



# GSA-5859 / PCA-5017

## SIG em Software Livre

Dados Raster

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Carlos H. Grohmann

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Instituto de Energia e Ambiente  
USP

## Dados Raster (matriciais)

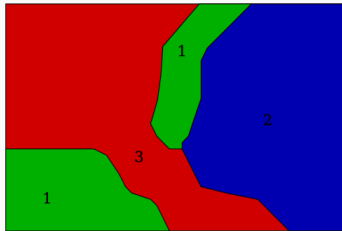
- São dados regularmente espaçados no espaço, em uma estrutura de matriz com células quadradas (normalmente) e de mesmo tamanho. Cada célula (pixel) recebe o valor de um atributo, que representa um fenômeno (por exemplo temperatura ou altitude). As células são organizadas em linhas e colunas, e seu valor pode ser acessado pelas coordenadas absolutas da matriz (linha/coluna) ou pelas coordenadas geográficas
- Tamanho do pixel = Resolução espacial

**Representações Raster e Vetorial dos mesmos objetos em SIG**

3	3	3	3	3	1	2	2	2
3	3	3	3	1	2	2	2	2
3	3	3	3	1	2	2	2	2
3	3	3	3	1	2	2	2	2
1	1	1	3	3	2	2	2	2
1	1	1	1	3	3	3	2	2

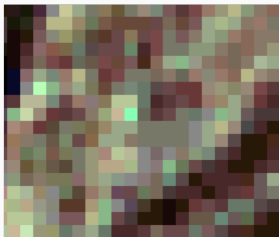
1 = área vegetada

2 = água

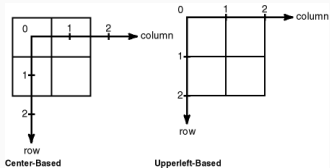


3 = área urbana

# Raster - pixels



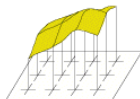
# Raster - valores e coordenadas



## Value applies to the center point of the cell

For certain types of data, the cell value represents a measured value at the center point of the cell. An example is a raster of elevation

+ 315	+ 319	+ 321	+ 323
+ 317	+ 323	+ 328	+ 326
+ 313	+ 318	+ 325	+ 323



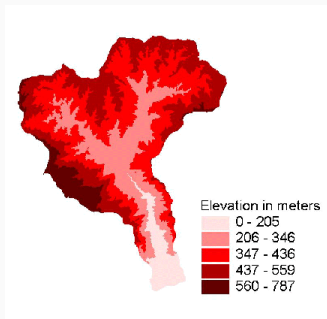
## Value applies to the whole area of the cell

For most data, the cell value represents a sampling of a phenomenon, and the value is presumed to represent the whole cell square.

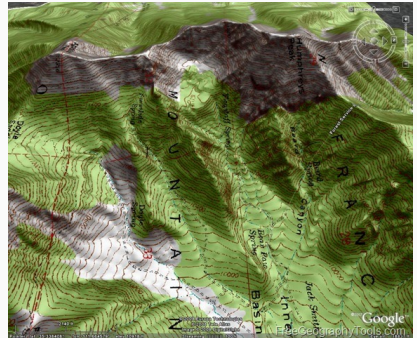
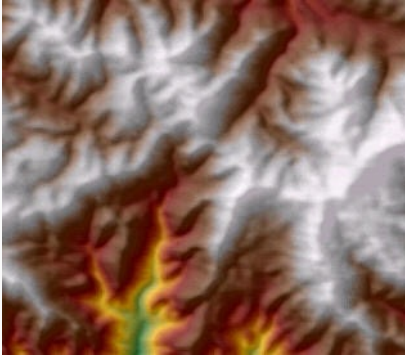
50	45	40	35
35	40	35	25
20	25	30	20



# Raster - pixel-is-area



# Raster - pixel-is-point(?)



- 1 bit – menor unidade de informação armazenada
- 1 byte (1B) – 8 bits
- 1 kB (kilobyte) =  $2^{10}$  bytes = 1.024 bytes
- 1 MB (megabyte) =  $2^{20}$  bytes = 1.048.576 bytes
- 1 GB (gigabyte) =  $2^{30}$  bytes = 1.073.741.824 bytes



