

Ciência da Computação

UNIVALI / CTTMAR

Bancos de Dados II

6º Período

Aula 13

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Período: 2015-2 C/H: 72

Dados geográficos

- Dados espaciais
- Representam fenômenos ou objetos na superfície terrestre
 - Podem ser posicionados em determinada região geográfica tendo por base suas coordenadas
- Representação gráfica (pontos, linhas e polígonos), numérica ou alfanumérica (letras e números).

Dados geográficos

- Dois tipos de estruturas de dados: vetoriais e matriciais.

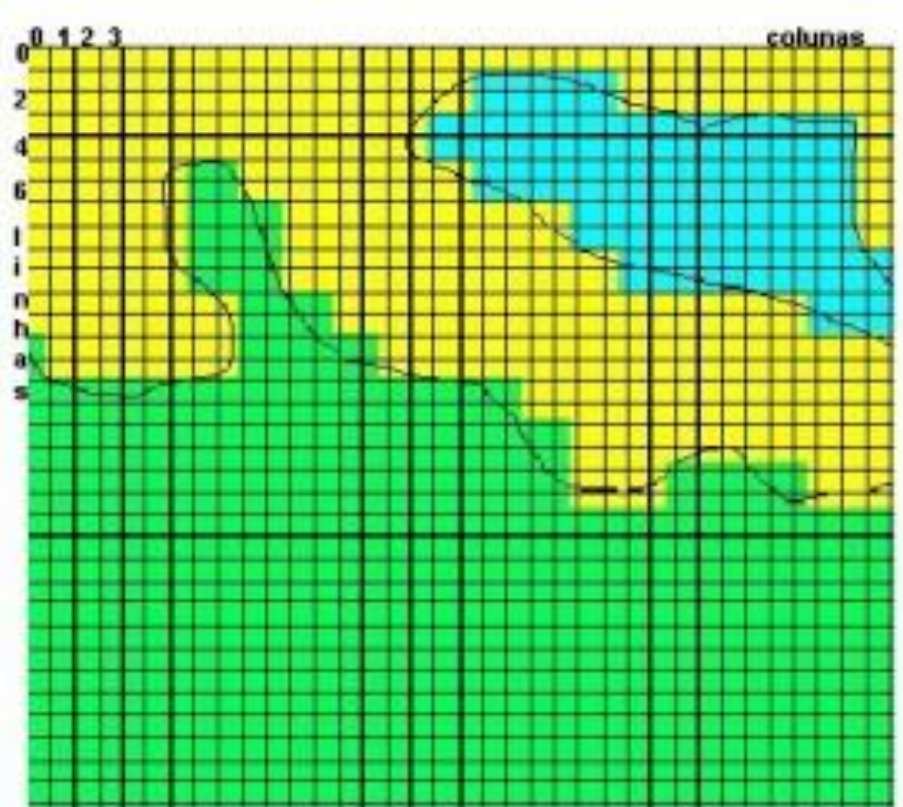
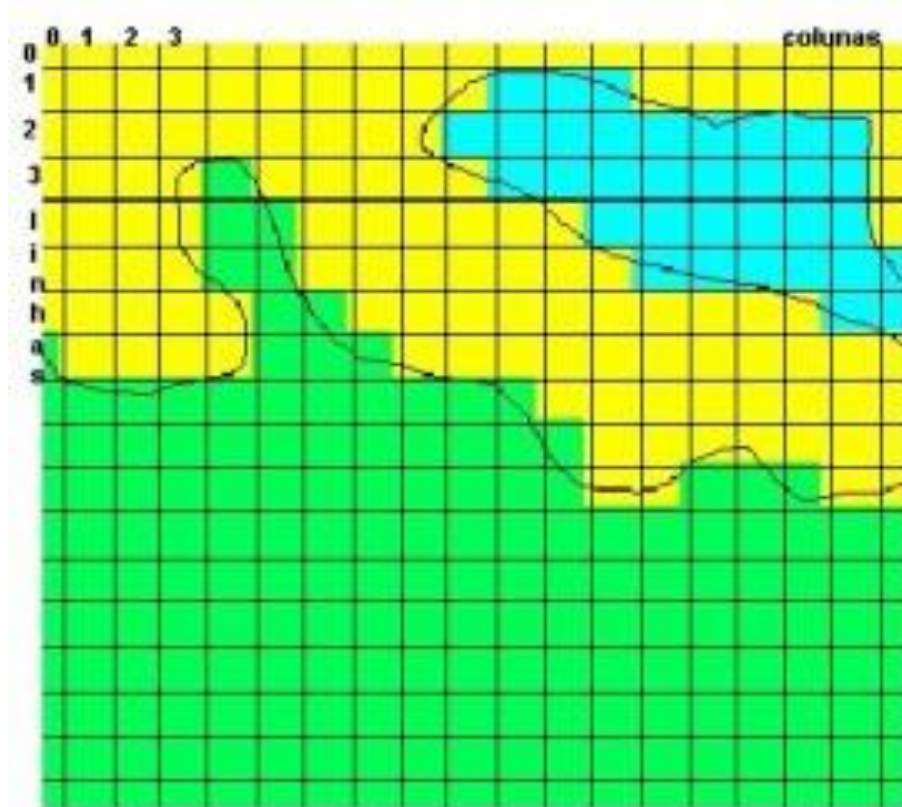


