Time Series discovery and access
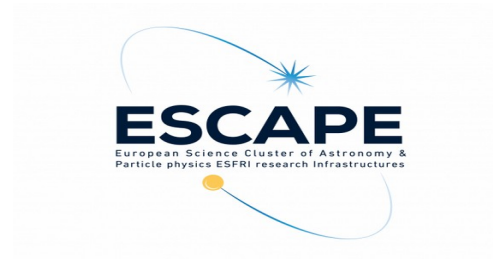
- In alphabetic order : François Bonnarel, Mireille Louys, Laurent Michel, Marco Molinaro, Ada Nebot

- Acknowledge : TD IG, DM WG, DAL WG discussions

What is a time series for us ?

- « some astronomical data » varying with time
- Time is independant variable
  - Light curve, Velocity curve
  - Multi-band light curve
  - Sequence of images (« movie »???)
- Is it a questionable definition (see semantics May 26th 5 UTC) ?

Question to solve for the VO

- How do we discover time Series
- How do we access them ?
- ~~How do we represent them ?~~
- Can we « build » them in tools from catalog data ?

Representation : not in this talk

- Simple Light curve serialisation :

- Nebot et al, 2020

- DAL or DM task to push it ?

- Alternatively, for more complex

- TimeSeries : **Cube DM** (+ Mango?)

- + DM annotation/serialisation

- → see DM Workshop output ? !

Abstract

This document describes a proposal to annotate in a VOTable time series data. It is limited to the most common type of time series in astronomy: light curves, but it can be extended to other type of time series data easily (e.g. radial velocities and positions). The annotation reuses elements of existing Data Models when possible and defines a set of new elements. This document can be taken as a test case of a more general purpose model.

Discovery mode

- Source driven

- Via ObsCore

- Mixed

Source driven (Gaia use case)

- (archived ?) TimeSeries are « attached » to a source in a catalog

- Source properties and mesearuments retrieved via SCS or TAP

- TimeSeries retrieved via dedicated column, via VOTable LINK or via DataLink response

  - The latter in case we have several TimeSeries for the same source or TimeSeries + other stuff (spectra, metadata)

ObsCore based discovery (1) (LSST ? Use case)

- TimeSeries are already pretty well described by ObsCore.

- Discover them by forcing

- dataproduct_type = « time series » + other criteria

- ObsTAP service will provide that functionality

- Do we need extra parameters to describe TimeSeries ?

  - Time sampling description

  - Data TimeFrame

  - Extension table (timeCore) in ivoa schema (or extra parameters in ObsCore) ?

  - New constraints available for discovery

ObsCore based discovery (2)

ObsCore DM Proposed Extension
for time series and radio visibilities

Mireille Louys,
F. Bonnarel, Ada Nebot, L.Michel
following discussions with Time domain IG and Radio

CDS and Observatoire de Strasbourg
ICube Laboratory, Strasbourg University

Louys et al , 2020
November interop

→ speak (now?)
    if you need it !

Time description in ObsCore

Obscore + TObs	Definition	Utype/datamodel path	UCD	Units	Mandatory/ optional
t_min	Time start of the sequence	Char.TimeAxis.Coverage.Bounds.Limits.LoLim	time.start;obs.sequence	s	man
t_max	Time end of the sequence	Char.TimeAxis.Coverage.Bounds.Limits.HiLim	time.end;obs.sequence	s	man
t_exptime	Exposure time (sum of multiple exposures)	Char.TimeAxis.Support.Extent	time.duration;obs.exposure	s	man
t_exp_min	minimal length of time sample (min integration time)	Char.TimeAxis.Sampling.Extent.loLim	time.duration;obs.sequence ;stat.min.	s	opt
t_exp_max	maximal length of time sample (max integration time)	Char.TimeAxis.Sampling.Extent.hiLim	time.duration;obs.sequence ;stat.max	s	opt
%time space between 2 time samples / cadence					
t_delta_min	minimal length of time interval between 2 observations / cadence (min)	Char.TimeAxis.Sampling.Period.loLim	time.interval;obs.sequence; stat.min.	s	opt
t_delta_max	maximal length of time interval between 2 observations / cadence (max)	Char.TimeAxis.Sampling.Period.hiLim	time.interval;obs.sequence; stat.max	s	opt
t_resolution	minimal interpretable time difference	Char.TimeAxis.Resolution.Refval			
t_xel	nb of time stamps in the series	Char.TimeAxis.numBins	meta.number	null	man

grey cell = current Obscore keywords

add every parameter in blue cells to *ivoa.t_obs* table

ObsCore based discovery (3)

- Why not a parameter based interface to ObsCore ?

- Extend SIA to discovery of TimeSeries

- Make use of optional parameter for extension ?

- See next talk : Simple « TimeSeries » access or more general Simple « DataSet » access protocol ?

Mixed (GAPS use case)

- The TimeSeries is attached to the source and both

  - the source parameters and

  - (let's say) the lightcurve obscore description

- are in a database

- (case of an exoplanet and companion star for example)

- → We may want to discover by constraints on both timeseries characterization and « spectral type » or « proper motion »

- → Store two tables in the TAP service and make joins or add star parameters to basic ObsCore

Access the data

- Full retrieval from DataLink or main source/Obscore table

- Excerpt/transform of the data via SODA-next

  - Selection of data points in a given time range

  - Extraction of one single scalar curve from a multi-scalar one

  - Reduction of dimensionality (cube with time axis → TimeSeries)

  - Changing TimeScale or Time representation

Can we « build » TimeSeries in tools from catalog data ?

- SCS or TAP services response may contain raws of catalogs with timestamps

- SCS-next has now a TIME attribute to select in ranges

- Catalogs in VOTable now provide TIMESYS element for the time frame

- Photometric calibration and system may also be provided in a standard way.

- → A client may provide a functionality to treat such service responses as if they were timeseries

- → moreover these « on the fly timeseries » may be exchanged with other tools (SAMP, Notebooks) or stored for the future

STMOCs

- STMOC servers may provide list of measurements with timestamps (like SCS)

- On the fly time series may be built.

- TAP, SIA and SCS would benefit to be queryable by STMOC.

Next

- IVOA note : what standards to implement,
  what changes to make in the standards was
  first published in 2018 (Molinaro and Bonnarel)

- New version in discussion with all of us

- Will be pushed on github next week

- Implementation note + Decisions about
  the changes to make in DAL standards
  in the next months

TimeSeries Discovery and Access
DAL procedure

Version 1.0

IVOA Note 2021-04-30

Working group
    DAL
This version
    http://www.ivoa.net/documents/TimeSeriesDiscoveryAndAccess1/20210430
Latest version
    http://www.ivoa.net/documents/TimeSeriesDiscoveryAndAccess1
Previous versions

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