Chair of
Information
Architecture

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Lecture 2
Spatiality
Urban Networks,
Connectivity, Path Detection,
Accessibility

Digital Urban Simulation

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Content

- Space as a configuration

- Spatial configurations and their representations - metric and topological

- Introduction into Urban Network Analysis : Space Syntax

- Urban networks **|** topological graphs **|** Convex spaces and their measurements

- Connectivity, Path detection, Accessibility

- Excercise:

- **ELK** Open street Map networks
- **CONFIGURBANIST** : **Network Distance analysis, Connectivity, Path Detection, Accessibility,**

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Learning objectives

- To learn aspects of spatial attributes related to urban environment

- Understanding the foundations of Urban Network Spatial Analysis (Space Syntax)

- Learn and Understanding how to use and interpret the Urban Network analysis:
- Distance analysis, Connectivity, Path Detection, Accessibility to Points of Interest

- Ability to apply and interpret the Urban Network analysis for:

- Excercise | Own projects | more evident Designs

Spatiality: Space as a Configuration

Rome – aerial view
http://lukaspecka.blog.idnes.cz/blog.aspx?c=188555
<accessed online, 1/10/2016>

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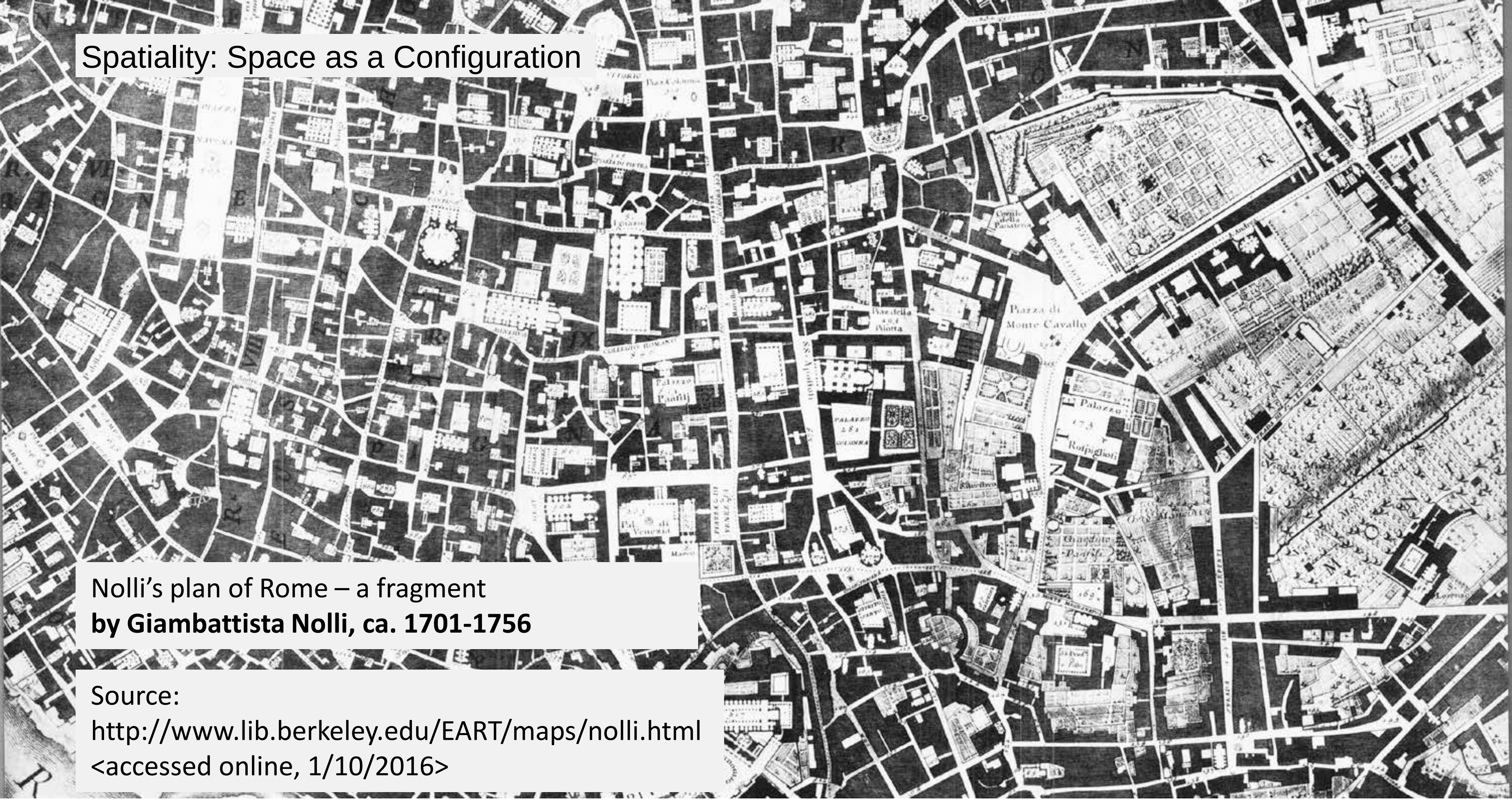
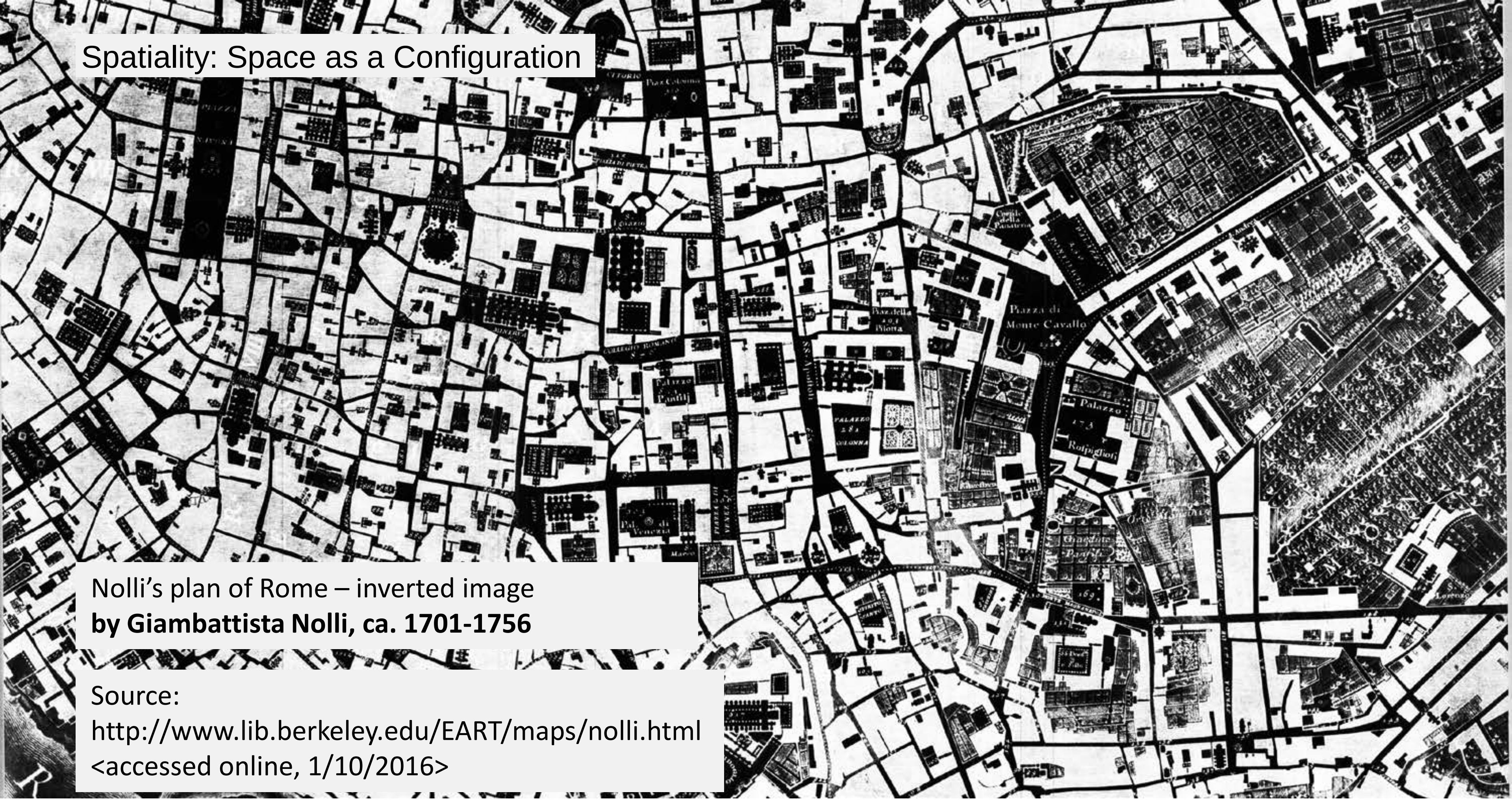
Spatiality: Space as a Configuration



Nolli's plan of Rome – a fragment
by Giambattista Nolli, ca. 1701-1756

Source:
http://www.lib.berkeley.edu/EART/maps/nolli.html
<accessed online, 1/10/2016>

