VIRTUAL ASTRONOMICAL OBSERVATORY

UTYPEs

the art of moving objects around

Omar Laurino
SAO/VAO
UTYPEs Tiger Team

“Where is the science here?”

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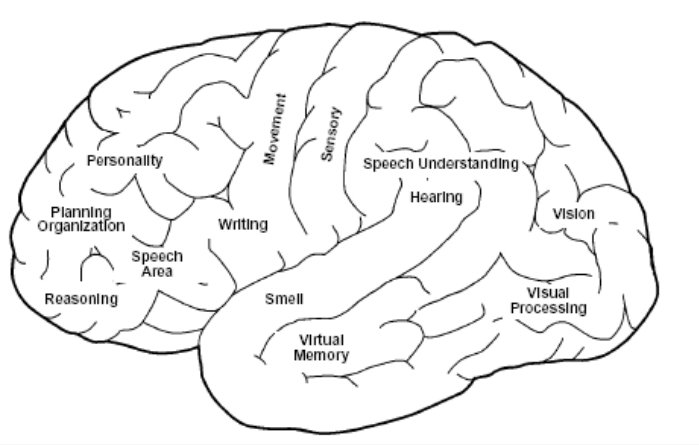
Where is the General Relativity Theory here?



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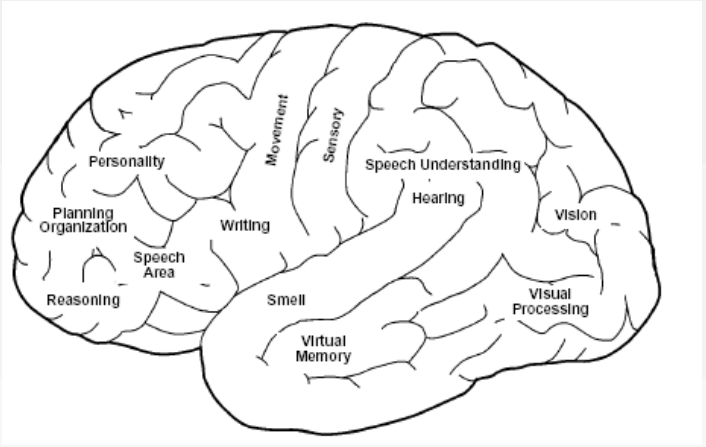
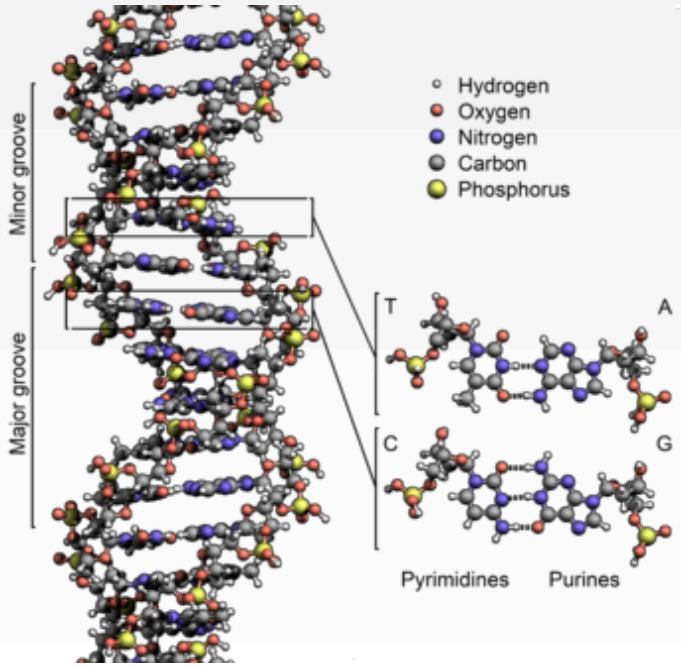
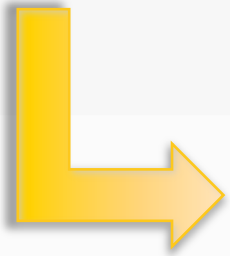
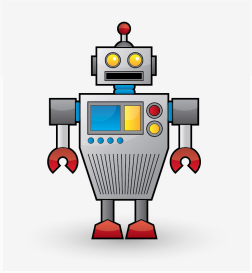


Or here?



