Reconocimiento de Patrones

Laboratorio avanzado de procesamiento de imágenes

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LaPI

Laboratorio avanzado de procesamiento de imágenes

1

" Given a number of features, how can one select the most important of them so as to reduce their number and at the same time retain as much as possible of their class discriminatory information? "

2

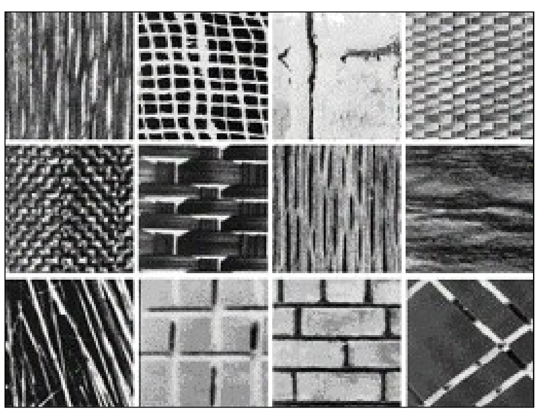
Preprocesamiento

- Quitar “outliers”
- Normalización de datos
- Datos faltantes

3

Contexto

- Textura : distribución espacialmente uniforme de variaciones de niveles de gris.



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4

Texture

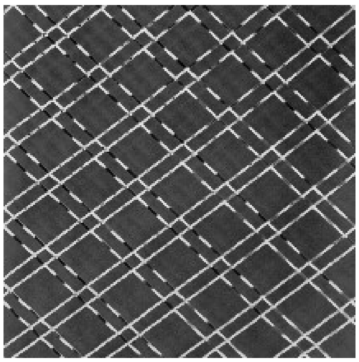
- Texture depicts spatially repeating patterns[Efros 2006]
- Textures are fine scale-details, usually with some periodicity and oscillatory nature.[Bresson 2009]
- Many natural phenomena are textures



5

Características básicas

- Tonos de Grises
- Frecuencia
- Escala
- Orientación



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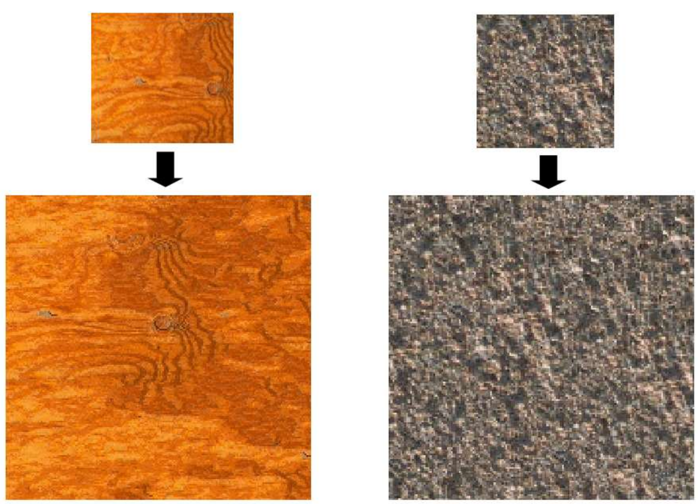
6

Texel

- Texture consists of texture primitives, texels
  - a contiguous set of pixels with some tonal and/or regional property

