DS 100 – Intro to Data Science

Lecture 8– Pivot, Joins, Comparison

02/13/2025

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Announcements

Lab03 (Functions & Visualizations) due Friday

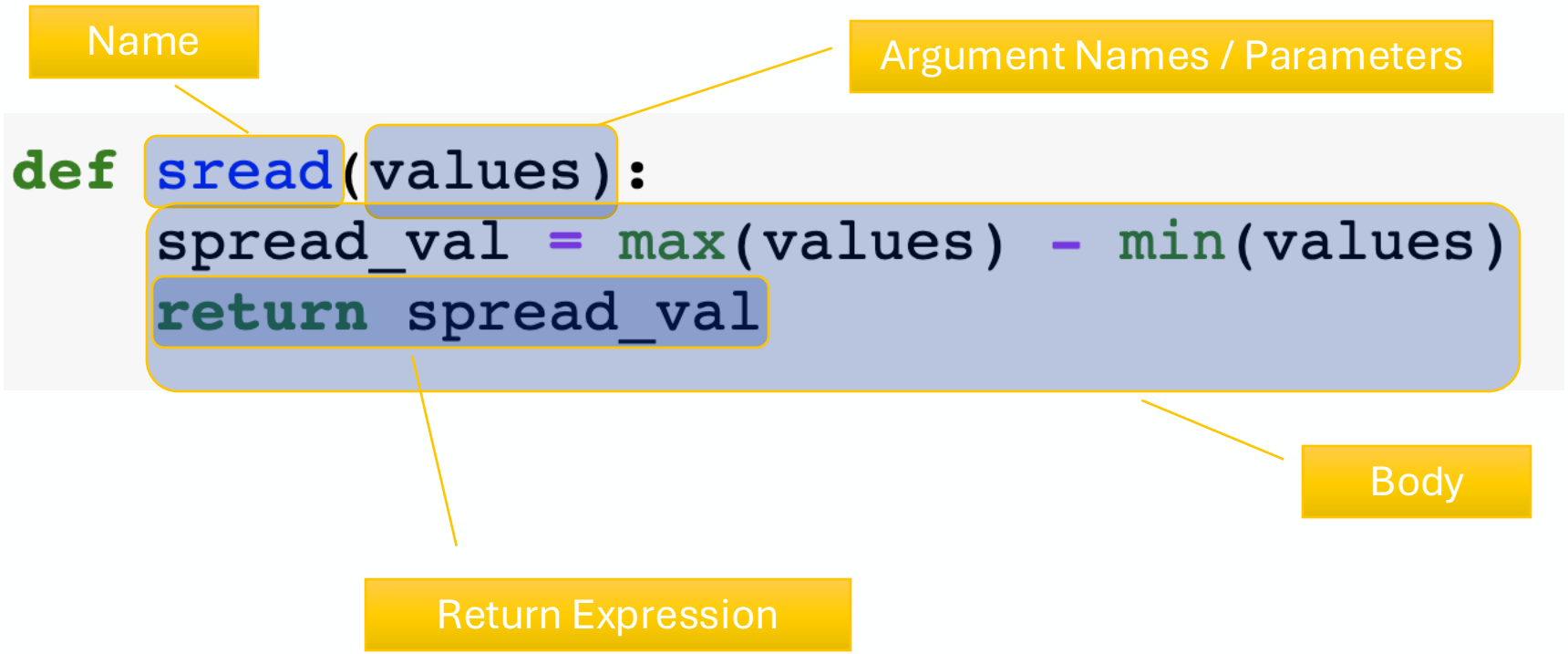
HW03 – Functions, Histograms, and Groups:

- Due Wednesday (02/19)

Checkpoint/Project 1:

- Paired assignment that covers the previous section of the course material
- Released today
- Due Wednesday 02/28

Example Function



Applying Functions to Columns

The apply method creates an array by calling a function on every element in input column(s)

- First argument: Function to apply
- Other arguments: The input column(s)

```
table_name.apply(function_name, 'column_label')
```

Grouping by One Column

The **group** method aggregates all rows with the same value for a column into a single row in the resulting table.