Spatiality: Space as a Configuration



Nolli's plan of Rome – inverted image
by Giambattista Nolli, ca. 1701-1756

Source:
http://www.lib.berkeley.edu/EART/maps/nolli.html
<accessed online, 1/10/2016>

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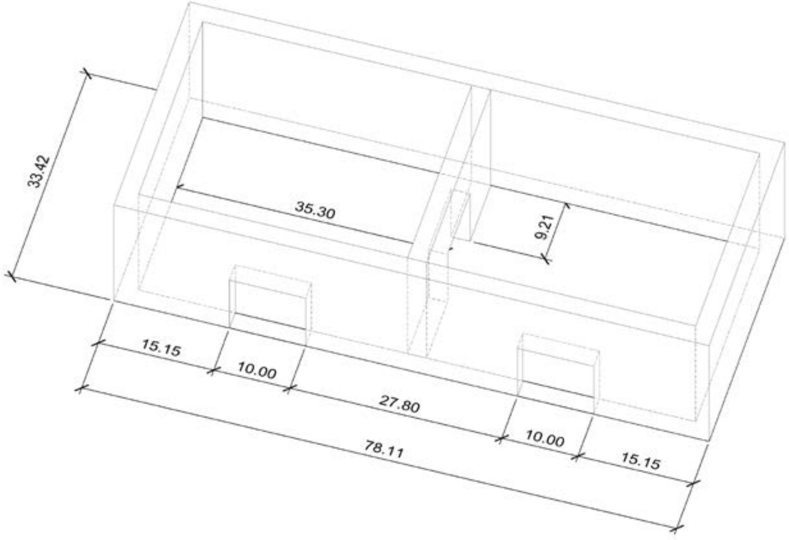
Spatial configurations and their representation

2 types of Spatial properties:

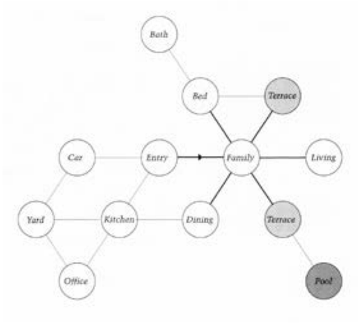
Metric

Absolute measures – distances, sizes, properties

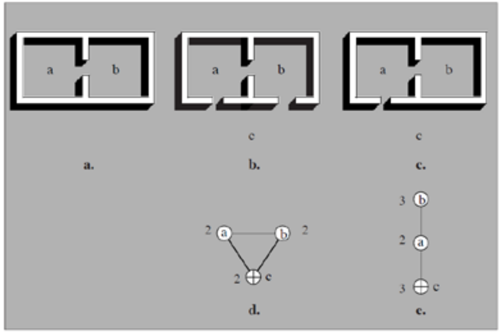


Topological

Relational qualities – relations between elements



Source:
The Logic of Architecture (Mitchell, 1990)



Source:
Space is the machine (Hillier, 2007)

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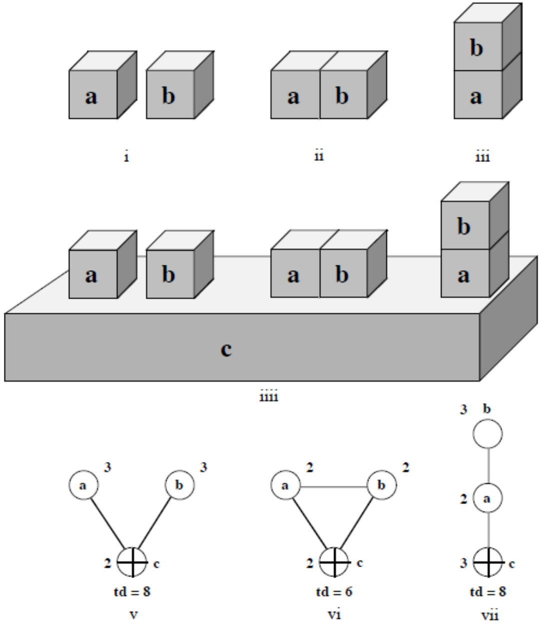
What is a configuration?

A formal description



Source: Space is the machine (Hillier, 2007)

A configuration consists of elements and the relationships between them.

Configurations with 2 elements (a and b)

Configurations with 3 elements (a, b and c)

Representation as graph

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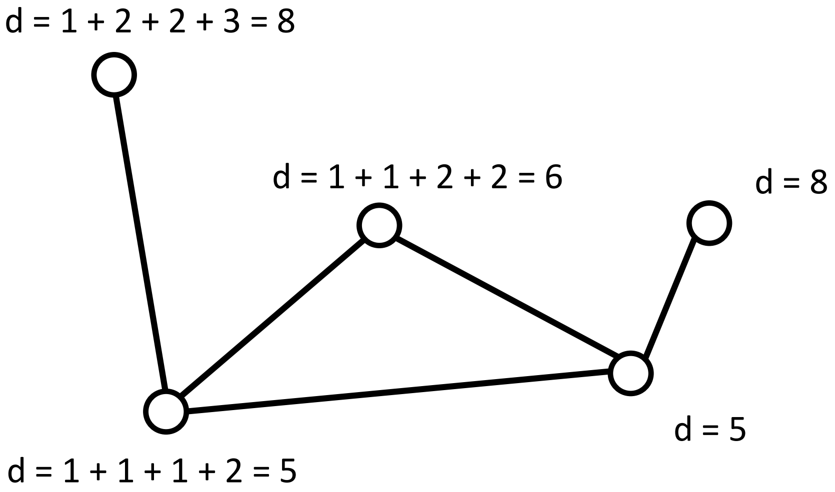
Depth

A central property of configurations



td = 8+5+6+5+8 = 32

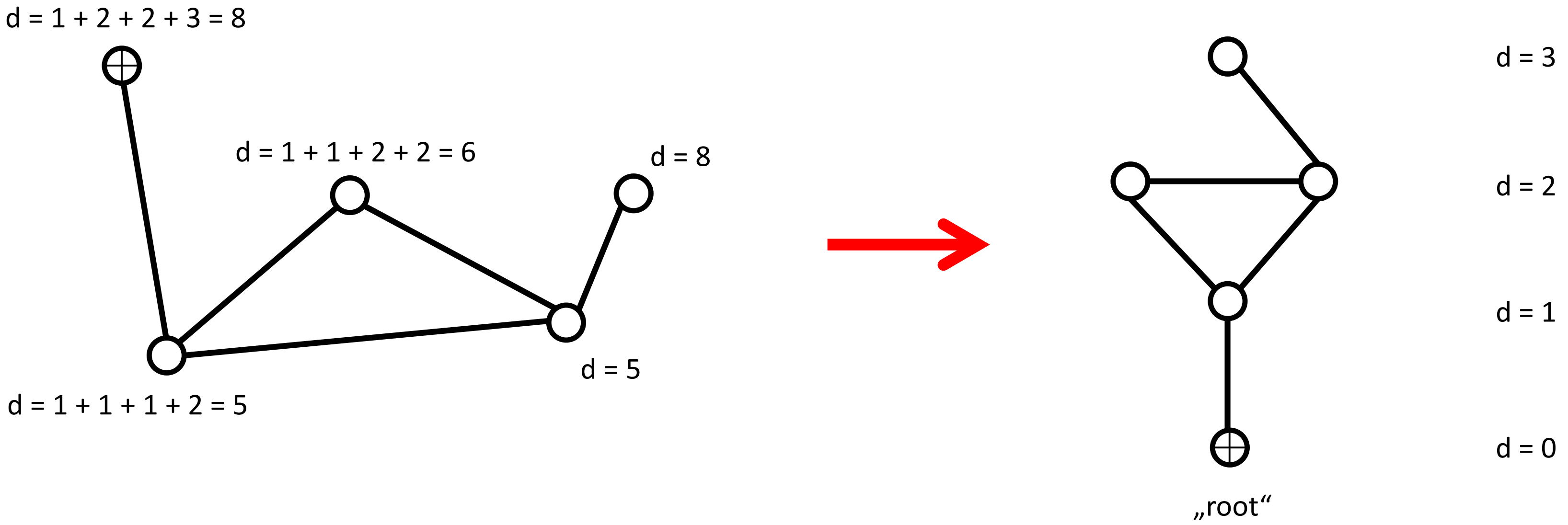
Depth *d* an element in a configuration is calculated by totaling the shortest distances from one element to all other elements.

The smaller the depth of an element, the simpler (shorter) it is to navigate from it to all other elements.

Detph is the basis to calculate the Integration of an element. The higher the depth the smaller the level of Integration and vice versa.

Total Depth (td) of a configuration is the sum of the depth of all nodes.

