06. Workflow Automation via ArcGIS ModelBuilder

GE3238 GIS Design and Practices
Geography@NUS
Chen-Chieh FENG

1

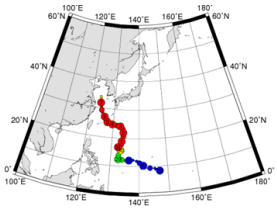
Which part of GIS design & practices?

- Data model with one example
  - network dataset
- From local data to data online
  - Web services versus geodatabase
- Automation via visual development tool
  - ModelBuilder within Esri's products e.g. ArcGIS Pro

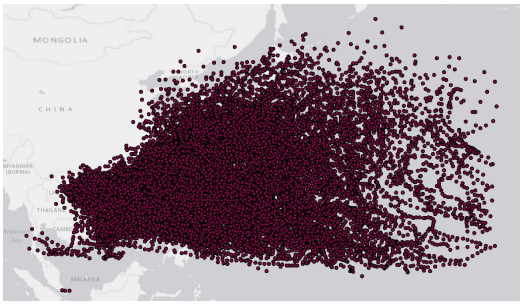
2

An Example of Automation

- The study of hurricane tracks
  - One third of the tropical cyclones globally originate in the western North Pacific
  - Large and growing coastal population
- One way to understand typhoon better is to study the parameters of typhoon behavior
  - Distribution
  - Frequency
  - Intensity
  - Features of typhoon tracks



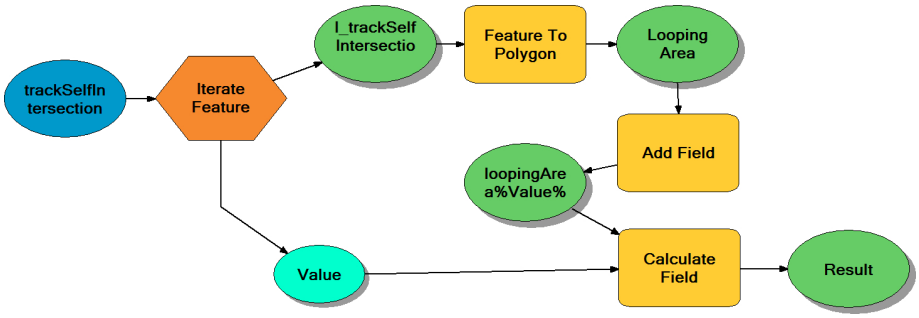
Source: KITAMOTO Asanobu / National Institute of Informatics



3

(Data Processing) Workflow

An example



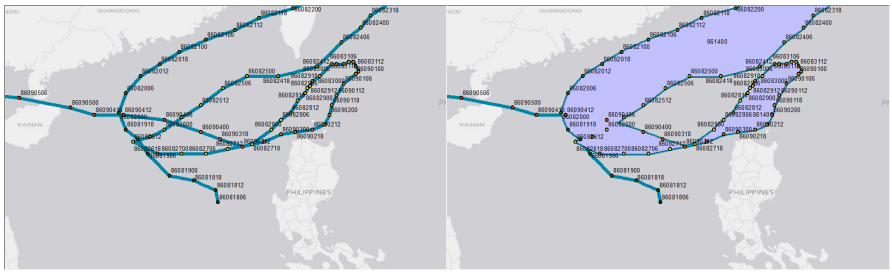
1. For each looping track, **construct** the corresponding polygon covering the whole of the looping area.
2. **Add** a new field into the polygon feature class.
3. **Calculate** for each looping area its size.

Key terms

Workflow

4

(Data Processing) Workflow (cont.)

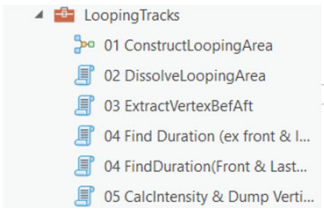


INPUT TRACK (one sample)

OUTPUT LOOPING AREA

Repeat for 1500+ tracks!

But you still do not feel like writing a script (in Python)



5

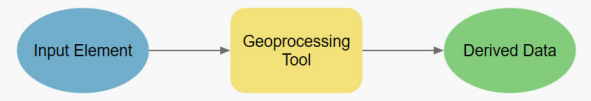
Customization

- To simplify how we interact with ArcGIS or to streamline the workflow
  - For yourself (e.g. grouping frequently used tools)
  - For specialized applications (e.g. simplified interface for data entry operators)
- Prevent users of the data or system from making unnecessary mistakes
  - Repeat the process consistently
- Developing Additional Capabilities
  - Automation of repetitive tasks and to string together tools for exploratory analysis
  - new analytical procedures

6

Goals of the Lecture

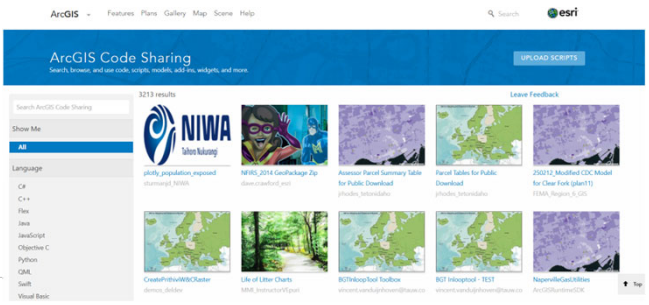
- Workflow and customization
  - Overview of the approaches
- Tool for customization: ModelBuilder
  - What is it?
  - Capability?
  - Integration to be part of the geoprocessing tools



