Time Series : CDS vision

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Use cases

- Retrieve all catalogues which have measurements for a given date (eg date of a Gaia observation)
- Look for stars with at lest N points exceding the 5-sigma limit of the mean photometric value
- Fermi has detected a flaring blazar. It has a certain error ellipse, say a few arc-minutes. An optical counterpart is not known. How can one get lightcurves for all objects in the error-ellipse to look for variability and thus possible counterparts to the blazar?

VizieR content

- Surveys such as Gaia, CoRoT, Hipparcos, OGLE, MACHO, EROS, contain light curves
- Apart from that,1500 catalogs with timeSeries flag
- 70 % of them have light curves

Time domain catalog metadata
(how to describe our catalogues)

- tmin, tmax, t mean, sigma t
- Dtmin, dtmax, dtmean, dtsigma
- Time domain column identification
- Observable caracterisation (ucd) and column identification
- Many of those are in ObsCore, others are in full caracterisation DM.
- Column identification are « service » metadata.

Time domain catalog metadata
(how to discover our catalogues and time series)

- Query by
  - source ID or position
  - + other metadata criteria.

- ObsCore query response
  - or
- Direct Light curve display (if unique)

Retrieving or building light curves or « scalar » TimeSeries

- VOTAble with one main table
- One row per measurement
- One FIELD for time coordinate.
- One (or several) FIELDs for Observable with appropriate ucd.
- Other FIELDs (or Params) with other coordinates or metainformation (eg measurement origin)
- Annotation with Utypes from SparseCube Data Model

VOTable sample serialization

With spatial, time, flux axes

```
<?xml version="1.0" encoding="UTF-8"?>
- <VOTABLE xsi:schemaLocation="http://www.ivoa.net/xml/VOTable/v1.2 http://www.ivoa.net/xml/VOTable/v1.2" xmlns="http://www.ivoa.net/xml/VOTable/v1.2" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" version="1.2">
    <DESCRIPTION> VizieR Astronomical Server vizier.u-strasbg.fr Date: 2017-03-06T14:04:53 [V1.99+ (14-Oct-2013)] Explanations and Statistics of UCDs: See LINK below In case of problem, please report to: cds-question@unistra.fr In this version, NULL integer columns are written as an empty string <TD></TD>, explicitely possible from VOTable-1.3 </DESCRIPTION>
      <!-- VOTable description at http://www.ivoa.net/Documents/latest/VOT.html -->
    <INFO value="1.99+ (14-Oct-2013)" name="votable-version" ID="VERSION"/>
    <INFO value="VOTx26728" name="-ref" ID="Ref"/>
    <INFO value="308.718050+60.153678,rs=5." name="-c" ID="Target"> </INFO>
  - <RESOURCE name="VizieR(2017-03-06T14:04:53)" ID="VizieR_S542124293">
      <DESCRIPTION>VizieR database maintained by CDS, see http://vizier.u-strasbg.fr</DESCRIPTION>
      <COOSYS ID="J2000_2000.000" epoch="2000.000" equinox="J2000" system="eq_FK5"/>
    - <TABLE name="VizieRTimeSeries" ID="VizieR_ts">
        <DESCRIPTION>all VizieR catalogues</DESCRIPTION>
          <!-- Definitions of GROUPs and FIELDs -->
        <FIELDref ref="ts_time"/>
      - <GROUP name="_ph" ID="ph" utype="spec:PhotometryPoint" ucd="phot">
          <DESCRIPTION>The SED group is made of 4 columns: mean frequency, flux, flux error, and filter designation</DESCRIPTION>
          <FIELDref ref="ts_flux" utype="photdm:PhotometryPoint"/>
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          <FIELDref ref="ts_filter" utype="photdm:PhotometryFilter.identifier"/>
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          <DESCRIPTION>Right ascension (FK5, Equinox=J2000.0) at Epoch=J2000, proper motions taken into account (computed by VizieR, not part of the original data)</DESCRIPTION>
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      - <PARAM value="+60.153622" name="_DEJ2000" ref="J2000" utype="cube:SparseCube.NDPoint.spaceAxis.value[1]" ucd="pos.eq.dec" datatype="double" unit="deg" precision="6" width="10">
          <DESCRIPTION>Declination (FK5, Equinox=J2000.0) at Epoch=J2000, proper motions taken into account (computed by VizieR, not part of the original data)</DESCRIPTION>
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          <DESCRIPTION>measurement origin</DESCRIPTION>
        </FIELD>
      - <FIELD name="_ts_time" ID="ts_time" utype="cube:SparseCube.NDPoint.timeAxis.value" ucd="time" datatype="double" unit="d" precision="E6" width="10" xtype="mjd">
          <DESCRIPTION>time of observation in d</DESCRIPTION>
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      - <FIELD name="_ts_flux" ID="ts_flux" ucd="phot.flux.density" datatype="float" unit="Jy" precision="E3" width="9">
          <DESCRIPTION>Corresponding flux density, in Jy</DESCRIPTION>
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      - <FIELD name="_ts_eflux" ID="ts_eflux" ucd="stat.error;phot.flux.density" datatype="float" unit="Jy" precision="E2" width="8">
          <DESCRIPTION>Mean error (standard deviations) of flux density</DESCRIPTION>
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      - <FIELD name="_ts_filter" ID="ts_filter" ucd="meta.id;instr.filter" arraysize="32*" datatype="char" unit="" width="32">
          <DESCRIPTION>Filter designation, in the form photoSystem:filterName; a designation starting by ':=' is an assumed monochromatic point; this column is empty when the frequency is specified for each data point.</DESCRIPTION>
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```

VOTable sample serialization (data part)

```
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          </TABLEDATA>
        </DATA>
      </TABLE>
    </RESOURCE>
  </VOTABLE>
```

DataModel to use

- Proposal to use SparseCube DataModel (by Jiri)
- Spatial, Time, Spectral, Pol axes
- Only Time must be sparsed
- Dependant variable (=Observable) is managed by a CustomAxis (eg PhotometryPoint)
- In light curves (or scalar TimeSeries) Ndpoint is well adapted to represent a « row » (measurement)
- Remaining metadata (Dataset, Characterization, Mappings) may be stored in PARAMS.
- Model could be extended to timeSeries of ND-Cubes in the future (sequences of variable spectra, images, etc…)