

Management and visualization of multitemporal data in GRASS GIS 7

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Spatio-temporal data in GIS

Spatio-temporal data is a new phenomena in GIS comparing to spatial data

- we have a lot of disk space
- we have more ways of measuring data (GPS, high-res imagery, lidar)
- we have been measuring for many years, so now we have enough data to analyze it

Brief history

For a long time, time dimension of data has been ignored. Banking systems were the first who handled temporal data (transactions in database).

Until now these questions haven't been fully answered:

- how to store and represent temporal dimension?
- how to visualize it?

D.J. Peuquet. Making space for time: Issues in space-time data representation. In: *Geoinformatica 5.1* (2001), pp. 11–32.

Carte Figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812-1813.

Dessiné par M. Minard, Inspecteur Général des Ponts et Chaussées en retraite. Paris, le 20 Novembre 1869.

Les nombres d'hommes perdus sont représentés par les largesurs des zones colorées à raison d'un millimètre pour dix mille hommes; ils sont de plus écrits en travers des zones. Le rouge désigne les hommes qui entrent en Russie; le noir ceux qui en sortent. — Les renseignements qui ont servi à dresser la carte ont été puisés dans les ouvrages de M. M. Chiers, de Cléjart, de Fozzonsac, de Chambray et le journal inédit de Jacob, pharmacien de l'Armée depuis le 28 Octobre. — Une mienne fautive jugée à l'œil la diminution de l'armée; j'ai supposé que le corps de Prince-Niemi en du Maréchal Davoust qui avaient été détachés sur Minsk et Mielnik a été rejoint vers Czestcha et Wlodek, anciens troupes unies avec l'armée.

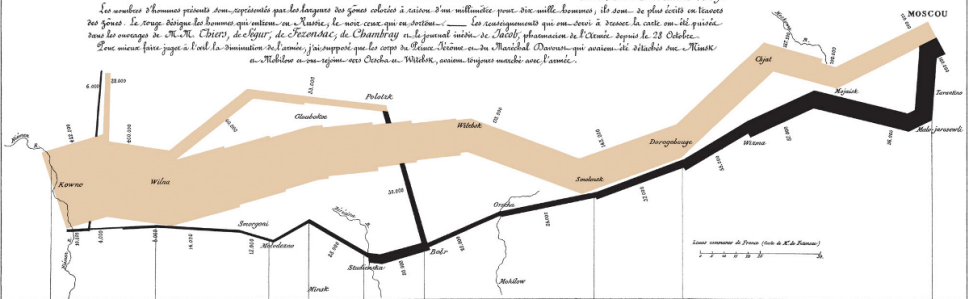
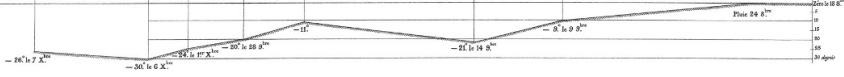


TABLEAU GRAPHIQUE de la température en degrés du thermomètre de Réaumur au dessous de zéro.

Les Courbes passent au gelye le Niléme gelé.



Spatio-temporal models

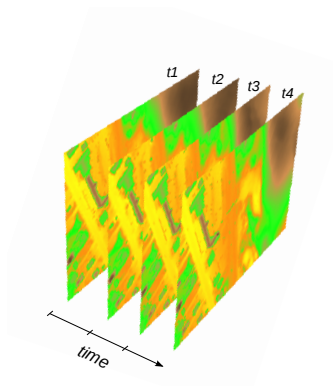
Spatio-temporal data modeling involves defining object data types, relations and operations, and ensuring database integrity

- snapshot model
- space-time composite data model
- event-oriented models
- three domains model
- object-oriented models
- ...

N. Pelekis, B. Theodoulidis, I. Kopanakis, and Y. Theodoridis. Literature review of spatio-temporal database models. In: *The Knowledge Engineering Review* 19.03 (2004), pp. 235–274.

Snapshot approach: pros and cons

- intuitive
- can be integrated into GIS easily
- data redundance
- describes states, not changes



GRASS GIS Temporal Framework

New addition in GRASS 7 (by Sören Gebbert) enables to manage and analyze large times series of data.

