

Building 3D Cities Using Esri CityEngine

Instructor Edition

Copyright © 2016 Esri
All rights reserved.

Course version 1.1. Version release date September 2016.

Printed in the United States of America.

The information contained in this document is the exclusive property of Esri. This work is protected under United States copyright law and other international copyright treaties and conventions. No part of this work may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying and recording, or by any information storage or retrieval system, except as expressly permitted in writing by Esri. All requests should be sent to Attention: Contracts and Legal Services Manager, Esri, 380 New York Street, Redlands, CA 92373-8100 USA.

EXPORT NOTICE: Use of these Materials is subject to U.S. export control laws and regulations including the U.S. Department of Commerce Export Administration Regulations (EAR). Diversion of these Materials contrary to U.S. law is prohibited.

The information contained in this document is subject to change without notice.

US Government Restricted/Limited Rights

Any software, documentation, and/or data delivered hereunder is subject to the terms of the License Agreement. The commercial license rights in the License Agreement strictly govern Licensee's use, reproduction, or disclosure of the software, data, and documentation. In no event shall the US Government acquire greater than RESTRICTED/LIMITED RIGHTS. At a minimum, use, duplication, or disclosure by the US Government is subject to restrictions as set forth in FAR §52.227-14 Alternates I, II, and III (DEC 2007); FAR §52.227-19(b) (DEC 2007) and/or FAR §12.211/12.212 (Commercial Technical Data/Computer Software); and DFARS §252.227-7015 (DEC 2011) (Technical Data - Commercial Items) and/or DFARS §227.7202 (Commercial Computer Software and Commercial Computer Software Documentation), as applicable. Contractor/Manufacturer is Esri, 380 New York Street, Redlands, CA 92373-8100, USA.

@esri.com, 3D Analyst, ACORN, Address Coder, ADF, AML, ArcAtlas, ArcCAD, ArcCatalog, ArcCOGO, ArcData, ArcDoc, ArcEdit, ArcEditor, ArcEurope, ArcExplorer, ArcExpress, ArcGIS, ArcGlobe, ArcGrid, ArcIMS, ARC/INFO, ArcInfo, ArcInfo Librarian, ArcLessons, ArcLocation, ArcLogistics, ArcMap, ArcNetwork, *ArcNews*, ArcObjects, ArcOpen, ArcPad, ArcPlot, ArcPress, ArcPy, ArcReader, ArcScan, ArcScene, ArcSchool, ArcScripts, ArcSDE, ArcSdl, ArcSketch, ArcStorm, ArcSurvey, ArcTIN, ArcToolbox, ArcTools, ArcUSA, *ArcUser*, ArcView, ArcVoyager, *ArcWatch*, ArcWeb, ArcWorld, ArcXML, Atlas GIS, AtlasWare, Avenue, BAO, Business Analyst, Business Analyst Online, BusinessMAP, CityEngine, CommunityInfo, Database Integrator, DBI Kit, EDN, Esri, Esri—Team GIS, Esri—*The GIS Company*, Esri—The GIS People, Esri—The GIS Software Leader, FormEdit, GeoCollector, Geographic Design System, Geography Matters, Geography Network, GIS by Esri, GIS Day, GIS for Everyone, GISData Server, JTX, MapIt, Maplex, MapObjects, MapStudio, ModelBuilder, MOLE, MPS—Atlas, PLTS, Rent-a-Tech, SDE, SML, Sourcebook·America, SpatiaLABS, Spatial Database Engine, StreetMap, Tapestry, the ARC/INFO logo, the ArcGIS logo, the ArcGIS Explorer logo, the ArcPad logo, the Esri globe logo, the Esri Press logo, the GIS Day logo, the MapIt logo, The Geographic Advantage, The Geographic Approach, The World's Leading Desktop GIS, *Water Writes*, www.arcgis.com, www.esri.com, www.geographynetwork.com, www.gis.com, www.gisday.com, and Your Personal Geographic Information System are trademarks, service marks, or registered marks in the United States, the European Community, or certain other jurisdictions. CityEngine is a registered trademark of Procedural AG and is distributed under license by Esri.

