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Abstract:

The Virtual Observatory (VO) standards for simulations, Simulation Data Model (SimDM) and Simulation Data Access Layer (SimDAL), establish a framework for the discoverability and dissemination of data created in simulation projects. These standards address the complexity of having a standard access and facade for data which is expected to be multifaceted and, of a diverse range.

Here, we detail the realisation of an application exposing the theoretical data products of one such scientific project via the simulation facades proposed by the VO. The scientific project in question, is a study of the evolution of young clusters in dense molecular clumps. The theoretical products arising from this study include a grid of 20 million SED (Spectral Energy Distribution) models for synthetic young clusters and related data products. Details on the implementation of SimDAL components in the application as well as the ways in which the data structures of SimDM are incorporated onto the existing data products are provided.

VO standards for simulations:

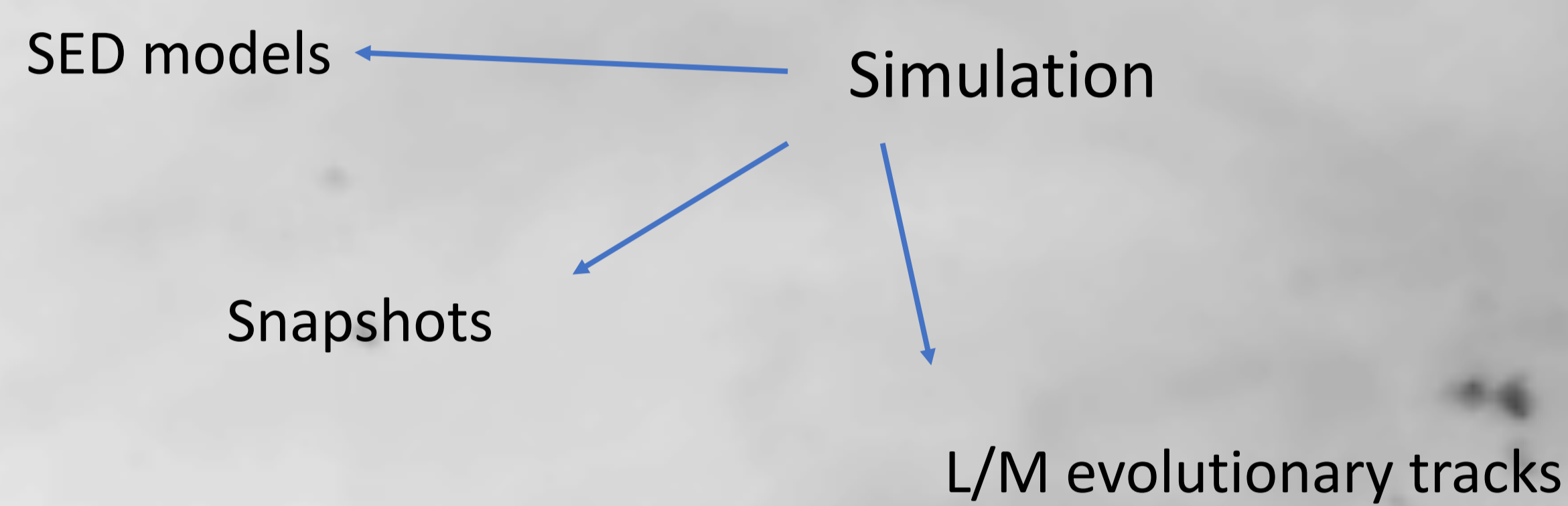
The main focus w.r.t simulations in VO has been to address the question of access of the variety of theoretical results and related data created in various astrophysical projects.

- Simulation Data Model (SimDM) describes the simulation data, providing a VO facade for the heterogeneous theoretical data components.
- The search and data access can be facilitated with constituents of SIMDAL (Simulation Data Access Layer).

SimDM Provides data structures; Experiment, Protocol, OutputTypes...

SimDAL

- Repository (a registry for simulations data)
- Search (service to peruse or look up for a specific dataset)
- Data Access layers (services to access the complete dataset or a subset).



The simulation project

The scientific project is a study of young stellar objects (YSO) clusters in massive clumps (highly dense and compact structures) in molecular clouds. The resultant data products of the study, i.e. the data that is to be relayed through the SimDAL application, include a grid of 20 million population synthesis SED models for protoclusters, related data and L/M evolutionary tracks. Details of this study is in the MNRAS accepted paper:



Organising data products w.r.t SimDM

The adjacent figure represents part of the instance diagram for the entire scientific project. The experiment and protocol at the top of the diagram are representative of the scientific project and the methodology used. The data products of the project, SED models for instance, is shown in the diagram as "OutputDataset" of the experiment. Each of the data products are modelled generically as an outputType ("OutputDataObjectType"s) and described in the protocol (Simulator). The SED models are accompanied by snapshots (an "OutputDataset") which are statistical values related to the respective SED models. This relation between the SED models and snapshots is embodied by the "SnapshotSedModel" (relationship) in the respective outputType.

