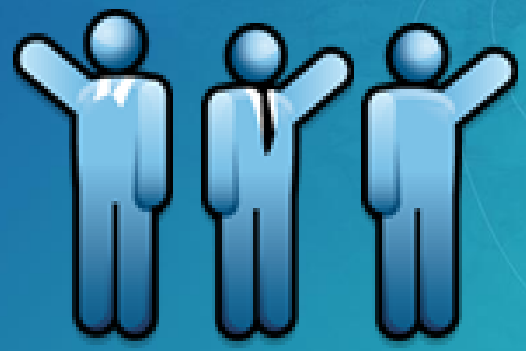
Getting Started with Map Algebra

Using the Raster Calculator and Python

Nawajish Noman

Poll the Audience

- How many of you use Spatial Analyst?
- How many of you are using Map Algebra prior to 10.x?
- How many of you know any Python?
- How many of you are writing stand alone Python scripts and/or script tools?



Overview

- What is Map Algebra?
- Raster Calculator tool - Benefits of Map Algebra
- Python Window - Raster Object, properties and save
- Operators - What can ‘+’ do?
- Complex equations - non SA, Boolean operators

What is Map Algebra?

- Map Algebra is a language of arithmetic expressions using relations (operators and functions) and variables that represent spatial data and values.

- Is this a Map Algebra expression?

  Out = A ** 2 / A_max ** 2

  A: Yes if A or A_max is a spatial dataset then result, Out, will be a spatial result.

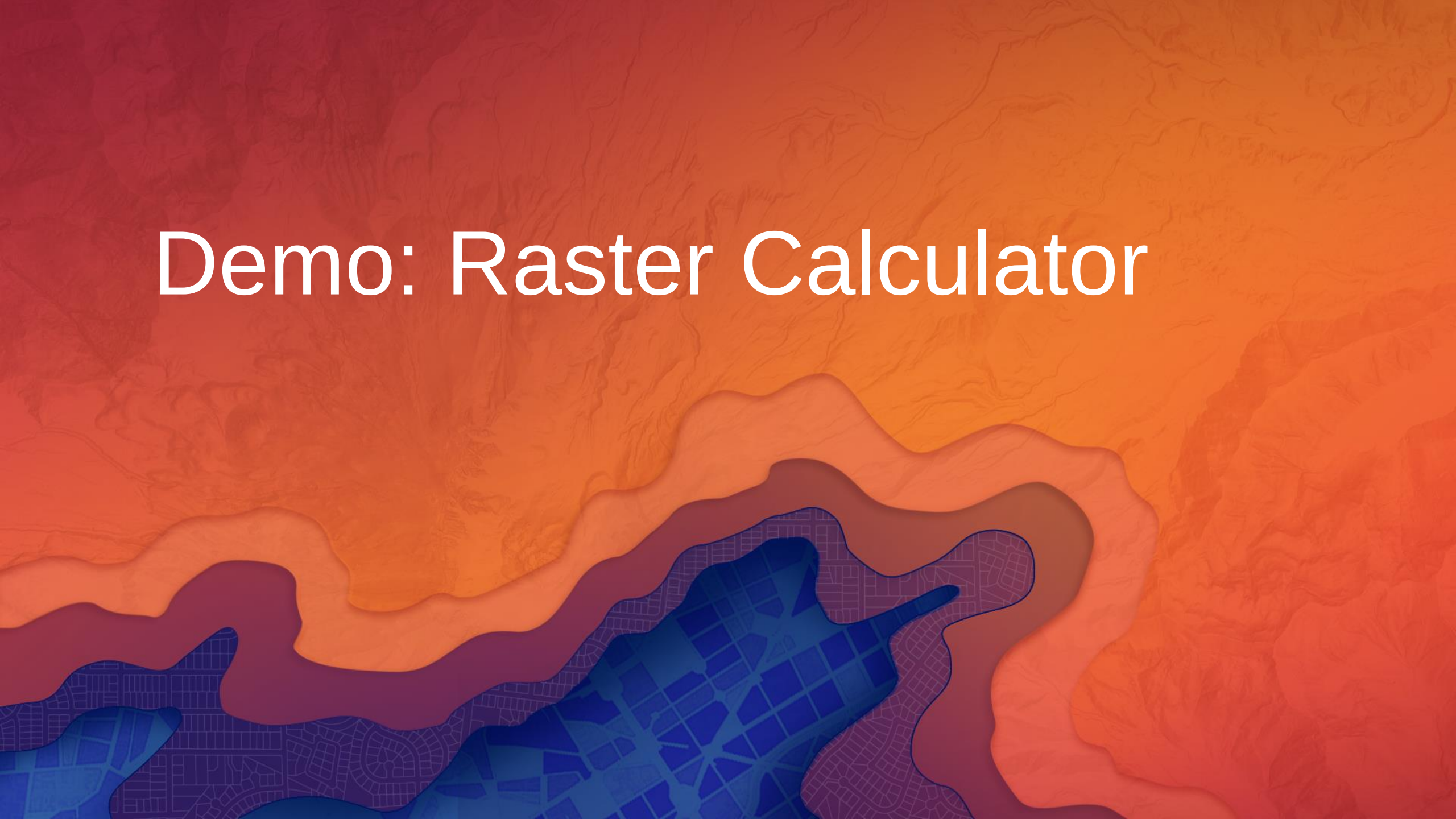
- What might B and C represent?

