

DEPARTMENT OF GEOMATICS



GEOGRAPHIC INFORMATION SYSTEMS

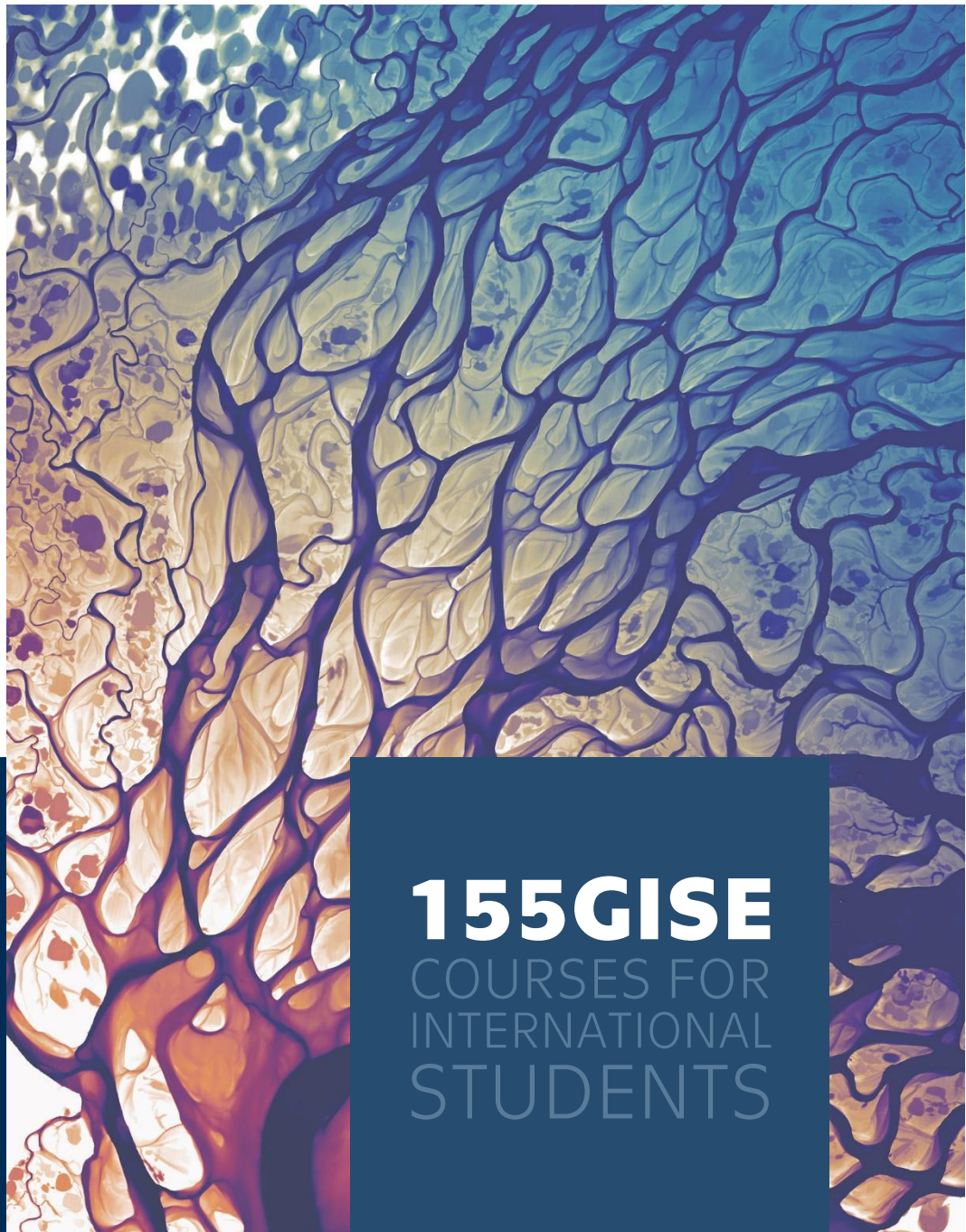
Subject:
Geomatics

Language:
English

Difficulty:
Introductory

Resources
and study materials

OCTOBER 2022



155GISE
COURSES FOR
INTERNATIONAL
STUDENTS

WHAT YOU'LL LEARN

Concepts fundamental to GIS use

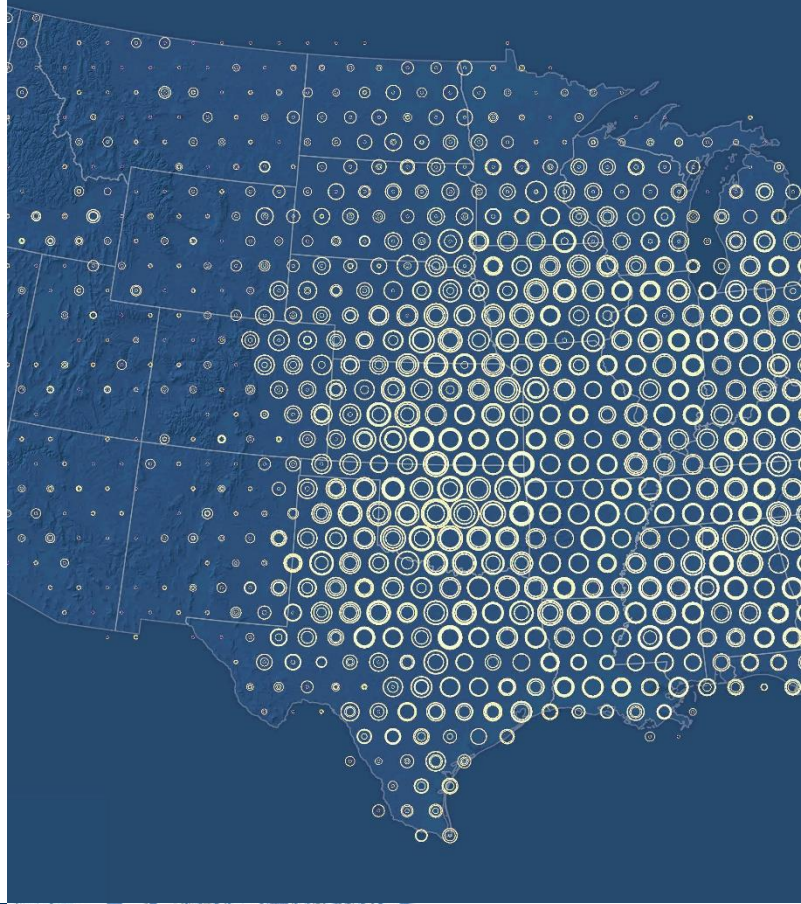
Create, manage, visualize, analyze, and interpret geospatial data

Work with GIS vector data, explore its attribute and spatial relationships, use various powerful geoprocessing tools

Work with raster data, its parameters, symbology and connection to terrain representation

Get general overview of data sources and ways of getting the right data for your next project

