



Esri CityEngine 规则开发

慕晓燕

内容



2013 Esri China
Developer Summit

- CityEngine 快览
- CGA 基础
- CGA 建模示例
 - Demo: 城市建筑物
 - Demo: 郊区房屋
 - Demo: 报表
- CityEngine Web Scene



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CityEngine 快览

CityEngine

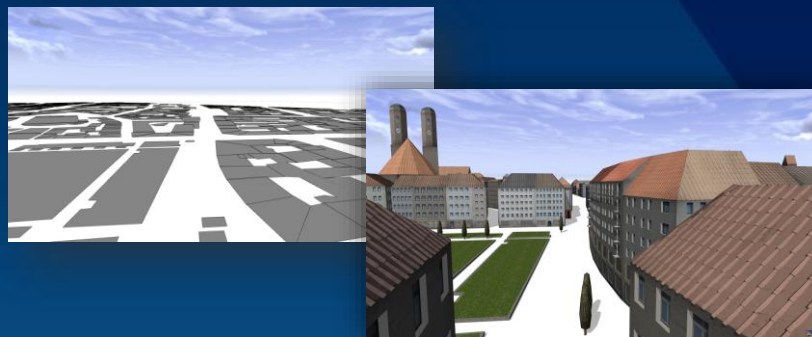
3D程序化建模与设计解决方案



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– 3D 城市内容构建

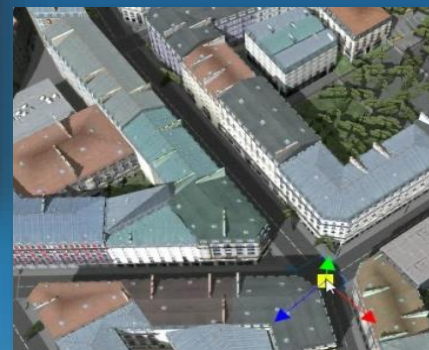
- 数据 + 规则



几何 + 属性 + 规则

– 3D 城市设计

- 交互式
- 规则驱动的3D设计



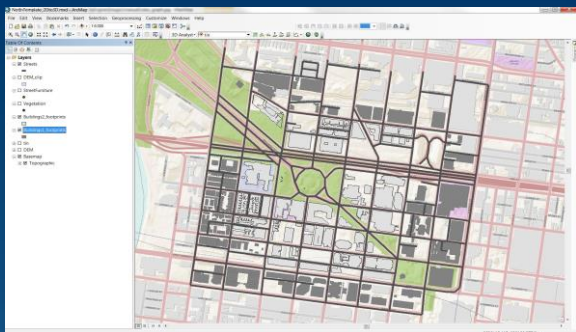
动态
参数化
编辑

3D 城市内容创建

程序化的自动建模



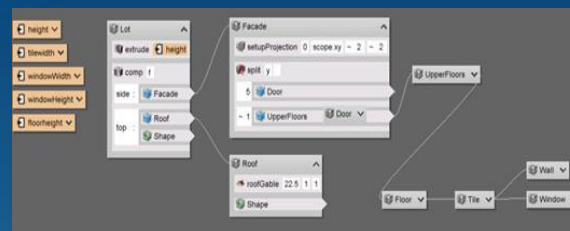
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几何

OBJECTID	Z_Min	Z_Max	Roof_Form	Ridge_3D	Eave_3D	Z	Bldg_ID	SHAPE	SHAPE_Length	SHAPE_Area
1	20.2522	64.411	fat	8.4	8.25	21.91448	25	Polygon	99.656355	418.683569
2	21.2607	66.6358	shed	9.86	8.66	20.632911	26	Polygon	50.555297	159.659544
3	36.3962	320.6558	fat	88.300796	88.300796	37.212535	103	Polygon	406.10474	16202.325473
4	22.3236	57.7907	shed	8.4	7.91	26.864543	34	Polygon	85.537074	376.8699192
5	23.8041	66.9362	shed	12.83	12.23	26.073111	20	Polygon	23.69814	32.508874
6	25.6566	63.256	fat	3.73	3.73	26.500617	33	Polygon	63.337769	136.829382
7	19.7574	188.1827	fat	42	42	22.610424	111	Polygon	787.48338	27252.421244
8	13.8502	65.6907	butterfly	16.7	14.3	13.73557	9	Polygon	175.638877	588.207114
9	17.2811	58.782	fat	32	32	33.950504	113	Polygon	133.65668	568.384153
10	17.2811	58.782	fat	169	169	27.132445	113	Polygon	273.955593	4960.000774
11	13.8502	65.6907	fat	11.04	10.29	17.423191	9	Polygon	148.659944	1350.038765
12	8.3995	305.2566	fat	91.79	90.565111	42.499004	541	Polygon	1931.426243	155219.733606
13	22.3236	57.7907	gable	10.59	8.5	22.805654	34	Polygon	93.104492	491.056073
14	40.5078	69.9607	fat	8.769062	48.395333	116	Polygon	48.899123	146.6142635	
15	28.0523	164.5985	fat	23.337257	41.344003	148	Polygon	1098.27786	63208.396968	
16	22.3236	57.7907	gable	6.71	6.42	26.665042	34	Polygon	109.914427	744.02796
17	35.9163	69.259	fat	10.165153	10.165153	37.865566	118	Polygon	48.728126	146.903501
18	20.2522	65.412	fat	11.04	10.29	21.585776	25	Polygon	150.421816	1290.800047

