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# Online Neutron Transport Problem Solver Tool

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## 1. Introduction

During the last 50 years, different numerical methods have been implemented to solve the neutron transport equation in the discrete ordinate approximation for both, fixed-source and eigenvalue problems [1]. Several Graphic User Interfaces have been created and documented to bring a user-friendly environment to perform these tasks for academic and industrial purposes. However, there are some well-documented limitations related to Desktop Applications. They are not portable or fixed to one operating system, both the program itself and the files it produces are stored on hard drives, they have to be installed on computers and have to manually updated.

In this work, we present an alternative based on an online neutron transport problem solver tool called Neutron Transport Simulator (NTS). The web application is oriented to bring a simple and easy-to use online graphic user interface with some well-known numerical scheme implemented to solve several neutron transport problems. In our first release, we are concentrated on solving two-dimensional fixed source monoenergetic problems with isotropic scattering based on the discrete-ordinates neutron transport equation. The available numerical methods are: Diamond Difference [2], Step [2], Linear Discontinuous [3], and Response Matrix – Constant Nodal [4] methods.

The web application is available on the internet without any hard drive space required nor the need to wait for the download and installation to be completed. It is not reliant on the hardware and system specifications to run since the components that are responsible for the app functionality are on the server and it does not depend on the operating system the user is launching the application from. Also, it is a responsive platform-independent and can be used on desktop/laptop, tablet or mobile devices.

## 2. Web-based Neutron Transport Simulator

NTS is a database-driven web application implemented using Django as a high-level Python web framework and deployed on Heroku server platform. The data is stored in a database and managed by Heroku Postgres as a service based on PostgreSQL. The client-side was designed using HTML5, CSS3 and JavaScript.

To use the application, a registered account is required allowing to save any task and access other features. The structure of the web application is showed in Fig. 1. Most of the work is done on the client-side where data input is compiled together with some settings required to the calculation process. The calculations are performed via Application Programming Interface (API), where users sent a request to the server and wait for the results. The numerical methods are implemented and compiled in C based on a 128-bit arithmetic precision, and each executable file is called on the server-side where the output data is saved on the database and then sent to the client-side for post processing. Each executable file has been validated and tested on several neutron transport problems reported in the literature [4].

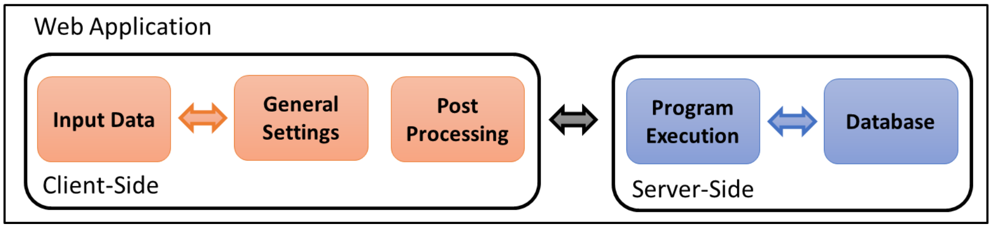



Figure 1: Web application structure and organization.

### 3. Results and Discussion

In this section, a model problem proposed by Dominguez et. al., (2010) is solved in order to show some of the web application features. The geometry configuration and nuclear data are displayed on Figs. 2 and 3, respectively.

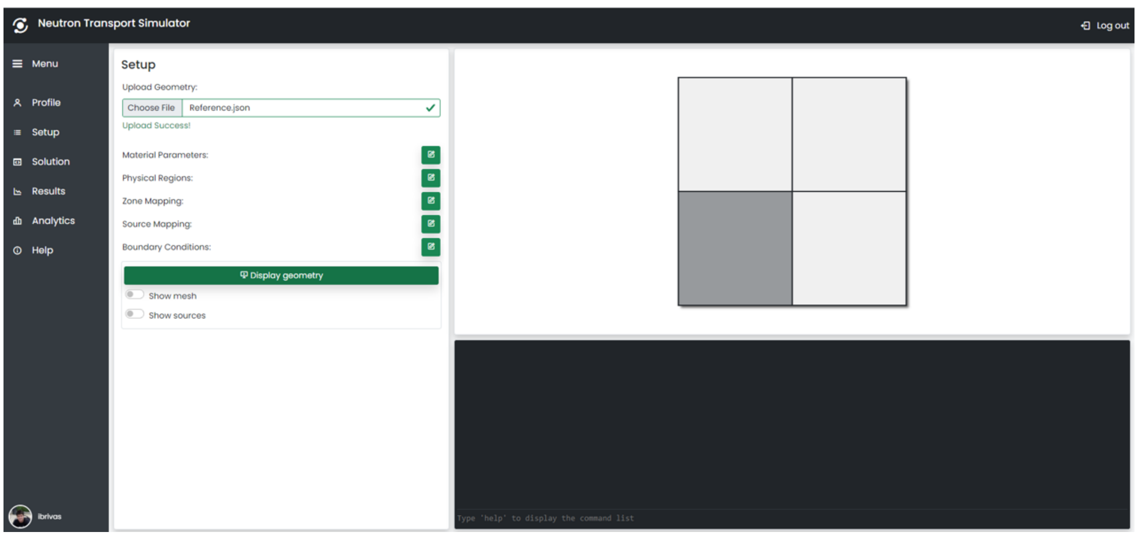



Figure 2: Graphic user interface and geometry of the model problem.