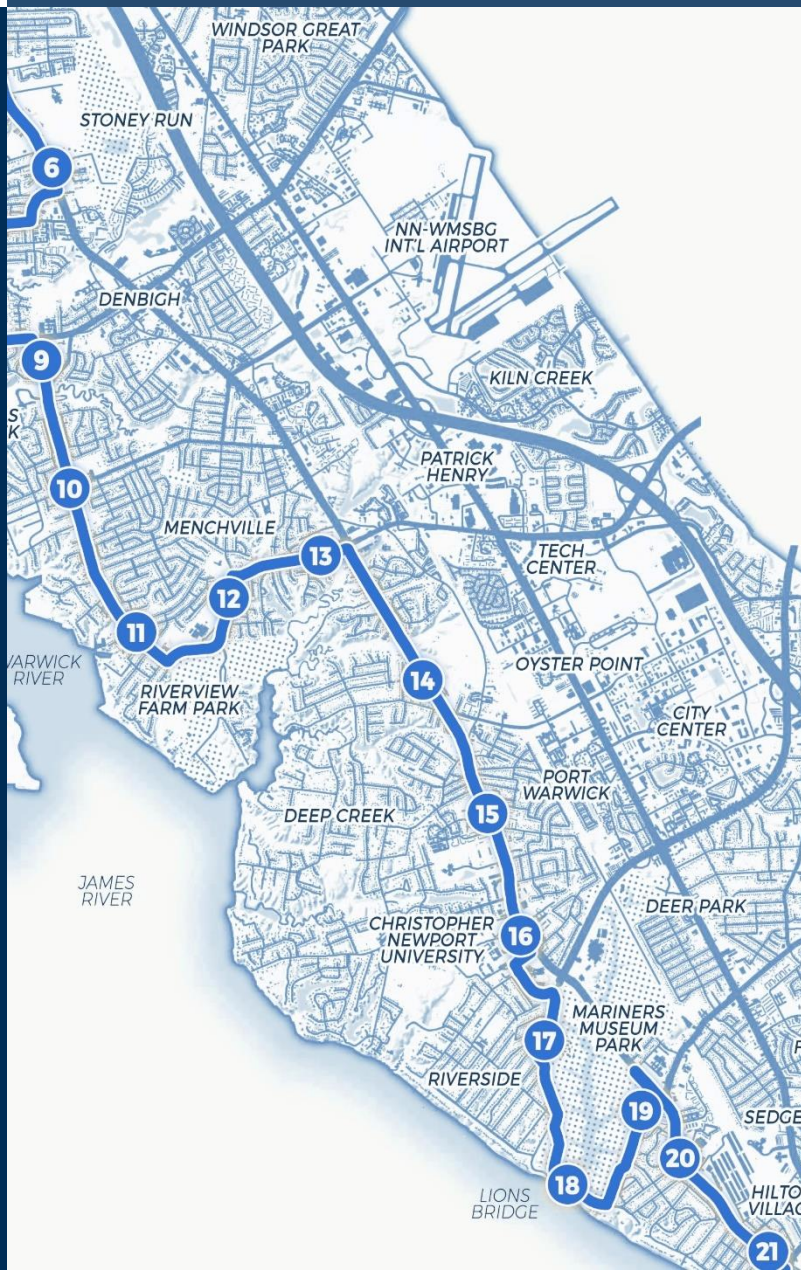
Easily share your maps to web environment for everyone to use



COURSE DESCRIPTION

Do you want to know the background and process of map creation? To create maps in a more sophisticated way than manually drawing in a graphic editor (Photoshop or Illustrator)? To learn how to further edit and analyze geographic data?

This course provides a hands-on approach for learning the basic principles of Geographic Information Systems (GIS) and how to apply them in practice. You will learn how to work with coordinate systems used around the world. You will also create, edit and store geographic data, both in vector and raster form. But GIS doesn't stop there – during the course, data will be further analyzed, resulting in the transformation of structured data into usable information. One of the important steps is also exploring web-based data sources and developing critical thinking skills in terms of credibility and accuracy of the collected data.



