3D GIS

Introduction

Welcome to this course focused on 3D GIS and geovisualization. The goal of this first module is to introduce the subject in general and the goals of this course more specifically.

Module Topics

1. Uses of 3D GIS
2. Benefits
3. Challenges
4. Software tools

2

These are the topics covered in this module.

What are the applications of 3D GIS?

- Geovisualization
- Urban planning
- Digital twins
- Forestry
- Infrastructure
- Landscape architecture
- Hazard assessment
- Subsurface geology
- Augmented reality
- Animation
- Filmmaking

Screen capture from Google Earth

3

Visualizing geospatial data in 3D has many applications in many fields, as highlighted on this slide. Our primary focus in this course will be creating and visualizing geospatial 3D data and scenes. We will not cover 3D analytical and geoprocessing techniques.

What has fueled the growth of 3D GIS?

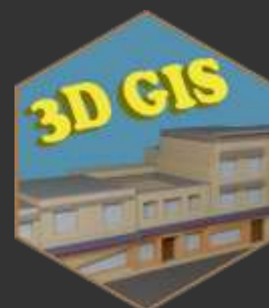
- Use cases
- Data availability
- Processing power
- Computer graphics

4

3D capabilities in GIS have advanced considerably over the last decade. This can be at least partially attributed to the variety of uses of these technologies, which has fueled the need for innovation, wider data availability (such as lidar-derived point clouds and drone-based structure from motion), increases in processing power, and advancements in computer graphics. Recent advances in deep learning and artificial intelligence have also contributed to developments in 3D GIS.

Course Objectives

1. Understand how geospatial data can be represented in 3D
2. Convert 2D and 2.5D data to 3D
3. Convert between 3D data types
4. Create 3D models and meshes
5. Style and texturize 3D models
6. Light 3D scenes
7. Work with aerial (ALS) and terrestrial (TLS) laser scanning data
8. Work with voxel data
9. Build thematic 3D scenes
10. Share 3D data and scenes using the web, videos, and virtual reality



5

This slide lists the learning objectives of this course.

We will begin with a discussion of how geospatial data are represented in 3D and the geospatial models that support these capabilities. We will discuss how to convert 2.5D data to 3D and how to convert between 3D data types (such as voxelizing point cloud data).

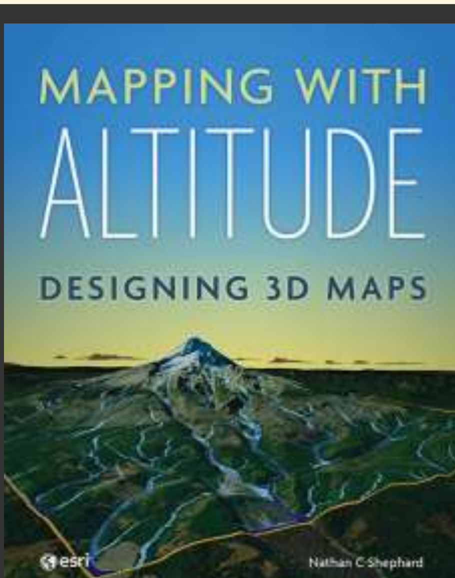
You will learn how to create 3D models and meshes; apply materials, styles, and textures; and create and light 3D scenes.

We will discuss how to work with and process laser-based data collected from aircraft- and ground-based sensors and how to work with voxel grids.

You will learn how to create thematic maps in 3D and associated considerations and best practices.

Lastly, you will learn to share your 3D data and scenes using a variety of methods including web-based scenes, video flythroughs, game engines, and virtual reality.

Book Recommendation



https://www.esri.com/en-us/esri-press/browse/mapping-with-altitude

6

There are a surprisingly limited number of books that focus on 3D geovisualization that are kept up-to-date. If you are interested in a textbook on this topic, I recommend *Mapping with Altitude: Designing 3D Maps* by Nathan Shepard.

