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2013 Esri China Developer Summit

Esri CityEngine 规则开发

慕晓燕

内容

- 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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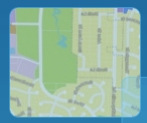
CityEngine 快览



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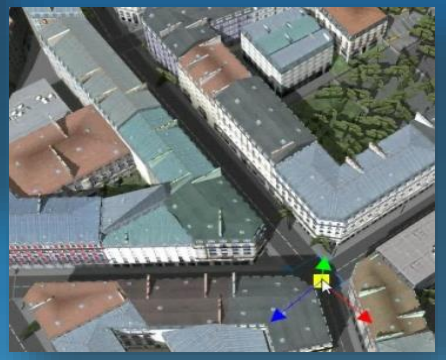
CityEngine

3D程序化建模与设计解决方案

– **3D 城市内容构建**
  - 数据 + 规则

几何 + 属性 + 规则

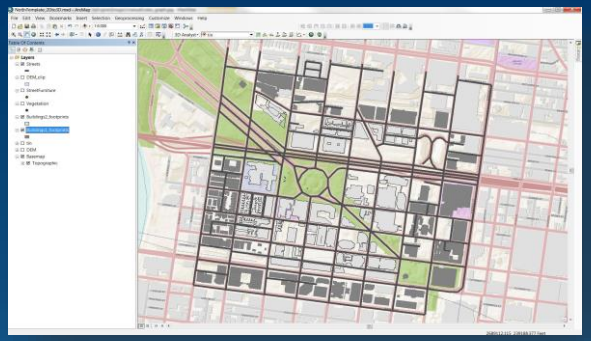
– **3D 城市设计**
  - 交互式
  - 规则驱动的3D设计



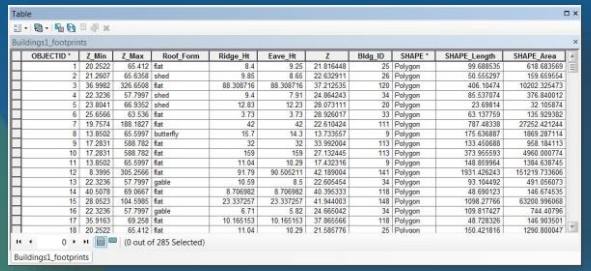
动态
参数化
编辑

3D 城市内容创建

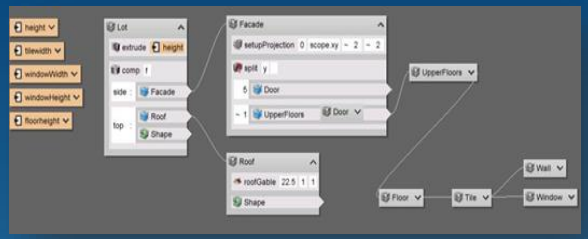
程序化的自动建模



几何



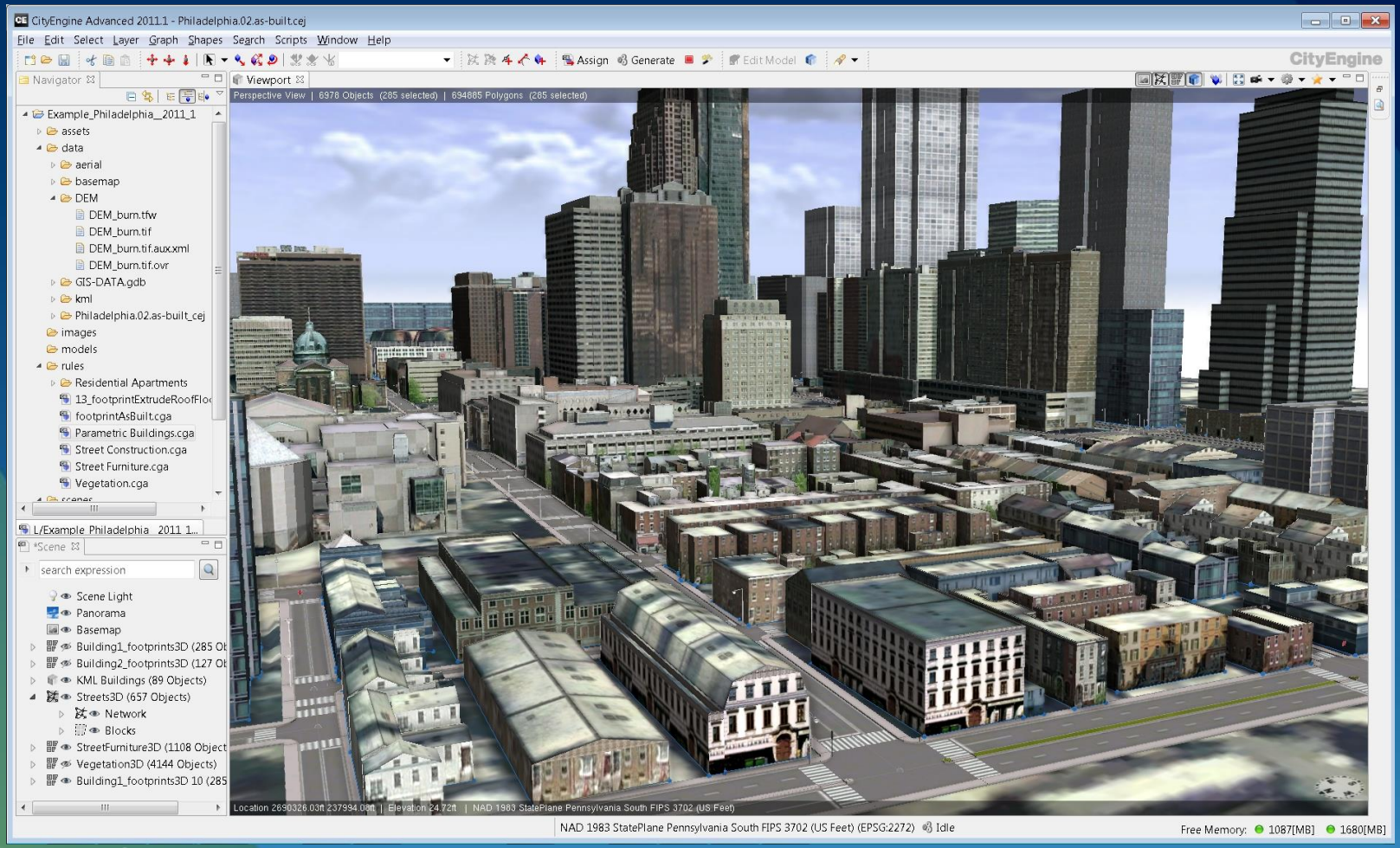
属性



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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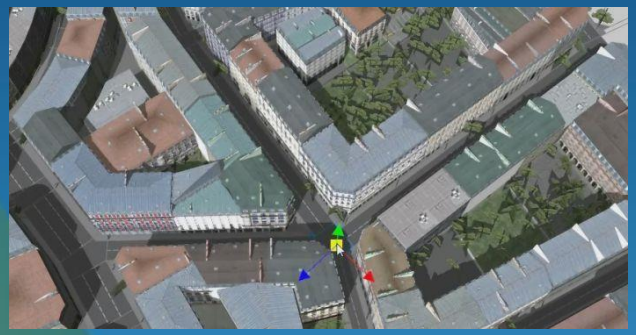
参数化编辑