属性



规则

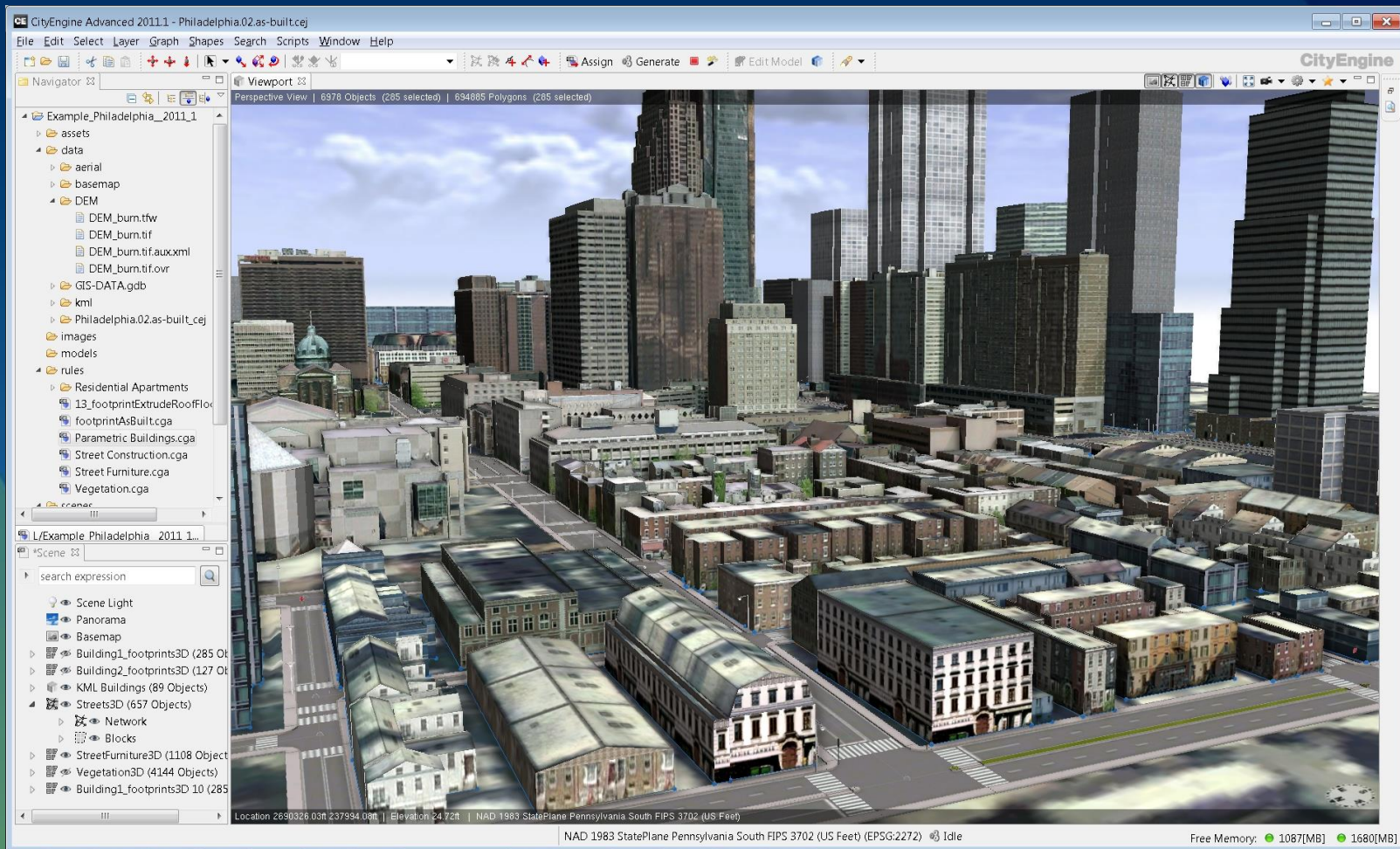


3D 城市内容创建

程序化的自动建模



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3D 城市设计

3D 程序化、参数化、动态设计



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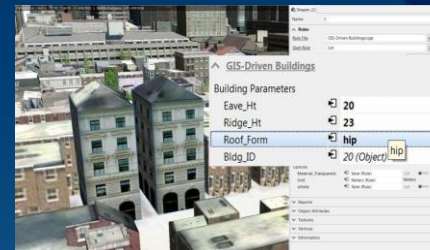
参数化编辑



添加楼层



添加屋顶



动态编辑



报表





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CGA 基础

CGA 语言



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CGA: Computer Generated Architecture;

CityEngine的独特语言;

越来越详细地迭代“进化”模型。





CGA 规则

Lot -->

```
extrude (rand (10,100) )
```

```
s ('0.5, '1, '0.5)
```

```
center (xz)
```

Building

Rule:

- 规则描述了shape 生成模型的过程。
- Lot 是 initial shape;
- 在 Lot 的基础上做更改, 产生Building;
- Lot 被替代;
- Building 称为叶子模型/Leaf Model。

Lot

Building



CGA shape

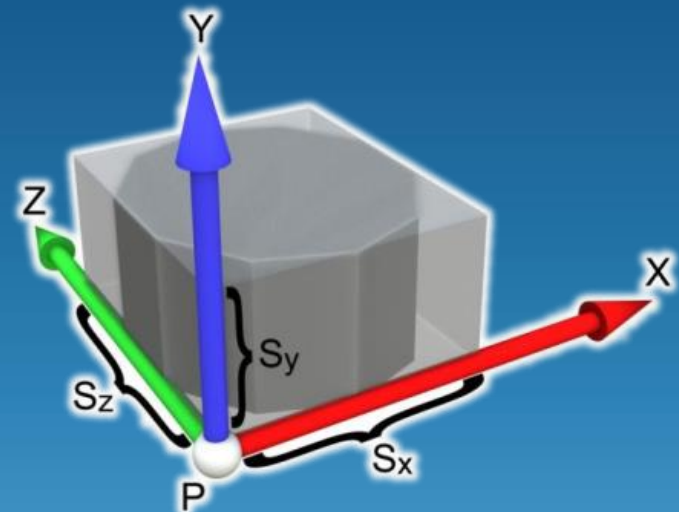
Lot -->

```
extrude (rand (10,100))  
s ('0.5, '1, '0.5)  
center (xz)
```

Building

Shape :

- ShapeSymbol : 规则名字
- Parameters: 参数
- Attributes: 模型的构成与形状
- Geometry: 几何对象, 包含纹理、颜色、图形
- Scope: 外接长方体范围
- Pivot: 模型坐标系