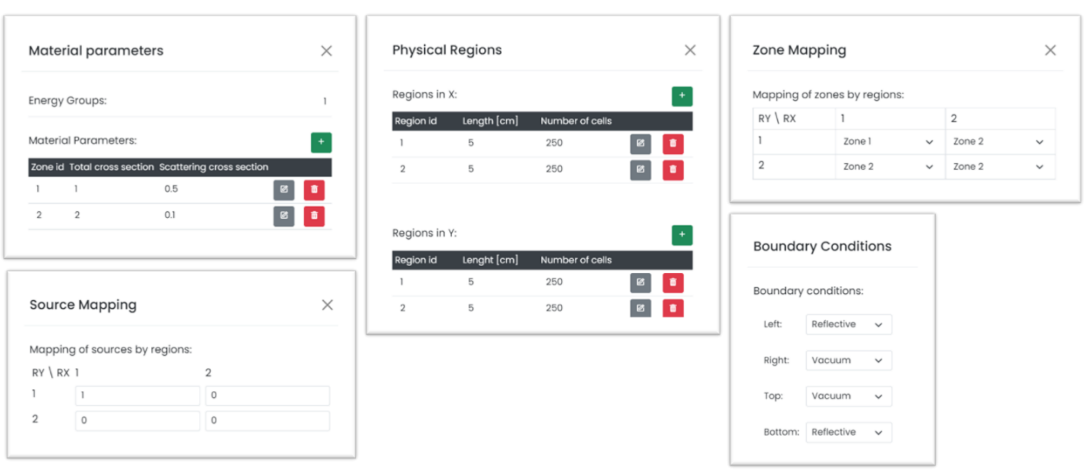



Figure 3: Material parameters, region specifications, zone and source distribution, and boundary conditions

of the model problem.

The discrete-ordinates directions and the numerical methods available for calculations are showed in Fig. 4. In the solution settings, users can change the quadrature order and the stopping criterion used in the calculations. In addition, there is a list of the numerical scheme available to use and an option to save the results in the database after calculations are done. Once the computation is completed, a notification email is sent to the user inbox and the numerical results can be found in the profile section where it can be loaded.

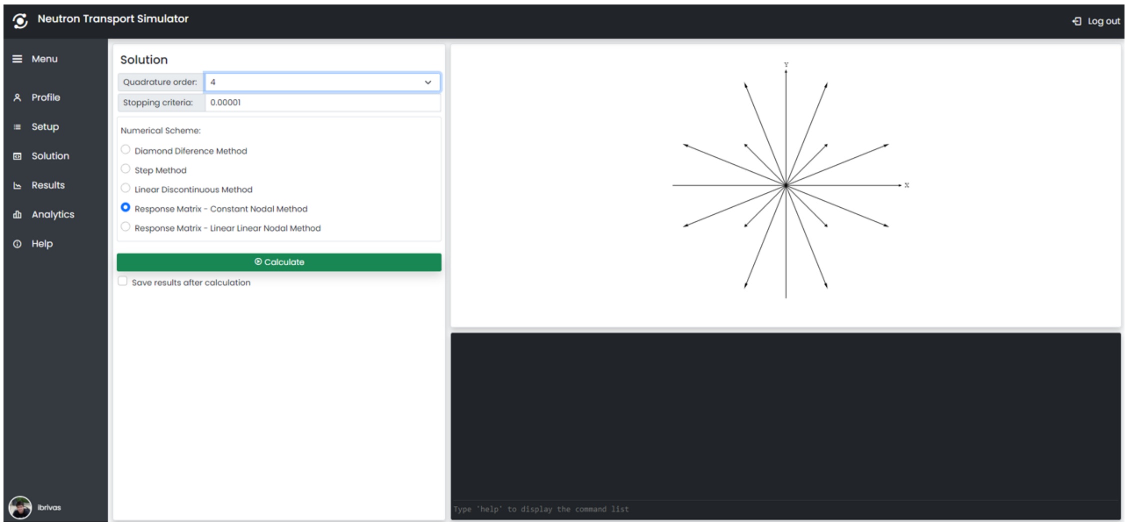



Figure 4: Solution settings for the model problem solution.

Finally, the results section and report table are presented in Figs. 5 and 6, respectively. The application came with the capability of download the numerical results as a JSON file. This file can be uploaded any time the user wants to visualize their results and make some modifications and/or new calculations.

