

# Dekorieren mit Mathematik

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## Voronoifenster

Mathematica

OpenSCAD

Ergebnis

## Küchenlampe

Mathematica

Mathe - GuRoBi

Bauen

Ergebnis



```
Table[RandomReal[80 + 10 j], {i, 1, 50}, {j, 0, 1}]
```

```
{ {27.7545, 74.2917}, {49.6636, 3.20789}, {9.25583, 71.3168}, {73.9722, 31.5465}, {8.76137, 23.9125}, {31.7818, 14.5377},  
{46.398, 42.4769}, {79.8582, 30.2178}, {64.9623, 70.6297}, {16.6098, 49.8505}, {40.0459, 33.1234}, {46.1588, 10.0471},  
{11.6288, 42.1775}, {5.70578, 3.29698}, {77.6771, 63.2185}, {73.9011, 83.2872}, {72.5977, 71.6679}, {75.4536, 11.4435},  
{61.0521, 25.2363}, {1.1424, 87.9429}, {35.8063, 66.3791}, {46.7224, 17.5104}, {32.715, 46.7187}, {45.5893, 53.6007},  
{44.7345, 10.8345}, {14.1519, 51.6928}, {71.8652, 23.5059}, {42.0382, 73.4808}, {30.9955, 7.41456}, {29.3171, 87.5003},  
{16.2138, 75.9761}, {68.9592, 70.3095}, {66.366, 74.0911}, {16.6475, 58.266}, {32.4872, 69.7532}, {0.84917, 44.0013}, {68.7232, 63.586},  
{51.7415, 17.4116}, {51.8611, 5.2774}, {42.1845, 45.2873}, {61.0273, 48.904}, {63.0348, 37.7985}, {71.3173, 5.37285}, {9.89057, 56.1727},  
{25.0593, 20.9508}, {6.41583, 20.4305}, {47.9316, 78.1059}, {79.3453, 72.5137}, {70.7425, 33.8249}, {15.5706, 32.3135}
```

```
vm = VoronoiMesh[%, {{0, 80}, {0, 90}},
```

```
MeshCellStyle -> {{2, All} -> Blend[{Gray, White}, .92], {1, All} -> Directive[RGBColor @@ {(255, 215, 0) / 255}, Thick]]]
```



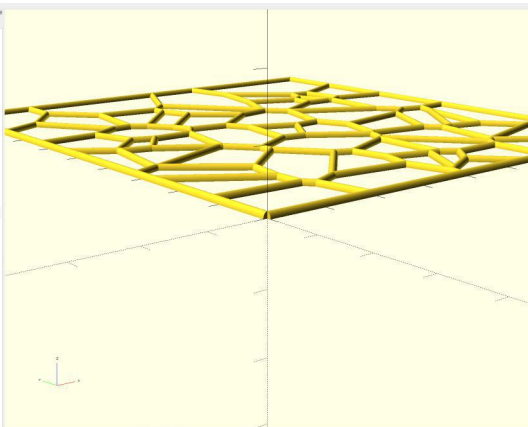
```
MeshPrimitives[vm, 1] /. Line[a_] -> a
```

```
{Point[{-1, 0}], Point[{1, 0}], Point[{0, 1}]}
```

```

1 include <lines>;
2
3 module strut(x1,y1,x2,y2){
4   dx=x2-x1;dy=y2-y1;
5   translate([x2,y2,0])
6   rotate([0,0,-atan2(dx,dy)])
7   scale([.7,sqrt(dx*dx+dy*dy),1])
8   rotate([90])
9   intersection(){
10    translate([-1,0,0])cube([2,1,1]);
11    cylinder(2,1,1,true,$fn=50);
12  }
13 }
14
15 for(l=lines)
16   strut(l[0][0].l[0][1].l[1][0].l[1][1]);

