C1 MD-Spline Demo

User Manual

WebApp Version 3.0

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INTRODUCTION

The C1 MD-Spline Demo is a webapp that allows the user to use MD C^1 splines, polynomial functions that can have a different degree in each piece. Presented in the paper "A Cox-de Boor-type recurrence relation for C1 multi-degree splines" published on Elsevier the 4th of October 2019 and written by Associate Professor Carolina Beccari and Professor Giulio Casciola, it has been significantly expanded. Along with a new user interface and some fixed bugs from the previous version, the application now allows loading and saving full SVGs, full colour rendering of curves and the capability of handling more than one curve per project.

During this rework of the application, some functions have changed the way they behave. This document will try to document as much as possible these changes where present. Inside this manual, the terms path and spline are used interchangeably.

THE INTERFACE
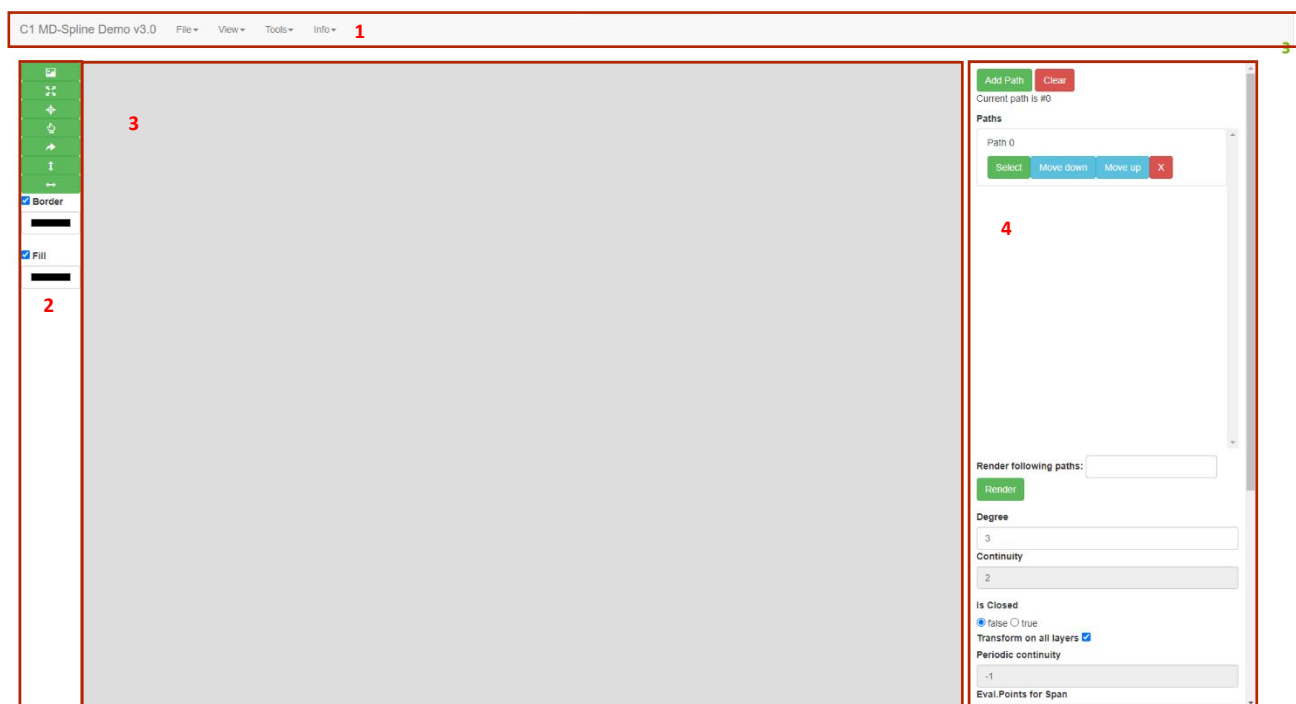
The application's interface is composed by 4 main entities:

1. The menu, containing file management, visualization, utility and help functions.
2. The left sidebar, containing the quick-access tools, such as rotate, flip, pan and zoom on area.
3. The canvas, where the curves are drawn and represented.
4. The right sidebar, containing the multipath management tools and some information about the currently selected curve.

