Depth map manual for "DUMMIES"

(…or for those of us with limited computer knowledge…)

Version 20

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This manual is for helping you to conduct the various space syntax analyses with the help of the DepthmapX software.

Downloading DepthmapX software:
Go to the site:
https://github.com/SpaceGroupUCL/depthmapX
and download the DepthmapX file

Recent literature for an introduction to space syntax can be found on:
Van Nes, A. & Yamu, C. (2021) Introduction to space syntax in urban studies, Springer Nature, https://www.springer.com/gp/book/9783030591397

Important preparations for axial analyses:

Draw an axial map on a separate layer in Autocad, Vector works, QGIS, ArchGIS or adobe illustrator. It is IMPORTANT that you use a "single line" instead of a "multiple line". And make sure that all lines are well connected! Export only the axial lines layer as a **dxf file**.

Making axial analyses:

1. File + new
2. Map + import (choose one of your dxf files with axial lines)
3. Map + convert drawings map. Under "new map type", choose "axial map".
4. Tools + Axial/Convex/Pesh + run graph analyses. Set radius n or 3 or 5 etc. Then just wait. The larger file, the longer time to wait. The local integration values like 3, 5, 7, 10 etc takes short time. On the left side, all the processed maps are presented. Radius "n" means global integration or "integration [HH]" as shown on the left side, radius 3 means local integration with radius 3 or "integration [HH]R3" etc.
5. In order to identify unlinks, click on "node count" on the left side. If there are any unlinks, most of the axial lines are red and the unlinked ones are blue. Correct the unlinked lines in your dxf file from autocad, adobe illustrator, vector works…etc. If all lines are linked, then all the lines are coloured in green. Another way is to go to "window + table". Under the connectivity column with values 0 are the unlinked lines. Likewise, lines with the value -1 under the column integration [HH] are also unlinked lines. Highlight all the lines under the references numbers. Then go to "window + 1 untitled map" and then the line is highlighted.
6. Draw extra lines or remove lines. Check on the "editable" on the folders on the left side (where you see the processed data). This step is important, otherwise you can not edit the axial map.
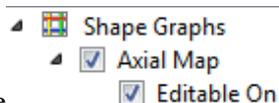
Which are show like ,then you can edit the axial map.

Click on the axial line you want to remove or make longer. For deleting lines: Edit + clear. Click on the line if you want to draw an extra line. After finishing this, run all the axial analyses again (important). Undo, use ctrl + Z (for pc users only).

7.   File + save as (give the city name or the area name, for example "delft.graph")

8.   Unlink lines: Click on the "unlink" button.
     Then click the first line, and then click the second line.

9.   Re-link lines: Click on the "link" button.
     Then click the first line and then the second line.
     OBS! You can only re-link or unlink 2 lines at the time.

10. Making bridges or tunnels: click on the link button, then click on the first line and then on the second line.

11. Remove bridges and tunnels: click on the unlink button, then click on the first line and then on the second line.

The most useful measurements for axial analyses:

Use the folders on the left for looking at various integration values for the axial map. The axial analyses shows the measurements for the topological distance = the fewest direction change.

Global integration: "integration [HH]" – show how each street is connected to all others in a whole city in terms of the maximum possible direction changes. Shows how integrated every street is in relation to the whole city/town. Highlights the potential main centre for car traffic.

Local integration with radius 3: "integration [HH]R3" - show how each street is connected to its vicinity in terms of three times direction changes. Shoes how integrated every street is in relation to its direct neighbours. Here it is three times direction change from every street. Highlights the potential for various local centres.

Local integration with radius 7: "integration [HH]R7" - show how each street is connected to its vicinity in terms of seven times direction changes.

The red lines show the streets with the highest integration values, while the blue ones shows the most segregated ones. Put the curser on the axial lines to get the various integration values (in numbers).

For checking **unlinked lines**, use the folder "node count". All the blue lines are the unlinked ones.

Recentre the image

12. Click on the recentre button ⛶ in order to fit the map to the screen.

Making Axial step depth analyses:

13. Select a line or several lines (then you must use the "shift" key). Then click on the "step depth" button ⊞ . Then use the Invert color range bottom ⬄ for reversing the colours (if you want to have the first step red instead of blue).

Making angular analyses:

Before doing the angular analyses you must run the axial analyses!!!!