```

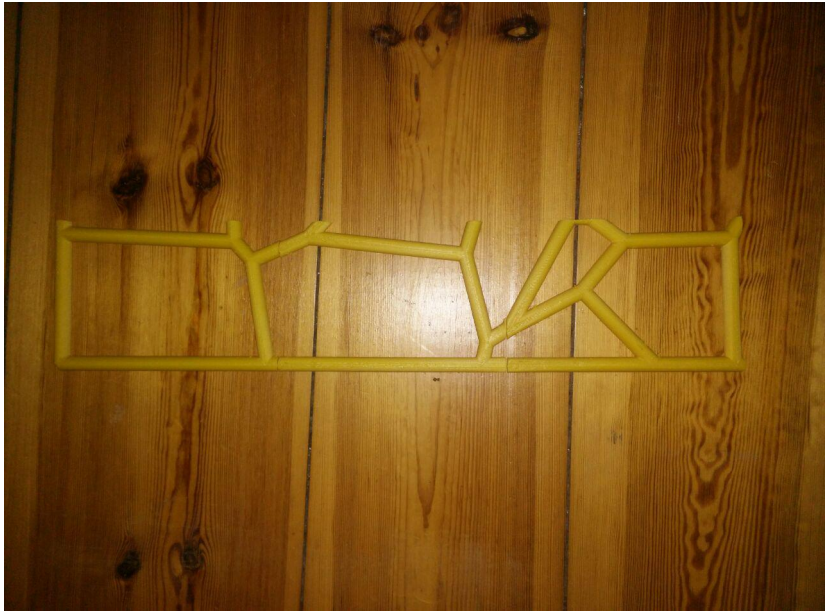


Messages  
 Computing design CSG Tree generation...  
 Computing design CSG Products generation...  
 Intersection in cache 0  
 Geometry generation in cache 0/0/0  
 CSG Polyhedra in cache 0  
 CSG in the tree in type 0  
 Computing design CSG Products normalization...  
 Normalizing CSG tree has 302 elements  
 Compile and construct finished  
 Total rendering time: 0 hours, 0 minutes, 0 seconds

```
include <lines >;

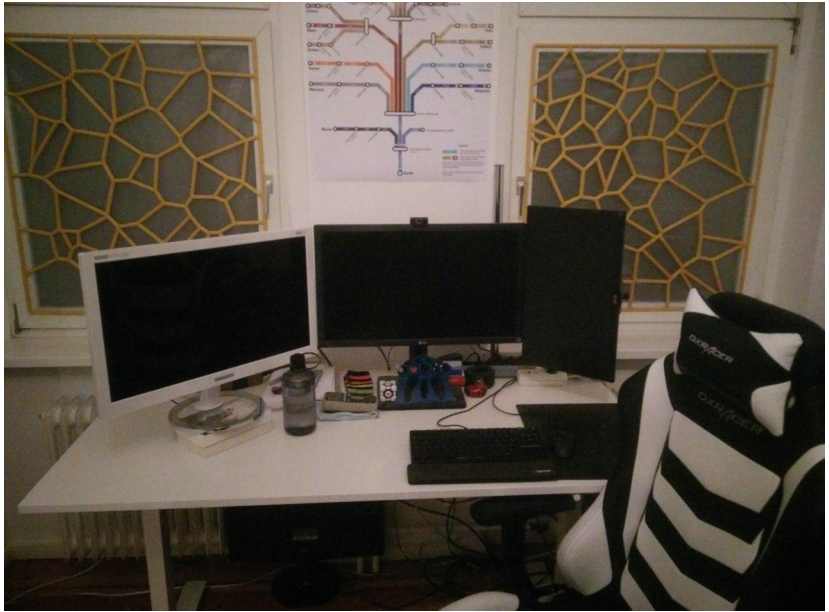
module strut(x1,y1,x2,y2){
    dx=x2-x1; dy=y2-y1;
    translate ([x2,y2,0])
    rotate ([0,0,-atan2(dx,dy)])
    scale ([.7,sqrt(dx*dx+dy*dy),1])
    rotate ([90])
    intersection(){
        translate([-1,0,0]) cube([2,1,1]);
        cylinder(2,1,1,true,$fn=50);
    }
}

for(l=lines)
    strut(l[0][0],l[0][1],l[1][0],l[1][1]);
```











