

## Tutorial 14: Manipulation Functions for Closed Polygons and Laser Cutting (SVG)

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### Complete List of all Tutorials with Publishable MATLAB Files of this Solid-Geoemtries Toolbox

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The following topics are covered and explained in the specific tutorials:

- Tutorial 01: First Steps Using the VLFL-Toolbox for Solid Object Design
- Tutorial 02: Using the VLFL-Toolbox for STL-File Export and Import
- Tutorial 03: Closed 2D Contours and Boolean Operations in 2D
- Tutorial 04: 2½D Design Using Boolean Operators on Closed Polygon Lists (CPL)
- Tutorial 05: Creation, Relative Positioning and Merging of Solid Geometries (SG)
- Tutorial 06: Relative Positioning and Alignment of Solid Geometries (SG)
- Tutorial 07: Rotation of Closed Polygon Lists for Solid Geometry Design
- Tutorial 08: Slicing, Closing, Cutting and Separation of Solid Geometries
- Tutorial 09: Boolean Operations with Solid Geometries
- Tutorial 10: Packaging of Sets of Solid Geometries (SG)
- Tutorial 11: Attaching Coordinates Frames to Create Kinematik Models
- Tutorial 12: Define Robot Kinematics and Detect Collisions
- Tutorial 13: Mounting Faces and Conversion of Blocks into Lightweight-structures
- Tutorial 14: Manipulation Functions for Closed Polygons and Laser Cutting (SVG)
- Tutorial 15: Create a Solid by 2 Closed Polygons
- Tutorial 16: Create Tube-Style Solids by Succeeding Polygons
- Tutorial 17: Filling and Bending of Polygons and Solids
- Tutorial 18: Analyzing and modifying STL files from CSG modeler (Catia)
- Tutorial 19: Creating drawing templates and dimensioning from polygon lines
- Tutorial 20: Programmatically Interface to SimMechanics Multi-Body Toolbox
- Tutorial 21: Programmatically Convert Joints into Drives (SimMechanics)
- Tutorial 22: Adding Simulink Signals to Record Frame Movements
- Tutorial 23: Automatic Creation of a Missing Link and 3D Print of a Complete Model
- Tutorial 24: Automatic Creation of a Joint Limitations
- Tutorial 25: Automatic Creation of Video Titels, Endtitels and Textpages
- Tutorial 26: Create Mechanisms using Universal Planar Links
- Tutorial 27: Fourbar-Linkage: 2 Pose Syntheses and Linkage Export for 3D Printing
- Tutorial 28: Fourbar-Linkage: 3 Pose Syntheses and Linkage Export for 3D Printing
- Tutorial 29: Create a multi body simulation using several mass points
- Tutorial 30: Creating graphical drawings using point, lines, surfaces, frames etc.
- Tutorial 31: Importing 3D Medical DICOM Image Data and converting into 3D Solids
- Tutorial 32: Exchanging Data with a FileMaker Database
- Tutorial 33: Using a Round-Robin realtime multi-tasking system
- Tutorial 34: 2D Projection Images and Camera Coordinate System Reconstruction
- Tutorial 35: Collection of Ideas for Tutorials

- Tutorial 36: Creating a Patient-Individual Arm-Skin Protector-Shell

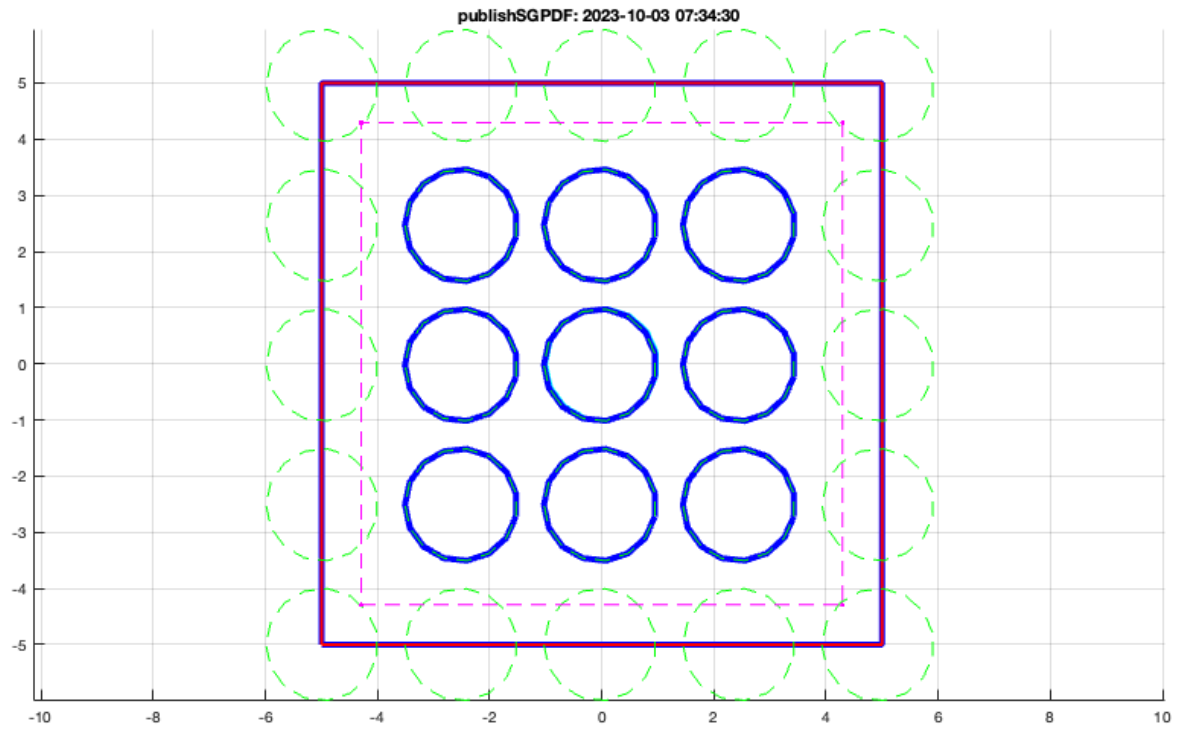
### Motivation for this tutorial: (Originally SolidGeometry 2.6.1 required)

#### 2. Fill a contour with copies of pattern

As it was shown already in the function SGplatesofSGML, it often makes sense to fill a contour with another pattern. This can be done by using one of the following functions:

