

Optimizing Parametric Parking Lots and Site Layouts with Dynamo and Project Refinery

Xavier Loayza

~~BIM Specialist/Photogrammetry/Integrator~~, Axoscape - BIM Services

Technology Enthusiast

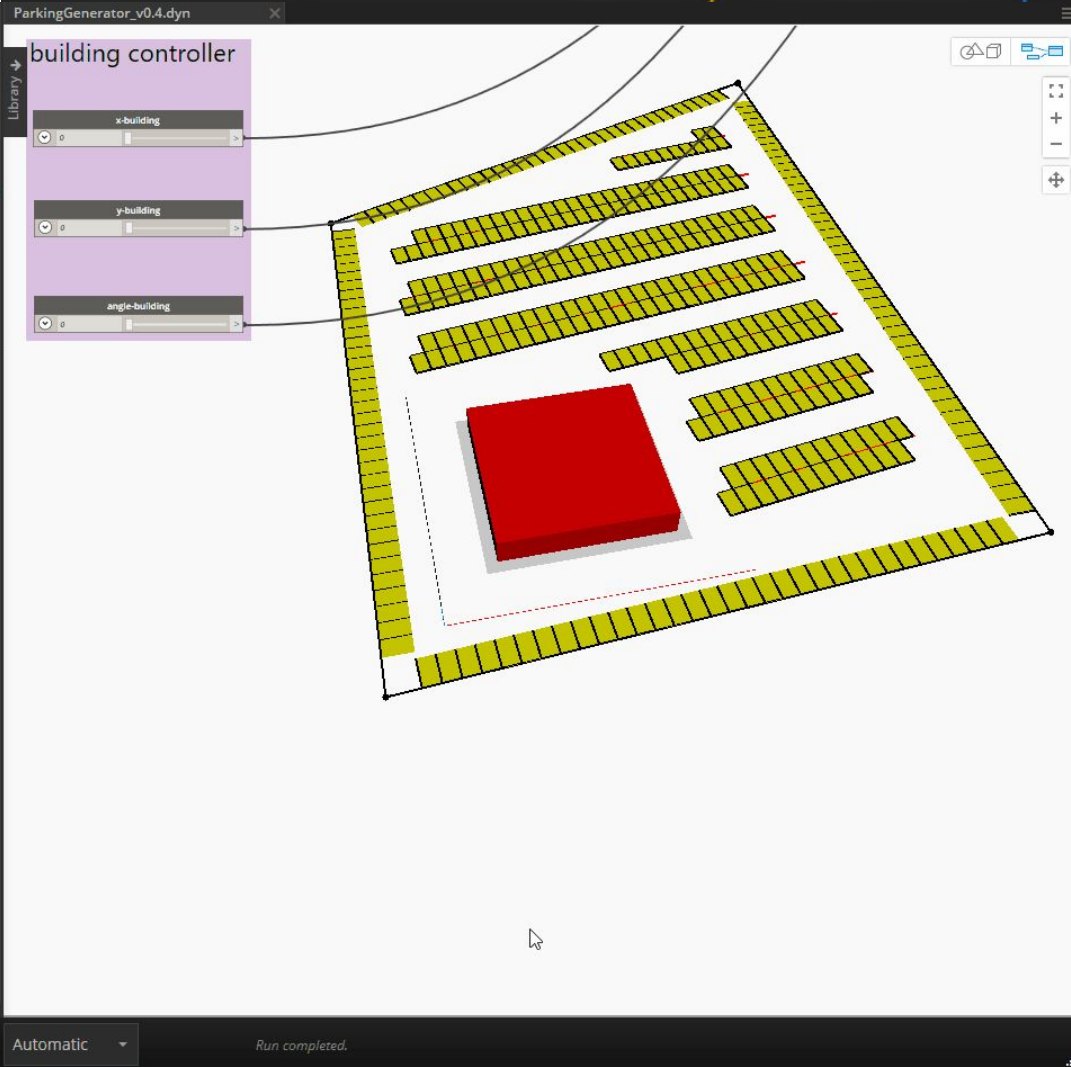
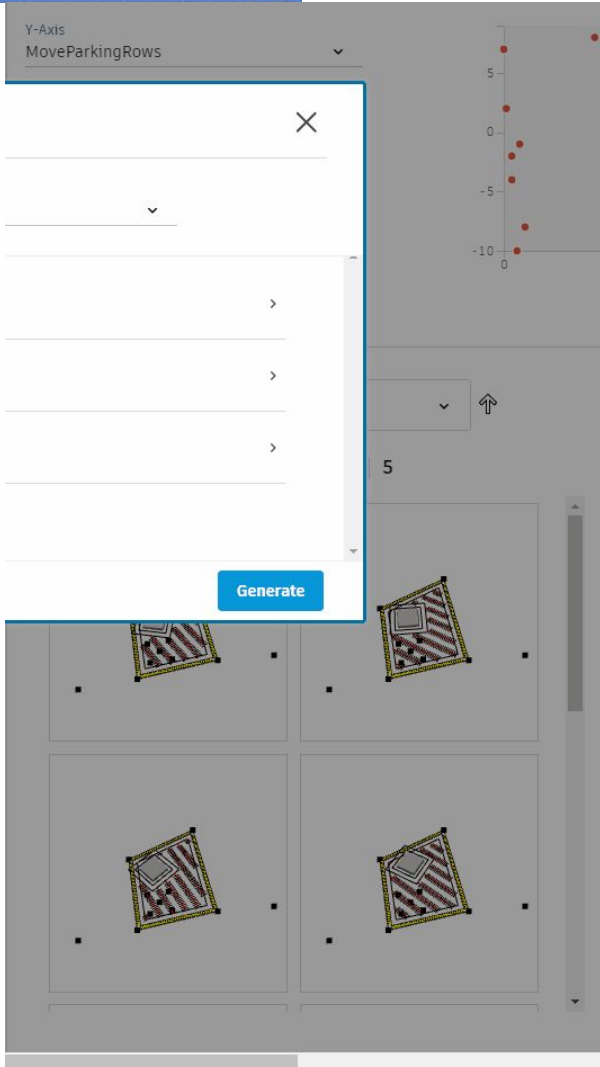
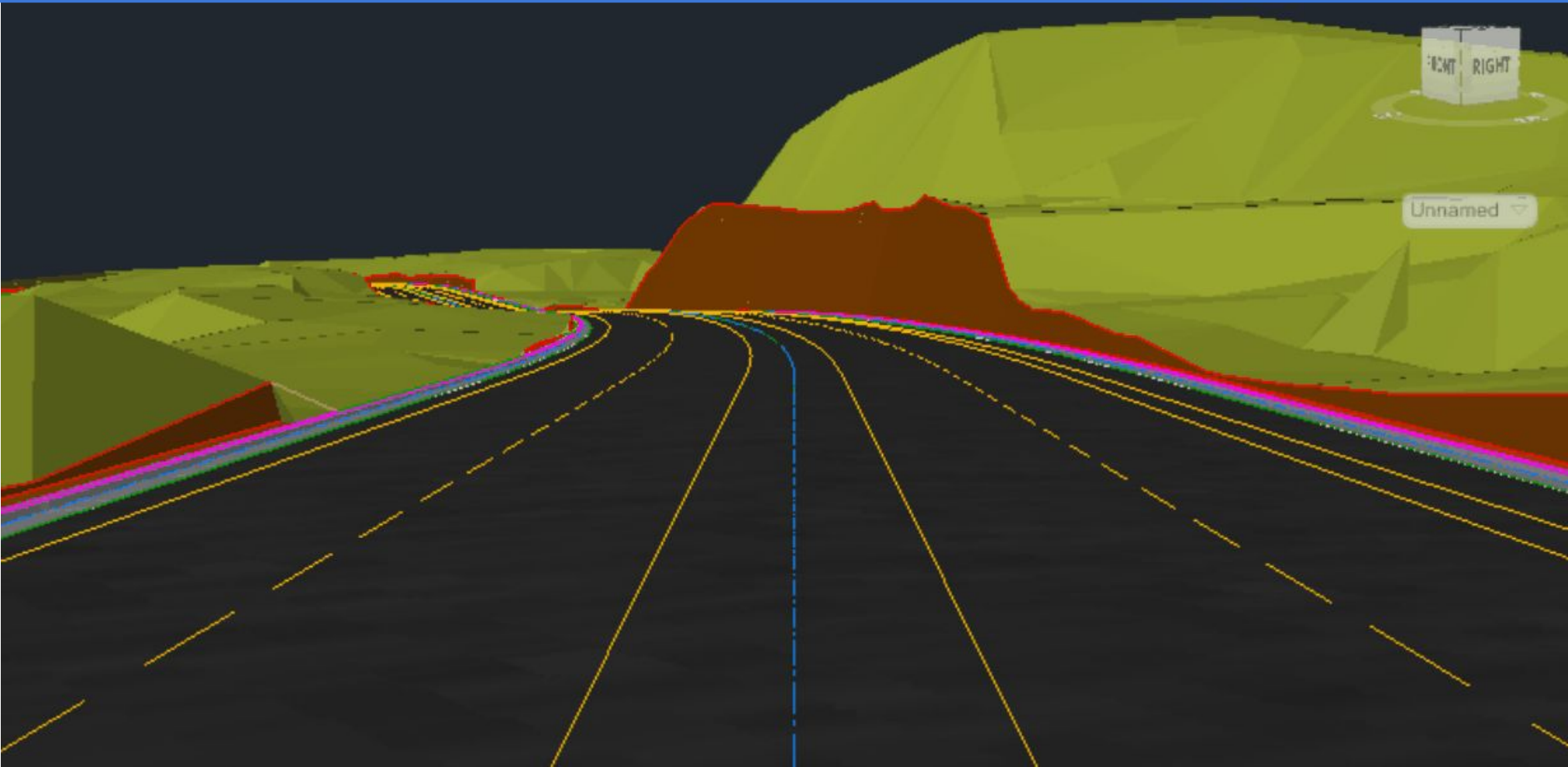
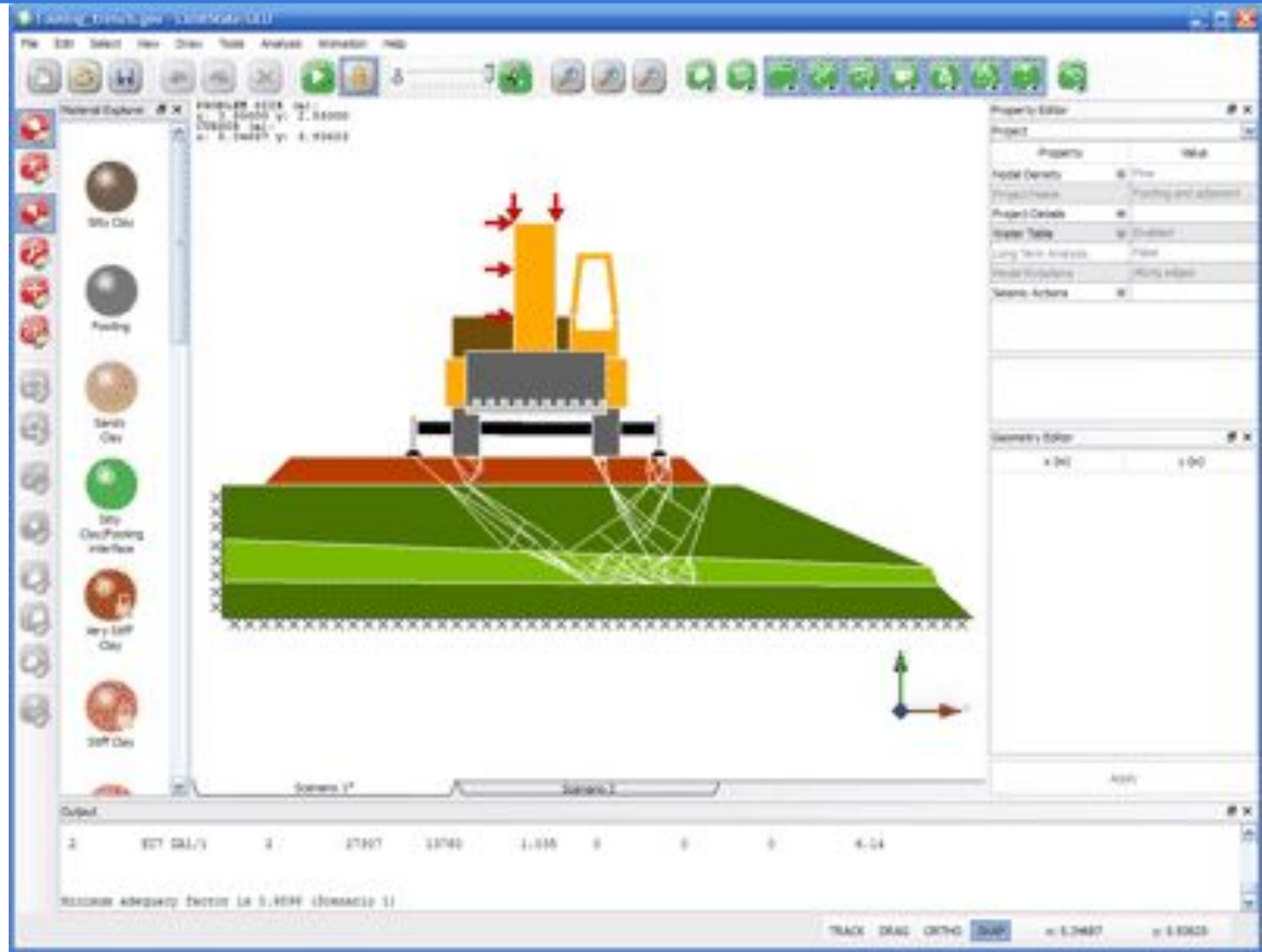


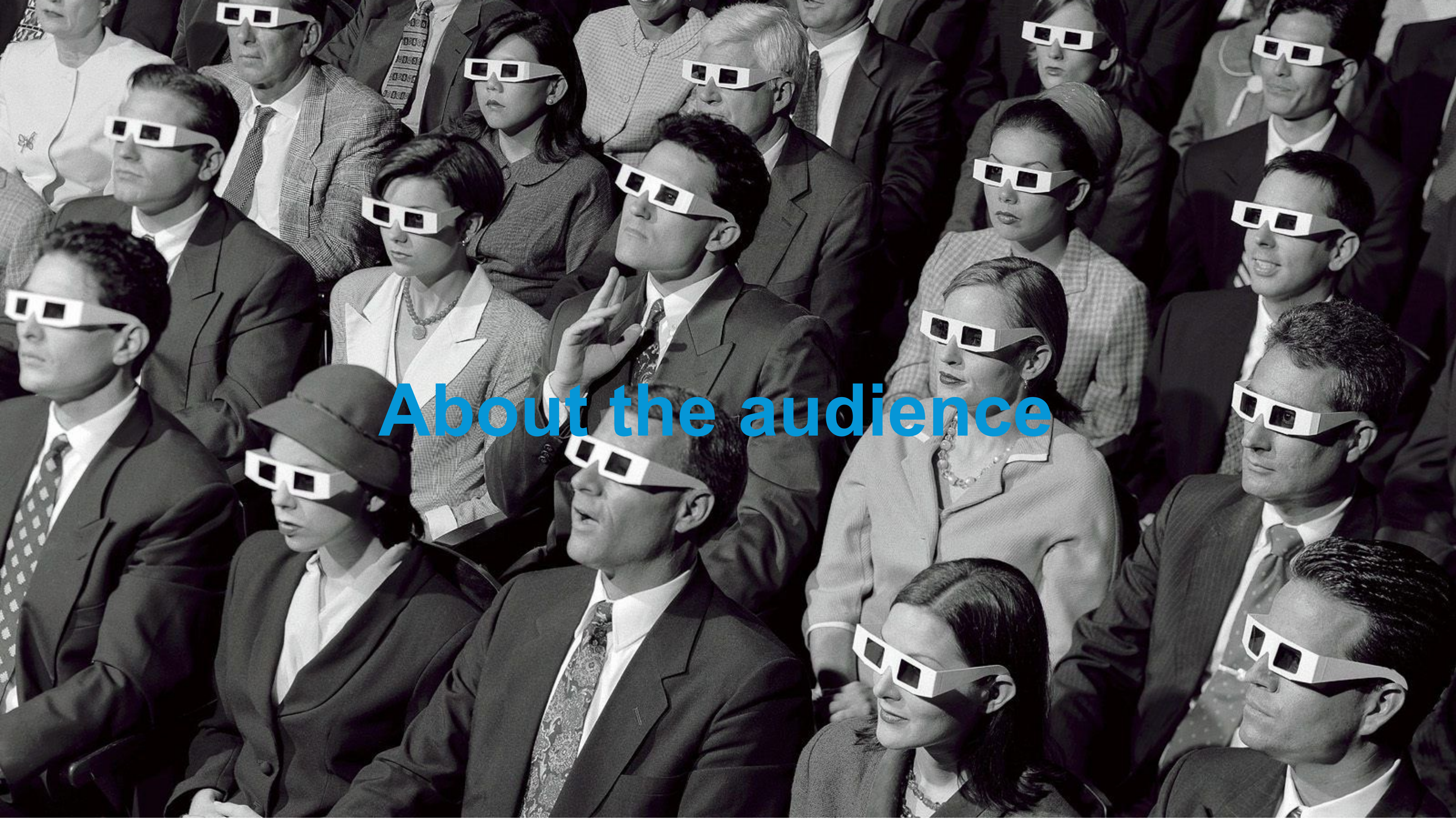
About the speaker

Xavier Loayza



@xloayzaHD





About the audience



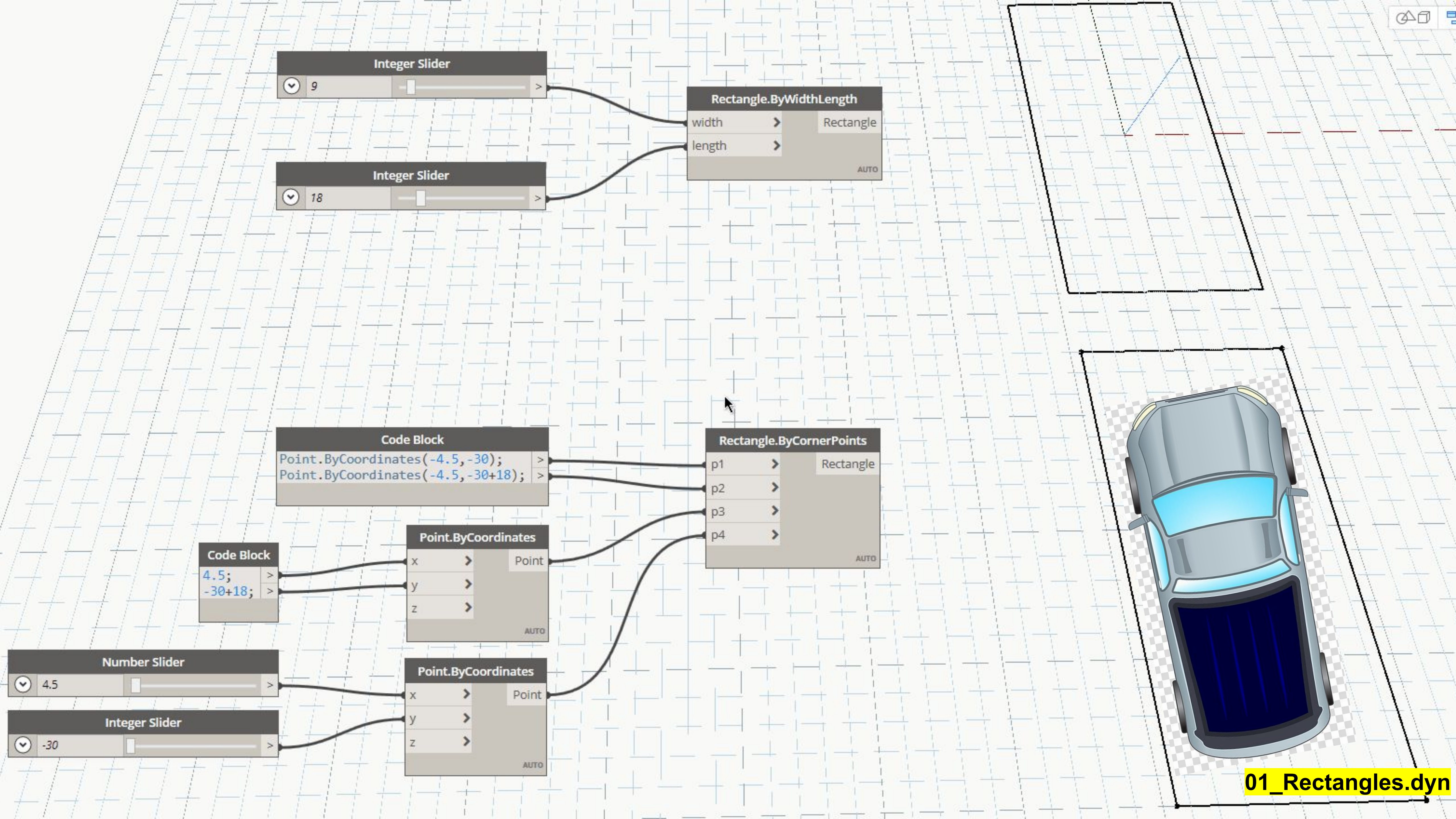
Objectives

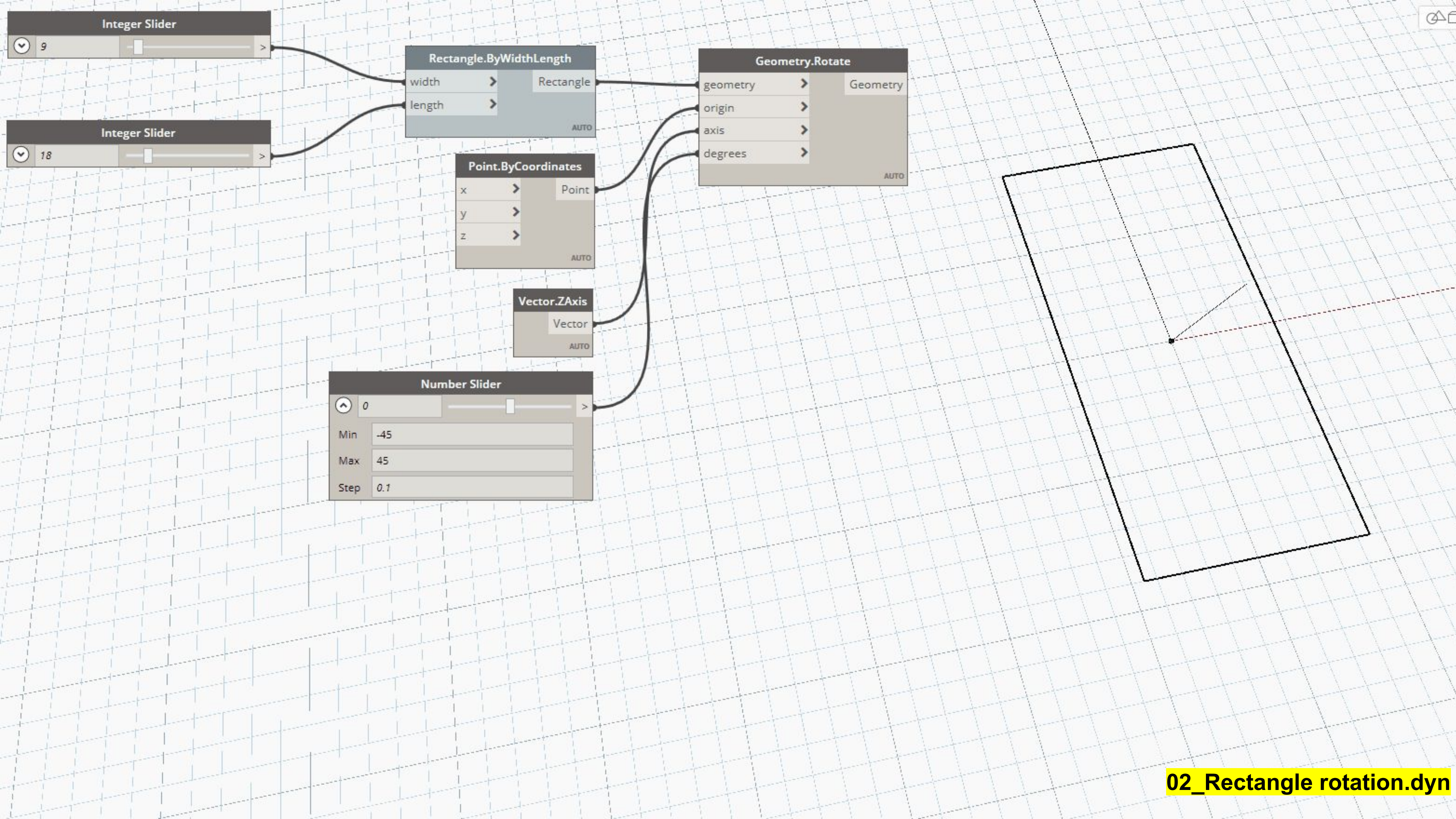
- Learn to combine Dynamo and Project Refinery to augment your design process.
- Learn about geometry relationships in a parametric system.
- Learn how to use Dynamo points, curves, polygons, surfaces, and solids to represent design components.
- Get ideas on how to approach the site planning and design algorithmically.

