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Formation permanente sur l'Observatoire Virtuel.

Les outils VO à l'IMCCE, jeudi 22 mai 2014

Le format de la journée reprend celui des autres journées de la semaine :

1. Un cours sur l'outil (30 min - 1 heure)
2. Une séance de Travaux Dirigés, avec toutes les étapes décrites (2 heures)
3. Un projet, avec seulement la description des étapes à suivre (pour l'après midi)

To follow this lecture, you will need a web browser connected to internet, and a shell to launch scripts (e.g., bash, csh), Aladin, and TOPCAT.

Cours sur l'outil
Mots-clefs :

1. TOPCAT
2. SkyboT
3. Outils VO de l'IMCCE, à retrouver sur *http ://vo.imcce.fr.*

Exercice 0 : Prise en main de l'outil
Déterminer les heures de lever/coucher du Soleil pour la date d'aujourd'hui à Paris. Discussion avec les intervenants sur le rôle de chacun des paramètres.

Exercice 1 : SkyBoT (Sky Body Tracker)

We will first train with the Sky Body Tracker (SkyBoT) tool. SkyBoT can list all Solar System Objects (SSOs) present within a given field of view at a given epoch.

Alike all the services hosted at IMCCE on the VO Solar System Portal, (http ://vo.imcce.fr), SkyBoT requests can be submitted in different ways (URL, PhP, SOAP), and results can be provided in different format (votable, ascii, html).

Please refer to the online help for more details :

`http://vo.imcce.fr/webservices/skybot/?documentation`

1. Request SkyBoT from Aladin
1.1. Launch Aladin
1.2. Retrieve the POSSII image (DSS2-red) at coordinates (height/width of 15 arcminutes)

```
RA   03 22 33
DEC +12 58 48
```

As it can be seen, there are several trails that are present on the image. They correspond to moving objects, i.e., solar system objects.

1.3. In the Aladin Image Server (Ctrl-I), select SkyBoT in the list of servers (right column). There are 7 fields, that will be discussed hereafter : Target, Radius, Epoch, Observer location, Search For, Max. uncertainty, Display filter.

1.4. First, let's see the native output of such a request. Click on the submit button.
Aladin created a new layer, interpreting the VO Table sent by SkyBoT in response to your request. This request uses the coneSearch utility :

`http://vo.imcce.fr/webservices/skybot/?conesearch`

For each SSOs, its position, apparent motion, and name is displayed in a new layer by Aladin. The 4 fields required for this results were Target, Radius, Epoch, and Observer location :

- Target specify the center coordinates of the field of view, here the coordinates of the POSS image.
- Radius is the size of the field of view on sky.
- Epoch is the mid-observing time, which is of course critical in our case of *moving* targets.
- Finally, the observer location gives the summit of the cone used for the search, i.e., the position of the observer, here geocenter (code 500). This location is generally given as a 3 characters code, called IAU observatory code :
  `http://www.minorplanetcenter.net/iau/lists/ObsCodesF.html`

  If the observatory has no IAU code, you can simply enter its longitude and latitude (see as well hereafter)
- This last parameter is critical owing to the finite (and small) distance of solar system objects compared to the distant stars. Hence, two different places on Earth would observe the same SSO at different coordinates at the exact same time.
- Two other parameters restrict the cone search to categories of SSOs (asteroids only, asteroids and planets...), to objects with accurate ephemeris (with cuts on the maximum position uncertainty).
- The last parameter list the different quantities to be displayed (apparent motion, position uncertainty...).

1.5. As you surely saw, the predicted positions of the SSOs do not correspond to the trails. This is due to an incorrect datation of the photographic POSS plate. Change the epoch to 1991-10-06T09 :47 :13 (i.e., 10h before) and request SkyBoT.

The predicted positions of the SSOs now correspond to the trails.