  A = Slope(B * C)

  B = Raster(“elevation”)

  C = 0.3048

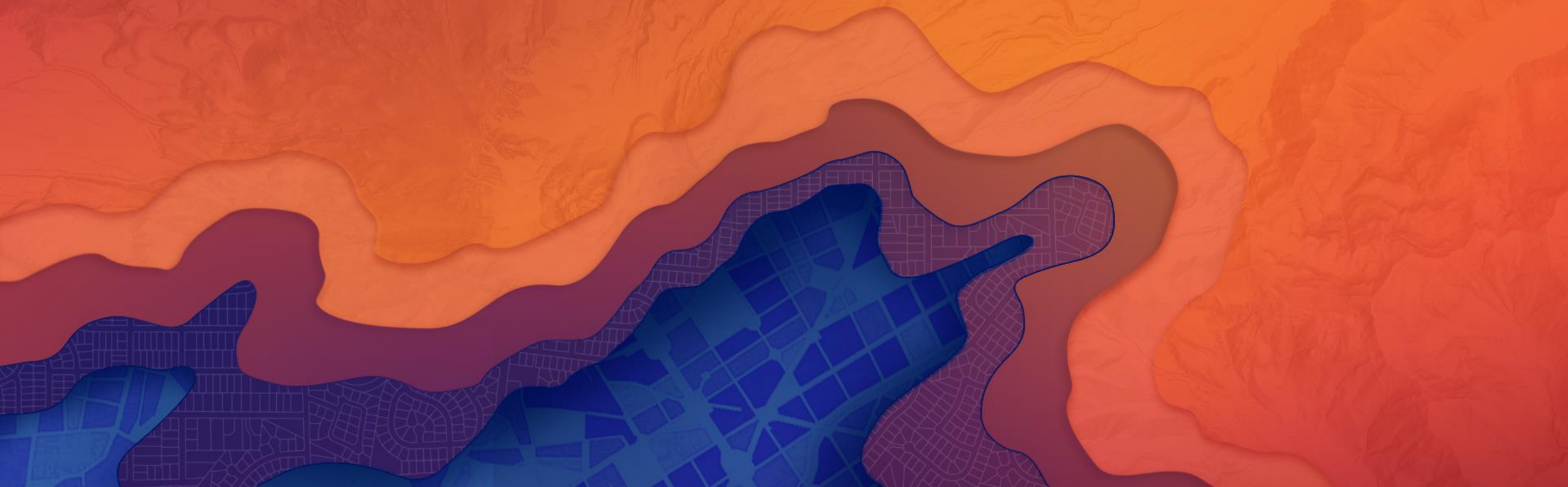
Demo: Raster Calculator



Raster Calculator Recap

- Performance benefits!
- No intermediate results!
- Like any other GP tool - used in model builder and follows the same environment settings
- Basically Python inside the Raster Calculator
- Single line expressions – Keep it simple
- Python is case sensitive

