交互与生成——空间句法辅助建筑设计的现状与展望

Interaction and Generation: Space Syntax Aided Architecture Design

Presenter：
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研究领域

Field of Research

- 理论
- 城市
- 社会议题
- 建筑 architecture
- 环境认知
- 算法技术

近几届空间句法大会研究主题分类

2017年第11届空间句法大会（11th SSS）共收录176篇文章，其中建筑主题35篇（20%）
2015年第10届空间句法大会（10th SSS）共收录152篇文章，其中建筑主题38篇（25%）

11			
10	9	8	7

CONTENTS

1. BUILDINGS AND ARCHITECTURE
2. CITIES AND URBAN STUDIES
3. ENVIRONMENT AND SPATIAL COGNITION
4. SPACE, SOCIETY, AND SUSTAINABILITY
5. METHODOLOGICAL AND TECHNICAL DEVELOPMENTS

Contents

01 – Housing and Homes
02 – Architecture and Complex Buildings
03 – Urban Morphology and History
04 – Urban Studies, Transport and Mobility
05 – Land Use Studies and Urban Economies
06 – Spatial and Social Justice
07 – Environmental and Spatial Cognition
08 – Space and Society
09 – Methodological Developments
10 – Posters

Contents

0 Keynote Speeches ›go
1 Architectural Design and Practices ›go
2 Building Morphology and Performativity ›go
3 Green Urbanism and Sustainable Developments ›go
4 Historical Evolution of Built Form ›go
5 Modelling and Methodological Development ›go
6 Spatial Analysis and Architectural Theory ›go
7 Spatial Cognition and Behaviours ›go
8 Urban Space and Social, Economic and Cultural Phenomena

SSS8 Themes:

- *Invited and Keynote Papers*
- *Architectural Theory and Spatial Analysis*
- *Building Morphology and Usage*
- *Historical Evolution of the Built Form*
- *Methodological Development and Modeling*
- *Spatial Cognition*
- *Urban Structure and Spatial Distribution*
- *Urban Space and Social Phenomena*
- *Public Urban Space*

Proceedings

01 Key-Note Papers
02 Invited Papers
03 Spatial Analysis and Architectural Theory
04 Building Morphology and Emergent Performativity
05 Spatial Morphology and Urban Growth
06 Urban Territoriality and Private and Public Space
07 Urban Structures and Spatial Distribution
08 Spatial Configuration and Social Structures
09 New Modes of Modelling and Methodological Development
10 Architectural Research and Architectural Design

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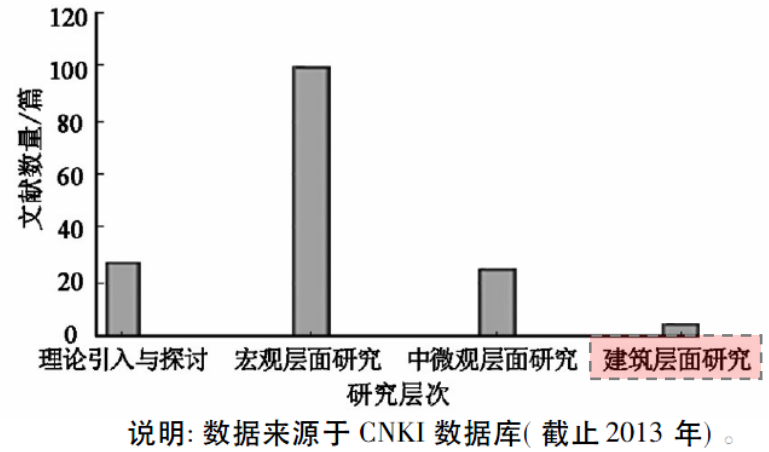
研究类型

Types

- 纯理论研究 theoretical
- **实践案例研究** Case study
- 算法技术研究 Technic tool

我国空间句法研究中 建筑领域的特点



说明: 数据来源于 CNKI 数据库(截止 2013 年) 。

国内空间句法各领域研究文献数量

“

我国空间句法在建筑学领域相对于城乡规划学来说，应用面较窄，

主要是集中在对住宅区环境的分析、展览类建筑的空间布局，及商业综合体等大型建筑中的路径设置等方面。

有代表性的研究包括以下几个方面：对建筑组群空间的分析，对建筑不同方案进行空间优劣评估，分析建筑组构中的某种空间特性与作用，分析大型建筑中公共空间的组织，分析建筑内部多层空间的结构。

”

国内空间句法在建筑领域研究的主要方面

The number of Space Syntax researches in architecture field is far less than that of urban planning in China.

Source：程明洋, 陶伟, 贺天慈. 空间句法理论与建筑空间的研究[J]. 地域研究与开发, 2015, 34(3):45-52.

Source：段进, 比尔·希列尔等. 空间句法在中国[M]. 东南大学出版社, 2015.

