SORA

Stellar Occultation Reduction and Analysis

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About us

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OUR TEAM
ERC LUCKYSTAR

IN COLLABORATION WITH MANY OF YOU!

CHEOPS SPACE TELESCOPE

Morgado et al., 2022, A&A

BRUNO SICARDY

ROBERTO VIEIRA-MARTINS

JOSÉ-LUIS ORTIZ

AND MANY MORE!

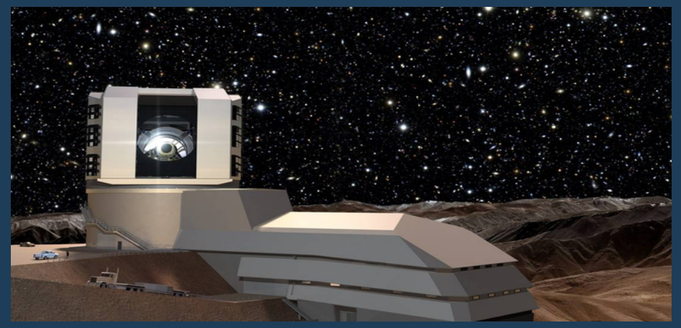
MOTIVATION

GAIA CATALOG

With the release of the Gaia catalog, the position of the stars is now very accurate. The Gaia EDR3 has positions for more than 1.8 billion sources with uncertainties below 1 mas (Mag. G < 21)