2. Request SkyBoT from HTTP

Let's now try the same request using another interface. We will not review here the query form :

`http://vo.imcce.fr/webservices/skybot/?forms`

but we will review the http request

`http://vo.imcce.fr/webservices/skybot/conesearch?`

that allows an easy interface with any code. As you can see in the online help

`http://vo.imcce.fr/webservices/skybot/?conesearch`

the syntax is straightforward, with each parameter provided in the url following :

`-parameter1=value1&-parameter1=value2&...`

The results are then displayed in the browser. A simple way to interface the service with any of your code is to dump the result locally, e.g., using curl or wget commands :

```
curl "request" or wget "request"
```

Question : Construct the request url corresponding to the latest result you had in Aladin hereabove

The native output of our services are VO Table. You can specify different output with the mime parameter, e.g., `mime=text` to output an ascii file.

Exercice 2 : Miriade : Solar System Object Ephemeris Generator

Miriade is the core of all ephemeris generated at IMCCE. It computes and provide general position and orientation ephemeris with the `ephemcc` and `ephemph` methods. Second order information such as rise, transit and set times of target can be requested (`rts` method), and visibility graphics produced (`ViSION`).

A typical usage of our services would include using `ViSION` to find the best night to observe a given set of objects. Position with a fine time step would then be computed with `ephemcc`. The images acquired being then compared with SkyBoT & VizieR star catalogs.

For objects with known spin axis and shape, `ephemph` describe their orientation on the plane of the sky at any epoch.

We will concentrate here on the `ephemcc` method, using the http request. For the exercise, it may be easier to use the html output to examine the results, while many "real-life" usages would use the votable or ascii outputs and dump the results for local codes.

For all this exercise, we highly recommend to seek information on the discussed parameters in the online documentation : `http://vo.imcce.fr/webservices/miriade/?ephemcc`

As a good practice, please always fill the `from` parameter (e.g., `&-from=VOschool2014`) for our statistics purpose. If you encounter an issue with our services, this flag will also help us in tracking the request that failed.

2.1. Where is Saturn ?
Find present coordinates of Saturn. Although SkyBoT may be more appropriate for such a request, it is the easiest way we can construct with `ephemcc` Only two or three parameters should be necessary : `name`, `type`, and `ep`.

Note that Miriade recalls us the basic settings we implicitly used when making this simple request. The coordinates are given in the equatorial astrometric J2000 reference frame, from the geocenter.
If you are not familiar with these definitions, see for instance (in French) : `https://media4.obspm.fr/public/AMC`

2.2 Where will be Saturn

Now predict the coordinates of Saturn every hour for the next two days.

2.3 What time is it ?

The oldest clocks were all based on the apparent position of the Sun in the sky : the sundials. If you are familiar with them, you should know there is a difference between the time indicated by the Sun and that of our clocks (based on atomic vibrations) due to the non-circular orbit of the Earth and the tilt between the ecliptic plane and Earth equator.

We will visualize this using TopCat. You will there dump the results locally to open them subsequently with TopCat.

Request the position of the Sun for a whole year, at a fix time every day, starting from January the first (e.g., at 2 pm) as seen from Paris. We want here the coordinates of the Sun in a local reference frame (Azimuth/Elevation or hour angle/elevation).

2.4. The situation in 3-D

We have seen how to generate the coordinates of objects on the plane of the sky. Miriade natively computes the cartesian coordinates in 3-D in the solar system and then converts them in local spherical reference frames. Miriade can therefore directly export the 3-D coordinates.

Compute and display the close encounter between asteroid (99942) Apophis and the Earth in April 2029. For the same epochs, display (on the same graph) the position of the Moon.

2.5. From a certain point of view

Until now, we mainly request ephemeris from the geocenter. To obtain accurate ephemeris, you will however need to specify your exact location on Eart. Objects in the solar system are much closer than the background stars, and parallaxe effects can be tremendous.

What were the coordinates of asteroid Duende (aka 2012 DA14) during its close encouter with Earth (take 2013, February the 15th, at 11pm) as seen from two observatories in Europe (e.g., Paris and La Palma) ?

