

Exercise: Building 3D Cities Using Esri CityEngine

(M.Sc) Photogrammetry and GeoInformatics

Esri CityEngine relies on three ingredients: feature geometry, feature attributes, and procedural rules. The more detail provided in each element, the greater the complexity and real-world accuracy of the generated 3D content.

CityEngine (CE) uses esri file geodatabase (including textured multipatches) as its native storage format. This means that you can use any geo-spatial vector data, such as parcels, building footprints, and street networks, in CityEngine.

Complexity:

Beginner

Data Requirement:

http://bit.ly/CE_Templates

Goal:

To get familiar with UI of CityEngine so as to create your first CityEngine CGA rule file for textured 3D models to publish it on web

Average length of time to complete:

120 Minutes

In this exercise, you will:

- Learn the steps to efficiently create a 3D city model based on existing 2D GIS data.
- Create a new CE project and understand its folder structures.
- Create a new CE scene file and import building footprints from FileGDB, terrain and imagery.
- Create and apply CGA rule to generate textured 3D models based on underlying GIS data.
- Export the CE scene to CityEngine Webscene Viewer and ArcGIS Online.

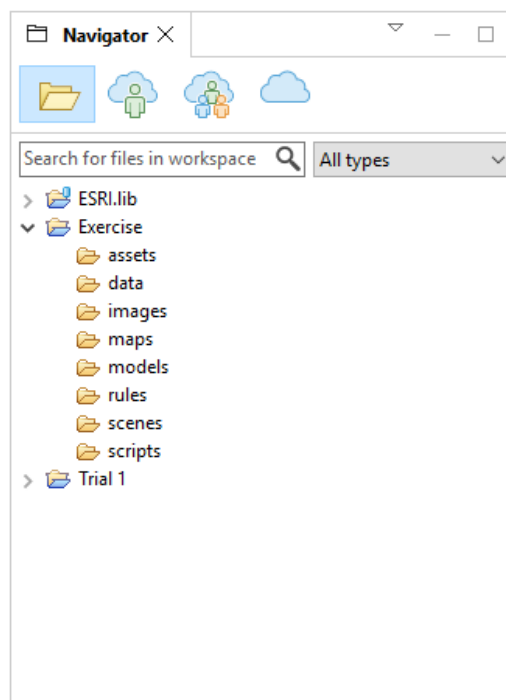
Part 1: Create a New CE Project

The first step in creating a 3D city model starts with creating a new CE project. On defining a new CE project, a folder structure will get created by default in the mentioned workspace/location.

Steps:

- File >> New >> CityEngine Project >> Finish

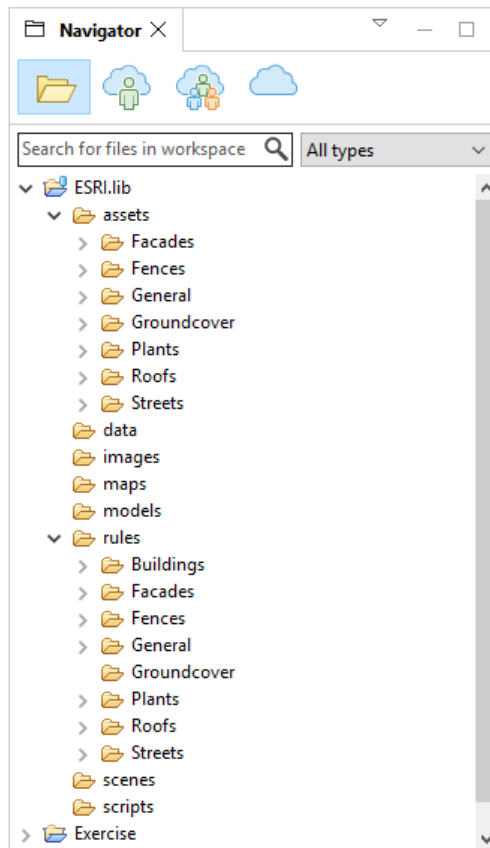
Once a new CE project has been created you will be able to see default folder structures in your navigator window.



These default folder structure will be available every time a new CE project is created. Description of these folder structure is as under

Folder Name	Description
assets	To store textures and 3D objects
data	Streets, building footprints, trees and other vector data
images	Screenshots or photoshop images
maps	Satellite imageries and terrain files
models	Output models from CE
rules	CGA rule files
scenes	CE scene files
scripts	Python scripts

By default, ESRI.lib project will be available out of box. ESRI.lib project folder is a set of CGA libraries and 3D assets libraries provided by ESRI out of box.



Part 2: Creating a new CE Scene and Data Import

On creating a new project, now you create a new scene. CE scene is where you do all the 3D modelling.

