Design of tools for spatiotemporal data analysis and dynamic visualization in a web-based GIS

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1

Index

✓Introduction

✓Objective

✓Motivation

✓State of art

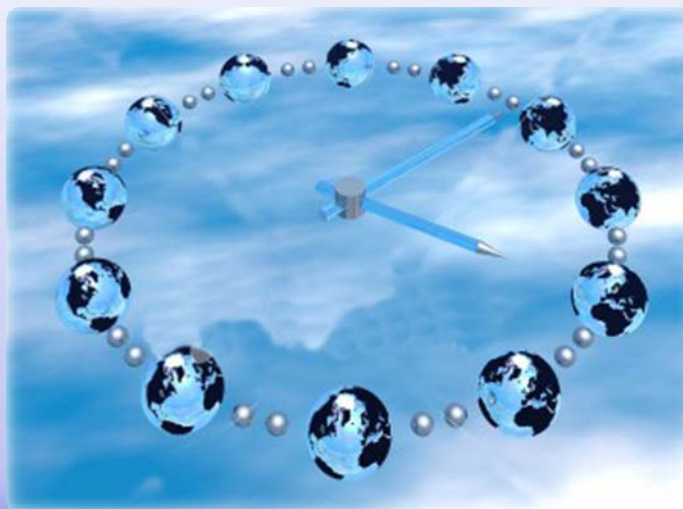✓Design of Spatiotemporal analysis tool

✓Conclusions and future works

Introduction

➤Spatial queries   ⟹   Spatiotemporal queries

➤Static visualization   ⟹   Dynamic visualization

Spatio-temporal GIS

Objective

➢ Design an user-friendly spatiotemporal analysis and dynamic visualization tool.

Motivation

➢ Discover behavioral patterns in human activities that clarify historical realities less known.

➢ Create a start point to incentive future applications in the social science field.

State of art

❖ The Snapshot Model (Langran,1988)

❖ The Space-Time Composite (STC) Data Model (Langran,1988)

❖ Data Models based on Simple Time-Stamping (Hunter,1990)

❖ Spatio-Temporal Object-Oriented (Worboys,1990)

❖ Event-Oriented Models (Peuquet, 1994)

❖ The Three-Domain Model (Yuan, 1994)

❖ The History Graph Model (Renolen, 1996)

❖ The Spatio-Temporal Entity-Relationship (Tryfona, 1997)

❖ Object-Relationship (Claramunt, 1998)

❖ Moving Object Data Models (Erwig, 1999)
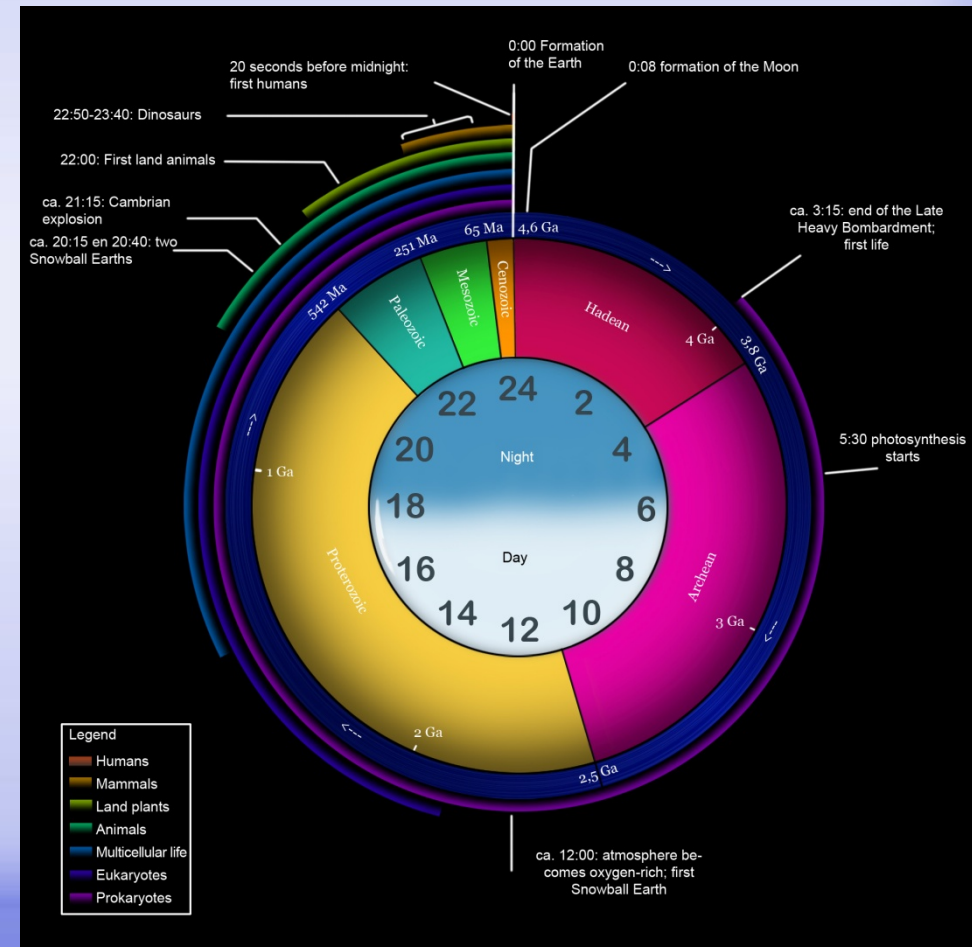
❖ Intentionally-Linked Entities (Kantabutra, 2007)

State of art

¿How GIS can integrate the concept of time and manage the information related with it?