Estruturas Matriciais

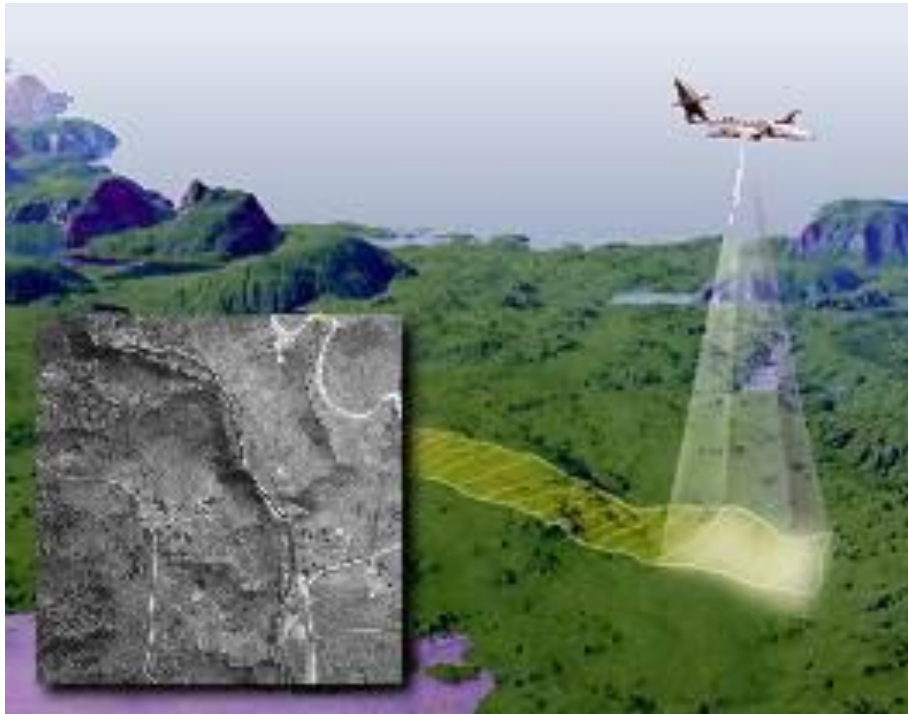
- Também chamado de *raster*
 - Tipo de estrutura que tem seus valores associados a uma matriz de células. Cada célula é um endereço identificado por coordenadas de linhas e colunas.