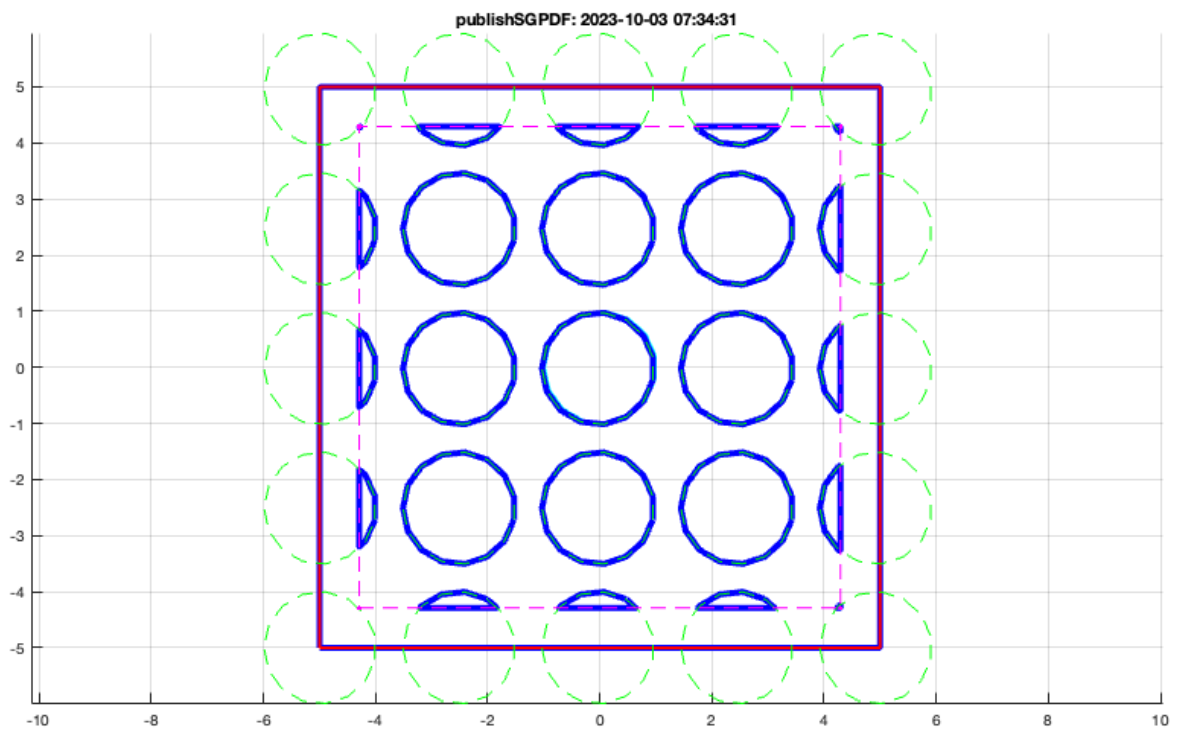
- **CPLfillPattern(CPLA, CPLB,w,d)** - fills a contour CPLA with copies of the pattern CPLB with a distance to the outer contour w and distance between the patterns of d

```
SGfigure; view(0,90); axis on;
CPLfillPattern(PLsquare(10,10),PLcircle(1),1);
```



This can also be done with cutted pattern instead of complete pattern

```
SGfigure; view(0,90); axis on;
CPLfillPattern(PLsquare(10,10),PLcircle(1),1,[],true);
```



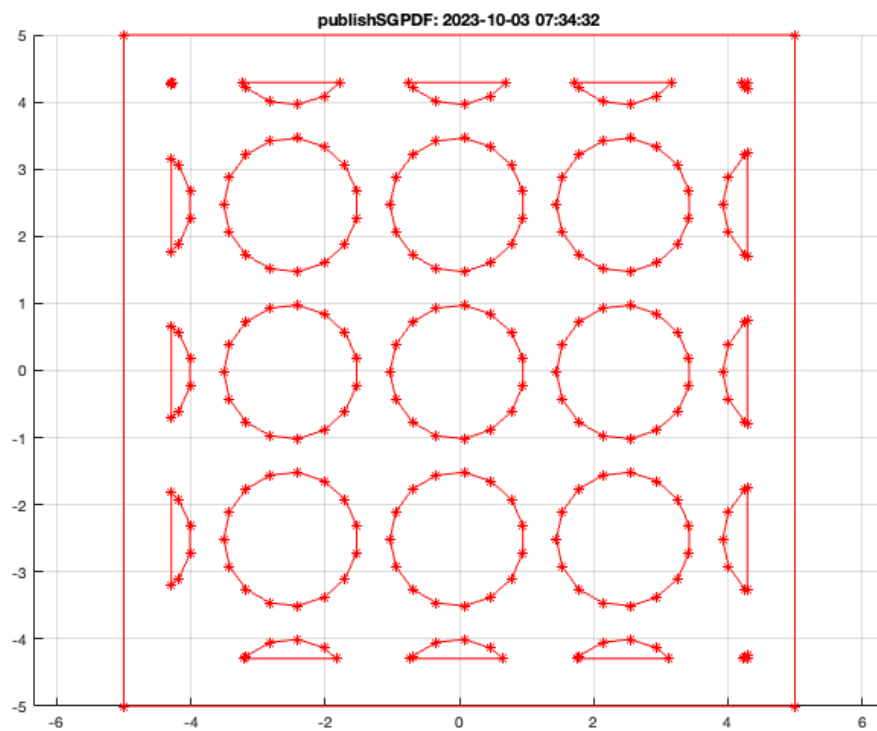
### 3. Writing a contour as SVG-File for laser-cutting

Especially for laser cutting or plating of contours, the SVG file-format is very popular. Handling of SVG Files is possible using the following functions:

- **CPLwriteSVG (CPL,Filename)** - writes the contours in a SVG-File

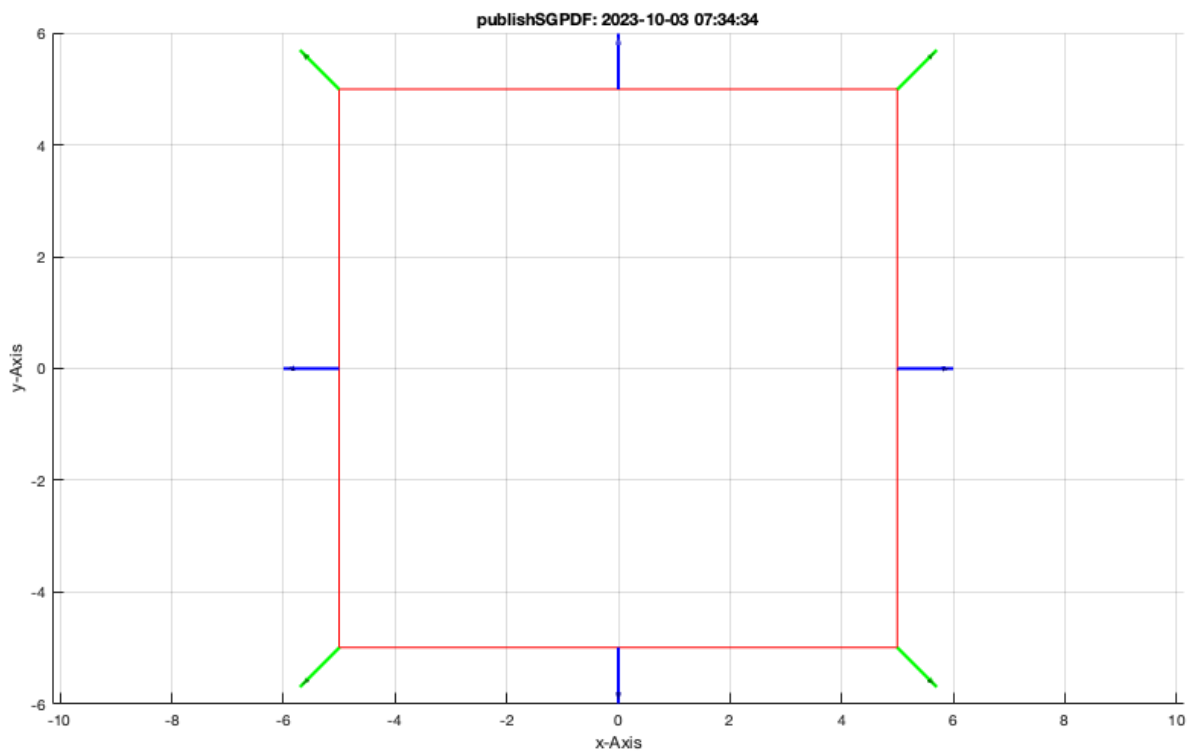
```
SGfigure; view(0,90); axis on;
A=CPLfillPattern(PLsquare(10,10),PLcircle(1),1,[],true);
CPLplot(A);
CPLwriteSVG(A,'VLFL_EXP14');
```

WRITING SVG FILE /Users/timlueth/Desktop/VLFL\_EXP14.SVG in ASCII MODE completed.