7

Customization of Geoprocessing Tools

- To access capabilities not on the standard interface
  - Downloaded from the web [ArcGIS Code Sharing]
  - Developed by you
    - ModelBuilder
    - Script via ArcPy

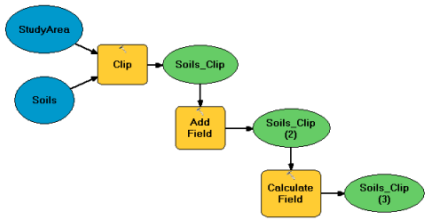


http://codesharing.arcgis.com/ (last accessed 19 Feb 2025)

8

Developing Additional Capabilities

- **ModelBuilder**
  - Multi-step, sequential processing of geoprocessing tools, using a visual development environment which comes as part of ArcGIS
- **ArcPy**
  - Based on Python
  - Provides access for all geoprocessing tools as well as a wide variety of useful functions and classes for working with GIS data




```
>>> import arcpy
>>> arcpy.AddField_management("c:/data/Portland.gdb/streets"
>>> arcpy.CalculateField_management("c:/data/Portland.gdb/st
>>> arcpy.FeatureClassToFeatureClass_conversion("c:/data/Por
```

9

Conclusion: Which One is Right for You?

The choice between ModelBuilder and Python scripting largely depends on your comfort level with coding and the complexity of your geoprocessing tasks. For simpler, more visual tasks, ModelBuilder might be the way to go. However, if you're looking for more control, flexibility, and efficiency, especially for complex operations, Python scripting could be your best bet.

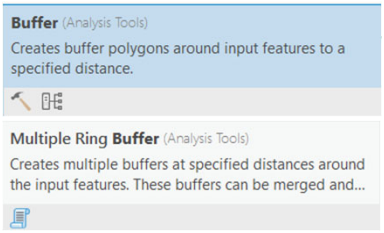
Remember, the best tool is the one that helps you achieve your goals most effectively. Whether you choose ModelBuilder, Python scripting, or a combination of both, ArcGIS Pro offers the tools you need to excel in the world of geospatial analysis.

https://mapscaping.com/comparing-arcpro-modelbuilder-and-python/ (last accessed 29 Feb 2025)

10

Geoprocessing tool types

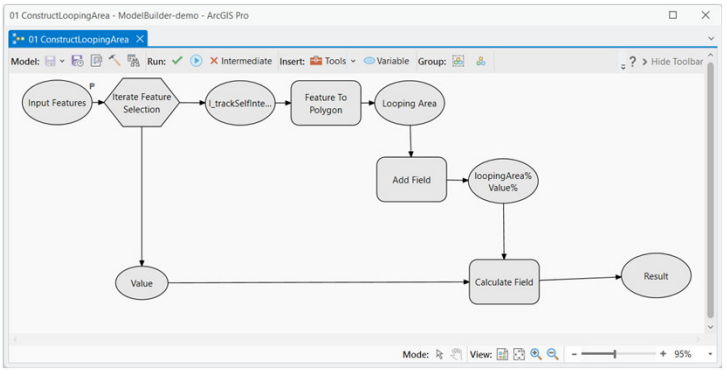
Tool type	Description
	Built-in tool. These tools are built using ArcObjects and a compiled programming language like .NET.
	Model tool. These tools are created using ModelBuilder.
	Script tool. These tools are created using the Script tool wizard and run a script file on disk, such as a Python file (`.py`), AML file (`.aml`), or executable (`.exe` or `.bat`).
	Specialized tool. These tools are rare—they are built by system developers and have their own unique user interface for using the tool. The ArcGIS Data Interoperability extension contains specialized tools.



11

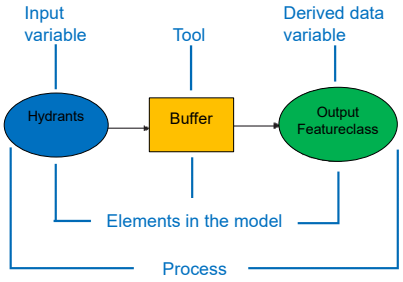
ModelBuilder and Its User Interface

- ModelBuilder helps us create, edit, document and distribute models
- After you create a model, it can be exported as a script (to Python, for example)
- More control over logical branching and looping



12

- Project elements (blue ovals) exist prior to model
- Tool to be executed (yellow rectangle)
- Derived data (green ovals) produced by tool
- Connector (arrow) showing sequence of processing
- Value (light blue oval)
- Derived value (light green oval)



