Inkscape Extension

Origami-Ext

User's Guide

v1.0.r3

01/04/2020

General operation

Description :

The Origami-Ext extension is intended to help drawing origami diagrams to easily solve geometry problems specific to it: if all can be drawn only using the Inkscape functionalities (with the notable exception Huzita-6 axiom), most require more or less numerous manipulations and/or calculations. The problems it helps solve are:

– The seven Huzita-Hatori-Justin axioms, basic set for all origami folds;
– The N-Section ($2 \leq N \leq 64$) of either an angle or a straight line segment into a set of perpendicular straight lines, useful for grids or dimension scales;
– The computation for the rabbit-ear fold of the fourth angle.

Each module deals with a specific problem and is described in more detail in the following pages, one by one.

Use :

The origami geometric problems only require the definition of points and straight lines segments. For that, Origami-Ext modules inputs only use an Inkscape tool:  , which allows drawing paths made of either Bézier curves or straight line segments bounded by two nodes. These nodes depict points and the straight line segments are depicted by a set of two nodes used as their boundaries. The curves or straight line segments for the drawn by Inkscape between nodes are purely and simply ignored by the modules and only the nodes are relevant. For the sake of clarity, in the rest of this document, points will mean nodes and the segments a set of two nodes bounding a straight line segment.

Using any modules rely on the same standard process, broken down into four stages:

1. Using the tool  , define a single path made of a number of points, their order and meaning being specific to each module, as detailed on the following pages. At the end of its creation, the path is, by default, selected (if, for any reason whatsoever, it is not or no longer, it is imperative to reselect it, as it represents the whole data supplied as input to the module for its computation);
2. Open the module you wish to use ("Extensions→Origami→Module_Name") and select its various options. Every single module has an option called "Suppress *construction segment*" which, in practice, should be checked to automatically suppress the construction segment as it usually won't be needed further in the diagram;
3. Click on the "**Apply**" button: the result is then displayed and saved as an Inkscape guide, allowing to draw precisely the fold resulting as a solution to the given problem and, if the option "Suppress *construction segment*" is checked, the construction segment is deleted or otherwise simply unselected;
4. Finally click on the "**Close**" button to exit the module and close its window.

Alternatively, you can check the "Live preview" checkbox which will run the module and display its result temporarily to check if it complies with your expectations. If everything is correct, then click the on the "**Apply**" button to commit the changes and then on the "**Close**" button to exit the module. Otherwise, you can either click directly on the "**Close**" button to rollback the changes and

exit the module or uncheck the "Live preview" checkbox which will not exit the module but rollback the changes, so you might revise your construction path and then check it again.

If there is no selected item or it is not a path or its number of points does not meet the module expectation, an error message is displayed and no computation is done

Note #1: if, unluckily, the start and end points of the path become are the same, Inkscape then considers the path as *closed* and does account this last point when describing the path into the status bar. But the modules take care of this case and, internally, add a virtual point to the path whose coordinates are those of the first point, making this event transparent to the user.

Note #2: the choice of drawing a guide rather than directly a segment for the fold comes is because the modules have no knowledge of its ends: the modules make a formal computation from the input data entered and know nothing about the diagram itself. Its result is just the position and orientation of the fold responding to the requested problem and then it is up to the user to draw the fold, knowing that its two ends are located somewhere on this guide. Note that there is a case where modules perfectly know the two ends of a segment to draw: the projection of a point onto a line (see next section).

Projections :

When the requested problem includes the use of projections of a point onto a line (a segment), the solution require the computation of a parabola whose focus is the point and their directrix the segments. Its parameter (which defines the parabola size and orientation) is then the size of the segment connecting the focus to the directrix, perpendicular to the latter. It is then a question of finding the fold corresponding to a tangent straight line to this parabola, such that it fulfills another condition as:

– **Huzita-5 :** go through a point;

– **Huzita-6 :** be tangent to another parable resulting from another projection;

– **Huzita-7 :** be perpendicular to a specific segment (other than the directrix).

There may be no or more than one solution for these problems. However, in a diagram, a single fold is requested. For that reason, these modules use an heuristic to eliminate the apparently aberrant solutions, which consists in ignoring any solution for which the projection of a point on a segment is located outside the limits of this segment, bounded by the two points used to define it.