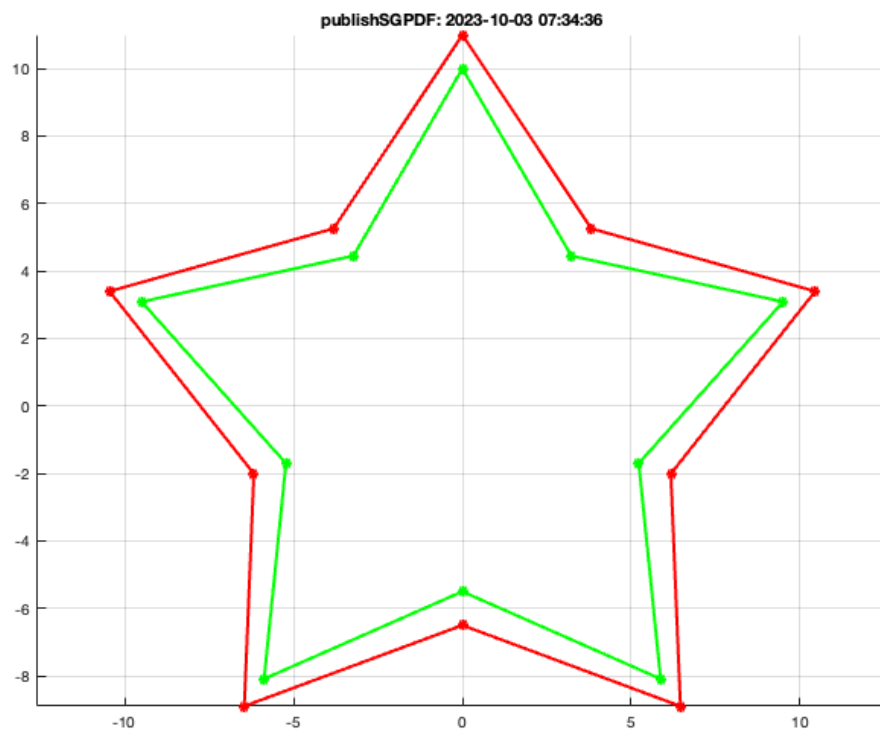
#### 4. Calculating the normal vectors of edges and points

```
SGfigure; view(0,90);  
CPLedgeNormal(PLsquare(10,10)); axis on;
```



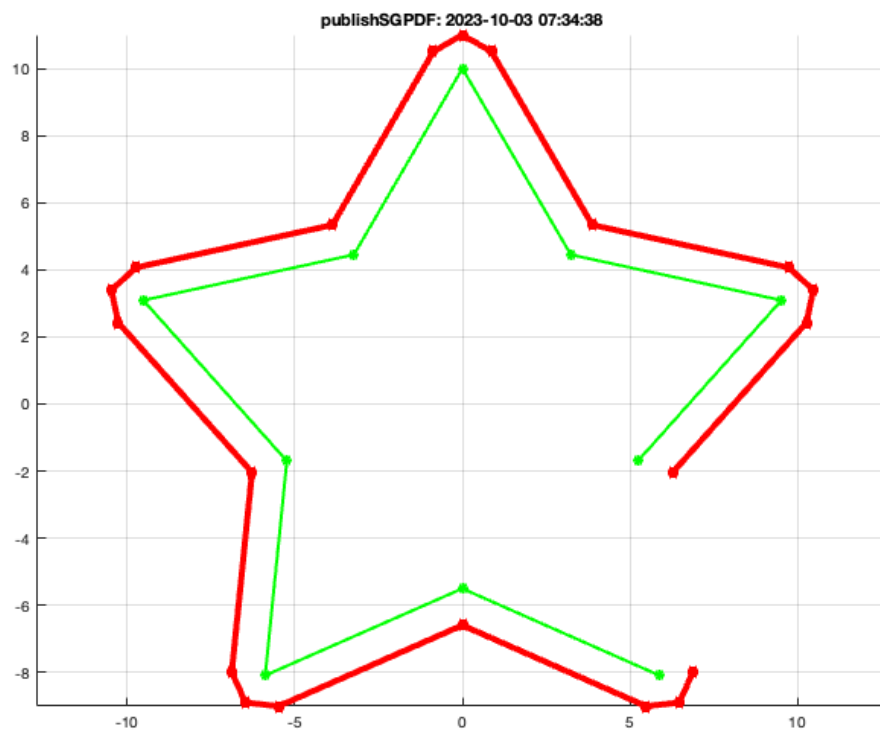
### 5. Growing with same number of points

```
SGfigure; view(0,90);  
CPLgrow(PLstar(10,10),1); axis on;
```



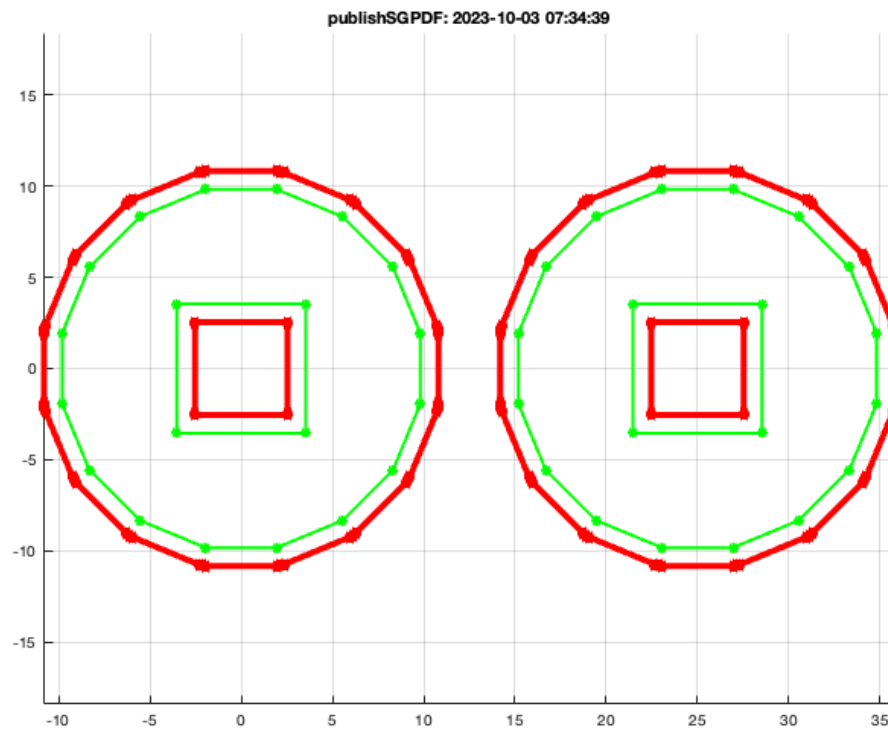
## 6. Growing with correct distance to edges

```
SGfigure; view(0,90); axis on;  
CPLgrowEdge(PLstar(10,10),1);
```



