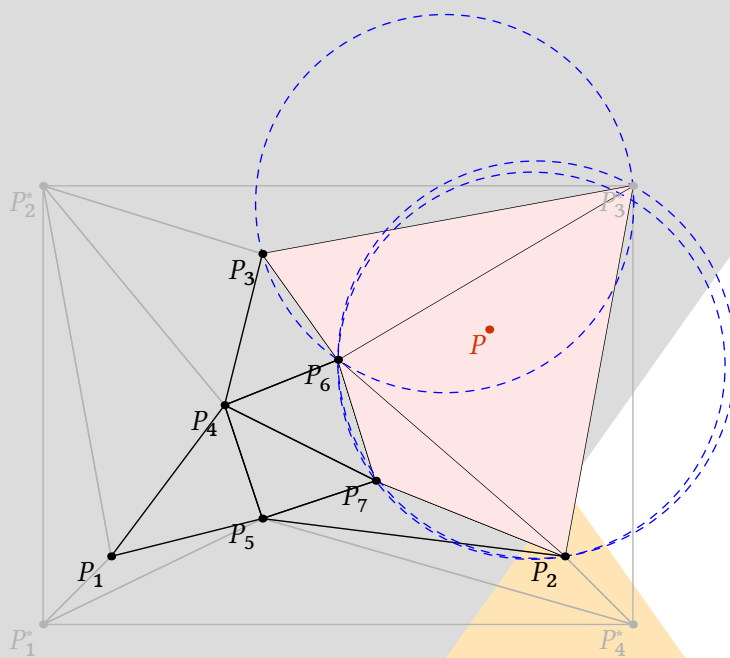


# mp-gdd

compute and draw meshes with Lua<sub>TEX</sub>



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<http://melusine.eu.org/syracuse/G/delaunay/>

# Luamesh: compute and draw meshes with Lua $\text{\LaTeX}$

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The package `luamesh` allows to compute and draw 2D triangulation of Delaunay. The algorithm is written with lua, and depending of the choice of the “engine”, the draw is done by MetaPost (with `luampLib`) or by `tikz`.

The Delaunay triangulation algorithm is the Bowyer and Watson algorithm. Several macros are provided to draw the global mesh, the set of points, a particular step of the algorithm.

I would like to thank Jean-Michel Sarlat, who hosts the development with a git project on the `melusine` machine:

<https://melusine.eu.org/syracuse/G/delaunay/>

Then, I would like to thank the first user, and an intensive *test* user: Nicole Spillane.

## 1 Installation

Of course, you can just put the two files `luamesh.lua` and `luamesh.sty` in the working directory, but it is not recommended.

### 1.1 With $\text{\TeX}$ live and Linux or Mac OSX

To install `luamesh` with  $\text{\TeX}$ live, you have to create the local `texmf` directory in your `home`.

```
user $> mkdir ~/texmf
```

Then we have to files to place in the correct directories. First, the `luamesh.sty` file must be in the directory:

`~/texmf/tex/latex/luamesh/`

and secondly, the `luamesh.lua` must be in the directory:

`~/texmf/scripts/luamesh/`

Once you have done this, `luamesh` can be included in your document with

---

```
\usepackage{luamesh}
```

---

## 1.2 With MikTeX and Windows

We do not know these two systems, so we refer to the documentation for integrating local additions to MikTeX:

<http://docs.miktex.org/manual/localadditions.html>

## 1.3 A LuaTeX package

If you want to use this package, you must compile your document with `luatex`:

```
user $> luatex mylatexfile.tex
```

## 1.4 Dependencies

This package is built upon two main packages to draw the triangulations :

1. `luamplib` to use MetaPost via the LuaTeX library `mplib`;
2. and `tikz`.

We will see how to choose between these two *drawing engines*.

Moreover, the following packages are necessary:

1. `xkeyval` to manage the optional arguments;
2. `xcolor` to use colors (needed by `luamplib`);
3. `ifthen` to help the programming with TeX.

## 2 The Basic Macros

Let us recall that this package provides macros to draw two dimensional triangulations (or meshes).

### 2.1 Draw a Complete Mesh

```
\buildMeshBW[<options>]{<list of points> or <file name>}
```

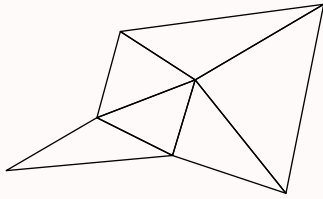
This macro produce the Delaunay triangulation (using the Bowyer and Watson algorithm) of the given *<list of points>*. The list of points must be given in the following way :

$(x_1, y_1); (x_2, y_2); (x_3, y_3); \dots; (x_n, y_n)$

---

```
\buildMeshBW{(0.3,0.3);(1.5,1);(4,0);(4.5,2.5);(1.81,2.14);(2.5,0.5);(2.8,1.5)}
```

---



### 2.1.1 The Options

There are several options to customize the drawing.