Optionally, these modules can draw the parabola(s) used for the computation if the option "*Draw construction"* in the <**Advanced**> tab is checked and/or, if the option "*Draw projection"* on the <**Options**> tab is checked, the segment(s) connecting the point to its projection onto the segment that can be very useful for representing the fold direction arrows in the diagram. The color and thickness of those segments can be configured in the <**Projections**> tab.

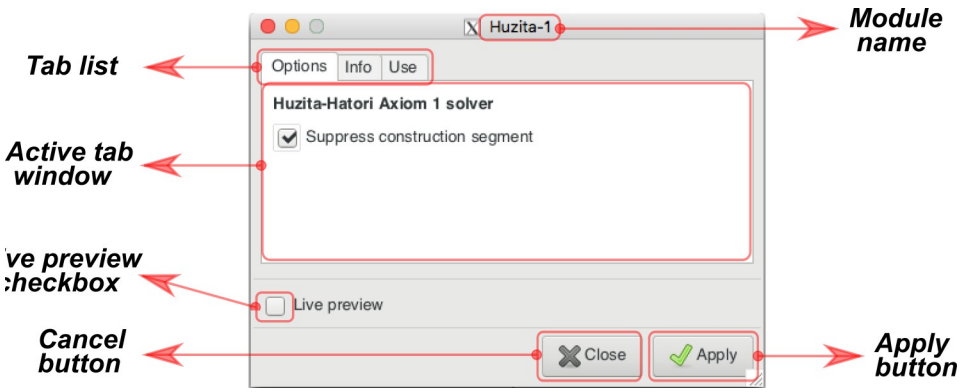
If, eventually, there is no solution, an error message is displayed and, if the "*Draw construction*" option has been checked, the parabola(s) are nevertheless drawn, which may be useful to understand the lack of solution. The height of the parabola(s) is tunable through the "**Advanced"** tab with the numeric box "*Scale*", which is the number of times the value of the parameter of the parabola height it will be.

If, despite the heuristic implemented, more than one solution is still possible, an warning message is displayed to tell the user he has to make a choice and manually remove the unneeded result(s): guide(s), parabola(s) and projection(s).

Note : Although the Huzita-4 module is not based on a point→line projection, it is based on a line→line projection and so the heuristic described above is therefore also applied to it.

Windows :

When a module is launched it opens a new window:



Tabs:

Each module window has a number of tabs which may vary. Whatever the module, three tabs are always available:

- **Options:** basic options ;
- **Info:** reminder of problem statement handled by the module (text only) ;
- **Use**: quick guide for the module input/output (text only).

Note : In the following pages describing each modules individually, the two tabs "Info" and "Use" will not be described, their use being strictly identical regardless of the module.

Two additional tabs are available for modules which require one or more point→line projections (Huzita-5, 6 and 7 modules):

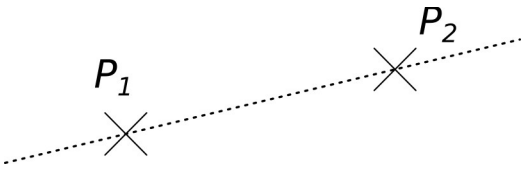
- **Advanced:** allows to choose to draw the construction parabola(s) and tune their height;
- **Projections :** allows to choose stroke thickness and color of the projection segment from the point onto the line it is projected to.

Buttons:

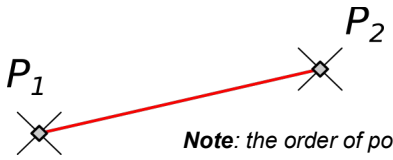
- **Live preview:** runs the module to temporarily display its result for checking;
- **Cancel:** closes the module window and cancel its actions if the live preview option is turned on;
- **Apply**: runs the module and commit its results, whatever state is the live preview option.

Huzita-1 module

Problem: Given to points P_1 and P_2, find the fold passing through these two points:

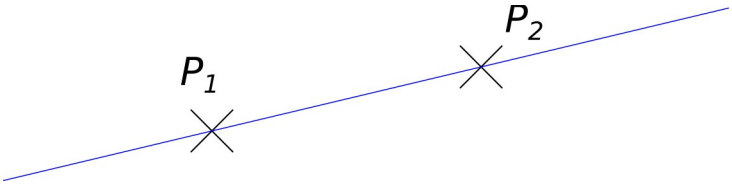


Construction : Draw a path from P_1 to P_2:



***Note**: the order of points 1 et 2 does not matter.*

Solution: From menu, select: "Extensions→Origami→Huzita-1" then click "**Apply"**.
Draws a guide materializing the resulting fold:



Tabs: <**Options**> :

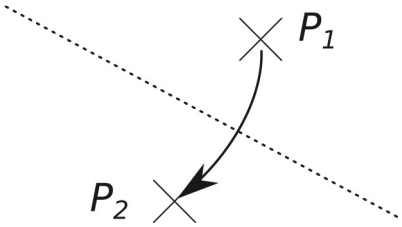
– "*Suppress construction segment*": Suppress automatically the construction segment.