The J-Graph (Justified Graph)



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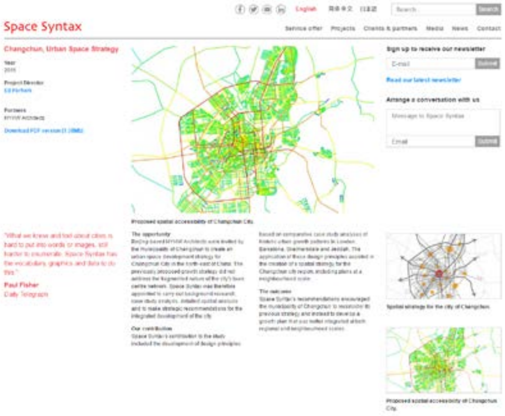
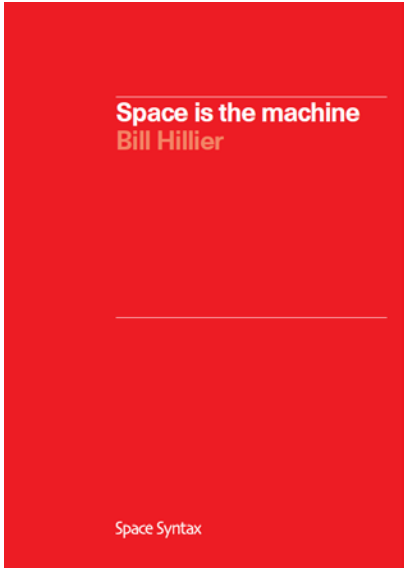
Introduction: Urban Network Analysis >>> Space Syntax

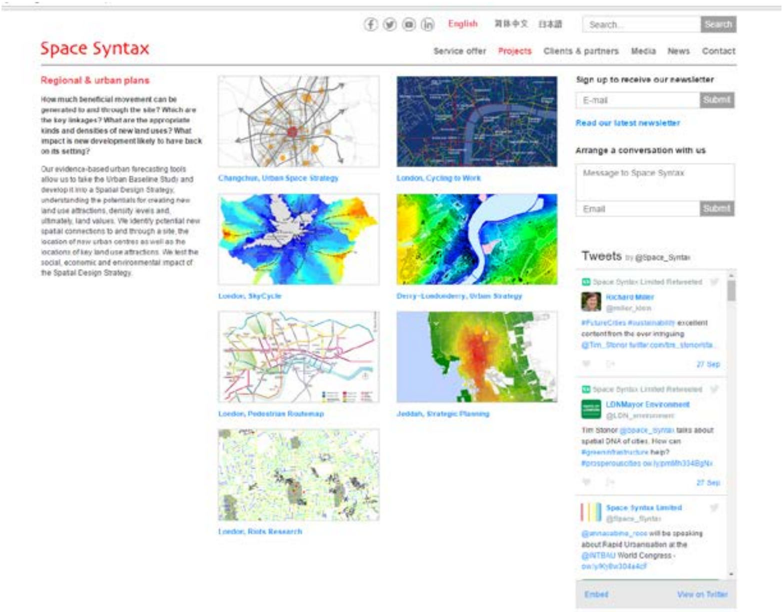
Method to analyse topological properties of spatial configurations





A configurational theory of architecture, 2007

download: http://eprints.ucl.ac.uk/3881/

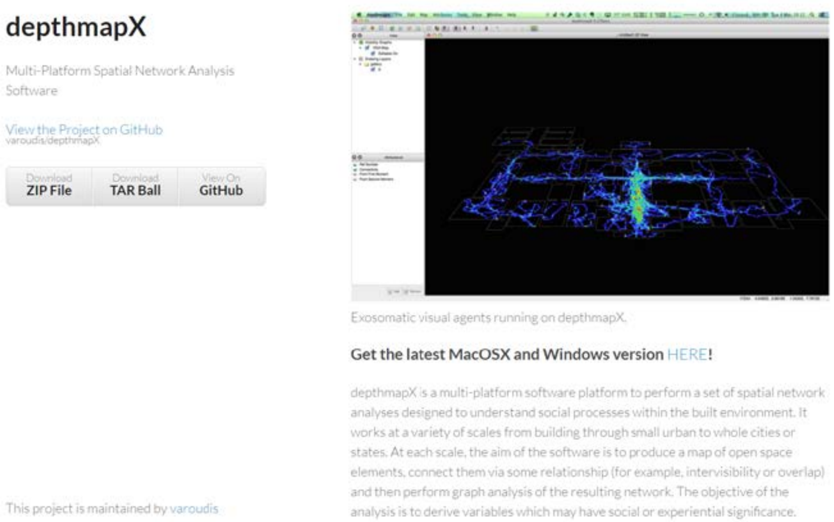


www.spacesyntax.com

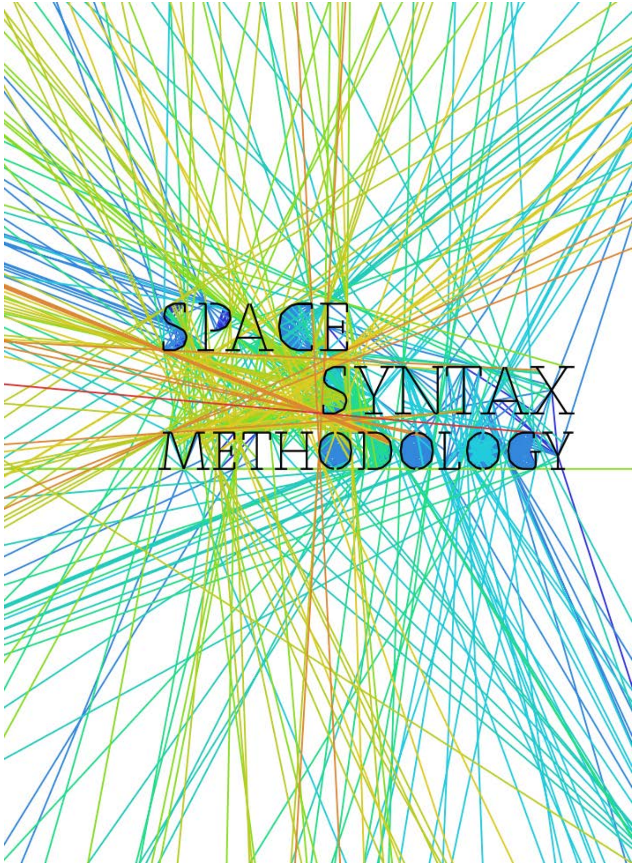
Introduction: Urban Network Analysis >>> Space Syntax

Al Sayed, K., Turner, A., Hillier, B., Iida, S., Penn, A., 2014 (4th Edition),
“Space Syntax Methodology”,
Bartlett School of Architecture, UCL, London

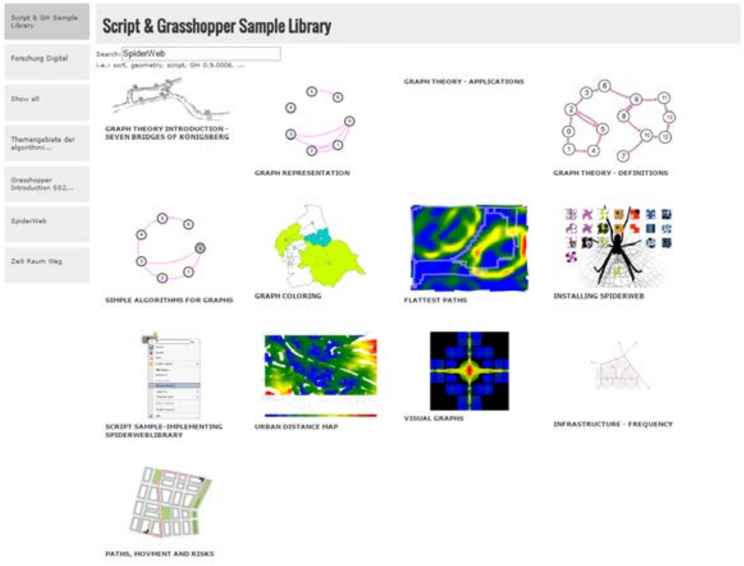
download:
http://discovery.ucl.ac.uk/1415080/1/SpaceSyntax-fulltextbook_HigherRe.pdf

