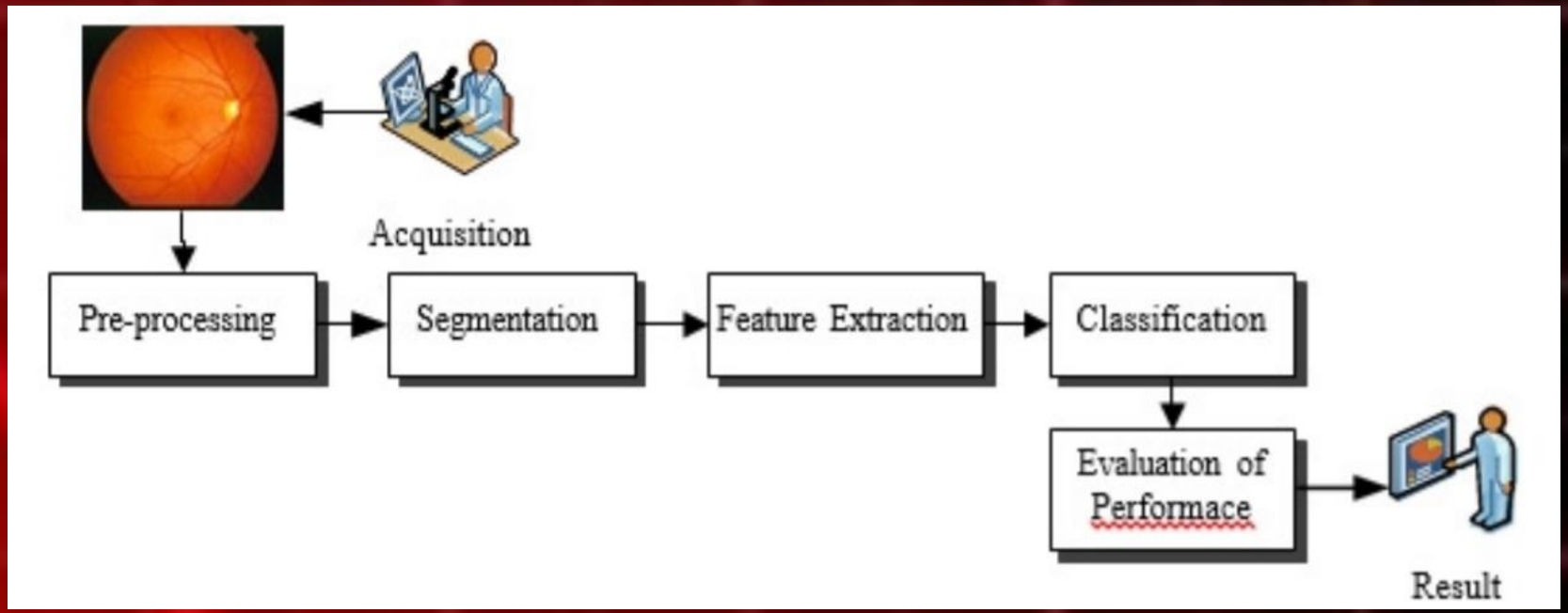
No-Tumor

Pituitary Tumor

- Dataset Lengkap : MRI Tumor
  - Glioma-Tumor
  - Meningioma-Tumor
  - No-Tumor
  - Pituitary Tumor
- https://www.kaggle.com/sartajbhuvaji/brain-tumor-classification-mri?select=Training

Model CAD

- Model secara umum dari CAD



Pre-processing

- Proses perbaikan kualitas image
  - Filtering
    - Mean filtering
    - Media filtering
    - dll