Benefits of 3D

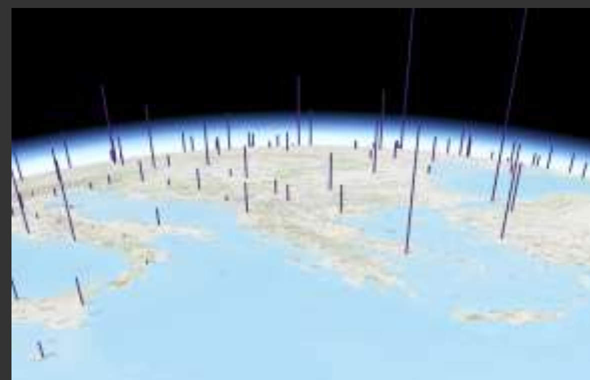
1. Engaging and interactive
2. Can be intuitive
3. Can be immersive
4. Provide information about vertical structure when it is important
5. Expands means to represent geographic data and phenomena
6. Provides new means to communicate

7

There are many benefits to presenting your data in 3D as noted on this slide.

Challenges with 3D

1. Can be difficult to judge relative sizes of features
2. Map content may be hidden behind other content
3. Can be hard to navigate
4. 3D data may be harder to create or obtain
5. Can be confusing and disorienting
6. Can be memory and graphics intensive



8

However, there are also some challenges associated with visualizing and presenting data in 3D. In other words, 3D is not always the best choice. There are many situations were a 2D representation is adequate or even preferable to a 3D alternative.

One key issue is that it, compared to a 2D map space, 3D spaces can be more difficult to navigate and can be disorienting. They can also stress bandwidth, memory, and/or computer graphics.

In short, as a mapping professional, you need to determine when a 3D representation is preferable or more effective. If you choose to use them, then you need to consider how best to generate a product that is useful, engaging, and practical. You should always have an intended audience in mind as you create data and produce 3D geovisualizations.

Software

This section introduces the software we will use in this course.

ArcGIS Pro

- Environmental Systems Research Institute (ESRI)
- First release in 2015
- Replaced older desktop software (ArcGIS Desktop)
- Fully functional desktop GIS
- Integrated into the ArcGIS software ecosystem

https://www.esri.com/en-us/arcgis/products/arcgis-pro/overview

10

We will make use of the commercial ArcGIS Pro software created by the Environmental Systems Research Institute (ESRI). ArcGIS Pro is capable of displaying data in both 2D, referred to as maps, and 3D, referred to as scenes. It allows for loading, editing, and symbolizing a variety of 3D data types. It is also possible to publish data and scenes to the web to use in web apps.

ArcGIS Online

- Allows you to create maps and apps and host content for use on the Web

https://www.arcgis.com/home/index.html

ArcGIS Online allows for storing data on the web and creating web apps. It supports the creation of both 2D maps and 3D scenes. The Scene Viewer allows you to visualize data in 3D, and 3D scenes can be used within web apps.

ArcGIS Experience Builder

- Web-based tool for generating multi-page websites that do not need to be centered around a map

https://www.esri.com/en-us/arcgis/products/arcgis-experience-builder/overview

12

ArcGIS Experience Builder is a tool to generate web apps, webpages, or websites with a variety of content. You don't even need to include geospatial data or maps/scenes; you could design an entire webpage without any maps or geospatial data or design pages with lots of maps/scenes. All this can be done without any coding. We will explore the Experience Builder in detail in a later module.

Note that ESRI provides other tools for creating web apps including Instant Apps, StoryMaps, Dashboards, and the ArcGIS Maps SDK for JavaScript.

In this course, we will use the Experience Builder to create interactive web apps to share and allow users to interact with 3D data.

Blender

https://en.wikipedia.org/wiki/Flow_%282024_film%29

- Free and open-source
- First release in 1994
- Fully functional 3D animation, modeling, and rendering software
- Used on a wide range of movies