COVERED TOPICS

COURSE INTRODUCTION

ARCGIS PRO BASICS

**COORDINATE SYSTEMS
GEODATABASE**

**SHAPEFILE
REFERENCE SCALE**

**VECTOR DATA
MAKING SELECTIONS**

**ATTRIBUTE QUERY
LOCATION QUERY**

CREATING VECTOR DATA

EDITING TOOLS

GEOPROCESSING TOOLS
Buffer, Clip, Union, Intersect
for a new city bus stop

SPECIFIC USE CASE
locating the best location

DATA RESOURCE OVERVIEW

WEB DATA SERVICES

**RASTER DATA
RASTER PARAMETERS**
extent, pixel size, pixel depth

**BASIC SYMBOLOGY
TERRAIN REPRESENTATION**
digital elevation model

GEOPROCESSING TOOLS FOR RASTER DATA
Slope, Aspect, Reclassify, Raster Calculator

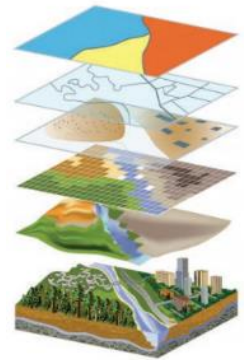
**RASTER/VECTOR CONVERSION
SUBSEQUENT CONVERSION GP TOOLS**

ARCGIS ONLINE

SHARING DATA FROM ARCGIS PRO

Course introduction, ArcGIS Pro basics

"A geographic information system (GIS) is a system that creates, manages, analyzes, and maps all types of data. GIS connects data to a map, integrating location data (where things are) with all types of descriptive information (what things are like there). This provides a foundation for mapping and analysis that is used in science and almost every industry. GIS helps users understand patterns, relationships, and geographic context. The benefits include improved communication and efficiency as well as better management and decision making." (esri.com)



resources

What is GIS?

usgs.gov

gislounge.com

esri.com

"ArcGIS Pro, the powerful single desktop GIS application, is a feature-packed software developed with enhancements and ideas from the ArcGIS Pro user community. ArcGIS Pro supports data visualization; advanced analysis; and authoritative data maintenance in 2D, 3D, and 4D. It supports data sharing across a suite of ArcGIS products such as ArcGIS Online and ArcGIS Enterprise, and enables users to work across the ArcGIS system through Web GIS. Discover the full spectrum of tools and capabilities within ArcGIS Pro today." (esri.com)

resources

ArcGIS Pro online tutorials

[Introduction to
ArcGIS Pro](https://pro.arcgis.com)

pro.arcgis.com

[ArcGIS Pro quick-start
tutorials](https://pro.arcgis.com)

pro.arcgis.com

[ArcGIS Pro Basics](https://esri.com)

esri.com

Coordinate systems, geodatabase, shapefile, reference scale

"Data usually comprises an array of numbers. Spatial data is similar, but it also includes numerical information that allows you to position it on earth. These numbers are part of a coordinate system that provides a frame of reference for your data, to locate features on the surface of the earth, to align your data relative to other data, to perform spatially accurate analysis, and to create maps.

All spatial data is created in a coordinate system, whether it is points, lines, polygons, rasters, or annotation. The coordinates can be specified in many different ways, such as decimal degrees, feet, meters, or kilometers; any form of measurement can be used as a coordinate system. Identifying this measurement system is the first step to choosing a coordinate system that displays your data in its correct position in ArcGIS Pro, in relation to your other data." (pro.arcgis.com)

resources

Coordinate systems in GIS

Coordinate systems, projections, and transformations

pro.arcgis.com

Coordinate Systems: What's the Difference?

esri.com

Coordinate Reference Systems

docs.ggis.org

resources

Storing GIS data

What is a geodatabase?

desktop.arcgis.com

What is a shapefile?

desktop.arcgis.com

**GeoPackage
(geodatabase alternative)**

geopackage.org

resources

Supporting online tutorials/courses

Getting Started with the Geodatabase

esri.com

Fix data when it appears in the wrong place

learn.arcgis.com

Vector data (Feature Classes), selections, attribute query, location query

"Feature classes are homogeneous collections of common features, each having the same spatial representation (such as points, lines, or polygons) and a common set of attributes (for example, a line feature class for representing road centerlines). The four most commonly used feature classes are points, lines, polygons, and annotation." (pro.arcgis.com)