Key terms

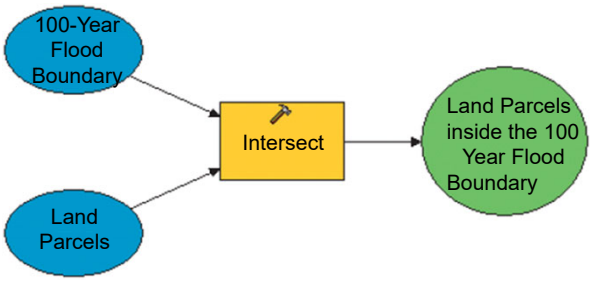
Input data
Derived (output) data
Connector
Value

13

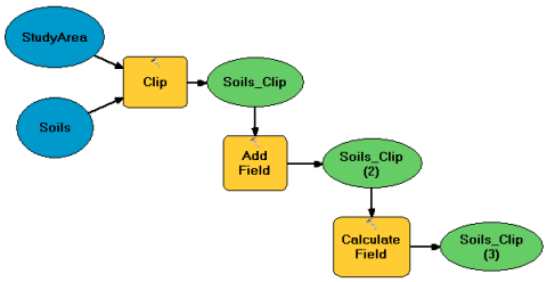
Single & Multiple Input Model

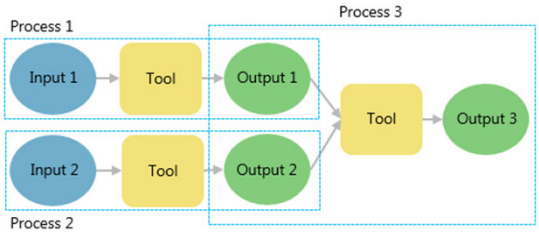
- Area Within 100 meters of Streams?

- Parcels within a flood zone



Two and More Tools

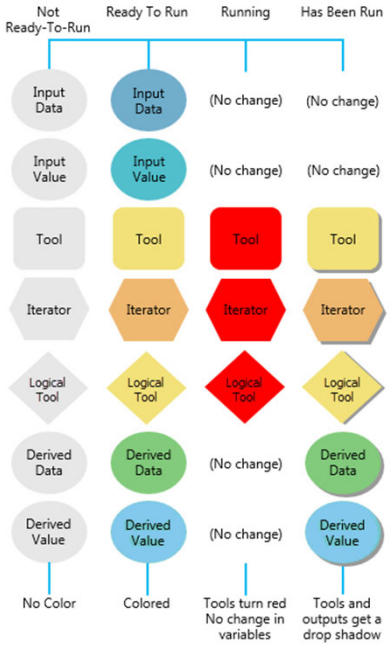




15

Process States

Process State	Description
Not ready-to-run	When you initially drag a tool into a ModelBuilder window, the process is in a not-ready-to-run state (the tool is white) because the required parameter values have not been specified. The not-ready-to-run state means that the model cannot be run within ModelBuilder. If your empty data or value variables are exposed as model parameters, you can run the model by opening the model tool dialog box from the ***Catalog*** window or ***ArcToolbox*** window and specifying the model parameter values.
Ready-to-run	A process is ready-to-run when all required parameter values have been specified. Processes that are ready-to-run are symbolized in color; input data elements are blue, tool elements are yellow or orange, and output data (derived data) elements are green.
Running	The process is currently running. Tools that are running are red. Learn more about running a model within ModelBuilder.
Has-been-run	If the model is run within ModelBuilder, the tool and output or derived data elements are displayed with drop shadows, indicating that the process has run.



Key terms

Process state
Ready-to-run
Running
Has-been-run

16

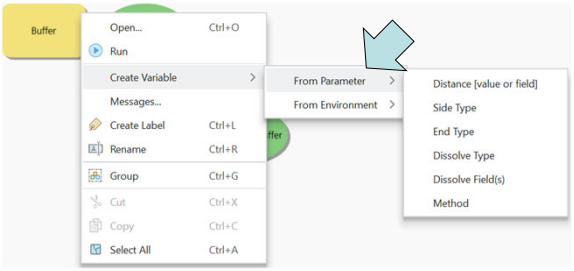
16

Parameters in ModelBuilder

- In ModelBuilder, our tools often need *required* or *optional* values to run. These are parameters.
  - For example, the Buffer tool needs a buffer radius in order to run
- We can "expose a parameter" to allow user input

Key terms

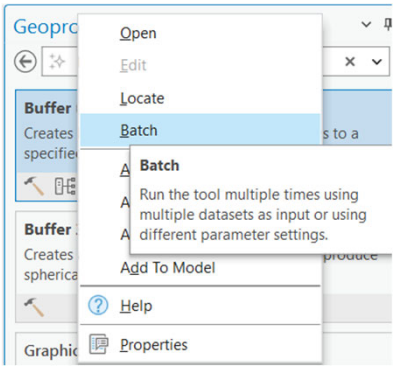
Parameter
Make variable

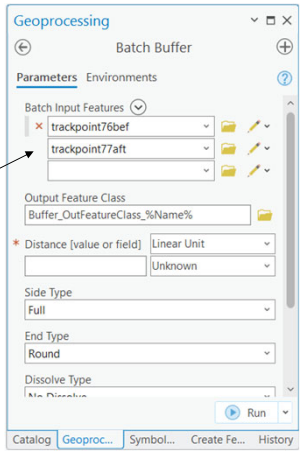


17

Iterations (loops…)