- First argument: Which column to group by
- Second argument: (Optional) How to combine values

len — number of grouped values (default)
list — list of all grouped values
sum — total of all grouped values

Lists as Generic Sequences

A list is a sequence of values (just like an array), but the values can all have different types

```
[2+3, 'four', Table().with_column('K', [3, 4])]
```

Lists can be used to create table rows.

If you create a table column from a list, it will be converted to an array automatically

Grouping by Multiple Columns

The **group** method can also aggregate all rows that share the combination of values in multiple columns

- First argument: A list of which columns to group by
- Second argument: (Optional) How to combine values

Pivot Example

sky = Table.read_table('skyscrapers_v2.csv')

name	material	city	height	age
One World Trade Center	mixed/composite	New York City	541.3	6
Willis Tower	steel	Chicago	442.14	46
432 Park Avenue	concrete	New York City	425.5	5

sky.pivot('material', 'city')

Pivot description

```
Tbl.pivot(col1, col2)
```

1. **string**: name of column whose unique values will make up columns of pivot table
2. **string**: name of column whose unique values will make up rows of pivot table

```
sky.pivot('material', 'city')
```

Pivot Example

sky.pivot('material', 'city')

name	material	city
Willis Tower	steel	Chicago
Trump International Hotel & Tower	concrete	Chicago
Aon Center	steel	Chicago
John Hancock Center	steel	Chicago
Bank of America Plaza	mixed/composite	Atlanta
U.S. Bank Tower	steel	Los Angeles
The Franklin - North Tower	mixed/composite	Chicago
JPMorgan Chase Tower	mixed/composite	Houston
Two Prudential Plaza	concrete	Chicago
Wells Fargo Plaza	steel	Houston

Pivot Example

sky.pivot('material', 'city')

city	concrete	mixed/composite	steel
Atlanta			
Austin			
Baltimore			
Boston			
Charlotte			
Chicago			
Cincinnati			
Cleveland			
Columbus			

name	material	city
Willis Tower	steel	Chicago
Trump International Hotel & Tower	concrete	Chicago
Aon Center	steel	Chicago
John Hancock Center	steel	Chicago
Bank of America Plaza	mixed/composite	Atlanta
U.S. Bank Tower	steel	Los Angeles
The Franklin - North Tower	mixed/composite	Chicago
JPMorgan Chase Tower	mixed/composite	Houston
Two Prudential Plaza	concrete	Chicago
Wells Fargo Plaza	steel	Houston

Pivot Example

sky.pivot('material', 'city')

city	concrete	mixed/composite	steel
Atlanta			
Austin			
Baltimore			
Boston			
Charlotte			
Chicago			1
Cincinnati			
Cleveland			
Columbus			

name	material	city
Willis Tower	steel	Chicago
Trump International Hotel & Tower	concrete	Chicago
Aon Center	steel	Chicago
John Hancock Center	steel	Chicago
Bank of America Plaza	mixed/composite	Atlanta
U.S. Bank Tower	steel	Los Angeles
The Franklin - North Tower	mixed/composite	Chicago
JPMorgan Chase Tower	mixed/composite	Houston
Two Prudential Plaza	concrete	Chicago
Wells Fargo Plaza	steel	Houston

Pivot Example

sky.pivot('material', 'city')

city	concrete	mixed/composite	steel
Atlanta			
Austin			
Baltimore			
Boston			
Charlotte			
Chicago	1		1
Cincinnati			
Cleveland			
Columbus			

name	material	city
Willis Tower	steel	Chicago
Trump International Hotel & Tower	concrete	Chicago
Aon Center	steel	Chicago
John Hancock Center	steel	Chicago
Bank of America Plaza	mixed/composite	Atlanta
U.S. Bank Tower	steel	Los Angeles
The Franklin - North Tower	mixed/composite	Chicago
JPMorgan Chase Tower	mixed/composite	Houston
Two Prudential Plaza	concrete	Chicago
Wells Fargo Plaza	steel	Houston