Estruturas Matricias

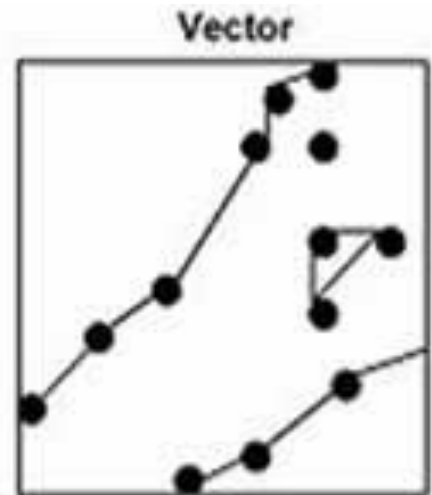


Estruturas Matriciais

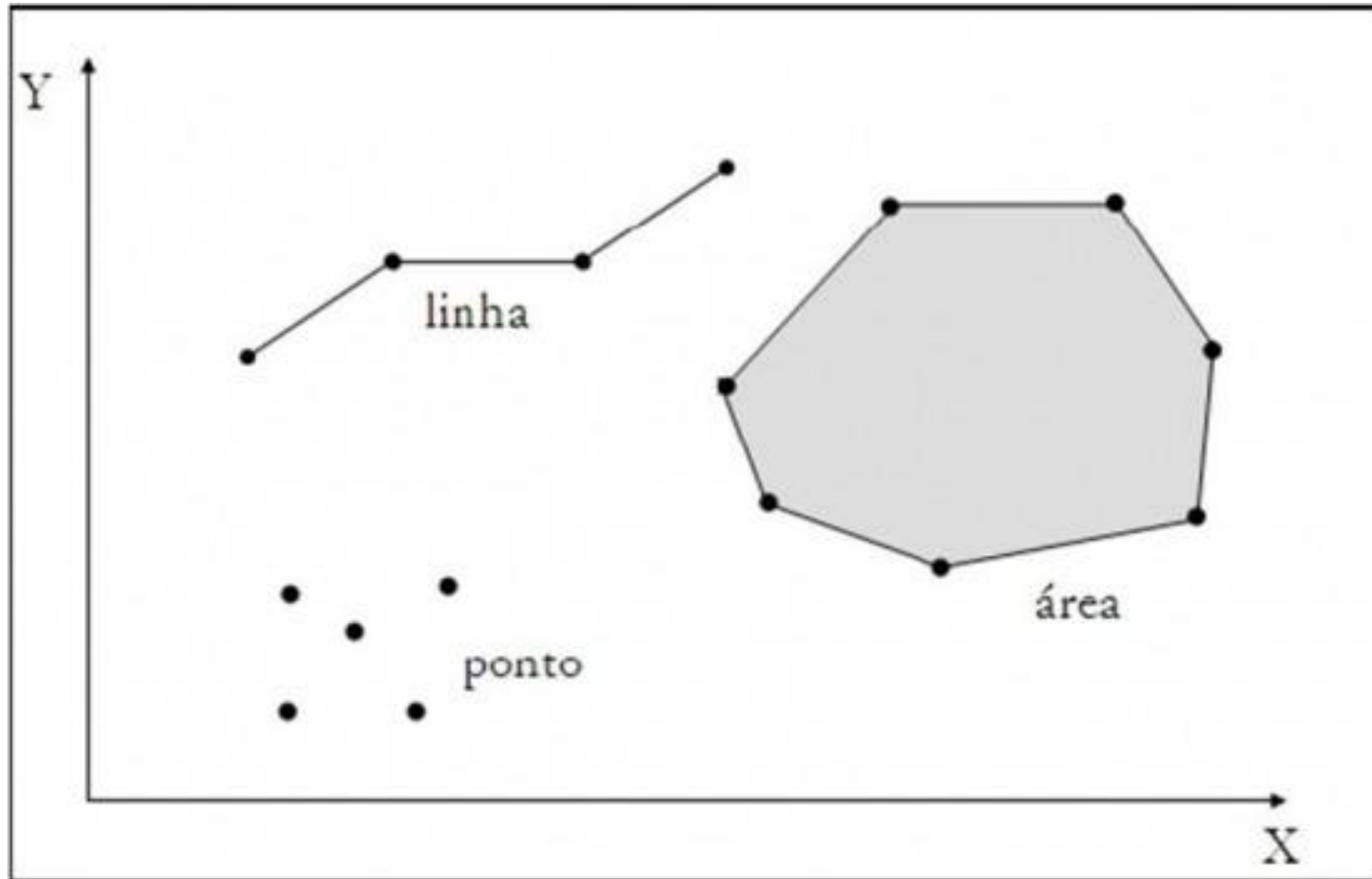


Estruturas Vetoriais

- Representam dados através de coordenadas X e Y, ou longitude e latitude, onde os símbolos do mundo real são localizados por pontos, linhas e polígonos.