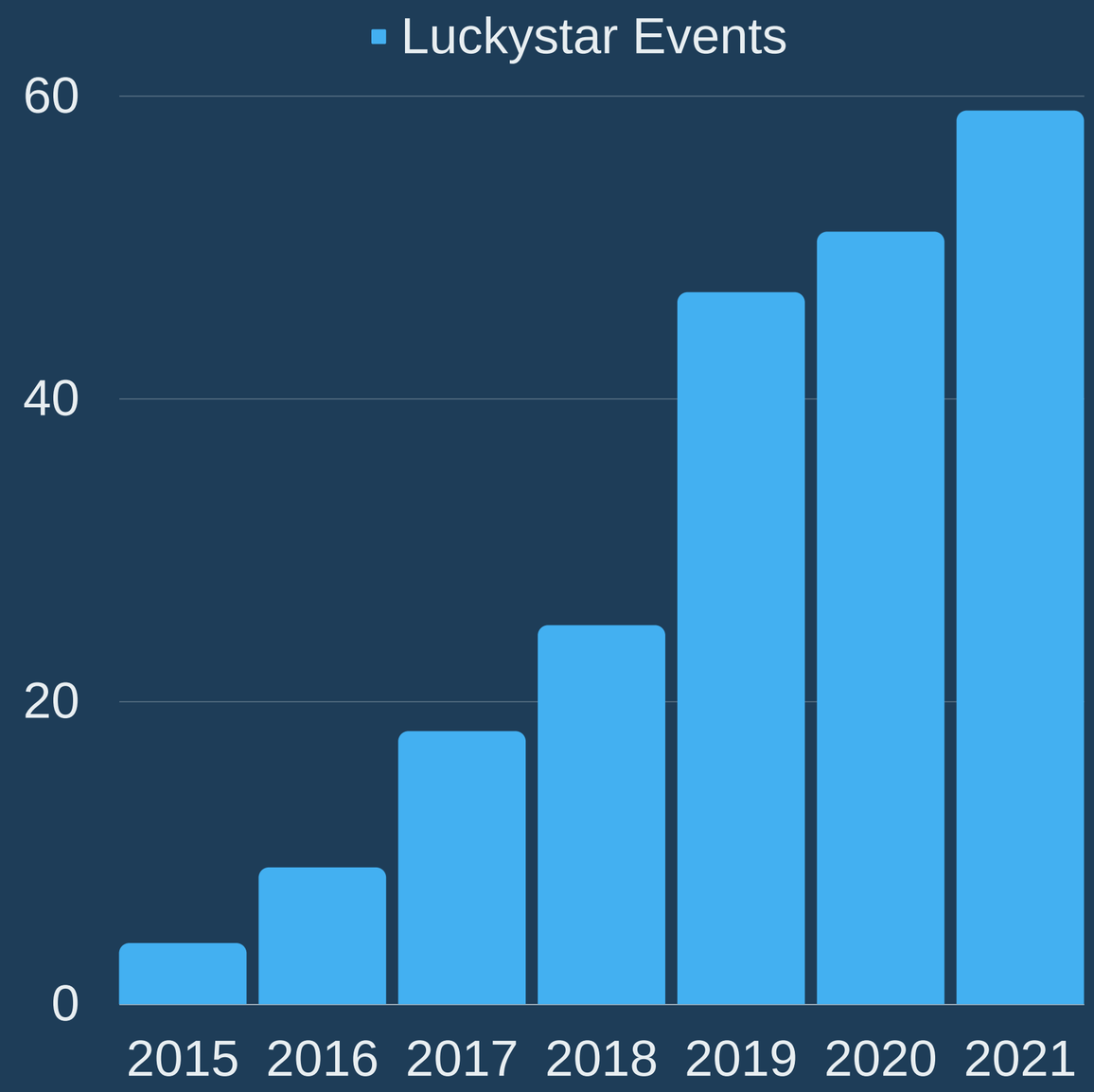
IMPROVED ORBITS

Previous stellar occultation combined with the effort to obtain precise astrometry of the occulting objects allows more accurate predictions, resulting in a larger number of detections and chords.



LSST PROSPECTS

Legacy Survey of Space and Time (LSST) at the Vera C. Rubin Observatory will provide positions of Solar System bodies and an unprecedented number of discoveries.



Big Data Era!

Increase of events over the years

A more significant number of events, combined with many chords, highlights the need for an efficient and as automated as possible toolkit to work with these data sets.

Basic Principles

The user can create their own pipeline.

- A Python library with various functionalities and tools to reduce and analyze Stellar Occultation data.
- Modern, faster, more efficient...
- Access to online databases (Gaia, JPL Horizons, VizieR, etc.).
- Many levels of automation, from manual to fully automated.
- The library is separated into modules.