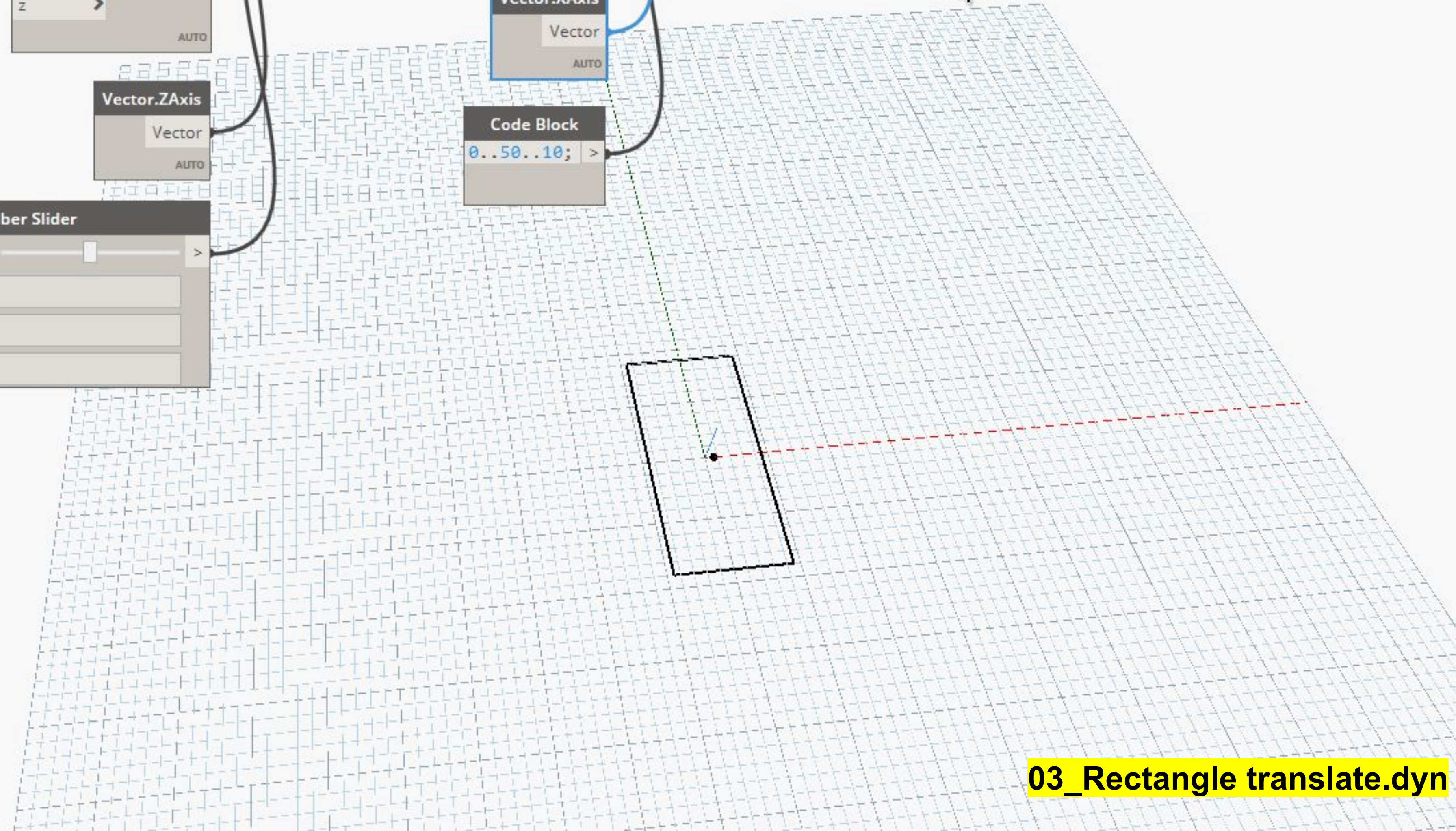
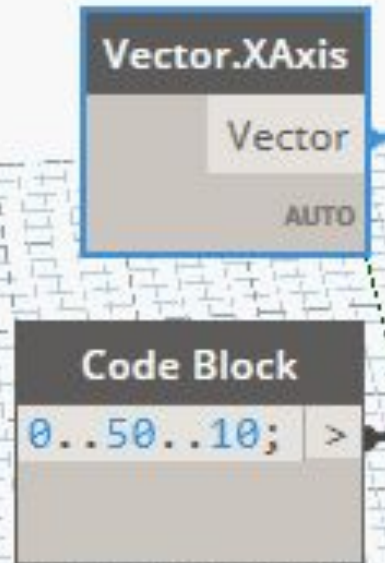
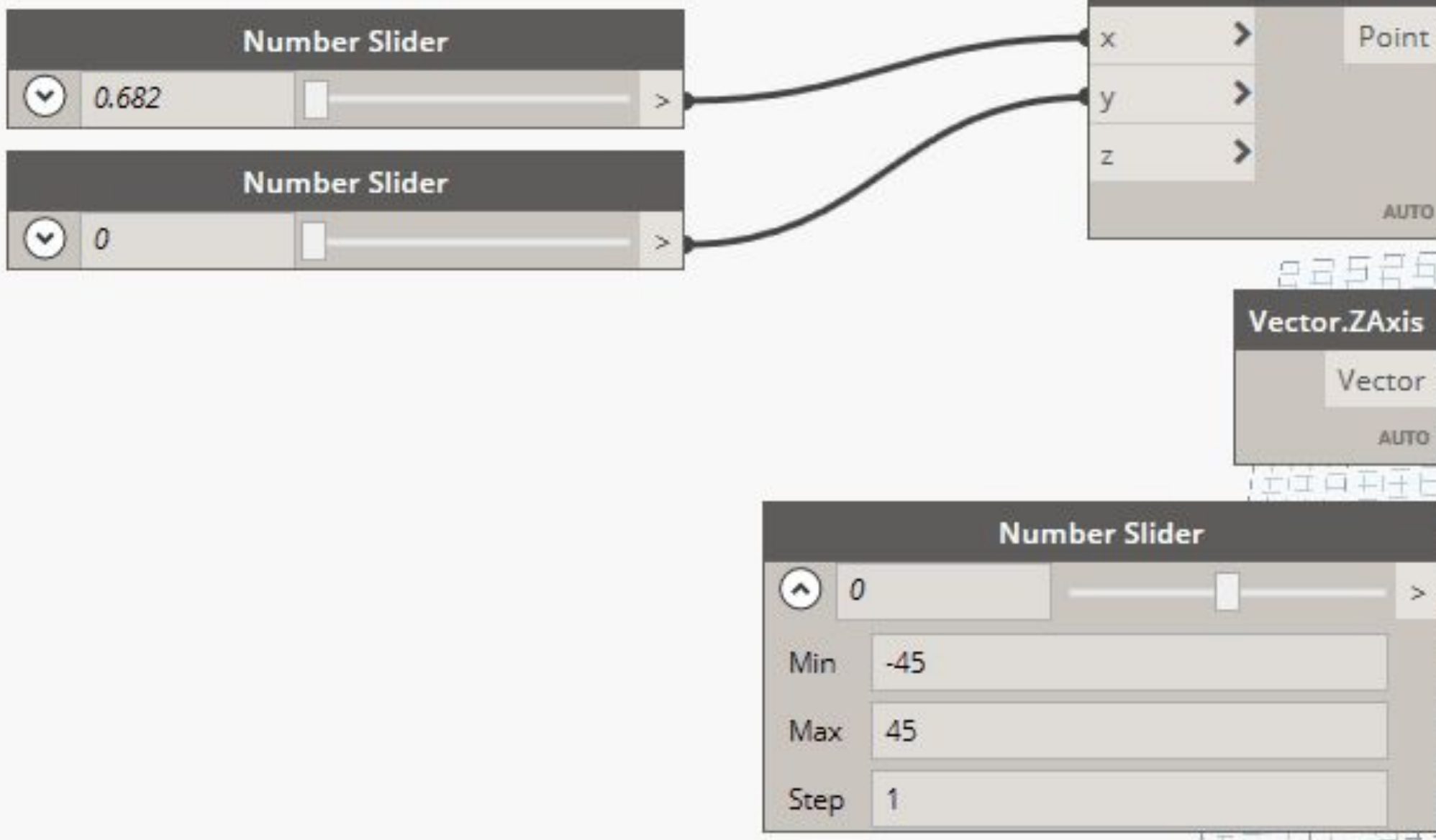
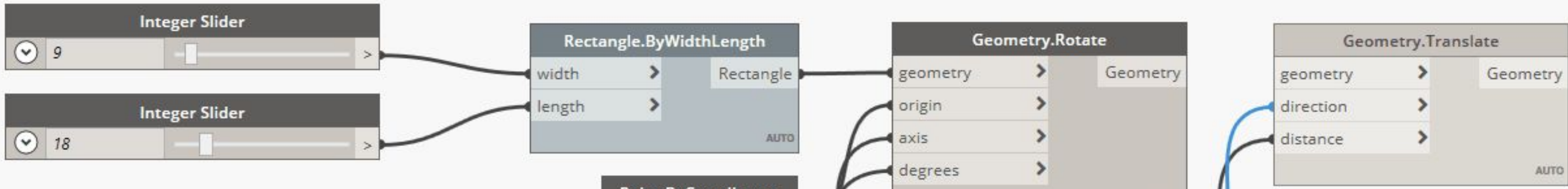
Parking lot elements



The Rectangular parking stall









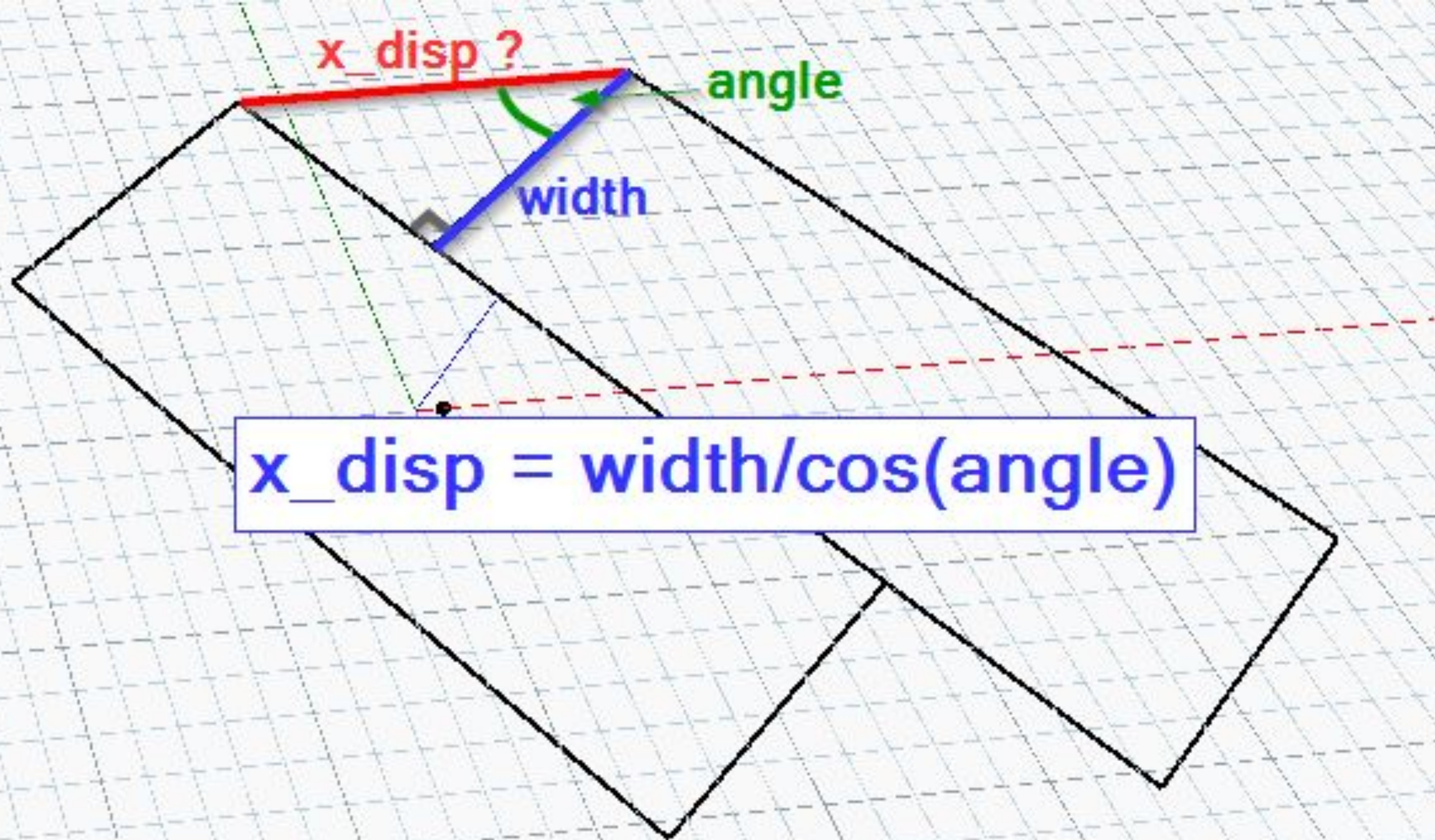
Purvi Irwin

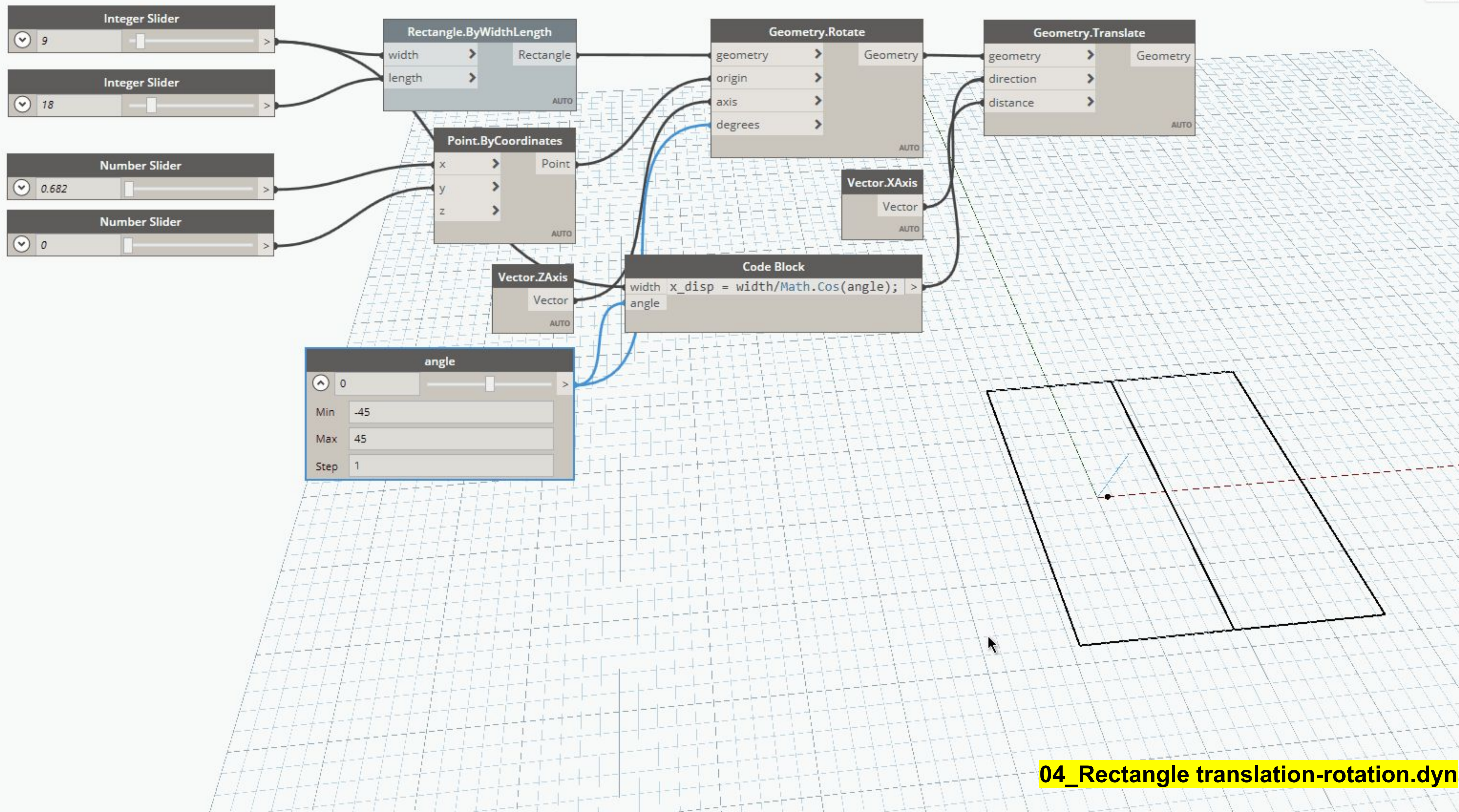
@BIMchiq

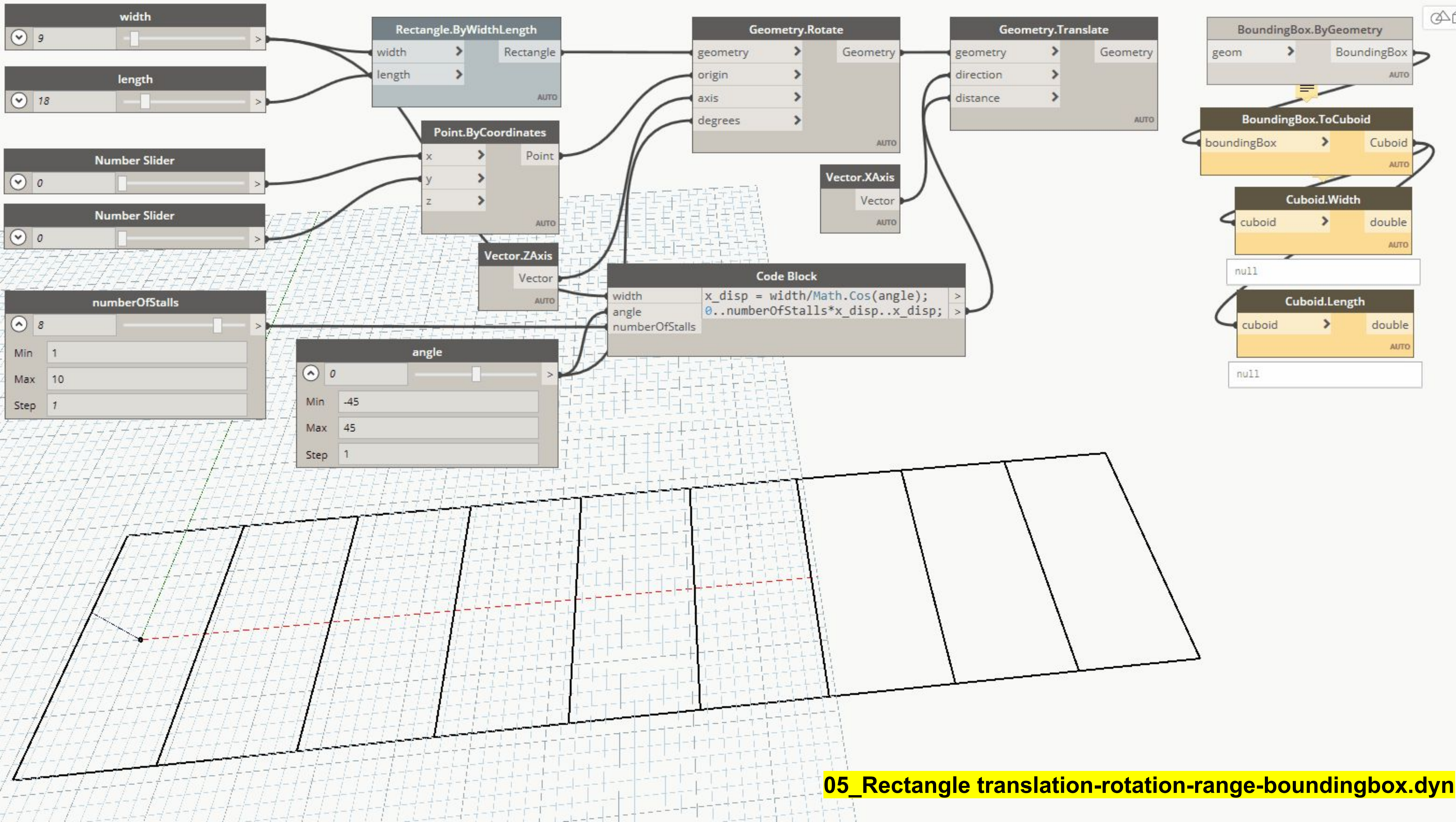


I used trigonometry in a formula in a [#Revit](#) family today. And kids say "When will I ever use this??"