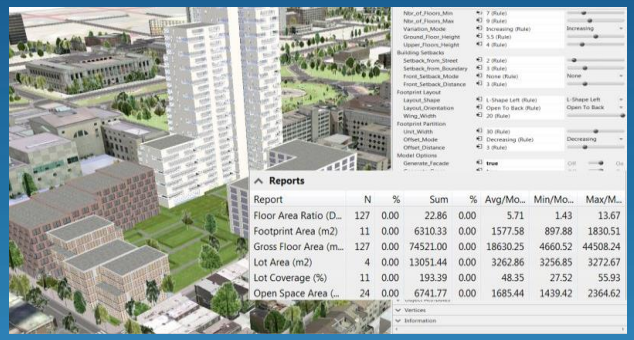
添加楼层

添加屋顶

动态编辑



报表



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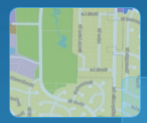
CGA 基础



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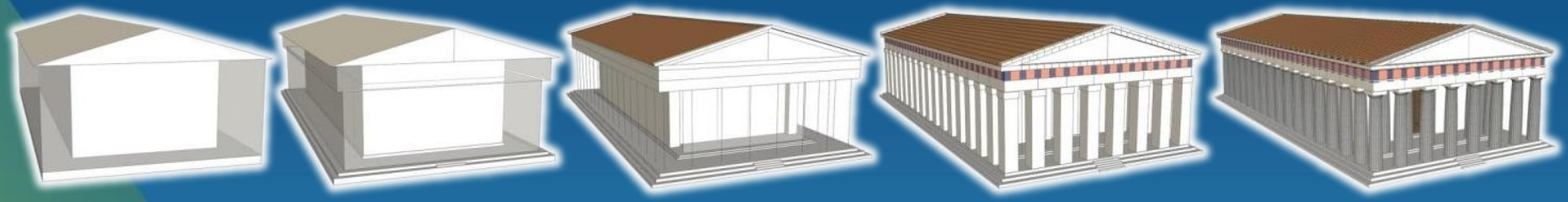
CGA 语言

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。

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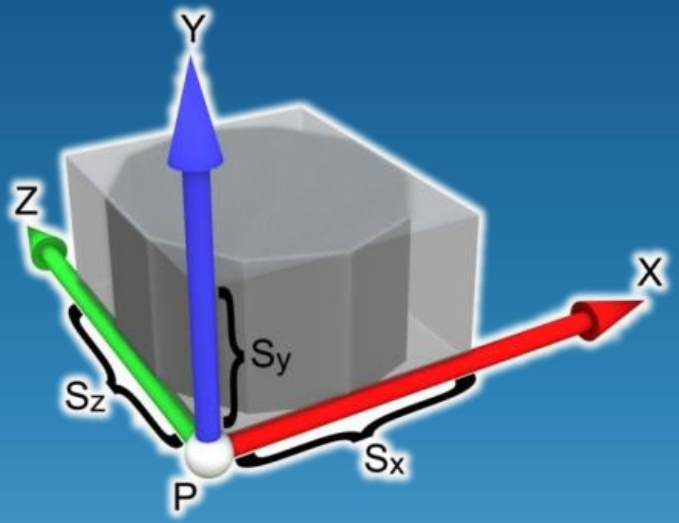
CGA shape


```
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

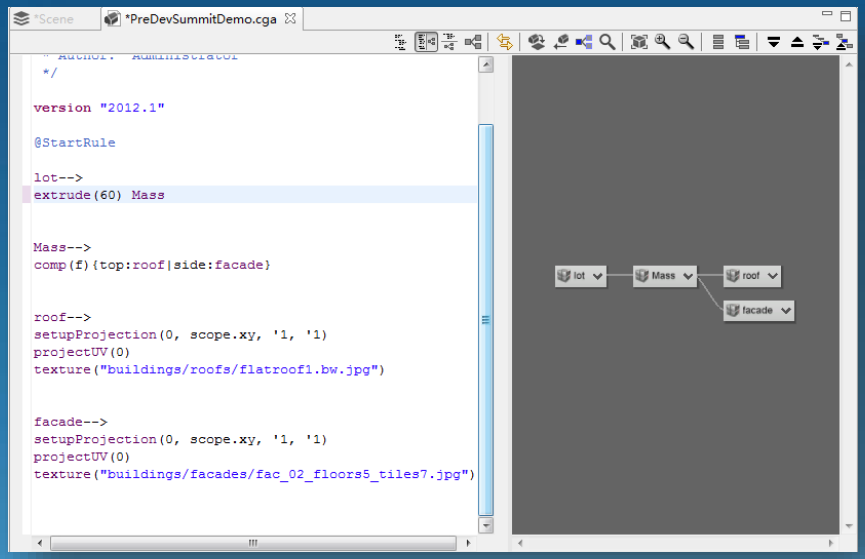
```
13# our first rule
14A --> extru
```

```
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

- 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
```

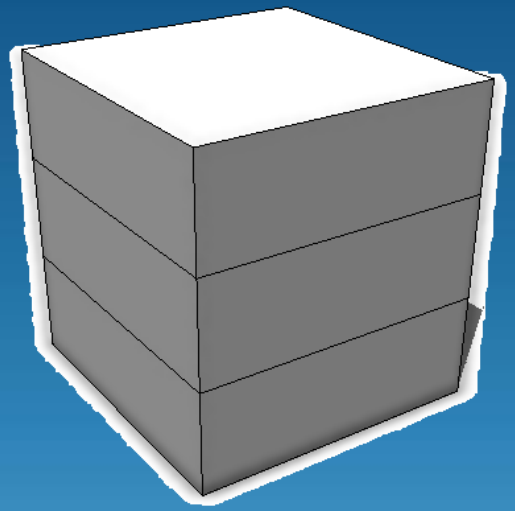
- Leaf Shape 形成结果模型

Shape 的替换