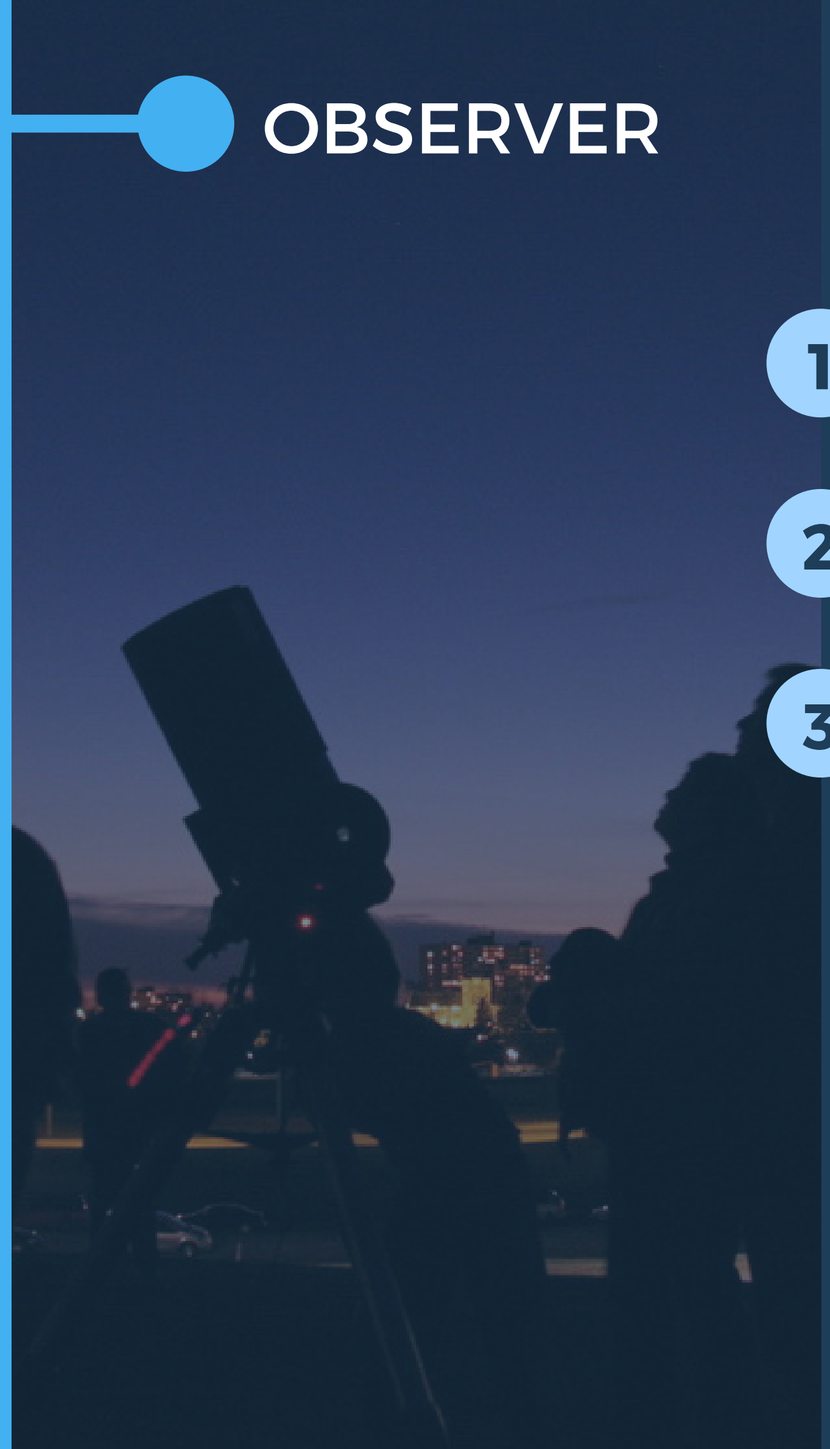
BODY

1. Querry objects parameters from JPL SBDB
2. Read and compute object ephemeris
   - 2.1 Querry from JPL/Horizons
   - 2.2 Compute from BSP files
   - 2.3 Compute from an ASCII file