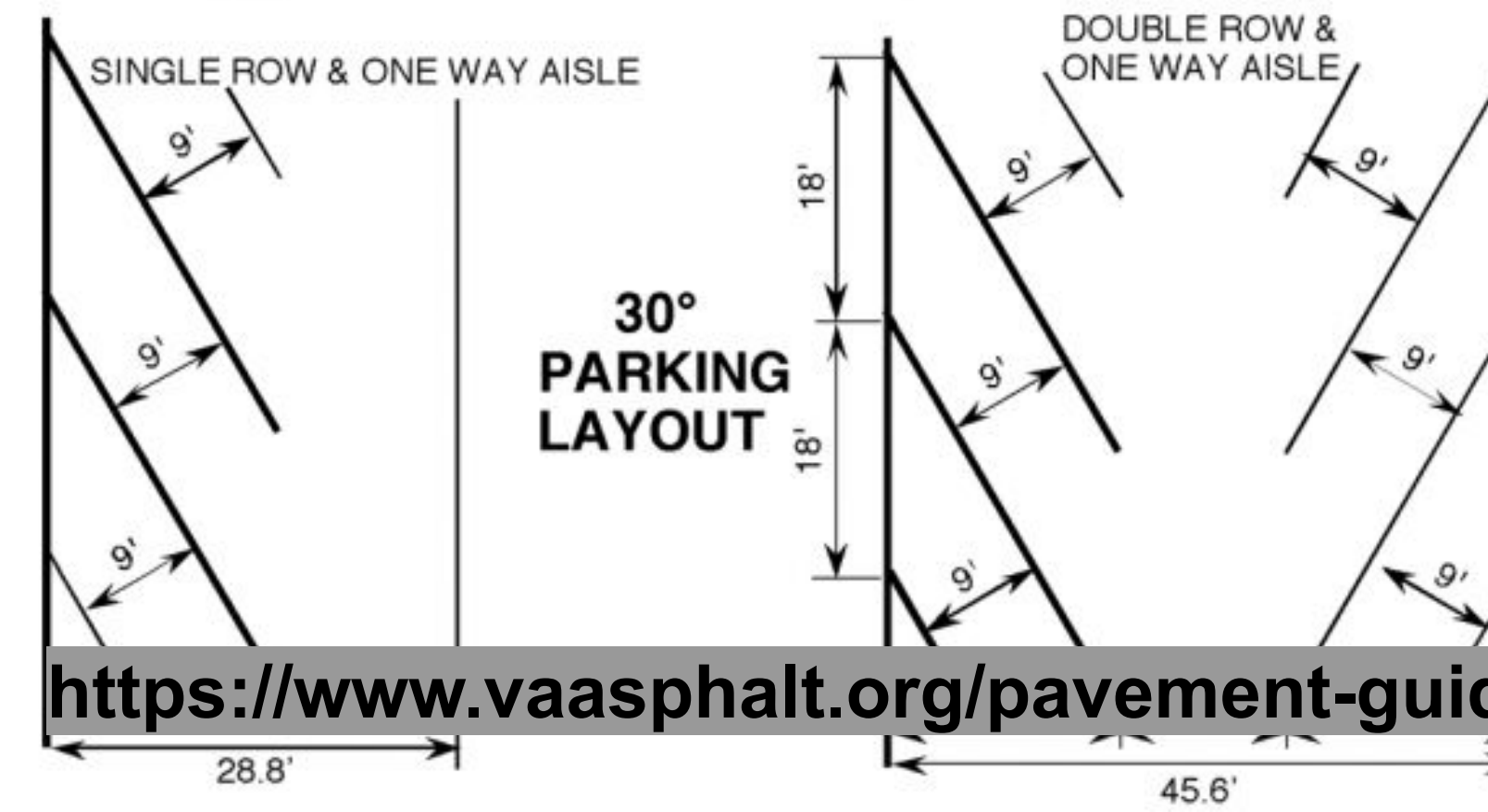
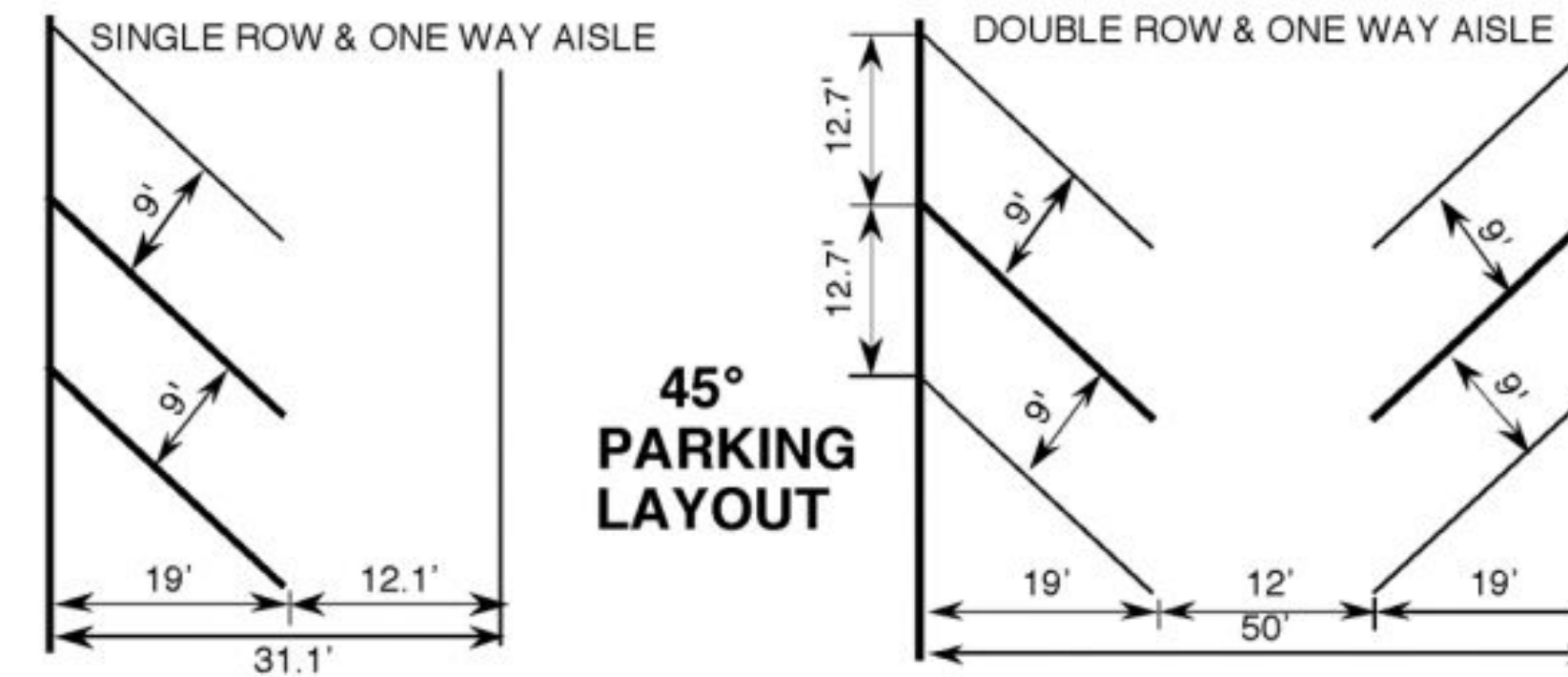
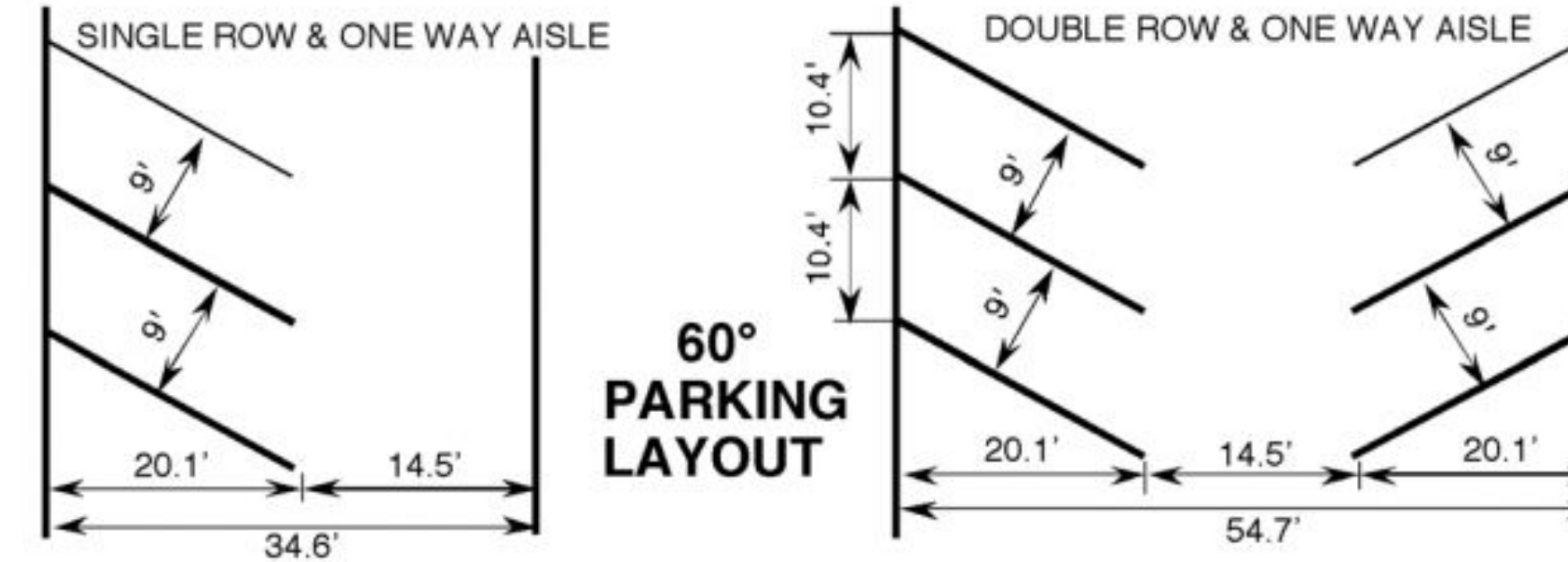
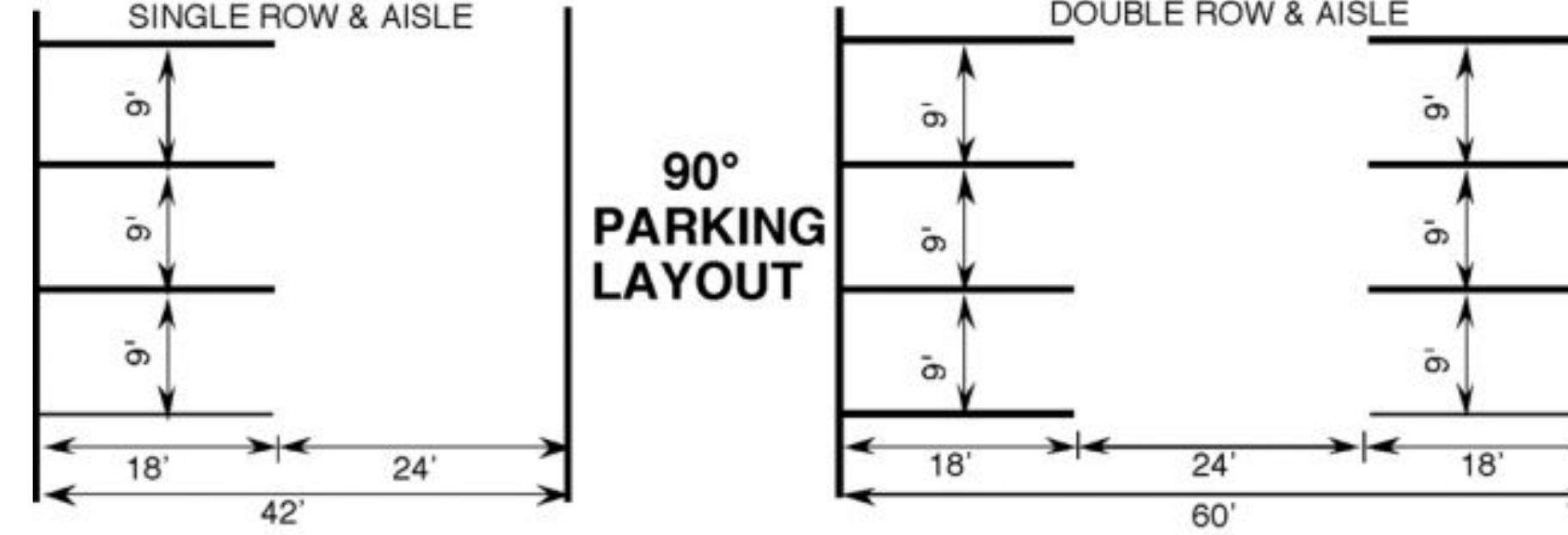




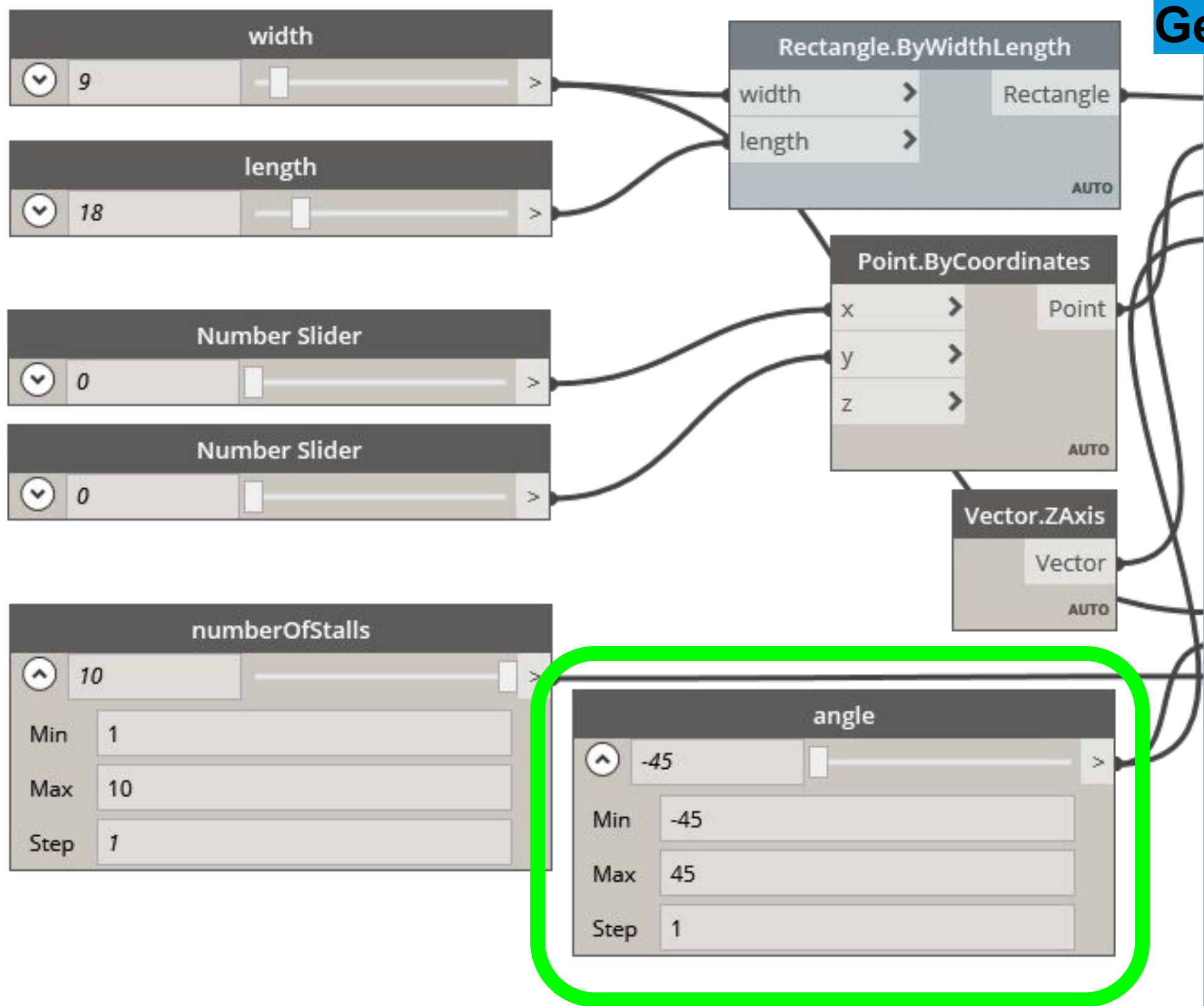








Generation Method: "OPTIMIZE"



Create Study

Generation Method

Optimize

Inputs

angle

-45

-45

45

Outputs

Area

2794.500000...

MINIMIZE

Settings

Population Size

20

Enter a number that is a multiple of 4.

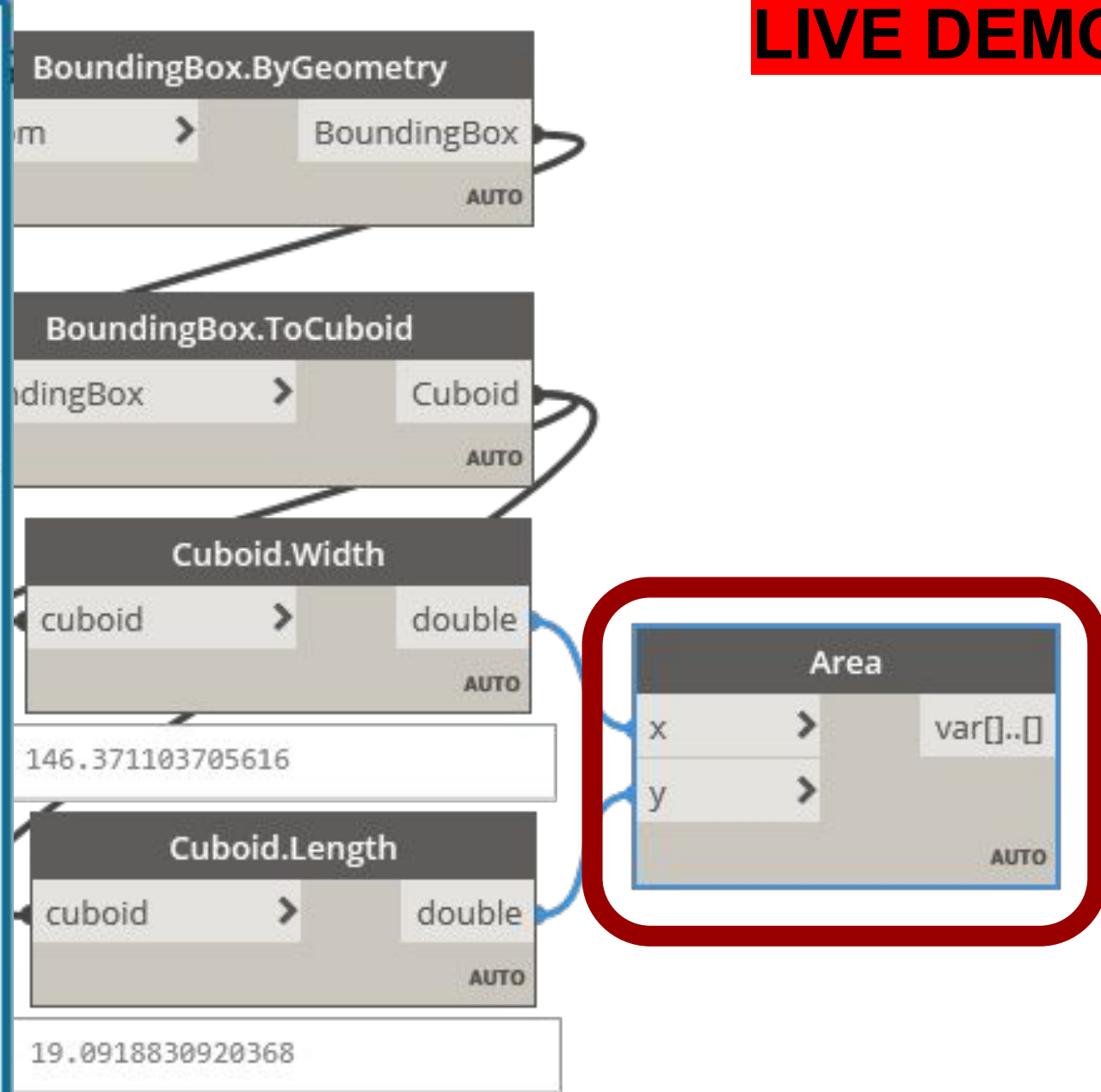
Generations

10

Enter a number.

Server is running.

Generate



Remove

Create Group

Remove from Group

Add To Group

Freeze

Preview

Show Labels

Rename Node...

Is Input

Is Output

Help...

Y-Axis

Area

X-Axis

angle

Size

Default

Color

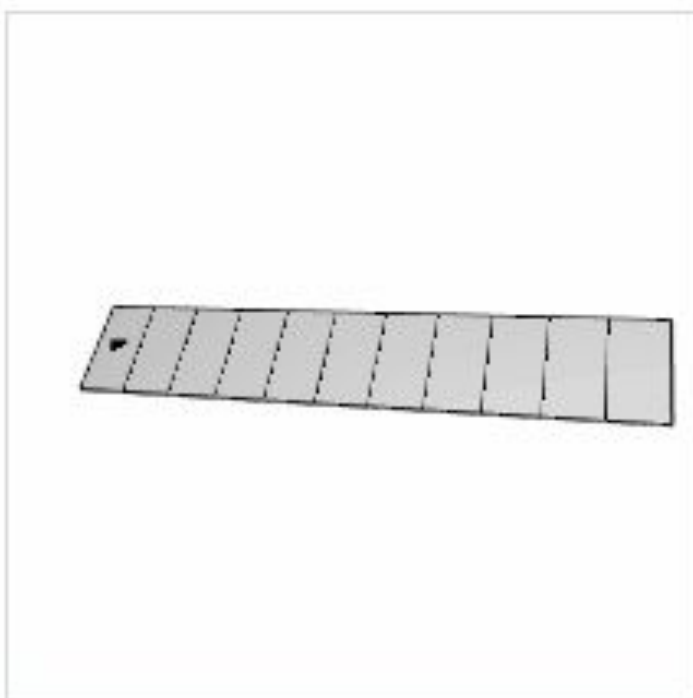
Default

Filter ☐

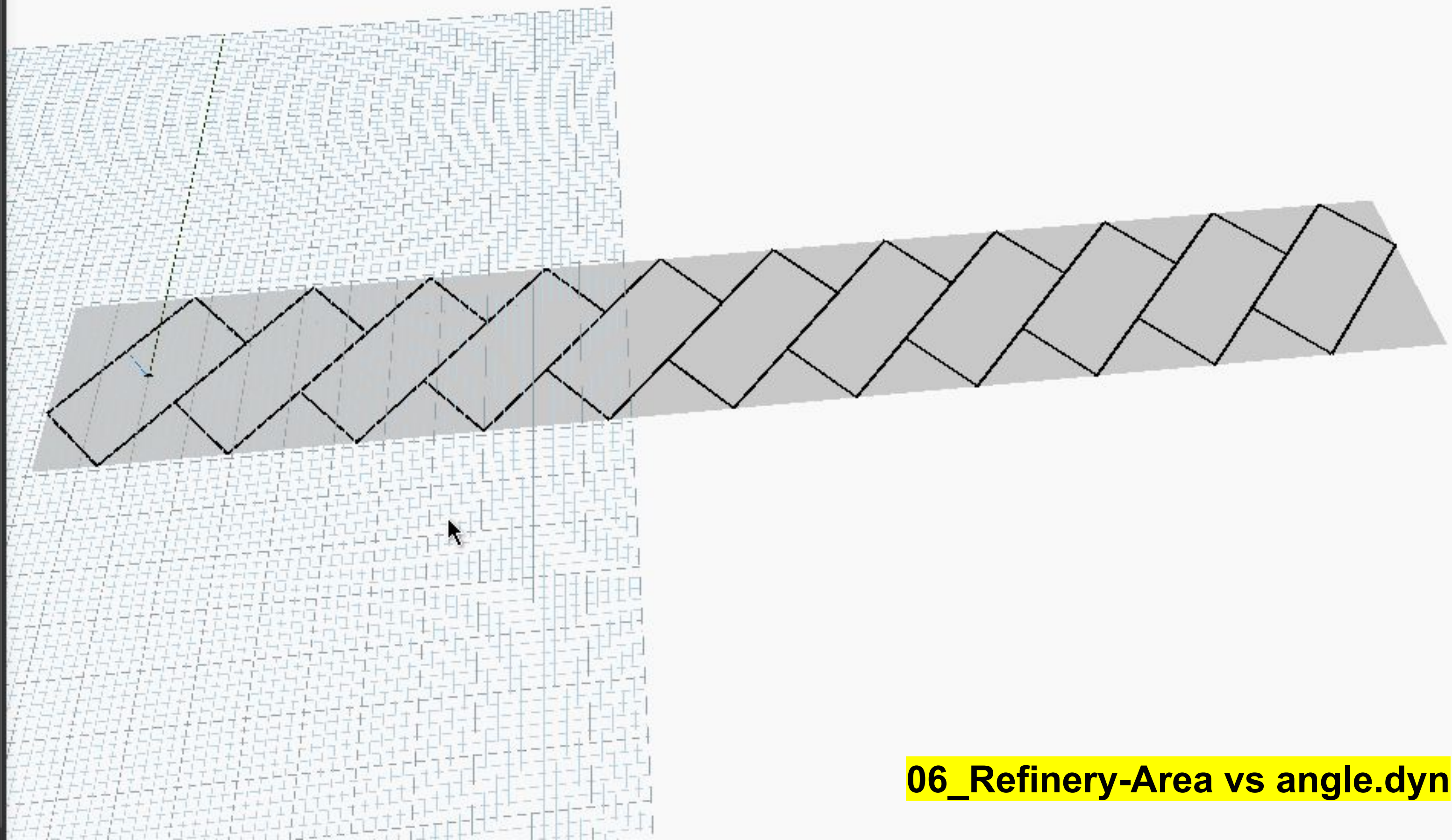
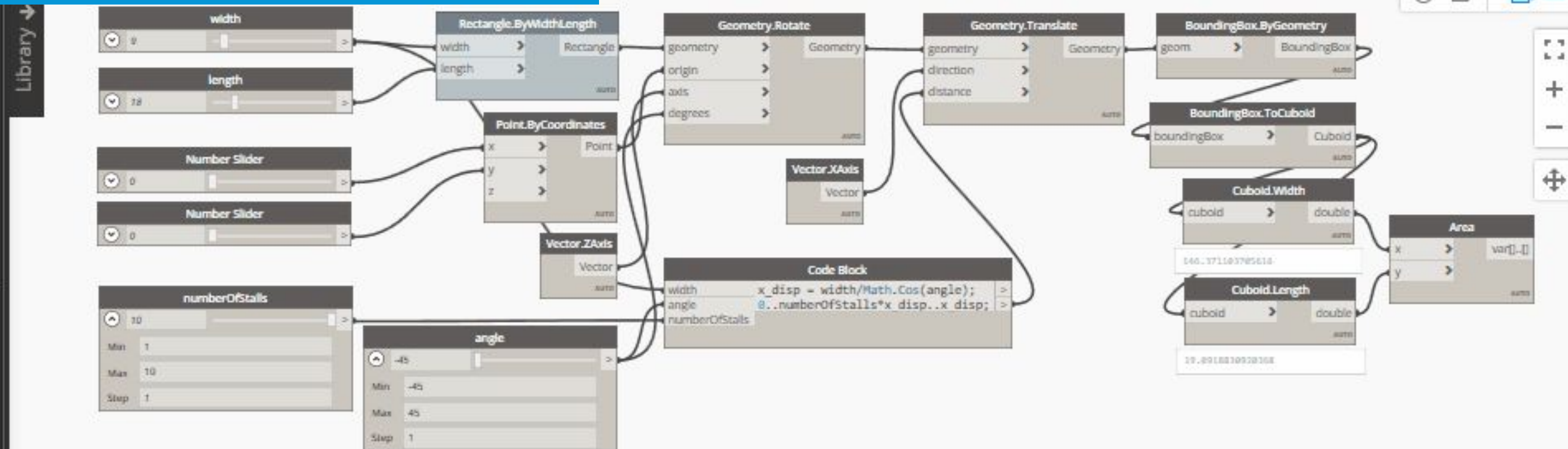
Sort by