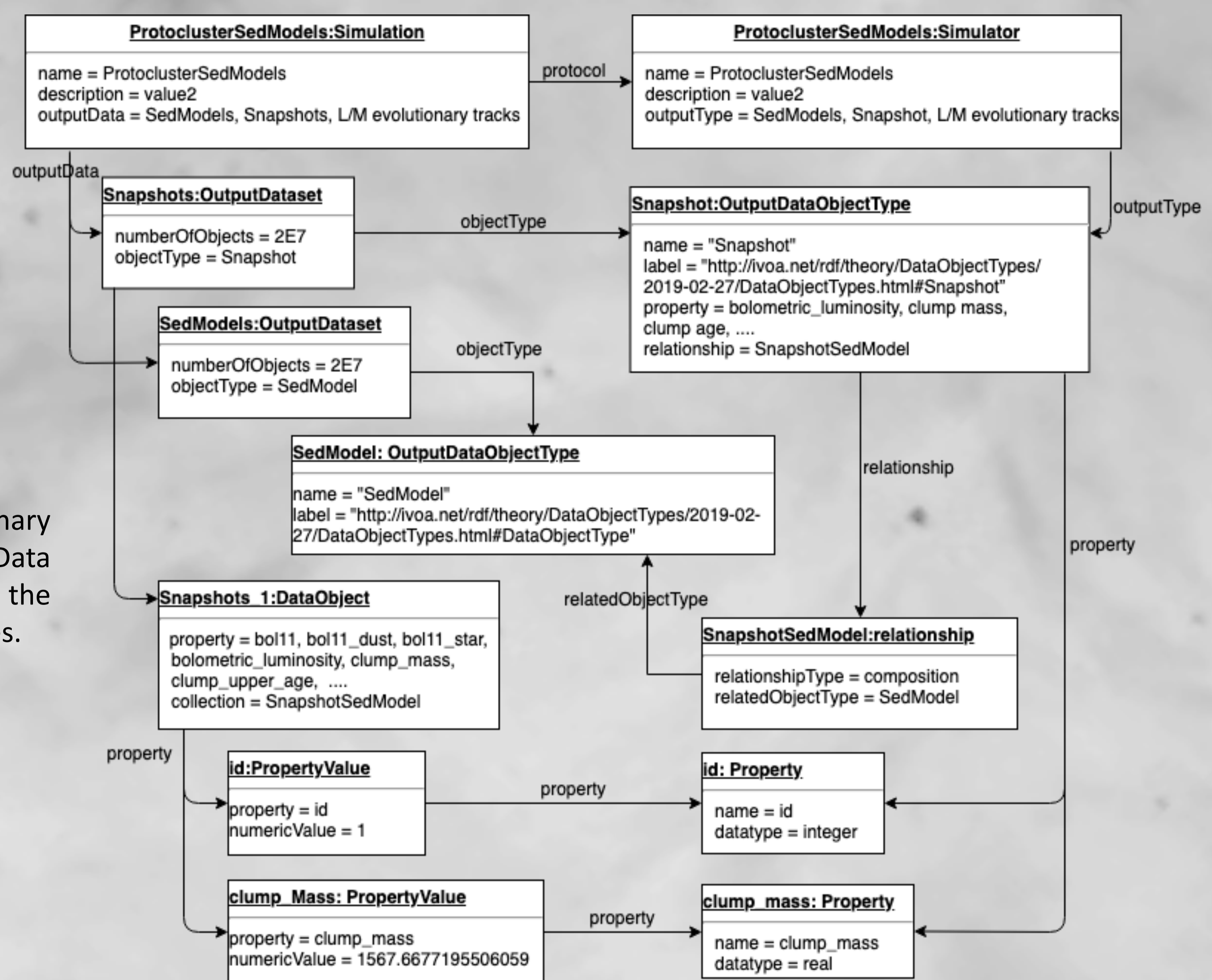
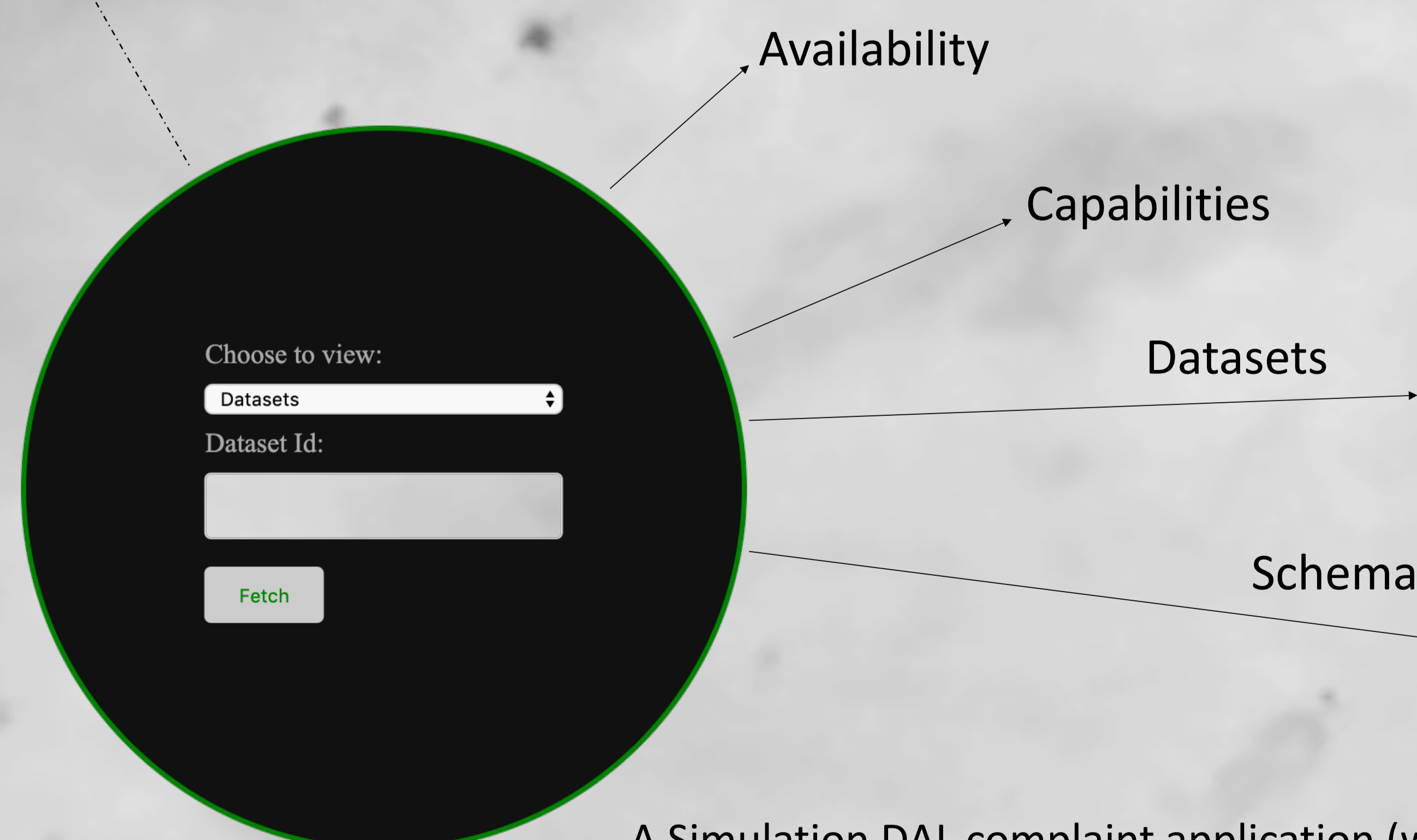