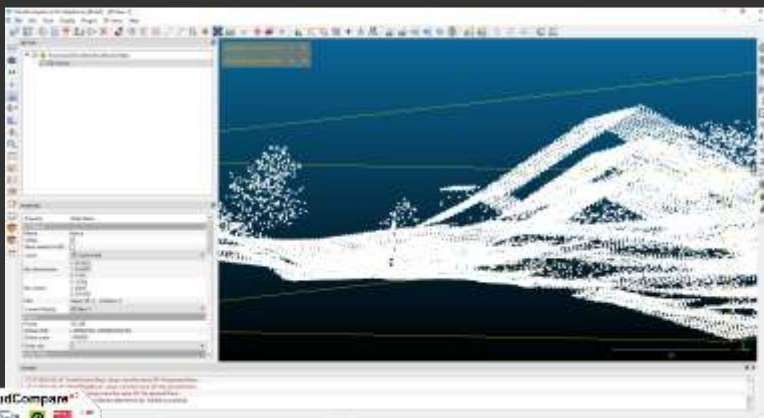
13

Blender is a free and open-source software tool that is used for 3D modeling, animation, simulation, and rendering. This will be our primary tool in this course for creating, styling, and lighting 3D models. It allows for simulating a variety of surface materials, lights, and cameras. You can use keyframing to create animations. This includes moving 3D objects, lights, and cameras.

Our goal in this course is not for you to become a 3D artist, designer, or animator. Instead, we will focus on leveraging 3D modeling software to improve or geospatial 3D models and visualizations.

CloudCompare

- For viewing and working with LiDAR/point cloud data

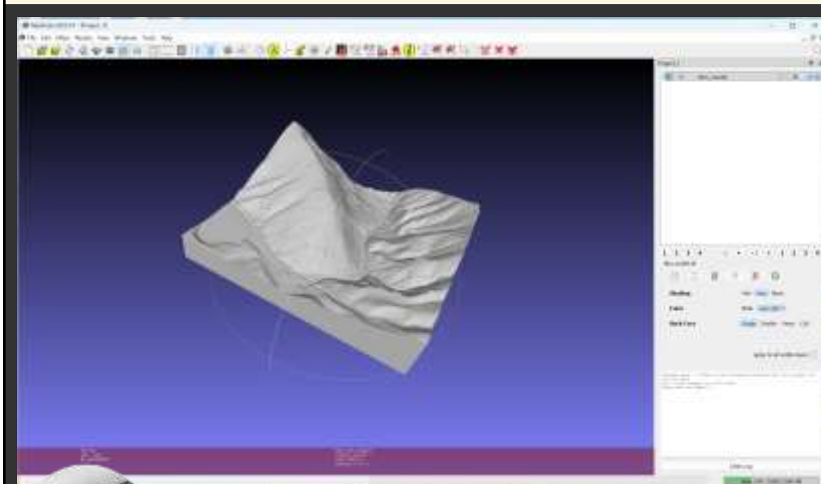


https://www.danielgm.net/cc/

14

CloudCompare allows for free viewing and manipulation of point cloud data, such as light detection and ranging (lidar) data sets. We will explore this tool for working with point cloud data collected from aerial or terrestrial units.

MeshLab



- Free and open-source
- Edit and work with mesh data

https://www.meshlab.net/

https://github.com/cnr-isti-vclab/meshlab

15

We will not use MeshLab in this course. However, I did want to mention it since it is a powerful tool for working with 3D meshes.

Open Drone Map

https://opendronemap.org/

16

Open Drone Map is an open-source tool for processing drone imagery to create derived products including digital surface models (DSMs), orthophotography, and point clouds. We will investigate this tool in the module focused on working with laser-based data.

Unity

- Cross-platform game engine
- Released in 2005
- Indie game development
- 2D and 3D game development
- Interactive simulation development

https://unity.com/

17

Towards the end of this course, we will explore gaming engines as a means to visualize and present 3D geospatial data. Unity is a commonly used gaming engine.

Unreal Engine

- Game engine
- Developed by Epic Games
- Used for 2D and 3D game development, film and cinema, and VR/AR development

https://www.unrealengine.com/

18

Unreal Engine is another commonly used gaming engine. In this course, we will explore Unreal Engine as opposed to Unity.

Cesium

- Cesium Ion: store 3D tiles
- Cesium for Unity: integration with Unity engine
- Cesium for Unreal: integration with Unreal engine
- CesiumJS: JavaScript library for creating 3D web scenes

https://cesium.com/

19

The Cesium products are used to represent 3D data on the web. Cesium Ion allows you to store 3D tiles on the web for use in applications. Cesium has been integrated into Unity (Cesium for Unity) and Unreal Engine (Cesium for Unreal). CesiumJS supports the creation of 3D web scenes displayed in view port on a web page.

This is the end of this lecture module.

Please return to the West Virginia View Webpage for additional content.

Thanks! Hope you found this useful.