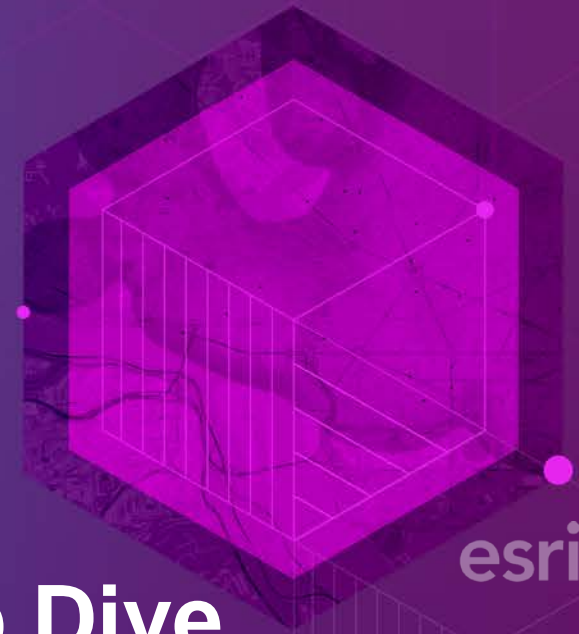


ArcGIS Pro and CityEngine: A Deep Dive

Deepinder Deol
Eric Wittner



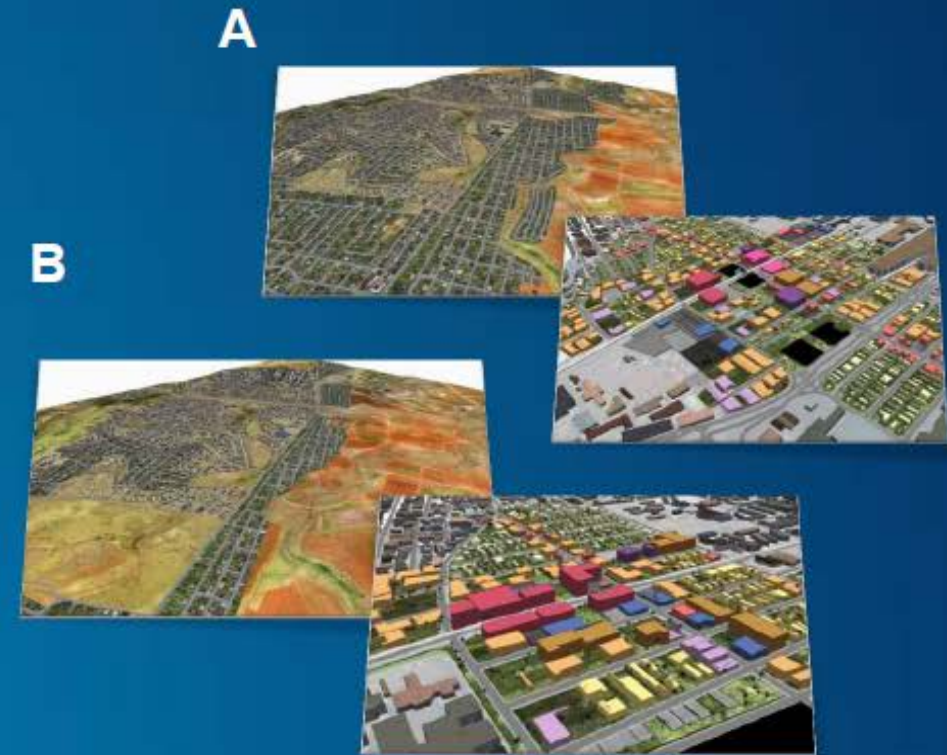
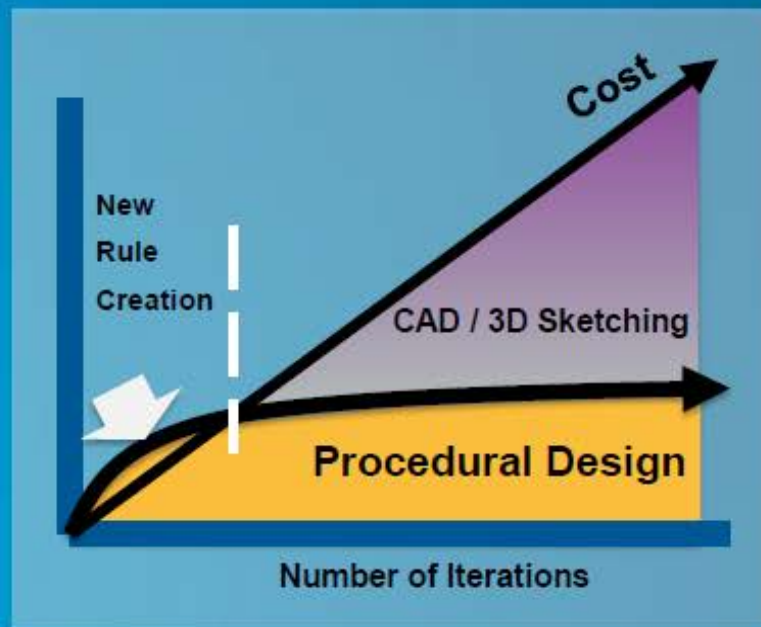
UC