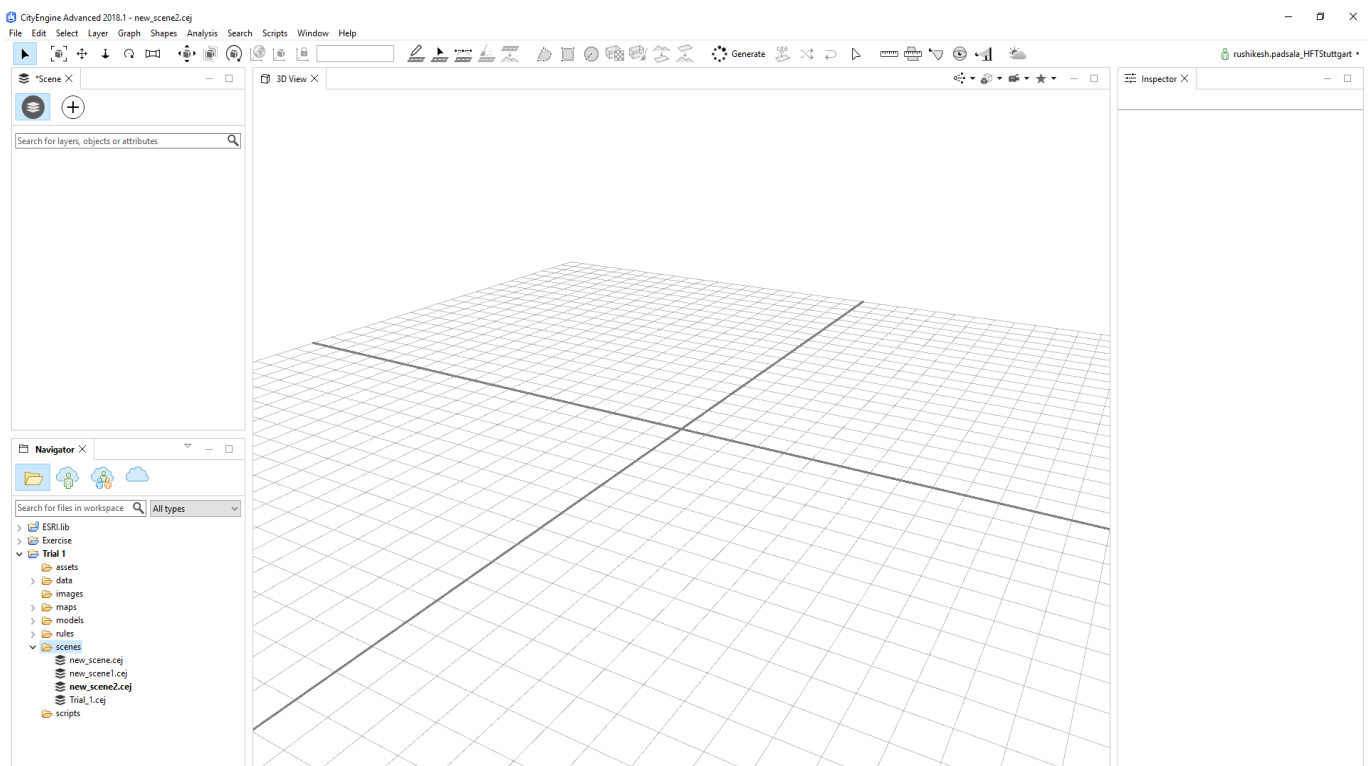
Steps:

- File >> New >> CityEngine Scene >> Finish

OR

- Right click on scenes folder >> New CityEngine Scene >> Finish

Initially if coordinate system (EPSG Code) is known, you can set it here or once you import GIS datasets, CE scene will automatically fetch coordinate system from the GIS dataset. Note that, CityEngine works only in meters. You will get a blank grid window once a new CE scene has been made.



Next is to import GIS data. GIS data is available from moodle. To import data follow steps as under.

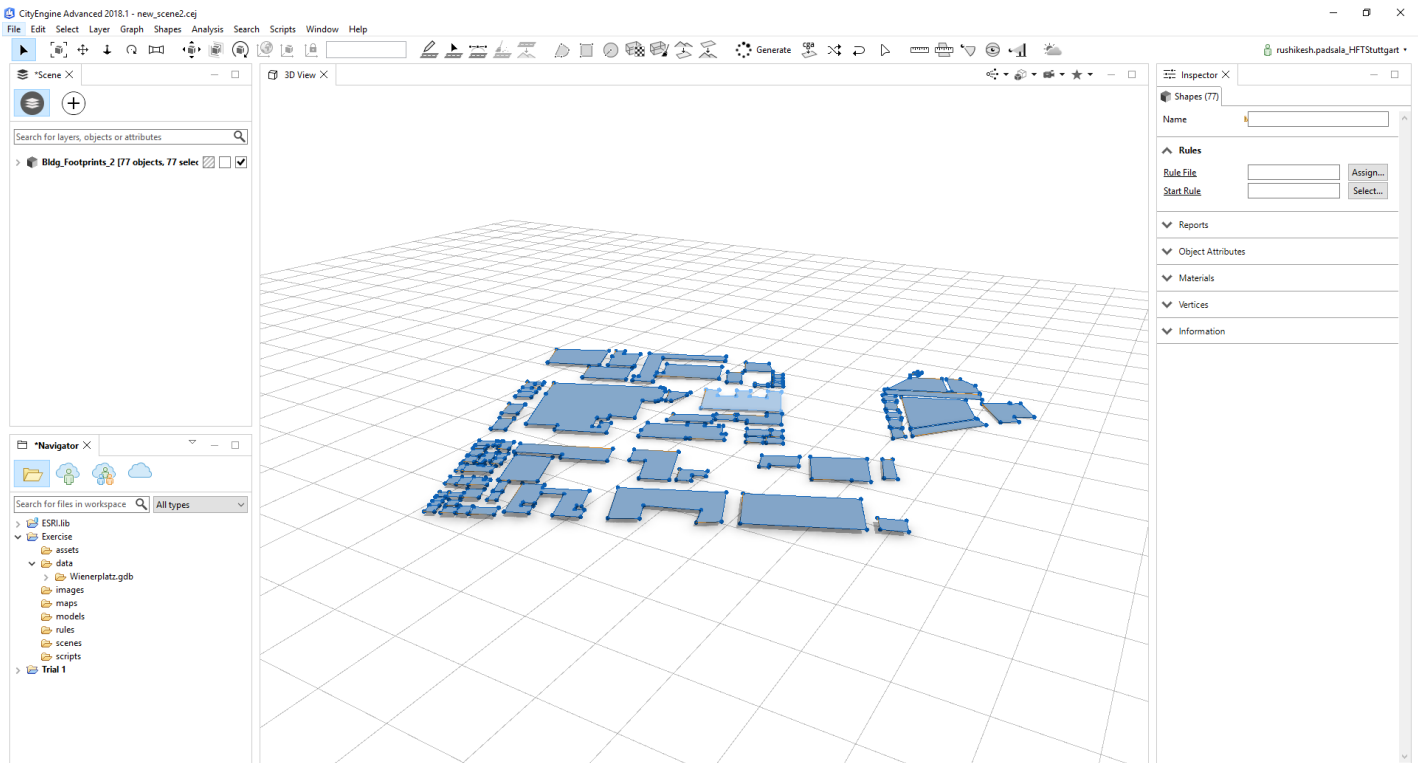
Steps:

- Right click on data folder >> import >> FileGDB import >> Locate your FileGDB >> Click ok on projection system picker >> Finish (Make sure import and map attributes is checked, keep everything as default)

OR

- Copy FileGDB folder from your location >> paste it in data folder of your project >> expand data folder >> right click on FileGDB folder >> import >> Click ok on projection system picker >> Finish (Make sure import and map attributes is checked, keep everything as default)

Once you import GIS data, you should get a screen as below. GIS data used here is a part of new development for Wiener Platz area of Stuttgart, Germany.

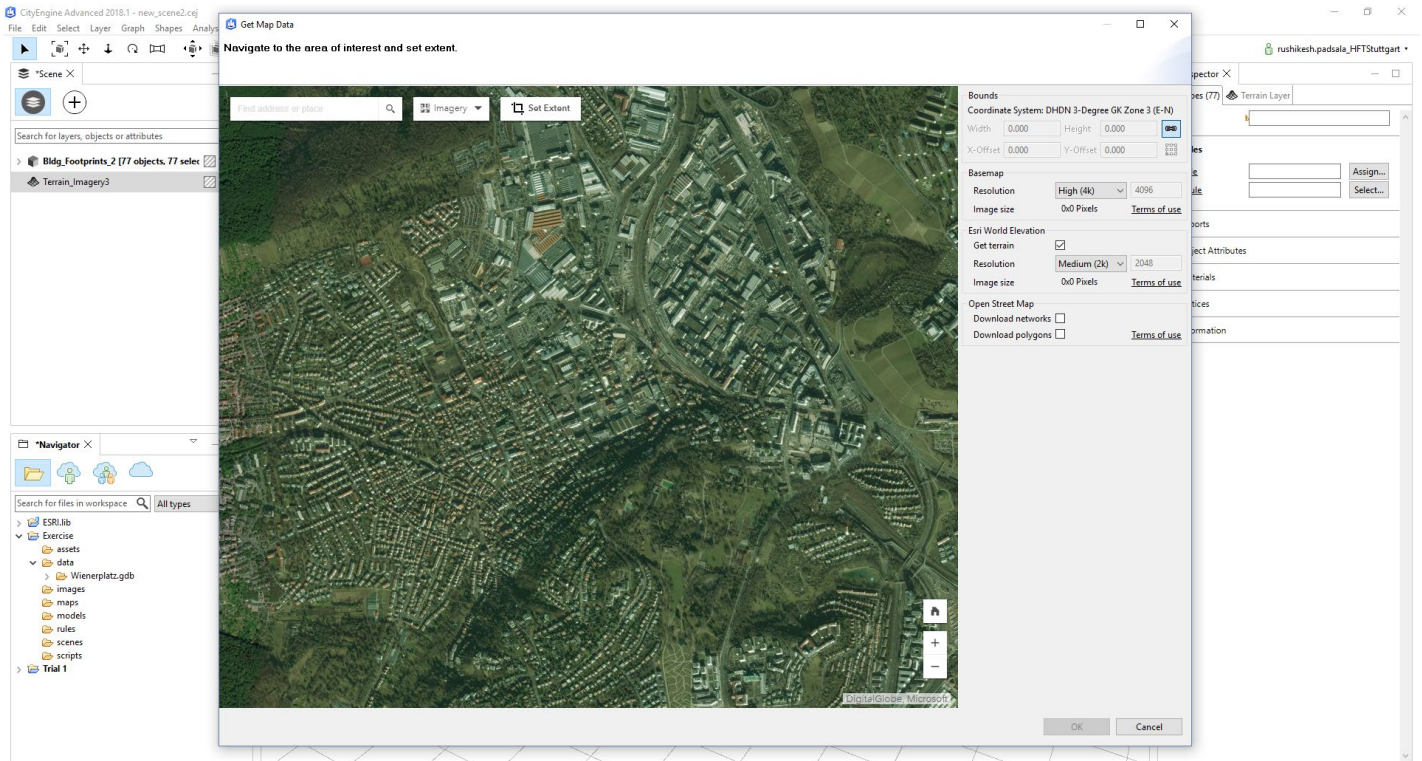


Optional Step for this exercise

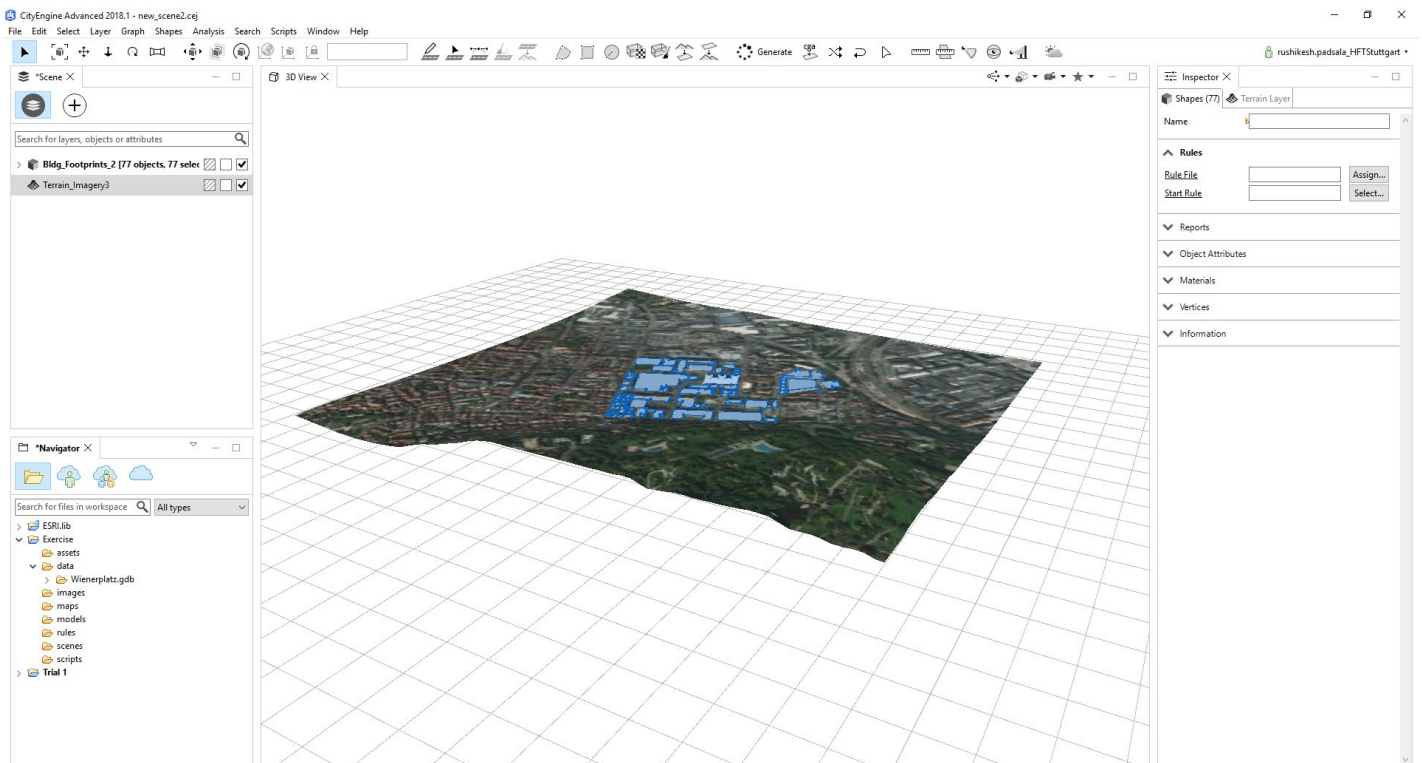