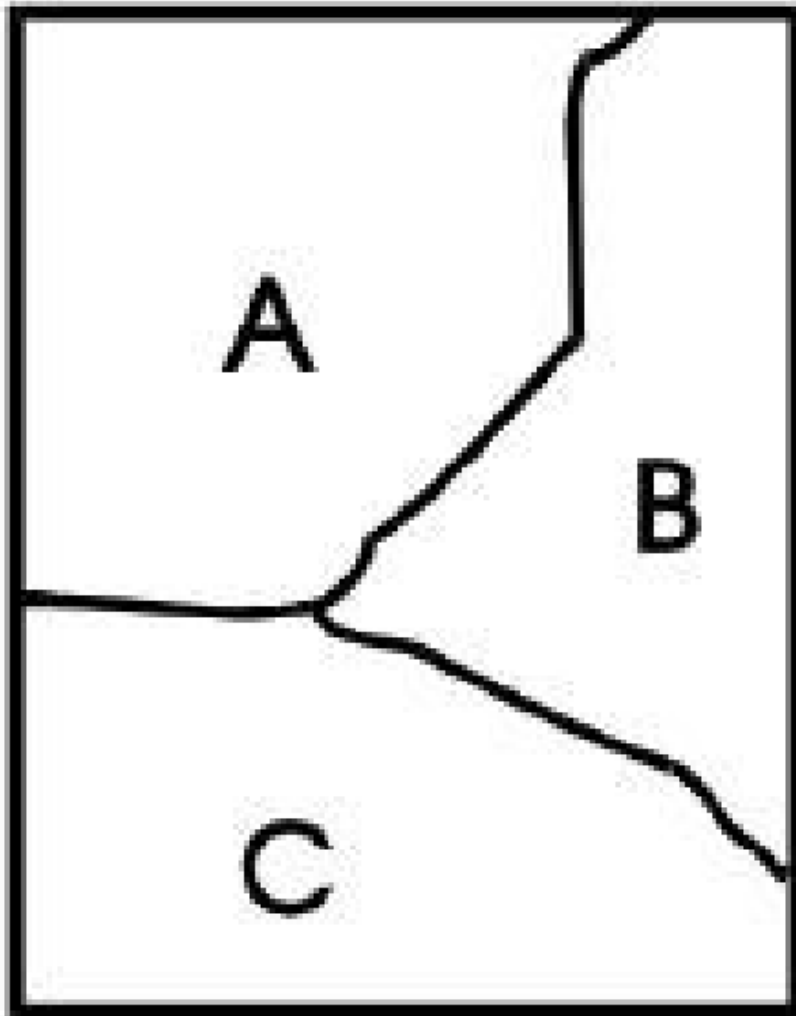
Estruturas Vetoriais



Estruturas Vetoriais

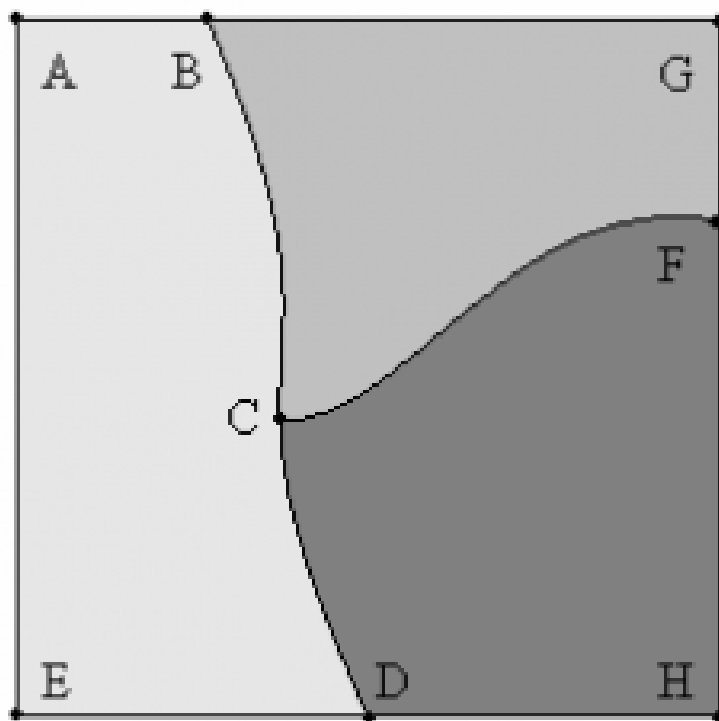


Vetorial

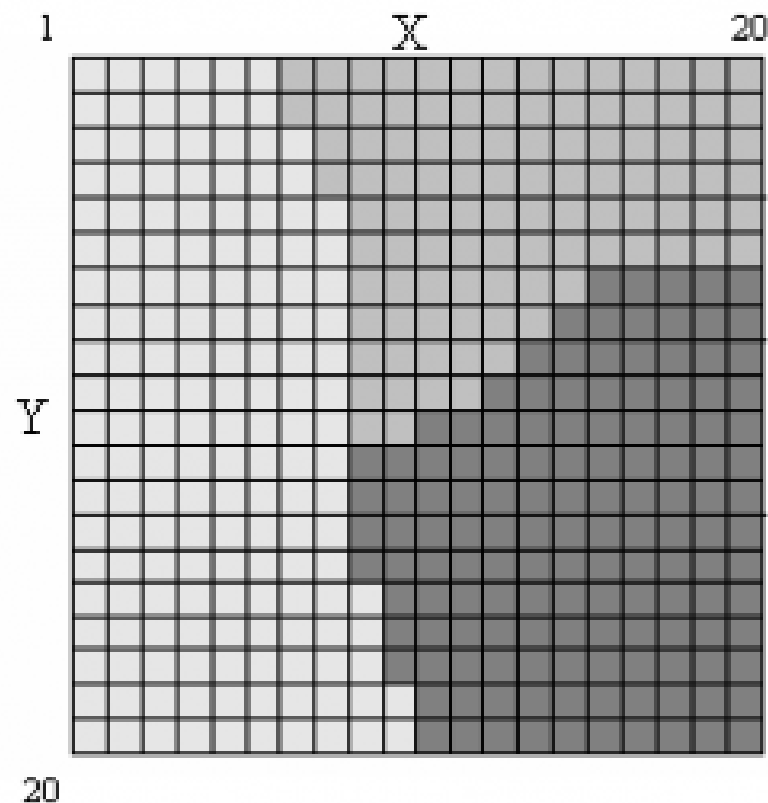


Matricial

A	A	A	A	A	B	B
A	A	A	A	A	B	B
A	A	A	A	B	B	B
A	A	A	A	B	B	B
A	A	A	B	B	B	B
C	C	C	B	B	B	B
C	C	C	C	B	B	B
C	C	C	C	C	B	B
C	C	C	C	C	C	C



Vector image



Raster image

Vector		
Polygon ID	Coordinates	Soil Type
1	A,B,C,D,E	Chalk
2	B,C,F,G	Clay
3	C,F,H,D	Gravel

Raster	
Grid Ref.	Item
x=1, y=1	Chalk
X=2, y=1	Chalk
X=3, y= 1	Chalk
X=4 ... etc.	...
X=20, y=20	Gravel

SIG

“SIG (Sistema de Informação Geográfica) ou GIS (*Geographic Information System*) são sistemas automatizados usados para armazenar, analisa e manipular dados geográficos, ou seja, dados que representam objetos ou fenômenos em que a localização geográfica é um característica inerente a informação e indispensável para analisa-la”

SIG

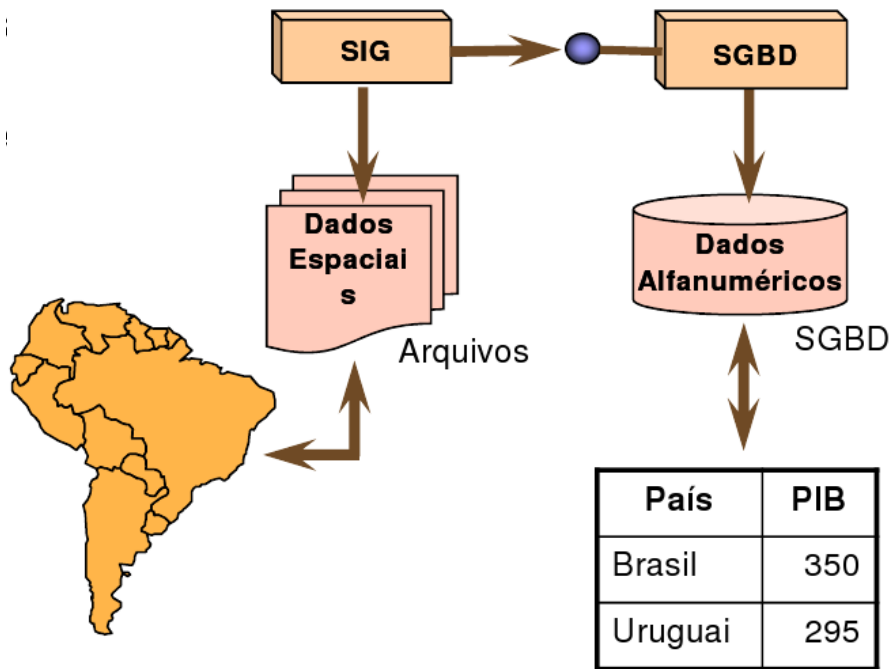
- Possuem capacidade para armazenar e manipular dados geográficos, além dos atributos descritivos.
- SIG precisa de meios de armazenamento (bancos de dados) que permitam armazenar e manipular os dados geográficos de forma eficiente:
 - Banco de Dados Geográfico (BDG)

