NumFOCUS Small Development Grants poliastro's proposal

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Abstract

Third round for NumFOCUS Small Development Grant is open till October 19, 2020. During this period, sponsored or affilliated organizations might apply in order to benefit from stippends which can be up to 5000$. *Proposed work must be achieved within 2021 year and money can be used for code and documentation improvements, workshops or other kind of activities which promote or enhance open-source project. This report presents a collection of ideas, tasks and new implementations for the poliastro project in order to apply for this last round of NumFOCUS sustainability program.*

1. Jorge

The NumFOCUS project is an organization who's mission is to promote open practices in research, data and scientific computing by providing economical support to open-source organizations. This financial help is partially done trough its sustainability programs. One of the programs, the **small development grants**, calls for proposals three times a year. In particular, **last round deadline proposal is October 19, 2020.**

It is possible for poliastro to apply for this third round. Therefore, a project idea needs to be presented together with several objectives to achieve if finally selected. Each proposal can obtain **up to** 5000$. This money can be used for **code and documentation development**, website maintenance, workshops and others. **Only condition is proposed tasks to be completed before 2021 year.**

Any person, no matter its nationality or role (student, postdoc...) can apply for the proposal once selected.

2. Project ideas for poliastro project during third round

The poliastro project is a **pure Python library focused in orbital mechanics computations** by providing a simple but powerful API. It has **successfully participated in other open-source programs** such us Google Summer of Code from which new and powerful implementations were merged into main source code.

In the following subsections, several ideas are presented as proposals for the small development grants program. Some of them try to continue the actual line of implementations of the project while other open new ones.

2.1. Extending Earth capabilities

At the moment, the project is focused on extending **Earth capabilities** due to the **interest increase** in small satellites and missions which take place in **orbits around the planet**. As a continuity of the GSoC'20 edition, the following features could be developed and included within future version of the software:

- Extend EarthSatellite attribute and methods: specific maneuvers, minimum altitude variation orbits, rise and set times, close approach analysis...
- Enable poliastro to generate internal orbit objects from TLE. New specific propagators such us SGP4 are required for this task.
- Include more gravitational and atmospheric ones.
- Documentation usage on EarthSatellite and tutorials on its usage.

This proposal would lead to feasible amount of work during the program. It might open new development branches within the project and attract more users.

2.2. Validation and testing

Many of the **unit tests used by poliastro assume expected results found in literature**. Although most of those are easy to validate, **some other routines might be too complex to be found in introductory academical books or manuals**, imposing the need of **alternative testing solutions**. Different astrodynamics and orbital mechanics softwares are available in the market but not all of them are open-source and script based. Among those, three possible options arise: Orekit, GMAT and AGI-STK.

Both GMAT and STK show a similar custom script syntax while **Orekit recently introduced a Python** wrapper. This API can be used to imitate actual poliastro's Orbit objects and test, for example, three-dimensional two-body maneuvers. Only disadvantage is that Orekit software uses Java as its main programming language being, therefore, not a pure Python software.

2.3. Three-body problem and N-body simulations

At the moment, poliastro does not have any kind of n-body simulator. Although a threebody/ module exists, it only contains numerical functions focused on patched conics and Lagrange points. This proposal would increase the amount of features related with N-body simulations, and in particular with the three-body problem. The following tasks might become a good starting point:

- Development of N-body integrator.
- Particular solutions, restricted three-body problem.
- Addition of documentation examples.

3. Proposals comparison and conclusion

Among all the different proposals depicted before, the **Extending Earth capabilities** would be the most interesting one at the moment for the poliastro project. Although the others provide new research and development branches, they require to be implemented from scratch. It becomes more interesting to **keep working on the new EarthSatellite object, increasing its usage by extending its attributes and methods**. This, as said before, may lead to an **increase of project users and its applications to real world problems.**