## Bits & Bytes...

- imagem 8 bits – 1 byte por pixel
- imagem 16 bits – 2 bytes por pixel
- imagem 32 bits – 4 bytes por pixel
  
- imagem 1000 linhas x 1000 col. x 1 banda x 1 byte =  
1.000.000 bytes
  
- 1 byte =  $2^8 = 256$
- imagem 8 bits – cada pixel pode ter valores de 0 a 255

p220r079\_7x20000507.met

PRODUCT\_SAMPLES\_PAN = 17654

PRODUCT\_LINES\_PAN = 15614

PRODUCT\_SAMPLES\_REF = 8827

PRODUCT\_LINES\_REF = 7807

PRODUCT\_SAMPLES\_THM = 4414

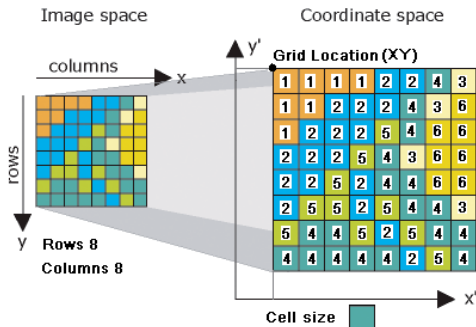
PRODUCT\_LINES\_THM = 3904

- Banda 8 (PAN):  $17654 \times 15614 \times 1\text{byte} = 275.649.556 \text{ B}$
- Bandas 1-5:  $8827 \times 7807 \times 1\text{byte} = 68.912.389 \text{ B}$
- Banda 6 (termal):  $4414 \times 3904 \times 1\text{byte} = 17.232.256 \text{ B}$

# Bits & Bytes...

- `1_BIT` — A 1-bit unsigned integer. The values can be 0 or 1.
- `2_BIT` — A 2-bit unsigned integer. The values supported can be from 0 to 3.
- `4_BIT` — A 4-bit unsigned integer. The values supported can be from 0 to 15.
- `8_BIT_UNSIGNED` — An 8-bit, unsigned data type. The values can range from 0 to 255. This is the default.
- `8_BIT_SIGNED` — An 8-bit signed data type. The values can range from -128 to 127.
- `16_BIT_UNSIGNED` — A 16-bit, unsigned data type. The values can range from 0 to 65,535.
- `16_BIT_SIGNED` — A 16-bit signed data type. The values can range from -32,768 to 32,767.
- `32_BIT_UNSIGNED` — A 32-bit unsigned data type. The values can range from 0 to 4,294,967,295.
- `32_BIT_SIGNED` — A 32-bit signed data type supported by GRID. The values can range from -2,147,483,648 to 2,147,483,647.
- `32_BIT_FLOAT` — A 32-bit data type supporting decimals.
- `64_BIT` — A 64-bit data type supporting decimals.

# Raster - Tamanho dos arquivos



List of cell values

[11112243112224361222546622254366225244662552544354452544444254]

- Diminuir o tamanho do arquivo (em bytes) para armazenagem e consulta
- Taxa de compressão depende do arquivo original
- Sem perda de informação (Lossless)
- Com perda de informação (Lossy)
- Uso de informação redundante
  - Ex.: 25.8888888888
  - lossless: 25.[9]8
  - lossy: 26

# Raster - Compressão por Run-length encoding (1)

**raster representation**

A	A	A	A	0	0	0	0
A	A	A	A	A	0	0	0
A	A	A	A	0	B	0	0
A	A	A	A	0	0	0	0
A	A	A	0	0	0	C	C
0	0	0	0	0	C	0	0
C	C	C	C	C	0	0	0
0	0	0	0	0	0	0	0

pixel	value
1	A
2	A
3	A
4	A
5	0
6	0
7	0
8	0
9	A
10	A
11	A
12	A
13	A
14	0
15	0
16	0
.	.
.	.
.	.
62	0
63	0
64	0

