Cartography Playground: Interactive, web-based applications to explain basic cartographic issues

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“Tell me and I will forget, show me and I may remember; involve me and I will understand.”
Konfuzius, *551 v. Chr. †479 v. Chr.

Abtract:

Today, modern smartphones have computing power that only desktop computers possible have had few years ago. As a result, Internet use receives the additional options of mobility and permanent availability. This opens up new possibilities for applications and services related to communication, navigation and information. The latter allows learning independent of time and place. Compared to traditional knowledge transfer, the challenge now arises to convey content digitally and comprehensibly on a variety of devices with different input methods and display sizes.

The Project "ZukunftsForum" of the German Federal Ministry of Education and Research (BMBF) on "Teaching, Learning and Living in the Digital World" showed an increasing interest in digital knowledge transfer in the population in two years of surveys. Until the age of 39, 66% of respondents agreed with the statement: "*Digital technology increases my interest to learn new things*".

Due to these technological and social developments, the idea of a map based mobile e-learning application grew: The “Cartography Playground”.

This is intended to convey the fundamentals of map reading and understanding, as well as basic cartographic methods and procedures in an easy and understandable way. Using interactive learning environments to playfully learn and consolidate the knowledge and being able to test one’s knowledge through a quiz should ensure learning success.

What are the Cartography Playgrounds? Comparable with widgets, these are, to the present state of development, twelve compact and short e-learning applications from a wide variety of application fields of cartography. This includes the Douglas-Peucker algorithm, the interpretation of contour lines, the introduction to map design, a comparison of different clustering methods, an overview of the methods of cartographic generalization and further more. The contents of all implemented playgrounds are sums up in a quiz (Figure 1).

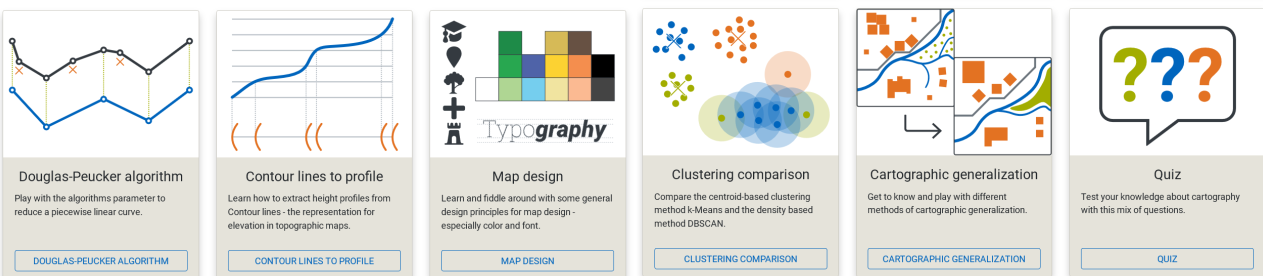

Figure 1: The first six e-learning Playgrounds

To ensure the user acceptance of an application, one has to take into account several different factors like the ease of use and presentation, the reaction speed of the program on an input (latency), the fast data transfer when loading content and the ability to run on different devices with their operating systems and display sizes (responsive web design). Not only these goals have been considered for the development of Cartography Playground, but also the future continuity and sustainability of further development.

For this purpose, the open source idea was implemented, which not only includes the programming languages used, but also provides the source code for further development in a developer community. The structures known as Distributed Git are web-based development environments (repositories) that provide the programmer community with the code for enhancements and further developments, control development progress through versioning, and publish final projects via project management.

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For the implementation of a web-based repository, the decision was taken to use the GitLab-platform with its already integrated and automated code execution of the so-called Continuous Integration and Deployment (CI/CD) for the generation of web pages. GitLab thus takes over the entire project of Cartography Playground and can host the processed results directly on the final webspace of a provider.