Other companies and products or services mentioned herein may be trademarks, service marks or registered marks of their respective mark owners.

Course introduction

Author course story

Introduction	i
Course goals	i
Additional resources	i
Installing the course data	i
Icons used in this workbook	vii
Understanding the ArcGIS Platform	iv

1 Getting started with Esri CityEngine

Author lesson story

Lesson introduction	1-1
3D across the platform	1-2
ArcGIS Pro and Esri CityEngine	1-3
Procedural modeling in Esri CityEngine	1-6
Why use procedural modeling?	1-8
What can you model in Esri CityEngine?	1-10
Procedural modeling examples	1-11
Esri CityEngine modeling workflow	1-17
Lesson review	1-18

2 Managing Esri CityEngine projects

Author lesson story

Lesson introduction	2-1
Workspaces and projects	2-2
User interface and project folders	2-6
Exercise 2: Explore a project	2-13
Start Esri CityEngine	2-14
Import an existing project	2-14
Explore the project structure	2-16
Explore the user interface and navigate in the 3D viewport	2-16
Explore scene layers	2-19
Lesson review	2-21

3 Building the foundation of a 3D city

Author lesson story

Lesson introduction	3-1
Esri CityEngine modeling workflow	3-3
How is data represented in Esri CityEngine?	3-4
Shape creation	3-8
Importing data	3-10
Using Get Map Data to import data	3-12
Evaluating data for 3D modeling	3-13

Exercise 3A: Create a 3D city model	3-15
Create an Esri CityEngine project	3-16
Import a terrain file	3-18
Import foundation data	3-20
CGA strategies	3-25
Finding and applying rules	3-26
Exercise 3B: Apply procedural rules	3-29
Import a project and open a scene	3-30
Explore rules and assets	3-31
Apply a rule to create buildings from building footprints	3-33
Apply rules to generate trees	3-35
Apply rules to generate streets	3-37
Lesson review	3-43

4 Using construction tools for urban planning and design

Author lesson story

Lesson introduction	4-1
Use cases	4-2
3D shape creation and editing	4-3
Exercise 4A: Create an urban planning design	4-5
Import the project	4-6
Select an area of interest	4-6
Sketch new buildings	4-8
Add texture to the building	4-11
Texture buildings procedurally	4-17
Generating parcels and applying rules	4-22
Exercise 4B: Create a 3D city design	4-23
Generate new parcels	4-24
Apply an urban planning rule	4-26
Use styles	4-28
Fine tune the design	4-30
Using handles to edit in 3D	4-32
Lesson review	4-35

5 Sharing 3D content

Author lesson story

Lesson introduction	5-1
Sharing 3D content	5-3
Exercise 5A: Share as a web scene and project	5-7
Share a web scene	5-8
Share a project	5-14
Sharing content to a portal	5-17
Exercise 5B: Publish a scene service on ArcGIS Online	5-19
Training Services account credentials	5-20

Export a scene to a scene package	5-20
Publish a scene layer package to ArcGIS Online	5-21
Unpack a scene layer package.....	5-23
Lesson review	5-28

6 Basic CGA shape grammar

Author lesson story

Lesson introduction	6-1
Basics of rule-based modeling	6-2
Visualizing the components of a rule	6-4
CGA rules, operations, and comments	6-9
Attributes and annotations.....	6-14
Identifying rule components	6-18

7 Importing and modifying rules

Author lesson story

Lesson introduction	7-1
Importing and modifying rules.....	7-2
Importing rules	7-3
Exercise 7A: Import and modify rules to create green roofs.....	7-5
Import a rule to increase green roofs.....	7-6
Modify a rule to use the green roof rule	7-8
Add a surface type to the green roof	7-9
Importing rules to texture buildings.....	7-11
Exercise 7B: Import rules to texture roofs and walls	7-13
Import a rule to texture roofs.....	7-14
Import a rule to texture walls	7-15
Working with parameterized rules.....	7-17
Exercise 7C: Import a rule to color buildings by zone	7-19
Import and modify an existing rule to display buildings thematically	7-20
Exercise 7D: Create street light models	7-25
Insert models on point shapes.....	7-26
Lesson review	7-29