```
Lot  --> extrude(10) Mass                    Rule #1

Mass -->
     split(y){ ~4 : Floor. }*                Rule #2
     Floor
```

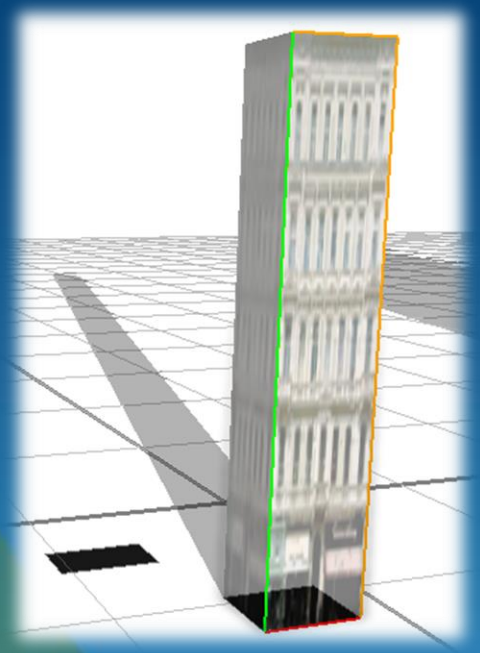
- Rule #2 是基于Mass的规则；
- Mass 被 Floor 替换。

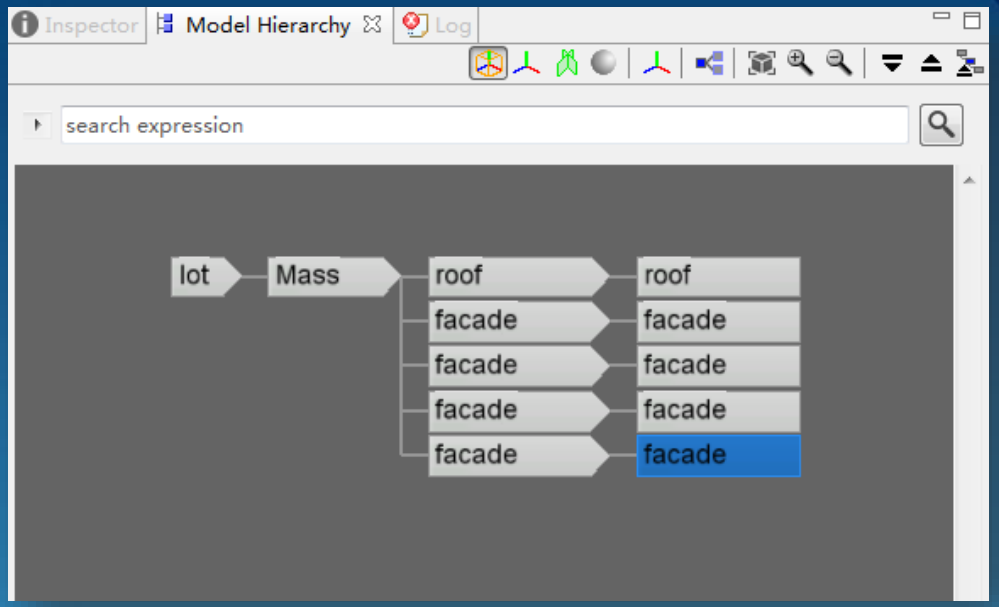


CGA 模型树查看器

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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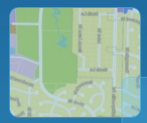
Demo：城市建筑物

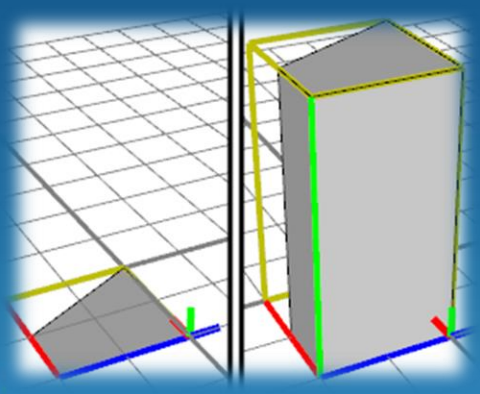


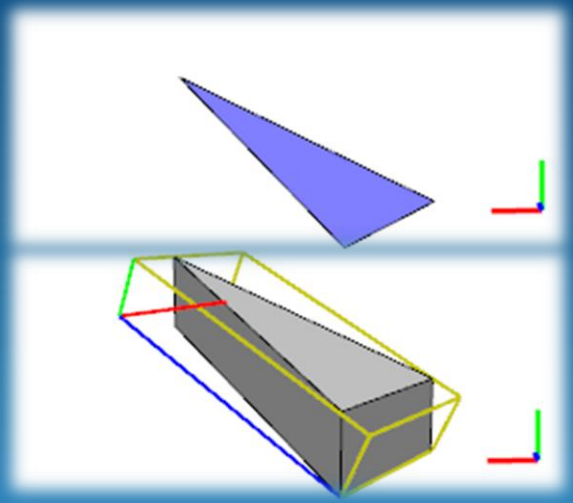



CGA：拉伸

2D Footprint → 3D building

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

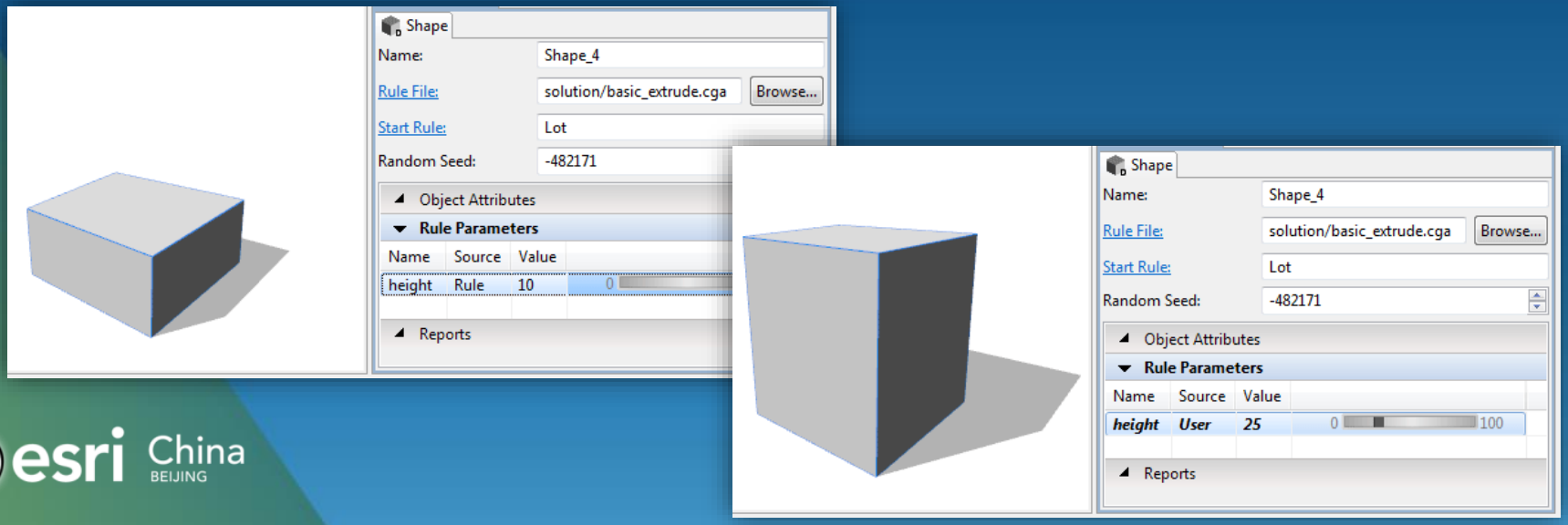




CGA：添加属性

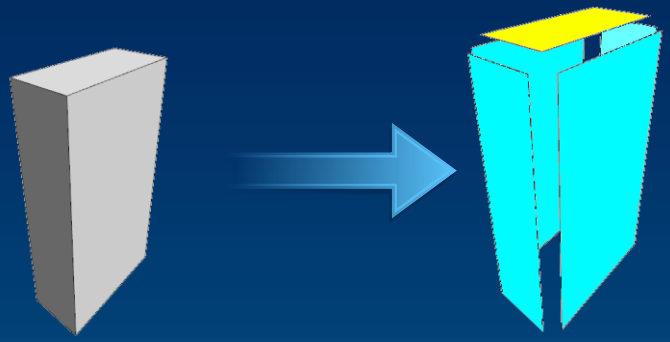