14. Map + convert active map. Under "new map type", choose "segment map". Click on "retain original map" and on "remove axial stubs" and set it on 40% of line length.

Adding metrical radiuses to the angular choice and segment integration analyses

15. For processing angular INTEGRATION and angular CHOICE analyses at the same time: Tools + segment + run angular analyses. Click on 'Tulip Analysis', and then tick the box for 'Include choice'.

16. For the radius type choose 'Metric'. You need to type value in *Radius / list of radius*. The value you type in *Radius/list of radius* is dependent on the middle coordinates which displayed at the lower right corner of the software display window.

| 5539 | 208.139 x 252.236 | 226.018, 152.733 |

For example, if it shows 208.139 x 252.236, you have to take the first number. Here in this case is 208.139, and before the point is 208. In this case you can take 208 for high value, and 10% of high value 208, which is 20, for low value.). In this example, you can type radius 200 and 20 in *Radius/list of radius*. Write it like *200, 20* . The metric radii needs to be separated with a comma (n, metric high, or metric low) or here in this case *n, 200, 20* .

17. Tick the box for 'Include weighted measures'. Choose 'angular connectivity' or 'weighted segment length'.

18. The click OK. Dependent on the size of the area you are analysing, these analyses can take some time.

19. In the folders on the left side, you find the various measurements with your metrical radiuses. Click for example on the "choice R200 metric" or "choice R20 metric or integration R200 metric or integration R20 metric. Here you will find the results from your analyses where angular choice (geometric distance) and segment integration (topological distance) combined with various metrical radiuses.

Segment Step Depth Analyses (+Angular Step/ +Topological step/ +Metic step)

20. You choose one line (a street segment) or several lines (streets), then go to --> Tools + segment + Step depth + **Angular step**. On the left side, the arrow is on the Angular step depth column ➡ Angular Step Depth .The result shows the values of Angular changes of streets net from the Chosen street.

21. You choose one line or several lines, then go to --> Tools + segment + Step depth + **Topological step**. On the left side, the arrow is on the Topological step depth column. The result shows the value of the directions changes of streets net from the Chosen street, which is Axial map based result.

22. You choose one line or several lines, then go to --> Tools + segment + Step depth + Metric step. On the left side, the arrow is on the Metrical step depth column. The result shows the pure metical value of streets net from the Chosen street.

Normalising the angular choice and segment integration analyses (NAIN and NACH)

23. **NAIN:** Go to Attributes + Add Column. Give it a new name, like for example NAIN (Normalised angular integration). Then click: Attributes + Update Column. Under the field Formula, write (or paste):
(value("T1024 Node Count")^(1.2))/(value("T1024 Total Depth")+2)
Otherwise: (then click under Existing attributes "T1024 Node Count". Then type ^(1.2))/(and then click under Exisitng attributes "T1024 Total Depth" and then type + 2) and then ok.
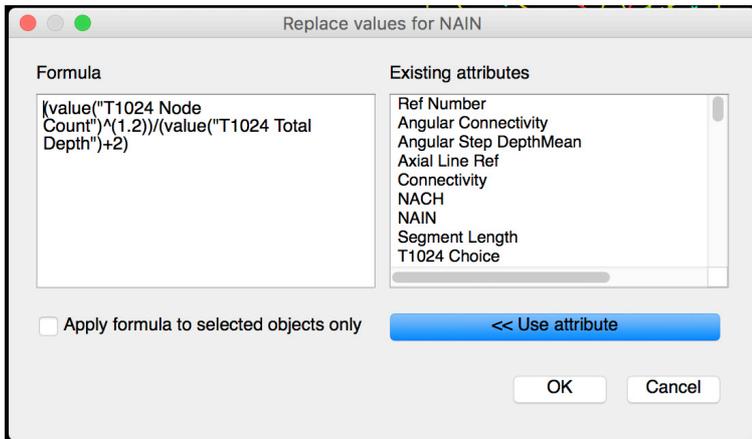
24. **NACH** Go to Attributes + Add Column. Give it a new name, like for example NACH (Normalised angular choice). Then click: Attributes + Update Column. Under the field Formula, write (or paste):

log(value("T1024 Choice")+1)/log(value("T1024 Total Depth")+3)

