Hands-on with Project Rediscover: generatively designing Autodesk Toronto's office

Kean Walmsley

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AUTODESK UNIVERSITY

About the speaker

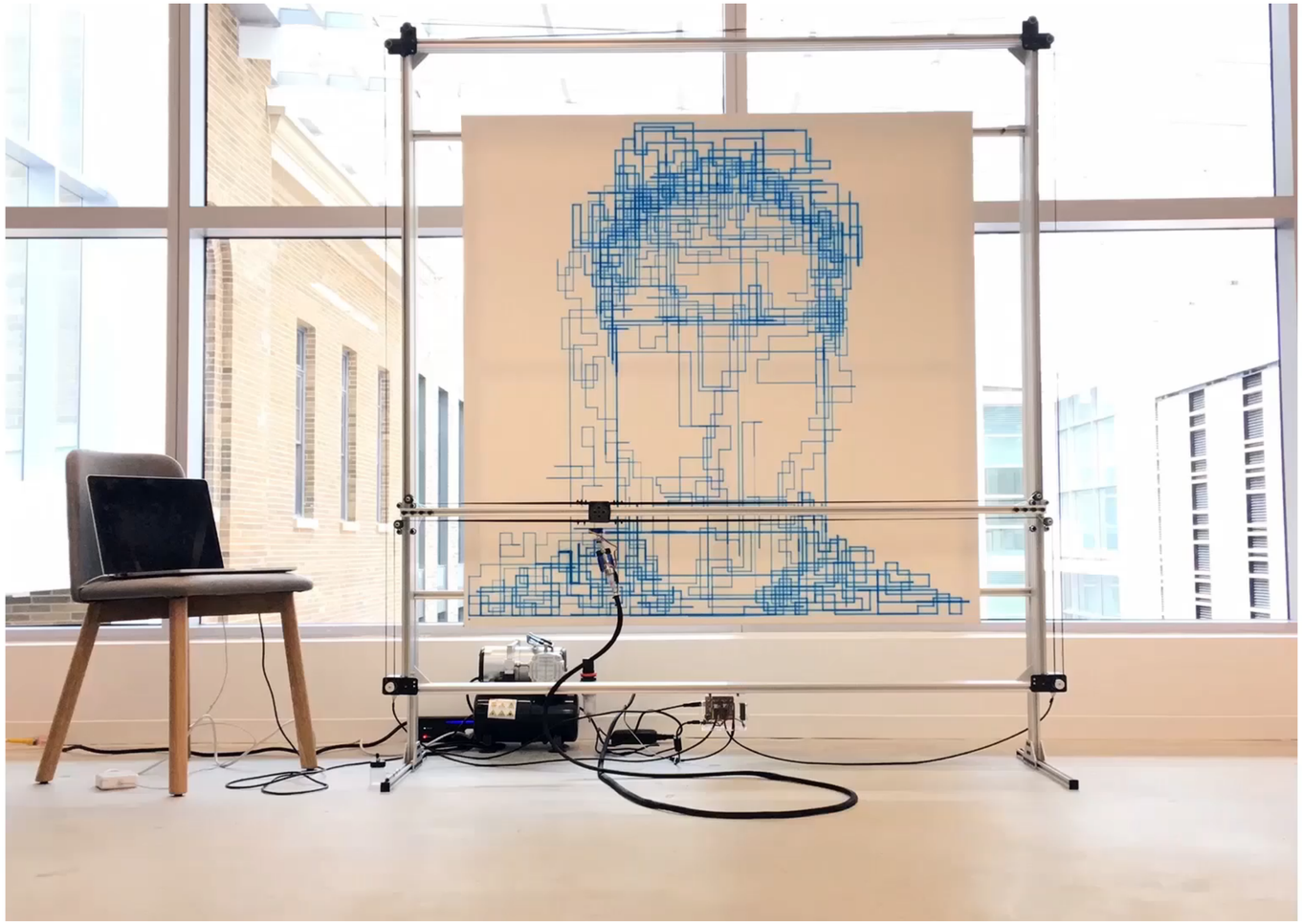
Kean Walmsley

1995-2012	ADN	1995-1998	UK
2012-2016	AutoCAD	1998-2000	Switzerland
2016- ...	Research	2000-2003	USA
		2003-2005	India
		2006- ...	Switzerland

2006- ... Through the Interface

Agenda

- Meet the Team
- Project Discover
- Project Rediscover
  - Geometry System
  - Evaluation System
  - Space Analysis
  - Rediscover and Refinery



THE LIVING

AUTODESK

Simon Breslav

Principal Research Scientist

Autodesk Research

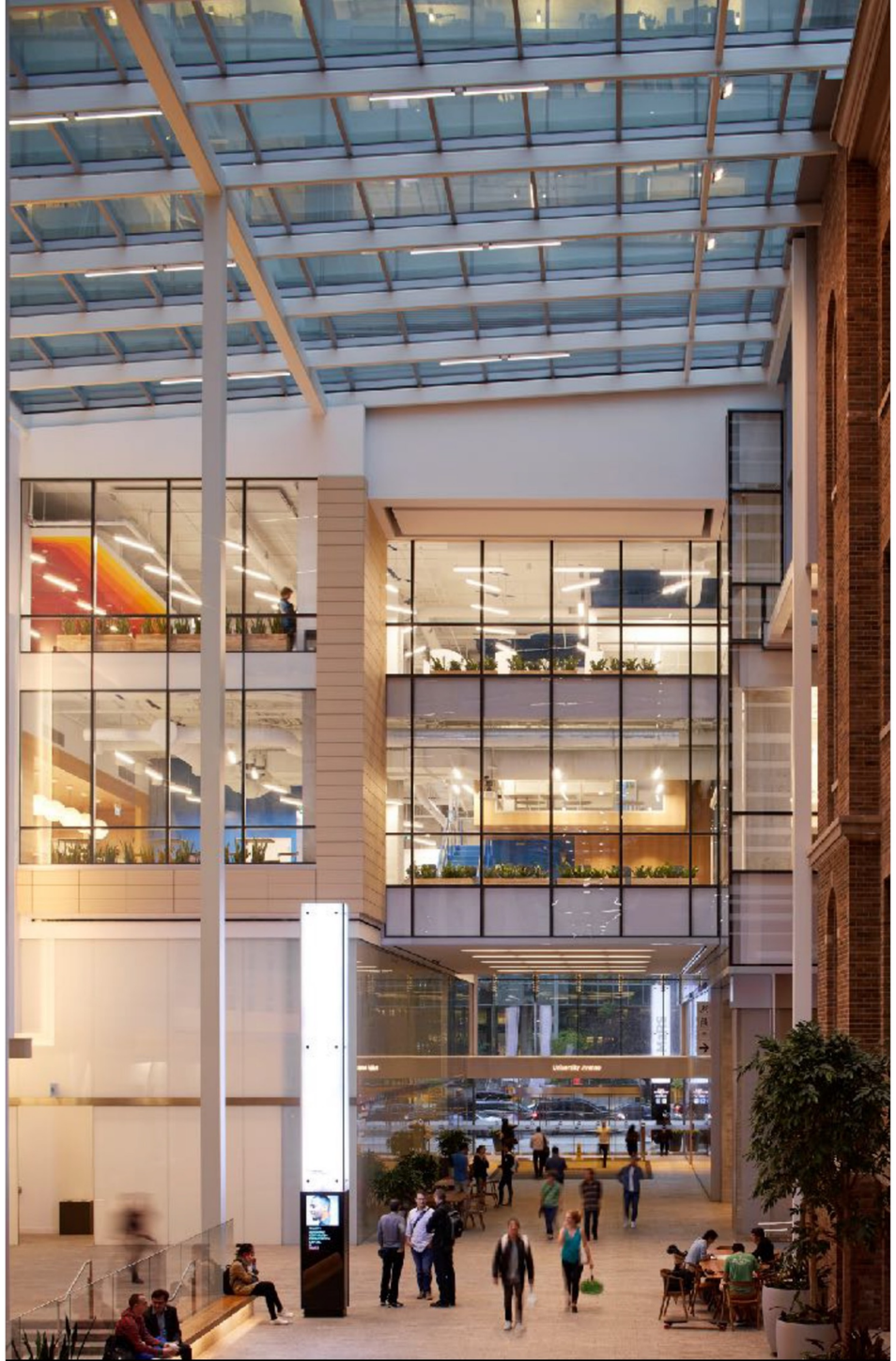
Rhys Goldstein

Principal Research Scientist

Autodesk Research

Project Discover

AUTODESK



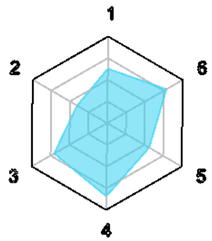
MAKE
ANYTHING

ALEXANDRA
SONG

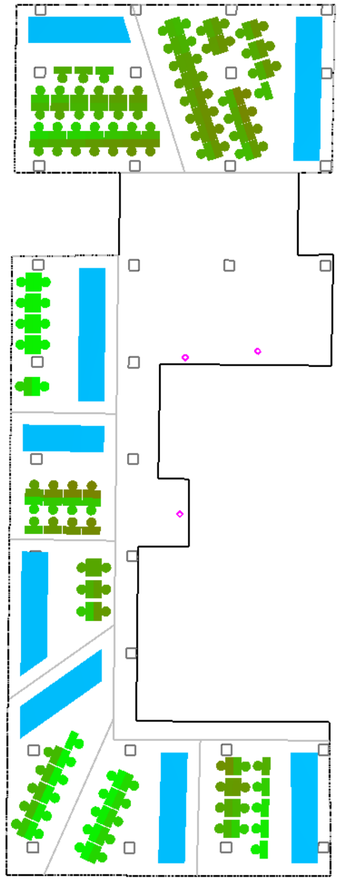
Project Rediscover

autode.sk/mars-graph

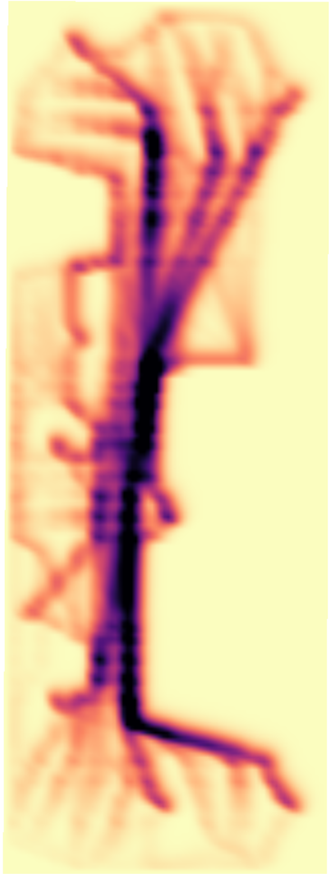
1. Adjacency: 96.764550
2. Buzz: 4.448632
3. Distraction: 0.235152
4. Views to Outside: 0.722067
5. Daylight: 0.531804
6. Work Style: 0.877024



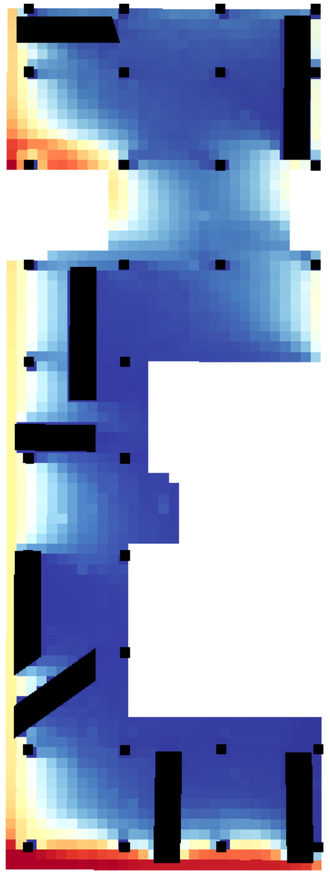
Distraction



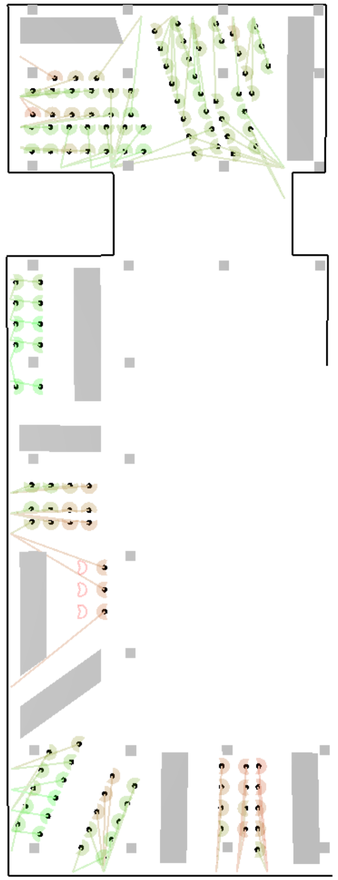
Adjacency/Buzz (Congestion Map)



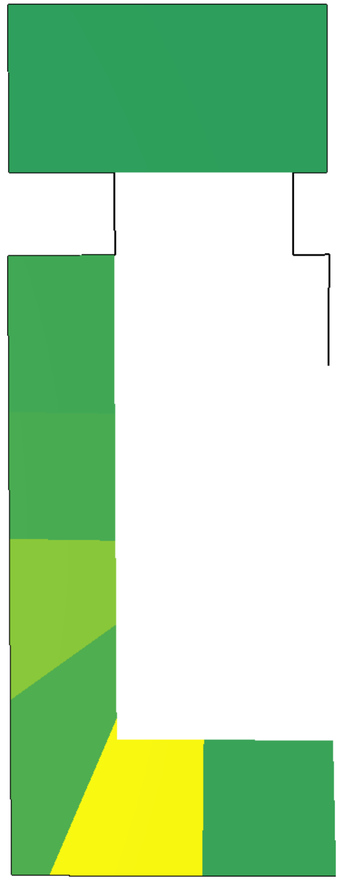
Daylight

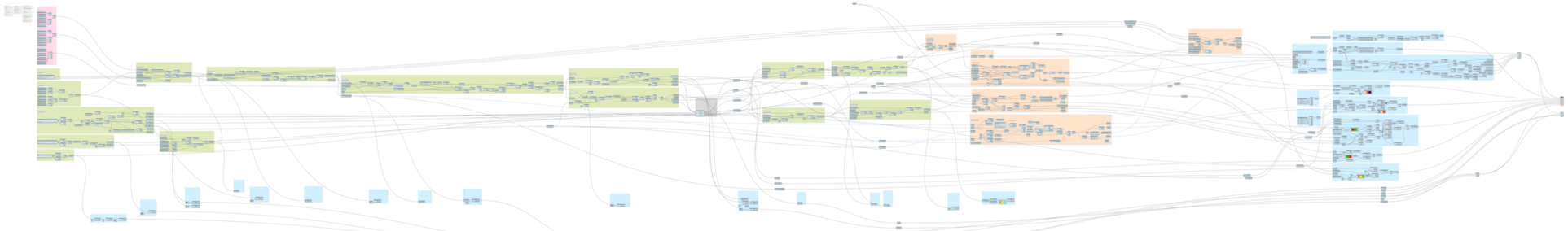


Views to Outside



Work Style

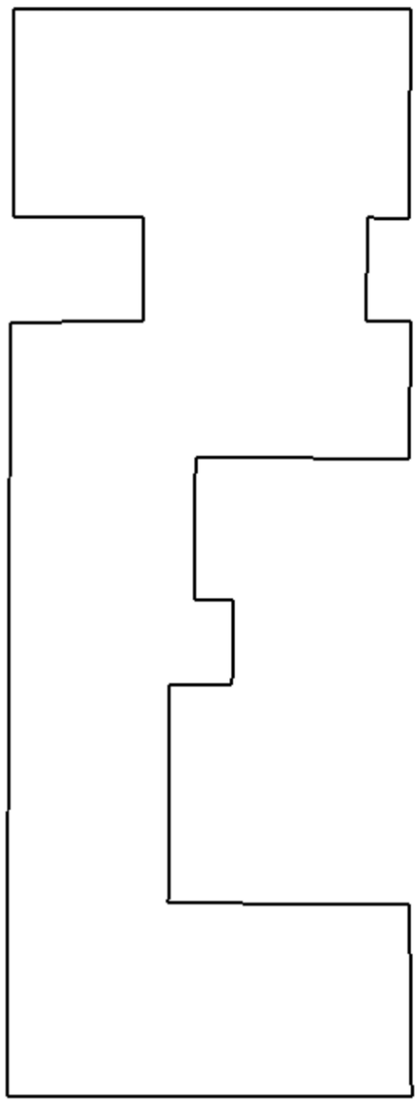




Geometry System

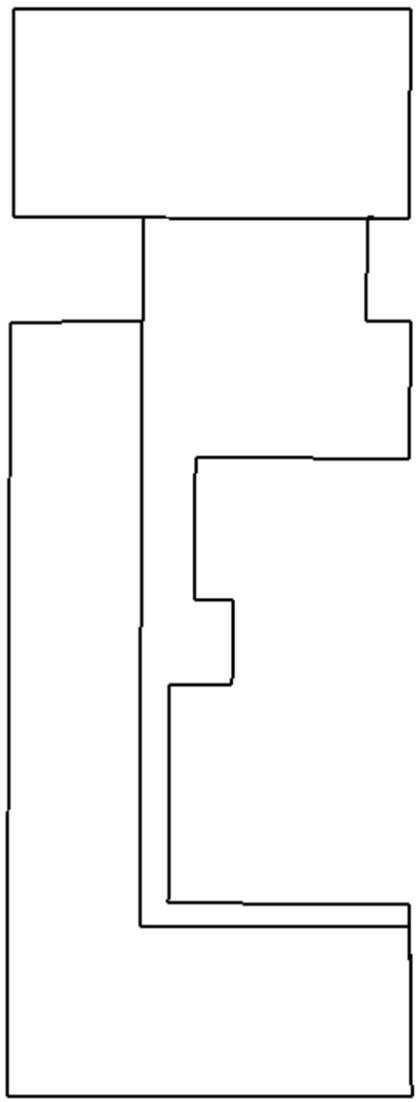
Boundary

- Hardcoded boundary and windows
- Could also be imported from
  - Revit
  - A file (such as DWG or SAT)