CGA 编辑器

- 打开 .cga 文件
- Ctrl + Space 或者 Alt + / 命令提示
- Errors 红色下划线
- Warnings 黄色下划线
- 分屏显示、可视化

```
12
13# our first rule
14A --> extru
15
16
17
18
```

extrude(float a) -
extrude(x|y|z|world.x|world.y|world.z, float b) -

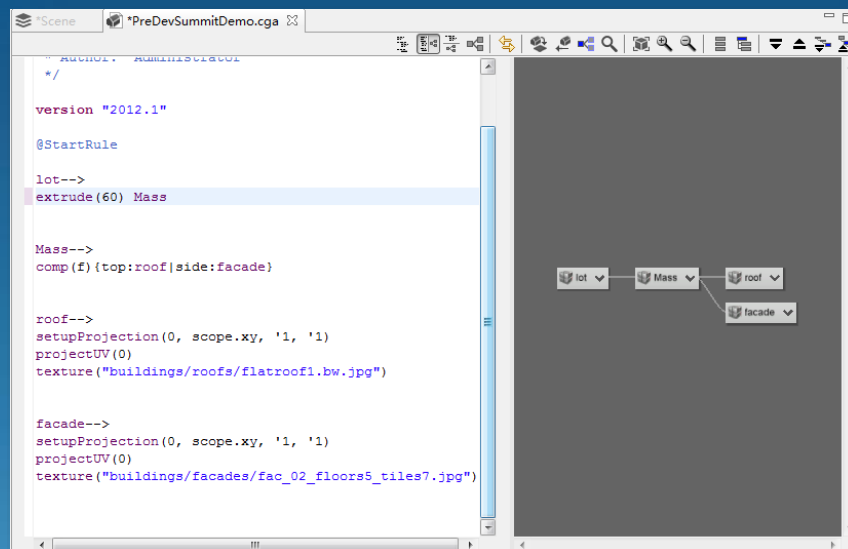
```
202
203 Shop ->
204   set(material.colormap, shopTexture(ceil(rand(6))))
205   setupProjection(0, scope.xy, scope.sx, scope.sy) projectUV(0)
206
```

CGA 编辑器



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- 打开 .cga 文件
- Ctrl + Space 或者 **Alt + /** 命令补全
- Errors 红色下划线
- Warnings 黄色下划线
- 分屏显示、可视化

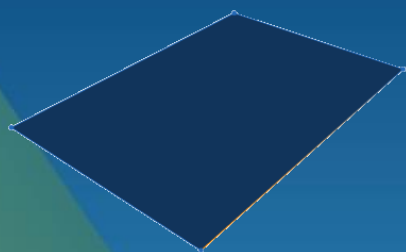




一个简单的规则

```
Lot --> extrude(10) Mass
```

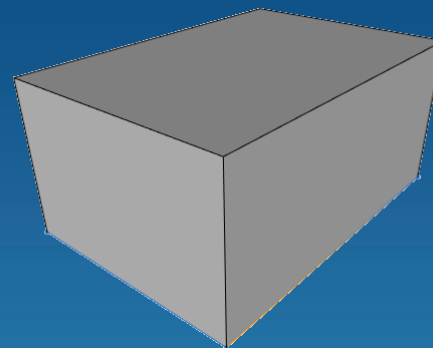
- Leaf Shape 形成结果模型



Lot



规则



Mass



Shape 的替换

```
Lot --> extrude(10) Mass
```

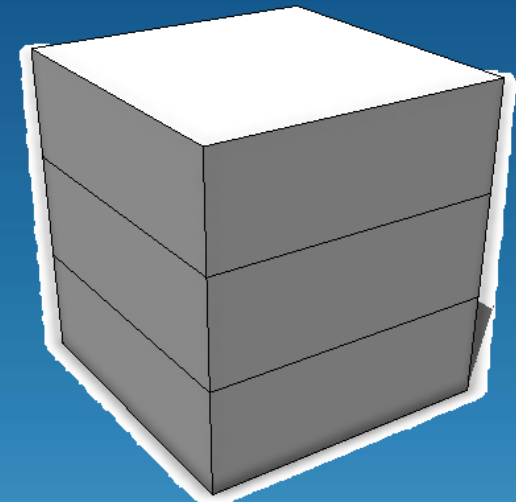
Rule #1

```
Mass -->
```

```
  split(y) { ~4 : Floor. } *  
  Floor
```

Rule #2

- Rule #2 是基于Mass的规则;
- Mass 被 Floor 替换。

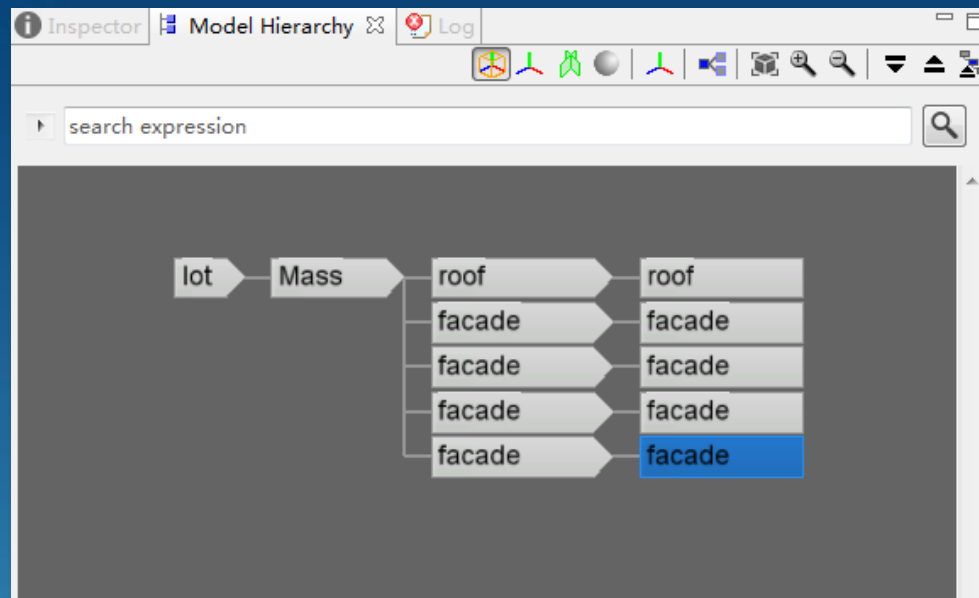
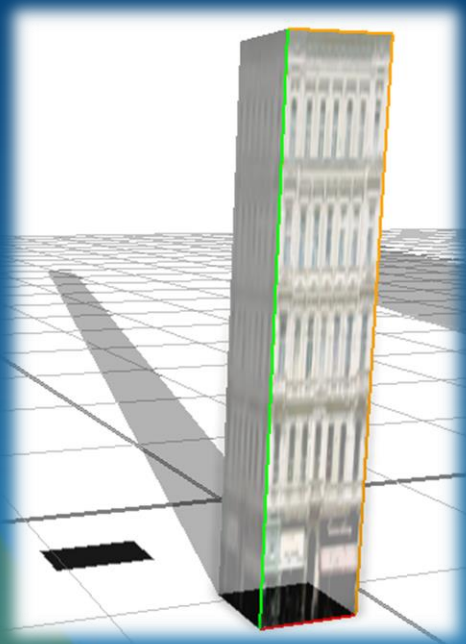
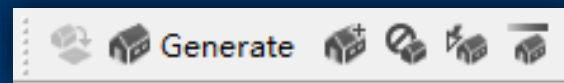