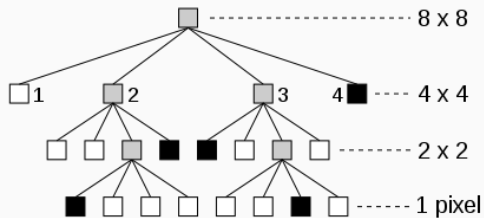
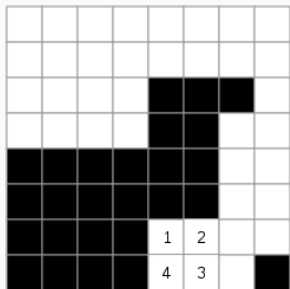
# Raster - Compressão por Run-length encoding (2)

**raster representation**

A	A	A	A	D	D	0	0
A	A	A	A	A	0	0	0
A	A	A	A	0	B	0	0
A	A	A	A	D	D	0	0
A	A	A	0	D	D	C	C
0	0	0	0	D	C	0	0
C	C	C	C	C	0	0	0
0	0	0	0	D	D	0	0

A,	4	0,	8				
A,	5	0,	8				
A,	4	0,	5	B,	6	0,	8
A,	4	0,	8				
A,	3	0,	6	C,	8		
0,	5	C,	6	0,	8		
C,	5	0,	8				
0,	8						

# Raster - Compressão por Quadrees





# Raster - tipos de arquivo

- BIL - Band Interleaved by Line (image format linked with satellite derived imagery)
- Digital raster graphic (DRG) - digital scan of a paper USGS topographic map
- ECW - Enhanced Compressed Wavelet (from ERMapper). A compressed wavelet format, often lossy.
- ESRI grid - proprietary binary and metadataless ASCII raster formats used by ESRI
- GeoTIFF - TIFF variant enriched with GIS relevant metadata
- IMG - ERDAS IMAGINE image file format
- JPEG2000 - Open-source raster format. A compressed format, allows both lossy and lossless compression.
- MrSID - Multi-Resolution Seamless Image Database (by Lizardtech). A compressed wavelet format, often lossy.

# Raster - tipos de arquivo

- USGS DEM - The USGS' Digital Elevation Model
- DTED - National Geospatial-Intelligence Agency (NGA)'s Digital Terrain Elevation Data
- GTOPO30 - Large complete Earth elevation model at 30 arc seconds
- SDTS - The USGS' successor to DEM
- HGT - SRTM (NASA)

# Análise de Dados Raster

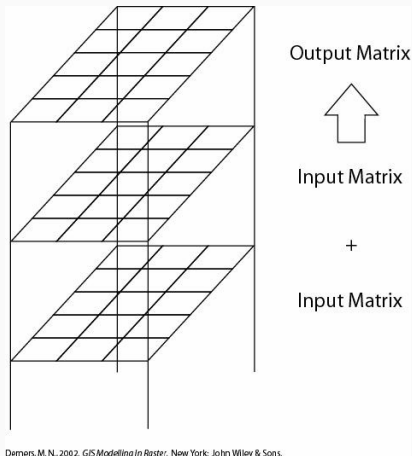
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# Operações em mapas raster

- Operações locais (pixel a pixel)
- Operações globais (consideram todo o layer)
- Operações focais (de vizinhança)
- Operações zonais (em regiões)
- Operações descritivas

# Operações locais (pixel a pixel)

- Reclassificação
- Sobreposição (overlay)



# Álgebra de mapas – soma

4	5	0
1	3	1
6	2	1

+

=

5	3	4
1	7	1
3	2	6

9	8	4
2	10	2
9	4	7

Demers, M.N., 2002. *GIS Modelling In Raster*. New York: John Wiley & Sons.

# Álgebra de mapas – média

Input Matrix

5	6	2	1
5	4		1
6	7	2	3
9	5	3	7

4	6	0	5
7	4		1
6	2	4	2
6	5	8	1

Input Matrix

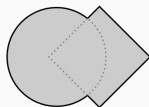
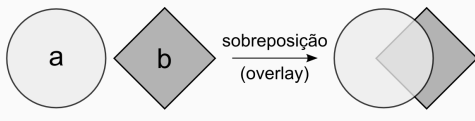
Mean =

Output Matrix

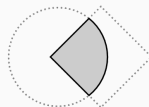
4.5	6	1	3
6	4		1
6	4.5	2	2.5
7.5	5	5.5	4

Demers, M.N., 2002. *GIS Modelling in Raster*. New York: John Wiley & Sons.