STAR

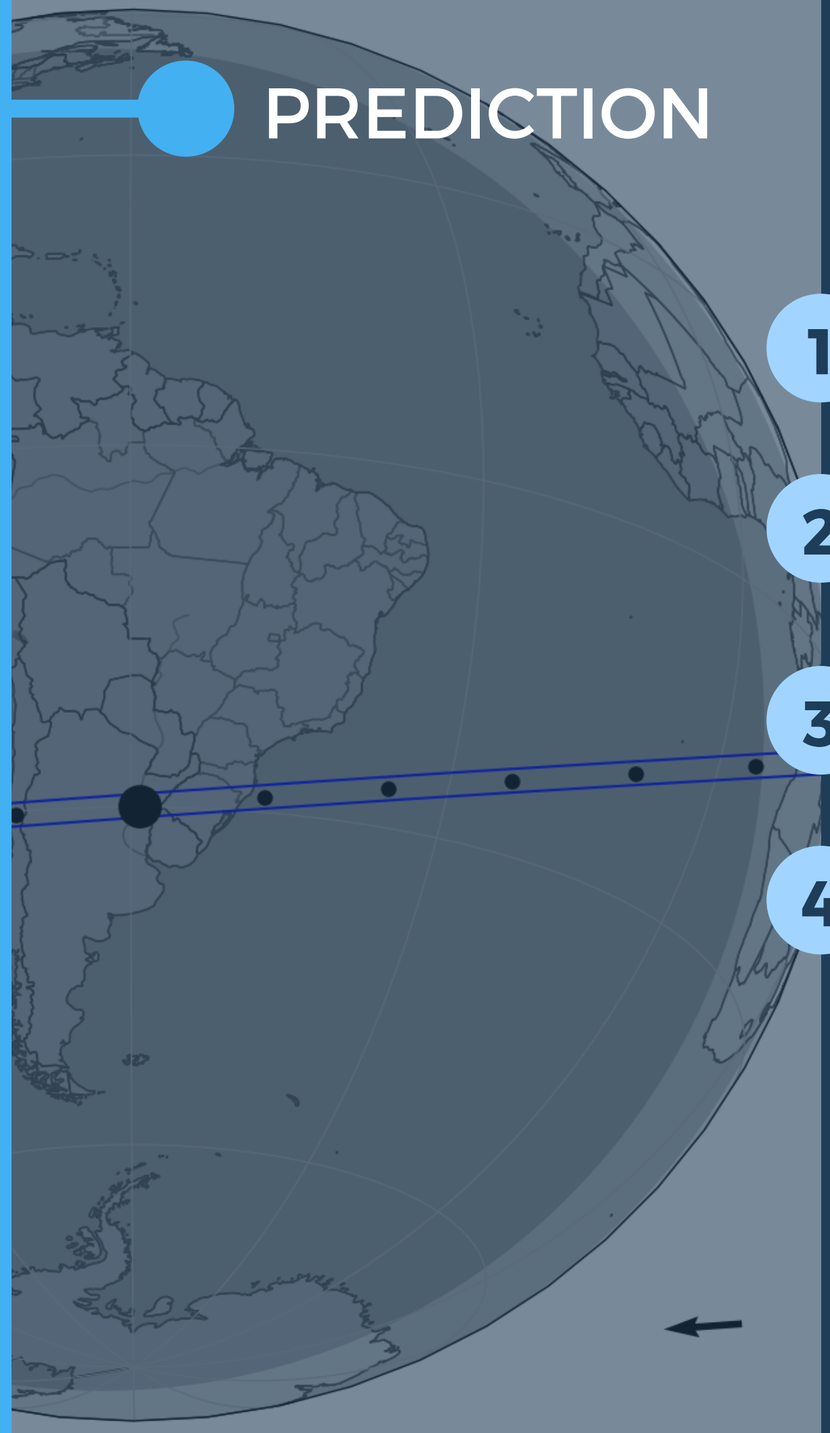
1. Querry star parameters from catalogs
2. Propagate the stellar position to the date
3. Read and compute stellar diameter
   - 3.1 Read from Gaia DR2
   - 3.2 Compute based on Kervella et al. (2004)
   - 3.3 Compute based on van Belle (1999)