Another condition, besides the open source idea, was the uniform design and the demand for high quality graphics and formulas. This should be done via Cascading Style Sheet (CSS) and vector-based graphics (SVG) as well as formula toolboxes from *JavaScript* libraries.

When implementing the application, the following programs and programming languages were used in their application sequence: *Bootsrap, Sass/SCSS, Jekyll, HTML5, SVG, JavaScript, Simplify.js, SVG.js, MathJax, Elevation-APIs, H5P, ugilfyJS* and *gzip*.

Bootstrap is a front-end framework for designing responsive websites. The CSS-preprocessor language Sassy Cascading Style Sheets (SCSS) allows for the use of variables and loops within *CSS*. Due to this the design is consistent across web pages and reduced maintenance by centralizing the defined variables. Through the designed template with its placeholders any number of Playgrounds can be created in a uniform design and completed on the final website.

By contrast, the *Jekyll* environment, with its mark-up language and logic and control blocks, generates static web pages from simple html-like files.

In order not to delay the data transfer by the incremental loading of raster images, almost all graphics were generated as *SVG*. Due to their xml-based drawing language, vector graphics are only created directly on the monitor. Raster artifacts are avoided when scaling, as they can only occur in raster images. The *SVG* graphics with their attributes can be changed via *JavaScript* and its libraries and provided with interaction. The combination with *JavaScript* libraries (*Simplify.js, SVG.js*) not only supports the responsiveness of the *SVG* graphics, but also brings the formulas in Latex style into their final appearance using the *MathJax*-tool.

With the inclusion of elevation APIs from Bing Maps and Open-Elevation, as well as the use of MapBox topographic maps, the range of display options increases to explain cartographic issues better and create more comprehensive visualizations into different cartography Playgrounds (e.g. the second Playground: contour lines to profile - Figure 2).

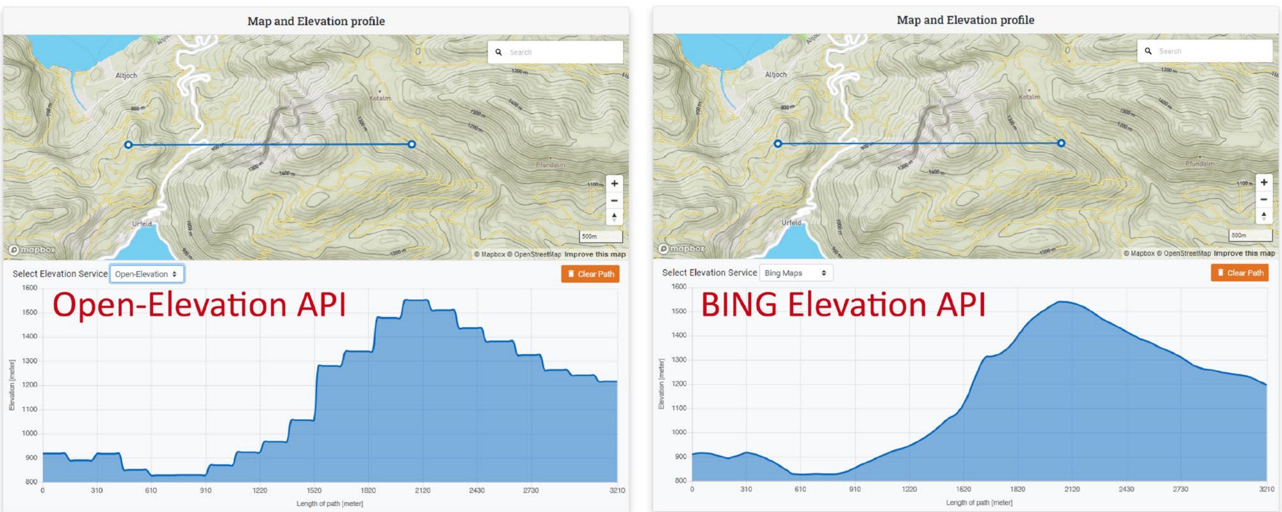

Figure 2: After drawing a line, two different elevation APIs with different data quality can be chosen

An integration of a different kind took place through the externally created *H5P*-quiz, which was placed in the website as *iframe* as its own Playground. The interactive quiz based on *JavaScript* and *HTML5* picks up on all topics from the Playgrounds again and thus allows the learned material to be retrieved playfully.

