PSTricks

`pst-intersect`
Intersecting arbitrary curves

v0.4

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Contents

1. Introduction

1.1. About the package

`pst-intersect` is a PSTricks package to calculate the intersections of Bezier curves and arbitrary Postscript paths.

Please note, that package versions 0.x are experimental, and may be subject to fundamental changes, which aren't backward compatible.

1.2. Requirements

`pst-intersect` requires recent versions of `pstricks`, `pst-node`, `pst-eucl` and `pst-func`.

All PSTricks package rely heavily on the Postscript language so that the typical workflow involves `latex`, `dvips`, and `ps2pdf`. Of course there are several alternative ways to compile your documents.[1]

1.3. Distribution and installation

This package is available on CTAN[2].

The `pst-intersect` package consists of the two main files `pst-intersect.ins` and `pst-intersect.dtx`. By running `tex pst-intersect.ins` the following derived files are generated:

- `pst-intersect.pro`: the Postscript prolog file
- `pst-intersect.sty`: the LaTeX style file

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[1] `http://tug.org/PSTricks/main.cgi?file=pdf/pdfoutput`

[2] `http://mirror.ctan.org/help/Catalogue/entries/pst-intersect.html`

- `pst-intersect.tex`: the TEX file

Save the files in a directory which is part of your local TEX tree.

Do not forget to run `texhash` to update this tree. For MiKTEX users, do not forget to update the file name database (FNDB).

For more detailed information see the documentation of your personal LATEX distribution on installing packages to your local TEX system.

1.4. License

1.5. Acknowledgements

I thank Marco Cecchetti, for his `lib2geom`-library[4] from which I derived great parts of the Postscript code for the Bézier clipping algorithm. Also I want to thank William A. Casselman for the Postscript code of the quicksort procedure and the procedure for calculating the convex hull from his book “Mathematical Illustration”[5], and the permission to use it. The documentation style is a mixture of the `pst-doc` class (Herbert Voß) and the `ltxdockit` package for the `biblatex` documentation (Philipp Lehman).

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[3] http://www.latex-project.org/lppl.txt
[4] http://lib2geom.sourceforge.net/
[5] http://www.math.ubc.ca/~cass/graphics/text/www/

2. Usage

The `pst-intersect` package can compute the intersections of arbitrary Postscript paths. These are composed of three primitive operations: lines (`lineto`), third order Bézier curves (`curveto`) and jumps (`moveto`). More specialized constructions, like circles, are converted internally to `curveto` operations. Besides these three path operations, the `pst-intersect` supports Bézier curves up to nineth order. As these aren't primitive Postscript path elements, they require separate handling.

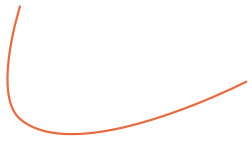
The general workflow consists in defining and saving paths and curves, and then compute the intersections between them. Following, those intersection points can be used as normal PSTricks nodes, or portions of the curves and paths can be retraced (e.g. between two intersections).

2.1. Saving paths and curves

`\pssavepath`[⟨*options*⟩]{⟨*curvename*⟩}{⟨*commands*⟩}

Saves the complete path, which is generated by ⟨*commands*⟩, under the name ⟨*curvename*⟩. The macro is a modification of `\pscustom`, and does, therefore, supports only the same commands.

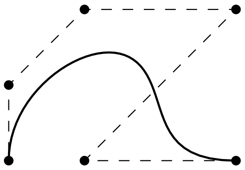
By default, the path is also drawn, which can be changed over the ⟨*options*⟩, e.g. with `linestyle=none`.



```
\begin{pspicture}(3,2)
  \pssavepath[linecolor=DOrange]{MyPath}{%
    \pscurve(0,2)(0,0.5)(3,1)
  }%
\end{pspicture}
```

`\pssavebezier`[⟨*options*⟩]{⟨*curvename*⟩}(⟨X_0⟩)...(⟨X_n⟩)

The Postscript language supports only third-order Bézier curves. With the macro `\pssavebezier` you can define Bézier curves up to nineth order. The specified nodes are the control points of the curve, for an n-th order curve $n+1$ control points are required. The drawing of the curve is done with the `\psBezier` macro from the `pst-func` package.