❑Is time a straight line or a cycle?
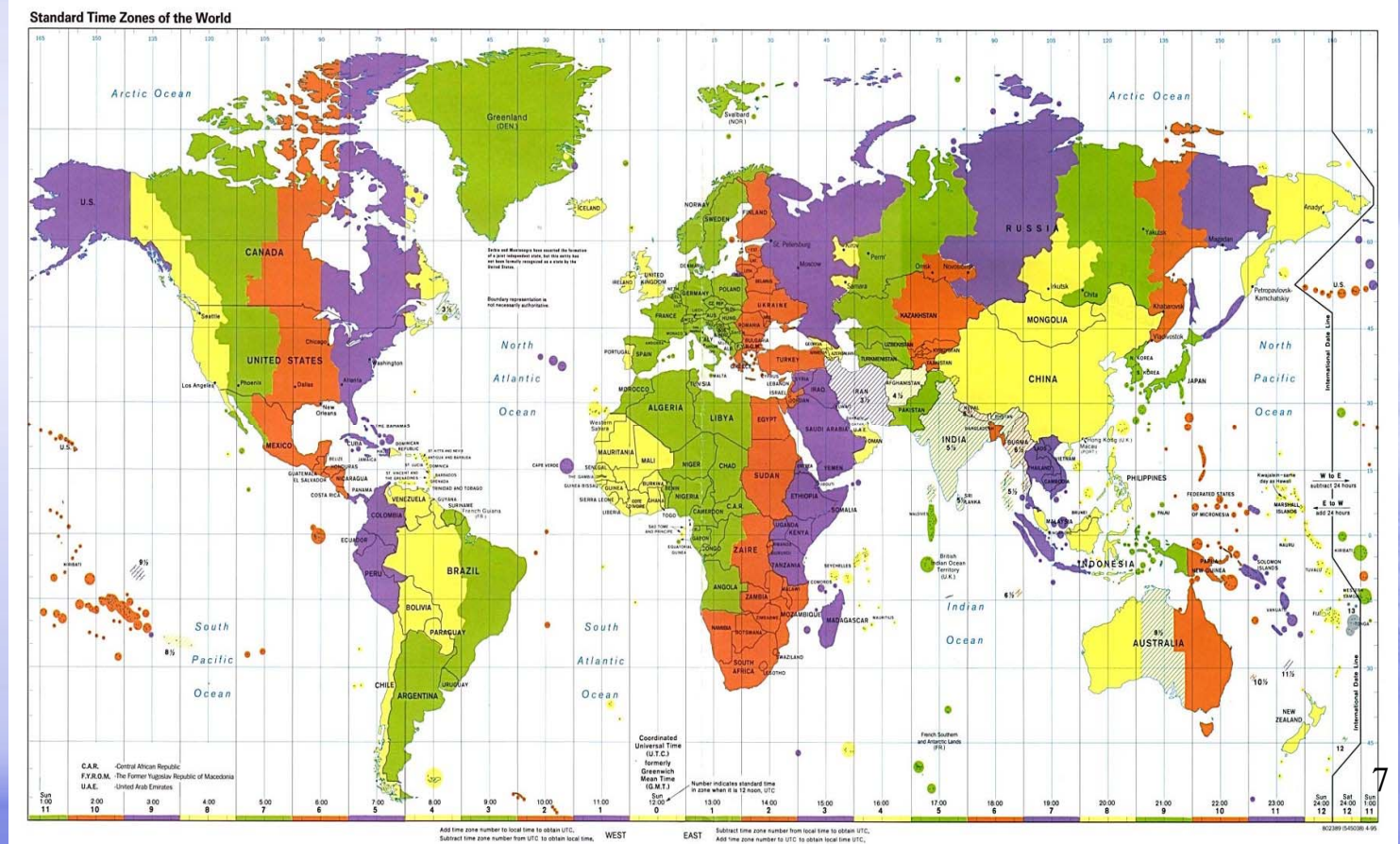
❑What is better to measure time, Seconds or Centuries?

