



2015 Esri China  
Developer Summit

# 2015 Esri 空间信息技术开发者大会

超务实的地图应用开发者大会



分享地理价值



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# 使用CityEngine构建三维城市

Esri China 慕晓燕



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# 内容

- Esri CityEngine
- Hello , CGA
- 3D城市建模实例
- 规则包/rpk
- CityEngine Web Scene





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# Esri CityEngine



# 3D GIS



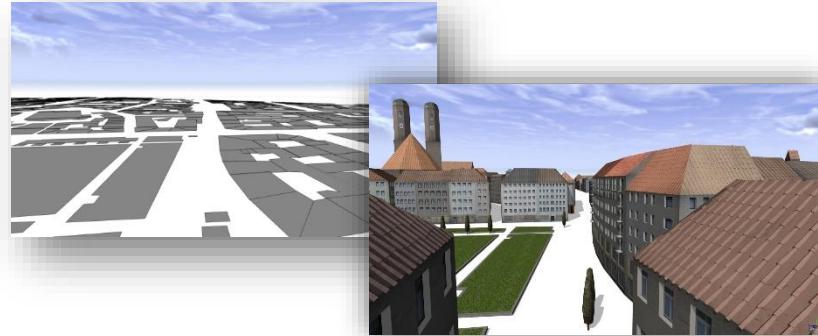
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### – 3D 城市内容构建

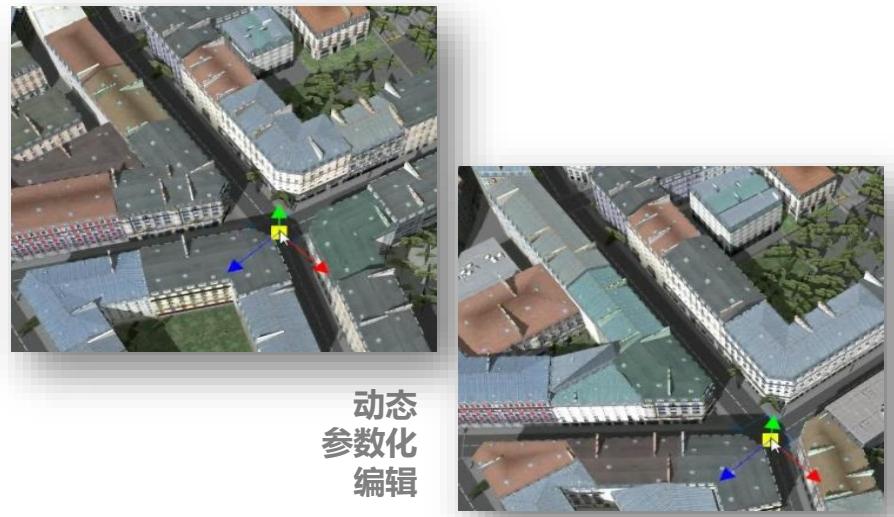
- 数据 + 规则



几何 + 属性 + 规则

### – 3D 城市设计

- 交互式
- 规则驱动的3D设计

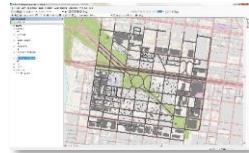


动态  
参数化  
编辑

# CityEngine



1 2D数据



+



2 程序化的规则

3D模型



+

纹理贴图



+



3 生成3D模型

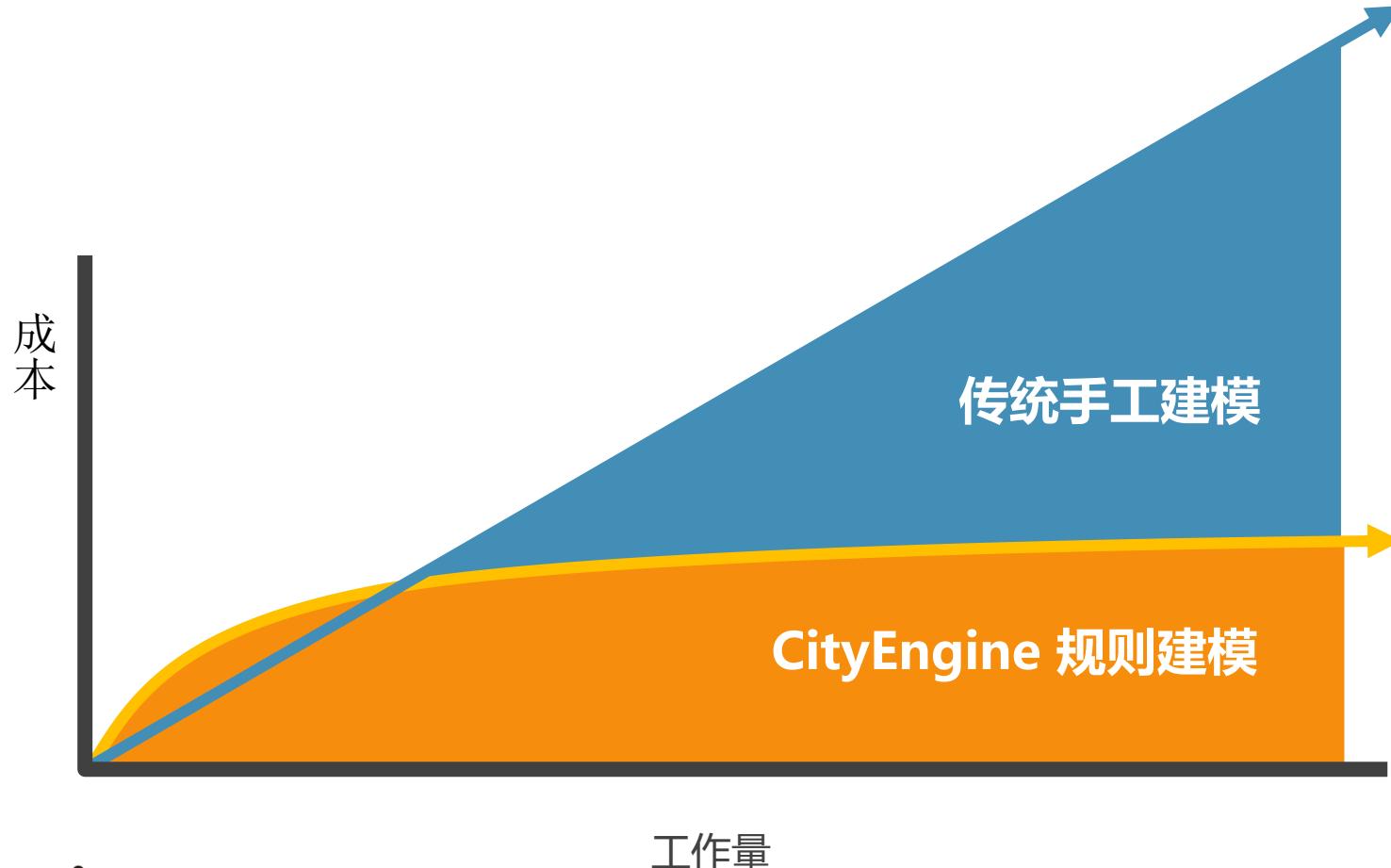


基本模型

迭代细化

最终3D模型

# CityEngine





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# Hello , CGA



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# What is CGA?

