

Higher Ed Guide to Esri E-Learning for Spatial Data Science



Overview

Spatial data science allows analysts to extract deeper insight from data using a comprehensive set of analytical methods and spatial algorithms, including machine learning and deep learning techniques. Spatial data science topics may be included in a range of courses, including data science, business, and GIS.

This guide is an aid for instructors who want to use authoritative Esri web-based learning resources as part of the college or university courses they teach. This list is *not* a comprehensive curriculum, nor is it course outline. It is intended to help instructors quickly identify and select those resources that best support their goals and students.

The guide is organized into three main sections:

- [Learning plans](#) – Esri-curated sets of e-learning offerings with a suggested order.
- [Technology](#) – Individual e-learning offerings that provide foundational concepts and skills to support spatial data science workflows.
- [Capabilities](#) – Individual e-learning offerings that focus on specific spatial data science analysis techniques.

All individually listed items are web courses unless noted otherwise. Full course descriptions can be found at the links provided, including required software. The complete Esri training catalog can be found at www.esri.com/coursecatalog. The information in this guide is subject to change without notice.

LEARNING PLANS

A [learning plan](#) is a set of learning resources with a suggested order. The Esri-created learning plans listed here include many of the offerings described above. You can use or assign one of these plans, make a copy and modify it before assigning it, or, you can create your own learning plan. See the site [Help](#) (Category: Learning Plans) for information about teaching with learning plans. The content in Esri-created learning plans is subject to change without notice, as component items are added or retired.

[ArcGIS Technology for Spatial Data Science](#) Learning Plan

This comprehensive plan exposes learners to the ArcGIS tools that enable spatial data science, including ArcGIS Pro, ArcGIS Online, ArcGIS API for Python, R-ArcGIS Bridge, ArcPy for ArcGIS Pro, and ArcGIS Notebooks.

[ArcGIS API for Python Fundamentals](#) Learning Plan

This plan collects the ArcGIS API for Python web courses into a single list. Learners will discover how to streamline analysis, manage content, and integrate Python with Jupyter Notebook to share scripts and reproducible research with others.

[ArcPy Essentials](#) Learning Plan

This plan includes courses from beginning Python scripting to creating scripts to automate geoprocessing workflows and analyzing rasters. Introduces using ArcGIS Notebooks and teaches how to access over 1,400 geoprocessing tools using ArcPy.

[R-ArcGIS Bridge Essentials](#) Learning Plan

This plan combines concepts and hands-on techniques for using the R-ArcGIS Bridge with several practical application tutorials.

[Identifying Clusters Using ArcGIS](#) Learning Plan

This plan collects into a single list the web courses that cover statistical cluster analysis and space-time cluster analysis techniques.

[Finding the Best Place](#) Learning Plan

This plan covers spatial tools and methods for suitability modeling.

[Interpolating Surfaces Using ArcGIS](#) Learning Plan

This plan covers spatial interpolation concepts, techniques for interpolation and kriging in ArcGIS Pro, and tutorials where students apply interpolation in practical scenarios.

[Image Classification Using ArcGIS](#) Learning Plan

This plan introduces image classification concepts and techniques using ArcGIS.

TECHNOLOGY

Spatial data science

The following resources introduce spatial data concepts and techniques. (Get an overview of ArcGIS [Spatial Analysis & Data Science](#) capabilities.)

- [Spatial Data Science: The New Frontier in Analytics](#) (MOOC, Free, 6 weeks. Check website for next course dates.) Explores the application of spatial data science to find patterns and improve predictive modeling. Shows how to integrate popular open data science packages into analyses.
- [ArcGIS API for Python for Analysts and Data Scientists](#) (Video, Free, 65 minutes) This technical workshop explains how Python programmers can tap into geospatial analysis and workflows using ArcGIS API for Python. Presents a thorough overview of benefits of using the API, the kinds of tools available, and benefits of using them. using examples in Jupyter notebooks.

ArcGIS® foundation

The following web courses cover skills and concepts about GIS and ArcGIS Pro that data science students may find helpful.

- [GIS Basics](#) (Free. 2 hrs., 35 mins.) Introduces the fundamental components and capabilities of GIS and how it addresses business needs.
- [ArcGIS Pro Basics](#) (Free, 50 mins.): Introduces tools to integrate, visualize, analyze, and share data.
- [Basics of Geographic Coordinate Systems](#) (1 hr., 15 mins.) Presents concepts about locating features on Earth's surface using different coordinate systems.
- [Getting Started with Spatial Analysis](#) (Free. 1 hr., 10 mins.) Introduces the six categories of spatial analysis that can help you answer geographic questions.
- [Symbolizing Map Layers](#) (1 hr., 45 mins.) Teaches basic principles of map symbology.