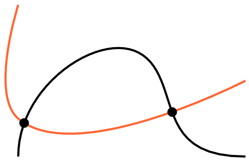


```
\begin{pspicture}(3,2)
  \pssavebezier[showpoints]{MyBez}(0,0)(0,1)(1,2)(3,2)(1,0)(3,0)
\end{pspicture}
```

2.2. Calculating intersections

`\psintersect`{⟨*curveA*⟩}{⟨*curveB*⟩}

After having saved some paths and curves, you can now calculate the intersections. That is done with the `\psintersect` macro. This needs as arguments two names of paths or curves (the ⟨*curvename*⟩ argument of the two `\pssave*` macros).



```
\begin{pspicture}(3,2)
  \pssavepath[linecolor=DOrange]{MyPath}{\pscurve(0,2)(0,0.5)(3,1)}
  \pssavebezier{MyBez}(0,0)(0,1)(1,2)(3,2)(1,0)(3,0)
  \psintersect[showpoints]{MyPath}{MyBez}
\end{pspicture}
```

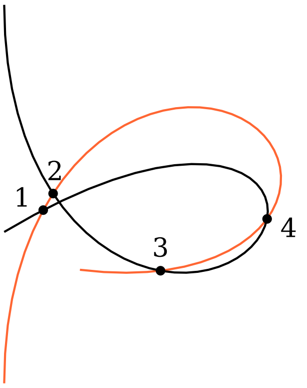
The `showpoints` PSTricks parameter determines, if the intersections are drawn directly.

`name`=⟨*string*⟩ default: `@tmp`

The calculated intersections can be saved for later use under this name (see Sec. 2.4).

`saveintersections`=`true`, `false` default: `true`

If this option is set, the intersections are saved as PSTricks nodes with the names ⟨*name*⟩1, ⟨*name*⟩2 .... The numbering is ascending according to the value of their x-coordinate.

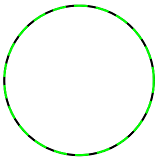


```
\begin{pspicture}(5,5)
  \pssavebezier[linecolor=DOrange]{A}%
            (0,0)(0,5)(5,5)(5,1)(1,1.5)
  \pssavebezier{B}(0,5)(0,0)(5,0)(5,5)(0,2)
  \psintersect[name=C, showpoints]{A}{B}
  \uput[150](C1){1}
  \uput[85](C2){2}
  \uput[90](C3){3}
  \uput[-20](C4){4}
\end{pspicture}
```

2.3. Visualization of saved paths

`\pstracecurve`[⟨*options*⟩]{⟨*curvename*⟩}

Saved paths and curves can be drawn again with this macro.

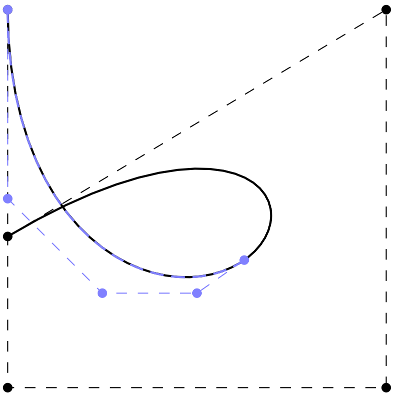


```
\begin{pspicture}(2,2)
  \pssavepath{Circle}{\pscircle(1,1){1}}
  \pstracecurve[linestyle=dashed, linecolor=green]{Circle}
\end{pspicture}
```

`tstart`=⟨*num*⟩

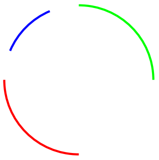
`tstop`=⟨*num*⟩

With these parameters also parts of paths and curves can be drawn. For Bézier curves the allowed range is $[0,1]$, where 0 corresponds to the start of the curve, which is given by the first node given to `\pssavebezier`.