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介入阶段
Design Stage

- **分析与使用评价-后期** POE
- 介入与生成设计-前期 During design process

我国空间句法研究中 建筑领域的特点

“

recognize

1. 第一是通过对已建成空间的分析，识别和发现有意义的“形态结构类型（morphological types）”；

2. 第二是直接应用到方案生成的过程中，在初始阶段引入轴向空间框架（axial spatial framework）进行构型的优化生成。

Form optimization

”

Peponis在空间句法理论的应用前景中强调了两个方面

Source：Peponis J. Strategic design choices and the premises of building evaluation: A discussion of some uses of space syntax. International Conference: Critical approaches to environmental design evaluation, Paris, 1990

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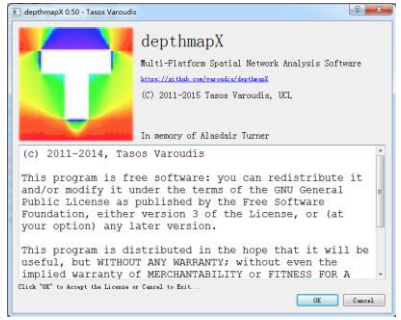
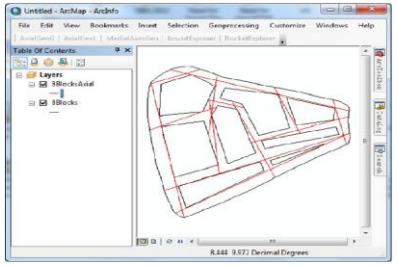
我国空间句法研究中 建筑领域的特点

分析软件 For analyze

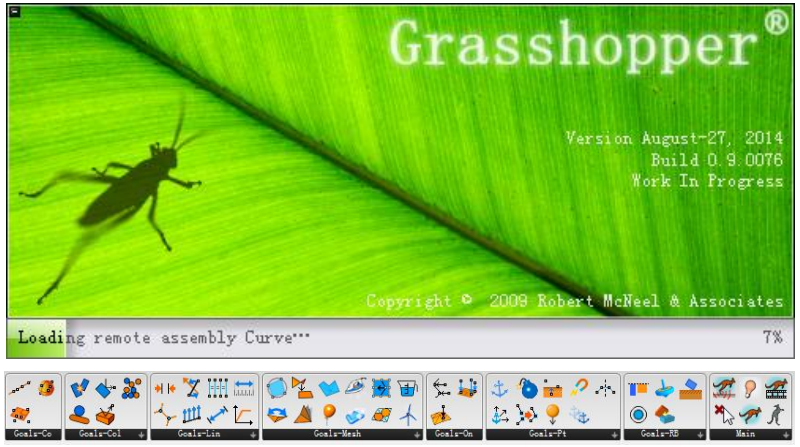


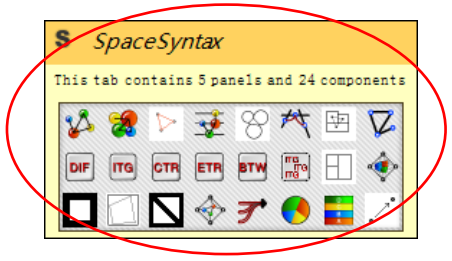
Depthmap



Axwoman

设计软件 For design





Grasshopper Based Plug-ins

研究领域

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介入阶段

Design Stage

- **分析与使用评价-后期** POE
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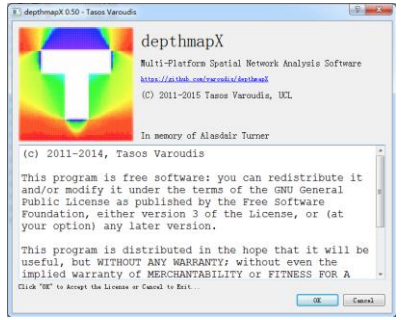
介入形式

