Workshop and Lecture:

GENERATIVE SYNTAX IN ARCHITECTURE AND URBAN DESIGN

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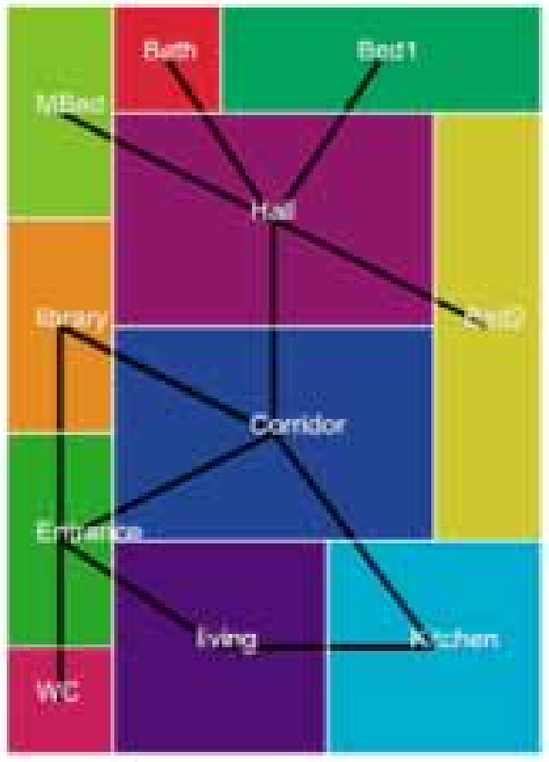
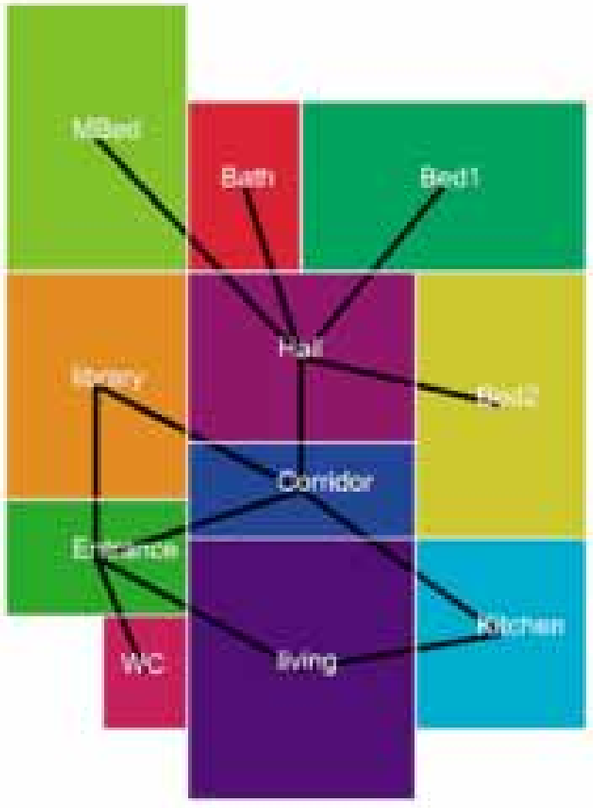
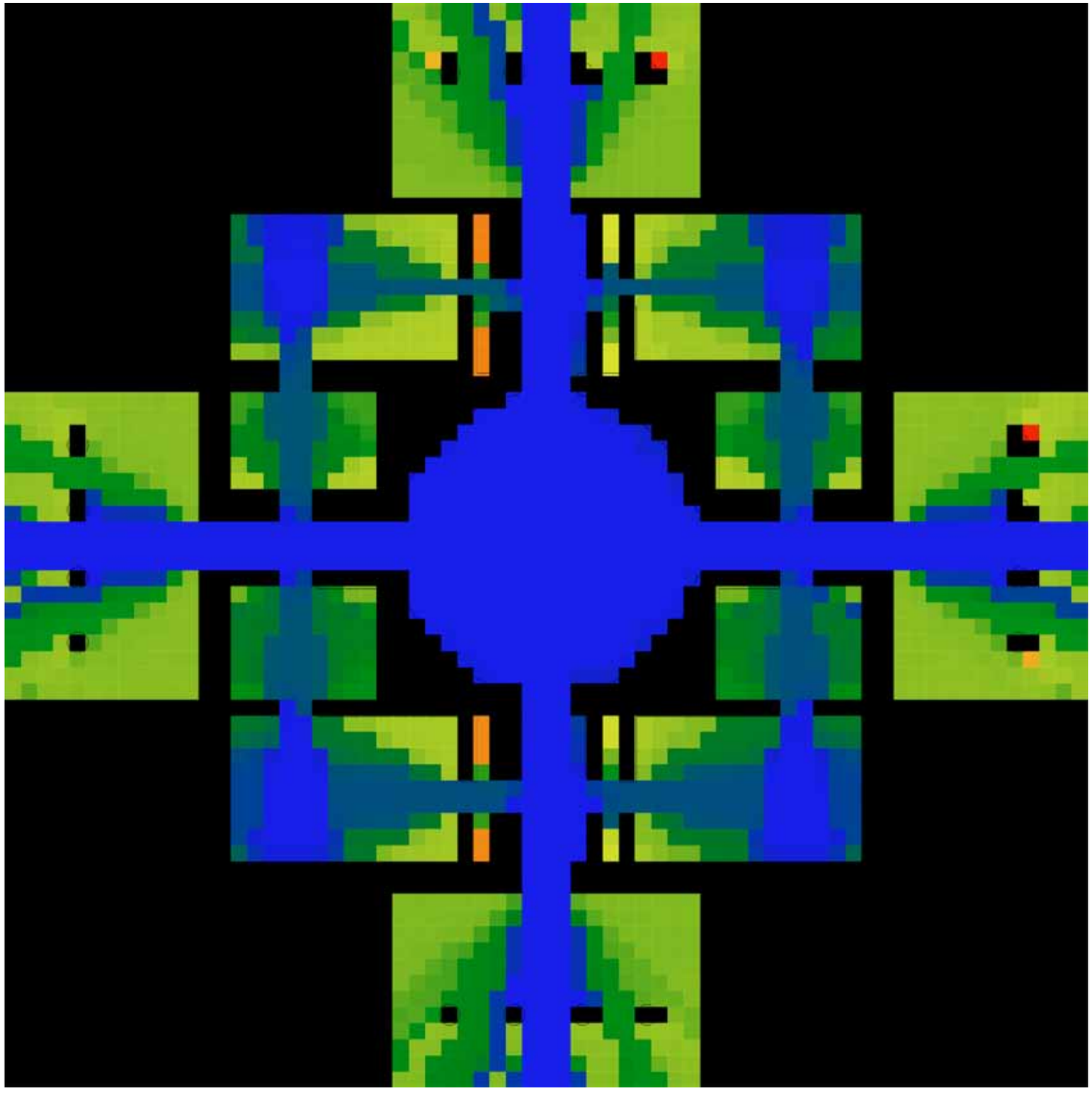
PhD Candidate, Researcher & Instructor @ TU Delft

AAG 2014, UCL, London, September 18-21, 2014: Advances in Architectural Geometry





What to expect



What to expect

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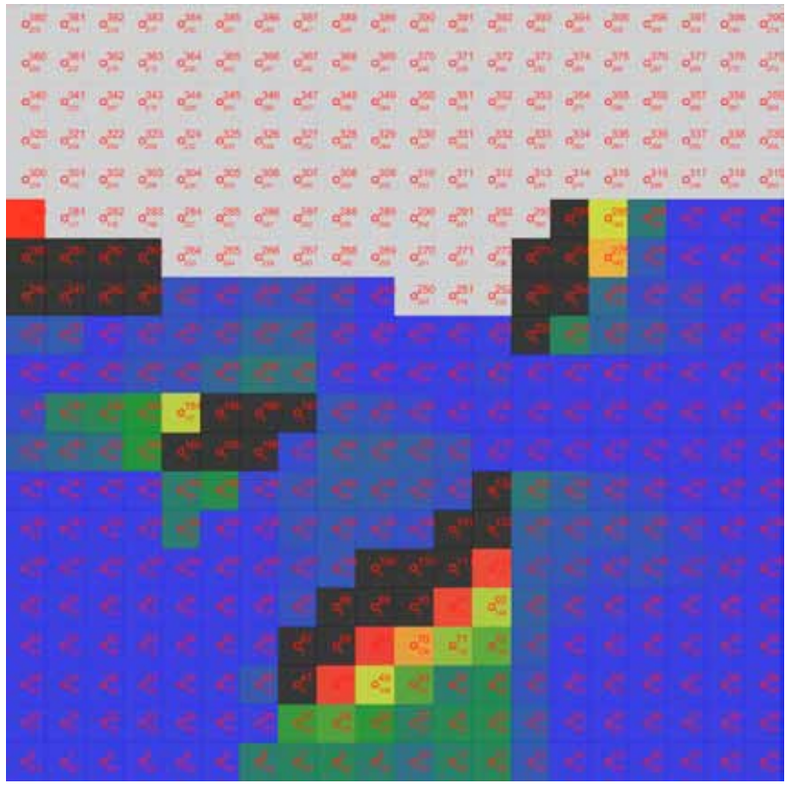
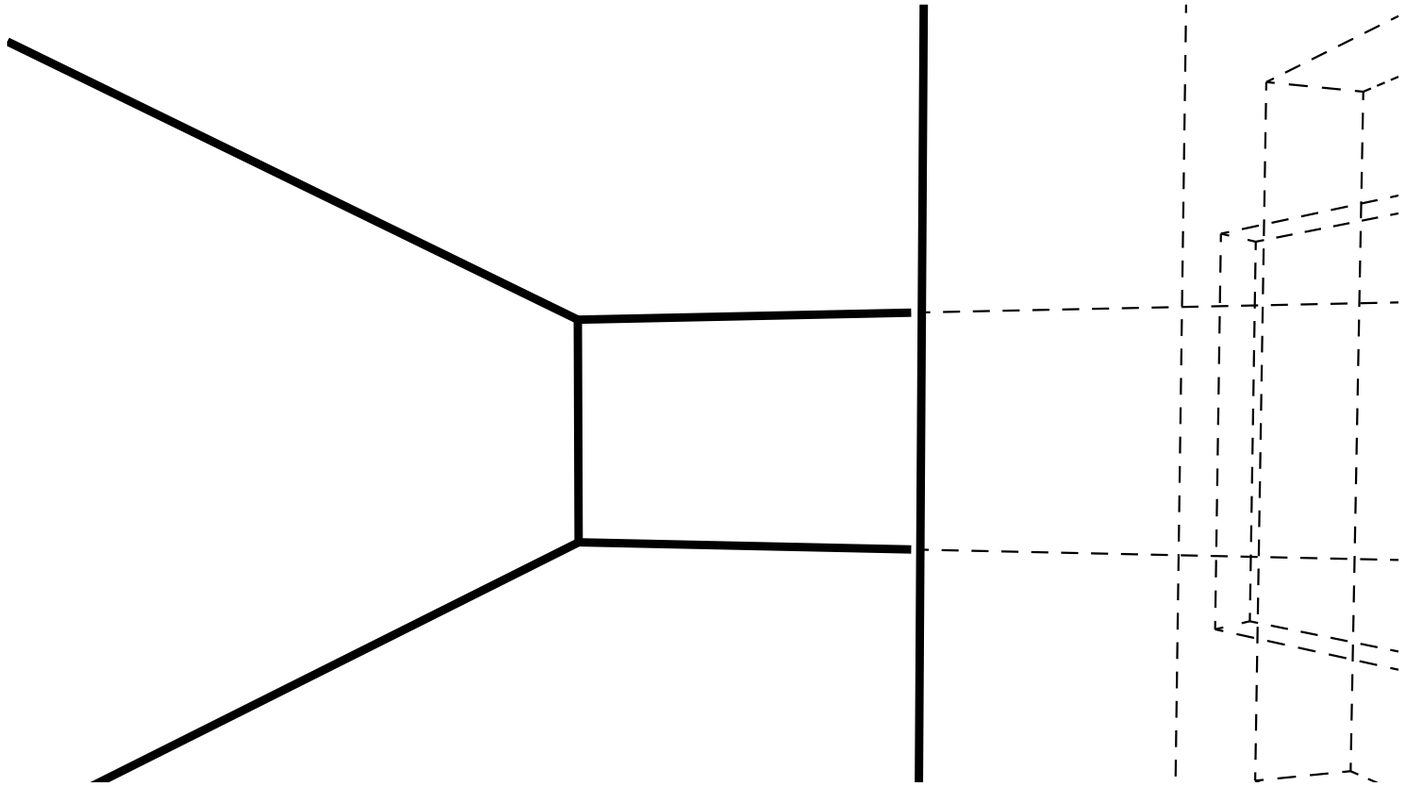
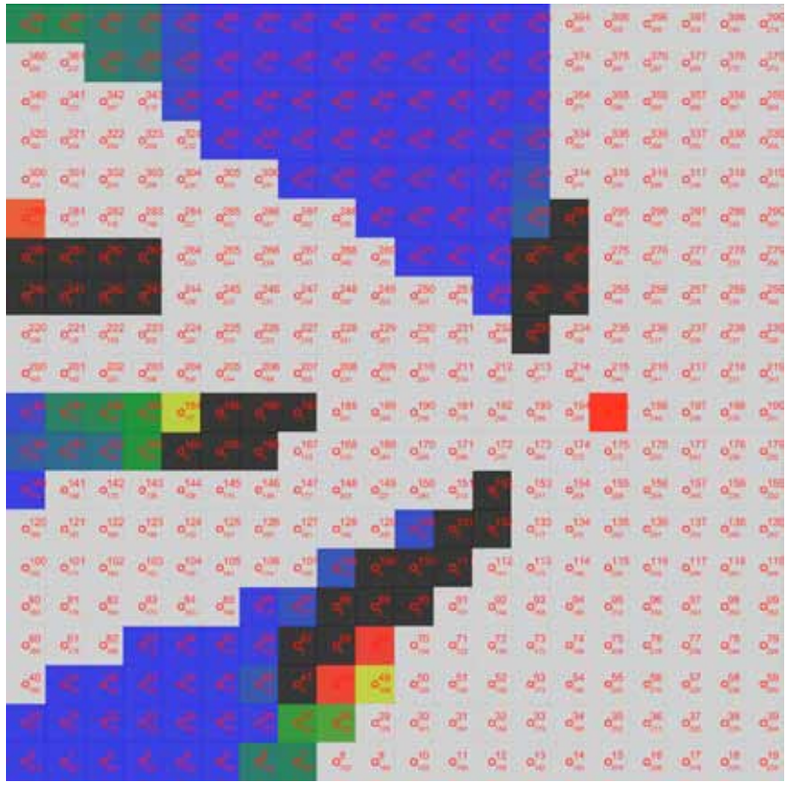
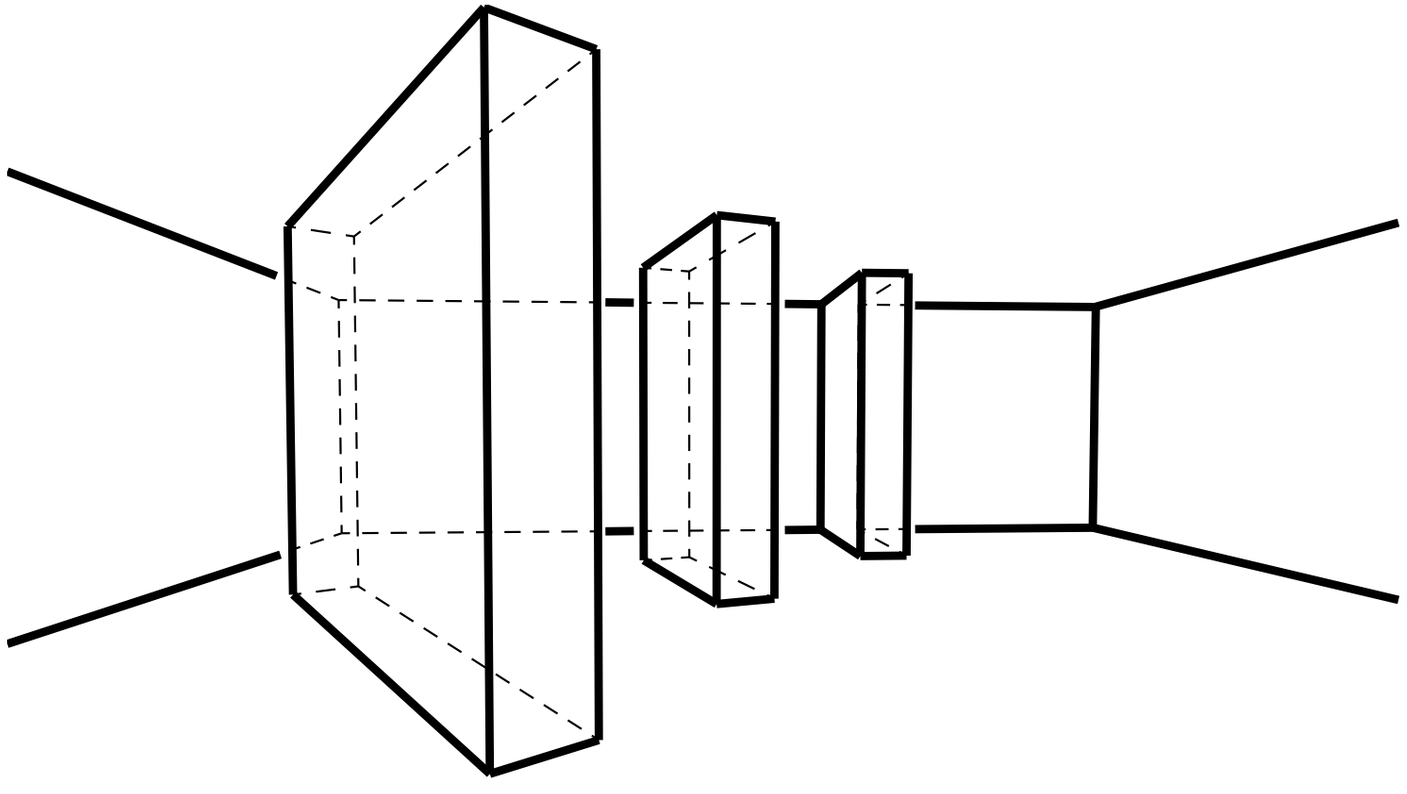
www.tudelft.nl ,www.gbl.tuwien.ac.at









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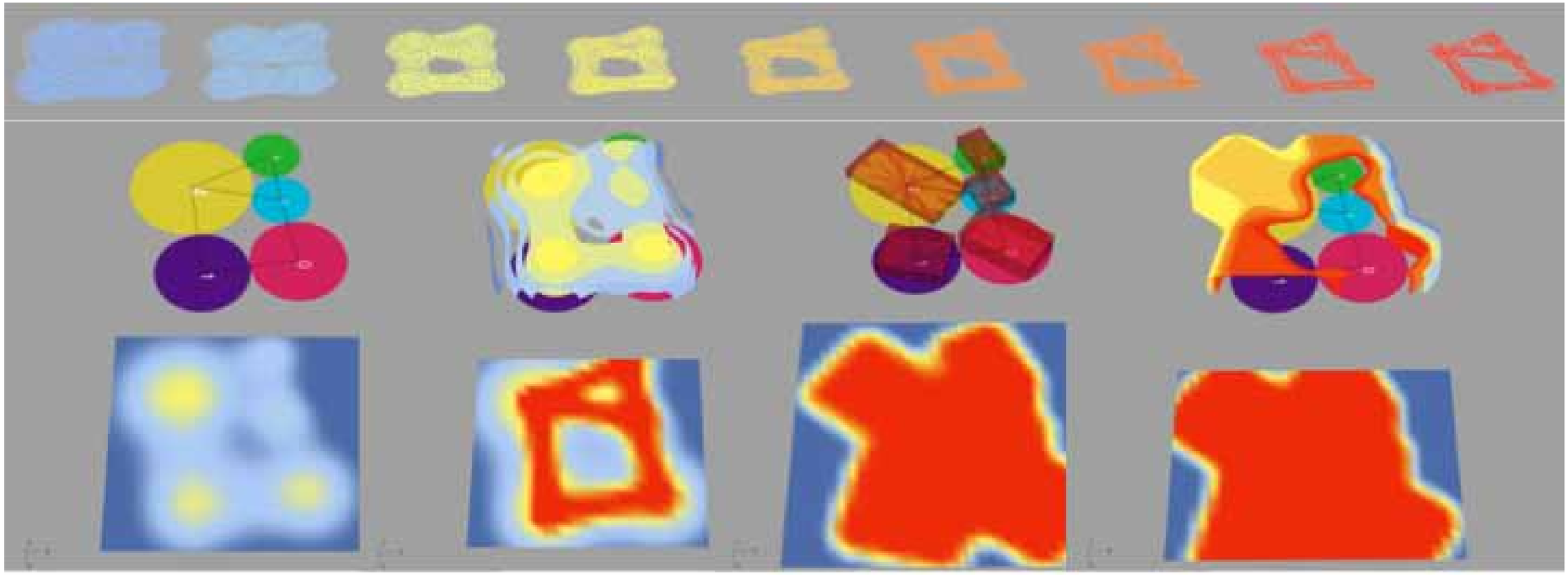

What to expect

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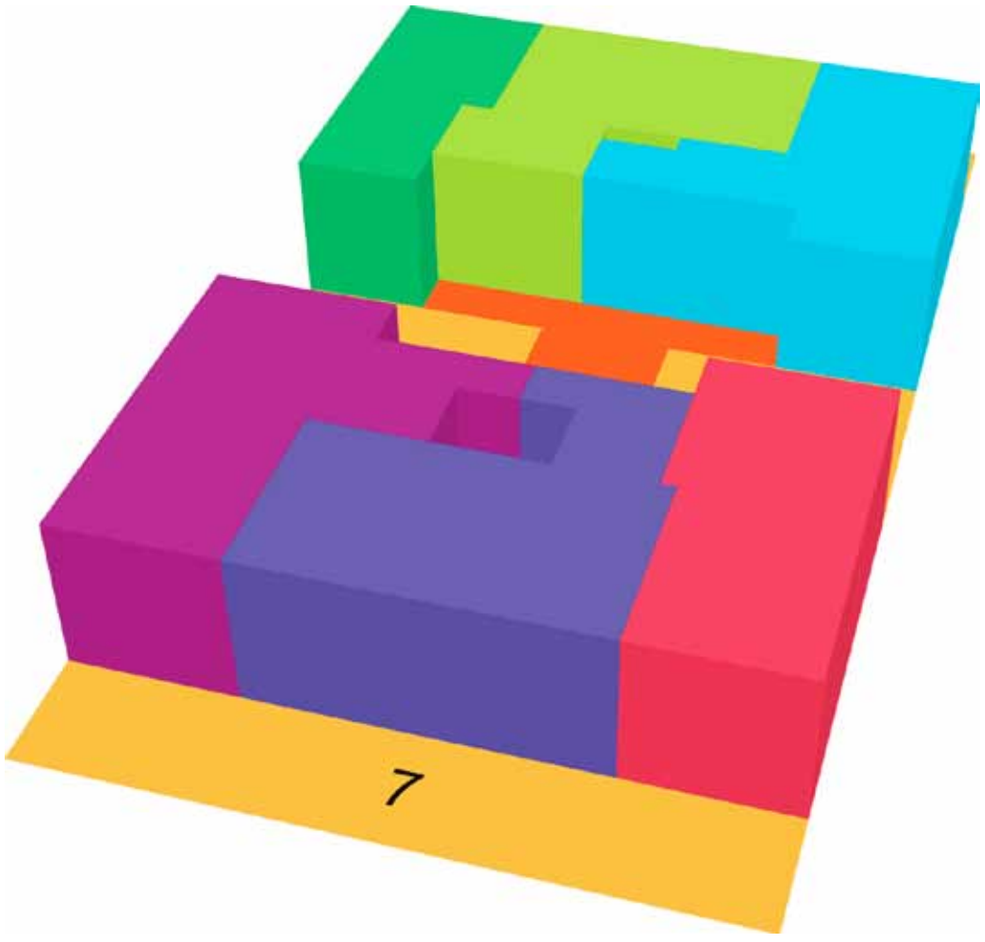
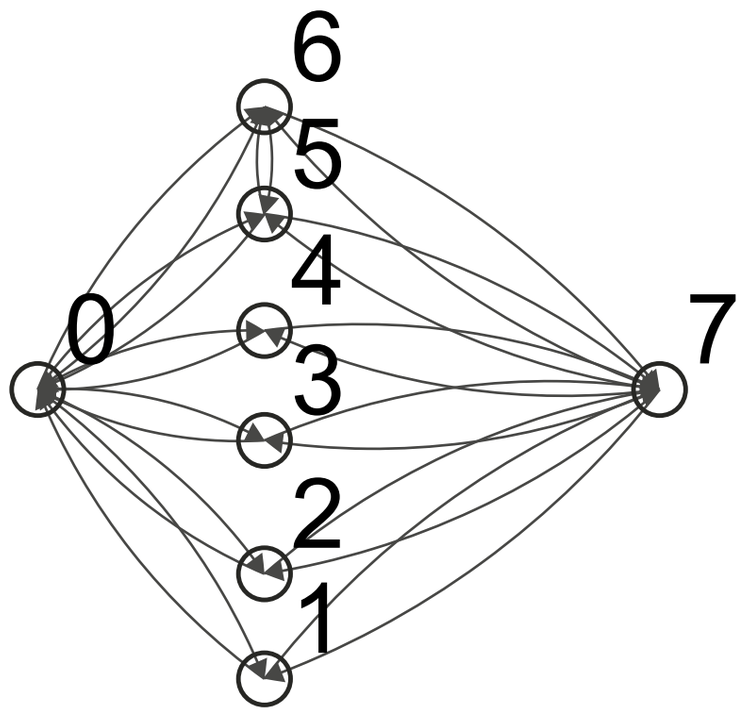




What to expect

Day 1

General Introduction

Initial Design

Analysis of Design

Desinging Bubblediagram

Grasshopper Plugins:
- Syntactic
- SpiderWeb

Day 2

Generative Design Approaches

Timetable

GBL

Forschung: Schule

Forschung: digital

Forschung: Gebäudeanalysen

Scriptum & GH Sample Library

Publikationen

Publikations Datenbank

Konferenz

Workshops

Contact:

https://sites.g...

further contact ...

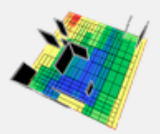
spiderweb
download

aag2012
workshop

aag2014
workshop

space syntax...
sss9

inventing ci...
ecaade2013



longest aver...
example

AAG2014

workshop

ADVANCES IN ARCHITECTURAL GEOMETRY | London, September 18 – 21, 2014

Konferenz: 18-19 September, UCL, London

Workshops: 20-21 September, UCL, London

Generative Syntax in Architecture and Urban Design by Richard Schaffranek (Vienna University of Technology), Pirouz Nourian (TU Delft)

Abstract: There are a few theories that describe and explain the role of spatial arrangement on the social interactions of people in built environments, best known of which is called Space Syntax. The term syntax, taken from linguistics, here refers to the [spatial] structure of the whole, as opposed to morphology, which looks at the qualities of individual items. Using these theories, we can analyze existing spatial configurations and in a way measure their socio-spatial performance. However, theories and methods for systematically generating spatial arrangements of certain properties are rare or not put into practice. Combining analytic theories (mostly based on graph theory) with the generation of geometry is at the core of the workshop. In this workshop, we will introduce computational methodologies that can help in generating spaces with known syntactic properties. Three toolkits and methodologies will be introduced: SpiderWeb, Syntactic and Configurbanist.

Workshop Files:

Grasshopper Plugins (preview):

Syntacitc
SpiderWeb

Grasshopper Examples:

Syntacitc
SpiderWeb

Presentation:

Presentation

Contact:

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TU Delft / Faculty of Architecture and the Built Environment
• Dep. AE+T/Design Informatics
• Dep. OTB/GIS technology
• Dep. Urbanism/Urban Design

Room 01+.West .020
Julianalaan 134, 2628 BL Delft,
PO Box 5043, 2600 GA Delft,
The Netherlands

Workshop resources

http://www.gbl.tuwien.ac.at/Archiv/digital.html?name=AAG2014

The Academic Interchange should provide and support the following functions:

- meeting place/s for members of the university and neighboring university technology park, international guests, business community and local dignitaries, alumni, friends and sponsors of the university;

- informal and formal meeting space/s and spaces for, ‘working lunches’/ dinners, receptions and press conferences;

- rooms for workshops, alumni fairs and professional training courses;

- graduation ceremony receptions and small exhibitions;

- chamber music/small musical performances;

- ‘incubator’ for internationalization efforts of the university;

- residential accommodation for the short- and medium-term stay of guest researchers/lecturers;

- business center for meetings to introduce scientists and the business community;

- overall, a socializing/mixing place for people from different backgrounds;

- to make university life more active and personal by extending activities and outreach into evening and weekends.

List of rooms & functions:

- faculty club - a catered restaurant/bar for faculty members and international researchers (sits 60) – doubles as canteen for house guests; bar should be usable even outside restaurant hours

- apartments for guest researchers (10 double rooms; 3 family suites (two bedroom, kitchen, living room)

- meeting and conference rooms (3 rooms of 20 people; 1 of 100 people (multifunctional for exhibitions, reception, chamber concerts))

- business hub (with hot-desking, printers etc. for 20 people; plus smaller meeting rooms for at least 5 groups of 2-6 people per group)

- administrative offices (10 for 2-3 people each)

- reception area

- visitor information center (for non-university visitors)

- The overall target area is 3000m2 and this has been calculated assuming ca. 23% (700m2) circulation and ancillary functions.

Site boundary:

- The site is 30 * 40 meters and can be accesses from a long and a short side.

Syntactic

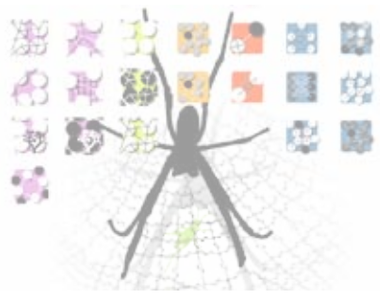
SpiderWeb Plugin

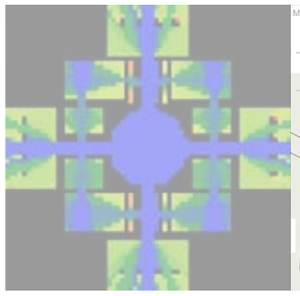
Visual Graphs

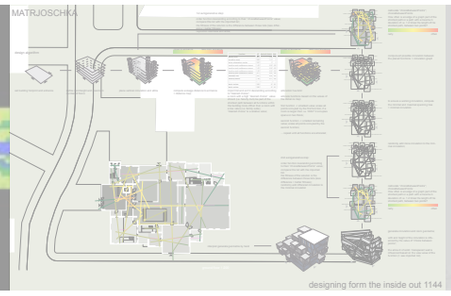
Metaheuristic Solvers

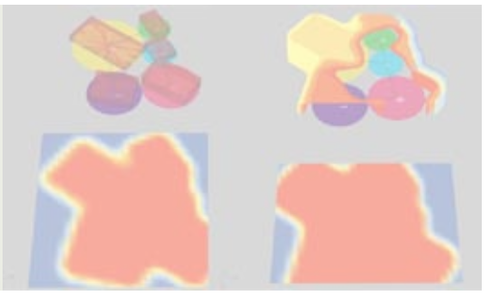
Field to Space

Parallel Planing



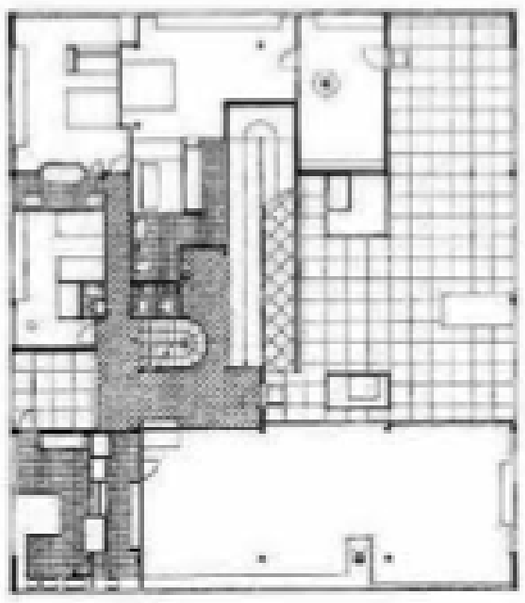






Design as Spatial Configuration

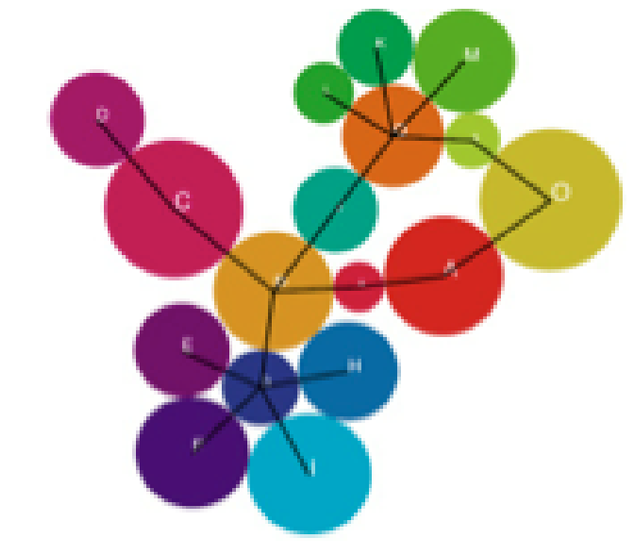
Configuration: the particular way, in which spaces are linked to each other in a building or a built environment



Villa Savoye Le Corbusier & Pierre Jeanneret

Spatial Configuration is an Intellectual Activity!

reverse?



A bubble diagram of Villa Savoye

- *Any meaningful set has something more than all of its items.*
- *A certain configuration 'reflects and affects' social interactions within a built environment.*
- *Main Question: How do we design a plan to embody a spatial configuration?*
- *Remember there is no such a thing as an automated design process!!!*

A Spectrum of Privacy to Community

Can you make an ordered list of spaces as to their intended privacy/community level? Something like:

entrance-toilet-living-kitchen-bedrooms-bathroom

How would you connect them to one another to achieve this (as in a bubble diagram)?

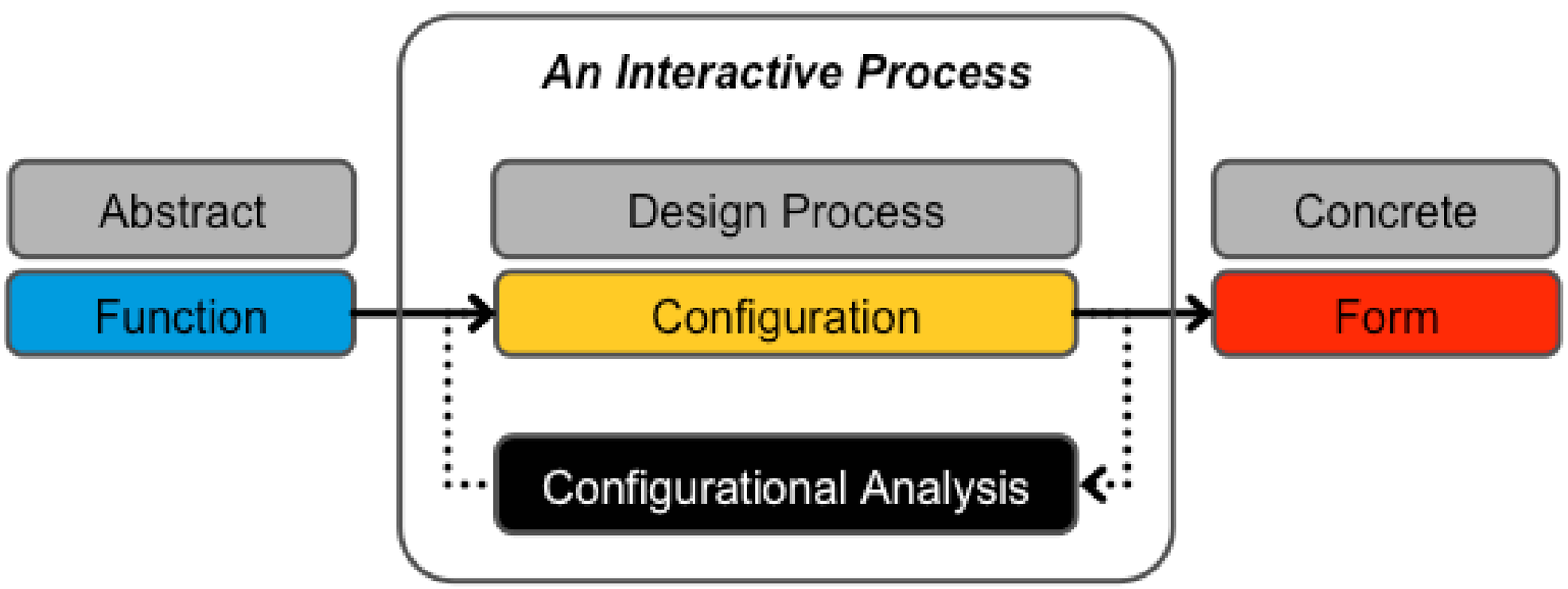
You can distinguish between (wanted/unwanted) spatial connectivity and adjacency links.

You would probably avoid connecting a kitchen to a bath room but you might put them next to each other for technical reasons, practically it will be good for them to share a wall, so that pipes can be brought to both efficiently. Right?

A Syntactic Design Process

How to design a plan with a particular spatial configuration?

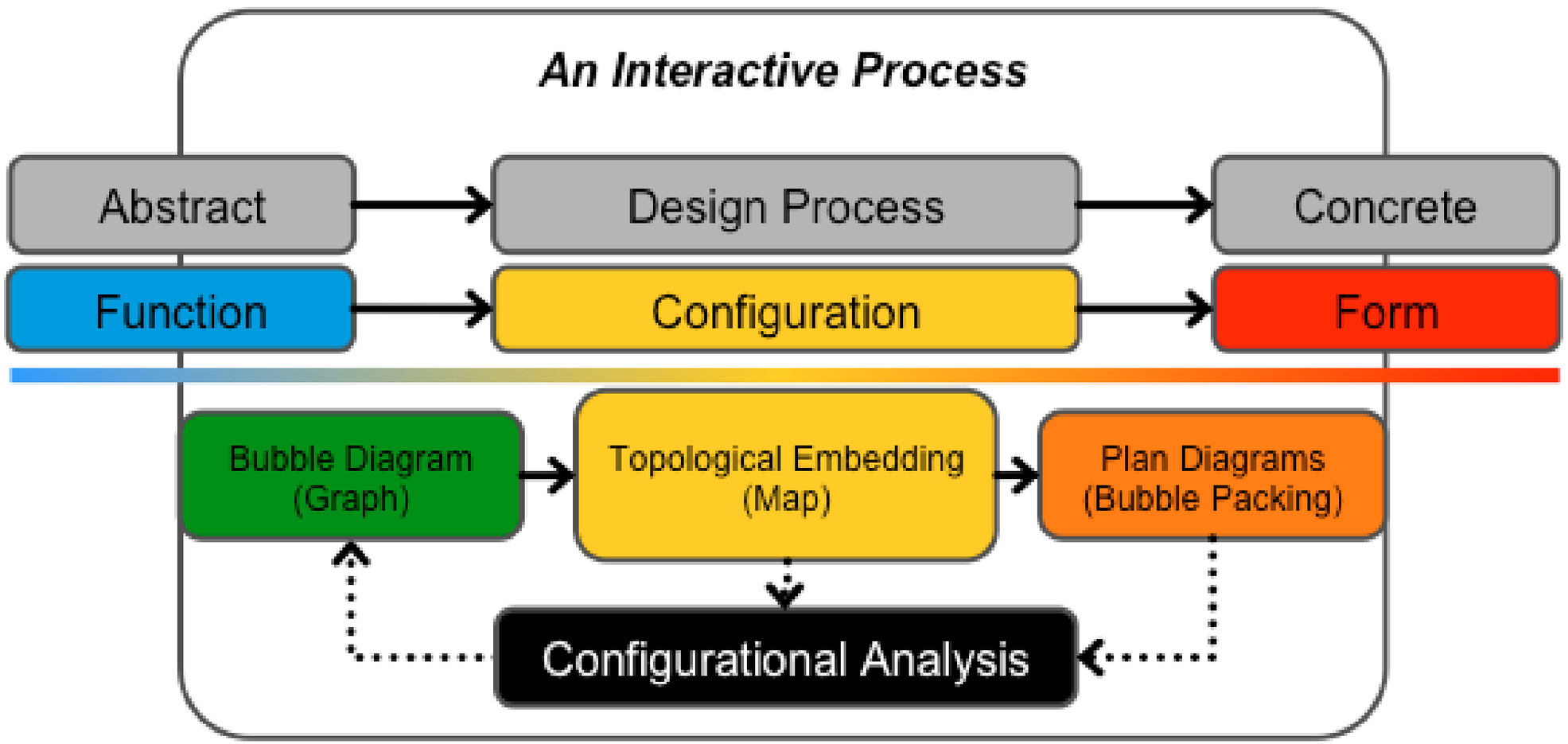
- *An abstract graph may correspond to many concrete plan layouts!*
- *A spatial configuration can be analyzed in terms of its social implications*
- *Configurations are in-between the abstract domain of functions and the concrete domain of forms*



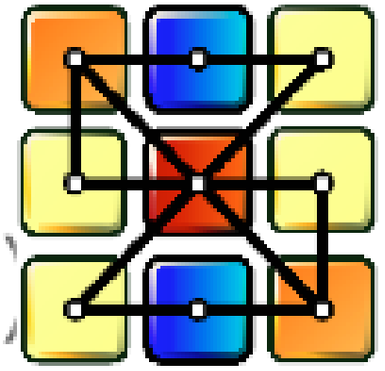
A Syntactic Design Process

How to design a plan with a particular spatial configuration?