OBSERVER

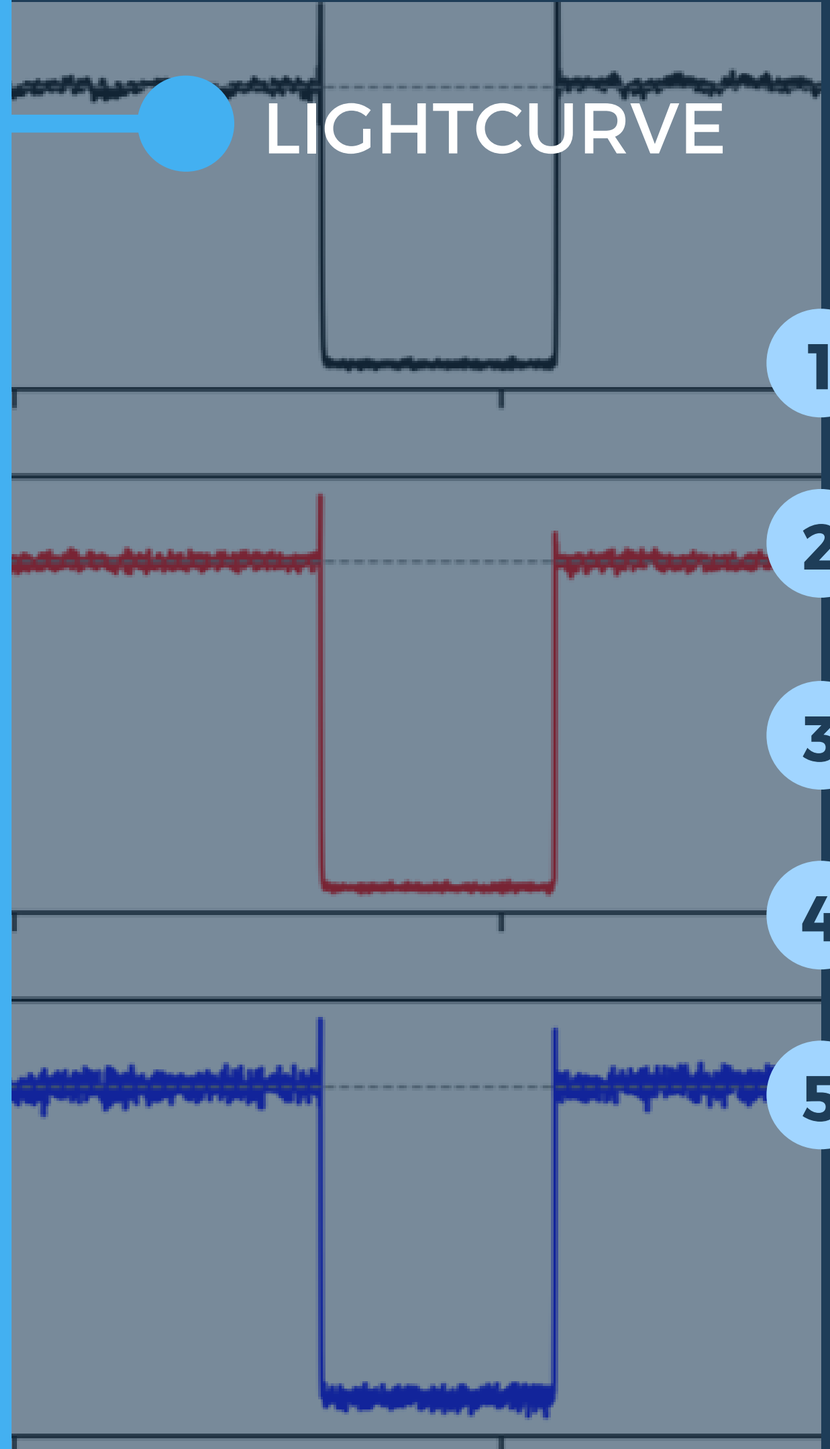


1. Querry observers location from MPC
2. Compute Latitude, Longitude, and Height
3. We can add a Spacecraft as an observer