Pivot Example

sky.pivot('material', 'city')

city	concrete	mixed/composite	steel
Atlanta			
Austin			
Baltimore			
Boston			
Charlotte			
Chicago	1		1
Cincinnati			
Cleveland			
Columbus			

name	material	city
Willis Tower	steel	Chicago
Trump International Hotel & Tower	concrete	Chicago
Aon Center	steel	Chicago
John Hancock Center	steel	Chicago
Bank of America Plaza	mixed/composite	Atlanta
U.S. Bank Tower	steel	Los Angeles
The Franklin - North Tower	mixed/composite	Chicago
JPMorgan Chase Tower	mixed/composite	Houston
Two Prudential Plaza	concrete	Chicago
Wells Fargo Plaza	steel	Houston

Pivot Example

sky.pivot('material', 'city')

city	concrete	mixed/composite	steel
Atlanta			
Austin			
Baltimore			
Boston			
Charlotte			
Chicago	1		2
Cincinnati			
Cleveland			
Columbus			

name	material	city
Willis Tower	steel	Chicago
Trump International Hotel & Tower	concrete	Chicago
Aon Center	steel	Chicago
John Hancock Center	steel	Chicago
Bank of America Plaza	mixed/composite	Atlanta
U.S. Bank Tower	steel	Los Angeles
The Franklin - North Tower	mixed/composite	Chicago
JPMorgan Chase Tower	mixed/composite	Houston
Two Prudential Plaza	concrete	Chicago
Wells Fargo Plaza	steel	Houston

Pivot Example

sky.pivot('material', 'city')

city	concrete	mixed/composite	steel
Atlanta			
Austin			
Baltimore			
Boston			
Charlotte			
Chicago	1		2
Cincinnati			
Cleveland			
Columbus			

name	material	city
Willis Tower	steel	Chicago
Trump International Hotel & Tower	concrete	Chicago
Aon Center	steel	Chicago
John Hancock Center	steel	Chicago
Bank of America Plaza	mixed/composite	Atlanta
U.S. Bank Tower	steel	Los Angeles
The Franklin - North Tower	mixed/composite	Chicago
JPMorgan Chase Tower	mixed/composite	Houston
Two Prudential Plaza	concrete	Chicago
Wells Fargo Plaza	steel	Houston

Pivot Example

sky.pivot('material', 'city')

city	concrete	mixed/composite	steel
Atlanta			
Austin			
Baltimore			
Boston			
Charlotte			
Chicago	1		3
Cincinnati			
Cleveland			
Columbus			

name	material	city
Willis Tower	steel	Chicago
Trump International Hotel & Tower	concrete	Chicago
Aon Center	steel	Chicago
John Hancock Center	steel	Chicago
Bank of America Plaza	mixed/composite	Atlanta
U.S. Bank Tower	steel	Los Angeles
The Franklin - North Tower	mixed/composite	Chicago
JPMorgan Chase Tower	mixed/composite	Houston
Two Prudential Plaza	concrete	Chicago
Wells Fargo Plaza	steel	Houston

Pivot Example

sky.pivot('material', 'city')

city	concrete	mixed/composite	steel
Atlanta			
Austin			
Baltimore			
Boston			
Charlotte			
Chicago	1		2
Cincinnati			
Cleveland			
Columbus			

name	material	city
Willis Tower	steel	Chicago
Trump International Hotel & Tower	concrete	Chicago
Aon Center	steel	Chicago
John Hancock Center	steel	Chicago
Bank of America Plaza	mixed/composite	Atlanta
U.S. Bank Tower	steel	Los Angeles
The Franklin - North Tower	mixed/composite	Chicago
JPMorgan Chase Tower	mixed/composite	Houston
Two Prudential Plaza	concrete	Chicago
Wells Fargo Plaza	steel	Houston