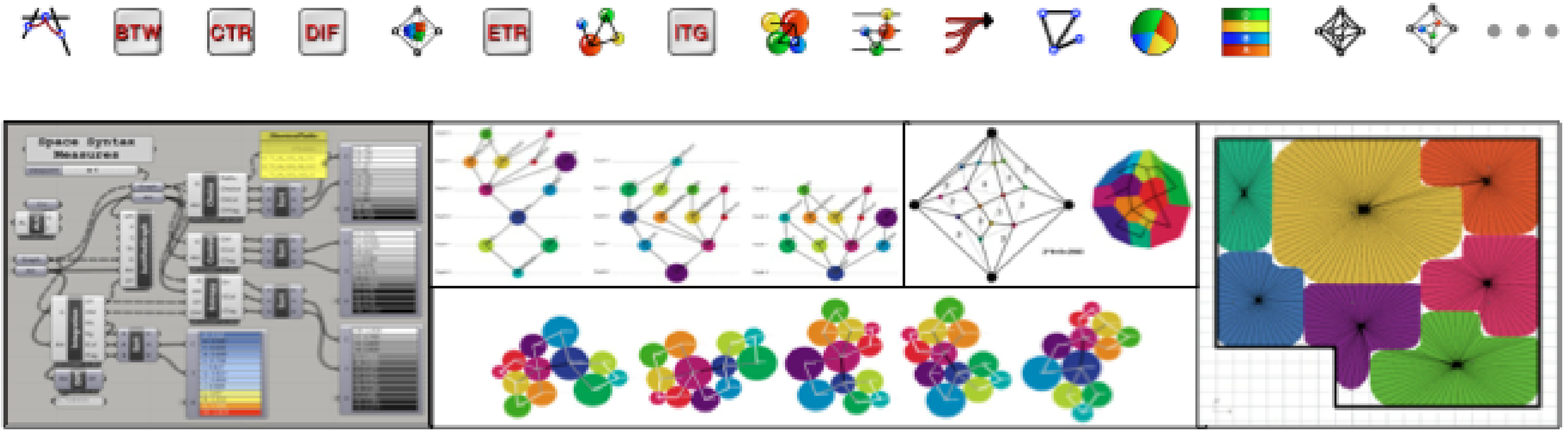
More specifically:



SYNTACTIC
(Space Syntax for Generative Design)

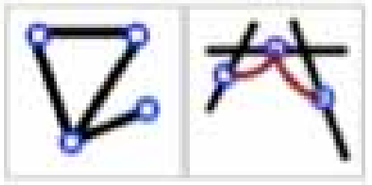


- real-time Space Syntax analyses for parametric design
- interactive bubble diagram
- automated graph drawing algorithms
- enumeration of plan configuration topologies
- measuring the socio-spatial performance

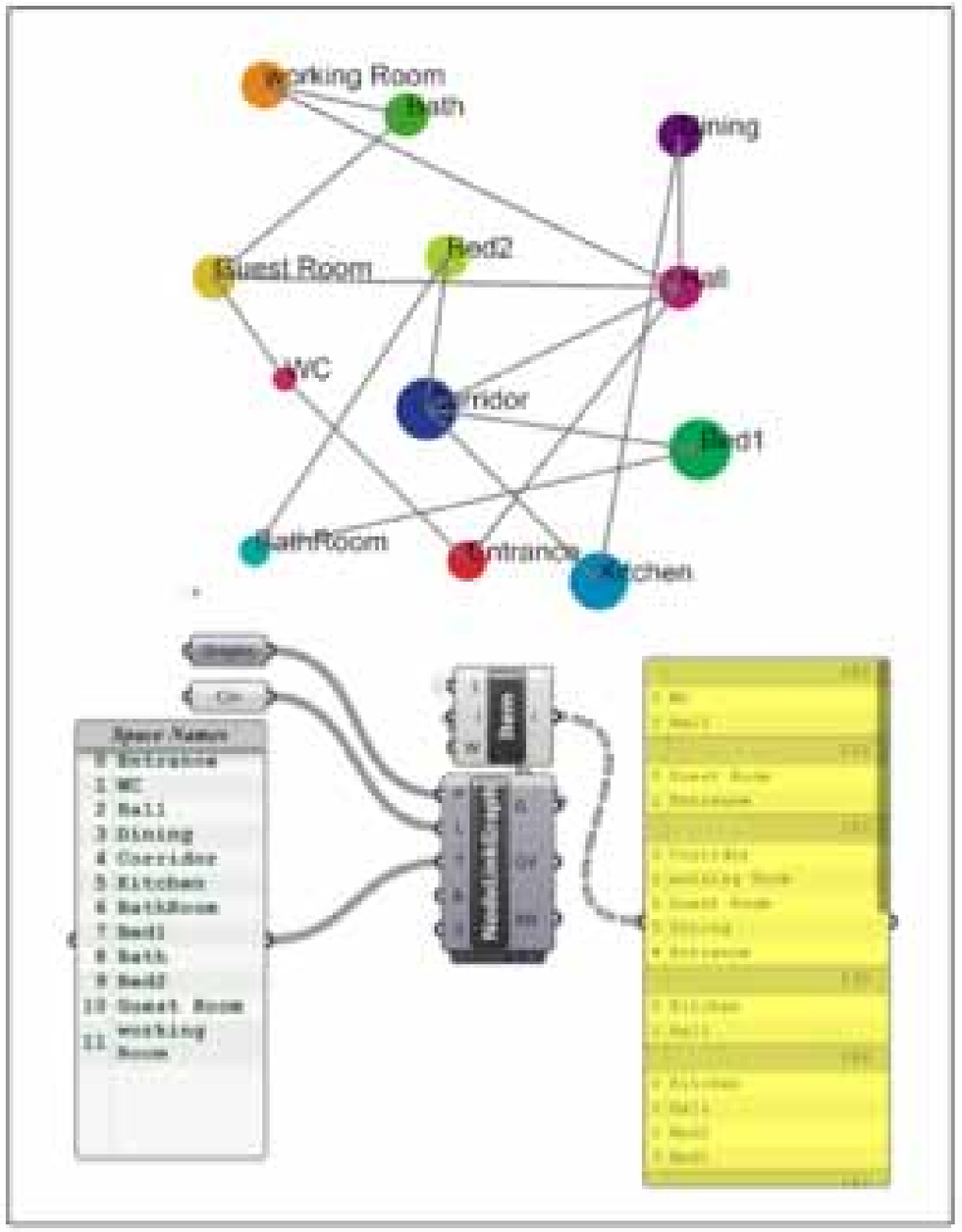


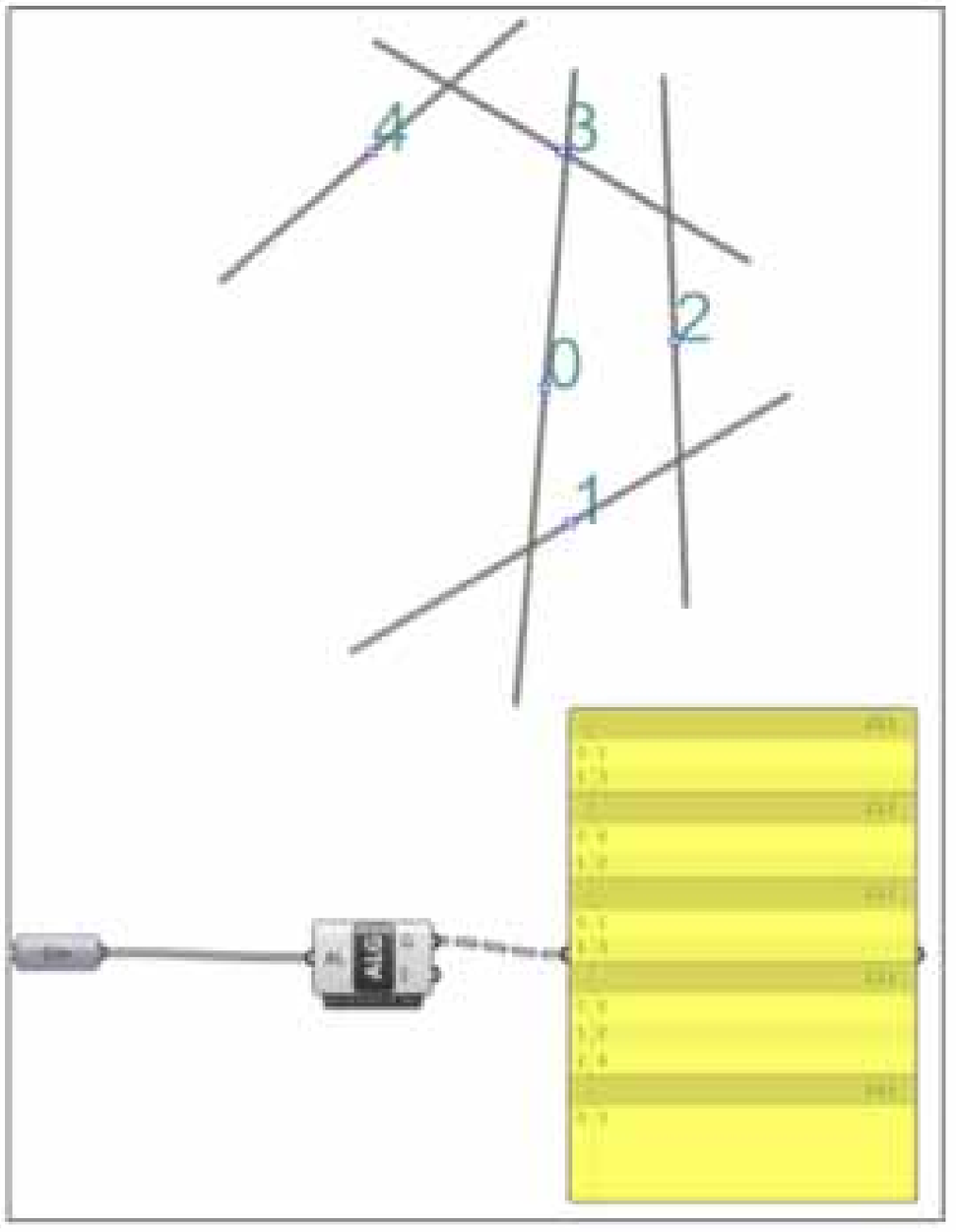
www.grasshopper3d.com/group/space-syntax
https://sites.google.com/site/pirouznourian/syntactic-design

Graph Representation



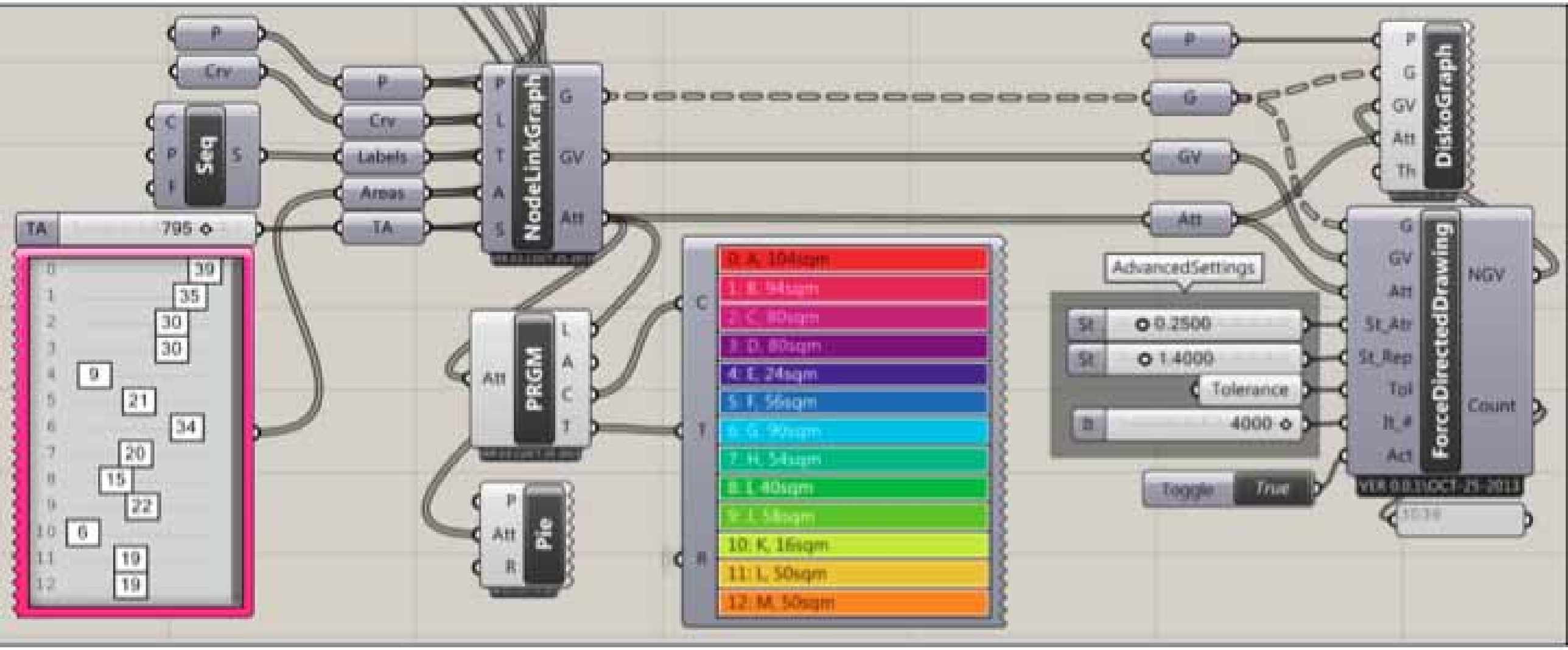
Which Spaces (Points/Axial-Lines) are connected to which others?





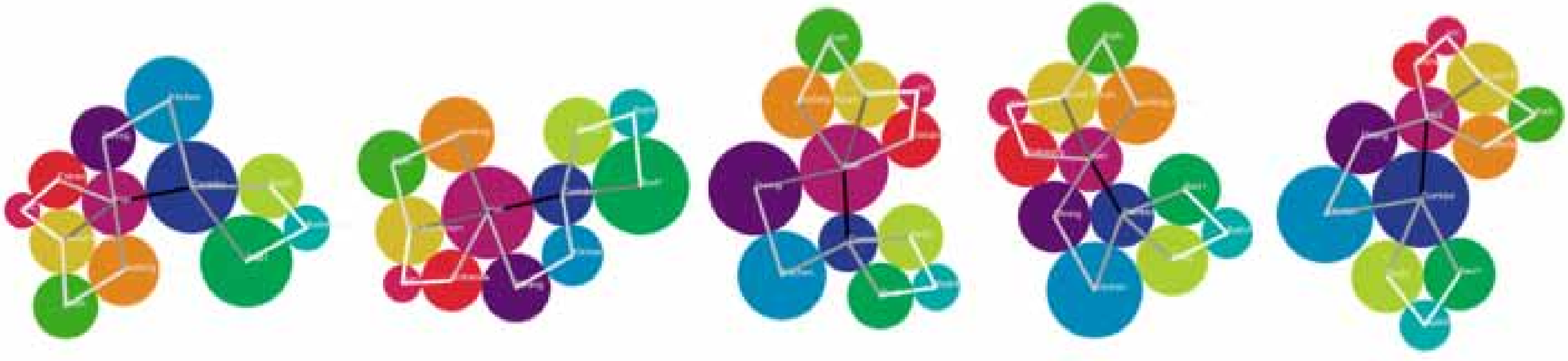
Graph Formation Tools in Action

A node-link graph builder + a force-directed graph drawing algorithm



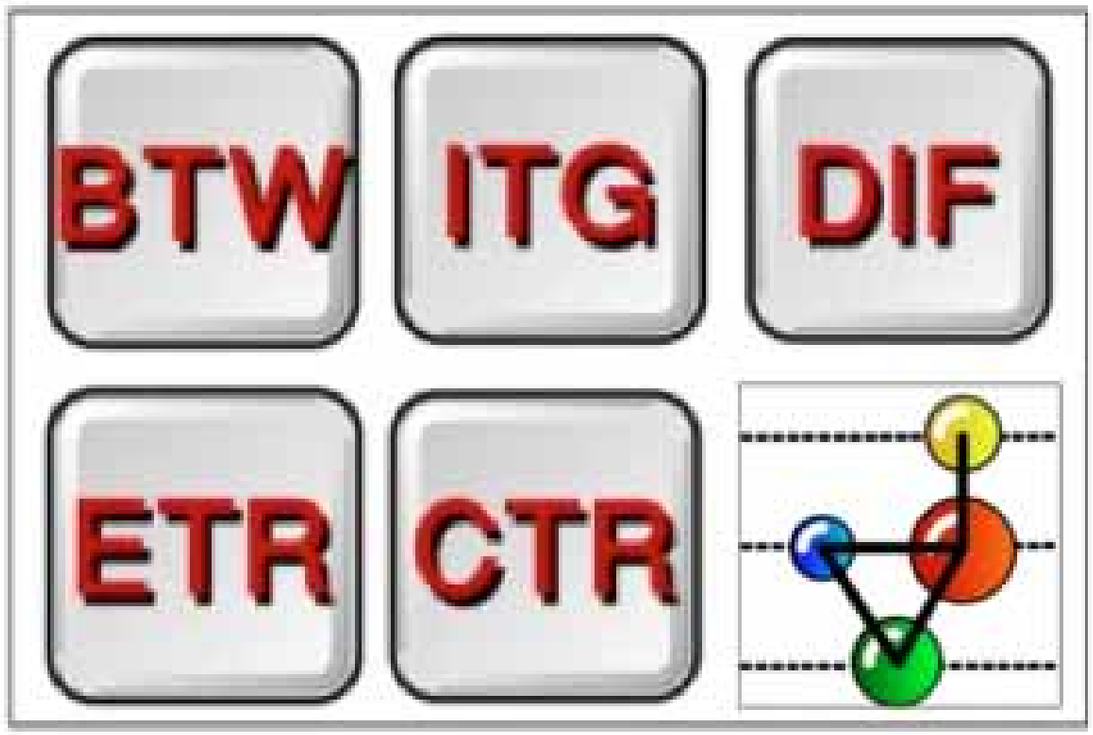
Interactive Bubble Diagrams

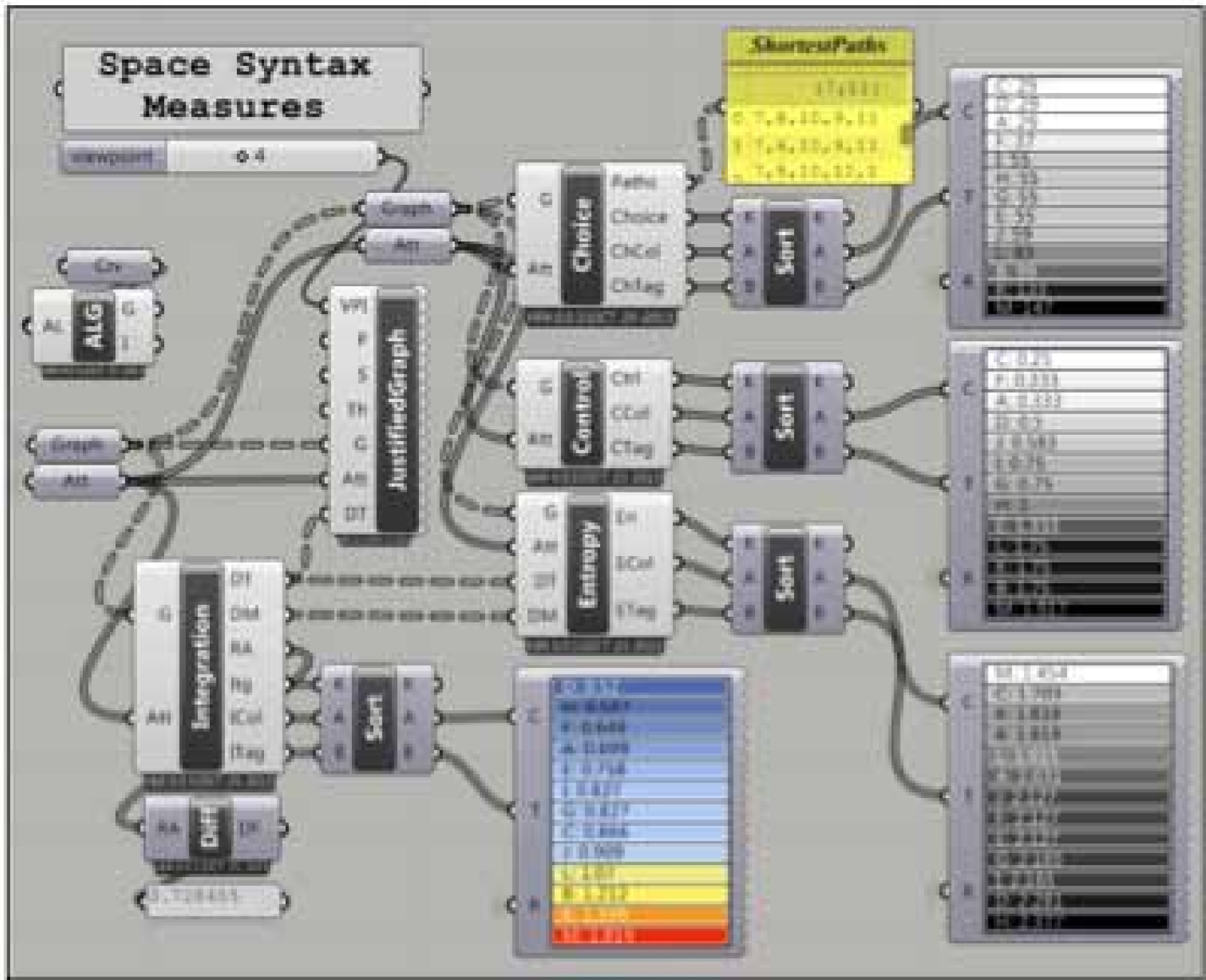
- The force-directed algorithm makes a neat drawing and lets the designer to focus purely on syntactic issues.
- Changing the configuration or the required spatial sizes the diagram updates accordingly.



Real-Time Space Syntax Analysis

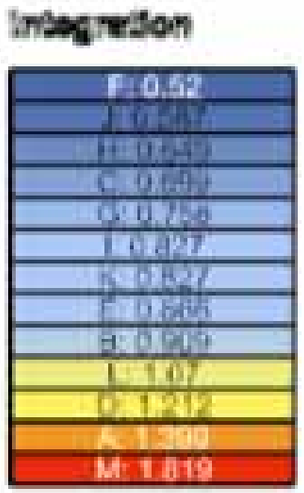
For letting the users know what are the social/spatial implications of their configurative ideas

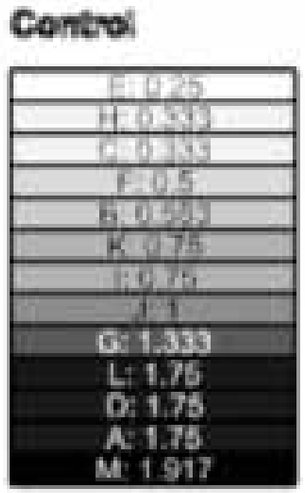


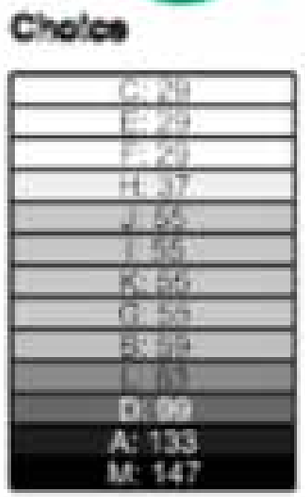


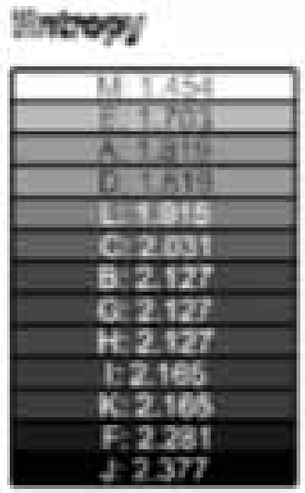
Augmented Bubble Diagrams

For letting the users know what are the social/spatial implications of their configurative ideas

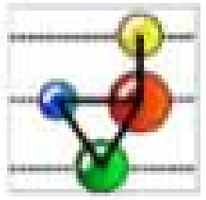




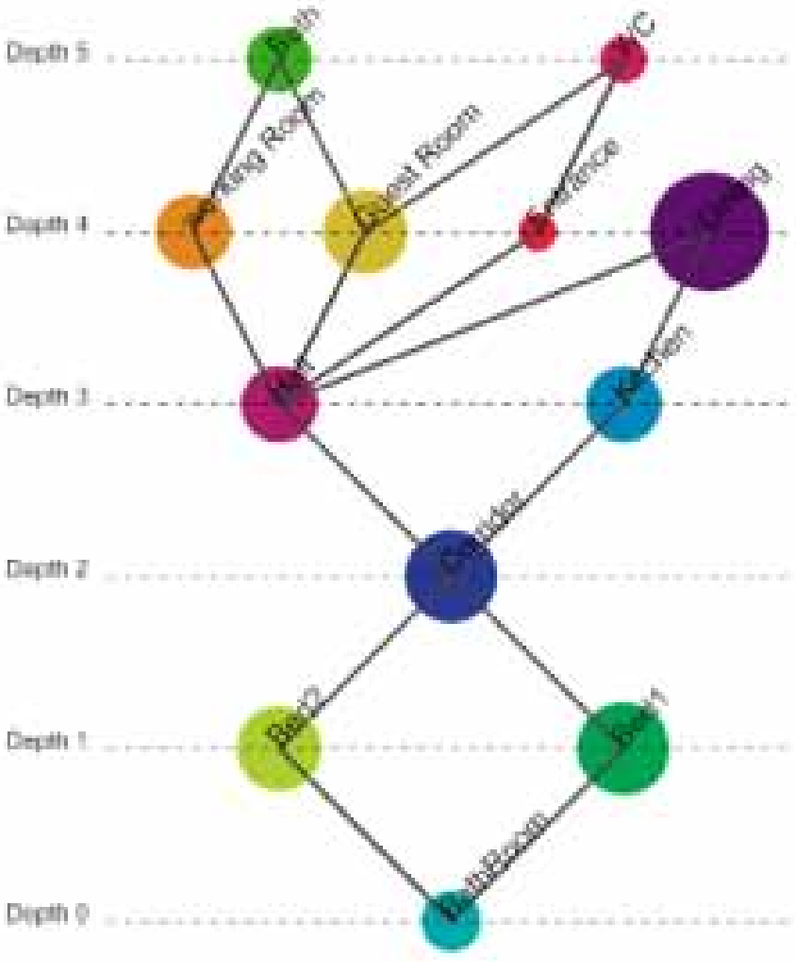


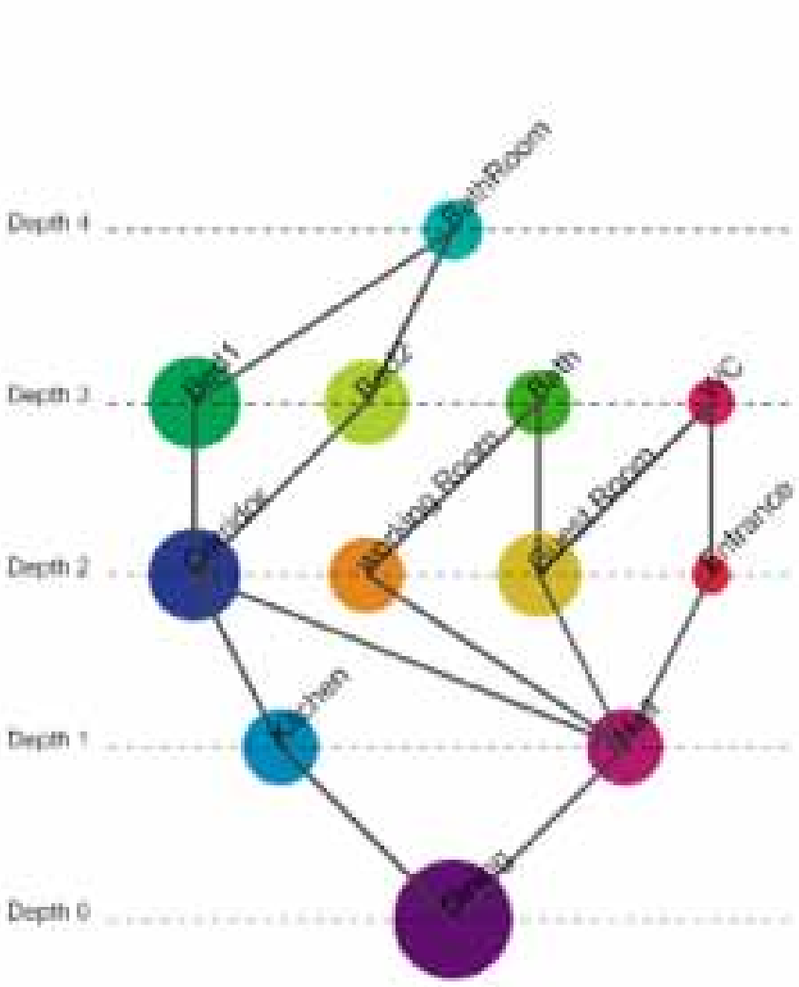


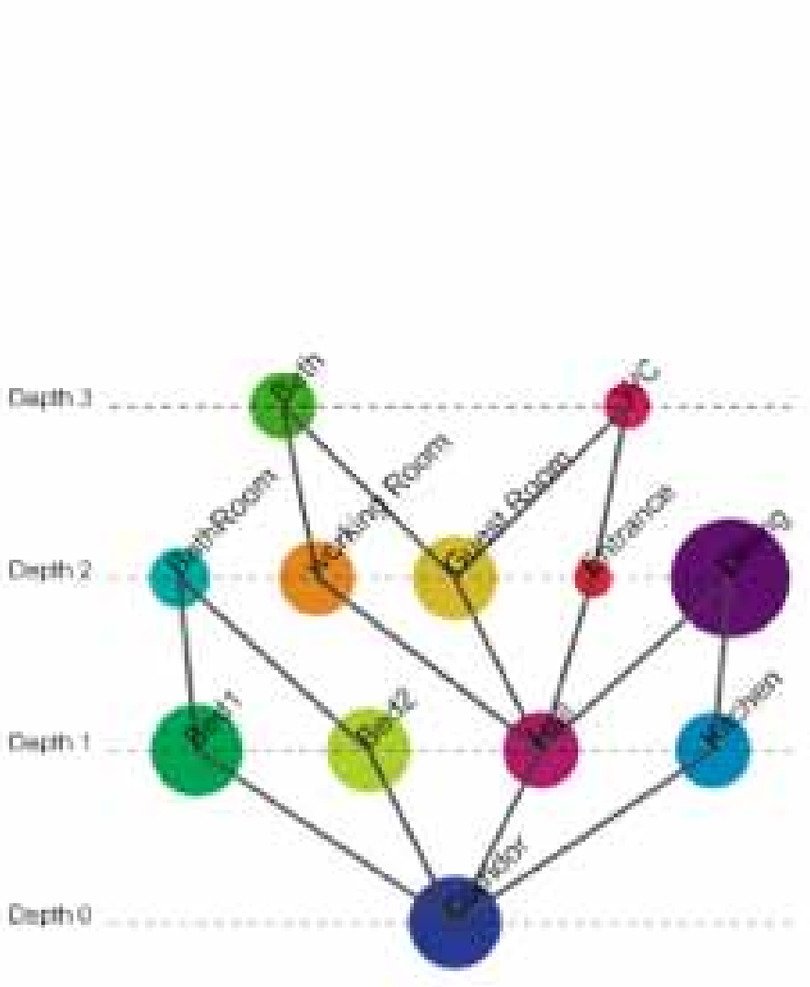
Justified Graphs



Justified graphs show the configuration from different points of views topologically: user chooses a point of view







TWO INDICATORS OF PRIVACY AND COMMUNITY

- Integration (Close-ness Centrality)
- Choice (Between-ness Centrality)

Integration *(Hillier and Hanson, 1984) is a measure of centrality that indicates how likely it is for a space to be private or communal. The more integrated a space, the shallower it is to all other nodes in a configuration. Intuitively shows how likely it is for people to* ***move to*** *a space. Integration is calculated by computing the total depth of a node when the depths of all other nodes are projected on it.*

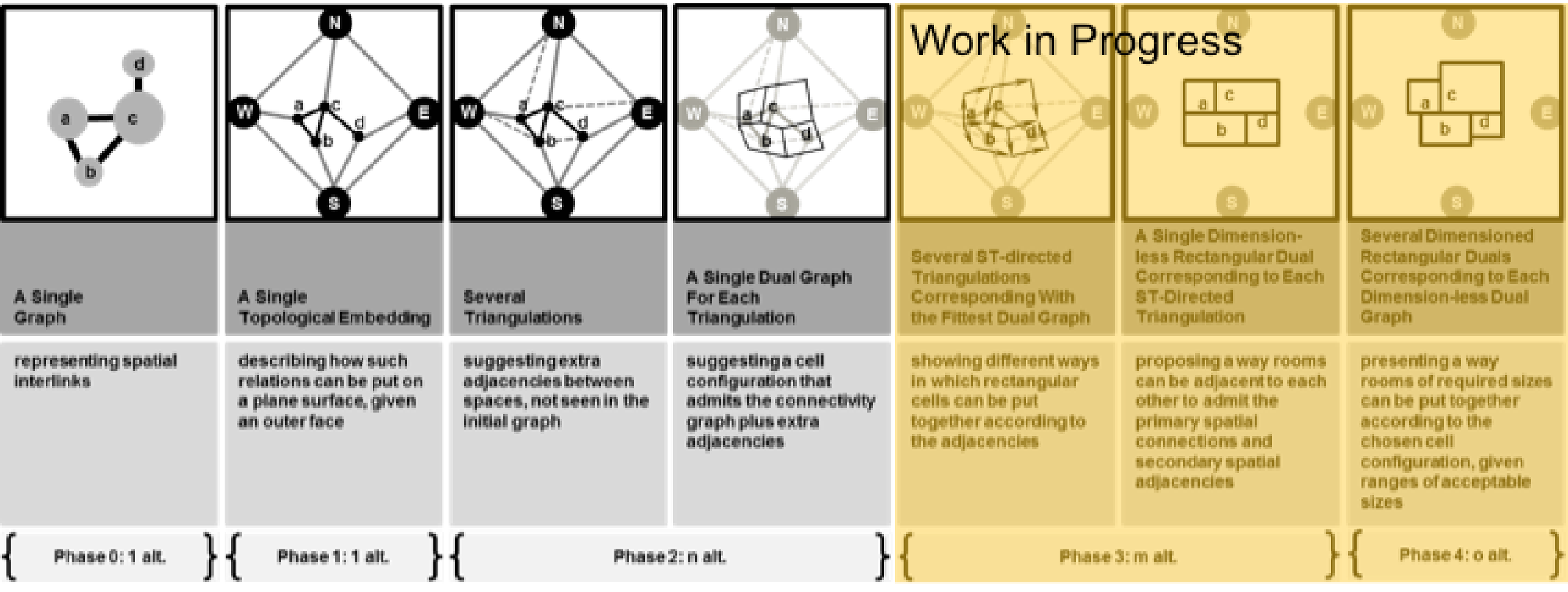
Choice *(Originally introduced as Betweenness by Freeman (Freeman, 1977))*
Choice or Betweenness is a measure of centrality for nodes within a configuration as to its role in shortest paths. Intuitively shows how likely it is for people to ***move through*** *a space. That literally tells how many times a node happens to be in the shortest paths between all other nodes. It can also be computed for the links connecting the nodes in a similar way.*

Now, can you re-look at your designed configuration and see if it matches your intentions in terms of privacy/community levels?

A SYNTACTIC DESIGN PROCESS

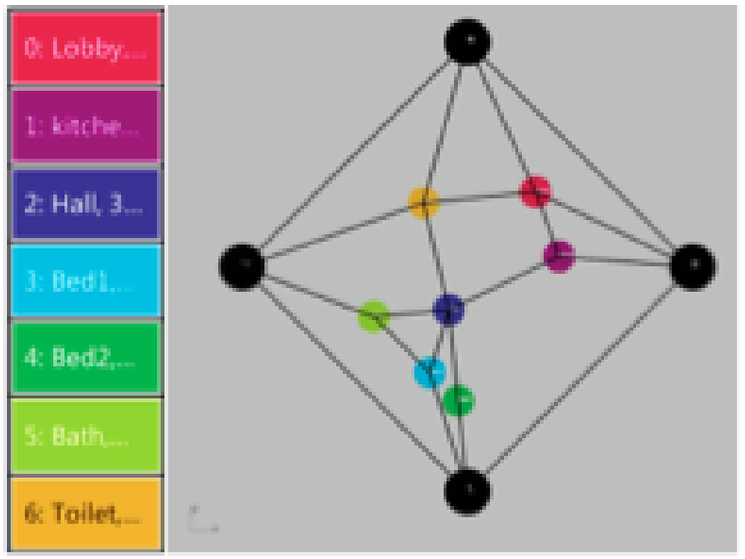
Graph to Map to Plan (after March & Steadman):

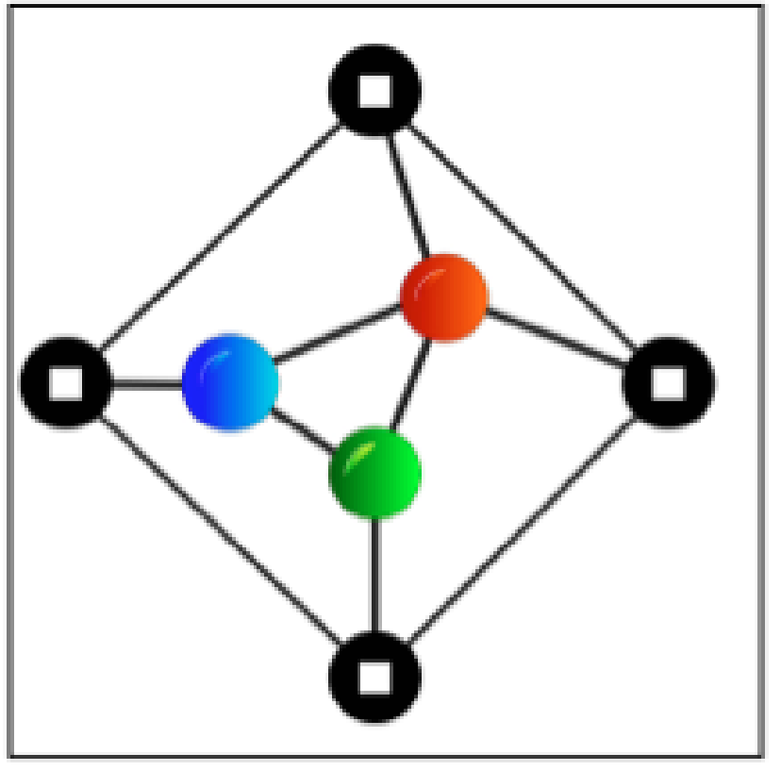
How many alternatives are out there?