For the later fast loading and calling of the eleven Playgrounds from the final website several compression and optimization methods were used. Thus, the *Sass/SCSS* code could be minimized by 23%, *JavaScript* files could be minimized by 29% using *ugilfyJS*. All content is then compressed and reduced by *gzip* which saves another 60-80% of file sizes for the final data-transfer. After the optimization, GTmetrix outputs a very good "Google Page Speed Score" of A (94%) and likewise very good "Yahoo YSlow score" of A (96%).

It can be stated that the combination of *Bootstrap*, *Sass/SCSS* and *Jekyll* has dispensed with the complete infrastructure of a Content Management System (CMS) with its *Linux*, *Apache*, *MySQL* and *PHP* (LAMP) environment. This reduces the security gaps caused by server-side processing and database queries, reduces the necessary maintenance on a web server, as well as opens the ability to compactly and easily store the entire static generated web page at a service provider for web hosting platforms, even without a CMS offer. The use of web standards such as *HTML5*, *JavaScript* and *SVG* ensured the functionality and flawless presentation of the website for all popular and modern web browsers.

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There are currently eleven Cartography Playgrounds. The Douglas-Peucker algorithm, contour lines, map design, clustering comparison, cartographic generalization, quiz, kernel density estimation, Delaunay Triangulation/Voronoi Diagram, Koppe Accuracy, data classification methods and a Toefer selection criterion. All Playgrounds but the quiz have the same structure, starting with a short description of the topic in text form including mathematical formulas, followed by sample graphics and a practical application part for interactive testing (Figure 3).

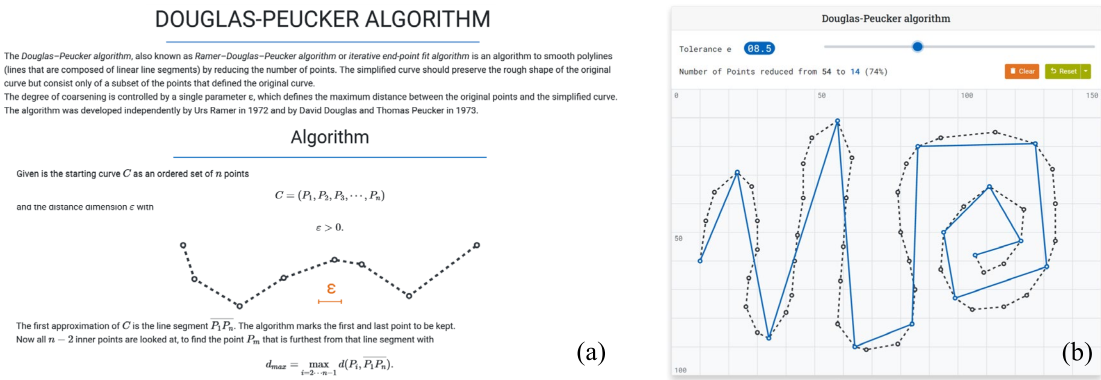

Figure 3: Douglas-Peucker algorithm description (a), with practical application part (b)

In the future, students will use the GitLab platform to develop further e-learning applications for the Cartography Playgrounds and release them for e-learning. These can be in the enhancement or refinement of existing Playgrounds, in new Playgrounds or even in outdoor Playgrounds that can be experienced on mobile using augmented reality. This includes the notions of hill shading methods or further important algorithmic methods for data analysis.

CARTOGRAPHY
PLAYGROUND

http://129.187.45.33/CartographyPlayground/

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