Area

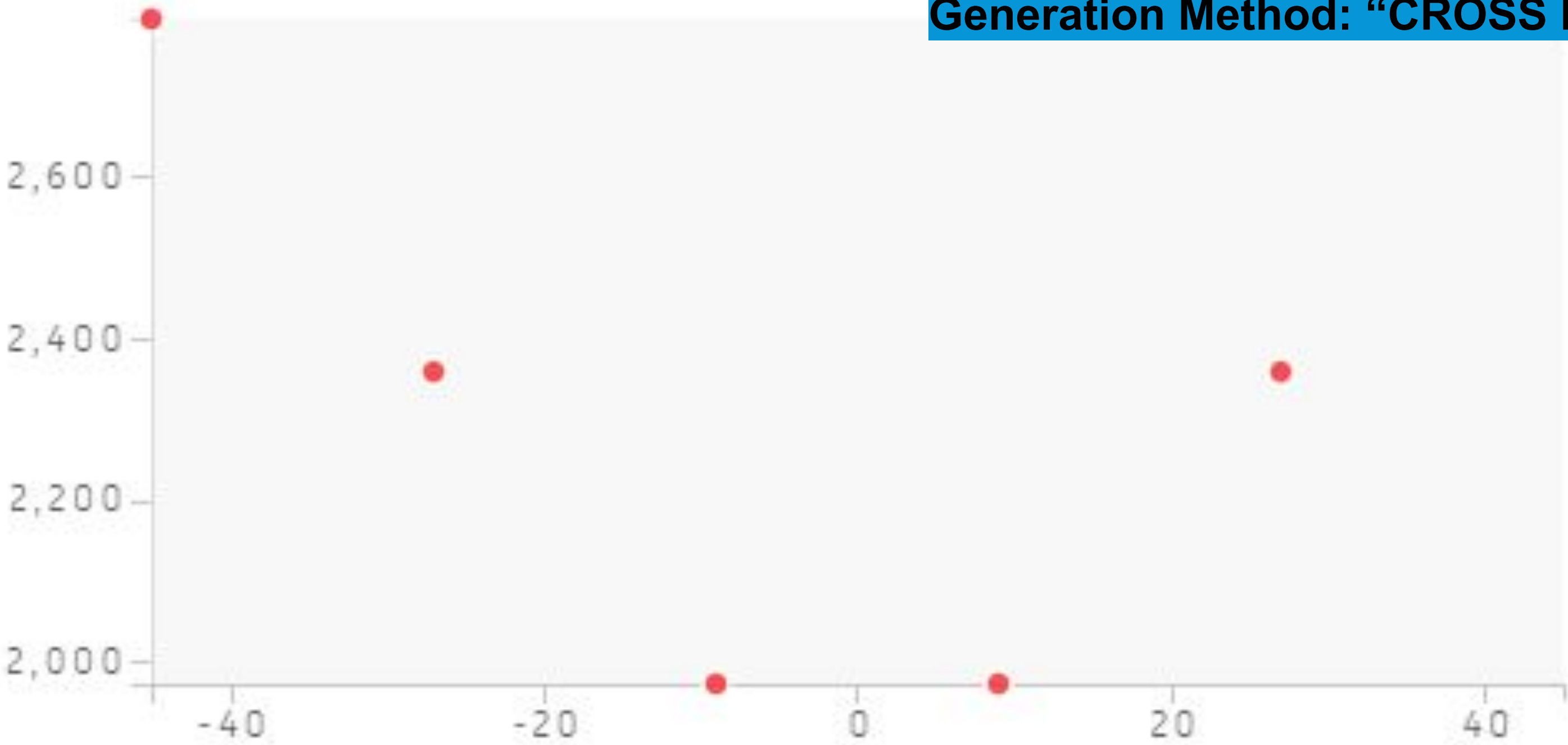
1



Generation Method: "OPTIMIZE"



Generation Method: "CROSS PRODUCT"



Create Study

6 Designs

Generation Method

Cross Product

Inputs

angle

0

-45

45

6

Outputs

Area

1782

Settings

Server is running.

06_Refinery-Area vs angle.dyn



Generation Method: "CROSS PRODUCT"

Y-Axis
Area

X-Axis
angle

Size
Default

Color
Default

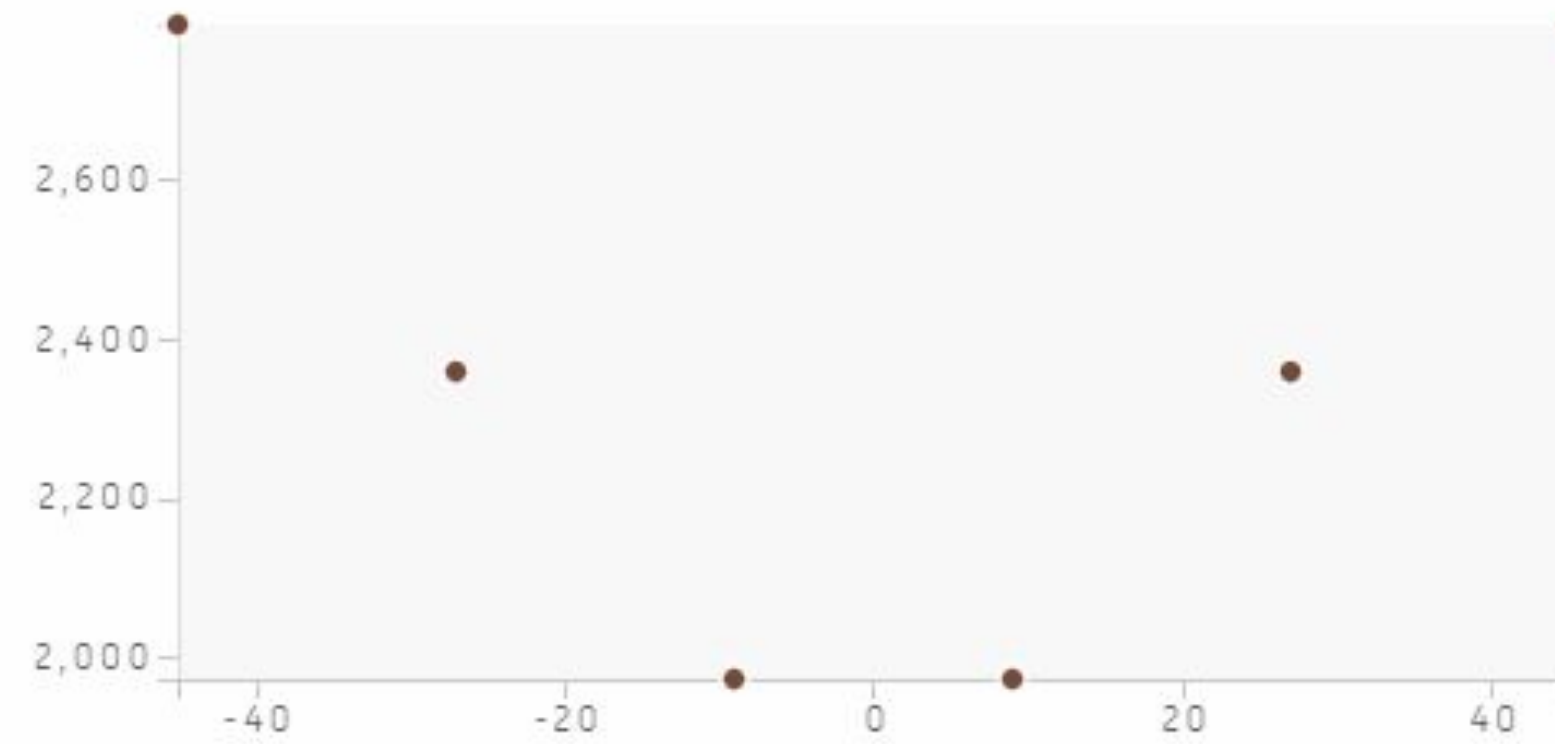
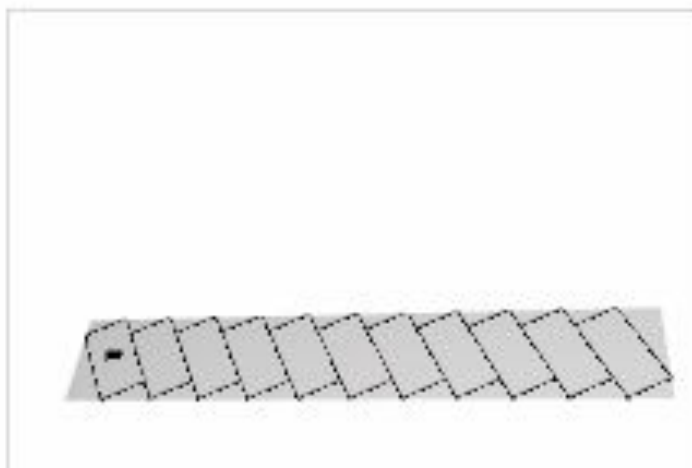
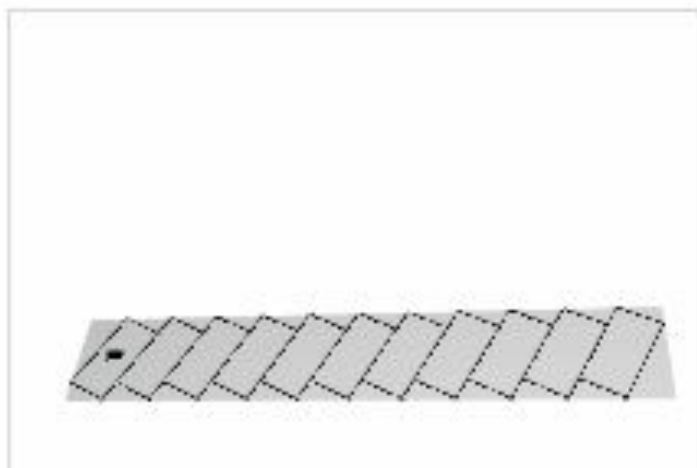
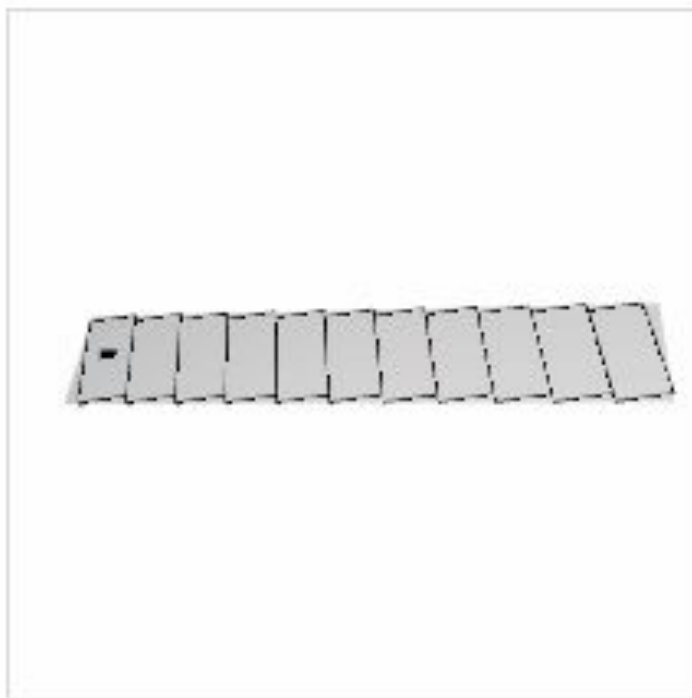
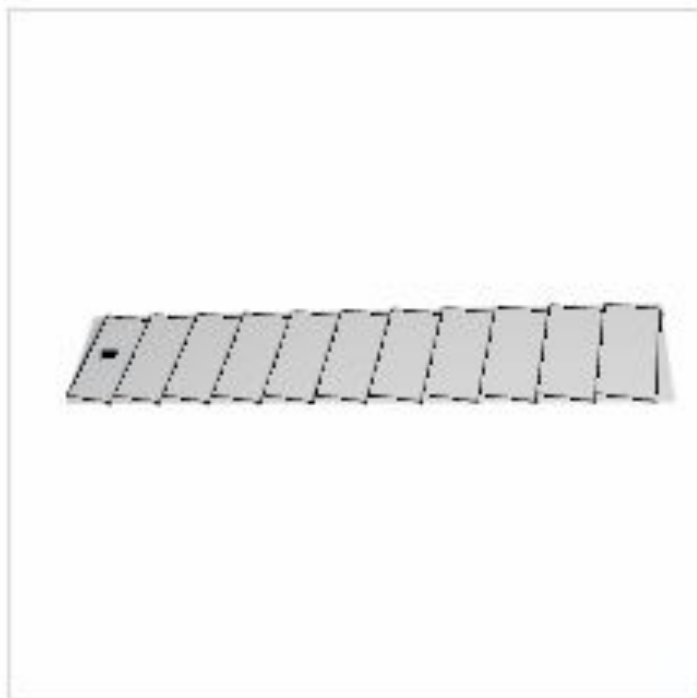
Filter ☐

Sort by

Area



1



angle

^ -45 >

Min -45

Max 45

Step 1

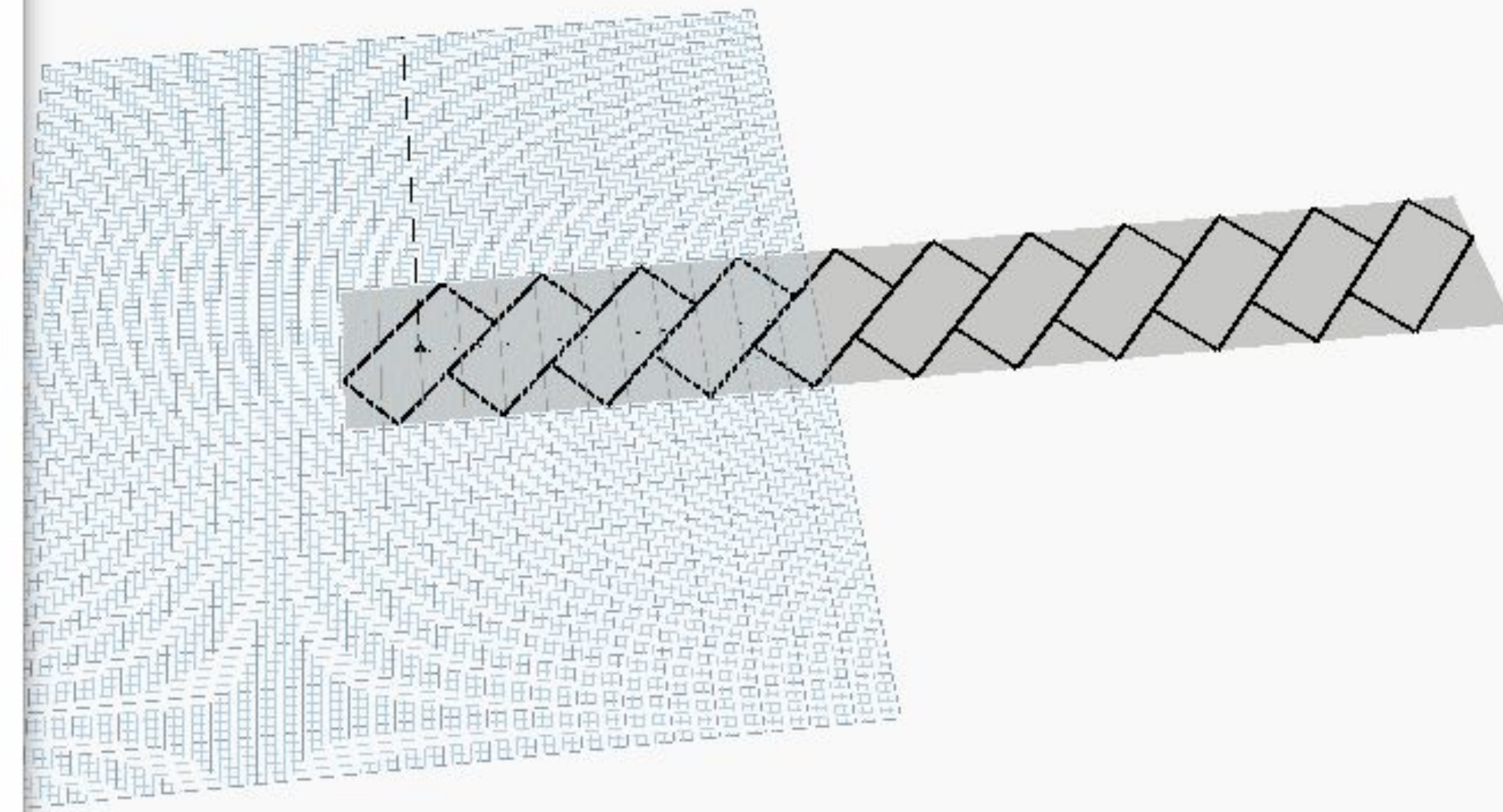
Area

x > var[]..[]

y >

AUTO

2794.500000000001



Generation Method: "RANDOMIZE"

Y-Axis

Area

X-Axis

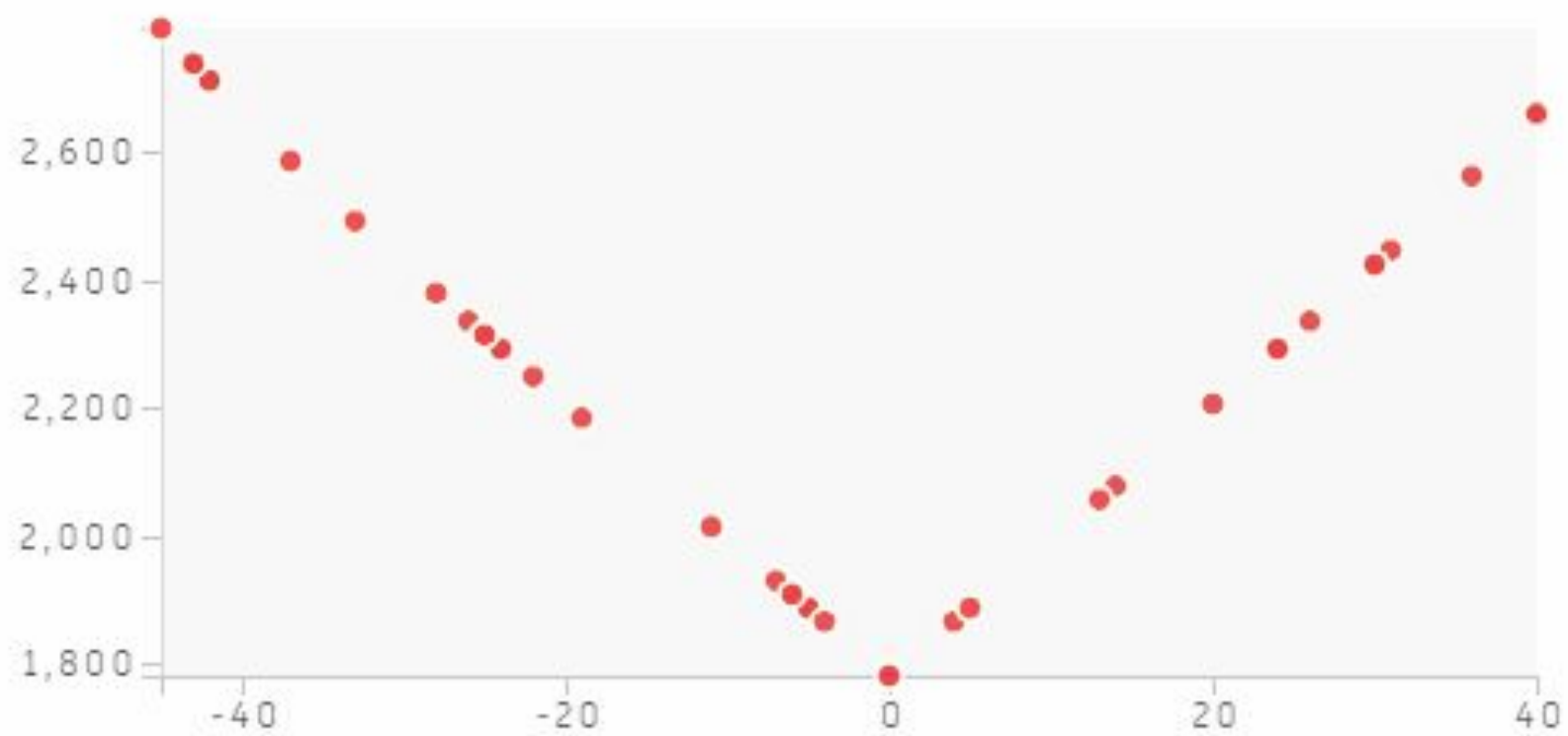
angle

Size

Default

Color

Default



Filter ☐

Sort by

Area

↑

- 1
- 2
- 3
- 4
- 5

angle

45

Min

-45

Max

45

Step

1

Area

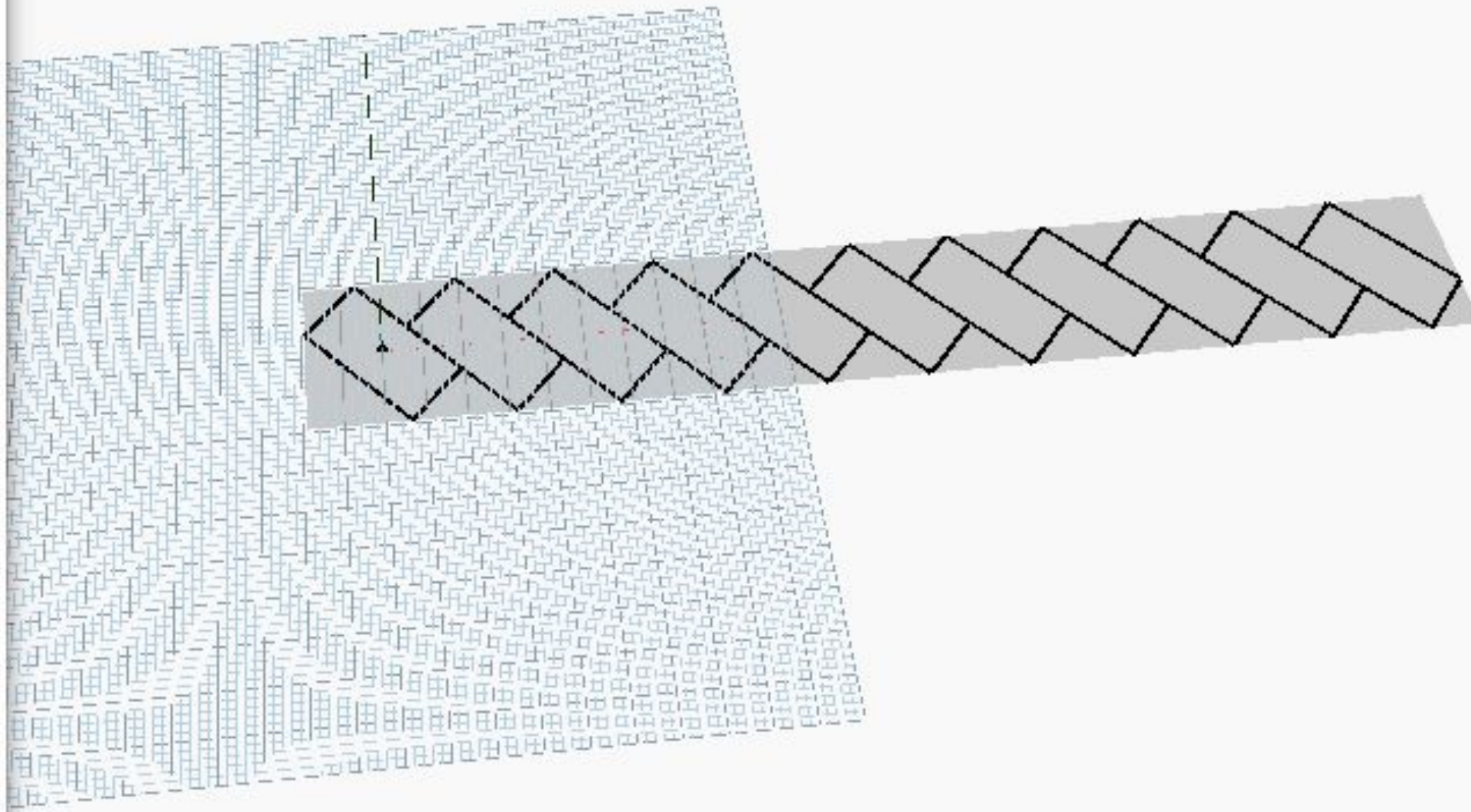
x

y

var[]..[]