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CGA 模型树查看器

查看已经生成的模型的层次；
对编辑和分析规则十分有帮助。





CGA 语法示例

```
attr height = 20
const groundfloor_height = 20
Lot --> extrude(height) Mass
Mass --> comp(f) { top : Roof.
                | front : Frontfacade
                | side : Facade}

# Facade
Facade -->
    setupProjection(0, scope.xy, 1,0.5, 1)
    split(y){groundfloor_height : Groundfloor |
    ~1 : UpperFloors}

Groundfloor -->
    case scope.sx > 10 : color("#cccccc")
    else : color("#ffcccc")
```

Boolean, float, string 表达式

1, 0.5, ("#cccccc"), scope.sx > 10

CGA 指定关键字

attr, top, front, case

CGA 操作

extrude(height), comp(f)

规则

Lot, Mass, Facade

自定义属性、常量、函数

height, groundfloor_height

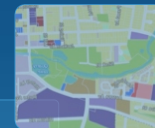
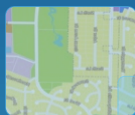
注释

#Facade, //, /* ... */



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Demo: 城市建筑物



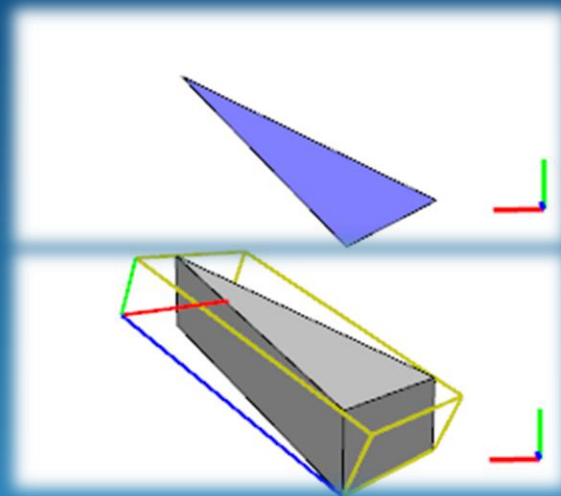
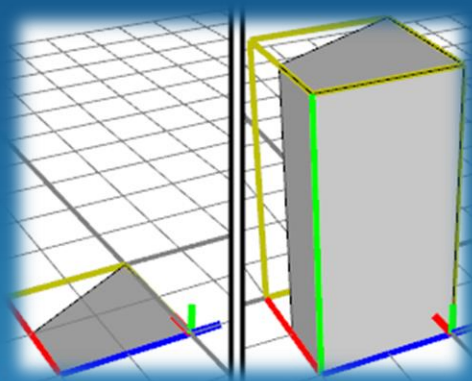


CGA: 拉伸

2D Footprint \rightarrow 3D building

```
extrude (height)
```

```
extrude (axisWorld, height)
```

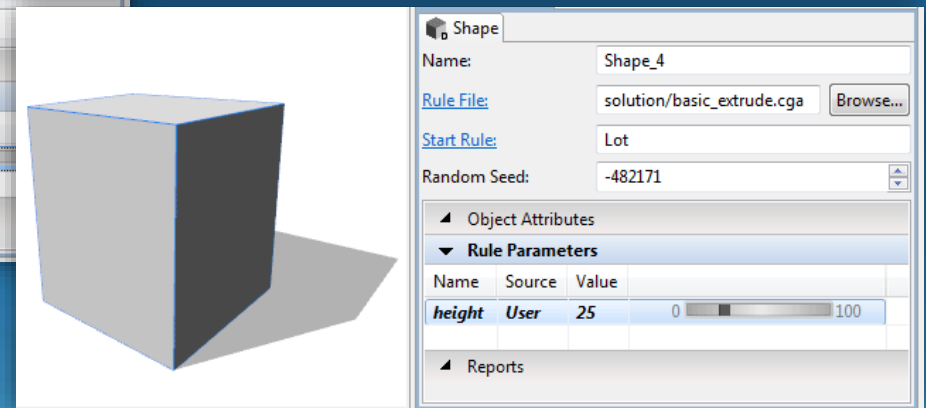
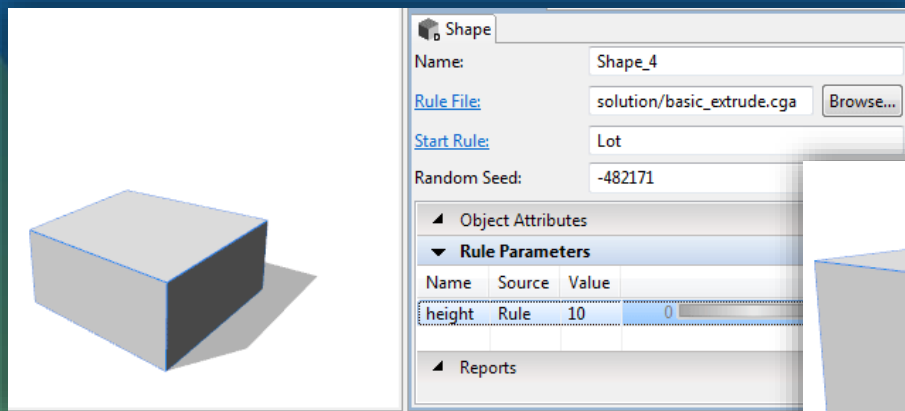