Segmentasi

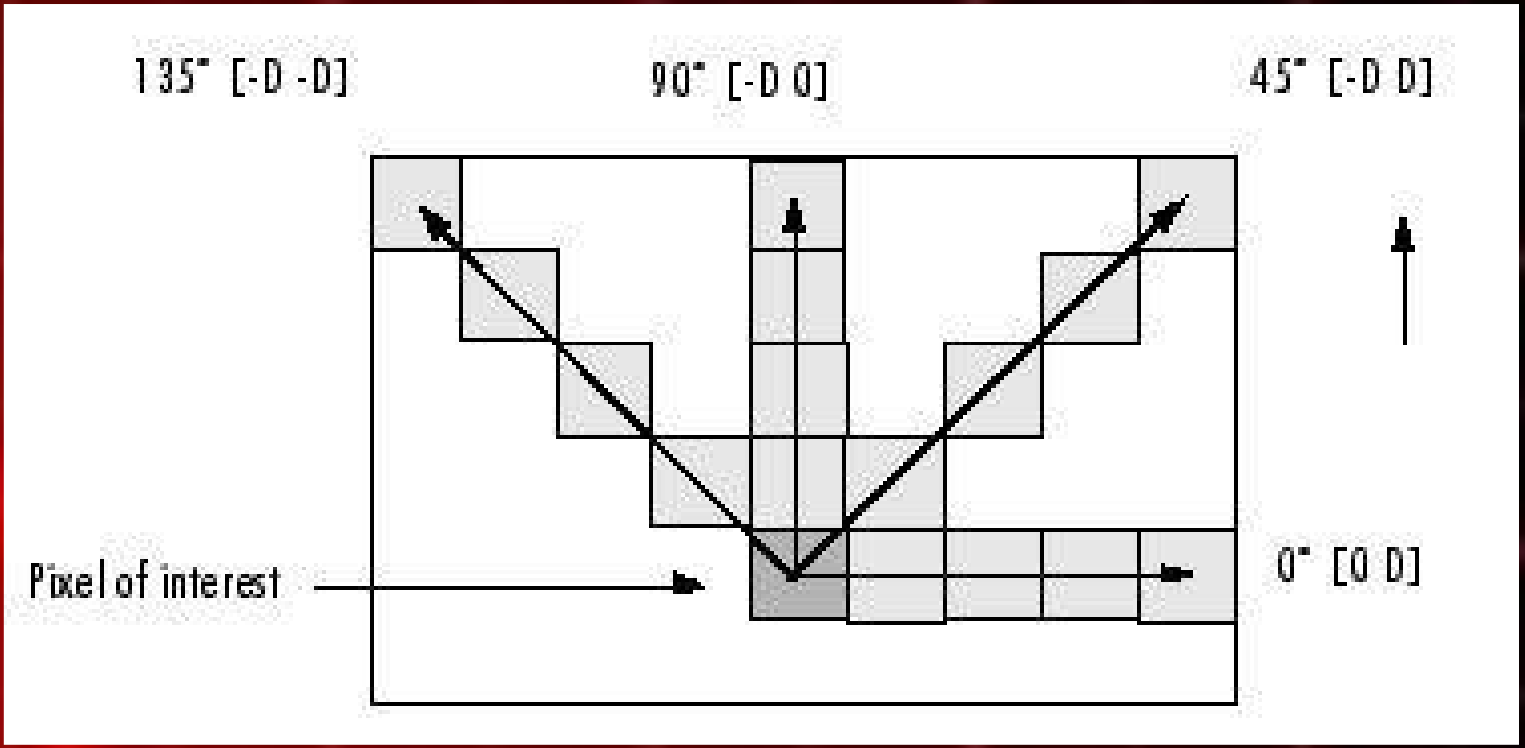
- Segmentasi membagi citra menjadi region-region atau objek-objek. Level sampai sejauh mana pembagian bisa dilakukan tergantung pada permasalahan yang diselesaikan.
- Secara umum algoritma-algoritma segmentasi didasarkan pada satu di antara dua buah karakteristik intensitas, yaitu diskontinuitas dan similaritas.
- Pada kategori pertama, pendekatan yang dilakukan adalah mempartisi citra berdasarkan pada perubahan intensitas yang cukup cepat, seperti tepian citra.
- Kategori kedua didasarkan pada kemiripan area citra menurut kriteria yang sudah ditentukan.
- Thresholding, region growing, dan region splitting/merging adalah contoh-contoh metode pada kategori dua.