AUTO

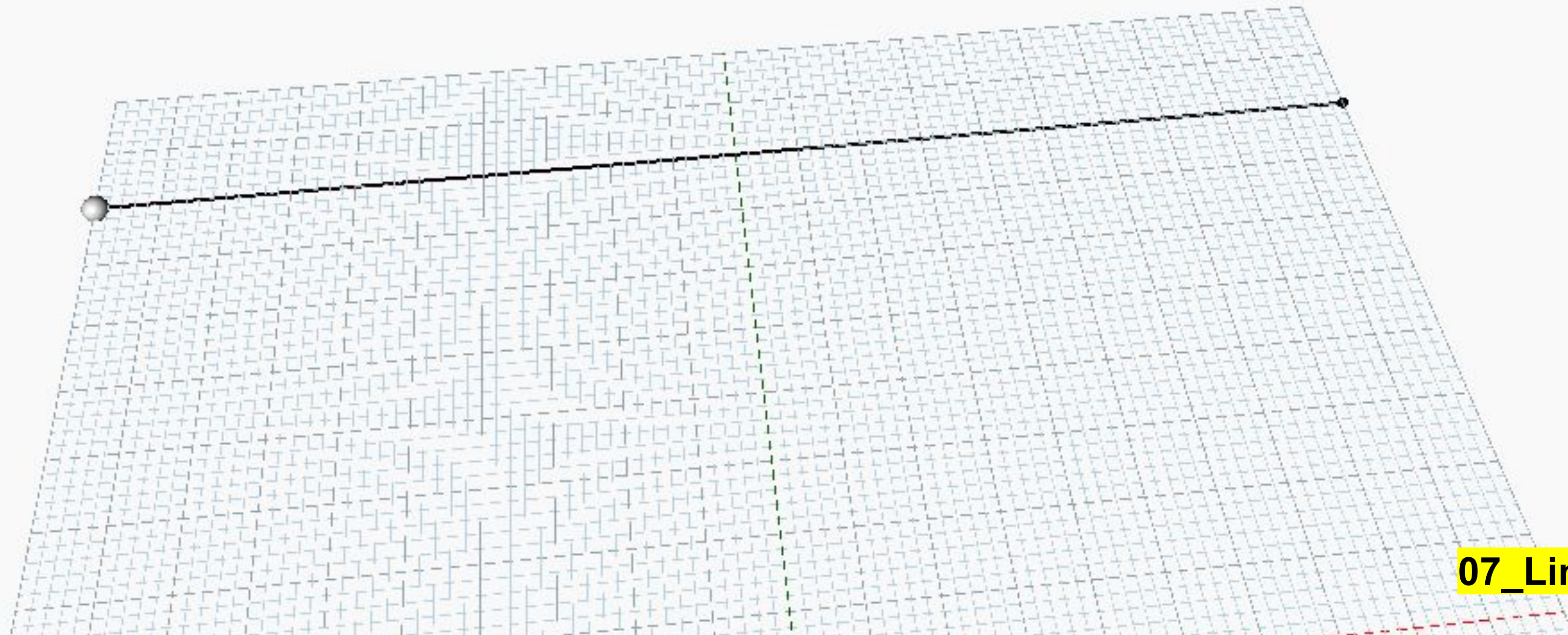
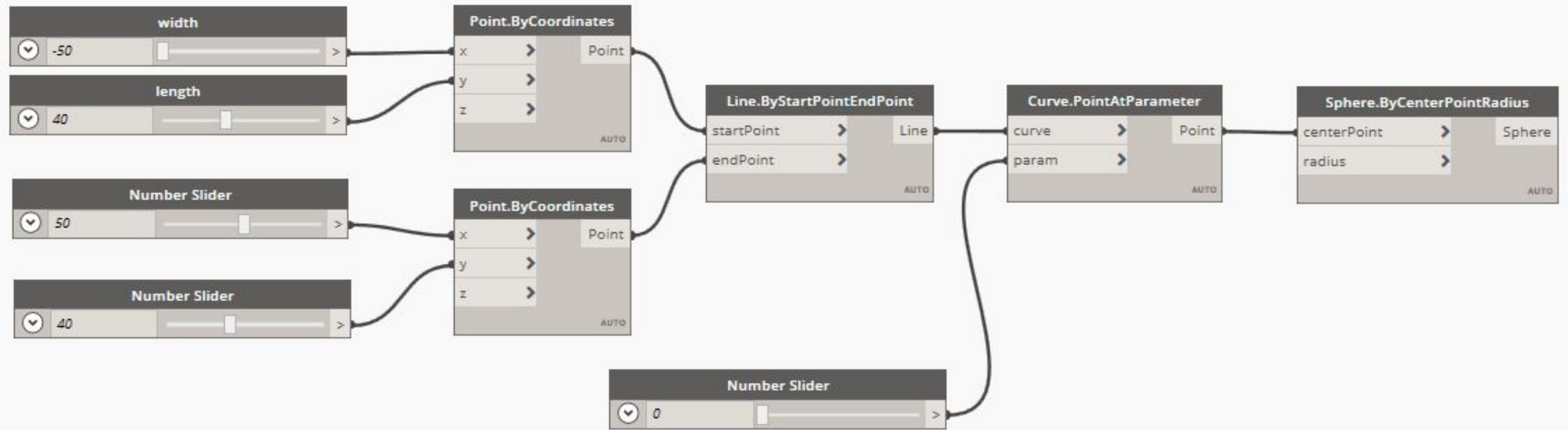
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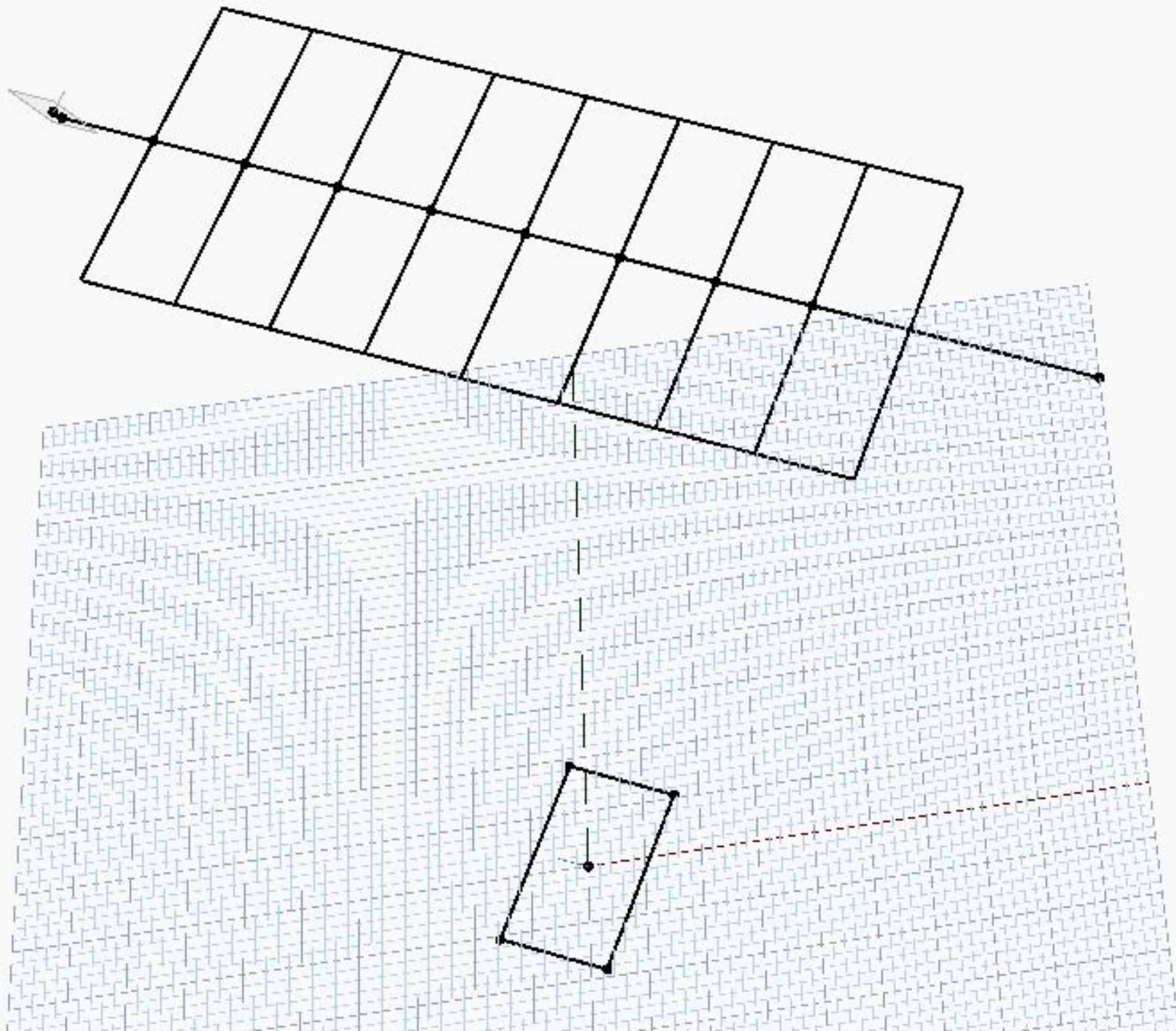


Share your knowledge. It
is a way to achieve
immortality.

Dalai Lama

Line based parking strip





width

10

length

16

angle

0

islandWidth

10

x1

-50

y1

84

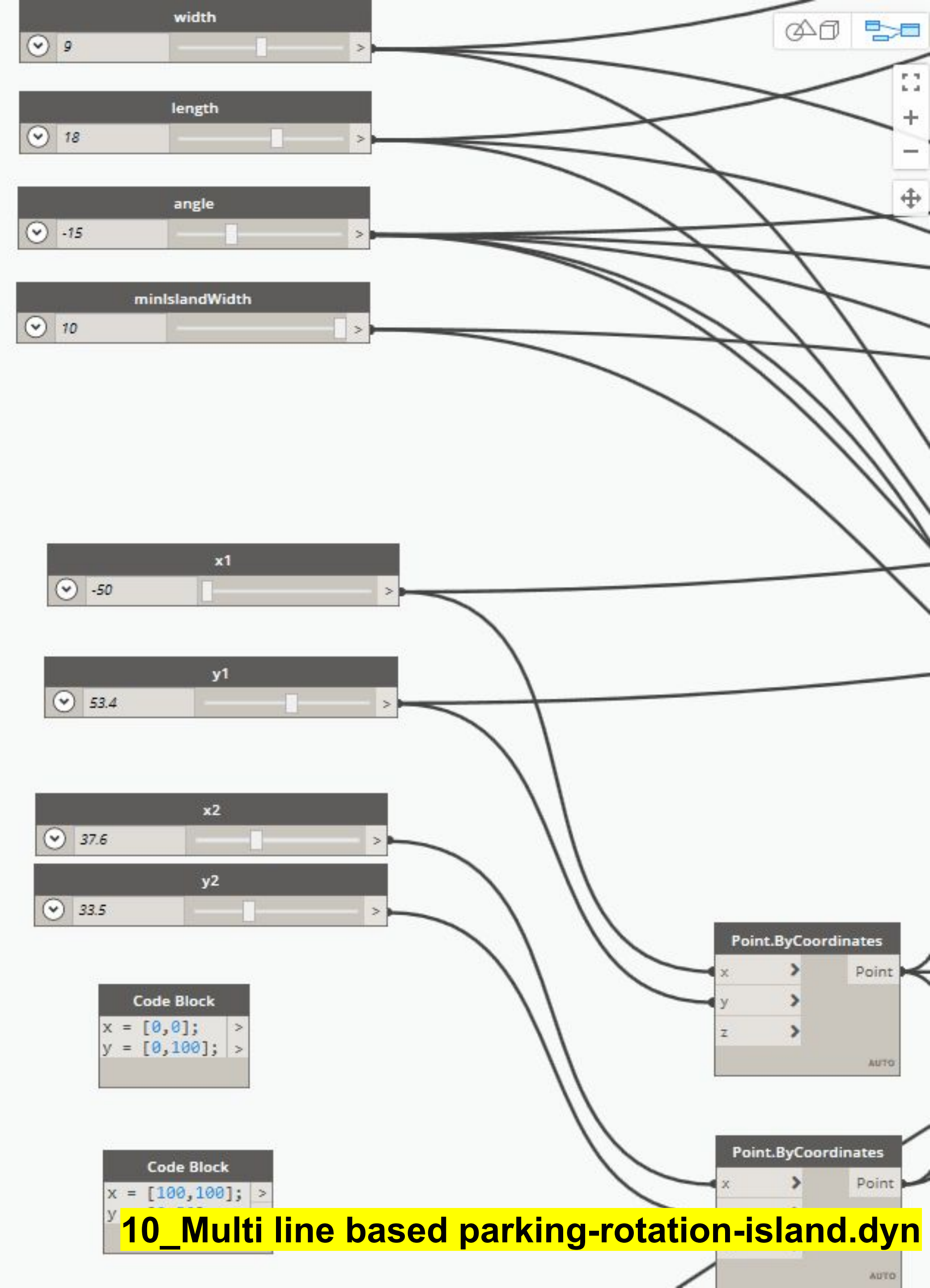
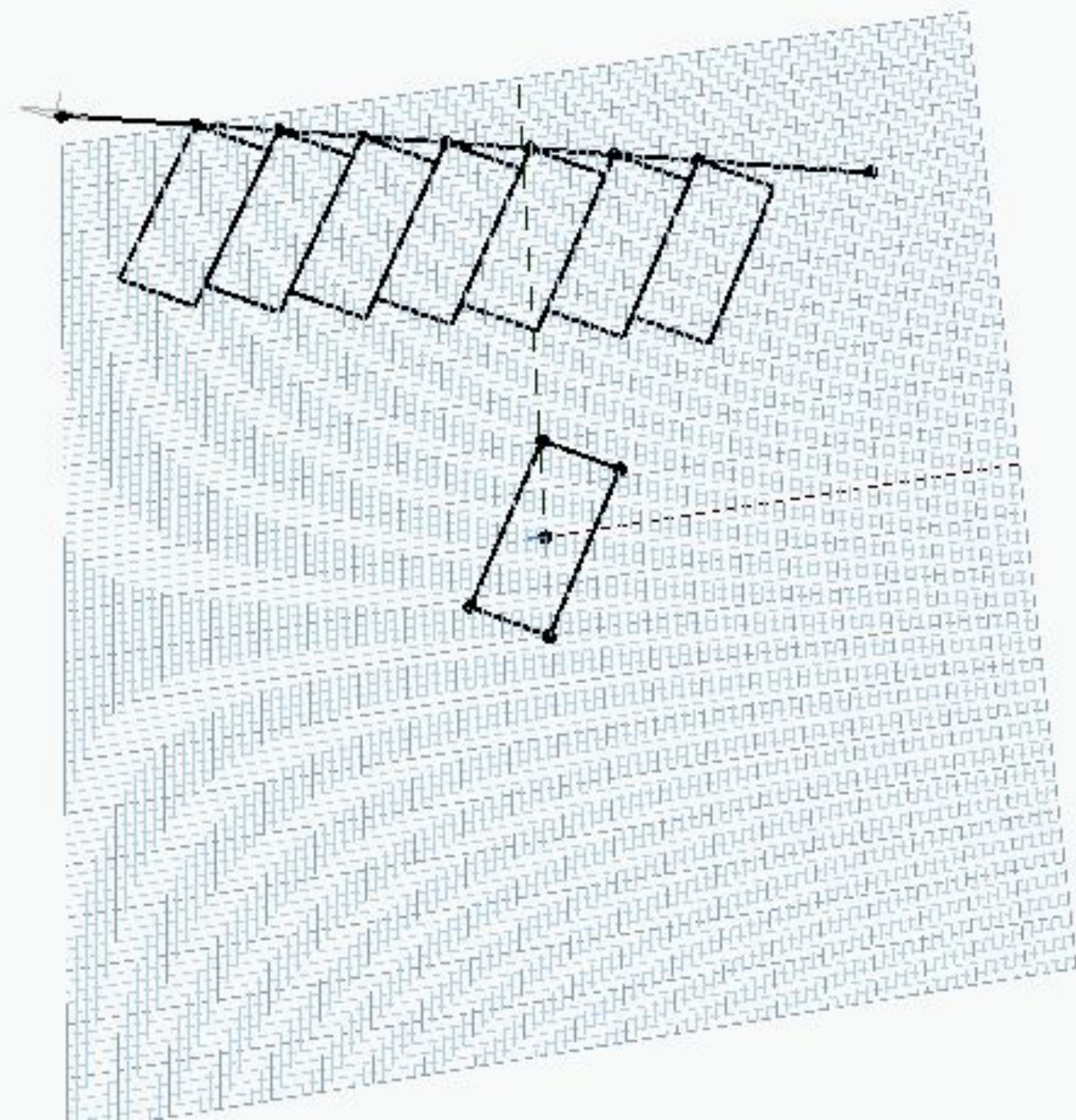
x2

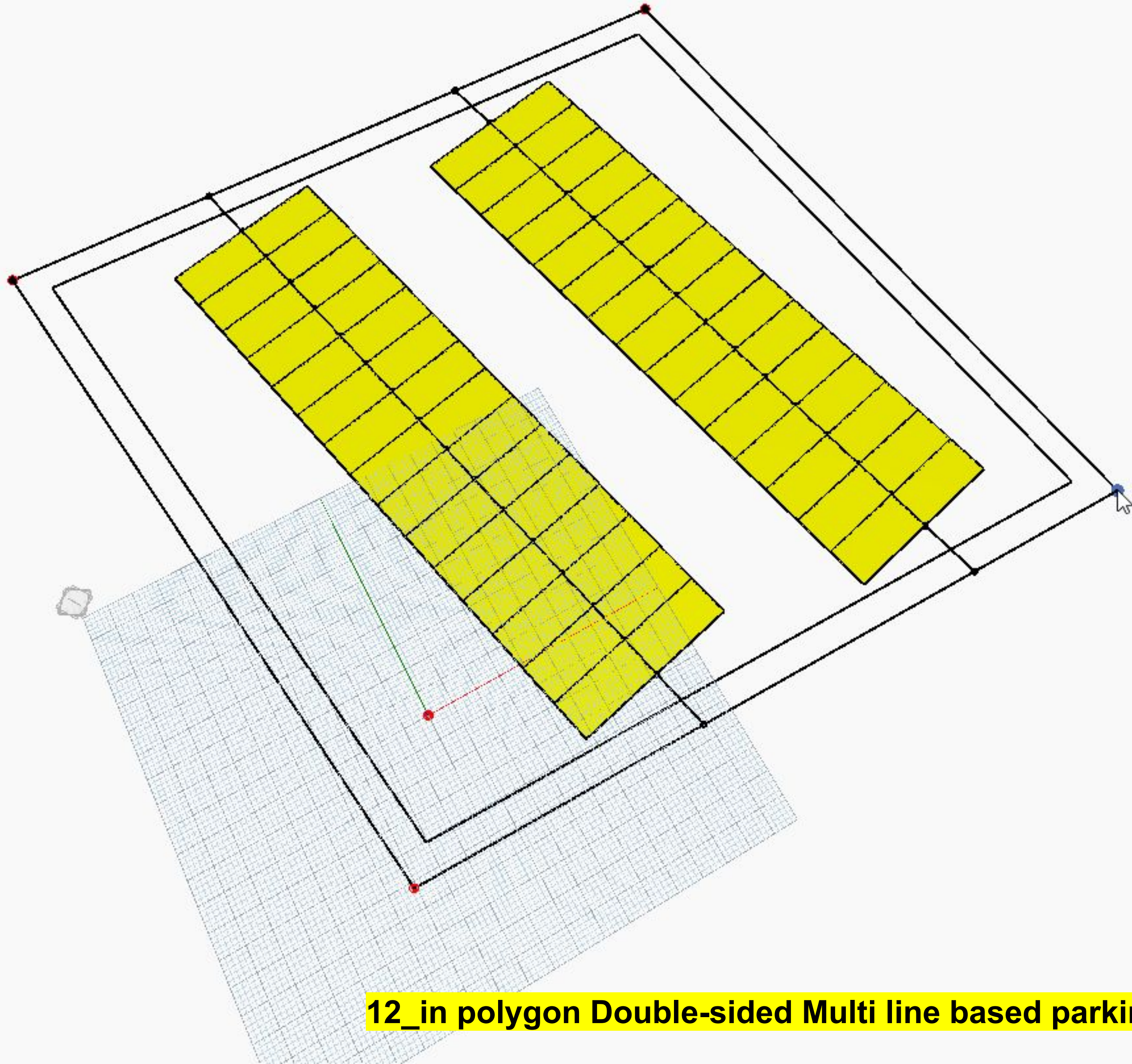
50

y2

40

```
numberOfStalls = Math.Floor((len-(2*islandWidth))/width);
x_disp = width/Math.Cos(angle);
y_disp = width*Math.Sin(angle);
parkingStripLen= numberOfStalls * width;
range = islandWidth..islandWidth+parkingStripLen-width..x_disp;
norm_range = range/len;
```





Motivation



**KEEP
CALM
AND BEAT YOUR
PERSONAL
BEST**

- Clients

- Sharing

My journey

A couple of hours in...