SIG

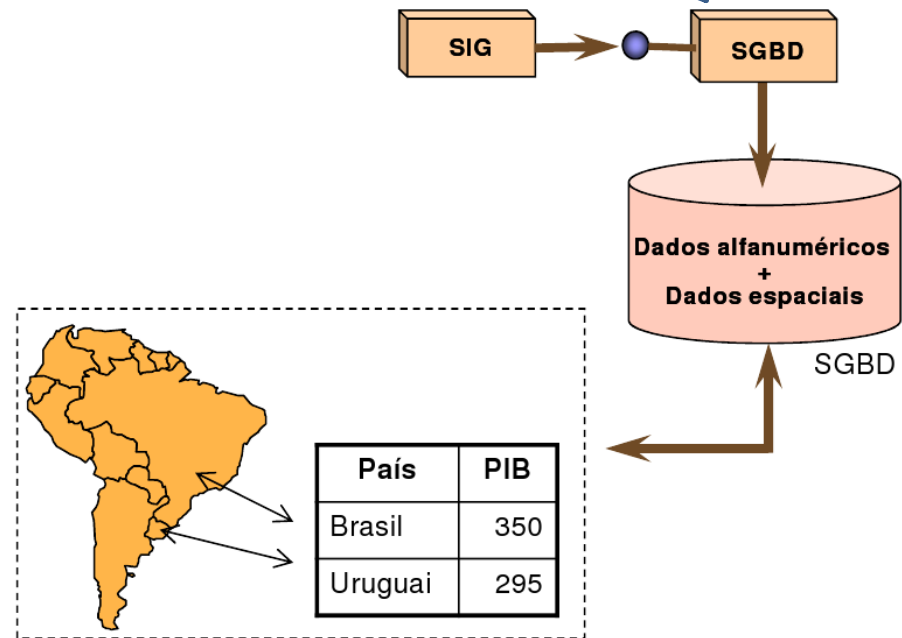
Arquitetura

Foco do estudo...

Dual



Integrada



Bancos de Dados Geográficos

- Mesmos princípios do SGBDs convencionais
- Diferença de suportar feições geométricas em suas tabelas
 - Análise e consultas

SGBDs e os dados geográficos

- Geralmente os SGBDs dão suporte a dados e operações geográficas através de extensões:
 - PostgreSQL: PostGIS
 - Oracle: Oracle Spatial
 - MySQL: MySQL Spatial
 - SQL Server: Spatial



PostGIS

- <http://postgis.refrations.net>
- A extensão espacial PostGIS foi desenvolvida pela empresa Refrations e é licenciada livremente para a comunidade de *software* livre
- Tem a função de permitir o armazenamento e manipulação de dados geográficos no SGBD PostgreSQL.

PostGIS

- Desenvolvimento da PostGIS obedece aos padrões OGC (<http://www.opengeospatial.org/>), que consiste em um conjunto de organizações e instituições que juntas estabelecem padrões para tratamento, interoperabilidade de dados espaciais.
 - <http://www.youtube.com/watch?v=bfkCdir-yO8>

PostGIS

OGC: Alguns tipos de dados espaciais

Point



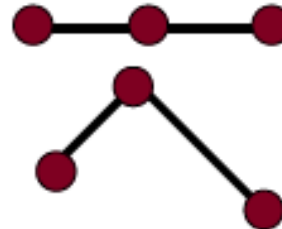
MultiPoint



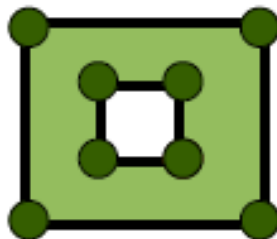
LineString



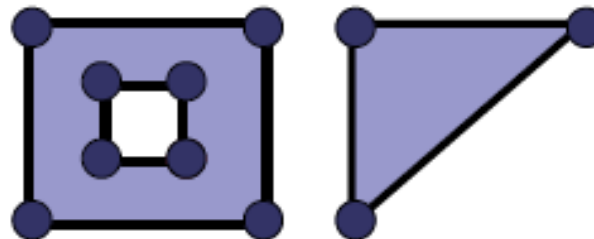
MultiLineString



Polygon



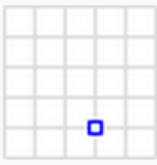
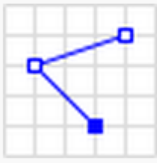
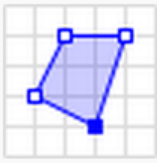
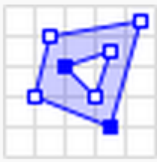
MultiPolygon



PostGIS

OGC: Formatos

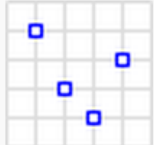
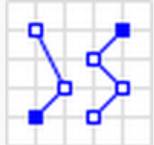
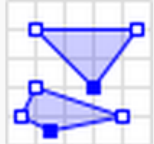
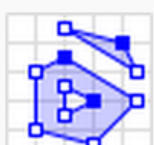
- **WKT (Well-known text)**
 - Forma textual para representação de dados geográficos