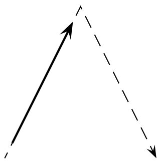
```
\begin{pspicture}(5,5)
  \psset{showpoints}
  \pssavebezier{B}(0,5)(0,0)(5,0)(5,5)(0,2)
  \pstracecurve[linestyle=dashed, linecolor=blue!50,
              tstart=0, tstop=0.5]{B}
\end{pspicture}
```

Paths can be composed of more than one segmet, and the range is $[0, n]$, where n is the number of path segments. For this you must keep in mind, that also e.g `\pscurve` paths, circles or arcs consist of several segments.

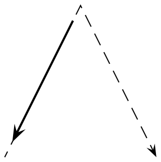


```
\begin{pspicture}(2,2)
  \pssavepath[linestyle=none]{Circle}{\pscircle(1,1){1}}
  \pstracecurve[tstart=0, tstop=1, linecolor=green]{Circle}
  \pstracecurve[tstart=2, tstop=3, linecolor=red]{Circle}
  \pstracecurve[tstart=1.25, tstop=1.75, linecolor=blue]{Circle}
\end{pspicture}
```

Please note, that the order of `tstart` and `tstop` plays a role. For `tstart` > `tstop` the path direction is reversed.



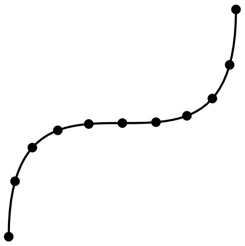
```
\begin{pspicture}(2,2)
  \psset{arrows=->, arrowscale=1.5}
  \pssavepath[linestyle=dashed, ⤸
      linewidth=0.5\pslinewidth]{A}{\psline(0,0)(1,2)(2,0)}
  \pstracecurve[tstart=0.1, tstop=0.9]{A}
\end{pspicture}
```



```
\begin{pspicture}(2,2)
  \psset{arrows=->, arrowscale=1.5}
  \pssavepath[linestyle=dashed, ⤸
      linewidth=0.5\pslinewidth]{A}{\psline(0,0)(1,2)(2,0)}
  \pstracecurve[tstart=0.9, tstop=0.1]{A}
\end{pspicture}
```

`\psGetCurvePoint`{⟨*curvename*⟩}{⟨t⟩}

Save the coordinates of ⟨*curvename*⟩ at the point ⟨t⟩.



```
\begin{pspicture}(3,3)
  \pssavebezier{A}(0,0)(0,3)(3,0)(3,3)
  \multido{\r=0+0.1}{11}{%
    \psdot(! \psGetCurvePoint{A}{\r} I-A.x I-A.y)}
\end{pspicture}
```

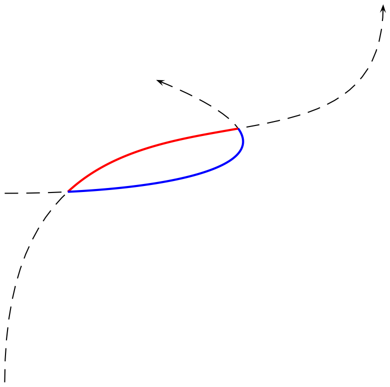
2.4. Visualization of saved intersections

`\pstracecurve`[⟨*options*⟩]{⟨*intersection*⟩}{⟨*curvename*⟩}

`istart`=⟨*num*⟩

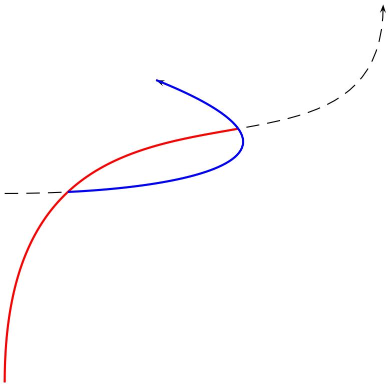
`istop`=⟨*num*⟩

These two parameters can be used to draw path or curve segments between intersections. The intersections are numbered starting at 1 in ascending order along the curve.



```
\begin{pspicture}(5.2,5.2)
\pssavebezier[linewidth=0.5\pslinewidth, ⤸
   linestyle=dashed, arrows=->]{A}(0,0)(0,5)(5,2)(5,5)
\pssavebezier[linewidth=0.5\pslinewidth, ⤸
   linestyle=dashed, ⤸
   arrows=->]{B}(0,2.5)(2.5,2.5)(4.5, 3)(2,4)
\psintersect[linecolor=green!70!black, name=C]{A}{B}
\pstracecurve[linecolor=red, istart=1, istop=2]{C}{A}
\pstracecurve[linecolor=blue, istart=1, istop=2]{C}{B}
\end{pspicture}
```