Feature Extraction

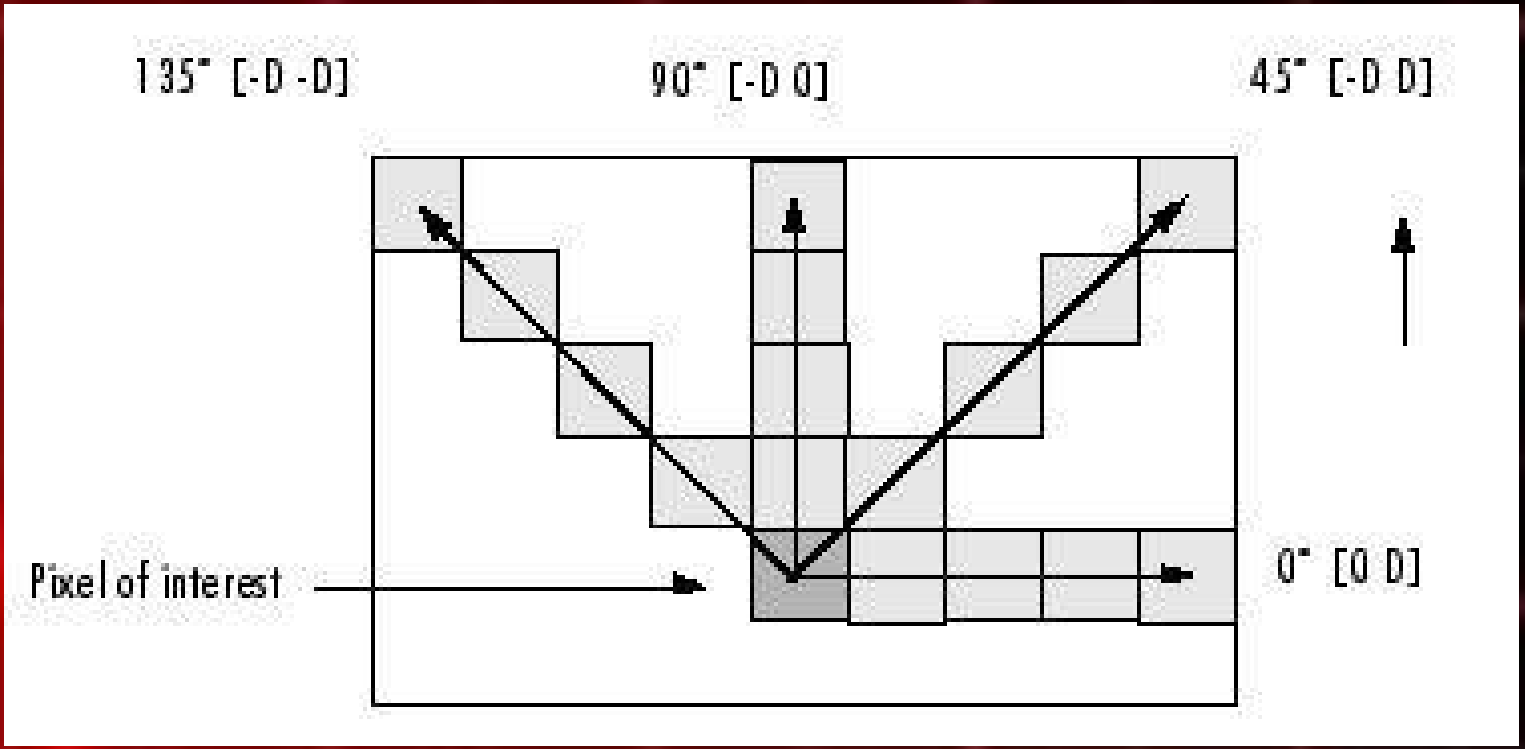
- *Feature Extraction* adalah teknik pengambilan ciri / *feature* dari suatu bentuk yang nantinya nilai yang didapatkan akan dianalisis untuk proses selanjutnya

GLCM

- GLCM adalah sebuah teknik untuk mendapatkan nilai statistik orde ke-2 dengan menghitung probabilitas hubungan kedekatan antara dua buah piksel pada jarak (d) dan sudut (θ) tertentu (Rahmanti, 2017).



- Nilai θ yang banyak adalah 0^0, 45^0, 90^0, dan 135^0



- GLCM adalah salah satu metode feature extraction order kedua pada fitur statistik teksture. Ektraksi order kedua menunjukkan hubungan statistik anatara 2 pixel.
- GLCM adalah sebuah matriks dengan jumlah baris dan kolom sebanding dengan gray level (G) dalam suatu citra.
- Metode menggunakan citra berskala keabuan (graysclae).

Contoh:

- Diketahui sebuah citra 3-bit sebagai berikut:

3	5	7
2	4	1
6	3	5

bentuklah GLCM dengan jarak 1 dan $\theta = 0^0$ ([0 1]) !