Ways of Applying Space Syntax

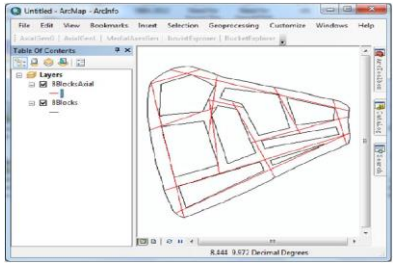
- 交互设计 Interaction
- 生成设计 Generation

我国空间句法研究中 建筑领域的特点

分析软件 For analyze

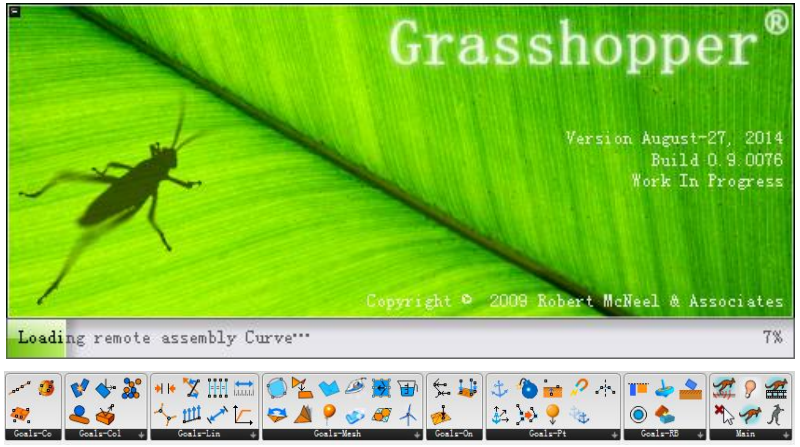


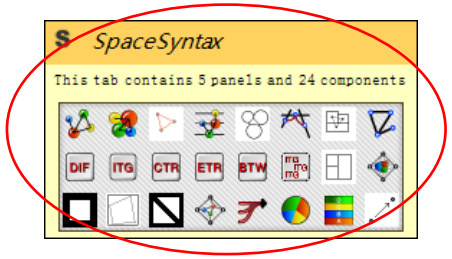
Depthmap



Axwoman

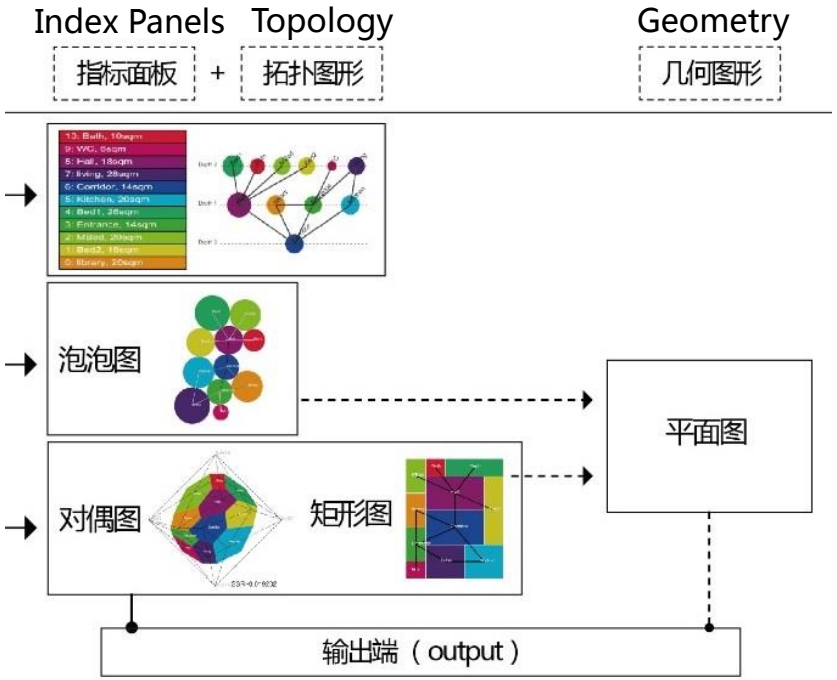
设计软件 For design

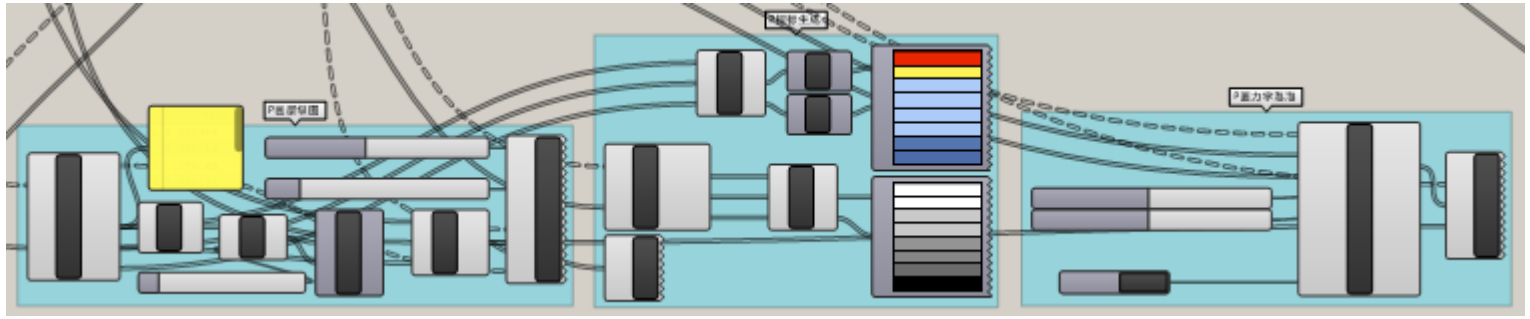




Grasshopper Based Plug-ins

插件功能实现 Parametric functions





空间深度计算，生成深度结构图　　–指标实时显示（面板与图解）　– 指标实时显示（泡泡图显色）

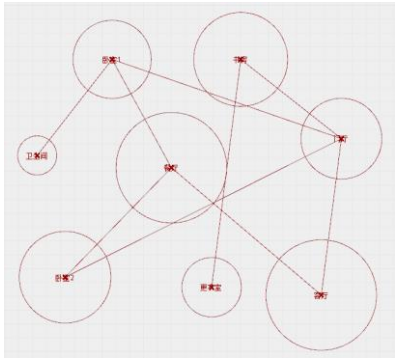
交互设计 Interaction
-空间句法指标实时可视化

生成设计 Generation
-基于构型的平面形式探索

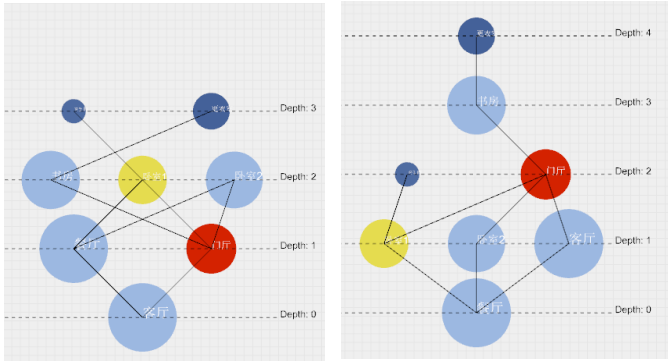
利用grasshopper实现生成与交互的流程与效果

Initials

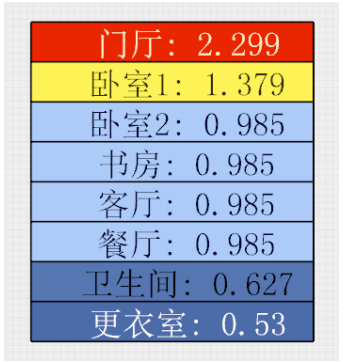
初始条件
（房间属性及构型关系）



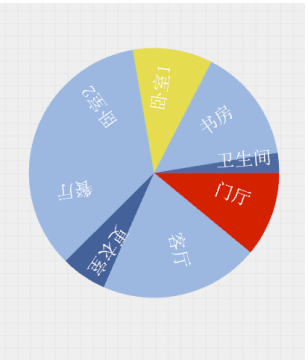
房间名称
面积大小
连接关系



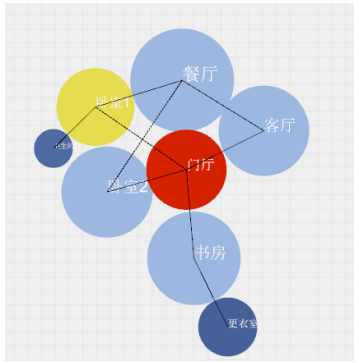