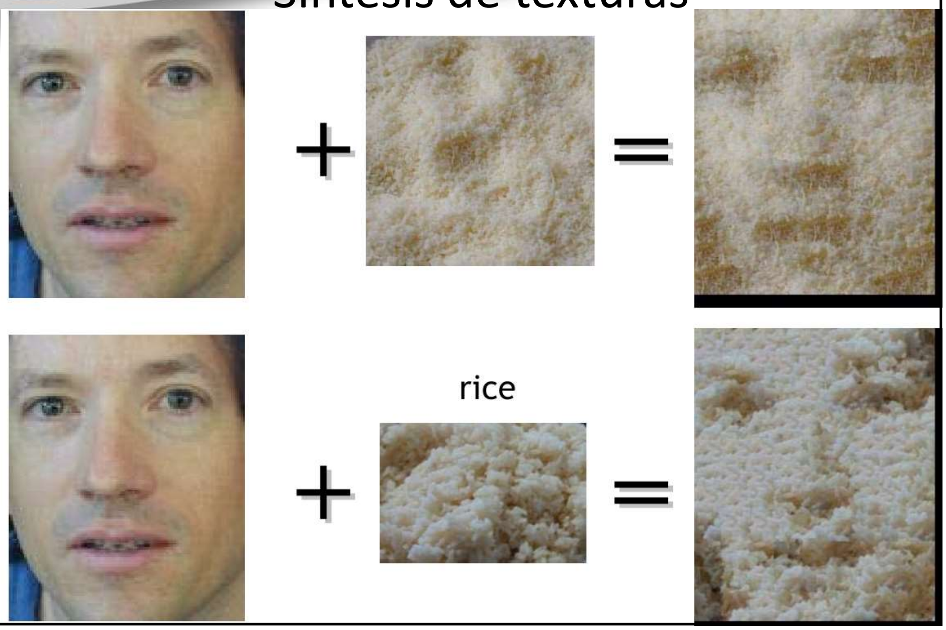
7

Síntesis de textura



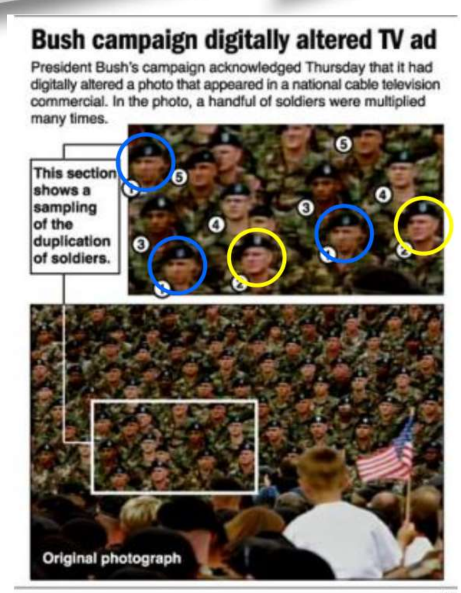
8

Síntesis de texturas



9

Textura en las noticias



Bush campaign digitally altered TV ad

President Bush's campaign acknowledged Thursday that it had digitally altered a photo that appeared in a national cable television commercial. In the photo, a handful of soldiers were multiplied many times.

This section shows a sampling of the duplication of soldiers.

Original photograph

AP

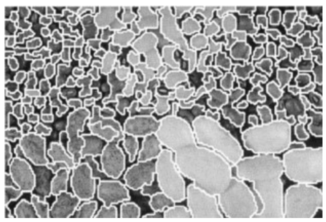
10

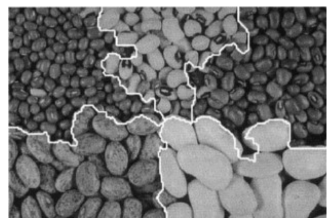
Características básicas

objetos

texturas

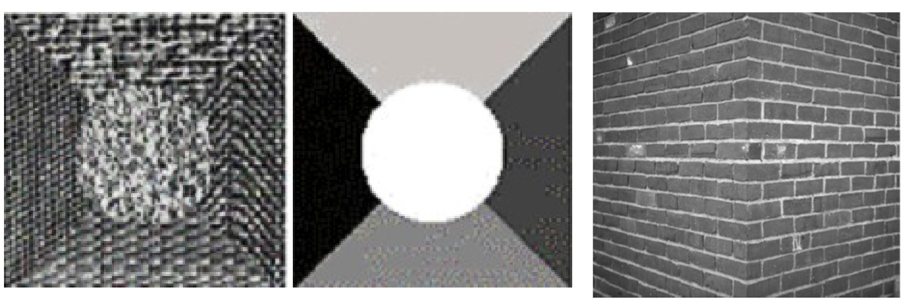
Escala





Aplicaciones

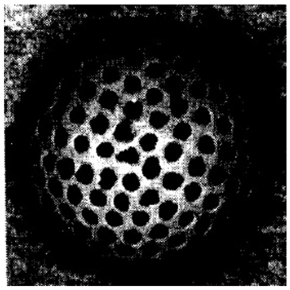
- Segmentación en regiones homogéneas de textura

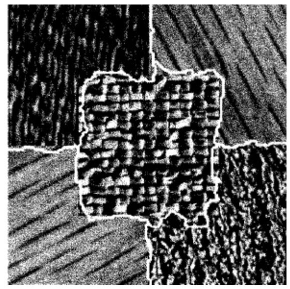


Divide and image into regions of different textures- texture segmentation

Aplicaciones

- **Extracción de la forma de superficie (shape from texture)**
- **Detección de contornos por textura**