- To repeat a process over and over with some degree of automation
  - First consider using the "batch" option





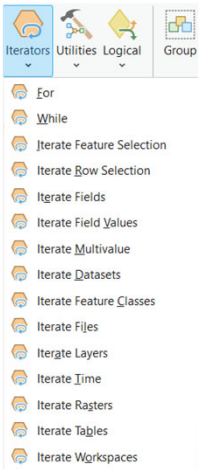
Key terms

Iteration
Batch mode

18

Iterator

- A tool to help repeat a process or set of processes on a set of inputs
- Granularity of the iterator
  - Entire model or a single tool
  - Individual elements in the data or dataset
    1. (Selected) features or rows
    2. Values in a field
    3. A list of values
    4. Elements in a workspace or feature dataset
    5. Files or workspaces in a folder



Key terms

Iterator

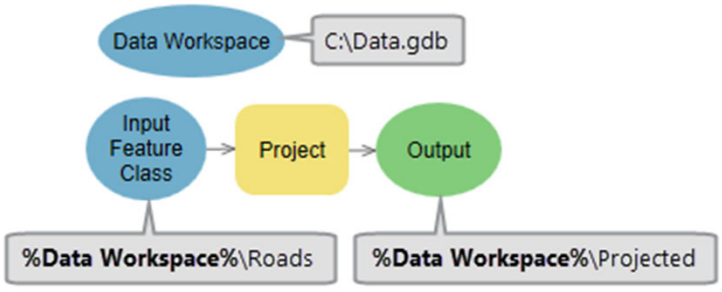
Granularity of iterator

19

19

Iteration of i, or e.g. for i = 1-10 …

- Model variable substitute
  - Value is substituted by
    - C:\Data.gdb
  - Variable
    - %Data Workspace%



https://pro.arcgis.com/en/pro-app/latest/help/analysis/geoprocessing/modelbuilder/inline-variable-substitution.htm

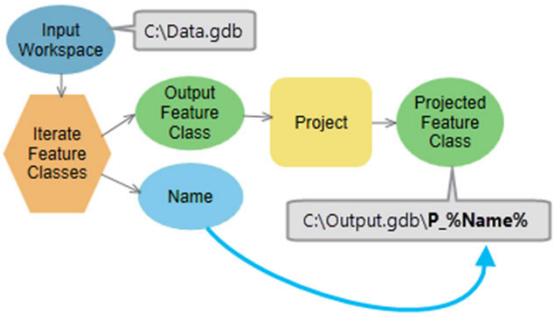
20

20

By extension

- What about iteration of all feature classes in a geodatabase or a feature dataset?