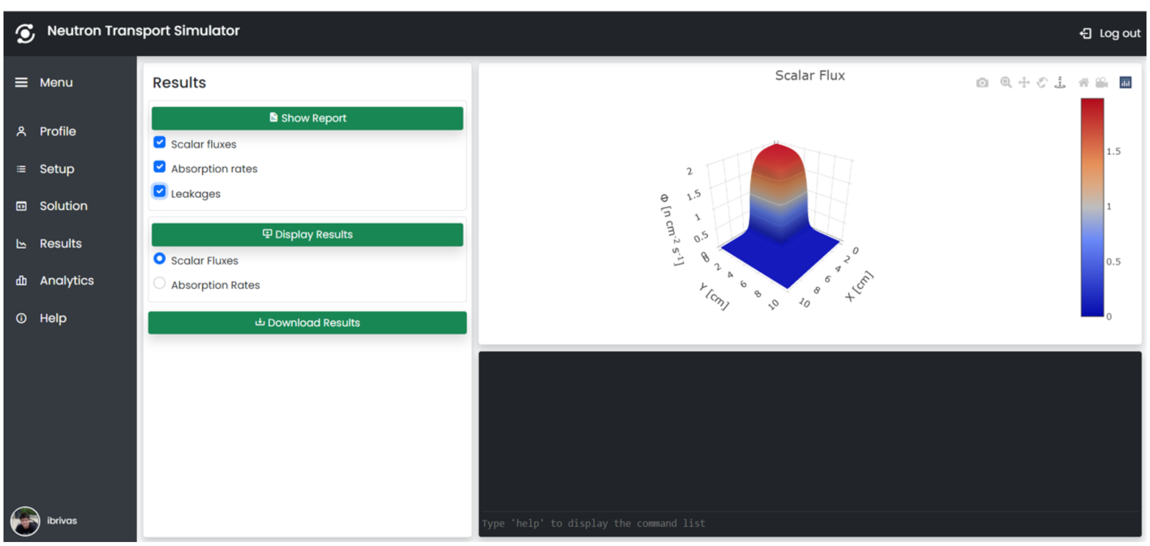
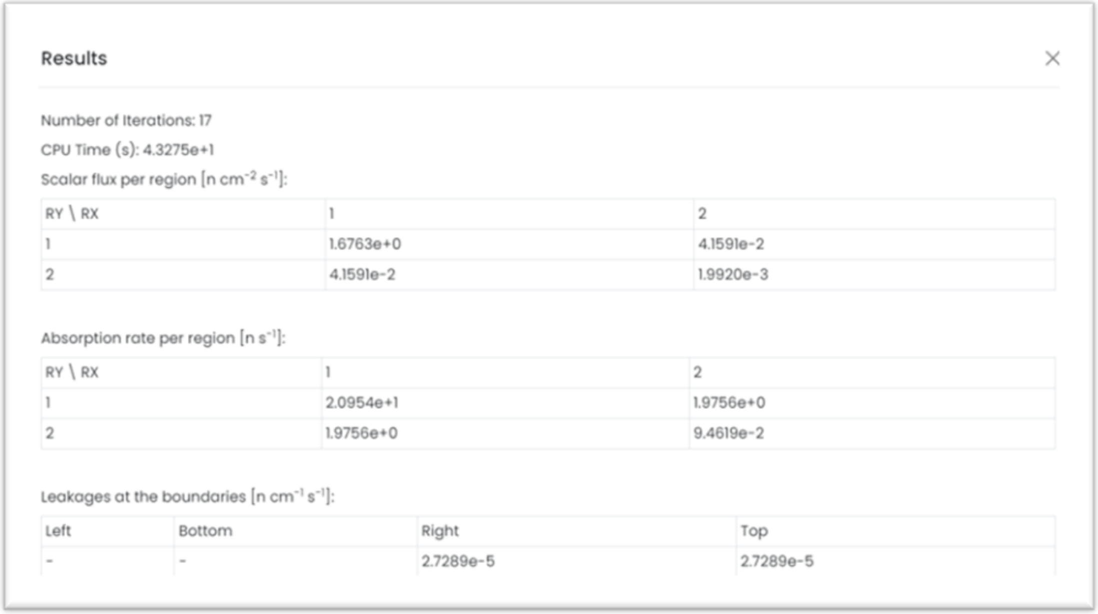



Figure 5: Results section.



Results

Number of Iterations: 17

CPU Time (s): 4.3275e+1

Scalar flux per region [n cm$^{-2}$ s$^{-1}$]:

| RY \ RX | 1 | 2 |
|---|---|---|
| 1 | 1.6763e+0 | 4.1591e-2 |
| 2 | 4.1591e-2 | 1.9920e-3 |

Absorption rate per region [n s$^{-1}$]:

| RY \ RX | 1 | 2 |
|---|---|---|
| 1 | 2.0954e+1 | 1.9756e+0 |
| 2 | 1.9756e+0 | 9.4619e-2 |

Leakages at the boundaries [n cm$^{-1}$ s$^{-1}$]:

| Left | Bottom | Right | Top |
|---|---|---|---|
| - | - | 2.7289e-5 | 2.7289e-5 |

Figure 6. Modal window report for the numerical solution.

## 4. Conclusions

An online solver tool to perform neutron transport calculations was presented. A two-dimensional fixed source model problem was solved to show the usage capabilities of the application. Overall, the NTS is a cross-platform responsive web application with no need for installation and automatic updates. It is available on the internet and it can be accessed from computers to mobile devices.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