Next is to get terrain and satellite imagery as basemap. Esri CityEngine has an inbuilt module called "Get Map Data" which connects to Esri servers to provide users with terrain and satellite imagery. Simultaneously, it also connects to Open Street Map to quickly download any vector data (points, building footprints, road networks etc) which are available on OSM which forms a part of 3D City Model. For this exercise we will only download satellite imagery and terrain for building footprints we imported in previous steps. One needs an ArcGIS Online subscription to access Get Map Data.

Steps:

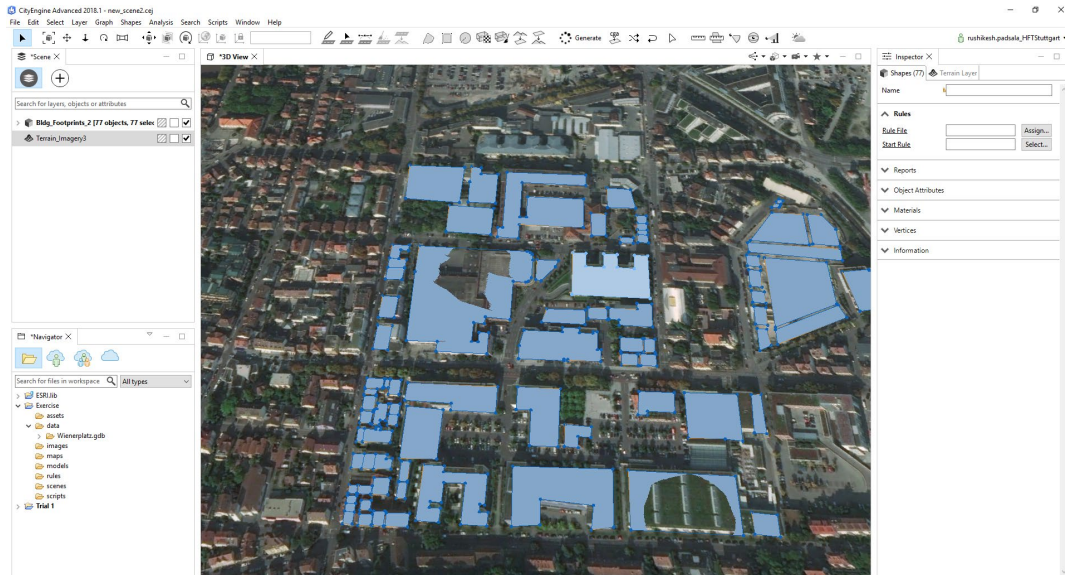
- File >> Get Map Data >> Enter your ArcGIS Online credentials >> Area of Interest will be automatically located (since we already have a GIS data imported before) >> Click on Set Map Extent >> Ok