8 Writing rules

Author lesson story

Lesson introduction	8-1
Writing rules strategy	8-2
Basics of rule-based modeling	8-3
Working with the color operation.....	8-4
CGA and building rules.....	8-7
Exercise 8A: Create a building rule	8-9
Import project files and open a scene	8-10
Create a new rule file	8-10

Create a start rule and define a rule	8-11
Use extrude to create a simple mass	8-12
Use attributes to define height	8-13
Use annotations to create a range slider	8-15
Use attributes to define roof type.....	8-15
Use the component split operation to create roof and wall shapes	8-16
Define the roof rule and use the color operation	8-17
Define the wall rule	8-18
Adding random variation to a city model	8-21
Working with functions	8-23
Exercise 8B: Use CGA to refine the building rule	8-25
Use case structures	8-26
Work with functions	8-29
Lesson review	8-33

9 Detailed modeling with CGA

Author lesson story

Lesson introduction	9-1
Understanding the concept of scope	9-2
Exploring scope using the model hierarchy window.....	9-4
Understanding projections and texturing.....	9-5
Using scope to texture buildings.....	9-8
Exercise 9A: Use CGA to add textures to buildings.....	9-9
Use CGA to texture buildings	9-10
Create a random texture	9-12
Use scope to improve the roof rule	9-14
Randomize roof textures	9-15
Use CGA to texture roofs.....	9-15
Using dashboards and creating reports	9-20
Creating a smart city with reporting and dashboards	9-22
Exercise 9B: Create a smart city with reporting and dashboards.....	9-25
Add reporting to your rule.....	9-26
View report in a dashboard.....	9-28
Key CGA learning concepts	9-32
Lesson review	9-33

10 Putting it all together

Author lesson story

Lesson introduction	10-1
Exercise 10: Model a 3D city	10-3
Choose data and import.....	10-4
Apply rules	10-5
Create high-density development	10-7
Import rules to create parks.....	10-9

Create bookmark fly-through.....	10-10
Create a web scene to share your city model.....	10-10
Lesson review	10-11

Appendixes

Appendix A: Esri data license agreement	A-0
Appendix B: Key CGA rule concepts	B-1
Appendix C: Answers to lesson review questions	
Lesson 1: Getting started with Esri CityEngine.....	C-1
Lesson 2: Managing Esri CityEngine projects.....	C-2
Lesson 3: Building the foundation of a 3D city.....	C-3
Lesson 4: Using construction tools for urban planning and design	C-4
Lesson 5: Sharing 3D content.....	C-5
Lesson 7: Importing and modifying rules	C-6
Lesson 8: Writing rules.....	C-7
Lesson 9: Detailed modeling with CGA.....	C-9
Lesson 10: Putting it all together	C-10
Appendix D: Demo scripts	
Demo 1A: Procedural modeling examples.....	D-1
Demo 2A: User interface and project folders	D-3
Demo 3A: Importing data.....	D-6
Demo 3B: Using Get Map Data to import data	D-10
Demo 3C: Finding and applying rules.....	D-11
Demo 4A: Use cases	D-17
Demo 4B: 3D shape creation and editing	D-21
Demo 4C: Generating parcels and applying rules.....	D-37
Demo 4D: Using handles to edit in 3D	D-45
Demo 5A: Sharing 3D content.....	D-47
Demo 5B: Sharing content to a portal.....	D-49
Demo 6A: Visualizing the components of a rule.....	D-52
Demo 7A: Importing rules	D-56
Demo 7B: Importing rules to texture buildings	D-68
Demo 8A: CGA and building rules	D-71
Demo 9A: Exploring scope using the model hierarchy window.....	D-72
Demo 9B: Using scope to texture buildings.....	D-78
Demo 9C: Creating a smart city with reporting and dashboards	D-81