Input

MoveParkingRows

^-2>

Min -10

Max 10

Step 1

RotateParkingRows

^5>

Min 0

Max 44

Step 1

Parking Count

List.Count

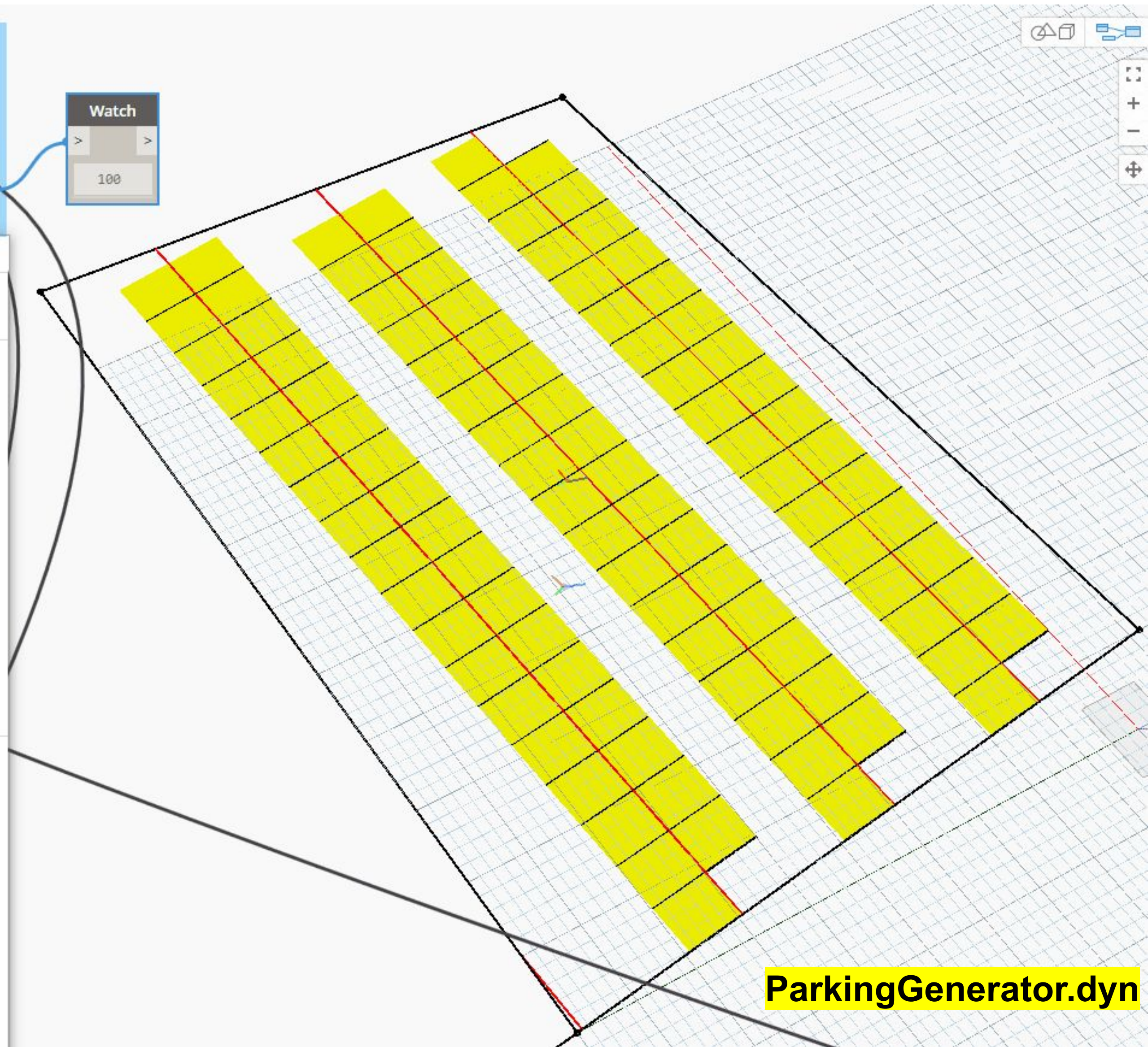
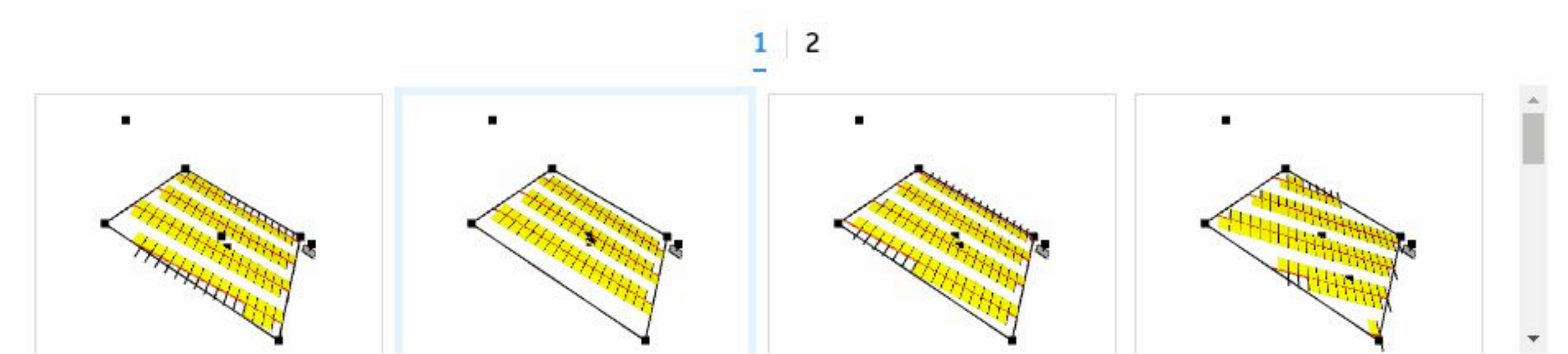
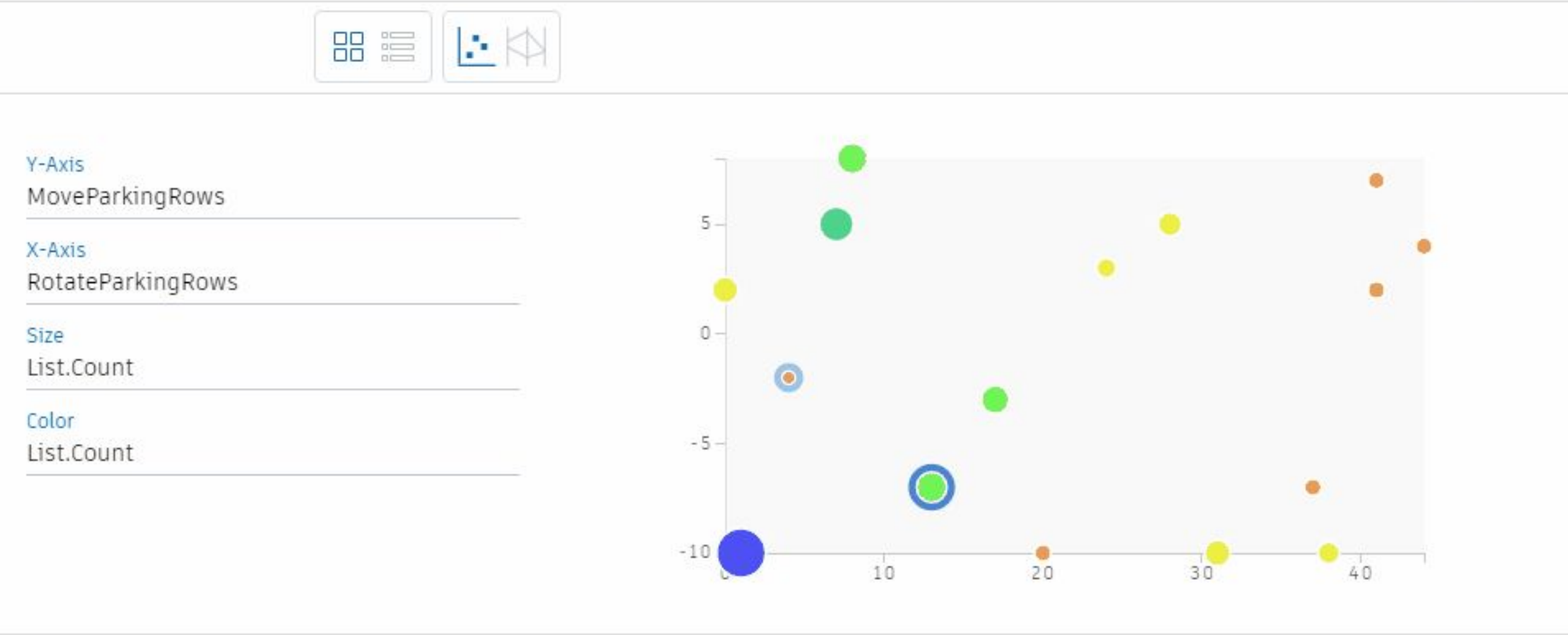
list > count

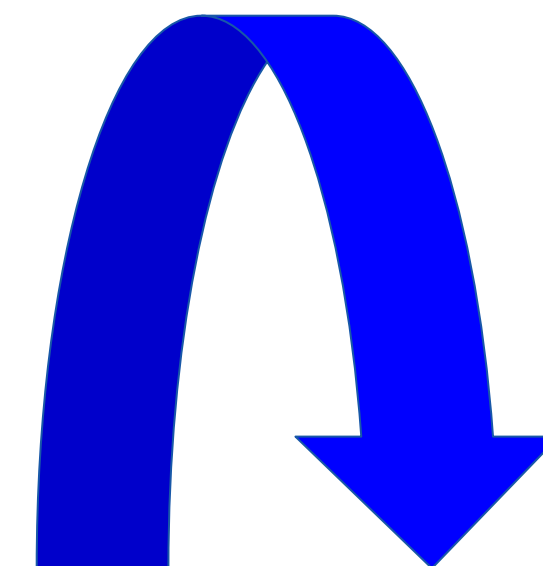
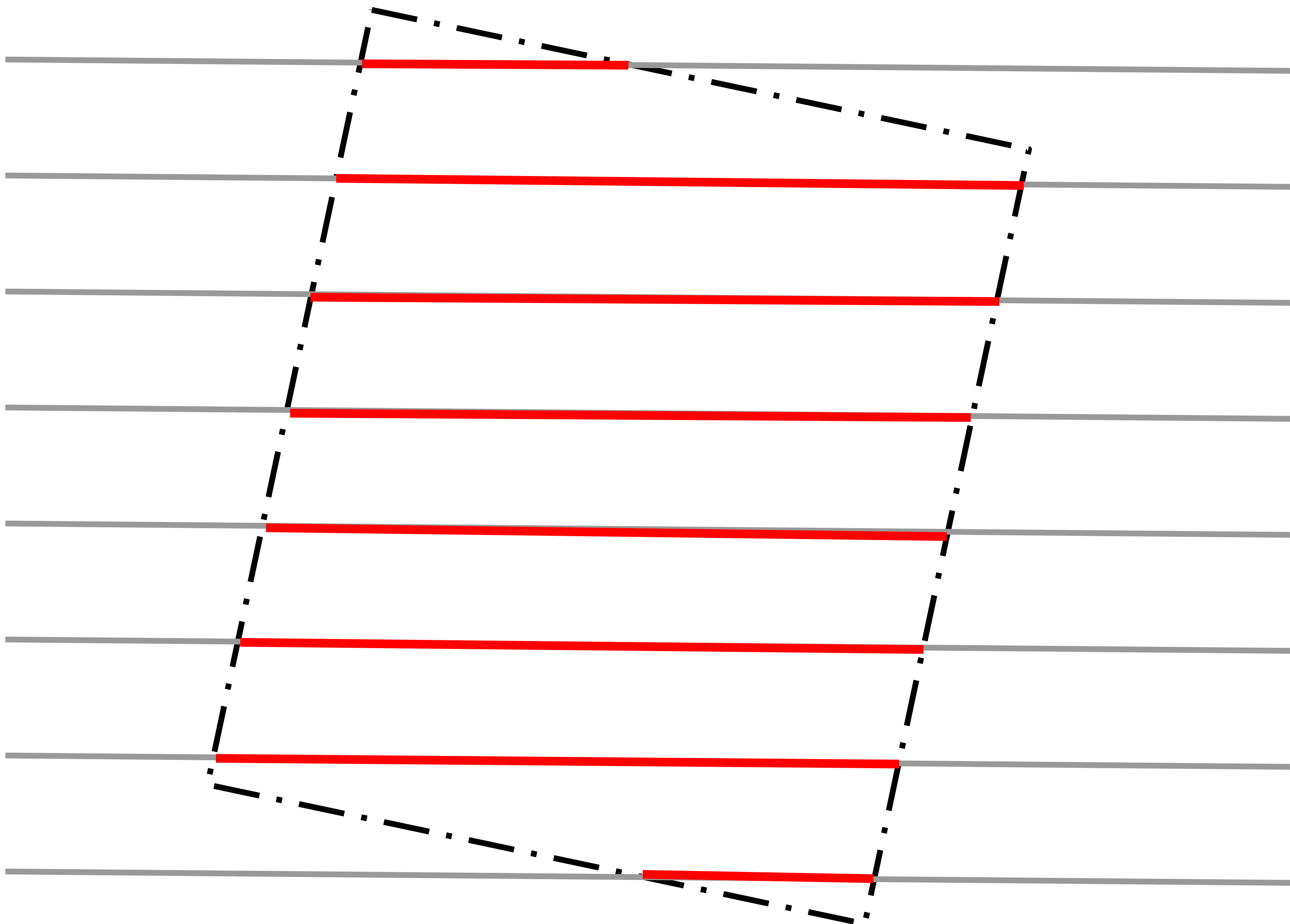
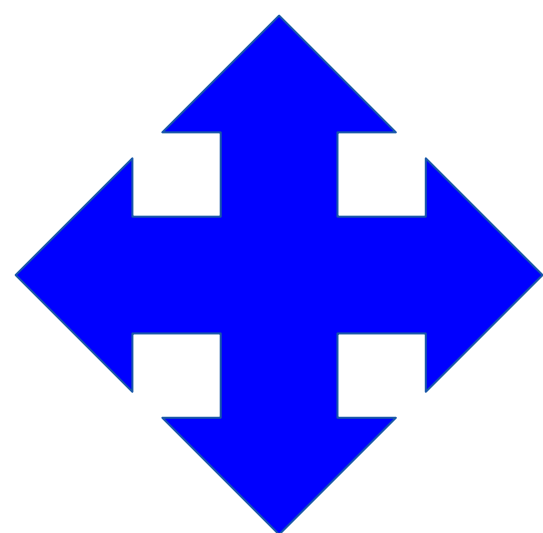
AUTO

Watch

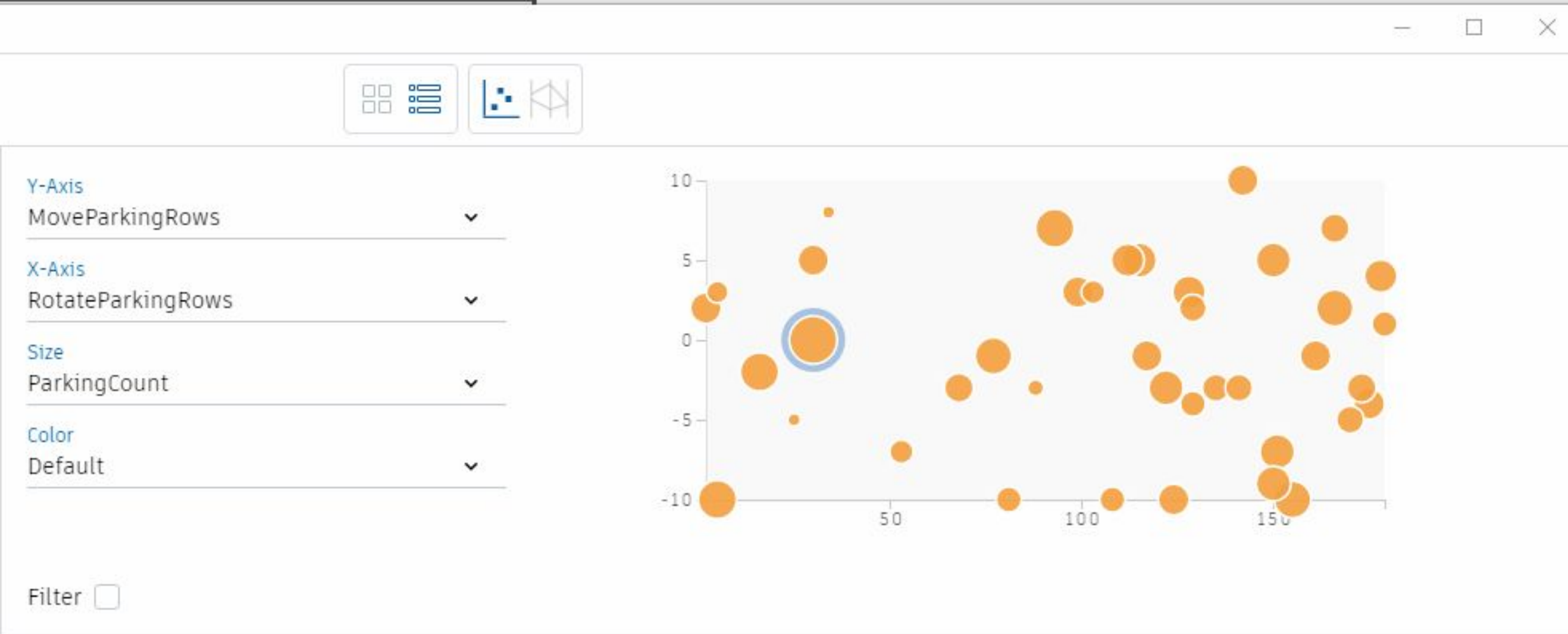
> >

100

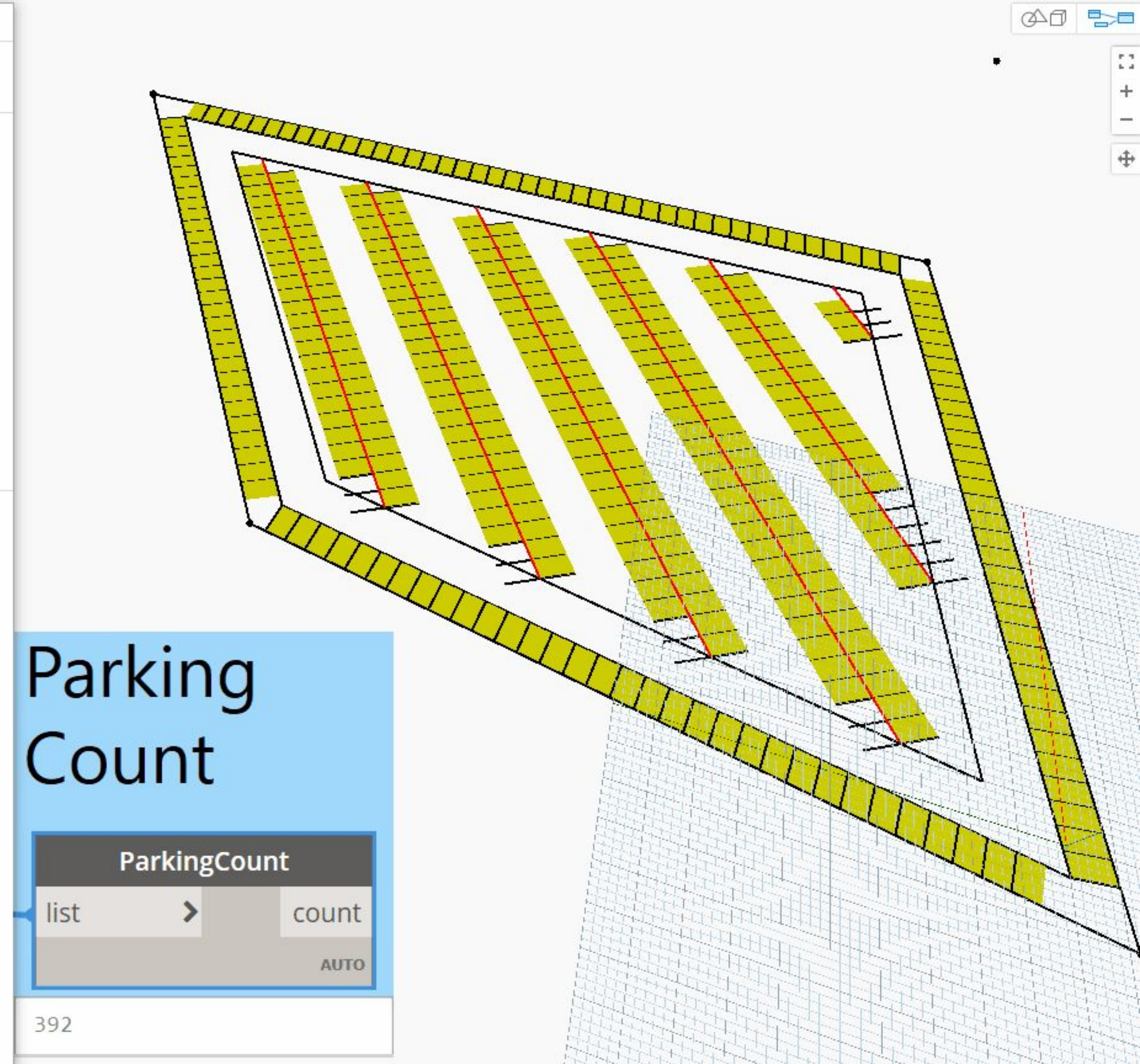




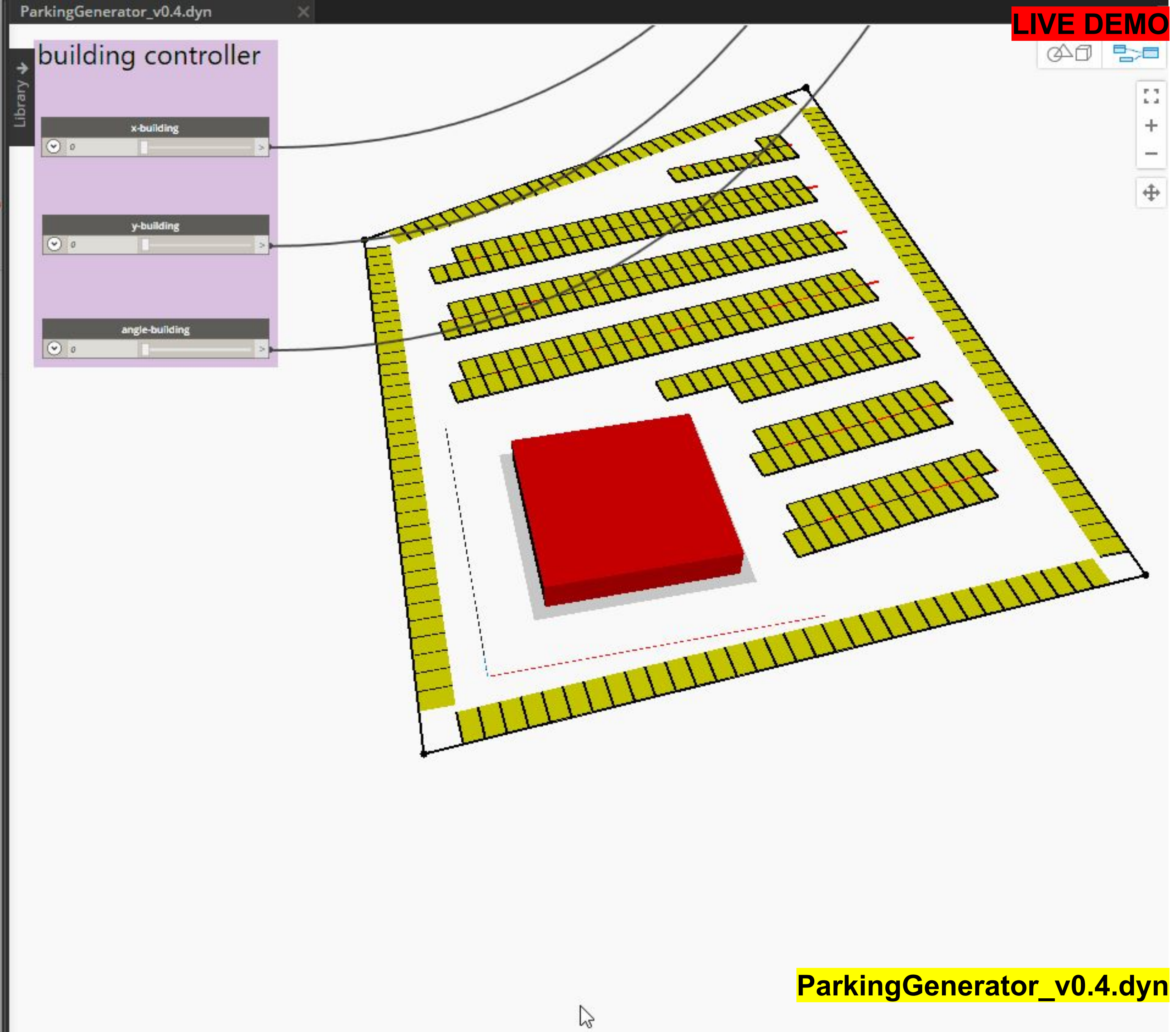
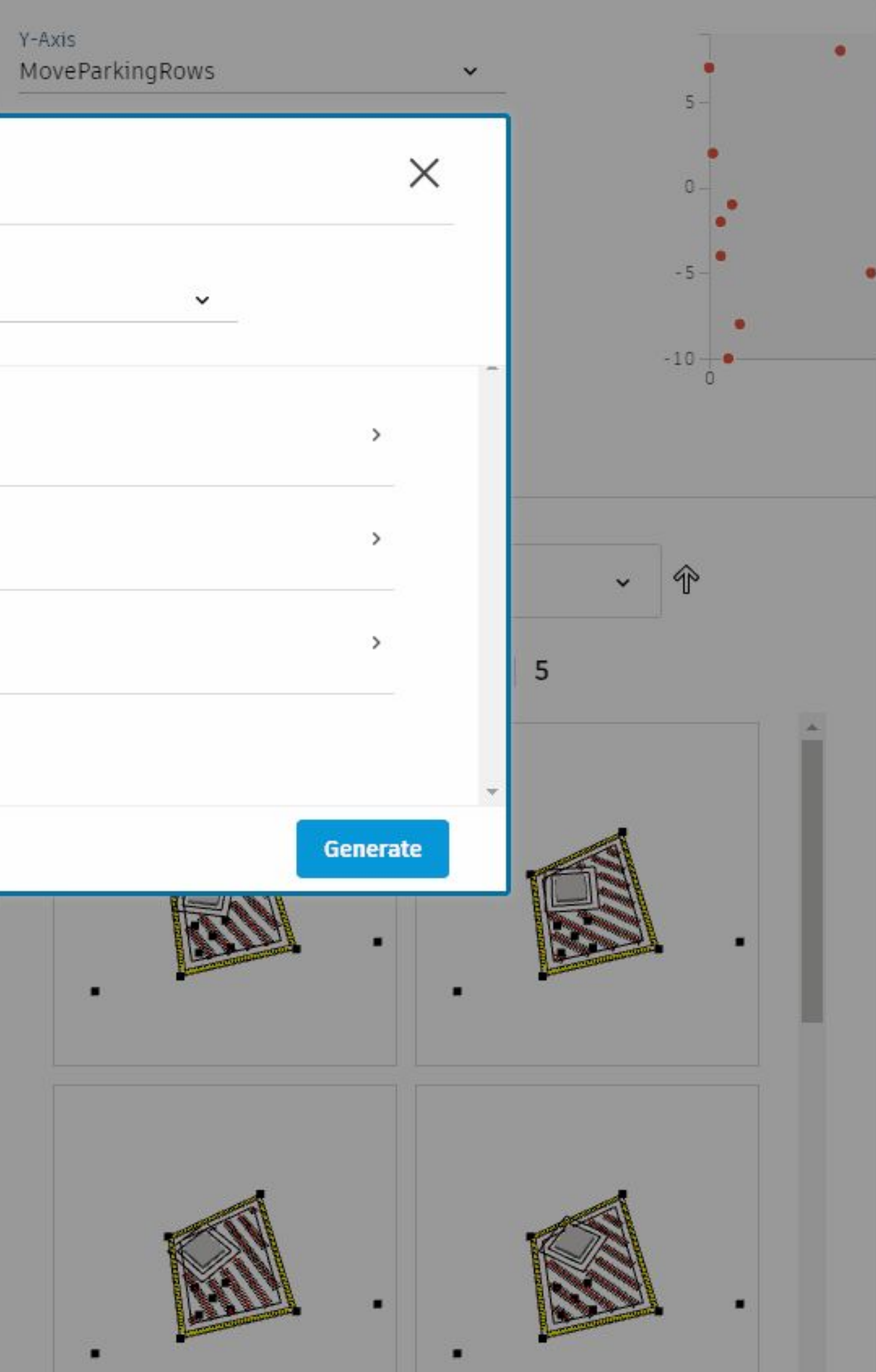
Let's add more parking!