Pivot Example

sky.pivot('material', 'city')

city	concrete	mixed/composite	steel
Atlanta		1	
Austin			
Baltimore			
Boston			
Charlotte			
Chicago	1		2
Cincinnati			
Cleveland			
Columbus			

name	material	city
Willis Tower	steel	Chicago
Trump International Hotel & Tower	concrete	Chicago
Aon Center	steel	Chicago
John Hancock Center	steel	Chicago
Bank of America Plaza	mixed/composite	Atlanta
U.S. Bank Tower	steel	Los Angeles
The Franklin - North Tower	mixed/composite	Chicago
JPMorgan Chase Tower	mixed/composite	Houston
Two Prudential Plaza	concrete	Chicago
Wells Fargo Plaza	steel	Houston

Pivot Example

sky.pivot('material', 'city')

city	concrete	mixed/composite	steel
Atlanta		1	
Austin			
Baltimore			
Boston			
Charlotte			
Chicago	1		2
Cincinnati			
Cleveland			
Columbus			

name	material	city
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Aon Center	steel	Chicago
John Hancock Center	steel	Chicago
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U.S. Bank Tower	steel	Los Angeles
The Franklin - North Tower	mixed/composite	Chicago
JPMorgan Chase Tower	mixed/composite	Houston
Two Prudential Plaza	concrete	Chicago
Wells Fargo Plaza	steel	Houston

Pivot Example

sky.pivot('material', 'city')

city	concrete	mixed/composite	steel
Atlanta		1	
Austin			
Baltimore			
Boston			
Charlotte			
Chicago	1		2
Cincinnati			
Cleveland			
Columbus			

name	material	city
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Trump International Hotel & Tower	concrete	Chicago
Aon Center	steel	Chicago
John Hancock Center	steel	Chicago
Bank of America Plaza	mixed/composite	Atlanta
U.S. Bank Tower	steel	Los Angeles
The Franklin - North Tower	mixed/composite	Chicago
JPMorgan Chase Tower	mixed/composite	Houston
Two Prudential Plaza	concrete	Chicago
Wells Fargo Plaza	steel	Houston

Pivot Example

sky.pivot('material', 'city')

city	concrete	mixed/composite	steel
Atlanta		1	
Austin			
Baltimore			
Boston			
Charlotte			
Chicago	1	1	2
Cincinnati			
Cleveland			
Columbus			

name	material	city
Willis Tower	steel	Chicago
Trump International Hotel & Tower	concrete	Chicago
Aon Center	steel	Chicago
John Hancock Center	steel	Chicago
Bank of America Plaza	mixed/composite	Atlanta
U.S. Bank Tower	steel	Los Angeles
The Franklin - North Tower	mixed/composite	Chicago
JPMorgan Chase Tower	mixed/composite	Houston
Two Prudential Plaza	concrete	Chicago
Wells Fargo Plaza	steel	Houston

Pivot Example

sky.pivot('material', 'city')

city	concrete	mixed/composite	steel
Atlanta		1	
Austin			
Baltimore			
Boston			
Charlotte			
Chicago	1	1	2
Cincinnati			
Cleveland			
Columbus			

name	material	city
Willis Tower	steel	Chicago
Trump International Hotel & Tower	concrete	Chicago
Aon Center	steel	Chicago
John Hancock Center	steel	Chicago
Bank of America Plaza	mixed/composite	Atlanta
U.S. Bank Tower	steel	Los Angeles
The Franklin - North Tower	mixed/composite	Chicago
JPMorgan Chase Tower	mixed/composite	Houston
Two Prudential Plaza	concrete	Chicago
Wells Fargo Plaza	steel	Houston