Procedural Modeling Provides a Flexible 3D Design Environment Supporting a Rapid and Repeatable Process

Steps

- Author Rules (or use Library)
- Generate Multiple Design Scenarios
- Evaluate Alternatives



Particularly When Projects Require Many Iterations

Procedural Modeling is Intelligent Rule Based Database

- Interactive
- Multiple Views
 - Realistic Display
 - 3D Thematic Rendering
- Performance Reporting
 - Driven by Attributes
 - Visualized Dynamically



Design



Infiltration Rate



Design



3-D Zoning



**When to use ArcGIS Pro?
When to use CityEngine?**

Procedural Geometry

	ArcGIS Pro	CityEngine
"2D to 3D" procedural engine	Yes	Yes
Interactive design tools <small>Dynamic reports, handles, local edits,...</small>	No	Yes
Rule authoring	No	Yes
Dynamic 3D streets & blocks	No	Yes

→ Continuous improvements & focus on visual rule authoring (with Portal/Online contents)

3D Data Types

	ArcGIS Pro	CityEngine
Lidar / reconstruction	Yes	No
BIM import	Partly	Partly
Multipatch editing	No	Yes
3D export (Unity, etc)	No	Yes

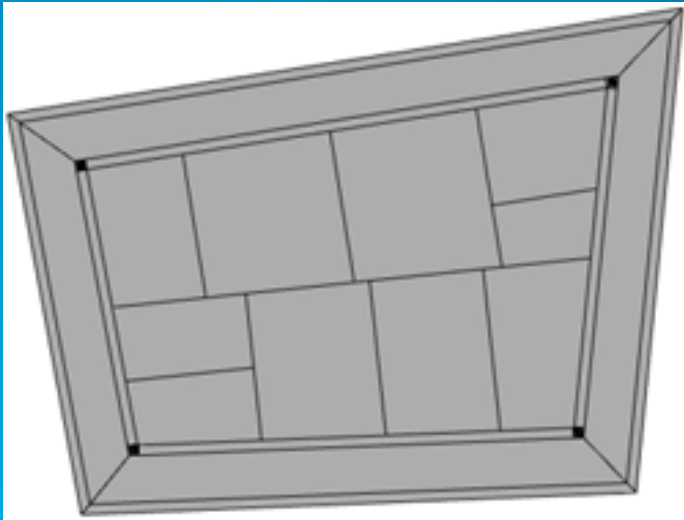
- CE for advanced 3D models (materials, instances...);
CE focus on CAD/BIM to WebGIS workflows