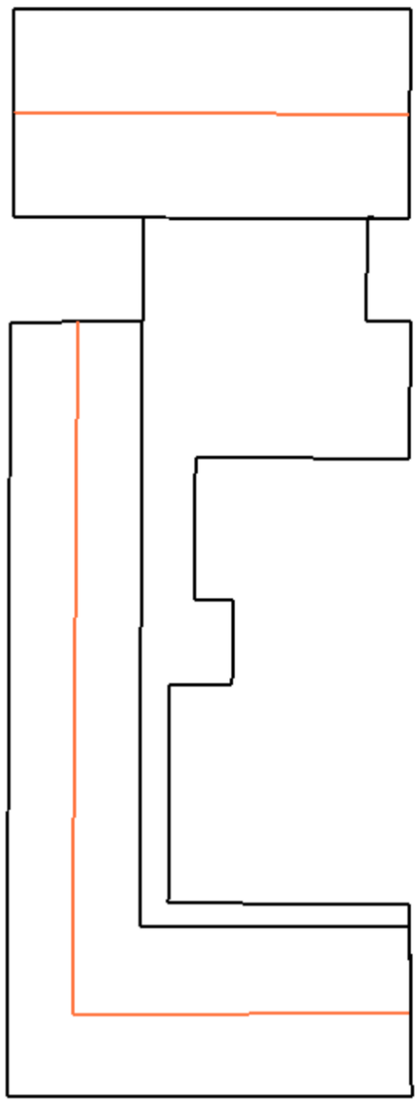
GD Regions

- One rectangle and one L-shape
- Also hardcoded for this graph



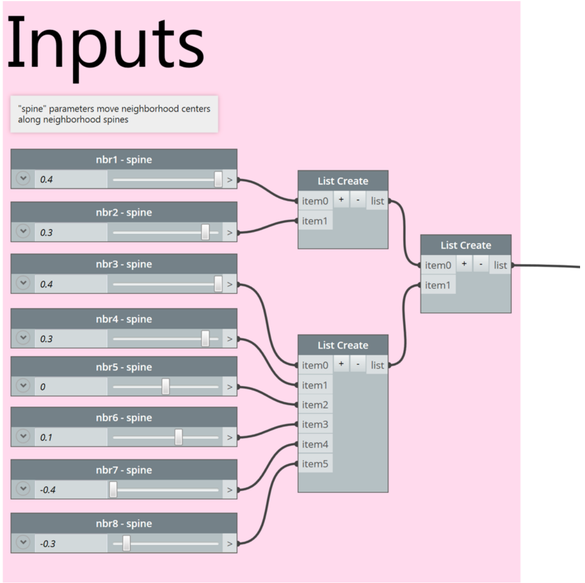
Region Spines

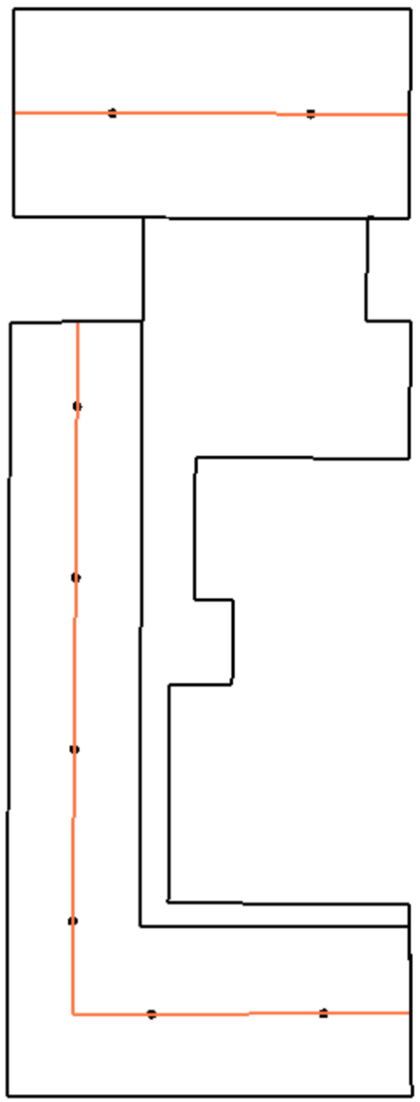
- Divide each of the GD regions
- Will help define neighborhoods



Neighborhood Points

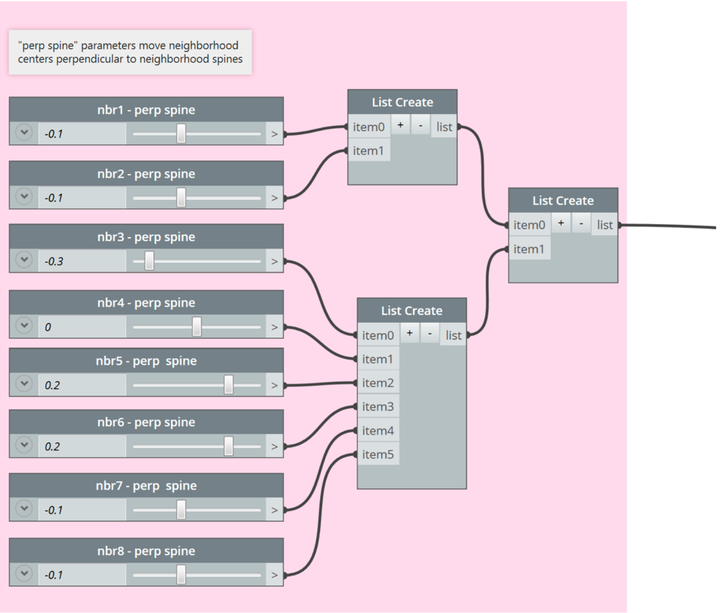
- Defined by parameters along the spine
- Driven by first set of inputs (“spine”)

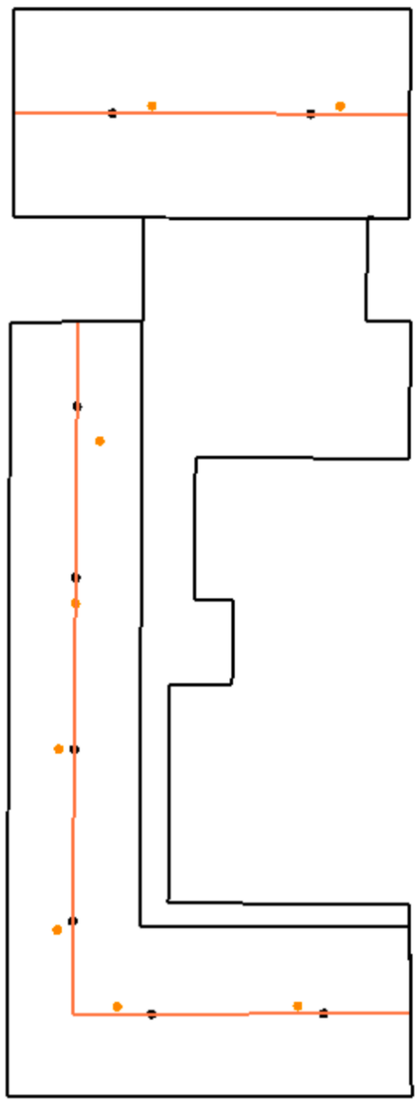




Neighborhood Centers

- Defined relative to the spine points
- Uses second set of inputs (“perp spine”)





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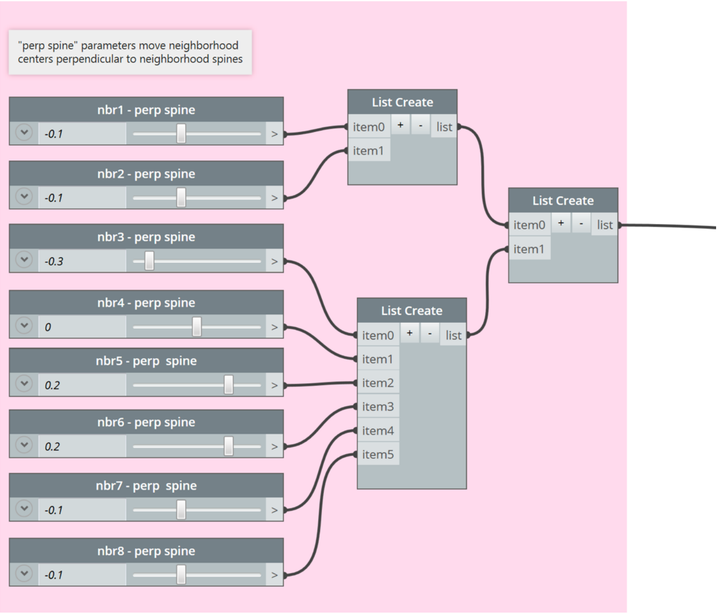
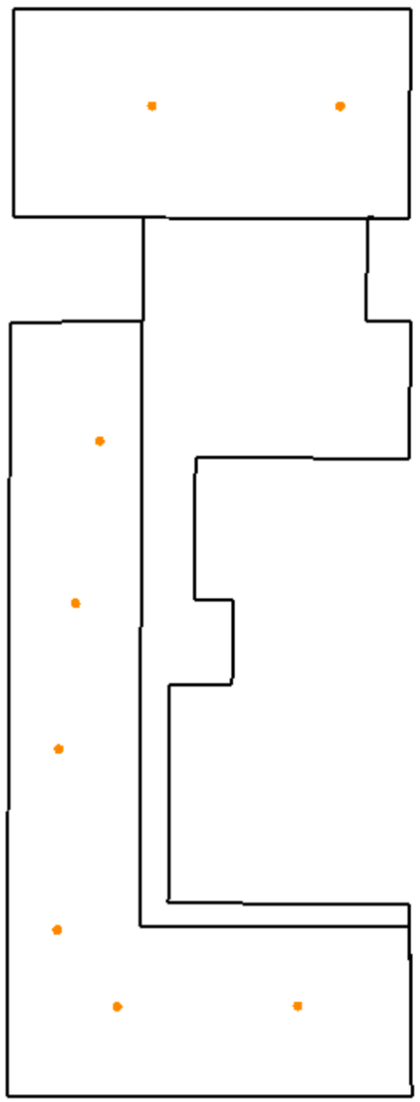
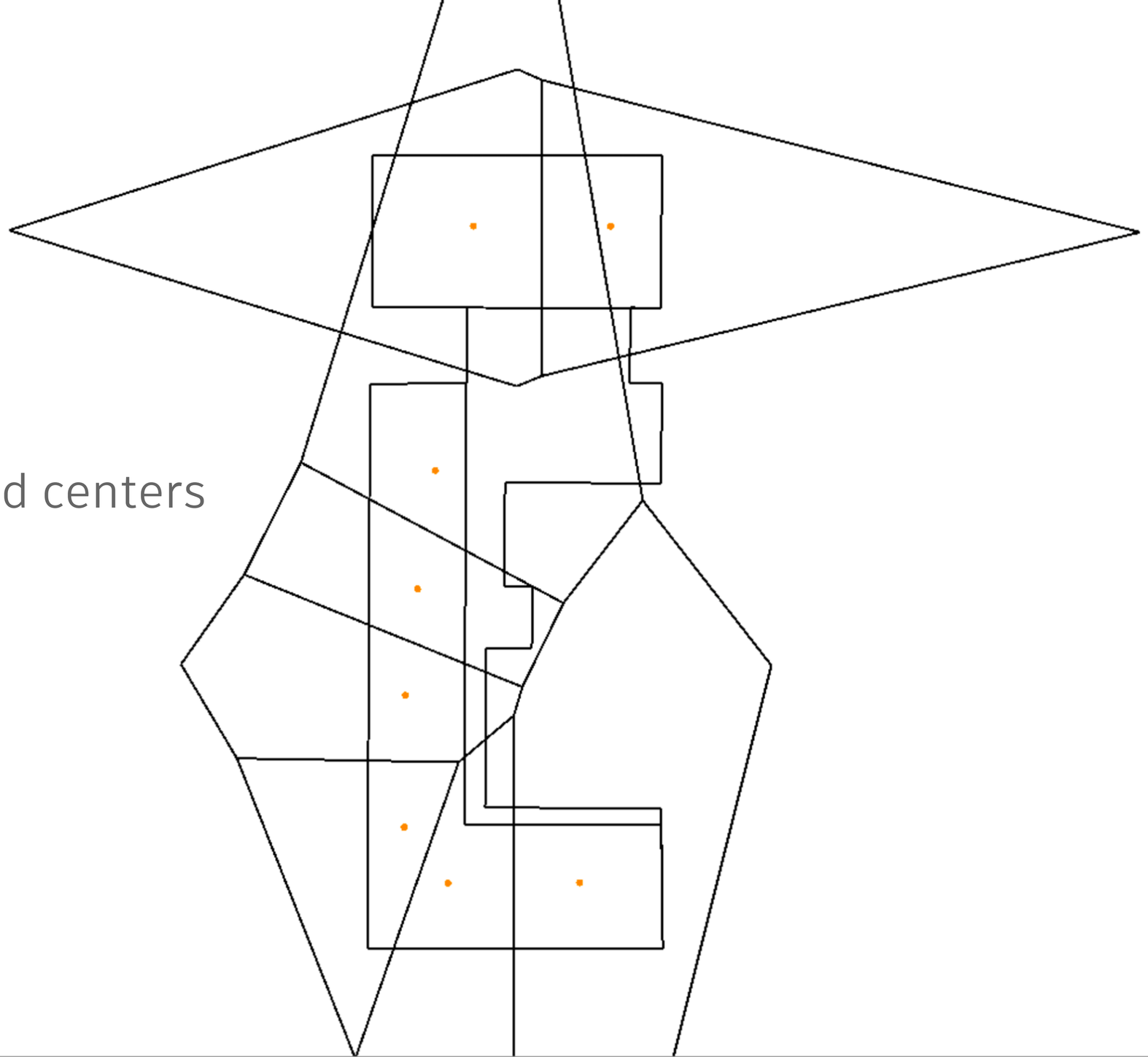