resources Feature layers

Feature layers
pro.arcgis.com

resources Coordinate systems in GIS

Coordinate systems, projections,
and transformations
pro.arcgis.com

Coordinate Systems: What's the
Difference?
esri.com

Coordinate Reference Systems
docs.ggis.org

resources Selections, queries, spatial relations

Introduction to query
expressions
pro.arcgis.com

SQL reference for query
expressions used in ArcGIS
pro.arcgis.com

Select By Location graphic
examples
pro.arcgis.com

resources Supporting online tutorials/courses

Getting Started with Data
Management
esri.com

Attribute table, join, spatial join, calculate field, calculate geometry

"A table view is a display of attribute information in a tabular format. In the simplest terms, tables are composed of rows and columns, and all rows have the same columns. Rows are commonly known as records, and columns as fields. Each field can store a specific type of data, such as number, date, or text. Rows and columns intersect to form cells that contain a specific value for one field in a record. The information displayed in a table comes directly from the attribute information stored in the data source.

The term table can be used to refer to both attribute and stand-alone tables. Attribute tables contain the nonspatial information about a geographic feature. A stand-alone table is a table of attributes that do not have associated geographic features. You can use a join or relate to connect geographic features to a stand-alone table, such as a fire hydrant location with a tabular list of completed inspections." (pro.arcgis.com)

resources

Attribute tables

Tables

pro.arcgis.com

Interact with a table

pro.arcgis.com

Common table and attribute tasks

pro.arcgis.com

Export an attribute table from ArcGIS Pro to Microsoft Excel

support.esri.com

resources

Supporting online tutorials/courses

Join tabular data to a spatial layer

learn.arcgis.com

Creating vector data, editing tools (constraints, snapping, absolute location, fixed angle/distance, move, rotate, scale, split, merge, copy geometry between layers)

resources

Supporting online tutorials/courses

[Editing Basics in ArcGIS Pro](#)

[esri.com](#)

[ArcGIS Pro Editing Essentials](#)

[esri.com](#)

[Copy features between layers](#)

[learn.arcgis.com](#)

[Create a feature class](#)

[pro.arcgis.com](#)

Geoprocessing tools (Buffer, Clip, Union, Intersect, Project), specific use case (finding the best location for a new city bus stop)

"Geoprocessing is a framework and set of tools for processing geographic and related data. The comprehensive suite of geoprocessing tools can be used to perform spatial analysis or manage GIS data in an automated way. Geoprocessing is for everyone that uses ArcGIS Pro. Whether you are a new or advanced user, geoprocessing will likely be an essential part of your day-to-day work.

A typical geoprocessing tool performs an operation on a dataset such as a feature class, raster, or table, and creates a resulting output dataset. For example, the Buffer tool takes features as input, creates buffer areas around the features to a specified distance, and writes those buffer areas to a new output dataset.

In addition to the suite of tools, geoprocessing is also a powerful framework that supports control of the processing environment and allows you to build custom tools that can further automate your work. You can use the geoprocessing tools included in ArcGIS Pro as building blocks to create an infinite number of custom tools that automate repetitive tasks or solve complex problems.

In ArcGIS Pro you can do the following:

- Find the geoprocessing tool that is right for the job by searching or browsing a list of tools.
- Run the geoprocessing tool after specifying parameter settings and other options.
- View the geoprocessing history of your project.
- Create and use custom geoprocessing tools which help you automate your work.
- Use batch geoprocessing to make repetitive tasks easy to complete by running a tool multiple times.
- Save sets of geoprocessing tools that are important to your project.
- Leverage the power of the ArcGIS platform by running analytic tools available through your portal."

(pro.arcgis.com)

resources

Geoprocessing tools

[Geoprocessing quick tour](#)

pro.arcgis.com

[ArcGIS Pro geoprocessing tool reference](#)

pro.arcgis.com

[Anatomy of a tool reference page](#)

pro.arcgis.com

resources

Supporting online tutorials/courses

[Use geoprocessing tools](#)

pro.arcgis.com

[Getting Started with Spatial Analysis](#)

esri.com

[Clip features to a region](#)

learn.arcgis.com

Data resource overview, web data services, geoportals

Some useful vector/raster data resources, web data services, and geoportals are described below.