MENU

The menu is where most of the functionalities that used to be activated with a button now reside, split in 4 categories.

C1 MD-Spline Demo v3.0   File ▾   View ▾   Tools ▾   Info ▾
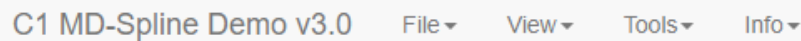
The "File" dropdown contains the functions to reset the project, or load/save it in the .md or .svg format.

The "View" dropdown contains three toggles:

- Toggle grid: enables/disables the grid on the canvas.
- Toggle filling: enables/disables curve filling.
    - In the previous version of the app this function only displayed colour until the mouse approached the canvas, this version on the other hand will display it until it is turned off.
- Toggle CPs: hides the curve control points until the mouse gets near the spline.

The "Tools" dropdown contains four functions:

- UPApprox: approximates a spline with a non-uniform partition in a uniformly partitioned one.
- Convert to non-periodic: converts a periodic curve to a non-periodic one.
- Open curve CP0: opens a closed curve on a breakpoint with continuity 0.
- Close curve: closes a curve, but without making it a periodic curve.

The "Info" dropdown contains information about the application usage and its development.

LEFT SIDEBAR

The left sidebar contains several buttons that provide access to the application's most frequently used functions. From top to bottom, they are:

- Centre and zoom on the whole picture.
- Centre and zoom on the selected curve.
- Centre and zoom on target.
    - Upon clicking the button, the application enters "zoom" mode. The user can, by holding clicked the left button of the mouse and dragging, a selection box. When the user lets the left button go, the selected area will be zoomed and centred.
- Pan.
    - Upon clicking the button, the application enters "pan" mode. While this mode is active, the user can click on a control point of the active curve, and while the left mouse is being held down, the movement of the mouse results in the view moving around the screen. This function can be used to only move the active spline, and this is accomplished by unticking the "Transform on all layers" box in the right sidebar.
    - In the previous version of the app, once the left mouse button was lifted, the application exited "pan" mode. In this version, the pan button must be clicked again.
- Rotate 90°
    - Rotates the splines (or single spline if the "Transform on all layers" box in the right sidebar is unticked) 90° clockwise.
- X Flip
    - Flips the splines (or single spline if the "Transform on all layers" box in the right sidebar is unticked) on the X axis.
- Y Flip
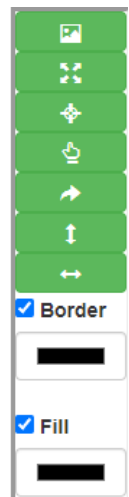
- Flips the splines (or single spline if the "Transform on all layers" box in the right sidebar is unticked) on the Y axis.
- Border and Fill colour
  - By clicking on these widgets, a colour selector pops up. Select the desired colour, and then hit enter.
  - The checkbox on the side of the "Border" and "Fill" labels can be toggled on or off to enable or disable transparency for the stroke or fill colour.

CANVAS

On the canvas, users can interact with the active curve and observe the other curves – if present and rendered – and additional effects may apply accordingly with the view options in the view tab of the menu.

Upon the creation of a new project or a new path, the user can draw a spline by clicking on the canvas, which creates points that will be used to manipulate and control the spline. When the user is done with the point placement, it can press the right mouse button to complete the spline definition. Splines can be periodic or non-periodic, and this can be defined by selecting the appropriate value of the "Is Closed" control located in the right sidebar. The number of evaluation points can also be adjusted in the right sidebar.

Left click on any of the black or red points to alter the spline shape and use the scroll wheel to zoom in and out. If the "Transform on all layers" setting of the right side panel is disabled, the zoom will work as a scale up/down of the currently selected curve.

Right-click on any of the points that delimit the segments that make up the spline (marked up by a yellow dot) to enter "edit" mode: a popup will open, and will allow the user to add a breakpoint in the chosen position, increase or lower the spline degree in that point or cancel the operation (this can be accomplished by clicking on "cancel", "close" or clicking outside of the popup.)