Voronoi Curves

- Create a Voronoi partition
- Based on the neighborhood centers



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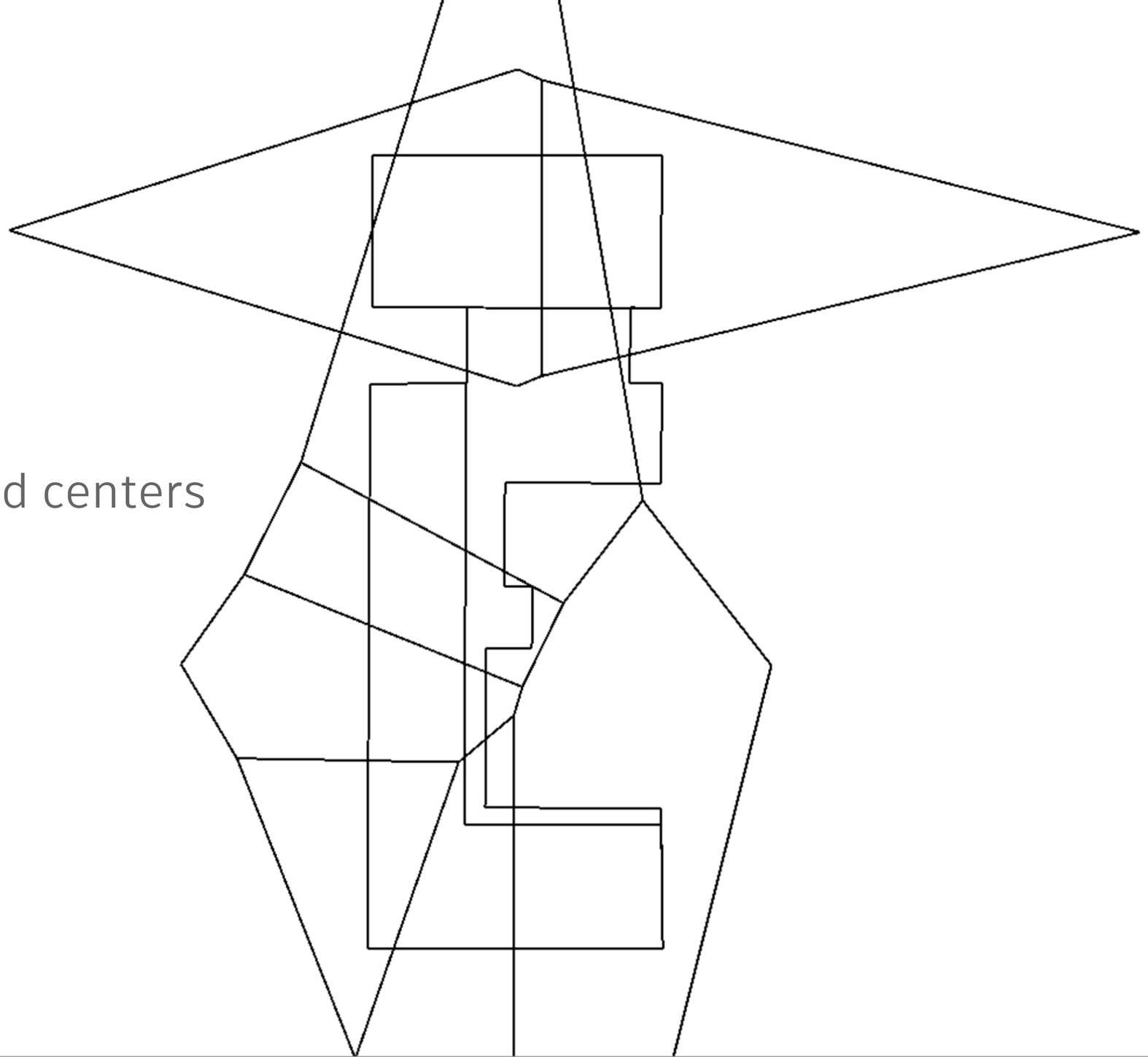
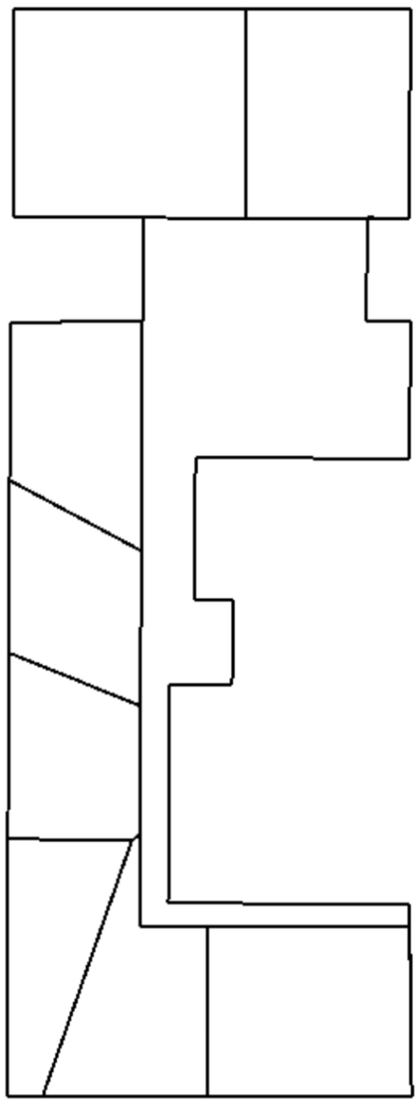


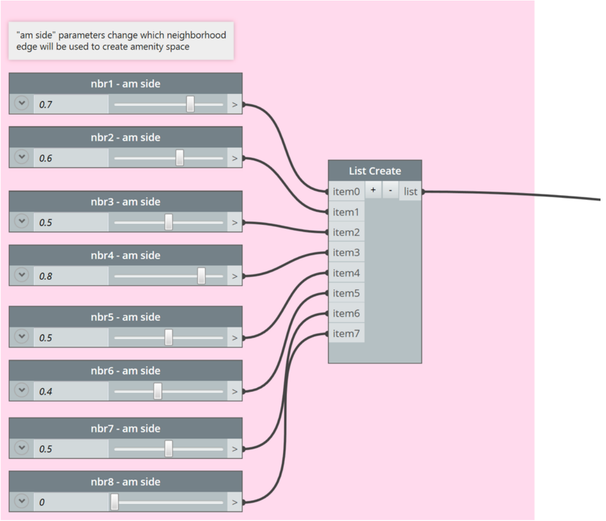
Neighborhood Outlines

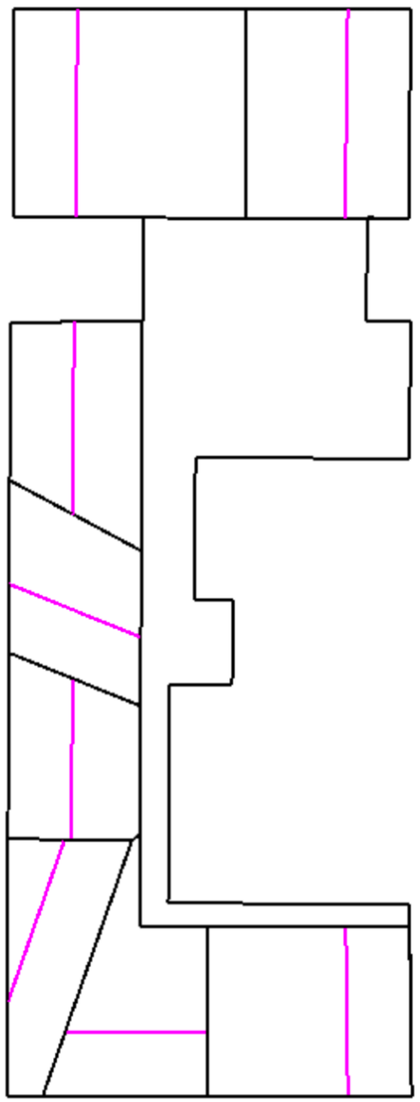
- Clip the Voronoi by the GD Regions
- We now have our neighborhoods



Neighborhood Split

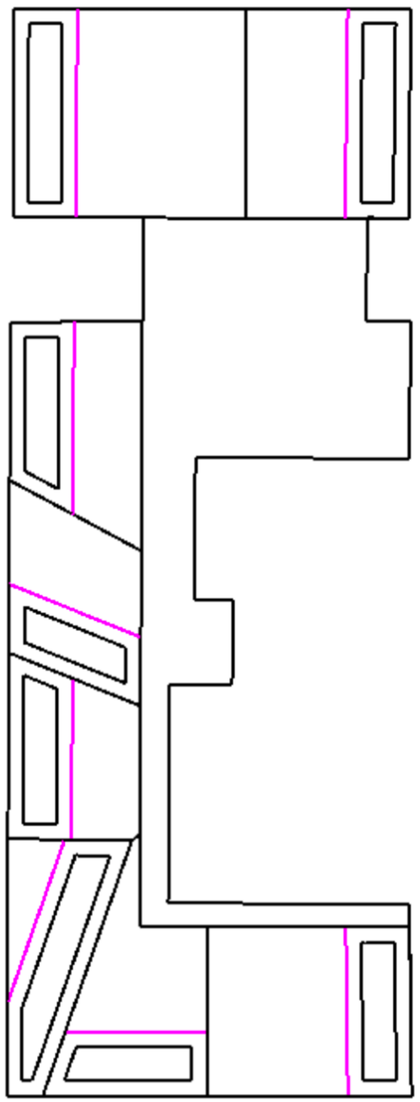
- Split the neighborhoods
- Fixed distance from one edge
- Chosen by the last inputs (“am side”)





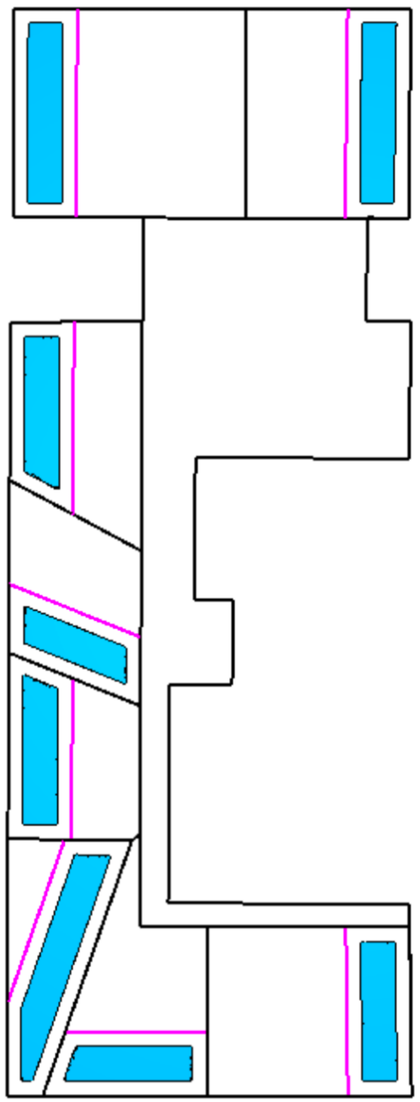
Amenity Assignment

- Amenity blocks are placed on the side at fixed distance from the edge
- Outline is determined by inward offset



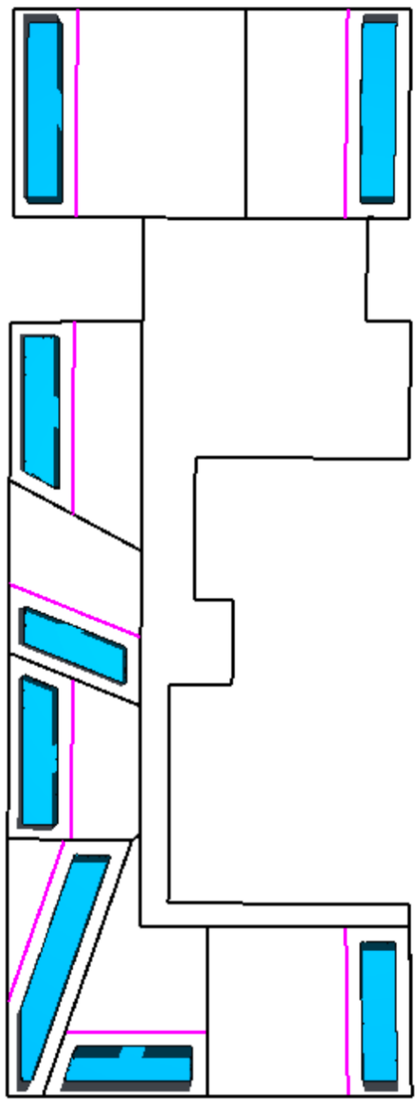
Amenity Assignment

- Amenity blocks are placed on the side at fixed distance from the edge
- Outline is determined by inward offset
- Resulting areas get filled



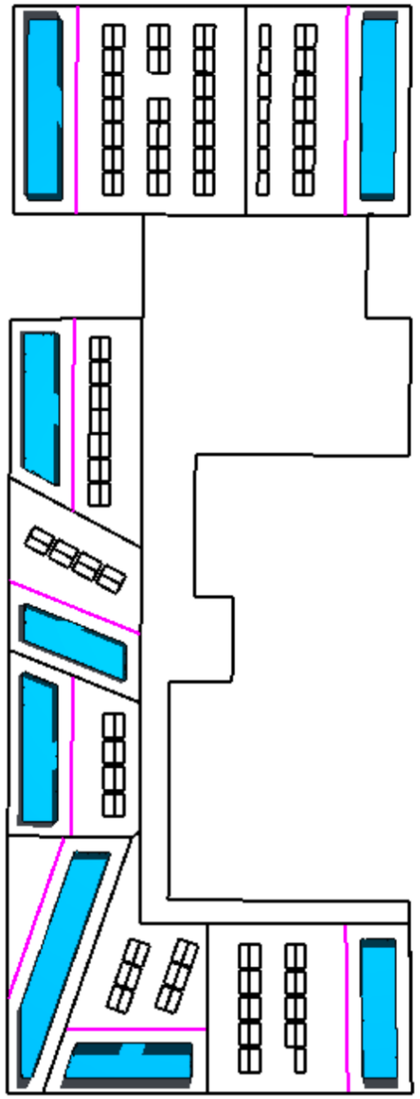
Amenity Assignment

- Amenity blocks are placed on the side at fixed distance from the edge
- Outline is determined by inward offset
- Resulting areas get filled
- Entrances are in the center near the neighborhood split line



Desk Assignment

- Desks are assigned in double rows
- Flow around structural columns



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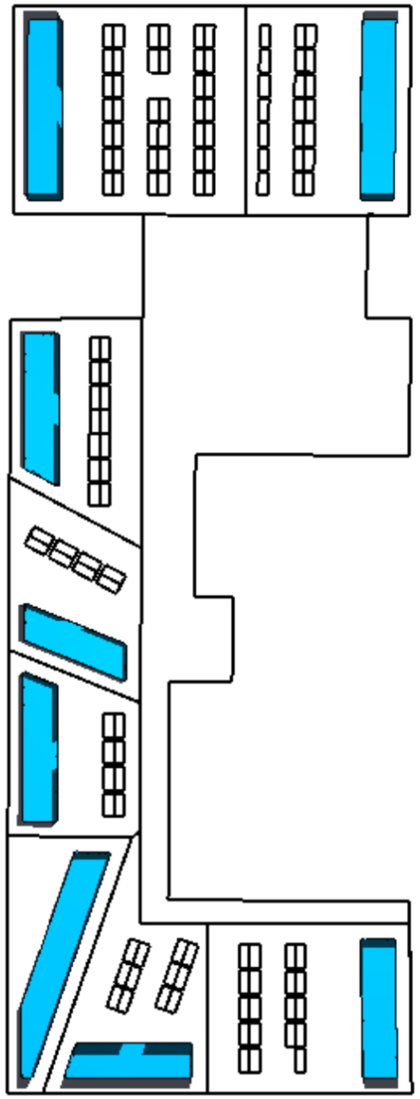
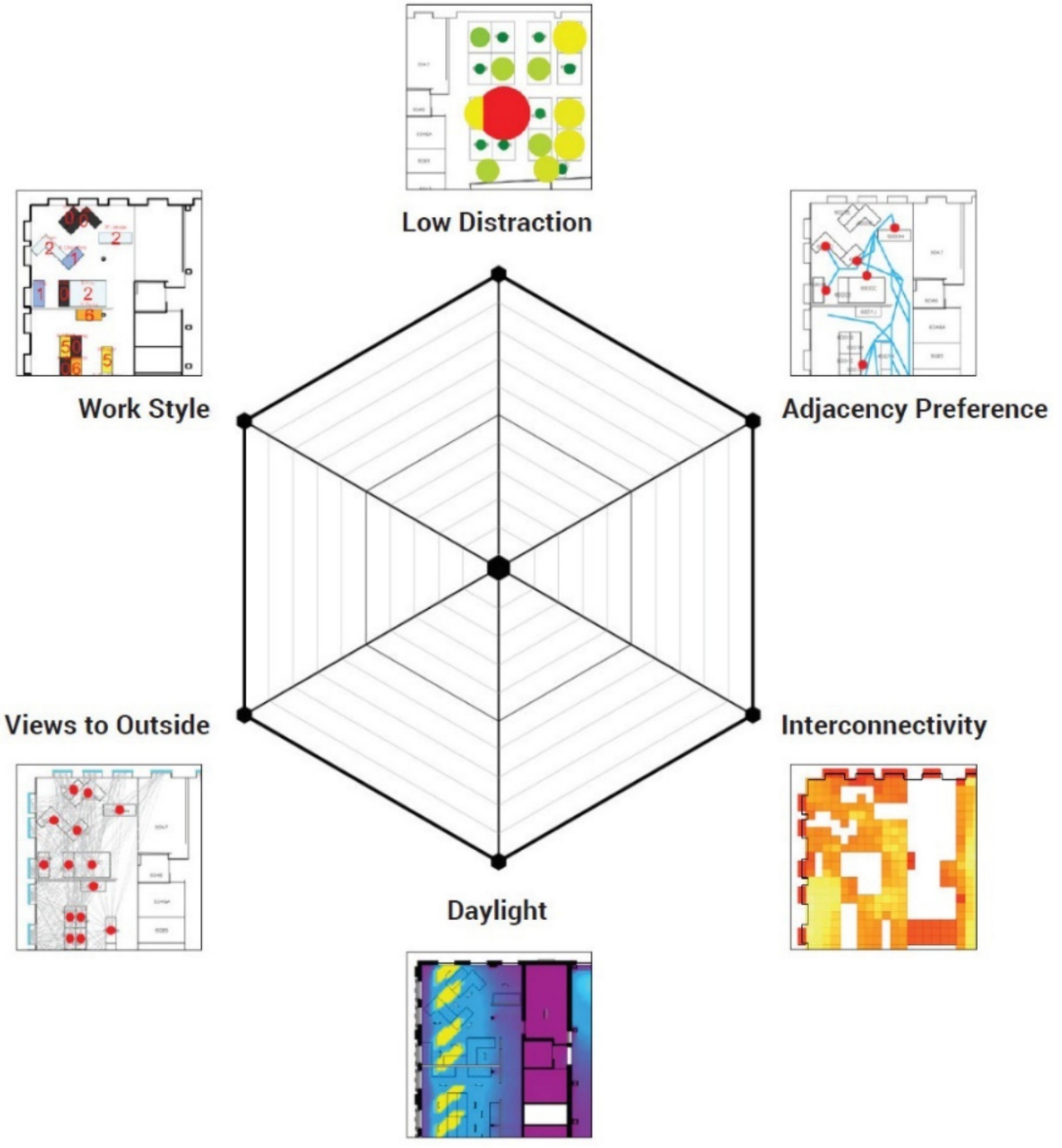
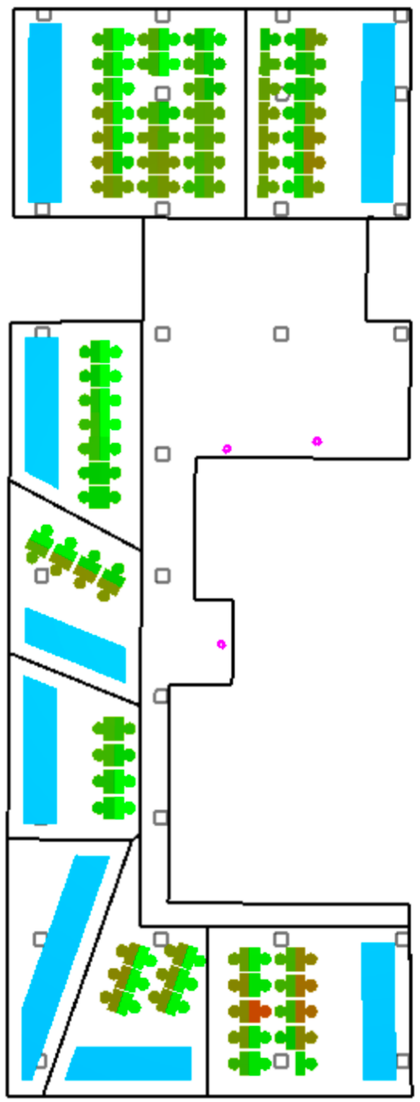