PREDICTION



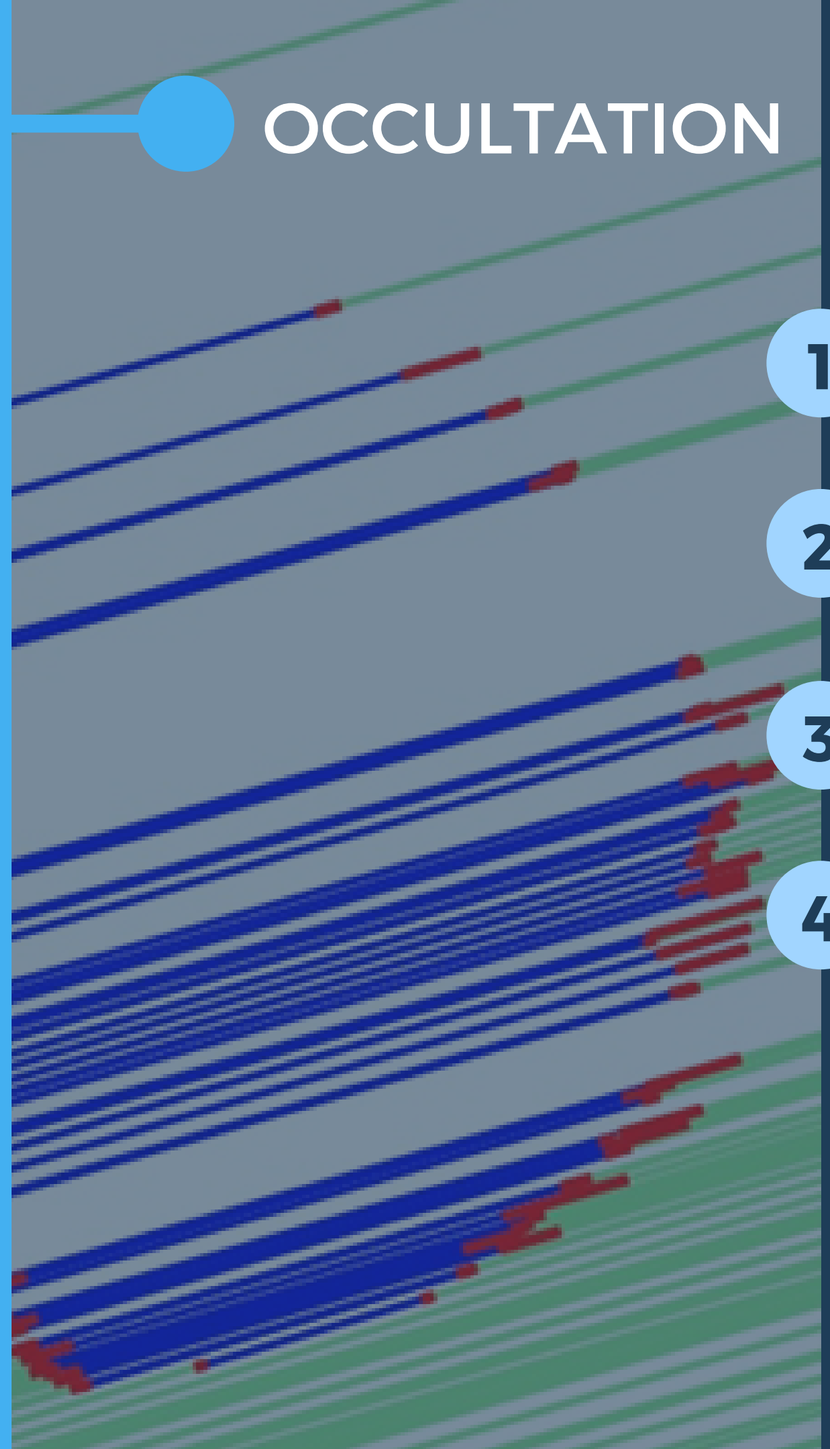
1. Predict stellar occultations
2. Organize the information in Dataframes
3. Create occultation maps
4. For observers on Earth or Spacecraft



LIGHTCURVE

1. Read the light curve from ASCII files
2. Detect a stellar occultation
3. Normalise the light curve
4. Model occultation light curves
5. Fit the immersion and emersion times

OCCULTATION



1. Combine all the other modules
2. Project the chords on the tangent plane
3. Fit a circular or elliptical shape
4. Calculate the positions and albedo

MAJOR CAPABILITIES

1

Predicting Stellar Occultations

It can predict stellar occultations for a single ground-based observer, the geocentre, and even space telescopes or probes.

2

Light Curve Analysis

After the photometry, SORA can be used to normalize the light curve, detect events and determine the dis- and re-appearance times.