Pivot Example

sky.pivot('material', 'city')

city	concrete	mixed/composite	steel
Atlanta		1	
Austin			
Baltimore			
Boston			
Charlotte			
Chicago	1	1	2
Cincinnati			
Cleveland			
Columbus			

name	material	city
Willis Tower	steel	Chicago
Trump International Hotel & Tower	concrete	Chicago
Aon Center	steel	Chicago
John Hancock Center	steel	Chicago
Bank of America Plaza	mixed/composite	Atlanta
U.S. Bank Tower	steel	Los Angeles
The Franklin - North Tower	mixed/composite	Chicago
JPMorgan Chase Tower	mixed/composite	Houston
Two Prudential Plaza	concrete	Chicago
Wells Fargo Plaza	steel	Houston

Pivot Example

sky.pivot('material', 'city')

city	concrete	mixed/composite	steel
Atlanta		1	
Austin			
Baltimore			
Boston			
Charlotte			
Chicago	2	1	2
Cincinnati			
Cleveland			
Columbus			

name	material	city
Willis Tower	steel	Chicago
Trump International Hotel & Tower	concrete	Chicago
Aon Center	steel	Chicago
John Hancock Center	steel	Chicago
Bank of America Plaza	mixed/composite	Atlanta
U.S. Bank Tower	steel	Los Angeles
The Franklin - North Tower	mixed/composite	Chicago
JPMorgan Chase Tower	mixed/composite	Houston
Two Prudential Plaza	concrete	Chicago
Wells Fargo Plaza	steel	Houston

Pivot Tables

Cross-classifies according to two categorical variables

Produces a grid of counts or aggregated values

Two required arguments:

- First: variable that forms column labels of grid
- Second: variable that forms row labels of grid

Two optional arguments (include **both** or **neither**)

values='column_label_to_aggregate'

collect=function_to_aggregate_with

Group vs Pivot

Pivot

- One combo of grouping variables **per entry**
- **Two** grouping variables: columns and rows
- Aggregate values of **values column**
- Missing combos **= 0 (or empty string)**

Group

- One combo of grouping variables **per row**
- **Any number** of grouping variables
- Aggregate values of **all other columns** in table
- Missing combos **absent**

Joining Two Tables

tblA.join(colA, tblB, colB)

tblA.join(colA, tblB)

Table Review

t.select(column, …) or t.drop(column, …)
t.take([row, …]) or t.exclude([row, …])
t.sort(column, descending=False)
t.where(column, are.condition(…))
t.apply(function, column, …)
t.group(column) or t.group(column, function)
t.group([column, …]) or t.group([column, …], function)
t.pivot(cols, rows) or t.pivot(cols, rows, vals, function)
t.join(column, other_table, other_table_column)

https://bmc-ds-100.github.io/python-reference.html

Comparisons

Comparison Operators

Operator	Table predicate
==	are.equal_to
!=	are.not_equal_to
>	are.above
>=	are.above_or_equal_to
<	are.below
<=	are.below_or_equal_to

The result of a comparison expression is a bool value:

True, False

Comparison Operators

The result of a comparison expression is a bool value

$x = 2$ $y = 3$

Comparison Operators

The result of a comparison expression is a bool value

Comparison Operators

The result of a comparison expression is a bool value

```
x = 2                    y = 3
```

Assignment Statements

```
x > 1                    x > y                    y >= 3

x == y                   x != 2                   2 < x < 5
```

Comparison Operators

The result of a comparison expression is a bool value

```
x = 2                    y = 3
```

Assignment Statements

```
x > 1                    x > y                    y >= 3

x == y                   x != 2                   2 < x < 5
```

Comparison Expressions

Combining Comparisons

The result of a comparison expression is a bool value

a = True

b = False

not b

a or b

a and not b

a and b

not (a or b)

b and b

Combining Comparisons

The result of a comparison expression is a bool value

```
a = True        b = False
```