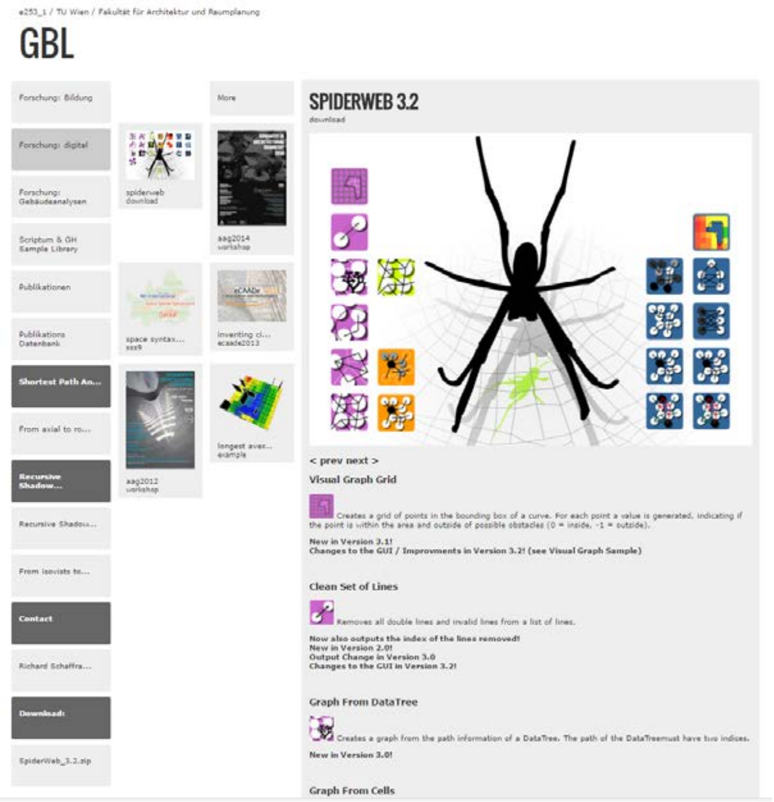


http://varoudis.github.io/depthmapX/



Introduction: Urban Network Analysis >>> Space Syntax



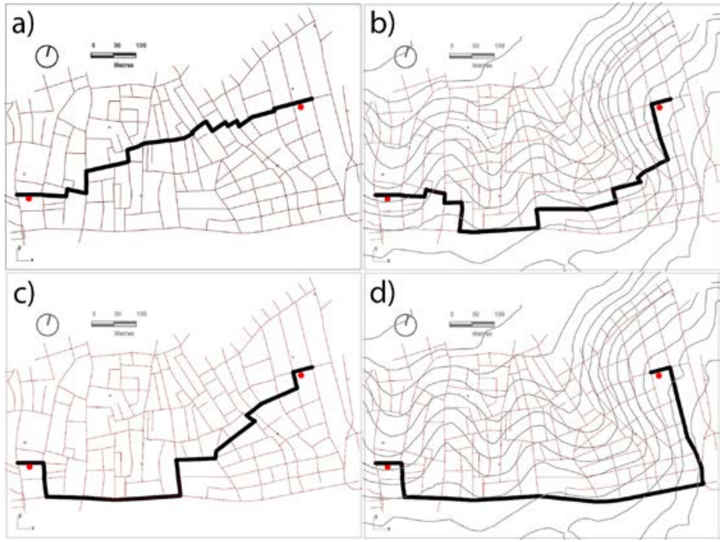


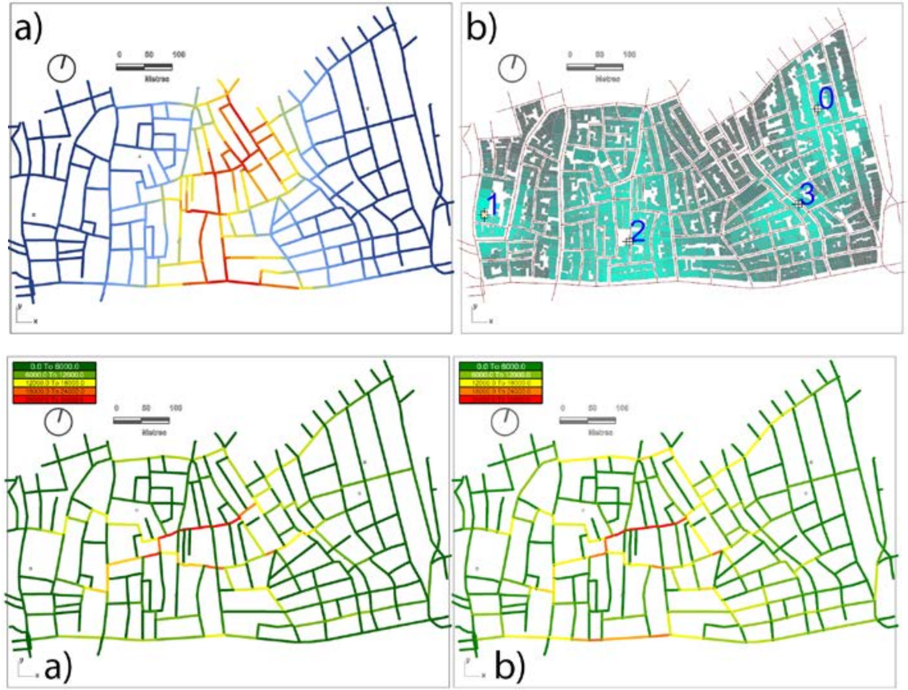
Richard Schaffranek

http://www.gbl.tuwien.ac.at/Archiv/digital.html?name=SpiderWeb_3.2

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

Introduction: Network Analysis >>> Space Syntax





Pirouz Nourian CONFIGURBANIST

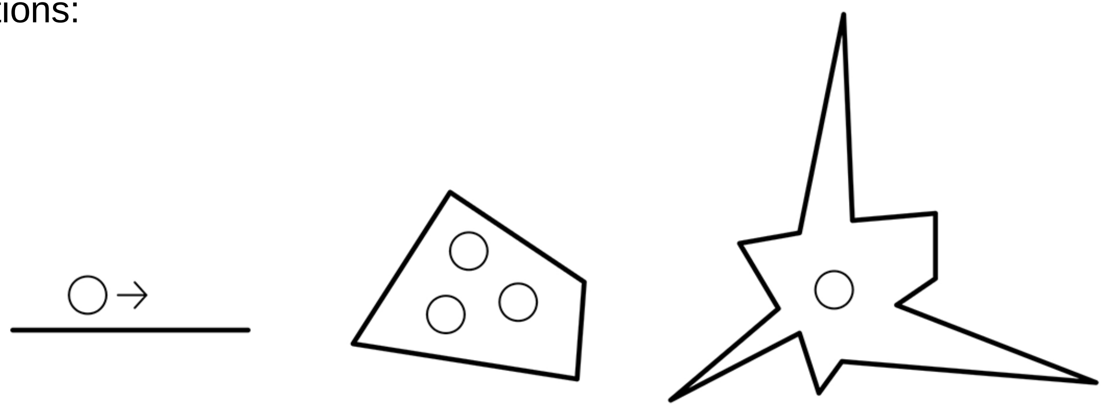
https://sites.google.com/site/pirouznourian/configurbanist

Images source: Nourian, P., Rezvani, S., Sariyildiz, S., van der Hoeven, F., Configurbanist: Urban Configuration Analysis for Walking and Cycling via Easiest Paths, eCAADe 2015, Towards Smarter Cities , vol. 1, eCAADe 2015, Vienna

Network Analysis >>> Space Syntax

- Represents streets as nodes and intersections as edges (in a topological representation)

- 3 main conceptions:

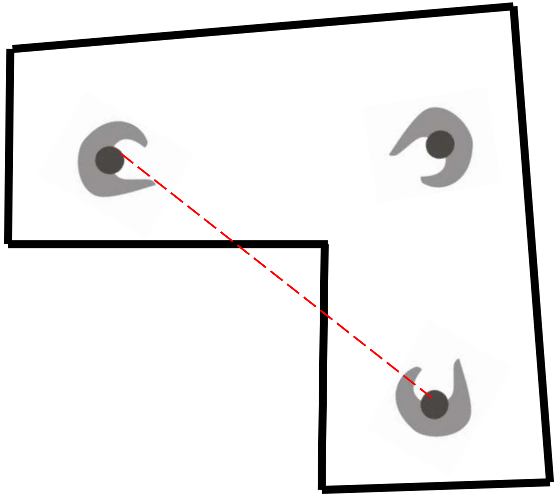


Axial Lines Convex Spaces Isovist – Visibility

(Hillier and Vaughan, 2007).

Convex Space

A convex space is a space in which all points that exist in this space are visible to each other.



Concave space blocks visible relationships.

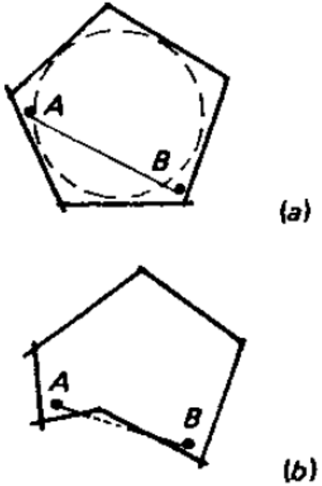


Fig. 39 (a) Convex space: no line drawn between any two points in the space goes outside the space.
(b) Concave space: a line drawn from A to B goes outside the space.