Evaluation System


Low Distraction
Adjacency Preference
Interconnectivity
Daylight
Views to Outside
Work Style

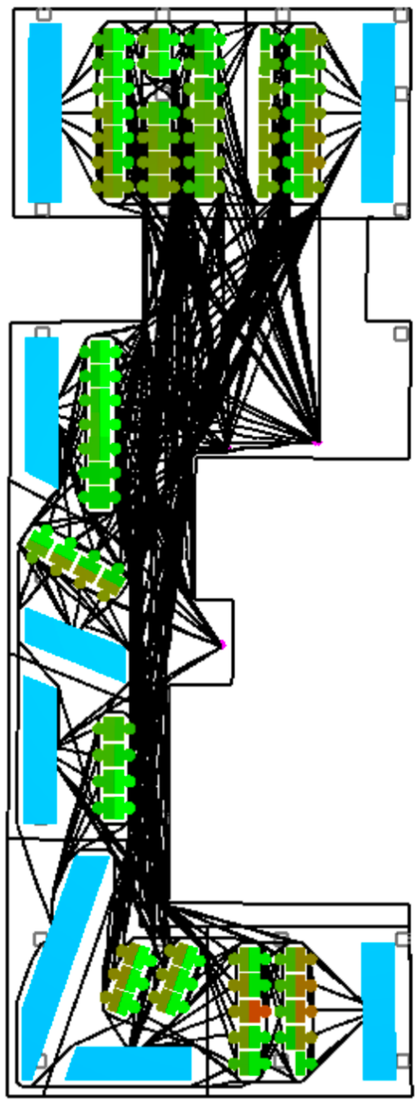
Distraction

- Based on proximity to other desks and areas of high congestion
  - More about congestion in a bit



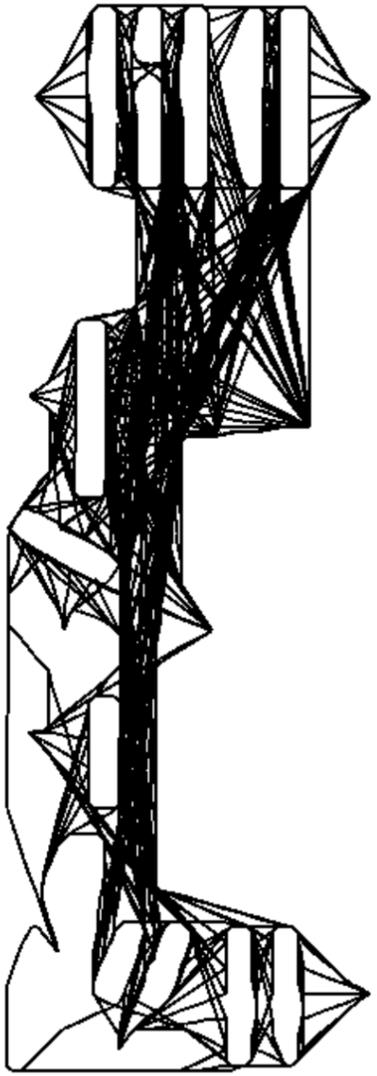
Adjacency & Buzz

- Shortest paths between desks and landmark locations
- Calculated using Space Analysis



Adjacency & Buzz

- Shortest paths between desks and landmark locations
- Calculated using Space Analysis
- Adjacency is simply the average length

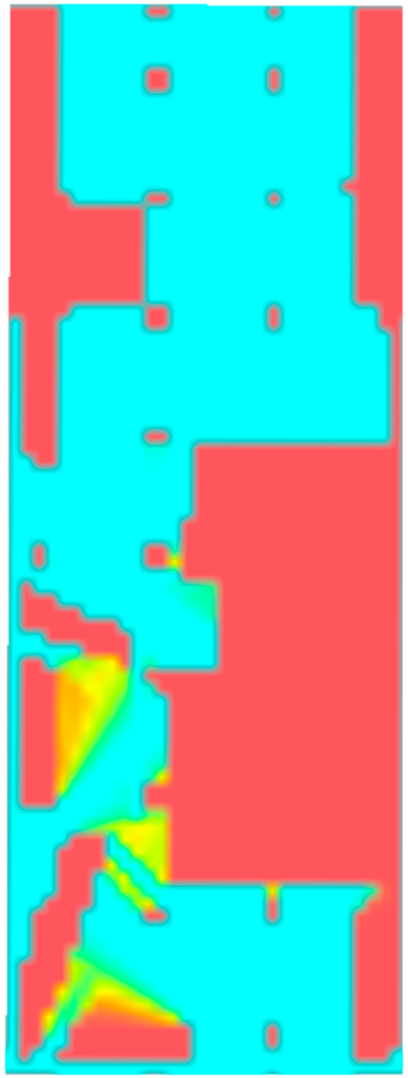


Adjacency & Buzz

- Shortest paths between desks and landmark locations
- Calculated using Space Analysis
- Adjacency is simply the average length
- Buzz is based on a congestion map
  - Common routes are more weighted

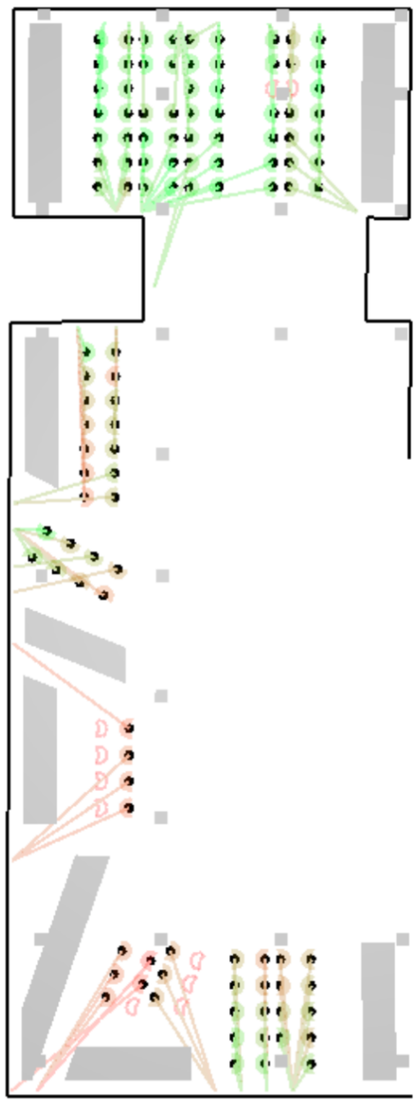
Views to Outside

- Create a visibility map from window points towards all floor locations
  - Also calculated using Space Analysis



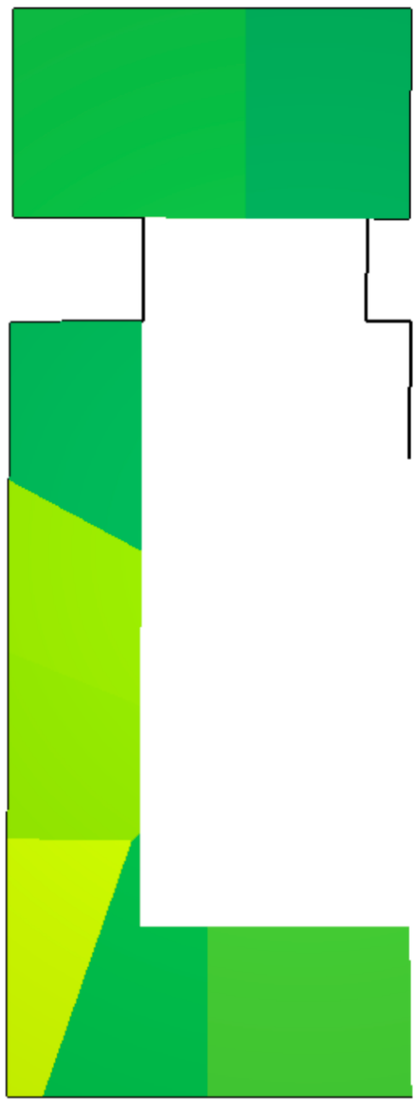
Views to Outside

- Create a visibility map from window points towards all floor locations
  - Also calculated using Space Analysis
- Check the visibility from each desk
  - Window to desk = desk to window
  - Draw line to closest window point



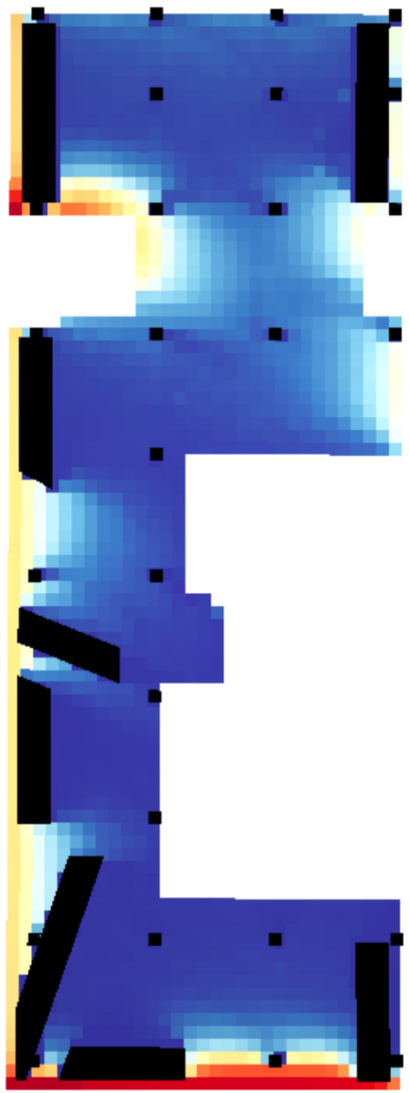
Work Style

- Preferences for light and distraction
  - Coded in a data structure
  - Synthetic in this graph, would otherwise come from survey data
- Colors reflect degree of matching by neighborhood

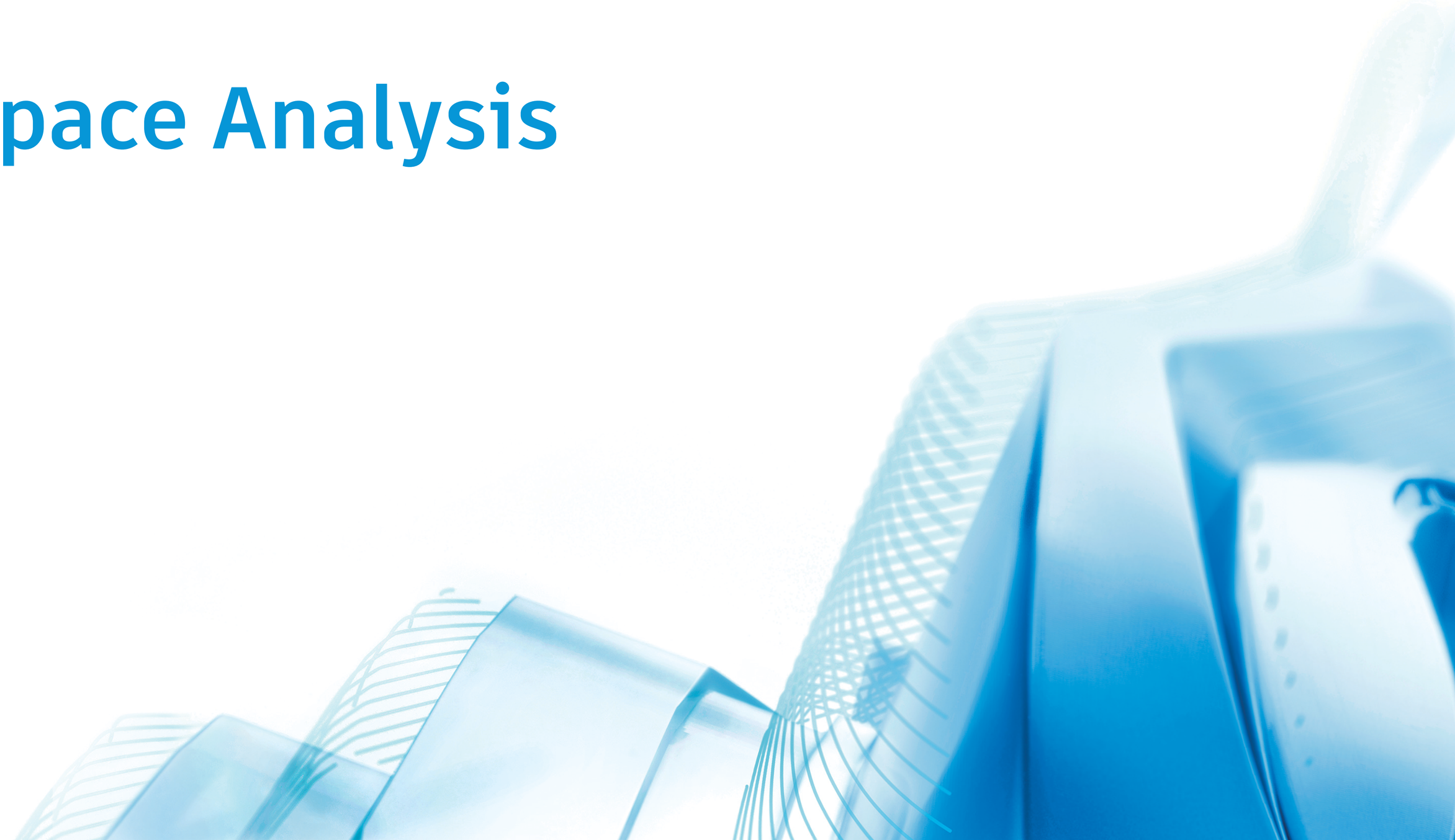


Daylight

- V1 used home-rolled approach
  - Based on raycasting
  - Worked, but was slow/expensive
- V2 uses Solar Analysis package
  - Based on former Ecotect engine
  - More efficient
- Calculate and display a year of data