**mode = int (default) or ext:** this option allows to use either the previously described set of point in the argument, or a file, containing, line by line (2 columns), the points. Such a file looks like :

```
x1 y1  
x2 y2  
x3 y3  
...  
xn yn
```

**bbox = none (default) or show:** this option allows to draw the added points to form a *bounding box*<sup>1</sup> and the corresponding triangulation. By default, these triangles are removed at the end of the algorithm.

**color = <value> (default: black):** The color of the drawing.

**colorBbox = <value> (default: black):** The color of the drawing for the elements (points and triangles) belonging to the bounding box.

**print = none (default) or points:** To label the vertices of the triangulations with an adding dot.

**meshpoint = <value> (default: P):** The letter(s) used to label the vertices of the triangulation. It is include in the math mode delimiters  $\$...\$$ . The bounding box points are labeled with a star exponent, and numbered from 1 to 4.

**tikz (boolean, default:false):** By default, this boolean is set to **false**, and MetaPost (with **luamplib**) is used to draw the picture. With this option, it is **tikz** the *drawing engine*.

**scale = <value> (default: 1cm):** The scale option defines the scale at which the picture is draw (the same for the two axis). It must contain the unit of length (cm, pt, etc.).

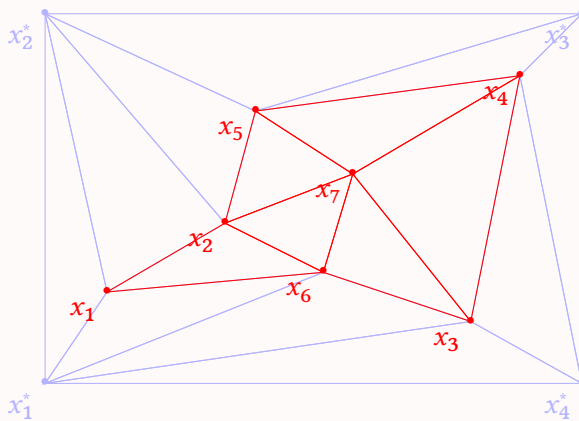
---


<sup>1</sup>The bounding box is defined by four points place at 15% around the box defined by  $(x_{\min}, y_{\min})$ ,  $(x_{\min}, y_{\max})$ ,  $(x_{\max}, y_{\max})$ , and  $(x_{\max}, y_{\min})$ .

To illustrate the options, let us show you an example. We consider a file `mesh.txt`:

```
0.3  0.3
1.5  1
4    0
4.5  2.5
1.81 2.14
2.5  0.5
2.8  1.5
```

```
\buildMeshBW[%
tikz,
mode = ext,
bbox = show,
color = red,
colorBbox = blue!30,
print = points,
meshpoint = x,
scale = 1.3cm,
]{mesh.txt}
```



 The drawing engine is not here very relevant. But it is useful to understand how the drawing is made. However, the engine will make sense for the so called *inc* macros (section 3), where we will be allowed to add code before and after the generated one by `luamesh`.

## 2.2 Draw the Set of Points

```
\drawPointsMesh[<options>]{<list of points> or <file name>}
```

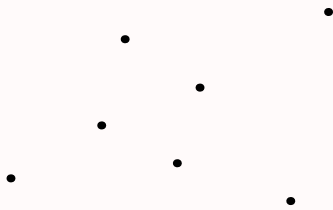
With the `\drawPointsMesh`, we plot the set of the points from which the Browyer and Watson algorithm compute the triangulation.

The use of this macro is quite similar to the `\buildMeshBW`. Here is an example of the basic uses.

---

```
\drawPointsMesh{(0.3,0.3);(1.5,1);(4,0);(4.5,2.5);(1.81,2.14);(2.5,0.5);(2.8,1.5)}
```

---



### 2.2.1 The Options

There are several options (exactly the same that for the `\buildMeshBW`) to customize the drawing.

**mode = int (default) or ext:** this option allows to use either the previously described set of point in the argument, or a file, containing, line by line (2 columns), the points. Such a file looks like :

```
x1 y1
x2 y2
x3 y3
...
xn yn
```

**bbox = none (default) or show:** this option allows to draw the added points to form a *bounding box* and the corresponding triangulation. By default, these triangles are removed at the end of the algorithm. *Here, because we plot only the vertices of the mesh, there is no triangles, but only dots.*

**color = <value> (default: black):** The color of the drawing.

**colorBbox = <value> (default: black):** The color of the drawing for the elements (points and triangles) belonging to the bounding box.