深度结构图（集成度着色）
Depth graph



集成度
Index panel



面积（集成度着色）
Pie chart



泡泡图（集成度着色）
Bubble Diagram

构型原理

— 符合设计师思维的生成过程（无几何束缚/有几何束缚）

交互设计 Interaction
-空间句法指标实时可视化

生成设计 Generation
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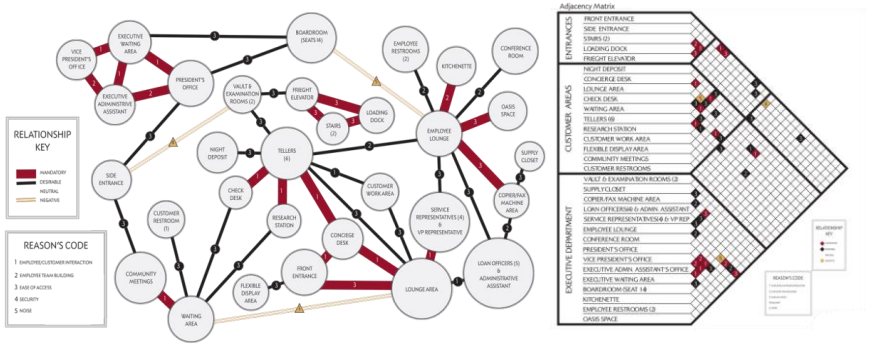
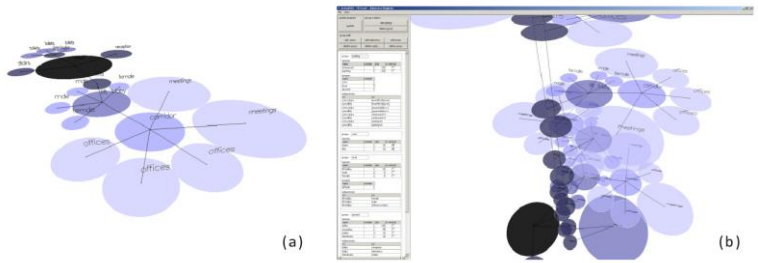
利用grasshopper实现生成与交互的流程与效果

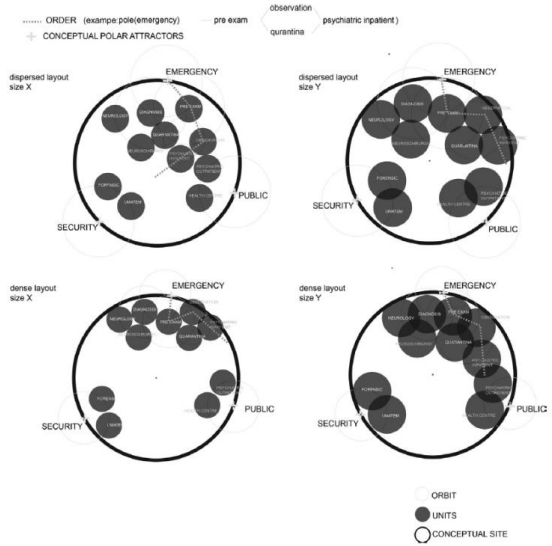


弗洛利达银行设计的泡泡图与邻接矩阵
Design Thinking Diagram

Source: http://www.coroflot.com/killebrew/florida-bank

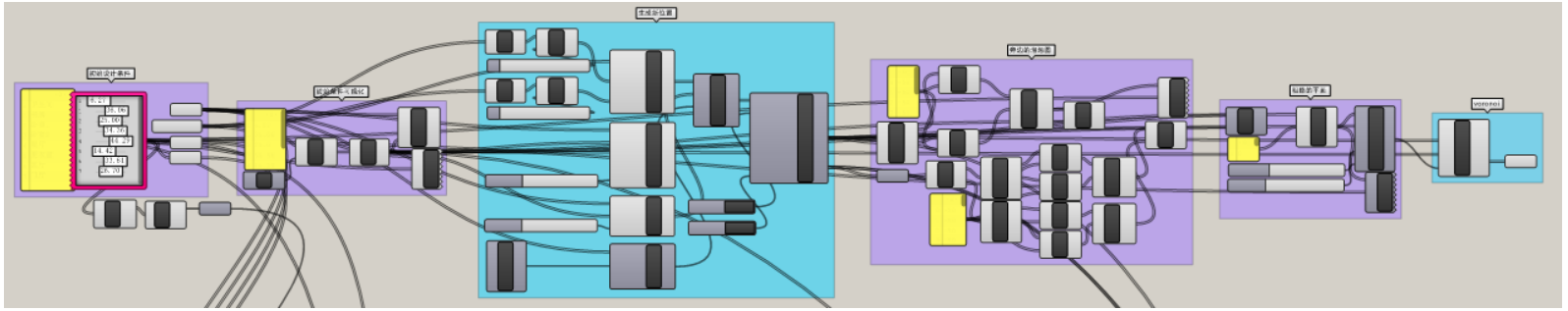


根据面积与关系生成的气泡图（力学原理）
Configuration Forming



具有特定关系的气泡图在场地中布局（空间设计）
Added Consideration of Site

Source：Journal of Space Syntax



初始条件 – 初始条件可视化 – 拓扑关系计算 – 泡泡图生成 – 平面轮廓生成 – 房间划分

交互设计 Interaction
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利用grasshopper实现生成与交互的流程与效果