A relocation robot





The Problem

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  - **Tag objects (and boxes?) with labels, so that a robot can (un)pack**

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- Some constraints:
  - You want to make sure that you can tell different clients' objects apart:
    - "This is Omar's mug"; "This is Jesus's mug"
  - You want to be able to query the inventory in the robot's memory:
    - "How many rooms are there in Pat's house?"
    - "Get the mug on the coffee table in Jesus's Living room"
  - You want to minimize your effort: the same "algorithm" must work with all clients. You don't want ad hoc solutions.
  - When the robots unpack, you want them to place objects exactly where they were.

The solutions

- Problem:
  - **Tag objects (and boxes?) with labels, so that a robot can (un)pack**

- Solution 1:

omar:Kitchen.Shelf.Mug

jesus:LivingRoom.CoffeeTable.Mug

…

The solutions

- Problem:
  - **Tag objects and boxes with labels, so that a robot can (un)pack**

- Solution 1:

omar:Kitchen.Shelf.Mug

jesus:LivingRoom.CoffeeTable.Mug

…

- Solution 2:

Type = pottery:Mug

Role = omar:Shelf.mug (in omar:Kitchen box)

Role = jesus:CoffeeTable.mug (in jesus:LivingRoom box)

…

Testing for Generality

Testing for generality

- Problem: **Ask a robot to find a mug (“pottery:Mug”) in Pat’s house**

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- Solution 1:

pat:DiningRoom.Table.Mug

- Solution 2:

Type = pottery:Mug

Role = pat:Table.redMug (in pat:DiningRoom box)

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It works w/ a LabelScanner and a formal Grammar, a Vocabulary, a Parser.

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- Solution 2:

Type = pottery:Mug

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It works with a LabelScanner and a string equality check.

Testing for generality

- Problem: **Ask a robot to find a mug (type="abc:def") in Pat's house**
- Solution 1:

wre:rt45wh.2wdf5t.prtg4

It works w/ a LabelScanner and a formal Grammar, a Vocabulary, a Parser.

- Solution 2:

Type = abc:def

Role = wre:2wdf5t.qazwsx (in wre:rt45wh box)

It works with a LabelScanner and a string equality check.

Let’s finally go back to Astronomy

Let's compare the two solutions

- Problem: **Find the SDSS.g magnitude:**

"path utypes"

```
<GROUP>
  <FIELDref utype="phot:Catalog.PhotometryPoint.Value" ref="refField1"/>
  <FIELDref utype="phot:Catalog.PhotometryPoint.Filter" ref="refGroup1"/>
 </GROUP>
```

"type&role utypes"

```
<GROUP utype="sdss+2mass:Catalog.sdssG">
    <PARAM utype="Instance.type" value="phot:PhotometryPoint"/>
    <FIELDref utype="phot:PhotometryPoint.value" ref="refField1"/>
    <GROUP utype="phot:PhotometryPoint.filter" ref="refGroup1"/>
</GROUP>
```

Still too abstract, right?
Let's see what happens in practice

Finding mugs, in practice

A Python library can read a VOTable according to the two specs:

>> votable = volib.read(“sdss_2mass_xmatch.vot”)

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Solution 1 ("path" utypes):

```
>> g_array = list()
>> for group in votable.get_groups(): // let's assume there are Groups
       filter = group.get_by_utype("phot:Catalog.PhotometryPoint.Filter")
       if filter.name == "sdssG": // let's assume this is standardized
           for row in votable.get_rows():
             g = PhotometryPoint()
             g.value = row.get_by_utype("phot:Catalog.PhotometryPoint.Value")
             g.error = row.get_by_utype("phot:Catalog.PhotometryPoint.Error")
             g_array.append(g)
```

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```

Solution 2 ("role+type" utypes **+ VO-DML + mapping spec**):

```
>> g_array = votable.sdss_2mass.catalog.sdss_g
```

Finding mugs, in practice

Get all photometry points in a file

>> votable = volib.read("sdss_2mass_xmatch.vot")

Solution 1 ("path" utypes):
You can't, unless you parse utypes (e.g. phot:~~Catalog.~~PhotometryPoint.*)

Solution 2 ("role+type" utypes **+ VO-DML + mapping spec**):
>> points = votable.get_objects("phot:PhotometryPoint")

Why VO-DML is the “smart” robot

This utype points to the “sdss_g” attribute of the “Catalog” type
Python: sdss_2mass.catalog.sdss_g

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<GROUP utype="sdss+2mass:Catalog.sdssG">
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This utype points to the “filter” attribute of the “PhotometryPoint” type
Python: sdss_2mass.catalog.sdss_g.filter