Firgure from: „The Social Logic of space“ (Hillier & Hanson, 1984)

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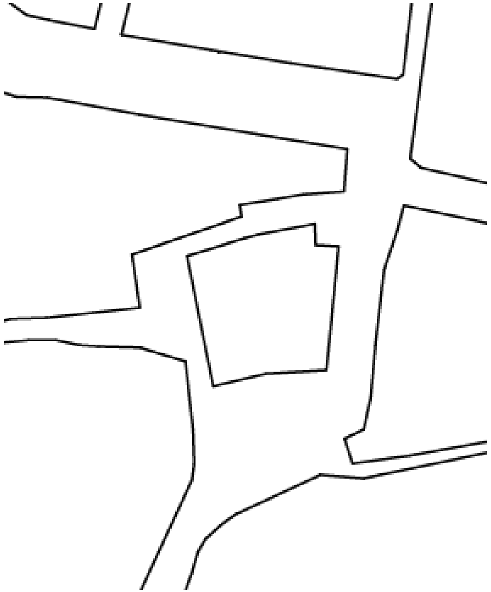
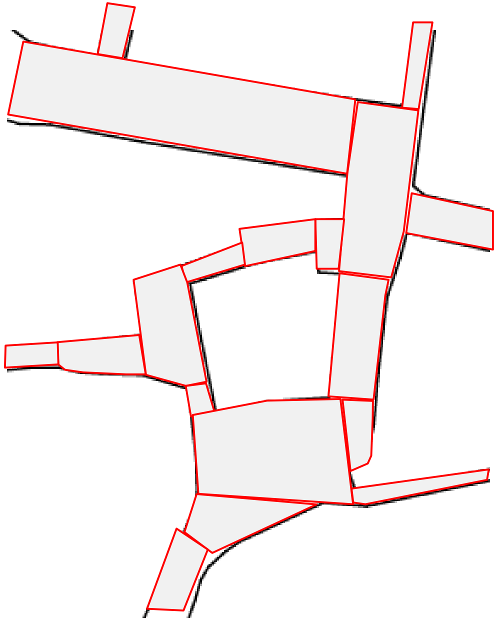
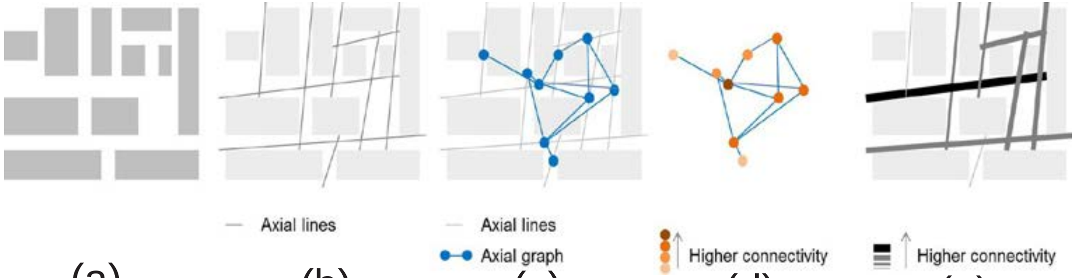
Convex Map

A Convex map consists of the fewest possible set of convex shapes needed to completely cover the open space of an environment





Network Analysis >>> Space Syntax and Connectivity Graph



(a) (b) (c) (d) (e)

The axial representation of Space Syntax.

An urban space represented by the fewest and longest axial lines (b), axial lines are represented by a graph (c), the graph Connectivity is by highlighted in (d & e).

Images source: Space Syntax Methodology (Al Sayed et al.,2014)

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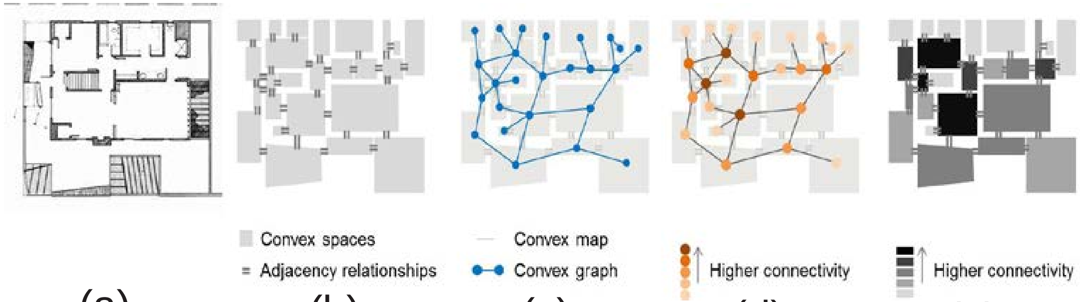
Network Analysis >>> Space Syntax and Connectivity Graph



(a) (b) (c) (d) (e)

The convex representation of Space Syntax.

An architectural space represented by the fewest and fattest convex spaces (b), convex spaces are represented by a graph (c), the graph Connectivity is by highlighted in (d & e).

Images source: Space Syntax Methodology (Al Sayed et al.,2014)

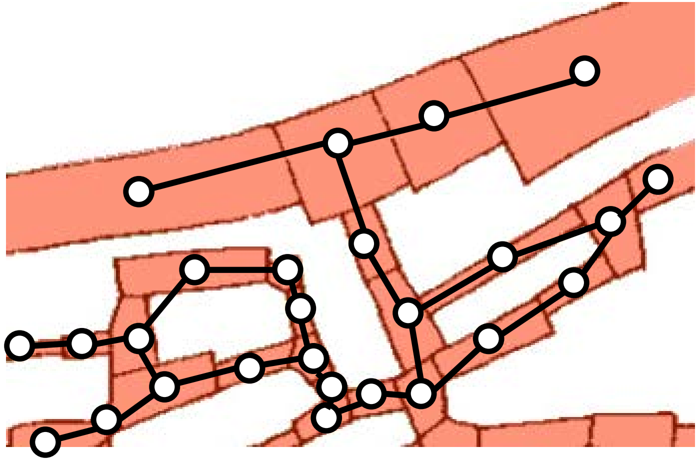
Analysing the convex map

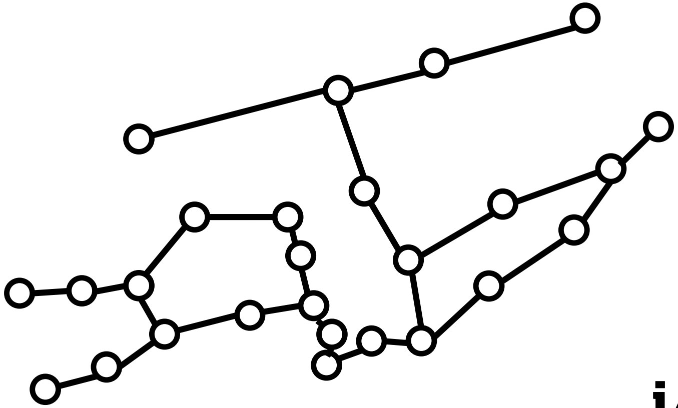
To Analyse a convex map it needs to be transcribed into a graph:

the Nodes of the graph are the convex spaces

the edges of the graph are the connections of a convex space to its direct neighbours

Now measures like **depth and connectivity** can be derived from the graph.





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Syntactic measures

- **Connectivity (degree)** measures **the number of immediate neighbours that are directly connected** to a space.

- **Integration (availability).** The global measure shows **how deep or shallow a space is in relation to all other spaces**. It is a variable that refers to how a space is connected with other spaces in its surroundings.

  Integration is usually indicative to **how many people are likely to be in a space**, and is thought to correspond to rates of social encounter and retail activities (Hillier, 1996).
  CONFIGURBANIST: **Proximity** measure component

- **Choice** measures movement flows through spaces. Spaces that record high global choice are located on the **shortest paths** from all origins to all destinations. Choice is a powerful measure at forecasting pedestrian and vehicular movement potentials.It literally shows how often a street happens to be on an shortest path between an origin and a destination.

- **Control** measures the degree to which a space controls access to its immediate neighbours taking into account the number of alternative connections.

Global & Local Properties (Depth & Connectivity)

Connectivity is a **local** property: it tells you how many elements (e.g. convex spaces) are directly connected with one certain element.

A local property can be experienced directly from a static location in space.

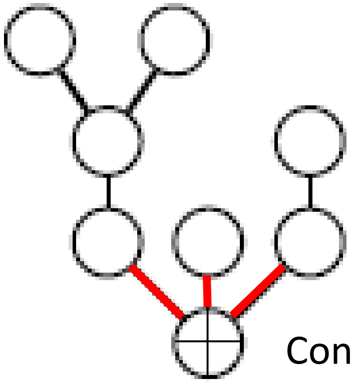
Depth is a **global** property: it tells you how „far away“ an element is from all the other elements.

A global property can only be experienced from moving through space.

(inverted) Depth = Integration

(low depth values mean high integration and vice versa)