```
attr height = 10
Lot --> extrude(height) Mass
```

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。



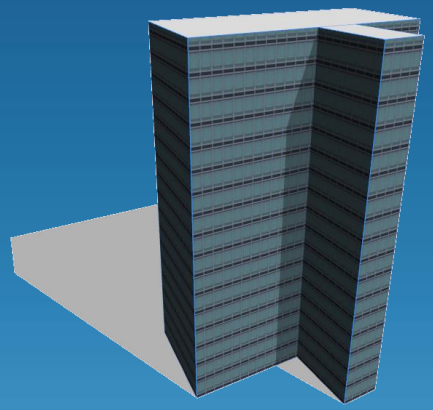
CGA：组件分割

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)`

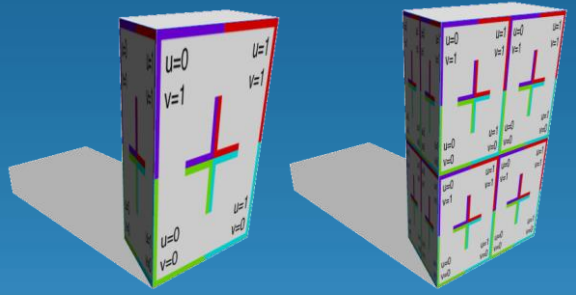
- 设置图片的贴图矩阵
- `width`、`height` 参数控制图片长宽或比例

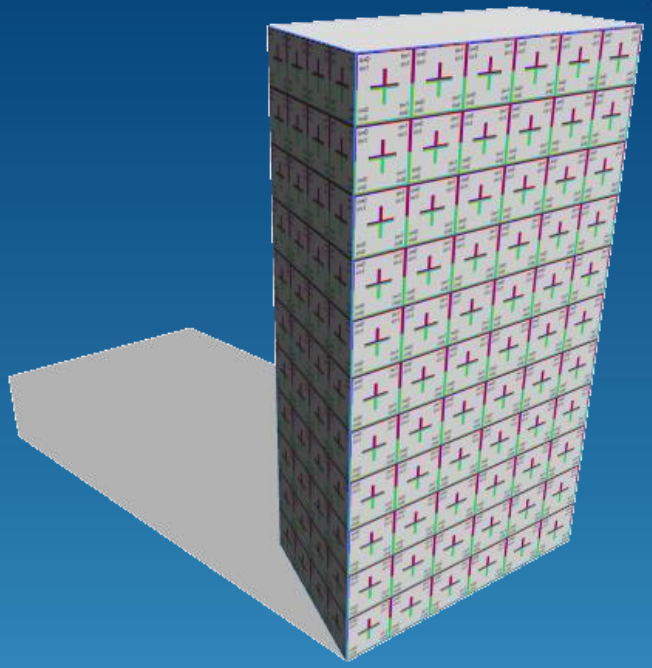
`projectUV(uvset)`

- 创建纹理图片坐标系

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

- 加载一幅纹理图片

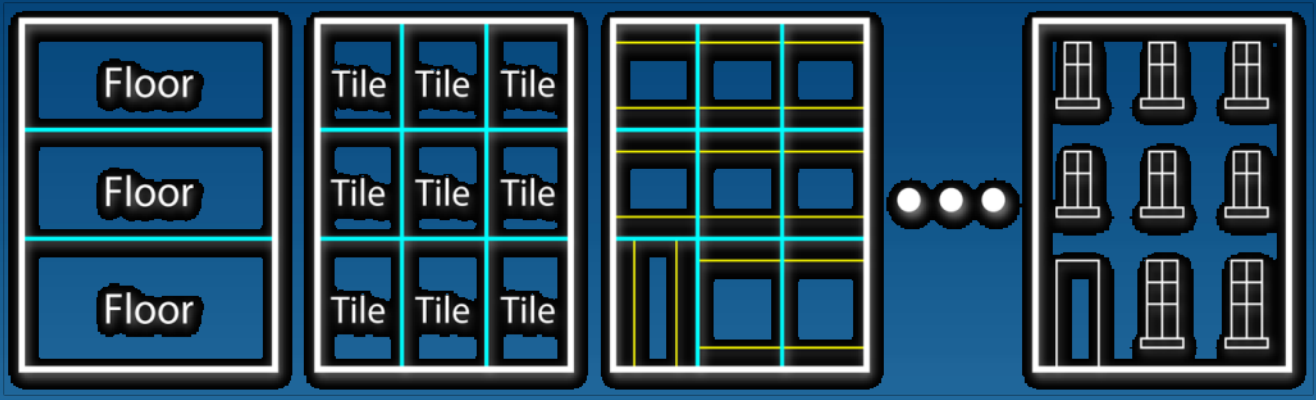




细化表面建模

通常情况下的表面细化结构，

Facade ⇢ Floor ⇢ Tile ⇢ Wall & Window/Door



CGA: 重复分割

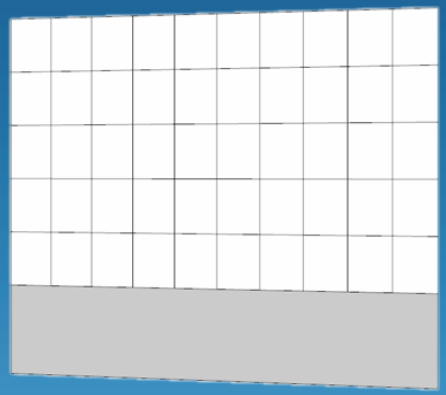
星号（*） 表示重复分割：