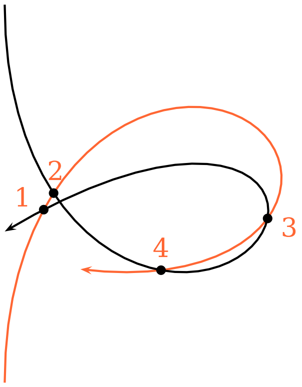
If only one value is specified, e.g. `istop`, the curve is drawn from the start to the respective intersection. If only `istart` is given, the curve is drawn from this intersection to the curve end. The parameters `istart` and `istop` can be combined with `tstart` and `tstop`.



```
\begin{pspicture}(5.2,5.2)
\pssavebezier[linewidth=0.5\pslinewidth, ⤸
   linestyle=dashed, arrows=->]{A}(0,0)(0,5)(5,2)(5,5)
\pssavebezier[linewidth=0.5\pslinewidth, ⤸
   linestyle=dashed, ⤸
   arrows=->]{B}(0,2.5)(2.5,2.5)(4.5, 3)(2,4)
\psintersect[linecolor=green!70!black, name=C]{A}{B}
\pstracecurve[linecolor=red, istop=2]{C}{A}
\pstracecurve[linecolor=blue, istart=1]{C}{B}
\end{pspicture}
```

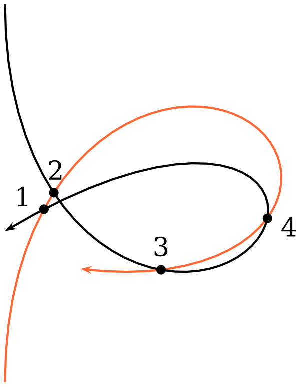
`\psGetIsectCenter`{⟨*intersection*⟩}{⟨*curvename*⟩}{⟨*n*⟩}

Loads the coordinates of the n-th intersection point of the path ⟨*curvename*⟩ in the intersection set ⟨*intersection*⟩. The numbering of the intersections starts at ⟨*n*⟩$= 1$ and the number increases along the path in its original direction.



```
\begin{pspicture}(4,5)
  \pssavebezier[linecolor=DOrange, arrows=->]{A}%
          (0,0)(0,5)(5,5)(5,1)(1,1.5)
  \pssavebezier[arrows=->]{B}(0,5)(0,0)(5,0)(5,5)(0,2)
  \psintersect[name=C, showpoints]{A}{B}
  \color{DOrange}
  \uput[150](!\psGetIsectCenter{C}{A}{1} I-C1.x I-C1.y){1}
  \uput[85](!\psGetIsectCenter{C}{A}{2} I-C2.x I-C2.y){2}
  \uput[-20](!\psGetIsectCenter{C}{A}{3} I-C3.x I-C3.y){3}
  \uput[90](!\psGetIsectCenter{C}{A}{4} I-C4.x I-C4.y){4}
\end{pspicture}
```

Without ⟨*curvename*⟩ the points are sorted according to their x-coordinate:

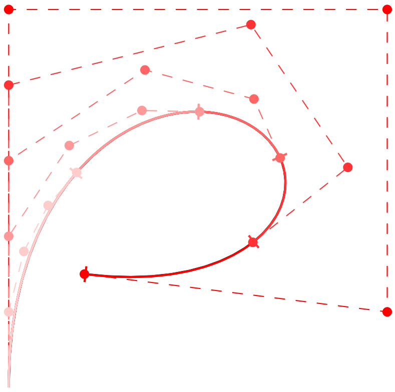


```
\begin{pspicture}(4,5)
  \pssavebezier[linecolor=DOrange, arrows=->]{A}%
          (0,0)(0,5)(5,5)(5,1)(1,1.5)
  \pssavebezier[arrows=->]{B}(0,5)(0,0)(5,0)(5,5)(0,2)
  \psintersect[name=C, showpoints]{A}{B}
  \uput[150](!\psGetIsectCenter{C}{}{1} I-C1.x I-C1.y){1}
  \uput[85](!\psGetIsectCenter{C}{}{2} I-C2.x I-C2.y){2}
  \uput[90](!\psGetIsectCenter{C}{}{3} I-C3.x I-C3.y){3}
  \uput[-20](!\psGetIsectCenter{C}{}{4} I-C4.x I-C4.y){4}
\end{pspicture}
```