3D Visualization

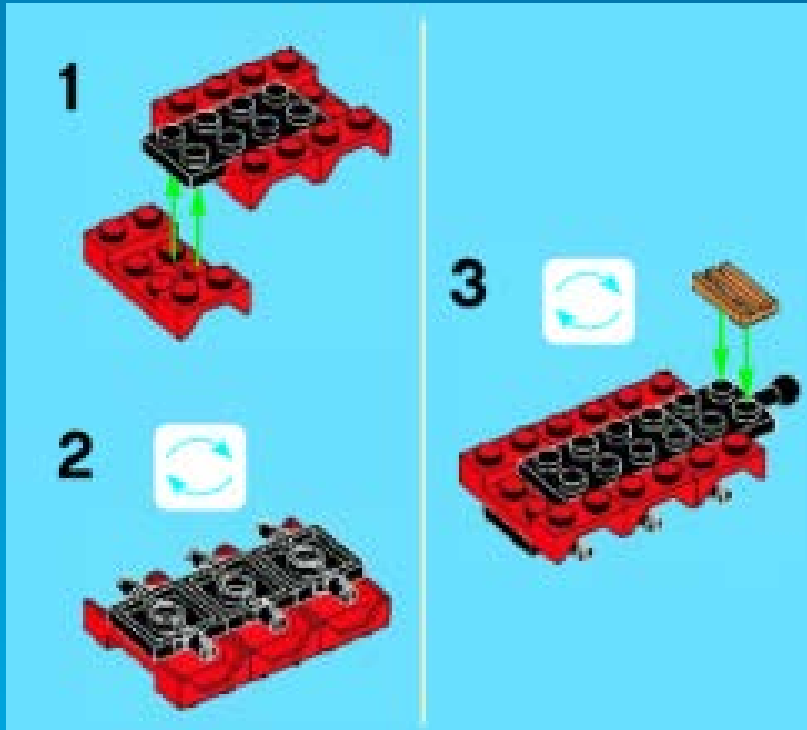
	ArcGIS Pro	CityEngine
Scales	All (global & local)	Up to city scale (local only)
Rendering	Streaming, adaptive	In-memory only
Animation	Yes	No
Analysis	Yes	No

→ Focus in CE on preview; Pro, Earth & WSV are our real-time visualization environments

Procedural Model/Symbol = Rules (CGA) + Assets on Shapes



“LegoScript”