```
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

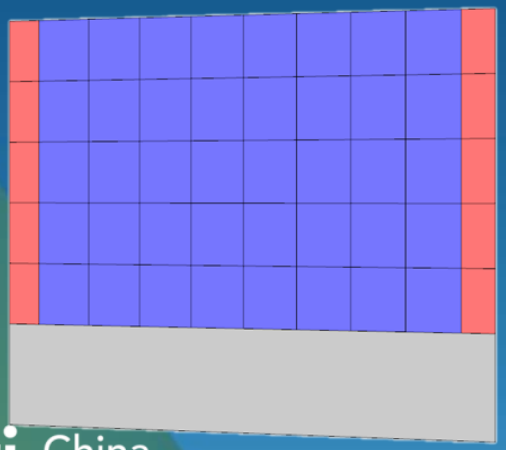
利用常规分割和重复分割组合使用。

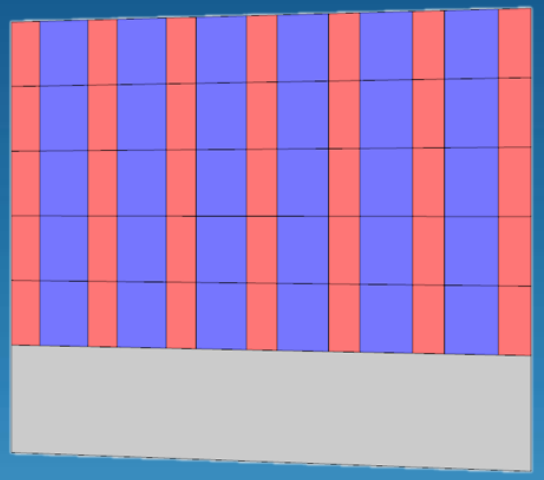
- A B* A

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

- { A B }* A

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



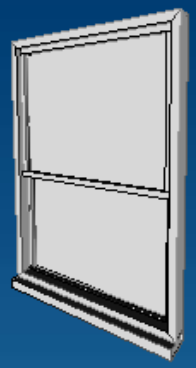


CGA: 插入模型素材

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。

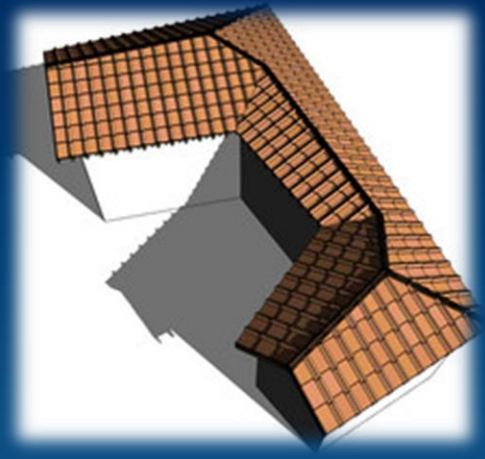


Demo：郊区房屋

CGA：屋顶样式

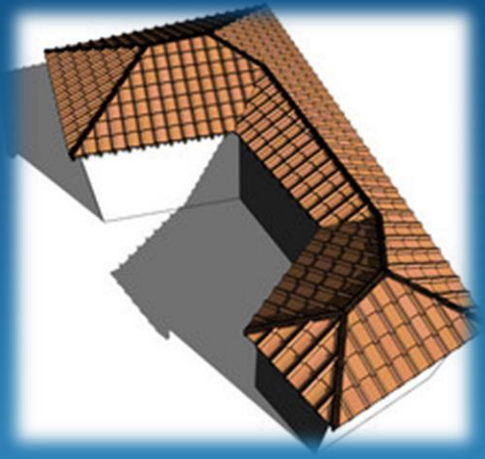
屋顶样式的控制：

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



额外设置：

- **屋顶倾角**
- **屋檐悬挂长度**



CGA：种植树木