Contoh:

- Membentuk GLCM [0 1]:

3	5	7
2	4	1
6	3	5

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	**1**	0	0	0
3	0	0	0	0	0	**2**	0	0
4	0	**1**	0	0	0	0	0	0
5	0	0	0	0	0	0	0	**1**
6	0	0	0	**1**	0	0	0	0
7	0	0	0	0	0	0	0	0

Contoh:

- Membentuk GLCM [0 1]:

3	5	7
2	4	1
6	3	5

- Setelah Normalisasi =

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	$^1/_6$	0	0	0
3	0	0	0	0	0	$^2/_6$	0	0
4	0	$^1/_6$	0	0	0	0	0	0
5	0	0	0	0	0	0	0	$^1/_6$
6	0	0	0	$^1/_6$	0	0	0	0
7	0	0	0	0	0	0	0	0

Feature Extraction : GLCM

- Ekstraksi fitur (*feature extraction*) tekstur GLCM menghasilkan beberapa fitur, antara lain:
  - Contrast
  - Correlation
  - Energy
  - Homogeneity

Contrast

- Contrast merupakan fitur yang merepresentasikan perbedaan tingkat warna atau skala keabuah (grayscale) yang muncul pada sebuah citra
- Contrast akan bernilai 0 jika piksel ketetanggaan mempunyai nilai yang sama

$$Con = \sum_{i} \sum_{j} (i-j)^2 \, p_{(i,j)}$$

Contoh:

- Hitunglah Contrast dari GLCM berikut:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	$1/6$	0	0	0
3	0	0	0	0	0	$2/6$	0	0
4	0	$1/6$	0	0	0	0	0	0
5	0	0	0	0	0	0	0	$1/6$
6	0	0	0	$1/6$	0	0	0	0
7	0	0	0	0	0	0	0	0

Contoh:

- Hitunglah Contrast dari GLCM berikut:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$Con_{(2,4)} = (2-4)^2 \times \frac{1}{6}$$

$$= \frac{4}{6}$$

$$= 0{,}667$$

Contoh:

- Hitunglah Contrast dari GLCM berikut:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$Con_{(3,5)} = (3-5)^2 \times \frac{2}{6}$$

$$= \frac{8}{6}$$

$$= 1{,}333$$

Contoh:

- Hitunglah Contrast dari GLCM berikut:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$Con_{(4,1)} = (4-1)^2 \times \frac{1}{6}$$

$$= \frac{9}{6}$$

$$= 1{,}5$$

Contoh:

- Hitunglah Contrast dari GLCM berikut:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$Con_{(5,7)} = (5-7)^2 \times \frac{1}{6}$$

$$= \frac{4}{6}$$

$$= 0{,}667$$

Contoh:

- Hitunglah Contrast dari GLCM berikut:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$Con_{(6,3)} = (6-3)^2 \times \frac{1}{6}$$

$$= \frac{9}{6}$$

$$= 1{,}5$$

Contoh:

- Hitunglah Contrast dari GLCM berikut:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$Con = \frac{4+8+9+4+9}{6}$$

$$= \frac{34}{6}$$

$$= 5{,}667$$

Correlation

- Correlation merepresentasikan keterkaitan linear dari derajat dari citra keabuan
- Correlation bernilai antara -1 hingga 1

$$Cor = \sum_{i} \sum_{j} \frac{(i - \mu i)(j - \mu j) p_{(i,j)}}{\sigma i \, \sigma j}$$

- Correlation merepresentasikan keterkaitan linear dari derajat dari citra keabuan
- Correlation bernilai antara -1 hingga 1

$$Cor = \sum_i \sum_j \frac{(i - \mu i)(j - \mu j)p_{(i,j)}}{\sigma i \, \sigma j}$$

Dimana:

- $\mu i = \sum_i \sum_j i p_{(i,j)}$
- $\mu j = \sum_i \sum_j j p_{(i,j)}$
- $\sigma i = \sqrt{\sum_i \sum_j (i - \mu i)^2 p_{(i,j)}}$
- $\sigma j = \sqrt{\sum_i \sum_j (j - \mu i)^2 p_{(i,j)}}$

Contoh:

- Hitunglah Correlation dari GLCM berikut:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	$1/6$	0	0	0
3	0	0	0	0	0	$2/6$	0	0
4	0	$1/6$	0	0	0	0	0	0
5	0	0	0	0	0	0	0	$1/6$
6	0	0	0	$1/6$	0	0	0	0
7	0	0	0	0	0	0	0	0

Contoh:

- Menghitung μi :

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$ui = \frac{2\times1+3\times2+4\times1+5\times1+6\times1}{6}$$

$$= \frac{23}{6}$$

$$= 3{,}833$$

Contoh:

- Menghitung μj :

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$uj = \frac{1\times1+3\times1+4\times1+5\times2+7\times1}{6}$$

$$= \frac{25}{6}$$

$$= 4{,}167$$

Contoh:

- Menghitung σi:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$\sigma i_{(2,4)} = \left(2 - \frac{23}{6}\right)^2 \times \frac{1}{6}$$

$$= \frac{121}{36} \times \frac{1}{6}$$

$$= \frac{121}{216}$$

$$= 0{,}56$$

Contoh:

- Menghitung σi:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$\sigma i_{(3,5)} = \left(3 - \frac{23}{6}\right)^2 \times \frac{2}{6}$$

$$= \frac{25}{36} \times \frac{2}{6}$$

$$= \frac{50}{216}$$

$$= 0{,}231$$

Contoh:

- Menghitung σi:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$\sigma i_{(4,1)} = \left(4 - \frac{23}{6}\right)^2 \times \frac{1}{6}$$

$$= \frac{1}{36} \times \frac{1}{6}$$

$$= \frac{1}{216}$$

$$= 0{,}005$$

Contoh:

- Menghitung σi:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$\sigma i_{(5,7)} = \left(5 - \frac{23}{6}\right)^2 \times \frac{1}{6}$$

$$= \frac{49}{36} \times \frac{1}{6}$$

$$= \frac{49}{216}$$

$$= 0{,}227$$

Contoh:

- Menghitung σi:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$\sigma i_{(6,3)} = \left(6 - \frac{23}{6}\right)^2 \times \frac{1}{6}$$

$$= \frac{169}{36} \times \frac{1}{6}$$

$$= \frac{169}{216}$$

$$= 0{,}782$$

Contoh:

- Menghitung σi:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$\sigma i = \sqrt{\frac{121+50+1+49+169}{216}}$$

$$= \sqrt{\frac{390}{216}}$$

$$= \sqrt{\frac{65}{36}}$$

$$= 1{,}343$$

Contoh:

- Menghitung σj:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$\sigma j_{(4,1)} = \left(1 - \frac{25}{6}\right)^2 \times \frac{1}{6}$$

$$= \frac{361}{36} \times \frac{1}{6}$$

$$= \frac{361}{216}$$

$$= 1{,}671$$

Contoh:

- Menghitung σj:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$\sigma j_{(6,3)} = \left(3 - \frac{25}{6}\right)^2 \times \frac{1}{6}$$

$$= \frac{49}{36} \times \frac{1}{6}$$

$$= \frac{49}{216}$$

$$= 0{,}227$$

Contoh:

- Menghitung σj:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$\sigma j_{(2,4)} = \left(4 - \frac{25}{6}\right)^2 \times \frac{1}{6}$$

$$= \frac{1}{36} \times \frac{1}{6}$$

$$= \frac{1}{216}$$

$$= 0{,}005$$

Contoh:

- Menghitung σj:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$\sigma j_{(3,5)} = \left(5 - \frac{25}{6}\right)^2 \times \frac{2}{6}$$

$$= \frac{25}{36} \times \frac{2}{6}$$

$$= \frac{50}{216}$$

$$= 0{,}231$$

Contoh:

- Menghitung σj:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$\sigma j_{(5,7)} = \left(7 - \frac{25}{6}\right)^2 \times \frac{1}{6}$$

$$= \frac{289}{36} \times \frac{1}{6}$$

$$= \frac{289}{216}$$

$$= 1{,}338$$

Contoh:

- Menghitung σj:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$\sigma j = \sqrt{\frac{361+49+1+50+289}{216}}$$

$$= \sqrt{\frac{750}{216}}$$

$$= \sqrt{\frac{125}{36}}$$

$$= 1{,}863$$

Contoh:

- Menghitung Correlation:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$Corr_{(2,4)} = \frac{\left(2-\frac{23}{6}\right)\times\left(4-\frac{25}{6}\right)\times\frac{1}{6}}{\sqrt{\frac{65}{36}}\times\sqrt{\frac{125}{36}}}$$

$$= \frac{\left(-\frac{11}{6}\right)\times\left(-\frac{1}{6}\right)\times\frac{1}{6}}{\frac{\sqrt{65\times125}}{36}}$$

$$= \frac{11}{6\times\sqrt{65\times125}}$$

$$= 0{,}02$$

Contoh:

- Menghitung Correlation:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$Corr_{(3,5)} = \frac{\left(3-\frac{23}{6}\right)\times\left(5-\frac{25}{6}\right)\times\frac{2}{6}}{\sqrt{\frac{65}{36}}\times\sqrt{\frac{125}{36}}}$$

$$= \frac{\left(-\frac{5}{6}\right)\times\left(\frac{5}{6}\right)\times\frac{2}{6}}{\frac{\sqrt{65\times125}}{36}}$$

$$= \frac{-50}{6\times\sqrt{65\times125}}$$

$$= -0{,}093$$

Contoh:

- Menghitung Correlation:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$Corr_{(4,1)} = \frac{\left(4-\frac{23}{6}\right)\times\left(1-\frac{25}{6}\right)\times\frac{1}{6}}{\sqrt{\frac{65}{36}}\times\sqrt{\frac{125}{36}}}$$

$$= \frac{\left(\frac{1}{6}\right)\times\left(-\frac{19}{6}\right)\times\frac{1}{6}}{\frac{\sqrt{65\times125}}{36}}$$

$$= \frac{-19}{6\times\sqrt{65\times125}}$$

$$= -0{,}035$$

Contoh:

- Menghitung Correlation:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	$^1/_6$	0	0	0
3	0	0	0	0	0	$^2/_6$	0	0
4	0	$^1/_6$	0	0	0	0	0	0
5	0	0	0	0	0	0	0	$^1/_6$
6	0	0	0	$^1/_6$	0	0	0	0
7	0	0	0	0	0	0	0	0

$$Corr_{(5,7)} = \frac{\left(5-\frac{23}{6}\right)\times\left(7-\frac{25}{6}\right)\times\frac{1}{6}}{\sqrt{\frac{65}{36}}\times\sqrt{\frac{125}{36}}}$$

$$= \frac{\left(\frac{7}{6}\right)\times\left(\frac{17}{6}\right)\times\frac{1}{6}}{\frac{\sqrt{65\times125}}{36}}$$

$$= \frac{119}{6\times\sqrt{65\times125}}$$

$$= 0{,}22$$

Contoh:

- Menghitung Correlation:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	$^1/_6$	0	0	0
3	0	0	0	0	0	$^2/_6$	0	0
4	0	$^1/_6$	0	0	0	0	0	0
5	0	0	0	0	0	0	0	$^1/_6$
6	0	0	0	$^1/_6$	0	0	0	0
7	0	0	0	0	0	0	0	0

$$Corr_{(6,3)} = \frac{\left(6-\frac{23}{6}\right)\times\left(3-\frac{25}{6}\right)\times\frac{1}{6}}{\sqrt{\frac{65}{36}}\times\sqrt{\frac{125}{36}}}$$

$$= \frac{\left(\frac{13}{6}\right)\times\left(-\frac{7}{6}\right)\times\frac{1}{6}}{\frac{\sqrt{65\times125}}{36}}$$

$$= \frac{-91}{6\times\sqrt{65\times125}}$$

$$= -0{,}168$$

Contoh:

- Menghitung Correlation:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$Corr = \frac{11 + (-50) + (-19)}{+119 - 91}$$

$$= \frac{-30}{6 \times \sqrt{65 \times 125}}$$

$$= -0{,}056$$

Energy

- Energy merepresentasikan ukuran keseragaman pada citra
- Semakin tinggi kemiripan citra maka akan semakin tinggi pula nilai Energy

$$Eng = \sum_i \sum_j p(i,j)^2$$

Contoh:

- Hitunglah Energy dari GLCM berikut:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	$1/6$	0	0	0
3	0	0	0	0	0	$2/6$	0	0
4	0	$1/6$	0	0	0	0	0	0
5	0	0	0	0	0	0	0	$1/6$
6	0	0	0	$1/6$	0	0	0	0
7	0	0	0	0	0	0	0	0

Contoh:

- Hitunglah Energy dari GLCM berikut:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$Eng = \left(\frac{1}{6}\right)^2 + \left(\frac{2}{6}\right)^2 + \left(\frac{1}{6}\right)^2 + \left(\frac{1}{6}\right)^2 + \left(\frac{1}{6}\right)^2 + \left(\frac{1}{6}\right)^2$$

$$= \frac{1^2 + 2^2 + 1^2 + 1^2 + 1^2}{6^2}$$

$$= \frac{8}{36}$$

$$= 0{,}222$$

Homogeneity

- Homogeneity merepresentasikan ukuran keserbasamaan
- Homogeneity akan bernilai tinggi jika semua piksel mempunyai nilai yang uniform

$$Hom = \sum_i \sum_j \frac{p(i,j)}{1 + |i - j|}$$

Contoh:

- Hitunglah Homogeneity dari GLCM berikut:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	$^1/_6$	0	0	0
3	0	0	0	0	0	$^2/_6$	0	0
4	0	$^1/_6$	0	0	0	0	0	0
5	0	0	0	0	0	0	0	$^1/_6$
6	0	0	0	$^1/_6$	0	0	0	0
7	0	0	0	0	0	0	0	0

Contoh:

- Hitunglah Homogeneity dari GLCM berikut:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$Hom_{(2,4)} = \frac{\frac{1}{6}}{1+|2-4|}$$

$$= \frac{1}{6\times(1+|2-4|)}$$

$$= \frac{1}{18}$$

$$= 0{,}056$$

Contoh:

- Hitunglah Homogeneity dari GLCM berikut:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$Hom_{(3,5)} = \frac{\frac{2}{6}}{1+|3-5|}$$

$$= \frac{2}{6\times(1+|3-5|)}$$

$$= \frac{2}{18}$$

$$= 0{,}111$$

Contoh:

- Hitunglah Homogeneity dari GLCM berikut:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$Hom_{(4,1)} = \frac{\frac{1}{6}}{1+|4-1|}$$

$$= \frac{1}{6\times(1+|4-1|)}$$

$$= \frac{1}{24}$$

$$= 0{,}042$$

Contoh:

- Hitunglah Homogeneity dari GLCM berikut:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$Hom_{(5,7)} = \frac{\frac{1}{6}}{1+|5-7|}$$

$$= \frac{1}{6\times(1+|5-7|)}$$

$$= \frac{1}{18}$$

$$= 0{,}056$$

Contoh:

- Hitunglah Homogeneity dari GLCM berikut:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$Hom_{(6,3)} = \frac{\frac{1}{6}}{1+|6-3|}$$

$$= \frac{1}{6\times(1+|6-3|)}$$

$$= \frac{1}{24}$$

$$= 0{,}042$$

Contoh:

- Hitunglah Homogeneity dari GLCM berikut:

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	1/6	0	0	0
3	0	0	0	0	0	2/6	0	0
4	0	1/6	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1/6
6	0	0	0	1/6	0	0	0	0
7	0	0	0	0	0	0	0	0

$$Hom = \frac{1+2+1}{18} + \frac{1+1}{24}$$
$$= \frac{4}{18} + \frac{2}{24}$$
$$= \frac{2}{9} + \frac{1}{12}$$
$$= \frac{8+3}{36}$$
$$= 0{,}306$$

Hasil Ekstraksi Fitur GLCM

- Hasil ekstraksi fitur GLCM:

3	5	7
2	4	1
6	3	5

i \ j	0	1	2	3	4	5	6	7
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	$1/6$	0	0	0
3	0	0	0	0	0	$2/6$	0	0
4	0	$1/6$	0	0	0	0	0	0
5	0	0	0	0	0	0	0	$1/6$
6	0	0	0	$1/6$	0	0	0	0
7	0	0	0	0	0	0	0	0

- Contrast :5,667
- Correlation :-0,056
- Energy :0,222
- Homogeneity:0,306

Hasil Ekstraksi Fitur GLCM

- Hasil ekstraksi fitur GLCM:
  - Contrast : 5,667
  - Correlation :-0,056
  - Energy : 0,222
  - Homogeneity : 0,306
- Fitur-fitur tersebut selanjutnya dapat digunakan dalam proses klasifikasi atau identifikasi citra dengan algoritma klasifikasi seperti KNN, ANN/JST, dsb.
- Untuk hasil ekstraksi fitur yang terlalu besar/banyak, dapat dilakukan proses seleksi fitur (*feature selection*) dengan algoritma seperti PCA.