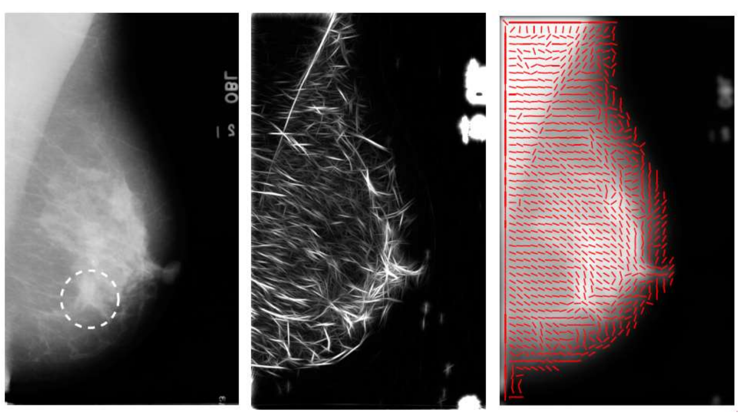
13

13

Aplicaciones - transformación

Gabor Filter Mamogram *"oriented texture"*

- Identify what a surface represents by analyzing the texture of a sample –texture classification

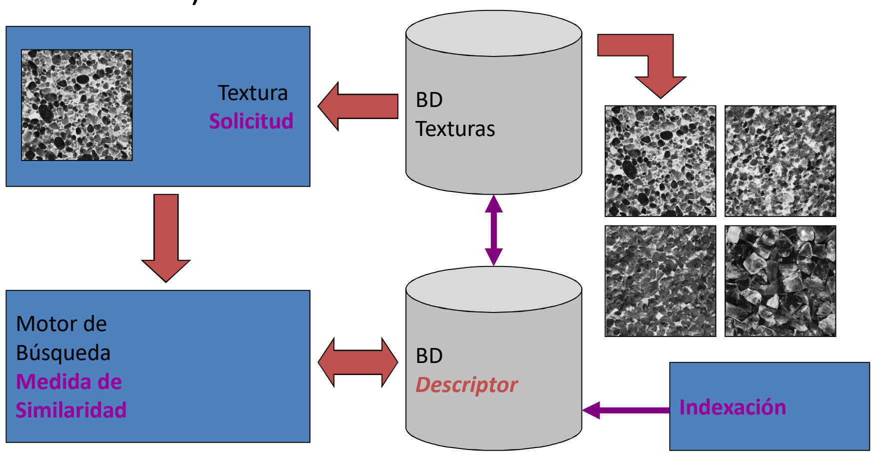


[Rangayyan, Biomedical Image Analysis2005]

14

Aplicaciones

- Recuperación de imágenes similares de textura (base de datos)

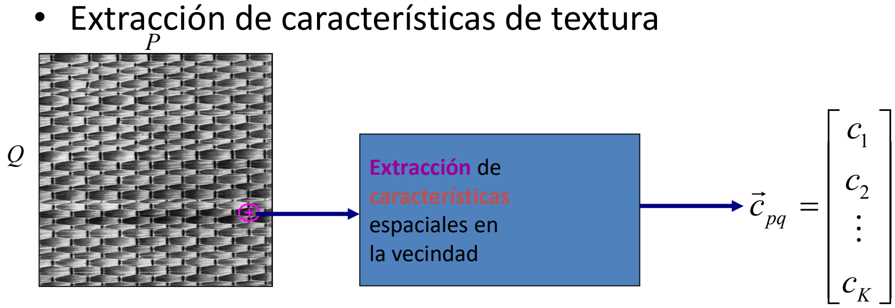


15

15

Aplicación

- Extracción de características de textura



$$T = \{\vec{c}_{pq} \mid p = 0,1,\ldots,P-1; q = 0,1,\ldots,Q-1\}$$

- Decide whether a texture is as it is expected to be or contains faults- texture feature detection.

16

16

Texture Segmentation Methods

[Nava 2013]

- **Statistical Methods** (probability distribution) analyze such as mean, variance, skewness, kurtosis, and so on. They are based on the assumption that intensity variations are more or less constant within a texture region and take a greater value outside their boundary.
- **Spectral Methods** collect a distribution of filter responses for a further classification. For instance have used Gabor or Hermite filters.
- **Structural Methods** which are organized according to a certain placement rule that defines the spatial relationship among primitives.
- **Stochastic Methods** assume that textures are the realization of a stochastic process and estimate parameter associated with the process, e.g., Bayesian approach as a texture descriptor.