Assignment Statements

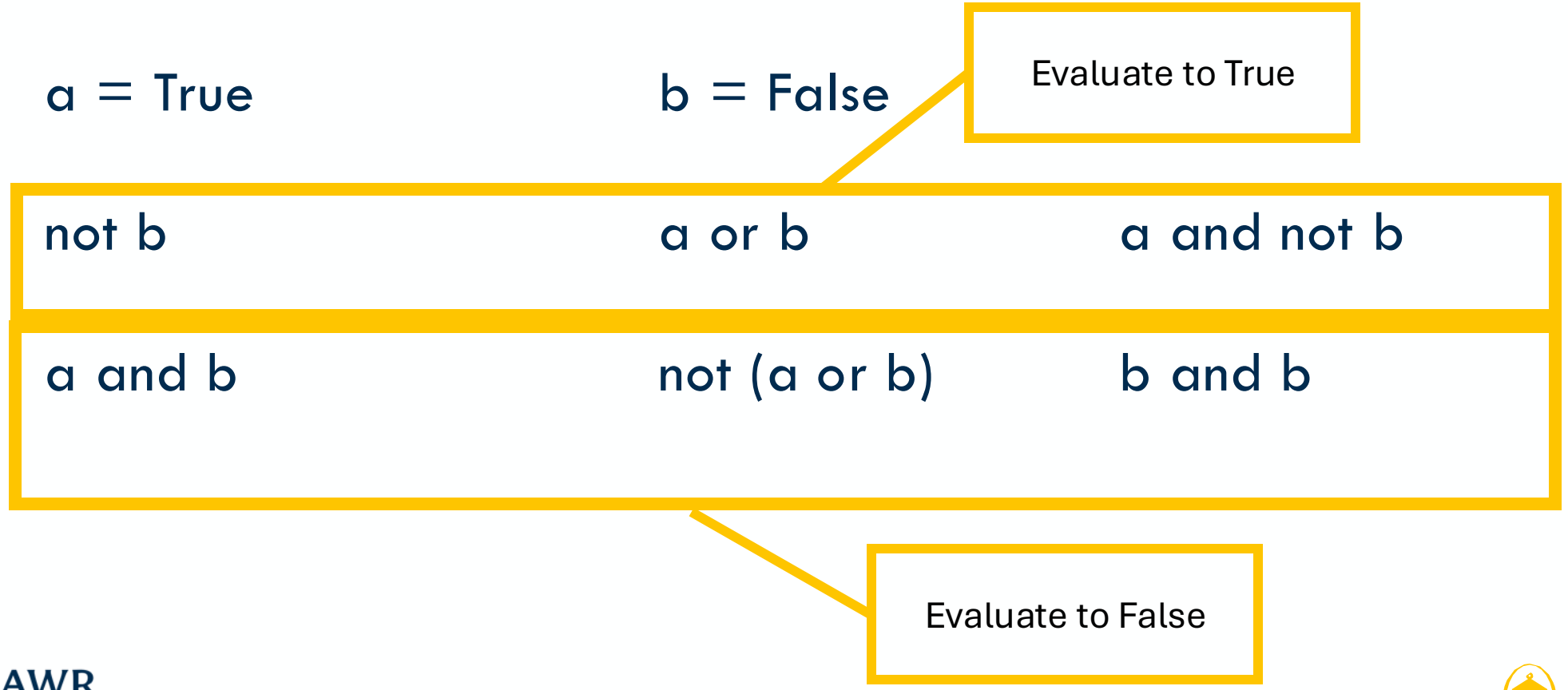
```
not b           a or b          a and not b

a and b         not (a or b)    b and b
```

Comparison Expressions

Combining Comparisons

The result of a comparison expression is a bool value



Aggregating Comparisons

Summing an array or list of bool values count the number of True values

```
1 + 0 + 1
True + False + True
sum([1     , 0     , 1])
sum([True, False, True)]
```