2.6. Observers and reference plane

Ephemeris deals with dynamics. Because everything moves fast in the solar system (compared to most astrophysical objects), the choice of the center of the reference frame can have a strong impact. We will illustrate this here, together with the choice of reference frame itself.

Compare the cartesian coordinates of Uranus in ecliptic and equatorial reference frame, as seen from the Sun and the Earth. You can use the 3-D plot utility of TopCaT.

Exercice 3 : Other services and Interoperability

3.1. The SkyBoT service is efficient because the ephemeris of all the solar system objects are pre-computed weekly, for the period 1899-2050. See the Status method for more details : `http://vo.imcce.fr/webservices/skybot/?status`.

The SkyBoT 3-D service is still under development, but you can already retrieve any epoch present in SkyBoT database, using the getAsterFile method :
`http://vo.imcce.fr/webservices/skybot3d/?getAsterFile`

Dump locally the current position on the plane the sky of all near-Earth asteroids using this service. We will manipulate the data in next section.

3.2. Interoperability
We can now open the file containing the NEAs we generated above with Topcat. Such manipulation can be useful to display the histogram of their apparent magnitude for instance.

Open Aladin and charge DSS (or any of the available all-sky colored catalog).

In TopCat, select the NEAs table and broadcast it to Aladin. You should see a large band of the sky covered with all the known NEAs (10,000). This layer is similar to the result of a SkyBoT request (see exercice I).

3.3. ViSION
When preparing proposals for observing time, it is always necessary to find the optimum date given a target list. Later, when preparing the night of observation, the relative position of the objects on the celestial sphere, their respective time of transit.. is of great importance.

The ViSION method has been designed for that purpose, from a list of target, a location on Earth, and a specified time span, the visibility of the targets is computed and displayed based on a series of threshold (e.g., elevation, magnitude).

Use ViSION query form to find the planets observable tonight :
`http://vo.imcce.fr/webservices/miriade/?forms`
Search now a better epoch for the rest of the year to see several planet during the same night (use a time step of 2 weeks approximately).

Exercice 4 : Astéroïdes et STILTS

1. Représenter l'orbite de Apophis :

1.1. dans le système solaire

1.2. dans un référentiel centré sur la Terre et dont le premier axe pointe vers le Soleil. *cette étape suppose disposer au préléable d'une éphéméride de la Terre. La représentation en repère tournant peut s'appuyer sur des manipulations SHELL.*

2. Représenter les trajectoires dans TopCaT.

3. Avec STILTS, transformer les éphémérides ASCII en Votable.

Projet : préparation d'une nuit d'observation

On va reproduire la démarche de l'article :
`http://adsabs.harvard.edu/abs/2012A%26A...544A.137C`

qui utilise l'instrument NTT. C'est télescope de 3.6m qui a donc la capacité d'atteindre la magnitude 22.
Voir : `http://www.eso.org/sci/facilities/lasilla/telescopes/ntt/overview.html`

1. On souhaite observer N objets de la famille d'Haumea, qui sont indiqués dans l'article. La période d'observation se situe à la mi février 2010.

Trouver les meilleurs moments d'observation des astéroïdes au cours de la nuit, en utilisant ViSION depuis le site ESO de La Silla. Remarquer les petites différences des conditions d'observation. Vérifier l'absence de Lune.

2. Une fois la bonne période trouvée pour chacun des astéroïdes, on a besoin d'éphémérides précises pour pointer les objets. Utiliser l'outil miriade pour avoir accès à ces éphémérides (en boucle ou pour toutes les cibles à la fois).

3. A partir des images .fits fournies, identifier les astéroïdes dans les champs. Il faudra pour cela :

- visualiser les images dans Aladin
- charger des catalogues astrométriques : UCAC4, 2MASS, USNO-B1 par exemple
- utiliser SkyBoT

L'analyse de chaque image fera apparaître des décalages de l'ordre d'une dizaine de secondes d'arc entre les sources et la position correspondante affichée par SkyBoT, due en bonne partie à la calibration astrométrique.