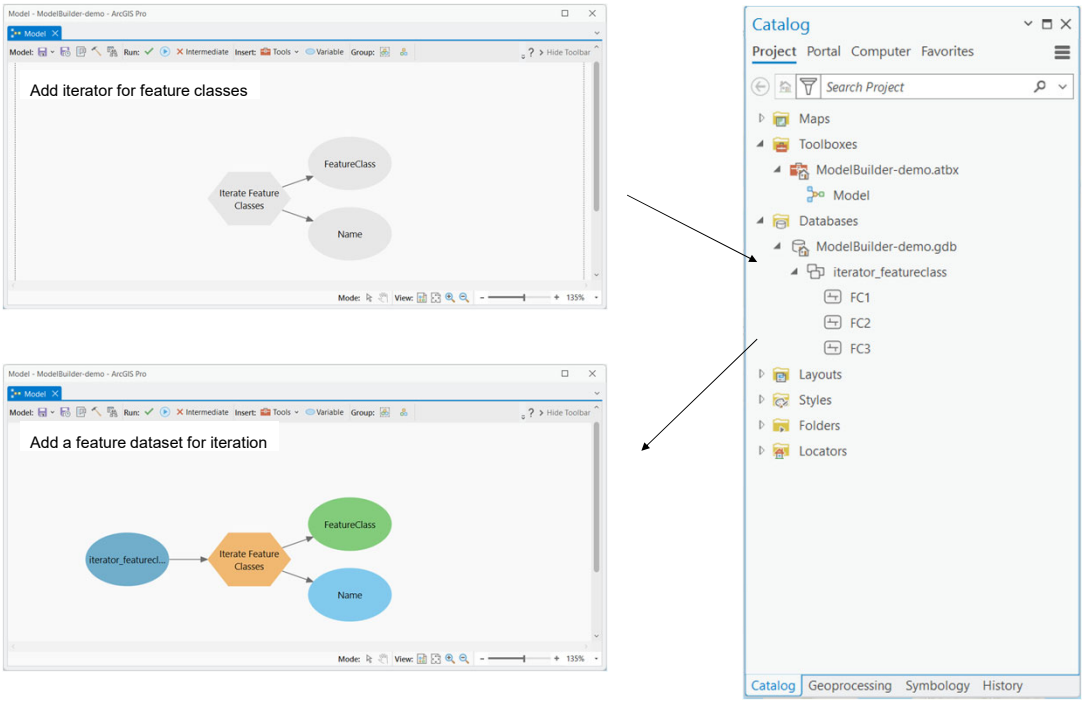
Key terms



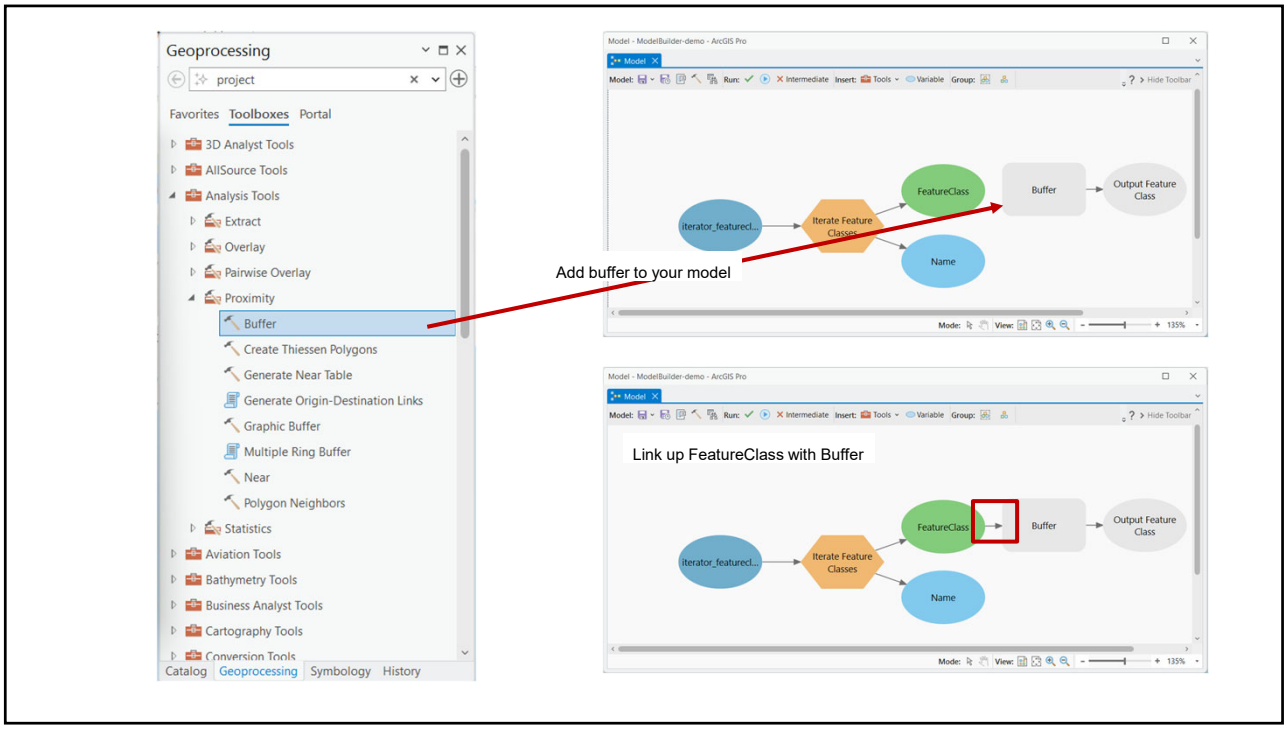
https://pro.arcgis.com/en/pro-app/latest/help/analysis/geoprocessing/modelbuilder/inline-variable-substitution.htm