**CGA:** Computer Generated Architecture

CityEngine的独特脚本语言

越来越详细地迭代细化模型



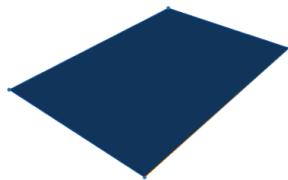


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# 一个最简单的规则

A -->

// Rule #1



A



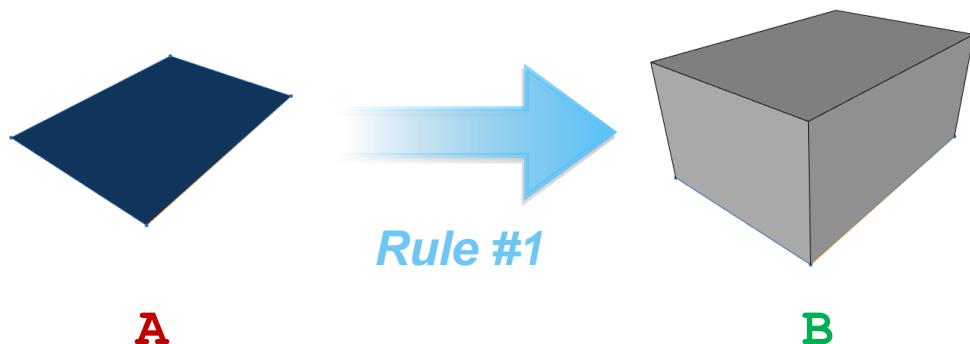
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# 一个最简单的规则

A --> extrude(10) B

// Rule #1

# A, B 是 CGA shape

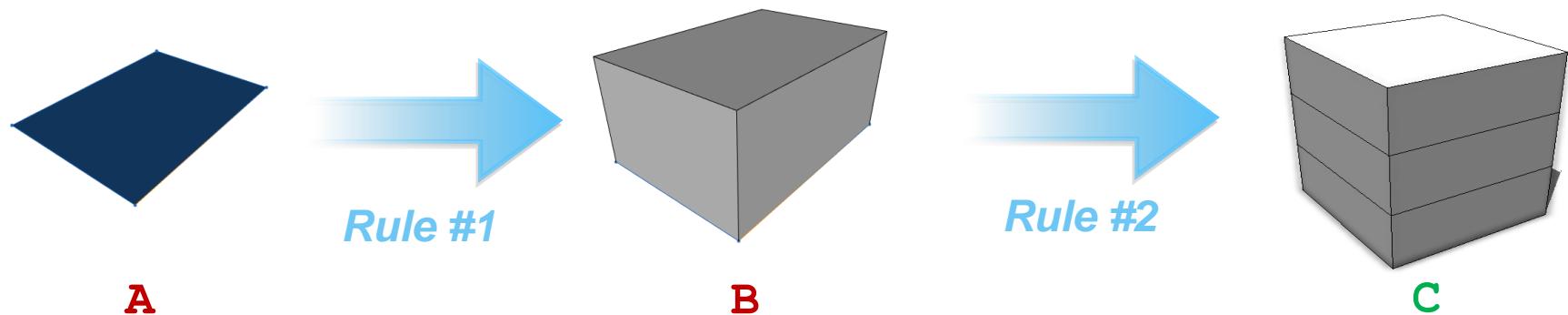




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# 一个最简单的规则

```
A --> extrude(10) B // Rule #1  
  
B --> split(y) {~4:Floor.}* C // Rule #2
```





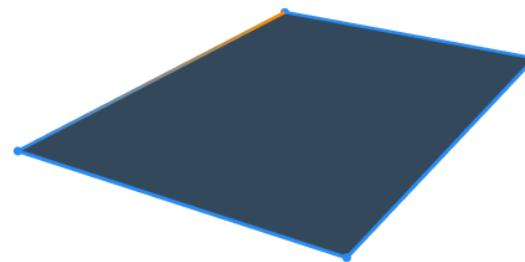
# CGA 基础

## 规则

### – Shape的迭代

```
Init-->
  extrude(10)
  comp(f) {
    side : Facade.
    top   : Roof
  }

Roof-->
  roofHip(30)
```





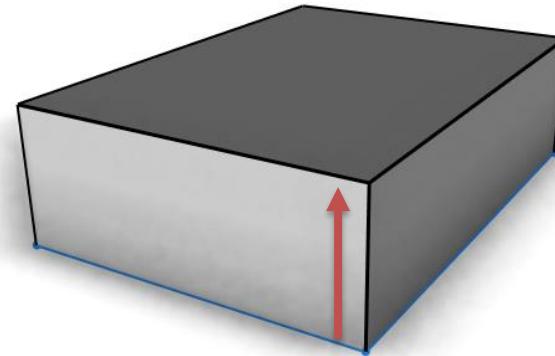
# CGA 基础

## 规则

### – Shape的迭代

```
Init-->
extrude (10)
comp(f) {
    side : Facade.
    top   : Roof
}

Roof-->
roofHip (30)
```





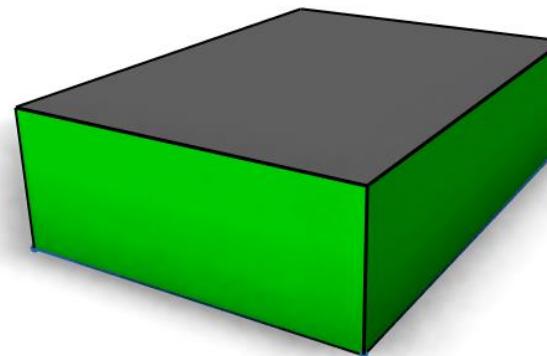
# CGA 基础

## 规则

### – Shape的迭代

```
Init-->
    extrude(10)
        comp(f) {
            side : Facade.
            top   : Roof
        }

Roof-->
    roofHip(30)
```





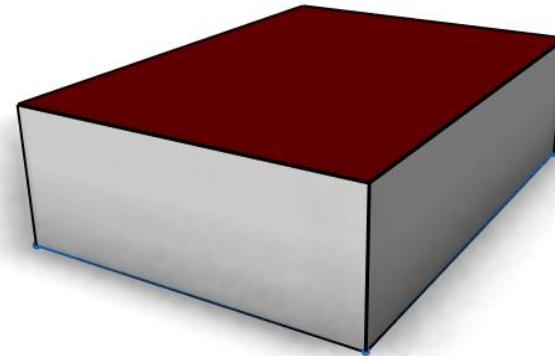
# CGA 基础

## 规则

### – Shape的迭代

```
Init-->
    extrude(10)
        comp(f) {
            side : Facade.
            top  : Roof
        }

Roof-->
    roofHip(30)
```