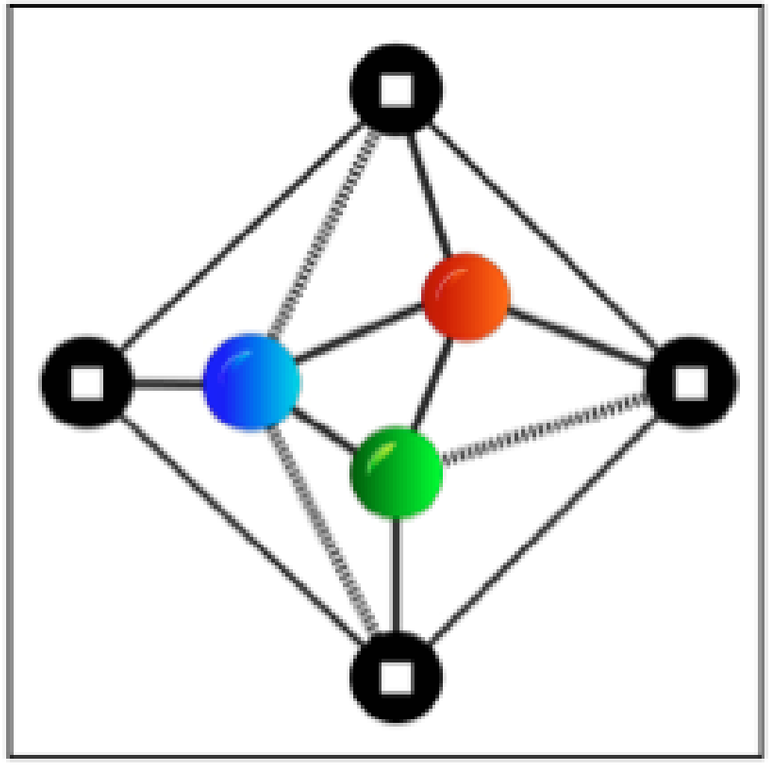
design space expanding from one 'graph-ic' possibility to, one planar topologic possibility to $n \times m \times o$ geometric possibilities

The Generative Process

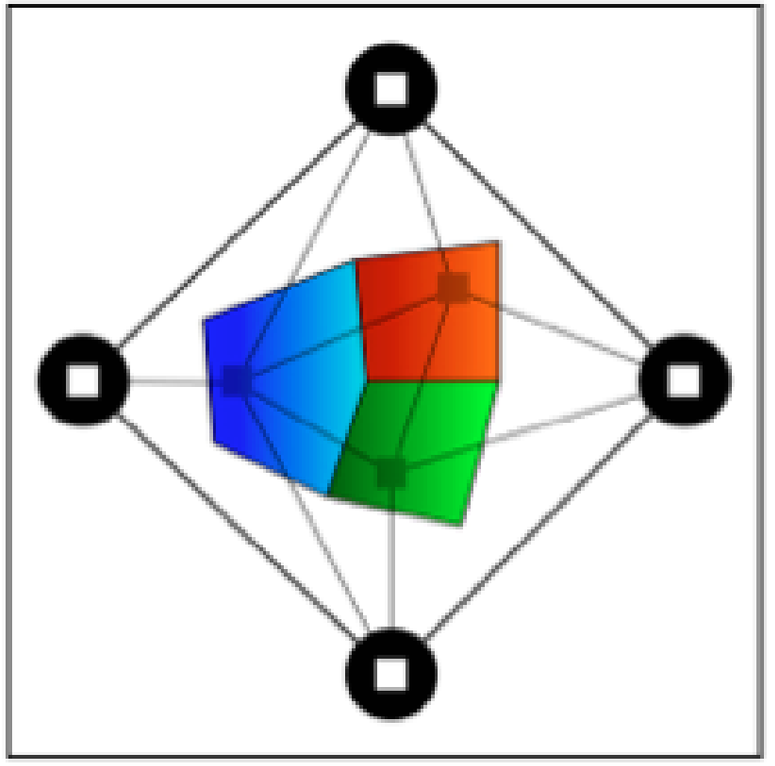




Tutte Convex Drawing



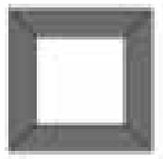
Triangulation

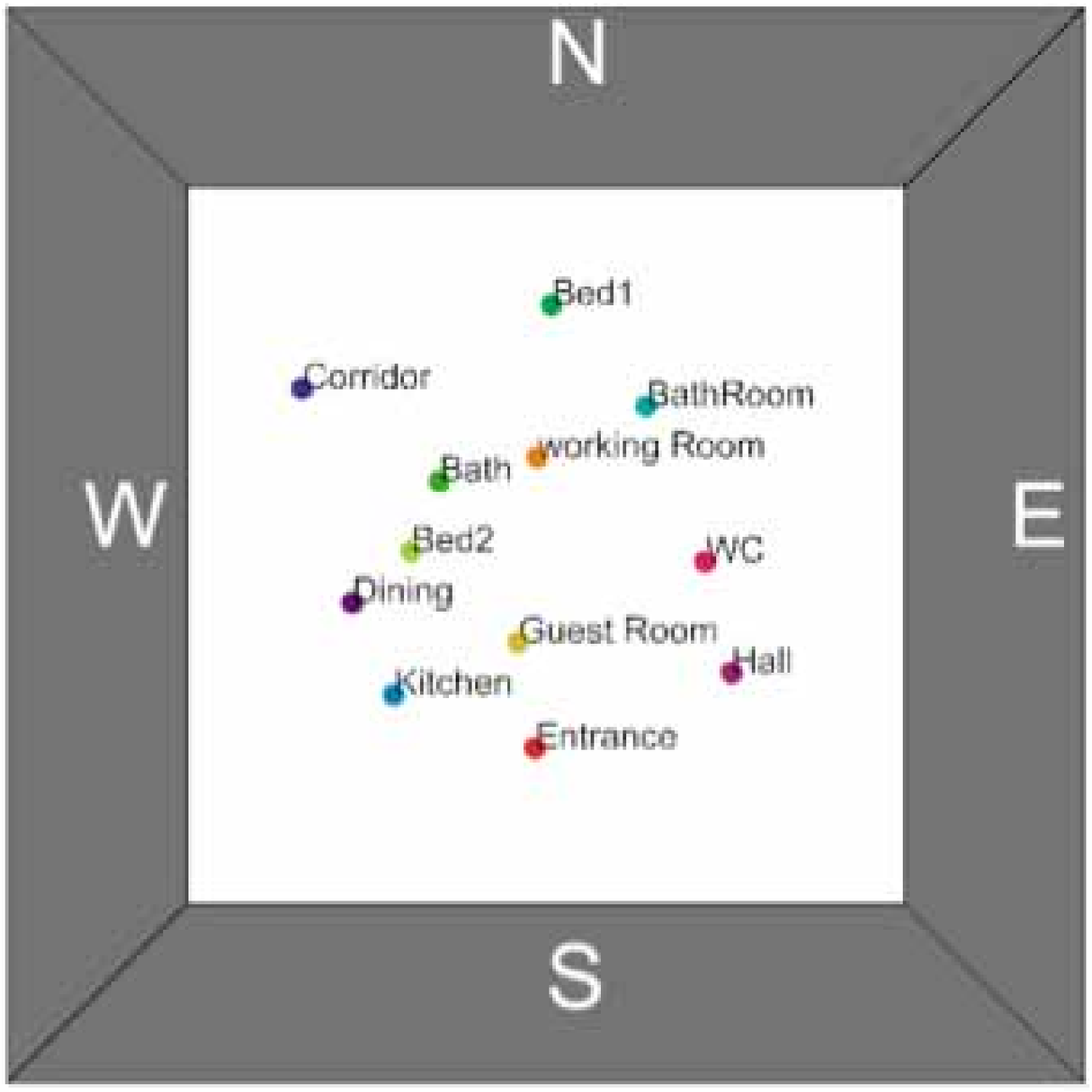


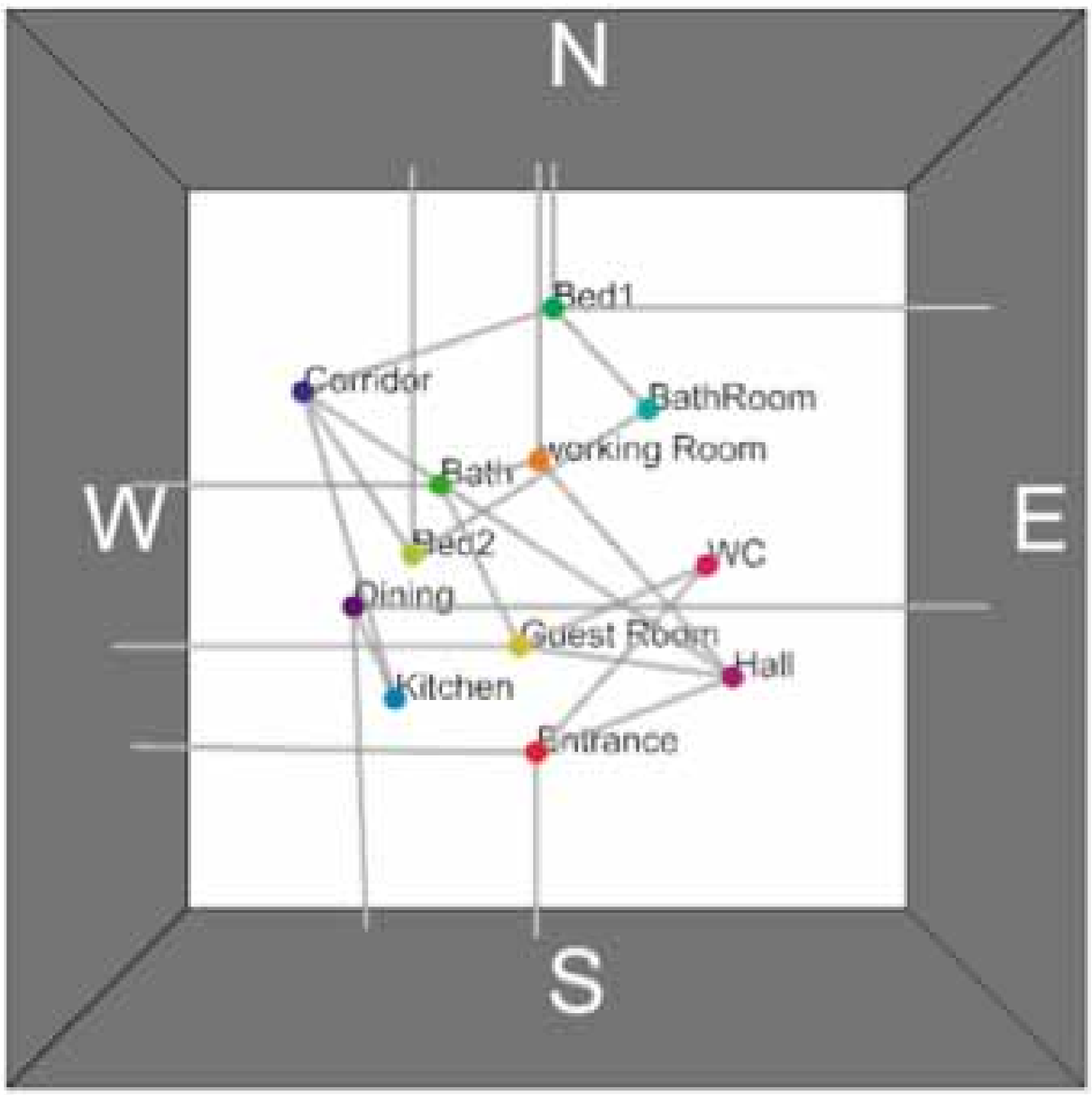
Dual Graph

Proposing Configurative Ideas

The sketchpad made by the NEWS Graph component

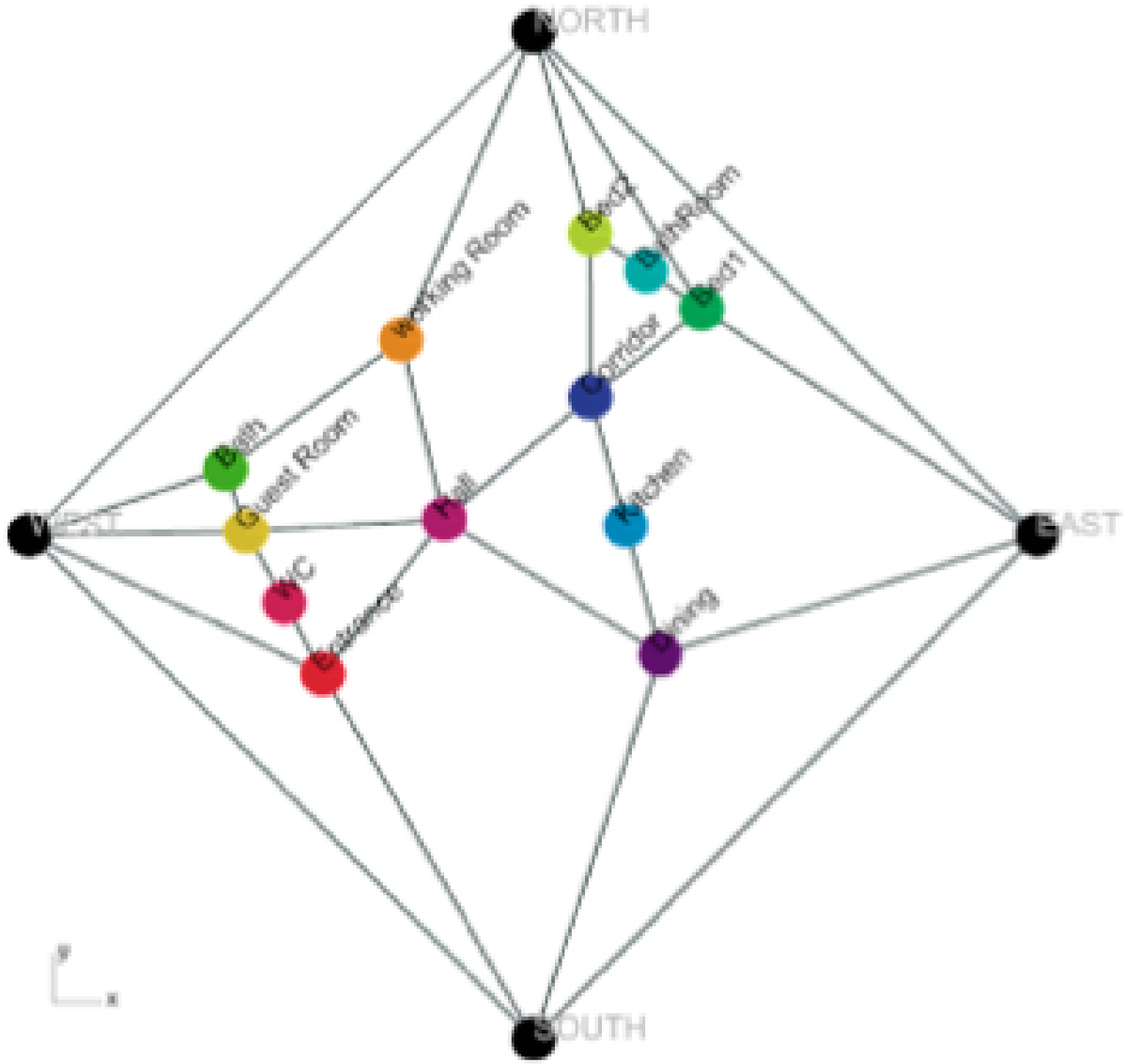


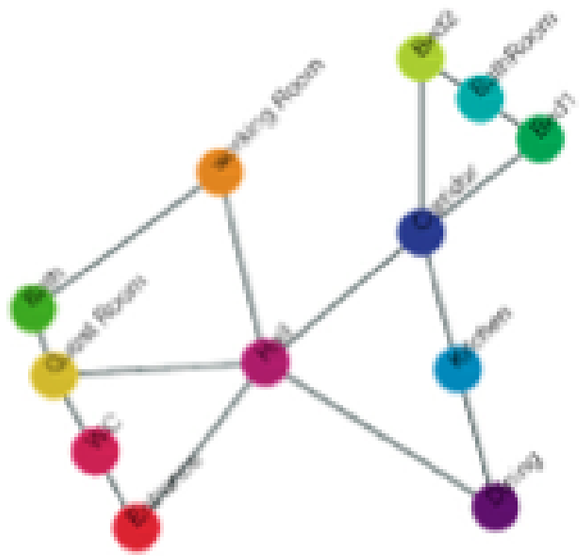




An Untangled Diagram: A Unique Convex Topology

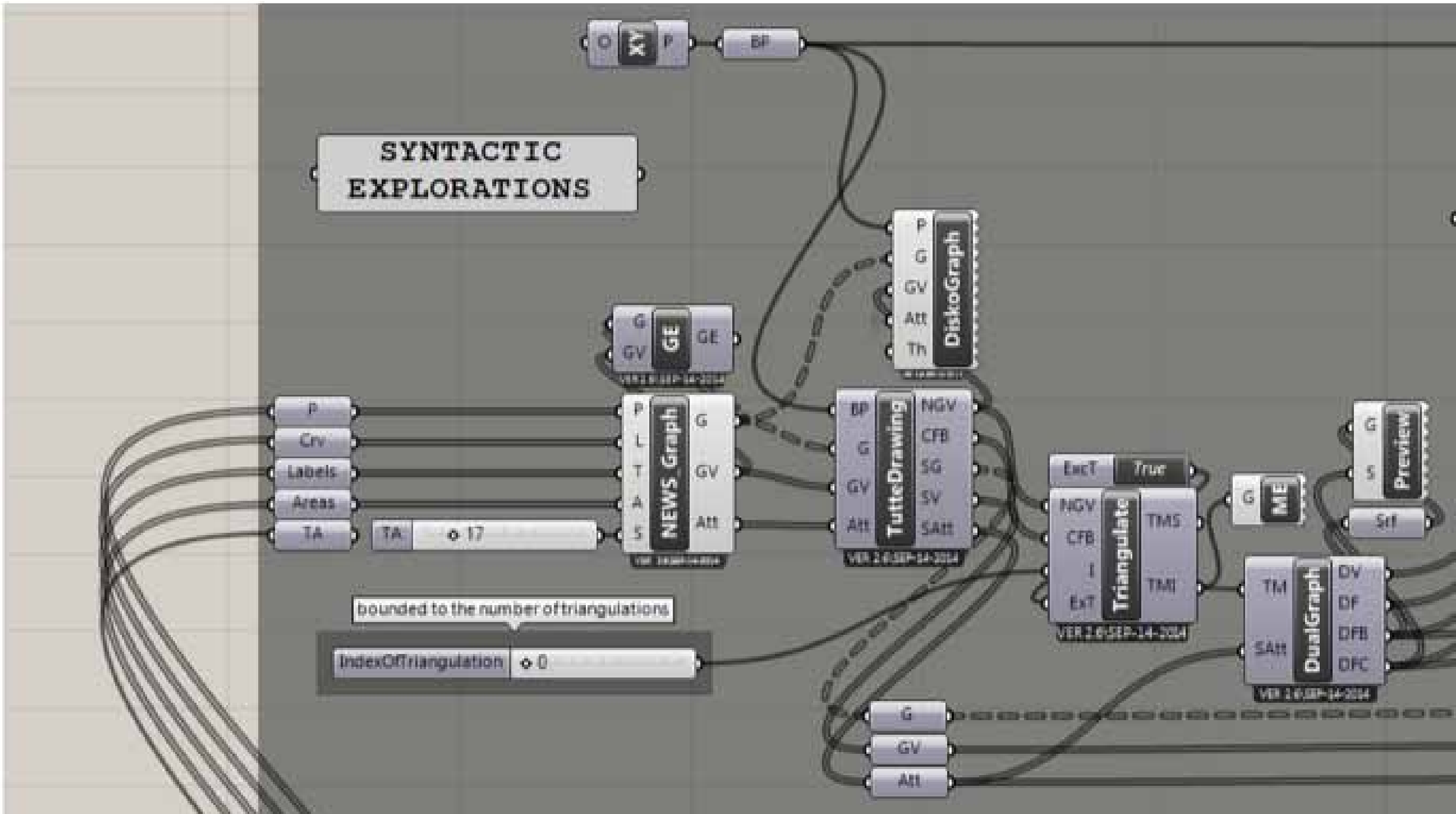
A unique planar representation of the configurative inputs





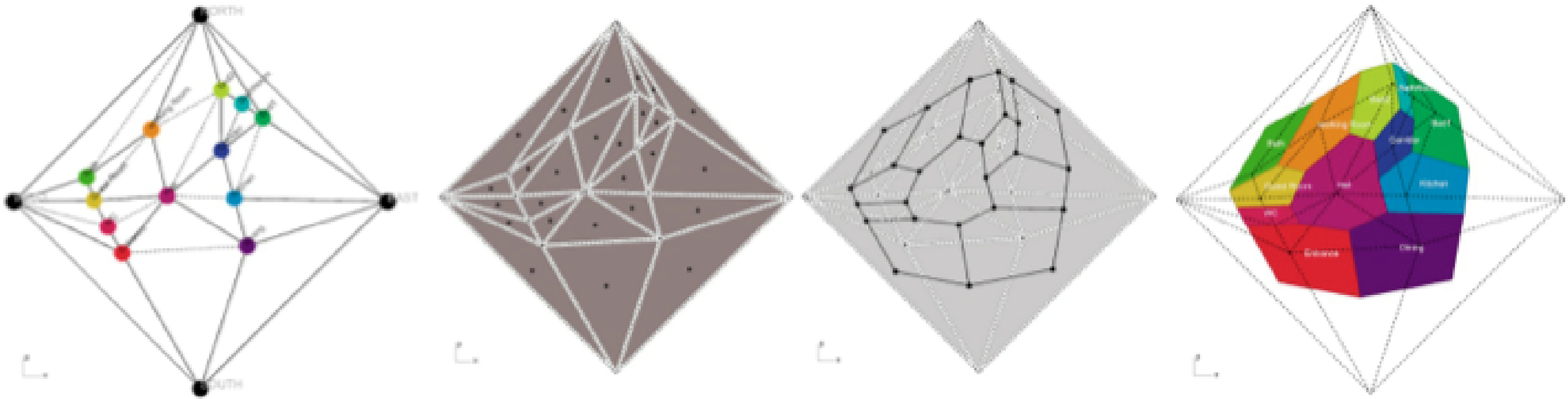
The Generative Tools in Action

From a planar topology to a set of geometric duals



Finding Possible Geometric Matches

From a planar topology to a set of geometric duals



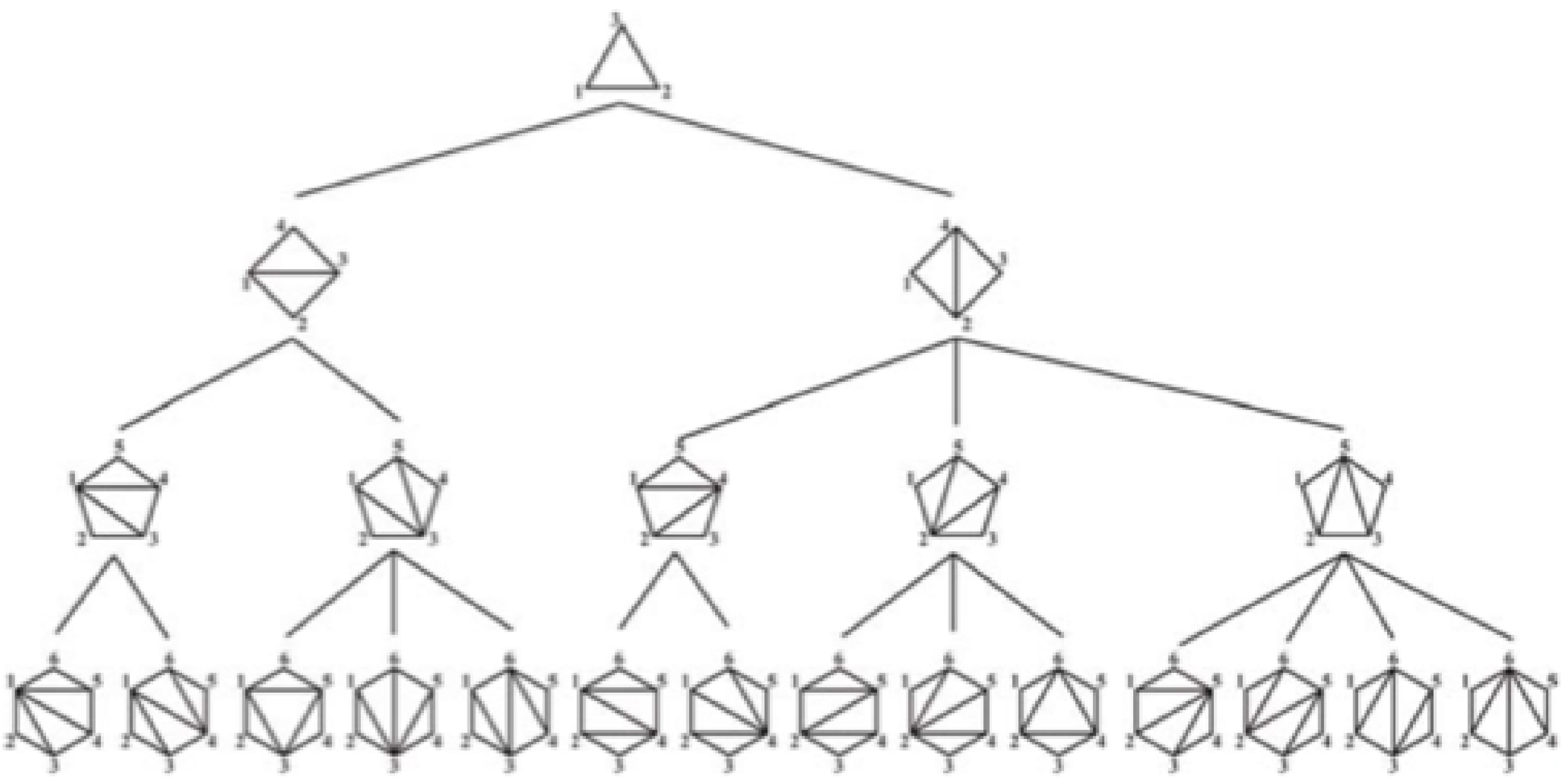
Triangulations and Dual Graphs

1. A triangulation of a convex drawing gives rise to a dual graph
2. When triangulating a convex graph drawing, we are introducing new adjacencies
3. A dual graph eventually becomes a rectangular dual, which is a “dimension-less”

How many triangulations per face?

The complexity behind architectural plan layout!

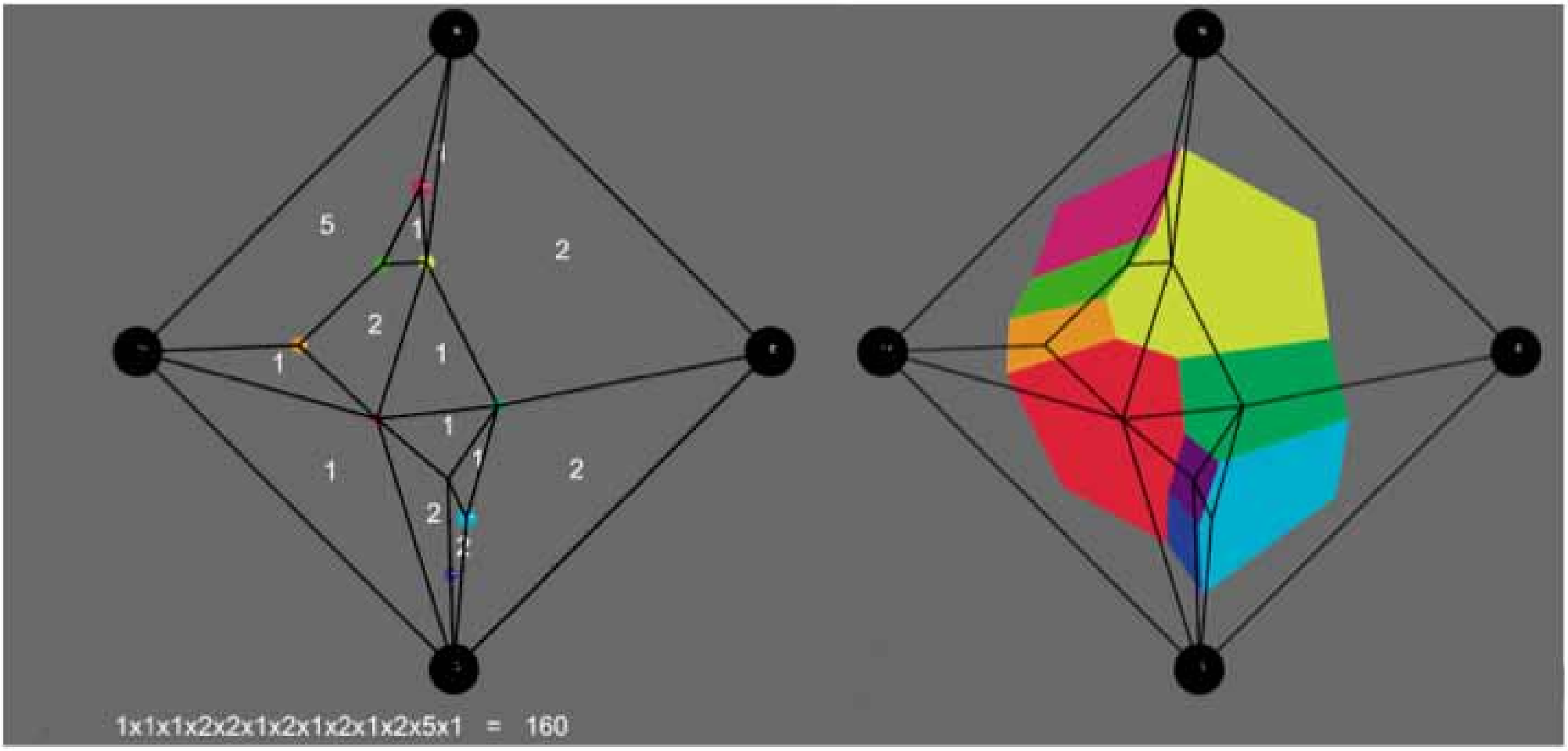
$$Catalan\ Number = \frac{1}{(n+1)}\binom{2n}{n}$$



Images by courtesy of Muzafer Saracevic, et al., IMPLEMENTATION OF THE CONVEX POLYGON TRIANGULATION ALGORITHM

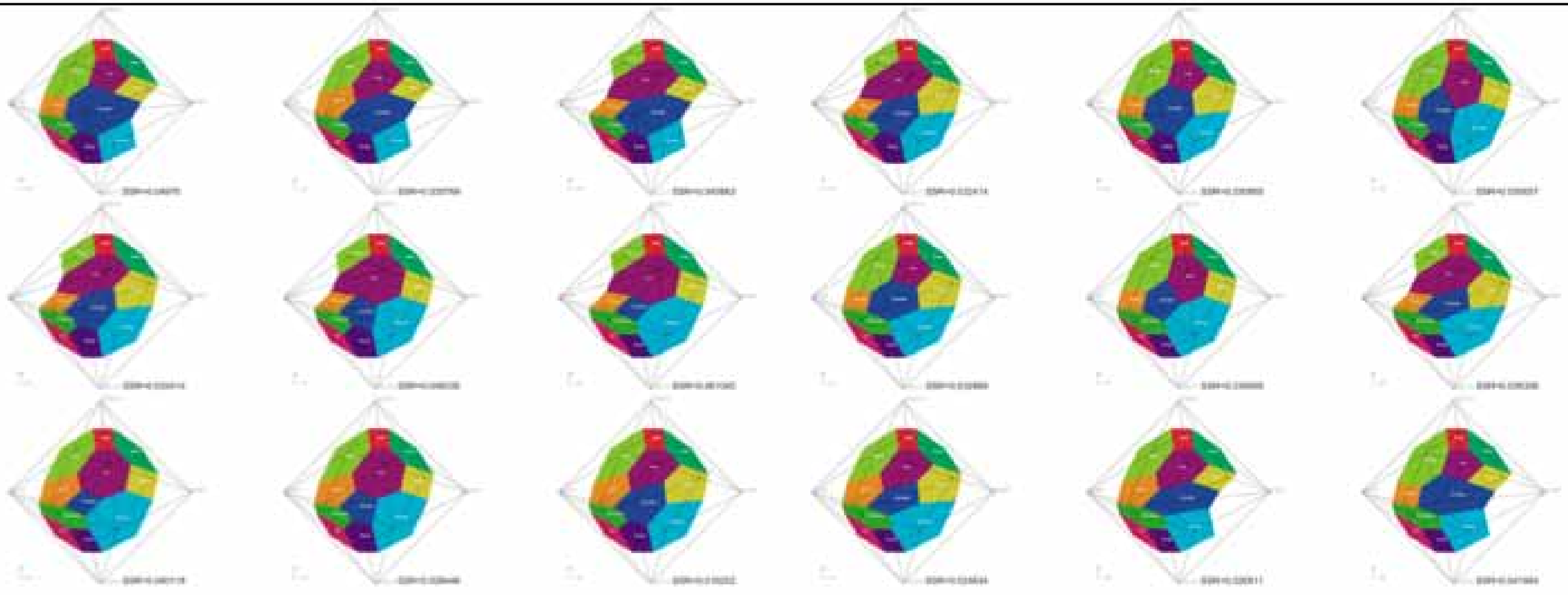
Possibilities

Introducing one more link may reduce the possibilities many times this number!



A Catalogue of Possibilities

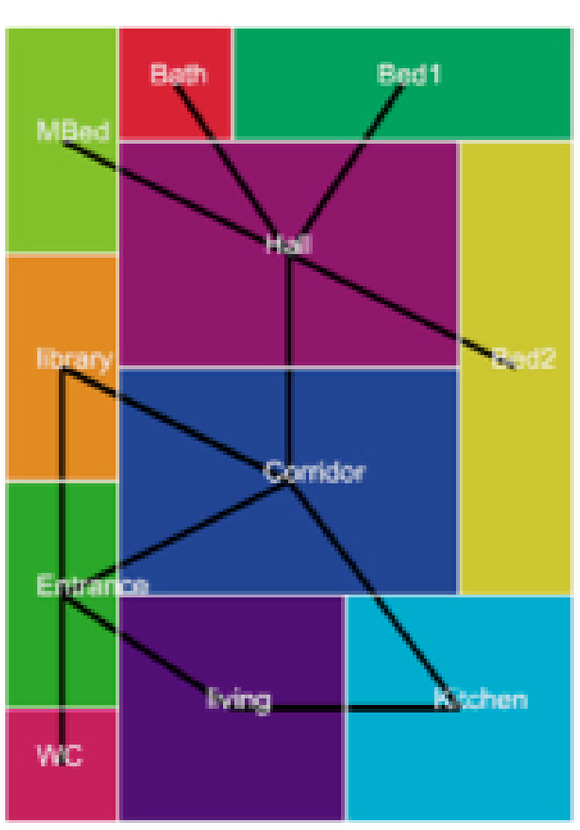
A limited number of possibilities, for a class of rectangular dissections: for example, the 18 admissible triangulations and dual graphs of a convex embedding.

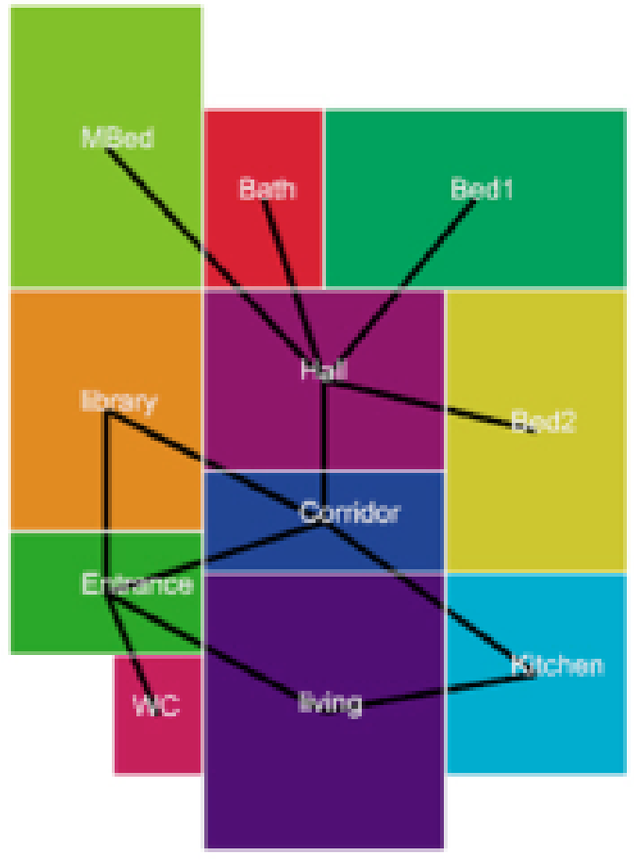


Dimensioning a Rectangular Diagram

A work-in-progress, after March & Steadman (1971, 1983), Roth & Hashimshony (1988)