The intersection points can also be loaded with `saveintersections` and `saveNodeCoors`. In that case, the numbering of the intersection increases according to their x coordinate.

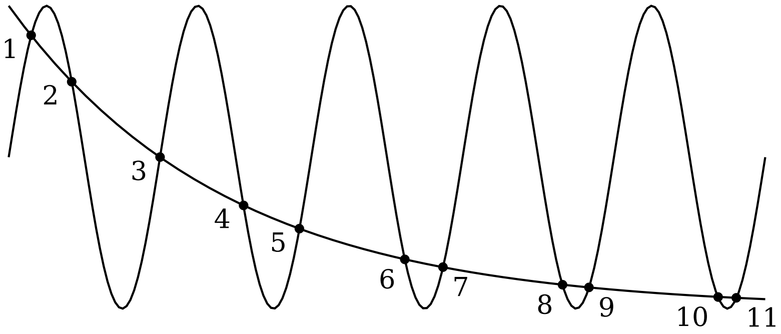
3. Examples

Ex. 3.1



```
\begin{pspicture}(5,5)
  \pssavebezier{A}(0,0)(0,5)(5,5)(5,1)(1,1.5)
  \multido{\i=100+-20,\r=1+-0.2}{5}{%
    \pstracecurve[linecolor=red!\i, tstop=\r, ⤸
        arrows=-|, showpoints]{A}
  }%
\end{pspicture}
```

Ex. 3.2: The package can also calculate the intersections of functions which are drawn with `\psplot`. Here you must keep in mind, that such curves consists of `plotpoints` segments, which must all be considered for intersections, what can result in long calculations.



```
\begin{pspicture}(10,4.4)
  \pssavepath{A}{\psplot[plotpoints=200]{0}{10}{x 180 mul sin 1 add 2 mul}}
  \pssavepath{B}{\psplot[plotpoints=50]{0}{10}{2 x neg 0.5 mul exp 4 mul}}
  \psintersect[name=C, showpoints]{A}{B}
  \multido{\i=1+1}{5}{\uput[210](C\i){\i}}
  \multido{\i=6+2,\ii=7+2}{3}{\uput[225](C\i){\i}\uput[-45](C\ii){\ii}}
\end{pspicture}
```

A. Revision history

This revision history is a list of changes relevant to users of this package. Changes of a more technical nature which do not affect the user interface or the behavior of the package are not included in the list. If an entry in the revision history states that a feature has been *improved* or *extended*, this indicates a modification which either does not affect the syntax and behavior of the package or is syntactically backwards compatible (such as the addition of an optional argument to an existing command). Entries stating that a feature has been *deprecated*, *modified*, *fixed*, *renamed*, or *removed* demand attention. They indicate a modification which may require changes to existing documents.

0.4 2014-03-16

Added `\psGetCurvePoint`.
Fixed `\pstracecurve` for use with `\pscustom`.
Fixed arrow behavior.

0.3 2014-03-04

Fixed `\psGetIsectNode` to work with more than one segment.
Modified `\psGetIsectNode` and the naming conventions of the variables.
Fixed missing support for `pst-node`'s `saveNodeCoors` parameter to `saveintersections`.

0.2 2014-02-26

Added support for `arrows` parameter to `\pstracecurve`.
Modified parameters `tstart`, `tstop`, `istart` and `istop` to respect different directions.
Added `\psGetIsectCenter`
Fixed a bug in the termination of the iteration procedure.
Fixed a bug in the point order of Bézier curves, which was related to a now fixed bug in `pst-func`.
Several other improvements.

0.1 2014-02-19

First CTAN version