Chapter 3
Geoprocessing in ArcGIS Pro

3.1 Introduction

This chapter introduces the geoprocessing framework in ArcGIS Pro, including the use of tools, models, and scripts. Understanding the geoprocessing framework is helpful in writing effective Python scripts. Python and ModelBuilder are often used in tandem, so a good knowledge of ModelBuilder is recommended to get the most out of Python scripting.

3.2 What is geoprocessing?

Geoprocessing in ArcGIS Pro allows you to perform spatial analysis and modeling as well as automate GIS tasks. A typical *geoprocessing tool* takes input data (a feature class, raster, or table), performs a geoprocessing task, and produces output data as a result. ArcGIS Pro contains more than a thousand geoprocessing tools. Examples of geoprocessing tools include tools for creating a buffer, adding a field to a table, and geocoding a table of addresses.

Geoprocessing supports the automation of workflows by creating a sequence that combines a series of tools. The output of one tool effectively becomes the input for the next tool. Creating these automated workflows by combining geoprocessing tools can be accomplished in ArcGIS Pro using models and scripts.

The *geoprocessing framework* in ArcGIS Pro consists of a set of windows and dialog boxes to organize and execute tools. This framework makes it easy to create, execute, manage, document,

and share geoprocessing workflows. Geoprocessing includes a set of tools that operate on data. The basic geoprocessing framework comprises the following:

- A collection of tools, organized in toolboxes and toolsets
- Methods to find and execute tools
- Environment settings and other geoprocessing options that control how tools are run
- Tool dialog boxes for specifying tool parameters and controlling the execution of tools
- ModelBuilder, a visual programming language for creating models that allow for the sequencing of tools
- Python window for executing tools using Python
- Geoprocessing history that logs the tools being executed
- Methods for creating Python scripts and using them as tools

The sections that follow describe these components in more detail. A few characteristics of this geoprocessing framework make it possible to work with tools in a consistent yet flexible manner. These characteristics include the following:

- All tools can be accessed from their toolbox, which makes for a consistent procedure for accessing tools, models, and scripts.
- All tools are documented in a similar manner, which allows for consistent cataloging and searching.
- All tools have a similar user interface (the tool dialog box) for specifying the tool parameters.

3.3 Using toolboxes and tools

Geoprocessing tools perform operations on datasets. Exactly which tools you have available depends in part on which license level you have: Basic, Standard, or Advanced. Almost all the typical tools, however, are part of the Basic license. Availability of tools also depends on whether you have a license for extensions, such as ArcGIS® 3D Analyst™, ArcGIS Network Analyst™, and ArcGIS Spatial Analyst™. The organization of the tools, however, remains the same, regardless of the license level or extensions.

Geoprocessing tools are typically accessed using the Geoprocessing pane. To open this pane from within ArcGIS Pro, click on the Analysis tab, and click Tools.
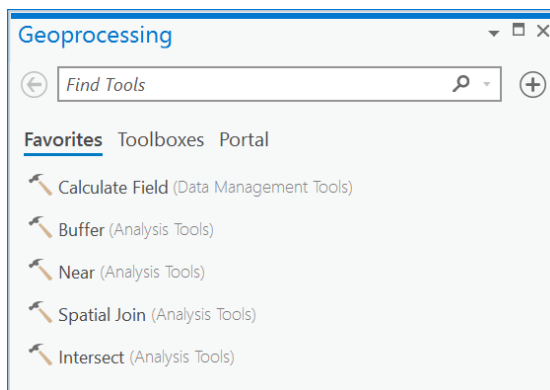
Locating tools using this Geoprocessing pane is accomplished in a variety of ways:

- You can search for tools by name.
- Tools can be added to a list of favorites—a default list with commonly used tools is already present.
- Tools that have recently been run will show up below the favorites.
- You can navigate to Toolboxes to locate specific tools.
- Tools available through Portal for ArcGIS are listed separately.