SSR=0.019202

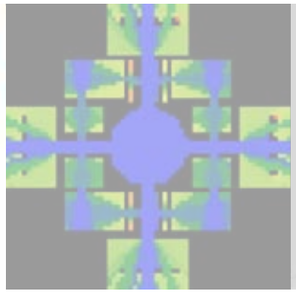




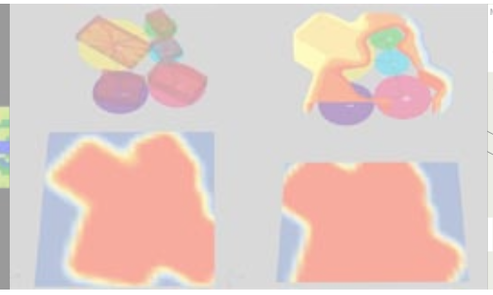
Syntactic

SpiderWeb Plugin

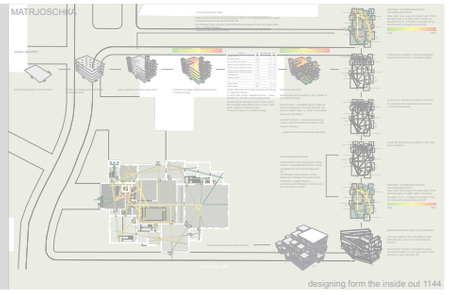
Visual Graphs



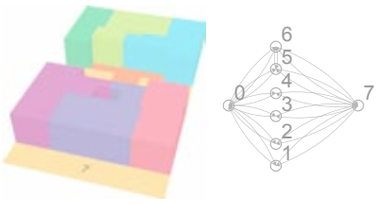
Field to Space

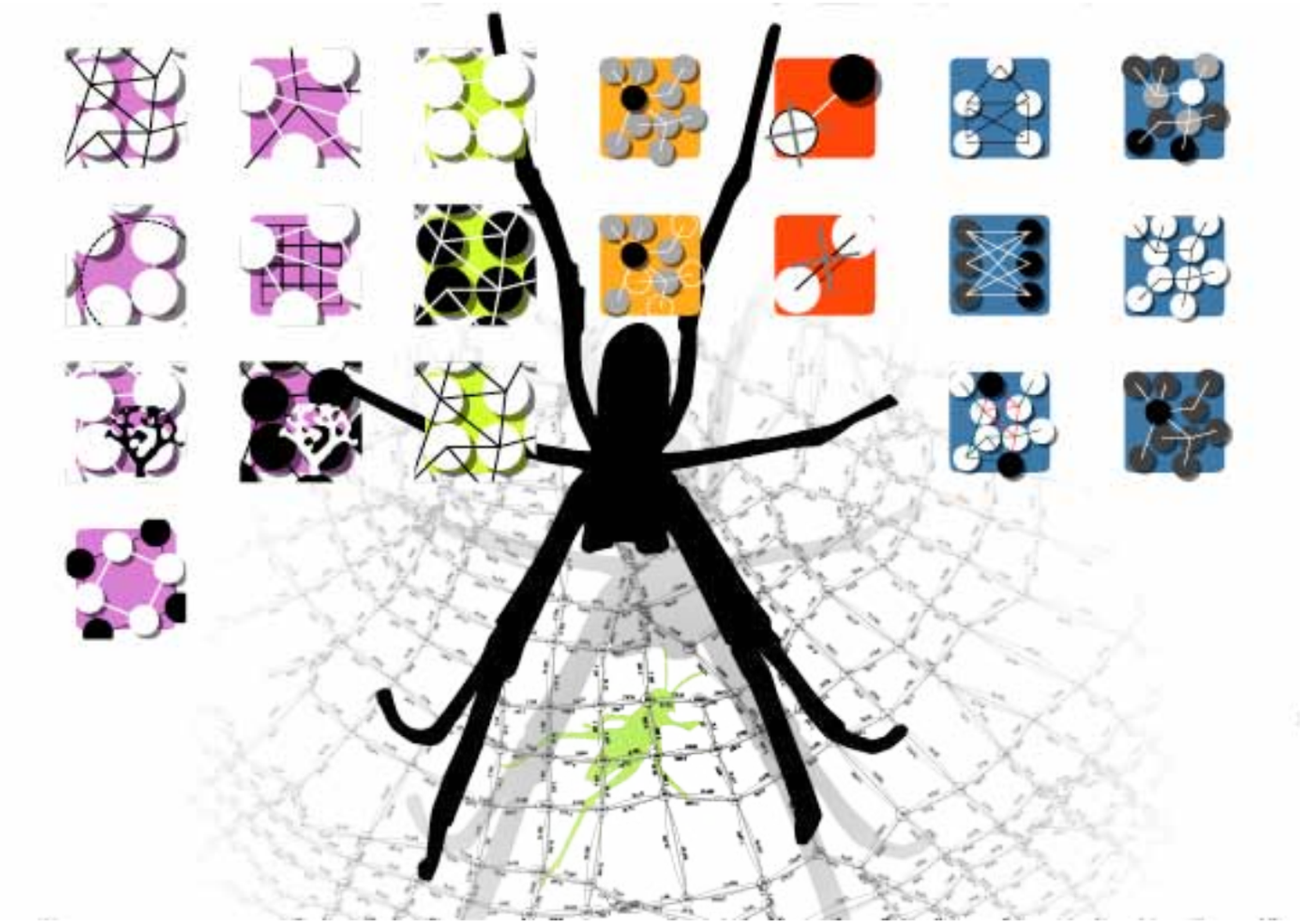


Metaheuristic Solvers

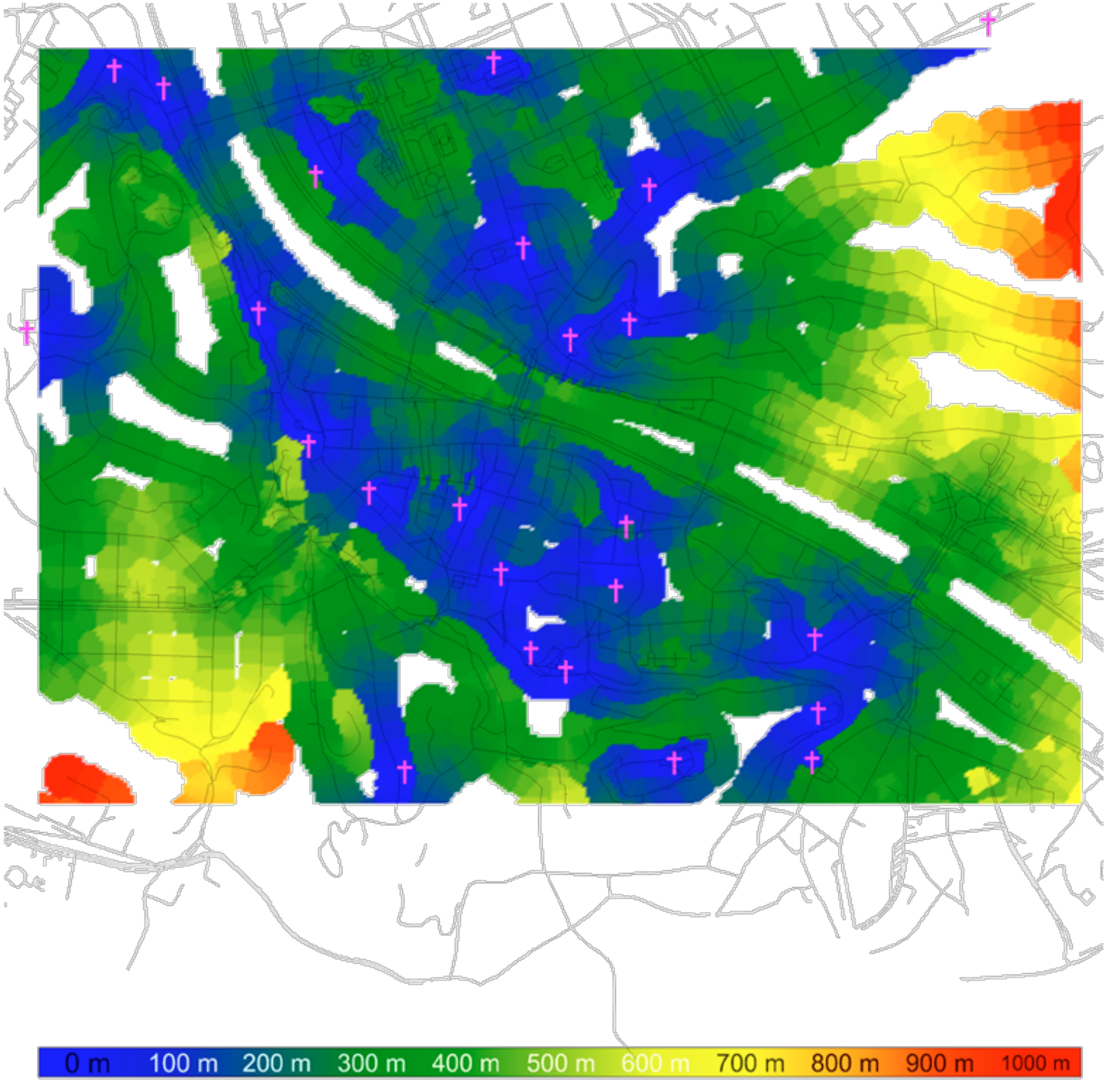


Parallel Planing





SpiderWeb
http://www.gbl.tuwien.ac.at/Archiv/digital.html?name=SpiderWeb

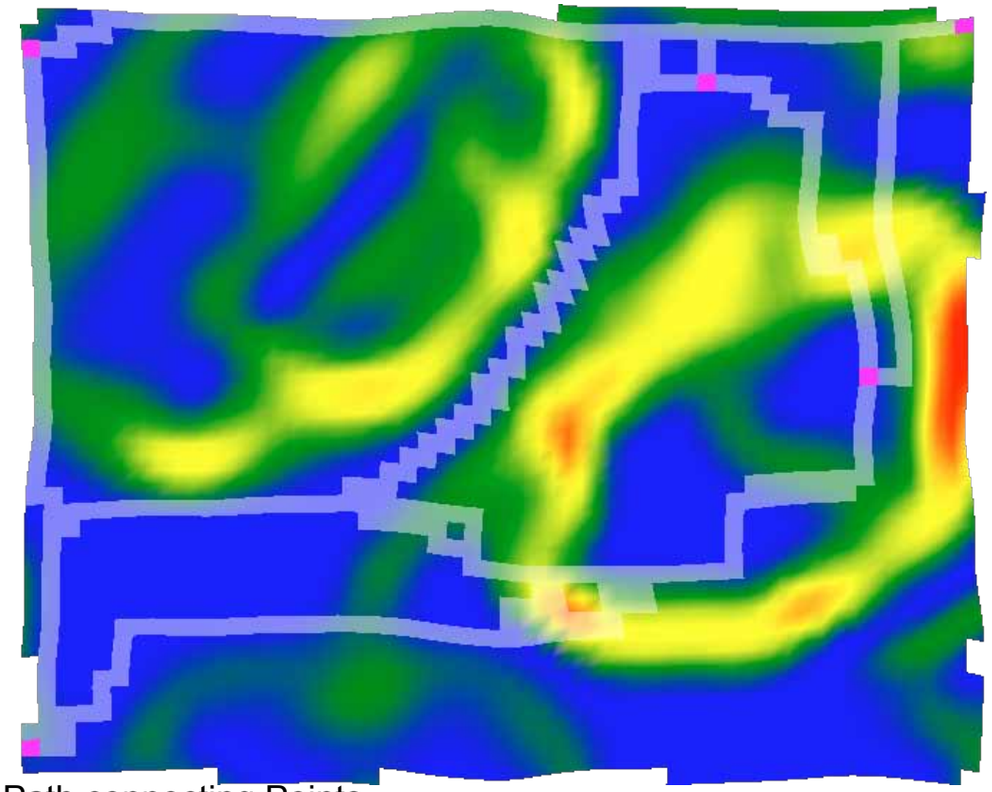


Urban distance

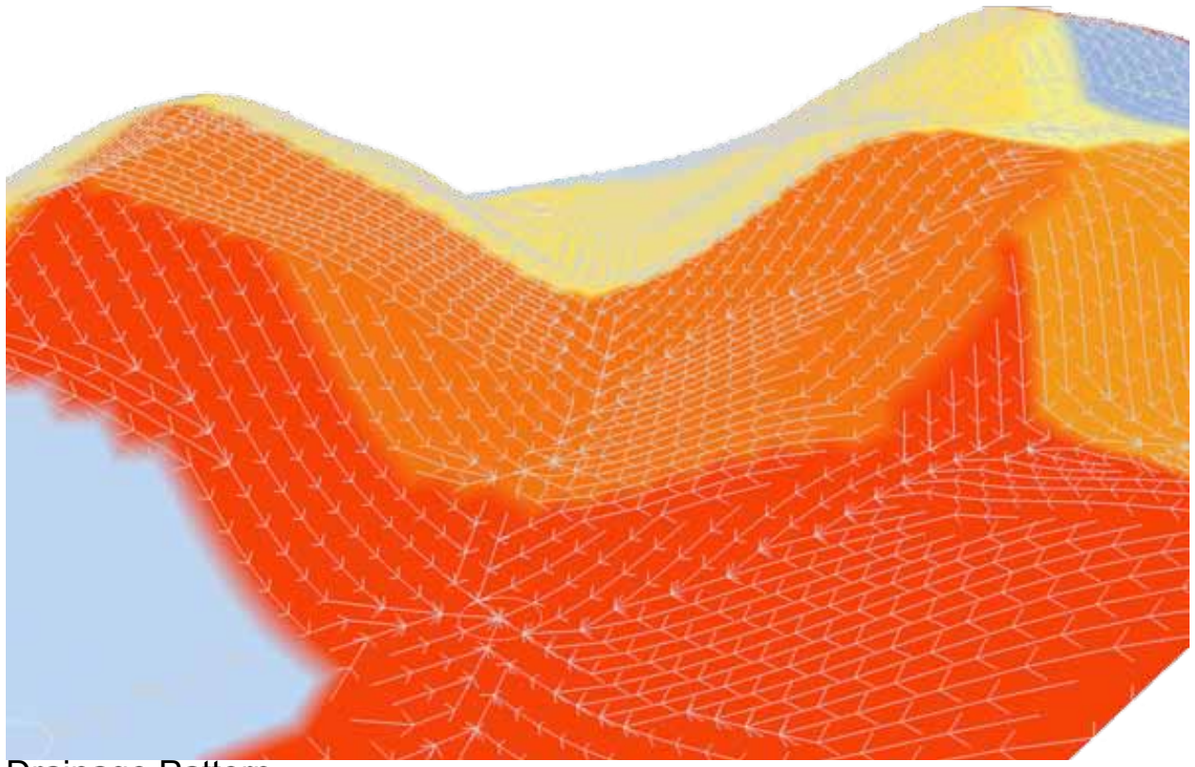
SpiderWeb Example

http://www.gbl.tuwien.ac.at/_docs/GrasshopperScriptum/GrasshopperScriptum.html?filter=SpiderWeb

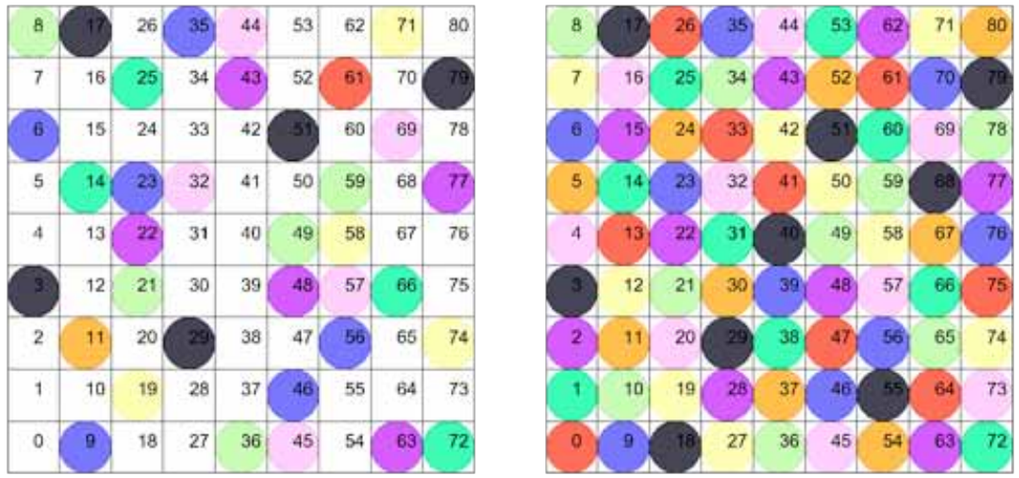
Pirouze Nourian, Richard Schaffranek
www.tudelft.nl ,www.gbl.tuwien.ac.at



Flattest Path connecting Points



Drainage Pattern

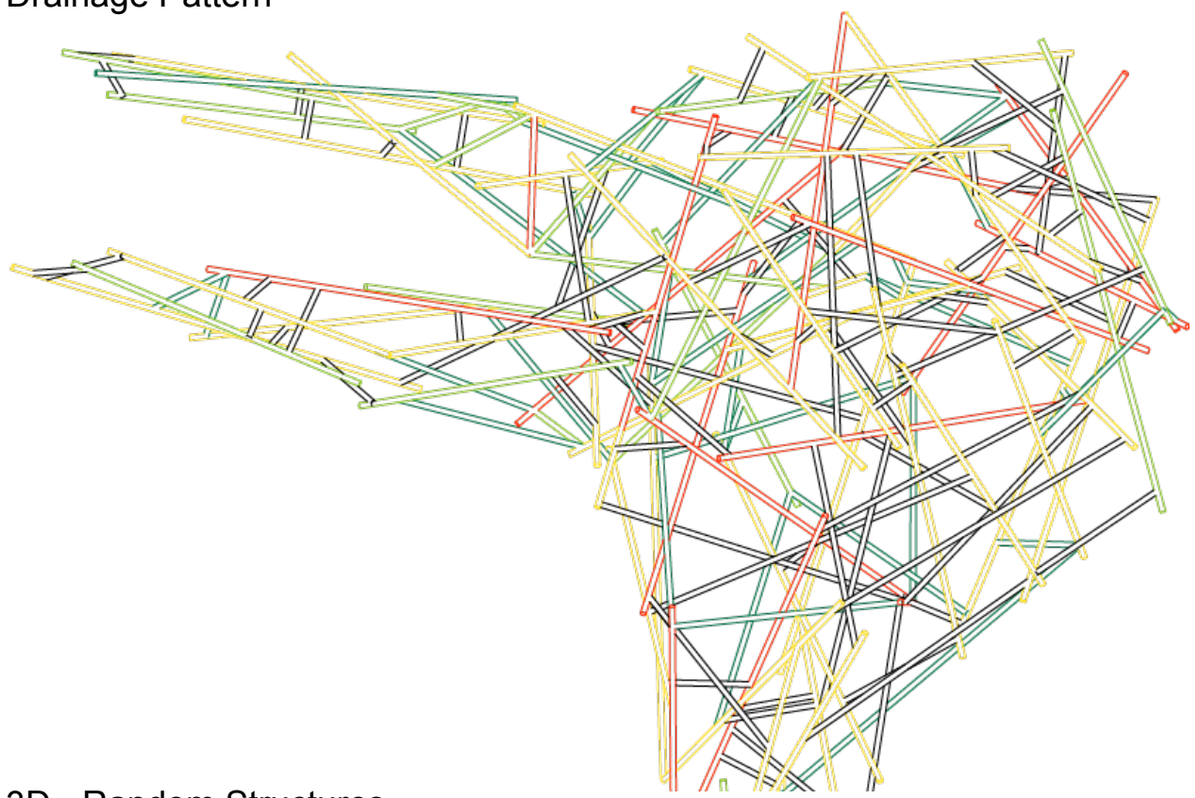


Sudoku Solver

Further applications

SpiderWeb Examples

http://www.gbl.tuwien.ac.at/Archiv/digital.html?name=SpiderWeb



3D - Random Structures

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GBL

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Show all

Themengebiete der algorithmi...

Grasshopper Introduction SS2...

SpiderWeb

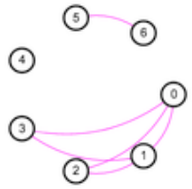
Zeit Raum Weg

Script & Grasshopper Sample Library

Search: SpiderWeb

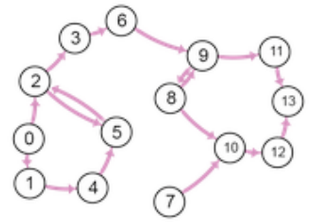
i.e.: sort, geometry, script, GH 0.9.0006, ...

GRAPH THEORY INTRODUCTION - SEVEN BRIDGES OF KÖNIGSBERG

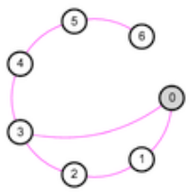


GRAPH REPRESENTATION

GRAPH THEORY - APPLICATIONS

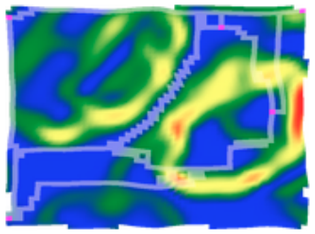


GRAPH THEORY - DEFINITIONS

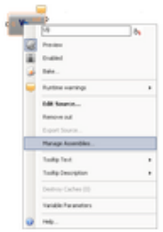


SIMPLE ALGORITHMS FOR GRAPHS

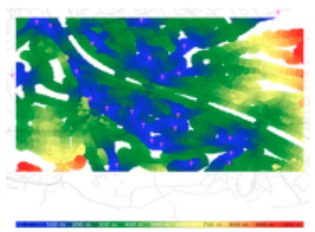
GRAPH COLORING



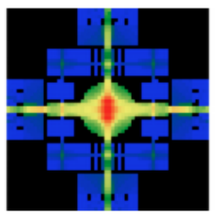
FLATTEST PATHS



SCRIPT SAMPLE-IMPLEMENTING SPIDERWEBLIBRARY



URBAN DISTANCE MAP



VISUAL GRAPHS

INFRASTRUCTURE - FREQUENCY

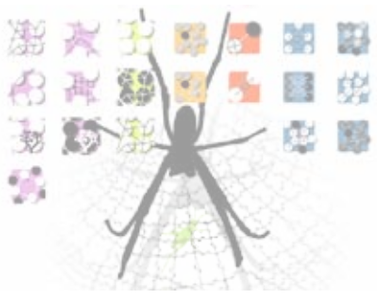
PATHS, MOVMENT AND RISKS

Help, Examples, Further Infromation

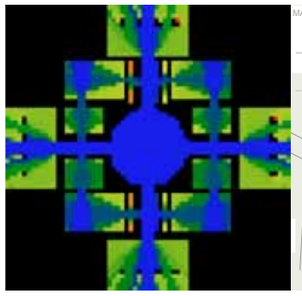
http://www.gbl.tuwien.ac.at/_docs/GrasshopperScriptum/GrasshopperScriptum.html?filter=SpiderWeb

Syntactic

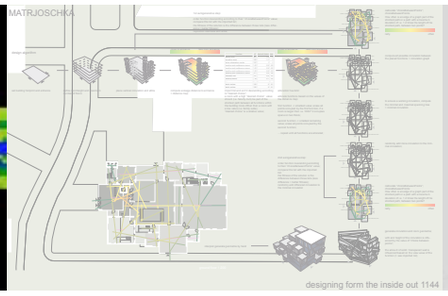
SpiderWeb Plugin



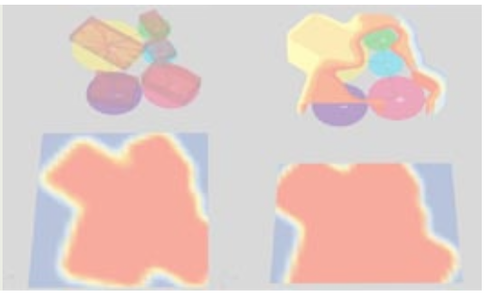
Visual Graphs



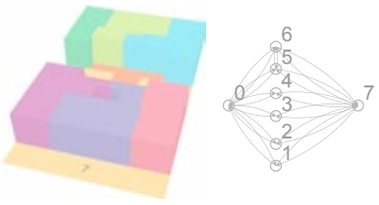
Metaheuristic Solvers

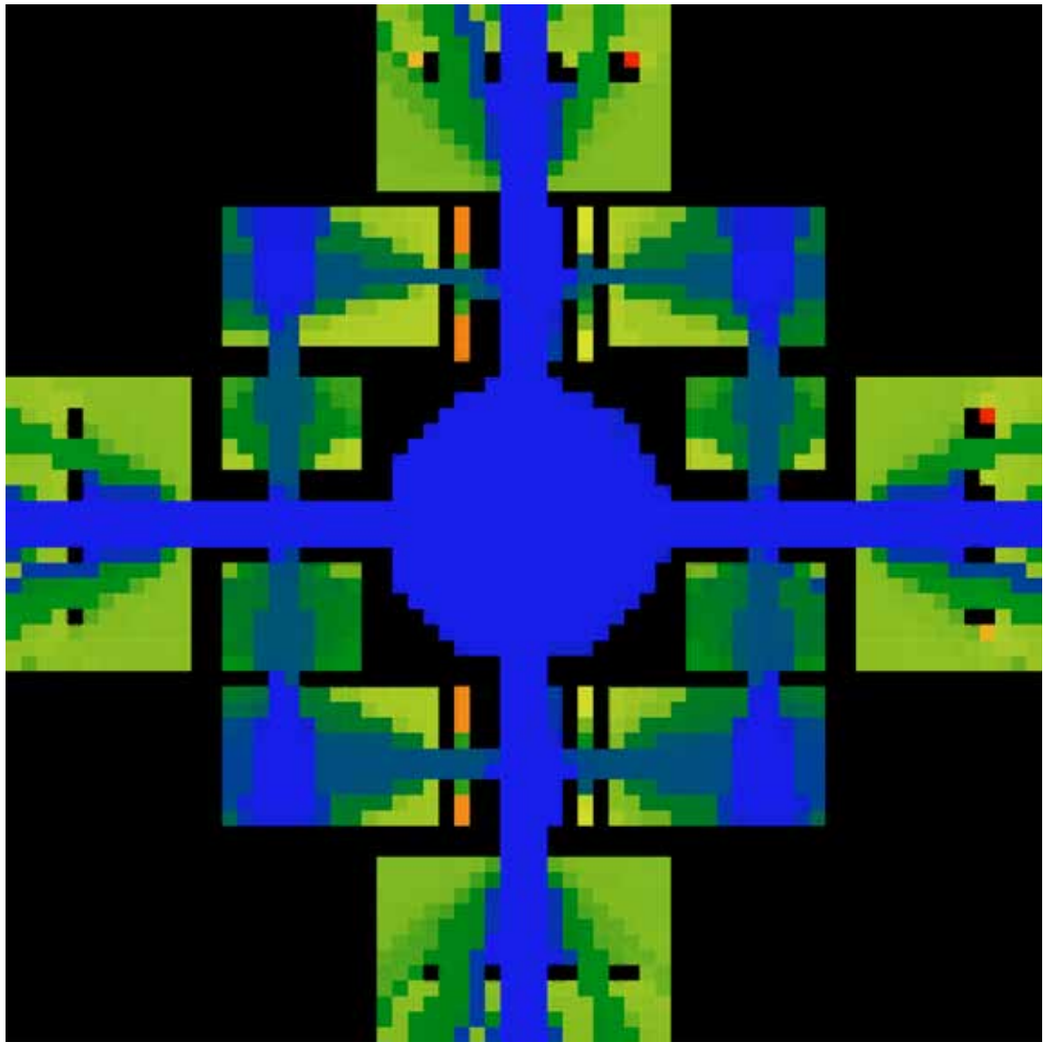


Field to Space

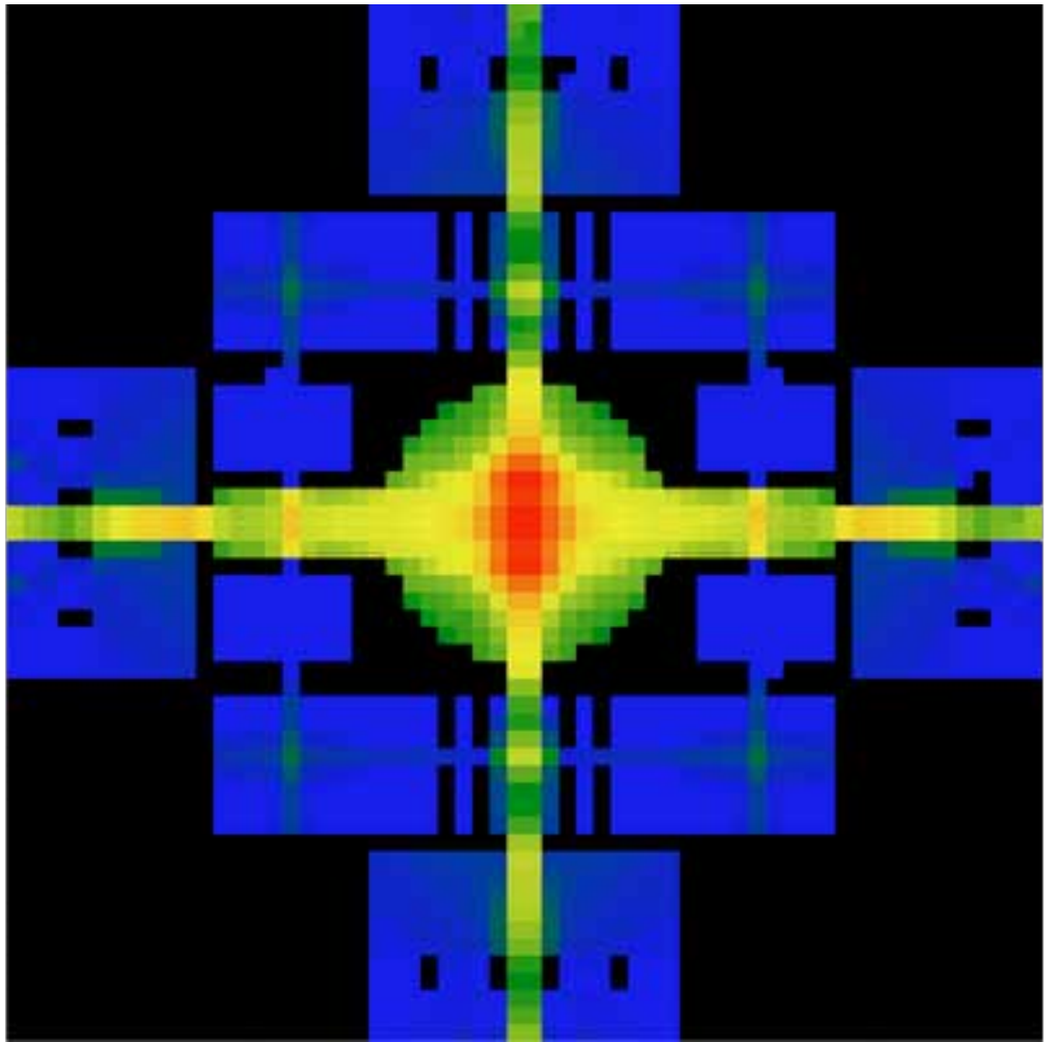


Parallel Planing





Mean Shortest Path



Visible Area

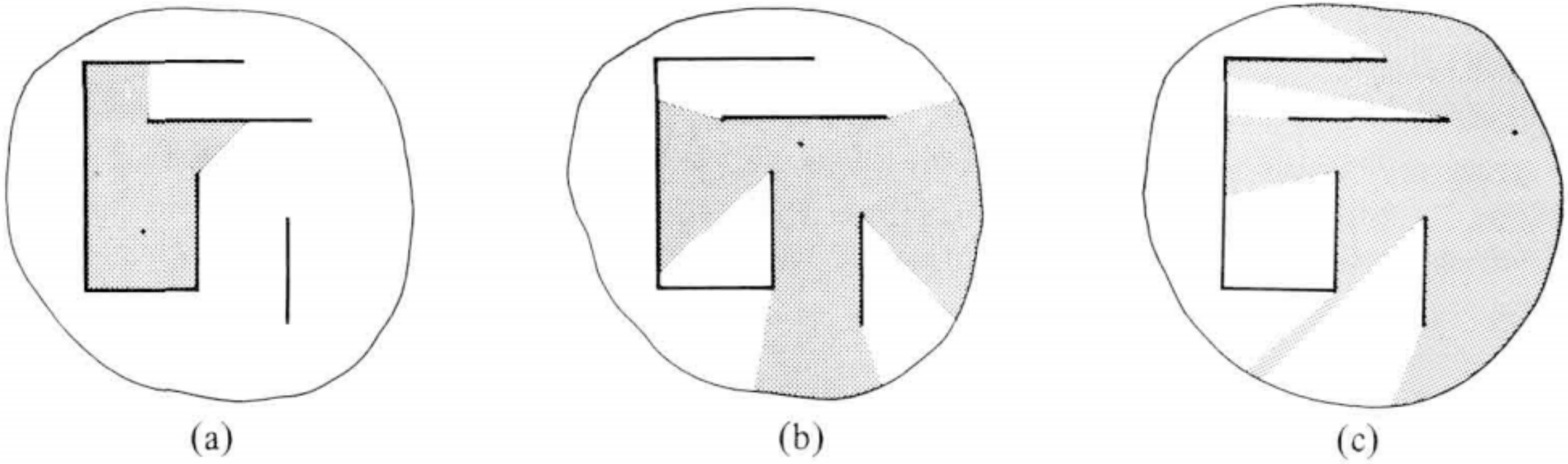
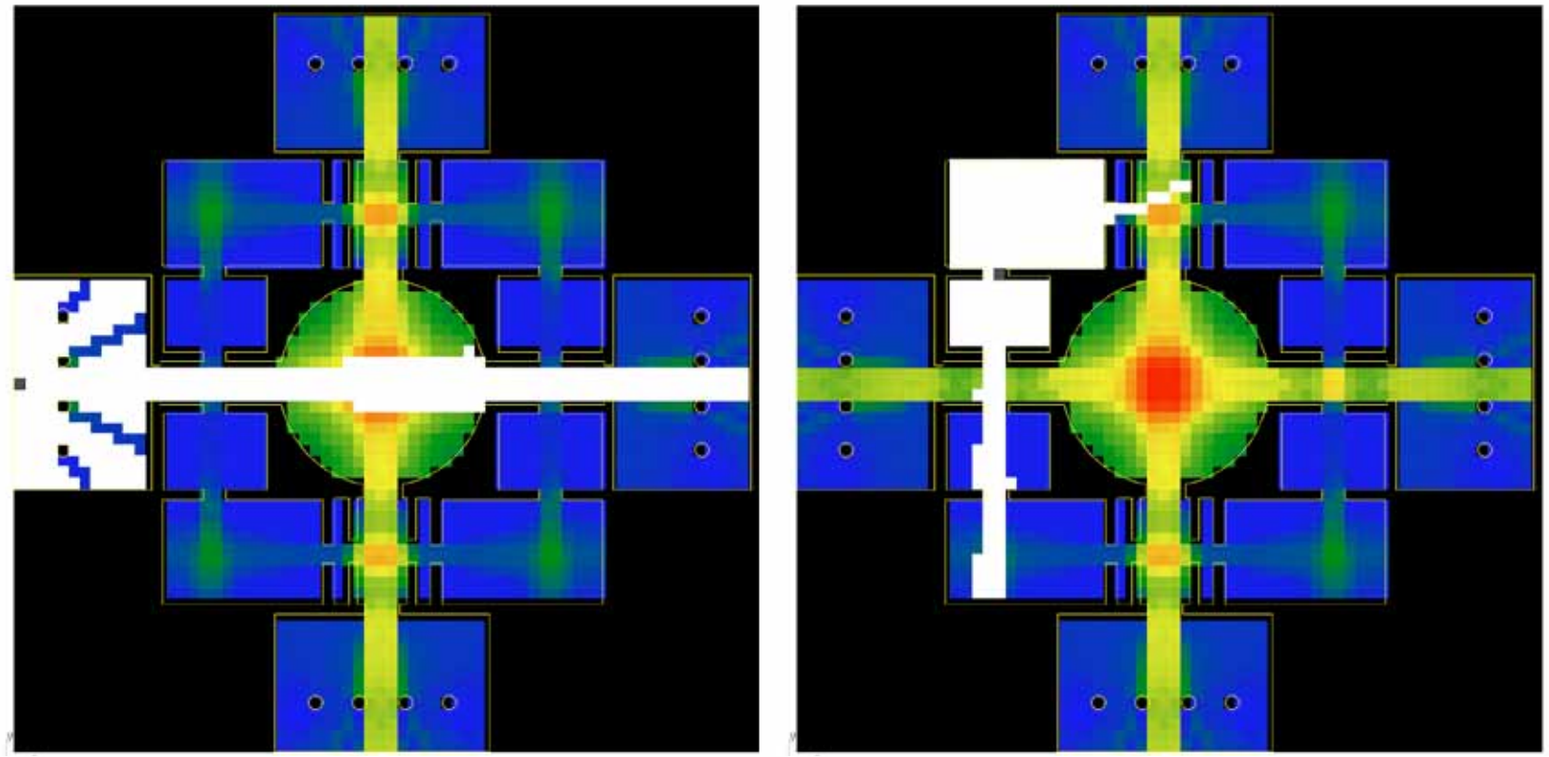
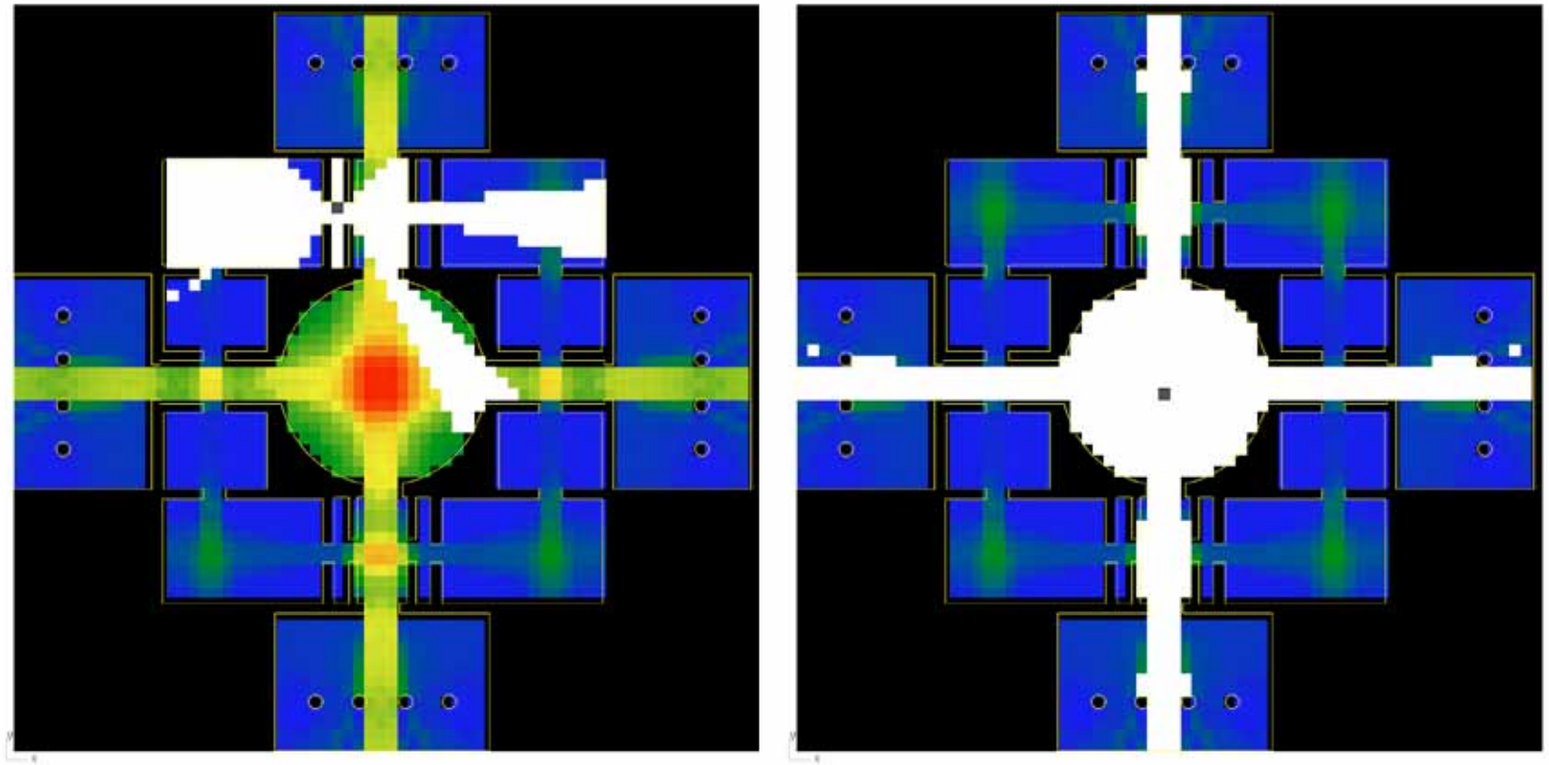


Figure 3 Three isovists in D, as created by E. - Benedikt M L, 1979,'To take hold of space: isovists and isovist fields''Environment and Planning B", p.50





Isovists
Visual Graphs Introduction

Pirouze Nourian, Richard Schaffranek
www.tudelft.nl ,www.gbl.tuwien.ac.at

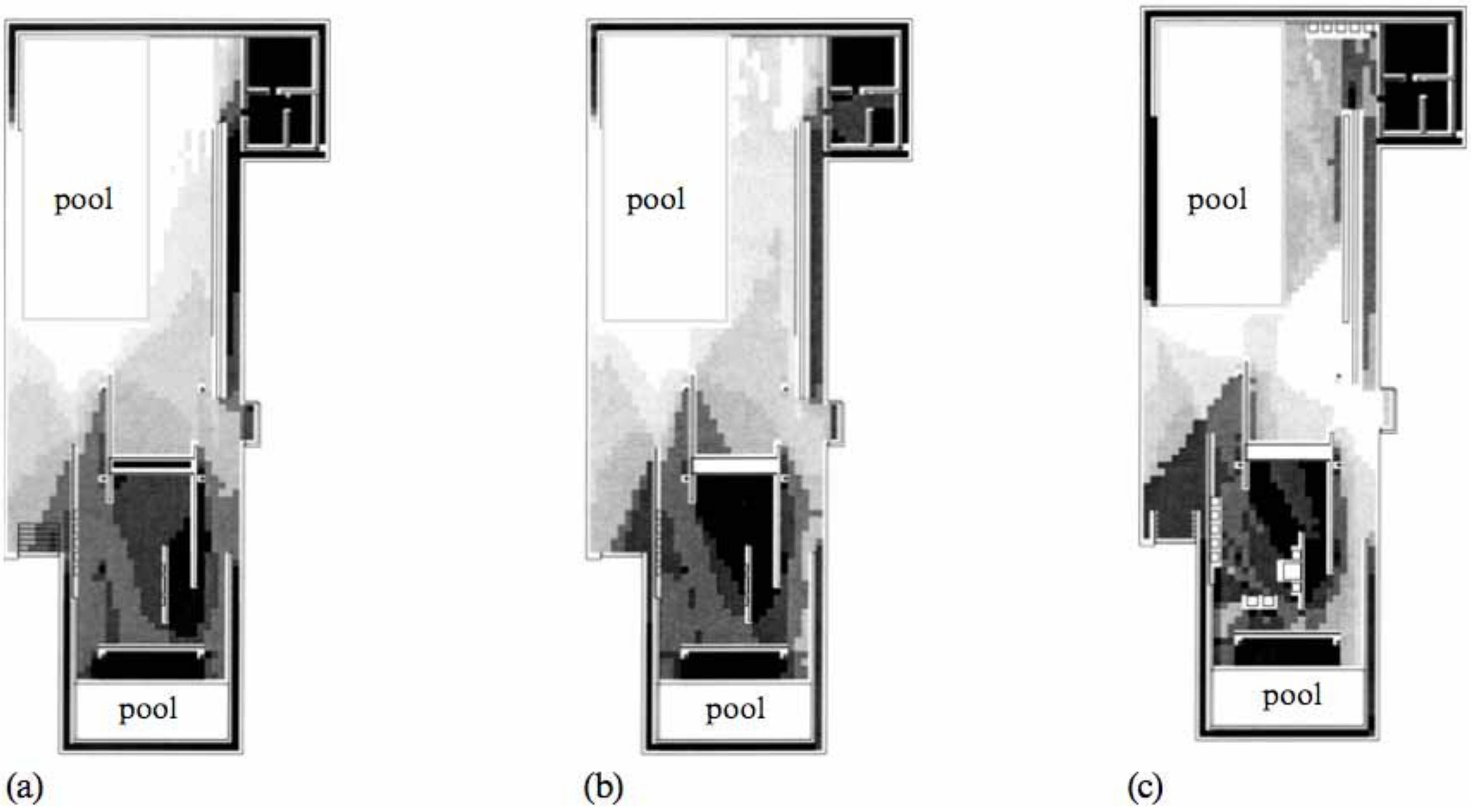
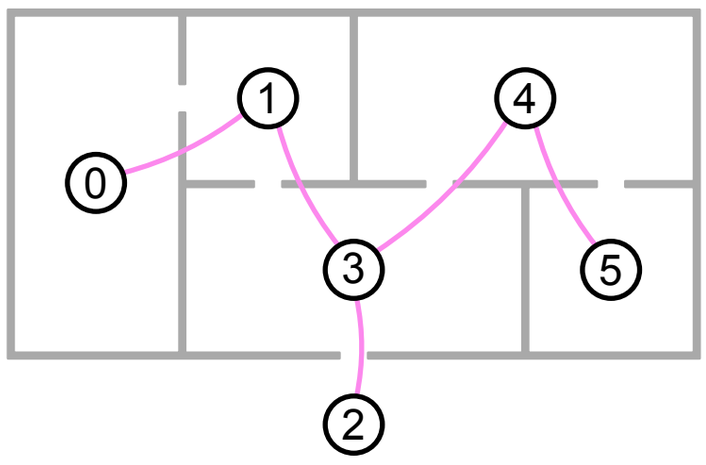


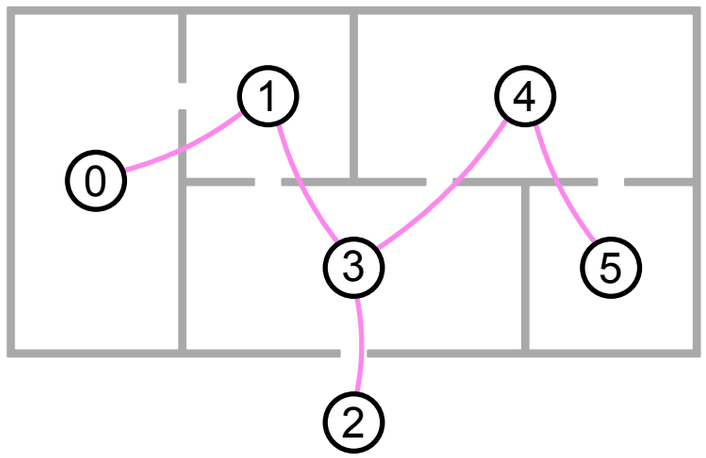
Figure 10. Mies van der Rohe's Barcelona Pavilion showing (a) neighbourhood size, (b) visibility mean shortest path length analysis, and (c) accessibility mean shortest path length analysis. - Turner, A; Doxa, M; O'Sullivan, D; Penn, A; (2001) From isovists to visibility graphs: a methodology for the analysis of architectural space. ENVIRON PLANN B, 28 (1) 103 - 121.