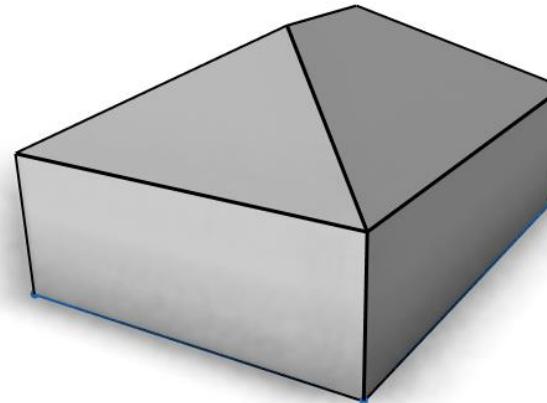
# CGA 基础

## 规则

### – Shape的迭代

```
Init-->
  extrude(10)
  comp(f) {
    side : Facade.
    top   : Roof
  }

Roof-->
  roofHip(30)
```



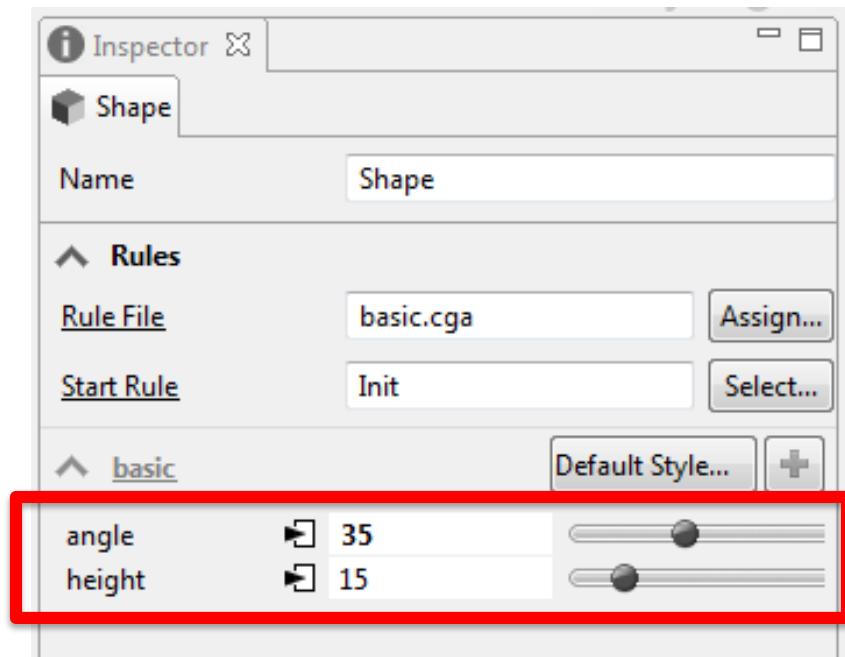


attr 函数可以将参数显示到外部，如，Inspector界面。

```
attr angle = 35
attr height = 15
```

```
Init-->
    extrude(height)
    comp(f) {
        side : Facade.
        top   : Roof
    }

Roof-->
    roofHip(angle)
```





```
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, //, /\* ... \*/



# CGA: 条件

Parcels -->

```
    case expression 1 :  
        .....  
        X.  
    case expression 2 :  
        .....  
        Y.  
else:  
    .....  
    Z.
```



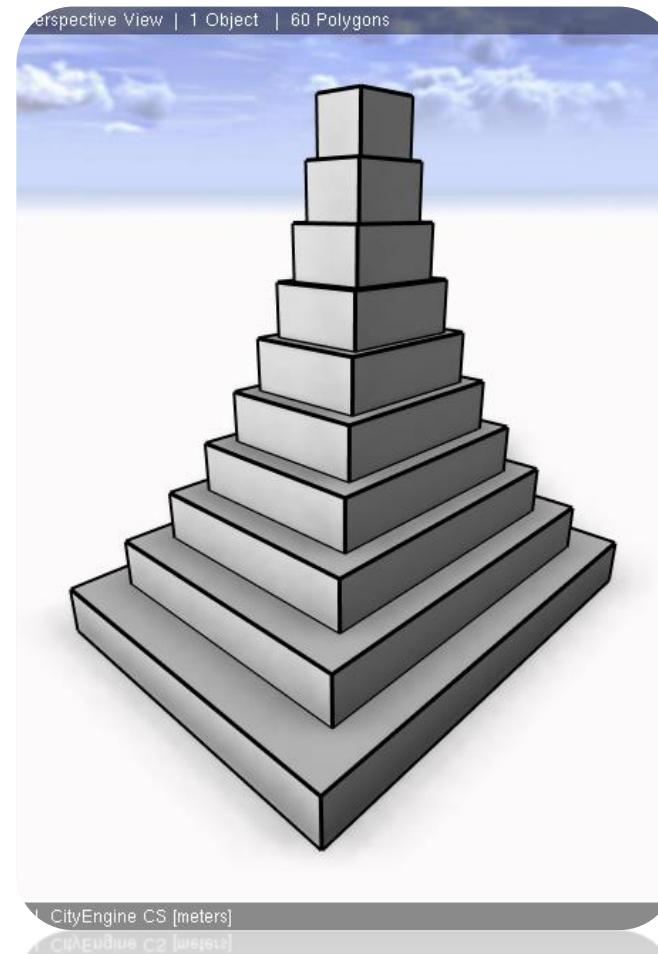


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# CGA: 迭代

```
Init-->
  Steps (10)

Steps (n) -->
  case n > 0:
    extrude (4)
      x
      s ('0.8, '1, '0.8)
      center (xz)
      comp (f)  {
        top: Steps (n-1)
      }
  else:
    NIL
```





# CGA: 随机

**PredecessorShape -->**

20%: Successor1

30%: Successor2

...

**else: SuccessorN**





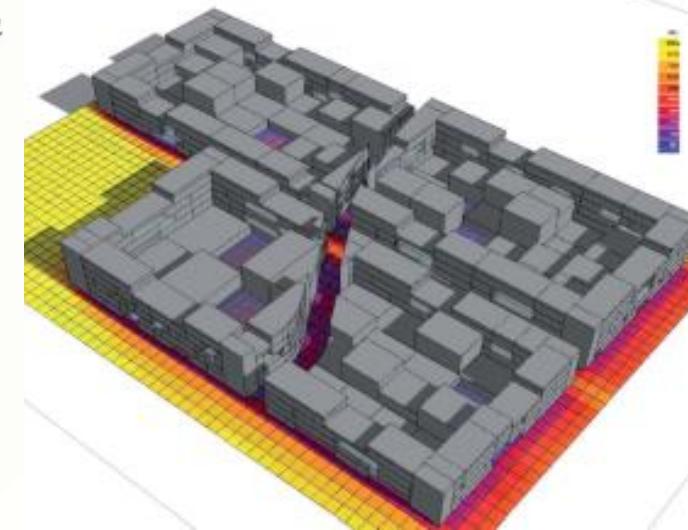
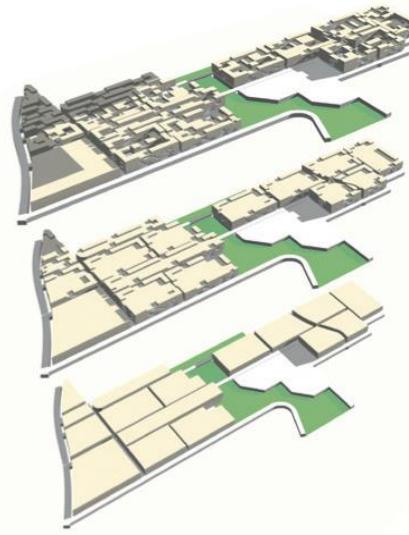
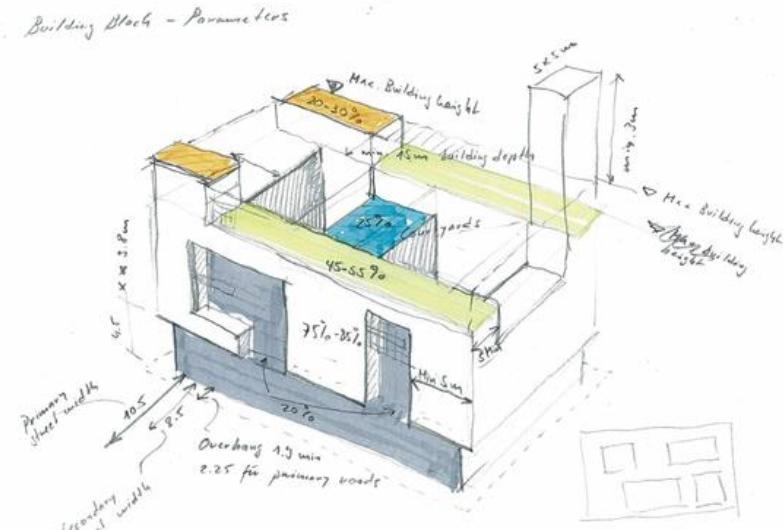
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# Demo: CGA基础



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# 3D城市建模实例





# 规则库

开箱即用

Build-in Esri rule library

- ✓ 3D Vegetation
- ✓ Facade Textures
- ✓ Roof Textures
- ✓ Street Construction
- ✓ Utilities



```
import PlantDis:"/ESRI.lib/rules/Plants/Plant_Distributor.cga"  
  