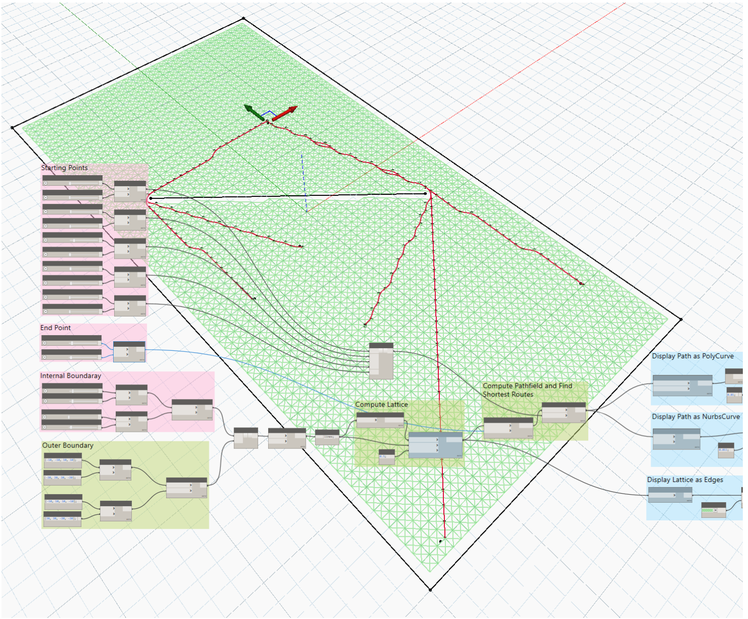


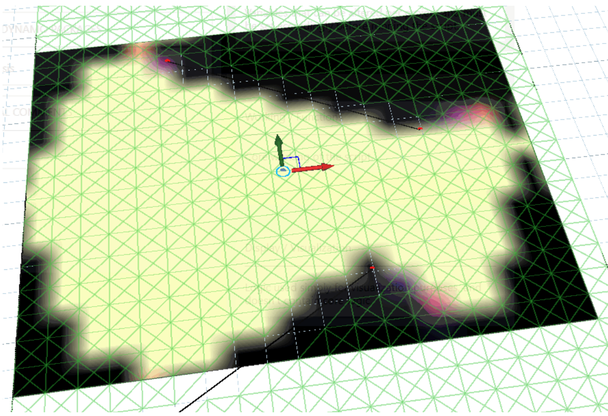
Space Analysis

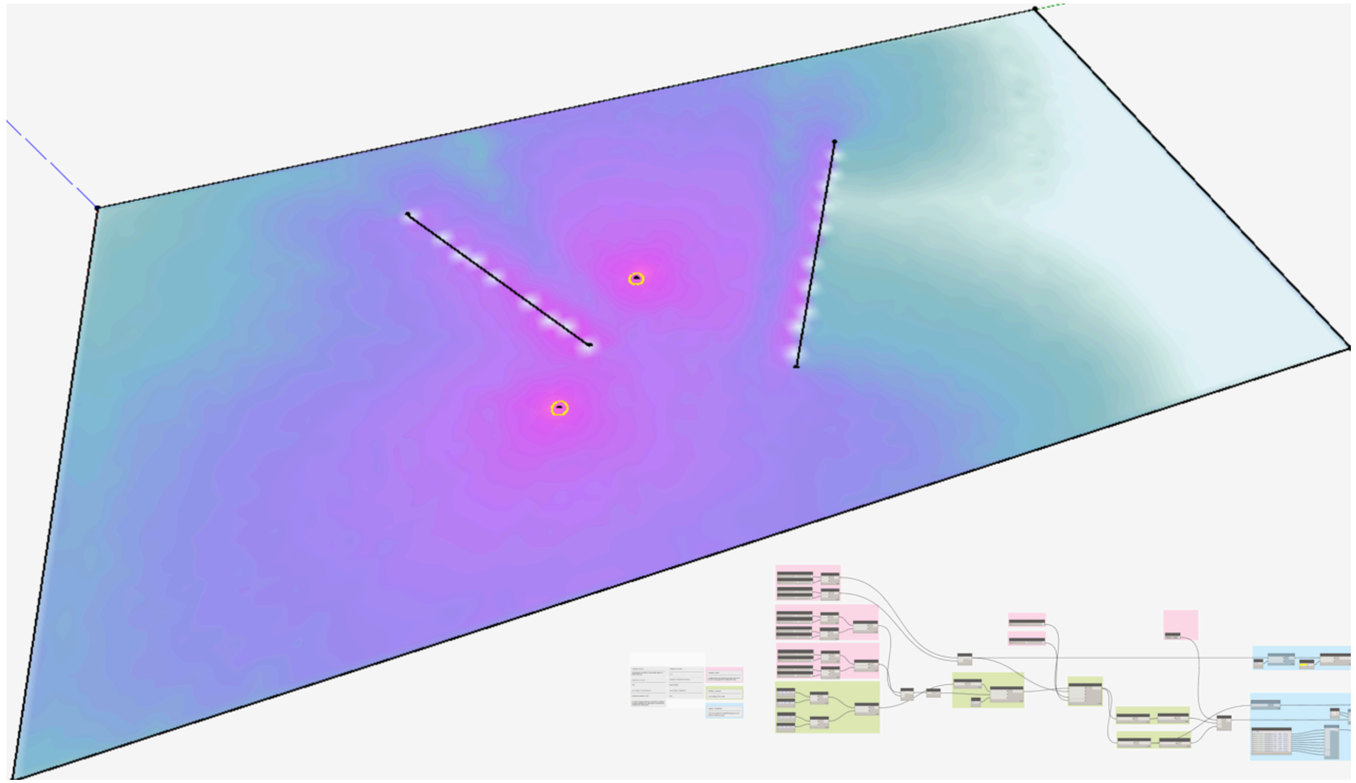


Space Analysis

- Dynamo package simplifying…
  - Pathfinding
  - Visibility
  - Acoustics
- Optimized for GD-related usage
  - Implemented using C++
  - 2D only

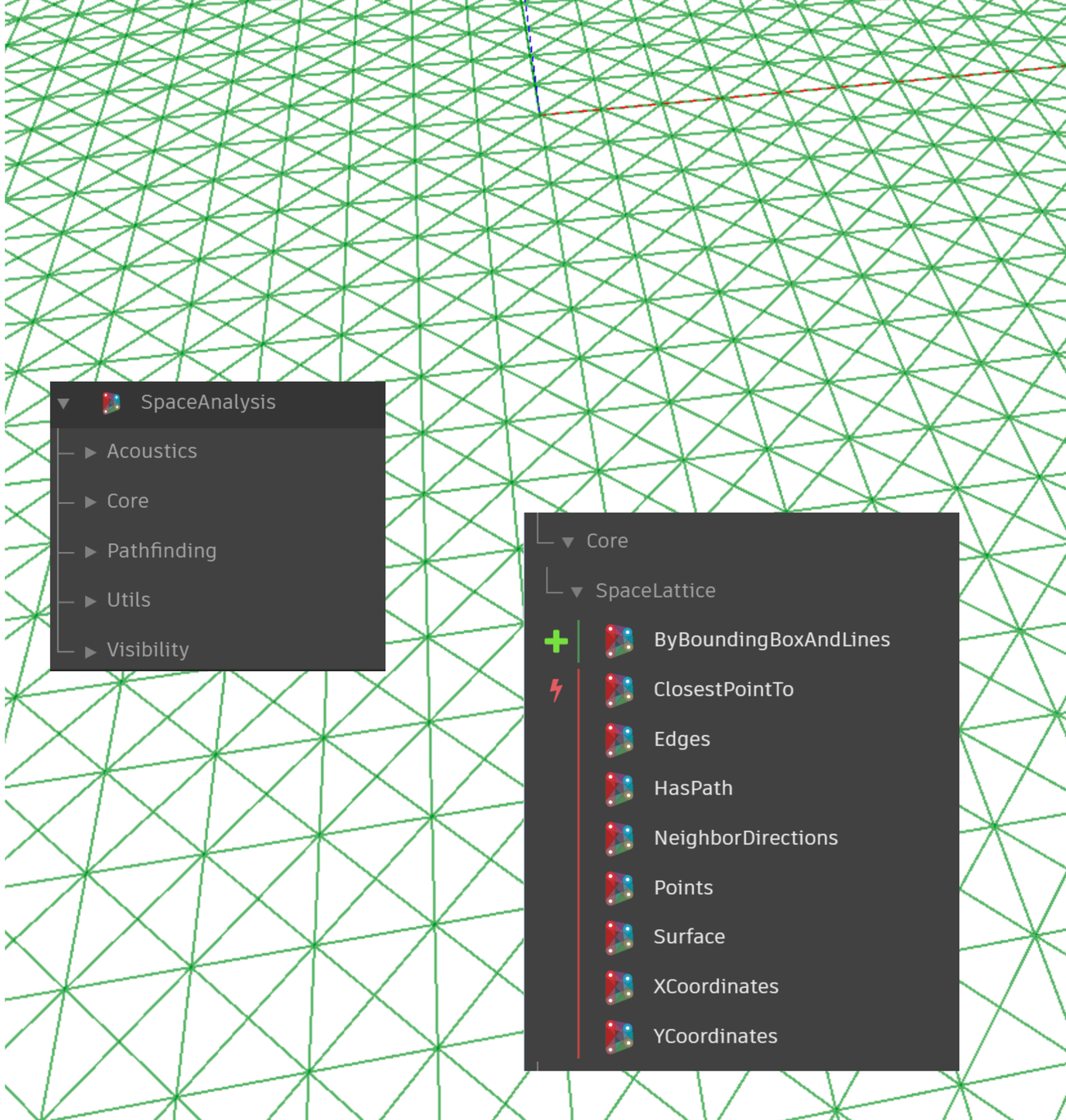






Space Lattice

- Core 2D data structure
  - Used for all types of analysis
- Important concepts
  - Display edges for debugging
  - Resolution
  - ClosestPointTo



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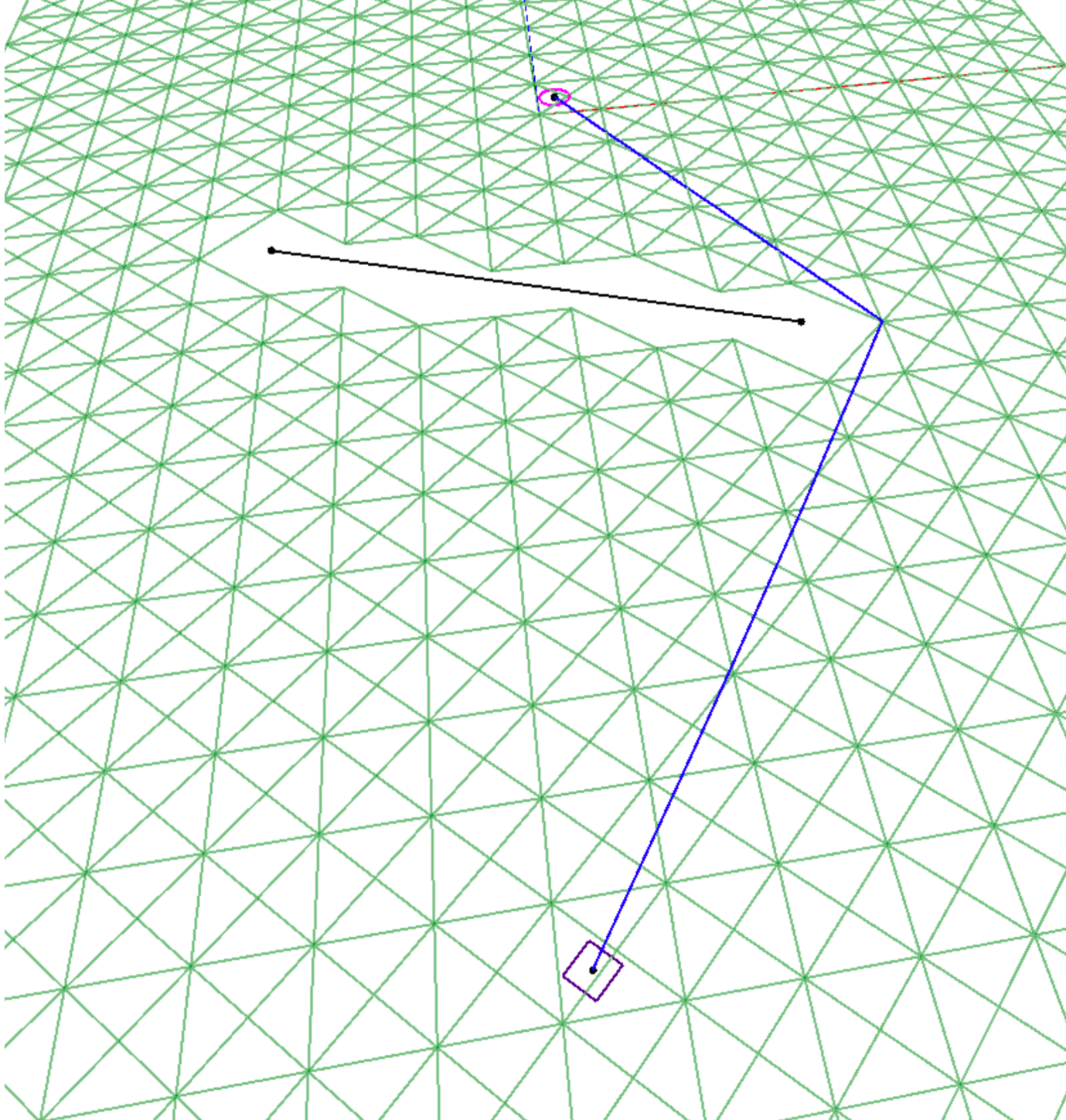
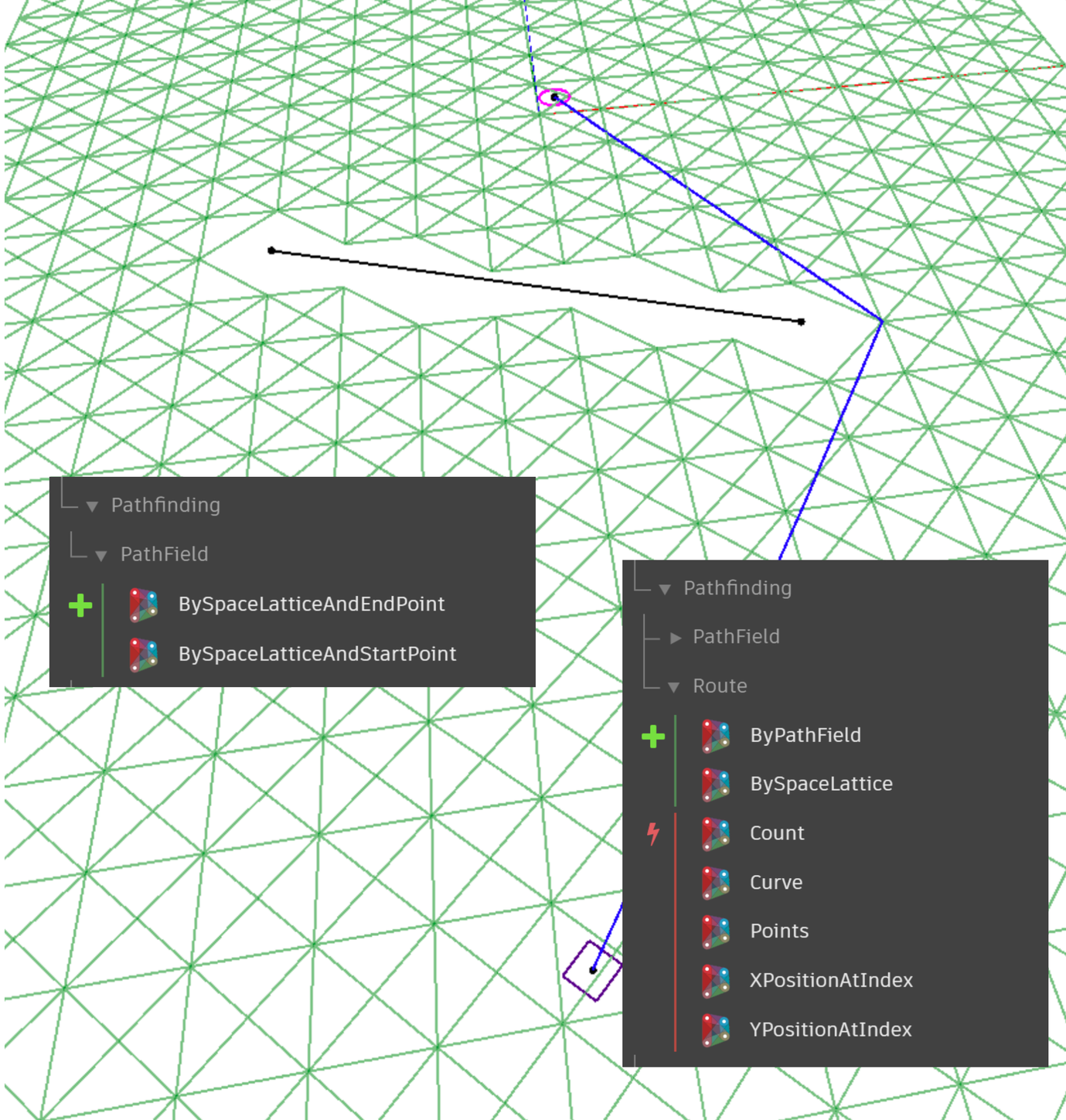


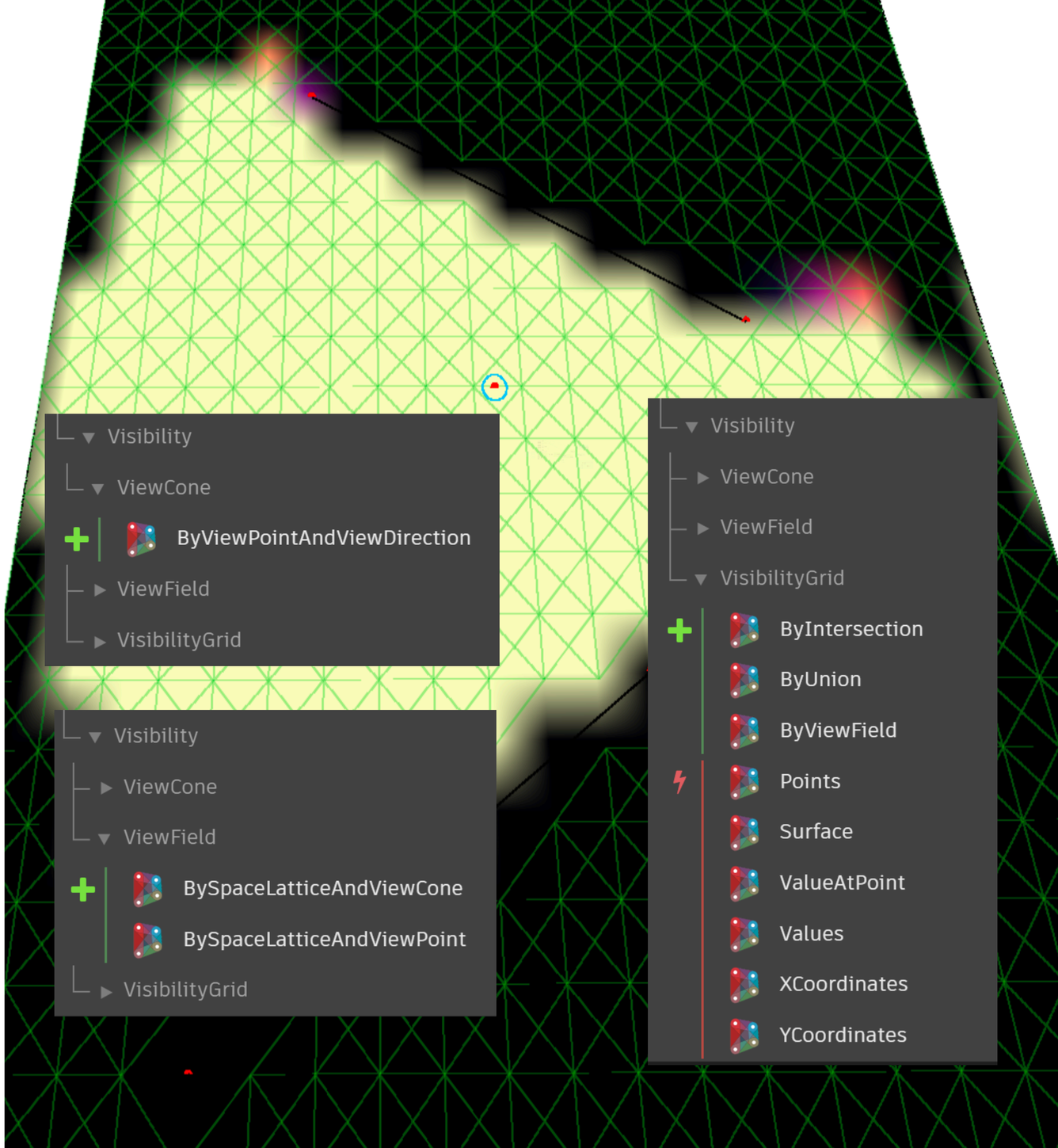
Pathfinding

- Shortest path from:
  - 1 to 1, 1 to many, many to 1
- Route smoothing
- Less elaborate than Revit's path of travel
  - Good enough for GD