Accessibility measures: Proximity, Vicinity



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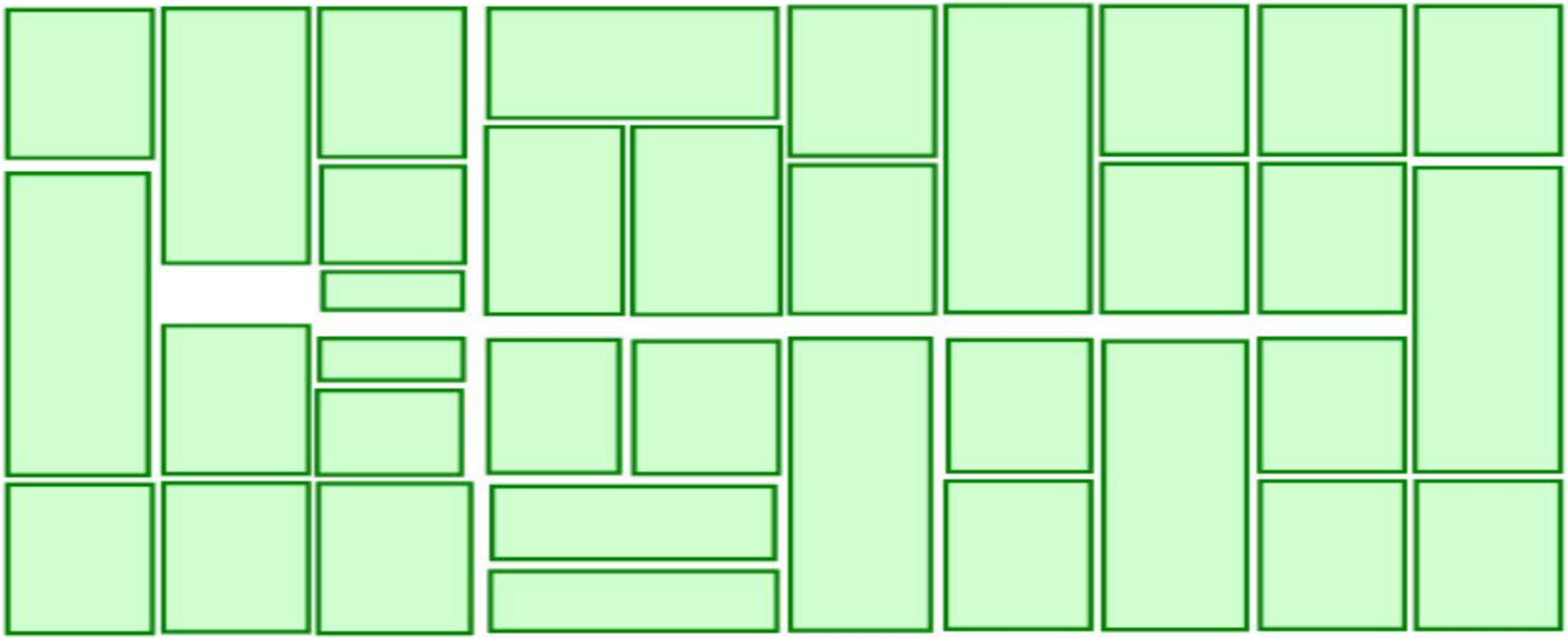
Choice



Tim Stonor & Ed Parham
Introduction to Space Syntax Harvard University Graduate School of Design

Measuring movement
Space Syntax © 2011

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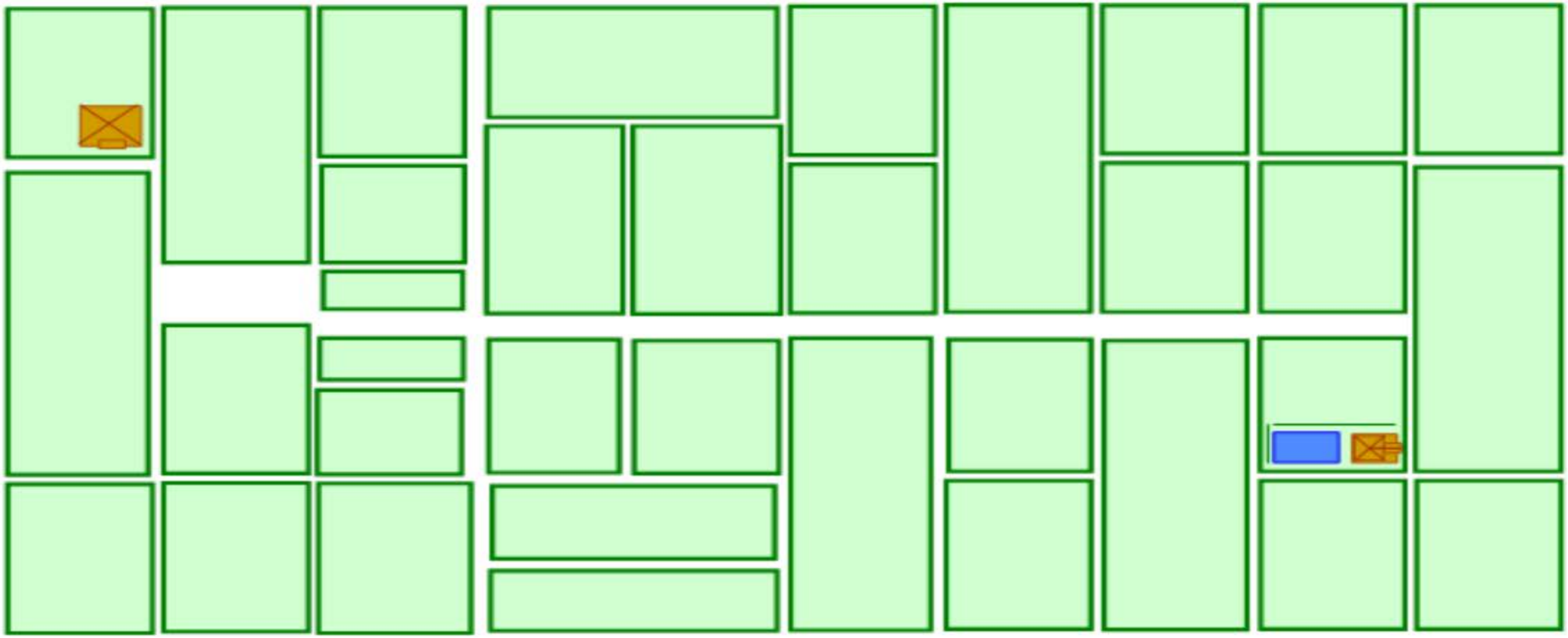
Choice



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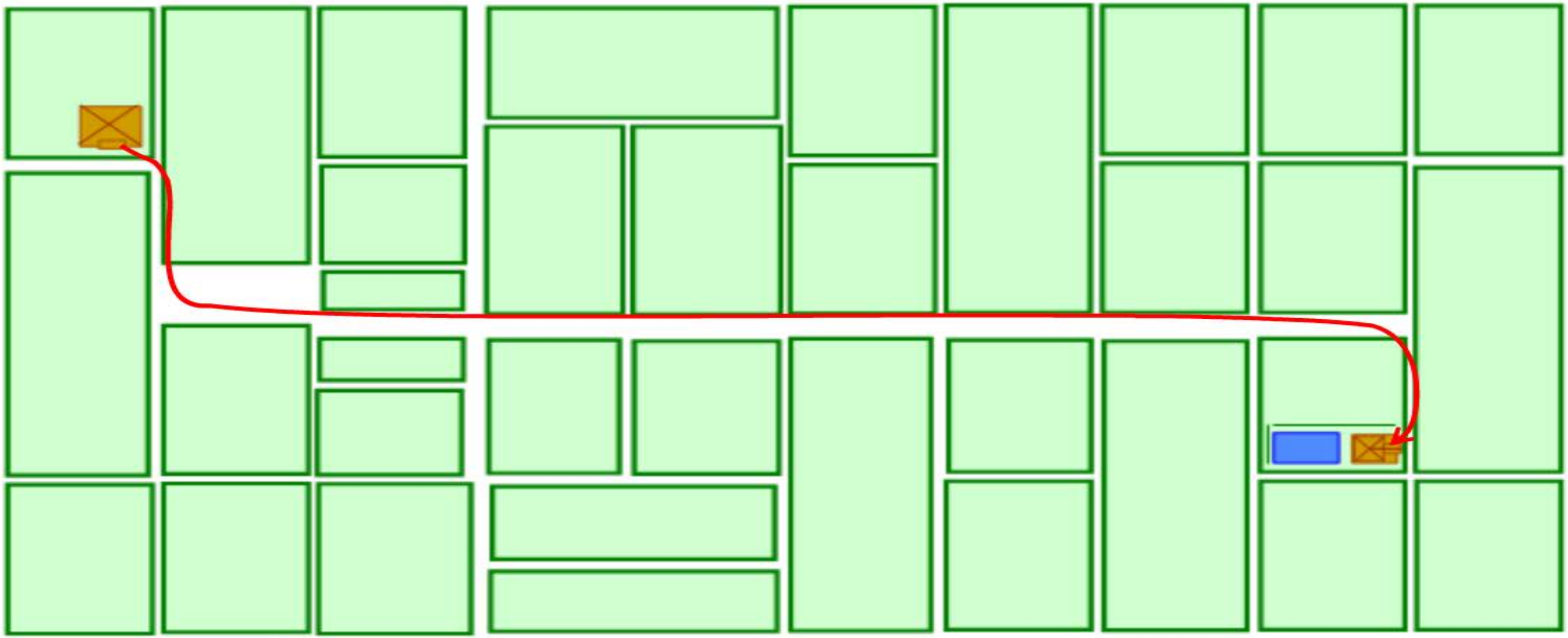