ParkingCount ↓	RotateParkingRows	MoveParkingRows
392.0	30	0
387.0	5	-10
387.0	93	7
387.0	16	-2
386.0	155	-10
386.0	77	-1
386.0	166	2
385.0	122	-3



Let's add a building!



Xavier Loayza
@xloayzaHD



I would like to facilitate more human input to it. Drag and drop, and stretching features (web browser?). Someone could say that most of the best results seem obvious. Maximizing parking lot count is not a good parameter to validate design. I had fun @keanw @LorenzoVillaggi





Lorenzo Villaggi @LorenzoVillaggi · May 28

Now I'd suggested "expanding" the design space by adding features to the geometry system (parking rows going all the way to the perimeter or even curved parking rows etc) and maybe add multiple metrics as [@keanw](#) suggested. Maybe a "congestion" metric could be interesting to add..



2



Kean Walmsley @keanw · May 26

Replying to [@xloayzaHD](#) and [@LorenzoVillaggi](#)

I'd consider some additional metrics, such as something spatial. How about minimising average distance from each parking spot to the building entrance? The tool starts to get interesting when optimising for multiple goals...

~~Shortest path~~

A.K.A The Black Friday Simulator

Sum of
Distances
from
parking
space to
building

Math.Sum

values → sum

AUTO

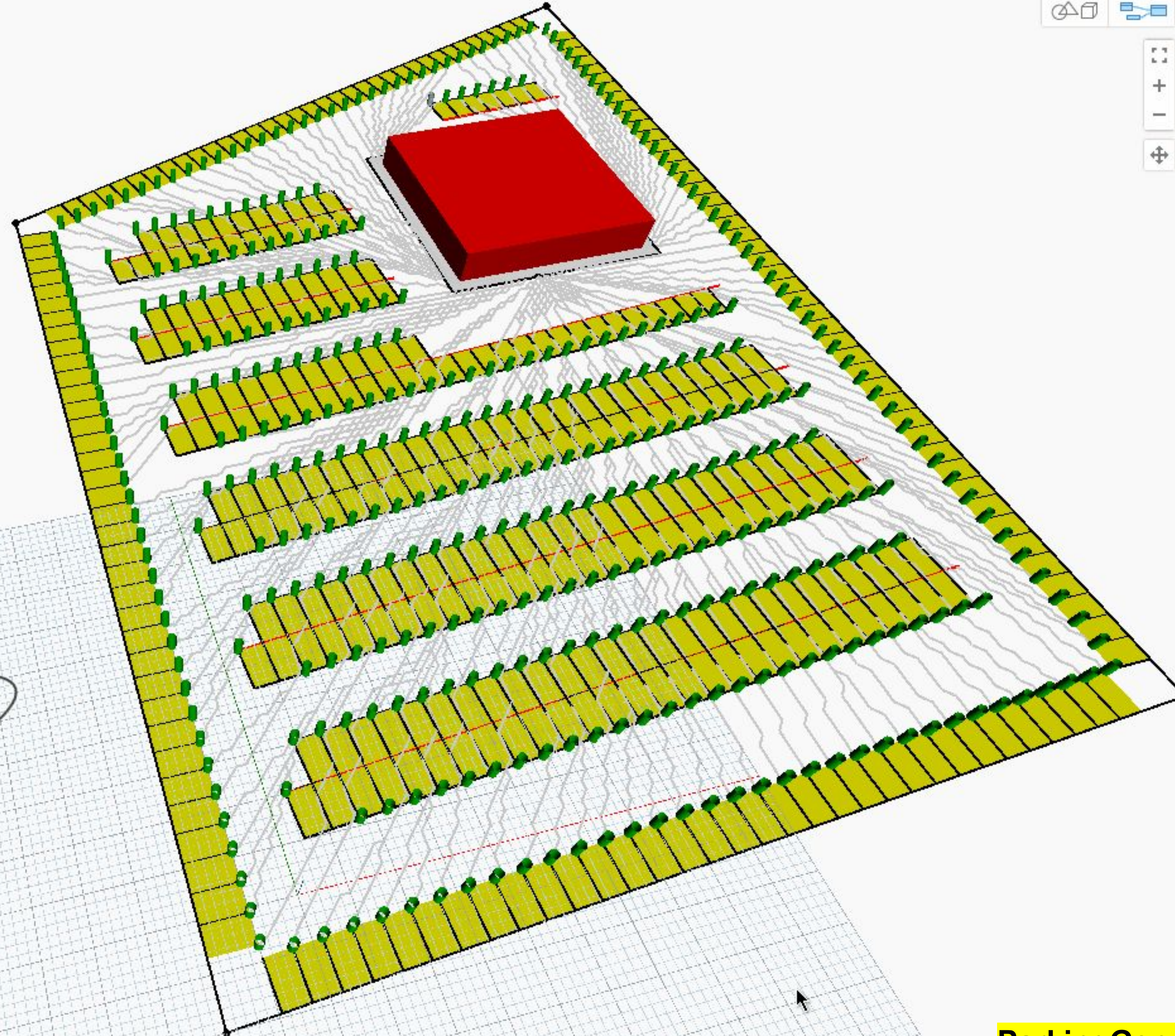
Number Slider

0

Min 0

Max 1

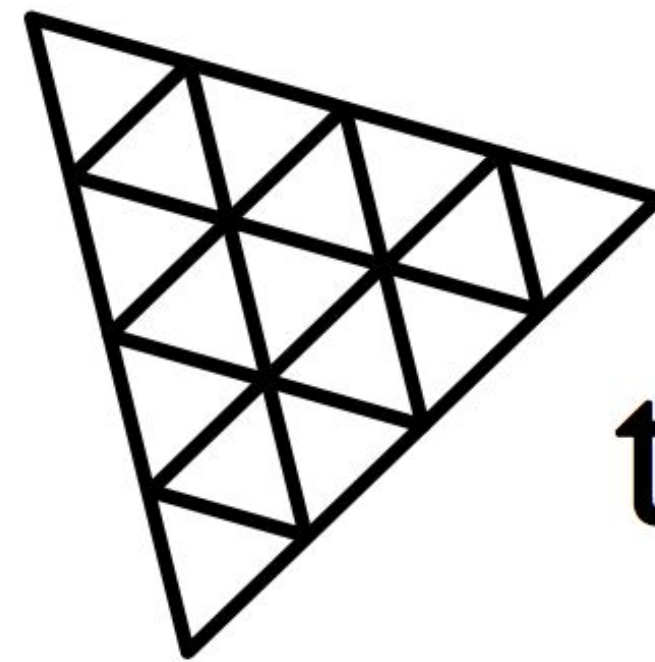
Step 0.05



+60 hours



+80 hours



three.js

ROBOTAXI

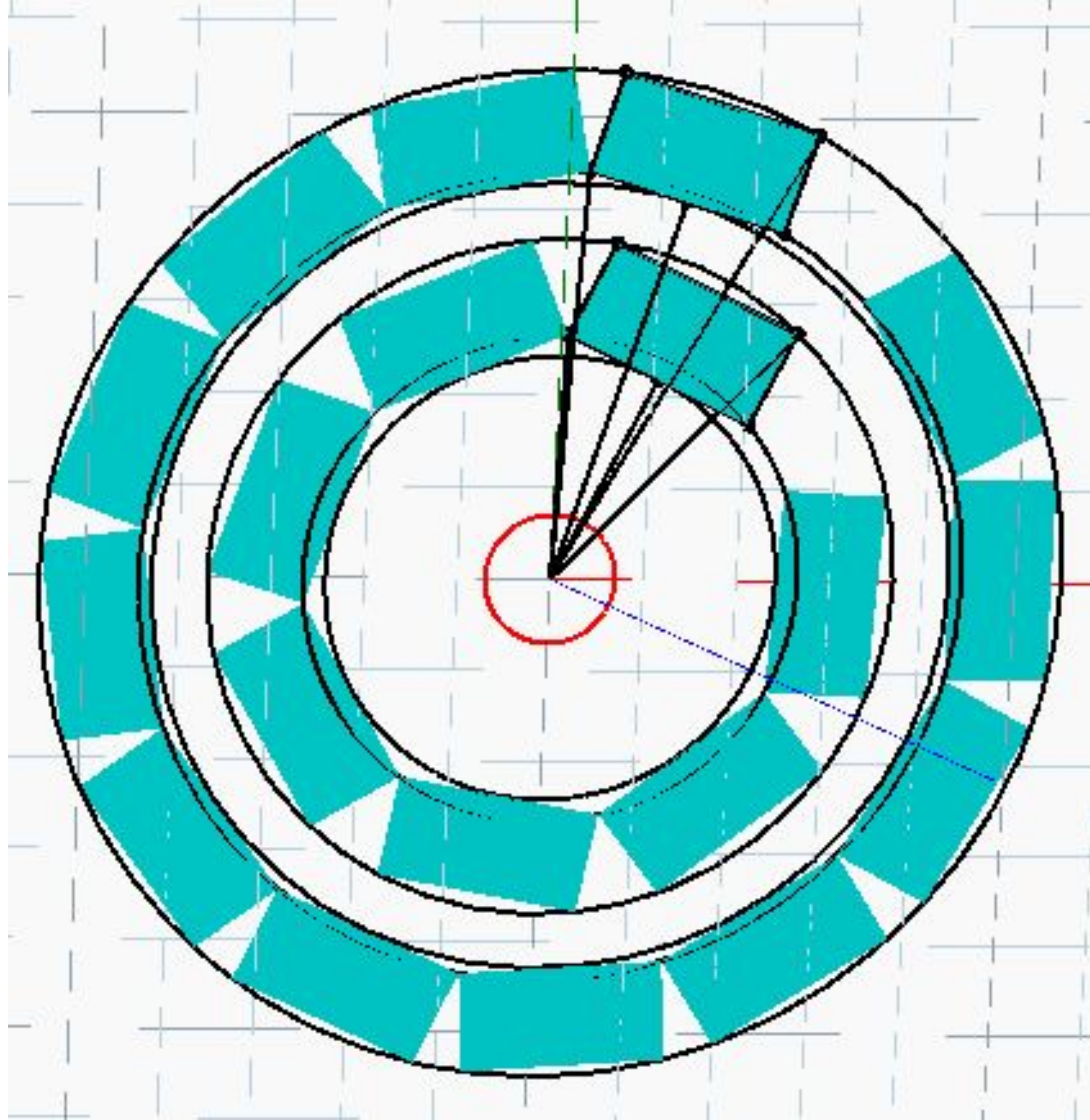
THE END OF THE STEERING WHEEL?



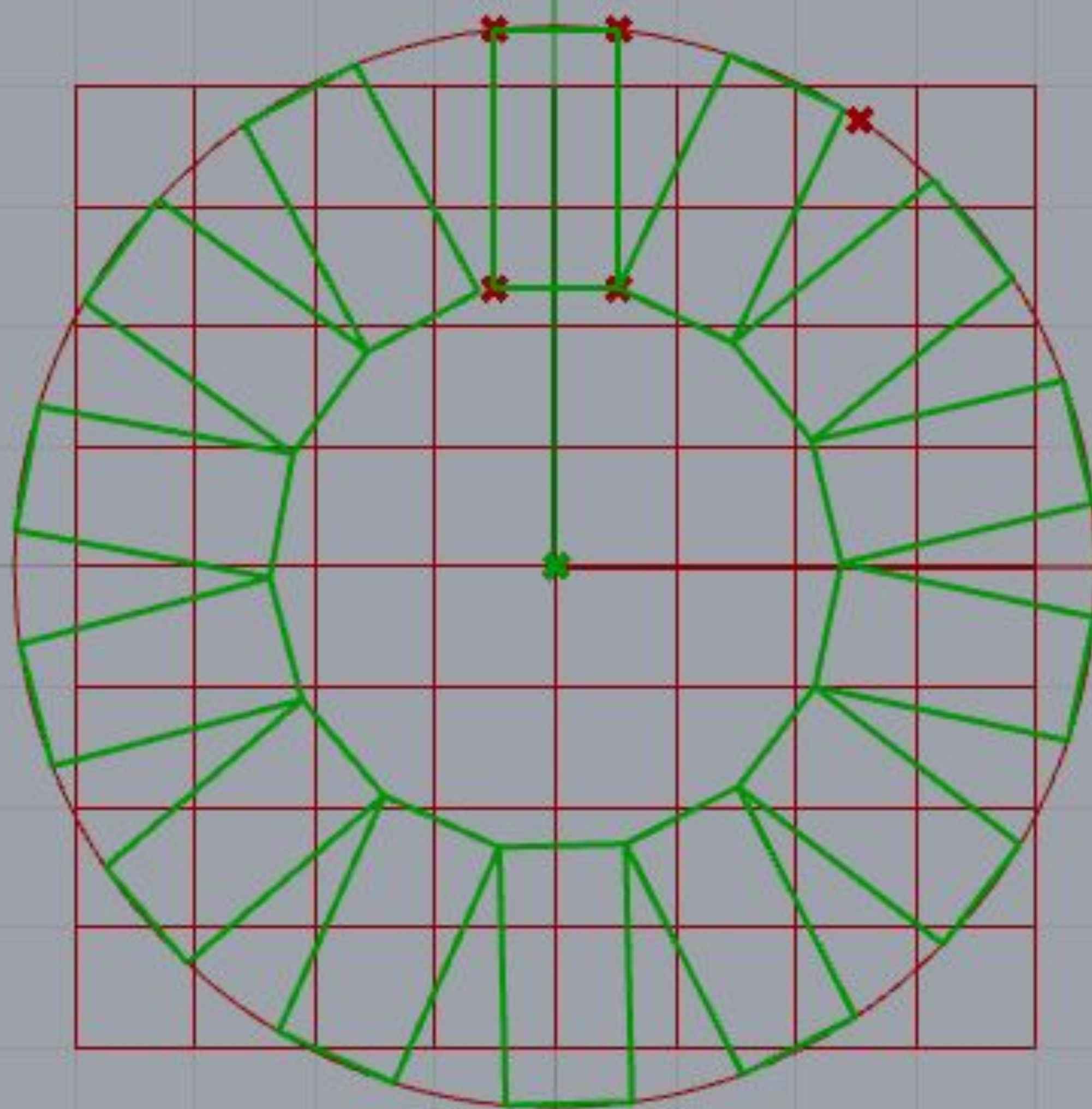


Imagination is more
important than
knowledge.