#### Another example using CPLsample

```
SGfigure; view(0,90);  
CPLgrowEdge(CPLsample(12),1); axis on;
```



#### Growing may have no problems

```

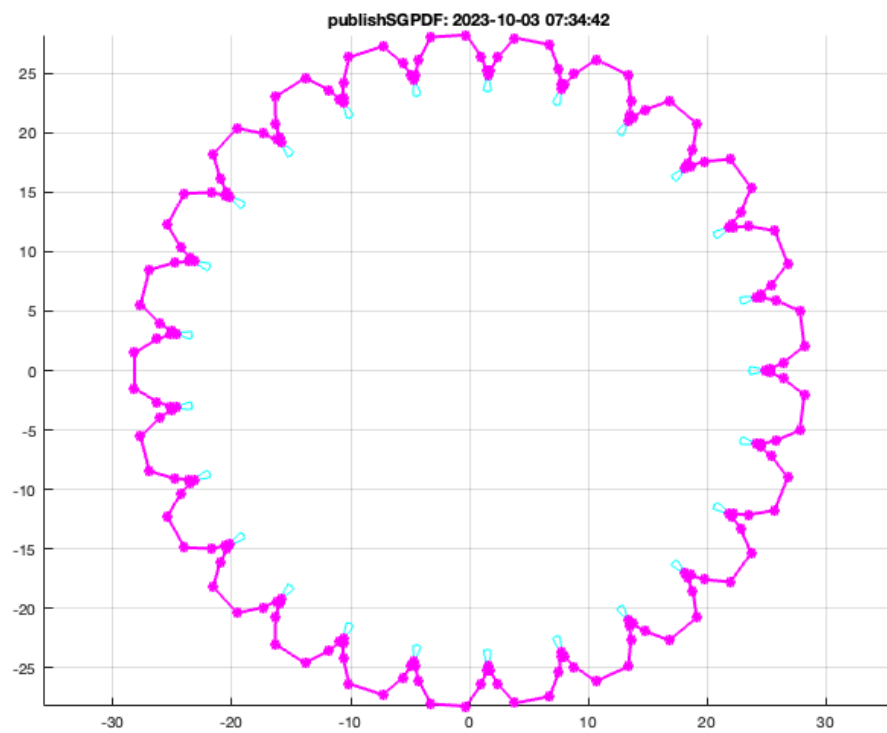
SGfigure; view(0,90);
CPLgrow(CPlofPL(PLgearDIN(2,25)),0.5); axis on;

% *Growing may have problems*
SGfigure; view(0,90);
CPLgrow(CPlofPL(PLgearDIN(2,25)),1.5); axis on;

% *Growing problems can be solved using CPLoutercontour*
SGfigure; view(0,90);
CPLoutercontour(CPLgrow(CPlofPL(PLgearDIN(2,25)),1.5));

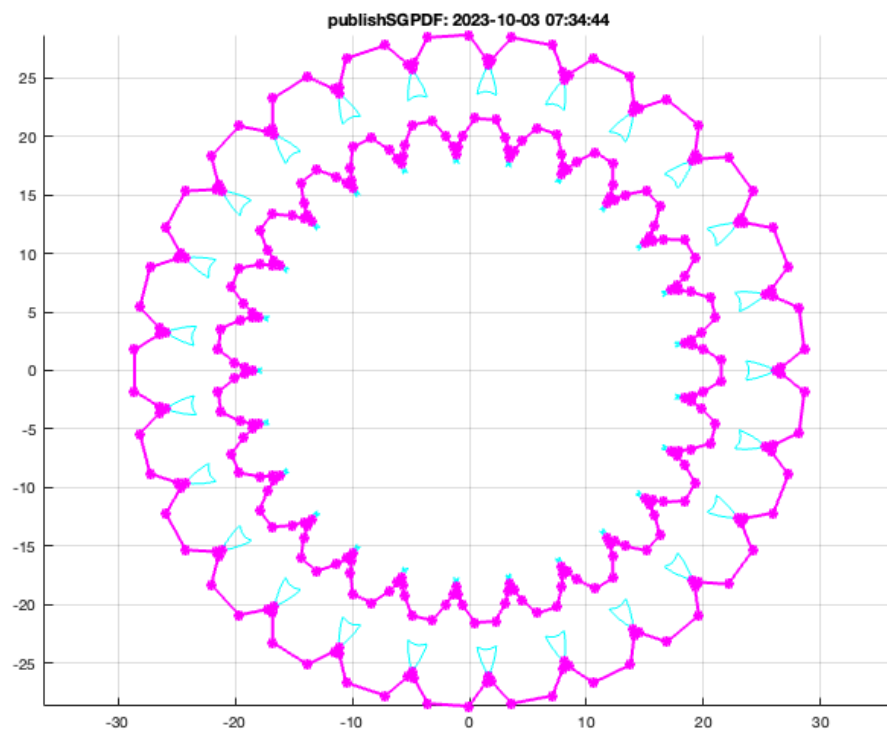
```