17

Métodos de análisis de textura

- Estadísticos

  Momentos, Matriz de Co-ocurrencia

- Basados en un modelo

  Características autorregresivas

- Características por procesamiento de señales :

  Filtrado

18

18

Descriptores de forma

Table 9.1 Some common, single-parameter descriptors for approximate shape in 2-D

Measure	Definition	Circle	Square	Rectangle as $b/a \to \infty$
Form factor	$\frac{4\pi \times \text{Area}}{\text{Perimeter}^2}$	1	$\pi/4$	$\to 0$
Roundness	$\frac{4 \times \text{Area}}{\pi \times \text{MaxDiameter}^2}$	1	$2/\pi$	$\to 0$
Aspect ratio	$\frac{\text{MaxDiameter}}{\text{MinDiameter}}$	1	1	$\to \infty$
Solidity	$\frac{\text{Area}}{\text{ConvexArea}}$	1	1	$\to 0$
Extent	$\frac{\text{TotalArea}}{\text{Area Bounding Rectangle}}$	$\pi/4$	1	indeterminate
Compactness	$\frac{\sqrt{(4 \times \text{Area})/\pi}}{\text{MaxDiameter}}$	1	$\sqrt{2/\pi}$	$\to 0$
Convexity	$\frac{\text{Convex Perimeter}}{\text{Perimeter}}$	1	1	1

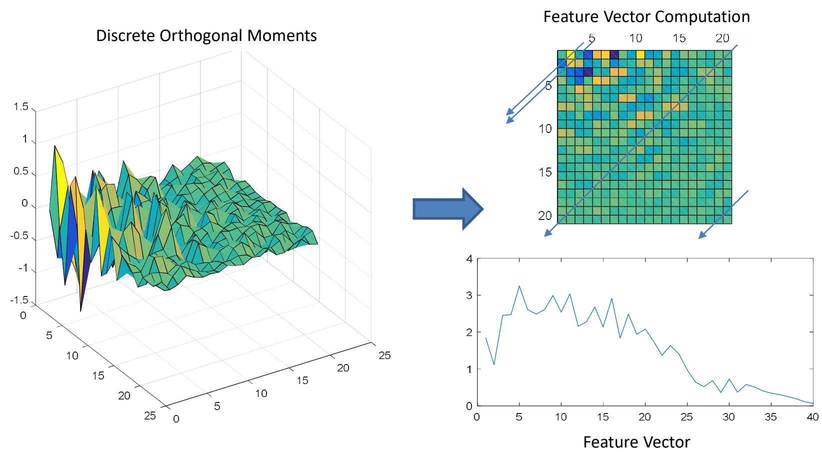
19

Métodos Estadísticos

Describe texture in a region by a vector of statistics (feature vector)

- First order statistics from the (texel) greylevel intensity histogram
- Second order statistics, describing relation between pairs of texels
- Higher order statistics, quantize region in runs of texels

20



Estadísticos basados en niveles de grises - Histograma

-Una imagen muestra la distribución espacial de los niveles de gris.

- El histograma de una imagen descarta la información espacial y muestra la frecuencia de ocurrencia de los valores de gris.

-Una imagen tiene un solo histograma, pero un histograma puede corresponder con infinitas imágenes.

-El histograma de una imagen es una función discreta que representa el número de pixeles en la imagen en función de los niveles de intensidad.

Imagen

2	4	5	4	5	5
1	6	3	6	3	5
0	7	5	7	0	4
5	6	3	7	1	2
3	4	3	5	5	4
4	2	4	2	4	3

Histograma

Nivel de Gris	No. de pixeles
0	2
1	4
2	4
3	5
4	7
5	8
6	4
7	2

Tres imágenes con sus correspondientes histogramas.

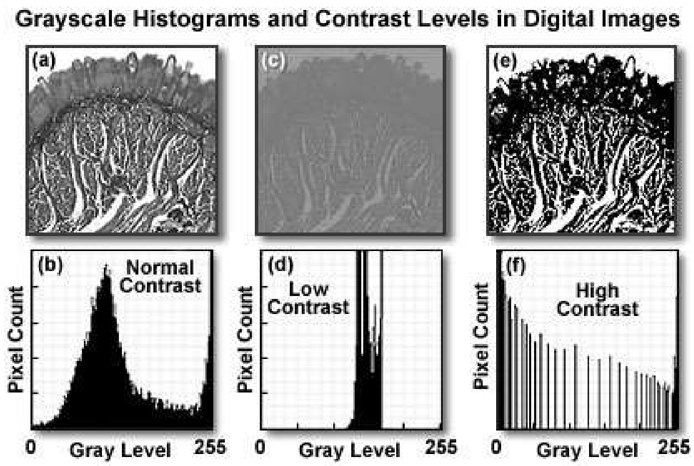
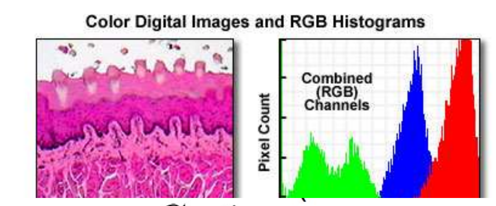