State of art

Spationtemporal reasoning theories: (Allen, 1984; Galton, 1987, Egenhofer and Al-Taha, 1992, Cohn et al., 1998, Frank, 1998)

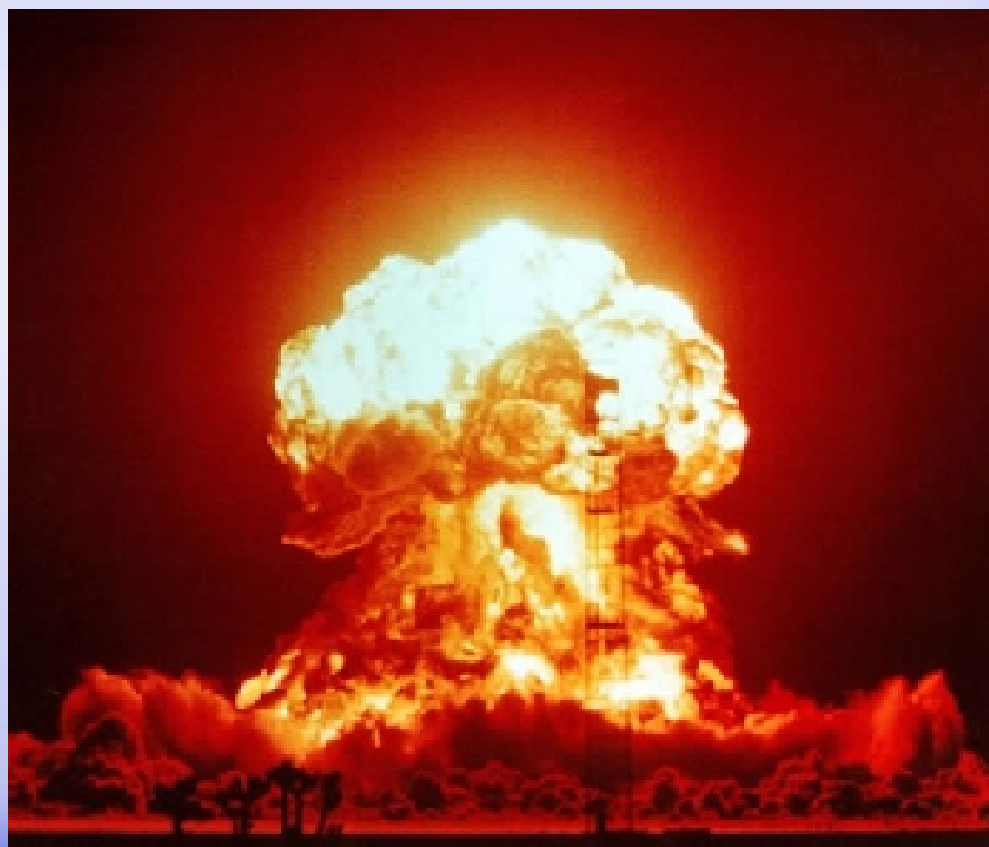❑What means Before?

❑What means After?

❑What means During?

State of art

Fuzzy logic and neuronal networks based theories (Dragicevic, 2004)

When the Cold War ended? 1989, 1990 or may be 1991?

Possible questions

Three components are the base of data types: space (where), time (when) and objects (what) (Peuquet, 1994)

· **When** + **Where** → **What** :
What phenomena were present at the time T at the location X?

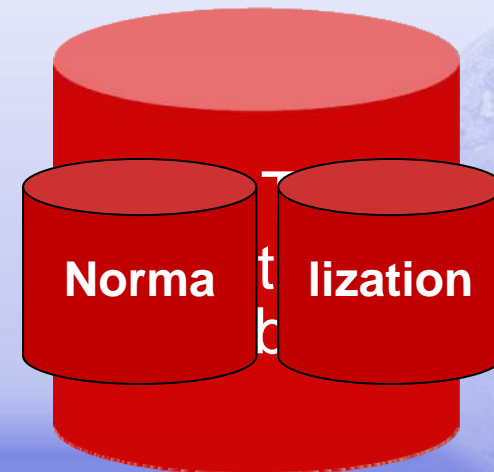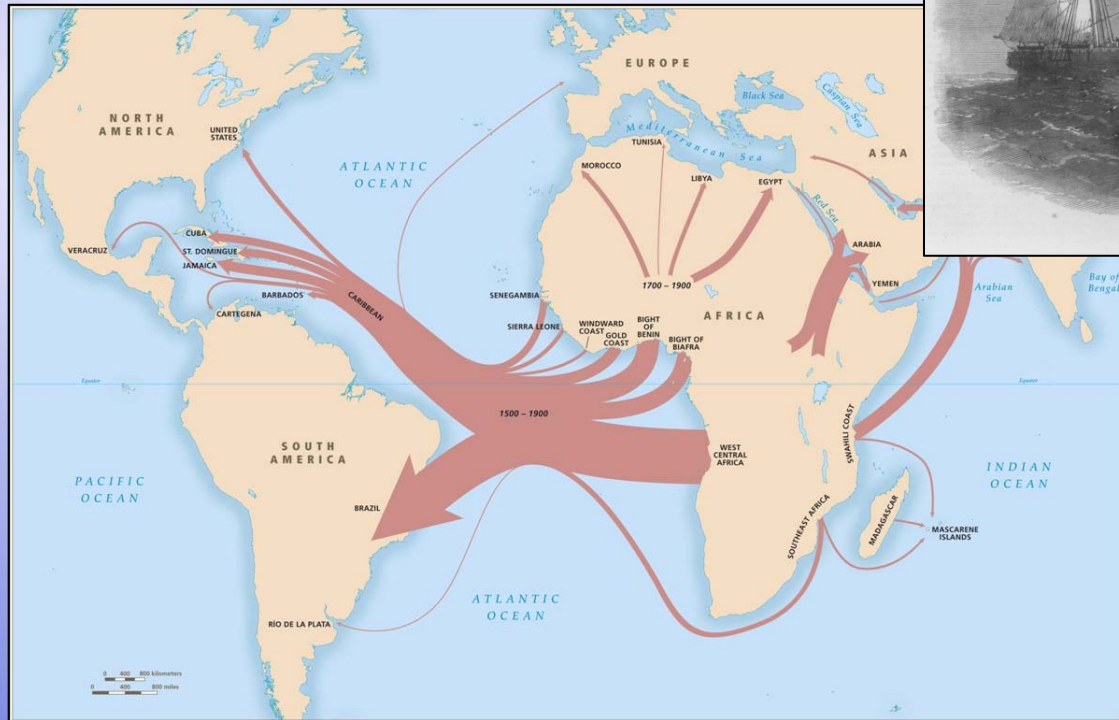· **What** + **When** → **Where** :
What was the location of the phenomenon P at the time T?