3

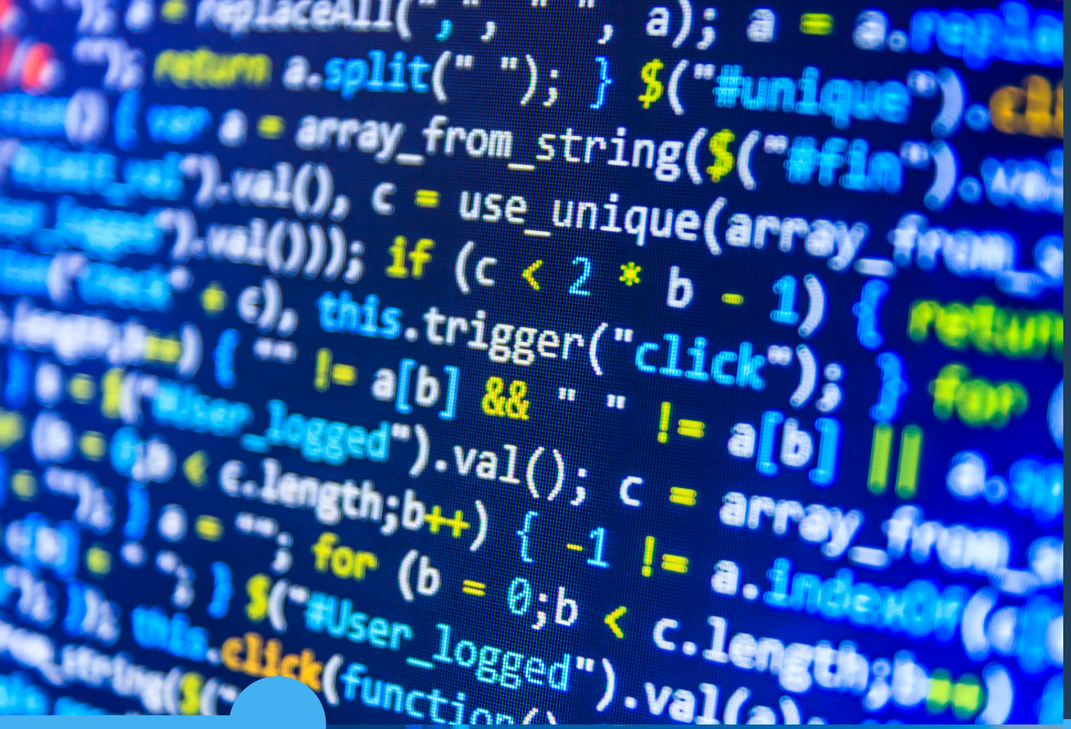
Fitting the 2D size and shape

Assuming a circular or elliptical shape, SORA fits the chords extremities and determines the occulting object's 2D apparent size and shape.

4

And more...

As an open-source code, functions on SORA can be used as a first step for other analysis, for instance, searching for material around objects.



Open Source

All the codes are freely available at GitHub (*https://github.com/riogroup/SORA*) and it can be installed using <*pip install sora-astro*>

Open Development

We welcome anyone that can contribute with new ideas, corrections, applications, and the development of new tools.

Our Helpdesk is on

SLACK

THERE YOU CAN ASK QUESTIONS,
PARTICIPATE IN SCIENCE DISCUSSIONS,
SUGGEST NEW FUNCTIONALITIES, ETC

The link will be provided in the Zoom chat, you can also find it in the "About us" page at
https://sora.readthedocs.io/

SORA

Documentation

https://sora.readthedocs.io/.

SORA Documentation

There you will find how to install how package.

Also, Jupyter-notebooks with examples and "Getting started" guides.

That was SORA v0.2.1

WHATS IS NEXT?

IN PRODUCTION

GAIA DR3 AND CATALOGS

Now the user will be able to use gaia DR3 and even custom catalogs to get the positions of the stars.

3D SHAPE TO FIT THE CHORDS

Comparing previously determined 3D shapes with the occultation chords.