CGA: 添加属性

```
attr height = 10  
Lot --> extrude(height) Mass
```

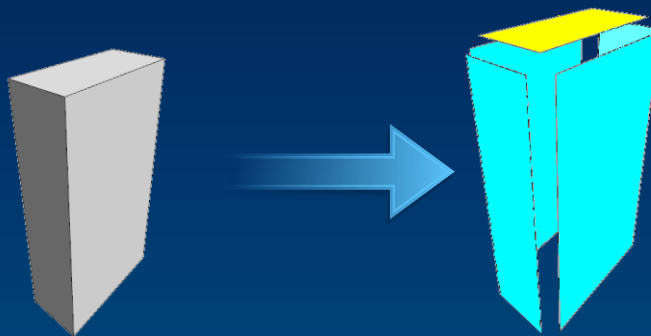
规则文件：添加属性 height;
查看器：属性 -> 参数;
参数可以在查看器中修改。





CGA: 组件分割

分割模型的不同组件:



– 面组件分割:

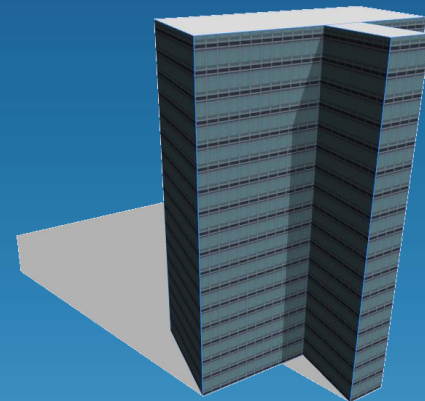
- `comp(f) { top : Roof | side : Facade }`

– 边和节点分割:

- `comp(e)`, `comp(v)`

– 通过不同的语义进行选择

`top`, `side`, `vertical`, `left`, `aslant`, ...





CGA: 纹理贴图

`setupProjection(uvset, axes, width, height)`

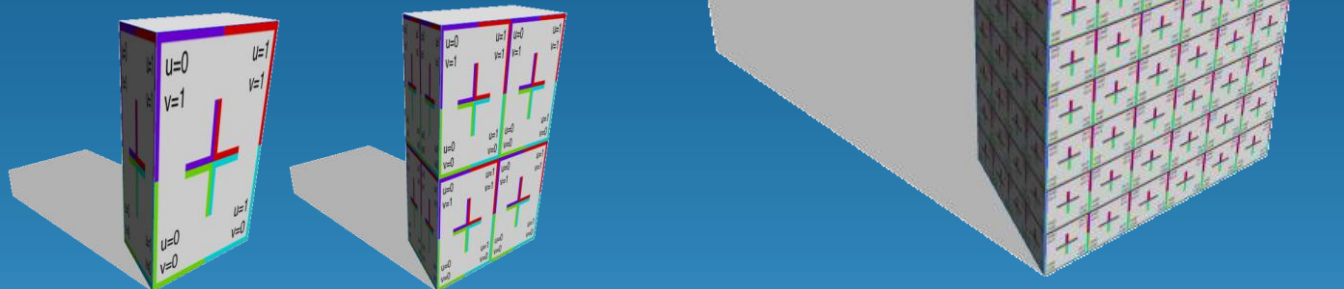
- 设置图片的贴图矩阵
- `width`、`height` 参数控制图片长宽或比例

`projectUV(uvset)`

- 创建纹理图片坐标系

`texture("builtin:uvtest.png")`

- 加载一幅纹理图片



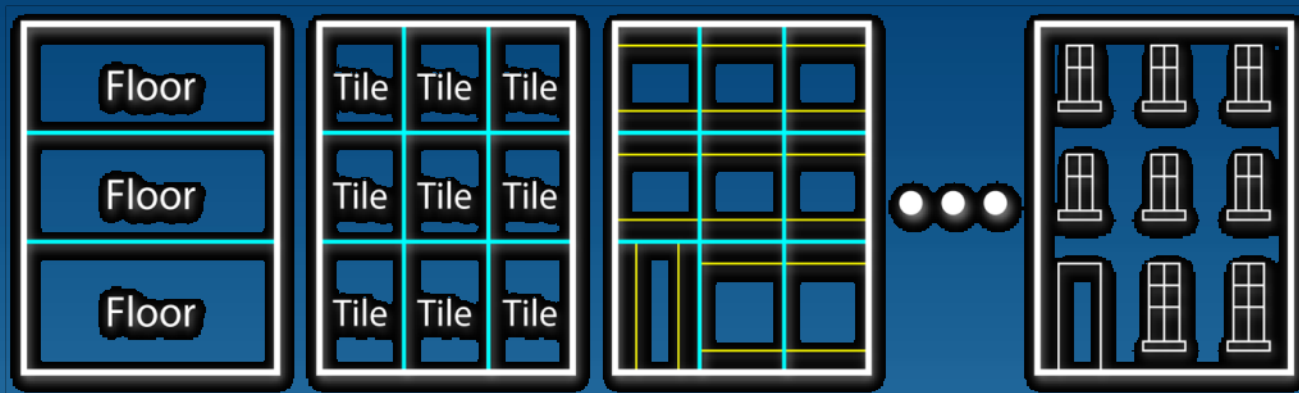
细化表面建模



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通常情况下的表面细化结构,

Facade → *Floor* → *Tile* → *Wall & Window/Door*





CGA: 重复分割

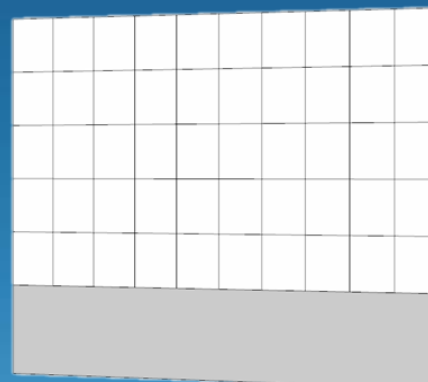
星号 (*) 表示重复分割:

```
split(y) {~width : A}*
```