21

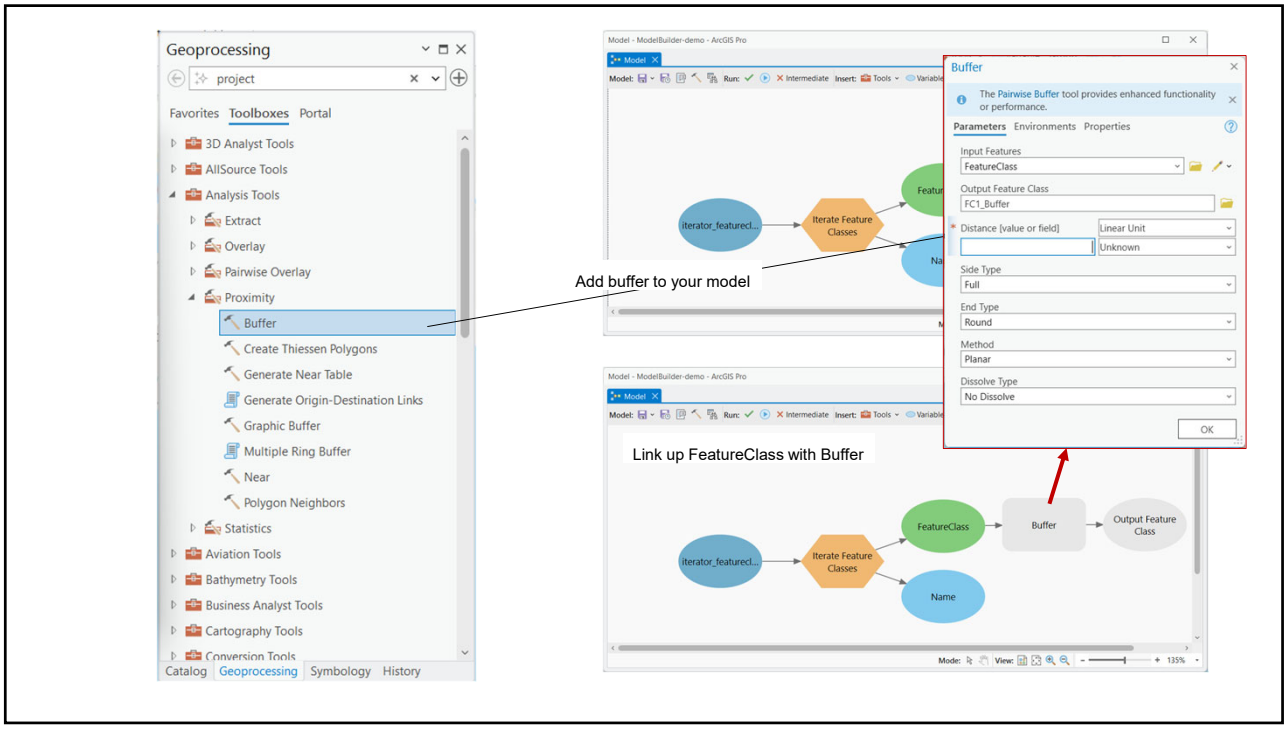
21



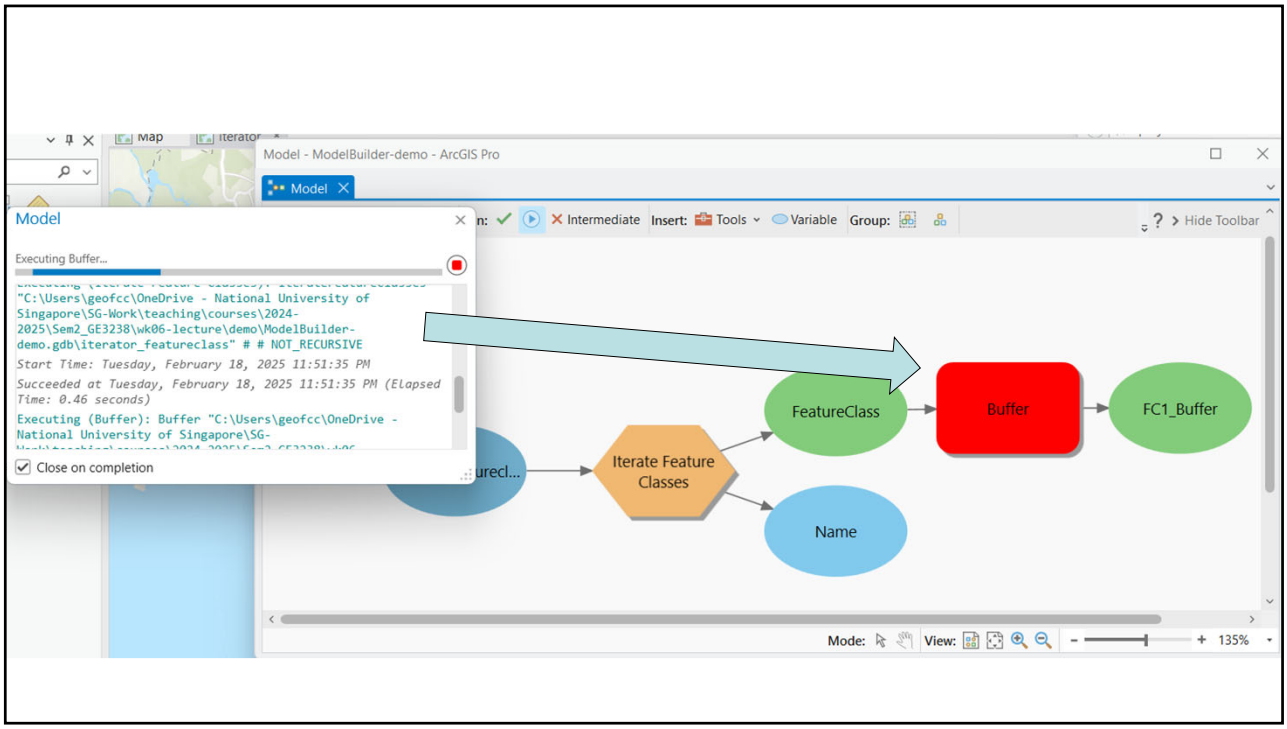
22


Geoprocessing
project
Favorites
Toolboxes
Portal
3D Analyst Tools
AllSource Tools
Analysis Tools
Extract
Overlay
Pairwise Overlay
Proximity
Buffer
Create Thiessen Polygons
Generate Near Table
Generate Origin-Destination Links
Graphic Buffer
Multiple Ring Buffer
Near
Polygon Neighbors
Statistics
Aviation Tools
Bathymetry Tools
Business Analyst Tools
Cartography Tools
Conversion Tools
Catalog
Geoprocessing
Symbology
History
Add buffer to your model
iterator_featurecl...
Iterate Feature Classes
FeatureClass
Name
Buffer
Output Feature Class
Link up FeatureClass with Buffer