Once you have the terrain and satellite imagery you should get following screen



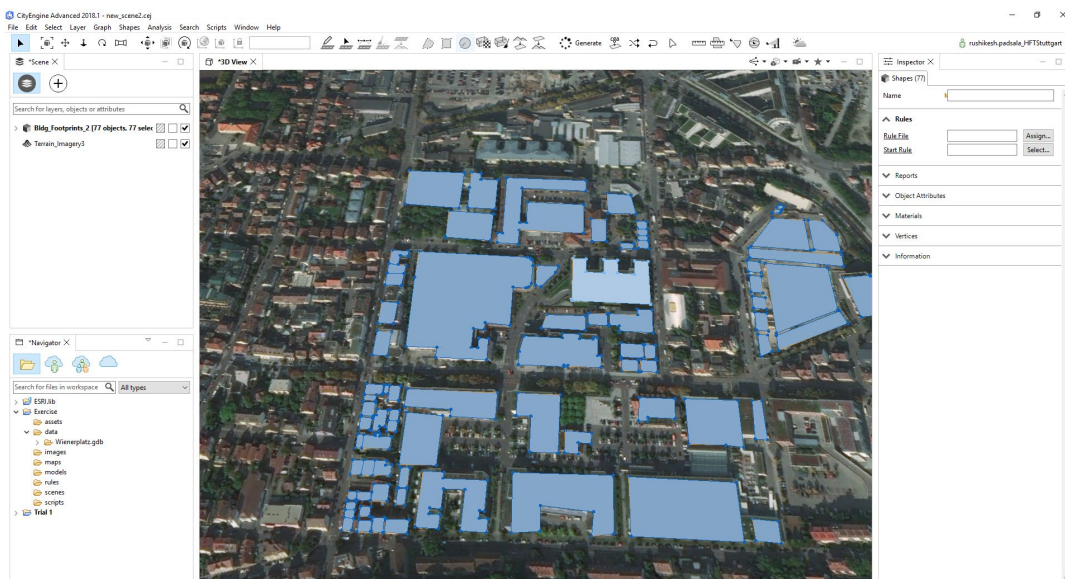
Now, ones you start zooming to the dataset, you will come across misalignment issue like below



Such issue is typically, because of 2D shapes digitised without any referene to terrain. Hence to fix such issues, two inbuilt tools can be used align shape to terrain and align terrain to shape. Using both tools simultaneously will solve shape-terrain misalignment issues.

Steps:

- Click on any one building footprint >> right click and select “Select Objects in the Same Layer” >> click on align shapes to terrain icon from toolbar >> In heightmap selection select imported terrain_imagery >> click finish.
- Now click on align terrain to shapes icon from toolbar >> In terrain selection select imported terrain_imagery >> click apply >> click close.