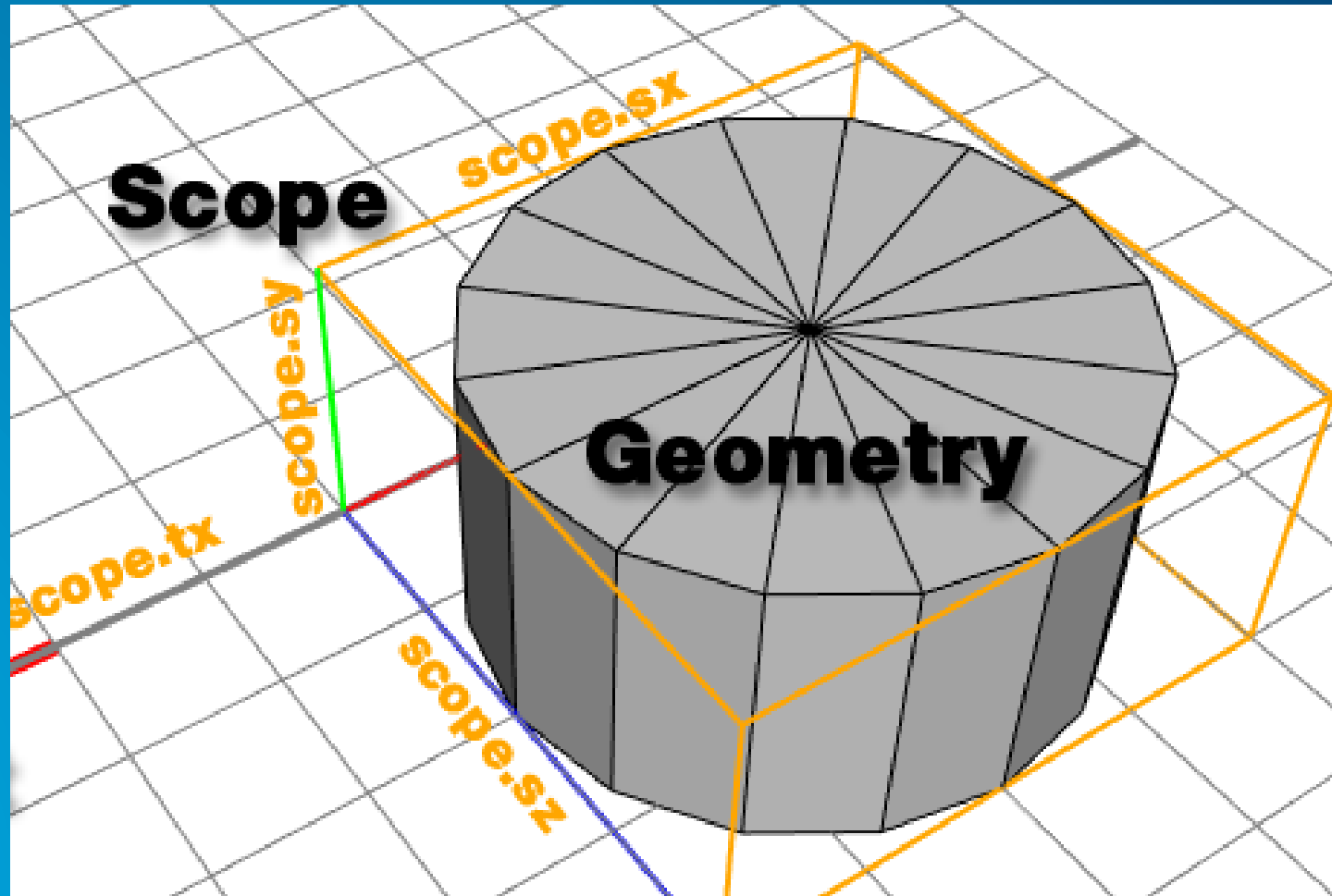


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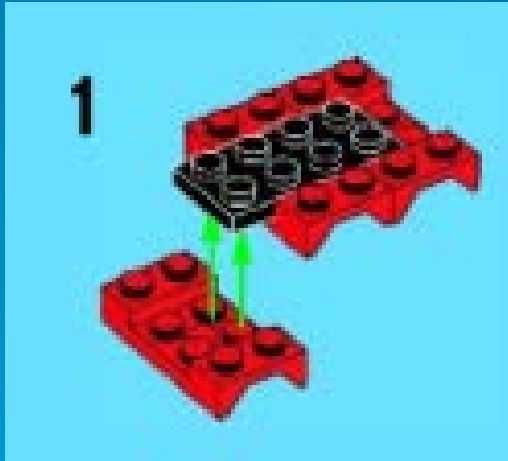