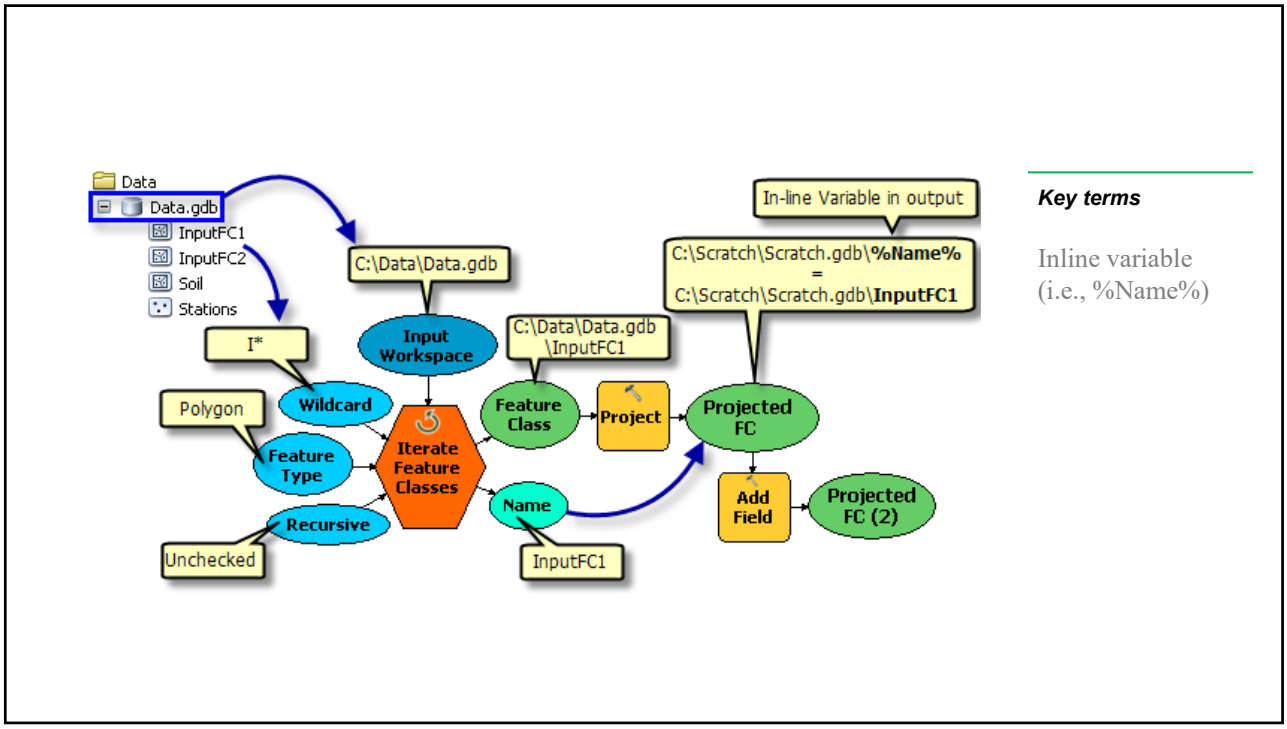
23


Geoprocessing
project
Favorites
Toolboxes
Portal
3D Analyst Tools
AllSource Tools
Analysis Tools
Extract
Overlay
Pairwise Overlay
Proximity
Buffer
Create Thiessen Polygons
Generate Near Table
Generate Origin-Destination Links
Graphic Buffer
Multiple Ring Buffer
Near
Polygon Neighbors
Statistics
Aviation Tools
Bathymetry Tools
Business Analyst Tools
Cartography Tools
Conversion Tools
Catalog
Geoprocessing
Symbology
History
Add buffer to your model
Buffer
The Pairwise Buffer tool provides enhanced functionality or performance.
Parameters
Environments
Properties
Input Features
FeatureClass
Output Feature Class
FC1_Buffer
Distance [value or field]
Linear Unit
Unknown
Side Type
Full
End Type
Round
Method
Planar
Dissolve Type
No Dissolve
OK
iterator_featurecl...
Iterate Feature Classes
FeatureClass
Name
Buffer
Output Feature Class
Link up FeatureClass with Buffer

24



25



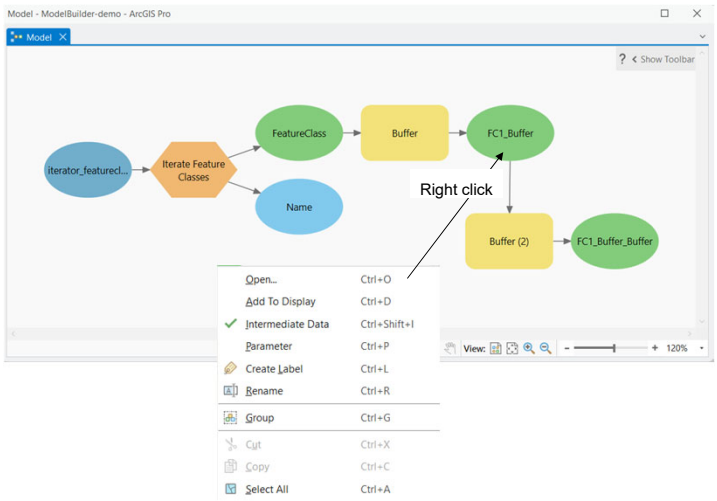
Key terms

Inline variable (i.e., %Name%)

26

Derived and Intermediate Data

- Data that is output from a process is called derived data
- If output data from a process is not a final result, it is intermediate data
  - When you right-click on an intermediate output, you will see if it has "Intermediate" checked.