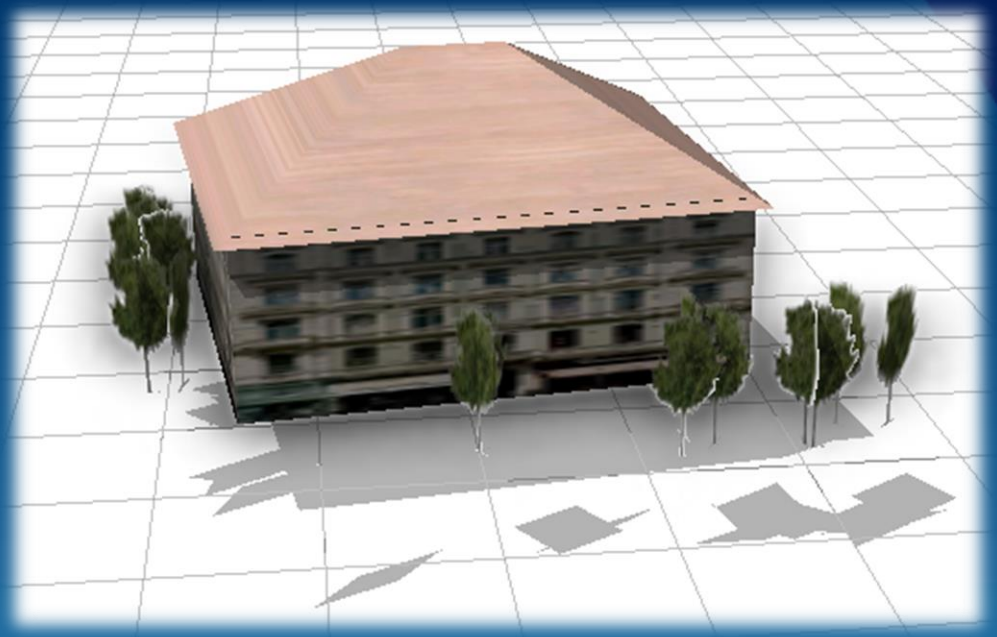
示例：

分割房屋边界：

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

种植树木：

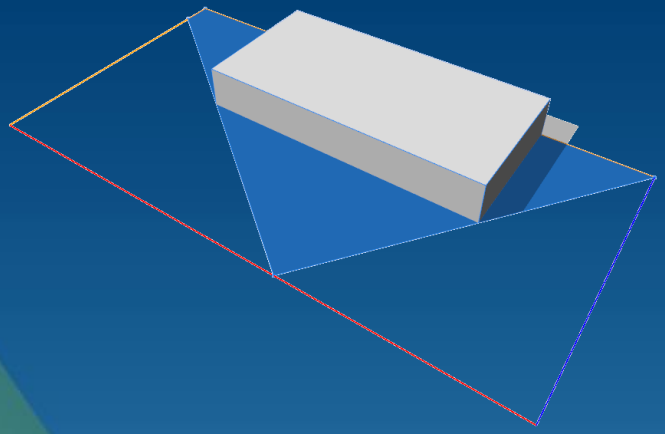
- `Scatter ()`

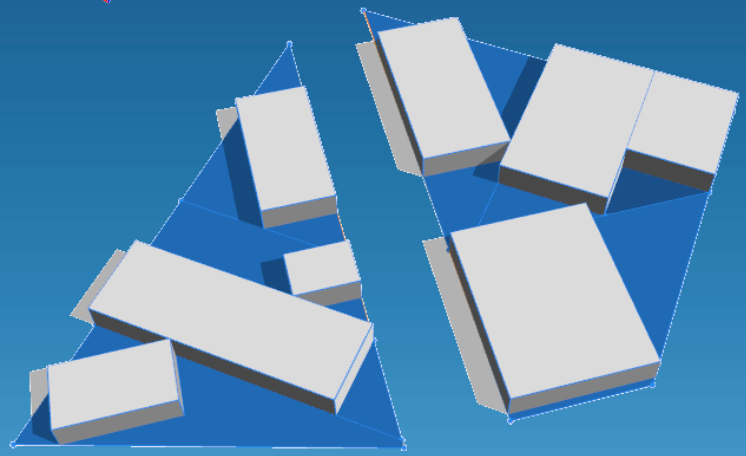


CGA：内接矩形

`innerRect`

将 Shape 转化成内接矩形，建立规则的房屋。





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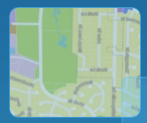
报表



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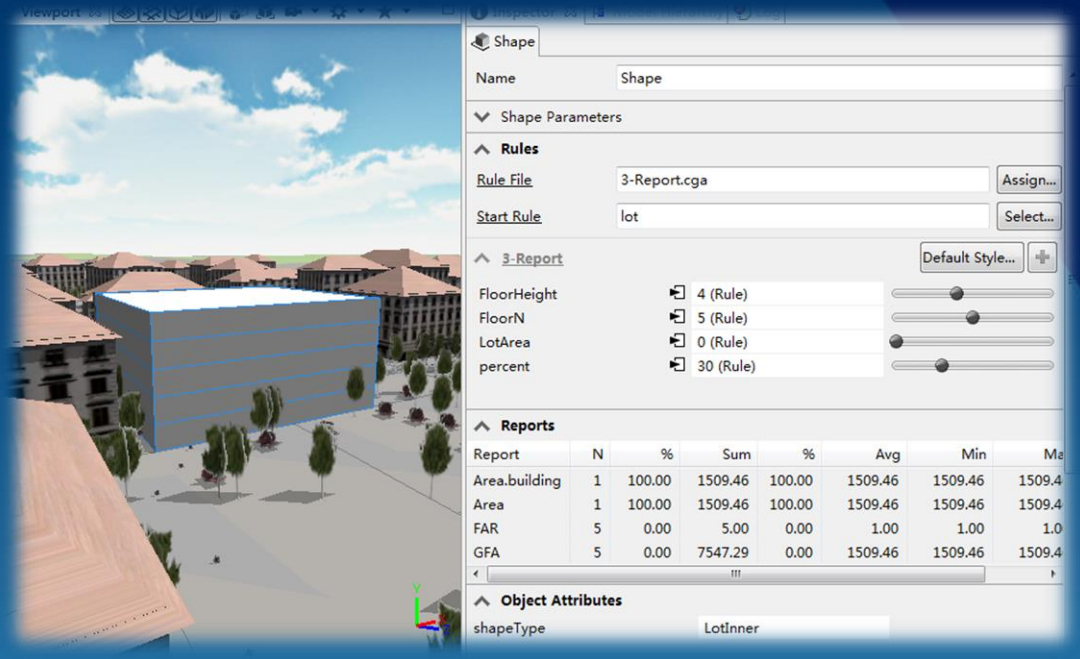
报表操作

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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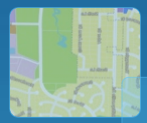
CityEngine Web Scene