Comments: – There is always one and only one solution.

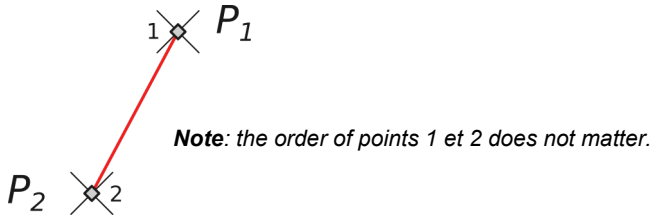
– This module is of very little interest since the construction segment is, with a few exceptions, already the fold itself. Its sole purpose is to complete the whole of the Huzita-Hatori-Justin axioms.

Huzita-2 module

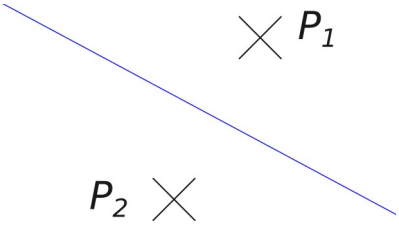
Problem: Given two points P_1 and P_2, find the fold resulting of the projection of P_1 onto P_2:



Construction : Draw a path from P_1 to P_2:



Solution: From menu, select: "Extensions→Origami→Huzita-2" then click "**Apply"**.
Draws a guide materializing the resulting fold:



Tabs: <**Options**> :

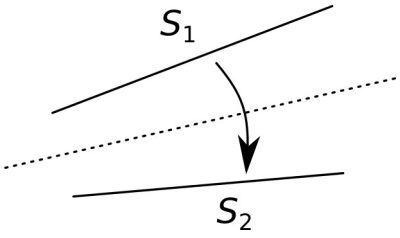
"*Suppress construction segment*": Suppress automatically the construction segment.

Comments : There is always one and only one solution.

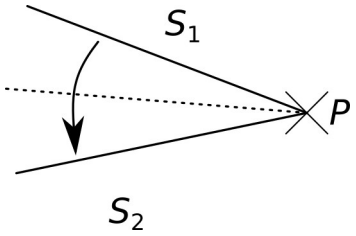
Huzita-3 module

Problem: Given two straight line segments S_1 et S_2, find the fold resulting of projection of S_1 onto S_2. Two cases are handled: either S_1 and S_2 are not concurrent (they might even be parallel) or S_1 et S_2 share the same origin, point P:

CASE 1

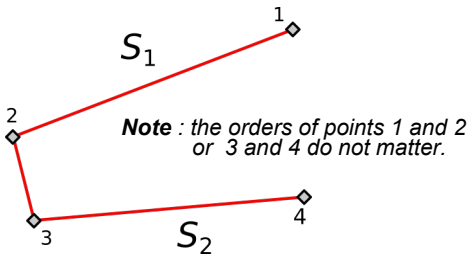


CASE 2

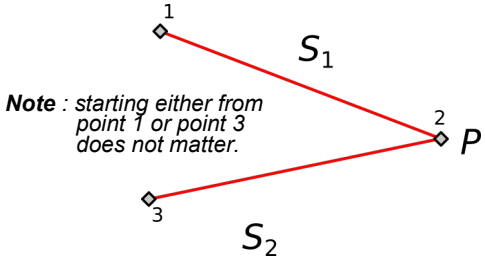


Construction:

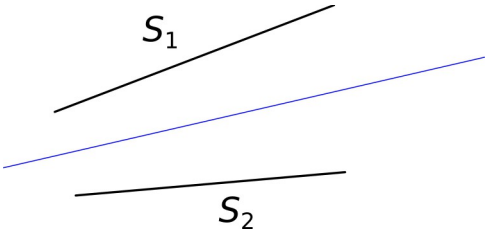
Draw a path connecting the two ends of S_1 followed by two other points at the two ends of S_2:

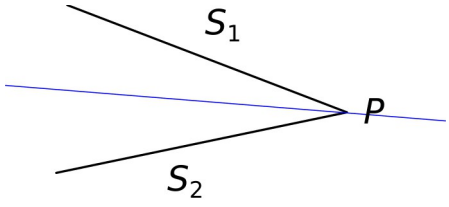


Draw a path connecting the free end of S_1 to P followed by a point at the other end of S_2:



Solution: From menu, select: "Extensions→Origami→Huzita-3" then click "**Apply**".
Draws a guide materializing the resulting fold:





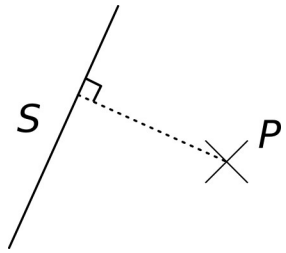
Tabs : <**Options**> :

"*Suppress construction segment*": Suppress automatically the construction segment.

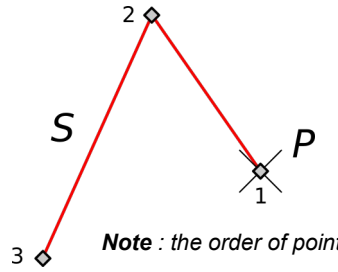
Comments : There is always one and only one possible solution **unless** for case 1, if the two segments are concurrent and one or both of them extend beyond their intersection point, in which case there are two possible solutions, with a 90° angle at the intersection point. In this case, a warning message is displayed and the two solutions are then drawn.

Huzita-4 module

Problem: Given a point *P* and a segment *S*, find the fold passing through *P* while projecting *S* onto itself:

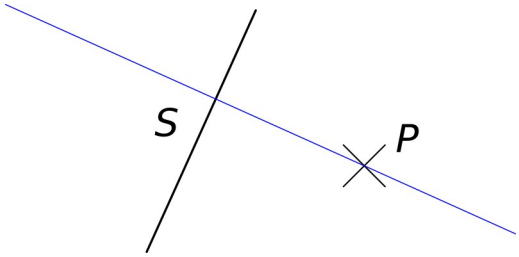


Construction : Draw a path starting from *P*, followed by two points located on each end of segment *S*, those points enforcing its boundaries:



***Note** : the order of points 2 et 3 does not matter.*

Solution: From menu, select: "Extensions→Origami→Huzita-4" then click "**Apply"**.
Draws a guide materializing the resulting fold:



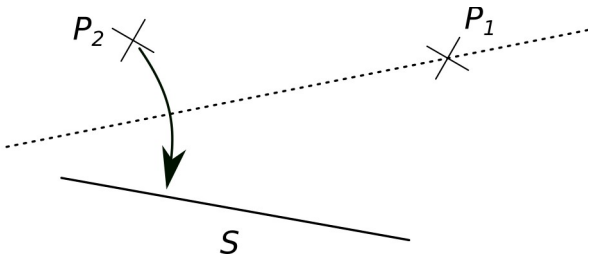
Tabs: <**Options**> :

"*Suppress construction segment*": Suppress automatically the construction segment.

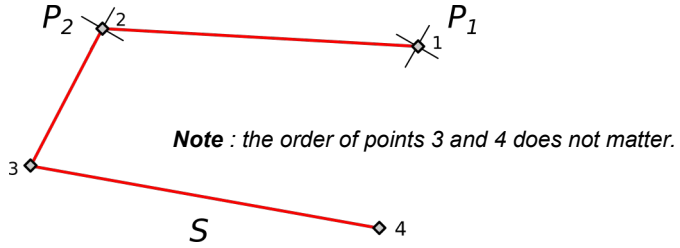
Comments: There can be one and only one solution **unless** the intersection between the fold and segment *S* is located outside the segment boundaries enforced by points 2 and 3. In this case, the solution is regarded as impossible and is therefore discarded and a warning message is displayed.