· **Where** + **What** → **When** :
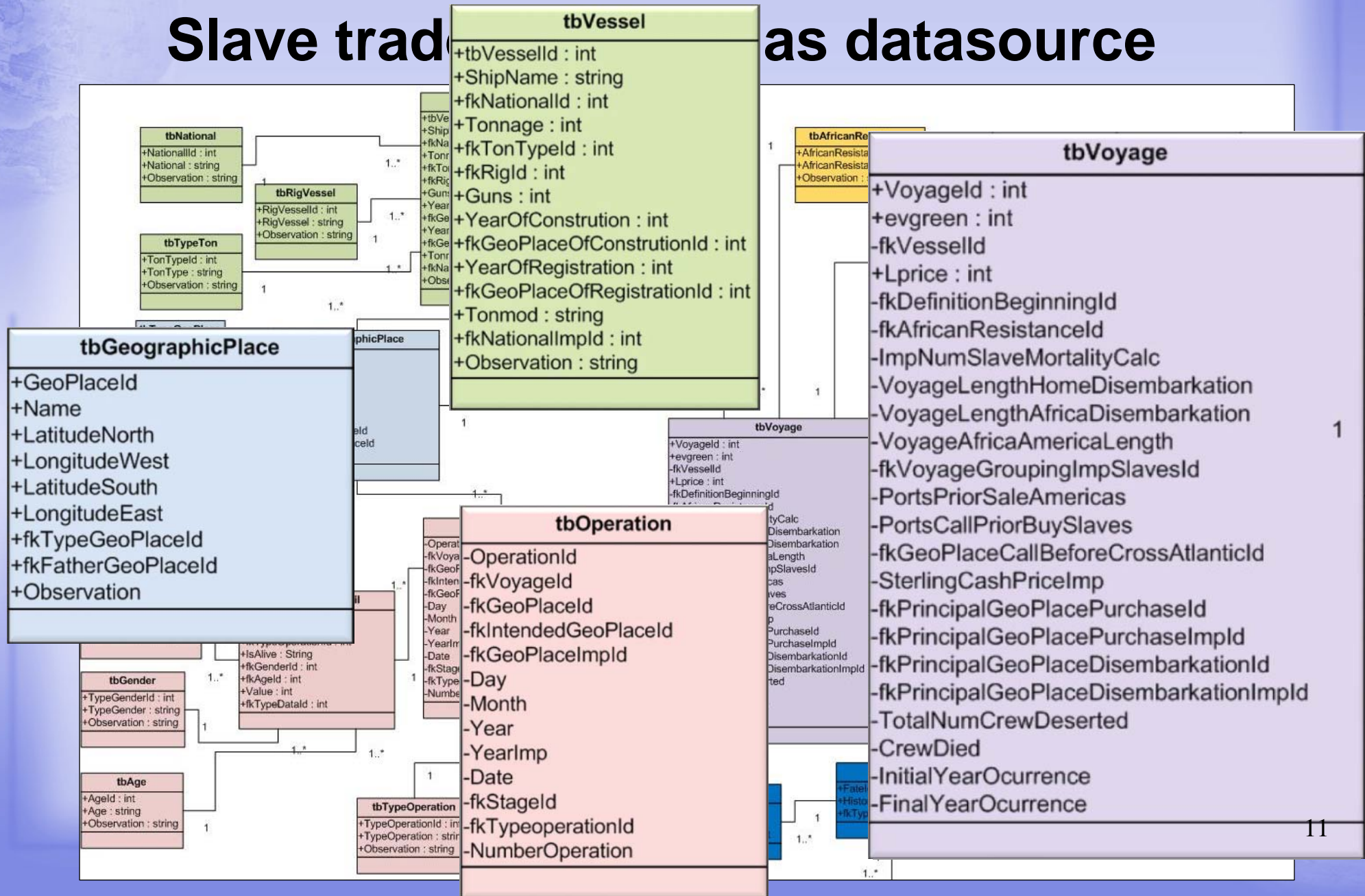When did