Justified Graph

Visual Graphs Introduction

Hillier, B. & Hanson, J., 1984. The Social Logic of Space J. Costermans & M. Fayol, eds., Cambridge University Press.



Justified Graph

Visual Graphs Introduction

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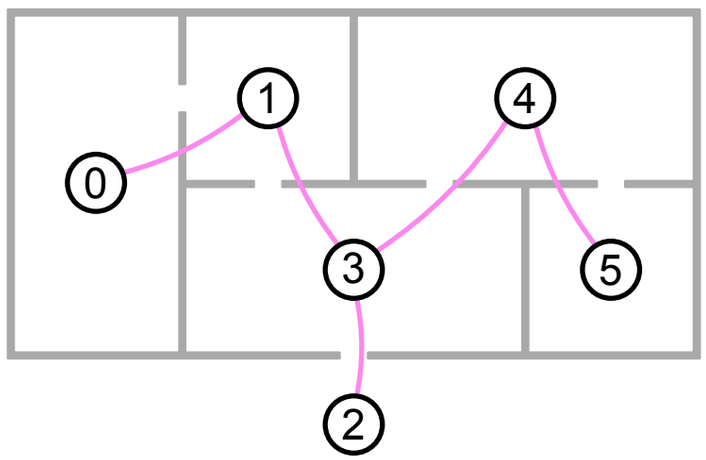

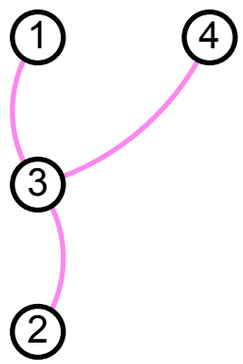

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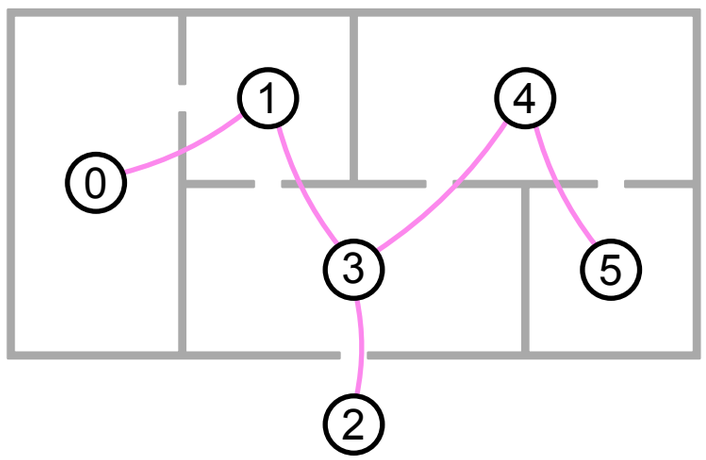
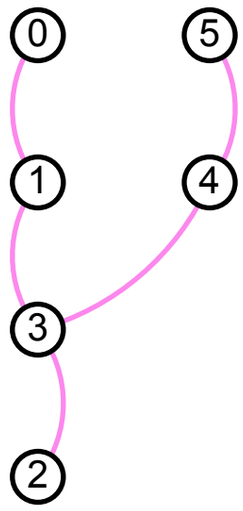
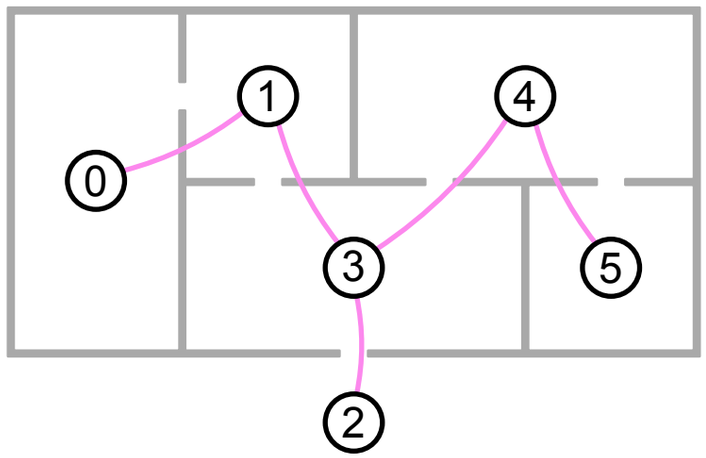


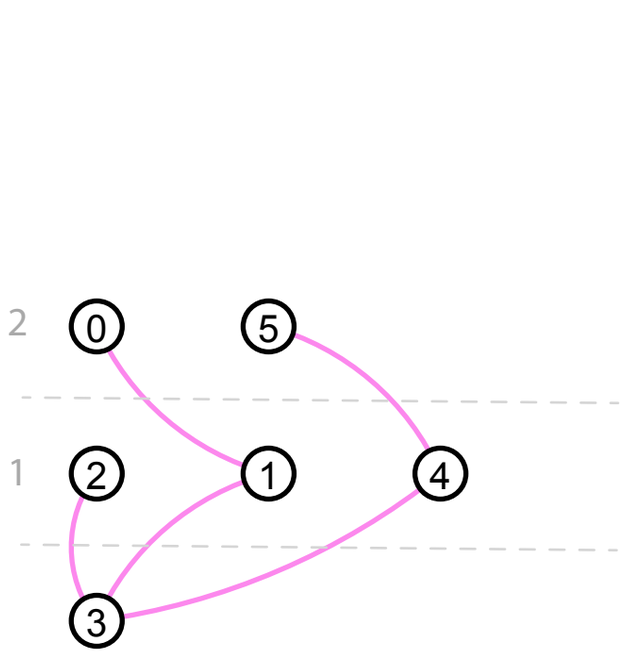


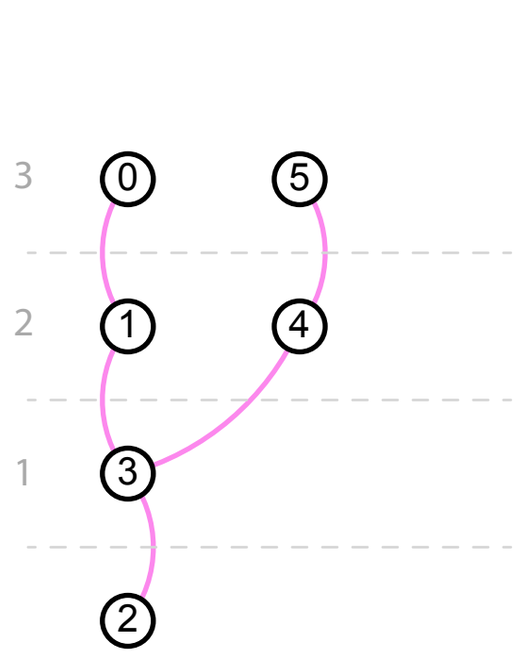
Justified Graph

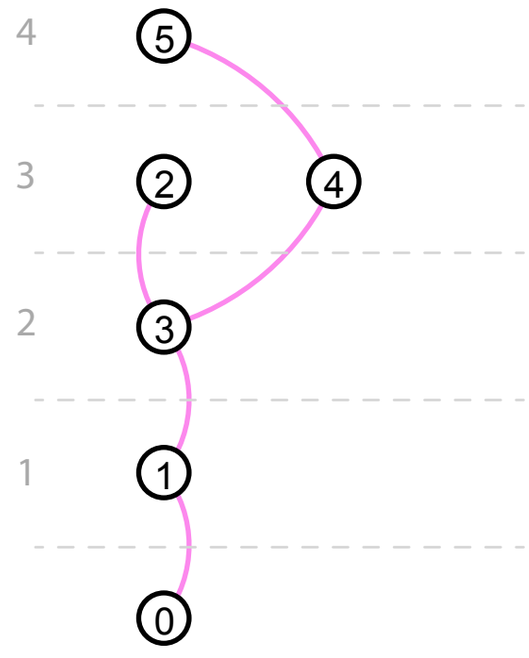
Visual Graphs Introduction

Hillier, B. & Hanson, J., 1984. The Social Logic of Space J. Costermans & M. Fayol, eds., Cambridge University Press.









Justified Graph

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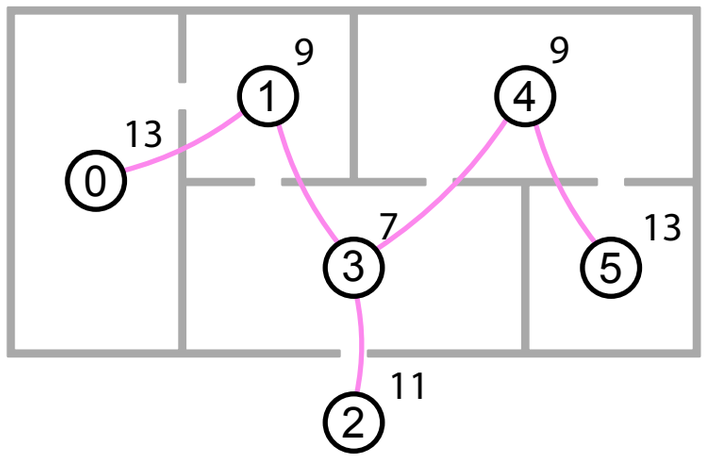
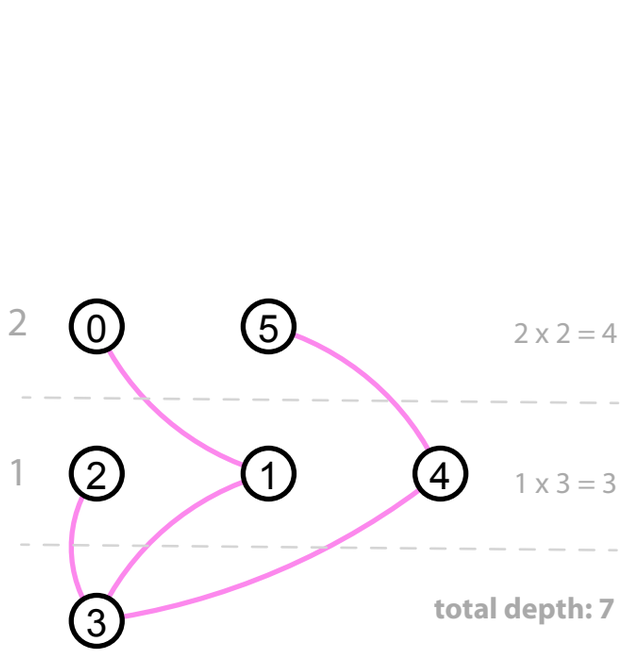
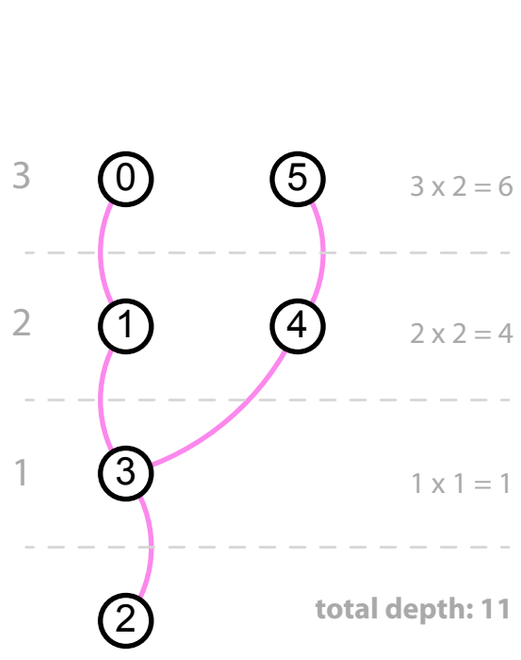
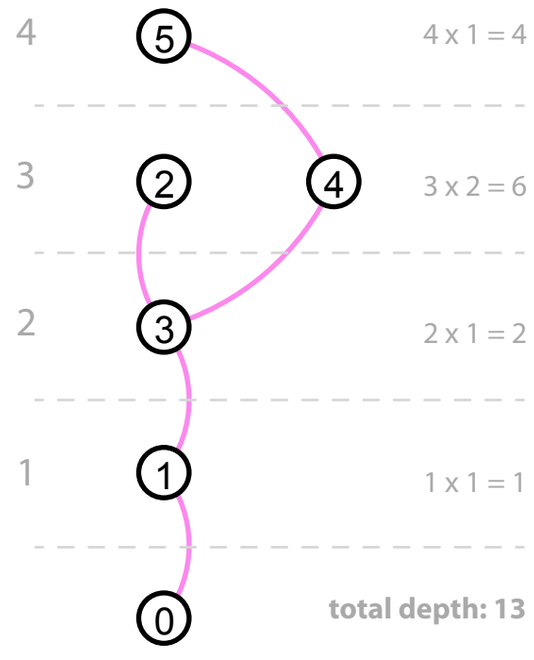
Hillier, B. & Hanson, J., 1984. The Social Logic of Space J. Costermans & M. Fayol, eds., Cambridge University Press.









$$\sum_{j}^{v_j \in V} d_{ij} \ .$$

Total Depth

Visual Graphs Introduction

Hillier, B. & Hanson, J., 1984. The Social Logic of Space J. Costermans & M. Fayol, eds., Cambridge University Press.

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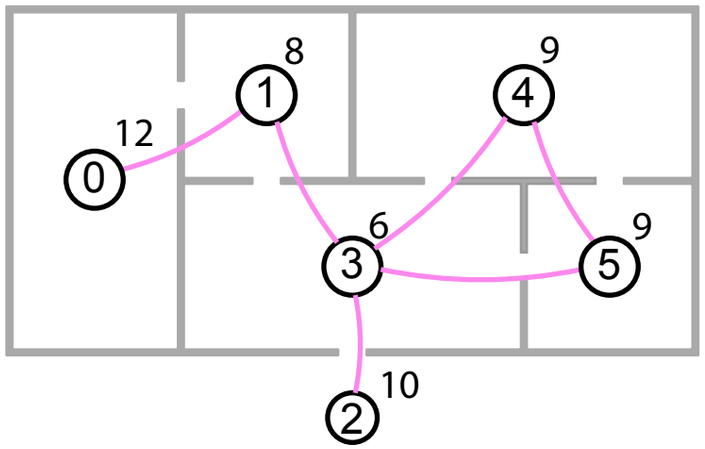

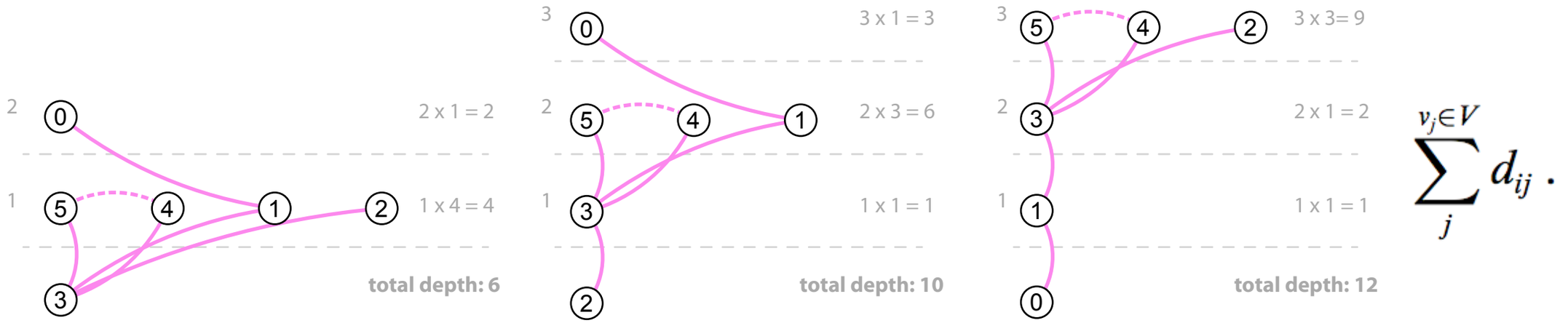

Local Changes have Global Impact

Visual Graphs Introduction

Hillier, B. & Hanson, J., 1984. The Social Logic of Space J. Costermans & M. Fayol, eds., Cambridge University Press.

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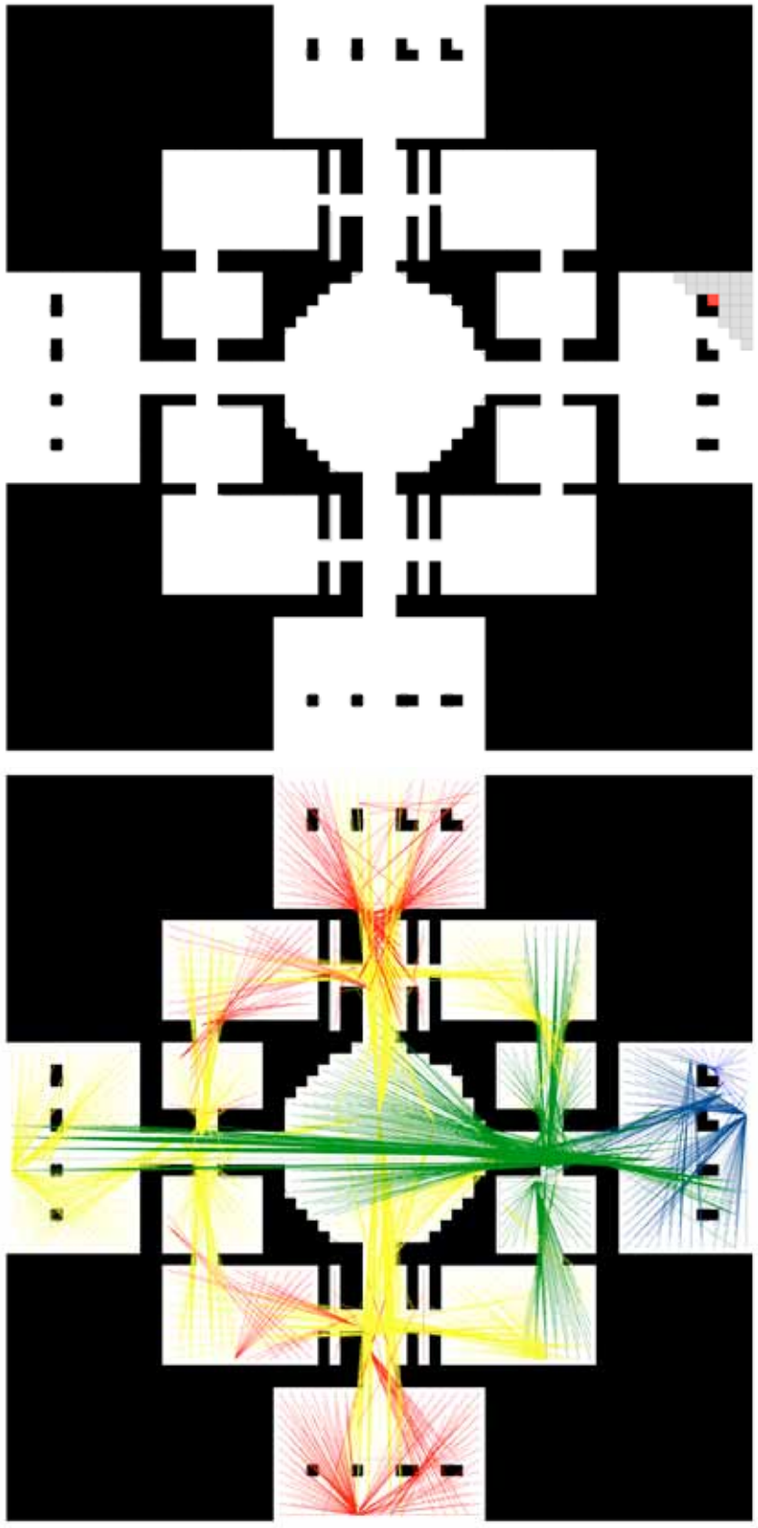
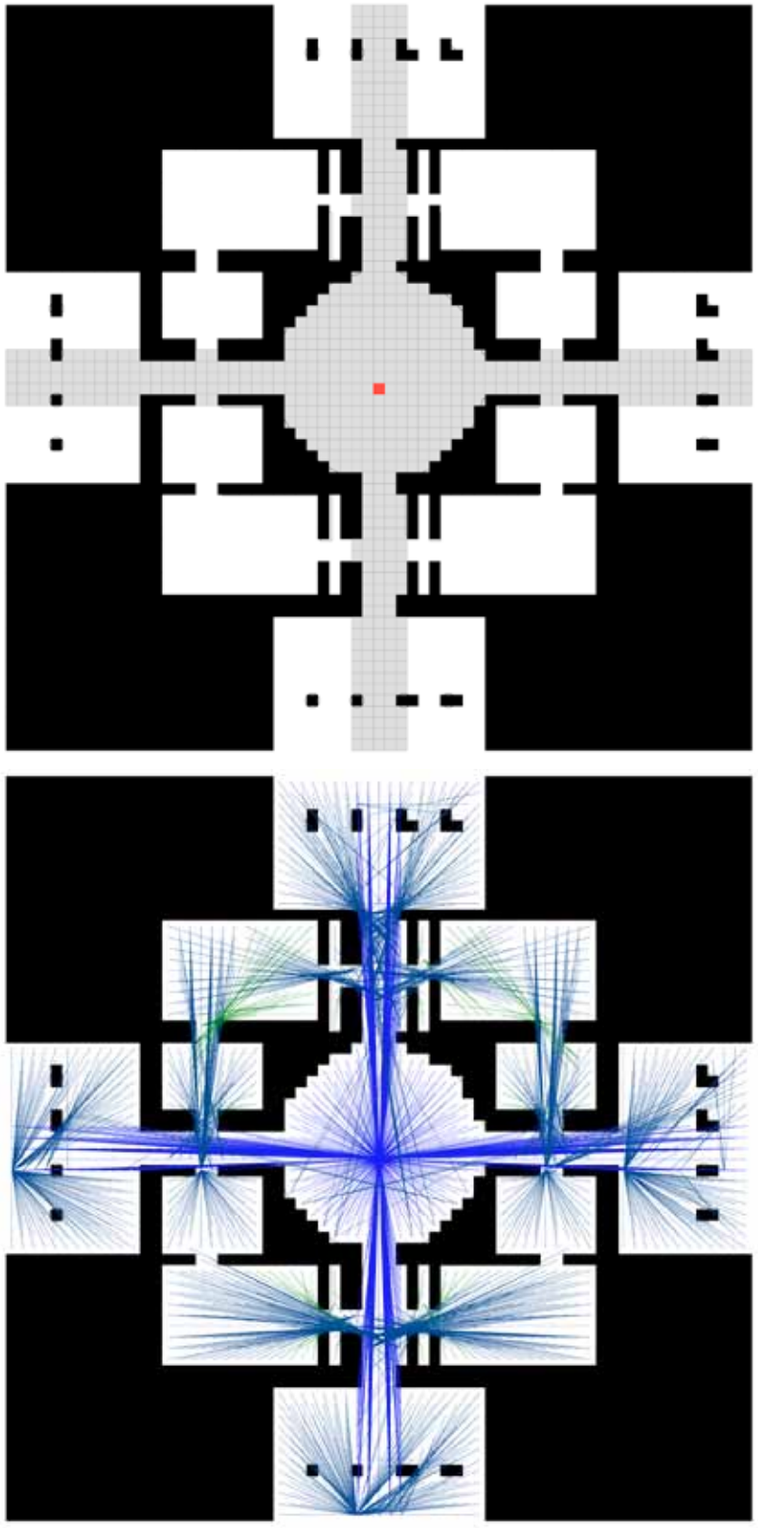




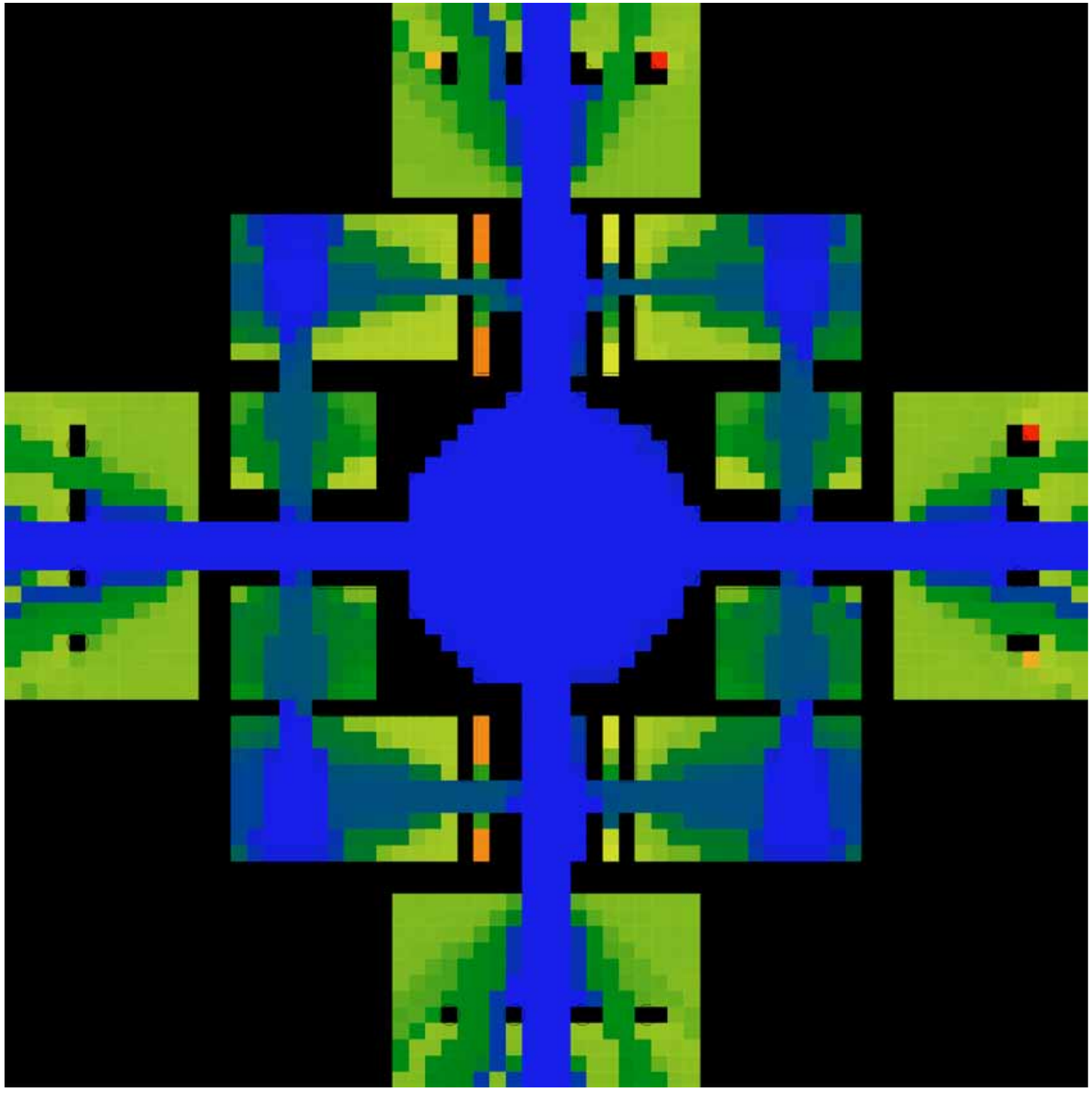
$$\bar{L}_i = \frac{1}{|V|} \sum_{j}^{v_j \in V} d_{ij} \, .$$

0 Steps — Many Steps

Mean Shortest Path (steps) - Two Sample Points

Visual Graphs Introduction

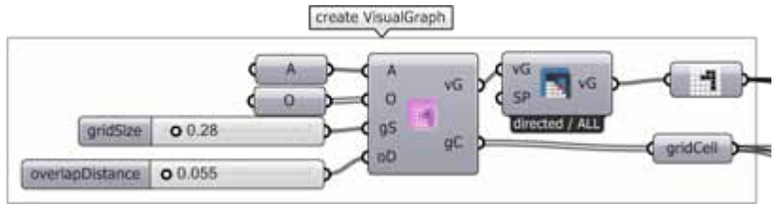
Turner, A; Doxa, M; O'Sullivan, D; Penn, A; (2001) From isovists to visibility graphs: a methodology for the analysis of architectural space. ENVIRON PLANN B, 28 (1) 103 - 121.



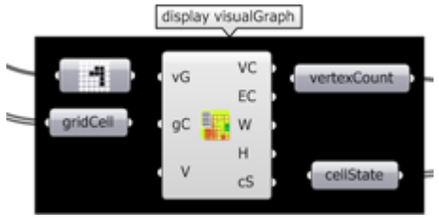
Mean Shortest Path (steps)

Visual Graphs Introduction

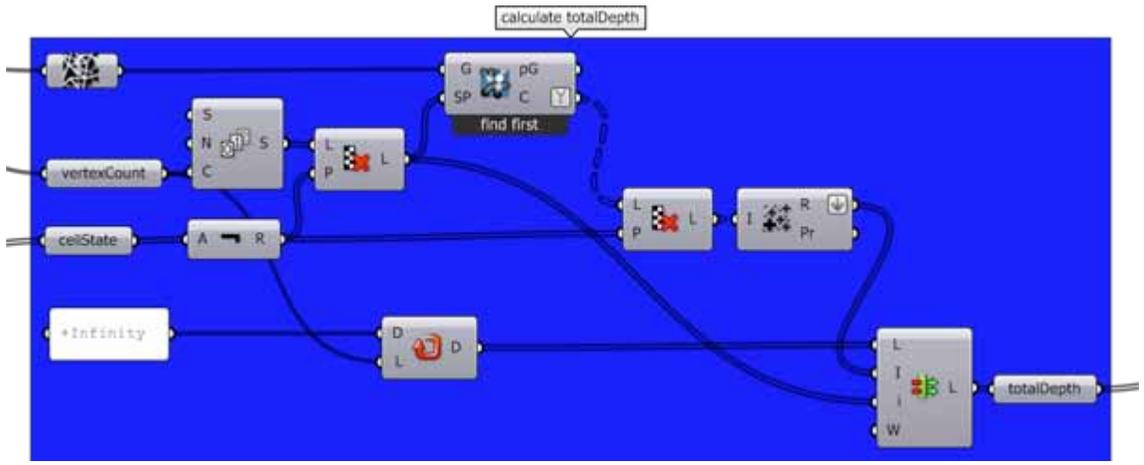
Turner, A; Doxa, M; O'Sullivan, D; Penn, A; (2001) From isovists to visibility graphs: a methodology for the analysis of architectural space. ENVIRON PLANN B, 28 (1) 103 - 121.



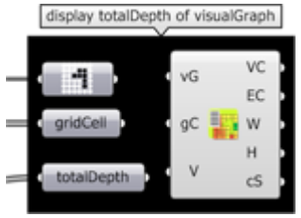
1. Create grid representation of the spatial configuration and calculate the visual graph



2. Get properties of the visual graph



3. Calculate the total depth from each graph vertex. Carfule do not use “find all” option on the visual graph since it is very dense (many edges)!



4. Display

Day 1

General Introduction

Initial Design

Analysis of Design

Desinging Bubblediagram

Grasshopper Plugins:
- Syntactic
- SpiderWeb

Day 2

Generative Designs

Discussion

Timetable

Syntactic

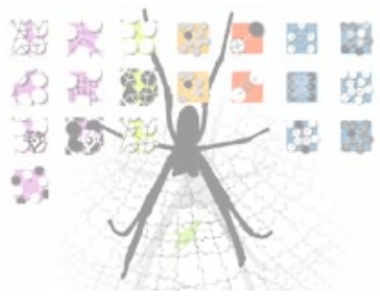
SpiderWeb Plugin

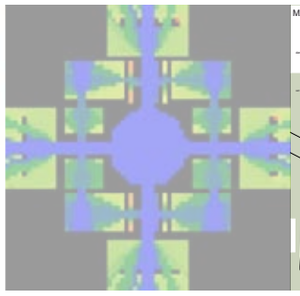
Visual Graphs

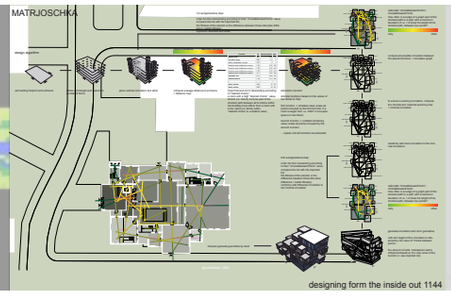
Metaheuristic Solvers

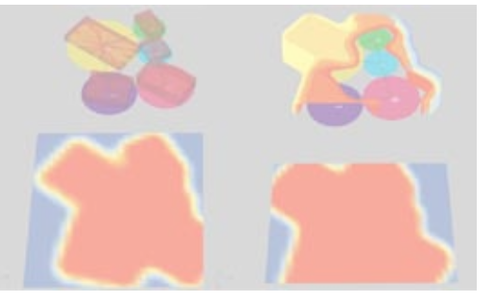
Field to Space

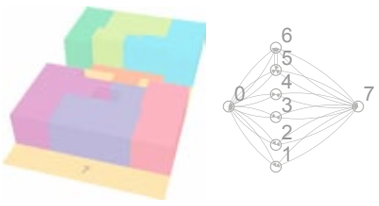
Parallel Planing

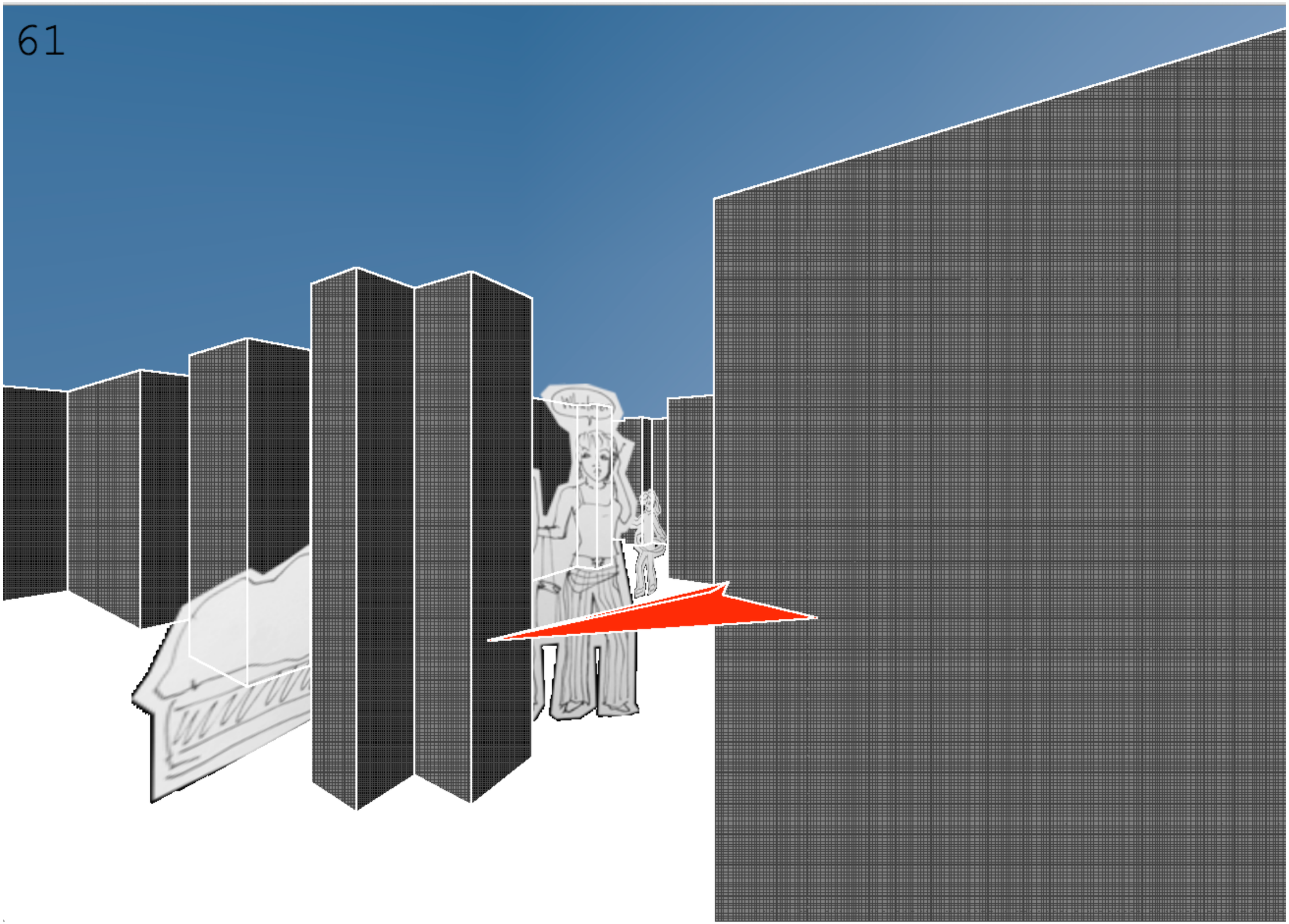












Labyrinth Runner - Metaheuristic Solvers

Please play: http://www.gbl.tuwien.ac.at/Archiv/digital.html?name=Labyrinth_Runner

http://www.gbl.tuwien.ac.at/Archiv/digital.html?name=Inventing_Circulation_Patterns_using_Available_Metaheuristic_Solvers

Pirouze Nourian, Richard Schaffranek
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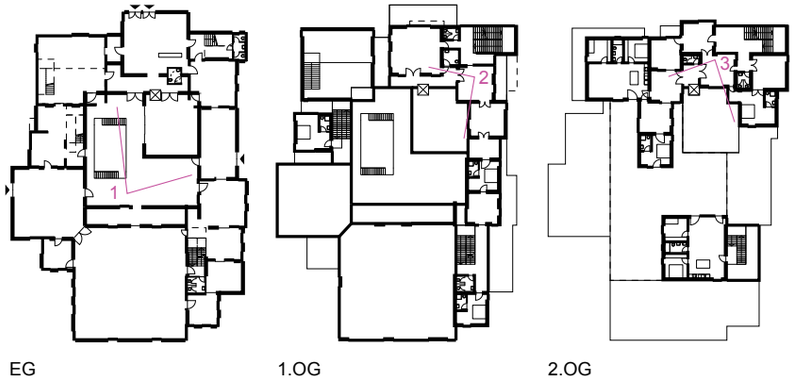
MATRJOSCHKA

view 1, ground floor, faculty club > attrium

view 2, 1st floor

view 3, 2nd floor



EG 1.OG 2.OG

designing form the inside out 1144

Matroschka - Methaheuristic Solvers

Competition entery: Design Form the Insight Out - Envisioning a Scientific Interchange

http://cognition.iig.uni-freiburg.de/martinb/inside-out/Competition_Brief-Designing_from_the_Inside_Out_23June2011.pdf