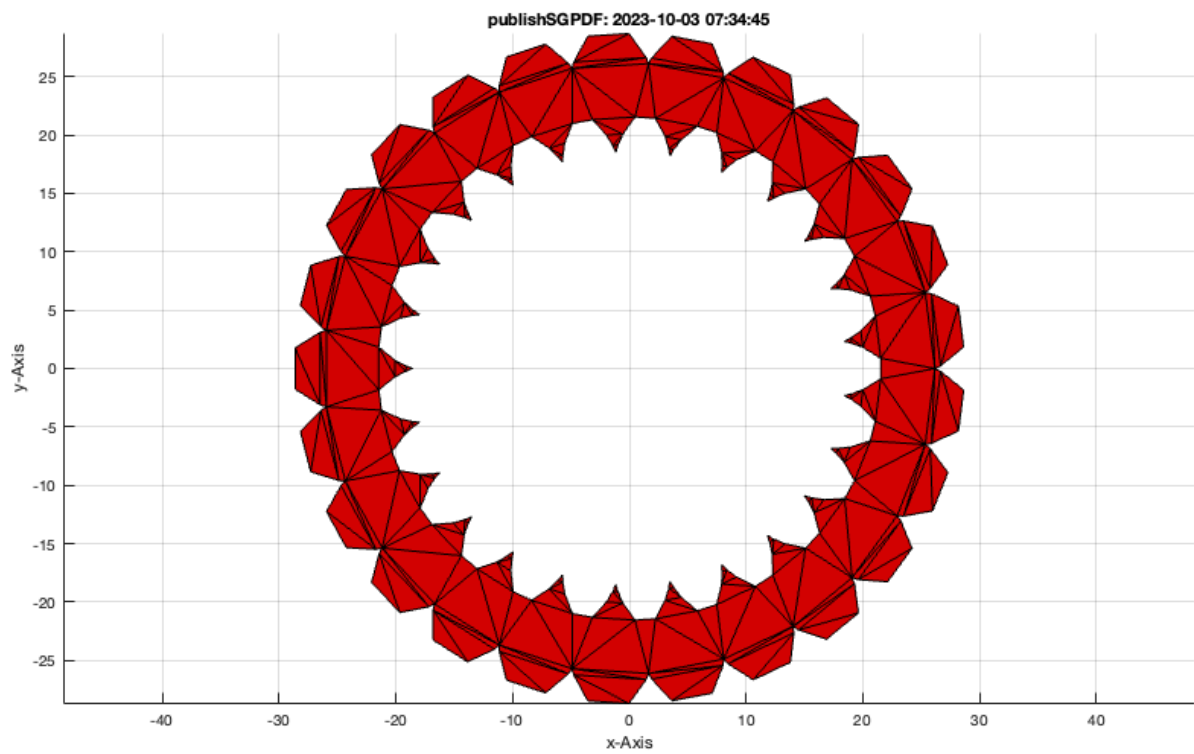


#### Another example using CPLoutercontour

```
SGfigure; view(0,90);  
CPLoutercontour(CPLsample(25),1); axis on;
```



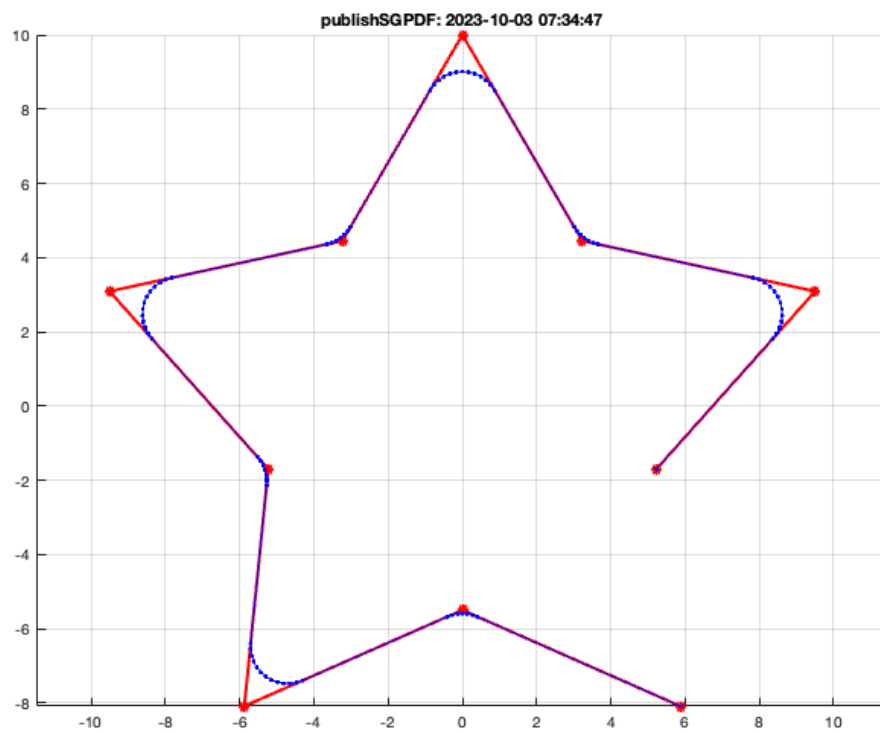
```
PLFLoFCPLdelaunay(CPLoutercontour(CPLsample(25),1));
```



## 7. Rounded edges inside a contour

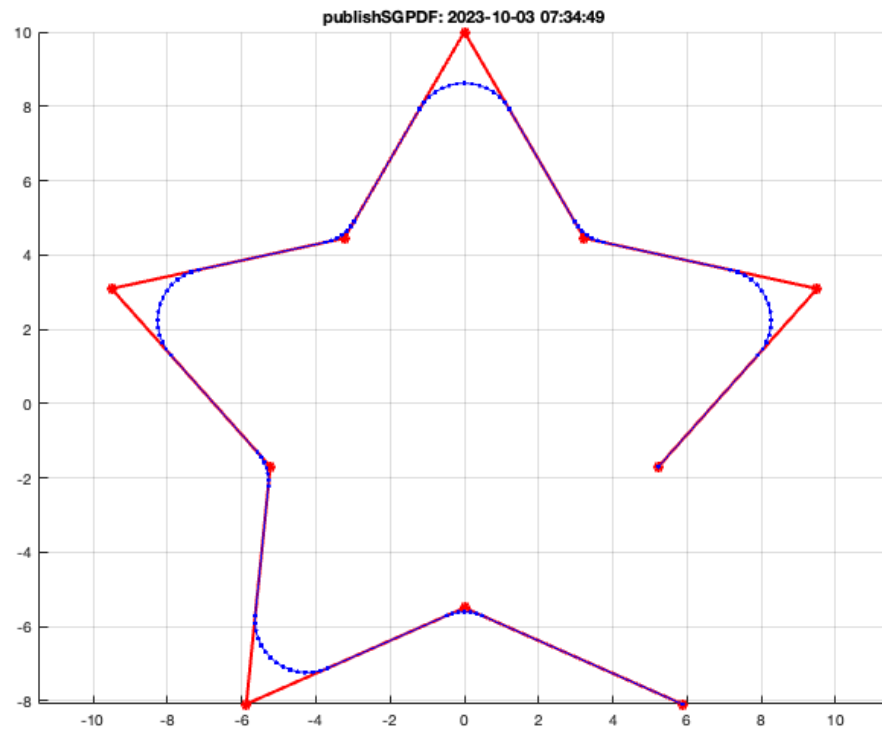
Another method to change the shape of a contour is to round the edges.

```
SGfigure; view(0,90);  
PLradialEdges(PLstar(10,10));axis on;
```



Another example using radius=2

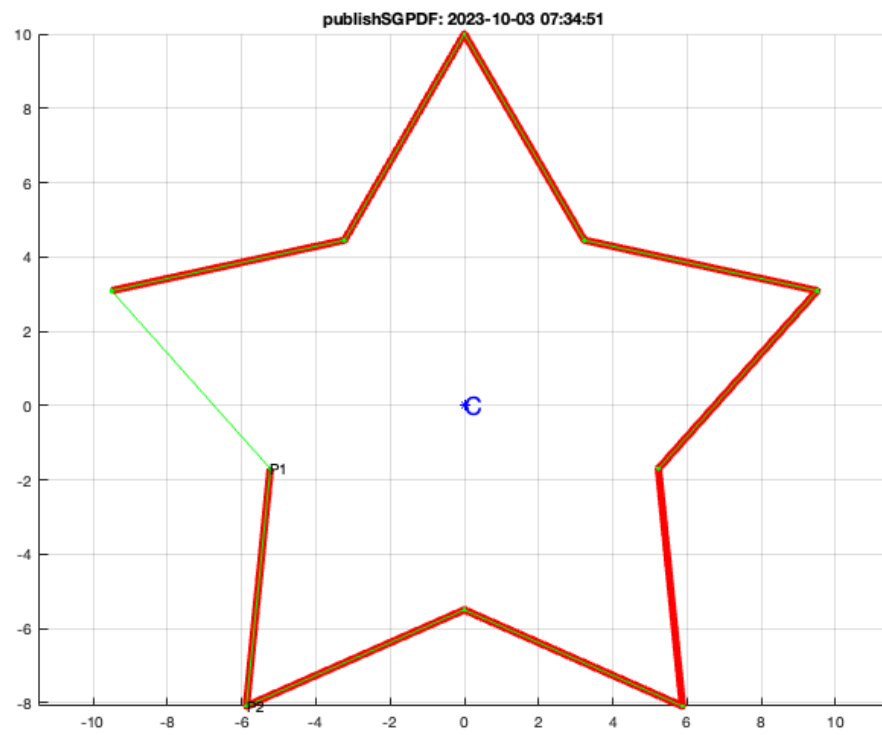
```
SGfigure; view(0,90); axis on;  
PLradialEdges(PLstar(10,10),2); axis on;
```