**print = none (default) or points:** To label the vertices of the triangulations with an adding dot. Without label, there is a dot.

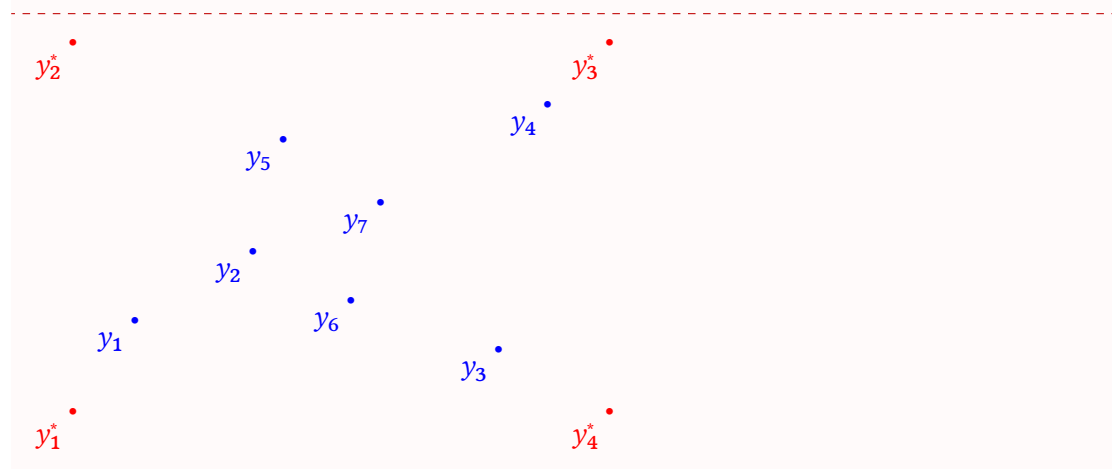
**meshpoint = <value> (default: P):** The letter(s) used to label the vertices of the triangulation. It is include in the math mode delimiters  $\$...\$$ . The bounding box points are labeled with a star exponent, and numbered from 1 to 4.

**tikz (boolean, default:false):** By default, this boolean is set to `false`, and MetaPost (with `luamplib`) is used to draw the picture. With this option, it is `tikz` the *drawing engine*.

`scale = <value> (default: 1cm)`: The scale option defines the scale at which the picture is draw (the same for the two axis). It must contain the unit of length (cm, pt, etc.).

With the same external mesh point file presented in section 2.1, we illustrate the different options.

```
\drawPointsMesh[%
tikz,
mode = ext,
bbox = show,
color = blue,
colorBbox = red,
print = points,
meshpoint = y,
scale = 1.3cm,
]{mesh.txt}
```



### 2.3 Draw a Step of the Bowyer and Watson Algorithm

`\meshAddPointBW[<options>]{<list of points> or <file name>}{<point> or <number of line>}`

This command allows to plot the different step of the addition of a point in a Delaunay triangulation, using the Bowyer and Watson algorithm.

This macro produce the Delaunay triangulation (using the Bowyer and Watson algorithm) of the given *<list of points>* and shows a step of the algorithm when the *<point>* is added. The list of points must be given in the following way:

$$(x_1, y_1); (x_2, y_2); (x_3, y_3); \dots; (x_n, y_n)$$

and the point is of the form  $(x, y)$ . The *<file name>* and *<number of line>* will be explained in the option description.

One can use the macro as fallow:

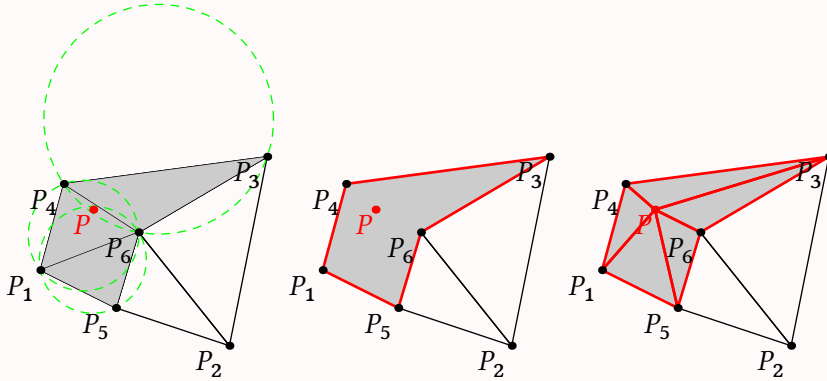
---

```

\meshAddPointBW[step=badtriangles]{(1.5,1);(4,0);(4.5,2.5);(1.81,2.14);(2.5,0.5);(2.8,1.5)
}{(2.2,1.8)}
\meshAddPointBW[step=cavity]{(1.5,1);(4,0);(4.5,2.5);(1.81,2.14);(2.5,0.5);(2.8,1.5)
}{(2.2,1.8)}
\meshAddPointBW[step=newtriangles]{(1.5,1);(4,0);(4.5,2.5);(1.81,2.14);(2.5,0.5);(2.8,1.5)
}{(2.2,1.8)}