Huzita-5 module

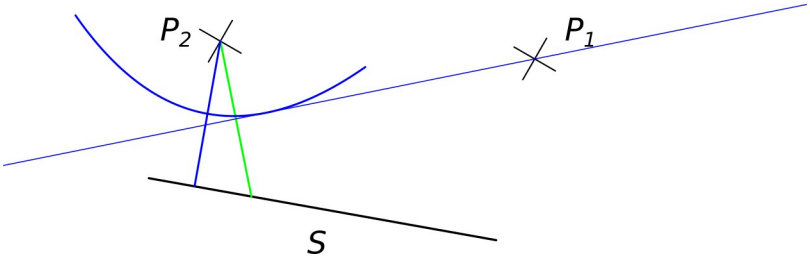
Problem: Given two points P_1 and P_2 and a segment S, find the fold passing through P_1 while P_2 is projected onto S :



Construction: Draw a path starting from P_1, followed a point located on P_2 and then two points located on each end of segment S, those points enforcing its boundaries:



Solution: From menu, select: "Extensions→Origami→Huzita-5" then click "**Apply"**.
Draws a guide materializing the resulting fold and optionally the parabola used for the construction and/or the projection segment:



Tabs : <**Options**> :

– *"Draw projections"*: Draws projection of point P_2 onto segment S;
– "*Suppress construction segment*": Suppresses automatically the construction segment.

<**Advanced**> :

– *"Draw construction"*: Draws the parabola used for the projection computation;
– *"Scale":* Defines the height of the parabola.

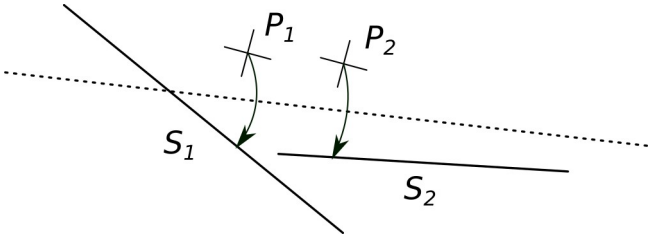
<**Projections**> :

– « *Stroke width* » : Defines projection segment stroke width;
– « *Stroke color* » : Defines projection segment stroke color;

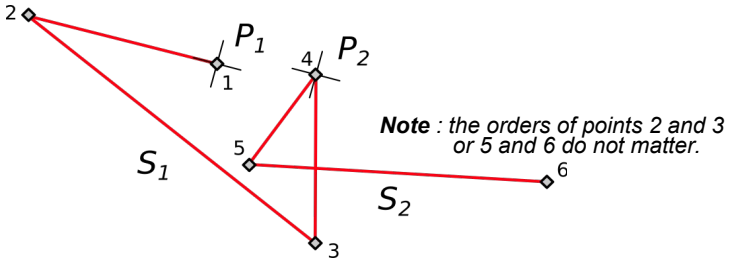
Comments:
– There can be between 0 and 2 solutions: those where the projection of P_2 onto segment S are located outside the segment boundaries enforced by points 3 and 4 of the construction, are regarded as impossible and are therefore discarded.
– If there is eventually more than one solution, a warning message is displayed to tell the user he has to make a choice and manually remove the unneeded result: guide and if requested, parabola and projection;
– If eventually there is no valid solution, a warning message is displayed but if the "*Draw construction*" option has been checked, the parabola is drawn anyway: it may help figuring out why no solution is found.

Huzita-6 module

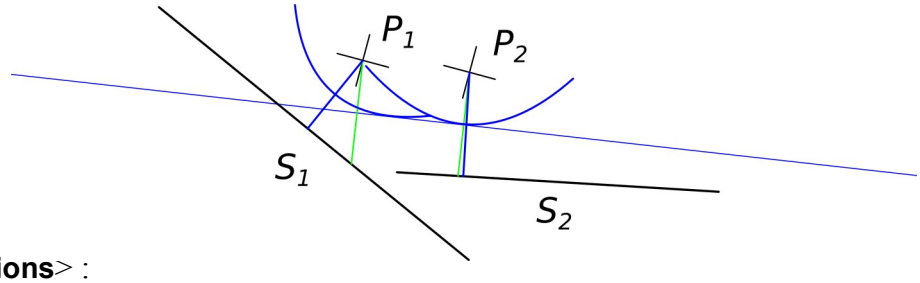
Problem: Given two points P_1 and P_2 and two segments S_1 et S_2, find a fold such as P_1 is projected onto S_1 while P_2 is projected onto S_2 simultaneously:



Construction: Draw a path starting from P_1, followed by two points located on each end of segment S_1 followed by one point located on P_2 and finally two points located on each end of segment S_2, the points on S_1 and S_2 enforcing their boundaries:



Solution: From menu, select: "Extensions→Origami→Huzita-6" then click "**Apply**".
Draws a guide materializing the resulting fold and optionally the parabolas used for the construction and/or the projection segments:



Tabs: <**Options**> :

– *"Draw projections"*: Draws projection of P_1 onto S_1 and P_2 onto S_2 ;

– "*Suppress construction segment*": Suppresses automatically the construction segment.