Pirouze Nourian, Richard Schaffranek
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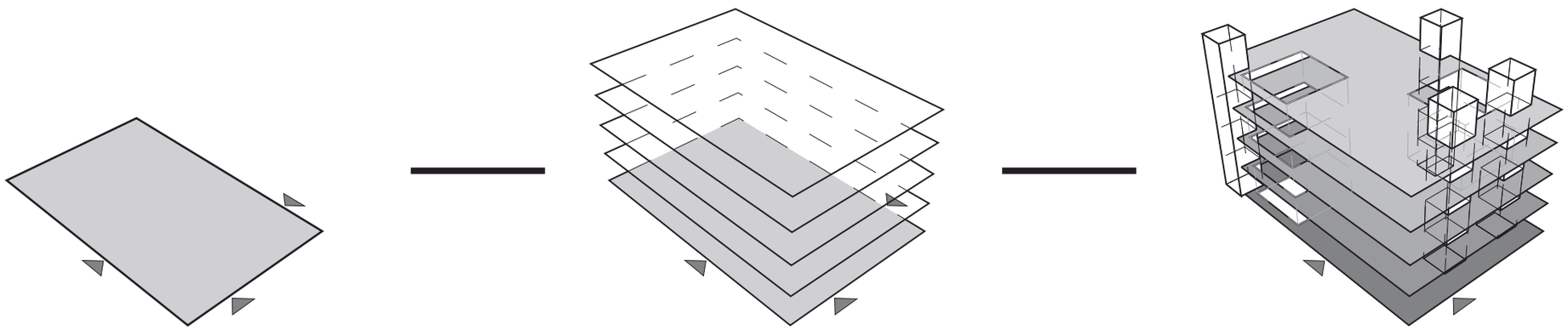

set building footprint and entrance

define roomheight and maximum number of floors

place vertical circulation and attria

Basic Spatial Generation

Matroschka - Design Algorithm

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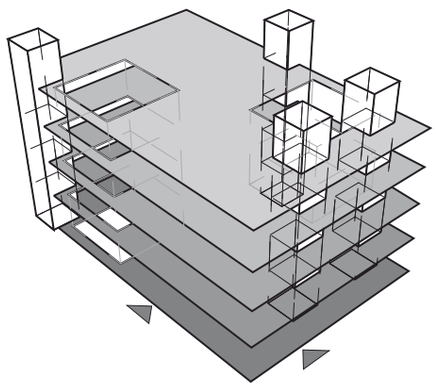
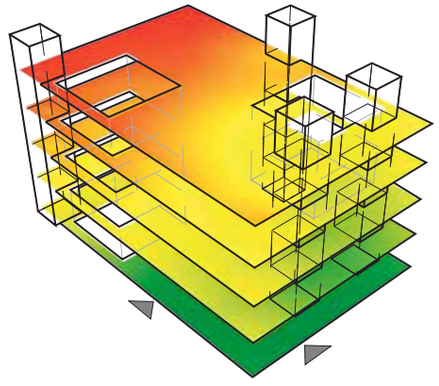
close to entrance — fare from entrance





place vertical circulation and attria

compute avreage distance to entrance
> distance map

Simple Distance Analysis

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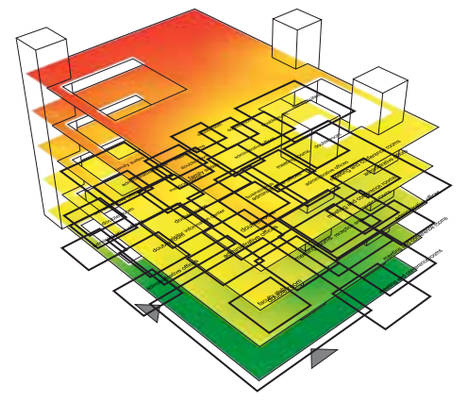
function	m²	desired choice	view
faculty club	317	1,2	1
reception area	102	1,1	1
visitor information center	127	1	1
meeting and conference rooms	63	0,8	0,5
meeting and conference rooms	63	0,8	0,5
meeting and conference rooms	63	0,8	0,5
meeting and conference rooms	317	0,8	0,8
business hub	127	0,8	0,2
meeting rooms	38	0,7	0,5
…	…	…	..
family suites	102	0	0,1
family suites	102	0	0,1

import list and sort it descending according to “desired choice”;
a room with a high “desired choice” value should (i.e. faculty club) be part of the shortest path between all functions within the building more ofthen then a room with a low value (i.e. family suite);
“desired choice” is a relative value;

close to entrance — fare from entrance



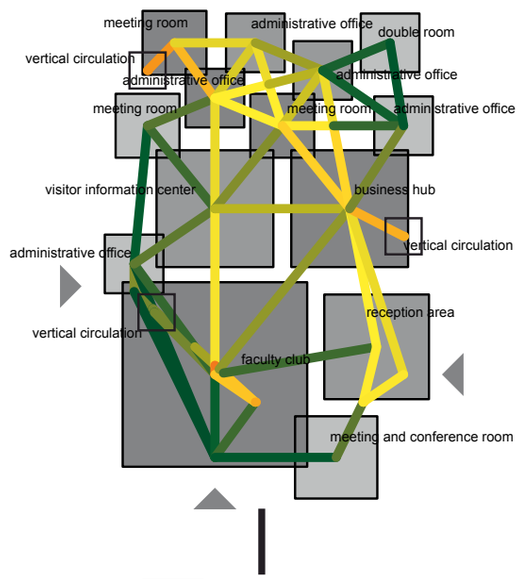
allocation heuristic:

allocate functions based on the values of the distance map:

first function -> smallest value; erase all points occupied by the first function; if a room is larger than i.e. 100m² it occupies space on two floors;

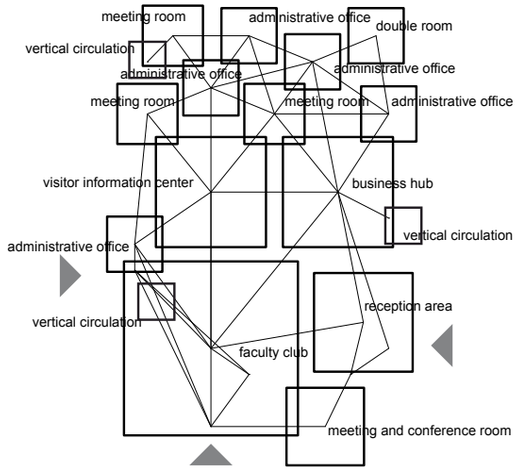
second function -> smallest remaining value; erase all points occupied by the second function;

... repeat until all functions are allocated;



callculate “choiceBetweenPoints”;
choiceBetweenPoints:
How often is an edge of a graph part of the shortest path or a path with a maximum deviation of i.e. 1.2 times the length oft he shortest path, between two points?

rarly — often



compute all possible circulation between the placed functions > circulation graph

Analysing Spatial Layout
Matroschka - Design Algorithm

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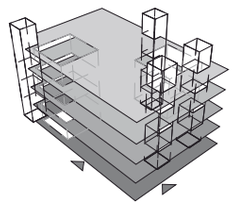
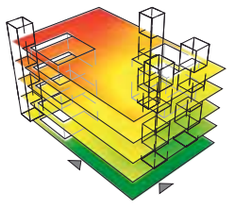
1st autogenerative step:

order function descending according to their “choiceBetweenPoints” value;
compare this list with the imported list;
the fittness of the solution is the difference between those lists (less difference > better fittness);
reposition staircase and attria;



place vertical circulation and attria

close to entrance — fare from entrance



compute avreage distance to entrance > distance map

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faculty club	317	1,2	1
reception area	102	1,1	1
visitor information center	127	1	1
meeting and conference rooms	63	0,8	0,5
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meeting and conference rooms	317	0,8	0,8
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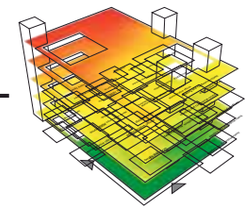
…	…	…	..
family suites	102	0	0,1
family suites	102	0	0,1

import list and sort it descending according to “desired choice”;
a room with a high “desired choice” value should (i.e. faculty club) be part of the shortest path between all functions within the building more ofthen then a room with a low value (i.e. family suite);
“desired choice” is a relative value;

close to entrance — fare from entrance



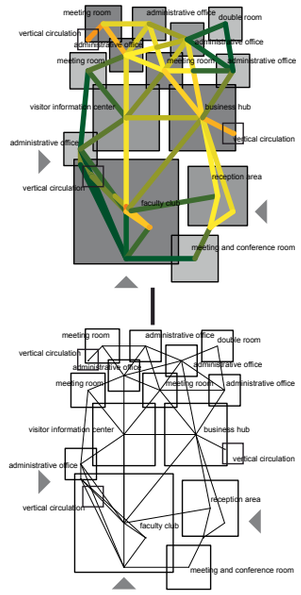
allocation heuristic:

allocate functions based on the values of the distance map:

first function -> smallest value; erase all points occupied by the first function; if a room is larger than i.e. 100m² it occupies space on two floors;

second function -> smallest remaining value; erase all points occupied by the second function;

... repeat until all functions are allocated;



callculate “choiceBetweenPoints”;
choiceBetweenPoints:
How often is an edge of a graph part of the shortest path or a path with a maximum deviation of i.e. 1.2 times the length oft he shortest path, between two points?

rarly — often

compute all possible circulation between the placed functions > circulation graph

1. Generative Step

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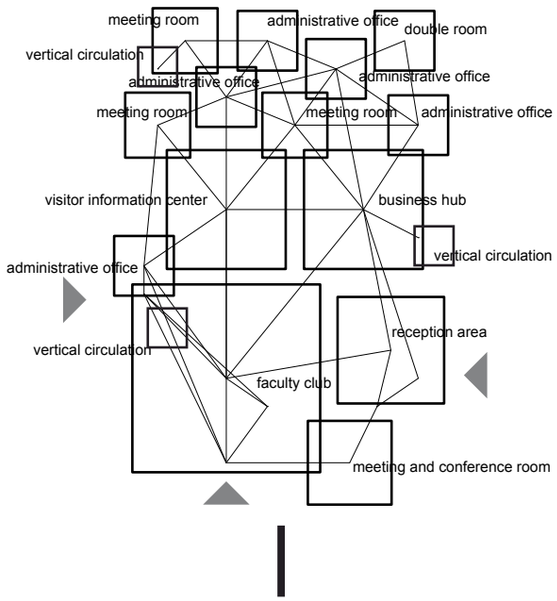
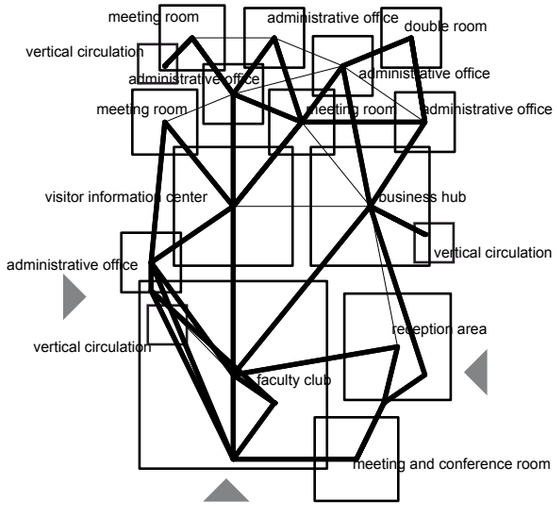


compute all possible circulation between the placed functions > circulation graph



to ensure a working circulation, compute the minimal and maximal spanning tree > minimal circulation

Generate Minimal Circulation

Matroschka - Design Algorithm

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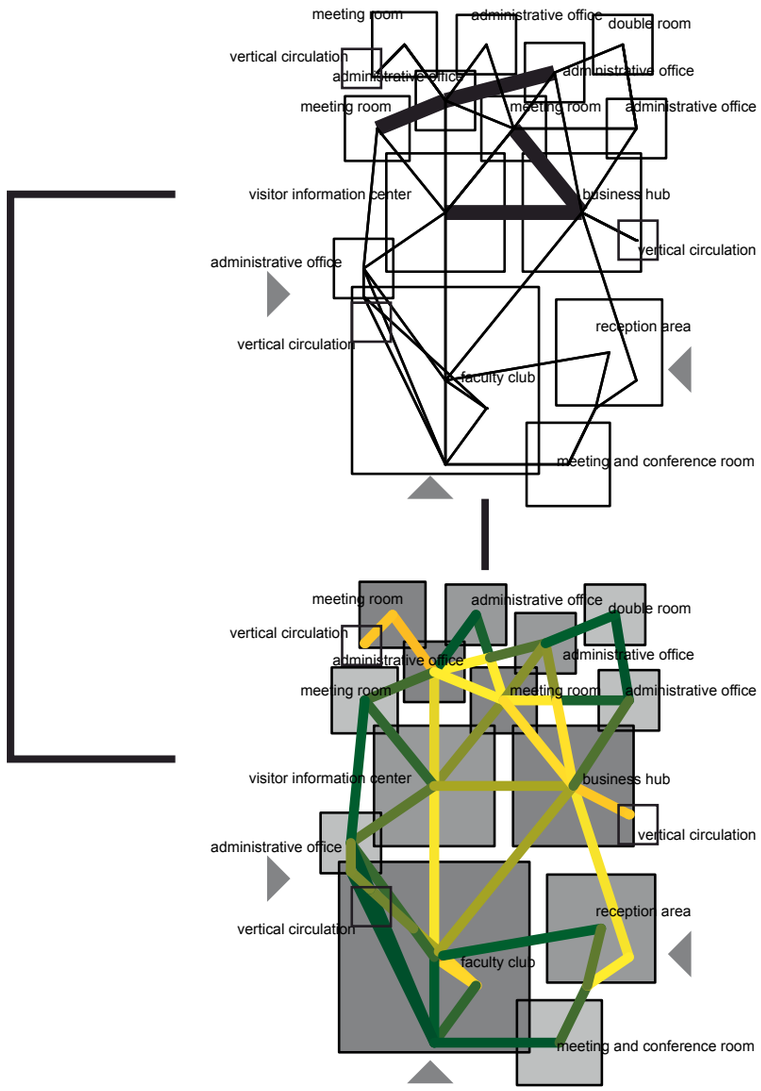
2nd autogenerative step:

order function descending according to their “choiceBetweenPoints” value;
compare this list with the imported list;
the fittness of the solution is the difference between those lists (less difference > better fittness);
randomly add differenet circulation to the minimal circulation



randomly add more circulation to the minimal circulation;

callculate “choiceBetweenPoints”;
choiceBetweenPoints:
How often is an edge of a graph part of the shortest path or a path with a maximum deviation of i.e. 1.2 times the length oft he shortest path, between two points?

rarly — often

2. Generative Step
Matroschka - Design Algorithm

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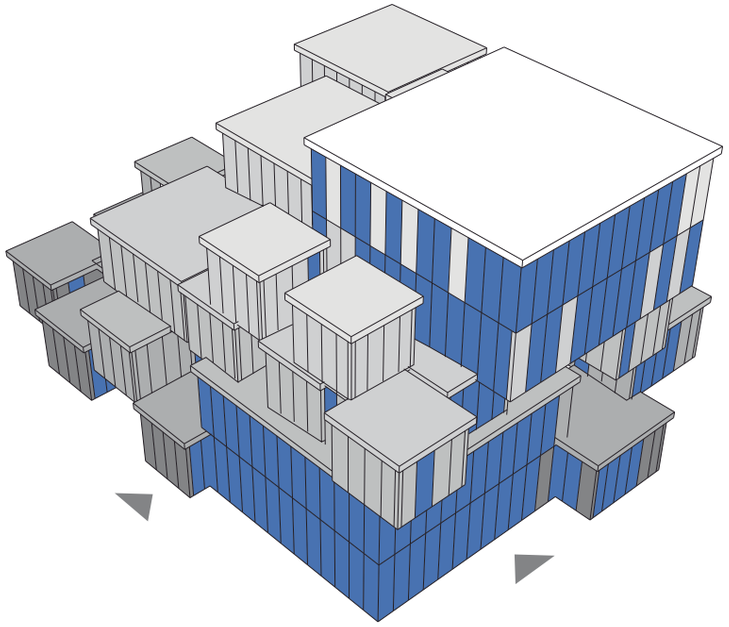
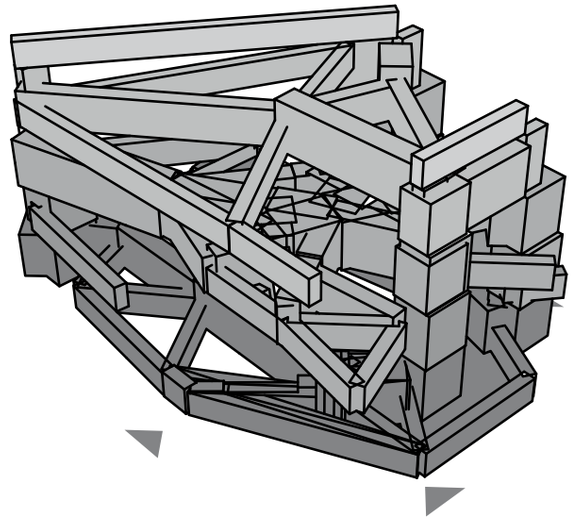




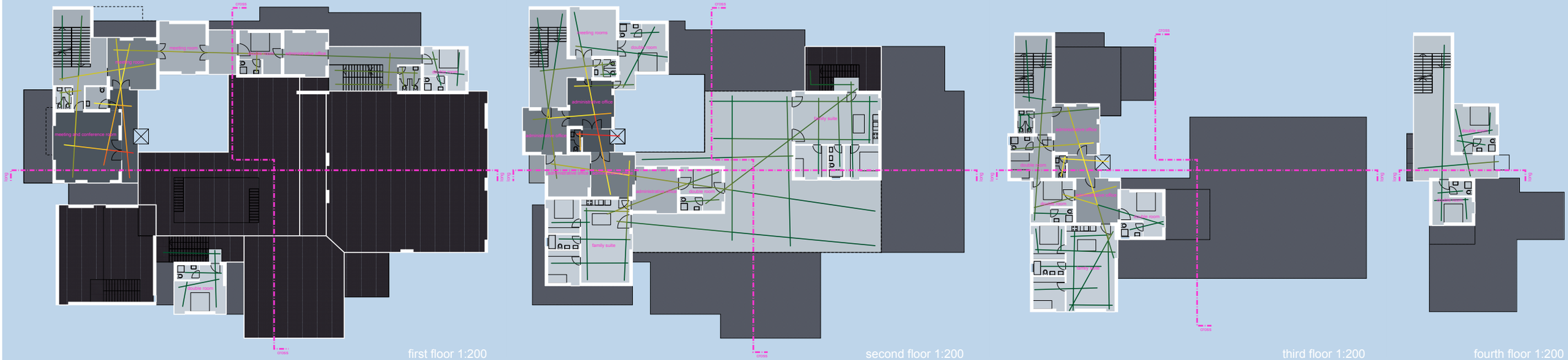
generate circulation and room geometrie;

with and height of the circulation is influenced by the value of “choice between points”;

the amount of solid / transparent wall is influenced based on the view value of the function (> see imported list)

Output
Matroschka - Design Algorithm

MATRJOSCHKA

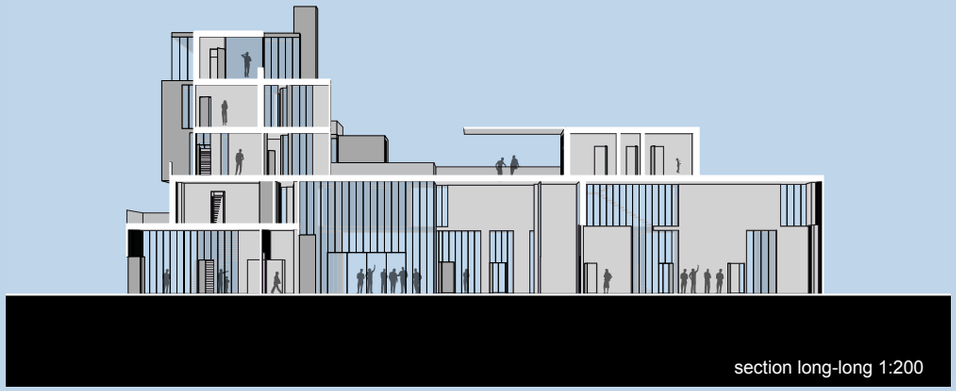


first floor 1:200

second floor 1:200

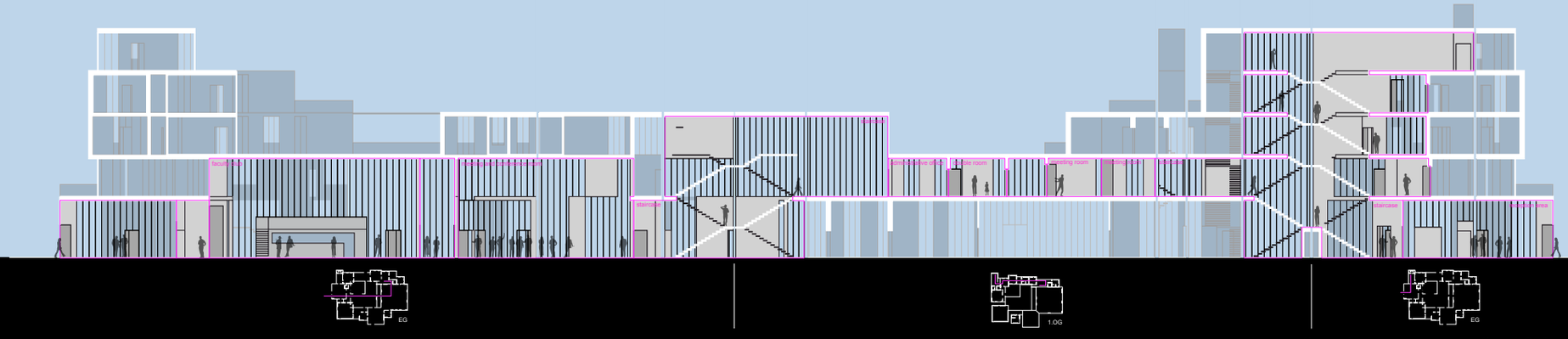
third floor 1:200

fourth floor 1:200



section long-long 1:200

section cross-cross 1:200



path reception - double room - reception 1:200

designing form the inside out 1144

Redrawn by Hand

Matroschka - Design Algorithm

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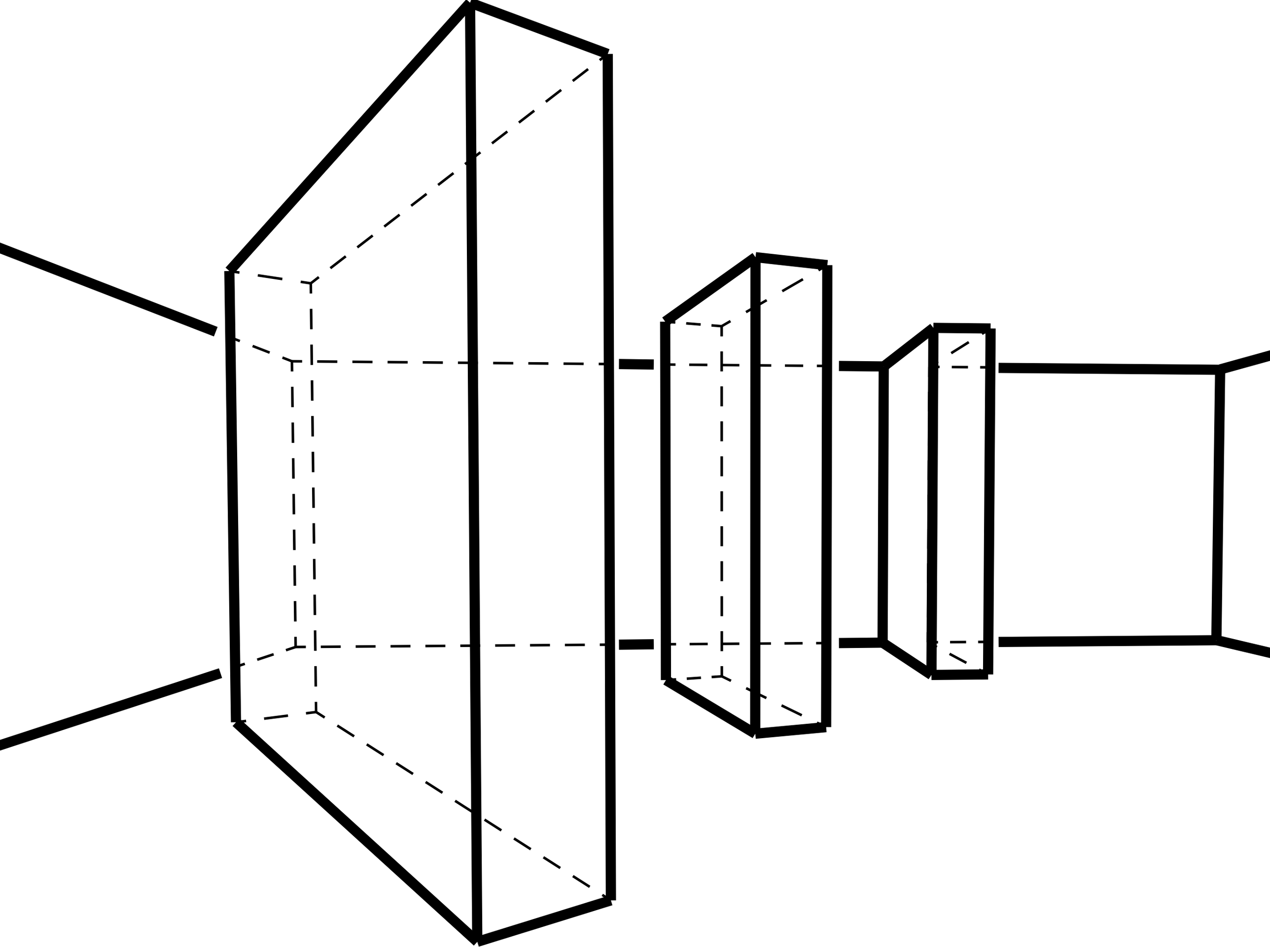
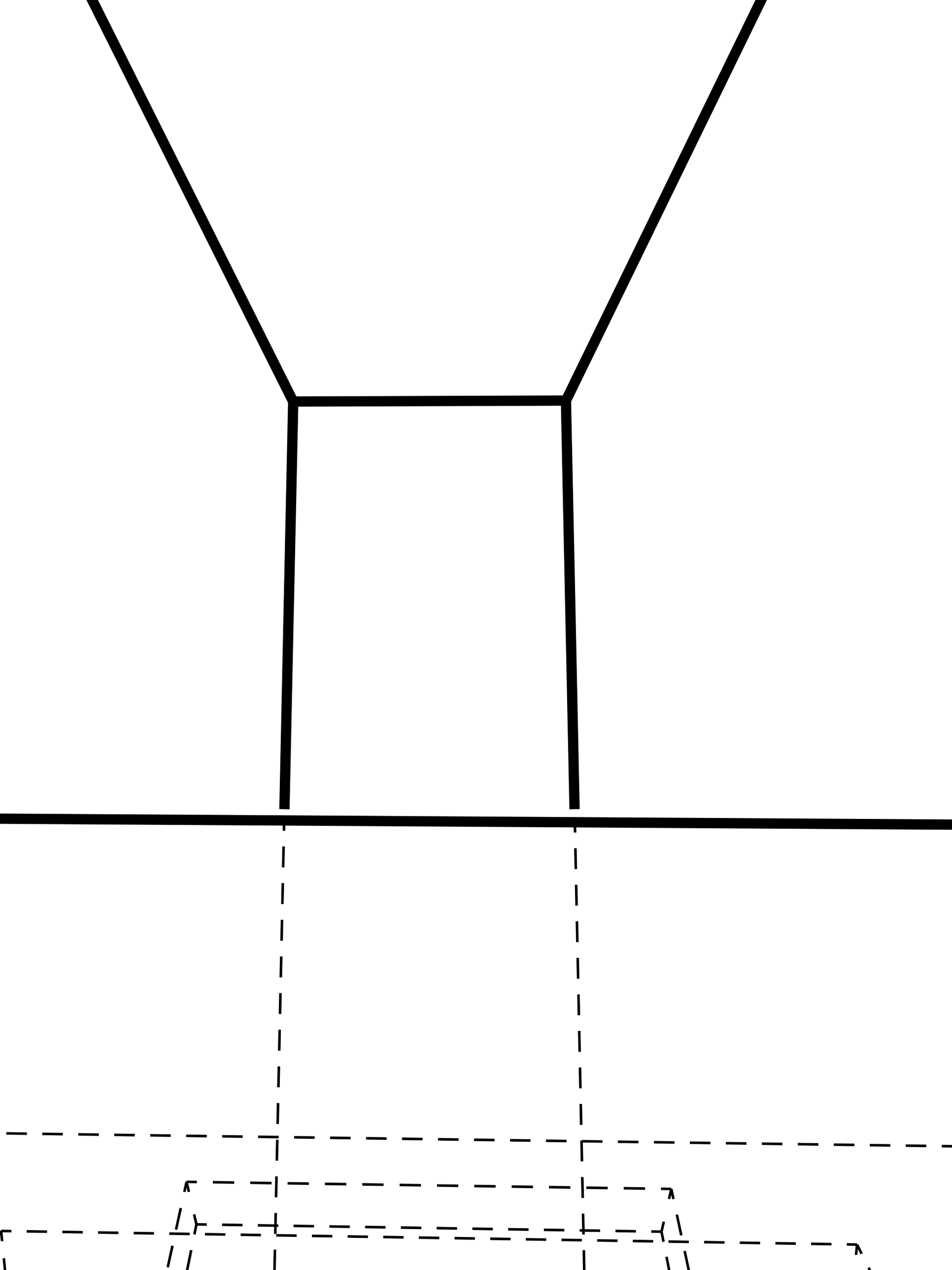
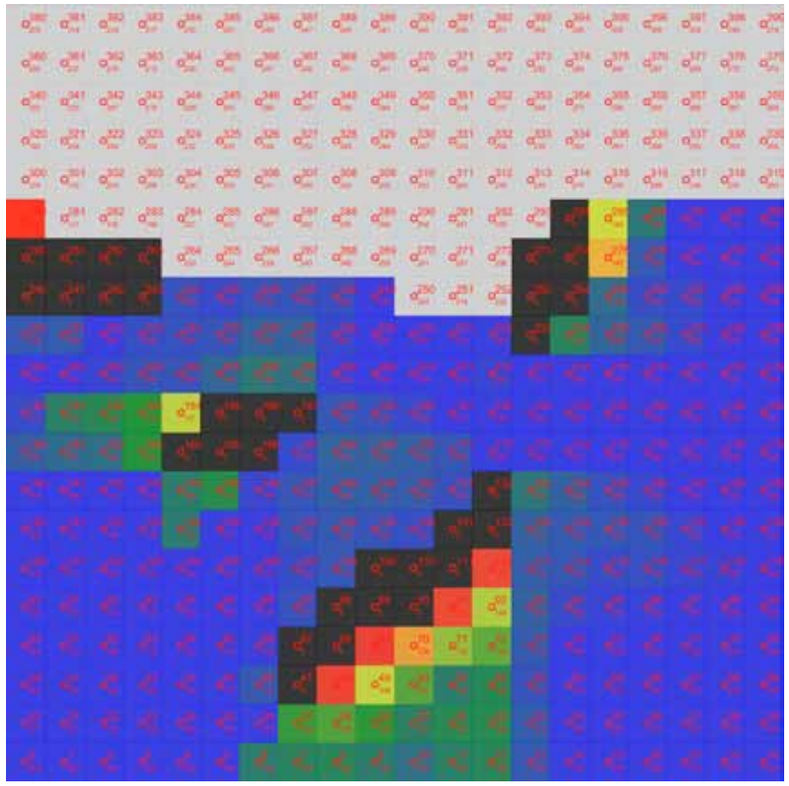
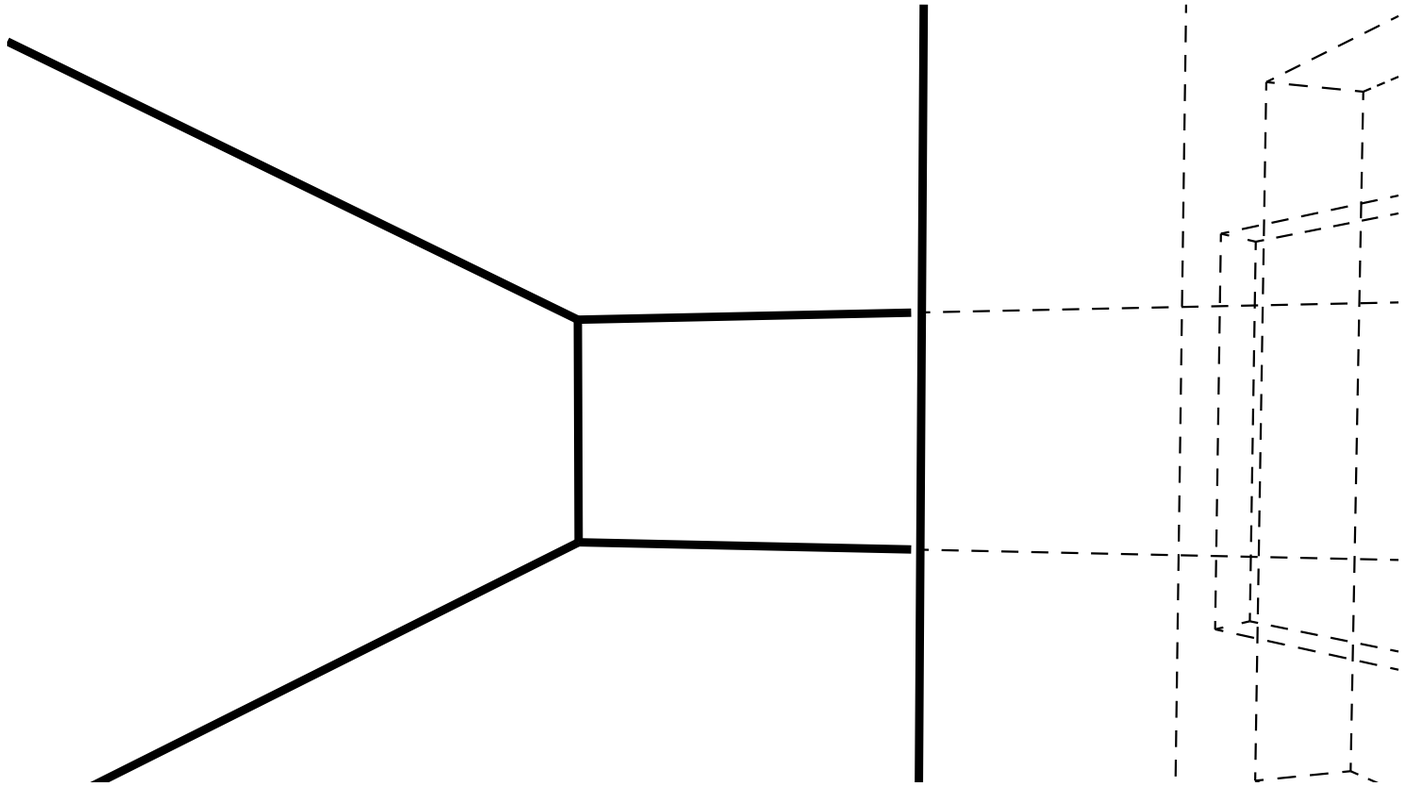
Generative Syntax in Architecture and Urban Design

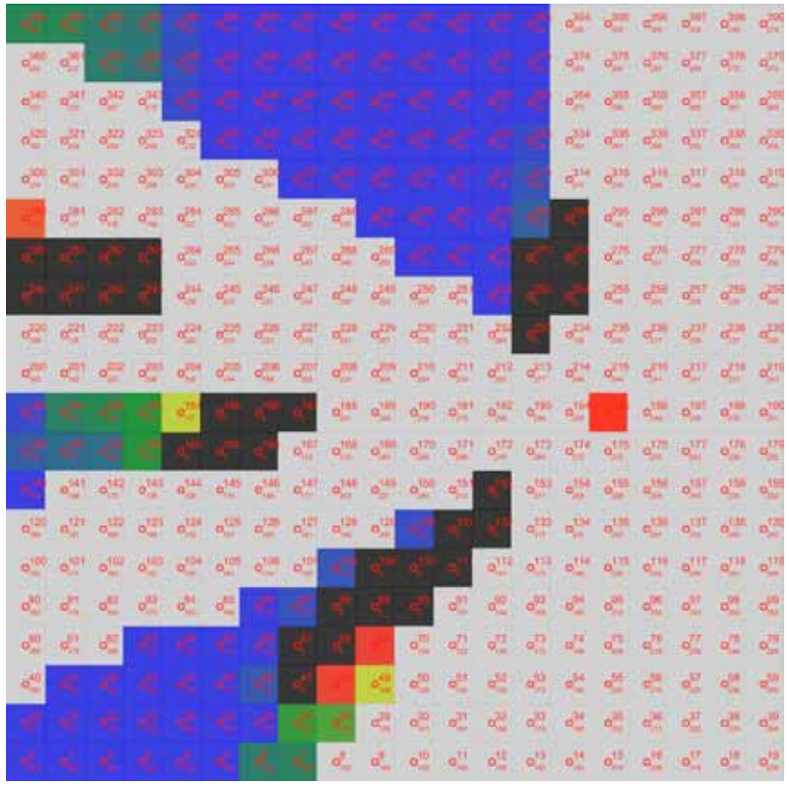
AAG 2014

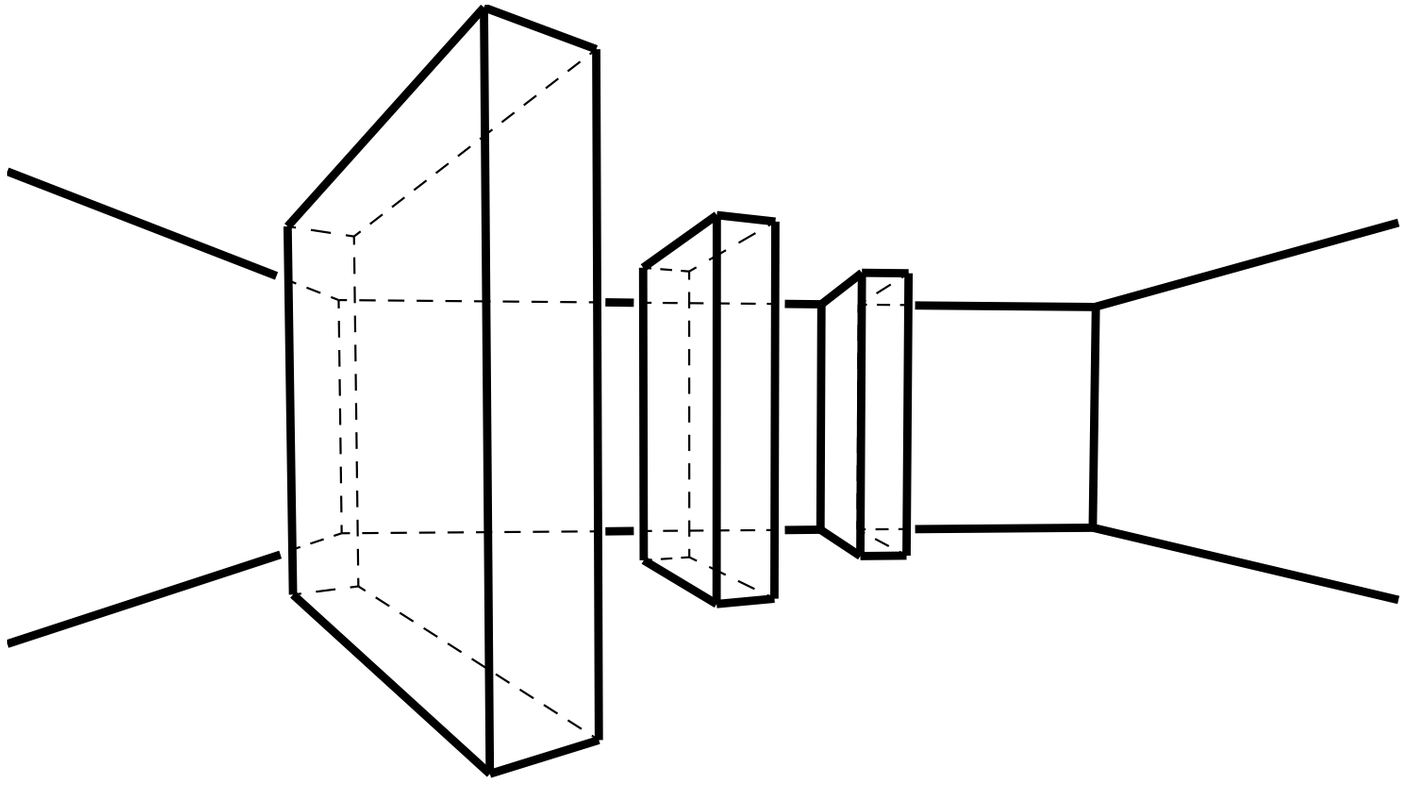






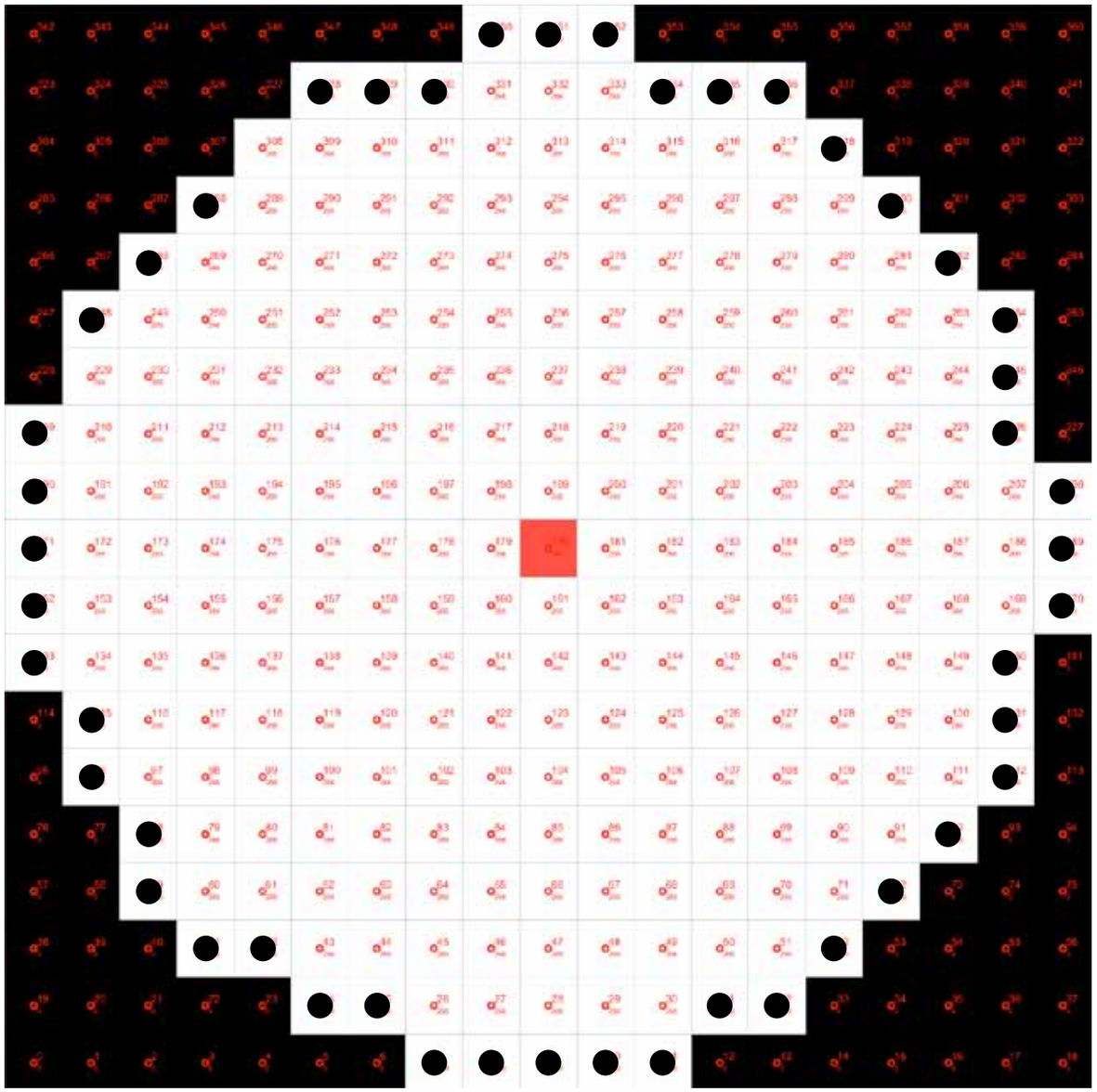






Visual Graphs & Metheuristic Solvers

compare to: Schneider, S. & König R. (2012). Exploring the Generative Potential of Isovist Fields - The Evolutionary Generation of Urban Layouts based on Isovist Field Properties. Proceedings of the 30th International Conference on Education and research in Computer Aided Architectural Design in Europe (eCAADe), Prague, Czech Republic.



$$Q = \frac{4\pi A}{L^2}$$

Point of view

Visible area (A)

Visible circumference (L)

Circularity: 0.9758

For a circle this the circularity / iroerimetric quatient should be 1. As the plugin works based on a discreet space partition there is a slight error.