Demo: Python Window



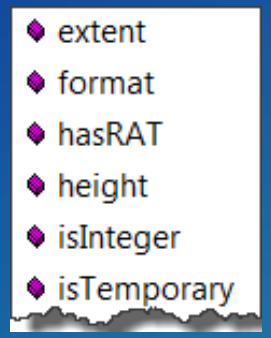
Python Window Recap

```
myElev = Slope("elevation", "DEGREE", 0.3048)
```

- Auto completion
- The input data type is a raster. (Layer or drag and drop from TOC or catalog)
- Drop down lists (“DEGREE”, “PERCENT RISE”)
- Strings are quoted in Python
- Numbers are not quoted
- Help – make sure you position it so you can see it
- Left hand result is a Raster Object

Python Window Recap (continued)

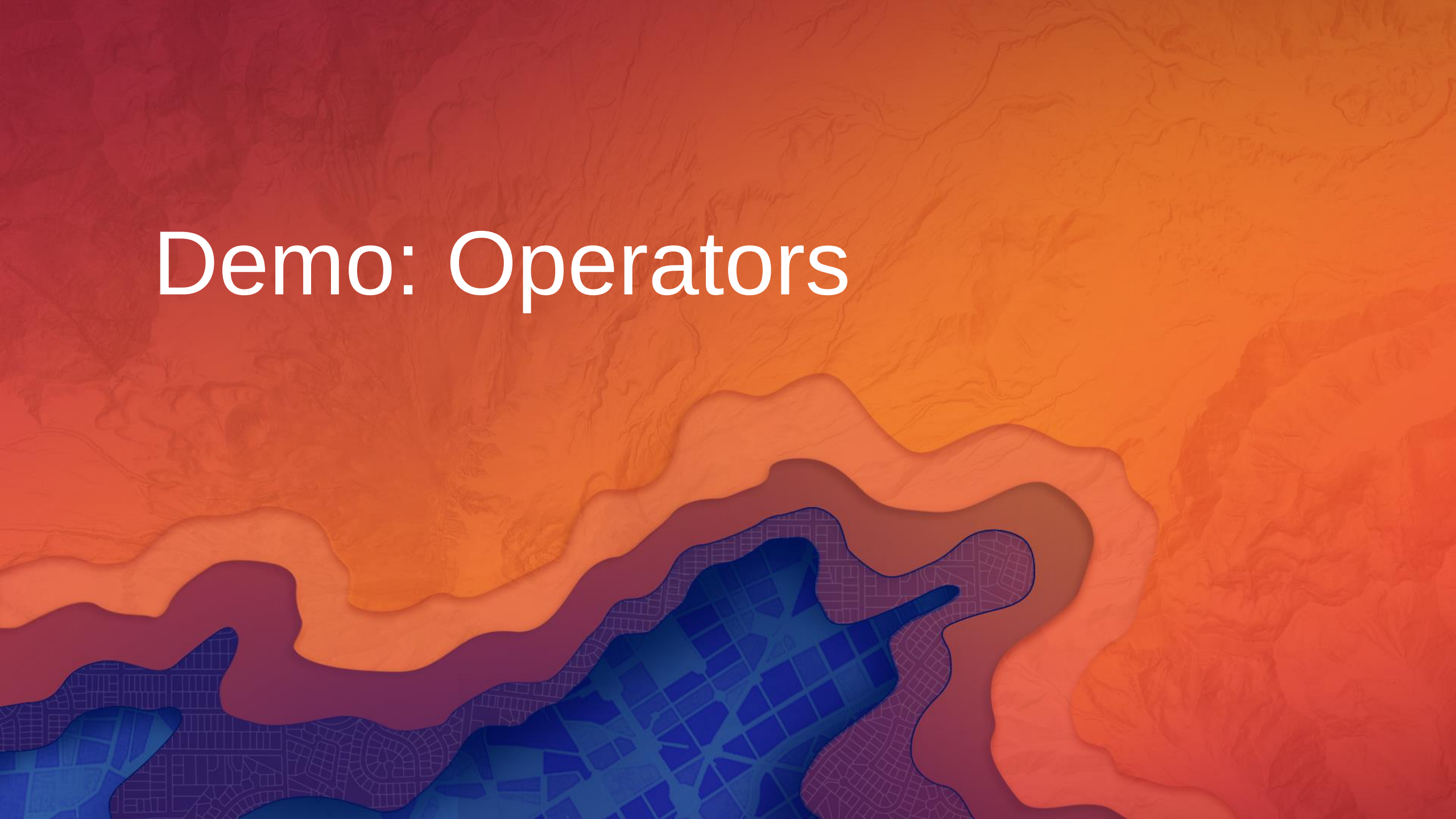
- Raster Object
  - Result is temporary
  - Properties