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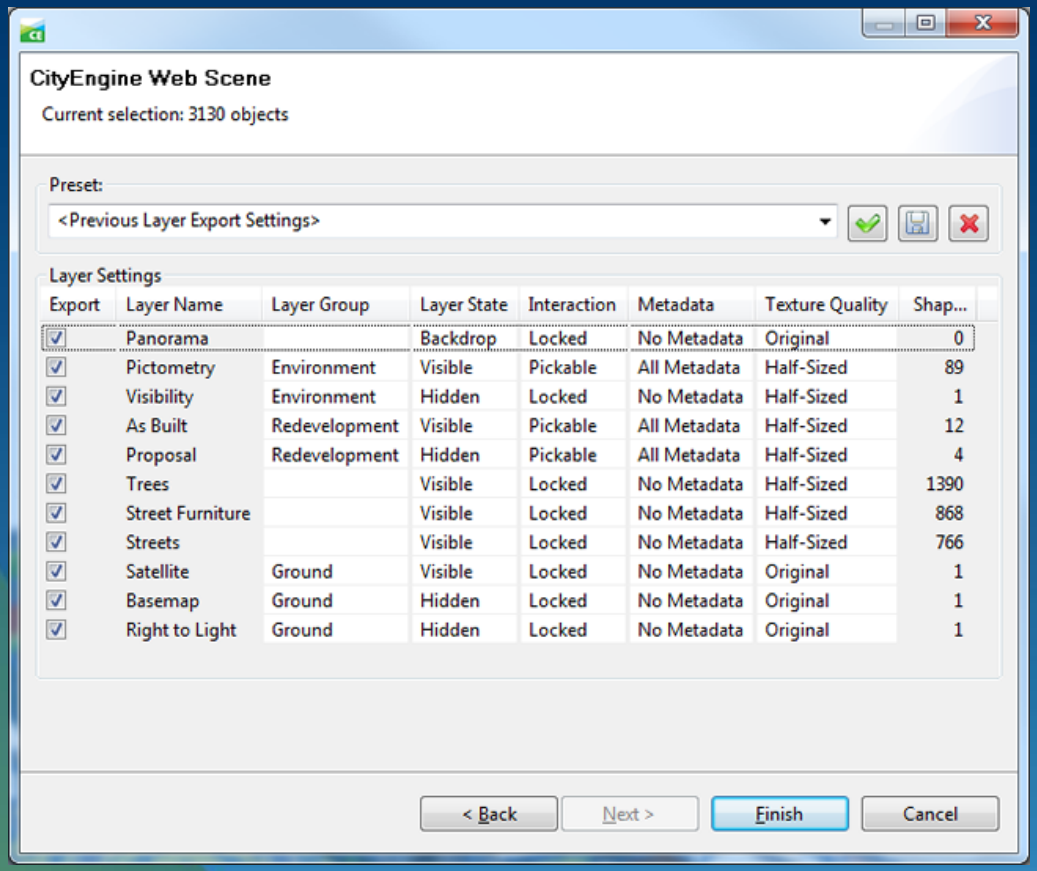
CityEngine Web Scene

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

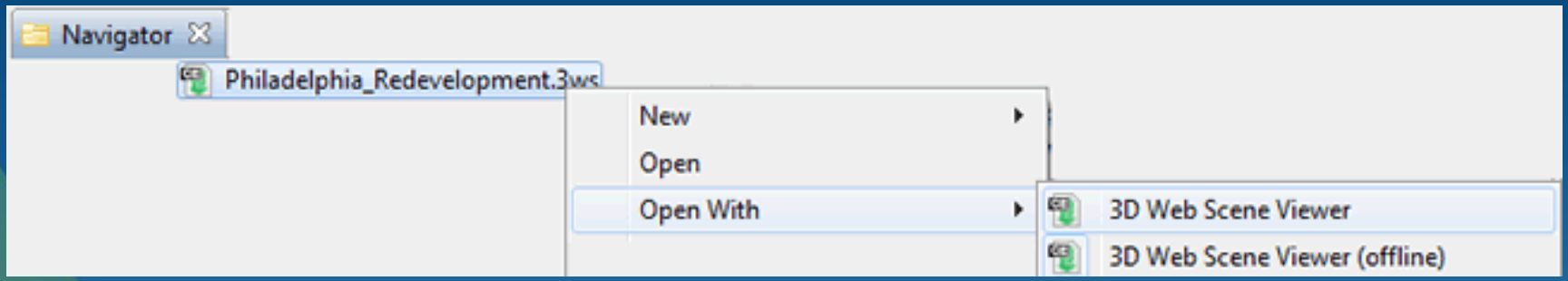
File → Export Models... → CityEngine Web Scene