Cicularity Measurment (p. 53) or Isoperimetric Quotient (Q)

Visual Graphs & Metheuristic Solvers

Benedikt M L, 1979,'To take hold of space: isovists and isovist fields''Environment and Planning B 6 47 - 65

Pirouze Nourian, Richard Schaffranek
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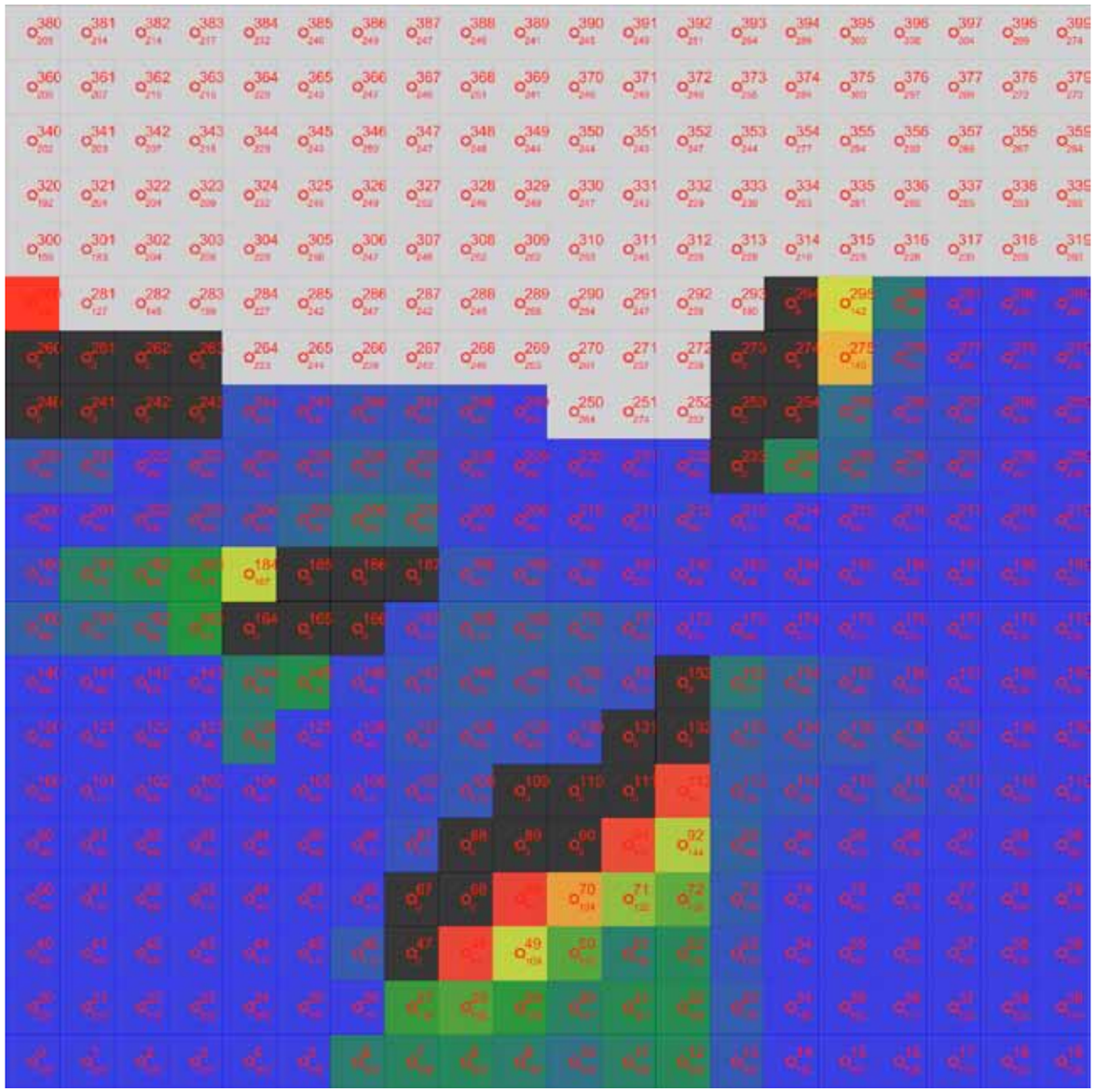

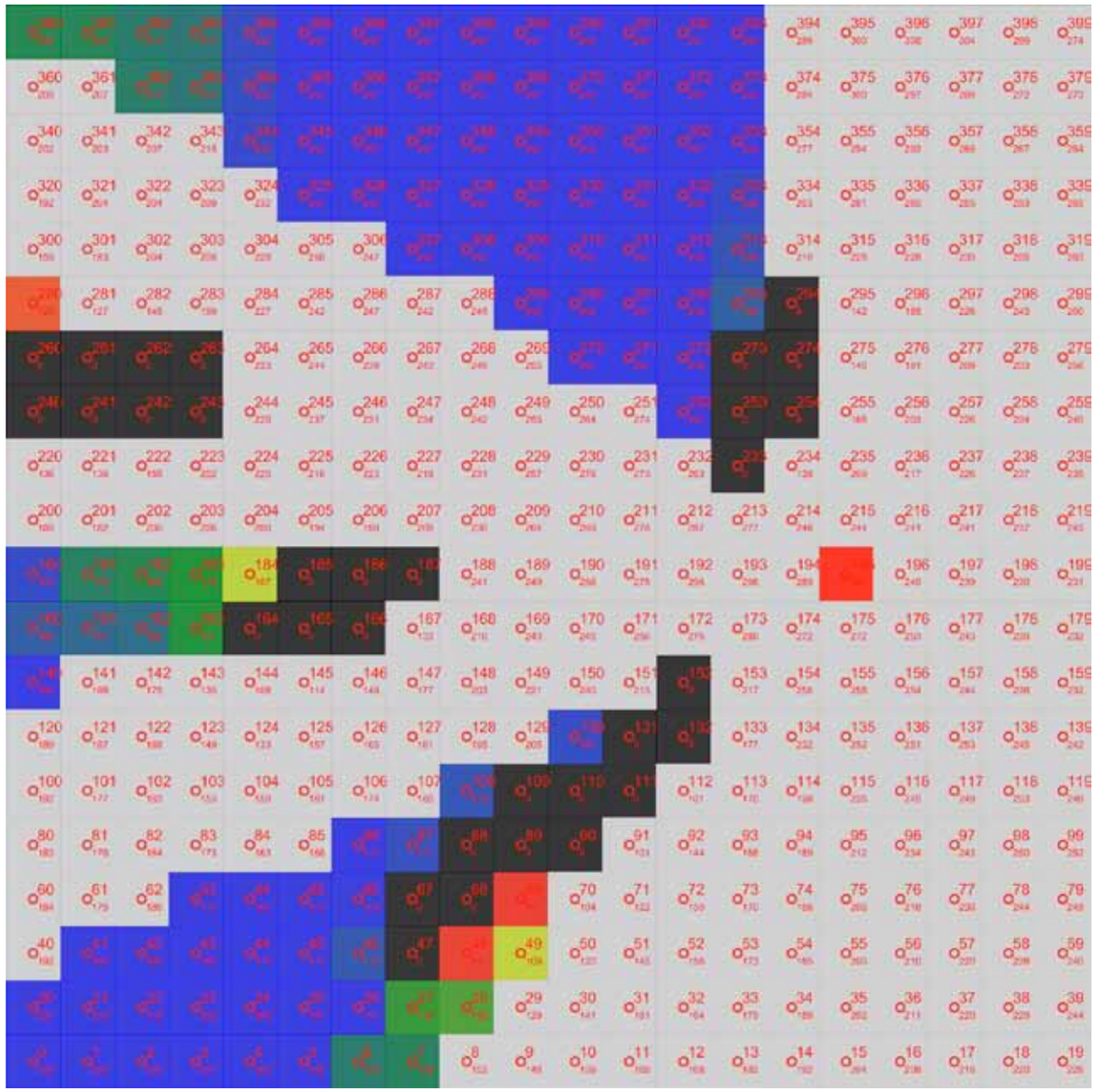

FOV Shape and Circularity Measurment

Visual Graphs & Metheuristic Solvers

Benedikt M L, 1979,’To take hold of space: isovists and isovist fields’’Environment and Planning B 6 47 - 65

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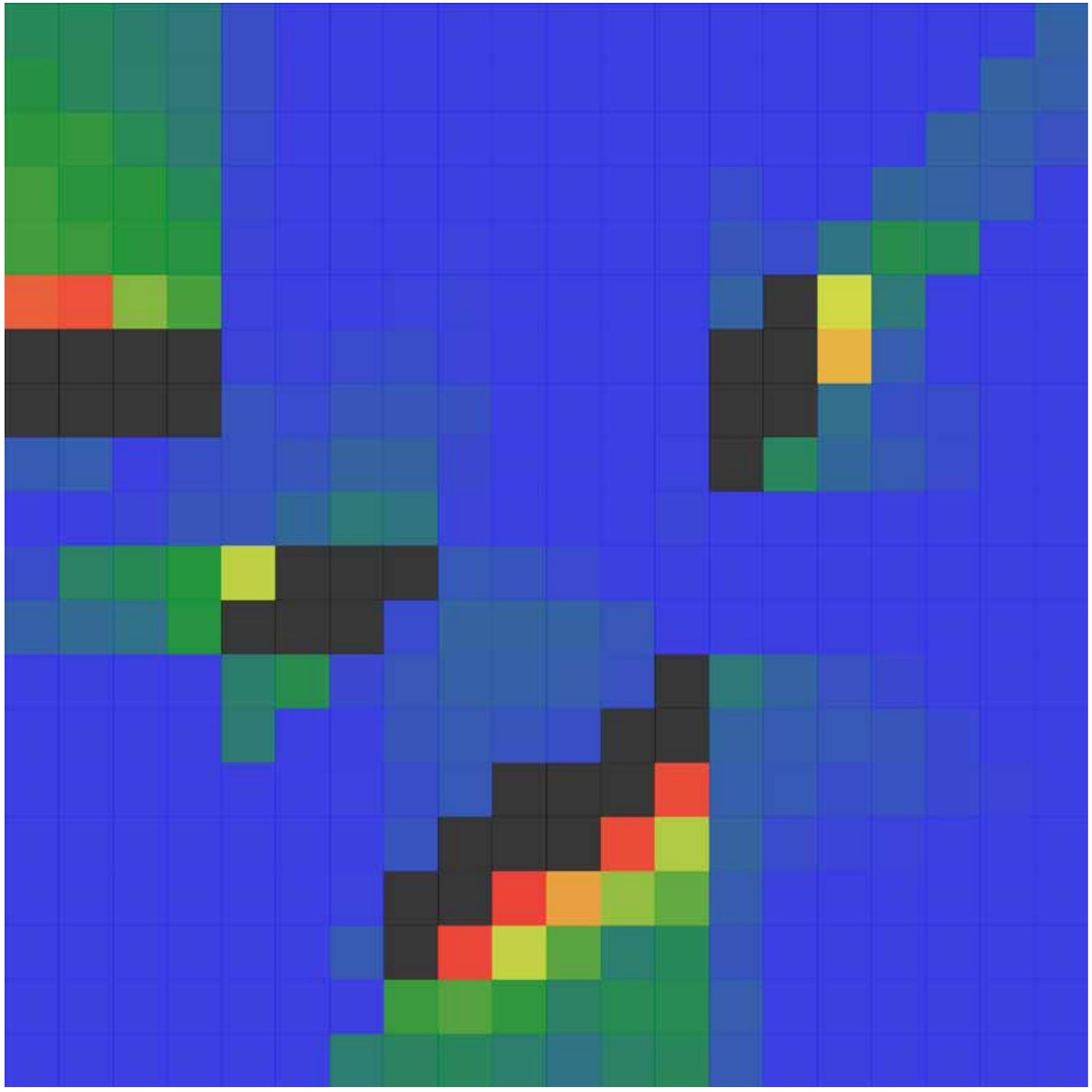

Resulting minimized geometric mean

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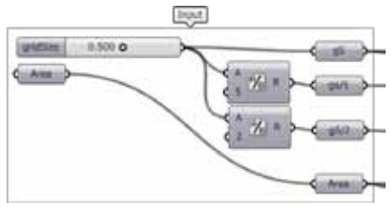
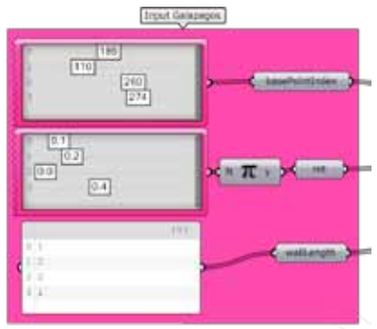
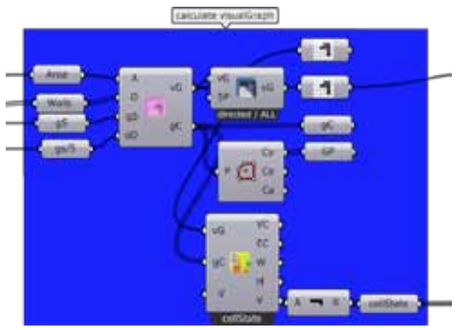


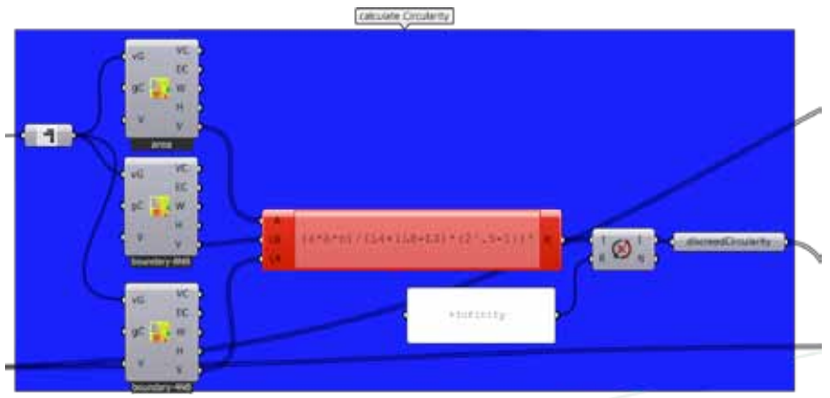
1. Input area and grid size of the analysis grid



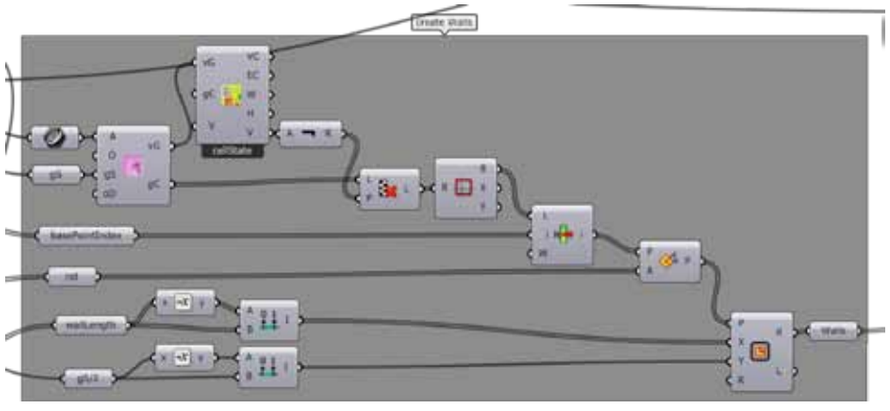
2. Genepools to controll the position and rotation of the walls



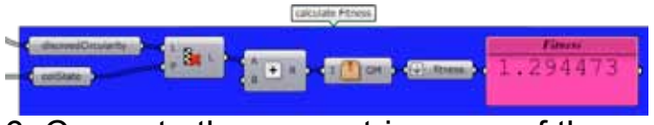
4. Create visual graph



5. Compute circularity measurment



3. Create walls

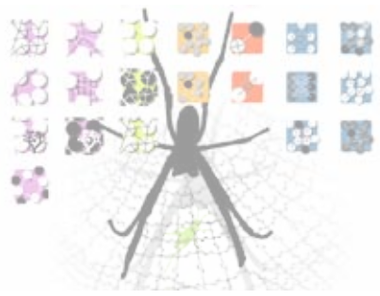


6. Compute the geometric mean of the given solution. (fitness)

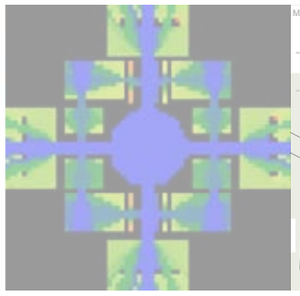
7. Use galapagos to minimize the fitness

Syntactic

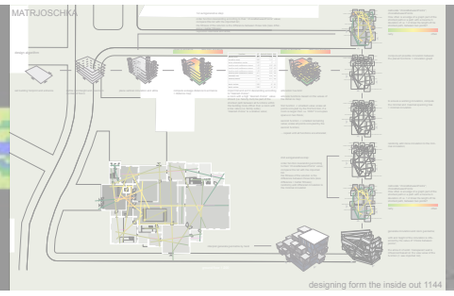
SpiderWeb Plugin



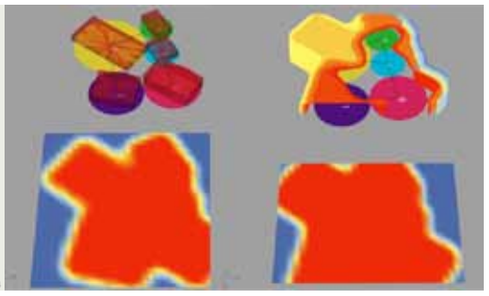
Visual Graphs



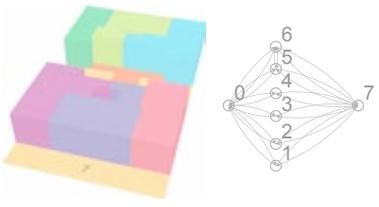
Metaheuristic Solvers



Field to Space



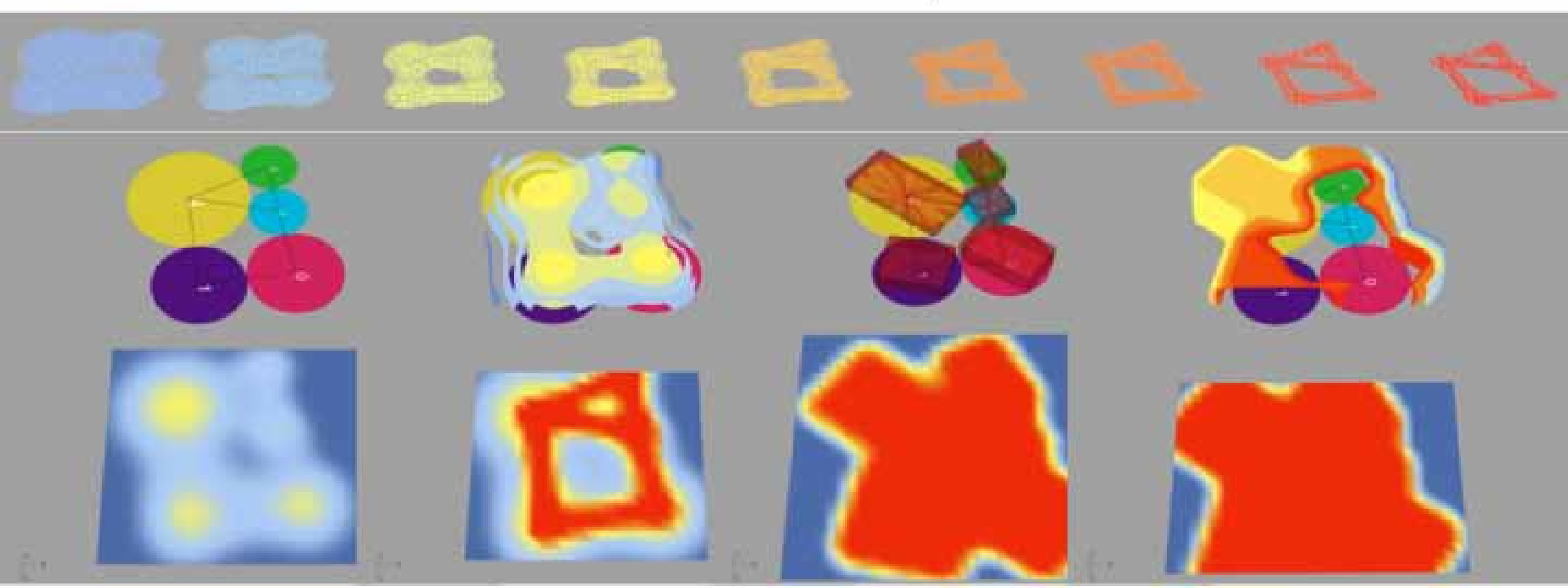
Parallel Planing



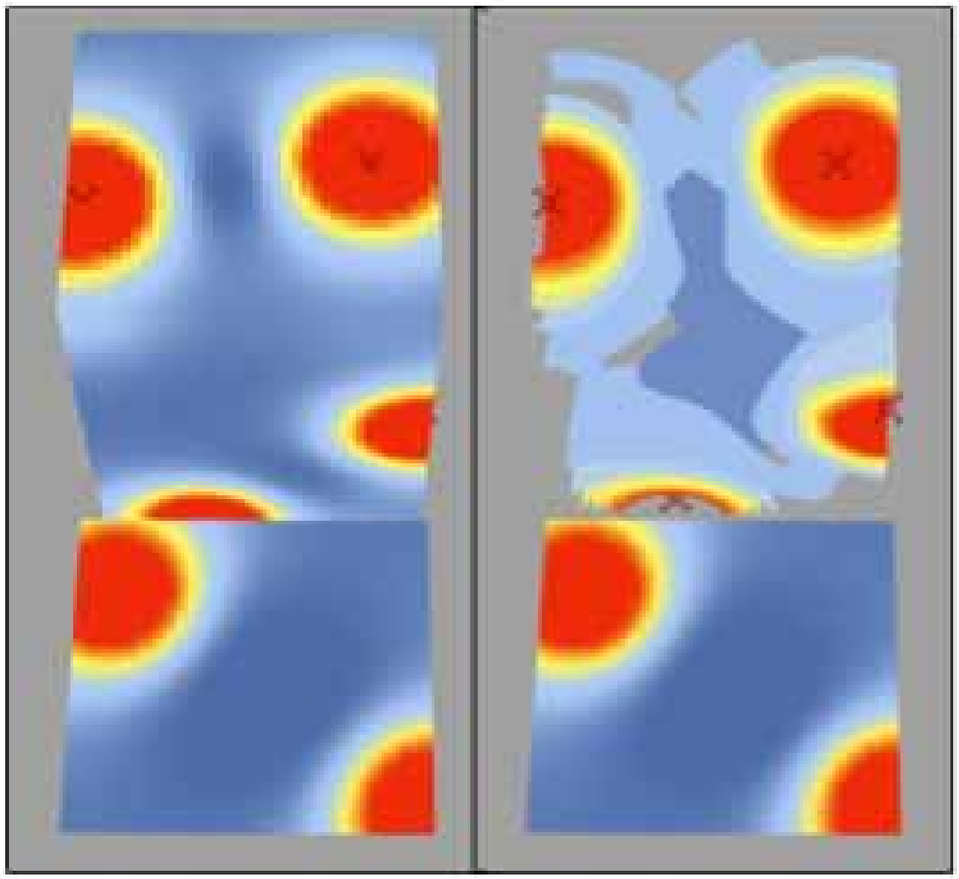
From Graph to Field to Space

a continuous approach to spatial configuration!?

Say each space is defined in simplest form as a node, then in the absence of external influences it becomes a circle or hemisphere then…



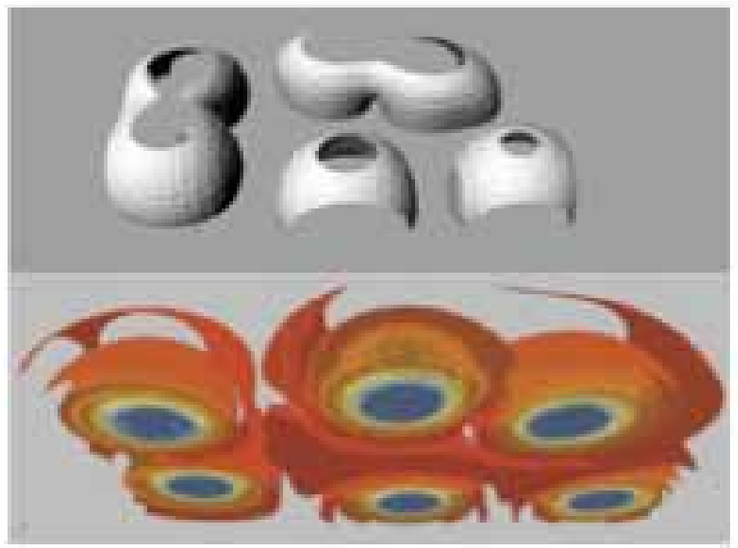
From Graph to Field to Space



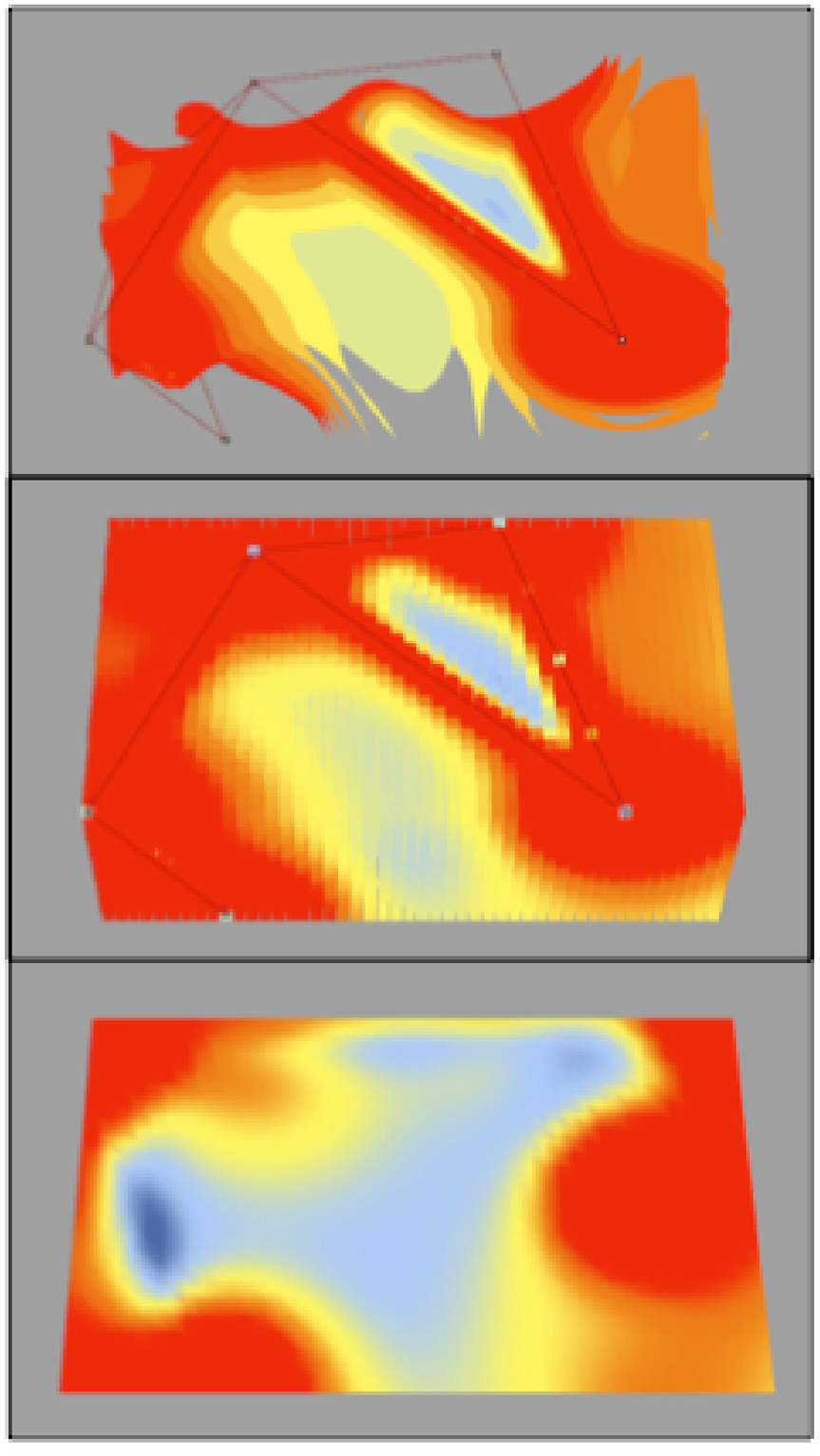
ISOSURFACE:
a scalar field of values is evaluated at every point of a 3D grid; then layers of the field can be found as ‘iso-surfaces’. An isosurface is the border between those points whose attribute values are above the iso value and the ones below.

Raster3D methods are based on OTB_3DGIS.DLL
https://sites.google.com/site/pirouznourian/otb_3dgis

- voxel representation of big spatial data
- converting 3D vector data to 3D raster data and vice versa
- using voxel representation in spatial analysis
- voxel operations for spatial planning



From Graph to Field to Space



What does (might) it all have to do with architecture?

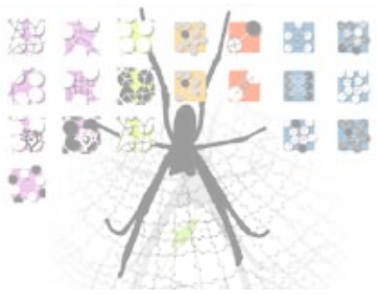
Imagine a 3D configuration composed of nodes and links (vertices and edges) as in the top picture. We can think of a field around this configuration, which looks in 2D like the slice shown at the bottom. Controlling the field we can create the boundaries of spaces as isosurfaces!

From Inside Out!? Try it out!

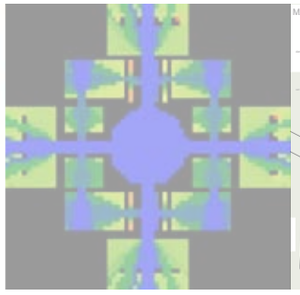
bubble diagram-to-field-to-space!?