Plants-->  
    PlantDis.Generate
```



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# Demo : 3D Vegetation

The screenshot displays a 3D visualization of a forest scene on the left and its corresponding configuration settings on the right.

**Viewport:** Shows a 3D rendering of several tall, green trees on a light blue ground plane. The sky is blue with white clouds. A wireframe cube is visible in the background.

**Inspector:** A panel on the right containing various configuration tabs and settings.

**Shape Tab:**

- Name: Shape
- Rule File: plantDistributor.cga
- Start Rule: PlantDistributor

**PlantDist Tab:**

- Mix: Random Forest, Density: 1, Distribution: Uniform without trunk over...
- Custom Mix: Keyword, MinHeight: 0, MaxHeight: 100, Zone: All, Continent: All, Mixture: Large species dominant, Options: MaxCountPerSpecies: 100

**Plant Tab:**

- Name: Orange Tree, Height: 9, Radius: 2.5
- Options: Representation: Model, Transparency: 0, OverwriteColor: Off, RandomRotation: true, RandomBrightness: false, RandomHeights: Mature and young, Reporting: None

**Reports Tab:** (This tab is currently collapsed.)



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# Demo: Facade & Roof

The screenshot shows the CityEngine software interface. On the left is a Perspective View window displaying a 3D model of a multi-story building with a dark, reflective facade and a brown base. The building is set against a blue sky with white clouds. A grid is visible on the ground plane. The right side of the screen contains the Inspector panel, which is currently focused on the "Shape" tab. The "Name" field is set to "Shape". Under the "Rules" section, the "Rule File" is "facades.cga" and the "Start Rule" is "Footprint". The "facades" rule has a "height" of 54.47. Under "FacadeTextures", the "Usage" is set to "Transport" with "Upperfloors..." and "Groundflo..." both mapped to "/my\_city/ass...". There are sliders for "Upperfloor..." (value 3), "Groundflo..." (value 5.5), and "TileWidth" (value 3.5). Under "RoofTextures", there is a "FlatRoofTexture" mapped to "/my\_city/ass...". The Inspector panel also includes sections for "Reports", "Object Attributes", "Materials", and "Vertices". At the bottom left of the interface, the text "Grid Size 10 | CityEngine CS [meters]" is visible.



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# Demo: Complete Street

The screenshot displays a 3D rendering of a city street with buildings, trees, and vehicles. To the right, an 'Inspector' panel shows detailed configuration settings for the street's components:

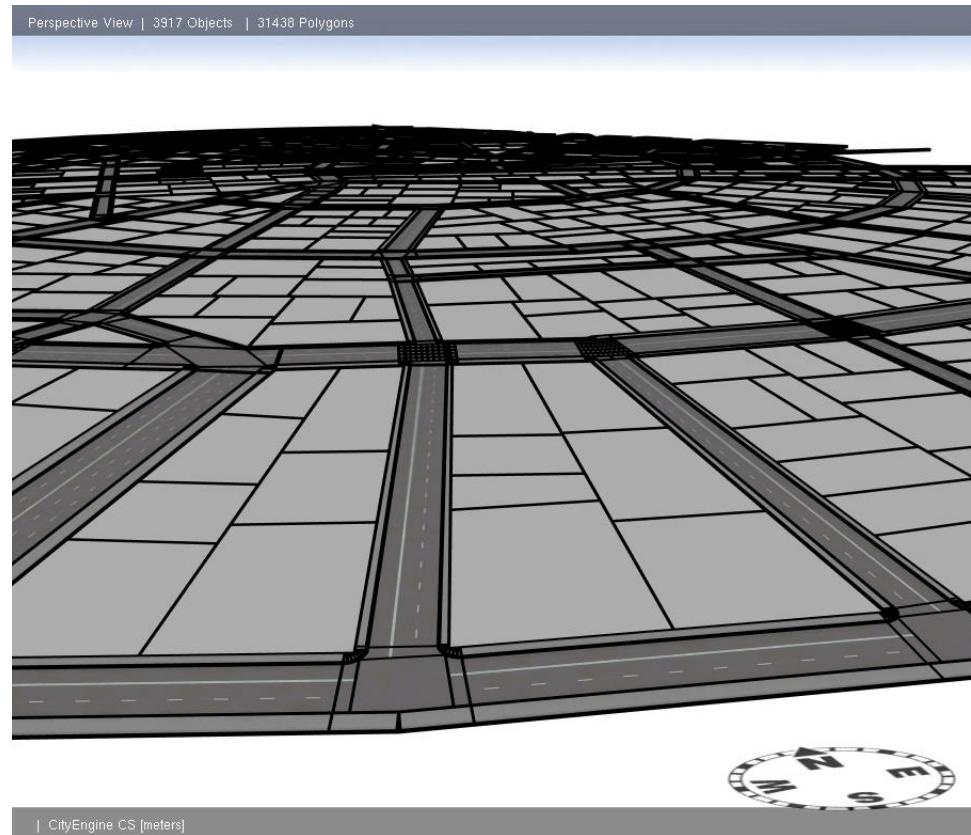
- DISPLAY OPTIONS**:
  - Display\_Textures: true (On)
  - Display\_Thematics: Thematics Off
  - Solid\_Color: #FFFFFF
  - Flag\_Empty\_Space: false (On)
  - LOD\_Setting: High
- ROAD LAYOUT**:
  - Basic Components:
    - Lane\_Distribution: 0
    - Lane\_Width: 3.5 (yellow)
    - Centerline\_Color: yellow
    - Traffic\_Direction: right-hand
    - Speed\_Limit\_in MPH: 20
  - Stop Markings:
    - Stop\_Begin: none
    - Stop\_End: none
  - Crosswalk Markings:
    - Crosswalk\_Begin: ladder custom
    - Crosswalk\_End: ladder custom
    - Begin\_Crosswalk\_To\_St...: -2
    - End\_Crosswalk\_To\_St...: -2
    - Crosswalk\_Color: white
    - Custom\_Crosswalk\_Tex...: Complete\_Streets/Sidewal...
    - Crosswalk\_Width: 18.05
  - On-Street Parking:
    - Right\_Parking\_Type: None
    - Right\_Parking\_Width: 0
    - Right\_Parking\_Length: 0
    - Left\_Parking\_Type: None
    - Left\_Parking\_Width: 0
    - Left\_Parking\_Length: 0
    - Parklet\_Percentage: 0
  - CENTER SECTION LAYOUT**:
    - Basic Attributes:
      - Center\_Type: None
      - Center\_Width: 0



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# 城市规划

基于现有的街道和地块，进行城市规划。





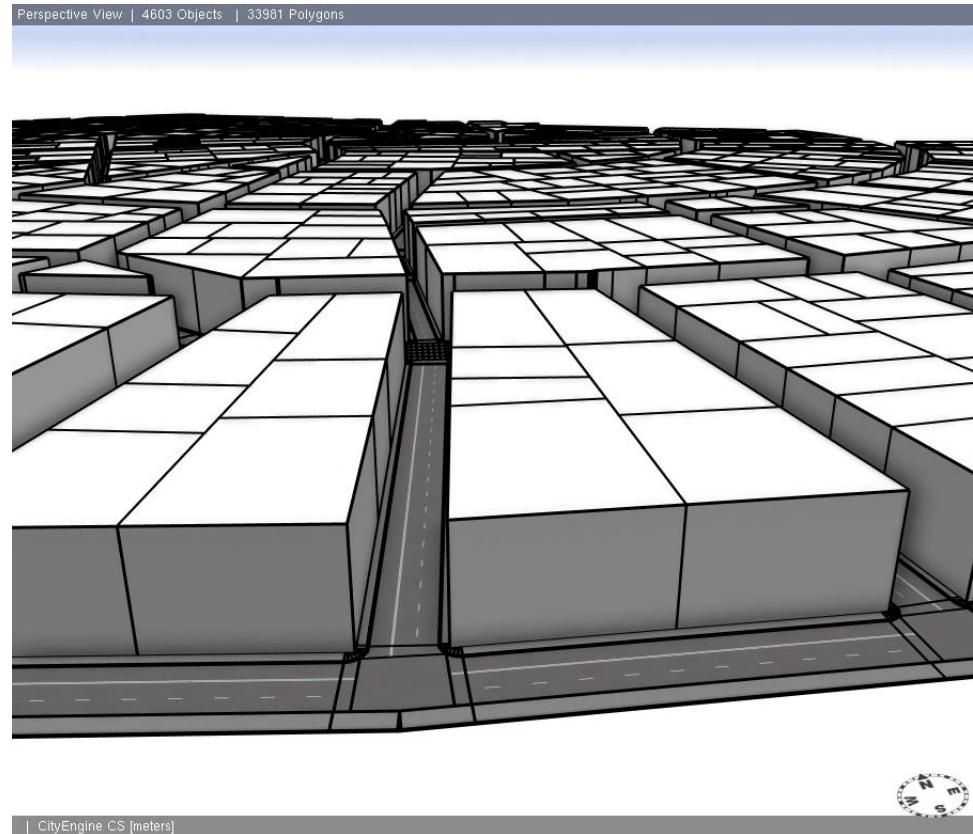
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# 城市规划

## 简单拉伸

Lot-->

**extrude (20)**



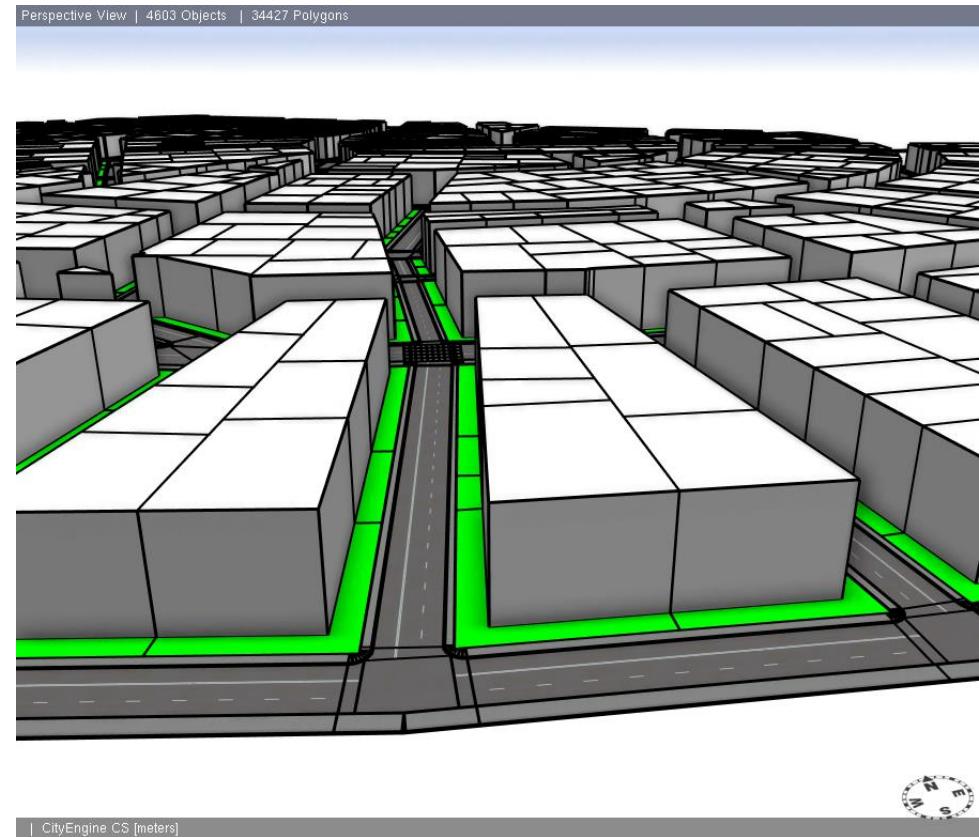
# 城市规划



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Lot-->