parameterized instructions + Legos

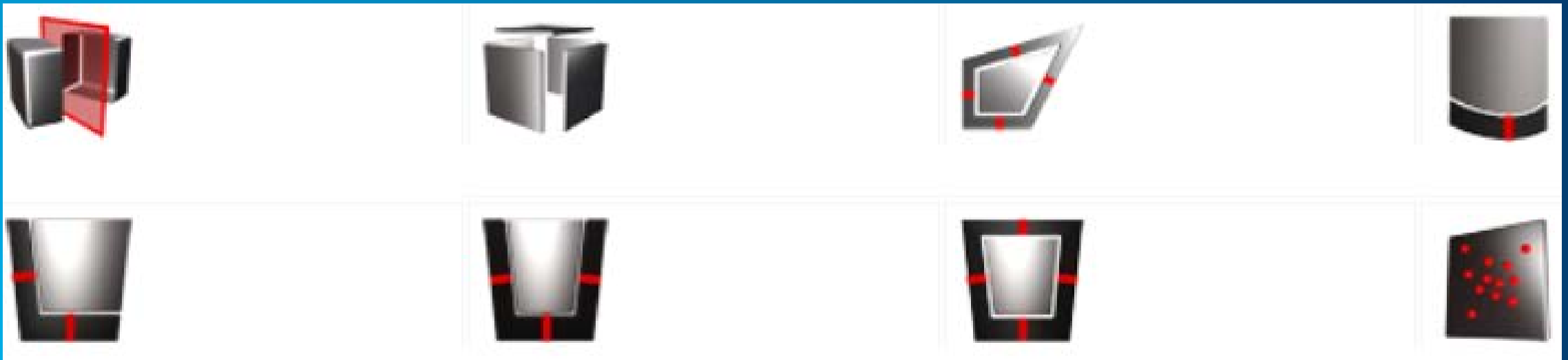
Shapes = Scope and Geometry



Shape Operations



modify scope and geometry



Rule = Sequence of Shape Operations

```
Envelope -->
  case scope.sx*scope.sz > 6000:
    15%: split(y) { '0.9 : Tower
                  | ~3   : s('0.8,'1,
                  | ~1   : s('0.6,'1,}
    15%: split(y) { 'rand68      : T
                  | ~rand(0.5,1.5): s
                  | ~1           : s
    15%: split(y) { 'rand48      : Tower
                  | ~1           : s('ran
    15%: split(y) { 'rand48      : Tower
                  | ~1           : t('ran

    else: Tower
  else: Tower
```

“Scripting for Shapes”

Authoring CGA for RPKs, tips

Assets

All will be included → beware the 'random' use of textures and models
Has a huge impact on file size → consider multiple / focused RPKs

Using Tags / Annotations

Define input geometry: @InPoint, @InLine, @InPolygon, @InPointCloud, @InMesh

Parameters (ie: the 'attr' definition)

Use it as much as needed... but no more
Use a good name → shown on the UI
Match to data model → auto-connect matching names
Set Ranges: @Range (v1, v2)
Provide 'type' information → @Distance, @Percent, @Angle

Protect the CGA (as needed)

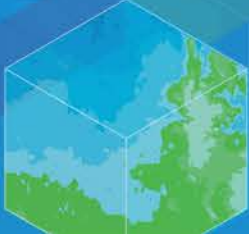
If your rule is something you sell, or has IP, then protect it

```
attr floorCount = 3
@Distance
attr roofHeightVal = 2
@Percent @Range(0,80)
attr percentageStripe = 5

@StartRule @InMesh
BuildingShell -->
```

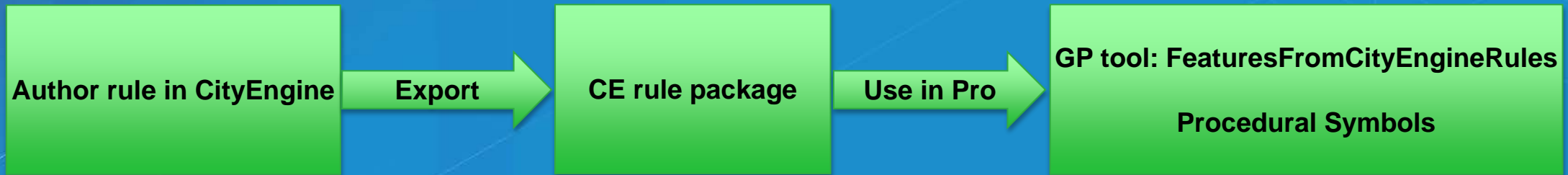
Creating procedural 3D content in ArcGIS Pro

- There are two options:
 - FeaturesFromCityEngineRules GP tool
 - Procedural symbols
- Both options use CityEngine rule packages (*.rpk) to create 3D content
 - Rules are authored in CityEngine
 - The rules can NOT be edited or authored in ArcGIS Pro



What is a rule package?