The right sidebar contains the multipath management tools, the rendering list, the edit continuity menu, information about the current curve, the "Is Closed" and "Transform on all layers" toggle, along with settings of the number of evaluation points per span and the grid resolution.

MULTIPATH MANAGEMENT TOOLS

From top to bottom, this component contains the following buttons and functions:

- The "Add path" button creates a new path and allows the user to enter new points.
- The "Clear" button erases all the paths in the project.
- The id of the currently selected path.
- The path list, a scrollable element which contains all the paths. The paths can be selected (which makes them active), moved up or down or deleted.
  - The change of order matters when dealing with coloured SVGs: the higher may cover up the smaller, since the Painter's algorithm is used to determine which element gets seen by the user.
  - The deletion of a path will get blocked if it's the only one remaining.
- The render list: this can be left empty, with a series of path ids separated by a comma or with the wildcard character "*", that will display all the paths that exist when the command was given.
- The Render button, that executes the render command.
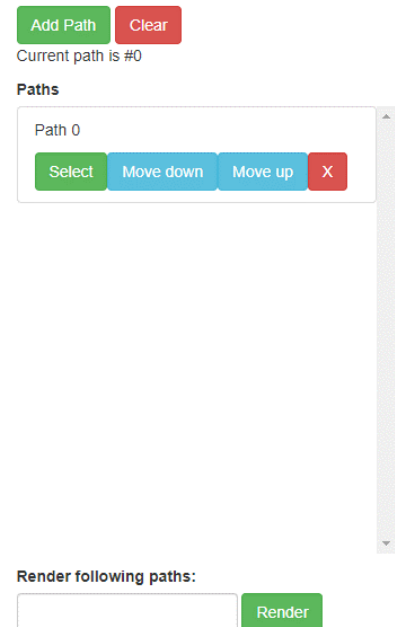
OTHER CONTROLS

Other controls that are located within the right sidebar are:

- The degree input displays the curve's degree and can be modified during the creation phase to specify the number of control points that make up the curve.
- The continuity value of the curve.
- The "Is Closed" toggle, that marks if the curve is periodic or not.
- The "Transform on all layers" toggle, that makes transforms (zooms, pans, mirror functions and rotations) work on a single layer or all.
- The "Eval. Points for Span", that defines the number of points that the program uses to represent the spline.
  - This information is related to a single path and can be changed by typing a number and clicking on the "Apply" button.
- Debug information, such as
  - Number of segments, Control Points, Break Points, Degrees, Continuities, Left and Right Knot Partition.

USING THE APPLICATION

STARTING A NEW PROJECT FROM SCRATCH

Upon opening the application, everything is already in-place to start the project. After configuring desired options in the right-sidebar and such, place as many points as needed with the left mouse button and use the right one to end the curve setup. To add a path, click on the appropriate button, and to see all the paths rendered together configure the render list properly (for example, putting the wildcard symbol "*") and clicking on "run". When you're done, save in the desired format using the "File" dropdown.

STARTING A PROJECT FROM A .MD OR .SVG SOURCE

Upon opening the application, click on the "File" dropdown of the menu and select the loading function accordingly to your file format: a popup will appear, select the file, and click on "open". The file will be imported and rendered on the canvas.

ADDENDUM ON SVG FILES

Transforms defined within the SVG file are not currently managed and will be removed. If in the SVG file contains shapes ("square", "circle", etc), they will get converted in path files. Paths that contain the "m" command in other parts than the beginning of the path will get split up in several paths.

Upon saving, the application will try to maintain the original structure of the file as much as possible, accordingly with the importer's restrictions.

The concept of a periodic path does not exist within the SVG specification. Hence, before exporting a project, it is mandatory to:

- Select one of the periodic paths, click on Tools>Convert to non-periodic.
- Click on Tools>Open curve CP0.
- Click on Tools>Close curve.
- Repeat on all periodic splines.

If the spline partitions are no longer uniform because of adding breakpoints and lowering their continuity, the spline can't be exported. The user must click on Tools>UPApprox to restore the uniformity of the partitions, and then save it

ADDENDUM ON .MD FILES

The .md file format can only be used to export the current path and does not support multiple paths stored within itself.