"*Natural Earth* is a public domain map dataset available at 1:10m, 1:50m, and 1:110 million scales. Featuring tightly integrated vector and raster data, with Natural Earth you can make a variety of visually pleasing, well-crafted maps with cartography or GIS software.

Data themes are available in three levels of detail mentioned above. For each scale, themes are listed on Cultural, Physical, and Raster category pages.

- Large scale data (1:10m) – The most detailed. Suitable for making zoomed-in maps of countries and regions. Show the world on a large wall poster.
- Medium scale data (1:50m) – Suitable for making zoomed-out maps of countries and regions. Show the world on a tabloid size page.
- Small scale data (1:100m) – Suitable for schematic maps of the world on a postcard or as a small locator globe."

(naturalearthdata.com)

"*ArcGIS Living Atlas of the World* is the foremost collection of geographic information from around the globe. It includes maps, apps, and data layers to support your work. There are multiple ways how to use ArcGIS Living Atlas of the World:

- Explore maps, apps, and data layers from Esri and thousands of other organizations.
- Combine content with your own data to create new maps and applications.
- Get inspired. See how others are visualizing data and solving problems."

(livingatlas.arcgis.com)

"*Copernicus* is the European Union's Earth observation programme, looking at our planet and its environment to benefit all European citizens. It offers information services that draw from satellite Earth Observation and in-situ (non-space) data.

Vast amounts of global data from satellites and ground-based, airborne, and seaborne measurement systems provide information to help service providers, public authorities, and other international organisations improve European citizens' quality of life and beyond. The information services provided are free and openly accessible to users.

(copernicus.eu)

resources

Global spatial data

Natural Earth data

naturalearth.com

ArcGIS Living Atlas of the World

livingatlas.arcgis.com

Copernicus

copernicus.eu

resources

Czech spatial data

Prague geographic data

geoportalpraha.cz

Czechia spatial data

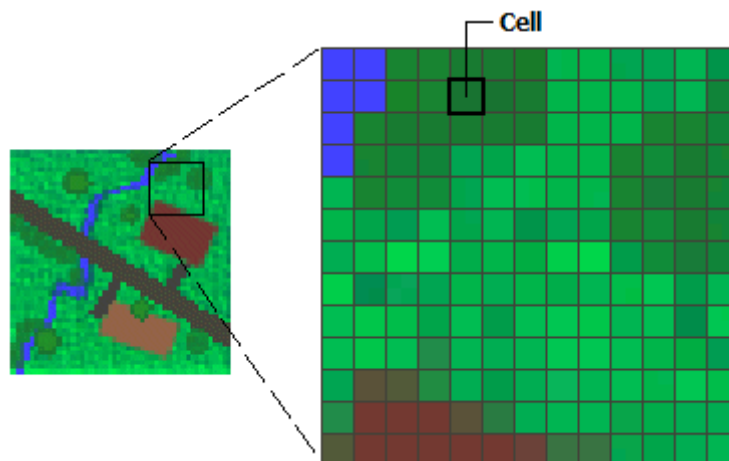
arcdata.cz

Nature conservation agency of the Czech Republic

data.nature.cz

Raster data, raster parameters (extent, px size, px depth, bands, pyramids, spatial reference), basic symbology, terrain representation in GIS

"In its simplest form, a raster consists of a matrix of pixels (or cells) organized into rows and columns (or a grid) in which each pixel contains a value representing information, such as image reflectance or temperature. Rasters are digital images collected by aircraft, drones, satellites, ground and water-based sensors, digital pictures, and scanned maps.



Data stored in a raster format represents real-world phenomena in the following ways:

- Continuous data represents spectral data, such as satellite, aerial, and drone images, and physical and environmental data such as elevation and temperature.
- Thematic data (also known as discrete data) represents features such as land use and soils data.
- Pictures can include scanned maps or drawings and building photographs.