## 8. Sort CPLs around its center

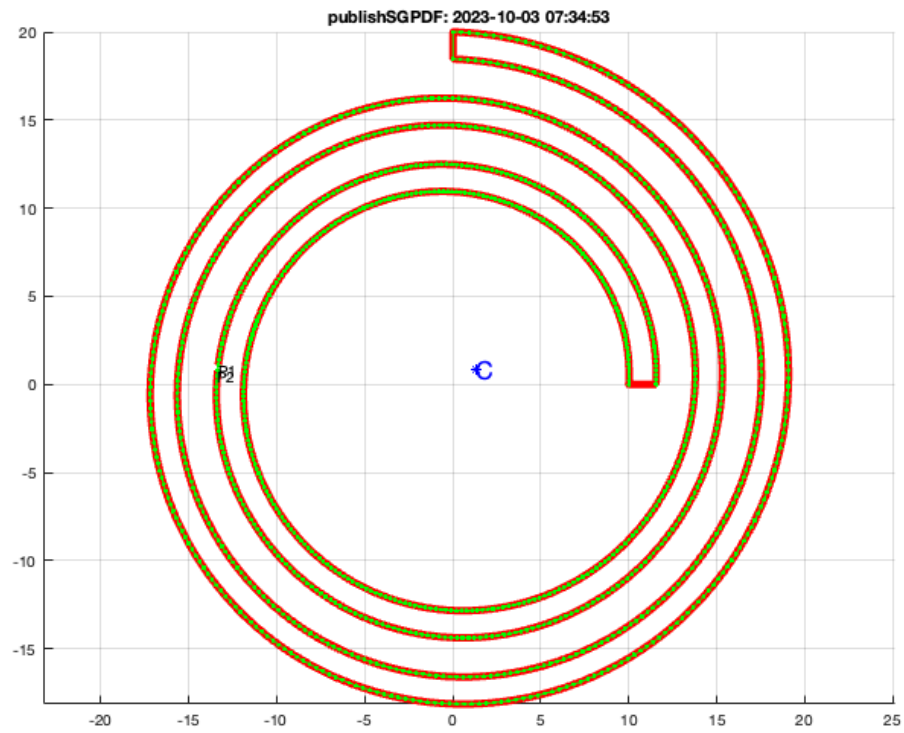
Find the minimal angle value of a star

```
SGfigure; view(0,90);  
CPLsortC(PLstar(10,10),'min'); axis on;
```



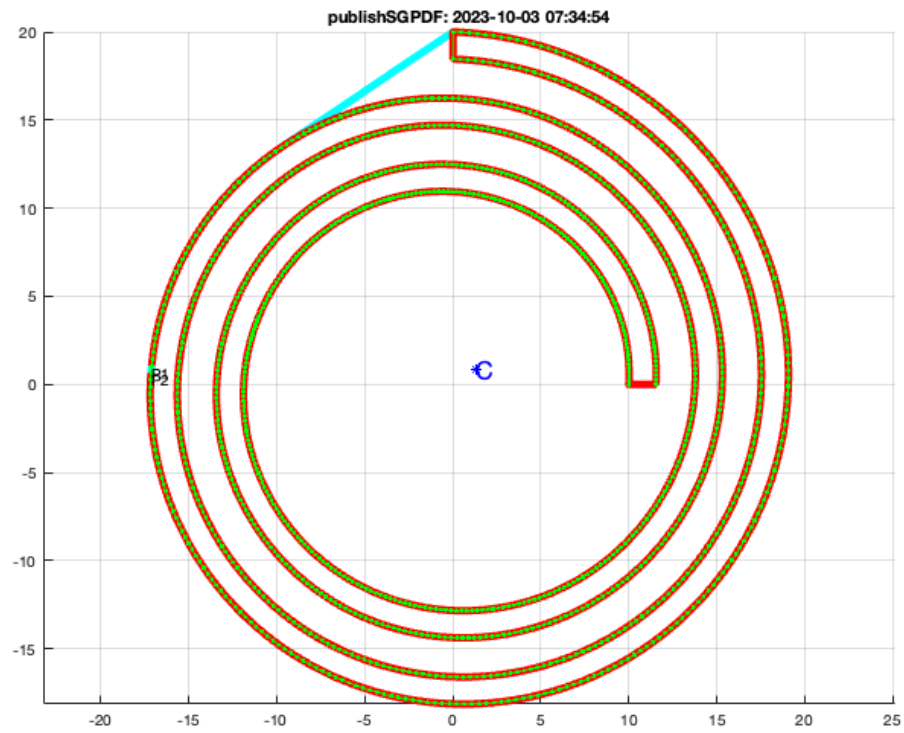
Find the minimal angle value of a spiral

```
SGfigure; view(0,90);  
CPLsortC(CPLspiral(10,20,4*pi+pi/2), 'min');
```



Find the minimal angle value of convex hull of a spiral

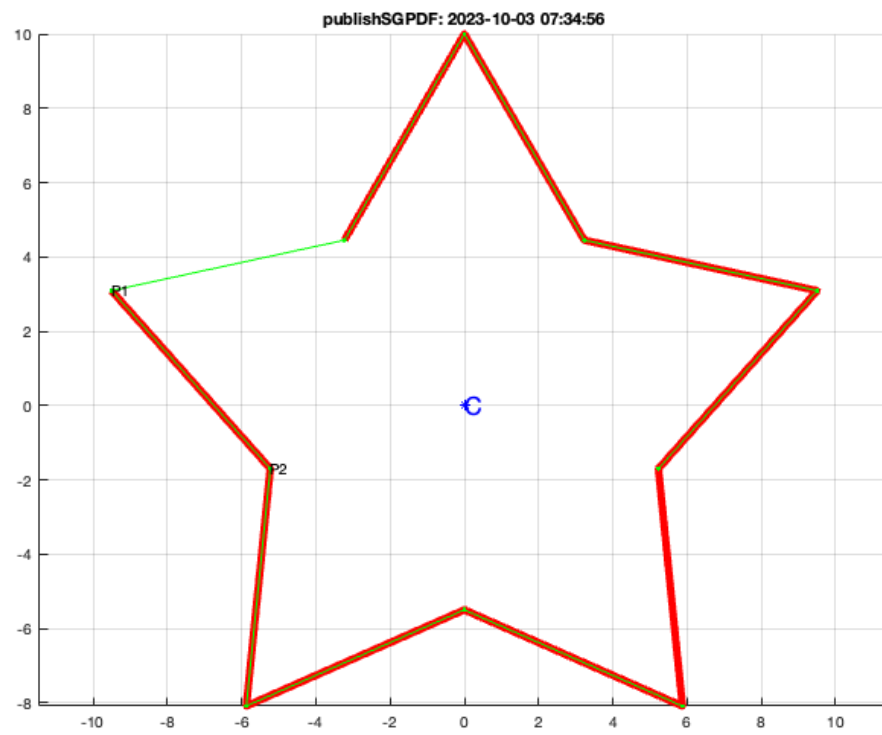
```
SGfigure; view(0,90);  
CPLsortC(CPLspiral(10,20,4*pi+pi/2), 'cmin');
```



Find the maximum angle value of a star

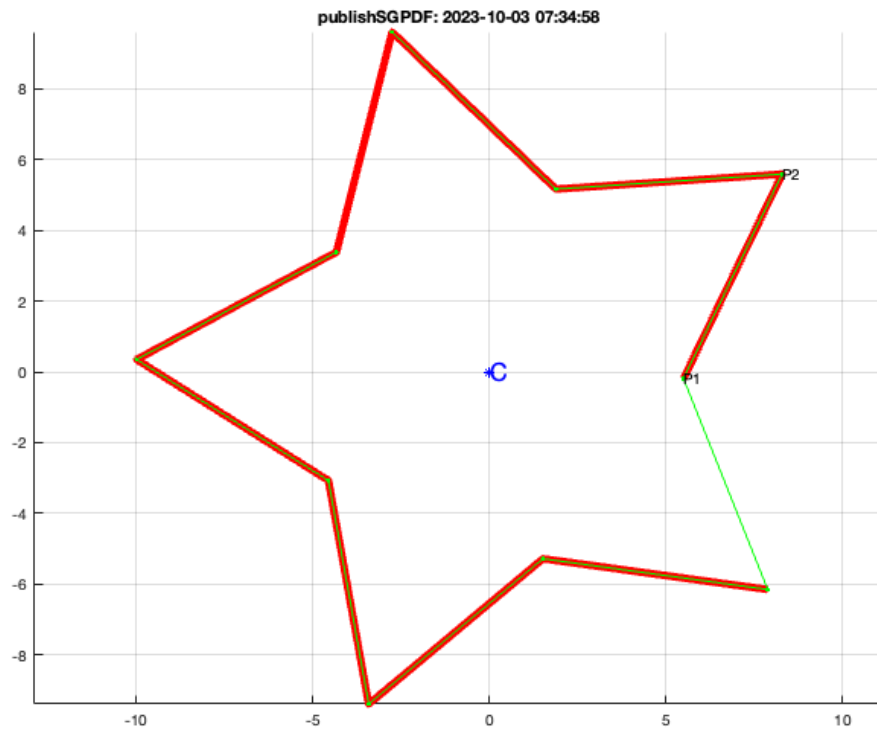
```
SGfigure; view(0,90);  
CPLsortC(PLstar(10,10),'max'); axis on;
```