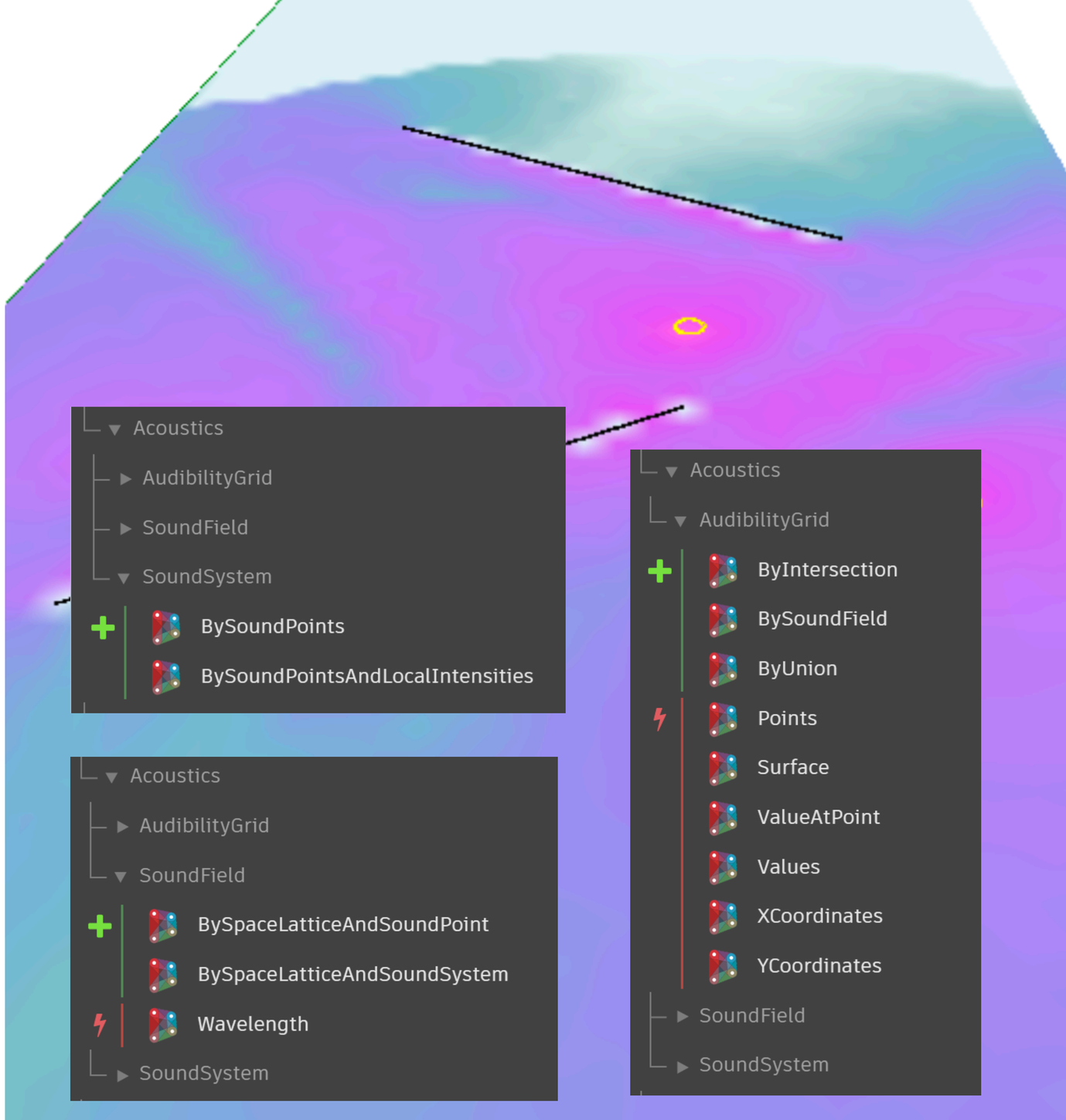
Visibility

- View point or view cone for field of view
- Global or local (with radius) visibility
- Set operations (union and intersection)
- Values can be mapped to a surface



Acoustics

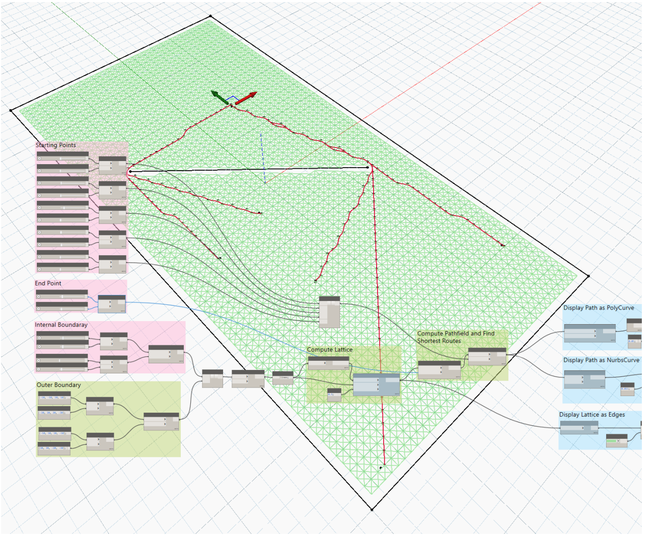
- Nodes are largely analogous to those for visibility
- Sound system for multiple sources of same frequency
- Local and global intensities
- Actual wavelength may be different, so can be queried

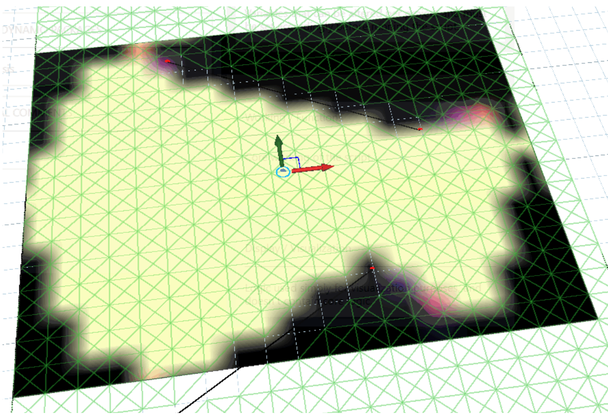


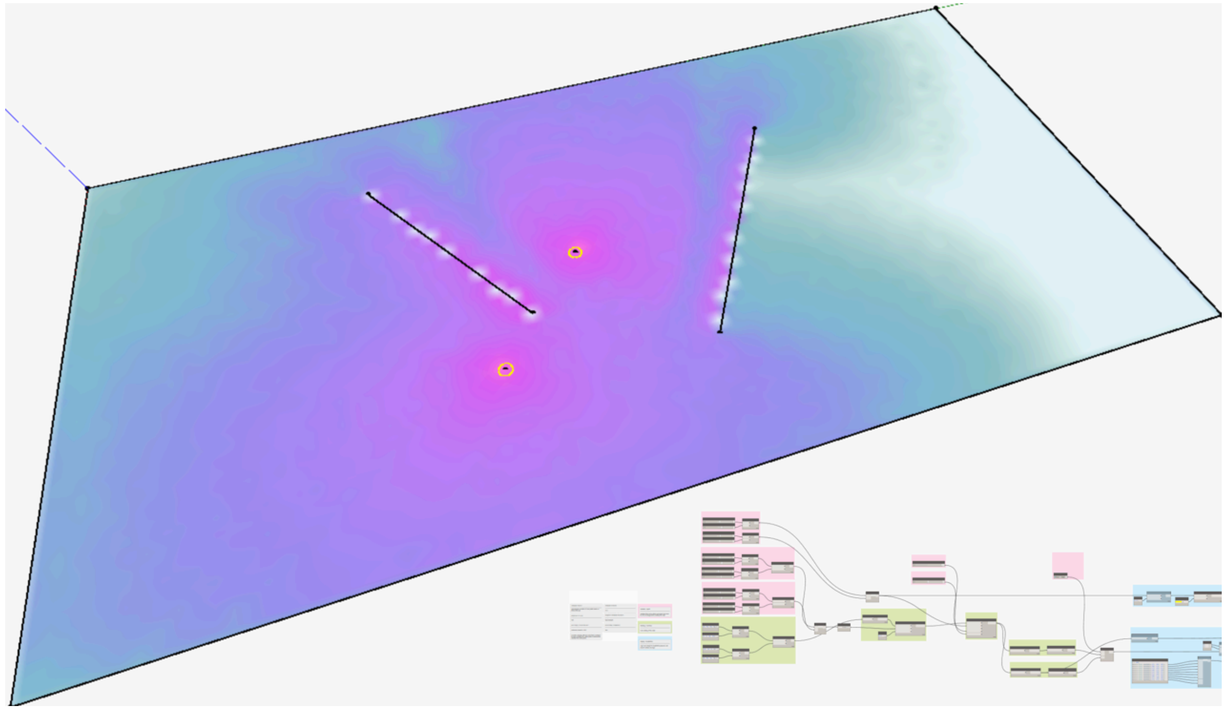
Space Analysis

- Install via Dynamo Package Manager
- Samples under package folder

  %appdata%\Dynamo\Dynamo Revit\2.x\packages\SpaceAnalysis\extra
- Feedback via the DynamoBIM forum
- Planning to release via Open Source







Refinery Toolkits

- For Space Planning and Massing
  - Some overlap with Space Analysis
- Already Open Source
  - github.com/DynamoDS/RefineryToolkits
  - Contributions welcome!
- Beta release also posted via GitHub

Refinery Toolkits

A collection of packages to accelerate generative design workflows in Dynamo & Refinery.

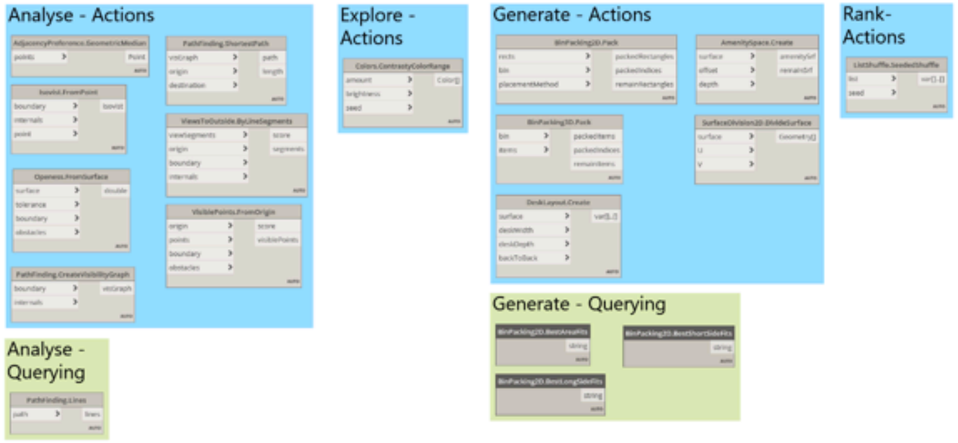
The toolkits

There are currently 2 packages included in the toolkit, each focusing on enabling specific types of workflows:

- SpacePlanning Toolkit
- Massing Toolkit

Space Planning Toolkit

The toolkit offers a range of nodes that help with general space-planning workflows in Dynamo and Revit.