- Rule package is a compressed file containing:
 - the compiled CityEngine rule
 - any assets (dae, obj, jpg, png etc.) used by the rule
 - optionally also the source CGA rule file



Sharing and consuming rule packages

- **Share as rule package**
 - Within your organization
 - Item on Portal
 - Item on AGOL

- **Consume in:**
 - ArcGIS 10.2
 - ArcGIS Pro
 - 3rd party 3D apps
 - CityEngine SDK

Rule Packages on ArcGIS Online

- Item type on ArcGIS Online
- Living Atlas
- ArcGIS Marketplace
 - *planned for future releases*

Supported geometry types

- Polygon
 - CGA start rule should be marked with **@InPolygon** annotation
- Multipatch
 - CGA start rule should be marked with **@InMesh** annotation
- Point
 - CGA start rule should be marked with **@InPoint** annotation

Supported geometry types

- CGA example for a rule that expects polygon geometry as input:

```
@StartRule @InPolygon
Lot --> extrude(HEIGHT) Bldg

Bldg --> color(1,0,0) RedBldg.
```

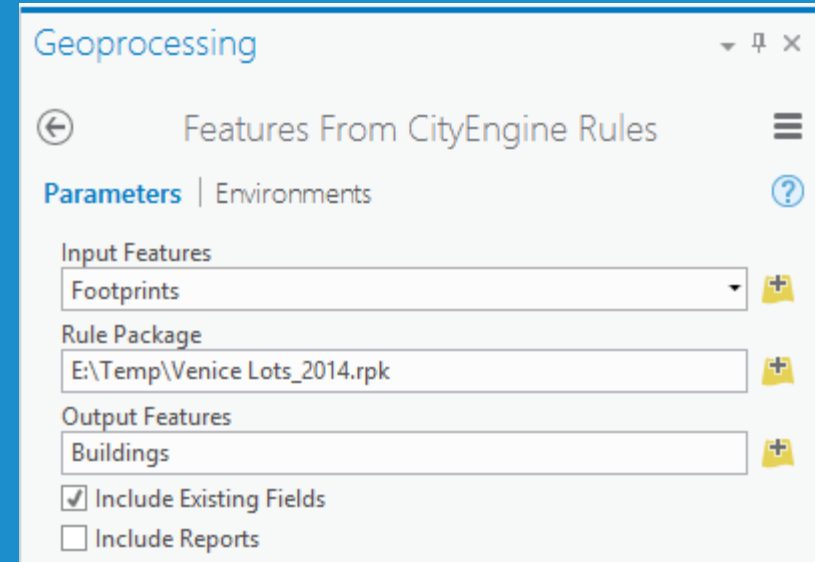
- **Lot** is the start rule. It is where shape generation starts
- **@StartRule** – is the CGA annotation that identifies the “start rule” (Lot in the example)
- **@InPolygon** – is the CGA annotation that specifies the expected input geometry

Do I need to write CityEngine rules?

- Sure, if you want to...
 - *You will have to learn CityEngine scripting/CGA*
 - *Might take some effort initially but the advantage is that you will be able to write your own custom rules for generating 3D content (and it is a lot of fun)*
- But you do not have to
 - *Search for RPKs shared on www.arcgis.com*
 - *For procedural symbols: look at the symbols available in Procedural Symbols style*