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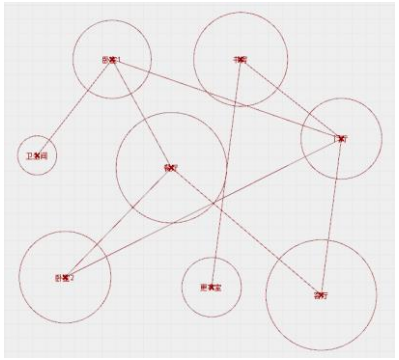
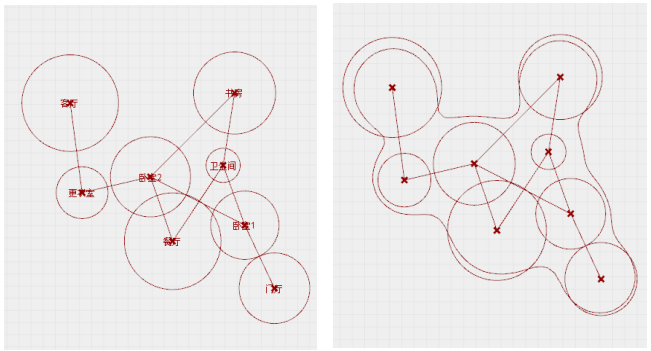
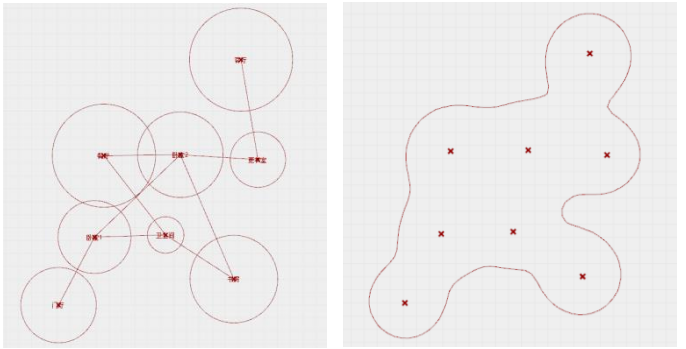