Geoprocessing tools are organized into *toolboxes*—for example, Analysis Tools, Cartography Tools, and Geocoding Tools, among others.
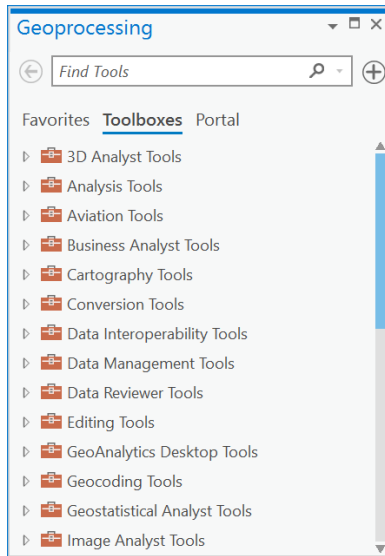

Each toolbox typically contains one or more *toolsets*, and each toolset contains one or more tools.
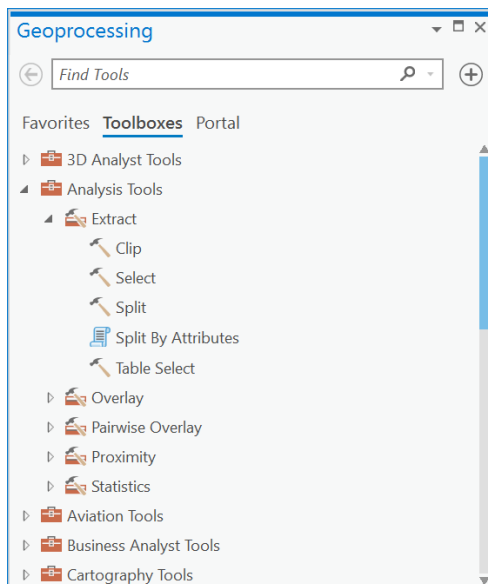
Considering the number of tools available, browsing can be cumbersome if you don't know where to look.

There are several ways to find the tools you need. First, some of the most commonly used tools can be accessed directly from the Analysis tab in ArcGIS Pro. However, only a handful of tools are listed under the Analysis Gallery.
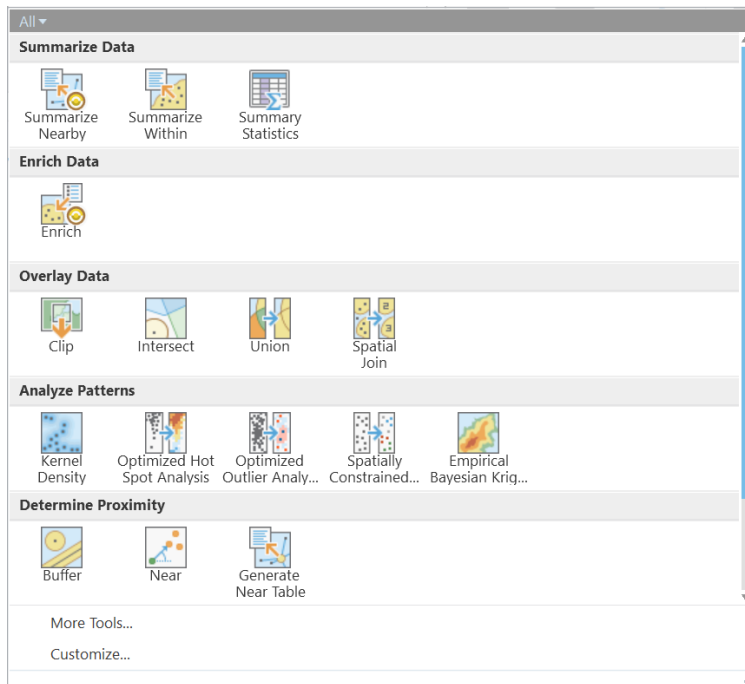
Although the number of tools here is limited, you can customize the Analysis gallery to show the tools you use frequently.