<**Advanced**> :

– *"Draw construction"*: Draws the parabolas used for the projection computation;

– *"Scale":* Defines the height of the parabolas.

<**Projections**> :

– « *Stroke width* » : Defines projection segments stroke width;

– « *Stroke color* » : Defines projection segments stroke color;

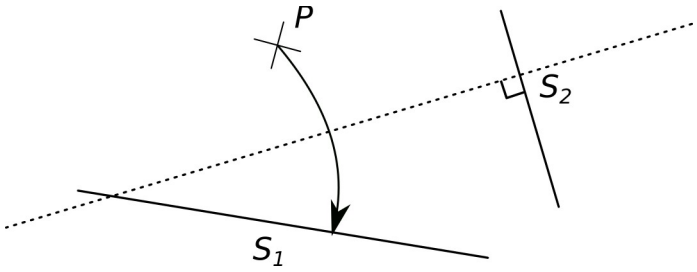
Comments : – There can be between 0 and 3 solutions: those where the projection of P_1 onto segment S_1 or of P_2 onto S_2 are located outside their segment boundaries enforced by points (2,3) and 5,6) of the construction, are regarded as impossible and are therefore discarded.

– If there is eventually more than one solution, a warning message is displayed to tell the user he has to make a choice and manually remove the unneeded result(s): guide(s) and if requested, parabola(e) and projection(s);

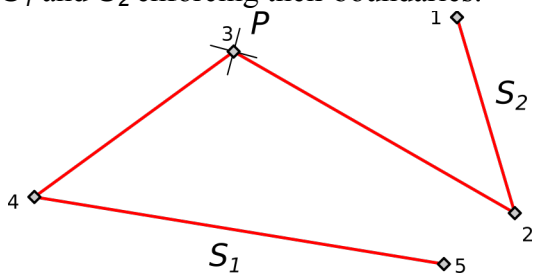
– If eventually there is no valid solution, a warning message is displayed but if the "*Draw construction*" option has been checked, the parabolae are drawn anyway: it may help figuring out why no solution is found.

Huzita-7 module

Problem: Given a point *P* and two segments S_1 et S_2, find a fold such as *P* is projected onto S_1 and perpendicular to S_2:

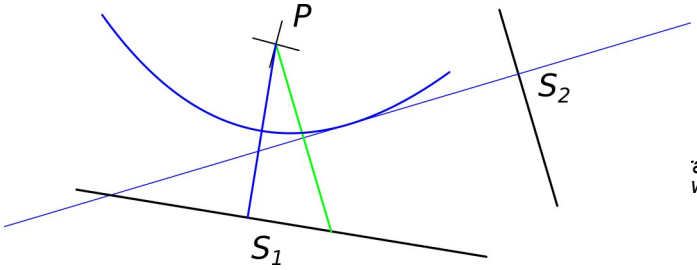


Construction: Draw a path starting with two points at each end of segment S_2, followed by a points located on point *P* and finally two points located on each end of segment S_1, the points on S_1 and S_2 enforcing their boundaries:



***Note** : the orders of points 1 and 2 or 4 and 5 do not matter.*

Solution: From menu, select: "Extensions→Origami→Huzita-7" then click "**Apply**".
Draws a guide materializing the resulting fold and optionally the parabola used for the construction and/or the projection segment:



abola and projection wings are optional.

Tabs: <**Options**> :

– *"Draw projections"*: Draws projection of point P_2 onto segment *S*;
– "*Suppress construction segment*": Suppresses automatically the construction segment.

<**Advanced**> :

– *"Draw construction"*: Draws the parabola used for the projection computation;
– *"Scale":* Defines the height of the parabola.