Syntactic

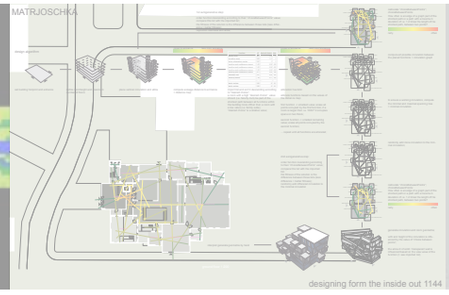
SpiderWeb Plugin



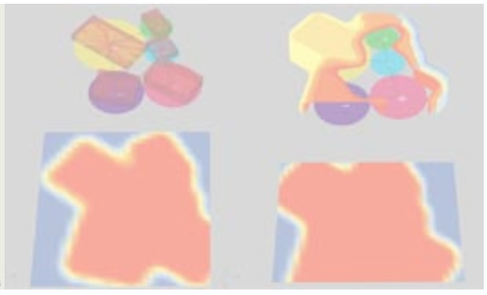
Visual Graphs



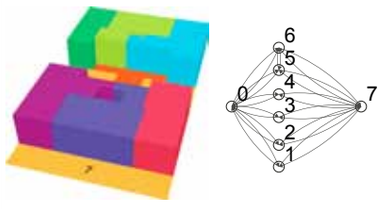
Metaheuristic Solvers

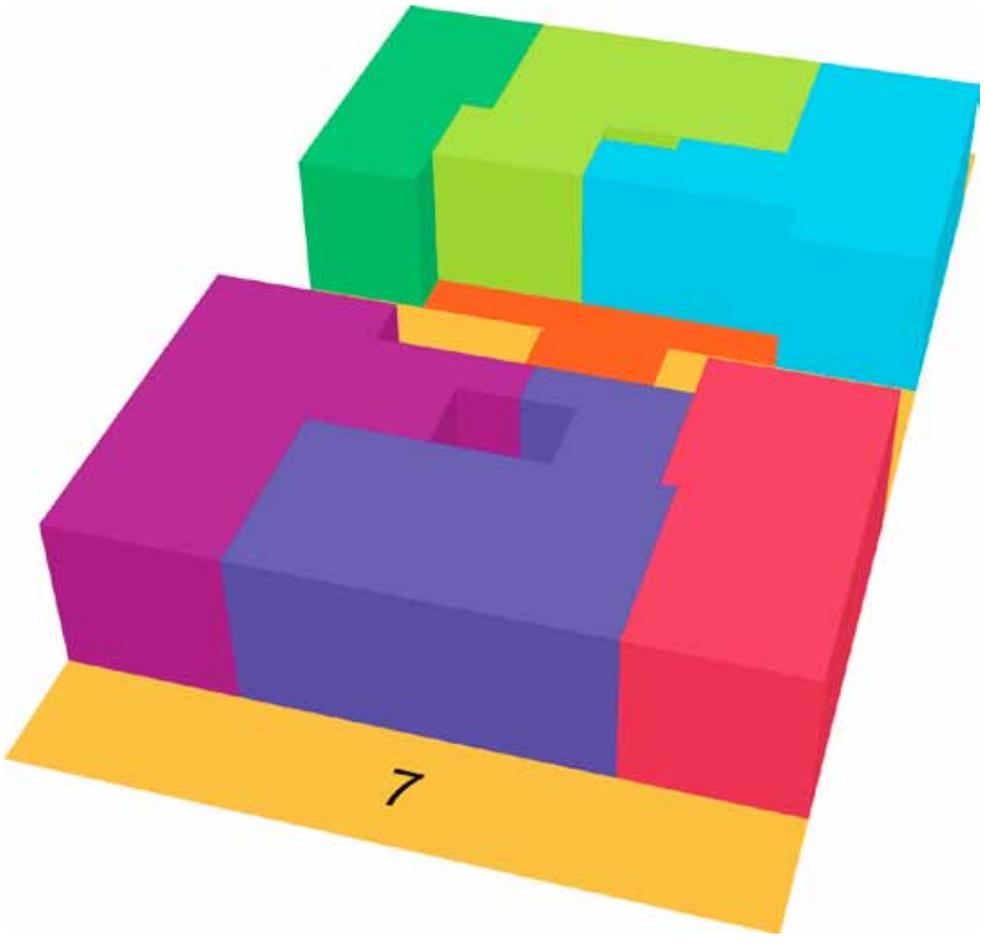


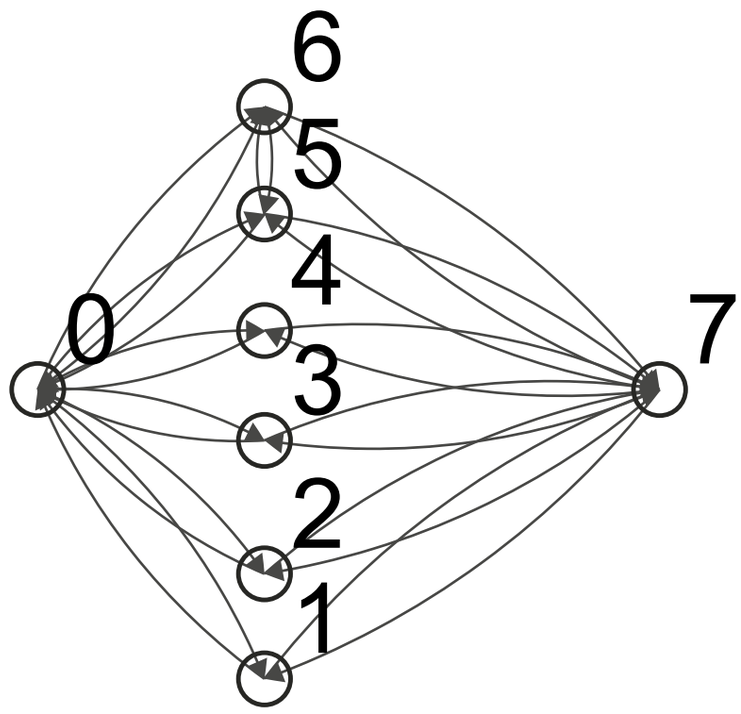
Field to Space



Parallel Planing

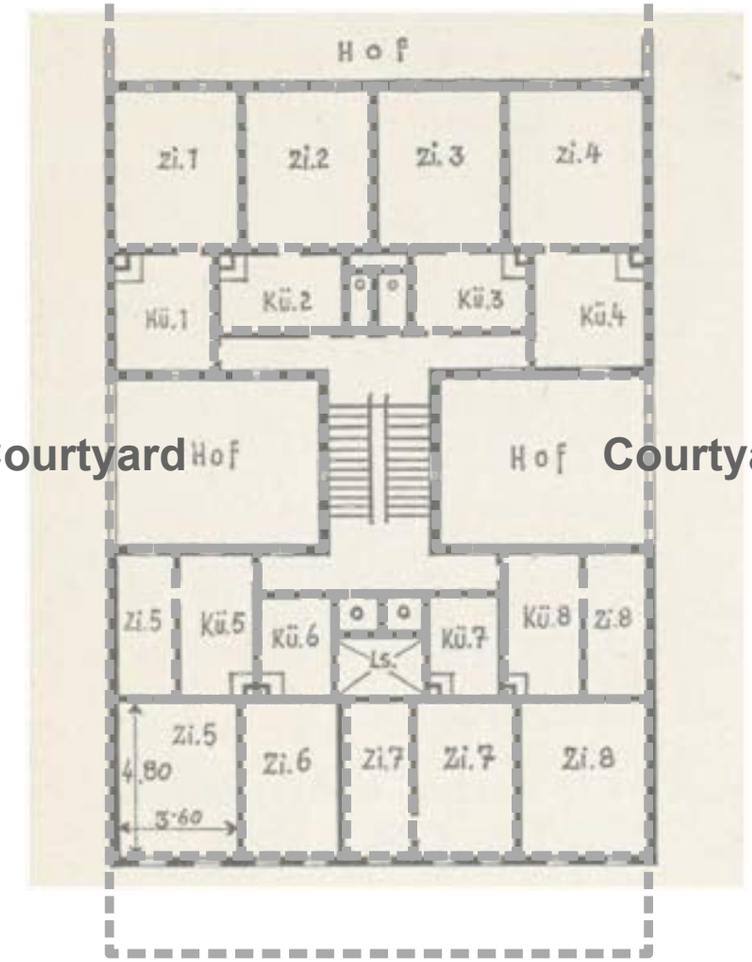






Paralell Planing

Courtyard

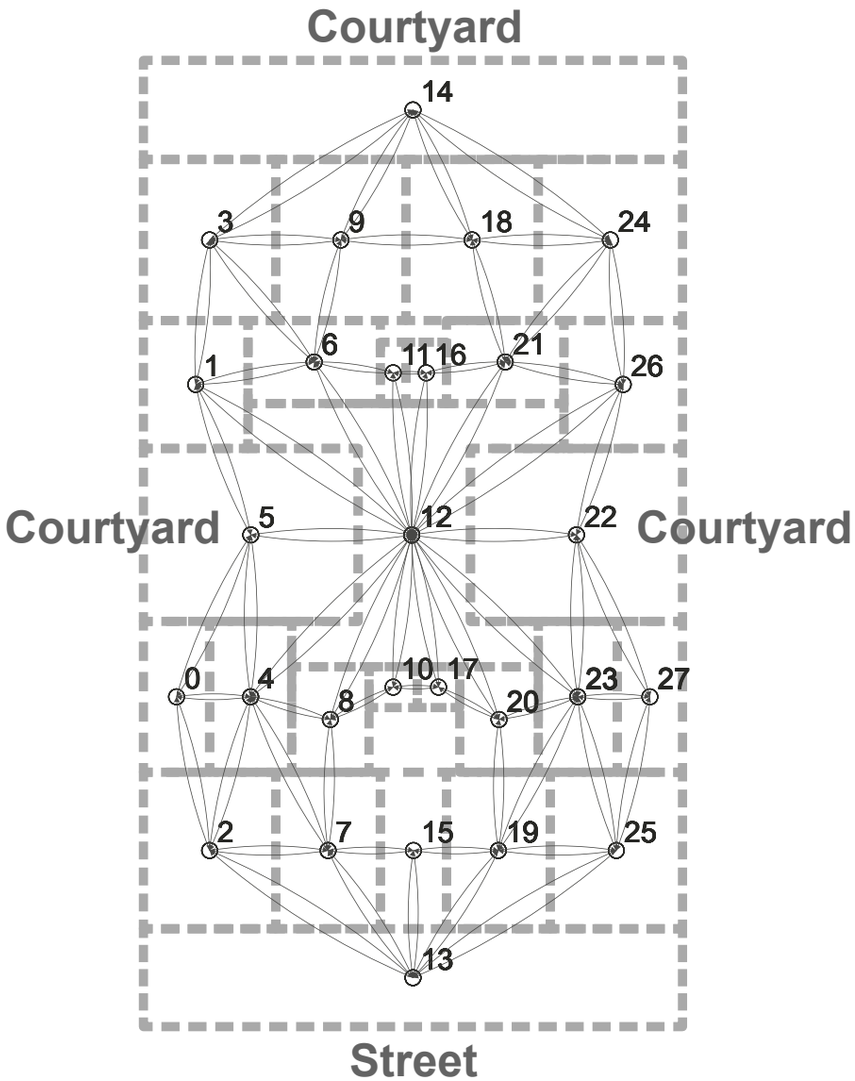


Courtyard Courtyard

Street

Process 1: Spatial Configuration e.g.: “Gründerzeit“ Building in Vienna

Parallel Planing



Process 1: Spatial Abstraction

Parallel Planing

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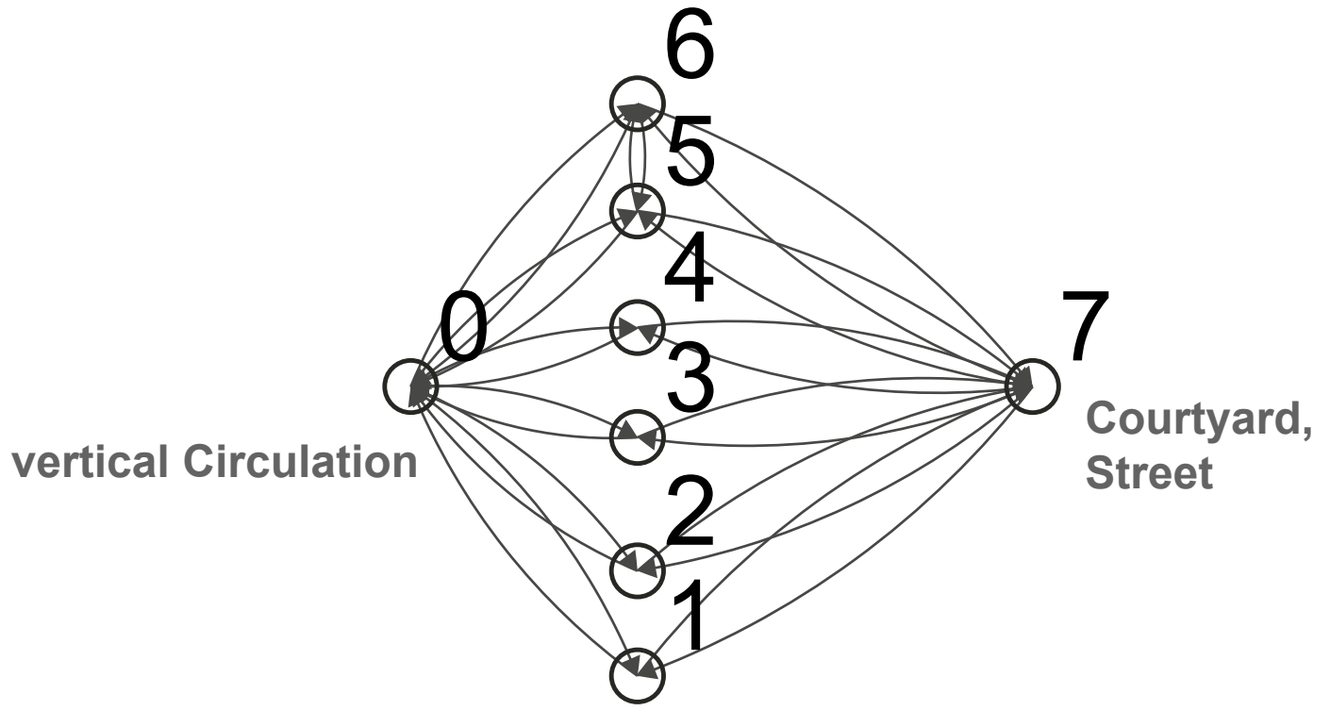

Process 2: Wanted Spatial Configuration eg. Flats

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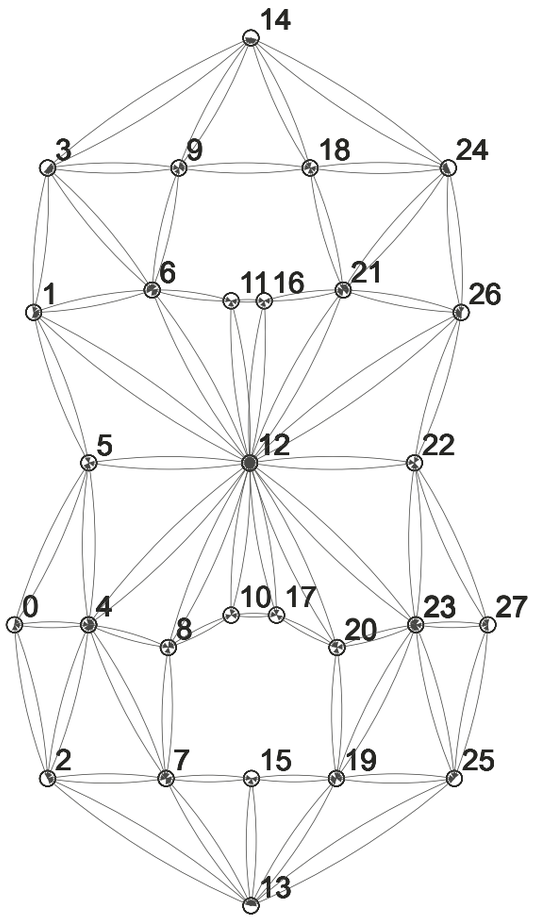

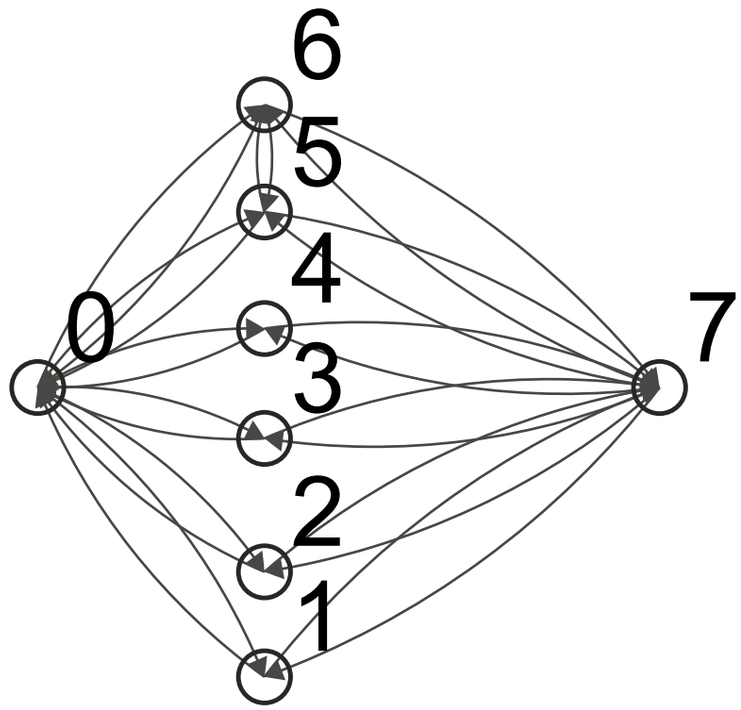

Matching Process 2 > Process 1

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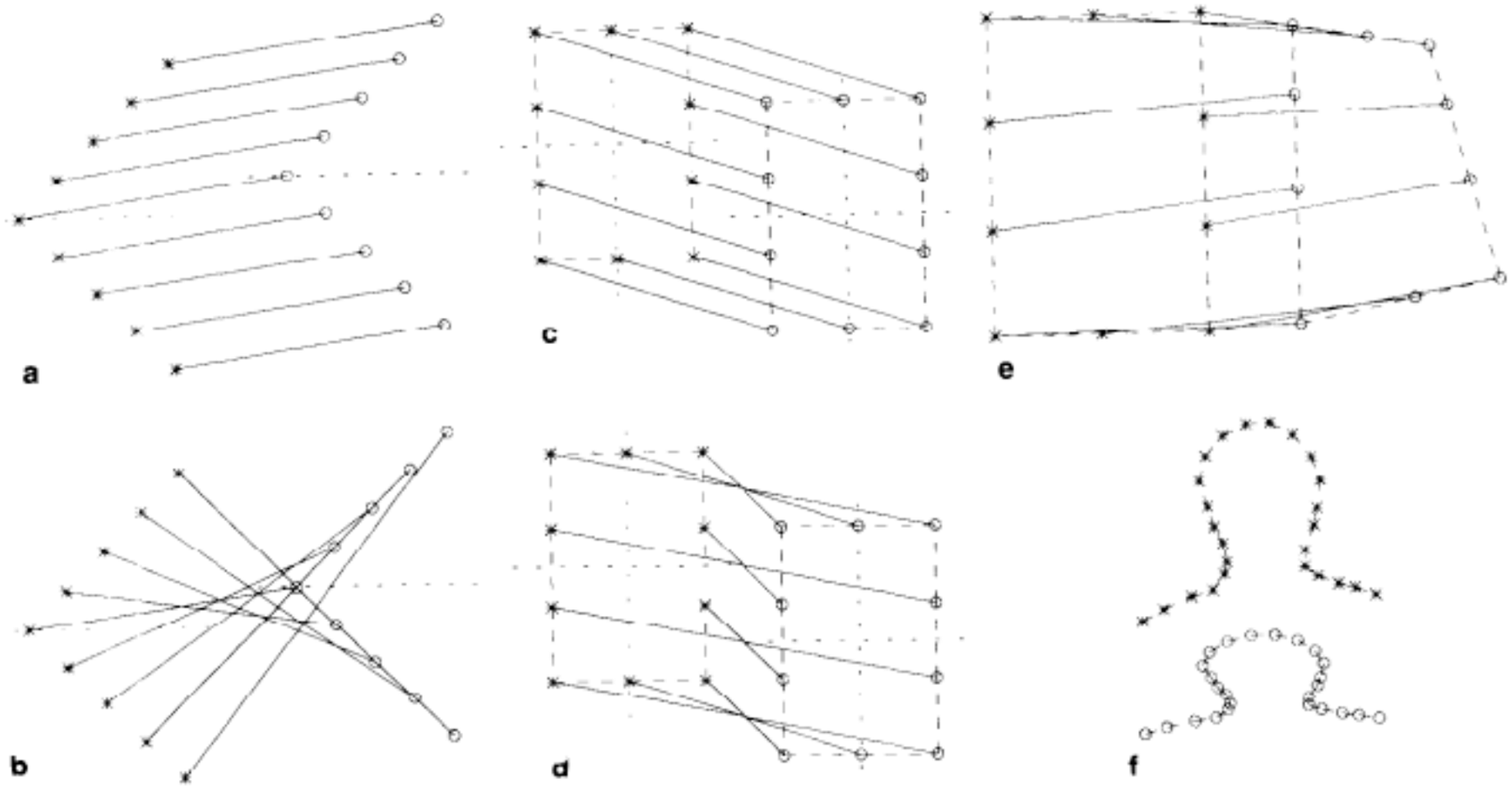


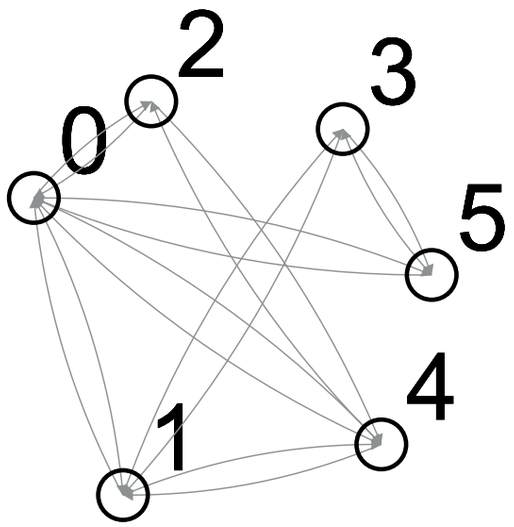
Figure 5. Modal algorithm (dotted lines show symmetry axes). (a) (b) Two possible mappings for a roof-like shape (one reflectional symmetry); (c) (d) two of four possible mappings for a rectangle (two reflectional symmetries); (e) rectangle skewed by small perspective distortion; (f) two skewed shapes whose modes are too dissimilar to match

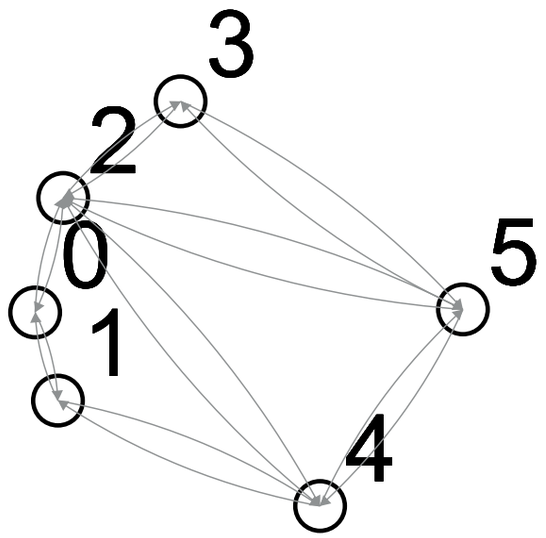
Image from: Shapiro, Larry S., and J. Michael Brady. “Feature-based correspondence: an eigenvector approach.” Image and vision computing 10.5 (1992): 283-288. (p. 287)

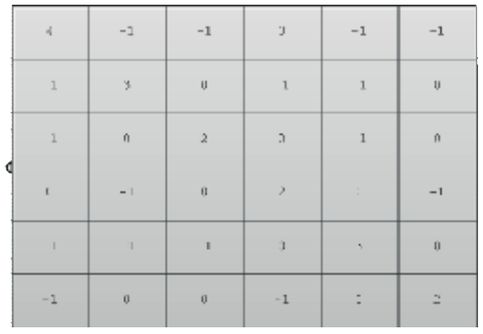
Graph Matching

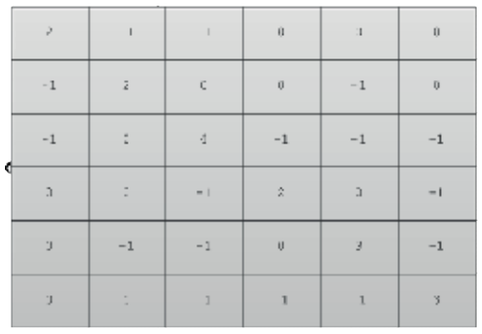
Parallel Planing

- Shapiro, Larry S., and J. Michael Brady. “Feature-based correspondence: an eigenvector approach.” Image and vision computing 10.5 (1992): 283-288.









Graph Representation

Parallel Planing

http://www.gbl.tuwien.ac.at/_docs/GrasshopperScriptum/GrasshopperScriptum.html?filter=Graph%20Re

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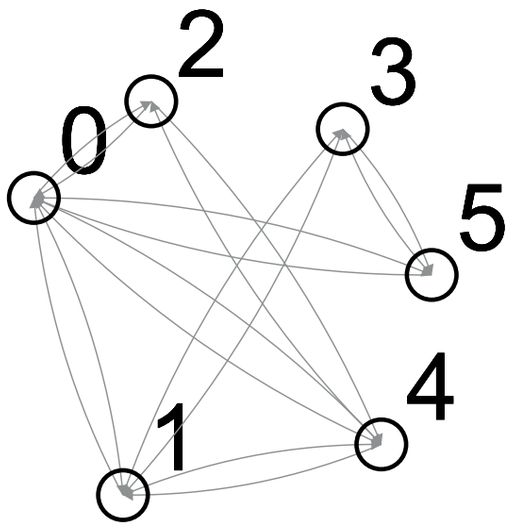

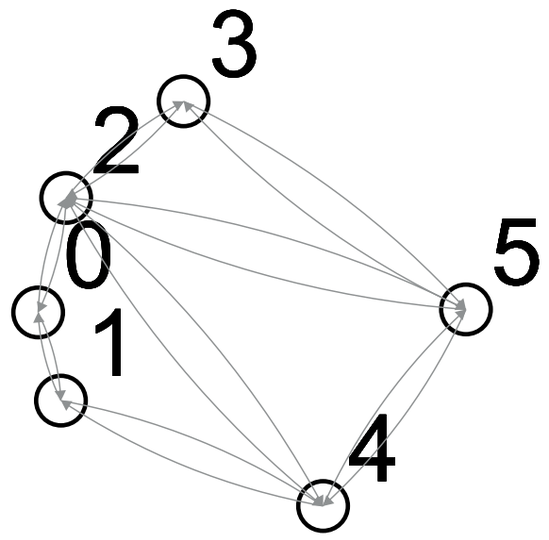

EigenValues	
	{0;0}
0	0.0
1	1.10878
2	2.295376
3	3.0
4	4.317431
5	5.070414

0.408	0.104	0.114	0.283	-0.294	0.794
0.408	0.032	0.367	0.283	0.500	0.415
0.408	0.562	0.308	0.577	0.201	0.221
0.408	-0.562	-0.308	-0.577	0.201	0.221
0.408	0.355	0.935	-0.283	-0.706	-0.089
0.408	-0.439	0.658	0.283	0.206	-0.339

EigenValues	
	{0;0}
0	0.0
1	1.10878
2	2.295376
3	3.0
4	4.317431
5	5.070414

0.408	-0.439	-0.658	0.283	0.206	-0.339
0.408	-0.562	-0.308	-0.577	0.201	0.221
0.408	0.104	0.114	0.283	-0.294	0.794
0.408	0.562	0.308	-0.577	-0.201	-0.221
0.408	-0.032	-0.367	0.283	-0.500	-0.415
0.408	0.355	-0.935	0.283	0.706	-0.089

Matrix Eigenvectors

Parallel Planing

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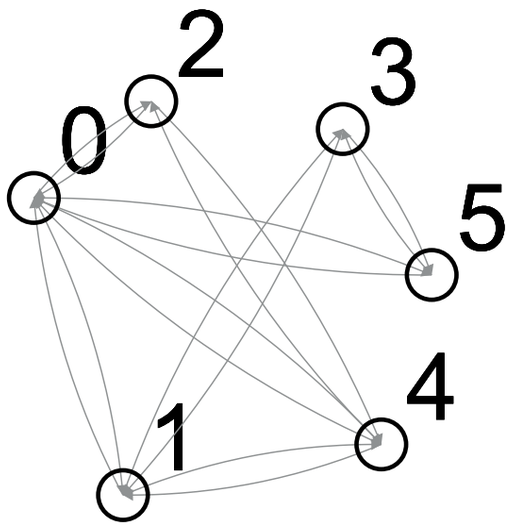

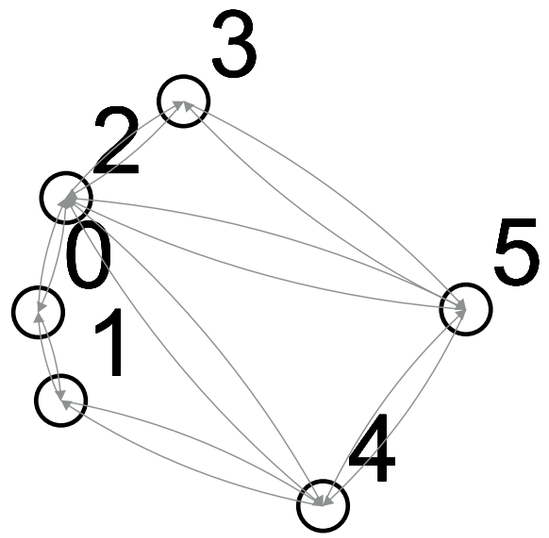

EigenValues	
	{0;0}
0	0.0
1	1.10878
2	2.295376
3	3.0
4	4.317431
5	5.270414

0.408	0.104	0.114	0.287	-0.294	0.794
0.408	0.662	0.567	0.287	0.500	0.415
0.408	0.562	0.308	0.577	0.201	0.221
0.408	-0.562	-0.308	-0.577	0.201	0.221
0.408	0.355	0.905	-0.287	-0.106	-0.089
0.408	-0.439	0.658	0.287	0.240	-0.339

EigenValues	
	{0;0}
0	0.0
1	1.10878
2	2.295376
3	3.0
4	4.317431
5	5.270414

0.408	-0.479	-0.454	0.289	0.240	-0.339
0.408	-0.562	-0.308	-0.577	0.201	0.221
0.408	0.104	0.114	0.287	-0.294	0.794
0.408	0.562	0.308	-0.577	-0.201	-0.221
0.408	-0.662	-0.567	0.287	-0.500	-0.415
0.408	0.355	-0.905	0.287	0.106	-0.089

Different Graphs?

Parallel Planing

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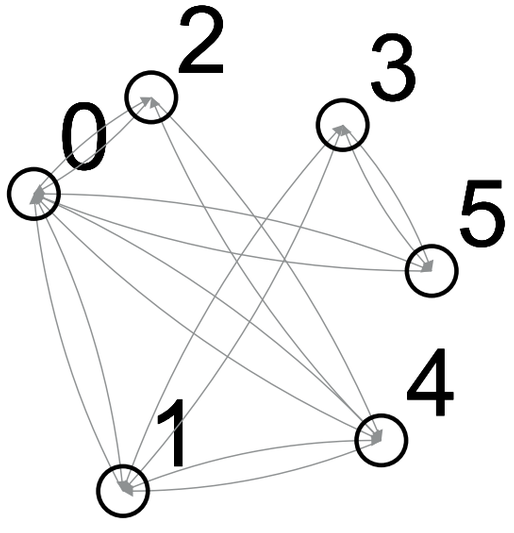

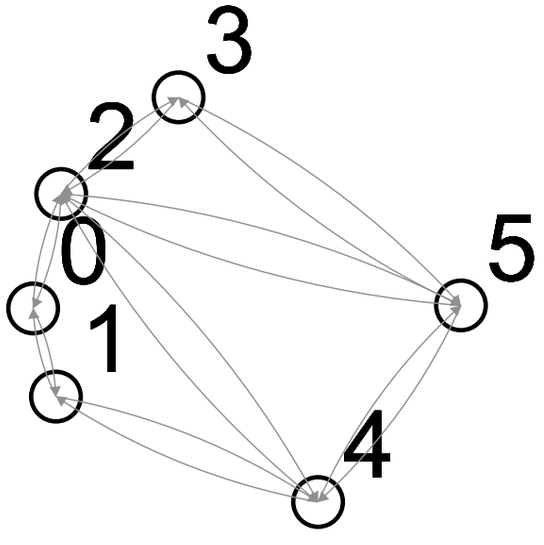

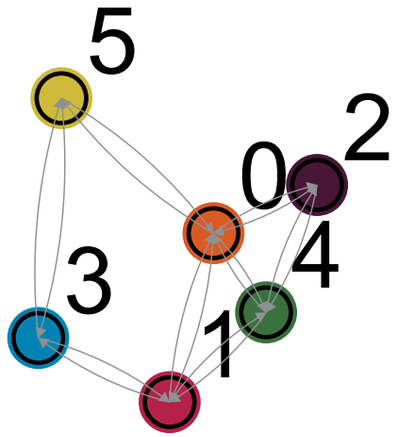

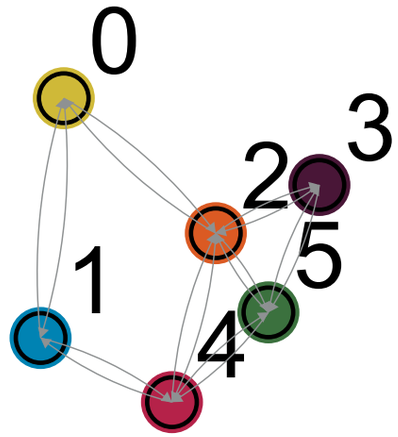

Graph Drawing by Eigenvectors

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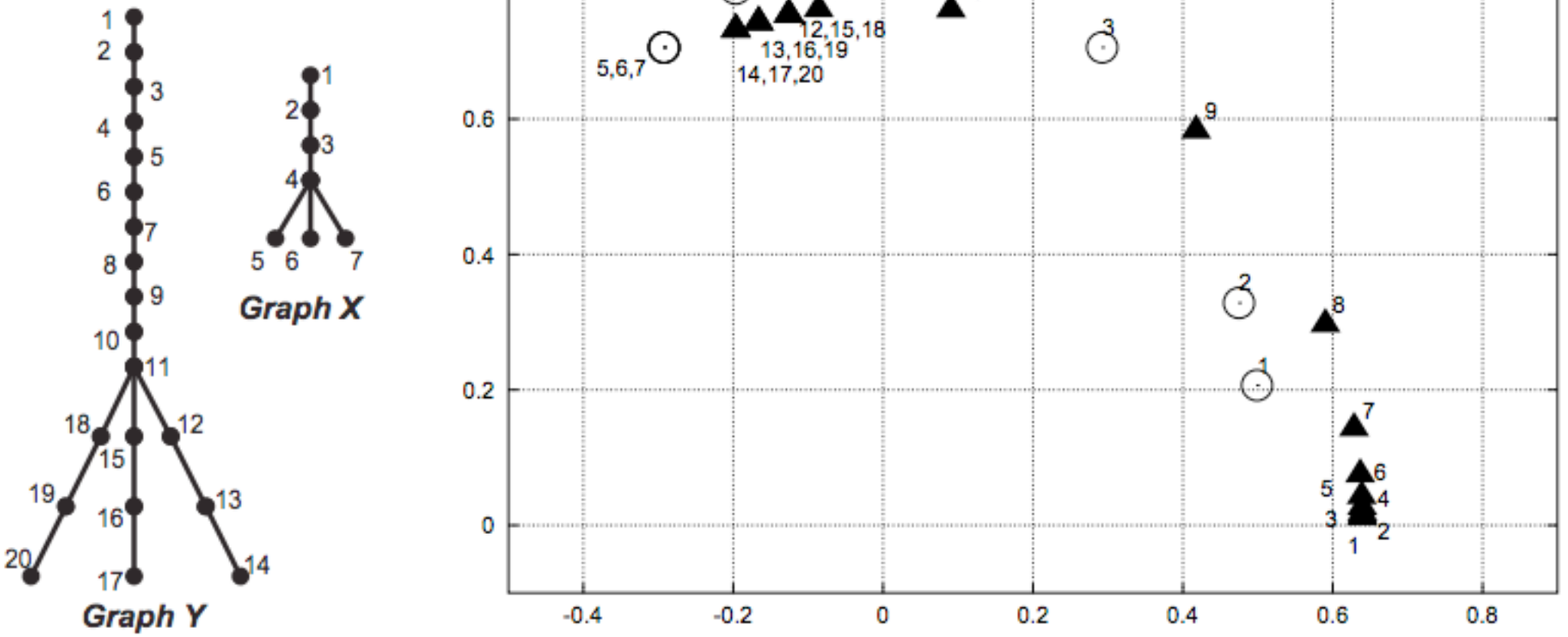


(a) Graphs X, Y.

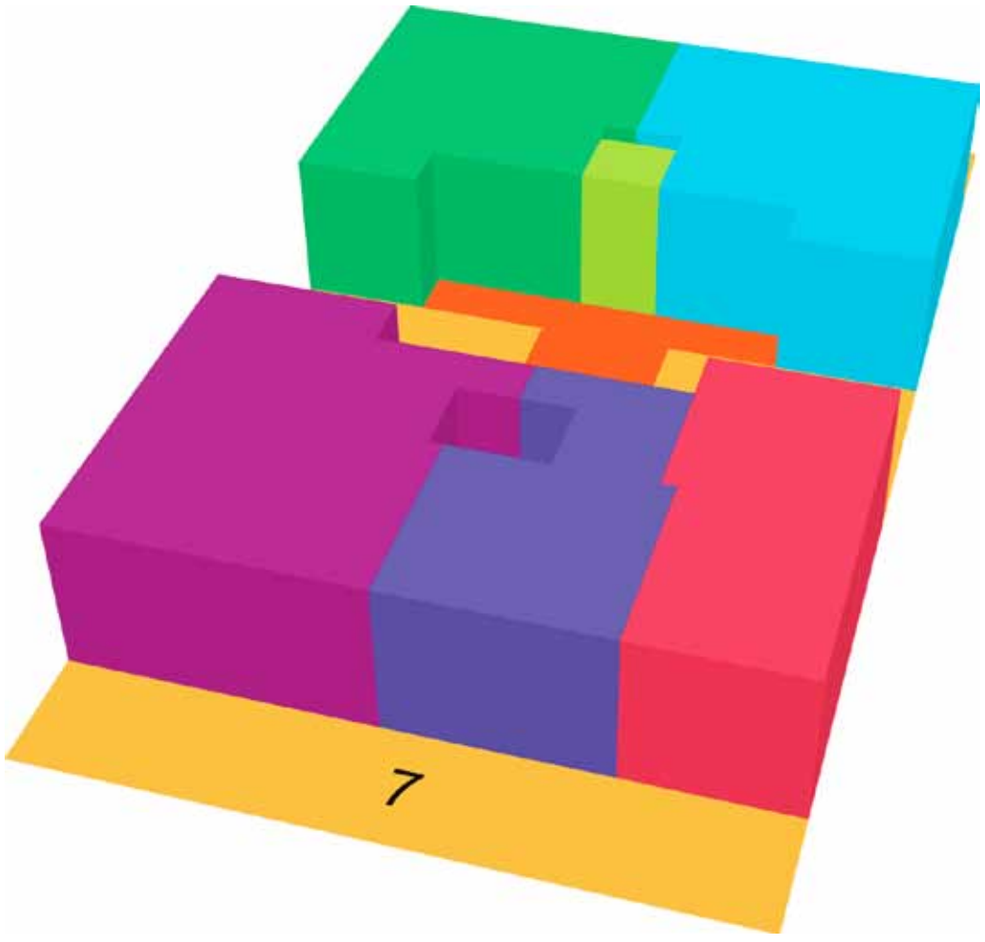
(b) Projections of graphs X and Y into 2D eigenvector subspace.

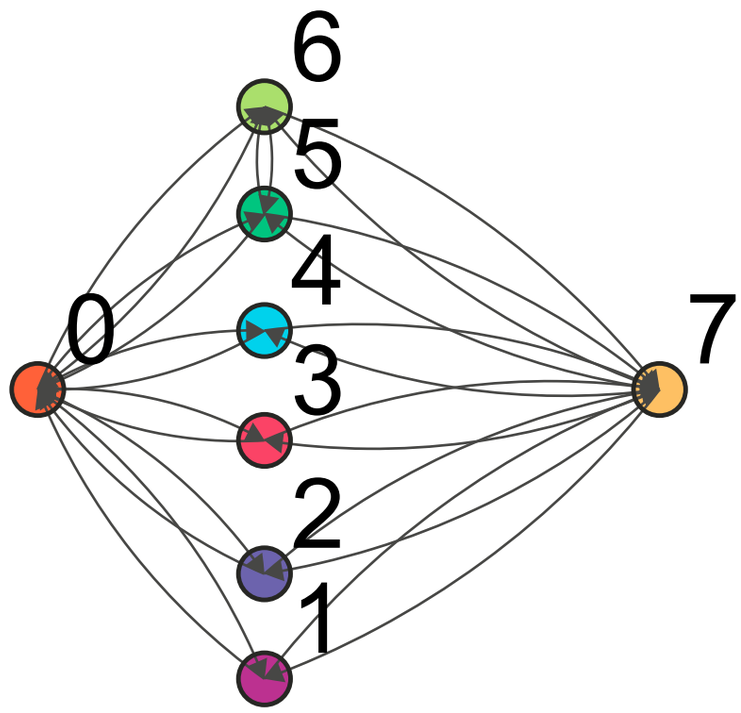
Image form: Kosinov, Serhiy, and Terry Caelli. “Inexact multisubgraph matching using graph eigenspace and clustering models.” Structural, Syntactic, and Statistical Pattern Recognition. Springer Berlin Heidelberg, 2002. 133-142. (p.137)

Inexact Graph Matching

Parallel Planing

Kosinov, Serhiy, and Terry Caelli. “Inexact multisubgraph matching using graph eigenspace and clustering models.” Structural, Syntactic, and Statistical Pattern Recognition. Springer Berlin Heidelberg, 2002. 133-142.





Inexact Graph Matching

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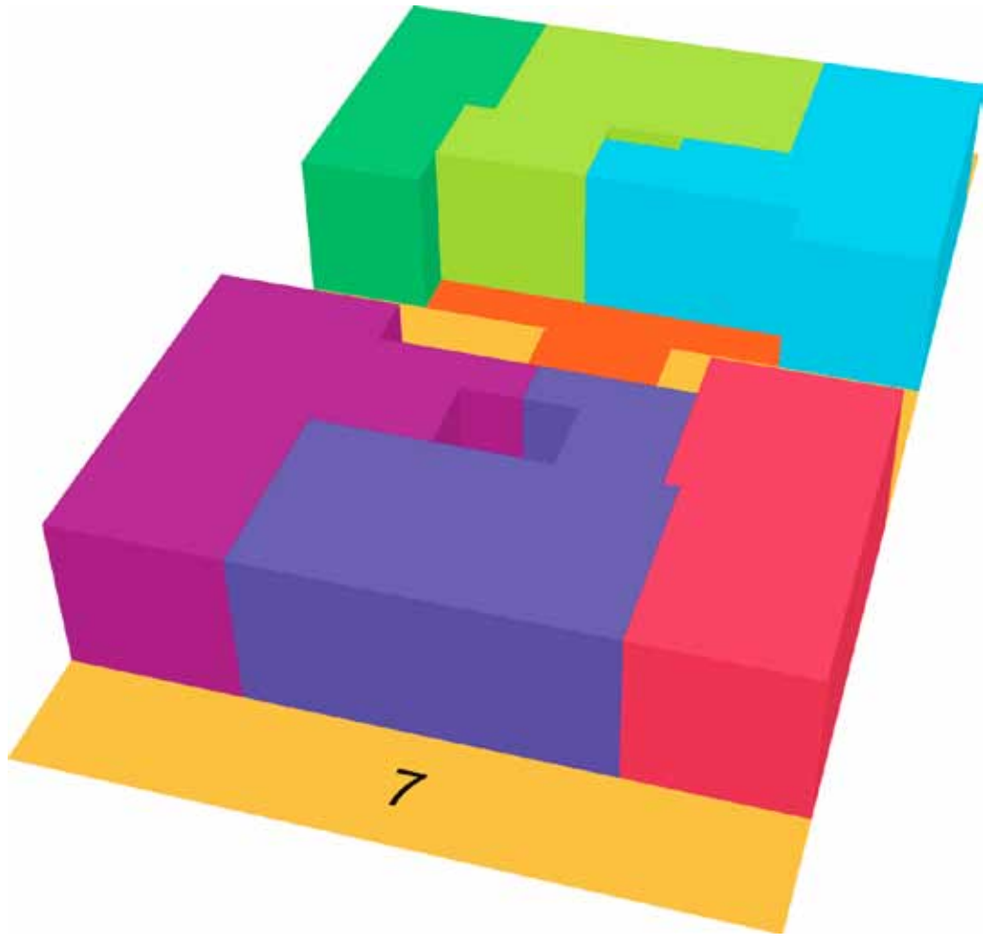

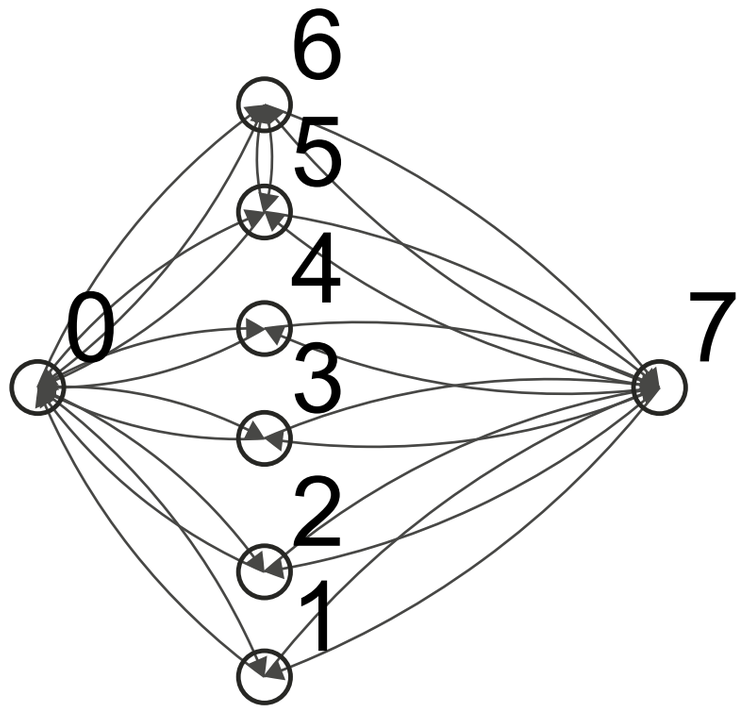

Final Graph Matching

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Further Readings

Space Syntax

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- Tutte, W. T., 1963. How to draw a graph. s.l., s.n.

Pirouz Nourian is PhD researcher and instructor of computational design at TU Delft since 2010. In addition to his regular studios at TU Delft in courses like High-rise Buildings and XXL buildings, he has taught computational urban design in international workshops in Delft (eCAADe Urban Datascope 2013), Istanbul (Tarlabasi Datascope 2013), Tehran (master class on high-rise design 2012), Lisbon (Measuring Urbanity 2012), Delft (HYPERBODY master class of computational design 2011). His main research interests are graph-theoretical design, spatial analysis, and configuration of street networks, density distributions and land-use allocation patterns. Released tool suites for computational design: SYNTACTIC & CONFIGURBANIST

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Richard Schaffranek is doctoral candidate and instructor of computational design / planning at Vienna UT since 2010. He has been teaching design studios at the TU Vienna with a focus on the application of algorithmic tools in planning. Together with three colleges, he contributed to the curriculum of the TU Vienna through introducing an algorithmic planning and analysing “Module” (a package of four courses for the diploma students in architecture). He is responsible for the development of a plugin for Grasshopper, “SpiderWeb”, enabling graph-based algorithms, which was presented for the first time in a workshop at AAG2012. His current focus is on statistical methods as a tool in generative design methods.

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Workshop presenters