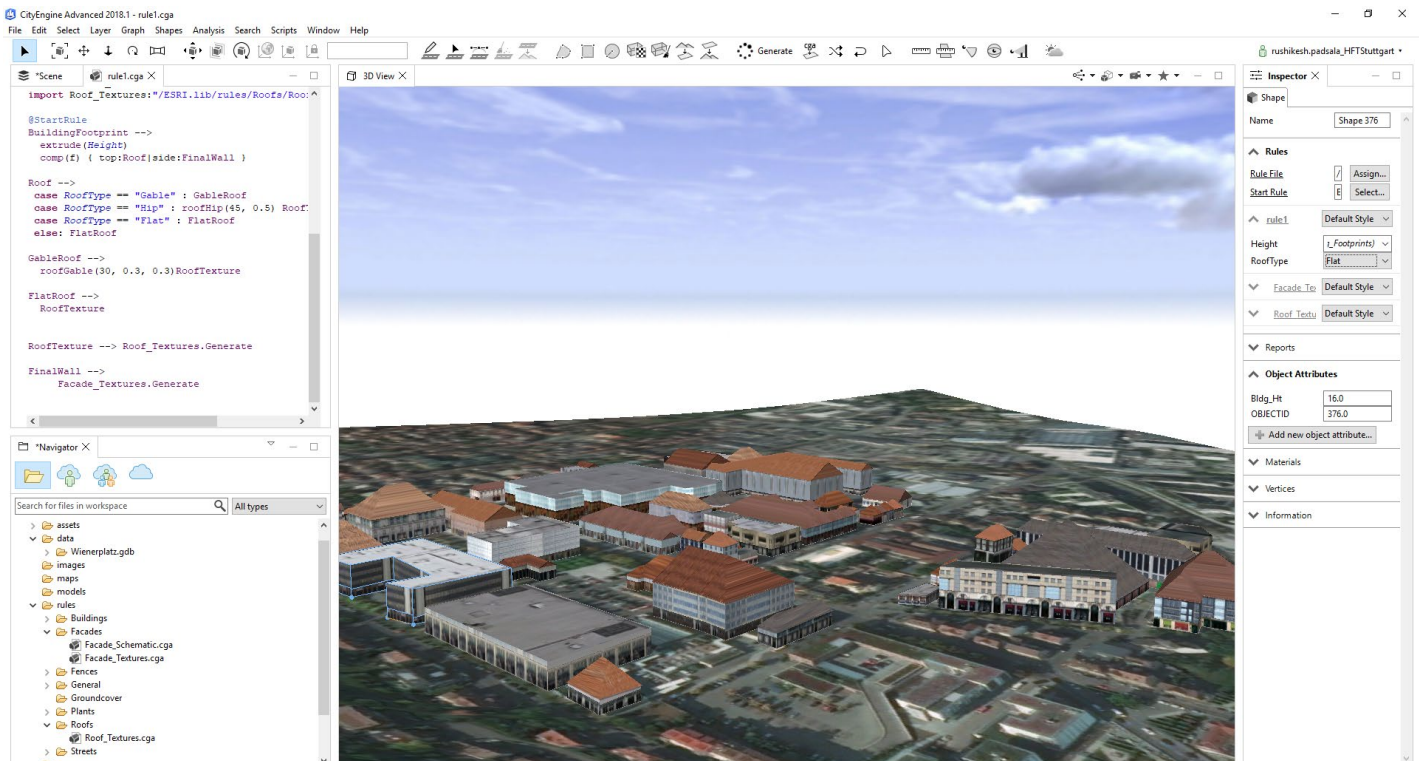
Part 3: Applying CGA rule file

Core of Esri CityEngine is its procedural modelling engine. Procedural modelling or CGA shape grammar is used to generate 3D models.

In this exercise we will create a simple CGA rule file which extrudes buildings, separates faces to roofs and facades and attach textures to them. For texturing we will import existing rule file from ESRI.lib

Steps:

- Right click on rule folder >> New >> CGA Rule File
- Now follow the script as described in the powerpoint presentation to generate 3D models with colored roofs.
- Now expand ESRI.lib folder >> rules >> drag and drop Facade_Textures rule file in your CGA script.
- Reference imported script as explain the powerpoint presentation. This will give walls a texture
- Try following the same by removing color function from leaf shapes of Roofs and importing Roof_Texture rule file from ESRI.lib folder.
- Save your rule file. To apply your rule file first select all the building footprints and then drag and drop your rule file over one of the building footprint shape
- To connect attributes to underlying GIS datasets, from inspector window, click on drop down button for Height >> Select connect attribute >> In layer attribute select bldg_footprints layer >> select Bldg_Ht as the attribute having building heights.



Part 4: Publish to Web (CityEngine local web viewer / ArcGIS Online)

Last and extremely important step is to publish your 3D models to web. For this CityEngine gives you two options CityEngine Web Scene and Esri Scene Layer Package (i3s)

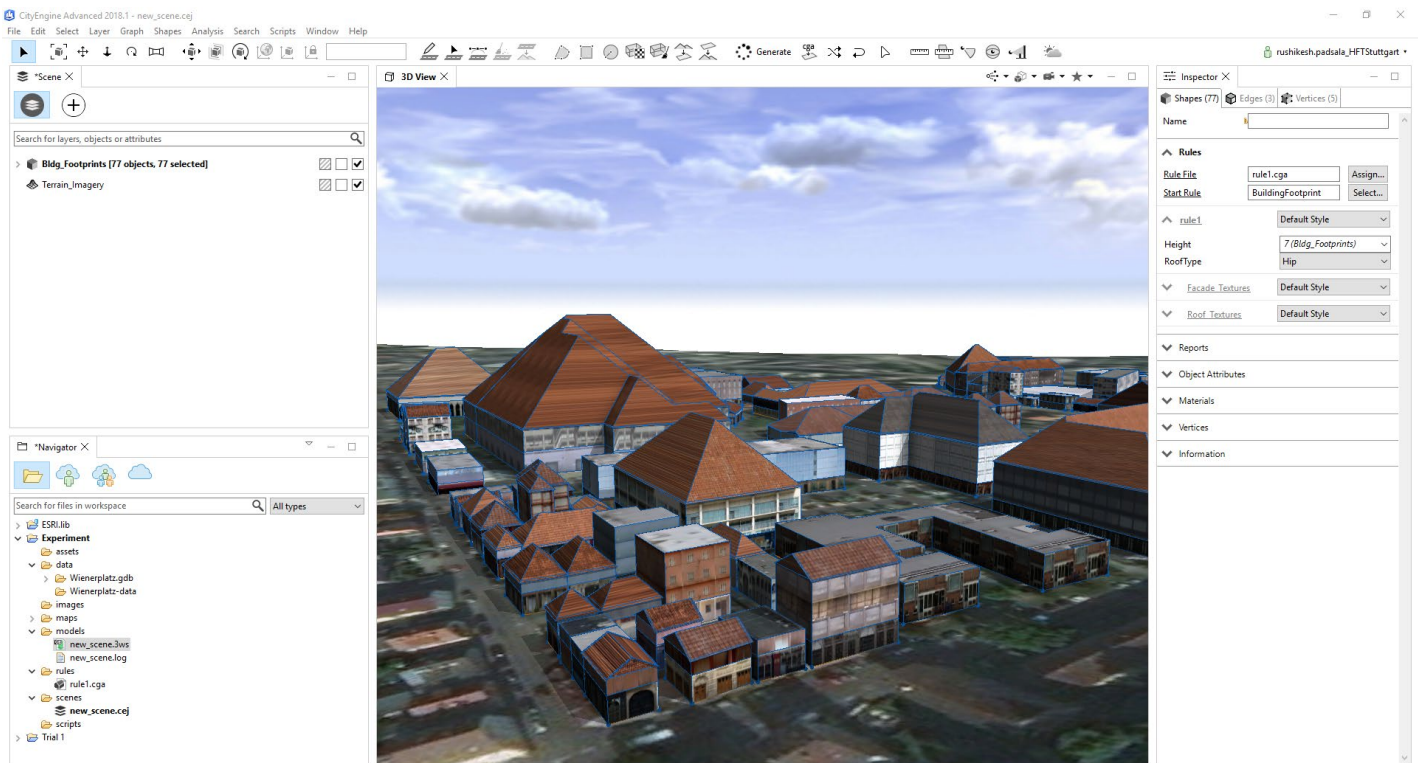
CityEngine Web Scene

CityEngine has an inbuilt web viewer which can be used either online (With ArcGIS Online) or on a local machine.