the phenomenon P visit the location L?
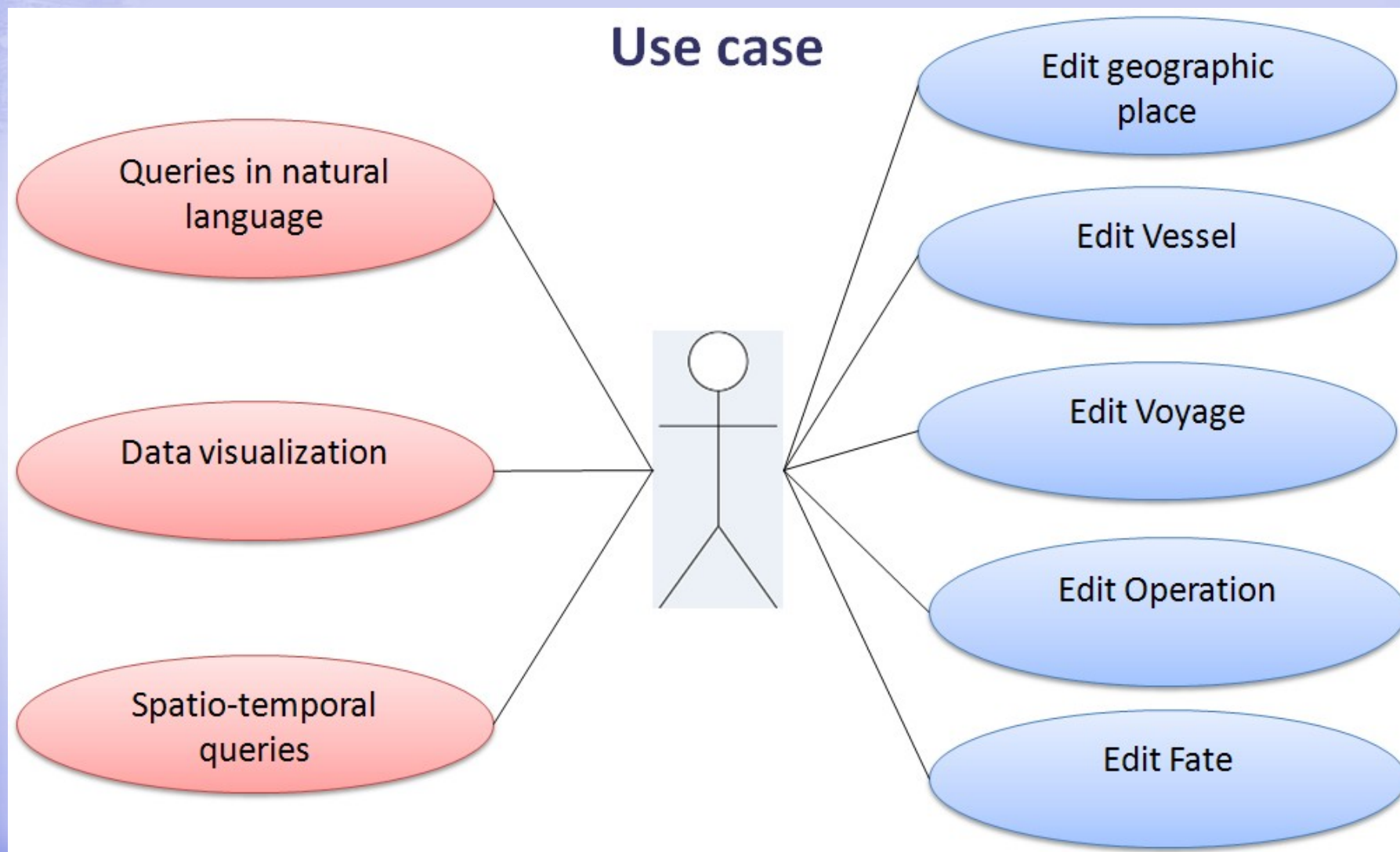
9