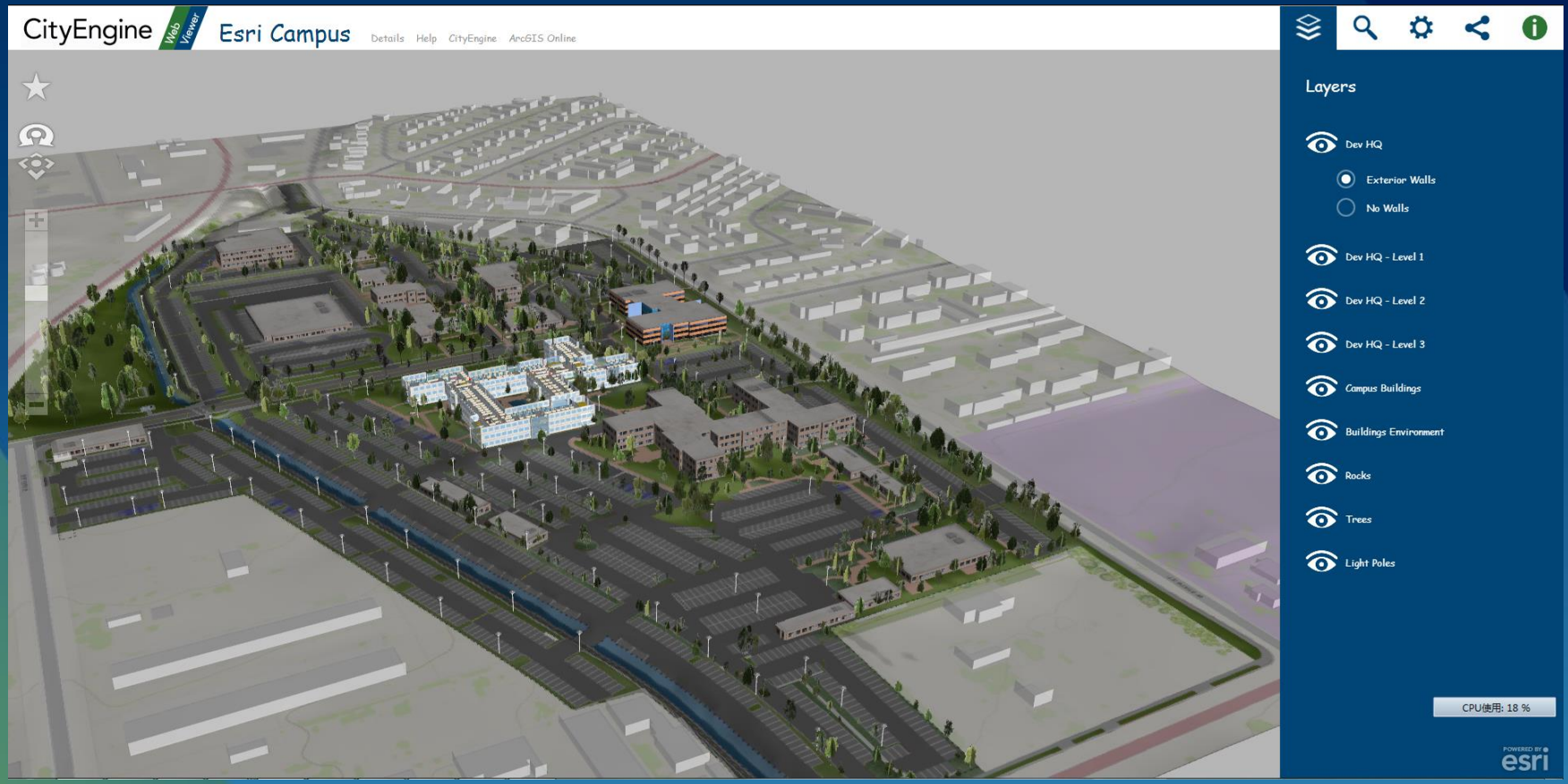
*.3ws 文件

浏览场景

Open With → CityEngine Web Scene Viewer



查看场景

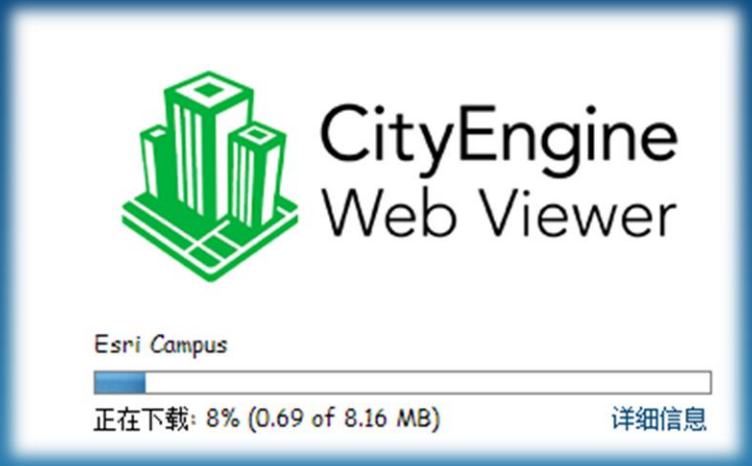

CityEngine
Web Viewer
Esri Campus
Details
Help
CityEngine
ArcGIS Online
Layers
Dev HQ
Exterior Walls
No Walls
Dev HQ - Level 1
Dev HQ - Level 2
Dev HQ - Level 3
Campus Buildings
Buildings Environment
Rocks
Trees
Light Poles
CPU使用: 18 %
POWERED BY
esri

分享场景

- Share as...
  - 发布到ArcGIS Online
  - 打包 zip 文件
- 上传到本地服务器

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。

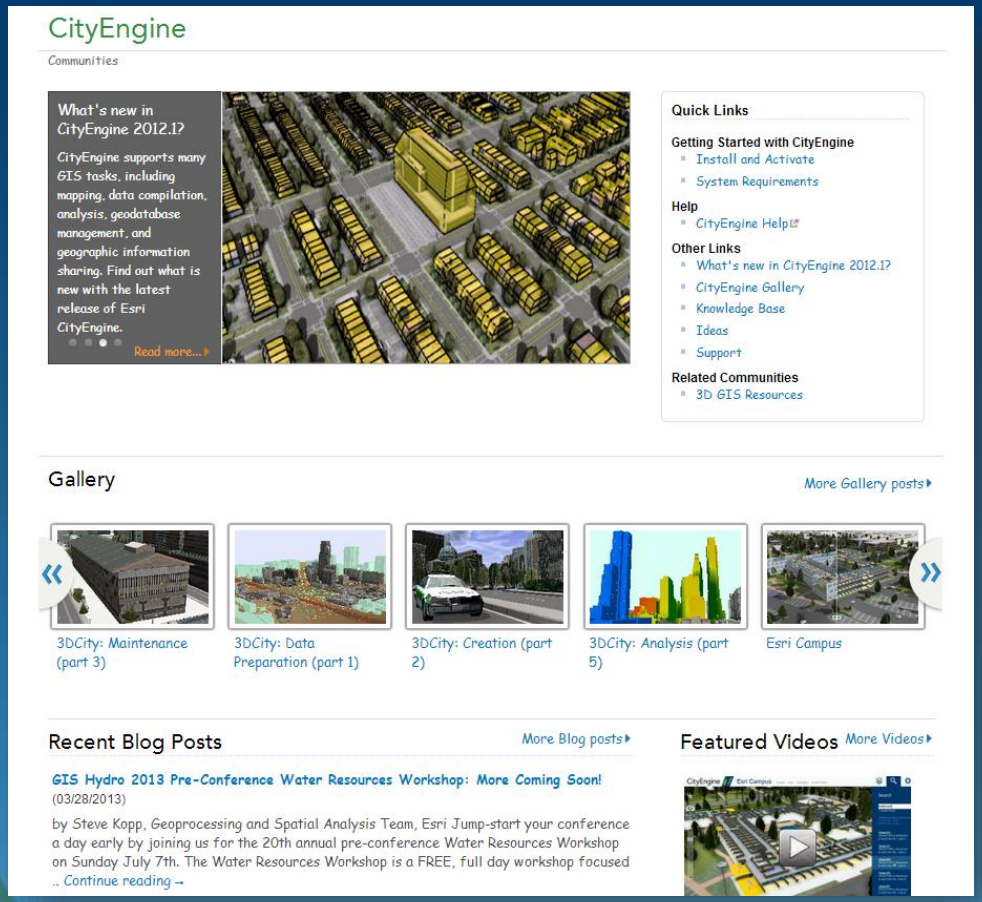


学习资源

2013 Esri China Developer Summit

CityEngine Community:

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



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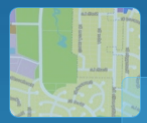
谢 谢！



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