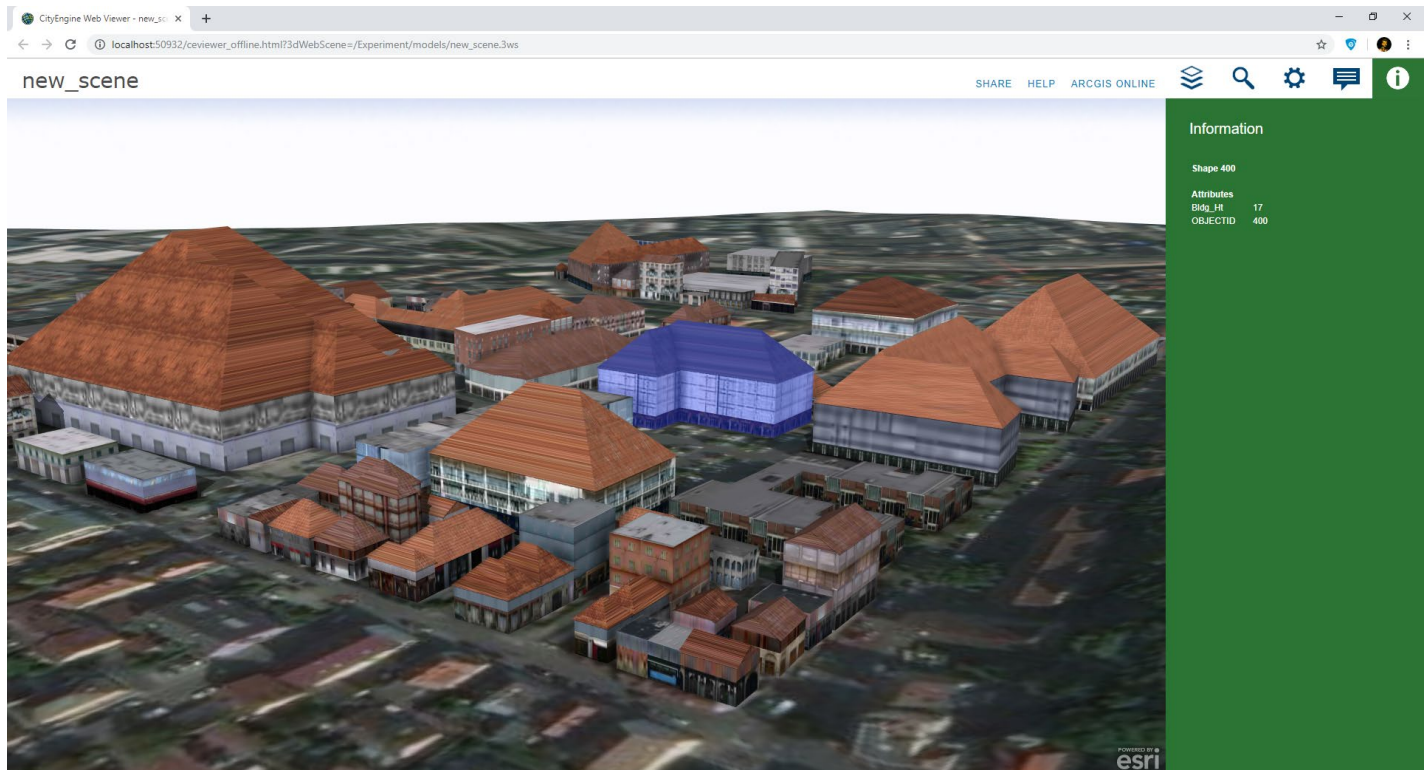
Steps:

- Save your 3D scene and select entire 3D scene by right clicking on layers and clicking select objects.
- Go to file >> Export Models >> CityEngine Webscene >> Next
- In export geometry option, select Models >> In Terrain Layers select All Terrain Layers >> Next
- Keep everything default >> Finish

Once the process finishes, you should get a file called new_scenes.3ws. “.3ws” is extension for CityEngine webscenes.



Now, right click on new_scenes.3ws >> Open With >> CityEngine Web Scene Viewer (offline)



Esri Scene Layer Package (Optional Exercise)

ArcGIS Online is an online platform to share maps and geographic information with others. It hosts the CityEngine Web Viewer application, which opens and displays shared CityEngine Web Scenes (as explained in last tutorial) and ArcGIS Online web globe. In order to display 3D models on ArcGIS Online globe, also called as ArcGIS Online web scene viewer, you first have to convert your models to Esri Scene Layer Package (i3s format). To view your data on AGOL web globe you must have an ArcGIS Online credential (Role: Publisher). CityEngine natively allows its users to convert 3D models to Esri Scene layer package (.slpk).

Steps:

- Save your 3D scene and select entire 3D scene by right clicking on layers and clicking select objects.
- Go to file >> Export Models >> Esri Scene Layer Package >> Next
- In export geometry option, select Models >> In Scene Environment you can select your choice. On selecting global scene, 3D models will be placed on AGOL web globe following WGS 84 i.e geographic coordinate system. On selecting a local scene, 3D models will be placed on AGOL web globe following coordinate system of your GIS datasets. In our case it will be DHDN_3_Degree_Gauss_Zone_3 >> Finish
- Once the process finishes, you should get a file called new_scenes.slpk under models folder.