```
setback(5) {  
    street.front:  
        color(0,1,0)  
        x.  
    remainder:  
        extrude(20)  
        x.  
}
```



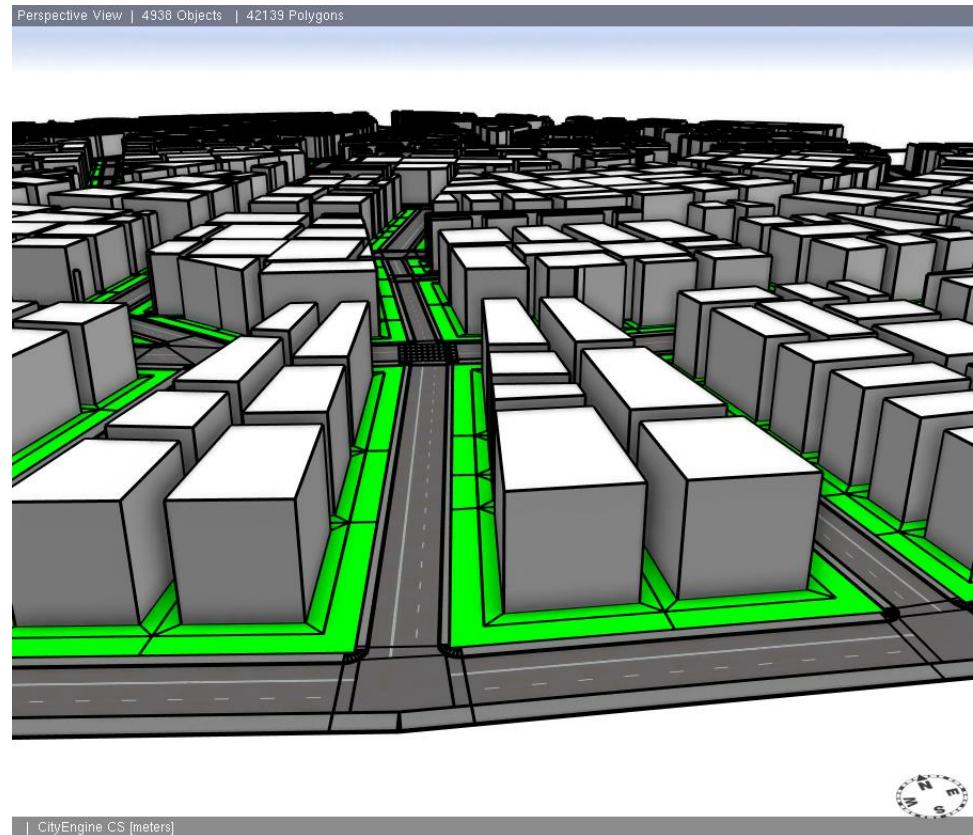


# 城市规划

## 使用 offset 分割地块。

Lot-->