<**Projections**> :

– « *Stroke width* » : Defines projection segment stroke width;
– « *Stroke color* » : Defines projection segment stroke color;

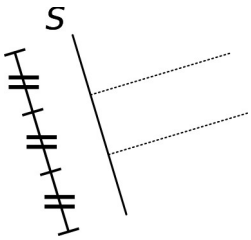
Comments: – There can be one and only one solution **unless** the projection of *P* onto segment S_1 is located outside the segment boundaries or the fold crosses the line defined by S_2 outside its boundaries, both enforced by points (1,2) and (4,5) of the construction.

– If eventually there is no valid solution, a warning message is displayed but if the "*Draw construction*" option has been checked, the parabola is drawn anyway: it may help figuring out why no solution is found.

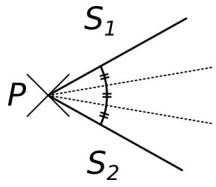
N-Section module

Problem: Divide into N equal parts (from 2 to 64) either a segment *S* into perpendicular segments, or a salient angle (0-180°) made of two distinct segments S1 and S2 of origin P (example given with N = 3):

SEGMENT

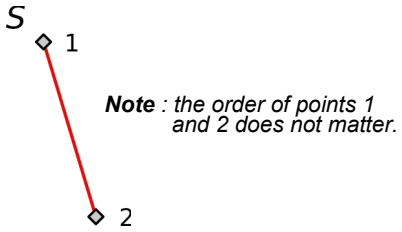


ANGLE



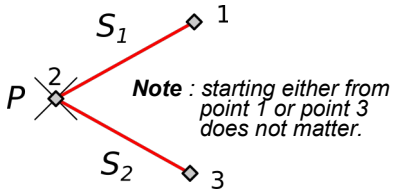
Construction:

Draw a path from each end of segment *S* to be divided:



***Note** : the order of points 1 and 2 does not matter.*

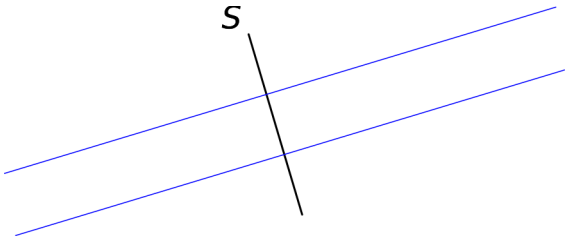
Draw a path starting at the free end of segment S_1, followed by a point located on *P and* then a last point at the free end of segment S_2:

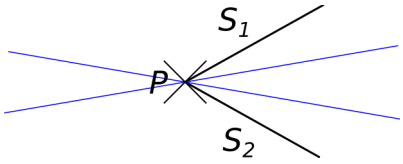


***Note** : starting either from point 1 or point 3 does not matter.*

Solution: From menu, select: "Extensions→Origami→N-Section"
then choose number of divisions (here, 3) in the "*Sections*" number-box
then click « **Apply** ».

Draws a set of guides (N-1) materializing the segment or angle division:





***Note** : only guides within the salient angular sector have meaning.*

Tabs : <**Options**> :

– "*Sections*": choose the division/section number;
– "*Suppress construction segment*": Suppresses automatically the construction segment.

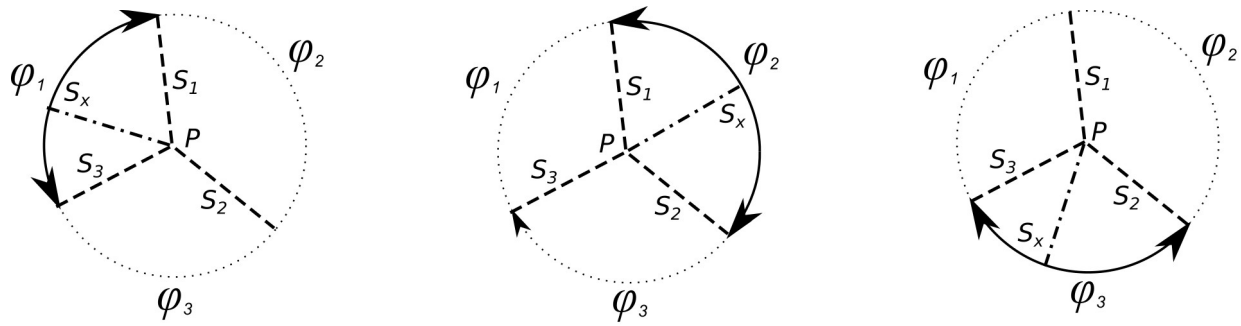
Comments: For the angular section only:

– The section is computed only for the salient angular sector (($0 \leq \varphi \leq 180°$)).
– If the angle is null, then N overlapping guides will be drawn.
– If the angle is flat, then N guides will split the plan around *P* in N*2 regular angular sectors.