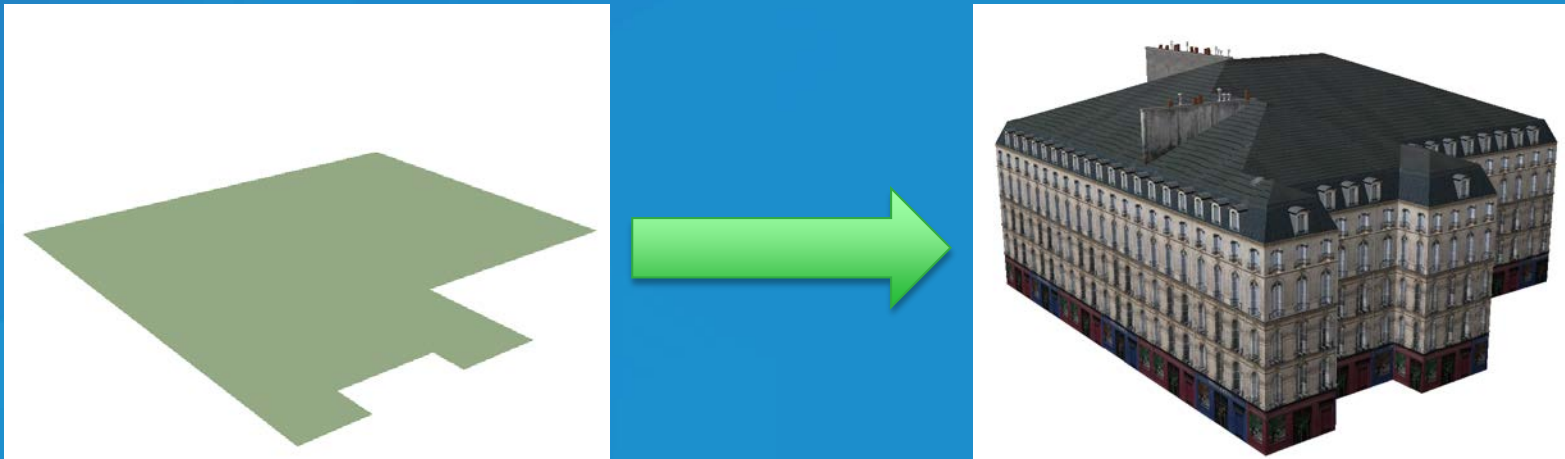
Features From CityEngine Rules

- Input can be polygon, multipatch or point
- Output is a multipatch feature class
- Can optionally:
 - generate reports
 - export leaf shapes
 - if start rule has **@Out (granularity=separatedShapes)** annotation



Procedural symbols

- Applied to polygon, multipatch or point feature layers
- Define custom attribute mappings
- Save symbols to style



Other related initiatives

CE Content and educational material

3D Content Library

- **3D models for use in visualization and publishing**
 - Core urban environment: People, cars, street furniture, etc.
 - Multi-LOD version
 - Custom colors for parts of model
- **Available as ...**
 - 3D styles in ArcGIS Pro (1.4)
 - 3D symbology in webviewer (eventually)
 - 3D Assets for CityEngine



3D Rule Library

- **What are they?**

- Based on common requirements
- Buildings, Streets, Street Furniture, Landscapes, Zoning, and Utilities
- Designed to run across the platform, with common attributes
- Updated regularly

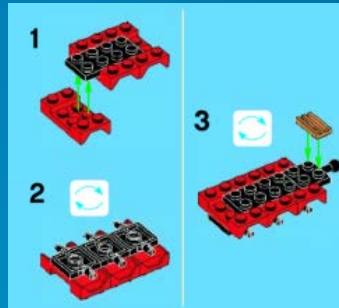
- **When and how?**

- Version 1.0 with 5 rules for UC
- Another 15 rules by the end of the year
- Installed with CE, available through living Atlas and AGOL



Take away

Rule packages are “LegoScript”



+



parameterized instructions + Legos

They can be used across the platform to make and inform 3D data

- Search for RPKs on AGOL & Living Atlas
- Get a free trial version of CityEngine at: [http:// www.esri.com/cityengine](http://www.esri.com/cityengine)
- Have a look at the forum: geonet.esri.com → search for CGA