  - Save method

```
>>> mySlope.save("slopeout")
>>> mySlope2.save("C:/data/slopeout2")
```

Demo: Operators



Operators Test

Q1. Why are layers not cast as Raster objects in the Raster Calculator tool?

A: They are cast as object but not by you

Q2. Why doesn’t the input to Slope have to be cast?

A: It is a geoprocessing tool. The data type for the input parameter is a raster dataset

Q3. What is the import statement needed to access Spatial Analyst operators?

A: `from arcpy.sa import *`

Q4. Bonus: Does it make sense to use the Raster Calculator in scripting? And why or why not?

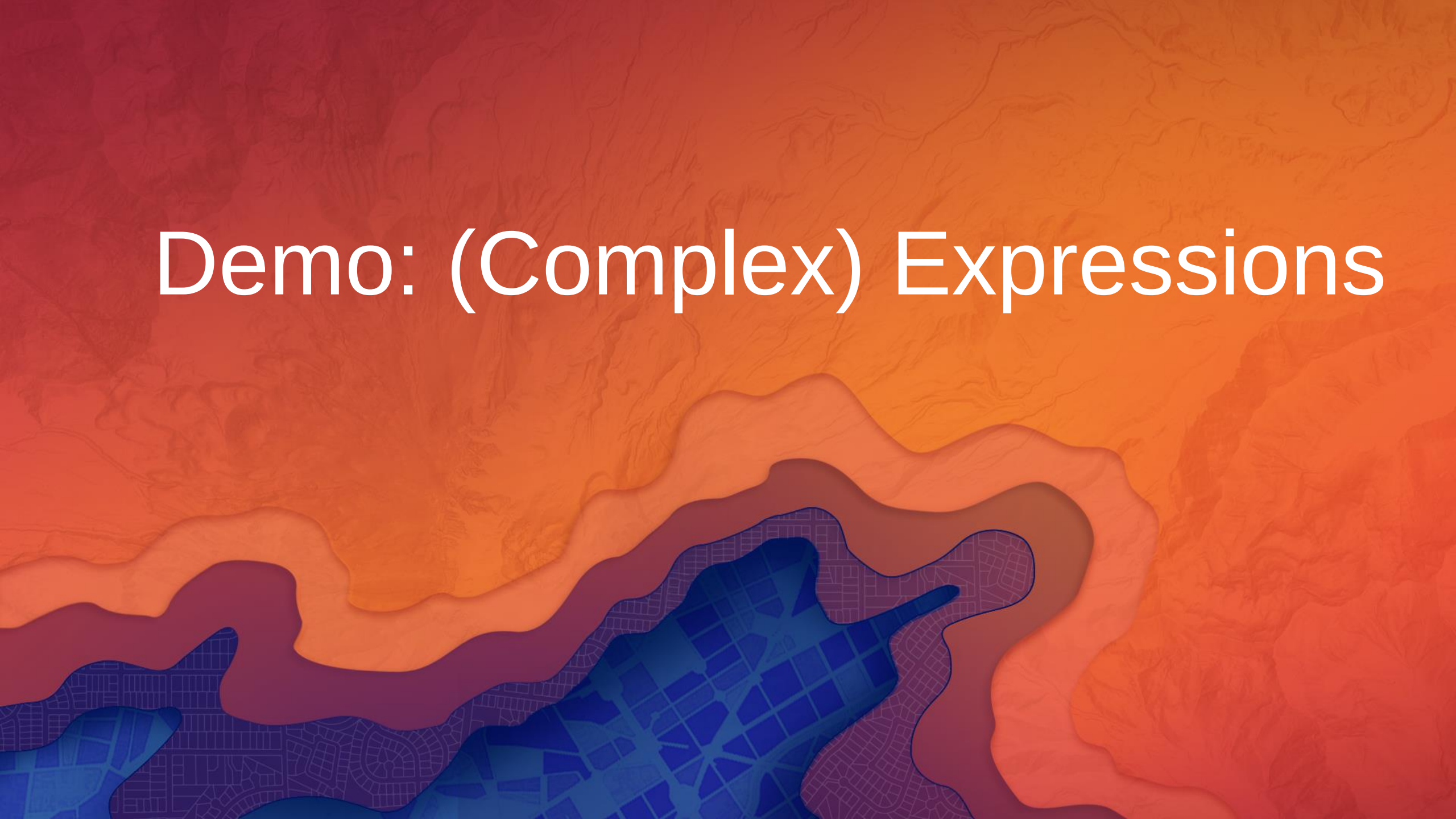
A: No, it is unnecessary because Map Algebra is now native to Python