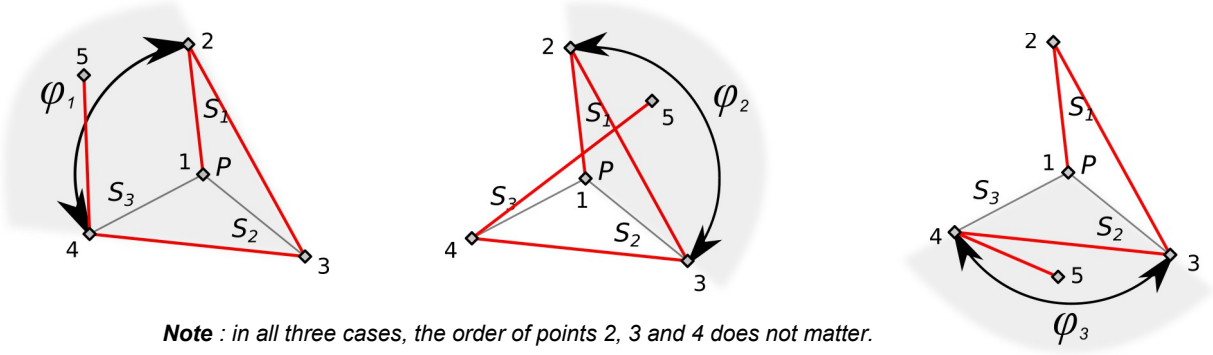
Rabbit-Ear module

Problem: Given three distinct folds S_1, S_2 et S_3 starting from point P, find the fourth fold S_x needed to fold a rabbit-ear. Unless one angular sector bounded by two folds is greater than or equal to 180°, there are three possible solutions, one for each angular sector φ_1, φ_2 or φ_3 :

S_x in φ_1 **S_x in φ_2** **S_x in φ_3**

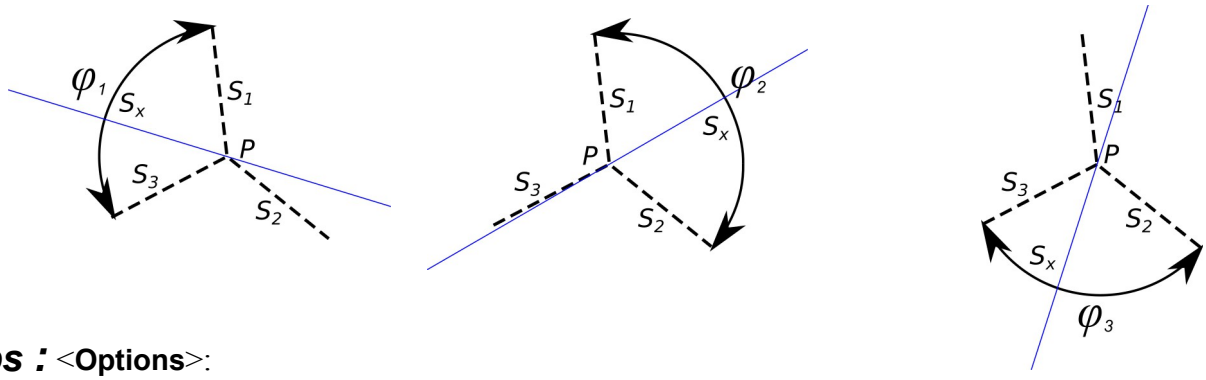


Construction: Draw a path starting at P followed by three points, other than P, located on segments S_1, S_2 et S_3 ending with , and finally a fifth point located anywhere inside the angular sector in which the solution is wanted:



***Note** : in all three cases, the order of points 2, 3 and 4 does not matter.*

Solution: From menu, select: "Extensions→Origami→Rabbit-Ear" then click "**Apply**".
Draws a guide materializing the resulting fold for the selected angular sector:



Tabs : <**Options**>:

– "*Suppress construction segment*": Suppresses automatically the construction segment.

Comments: If one angular sector is greater than or equal to 180°, there is only one sole solution located in this angular sector. If the fifth point indicates another sector, a warning message is displayed to warn the user of a possible mistake and this unique solution is drawn.