Type	Examples	
Point	<code>POINT (30 10)</code>	
LineString	<code>LINESTRING (30 10, 10 30, 40 40)</code>	
Polygon	<code>POLYGON ((30 10, 10 20, 20 40, 40 40, 30 10))</code>	
	<code>POLYGON ((35 10, 10 20, 15 40, 45 45, 35 10), (20 30, 35 35, 30 20, 20 30))</code>	

PostGIS

OGC: Formatos

- **WKT (Well-known text)**
 - Forma textual para representação de dados geográficos

Type	Examples	
MultiPoint	<code>MULTIPOINT ((10 40), (40 30), (20 20), (30 10))</code>	
	<code>MULTIPOINT (10 40, 40 30, 20 20, 30 10)</code>	
MultiLineString	<code>MULTILINESTRING ((10 10, 20 20, 10 40), (40 40, 30 30, 40 20, 30 10))</code>	
MultiPolygon	<code>MULTIPOLYGON (((30 20, 10 40, 45 40, 30 20)), ((15 5, 40 10, 10 20, 5 10, 15 5)))</code>	
	<code>MULTIPOLYGON (((40 40, 20 45, 45 30, 40 40)), ((20 35, 45 20, 30 5, 10 10, 10 30, 20 35), (30 20, 20 25, 20 15, 30 20)))</code>	

PostGIS



















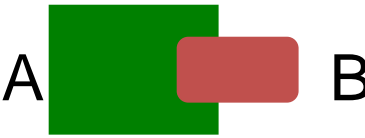


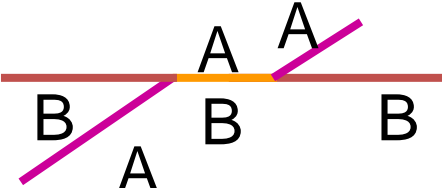
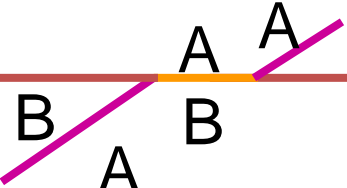




OGC: Formatos

- WKB (**Well-known binary**)
 - Forma binária para representação de dados geográficos
 - 00000000014000000000000000004010000000000000
 - 1-byte integer 00 or 0: big endian
 - 4-byte integer 00000001 or 1: POINT (2D)
 - 8-byte float 4000000000000000 or 2.0: x-coordinate
 - 8-byte float 4010000000000000 or 4.0: y-coordinate

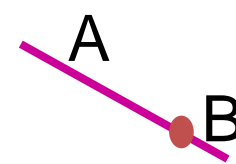
PostGIS



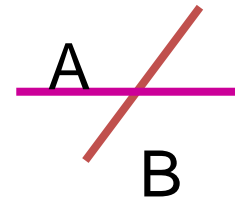
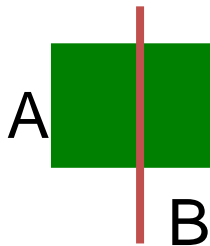
Operações Topológicas

 <p>A   B</p>	 <p>A   B</p>	 <p>A   B</p>
 <p>A   B</p>	 <p>A   B</p>	 <p> A  B</p>
 <p>A   B</p>	 <p> A  B</p>	 <p>A   B</p>

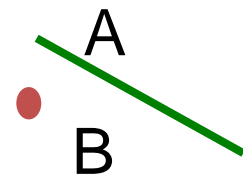
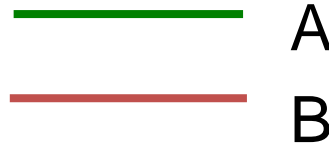
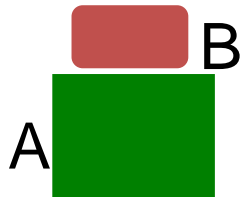
Operações Topológicas



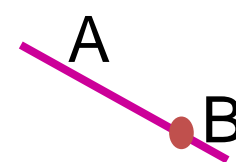
B está contido em / cobre A ?



B cruza A ?



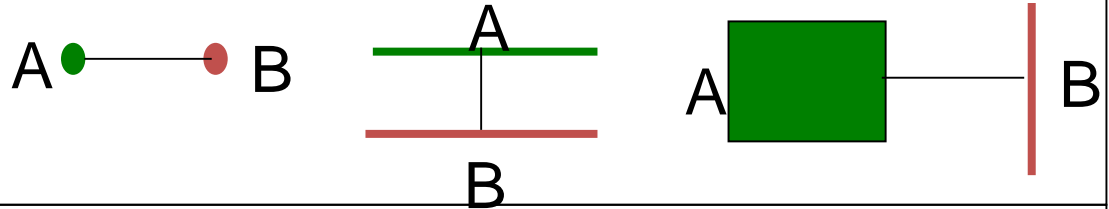
B acima (N) / abaixo (S) / ao lado (L/O/ Esq / Dir) de A



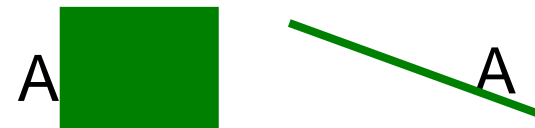
B sobre / sob A ?

