Annotating TAP responses on-the-fly against an IVOA data model

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Abstract.

With the success and widespread of the IVOA Table Access Protocol (1) for discovering and querying tabular data in astronomy, more than one hundred of TAP services exposing altogether 22 thousands of tables are accessible from the IVOA Registries at the time of writing. Currently the TAP protocol presents table data and metadata via a TAP_SCHEMA describing the served tables with their columns and possible joins between them. We explore here how to add an information layer, so that values within table columns can be gathered and used to populate instances of objects defined in a selected IVOA data model like Photometry, Coords, Measure, Transform or the proposed MANGO container model. This information layer is provided through annotation tags which tell how the columns’ values can be interpreted as attributes of instances of that model. Then when a TAP query is processed, our server add-on interprets the ADQL query string and produces on-the-fly, when possible, the TAP response as an annotated VOTable document. The FIELD elements in the table response are mapped to corresponding model elements templated for this service. This has been prototyped in Java, using the VOLLT package library and a template annotation document representing elements from the MANGO data model. This has been exercised on examples based on Vizier and Chandra catalogs.

1. Goal

Today a large collection of services distributing table data via the TAP access protocol (Dowler et al. 2019) are provided within the IVOA framework. In this paper we focus on source catalogs, served by TAP. Catalogs are enriched nowadays with associated data added to the astronomical source’s measurements, like previews or images from other collections on which it can be located, a spectrum or a time series recorded for this object, etc. TAP relies on the standardized VOTable format ((Ochsenbein et al. 2019) to present TAP responses but it uses free names for table columns, so these are not homogeneous across various TAP services. However data interpretation relies on general quantities like coordinates in spatial and spectral domains, photometric flux or densities, velocity, time stamps for events, etc. Those concepts are represented in IVOA data models as Coords (Rots et al. 2021), Measurement (Cresitello-Dittmar & Rots 2021), Photometry (Salgado et al. 2013). The data associated to a source, and linked
to a catalog entry can also be described using 'data products-oriented' data models like
ObsCore, Spectrum or Cube data models. In a new attempt to unify the source measure-
ments together with associated data sets in a common Object Oriented interface, we
have designed MANGO (Michel et al. 2021b) to describe the various facets contained
in a source catalog.

This is very useful when dealing with enriched catalogs. Data models carry an
elaborated view on catalog data and help to represent and trace various kinds of data
and metadata such as:

- catalog data with groups of columns interpreted as objects
- detailed calibration metadata in terms of astrometry, photometry, spectral and
temporal calibration, etc.
- classification or quality flags
- data products attached to a detection (source) and distributed by another service
  like spectrum, spectral energy distribution, light-curve, image, cube, etc.

We exercised an annotation framework using:

- the ModelInstanceinVOTable specification syntax (in development see (Michel
  et al. 2021a)) to represent annotated objects from MANGO
- a JSON template format to express how TAP columns can be encapsulated as
  attributes of objects in the data model logic

This has been implemented on a prototype TAP service with the CDS-TAP library
(Mantelet 2019). The VOLL TAP toolkit (Mantelet 2021) allows to customize the
"writeHeader" method in order to decorate the VOTable TAP response with a
MANGO annotation block in XML, in compliance to the JSON template provided.
From the VODML-XML representation of each data model, a list of model elements
can be extracted to form the list of XML components for annotating TAP outputs for
one IVOA Model. A JSON dictionary of components, can be derived and adjusted by
the data provider to each table served with additional references to the FIELDS
provided in the TAP response.

Fig.1 summarizes the usual TAP query mechanism (in green) and highlights the role
of the developed Mapping Engine which incorporates in the annotation the XML
components snippets based on data model elements and mentioned as used elements
in the provider’s JSON profile.

2. Scenario description

Fig.2 illustrates the various steps involved for creating the list of XML components,
analysing the selection in the query and building the annotation block.

Here is the summary of a typical annotation scenario to run on the prototype:

- A TAP query is processed by the server which prepares results in a VOTable
  TABLE structure.
- The Annoter gets the appropriate annotation profile (currently in JSON format)
defined by the data curator as a list of components served by the TAP server. It
  contains the binding of data model elements and column references to reach
data model leaves.
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Figure 1. Annotation process on top of the TAP query scenario: in green the usual query scenario, in orange, the elements added for the annotation.

Figure 2. The building blocks used for the mapping generation. From left to right: the Component Builder, the Annotation Merger and the Instance Builder. Cf. presentation by L. Michel, IVOA meeting May 2020, A Component and Association Based Model For Source Data

- The TreeWalker program browses this annotation profile. It compares the FIELDS elements in the VOTable response with their counterparts attributes in the model elements represented. Relevant XML components are identified and appended into the annotation tree.
- The Annoter wraps this annotation block as a VOTable resource and inserts it at the top of the usual VOTable TAP response.

Examples of the various files run with the prototype are available at https://github.com/loumir/TAP-annoter/AdassProceedingsX3-010/.
3. Parsing the annotated tables

After an annotation is produced and inserted on top of the VOTable response, a client application can reuse it in different ways. For instance for checking errors only, or for building full objects instances.

4. Conclusion

The prototype serves as a proof of concept for the wrapping of TAP responses with IVOA models’ metadata, here MANGO and the Coords, Meas, Photometry data models. The format used to describe the library of mapping components can be either XML or JSON. We foresee development for an integration of such a strategy in the PyVO framework.

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