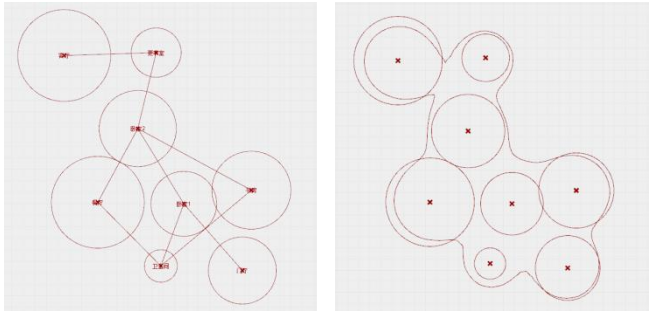
房间名称
面积大小
连接关系



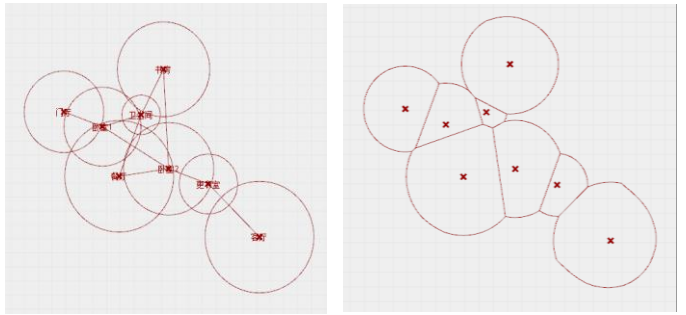
1 构型关系+包裹边界



3 包裹边界

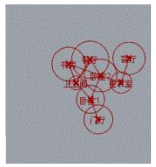


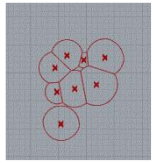
2 房间位置+包裹边界

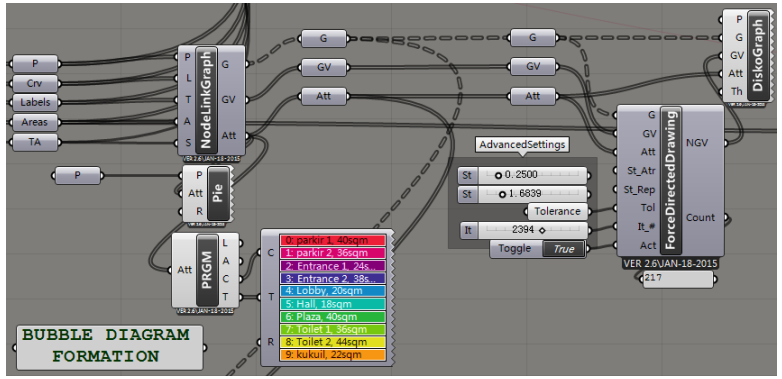


4 包裹边界中的房间划分

过程Gif







$$引力AF_{ij}=k_a \Delta x_{ij} \quad for\ all\ linked(i,j)$$

$$斥力RF_{ij}=\Delta \frac{ka}{xij} \quad for\ all\ (i,\ j)$$

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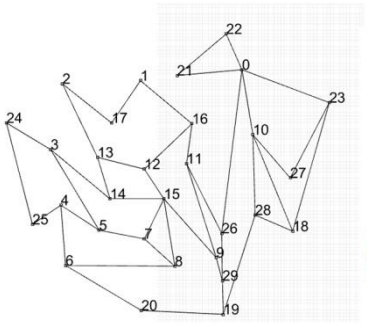
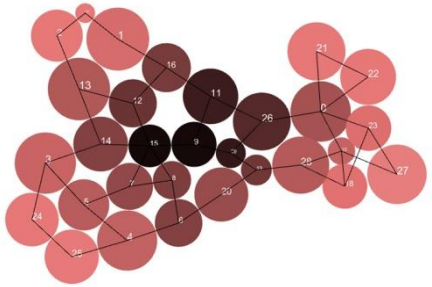
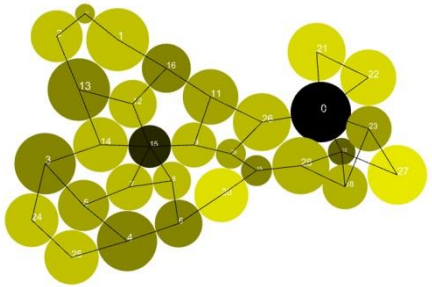


Original



Integration colored

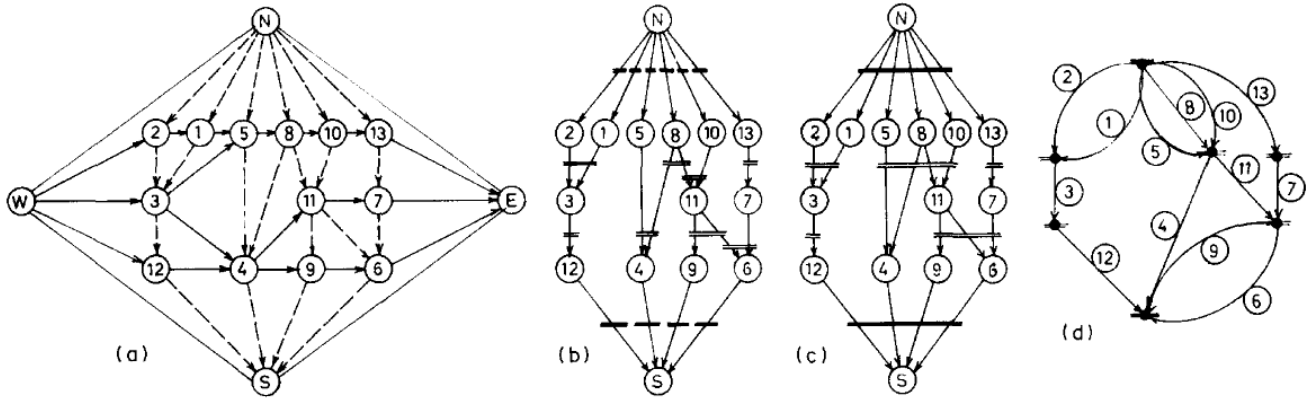


Choice colored

→ 相互检验
Text with FAR, function…

→ 形态特征
Width ? Material ? ….

→ 尺度拓展
Different scale….



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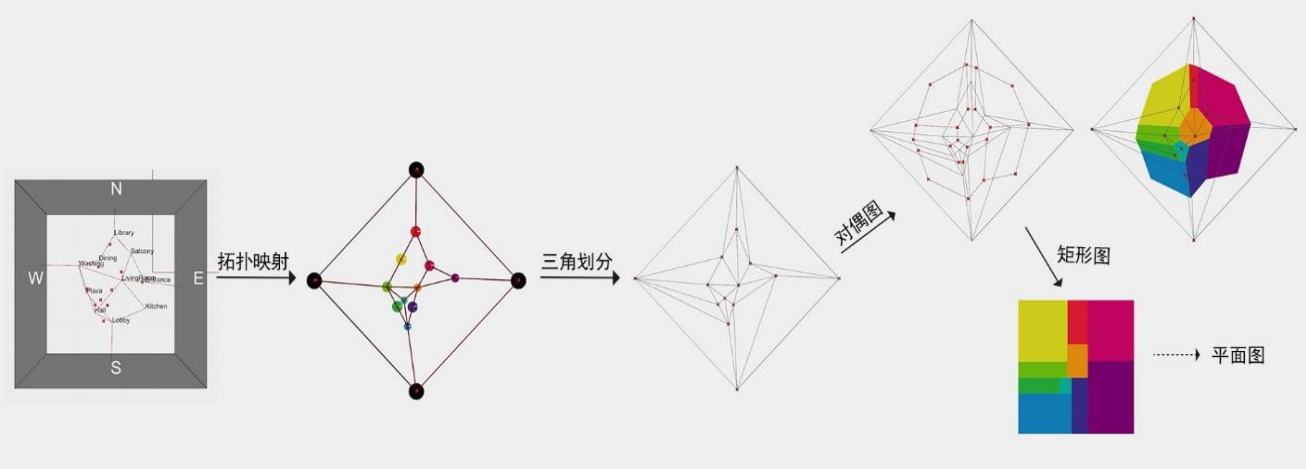
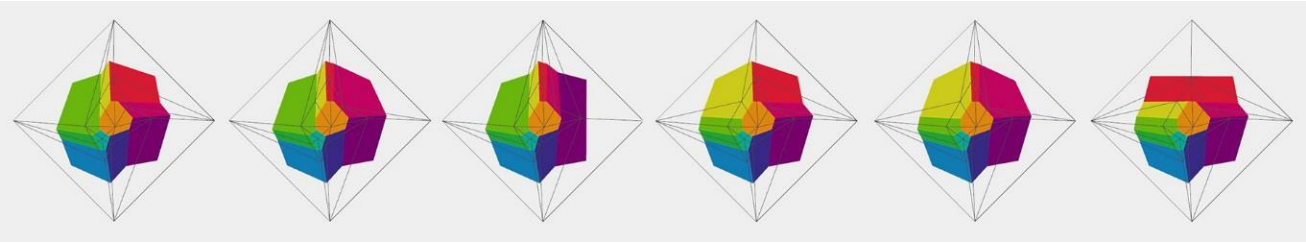