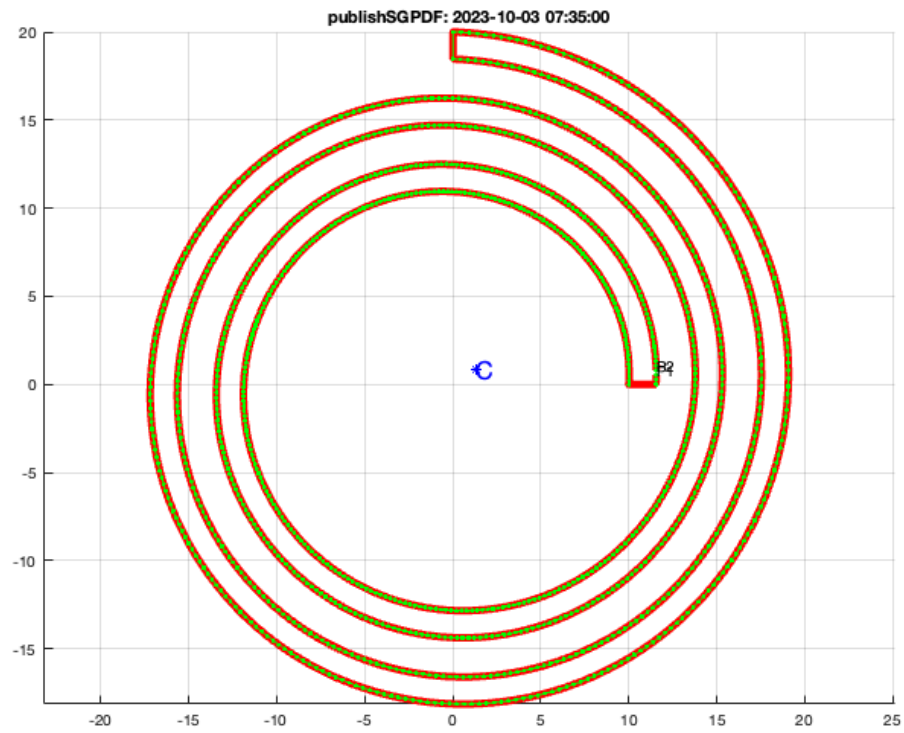
Find the angle value nearest to zero of a star

```
SGfigure; view(0,90);  
CPLsortC(PLtrans(PLstar(10,10),rotdeg(160)), 'zero'); axis on;
```



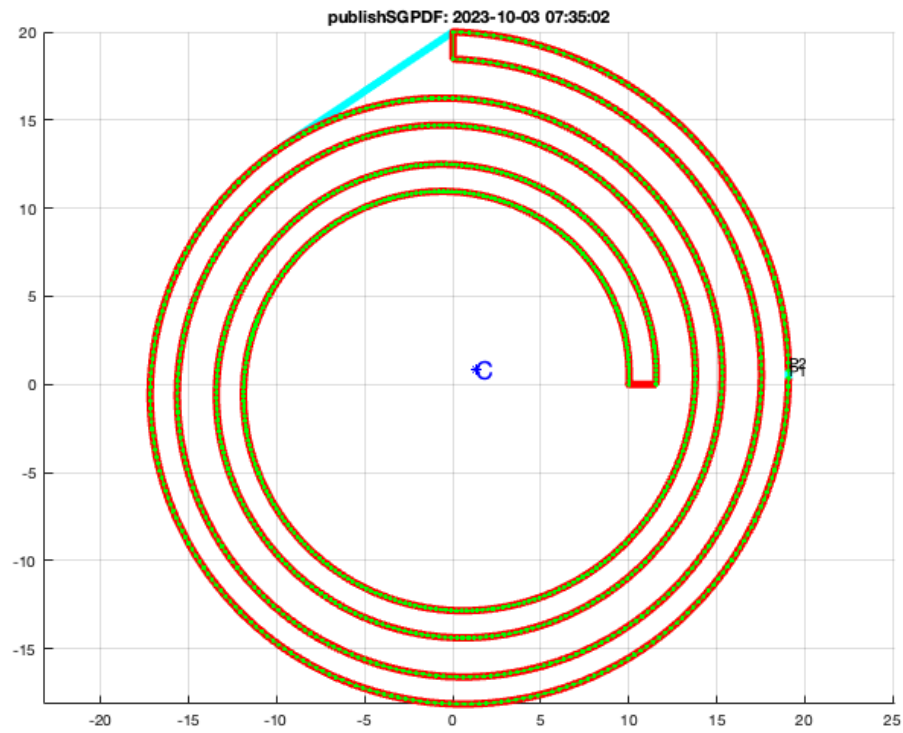
Find the angle value nearest to zero of a spiral

```
SGfigure; view(0,90);  
CPLsortC(CPLspiral(10,20,4*pi+pi/2), 'zero');
```



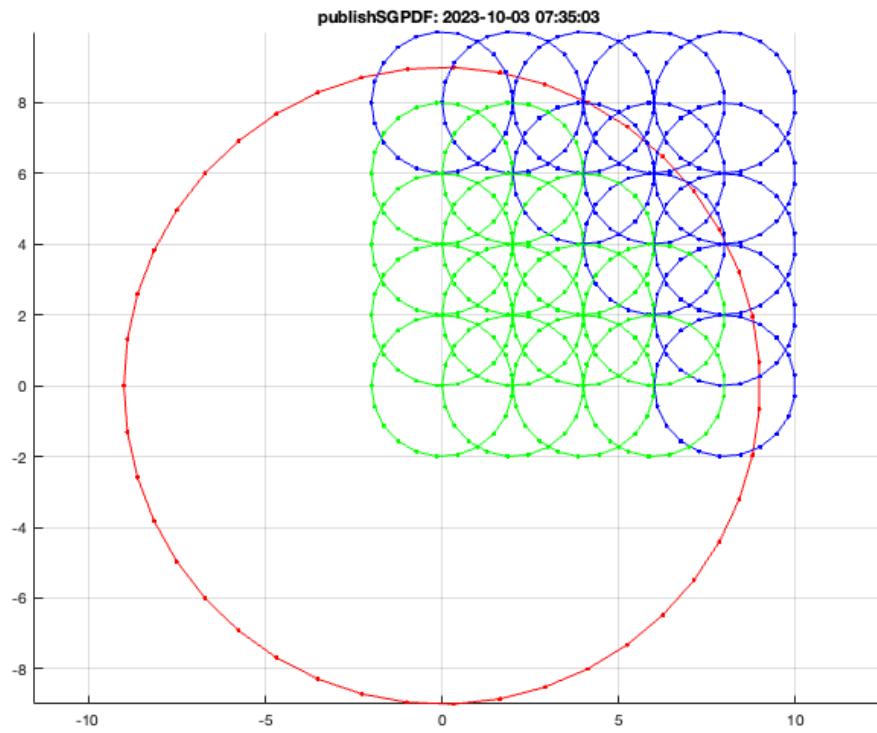
Find the angle value nearest to zero of convex hull of a spiral

```
SGfigure; view(0,90);  
CPLsortC(CPLspiral(10,20,4*pi+pi/2),'czero');
```