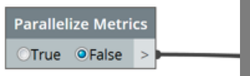
Massing Toolkit

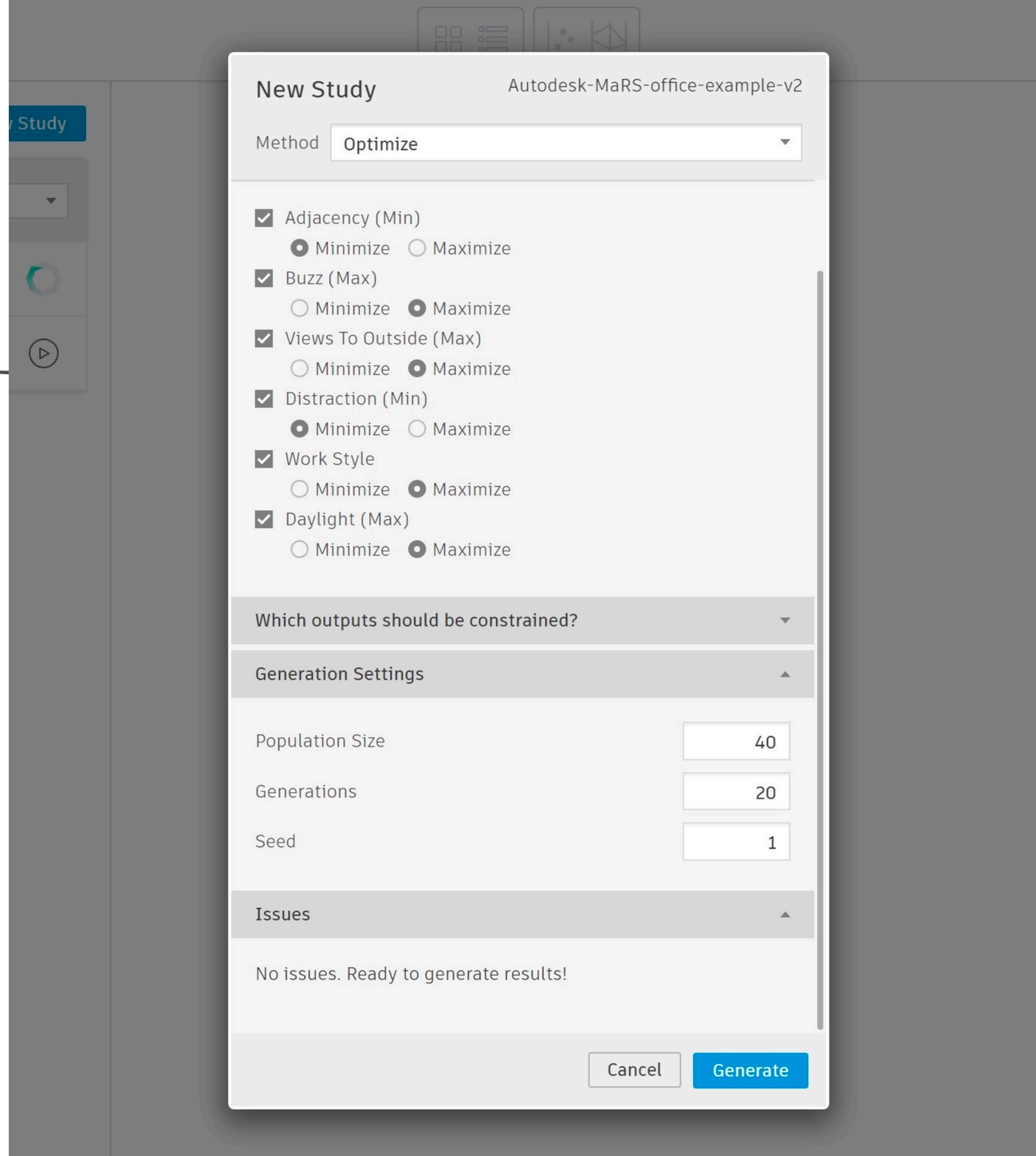
optimization & design option generation

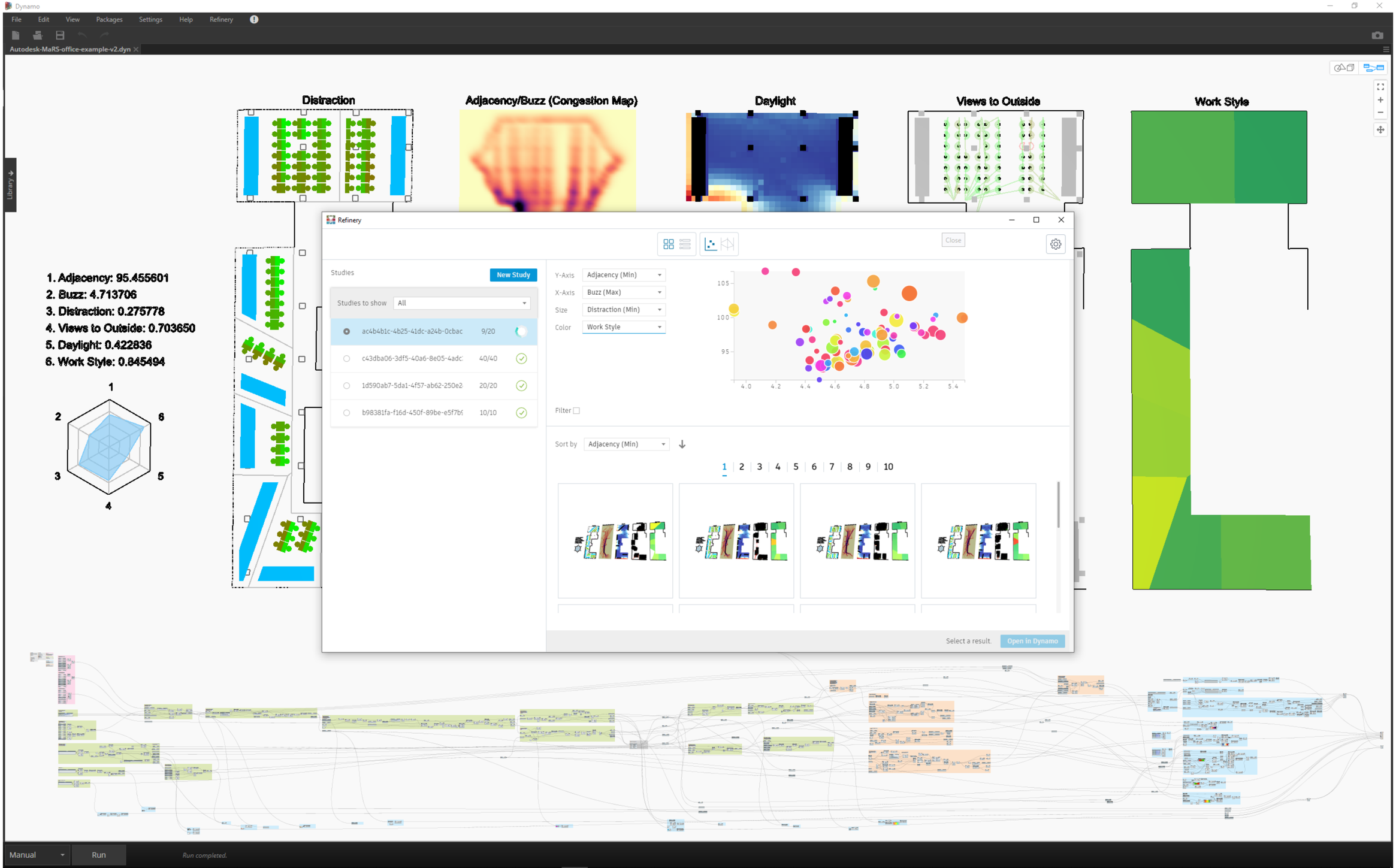
Rediscover and Refinery

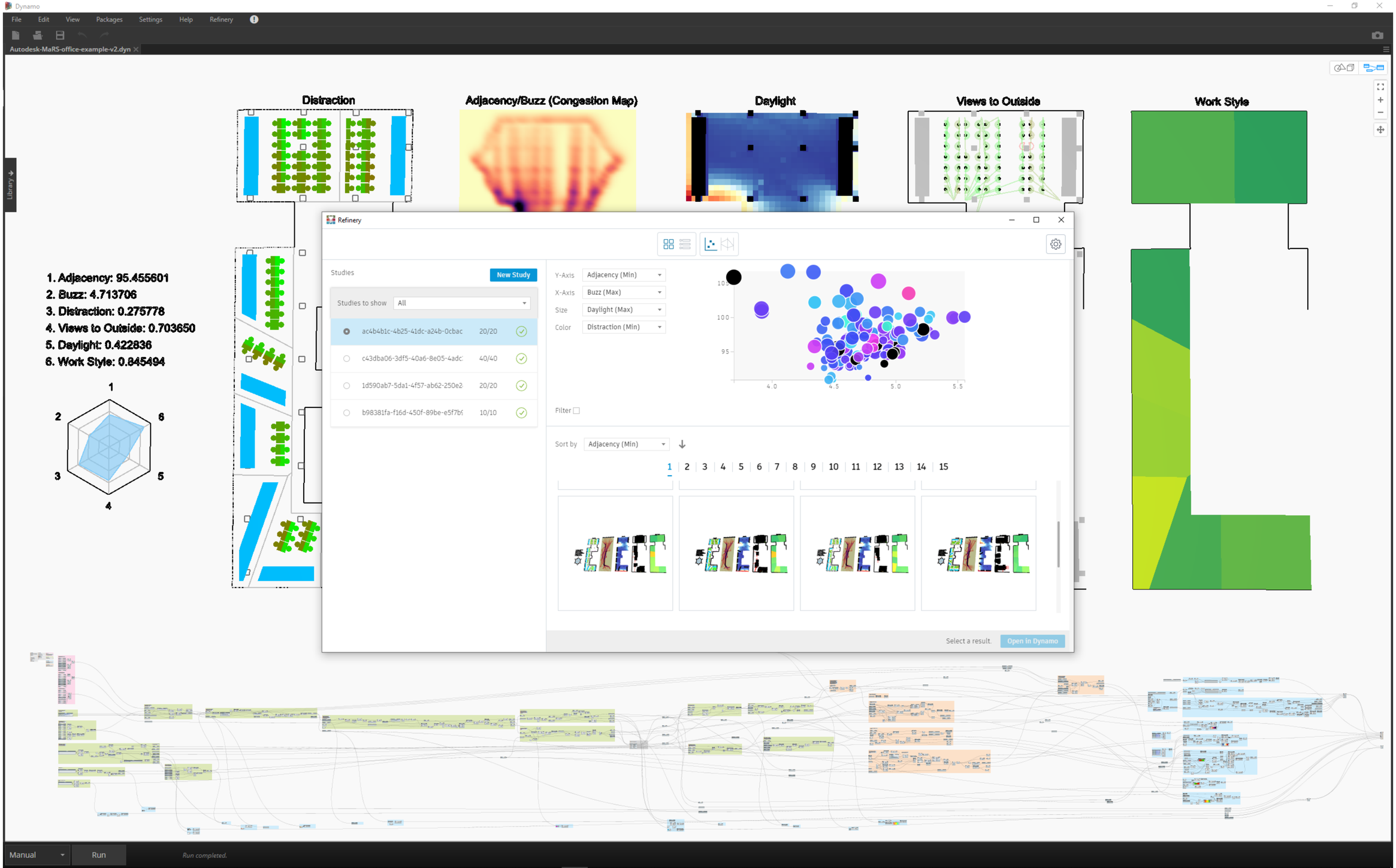
Refinery

- Works well with this version
  - Parallelize Metrics -> False
    - This is the default setting
- Also works with Capturefinery
  - Captures presentation graphics from Refinery studies






Dynamo
File
Edit
View
Packages
Settings
Help
Refinery
Autodesk-MaRS-office-example-v2.dyn
Library
Distraction
Adjacency/Buzz (Congestion Map)
Daylight
Views to Outside
Work Style
1. Adjacency: 95.455601
2. Buzz: 4.713706
3. Distraction: 0.275778
4. Views to Outside: 0.703650
5. Daylight: 0.422836
6. Work Style: 0.845494
1
2
3
4
5
6
Refinery
Close
Studies
New Study
Studies to show
All
ac4b4b1c-4b25-41dc-a24b-0cbac
9/20
c43dba06-3df5-40a6-8e05-4adc
40/40
1d590ab7-5da1-4f57-ab62-250e2
20/20
b98381fa-f16d-450f-89be-e5f7b
10/10
Y-Axis
Adjacency (Min)
X-Axis
Buzz (Max)
Size
Distraction (Min)
Color
Work Style
Filter
Sort by
Adjacency (Min)
1 2 3 4 5 6 7 8 9 10
Select a result.
Open in Dynamo
Manual
Run
Run completed.


Dynamo
File
Edit
View
Packages
Settings
Help
Refinery
Autodesk-MaRS-office-example-v2.dyn
Library
Distraction
Adjacency/Buzz (Congestion Map)
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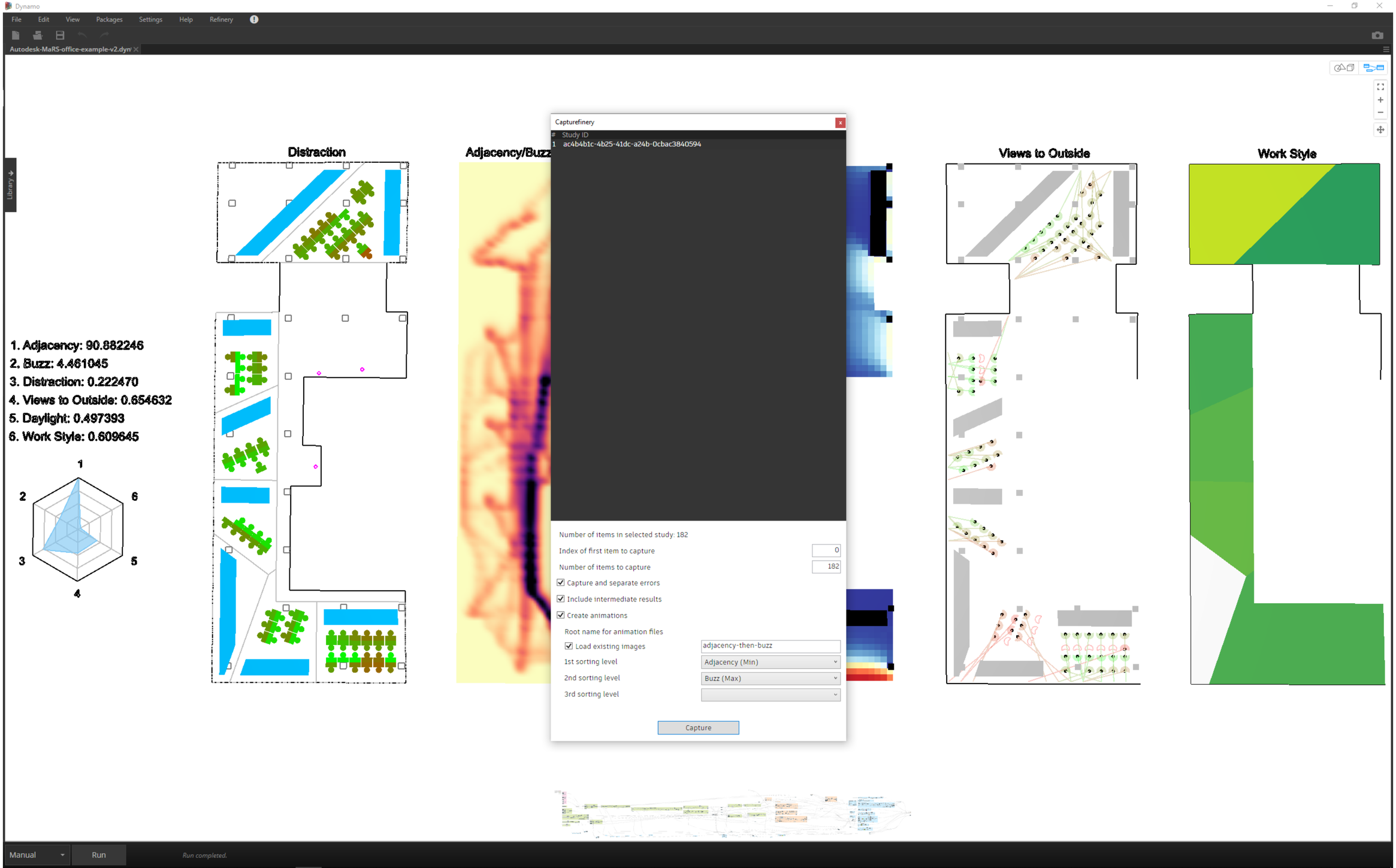
Refinery
Studies
New Study
Studies to show
All
ac4b4b1c-4b25-41dc-a24b-0cbac
20/20
c43dba06-3df5-40a6-8e05-4adc
40/40
1d590ab7-5da1-4f57-ab62-250e2
20/20
b98381fa-f16d-450f-89be-e5f7b
10/10
Y-Axis
Adjacency (Min)
X-Axis
Buzz (Max)
Size
Daylight (Max)
Color
Distraction (Min)
Filter
Sort by
Adjacency (Min)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Select a result.
Open in Dynamo
Manual
Run
Run completed.


Dynamo
File
Edit
View
Packages
Settings
Help
Refinery
Autodesk-MaRS-office-example-v2.dyn
Library
Distraction
Adjacency/Buzz
Views to Outside
Work Style
1. Adjacency: 90.882246
2. Buzz: 4.461045
3. Distraction: 0.222470
4. Views to Outside: 0.654632
5. Daylight: 0.497393
6. Work Style: 0.609645
1
2
3
4
5
6
Capturefinery
Study ID
1 ac4b4b1c-4b25-41dc-a24b-0cbac3840594
Number of items in selected study: 182
Index of first item to capture
0
Number of items to capture
182
Capture and separate errors
Include intermediate results
Create animations
Root name for animation files
Load existing images
adjacency-then-buzz
1st sorting level
Adjacency (Min)
2nd sorting level
Buzz (Max)
3rd sorting level
Capture
Manual
Run
Run completed.

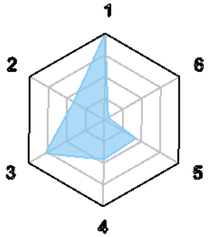
Dynamo

File Edit View Packages Settings Help Refinery

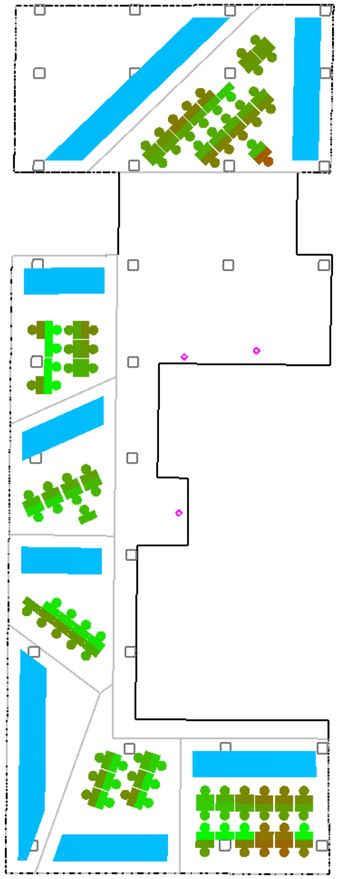
Autodesk-MaRS-office-example-v2.dyn

Library

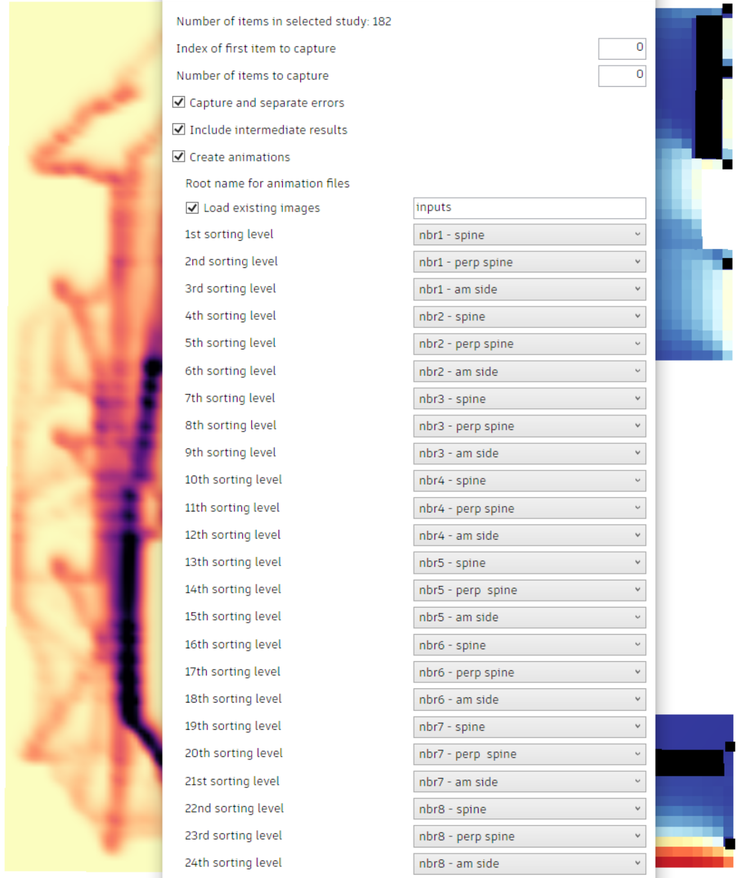
1. Adjacency: 90.882246
2. Buzz: 4.461045
3. Distraction: 0.222470
4. Views to Outside: 0.654632
5. Daylight: 0.497393
6. Work Style: 0.609645



Distraction



Adjacency/Buzz



Capturefinery

#	Study ID
1	ac4b4b1c-4b25-41dc-a24b-0cbac3840594

Number of items in selected study: 182

Index of first item to capture: 0

Number of items to capture: 0

- [x] Capture and separate errors
- [x] Include intermediate results
- [x] Create animations