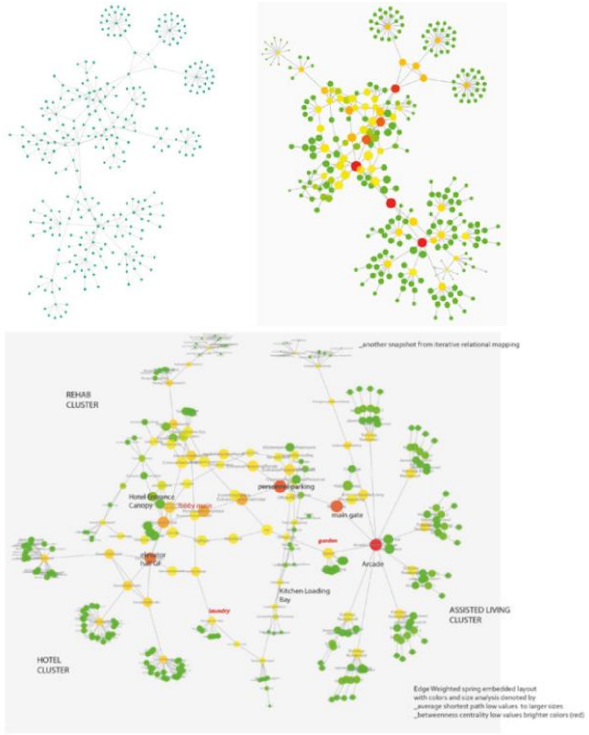
Tutte Dual Graph (graph theory)



Different Reservations

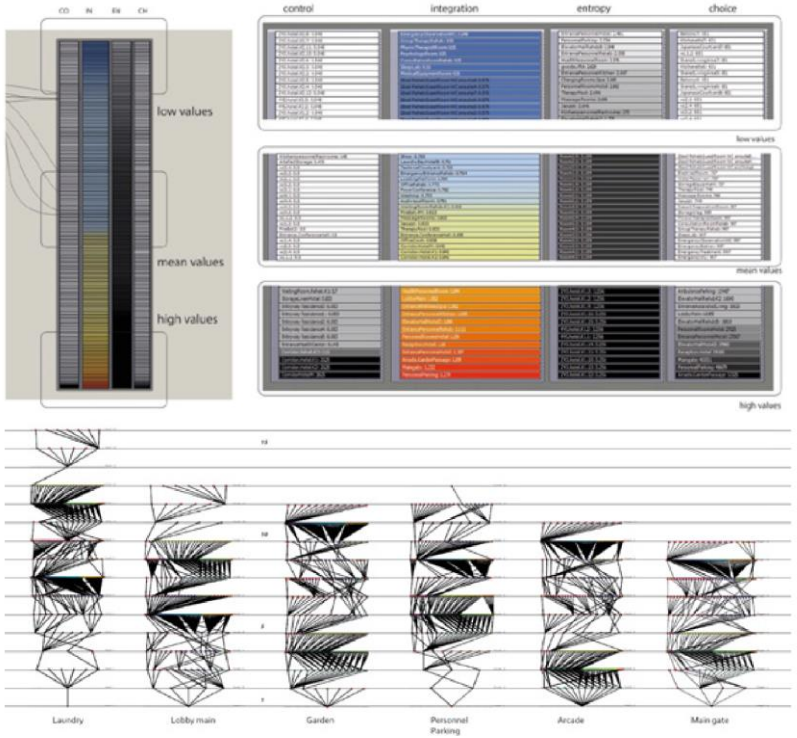
构型原理 Configuration

— 复杂功能建筑的关系型模型



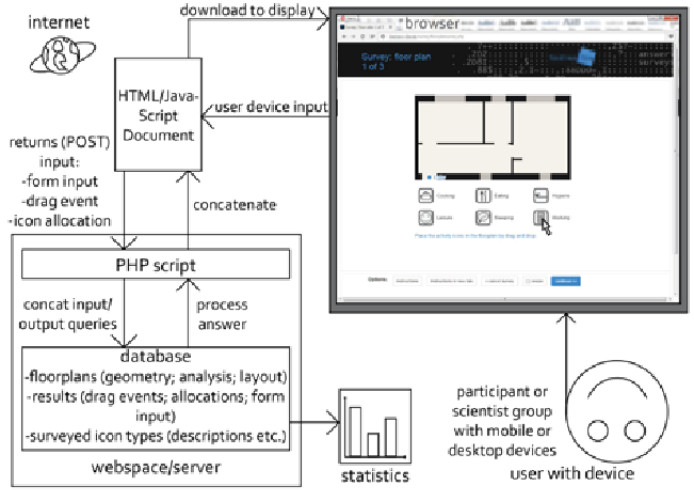
多功能综合体的房间网络（设计初始）
Complex Building / HOPSCA