~ 表示取平均值, 确保适合模型表面尺寸。

常规分割和重复分割可以组合使用:

```
split(y) {groundfloorheight : Groundfloor  
| {~ floorheight : Floors}* }
```





CGA: “节奏” 分割

利用常规分割和重复分割组合使用。

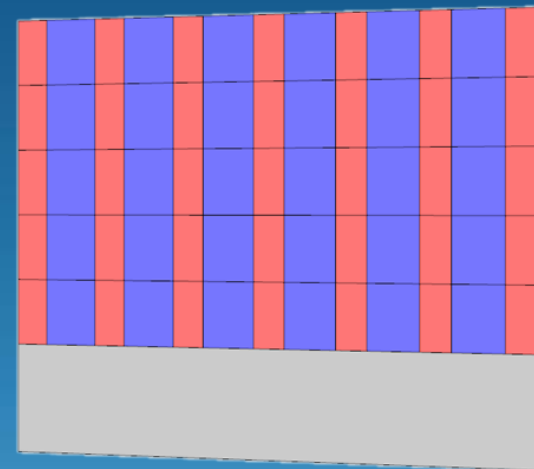
- **A B* A**

```
split(x) { widthA: TileA  
  | {~ widthB : TileB}*  
  | widthA : TileA }
```



- **{ A B }* A**

```
split(x) { { widthA: TileA  
  | ~ widthB : TileB }*  
  | widthA : TileA }
```



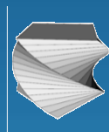
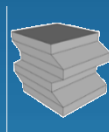


CGA: 插入模型素材

将外部的模型插入当前shape。

`Asset --> i ("asset.obj")`

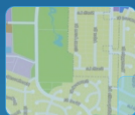
- 插入任意 obj 文件
- 插入静态模型 (例如: 树木、窗户等)
- 插入的对象可以被CGA规则进一步处理。





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Demo: 郊区房屋



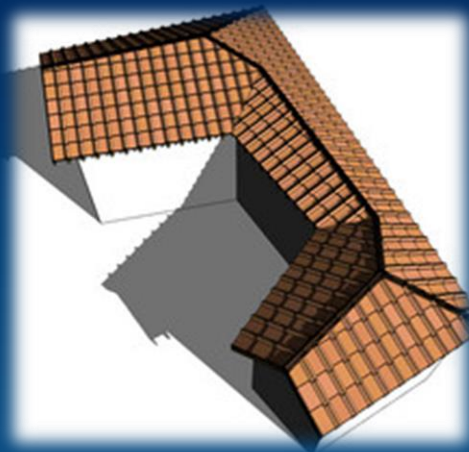


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CGA : 屋顶样式

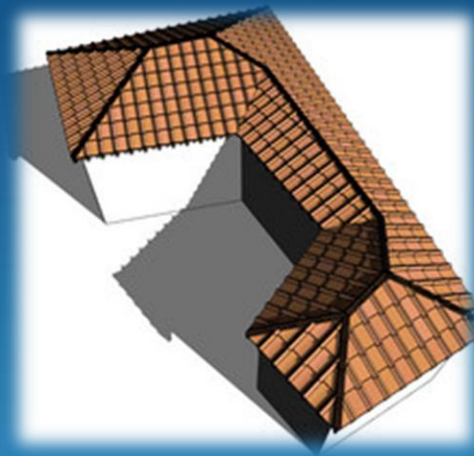
屋顶样式的控制:

- `roofGable()`
- `roofHip()`
- `roofPyramid()`
- `roofShed()`



额外设置:

- 屋顶倾角
- 屋檐悬挂长度





CGA: 种植树木

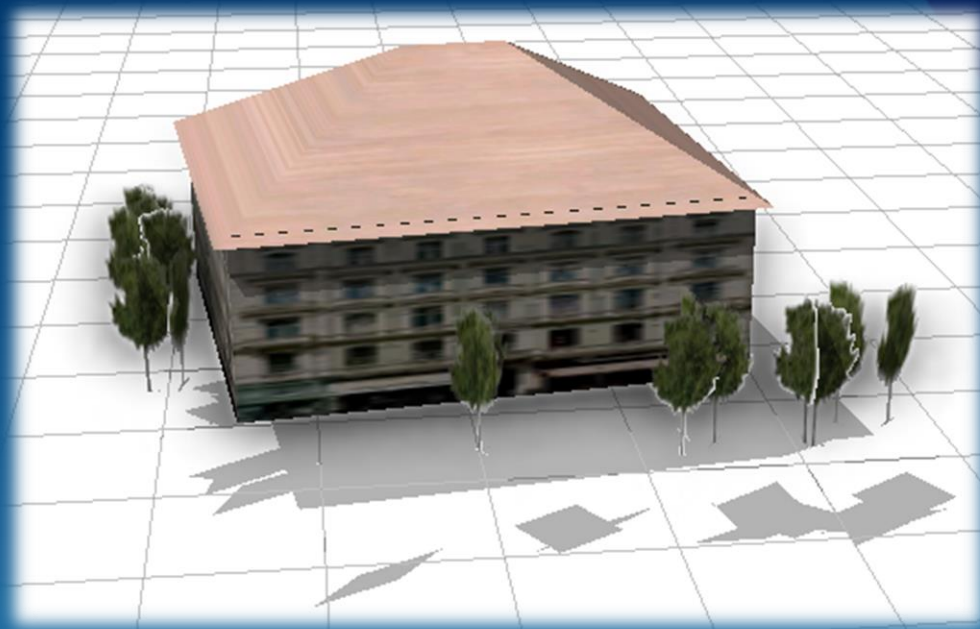
示例:

分割房屋边界:

- shapeL ()
- shapeU ()
- shapeO ()