```
setback(5) {  
    street.front:  
        color(0,1,0)  
        x.  
    remainder:  
        offset(-3)  
        comp(f) {  
            border:  
                color(0,1,0)  
                x.  
            inside:  
                extrude(20)  
                x.  
        }  
    }  
}
```

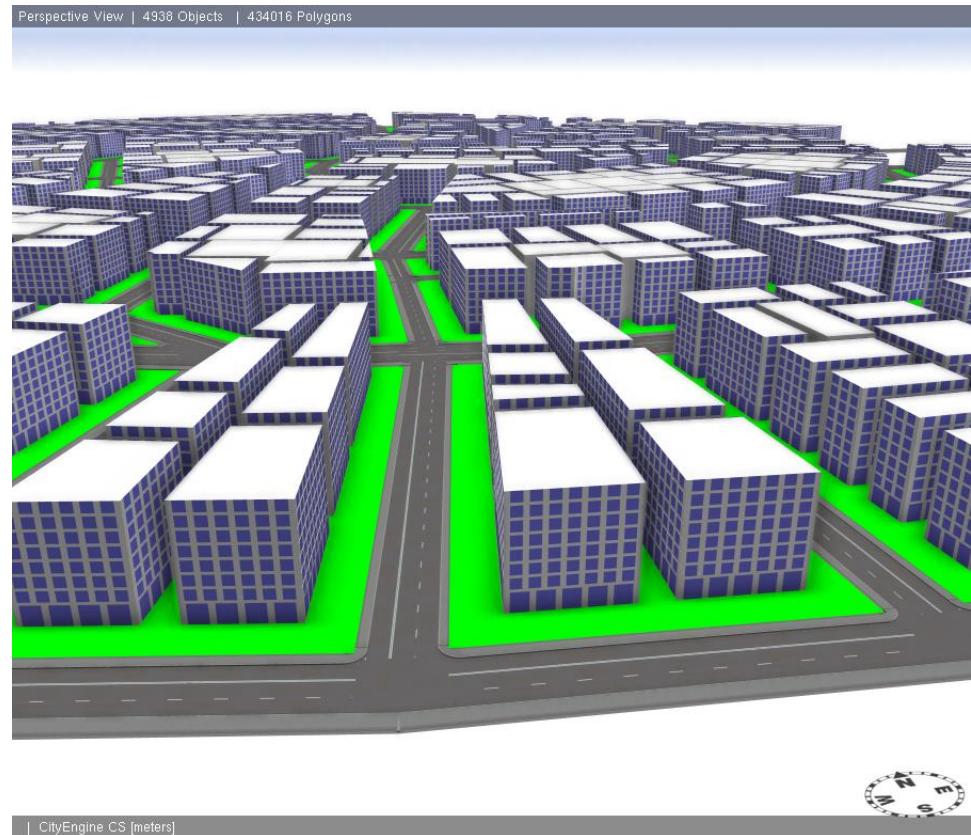




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# 城市规划

## 表面细化建模





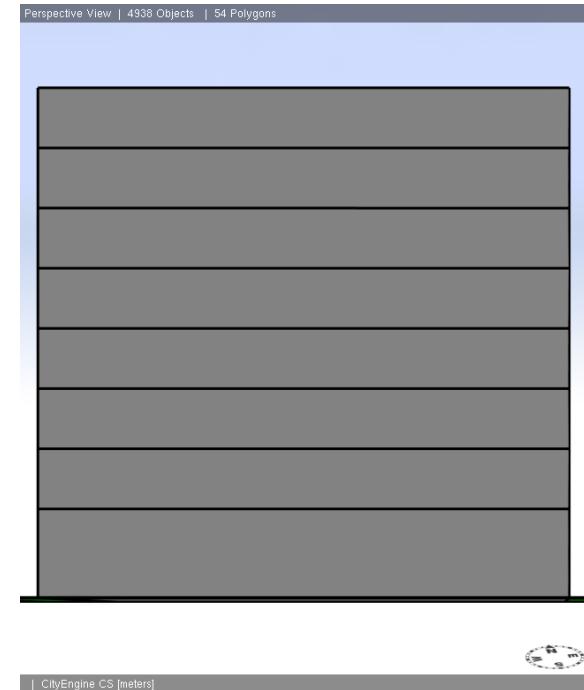
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# 城市规划

建筑物体 → 楼层

Mass-->

```
split(y) {  
    3.5 : GroundFloor.  
    { ~2.5 : Floor. }*  
}
```





# 城市规划

楼层 → 窗户 + 墙体

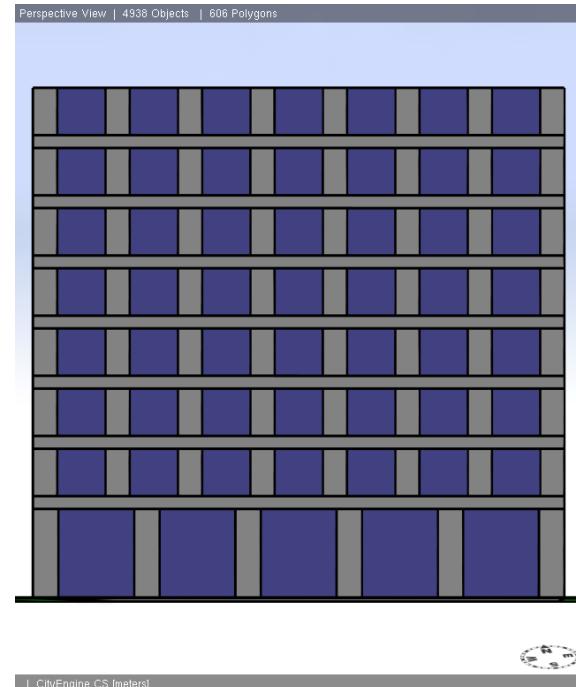
```
GroundFloor-->
  comp(f) { side : GFFacade }

GFFacade-->
  split(x) {
    { ~1 : Wall. | ~3 : Window }* | ~1 : Wall.
  }

Floor-->
  comp(f) { side : FloorFacade }

FloorFacade-->
  split(y) {
    0.5 : Wall. | ~1 : split(x) {
      {~1 : Wall. | ~2 : Window }* | ~1 : Wall. }
  }

Window-->
  color(0.5,0.5,1)
```





# 城市规划

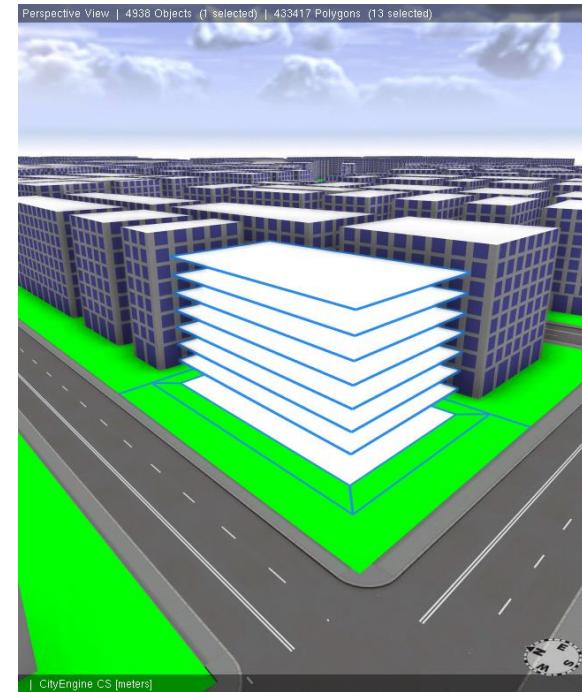
## 报表

- ✓ 例如： 总建筑面积/GFA， 容积率/FAR

FloorGFA-->

```
comp(f) {  
    bottom:  
        report("GFA", geometry.area)  
}
```

Report	N	%	Sum	%	Avg	Min	Max	NaNs
GFA	8	0.00	4997.25	0.00	624.66	624.66	624.66	0

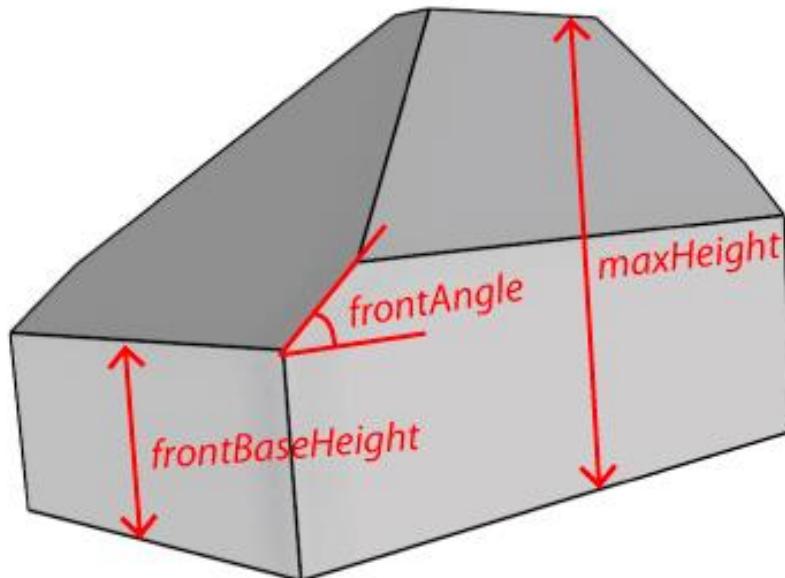




# 规划控制

## 控规