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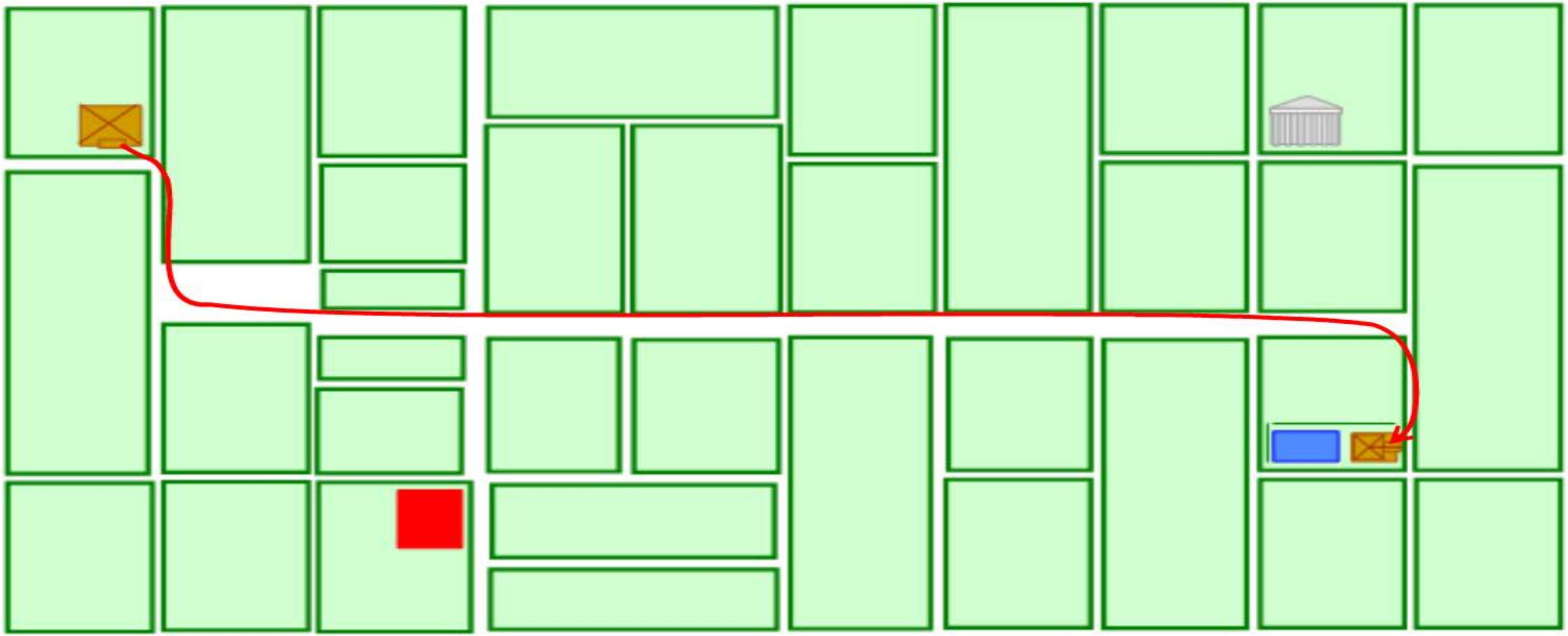

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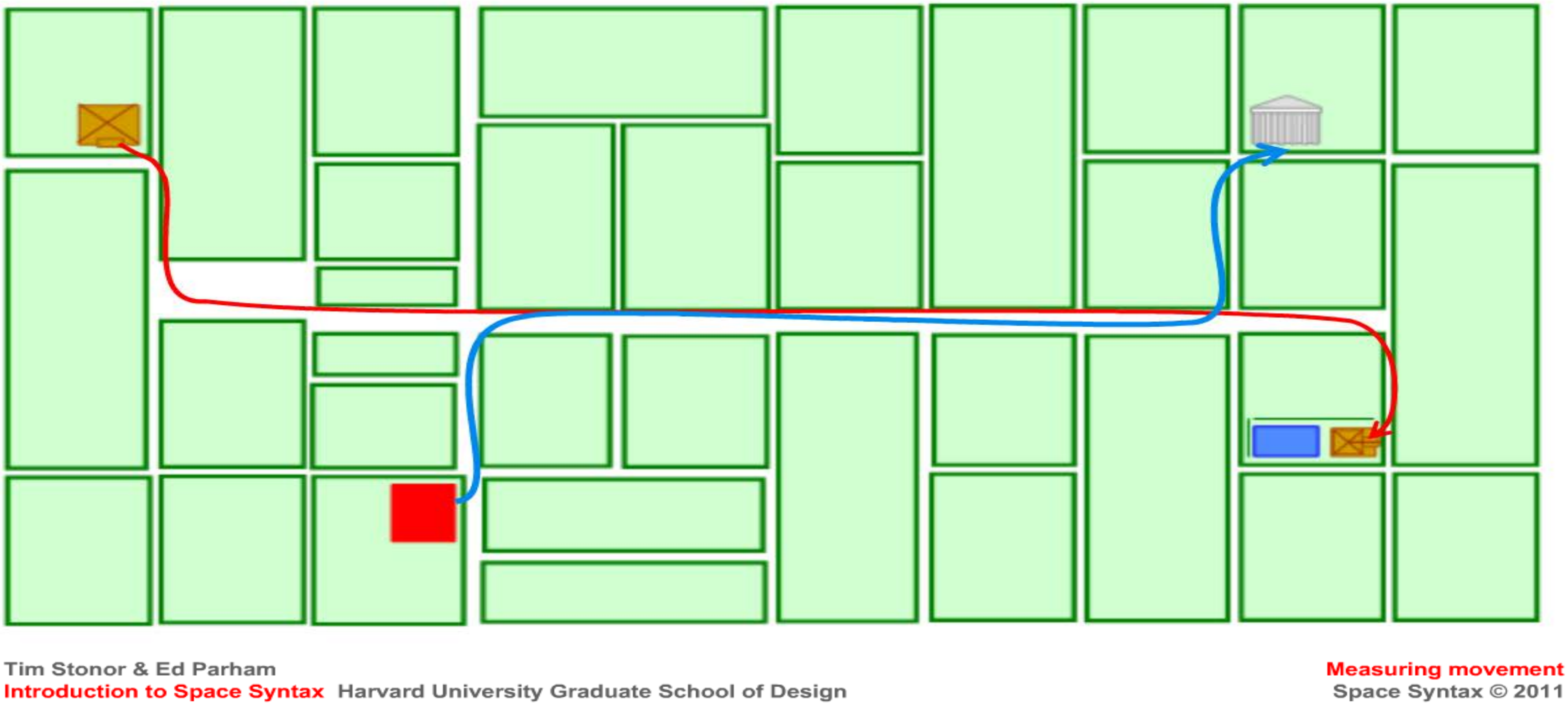
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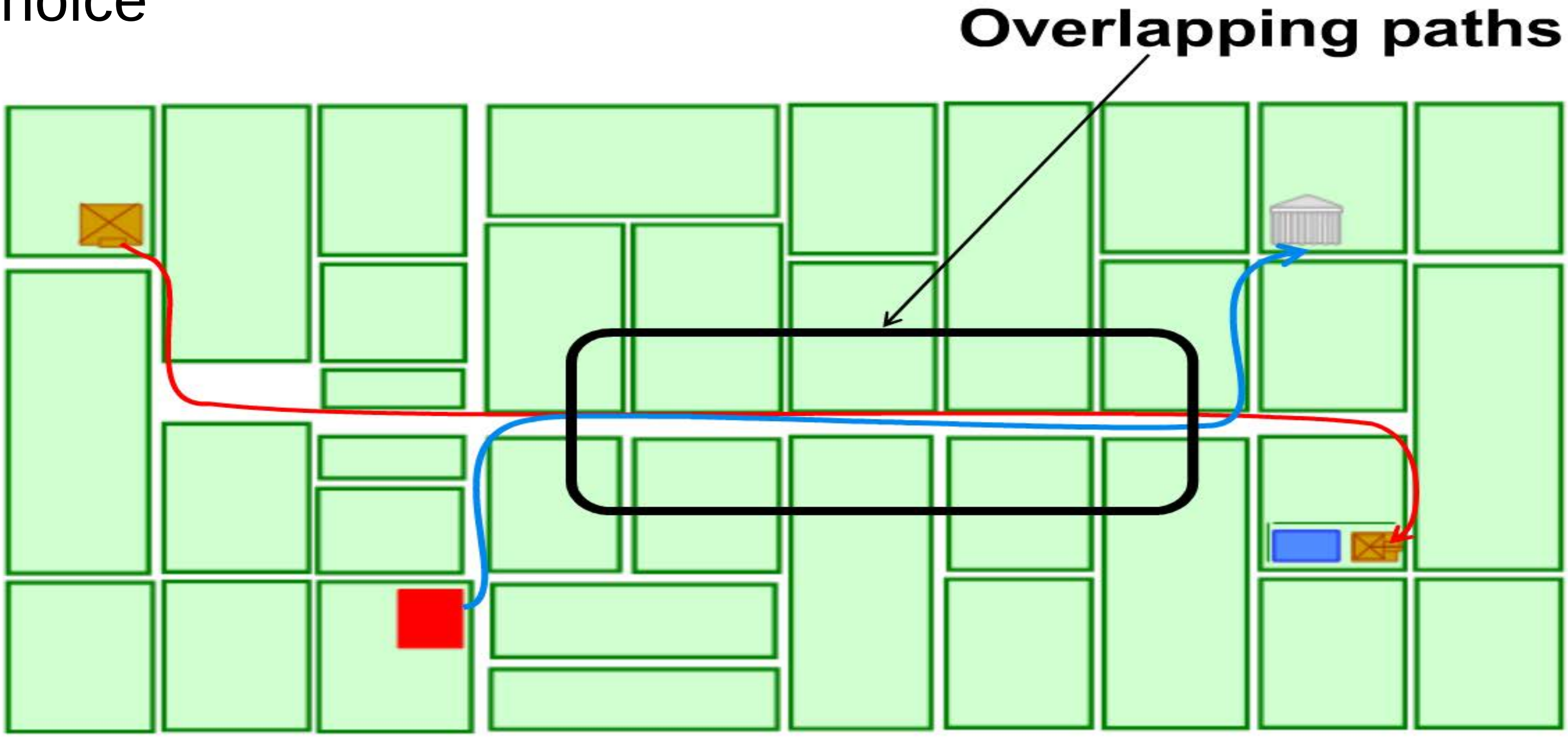