种植树木:

- Scatter ()



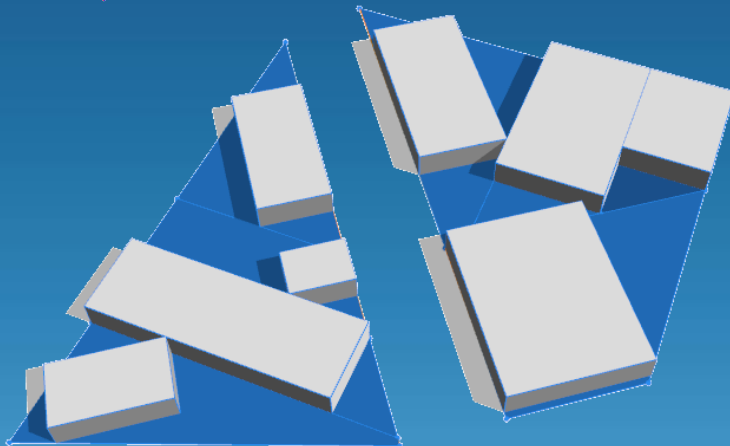
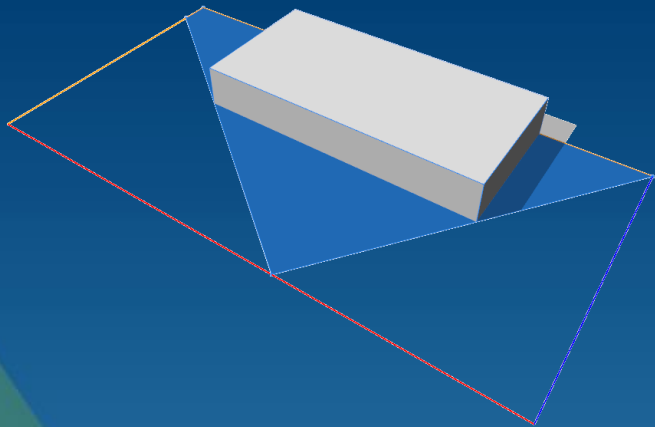


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CGA : 内接矩形

innerRect

将 Shape 转化成内接矩形，建立规则的房屋。





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报表

报表操作



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在模型建立时收集数据;

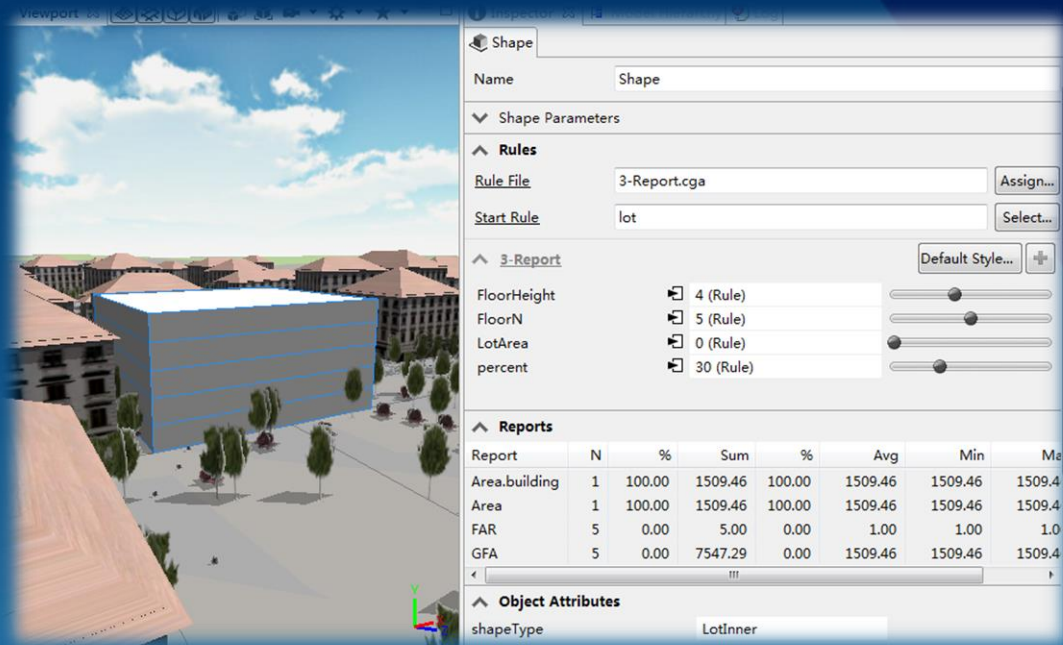
可在规则任意位置使用。

`report (key, value)`

示例

`OfficeFloor -->`

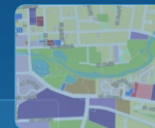
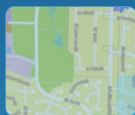
`report ("GFA.Office", geometry.area)`





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CityEngine Web Scene



CityEngine Web Scene



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在浏览器中查看 3D 城市景观和其他 3D 场景的 Web 应用程序。