```
envelope (direction, maxHeight, frontBaseHeight, frontAngle, ..... , ....)
```





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# 规划控制



Location 7642326.46ft 884720.70ft | Elevation 1.64ft | Grid Size 100ft | NAD 1983 HARN StatePlane Oregon North FIPS 3601 (Intl Feet)



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# Demo: 城市规划



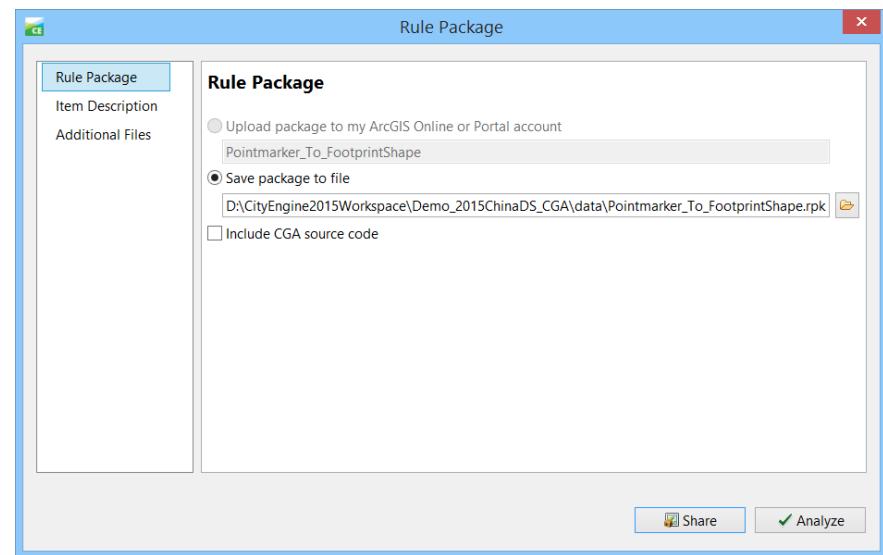
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# CityEngine 规则包



# 规则包/RPK

- 分享与交互CGA代码与资源的格式 **\*.rpk**
- 文本的CGA代码 **编译**  
**基于Java 类文件**  二进制的CGB
- 平台独立
- 程序运行时 = 执行CGB的虚拟机
- RPK = 可执行文件



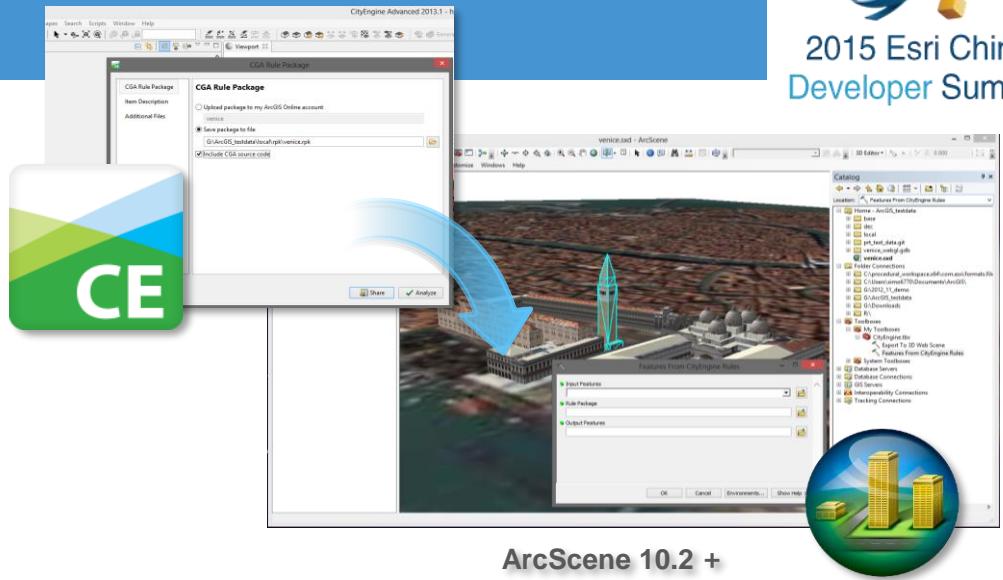


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# 规则包/RPK

CityEngine:

- 编写规则文件



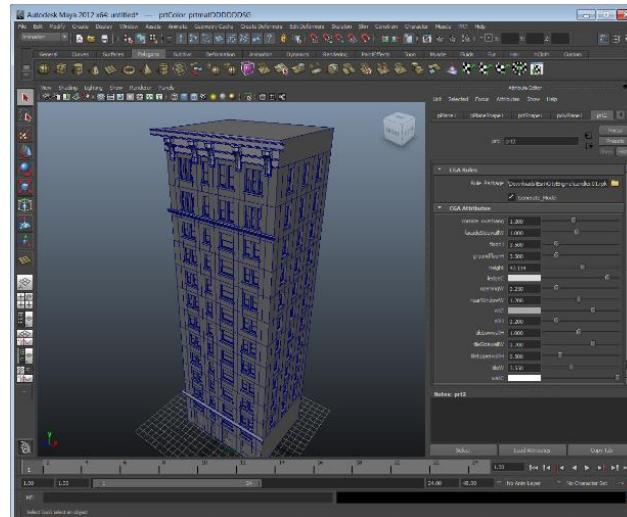
ArcScene 10.2 +

将rpk分享于:

- 组织内部
- Portal for ArcGIS
- ArcGIS Online

使用rpk:

- ArcGIS 10.2 +
- ArcGIS Pro
- 3<sup>rd</sup> party 3D apps
- 自定义应用/CityEngine SDK

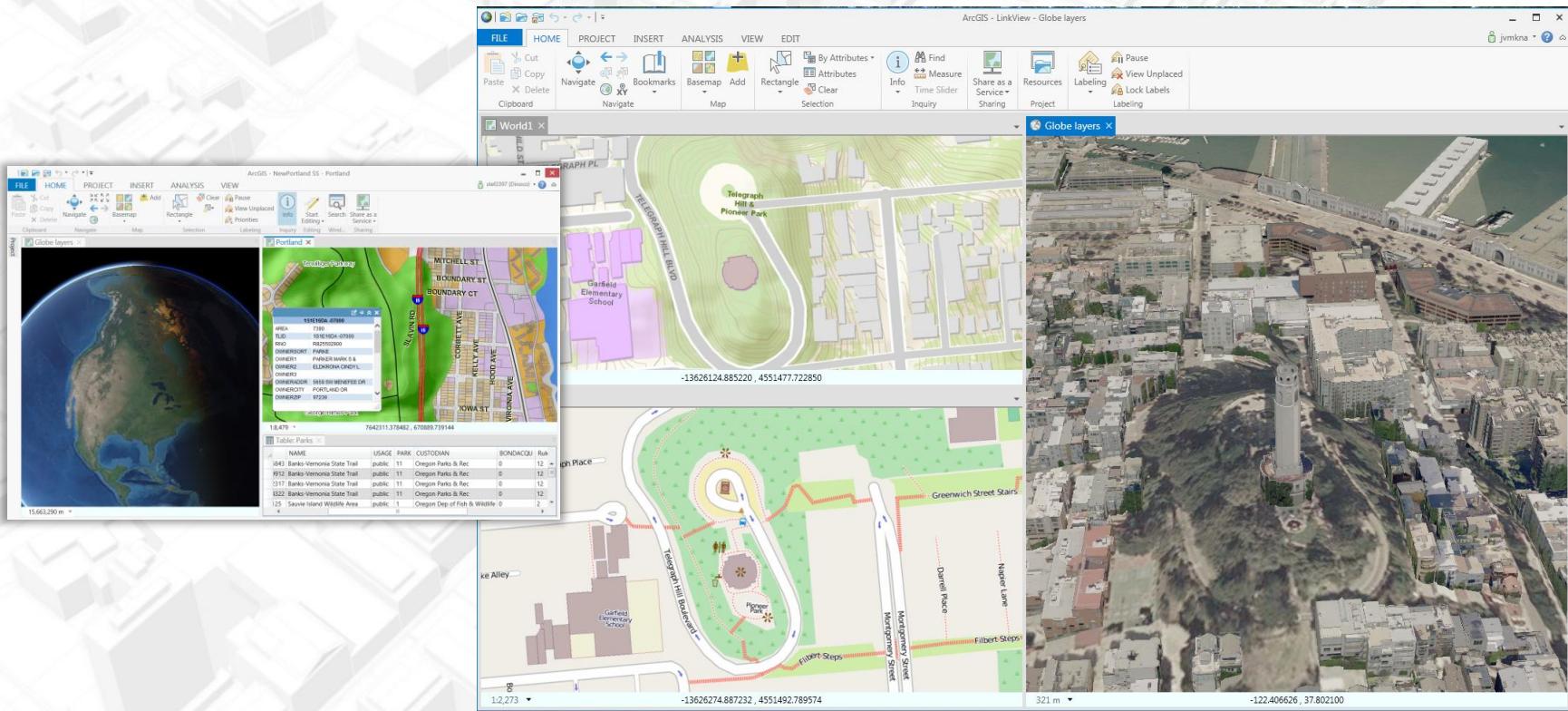


Maya

# 规则包/RPK

ArcGIS Pro

## 2D/3D 一体化





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# Demo: 分享CityEngine规则包 用于 ArcGIS Pro



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# CityEngine Web Scene



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# CityEngine Web Scene

- ✓ 在Web浏览器中查看 3D 内容
- ✓ 免插件



## 技术

- WebGL
- JavaScript
- HTML/CSS

### Esri CityEngine

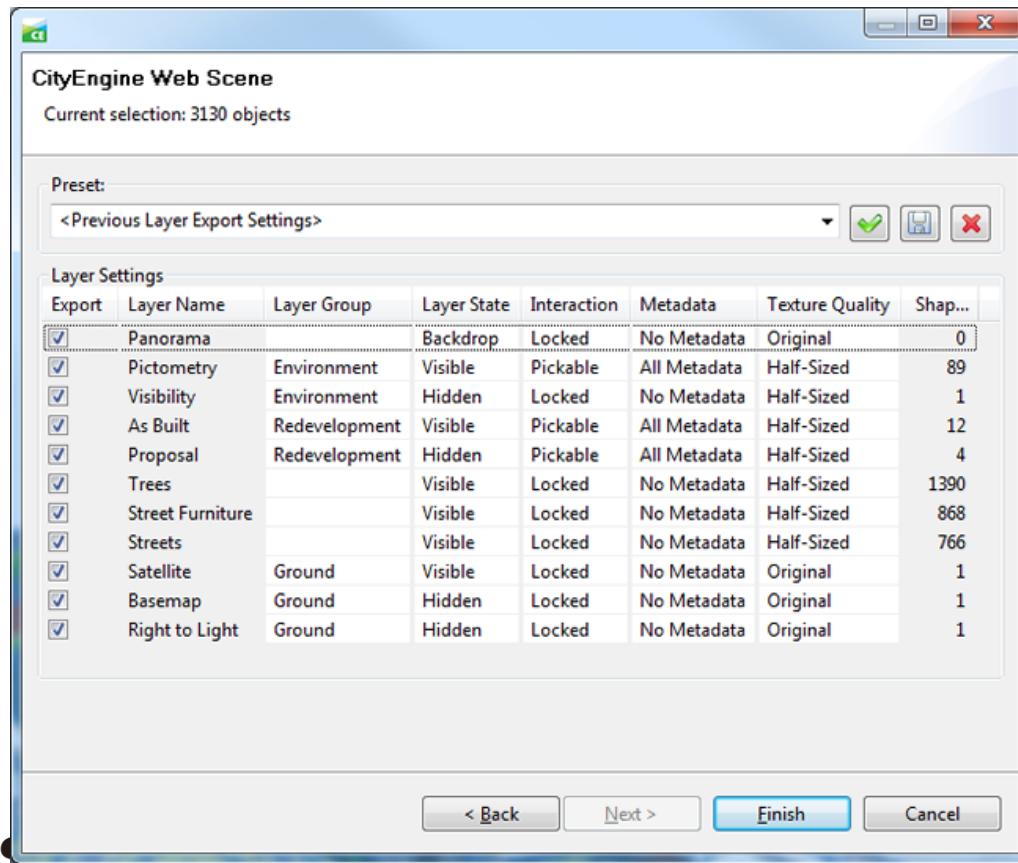




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# 导出 3ws

File → Export Models... → CityEngine Web Scene



\*.3ws 文件



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# 查看场景

Demo3DCity2

SHARE HELP ARCGIS ONLINE

Settings

Sunlight

3:05 PM      GMT-9

March

Shadowing

Direct Shadow (cast by sunlight)

Diffuse Shadows (ambient occlusion)

Screenshot

Viewport size      Save

The screenshot displays a 3D rendering of a coastal urban environment. A long bridge spans a body of water towards a city skyline. The shoreline is lined with green trees and a paved walkway. The sky is blue with scattered white clouds. On the left, there's a cluster of modern-looking buildings. The right side features a large, curved embankment with a dense row of trees. At the bottom of the screen, there's a toolbar with various icons for navigating the 3D view. Below the toolbar is a horizontal bar containing several small thumbnail images of different parts of the scene. To the right of the main view, there's a dark blue sidebar titled "Settings" which contains options for "Sunlight" (with a time and timezone dropdown), "Shadowing" (with two checked checkboxes for direct and diffuse shadows), and "Screenshot" (with a "Viewport size" dropdown and a "Save" button). The overall interface is clean and professional, typical of a GIS application.