— 实时可视化指标呈现



不同房间的深度值指标（设计过程）
Real-Time Index

— 业主参与的交互设计过程

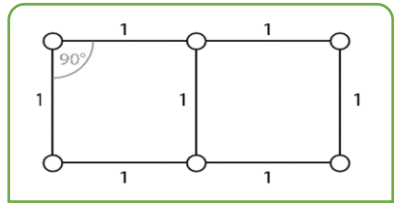


收集业主意见的线上网站界面（设计前期）
Online Participation

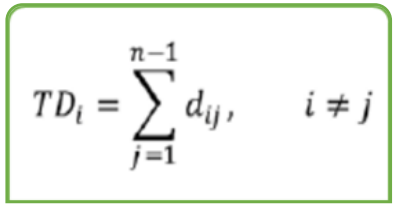
Source：11th Space Syntax Symposium Proceeding

交互设计　Interaction
-空间句法指标实时可视化

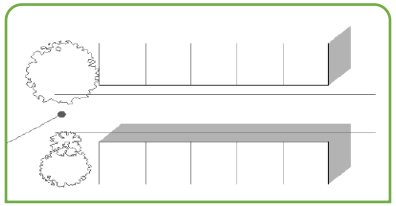
算法基础：深度、集成度等拓扑运算原理
实现方式：C#电池块编写+Legend+着色
难度：简单
发展方向：更有意义的呈现方式
Prospect: Convenient / useful presentation



topology



formulation



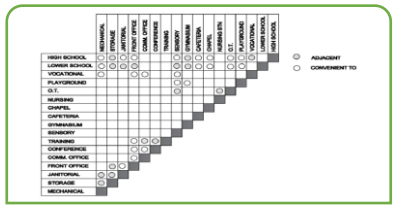
Integrating other factors

互动与生成涉及的原理与发展方向

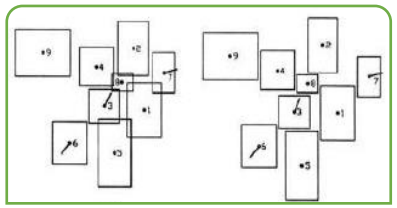
生成设计　Generation
-基于构型的平面形式探索

算法基础：图论算法、遗传算法等
实现方式：插件+C#电池块编写
难度：较难
发展方向：选择不同的算法，更多几何形式，边界限制与已有区域合理划分

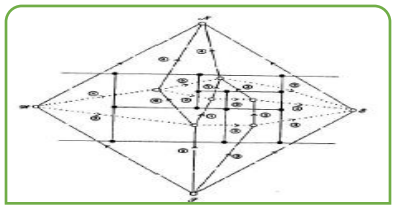
Prospect: Proper Algorithms /
Relationships between index and performance



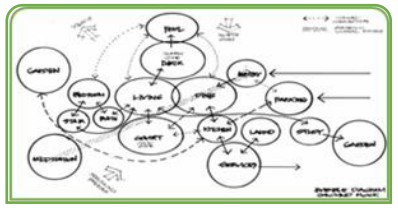
adjacency matrix



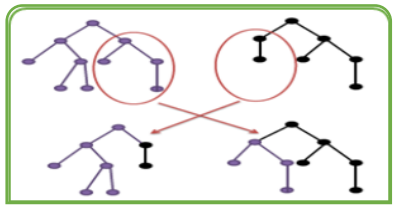
Physically-based model



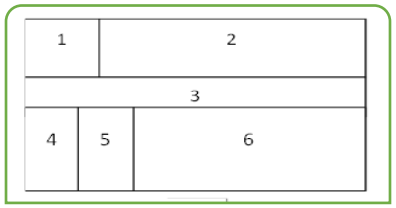
Graph algorithm



Babble diagram



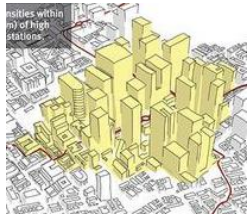
crossover



Geometry solution

“集约” 空间特征 计算机转译

Intensified Urban Environment calls for high relevance of space and performance – Spatially high efficiency



高密度空间布局
High Density

紧凑的平面肌理
Compact Texture

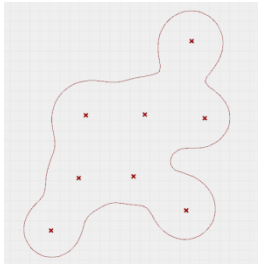
高效的功能逻辑
Function Logic

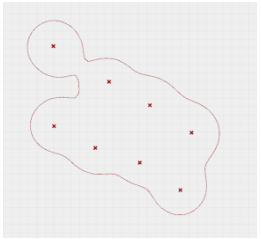
全时段的活力
All-time Use

在集约型街区生成设计中的应用展望

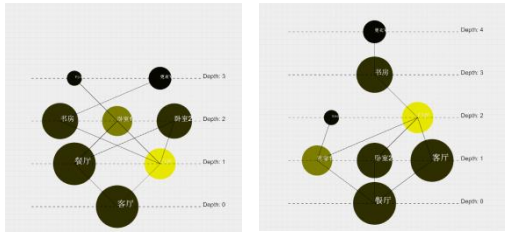
Prospect for my further studies

构型的立体生成
3d forming





包裹面积/周长/适应基地形状
Evolutionary algorithms



可实时监测与交互的构型关系
Interactive Design Process

完

Thank you

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