SPLINES IN IPE

A brief overview
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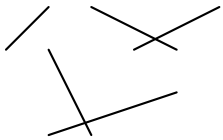
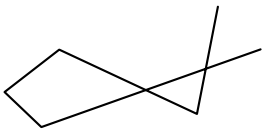
Spline ressources:
- IPE manual (path objects)
- Freya Holmér's spline video
- Raph Leviens thesis

Legend	
left click	endpoint
i-th left click	control point
right click	rendered curve
i-th right click	edit mode curve

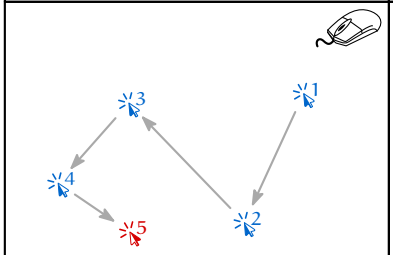
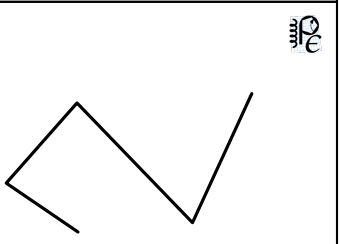
Right, so IPE does lines:



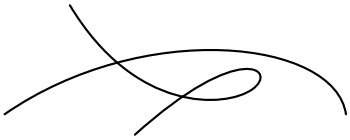
...and polylines too:



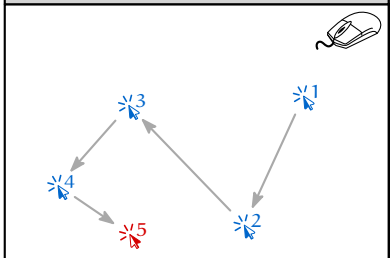
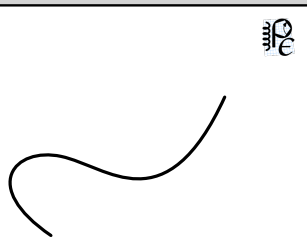
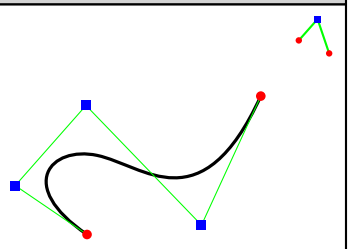
We create them using the lines and polylines [P] tool 

What you do	What you get
	

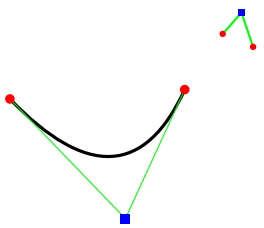
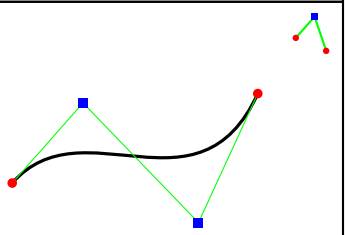
Similarly, IPE does splines:



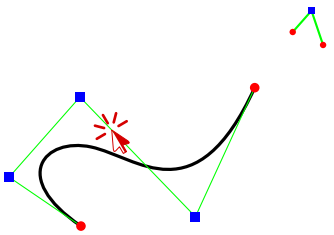
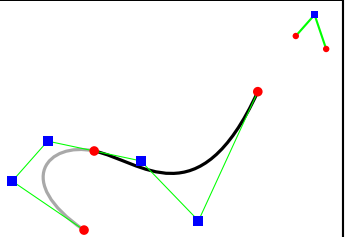
We create them using the splines [S] tool  . The connection between the clicks and the curve is seen in the edit mode.

What you do	What you get	Edit mode [CTRL + E]
		

Splines in IPE come in different variants (B-splines, Cardinal and Spiro). Change via **"Properties → Spline type"**. There is a lot of information online about different spline types, but this tutorial will only explain them to the extent necessary to understand the tools in IPE:

Quadratic	Cubic
	

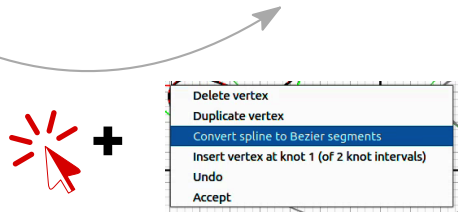
B-splines are the standard spline setting in IPE. All curves above were created using the B-spline. Any spline with one or two control points (not counting start or end) is represented as a quadratic or cubic spline repsectively.

3 control points	Decomposition
	

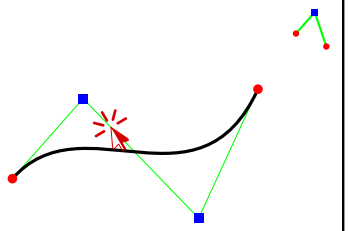
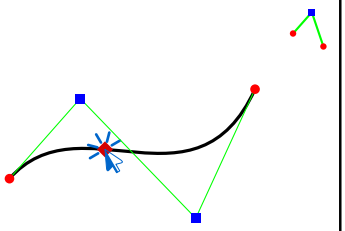
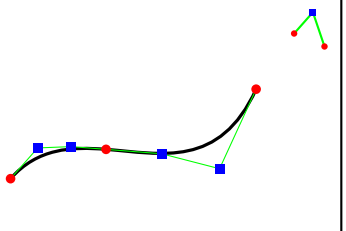
If you create any B-spline with $k > 2$ control points, IPE will render it approximately as a composition of $k-1$ cubic B-splines, i.e., with 2 control points.