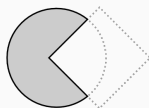
# Sobreposição (overlay) - lógica Booleana



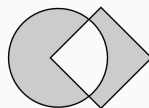
união (OR)  
 $a$  OU  $b$



intersecção (AND)  
 $a$  E  $b$



exclusão (NOT)  
 $a$ , mas NÃO  $b$



exclusão (XOR)  
 $a$  OU  $b$ , mas NÃO  $a$  E  $b$




# Funções locais (pixel a pixel)

- Operadores principais:
  - trigonométricos
  - exponenciais e logaritmos
  - reclassificação
  - seleção baseada em condição
  - estatística (média, mediana, moda)
  - aritmética (ex., valor absoluto de  $x$ )

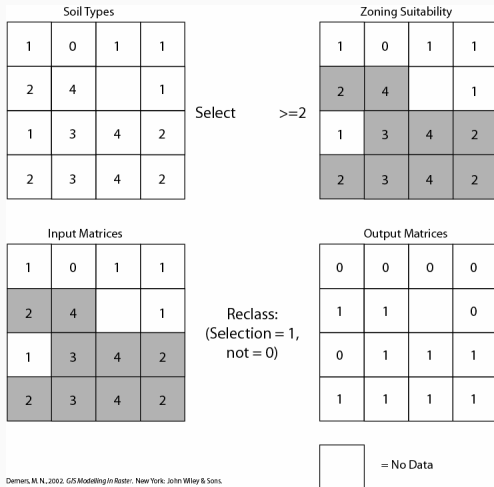
# Função local – Trigonométrica

1	0	1	1	Sin	=	0.8	0	0.8	0.8
2	4		1			0.9	-0.8		0.8
1	2	4	2			0.9	-0.8	-0.8	0.9
2	1	4	2			0.9	0.8	-0.8	0.9

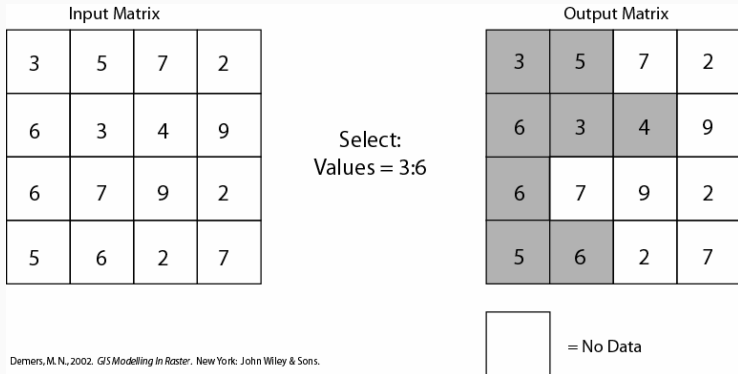
 = No Data

Demers, M. N., 2002. *GIS Modelling In Raster*. New York: John Wiley & Sons.

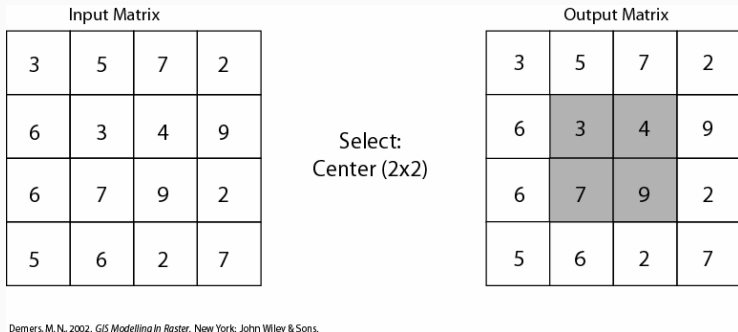
# Função local – Reclassificação



# Função local – Seleção



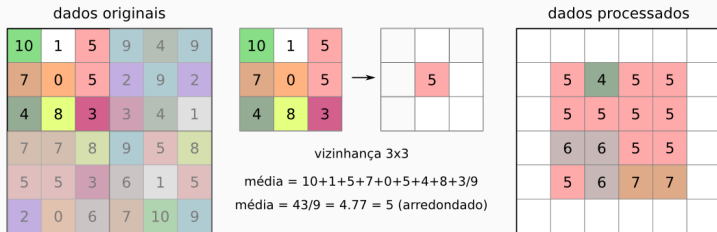
# Função local – Seleção por posição e janela