- Now login into ArcGIS Online using your credentials
- Inside ArcGIS Online >> Content >> Add Item >> From my computer
- Now locate your .slpk file and make sure Publish this file as a hosted layer option is checked.

Add an item from my computer ? ×

File:

Choose file new_scene.slpk

☒ Publish this file as a hosted layer. (Adds a hosted layer item with the same name.)

Title:

new_scene

Tags:

Add tags

Add Item Cancel

- Give a tag >> Click Add Item

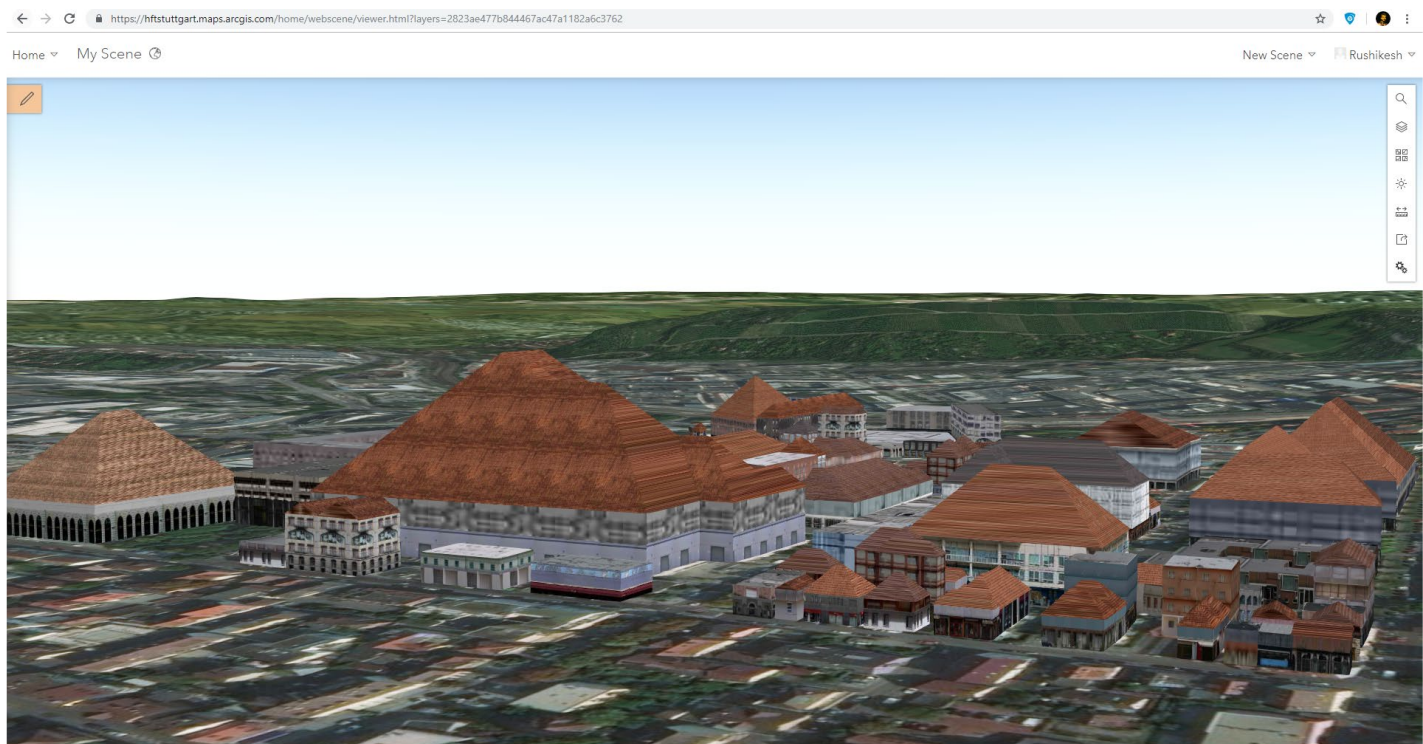
Once the processing finishes, you should get a web page like below

The screenshot shows the ArcGIS Online interface for a newly created item named 'new_scene'. The top navigation bar includes links for Home, Gallery, Map, Scene, Groups, Content, and Organization. The user profile 'Rushikesh Padsala' is visible in the top right. The item page is divided into several sections:

- Overview:** Contains a thumbnail of a 3D scene, a brief summary, and a description. The description states: 'Scene Layer - 3D Object (hosted) by rushikesh.padsala_HFTStuttgart'. It also shows the creation and update dates (Jun 12, 2019) and a view count of 0.
- Layers:** Lists the item as 'new_scene'.
- Terms of Use:** A section for adding special restrictions, disclaimers, terms and conditions, or limitations on using the item's content.
- Comments:** A section for leaving comments, with a 'Leave a comment' text box and a 'Comment' button.
- Item Information:** A section showing the item's progress (a green bar) and a 'Top Improvement' suggestion to 'Add a summary'.
- Details:** A section providing metadata about the item, including the source (Scene Service), creation date, size (502 KB), and sharing status (The item is not shared).
- Owner:** A section showing the owner's name, 'rushikesh.padsala_HFTStuttgart'.
- Folder:** A section showing the folder name, 'rushikesh.padsala_HFTStuttgart'.
- Tags:** A section showing the tag 'test'.

To view your 3D scene click on Open Scene Viewer.

3D Scene in global scene



3D Scene in local scene – Basemap and Terrain from AGOL will be removed as we are using local coordinate system and not WGS 84. WGS 84 is the projection system used by basemaps WMS services provided by esri. You can use your own basemap with terrain if available in DHDN_3_Degree_Gauss_Zone_3.