Otherwise: log(then click under Existing attributes "T1024 Choice". Then type (+1)/log(and then click under Exisitng attributes "T1024 Total Depth" and then type + 3) and then ok.
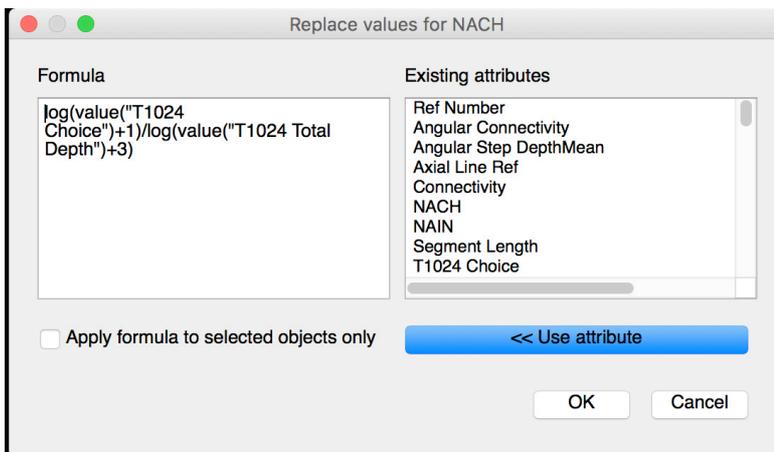
25. To see the column properties (value of attributes), right click on column properties. There you find the max and the average values for the city you are analysing. If you want a summary of all the attributes: view + attribute summary

26. If you want to export a table: Map + export. Choose csv format.

Attribute Properties

Name

NAIN

Values

	Value	Attribute	Selection
1	Average	0.951158	No Value
2	Minimum	0.445378	No Value
3	Maximum	1.4045	No Value
4	Std Dev	0.175398	No Value
5	Count	9085	0
6	< 0.541291	89	No Value
7	0.541291 to …	315	No Value
8	0.637203 to …	713	No Value

Formula

(value("T1024 Node Count")^(1.2))/(value("T1024 Total Depth")+2)

Note: the formula may have been applied to a subset of objects

OK

27. For combining segment integration and choice: use the formula: (value("T1024 Integration"))*(log(value("T1024 Choice")+2)). You can also use the various metical local radii.

Adjusting colours for highlighting the analyses or for making grey scales images

28. Click on window + colour range. There you can choose between black and white, or adjust the colours in order to highlight the integrated structure in your analyses.

Use Invert color range bottom ⟷ can simply reverse red to blue color.

Making scatter Plot:

29. Click on window + scatter Plot. Then a window will be opened with various options. The most usual is to show the correlation between integration [HH]R3 and integration [HH]. This measures the degree of synergy between them. The correlation between integration [HH] and connectivity shows the degree of intelligibility of a built environment.

30. By clicking on the R2 button R^2 , the correlation coefficient is shown between the chosen measurements.

31. For comparing variables from the segment analyses, click on segment. There it is possible to reveal the correlation between "Mean Depth R 3 metric" on the vertical axe, and "Mean Depth R n metric" on the horizontal axe. Or look at the correlation between the analyses with a low and a high metrical radii.

32. The scatter Plot are also useful for identifying unlinked lines that are hard to see on the axial map (because they are very small). Use node count on both axes and mark the blue one. Then the unlinked line (or lines) are marked and you can choose to delete them or correct them (see point 5.)

Exporting data:

33. Edit + export screen (an eps file will be made). The file can be imported into various photoshops programs or powerpoint. Edit + copy screen is useful for pasting images directly into powerpoint files. Under "layer + export" you can export map info (mif) files or txt files useful for GIS, autocad, adobe illustrator or vector works.

View the table:
34. Click on window + table. There you will see all the processed values. If you want the variables of a particular line, click on the line before you open the table. Then the relevant line will be on the top in the table.
35. In large cities, for selecting the values for only one neighbourhood, first select the lines on the map. Then, Edit + Selection to layer. Write the name of the new layer + ok. Then, Map + Export and save the file as .txt. Right click the .txt file (open with excel). Mark everything (all layers) and then double click the divider line button. Save as excel file.
36. If you want the average values for a specific neighbourhood: first select the lines, then go to attributes + column properties. Click on the folder you want to investigate. For example click on choice with a high radius. Then you move the arrow on the lines or you open up the table via attributes + column properties (descriptive statistics).