Slave trade database as datasource

Slave trad... ...as datasource

Use case

Port

New Port   Edit Port   Eliminate Port

	Port	Obser
	Alicante	
	Barcelona	
	Bilbao	
	Cadiz	
	Figuera	
	Gibraltar	
	La Coruña	
	Santander	
	Seville	
	San Lucar	
	Vigo	
	Canary Islands	
	Tenerife	
	Spain, port unspecified	
►*		

Region

New Region   Edit Region   Eliminate Region   Quit

	Region	Observation
►	Spain	
	Portugal	
	Great Britain	
	England	
	Scotland	
	Ireland	
	France	
	Netherlands	
	Denmark	
	Northern Germany	
	Belgium	
	Norway	
	France	
	Sweden	
	Italy	

Broad Region

New Broad Region   Edit Broad Region   Eliminate Broad Region   Quit

	Broad Region	Observation
	Europe	
	Mainland North America	
	Caribbean	
	Spanish American Mainland	
	Brazil	
	Africa	
	Other	

Edit geographic place

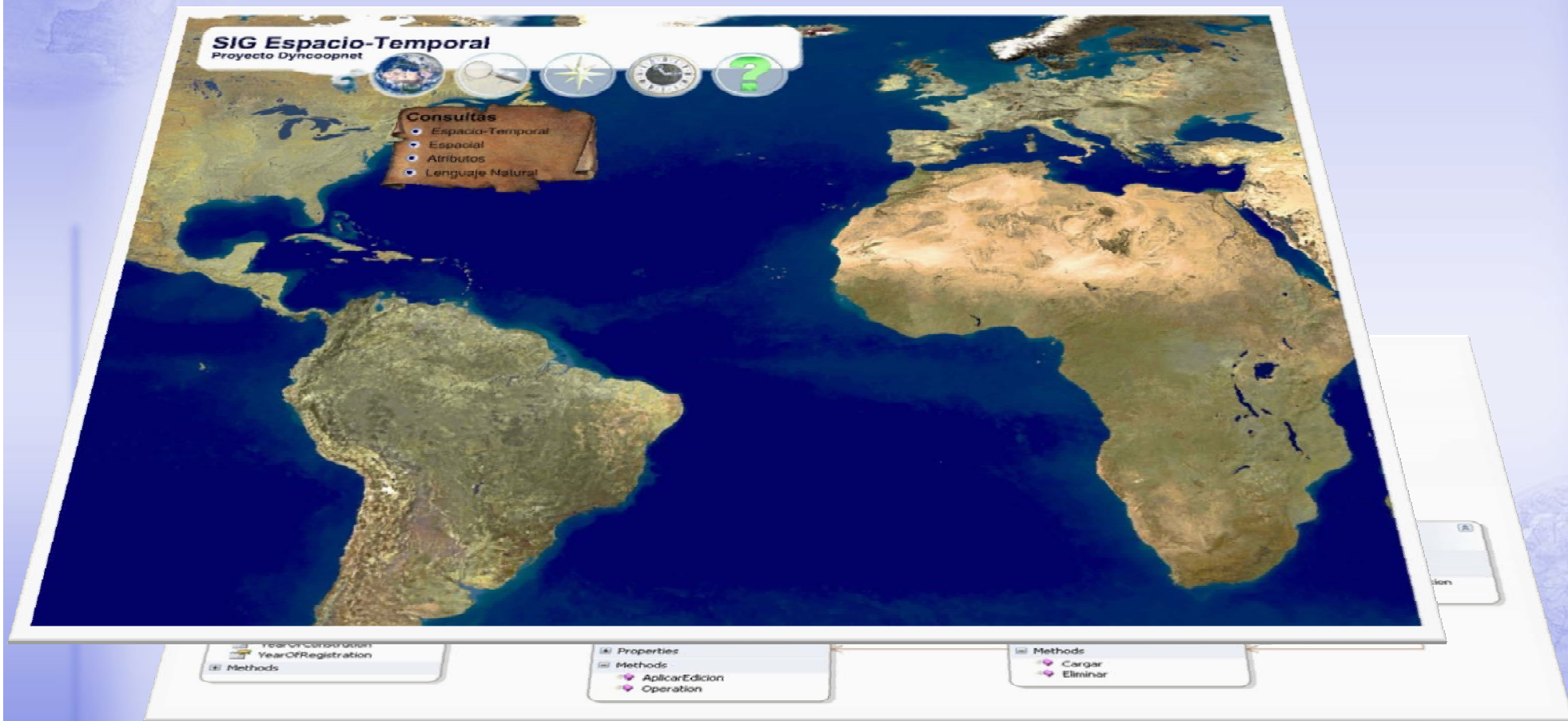Edit Vessel

Edit Voyage

Edit Operation

Edit Fate

13
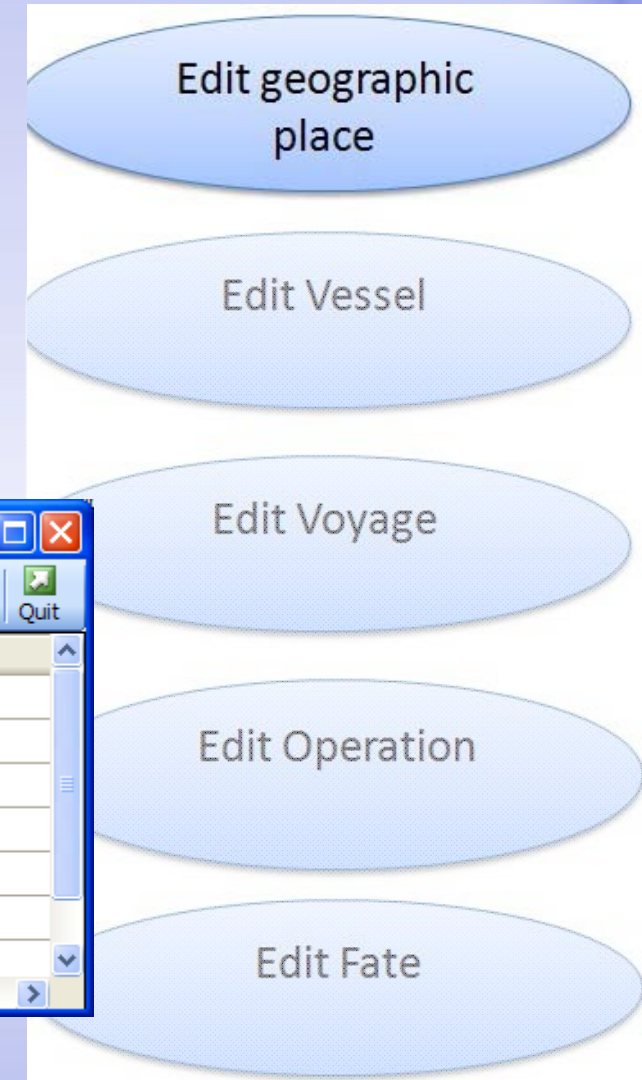
Class diagram: Methods
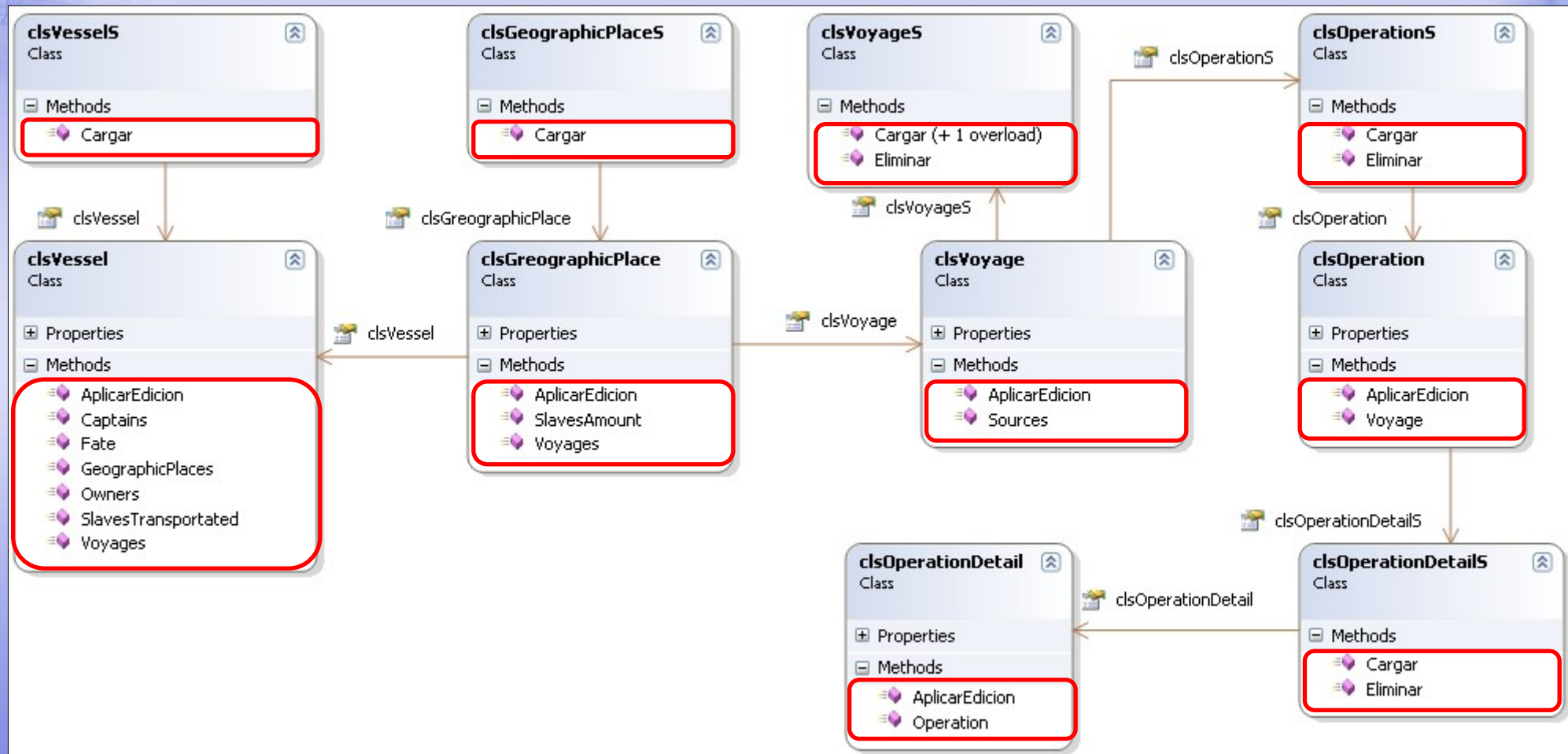
User interface

Scheme of user interface based on a set of parameters variation.