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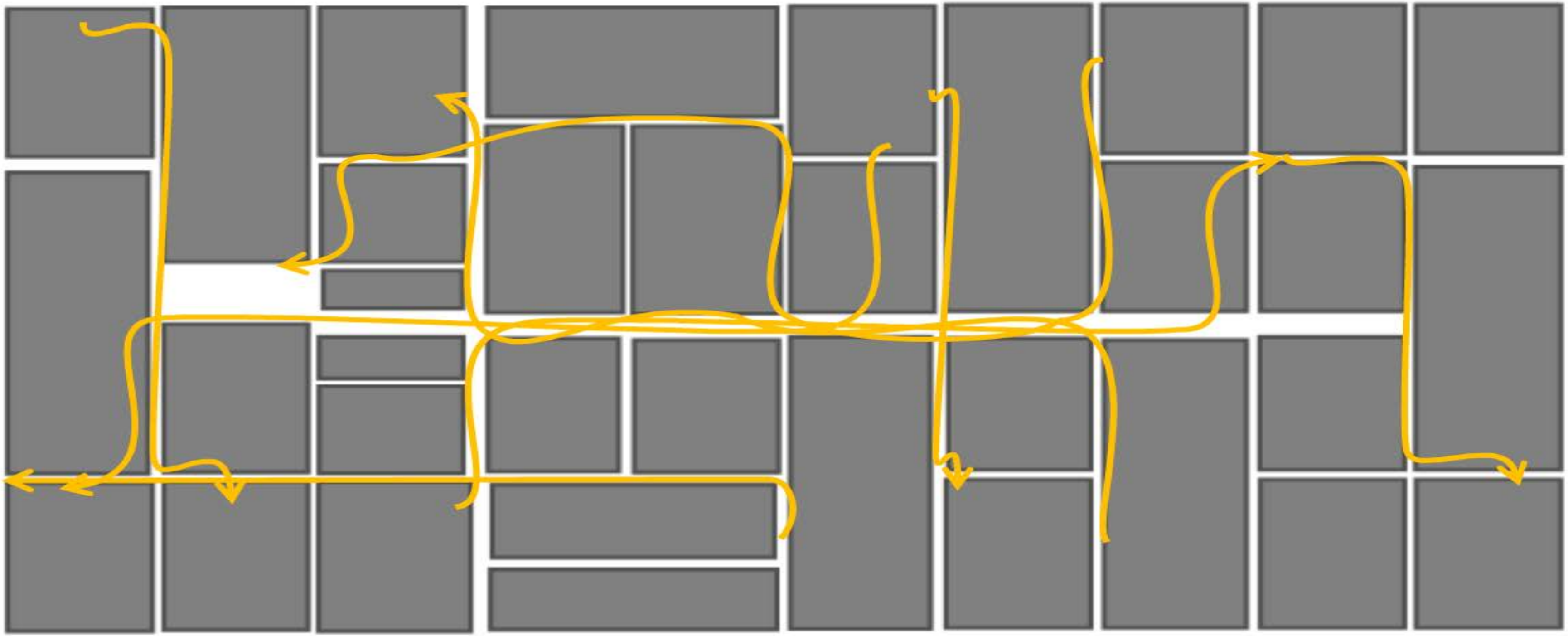

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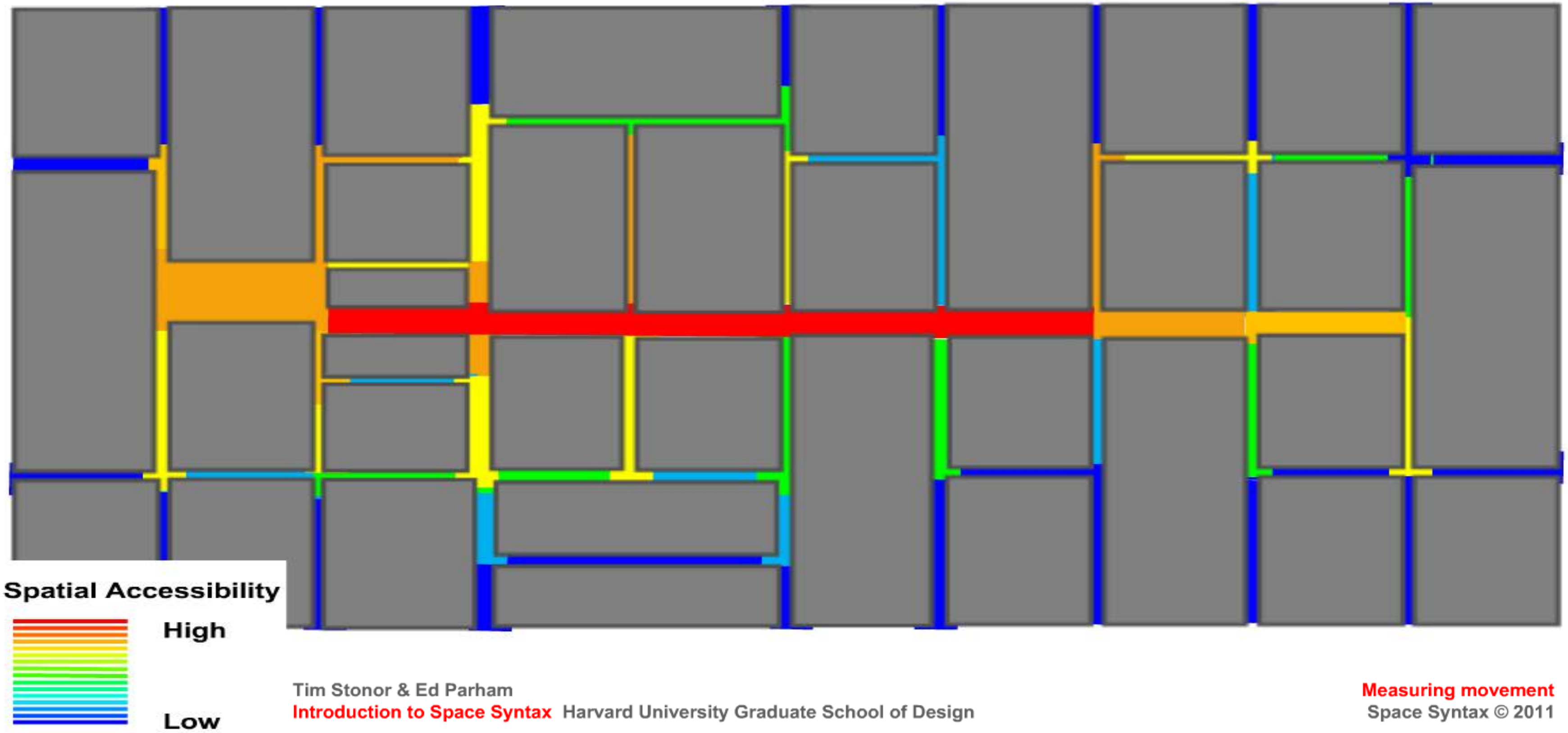
Spatial Accessibility
High
Low
Tim Stonor & Ed Parham
Introduction to Space Syntax Harvard University Graduate School of Design
Measuring movement
Space Syntax © 2011

Excersise: measuring Connectivity and Accessibility Rhino+Grasshopper+Elk+CONFIGURBANIST

- Importing Open Street Map data into Rhino+G modelling framework
- Topography integration (using Image sampler)
- Distance Network Analysis
- Shortest - Easiest Path
- Accessibility indicators (Proximity, Vicinity) for various Points of Interest (POI) - **(Integration)**
- Catchement areas to all/any of POI

Nourian, P., Rezvani, S., Sariyildiz, S., van der Hoeven, F., Configurbanist: Urban Configuration Analysis for Walking and Cycling via Easiest Paths, eCAADe 2015, Towards Smarter Cities , vol. 1, eCAADe 2015, Vienna

References

Nourian, P., Rezvani, S., Sariyildiz, S., van der Hoeven, F., Configurbanist: Urban Configuration Analysis for Walking and Cycling via Easiest Paths, eCAADe 2015, Towards Smarter Cities , vol. 1, eCAADe 2015, Vienna

Al_Sayed, K., Turner, A., Hillier, B., Iida, S., Penn, A., 2014 (4th Edition), "Space Syntax Methodology", Bartlett School of Architecture, UCL, London.

Hillier, B. (1996, 2007), *Space is the machine. A Configurational Theory of Architecture*, Space Syntax, London.

Dettlaff, W., Space Syntax Analysis: Methodology of Understanding the Space, PhD interdisciplinary journal, article

Hillier, B. and L. Vaughan (2007), 'The City as One Thing', *Progress in Planning*