ArcGIS and Python scripting foundation

The following resources introduce ArcGIS Python libraries, ArcGIS Notebooks, and other context needed by students to begin Python scripting with geospatial data. (Get an overview of [ArcGIS Python Libraries](#).)

- [Python Libraries for Spatial Data Science](#) (Training Seminar, 1 hour, 12 mins.): Provides a guided tour of the most essential Python libraries for geospatial professionals and data science practitioners who want to include spatial data and techniques in their analytical workflows. Compares ArcPy and ArcGIS API for Python.
- [Get Started with ArcGIS Notebooks](#) (Training Seminar, 65 minutes) Introduces basic concepts of data science, machine learning, and artificial intelligence in the context of ArcGIS Notebooks, the Python scripting environment in ArcGIS Enterprise.
- [Python for Everyone](#) (Free, 3 hours, 30 mins.) Introduces basic Python concepts and the Python scripting environment in ArcGIS.
- [Introduction to ArcGIS API for Python](#) (35 minutes) Introduces numerous spatial capabilities available. Describes the organization of modules and objects in the API.

Scripting with ArcGIS and Python

The following courses and tutorials guide students through creation of Python scripts for common spatial data workflows. The descriptions indicate which solution is used: ArcGIS Pro/ArcPy, ArcGIS API for Python, or both.

- [Scripting for Geoprocessing Workflows](#) (3 hours, 30 mins.) Create python scripts using desktop GIS and ArcPy. Teaches a common scripting workflow and how to set geoprocessing environments, access data for automation, choose a cursor option, get parameter values interactively, and turn a script into a tool.
- [Creating Python Scripts for Raster Analysis](#) (1 hour) Uses the Python window in ArcGIS Pro and the ArcPy raster object class to solve a spatial problem.
- [Update Real Time Data with Python](#) (Tutorial, Free, 1 hour, 50 mins.) Shows how to create a Python feed routine in ArcGIS Pro to automate GIS data layer updates. Uses ArcGIS API for Python to update an online feature service.
- [Predict Seagrass Habitats with Machine Learning](#) (Tutorial, Free, 1 hour, 30 mins.) Uses Python to perform random forest classification, then applies spatial analysis to evaluate prediction results.
- [Performing Analysis Using ArcGIS API for Python](#) (1 hour, 35 mins.) Introduces analysis capabilities available in the API and demonstrates the process for integrating them into apps.
- [Accessing Data in a Portal Using ArcGIS API for Python](#) (1 hour) Teaches accessing data from a portal using the API so that you can integrate spatial data into your Python apps.

Related Learning Plans

- [ArcPy Essentials](#)
- [ArcGIS API for Python Fundamentals](#)

R-ArcGIS Bridge

ArcGIS provides a set of statistical cluster analysis tools that allow you to specify each parameter in your analysis. The following courses present concepts and skills needed to use the various tools. (Get an overview of [R-ArcGIS Bridge](#).)

- [Using the R-ArcGIS Bridge](#) (2 hours) Shows how to load spatial data into an R workspace to perform statistical analysis using the R-ArcGIS bridge.
- [Integrating R Scripts into ArcGIS Geoprocessing Tools](#) (1 hour) Teaches how to apply a workflow to create a geoprocessing script tool that uses the capabilities of R.

- [Analyze Crime Using Statistics and the R-ArcGIS Bridge](#) (Tutorial, Free, 2 hours) Utilizes ArcGIS Pro to explore temporal trends and hot spots, and functions in R to perform statistical analysis.
- [Identify an Ecological Niche for African Buffalo](#) (Tutorial, Free, 3 hours) Includes steps to prepare data for analysis, Analyze raster and vector data in R, and quantify habitat suitability.

Related Learning Plan

- [R-ArcGIS Bridge Essentials](#)

CAPABILITIES

Pattern detection

ArcGIS provides a set of statistical cluster analysis tools that allow you to analyze where clusters exist. The following courses present concepts and skills needed to use these tools.

