**GIS Programming Class Notes (2/11/25)**

**1. Lecture Notes & Discussion**

**1.1 PB&J Assignment & Programming Logic**

* The class began with a discussion about **programming logic and explicit instructions**, using a **PB&J sandwich-making example**.
* Key takeaways:
  + **Computers only do what they are told**. If a step is unclear, the program won’t function as expected.
  + The example illustrated how detailed a program must be to execute even simple tasks.
  + **Automated vehicles & decision-making**: How do they decide whether to hit a person or a building? **Programmers make these decisions** when writing AI algorithms.

**1.2 Geoprocessing in ArcGIS Pro Overview**

* **Geoprocessing allows for spatial analysis, modeling, and automation.**
* ArcGIS Pro provides **over 1,000 geoprocessing tools**, organized in **toolboxes** and **toolsets**.
* Python scripting and ModelBuilder are **often used together** for automation.
* **Layer order matters**: If layers are incorrectly ordered, **important features may be hidden**.

**1.3 Geoprocessing History, Errors, and Warnings**

* ArcGIS Pro **logs all executed tools** in the **History Pane**, allowing for:
  + Reviewing tool **parameters**.
  + **Re-executing tools** with the same settings.
  + Checking **errors and warnings**.
* **Error Types**:
  + **Red X** = Critical error; tool cannot run.
  + **Yellow Triangle** = Warning; tool can run but might not give desired results.
  + **Best Practice**: Run the **Analyze** function before execution to check for issues.

**1.4 ModelBuilder vs. Python Scripting**

* **ModelBuilder**:
  + **Visual programming tool** for automating workflows.
  + Uses **tools, variables, and connectors** to create a process flow.
  + **Easier to use**, but **limited for complex tasks**.
* **Python Scripting**:
  + **More powerful and flexible**.
  + Allows for **loops, conditionals, and error handling**.
  + Can be run **inside or outside ArcGIS Pro**.
  + **ModelBuilder workflows can be exported as Python scripts** for further customization.

**2. Chapter 3: Geoprocessing in ArcGIS Pro**

**2.1 What is Geoprocessing?**

* Geoprocessing takes **input data**, applies a **tool**, and produces **output data**.
* Supports **workflow automation** by linking tools together.
* Examples:
  + **Buffer Tool** (creates a zone around a feature).
  + **Clip Tool** (extracts data inside a boundary).
  + **Geocoding** (converts addresses into points).

**2.2 Using Toolboxes & Tools**

* Tools are **stored in toolboxes and toolsets**.
* Access methods:
  + **Geoprocessing Pane** (search bar, recent tools, favorites).
  + **Toolbox Explorer** (categorized tools).
  + **Analysis Tab** (quick access to commonly used tools).

**2.3 Types of Tools**

1. **Built-in Tools**: Pre-programmed in C++.
2. **Script Tools**: Created using Python.
3. **Model Tools**: Created using ModelBuilder.
4. **System Tools**: Provided by Esri.
5. **Custom Tools**: Created by users or third parties.

**2.4 Running Tools & Troubleshooting**

* Each tool has a **dialog box** with **parameters** (inputs/outputs).
* The **History Pane** logs tool execution for troubleshooting and re-use.
* **Error & Warning Messages**:
  + **Error (Red X)** = Tool will not run.
  + **Warning (Yellow Triangle)** = Tool will run, but may cause unexpected results.

**2.5 Environment Settings in ArcGIS Pro**

* **Environment settings** define tool behavior and workspace locations.
* **Key Environment Settings**:
  + **Current Workspace**: Default input/output location.
  + **Output Coordinate System**: Defines spatial reference.
  + **Scratch Workspace**: Stores temporary data.
* **Environment Hierarchy** (settings can be overridden at different levels):
  1. **Application-wide settings**.
  2. **Tool-specific settings**.
  3. **Model-specific settings**.
  4. **Script-based settings (highest priority override).**

**2.6 Batch Processing & Dynamic Naming**

* **Batch Processing** automates repetitive tasks.
* **Dynamic Naming** uses %Name% to auto-generate filenames (e.g., parks\_clip, rivers\_clip).

**2.7 Using ModelBuilder**

* **ModelBuilder Steps**:
  1. **Create a model** (Analysis Tab → ModelBuilder).
  2. **Add tools & data**.
  3. **Set parameters & connections**.
  4. **Run the model**.
  5. **Review results**.
* **Advantages**:
  1. Easier for **non-programmers**.
  2. **Flowchart-based**.
  3. Can be **exported to Python**.

**2.8 Python Scripting & Automation**

* **Why use Python?**
  + More **customization & flexibility**.
  + Can **run outside ArcGIS Pro**.
  + Handles **complex logic (loops, conditionals, error handling).**
* **Running Python Scripts**:
  + **Python Window** (within ArcGIS Pro).
  + **Standalone Scripts** (.py files in PyCharm/IDLE).
  + **Script Tools** (packaged Python scripts within ArcGIS Pro).

**2.9 Scheduling Python Scripts**

* **Windows Task Scheduler** can run scripts at specific times.
* **Challenges**:
  + Computer must be **on & logged in**.
  + Requires **admin privileges**.
  + System settings **can interfere**.

**3. Key Takeaways**

✅ **Geoprocessing automates spatial analysis & modeling**.

✅ **ArcGIS Pro contains built-in, script, and model tools**.

✅ **Environments control geoprocessing behavior**.

✅ **Batch processing automates repetitive tasks**.

✅ **ModelBuilder simplifies workflows but has limitations**.

✅ **Python scripting enables advanced automation**.

✅ **Scripts can be scheduled to run automatically**.

**4. Review Questions**

1. **What are the three types of tools in ArcGIS Pro?**
2. **Explain the difference between system tools and custom tools.**
3. **What are some commonly used environment settings?**
4. **What are the strengths and limitations of batch processing?**
5. **What is dynamic naming, and how is it used in batch processing?**
6. **Compare ModelBuilder tools and script tools.**
7. **Why develop a script instead of a model?**
8. **What are the typical ways to run Python in ArcGIS Pro?**

**Next Class Preparation**

* Work on **Exercise 3**.
* No class on **Feb 20 & 21** due to professional development.
* **Week 5 materials are available but not required to start early**.

Would you like me to add any additional clarifications or formatting changes?