Operações Métricas

distância A-B



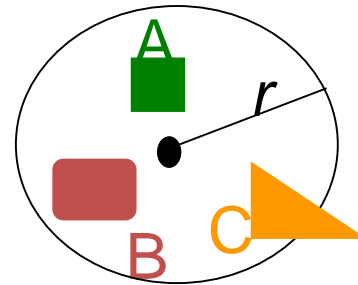
comprimento/perímetro A



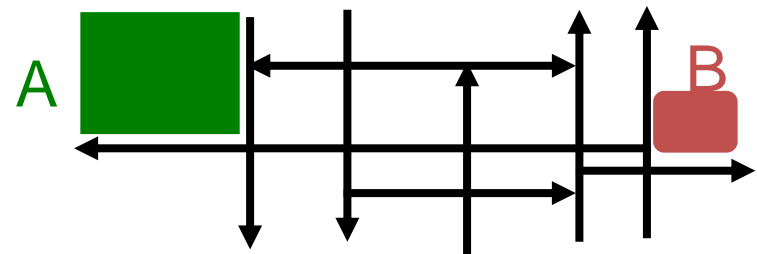
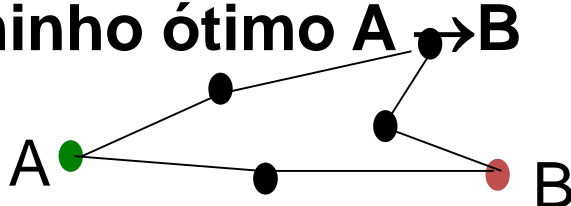
área/volume A



raio de alcance



caminho ótimo A → B



PostGIS

Adicionando coluna geométrica

- Coluna com tipo “geometry”
 - Sem restrição do tipo de geometria e SRID

```
CREATE TABLE area_interesse
(
    id serial NOT NULL,
    nome character varying(255),
    geometria geometry,
    CONSTRAINT pk_area_interesse PRIMARY KEY (id )
);

CREATE TABLE ponto_interesse
(
    id serial NOT NULL,
    nome character varying(255),
    tipo character varying(50),
    geometria geometry,
    CONSTRAINT pk_ponto_interesse PRIMARY KEY (id )
);
```

PostGIS

Adicionando coluna geométrica

- Através da função “addgeometrycolumn”
 - Boa prática
 - `SELECT AddGeometryColumn (`
 `'nome_schema', --nome do schema`
 `'nome_tabela', --nome da tabela`
 `'nome_coluna', --nome da coluna`
 `4326, --SRID`
 `'POINT', -- Tipo da geometria`
 `2); --Dimensão (2 para X, Y e 3 para X, Y, Z)`

PostGIS

Adicionando coluna geométrica

- Através da função “addgeometrycolumn”

```
CREATE TABLE area_interesse
(
  id serial NOT NULL,
  nome character varying(255),
  CONSTRAINT pk_area_interesse PRIMARY KEY (id )
);
SELECT AddGeometryColumn ('schema_aula', 'area_interesse', 'geometria', 4326, 'POLYGON', 2);

CREATE TABLE ponto_interesse
(
  id serial NOT NULL,
  nome character varying(255),
  tipo character varying(50),
  CONSTRAINT pk_ponto_interesse PRIMARY KEY (id )
);
SELECT AddGeometryColumn ('schema_aula', 'ponto_interesse', 'geometria', 4326, 'POINT', 2);
```

PostGIS

Inserindo dados

```
INSERT INTO area_interesse (nome, geometria) VALUES ('Local 1',  
st_geomfromtext('POLYGON((-48.0 -26.0, -48.0 -25.9, -47.9 -25.9, -47.9 -26, -48.0 -26.0))', 4326));
```

```
INSERT INTO area_interesse (nome, geometria) VALUES ('Local 2',  
st_geomfromtext('POLYGON((-47.0 -25.0, -47.0 -24.9, -46.9 -24.9, -46.9 -25, -47.0 -25.0))', 4326));
```

```
INSERT INTO ponto_interesse (nome, tipo, geometria) VALUES ('Posto A', 'Posto',  
st_geomfromtext('POINT(-48.669620 -26.917412)', 4326));
```

```
INSERT INTO ponto_interesse (nome, tipo, geometria) VALUES ('Reitoria UNIVALI', 'Universidade',  
st_geomfromtext('POINT(-48.660922 -26.914005)', 4326));|
```

PostGIS

Recuperando dados

```
select nome, tipo, st_astext(geometria), st_x(geometria), st_y(geometria) FROM ponto_interesse
```

	nome character varying(255)	tipo character varying(st_astext text	st_x double precision	st_y double precision
1	Posto A	Posto	POINT(-48.66962 -26.917412)	-48.66962	-26.917412
2	Reitoria UNIVALI	Universidade	POINT(-48.660922 -26.914005)	-48.660922	-26.914005

PostGIS

Analizando dados

```
select nome, st_area(geometria), st_perimeter(geometria) FROM area_interesse
```

	nome character varying(255)	st_area double precision	st_perimeter double precision
1	Local 1	0.0100000000	0.4000000000
2	Local 2	0.0100000000	0.4000000000

SELECT

```
nome,
st_area(st_transform(geometria, 29182)) as area_metros,
st_perimeter(st_transform(geometria, 29182)) as area_metros
```

FROM

```
area_interesse
```

	nome character varying(255)	area_metros double precision	area_metros double precision
1	Local 1	111131822.63	42221.246166
2	Local 2	112243358.86	42423.267224