- [Mapping Clusters: Introduction to Statistical Cluster Analysis](#) (50 minutes) Provides foundational skills and concepts required to begin cluster analysis and interpret results. Uses Hot Spot and Cluster and Outlier Analysis tools.
- [Mapping Clusters: Optimized Hot Spot and Optimized Outlier Analysis](#) (2 hours) Teaches two tools that use your data to define the parameters of your analysis and allow you to refine analysis decisions.
- [Mapping Clusters: Hot Spot and Cluster and Outlier Analysis](#) (1 hour, 20 mins.) Introduces the Hot Spot Analysis (Getis-Ord Gi*) tool and the Cluster and Outlier Analysis (Anselin Local Moran's I) tool and explains how they permit you to control your analysis.

Related Learning Plan

- [Identifying Clusters Using ArcGIS](#)

Space-time analytics

The following offerings teach methods to extend statistical cluster analysis to find patterns across both space and time.

- [Space Time Pattern Mining: A New Frontier in Spatial Analysis](#) (Training Seminar, Free, 1 hour) Reviews cluster analysis methods and explores space-time pattern mining techniques.
- [Introduction to Space-Time Analysis](#) (25 minutes) Describes space-time analysis and its capabilities.
- [Creating a Space Time Cube](#) (40 minutes) Describes components of a space-time cube, which is the foundation of space-time analysis, and teaches how to create one.
- [Space-Time Analysis: Finding Temporal Trends](#) (2 hours, 10 mins.) Explains how to perform emerging hot spot analysis to pinpoint trends and visualize them using space and time.
- [Analyzing Traffic Accidents in Space and Time](#) (Story Map, Free): Presents a workflow that uses spatial statistics to analyze crashes in space and time along a road network. Includes link to associated tutorial.
- [Identifying Popular Places with Spatiotemporal Data Science](#) (Tutorial, Free, 1 hour, 45 mins.) Includes how to aggregate data, detect spatial and temporal clusters, create a space-time cube. Analyze emerging hot spots to identify where to locate a new business.

Related Learning Plan

- [Identifying Clusters Using ArcGIS](#)

Predictive analytics

The following offerings teach interpolation workflows to create prediction surfaces.

- [Determine How Location Impacts Interest Rates](#) (Tutorial, Free, 1 hour) Create a hot spot map and regression model, and map correlation variations.
- [Introduction to Regression Analysis Using ArcGIS Pro](#) (3 hours) Introduces the statistical method used to investigate why something occurs. Teaches how to create a properly specified regression model.
- [Spatial Interpolation with ArcGIS Pro](#) (Training Seminar, Free, 1 hour) Discusses how to understand uncertainty related to predicted values. Explains how to use the Geostatistical Wizard and apply kriging techniques.
- [Geostatistical Interpolation: Introduction](#) (1 hour, 40 mins.) Explains key geostatistical interpolation concepts. Shows how to use ArcGIS Pro to evaluate associated data assumptions.
- [Geostatistical Interpolation: Using Empirical Bayesian Kriging and EBK Regression Prediction](#) (3 hours, 45 mins.) Explains how ArcGIS Pro automates the most difficult aspects of building a valid kriging model. Shows how to perform exploratory spatial data analysis. Teaches how to create prediction surfaces and cross-validate the results.
- [Analyze Urban Heat Using Kriging](#) (Tutorial, Free, 1 hour, 30 mins.) Map data, examine a histogram, compare simple and Bayesian kriging, and use EBK regression prediction.
- [Geostatistical Interpolation: Reaggregating Data Using Areal Interpolation](#) (3 hours, 45 mins.) Areal interpolation applies kriging theory to data averaged or aggregated within polygons. This course teaches the two main use cases: downscaling a source polygon dataset and using the prediction surface to fill in missing polygon data.
- [Downscale Climate Data with Machine Learning](#) (Tutorial, Free, 4 hours) Set up a Conda environment, build a regression model, use Jupyter Notebook and Python to automate temperature estimation, and create a time series mosaic and use R to analyze data.
- [Model Water Quality Using Interpolation](#) (Tutorial, Free, 1 hour, 20 mins.) Explore data using histograms and line charts, interpolate data in ArcGIS Pro, and assess interpolation results.
- [Interpolate 3D Oxygen Measurements in Monterey Bay](#) (Tutorial, Free, 2 hours) Teaches how to perform 3D geostatistical interpolation, map results, and share an animation of the 3D model.

Related Learning Plan

- [Interpolating Surfaces Using ArcGIS](#)

Suitability modeling

These offerings teach spatial tools and methods that can be used to solve suitability problems such as finding the best location, allocating resources effectively or minimizing costs.

