JSPlotly: an application for interactive graphics in Biochemistry for HTML viewers

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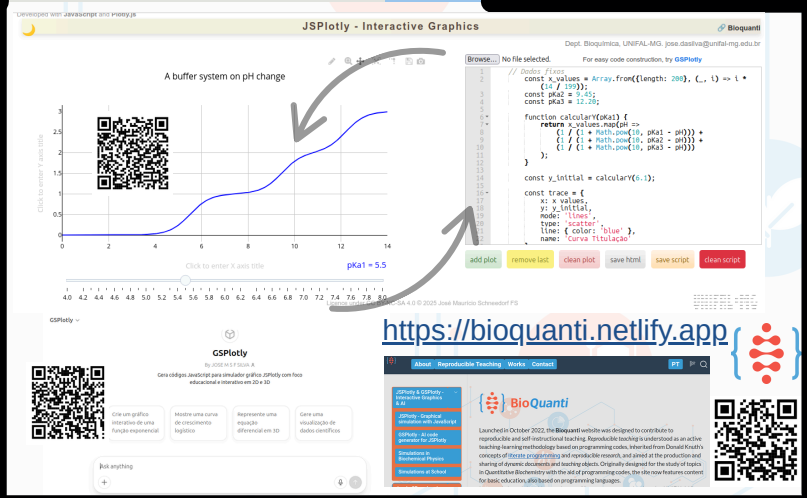
INTRODUCTION

Graph-based mathematical representations are frequent in biochemistry education, yet their interpretation demands visual literacy that may hinder learning. JSPlotly is a lightweight (under 25kB), open-source application for creating interactive and dynamic 2D and 3D graphics based on equations and data visualization. Designed for education and research, it enables the creation, editing, and sharing of dynamic graphs and their code without requiring installation or internet access. Customizable via any text editor, it runs on all devices and preserves interactivity upon export. To enhance its use, the custom GSPlotly GPT was developed to generate JavaScript code from natural language, promoting scientific literacy, computational thinking, and the essential and pressing digital competencies required for Education 5.0.

CHARACTERISTICS

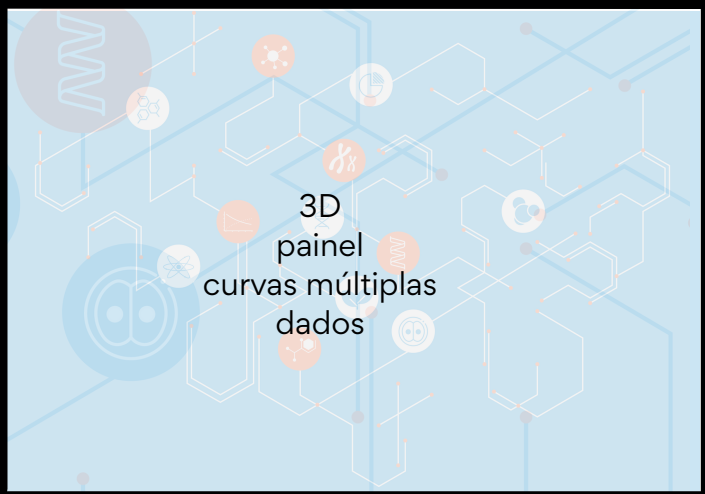
1. It is free;
2. No installation required;
3. No additional requirements (e.g., Microsoft .NET libraries, Java*);
4. No network connection required;
5. No machine configuration or minimum performance requirements (e.g., RAM);
6. Can be loaded from a simple HTML viewer (Firefox, Edge, Safari, Chrome);
7. Does not require a specific editor for construction, and can be created using a simple notepad;
8. Source code and graphic product are contained in the same file, facilitating storage and sharing;
9. Can be loaded from a computer, mobile devices (smartphone), or removable devices (USB stick);
10. Is interpreted from simple text code, using negligible physical memory (20kB), while allowing the creation of sophisticated, interactive, and dynamic graphics (updated by user event or in real time);
11. It has unrestricted sharing of its source code (CC BY-NC-SA 4.0 license);
12. It is capable of producing interactive 2D and 3D graphics instantly, both from equations and from user-entered data;
13. It is capable of producing interactive maps, extending its use to non-mathematical applications;
14. It has a clean visual layout (just a window with a graphic screen and editor) and only six buttons to add, remove, and clear the graphic area, as well as to save the script, clear the editor, and save the graphic;
15. The graph can be exported as PNG, SVG, or HTML, the latter allowing interactivity of the saved file;
16. It has a top bar for changing the curve color, exporting, zooming, spanning, auto-scaling, and access to the library developer's online editor (Plotly Chart Studio);
17. It has several mouse interactivity options in the graphic area, as mouse hover, data tooltips, data coordinates, curve color change, individual axis displacement, zoom with central button, and insertion of labels in titles and axes;
18. Correlates directly to the use of programming languages, as required by the *4th and 5th Industrial Revolutions*, and respectively mirrored in the digital skills of *Education 4 and 5.0*;
19. Due to its simplicity as a single HTML file, it can be incorporated into web pages or virtual environments, allowing its use for any type of teaching-learning modality (e.g., face-to-face, hybrid, remote, distance learning);
20. Allows working with functions or data entered by the user;
21. Fits into the concepts of *reproducible research* as well as *reproducible teaching*, based on open, facilitated, and documented access and sharing for digital tools aimed at scientific content, as well as curriculum matrices;
22. Allows other JavaScript libraries to be incorporated into the source code, complementary to graphics production and management (e.g., *numjs* for numerical computation and linear algebra, *jsmath* for complex mathematical notation, *jStat* for statistical computation);
23. It has several interactive actions that can be performed with mouse clicks, adding a playful element to the experimentation of mathematical functions in natural sciences;
24. Renders graphics using a modern and widely used programming language, which also allows learners to gradually learn programming techniques contained in other common languages (*Python*, *R*) and the geek world (Arduino - *C/C++*);
25. Integrates infinite undo in the code editor;
26. Optionally renders instant code by custom GPT (GSPlotly), also assisting in code correction and customization.

RESULTS



https://bioquanti.netlify.app

EXAMPLES

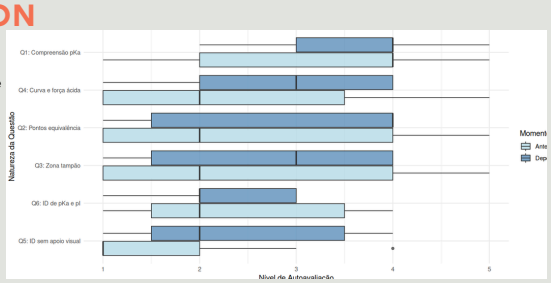


HOW TO USE

1. Go to the Bioquanti website (PT/EN);
2. Access JSPlotly;
3. Choose an example in Biophysical Chemistry or Basic Education;
4. Click on the graph image;
5. Click on Add Plot.

EVALUATION

The effectiveness of *JSPlotly* in supporting the learning of acid-base balance was evaluated in a chemistry course by comparing Likert-scale responses collected after the initial session of the semester (without the application) and a subsequent session incorporating the tool.



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