This utype points to the “value” attribute of the “PhotometryPoint” type
Python: sdss_2mass.catalog.sdss_g.value

UTYPEs are mere pointers

This utype points to the “sdss_g” attribute of the “Catalog” type
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The sdss_g attribute **is a** PhotometryPoint type

```
<GROUP utype="sdss+2mass:er$3qer$^sa">
    <PARAM utype="Instance.type" value="phot:04cg^5$sdrt"/>
    <FIELDref utype="phot:vf5$6&88*dsa@" ref="refField1"/>
    <GROUP utype="phot:axdf54rt^!wdrg987" ref="refGroup1"/>
</GROUP>
```

This utype points to the “filter” attribute of the “PhotometryPoint” type
Python: sdss_2mass.catalog.sdss_g.filter

This utype points to the “value” attribute of the “PhotometryPoint” type
Python: sdss_2mass.catalog.sdss_g.value

Meanwhile, in a Spectral Energy Distribution…

Sanity Check

- **Meanwhile, in a Spectral Energy Distribution…**

Solution 1 (“path” utypes)

```
<FIELD utype=“sed:Sed.PhotometryPoint.Value”/>
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Solution 2 (“type&role” utypes)

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<GROUP utype=“sed:Sed.photometryPoint”>
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```

Extract all photometry points with the python generic, not ad hoc, library:

“path utypes”

You can’t unless you parse the utypes

“type+role” utypes

```
>> points = votable.get_objects(“phot:PhotometryPoint”)
```

“I am concerned about backward compatibility”

Plenty of Room

Mappings not specified allow custom/legacy usage

- FIELDs.
- Standalone PARAMs.
- GROUPs with @utype of undeclared prefix.
- TABLE, RESOURCE

Transition

- No changes required in current stds, protocols.
- If Data Providers want to upgrade, they can **add** metadata, not change the current metadata.
- Services prototyped against WDs can simply **add** metadata.

New, complex Data Models can benefit

- Data nCubes and their projections/combinations: TimeSeries, SED, Spectral, Photometry

“Can we remove the boundaries between image, spectrum, SED, cube?”

We Must! The new UTYPEs proposal can help

- The needed bulding blocks are few

- Don’t reinvent the wheel:
  - spec:Segment.Char.SpectralAxis.Accuracy.StatErr
  - spec:Segment.Data.SpectralAxis.Accuracy.StatErr
  - spec:Segment.Char.FluxAxis.Accuracy.StatErr
  - char:SpectralAxis.Accuracy.StatErr
  - …on and on and on and on…
  - Why don’t we just put a char:Accuracy.StatErr in every box it is needed?

- If a Data Cube is described by the ImageDM, what is the Data Model describing a projection of the cube? What about Planetary science?

We Must! The new UTYPEs proposal can help

So, we **must** reuse Models consistently!

“Tools cannot do everything!!!!”

That's why we suggest a strict specification

- Right now clients do not know what to expect
- Thousands of UTYPEs and counting (often pointing to same concept)
- Where to look for a unit (ucd, value) string?
  - UTYPE.unit
  - FIELDref unit
  - FIELD unit
- How to refer to other objects?
- The UTYPEs proposal defines the mapping patterns

“I cannot represent STC using the new UTYPEs”

STC serialization

```
<GROUP utype=”vo-dml:Instance.root”>
   <PARAM utype="vo-dml:Instance.type" value="stc:AstroCoords"/>
   <PARAM utype="stc:AstroCoords.coord_system_id" value=”UTC-ICRS-TOPO” />
   <GROUP utype=”stc:AstroCoords.position2D”>
    <PARAM utype=”vo-dml:Instance.type” value=”stc:AstroCoords.Position2D”>
    <GROUP utype=”stc:Position2D.value2”>
      <PARAM utype="vo-dml:Instance.type" value="stc:Value2D"/>
      <FIELDref utype="stc:Value2.C1" ref="col1"/>
      <FIELDref utype="stc:Value2.C2" ref="col2"/>
    </GROUP>
   </GROUP>
</GROUP>

<AstroCoords coord_system_id=”UTC-ICRS-TOPO">
<Position2D unit="deg">
      <Value2 id="Center">
       <C1>148.88821</C1>
       <C2>69.06529</C2>
      </Value2>
</Position2D>
</AstroCoords>
```

“Back in 2009 I asked some questions about UTYPEs: I am glad to finally see a consistent answer to most of them, but do you spell it Utype, UTYPE, Utype, or utype?!”

Thank you!

"Let's not reinvent the wheel, please"