Operator help documentation

- Use the web help, it is more up to date
- Make sure you know what the operator is doing
  - Boolean And is & (not AND) when working with raster, but is a ‘bitwise and’ when working with numbers
- Make sure you know the order of execution (precedence level)
- If your equation fails, add more parenthesis!

http://desktop.arcgis.com/en/desktop/latest/guide-books/extensions/spatial-analyst/map-algebra/what-is-map-algebra.htm

Demo: (Complex) Expressions



(Complex) Equation Recap

1) Using non spatial Analyst tools in Map Algebra

```
forest_ac =
(ZonalStatistics(arcpy.Buffer_analysis("mills","#",1000),
"OBJECTID","Forest","SUM"))* 0.000247
```

2) Using multiple relation and/or boolean operators

```
camps = ("dist_lake" < 2000) & ("dist_urban" > 5000)
```

(Complex) Equations Recap (continued)

- Non Spatial Analyst
  - Result Object output
  - Managed output “#”
  - Not all tools that output a raster, output a raster object

- Multiple Relational and Boolean operators
  - Use brackets
  - Make sure you know the precedence level!

Raster Calculator equations

What might these be used for?

1) `("pop" > 150) & ("dist" > 10)`
2) `(("reclass_rd_dist" * 3) + ("reclass_landuse" * 2) + "reclass_elev") /6.0`
3) `("Band4" - "Band3") / Float("Band4" + "Band3")`
4) `Con(("elev" <= 3000), 1, 0)`
5) `Con(IsNull("elev"),0, "elev")`

Complex RC Equation Test

1) Where do the brackets go?

```
Con "landuse1" == 1 & "landuse2" == 5, 0, 1
```

A: `Con(("landuse1" == 1) & ("landuse2" == 5),0,1)`

2) What is another way to do this analysis?

```
Con("elev", 1, 0, "VALUE <= 3000")
```

A: `Con(Raster("elev") <= 3000, 1, 0)`

What is wrong with these expressions

(Or how can you improve them?)

- Con(“elev” > 1500, 1, 0)
- (Raster(“dist_wat”) < 1000) AND (Raster(“dist_forest”) < 500)
- Raster(“dist_wat”) < 1000 & Raster(“dist_forest”) < 500
- >>> a = “layer” + 3
- mySlope = Slope(“input”, “output”, “DEGREES”, 0.348)
- mSlope2 = Slope(“input”, “DEGREES”, “0.348”)
- import arcpy.sa

esri
THE
SCIENCE
OF
WHERE