Advantages of storing data as a raster include the following:

- A simple data structure – A matrix of pixels with values having a coordinate location that can be linked to an attribute table
- A format for advanced spatial and statistical analysis
- Represent continuous image data, surfaces, and perform scientific analysis
- Uniformly store points, lines, polygons, and surfaces
- Perform fast overlays with complex datasets"

(pro.arcgis.com)

resources

Raster data

Introduction: [raster & image data](#)

[pro.arcgis.com](#)

[Raster bands](#)

[pro.arcgis.com](#)

[What is a pixel](#)

[pro.arcgis.com](#)

[Pixel size](#)

[pro.arcgis.com](#)

[Raster dataset properties](#)

[pro.arcgis.com](#)

Geoprocessing tools for raster data (Slope, Aspect, Reclassify, Raster Calculator)

"The *Aspect* tool identifies the direction the downhill slope faces. The values of each cell in the output raster indicate the compass direction the surface faces at that location. It is measured clockwise in degrees from 0 (due north) to 360 (again due north), coming full circle. Flat areas having no downslope direction are given a value of -1.

The *Slope* tool identifies the steepness at each cell of a raster surface. The lower the slope value, the flatter the terrain; the higher the slope value, the steeper the terrain. The output slope raster can be calculated in two types of units, degrees or percent (percent rise). The percent rise can be better understood if you consider it as the rise divided by the run, multiplied by 100."

(pro.arcgis.com)

resources

Raster geoprocessing tools

[How Slope works](#)

[pro.arcgis.com](#)

[How Aspect works](#)

[pro.arcgis.com](#)

[Aspect-Slope function](#)

[pro.arcgis.com](#)

[How Raster Calculator works](#)

[pro.arcgis.com](#)

[Understanding reclassification](#)

[pro.arcgis.com](#)

Raster/vector conversion, subsequent conversion GP tools

"*Rasterization* refers to converting vectors into rasters. While *vectorization* transforms rasters into vectors."

(gisgeography.com)

"With the tools in the *From Raster* toolset (Conversion Toolbox), you can convert the information in a raster dataset to a different type of data structure, such as a feature class (point, polyline, or polygon features), or to a different type of file, such as a binary or text file.

There are also tools that allow you to convert different types of feature information into rasters. Feature data comes in several forms: point, line, polygon, and multipatch. To Raster toolset (Conversion Toolbox) contains a tool that can convert point, line, or polygon feature data into a raster, but there are also tools for each specific feature type that provide greater control over the conversion process."

(pro.arcgis.com)

resources

Raster/vector conversion tools

Raster to Point

pro.arcgis.com

Raster to Polyline

pro.arcgis.com

Raster to Polygon

pro.arcgis.com

How Point to Raster works

pro.arcgis.com

How Polyline to Raster works

pro.arcgis.com

How Polygon to Raster works

pro.arcgis.com

ArcGIS Online, sharing data from ArcGIS Pro

"ArcGIS Online is a cloud-based mapping and analysis solution. Use it to make maps, analyze data, and to share and collaborate. Get access to workflow-specific apps, maps and data from around the globe, and tools for being mobile in the field. Your data and maps are stored in a secure and private infrastructure and can be configured to meet your mapping and IT requirements.

Work with smart, data-driven styles to explore and visualize 2D and 3D data. Share your maps with anyone, anywhere or keep them private. Work collaboratively with your colleagues to build maps, scenes, apps and notebooks. Access intuitive analysis tools that help you better understand data."

(doc.arcgis.com)

resources

What you can do with ArcGIS Online

What is ArcGIS Online

pro.arcgis.com

Create web maps

pro.arcgis.com

Get started with creating
3D web scenes

pro.arcgis.com

Create apps from maps

pro.arcgis.com

Perform analysis

pro.arcgis.com

Publish hosted layers

pro.arcgis.com

Share items

pro.arcgis.com



**FACULTY OF CIVIL
ENGINEERING
CTU IN PRAGUE**

Feel free to contact

prof. Ing. Jiří Cajthaml, Ph.D.



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esri.com
GIS software developer