OBJECT	LOCATION	TIME	STATE	QUANTITY	OPERATOR
What?	Where?	When?	How?	How much?	
Vessel	Here	Before	Good	A little	OR
Slave	Near	Today	Bad	Much	AND
Port	Far	Later	Regular	Quite	NOT
Route	Around	Always	Best	More	XOR
….	….	Never	Worse	Less	
		Still	….	All	
		Between		Nothing	

16

Spatiotemporal queries

Dynamic visualization in GIS

Dynamic visualization in GIS

Conclusion

✓User-friendly spatio-temporal analysis tool.

✓Database normalization.

✓Use cases creation.

✓User interface design.

✓Classes modeling.

✓Spatio-temporal queries.

✓Dynamic visualization.

Future works

✓To implement the designed tool in GIS enviroment.

✓To improve the datatest, database design and class diagram after implementation.

✓To analyze in detail the data sources with the objective to find implicit relationships in the data.

✓To design a new tool for spatiotemporal datamining.

✓To obtain feedback from the end-users of the tool and other researchers.

¡Thank you!
谢谢您

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tbVessel
+tbVesselId : int
+ShipName : string
+fkNationalId : int

	VesselId	ShipName	National	Tonna...	TonTy...	RigVessel	Guns	YearOfConstrution	GeoPlace
1	30380	Aimable Henriette	France	138	French	Brig	NULL	1815	Nantes
2	30593	Aimable Henriette	France	138	French	Brig	NULL	1822	Nantes
3	30615	Marie	France	122	French	Brig	2	1824	Basse Indres
4	30696	Angélina	France	174	French	Brig	4	1824	Nantes
5	30700	Jeune Louis	France	219	French	Brig	2	1824	Nantes
6	30708	Gaspard	France	178	French	Brig	4	1824	Nantes
7	30713	Félicie	France	131	French	Schooner-brig	2	1824	Paimboeuf

tbGeographicPlace

	GeoPlaceId	GeoPlaceName	LatitudeNorth	LongitudeWest	LatitudeSouth	LongitudeEast	TypeGeoPlace	FatherGeoPlace
1	10000	Europe	NULL	NULL	NULL	NULL	Broad Region	Europe
2	10100	Spain	NULL	NULL	NULL	NULL	Region	Europe
3	10101	Alicante	NULL	NULL	NULL	NULL	Port	Spain
4	10102	Barcelona	NULL	NULL	NULL	NULL	Port	Spain
5	10103	Bilbao	NULL	NULL	NULL	NULL	Port	Spain
6	10104	Cadiz	NULL	NULL	NULL	NULL	Port	Spain
7	10105	Figuera	NULL	NULL	NULL	NULL	Port	Spain

tbVoyage

+VoyageId : int

	VoyageId	Shipname	DefinitionBeginning	InitialYearOcurrence	FinalYearOcurrence	VoyageAfricaAmerica
1	3	Paquete Real	Guia de despacho (added)	1816	1820	NULL
2	10	Comerciante	Guia de despacho (added)	1816	1820	22
3	12	Bonfim	Guia de despacho (added)	1816	1820	27
4	14	S Lourenço	Guia de despacho (added)	1816	1820	24
5	15	Paquete da Bahia	Guia de despacho (added)	1816	1820	NULL
6	16	Sociedade	Guia de despacho (added)	1816	1820	29
7	26	S Pedro do Sul	Port clearance (Provisão or Alvará)	1816	1820	35
8	36	S José Diligente Vulcano	Port clearance (Provisão or Alvará)	1816	1820	32
9	38	NS do Livramento Telêmaco	Port clearance (Provisão or Alvará)	1816	1820	43

tbOperation

-OperationId

	OperationId	VoyageId	GeographicName	Stage	TypeOperation	NumberOperation	year	month	day
1	11809	1	Rio de Janeiro	Europe-Africa	Departure	NULL	1816	8	4
2	11810	1	Mozambique	Purchasing	Departure	1	NULL	NULL	NULL
3	11816	1	Bahia, port unspecified	Selling	Disembarkation	1	NULL	NULL	NULL
4	11818	1	Bahia, port unspecified	Selling	Disembarkation	3	NULL	NULL	NULL
5	11819	1	Bahia, port unspecified	Selling	Unknown	NULL	NULL	NULL	NULL
6	11823	2	Bahia, port unspecified	Europe-Africa	Departure	NULL	1816	7	11
7	11824	2	Mozambique	Purchasing	Departure	1	NULL	NULL	NULL