- [Finding Optimal Locations: Suitability Modeling in ArcGIS Pro](#) (Training Seminar, 1 hour) Teaches the concepts of how to create a valid and effective suitability model. Presents the suitability modeling workflow and its applications.
- [Introduction to Suitability Modeling](#) (1 hour, 20 mins.) Teaches the concepts of how to create a valid and effective suitability model. Presents the suitability modeling workflow and its applications.
- [Preparing Data for a Suitability Model](#) (1 hour, 10 mins.) Explains how to align a suitability model goal and criteria with readily available data. Applies methods to derive data for a suitability model.
- [Transforming Data for a Simple Suitability Model](#) (45 minutes) Teaches methods used to transform data to a common scale for use in a binary suitability model.
- [Creating a Simple Suitability Model](#) (1 hour, 25 mins.) Explains how to use a simple (binary) suitability model to find locations that meet criteria.

- [Transforming Data for a Weighted Suitability Model](#) (1 hour, 10 mins.) Teaches methods used to transform data to a common scale for use in a weighted suitability model.
- [Creating a Weighted Suitability Model](#) (1 hour, 35 mins.) Shows how to combine prepared datasets to find locations with the highest preference, and evaluate the model using sensitivity and error analysis.
- [Locating Suitable Regions](#) (1 hour, 25 mins.) Uses the Locate Regions tool to refine suitability model results to find the best contiguous areas for purposes such as habitat, infrastructure, or business.

Related Learning Plan

- [Finding the Best Place](#)

You might also be interested in the [Spatial Statistics Resources](#) page created by the Esri Spatial Statistics team.

Deep learning (AI with imagery)

Deep learning functionality in ArcGIS enables you to easily create map layers extracted from imagery. These offerings teach why and how to use different tool options. (Get overviews of ArcGIS [Machine Learning and AI](#) and Image [Analysis with AI](#) capabilities.)

- [Introduction to Image Classification](#) (1 hour, 15 minutes) Introduces options for creating thematic classified rasters in ArcGIS.
- [ArcGIS Deep Learning Tools for Imagery](#) (Training Seminar, 1 hour) Introduces options for creating thematic classified rasters in ArcGIS that can help convey information to decision makers.
- [Performing Supervised Pixel-Based Image Classification](#) (1 hour, 10 mins.) Covers how to improve image classification results with user input about visually recognized features during pixel-based image classification.
- [Performing Unsupervised Pixel-Based Image Classification](#) (55 minutes) Introduces how to create thematic classified rasters using computer-created pixel clusters.
- [Performing Supervised Object-Based Image Classification](#) (1 hour, 15 mins.) Introduces how to improve image classification with user-identified objects or features.
- [Detecting Objects with Deep Learning](#) (1 hour, 35 mins.) Deep-learning models for image classification and object detection rely on multiple layers of nonlinear processing. This course teaches the workflow and covers the limitations and benefits of the technique.
- [Performing Accuracy Assessment for Image Classification](#) (50 minutes) Discusses how statistical analysis can be applied to thematic classified rasters, to understand how well they represent the study area.
- [Unlocking Information from Imagery in ArcGIS](#) (Story Map, Free) Shows how to use imagery workflows and deep learning for efficient, action-oriented problem solving.
- [Classify Land Cover to Measure Shrinking Lakes](#) (Tutorial, Free, 1 hour, 15 mins.) Presents a workflow using unsupervised image classification to compare images and quantify change.
- [Calculate Impervious Surfaces from Spectral Imagery](#) (Tutorial, Free, 1 hour, 30 mins.) Segment imagery, perform a supervised classification based on land use, and assess classification accuracy.
- [Earth Imagery at Work](#) (MOOC, free, 6 weeks. Check online for next offering): Provides hands-on experience with authentic imagery analysis and information products to support decisions.

Related Learning Plan

- [Image Classification Using ArcGIS](#)

Notes

- For questions about courses, contact GIStraining@esri.com or (800) 447-9778, ext. 5757.
- You and your students may be eligible for unlimited access to the entire collection of self-paced e-Learning (web courses, training seminars, and more) if your institution has a qualifying product with a current maintenance subscription. To determine if this applies to you, contact your Esri software license administrator, [check online](#), or email HigherEd@esri.com.
- You can view lists of new training, training pending retirement, and retired training on the [New and Retired Training Options](#) page. You will receive a message when retirements are announced (click View Messages when signed in to Training).
- If you plan to assign a MOOC to a group of students or an entire class, please review these resources:
 - For students: [How to Succeed in an Esri MOOC](#)
 - For instructors: [Assigning an Esri MOOC to Students](#)
- Esri can transfer a student's training history from an institutional account to a different account. To do so, students should contact Esri Customer Service at service@esri.com or (888) 377-4575.