Second, you can search for tools. The Geoprocessing pane includes a search bar at the top. Enter a search term here to see the available tools. The search returns tools with the exact name of the tool, as well as other tools in which the term appears in the description or which provide similar functionality.
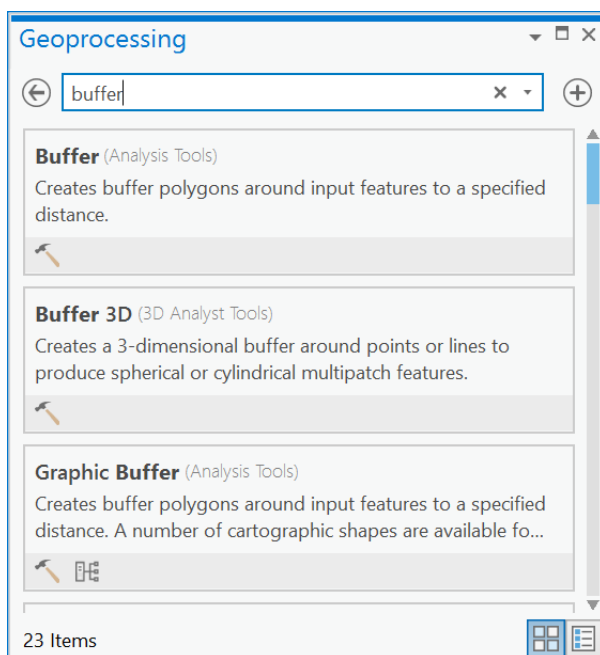
A search for the term "buffer" returns the tools Buffer, Buffer 3D, Graphic Buffer, and so on as well as tools such as Select Layer By Location, which includes a distance option. You can also enter more conceptual terms that describe the nature of the analysis instead of the actual tool name. For example, terms such as "proximity," "overlay," "summary," or "regression" will suggest tools that may be of interest within those general types of analysis.

Scroll through the search results and double-click on the tool of interest to bring up the tool dialog box.

3.4 Types and categories of tools

There are several types of tools in ArcGIS Pro, and each is designated by a different symbol.

Built-in tools: These tools are built using ArcObjects and a compiled programming language such as C++. Esri creates these tools when authoring its software, and most of the tools in Arc-GIS Pro are built-in tools.

 Clip

Script tools: These tools consist of Python scripts that are accessible using a tool dialog box. When a tool is executed, a script is run to carry out the geoprocessing operations.
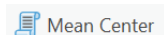
 Mean Center

Model tools: These tools are created using ModelBuilder.

 MyModel

Although these types of tools are created using different methods, the tool dialog boxes for all tools look the same, which is one of the strengths of the geoprocessing framework in ArcGIS Pro. There are also two categories of tools:

- *System tools*: These tools are created by Esri and installed as part of the regular ArcGIS Pro software. Exactly which system tools are available depends on the product license level and number of extensions. Most system tools are built-in tools, but several script tools are also authored by Esri.
- *Custom tools*: These tools commonly consist of script and model tools. Custom tools can be created by a user, but also can be obtained from a third party and added to ArcGIS Pro.

When using geoprocessing tools, you may not notice which tools are system tools and which are custom tools because they are designed to work the same way. Once a custom tool is created, it can be added to a geoprocessing workflow the same way as any of the system tools.

3.5 Running tools using tool dialog boxes

When you find a tool, you can open it by clicking it, which brings up the tool dialog box. Each tool has parameters that must be specified before the tool can be run. A *tool parameter* is a text string, number, or other input. The *tool dialog box* provides an easy-to-use interface for specifying these parameters. The tool dialog box allows browsing for and choosing datasets, choosing options from a list, and entering values.

Most tools require one or more input datasets. Other common parameters are preset text strings called *keywords*. Although each tool has one or more parameters, not all parameters are required. Optional parameters have default values that are set by the tool. You can accept the default value simply by not changing the parameter or not specifying a value. Default values for keywords are typically shown in the tool dialog box when it is first opened.