Albert Einstein







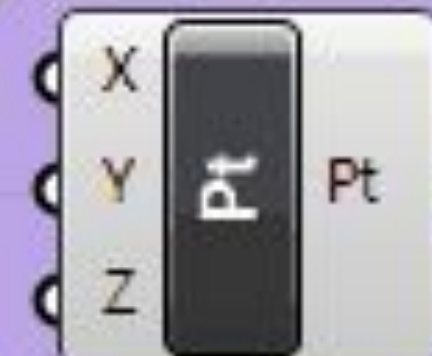
Input variables

Variable R 4.500

width 1.05

length 2.15

local rotation 0.000

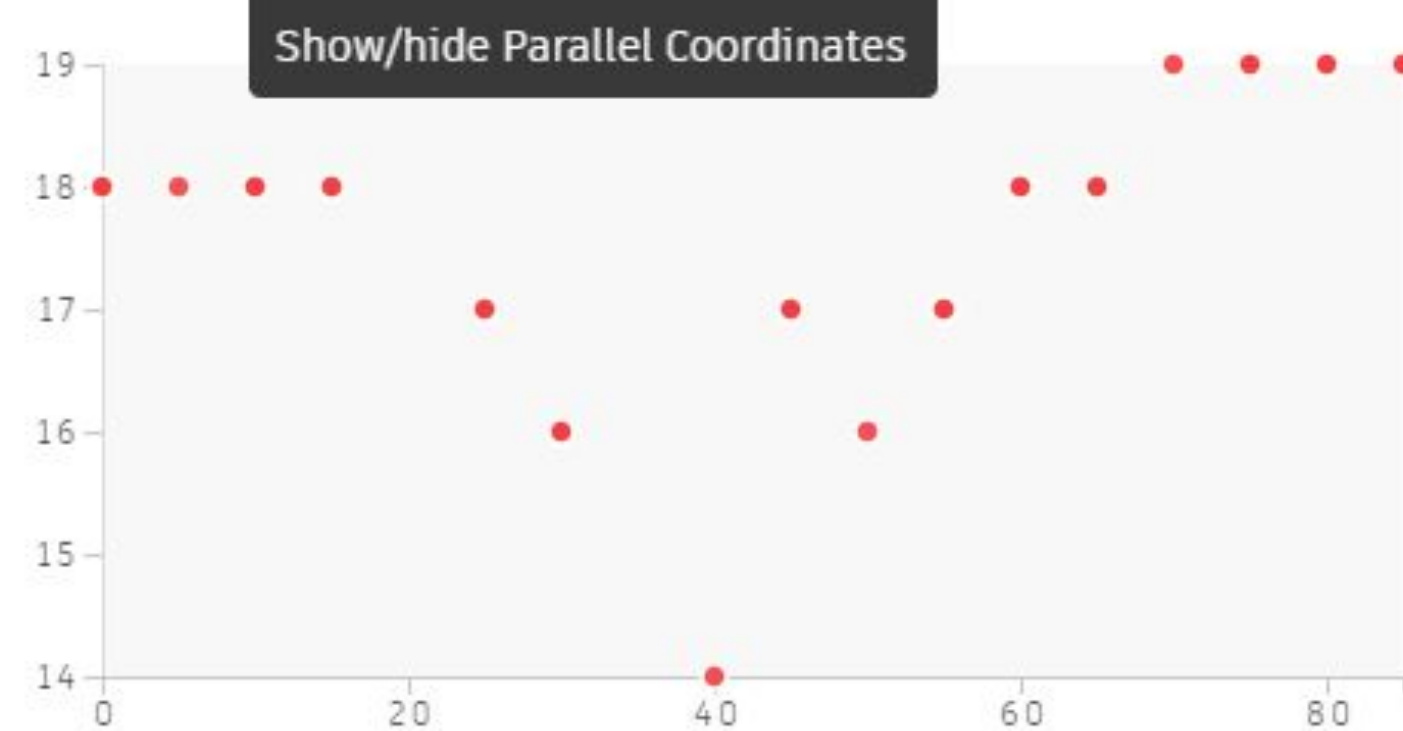


Y-Axis
Rectangle count

X-Axis
rotation

Size
Default

Color
Default



Filter ☐

Sort by

Rectangle count



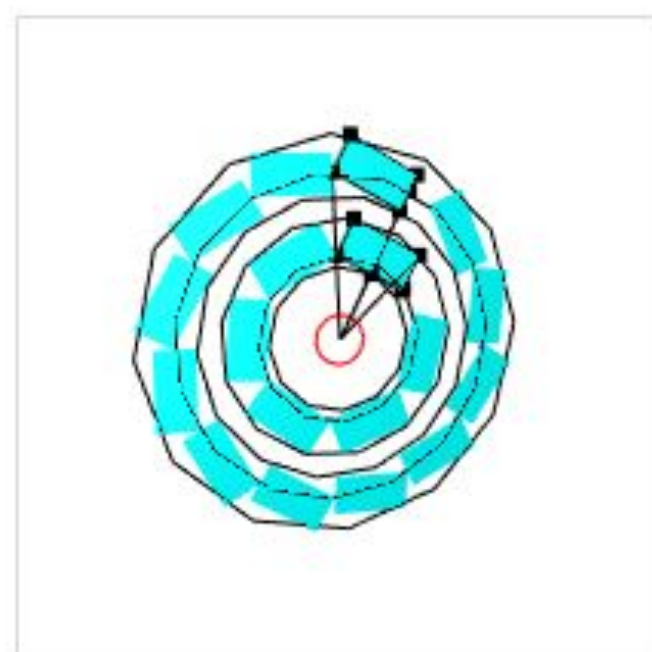
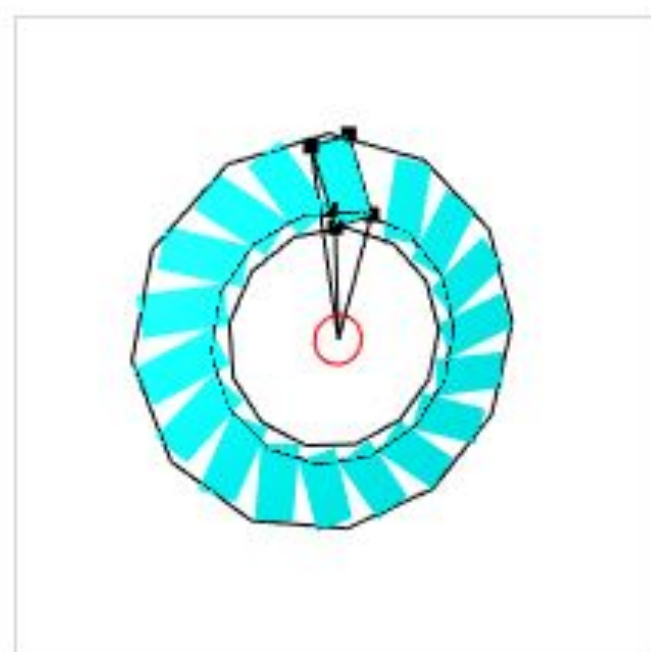
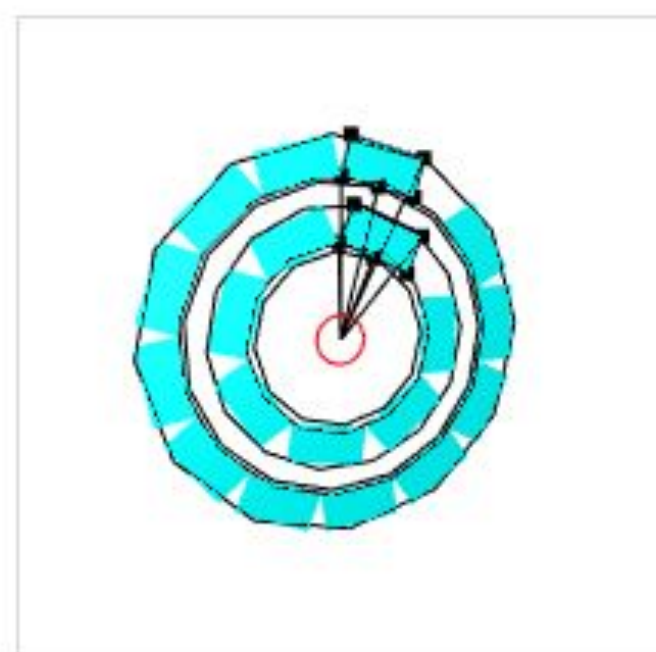
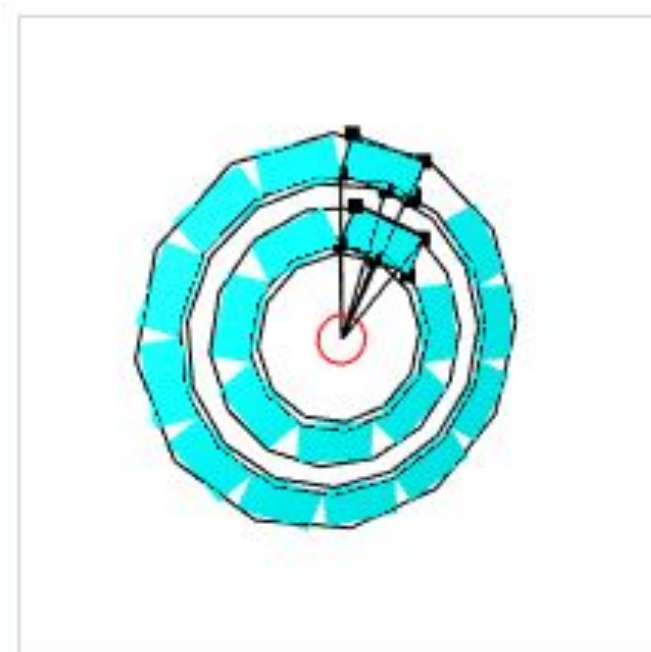
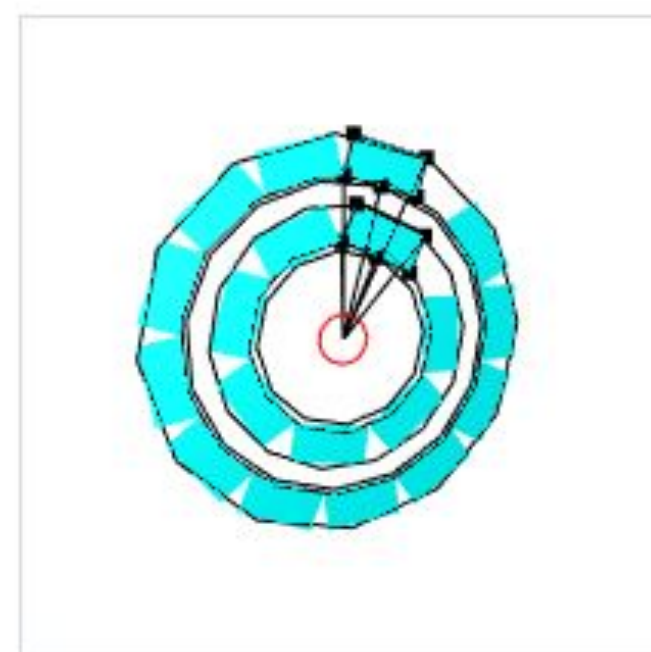
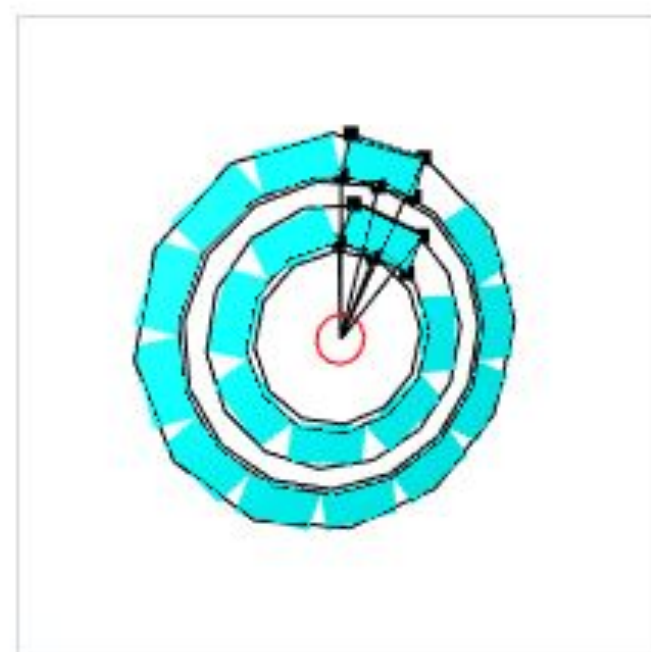
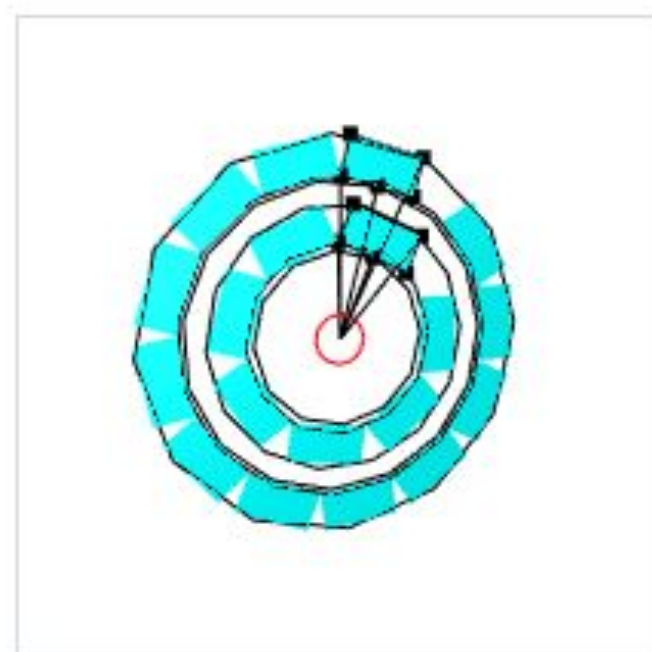
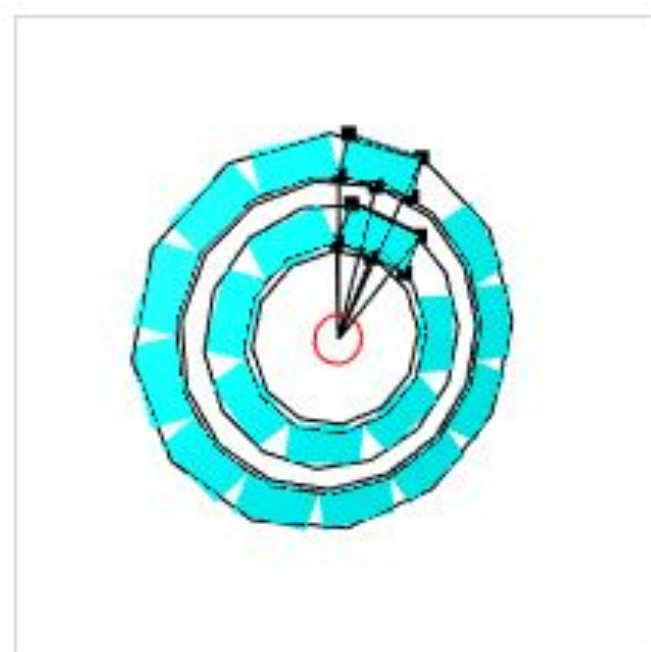
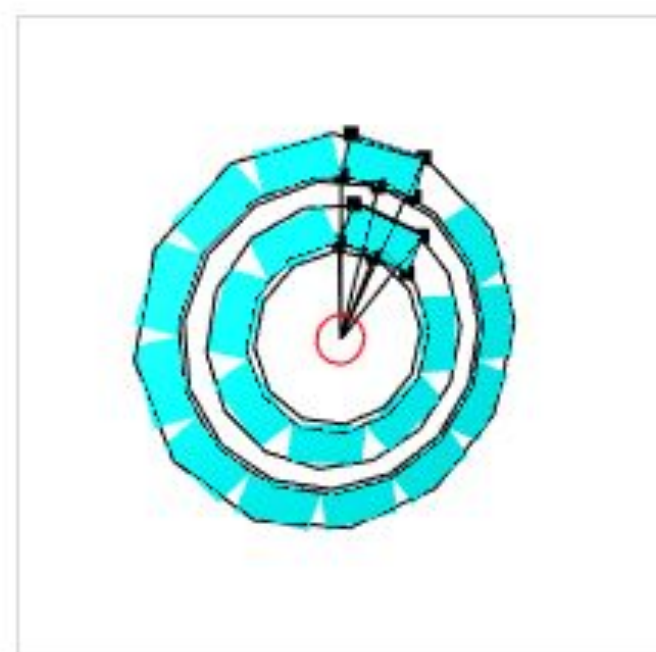
1

2

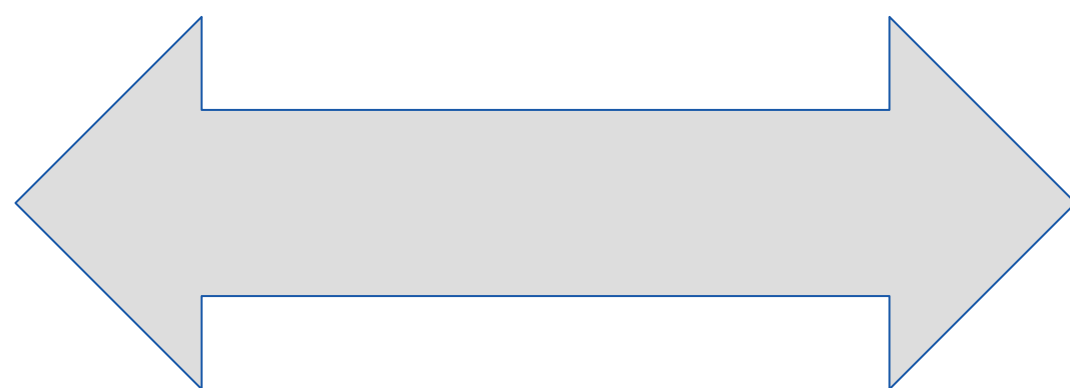
3

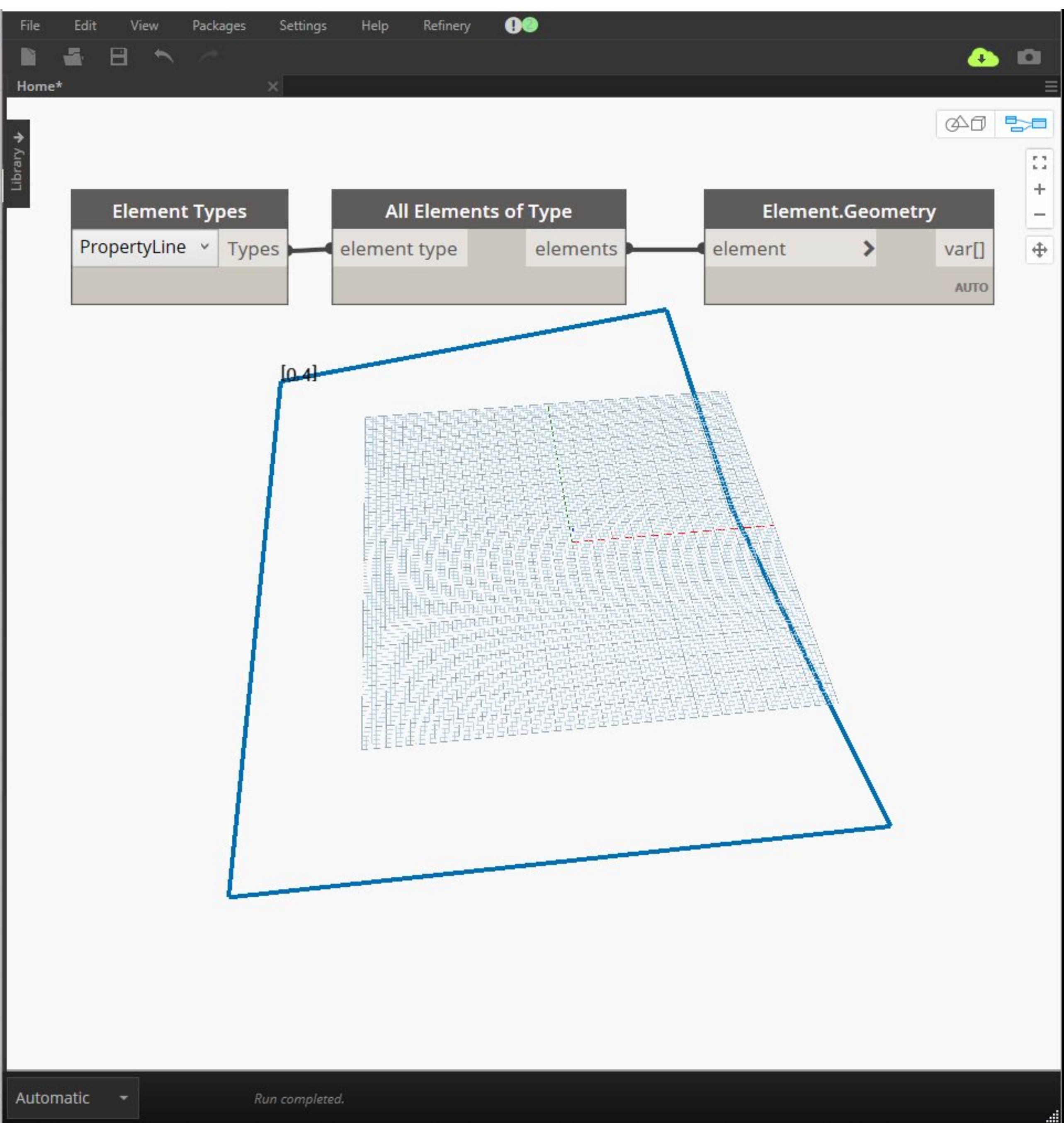
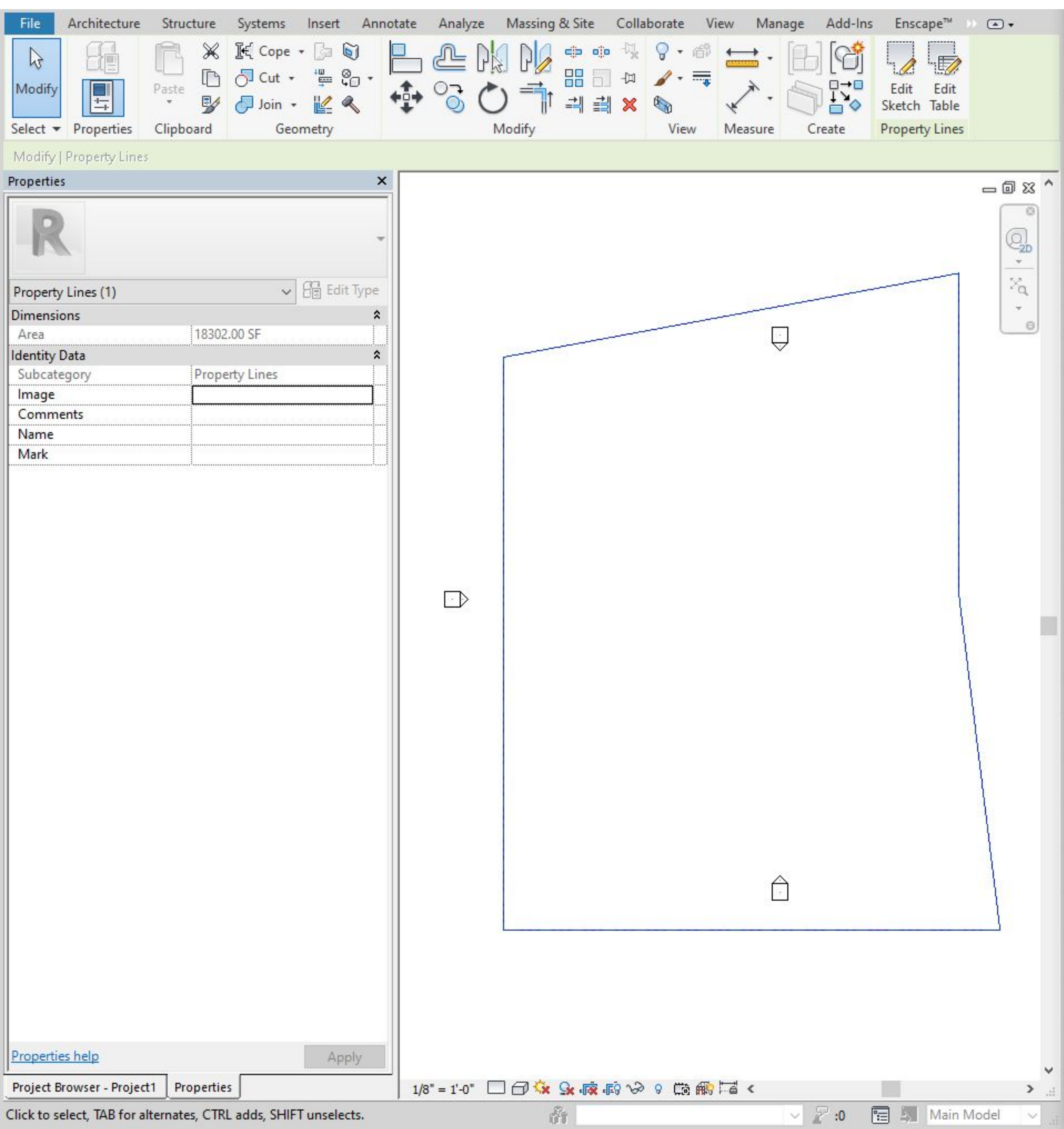
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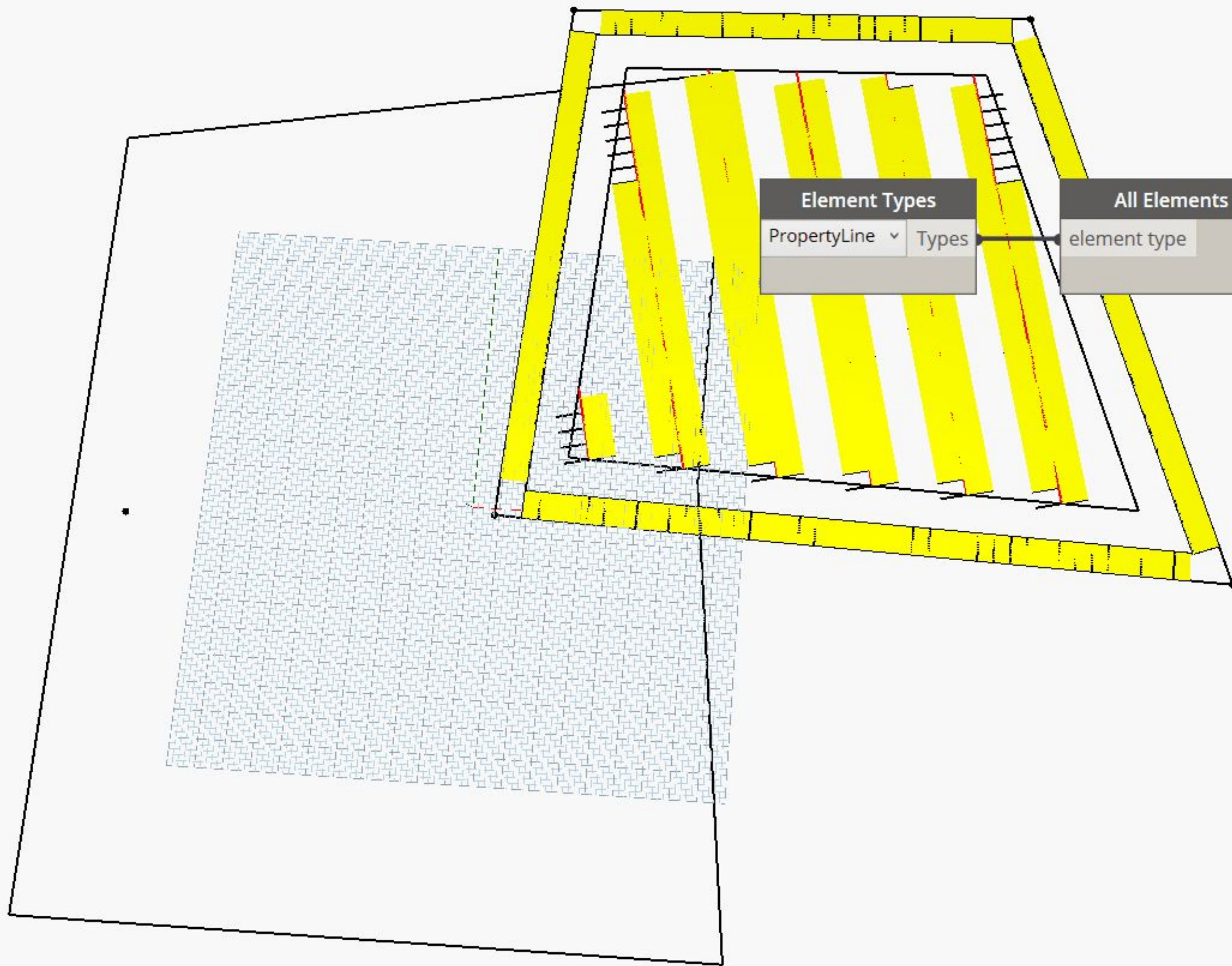
5



Future Testing







Element Types

PropertyLine ▾ Types

All Elements of Type

element type elements

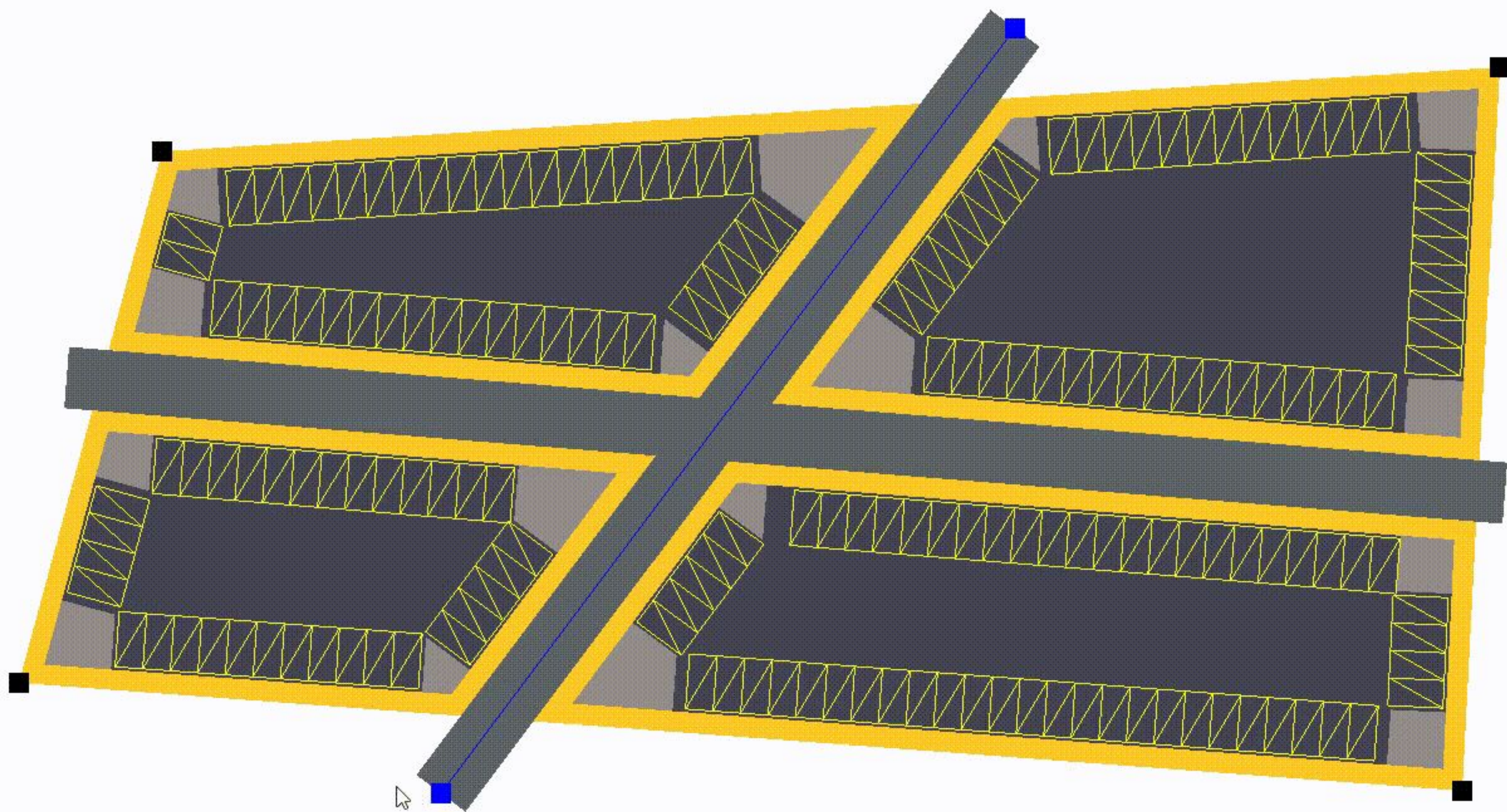
Element.Geometry

element > var[]

AUTO



UX & algorithms





Resources

- <https://www.autodesk.com/solutions/refinery-beta>
- <https://threejs.org/>
- <https://www.keanw.com/2018/11/project-refinery-implement-generative-design-workflows-for-aec.html>
- <https://www.keanw.com/2019/11/project-rediscover-version-2-of-the-mars-graph-is-now-available-for-download.html>
- <https://github.com/DynamoDS/RefineryPrimer>
- https://www.amazon.com/Parametric-Design-Architecture-Wassim-Jabi/dp/1780673140/ref=pd_sbs_14_8?_encoding=UTF8&pd_rd_i=1780673140&pd_rd_r=b4e6d8bc-45e2-4c4c-8090-595b5f3d66c5&pd_rd_w=t396q&pd_rd_wg=1lnYe&pf_rd_p=52b7592c-2dc9-4ac6-84d4-4bda6360045e&pf_rd_r=572ZSWG1GV3T1GQEXEY&psc=1&refRID=572ZSWG1GV3T1GQEXEY
- <http://stanislaschaillou.com/expliquer/>
- <https://natureofcode.com/book/chapter-9-the-evolution-of-code/>



Parametric Design
for Architecture

Objectives

- Learn to combine Dynamo and Project Refinery to augment your design process.
- Learn about geometry relationships in a parametric system.
- Learn how to use Dynamo points, curves, polygons, surfaces, and solids to represent design components.
- Get ideas on how to approach the site planning and design algorithmically.



Questions?



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