## Maximum Coverage

$\max r$

$$\text{dist}(C_i, C_j) \geq r$$

$$\text{dist}(C_i, B) \geq r$$

```

Maximize[{r, Join[{x[#] - x[#2]^2 + (y[#] - y[#2])^2 >= r^2 & && Subsets[Range[12], {2}], r <= x[#] <= 3.4 - r & /@ Range[12],
r <= y[#] <= 2.9 - r & /@ Range[12]}], {x, {x[#] - 1.65}^2 / 1.65^2 + {y[#] - 1.5}^2 / 1.5^2 - 1 <= 0 & /@ Range[12]}]}, Join[{r}, x /@ Range[12], y /@ Range[12]]]
{0.6022, {r -> 0.6022, x[1] -> 2.38256, x[2] -> 0.939197, x[3] -> 1.86489, x[4] -> 1.35891, x[5] -> 2.7978, x[6] -> 2.25572, x[7] -> 2.64735, x[8] -> 1.82692,
x[9] -> 0.83548, x[10] -> 0.602209, x[11] -> 1.20443, x[12] -> 1.70897, y[1] -> 1.0353, y[2] -> 0.602203, y[3] -> 2.29779, y[4] -> 1.97125,
y[5] -> 1.57736, y[6] -> 1.83964, y[7] -> 2.29759, y[8] -> 0.802173, y[9] -> 1.66863, y[10] -> 1.10131, y[11] -> 1.14286, y[12] -> 1.47191}}

Maximize[{r, Join[{x[#] - x[#2]^2 + (y[#] - y[#2])^2 >= r^2 & && Subsets[Range[12], {2}], 0.2 <= x[#] <= 3.1 & /@ Range[12],
0.2 <= y[#] <= 2.8 & /@ Range[12], {x[#] - 1.65}^2 / 1.65^2 + {y[#] - 1.5}^2 / 1.5^2 - 1 <= 0 & /@ Range[12]}]}, Join[{r}, x /@ Range[12], y /@ Range[12]]]

```

In[4]=

```

pts = {{2.16516, 1.25139}, {2.16393, 2.30724}, {0.2, 0.2}, {1.23127, 1.74416}, {1.22997, 2.8}, {2.06753, 0.2}, {3.09774, 2.8},
{3.09999, 0.420986}, {0.203718, 1.44356}, {3.09962, 1.74389}, {1.13377, 0.69283}, {0.201936, 2.50326}}

```

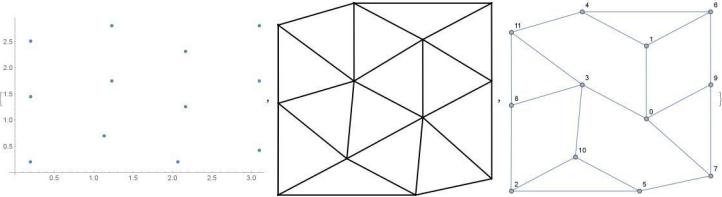
In[7]=

```

{ListPlot[pts, DelaunayMesh[pts, MeshCellStyle -> {{0, All} -> Directive[Thick, Black], {1, All} -> Directive[Thick, Black], {2, All} -> White}],
Graph[{0 -> 1, 0 -> 3, 0 -> 7, 0 -> 9, 1 -> 4, 1 -> 6, 2 -> 5, 2 -> 8, 2 -> 10, 3 -> 8, 3 -> 10, 3 -> 11, 4 -> 6, 4 -> 11, 5 -> 7, 5 -> 10, 6 -> 9, 7 -> 9, 8 -> 11},
VertexCoordinates -> {Join[Thread[Range[0, 11] -> pts]}], VertexLabels -> "Name"}]

```

Out[7]=



```

SortBy[# -> #2 -> Norm[Append[# /. ptsrule, .4] - Append[#2 /. rptsrul, .2]] & &&&
{2 -> 12, 5 -> 12, 2 -> 13, 8 -> 13, 8 -> 14, 11 -> 14, 4 -> 15, 6 -> 15, 6 -> 16, 9 -> 16, 9 -> 17, 7 -> 17}, Last]

```

## Minimal Distance

$$\min \sum_{i < j} \|x_i - x_j\| e_{ij}$$

$$e_{ij} + e_{kl} \leq 2 - \text{cross}(x_i, x_j, x_k, x_l)$$

$$\sum_i e_{ij} \geq 3$$

connected

## Minimal Cuts

$$\min \sum_{i,j} x_{ij} - n$$

$$l_{ij} \leq \text{length}(j) * x_{ij}$$

$$\sum_j l_{ij} = \text{length}(j)$$

$$\sum_i l_{ij} = \text{length}(i)$$



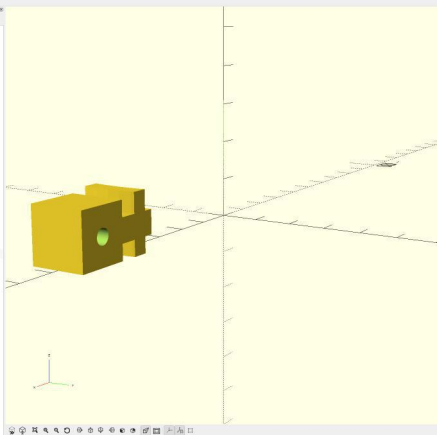




```

1 n=6;
2 $fn=100;
3
4 difference(){
5   union(){
6     translate([43,-7.4])cube([12,14,6]);
7     for (i = [0:1])translate([0,0,10*i])
8     intersection(){
9       difference(){
10        cylinder(5,50,50);
11        translate([0,0,-1])cylinder(7,46,46);
12      }
13      translate([43,-7,0])cube([10,14,10]);
14    }
15  }
16  translate([54,-7,0])difference(){
17    cube([14,14,14]);
18    translate([7,15,7])rotate([90,0,0])cylinder(16,2,2);
19  }
20 }
21 translate([0,-11,-1])cube([43,22,32]);
22 }
23 //difference(){
24 //  rotate([0,0,0])cube(20.);
25 //}