An example of the tool dialog box for the Clip tool is shown in the figure.
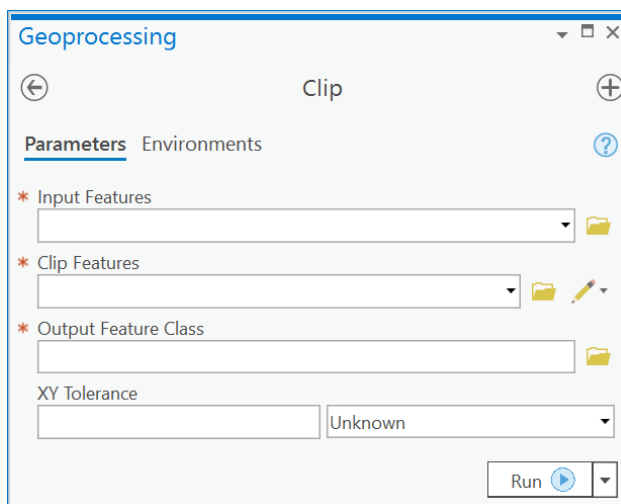
You can get help with a tool in a few different ways. Hovering your cursor over the blue question mark in the upper right causes a pop-up window to appear that shows a quick summary of the tool. If you are not familiar with the tool, this description is useful for ensuring you have the correct tool.
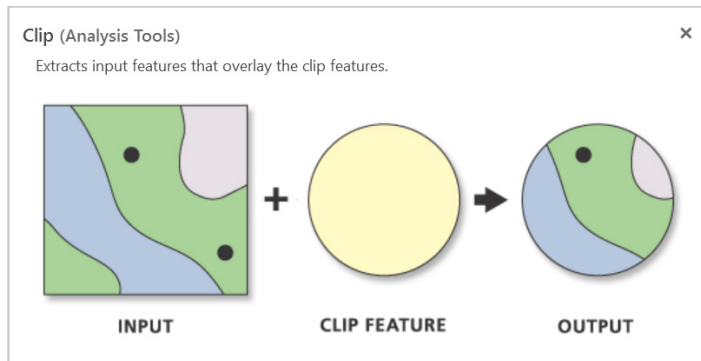
Clicking on the blue question mark symbol brings up the online help page for the tool using your default browser. The help provides a more complete description of the tool, including a detailed description of the tool parameters.

You will view help pages in more detail in later chapters for examples of how to use a tool in a Python script.

From within the tool dialog box, you also can get help on each parameter by pausing your cursor over the blue info symbol that appears to the left of the parameter name.
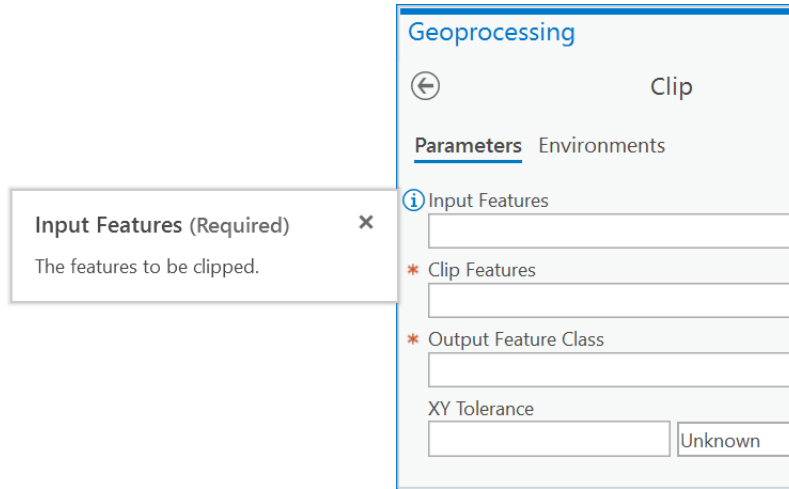
The tool dialog box contains the parameters that must be specified for the tool to run. Notice that there is a total of four parameters in the case of the Clip tool. Three of them are flagged by a small red asterisk symbol, which indicates the parameter is required and needs a value. The XY Tolerance parameter is optional, as indicated by the absence of an asterisk symbol. You do not need to specify a value for this parameter for the tool to run. A default value will be used.

The tool dialog box has several mechanisms for ensuring proper inputs. For example, instead of typing a path and file name, you can click the drop-down arrow to choose from a list of feature layers in the current map. The drop-down arrow appears only when there are acceptable feature layers in your map to choose from.