27

Model Validation

- "Validate the Entire Model" button: It checks that all of your model parameters are correct and that your input data can be found
- Models that need repair (for example, if an input data set was moved from its initial location) will show up in the toolbox with a red **X** through them
- You also need to validate your model if all processes in the model have been run and you want to run them again

Key terms

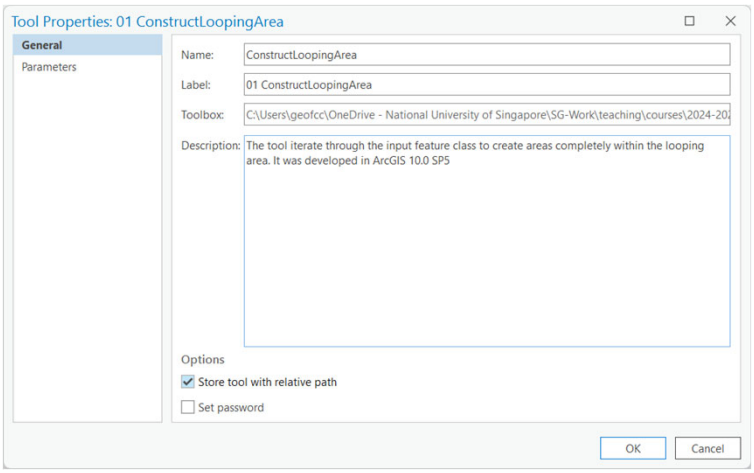
Model validation
Completeness

28

28

Distributing Your Model

- To distribute your model, you will need to set model properties, including
  - Model name, description, etc
  - Relative paths to the toolbox location (pathnames maintained *relative* to the toolbox)
  - Preview model parameters and environment



29

Summary

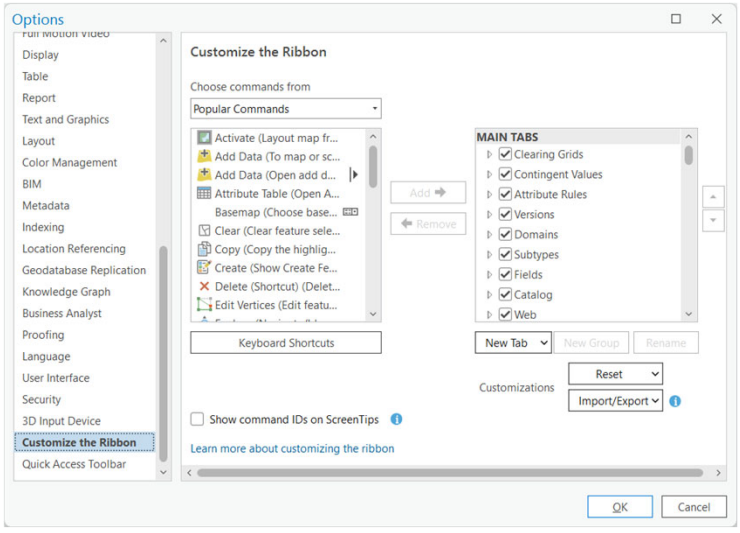
- Why customization?
  - Generic tool to be used for specific applications
  - Streamline the workflow (aggregation of tools in specific sequence) and reduce the chance of error
  - Support exploratory data analysis
  - Add new geoprocessing tools
- Tool for customization -- ModelBuilder
  - A graphic-based tool integrated with ArcGIS
  - Iterator support

30

Supplement Slides

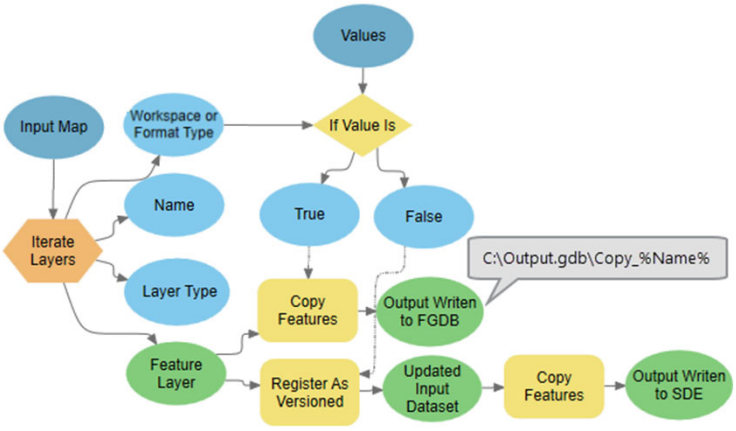
31

Customize Ribbon



32

Iterate Layers



- https://pro.arcgis.com/en/pro-app/latest/tool-reference/modelbuilder-toolbox/iterate-layers.htm

33