Figure 7

23

- El histograma de una imagen a color RGB consiste en tres gráficas siendo cada una el histograma de cada color primario:



$$m_n = \sum_{i=0}^{G-1} (i-\mu)^n P(i)$$

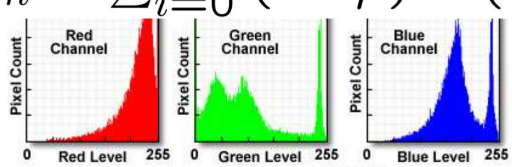


Figure 8

24

Estadísticos de 1er orden a partir de los niveles de gris

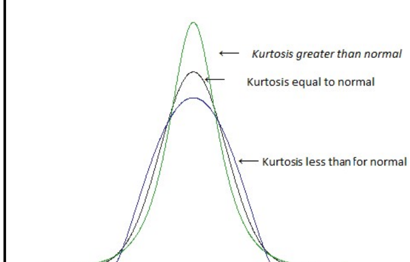
- Media *(hardly a useful feature)* $$\mu = \frac{\sum_{i=0}^{G-1} ip(i)}{\sum_{i=0}^{G-1} p(i)} = \frac{\sum_{i=0}^{G-1} ip(i)}{n} = \sum_{i=0}^{G-1} iP(i)$$
- Varianza *(a more credible feature, measure region "roughness")* $$\sigma^2 = \sum_{i=0}^{G-1} (i-\mu)^2 P(i)$$
- Asimetría - *Skewness (are the texel intesities usually darker/lighter than average?)* $$m_3 = \sum_{i=0}^{G-1} (i-\mu)^3 P(i)$$
- Curtosis – *Kurtosis (how "uniform" is the greylevel distribution?)* $$m_4 = \sum_{i=0}^{G-1} (i-\mu)^4 P(i)$$

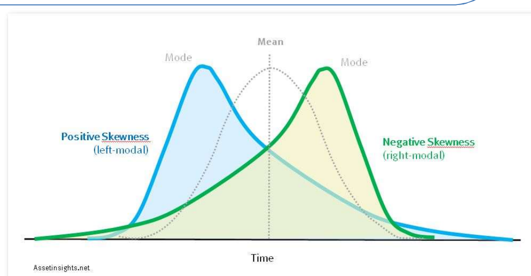
25

Métodos Estadísticos

Kurtosis -Curtosis. En teoría de la probabilidad y estadística, la curtosis es una medida de la forma. Así, las medidas de curtosis tratan de estudiar la proporción de la varianza que se explica por la combinación de datos extremos respecto a la media en contraposición con datos poco alejados de la misma. Una mayor curtosis implica una mayor concentración de datos muy cerca de la media de la distribución coexistiendo al mismo tiempo con una relativamente elevada frecuencia de datos muy alejados de la misma. Esto explica una forma de la distribución de frecuencias con colas muy elevadas y con un centro muy apuntado.

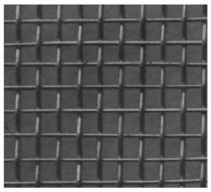
- **Skewness- Asimetria estadística Skewness –** asimetria. el grado de simetría (o asimetría) que presenta una distribución de probabilidad de una variable aleatoria sin tener que hacer su representación gráfica.