```

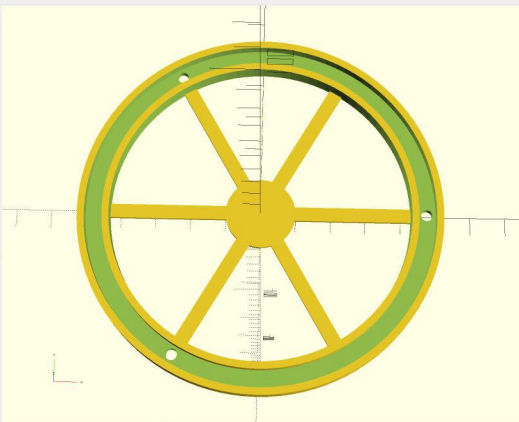


Events  
 Complete design CSG Tree generation...  
 Complete design CSG Products generation...  
 Completed in 0.001 s  
 Complete design CSG Tree generation...  
 Complete design CSG Products generation...  
 Completed in 0.001 s  
 Complete design CSG Tree generation...  
 Complete design CSG Products generation...  
 Completed in 0.001 s  
 Complete design CSG Tree generation...  
 Complete design CSG Products generation...  
 Completed in 0.001 s  
 Complete design CSG Tree generation...  
 Complete design CSG Products generation...  
 Completed in 0.001 s

```

1  h=6;
2  $fn=100;
3
4  cylinder(1,10,10,false,$fn=400);
5  for(i=[1:n])
6    rotate(360*i/n)translate([5,-2,0])cube([40,4,1]);
7  difference(){
8    cylinder(5,52,52);
9    translate([0,0,-1])cylinder(0.43,43);
10   translate([0,0,2])difference(){
11     cylinder(7,50,50);
12     cylinder(7,45,45);
13   }
14   for(i=[1:3])
15     rotate(120*i)translate([47.5,0,-1])cylinder(5,1,6,1,6);
16 }

```

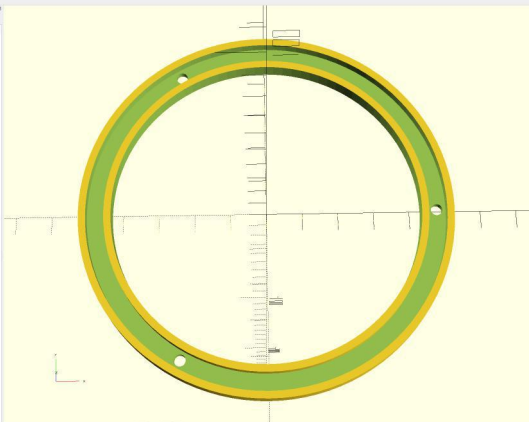


**Console**  
 Compiling design 12345: Tree generation.  
 Compiling design 12345: Primitives generation.  
 Downloading in 100ms: 12345  
 Downloading in 100ms: 12345  
 CGAL Polyhedron in 100ms: 12345  
 CGAL in 100ms: 12345  
 Compiling design 12345: Primitives normalisation.  
 Normalized 12345: 10 elements.  
 Complete and preview finished.  
 Total rendering time: 0 hours, 0 minutes, 0 seconds

```

1 n=6;
2 $fn=100;
3
4 difference(){
5   cylinder(5,52,52);
6   translate([0,0,-1])cylinder(22,43,43);
7   translate([0,0,2])difference(){
8     cylinder(7,58,58);
9     cylinder(7,45,45);
10  }
11  for(i=[1:3])
12    rotate(120*i)translate([47.5,0,-1])cylinder(7,1.6,1.6);
13 }

```



Messages  
 Compiling design 1/30 Tree generation...  
 Compiling design 1/30 Previews generation...  
 Downloading in cache 0  
 Downloading precompiled in cache 10/200  
 Using Precompiled in cache 0  
 Using in the view in type 0  
 Compiling design 1/30 Previews normalization...  
 Normalizing 1/30 over 11 elements...  
 Compile and/or save finished.  
 Total rendering time: 0 hours, 0 minutes, 0 seconds