# Funções focais

- Funções examinam a célula de interesse e suas vizinhas imediatas
- A vizinhança pode ser retangular, circular, etc

# Função focal – janelas móveis (moving-windows)



# Função focal – janela tipo “rosquinha”

Input Matrix

4	6	2	5
7	4	7	1
2	5	4	2
6	5	8	1

FOCALSUM  
(grid,annulus)

Output Matrix

4	6	2	5
7	37	7	1
2	5	4	2
6	5	8	1

Demers, M. N., 2002. *GIS Modelling In Raster*. New York: John Wiley & Sons.



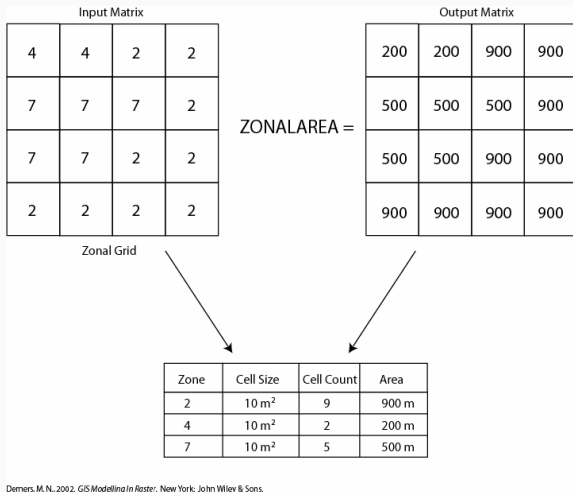
# Função focal – min, max, etc

Input Matrix						Output Matrix				
4	7	2	1	9	FOCALMAJORITY (Grid, Neighbourhood, Rectangle, 3, 3)	4	7	2	1	9
7	2	3	2	7		7	2	3	2	7
3	2	5	3	5		3	2	2	3	5
4	1	2	2	4		4	1	2	2	4
9	5	4	6	2		9	5	4	6	2
Input Matrix						Output Matrix				
4	7	2	1	9	FOCALMIN (Grid, Neighbourhood, Rectangle, 3, 3)	4	7	2	1	9
7	2	3	2	7		7	2	3	2	7
3	2	5	3	5		3	2	1	3	5
4	1	2	2	4		4	1	2	2	4
9	5	4	6	2		9	5	4	6	2
Input Matrix						Output Matrix				
4	7	2	1	9	FOCALMEAN (Grid, Neighbourhood, Rectangle, 3, 3)	4	7	2	1	9
7	2	3	2	7		7	2	3	2	7
3	2	5	3	5		3	2	2.4	3	5
4	1	2	2	4		4	1	2	2	4
9	5	4	6	2		9	5	4	6	2

Demers, M. N., 2002. GIS Modelling in Raster. New York: John Wiley & Sons.

- Funcionam como as operações de vizinhança locais, mas usam todas as células de uma categoria (zona)

# Função zonal (zonalarea)



Demers, M.N., 2002. *GIS Modelling In Raster*. New York: John Wiley & Sons.

# Função zonal (zonalmax)

Input Matrix 1  
Zonal Grid

4	4	2	2
7	7	7	2
7	7	2	2
2	2	2	2

Input Matrix 2  
Value Grid

4	6	2	5
3	4	9	1
2	5	4	2
6	5	8	1

ZONALMAX  
(Zonal grid,  
Value grid) =

Output Matrix

6	6	8	8
9	9	9	8
9	9	8	8
8	8	8	8

Demers, M.N., 2002. *GIS Modelling in Raster*. New York: John Wiley & Sons.

# Buffers