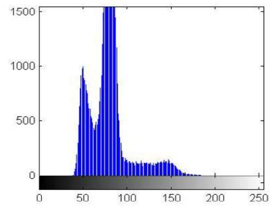




26

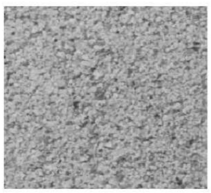
Ejemplos Estadísticos de 1er orden

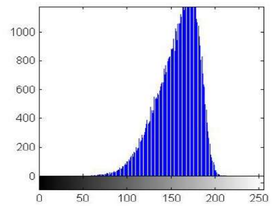




Brickwall texture

- Mean 79.13
- Variance 42.73
- CV 0.08
- Skew 1.37
- Kurtosis 5.93





Granite texture

- Mean 157.08
- Variance 96.9573
- CV 0.06
- Skew -0.73
- Kurtosis 3.25

27

Estadísticos de 1er orden

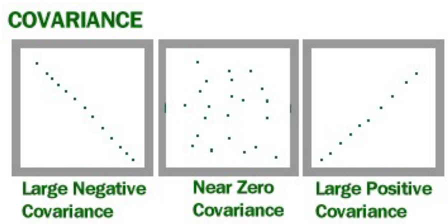
- Entropy $H = -\sum_{i=0}^{G-1} P(i) log_2 P(i)$
  - Histogram uniformity measure
  - We see that $0 \leq H \leq \log G$
  - H is also the lower limit for mean codeword length (bits/pixel) in lossless, non-contextual compression
- Energy $E = -\sum_{i=0}^{G-1} [P(i)]^2$
  - Histogram non-uniformity measure
  - If all *P(i)* are similar we have, $E = G\left[\frac{1}{G}\right]^2 = G^{-1}$
  - If just one graylevel is present (homogenous region),

    $E = (G-1) \times 0^2 + 1 \times 1^2 = 1$
  - This means that $G^{-1} \leq E \leq 1$

28

Covariance

Statistics > Covariance. Covariance is a measure of how much two random variables vary together. It's similar to variance, but where variance tells you how a single variable varies, co variance tells you how two variables vary together.



29

What is the use of covariance?

Covariance is a measure of how changes in one variable are associated with changes in a second variable. Specifically, covariance measures the degree to which two variables are linearly associated. However, it is also often used informally as a general measure of how monotonically related two variables are.

30

What does covariance between variables mean?

In probability theory and statistics, covariance is a measure of the joint variability of two random variables. ... In the opposite case, when the greater values of one variable mainly correspond to the lesser values of the other, i.e., the variables tend to show opposite behavior, the covariance is negative.

31

Example

	Var 1	Var2	Var3
Observación_1:	4.0000	2.0000	0.6000
Observación_2:	4.2000	2.1000	0.5900
Observación_3:	3.9000	2.0000	0.5800
Observación_4:	4.3000	2.1000	0.6200
Observación_5:	4.1000	2.2000	0.6300

- The set of 5 observations, measuring 3 variables, can be described by its *mean vector* and *variance-covariance matrix*. The three variables, from left to right are length, width, and height of a certain object, for example. Each row vector is another observation of the three variables (or components).

32

Definition of mean vector and covariance matrix

- The mean vector consists of the means of each variable
- The covariance matrix consists of the variances of the variables along the main diagonal and the covariances between each pair of variables in the other matrix positions.

33

Covariance - S

- S is calculated by

$$S = \frac{1}{N}\sum_{1}^{N}(X_i - \boldsymbol{\mu})(X_i - \boldsymbol{\mu})^T$$

where N=5 for this example, sometimes for practical reasons instead of N-1 we use n in the first denominator.

34

Ejemplo

a=

4.0000	2.0000	0.6000
4.2000	2.1000	0.5900
3.9000	2.0000	0.5800
4.3000	2.1000	0.6200
4.1000	2.2000	0.6300

35

- mean(a)

ans =

4.1000	2.0800	0.6040

- >> cov(a)

ans =

0.0250	0.0075	0.0017
0.0075	0.0070	0.0014
0.0017	0.0014	0.0004

Thus, 0.025 is the variance of the length variable, 0.0075 is the covariance between the length and the width variables, 0.00175 is the covariance between the length and the height variables, 0.007 is the variance of the width variable, 0.00135 is the covariance between the width and height variables and 0.00043 is the variance of the height variable.

36

Covariance

For two random variable vectors A and B,
the covariance is defined as

$$\mathrm{cov}(A,B) = \frac{1}{N-1}\sum_{i=1}^{N}(A_i - \mu_A)^*(B_i - \mu_B)$$

where µA is the mean of A, µB is the mean of B,
and * denotes the complex conjugate.

37

Ligas interesantes

- https://northstar-www.dartmouth.edu/doc/idl/html_6.2/Overview_of_Masks_and_Image_Statistics.html
- https://scipy-lectures.org/advanced/image_processing/#measuring-objects-properties-ndimage-measurements

38