You can decompose any spline (even cardinal and spiro types) into the sequence of cubic B-splines that IPE uses. To do so enter edit mode, right click (in the interior of the spline) and select **"Convert spline to Bezier segments"**.

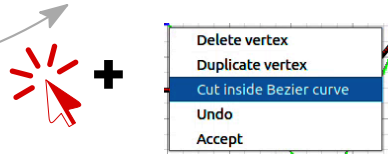
You can also do this decomposition individually for anyone of the $k-2$ vertices that would be added using **"Insert vertex at knot 1 (of $k-1$ knot intervals)"**.



You can additionally cut any quadratic (cubic) B-Spline at any interior point to obtain two quadratic (cubic) B-splines, which together represent the same geometry as the original.

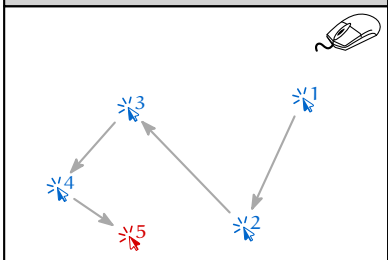
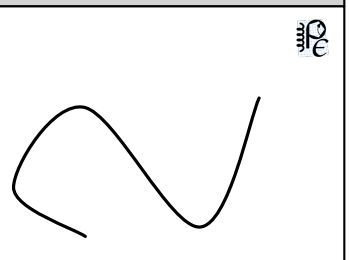
Edit mode	Cutting mode	Result
		

Use right click and **“Cut inside Bezier curve”**.

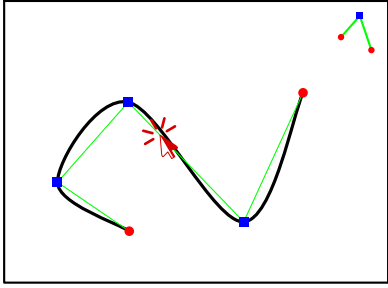
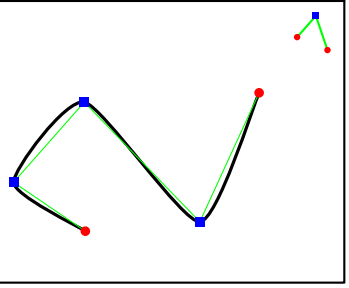


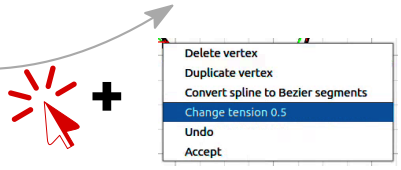
Note that this action actually cuts the spline in two. You obtain one spline object consisting of two disconnected subpaths and two endpoints of these paths coincide.

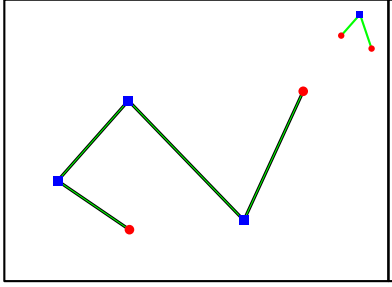
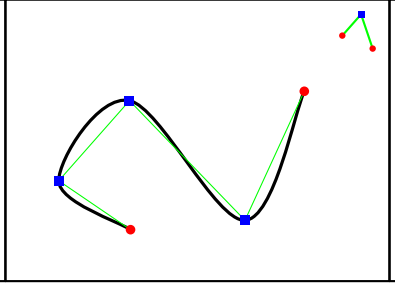
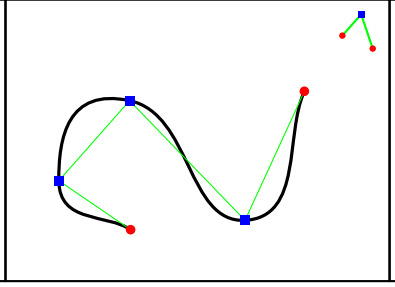
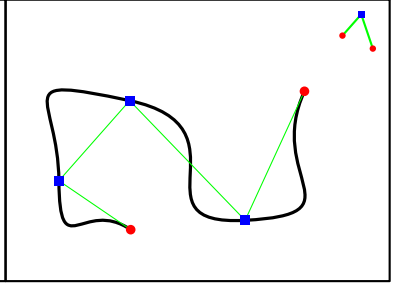
Cardinal splines guarantee that the spline passes through all control points. Other than the already mentioned possible conversion into B-splines, there is the option of adapting the tension parameter (it changes what curve the control points imply).

What you do	What you get
	

To adapt the tension, right click the spline in edit mode, select **“Change tension X”** and enter the desired value. Higher values tend to “flatten” the curve around control points. Conversely tension 0 just creates the polyline.

Tension $= 0.5$	Tension $= 0.3$
	



Tension $= 0$	Tension $= 0.5$	Tension $= 1$	Tension $= 2$
			

Finally **Spiro splines** (also called clothoids) are splines whose curvature changes linearly, which creates nicely curved splines. There are no special interactions outside of the already mentioned decomposition into cubic B-splines.

What you do	What you get