It consists of:

- database (stores only temporal information and metadata)
- Python API
- t.* modules (around 40 modules)

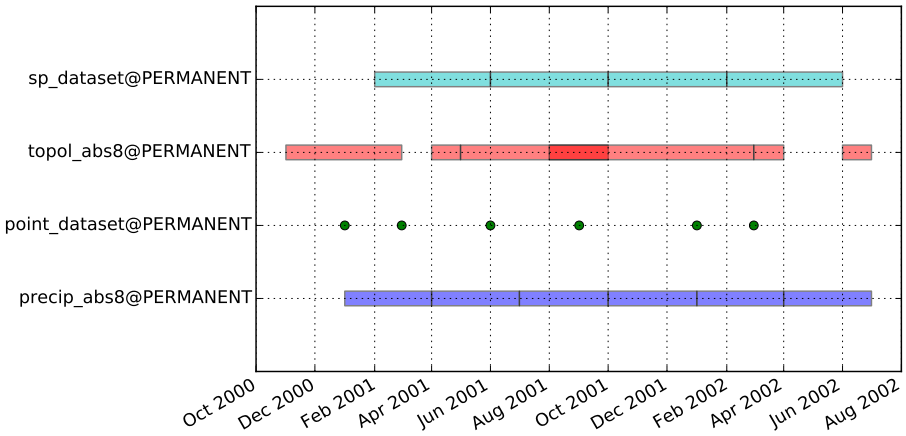
Time concepts

interval vs. instant

- not always so easy to decide which to use
- precipitation vs. current temperature
- generally, when both make sense, use interval
- interval contains start time, not end time: [start, end)

absolute vs. relative

- again, not always so easy to decide which to use
- absolute date time format: 2013-10-15 13:00:00
- relative: 4 years, - 90 days



Temporal granularity

Granularity is a characteristics of a spatio-temporal dataset similar to resolution.

Temporal granularity is the greatest common divisor of the temporal extents (and possible gaps) of all maps of the dataset

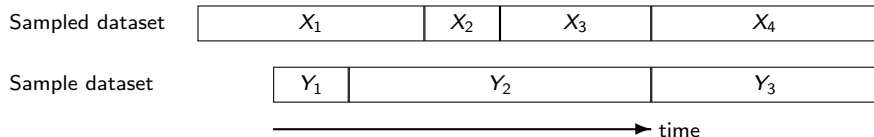
Temporal topology

Temporal topology analyzes temporal relations between time intervals.

X 	Y 	before/after
X 	Y 	precedes/follows
X 	Y 	overlapped/overlaps
X 	Y 	starts/started
X 	Y 	during/contains
X 	Y 	finishes/finished
X 	Y 	equals

Temporal sampling

Temporal sampling is used to determine the state of one process during a second process.



	start	during	contain	overlap	equal	follow	precede
Y_1	—	—	X_1	—	—	—	—
Y_2	X_2, X_3	X_2, X_3	—	X_1	—	X_4	—
Y_3	X_4	—	—	—	X_4	—	X_3

Spatio-temporal datasets

Spatio-temporal dataset is a collection of raster/vector/voxel maps stored in GRASS database with time stamp defined in temporal database.

- strds, stvds, str3ds

Datasets have metadata: time granularity, spatial and temporal extent, min and max values, temporal type (absolute, relative).

Spatio-temporal datasets

How to create a dataset?

`t.create` → `t.register`

How to change a dataset?

`t.rename`, `t.remove`, `t.support`, `t.unregister`

How to get any information about the dataset?

metadata: `t.list`, `t.info`, `t.rast.list`, `t.topology`, `g.gui.timeline`

content: `t.rast.univar`, `t.vect.db.select`

Spatio-temporal data processing

- spatial, temporal aggregation
- raster algebra
- temporal sampling
- convert space-time raster dataset to voxel
- interpolation of gaps
- import/export
- extract smaller dataset
- shifting or merging datasets

Go to GRASS wxGUI → Search modules tab → Temporal