1) Angular Secont Moment

$$ASM = \sum_i \sum_j \{p(i,j)\}^2$$

2) Contrast

$$CON = \sum_k k^2 \left[\sum_i \sum_j p(i,j) \right]$$

$$|i-j| = k$$

3) Correlation

$$COR = \frac{\sum_i \sum_j (ij).p(i,j) - \mu_x \mu_y}{\sigma_x \sigma_y}$$

4) Variance

$$VAR = \sum_i \sum_j (i-\mu_x)(j-\mu_y)\,p(i,j)$$

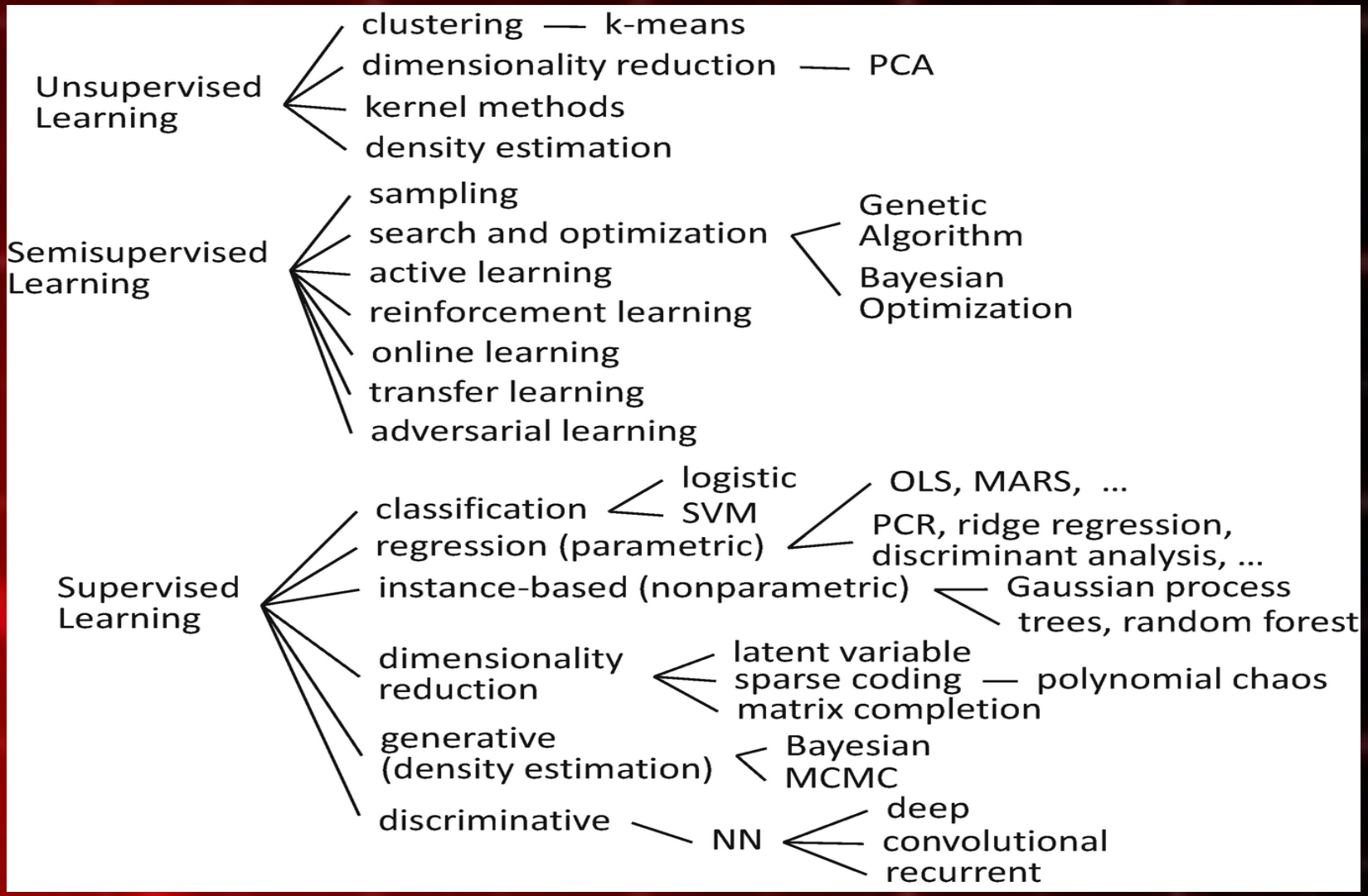
5) Inverse Different Moment

$$IDM = \sum_i \sum_j \frac{1}{1+(i-j)^2}\,p(i,j)$$

6) Entropy

$$ENT = -\sum_i \sum_j p(i,j).\log p(i,j)$$

Klasifikasi



Tugas-1

- Buatlah model computer aided diagnosis (CAD) sederhana untuk mendeteksi penyakit :
  - Pneumonia
  - Normal
  - Covid-19
- Feature extraction : GLCM atau yang lainnya (missal : CNN)
- Klasifikasi :
  - Deep Neural Network
  - Ensemble Bagging
  - Ensemble Adaboost
  - Support Vector Machine (SVM)
- Output : Laporan dengan format (*.docx)
  - Latar belakang
  - Method
  - Hasil dan Pembahasan
  - Kesimpulan
  - Pustaka
- Waktu Makasimal : 29 September 2021
- Kelompok : @2 Mahasiswa

Next