Import/Export data from GIS:
37. Export your axial map shape file as Mapinfo MIF Layer and your unlink shape file as txt file. You can import the *.mif file in Depthmap and process it as described above.
38. Depending on the GIS software you use there are several possibilities to create a *.mif file. If you use the open source software QGIS you can export your shape file using 'Save vector layer as'. Choose 'Mapinfo MIF' as file format. If you have processed your axial map in Depthmap you can export iyour *.graph file as a *.mif file. You can use the software MapInfo, ArcGIS or QGIS to open/import your *.mif file and convert it into a shape file.
39. The open source software QGIS supports Space Syntax analyses. You can download and install the application by using the plugin manager: Plugins →Manage and install plugins → type in your search field: 'Space Syntax Toolkit'→ install. You will get two Space Syntax icons on your bar. For further instructions how to process Space Syntax analyses using QGIS platform please see 'qgisSpaceSyntaxToolkit: https://github.com/SpaceGroupUCL/qgisSpaceSyntaxToolkit

The most useful measurements for segment analyses:
The segment map measures the geometric distance = the fewest angular deviation.
Use the folders on the left for looking at various integration values:
Local angular choice with a high metrical radius: "Choice R5000 metric" - show how each street is connected to its vicinity in terms of a high metrical radius. Here in this case (with a geo-referenced axial map) it is 5 km. Shows how integrated a street segment is in a large metrical radius. Highlights the potential *through-movement* routes running through or around urban neighbourhoods.
Local angular choice with a low metrical radius: "Choice R500 metric" - show how each street is connected to its vicinity in terms of a low metrical radius. Here in this case (with a geo-referenced axial map) it is 500 meters. Shows how integrated a street segment is in a short metrical radius. Highlights the potential *through-movement* routes inside pedestrian based local centres.
Local segment integration with a high metrical radius: "Integration R5000 metric" - show how each street is connected to its vicinity in terms of a high metrical radius. Here in this case (with a geo-referenced axial map) it is 5 km. Shows how integrated a street segment is in a large metrical radius. Highlights the potential *to-movement* routes for various local big centres in a city.
Local segment integration with a low metrical radius: "Integration R500 metric" - show how each street is connected to its vicinity in terms of a low metrical radius. Here in this case (with a geo-referenced axial map) it is 500 meters. Shows how integrated a street segment is

in a short metrical radius. Highlights the potential *to-movement* routes to pedestrian based local centres.

Angular step depth from one segment "Angular Step Depth" – shows how all street segments are connected from one particular segment in terms of angular deviation.

The red lines show the streets with the highest integration values, while the blue ones shows the most segregated ones. Put the curser on the axial lines to get the various integration values (in numbers).

<u>**Important preparations for all lines, isovist and point depth analyses**</u>

Draw a map with all obstacles (building, trees, water etc) with CLOSED polygons of a local area on a separate layer in Autocad, Vector works or adobe illustrator. It is IMPORTANT that you use multiple lines. Do NOT use the circle when you place the trees. Export only the closed polygon layer as a **dxf file**.

Making visibility graph analysis:

40. File + new
41. Map + import
42. Tools + visibility + set grid (various options). Or you can press the set grid bottom ▦ .
43. Click on the fill button 🪣 and then your mouse sign will show as 🖊 ,click on the "public spaces" on the drawing
44. Tools + visibility + make visibility graph.
45. Tools + visibility + run Visibility Graph Analysis. Then a window appears.
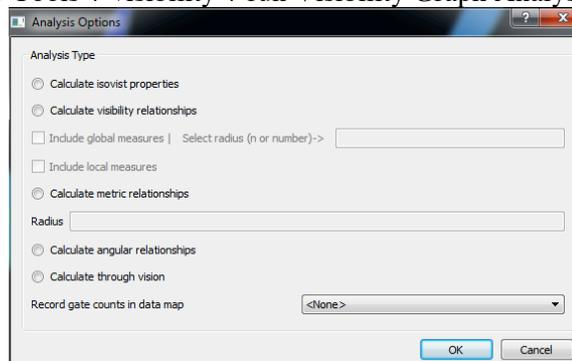
46. You can choose between metrical relationships, visibility relationships with a radius like "n" or 3, 5, etc, or isovist relationships. Then click ok. It will take a long time – depending on how fine-grained the grid is.
47. View + show grid (in order to remove the grid)

Making agent based modelling:

48. Tools + agent tools + run agent analyses + set a number of agents (use for example 5000 agents) + ok
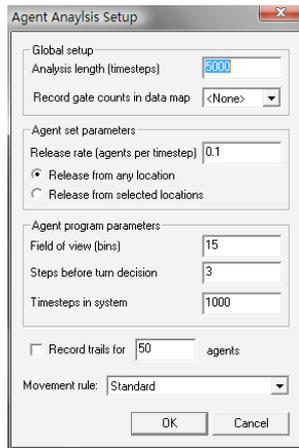
Field of view =15 , Steps before turn decision =*3*

49. Click outside the drawing (then you see their traces). Use "view + show grid" in order to remove the grid.

50. In order to put in individual "moving agents", use "window + 3D view". Click on the ![icon] Then you can click on the public spaces in your drawing in order to place a set of agents.

    Their movement traces can be seen if you press the agent trace bottom ![icon] .

More detail explanation about the bottoms show in the software:

You can use the bottoms to start ![icon] ,pause ![icon] or stop ![icon] the movement of the agents. You can rotate ![icon] the analysis, move the analysis by Pan tool bottom ![icon] , Zoom the analysis by zoom bottom ![icon] and Camera the view from distance by click bottom ![icon] .

You can also change the analysis background into color based by click on bottom ![icon] .
If you finished your agent analysis, you go to "window + 3D view", then you'll be back to former 2D analysis again.

Making all lines analyses:
51. File + new
52. Map + import
53. Click on the all lines button ![icon] and then your mouse sign will show as ![icon] , click on the "public spaces" on the drawing.

Making axial and segment map from all lines analyses:
54. Tools + axial/convex/push + reduce to fewest line map.
55. Click on the fewest line map (minimal) folder on the left side
56. Tools + axial/convex/push + run graph analyses + set radius (n=global integration or integration HH, 3=local integration with radius 3 or integration (HH)R3 etc….).
57. Click on "node count" on the left in order to look for unlinks. If there are no unlinks, the lines inside the map is coloured green, otherwise they are coloured red. Then you click on bottom "+", ![icon] Fewest-Line Map (Minimal) which shows in the first place in the Fewest-Line Map(Minimal) folder on left side.Then it will become "-", which will show"Editable on"below Fewest Line Map(Minimal) folder
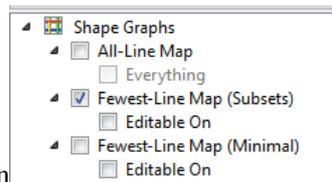
column . (Important! When it is "Editable off", you cannot edit the map!) Now you can start to delete these unlink lines. You mark the line, then use "edit + clear". Then the line will disappear.

58. For making **angular analyses:** Map + convert Active layer. Under "new layer type", choose "segment map". Then use tools + segment + run Angular segment analyses. (use the steps described in the angular analyses, point 13-15)

Making isovist analysis from one point:

59. File + new
60. Map + import

61. Click on the isovist button and then your mouse sign will show as , click on the "public spaces"on the drawing where you want the root of the isovist. There will be a window will pop up where you can choose different degrees.
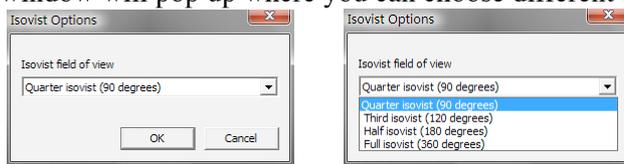
 then click OK. You can choose between 90 degrees,120 degrees, 180 degrees or 360 degrees from the window.

62. Creating isovist paths: Map + new. Choose a map and name it isovist path.
63. Use the "line" icon and draw the route. Then go to tools + visibility + make isovist path
64. Choose the isovist angle you want (90. 120, 180 or 360 degrees)

Drawing convex maps in DepthmapX:

65. File + new
66. Map + import (import the dxf file of a building plan or a local neighbourhood)
67. Set up a new layer by going to Map + new and a new map window will appear.
68. Choose **convex map** as map type, and give your map a specific name. Set the layer to be editable and draw your convex map. You have to check the polygon icon on the map window. Use the left mouse key to identify every single point that defines the boundary. Click on the starting point to finish the polygon.
69. For importing a ready-made convex map, use file + new, map + import, Select new map type to be "convex map"
70. Use the link tool for connecting all the convex spaces with one another.
71. Go to tools + axial/convex/pesh + run graph analyses. Click "include local measures"