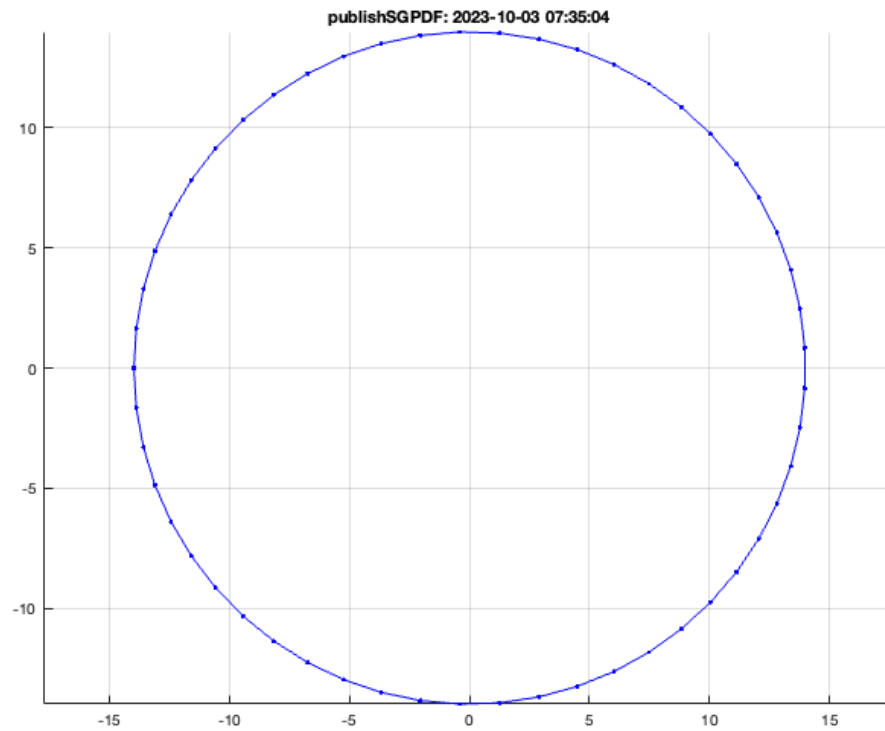
### 9. Informations on contours inside of others

```
SGfigure; view(0,90);  
CPLinsideCPL(PLcircle(9),CPLcopypattern(PLcircle(2),[5 5],[2 2])); axis on;
```



Identical contours are not inside each other

```
CPLinsideCPL(PLcircle(14),CPLsortC(PLcircle(14)));
```



## 10. Order contours for the sequential plot with a laser cutter

The "level" starts with zero runs from outer to inner. In case of a laser cutter it is necessary to cut the inner contours first.

- **\*CPLwriteSVG\*** - writes a CPL and SVG on disk
- **\*svgpolylineofCPL\*** - plots an SVG file
- **\*separateNaN\*** - separates CPLs and CVLs
- **\*selectNaN\*** - creates a new set of selectex CPLs/CVLs
- **\*CPLsortinout\*** - sorts contours to inner and outer

```
SGfigure; view(0,90);
[ci,CC]=CPLsortinout(CPLsample(14))
CPLsortinout(CPLsample(14));
```

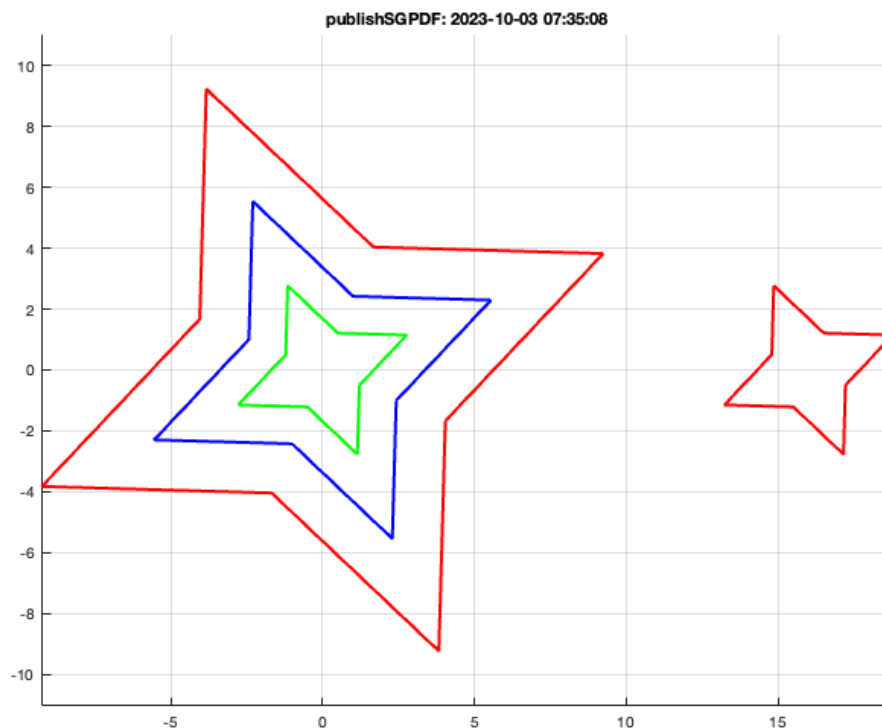
```
ci =
    0
    1
    2
    0
    1
    2
CC =
NaN    1    1   -1   -1   -1
-1   NaN    1   -1   -1   -1
-1   -1   NaN   -1   -1   -1
-1   -1   -1   NaN    1    1
-1   -1   -1   -1   NaN    1
-1   -1   -1   -1   -1   NaN
```

Show a selection from inner to outer for laser cutting

```
CPLsortinout(selectNaN(CPLsample(14),[1,2,3,6]));
```

Now change the order direction from outer to inner

```
CPLsortinout(selectNaN(CPLsample(14),[1,2,3,6]),false);
```



Now write is als a cutter file

```
CPLwriteSVG(CPLsample(14), 'VLFL_EXP14_cutter', '', true);
```

WRITING SVG FILE /Users/timlueth/Desktop/VLFL\_EXP14\_cutter.SVG in ASCII MODE completed.

Final remarks on toolbox version and execution date

VLFLlicense

```
This VLFL-Lib, Rel. (2023-Oct-03), is for limited non commercial educational use only!
Licensee: Tim Lueth (Development Version)!
Please contact Tim Lueth, Professor at TU Munich, Germany!
WARNING: This VLFL-Lib (Rel. ) license will exceed at 06-Jul-2078 07:35:09!
Executed 03-Oct-2023 07:35:11 by 'timlueth' on a MACI64 using Mac OSX 13.6 | R2023a Update 5 | SG-Lib 5.4
===== Used Matlab products: =====
database_toolbox
distrib_computing_toolbox
fixed_point_toolbox
image_toolbox
map_toolbox
matlab
optimization_toolbox
pde_toolbox
phased_array_system_toolbox
signal_blocks
signal_toolbox
simmechanics
simscape
simulink
statistics_toolbox
=====
```

- Tim Lueth, tested and compiled on OSX 10.7.5 with Matlab 2014b on 2015-09-20
- \_\_\_\_\_, executed and published on 64 Bit PC using Windows with Matlab 2015a on 2015-xx-xx\_

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