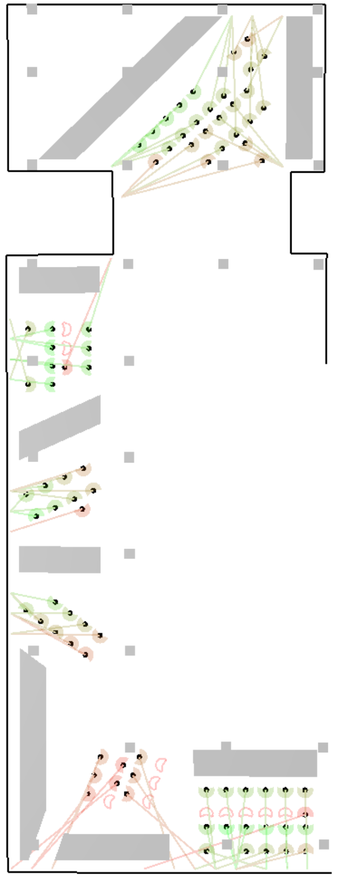
Root name for animation files

- [x] Load existing images: inputs

1st sorting level	nbr1 - spine
2nd sorting level	nbr1 - perp spine
3rd sorting level	nbr1 - am side
4th sorting level	nbr2 - spine
5th sorting level	nbr2 - perp spine
6th sorting level	nbr2 - am side
7th sorting level	nbr3 - spine
8th sorting level	nbr3 - perp spine
9th sorting level	nbr3 - am side
10th sorting level	nbr4 - spine
11th sorting level	nbr4 - perp spine
12th sorting level	nbr4 - am side
13th sorting level	nbr5 - spine
14th sorting level	nbr5 - perp spine
15th sorting level	nbr5 - am side
16th sorting level	nbr6 - spine
17th sorting level	nbr6 - perp spine
18th sorting level	nbr6 - am side
19th sorting level	nbr7 - spine
20th sorting level	nbr7 - perp spine
21st sorting level	nbr7 - am side
22nd sorting level	nbr8 - spine
23rd sorting level	nbr8 - perp spine
24th sorting level	nbr8 - am side
25th sorting level	

Capture

Views to Outside

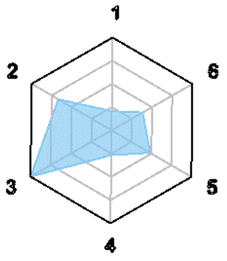


Work Style

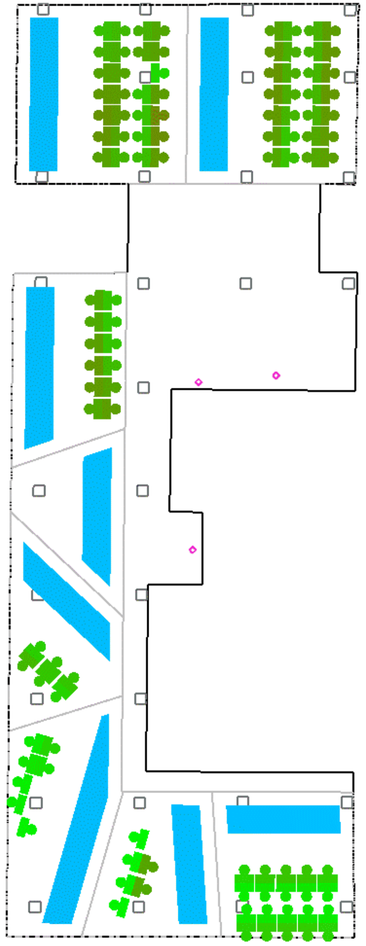
Manual Run

Run completed.

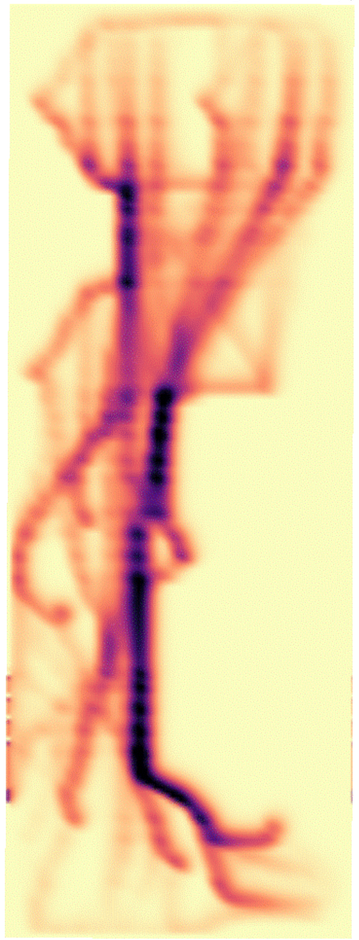
1. Adjacency: 103.448113
2. Buzz: 4.937391
3. Distraction: 0.183898
4. Views to Outside: 0.621622
5. Daylight: 0.511470
6. Work Style: 0.730830



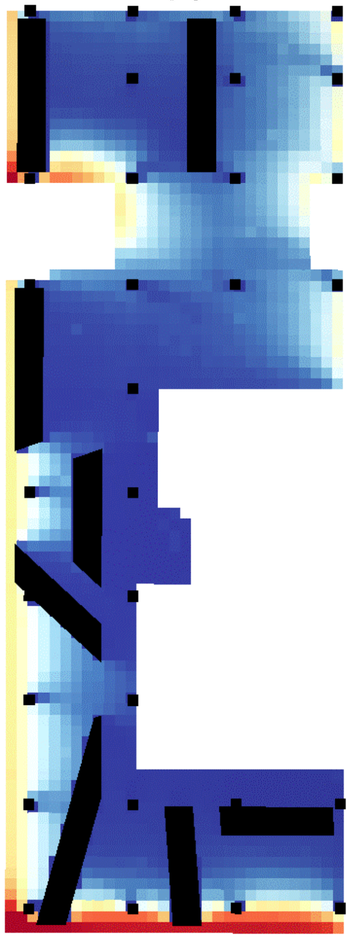
Distraction



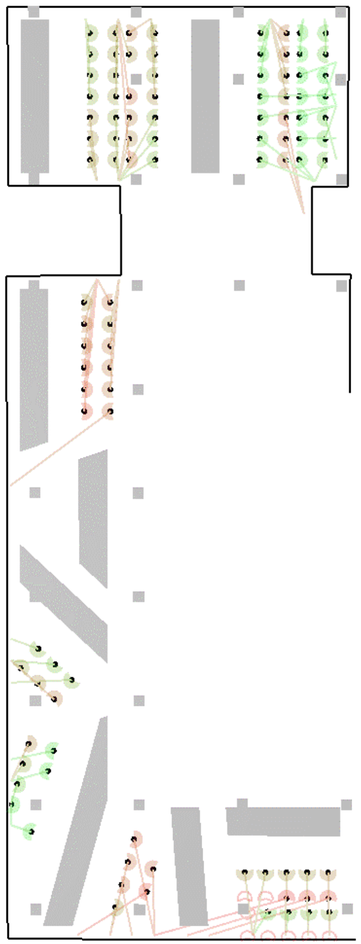
Adjacency/Buzz (Congestion Map)



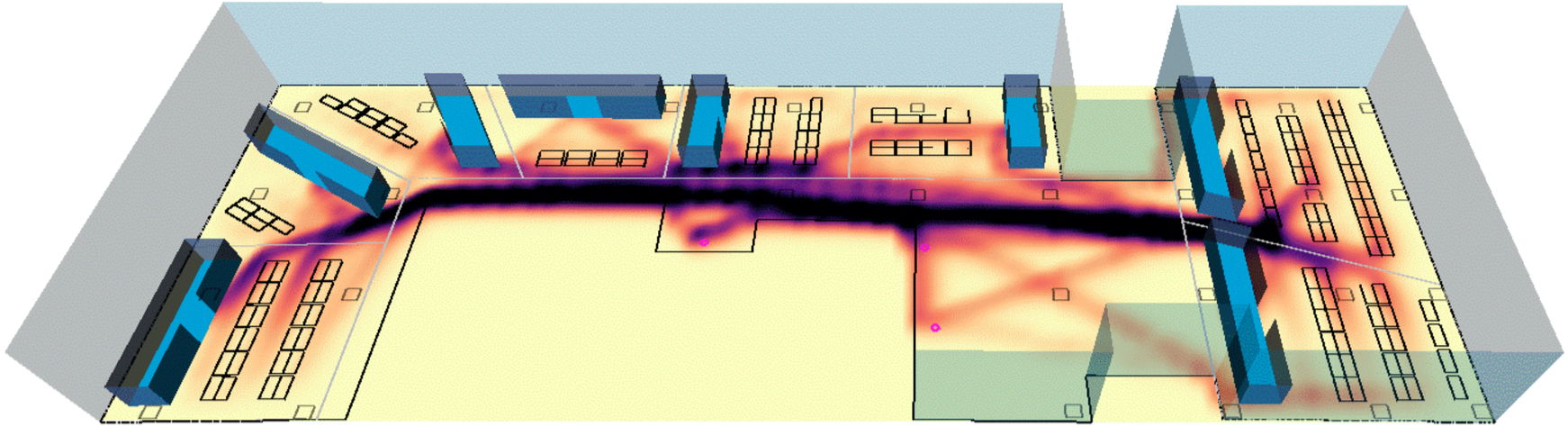
Daylight

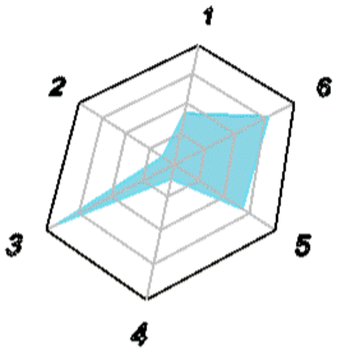


Views to Outside

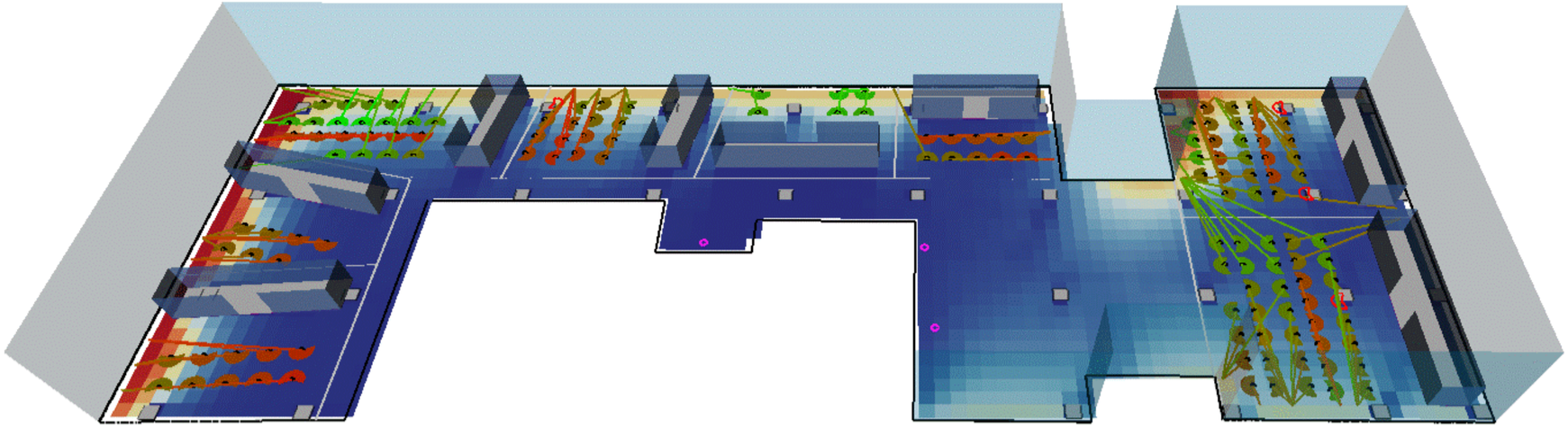


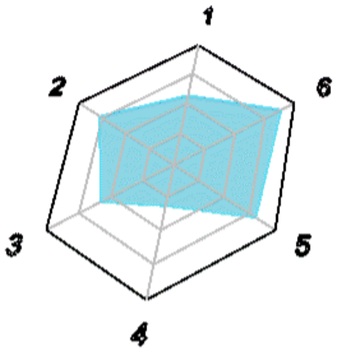
Work Style



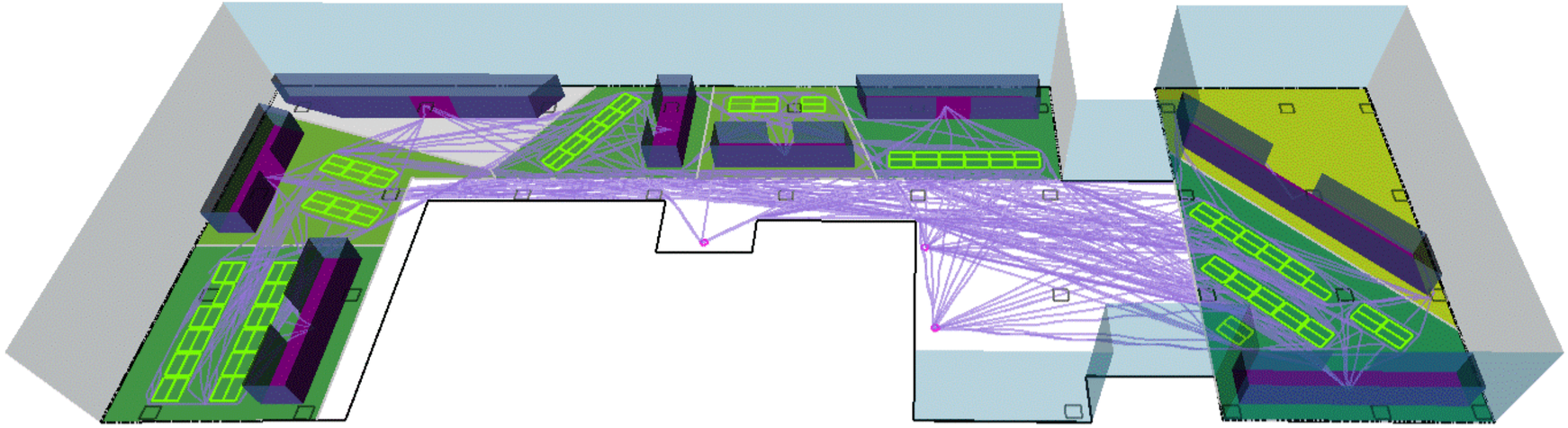


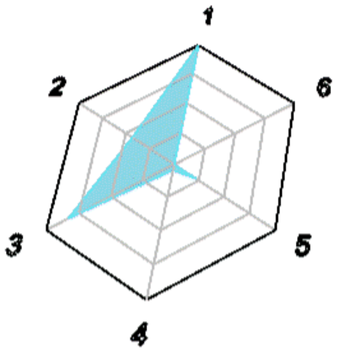
1. Adjacency: 100.135036
2. Buzz: 3.917679
3. Distraction: 0.201396
4. Views to Outside: 0.594491
5. Daylight: 0.561522
6. Work Style: 0.875945





1. Adjacency: 97.786070
2. Buzz: 5.143997
3. Distraction: 0.254849
4. Views to Outside: 0.630393
5. Daylight: 0.594369
6. Work Style: 0.915028



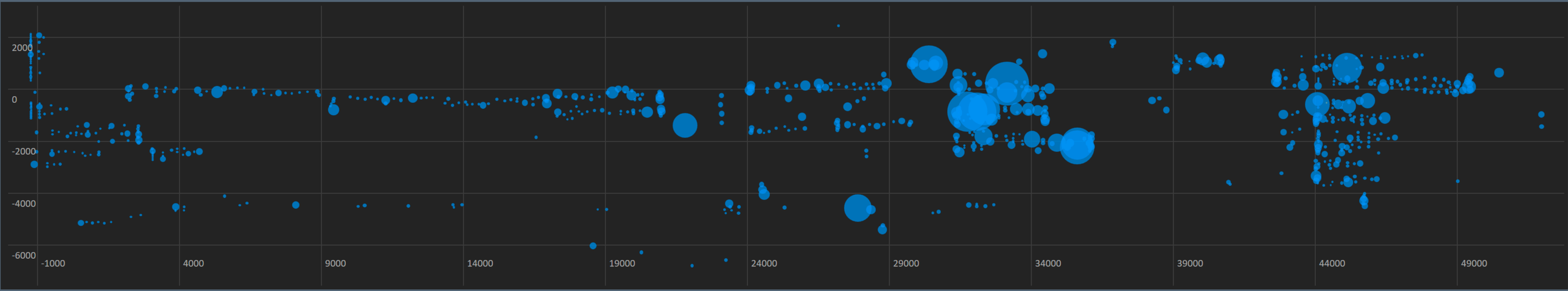


1. Adjacency: 90.918519
2. Buzz: 4.496665
3. Distraction: 0.214622
4. Views to Outside: 0.582591
5. Daylight: 0.446298
6. Work Style: 0.590003

Autodesk-MaRS-office-example-v2

Graph Name

SCATTER PLOT



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bd617fef-0a89-44e9-a8ea-919c3273697c	Code Block	95
de5adc74-d5a8-4a3a-8fee-e5cffbe04db3	Code Block	89
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7a92d8fa-8dcf-4ce2-af46-c071b8984652	Code Block	48
e062e63c-2a8d-4bc5-a8c5-fcd164958464	Code Block	48

https://github.com/alvpickmans/Dynamo-Diagnostic-Toolkit

REQUEST EXECUTION

Questions?

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