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# 分享场景

## □ Share as...

- ✓ 发布到ArcGIS Online
- ✓ 压缩包分享
- ✓ 上传到本地服务器

The screenshot shows a user interface for managing digital content. At the top, there's a navigation bar with links: HOME, GALLERY, MAP, SCENE, GROUPS, MY CONTENT, and MY ORGANIZATION. Below this is a header for the item 'MyPortland3DCityEngine'. The main content area displays a thumbnail image of a world map with green and yellow regions, representing a 3D city model. To the right of the thumbnail, the item name 'Portland3DCityEngine' is shown, along with a small thumbnail of the item itself, the date 'Last Modified: May 13, 2015', and a rating section indicating '0 ratings, 0 views'. Below this are social sharing buttons for Facebook and Twitter. A row of action buttons includes OPEN, SHARE, EDIT, DELETE, MOVE, CHANGE OWNER, USAGE, and UPDATE.





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# Demo: 分享CityEngine web Scene



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# 更多资源.....

## CityEngine trial:

<http://www.esri.com/software/cityengine>

## CityEngine Community:

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

ArcGIS Resources

ArcGIS Online Sign Out English ▾

esri

Home Communities Help Blog Forums Videos Search City Engine

## CityEngine

Communities

What is CityEngine?

CityEngine allows you to efficiently create 3D urban landscapes using your existing GIS data, as well as do conceptual geodesign in 3D. Scenarios can be brought back into ArcGIS for further analysis or exported to high-end simulation engines or web clients.

Read more... ▶



Quick Links

What's new

- What's new in CityEngine?

Getting Started with CityEngine

- Quick start guide
- License Manager
- Installation guide (Windows)
- Installation guide (MacOS)
- Installation Guide (Linux)
- System requirements

Help

- CityEngine Help ▾
- Tutorials

Other Links

- Knowledge Base
- Ideas
- Support

Related Communities

- 3D GIS Resources



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精彩继续，下一场

# 使用 JavaScript 构建3D Web应用



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