```

---




---

The default value for `step` is `badtriangles`. The first line is then equivalent to

---

```

\meshAddPointBW{(1.5,1);(4,0);(4.5,2.5);(1.81,2.14);(2.5,0.5);(2.8,1.5)}{(2.2,1.8)}

```

---

### 2.3.1 The Options

There are several options (some of them are the same as for `\buildMeshBW`) to customize the drawing.

`mode = int (default) or ext`: this option allows to use either the previously described set of point in the argument number one, or a file, containing, line by line (2 columns), the points. Such a file looks like :

```

x1 y1
x2 y2
x3 y3
...
xn yn

```

For the second argument of the macro, if we are in the `mode = ext`, the argument must be the *line number* of the file corresponding to the point we want to add. The algorithm will stop the line before to build the initial triangulation for which it will add the point corresponding to the line. The other lines of the file are ignored.

`bbox = none (default) or show`: this option allows to draw the added points to form a *bounding box* and the corresponding triangulation. By default, these triangles are removed at the end of the algorithm.



- color** =  $\langle \text{value} \rangle$  (default: black): The color of the drawing.
- colorBbox** =  $\langle \text{value} \rangle$  (default: black): The color of the drawing for the elements (points and triangles) belonging to the bounding box.
- colorNew** =  $\langle \text{value} \rangle$  (default: red): The color of the drawing of the “new” elements which are the point to add, the polygon of the cavity, and the new triangles.
- colorBack** =  $\langle \text{value} \rangle$  (default: black!20): The color for the filling of the region concerned by the addition of the new point.
- colorCircle** =  $\langle \text{value} \rangle$  (default: green): The color for circoncircle of the triangles containing the point to add.
- meshpoint** =  $\langle \text{value} \rangle$  (default: P): The letter(s) used to label the vertices of the triangulation. It is include in the math mode delimiters  $\$...\$$ . The bounding box points are labeled with a star exponent, and numbered from 1 to 4.
- step** = **badtriangles** (default) **or** **cavity** **or** **newtriangles**: To choose the step we want to draw, corresponding to the steps of the Bowyer and Watson algorithm.
- newpoint** =  $\langle \text{value} \rangle$  (default: P): The letter(s) used to label the new point of the triangulation. It is include in the math mode delimiters  $\$...\$$ .
- tikz** (boolean, default:false): By default, this boolean is set to **false**, and MetaPost (with **luamplib**) is used to draw the picture. With this option, it is **tikz** the *drawing engine*.
- scale** =  $\langle \text{value} \rangle$  (default: 1cm): The scale option defines the scale at which the picture is draw (the same for the two axis). It must contain the unit of length (cm, pt, etc.).

Here is an example of customization of the drawing. First, recall that the external file **mesh.txt** is:

```
0.3    0.3
1.5    1
4      0
4.5    2.5
1.81   2.14
2.5    0.5
2.8    1.5
```

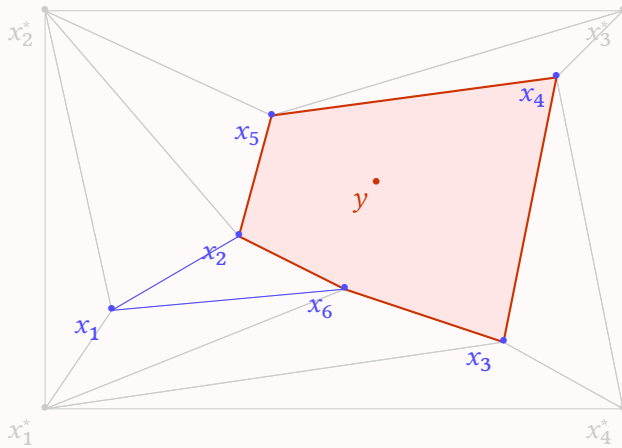
We draw the addition of the 6th point. The 7th line will be ignored.

---

```
\meshAddPointBW[
tikz,
mode = ext,
color = blue!70,
meshpoint = x,
newpoint = y,
```

---

```
colorBack=red!10,  
colorNew = green!20!red,  
colorCircle = blue,  
colorBbox = black!20,  
bbox = show,  
scale=1.4cm,  
step=cavity]  
{mesh.txt}{6}
```



### 3 The *inc* Macros

#### 3.1 With MetaPost

### 4 Gallery of Examples