Figure below depicts the application, currently in its preliminary stages of implementation. For compliancy with SimDAL Data Access component, the service must expose the datasets of the simulation along with VOSI-availability and capabilities resources.



| Table: datasets | |
|-----------------|------------------------|
| ident | created |
| Snapshots | 2019-06-06 13:07:45+02 |
| SedModels | 2019-06-06 13:07:45+02 |

| Table: links | | |
|--------------|------------------------|---|
| dataset | link-rel | link-uri |
| Snapshots | datasets/schema | http://localhost/Ladmis/vlkb/SEDModels/stats/schema |
| Snapshots | datasets/cutouts | http://localhost/Ladmis/vlkb/SEDModels/stats/cutouts |
| Snapshots | datasets/async/cutouts | http://localhost/Ladmis/vlkb/SEDModels/stats/async/cutouts |

```

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xmlns:obj="http://www.ivoa.net/xml/SimDM/v1.0/object"
xmlns:p="http://www.ivoa.net/xml/SimDM/v1.0/resource/protocol"
xmlns:resource="http://www.ivoa.net/xml/SimDM/v1.0/resource" xmlns:xsi="http://www.w3.org/2001/XMLSchema-
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</property>
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</relationship>
</label>
http://ivoa.net/rdf/theory/DataObjectTypes/2019-02-27/DataObjectTypes.html#Snapshot
</p>
  
```

A Simulation DAL complaint application (work in progress...)

Future work is aimed towards developing client interface and services {cutouts}, {rawdata} ... to access the statistical data as well as the SED models. We also plan to extend this work to other simulations; particularly into the domain of cosmological simulations.

References:

Lemson et al. (2012), 'Simulation data model'. URL: <http://www.ivoa.net/documents/SimDM/20120503/html/SimDM.html>

David Languig on et al. (2017), 'Simulation Data Access Layer' URL: <http://www.ivoa.net/documents/SimDAL/index.html>

Background image makes use of data products from the Wide-field Infrared Survey Explorer, which is a joint project of the University of California, Los Angeles, and the Jet Propulsion Laboratory/California Institute of Technology, funded by the National Aeronautics and Space Administration.