- 基于 WebGL 技术
- 在 Web 浏览器中查看 3D 内容
- 无需安装插件

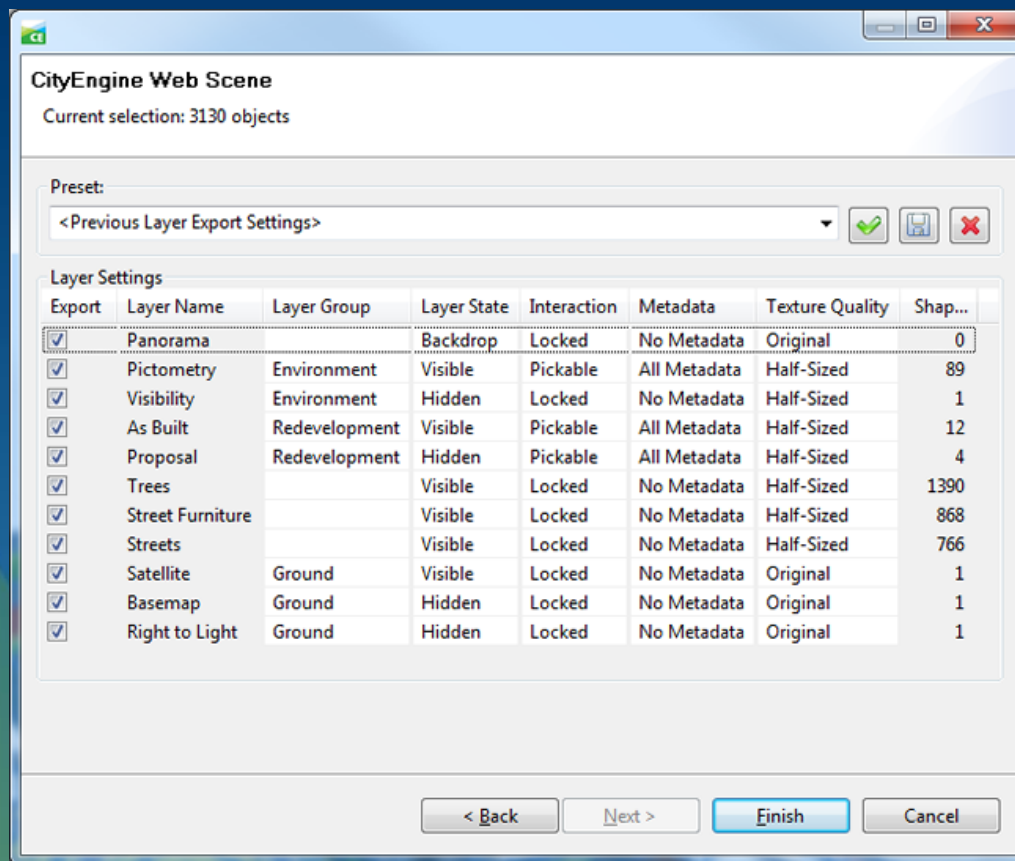


导出 3ws



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File → Export Models... → CityEngine Web Scene



*.3ws 文件

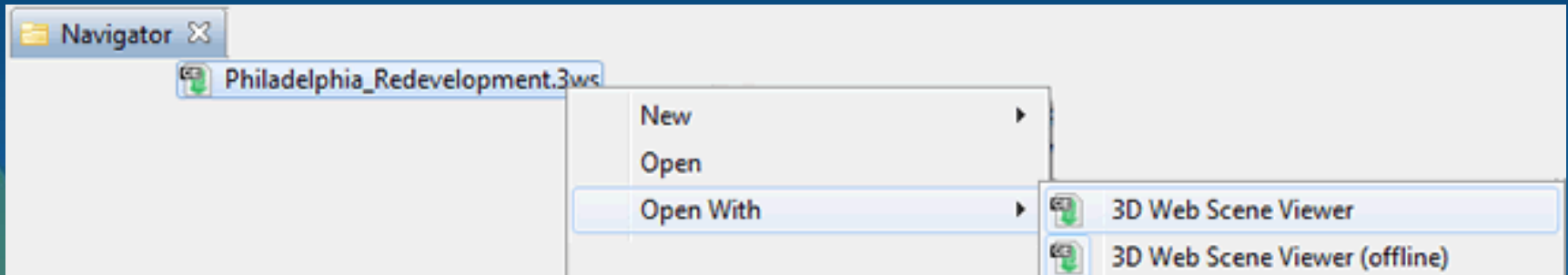


浏览场景



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Open With → CityEngine Web Scene Viewer




查看场景



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CityEngine Web Viewer Esri Campus [Details](#) [Help](#) [CityEngine](#) [ArcGIS Online](#)



Layers

- Dev HQ
 - Exterior Walls
 - No Walls
- Dev HQ - Level 1
- Dev HQ - Level 2
- Dev HQ - Level 3
- Campus Buildings
- Buildings Environment
- Rocks
- Trees
- Light Poles

CPU使用: 18 %

Powered by **esri**

分享场景



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□ Share as...

- 发布到ArcGIS Online
- 打包 zip 文件



□ 上传到本地服务器



Local
Server





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查看场景

- 缩放、平移和旋转来导航地图；
- 选择书签；
- 选择要查看的特定图层；
- 搜索对象、属性等；
- 更改光照和阴影；
- 通过各种社交媒体进行共享；
- 查看地图的其他信息。



CityEngine
Web Viewer

Esri Campus



正在下载: 8% (0.69 of 8.16 MB)

[详细信息](#)

学习资源



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CityEngine Community:

<http://resources.arcgis.com/en/communities/city-engine/>

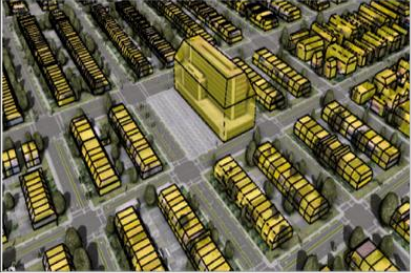
CityEngine

Communities

What's new in CityEngine 2012.1?

CityEngine supports many GIS tasks, including mapping, data compilation, analysis, geodatabase management, and geographic information sharing. Find out what is new with the latest release of Esri CityEngine.

[Read more...](#)



Quick Links

Getting Started with CityEngine

- Install and Activate
- System Requirements

Help

- CityEngine Help

Other Links


- What's new in CityEngine 2012.1?
- CityEngine Gallery
- Knowledge Base
- Ideas
- Support

Related Communities

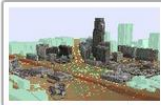
- 3D GIS Resources

Gallery


[More Gallery posts](#)




3D City: Maintenance (part 3)




3D City: Data Preparation (part 1)



3D City: Creation (part 2)



3D City: Analysis (part 5)



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GIS Hydro 2013 Pre-Conference Water Resources Workshop: More Coming Soon!
(03/28/2013)

by Steve Kopp, Geoprocessing and Spatial Analysis Team, Esri Jump-start your conference a day early by joining us for the 20th annual pre-conference Water Resources Workshop on Sunday July 7th. The Water Resources Workshop is a FREE, full day workshop focused ... [Continue reading](#) →

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