PostGIS

Analizando dados

```
select
    nome,
    st_within(st_geomfromtext('POINT(-46.91 -24.95)', 4326), geometria) as ponto_dentro
FROM
    area_interesse
```

	nome character varying(255)	ponto_dentro boolean
1	Local 1	f
2	Local 2	t

PostGIS

Exportando dados

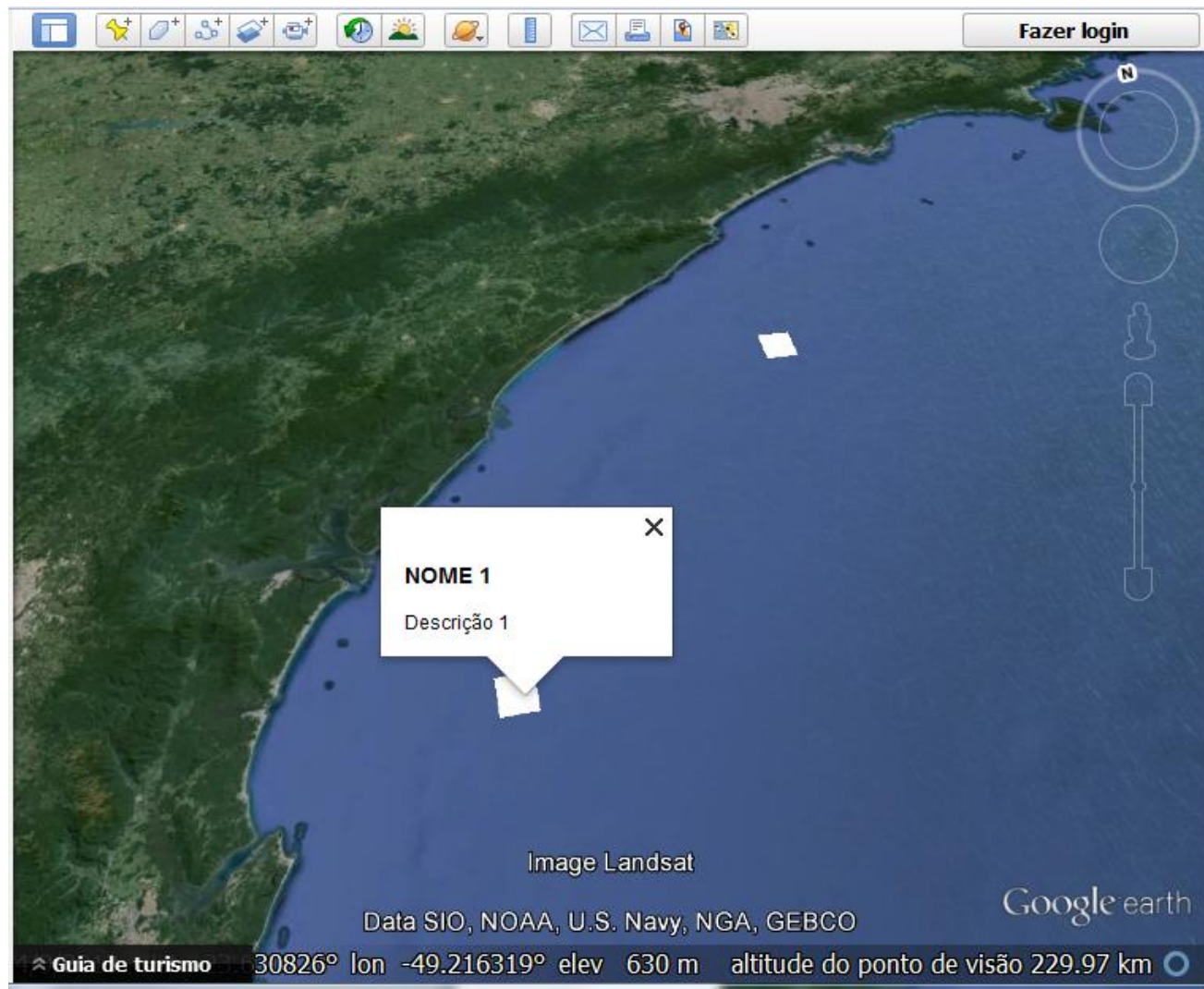
```
SELECT st_askml(geometria) FROM area interesse
```

	st_askml text
1	<Polygon><outerBoundaryIs><LinearRing><coordinates>-48,-26 -48,-25.
2	<Polygon><outerBoundaryIs><LinearRing><coordinates>-47,-25 -47,-24.

```
<?xml version="1.0" encoding="UTF-8"?>
<kml xmlns="http://www.opengis.net/kml/2.2">
<Document>
  <Placemark>
    <name>NOME 1</name>
    <description>Descrição 1</description>
    <Polygon><outerBoundaryIs><LinearRing><coordinates>-48,-26
  </Placemark>
  <Placemark>
    <name>NOME 2</name>
    <description>Descrição 2</description>
    <Polygon><outerBoundaryIs><LinearRing><coordinates>-47,-25
  </Placemark>
</Document>
</kml>
```

PostGIS

Exportando dados



PostGIS

Manipulando dados

```
SELECT st_astext(st makeline(geometria)) from ponto interesse
```


	st_astext text
1	LINESTRING(-48.66962 -26.917412,-48.660922 -26.914005)

PostGIS

Exportando dados

```
SELECT st_askml(st_makeline(geometria)) FROM ponto_interesse
```

	st_askml text
1	<LineString><coordinates>-48.66962000



```
<?xml version="1.0" encoding="UTF-8"?>
<kml xmlns="http://www.opengis.net/kml/2.2">
<Document>
<Placemark>
  <name>NOME DA LINHA</name>
  <description>Linha 1</description>
  <LineString><coordinates>-48.6696200000000002,-26
</Placemark>
</Document>
</kml>
```

PostGIS

Exportando dados