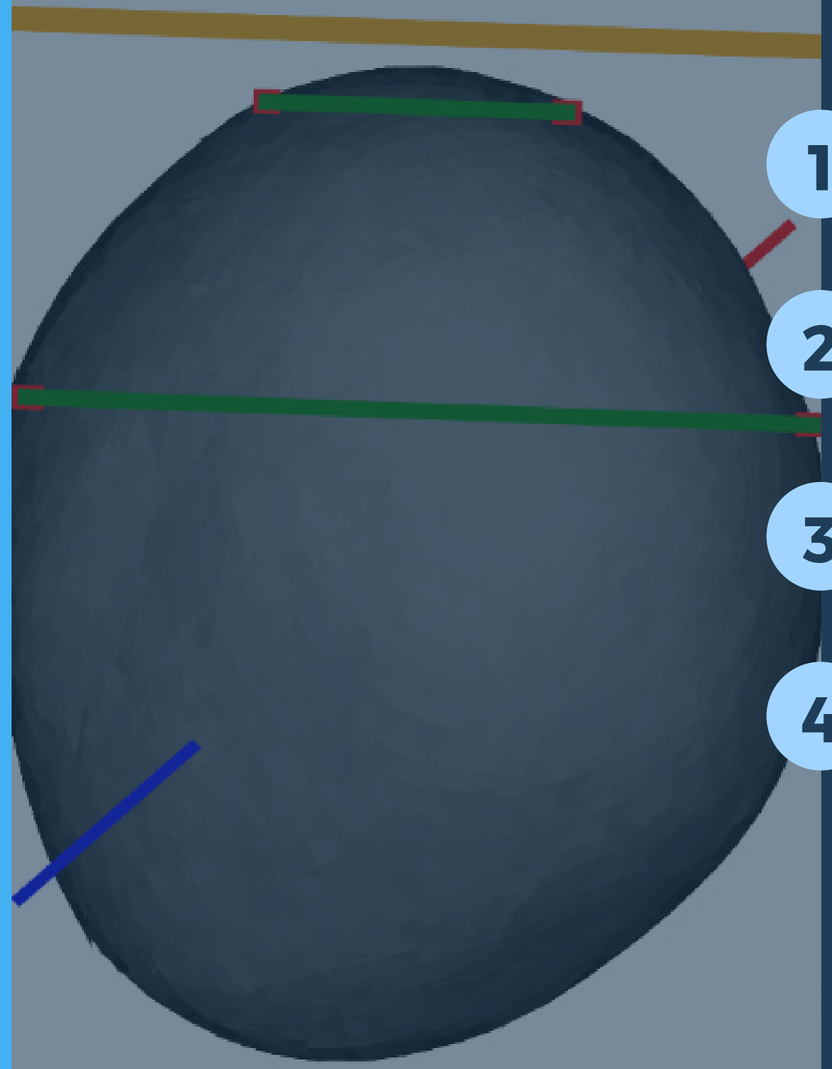
ROTATIONAL ELEMENTS

Using the rotational elements of bodies to predict the limb that will be observed.

IMPROVED FITTING METHODS

Include new and more efficient methods to determine the parameters and their uncertainties.

3D MODEL



1. Project 3D shapes on the tangent plane
2. Determine the limb of the figure
3. Fittting the central positions and scale
4. TO BE DEVELOP
   - 4.1 Fit the pole orientation

That was SORA v0.3

SOON IT WILL BE PUBLICLY AVAILABLE

TO BE DEVELOPED

FITTING MULTIPLE OCCULTATIONS

Statistical methods that will combine multiple occultations data, in order to obtain the best fit.

ANALYSIS OF ATMOSPHERES

Add in the SORA library functions and methods to deal with occultations by bodies with atmospheres.

SEARCH FOR MATERIAL

Even though this has been used already, we need to organize and optimize this feature.

SECONDARY EVENTS

Modify our methods to better deal with secondary events, such as double stars, objects satellites, etc.

SORA is a python package,

BUT WE ARE PREPARING SOMETHING ELSE

WITH FUNDS FROM HEISING-SIMON FOUNDATION

Occultation Interface

We are aware that any SORA's user needs some python skills.

So, we are starting to develop a Interface that will be available to the community in the future.

HEISING-SIMONS FOUNDATION

Thanks!

Documentation

https://sora.readthedocs.io/.

GitHub

https://github.com/riogroup/SORA

Scientific Publication

Gomes-Júnior et al., 2021, MNRAS