Control Statements

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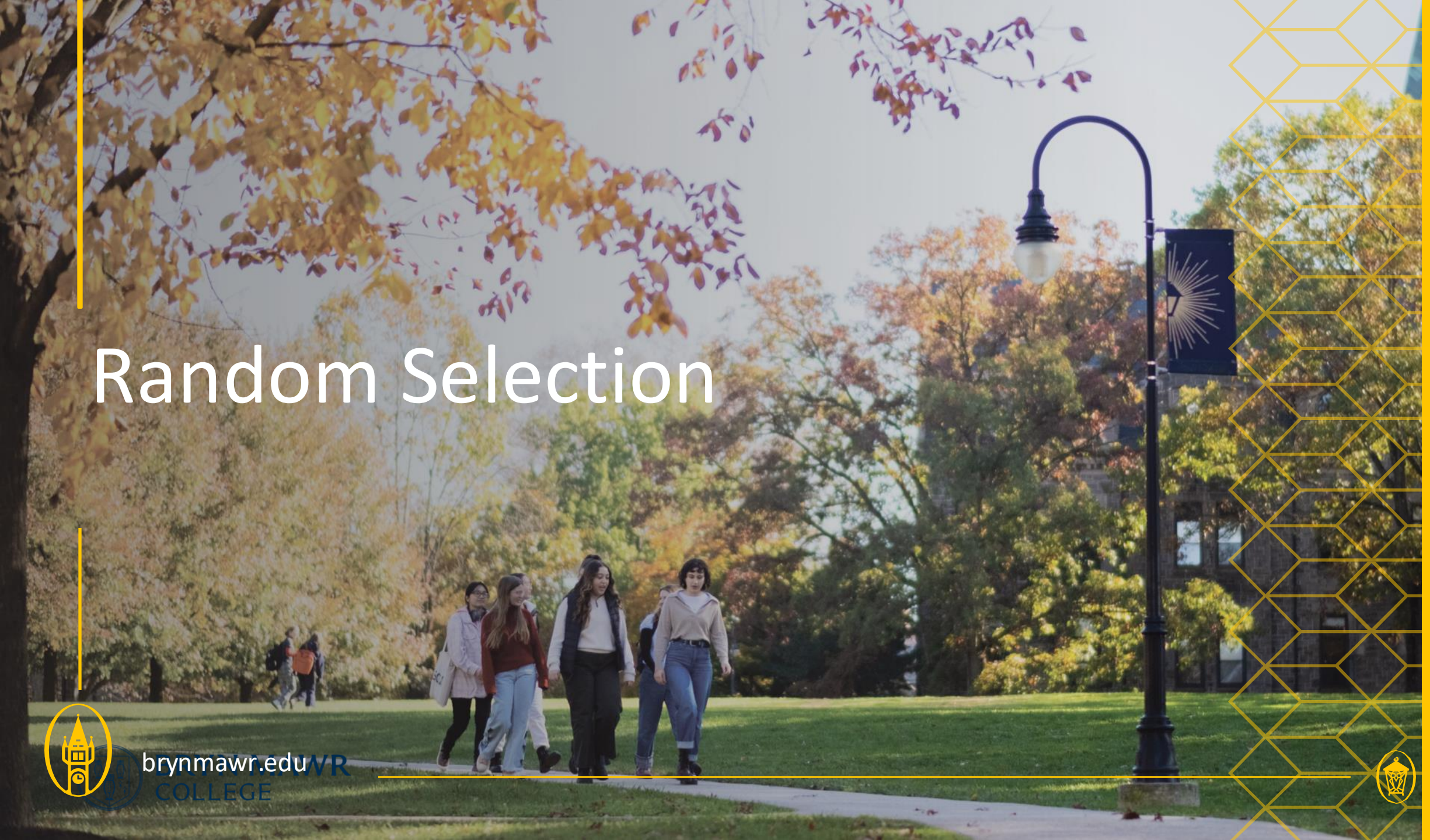
Control Statements

These statements *control* the sequence of computations that are performed

The keywords `if` and `for` begin control statements

The purpose of `if` is to define functions that choose different behavior based on their arguments

Random Selection



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Random Selection

np.random.choice

- Selects at random
- With replacement
- From an array
- A specific number of times

np.random.choice(some_array, sample_size)

Appending Arrays

A longer array

np.append(array_1, value):

- new array with value appended to array_1
- value has to be of the same type as elements of array_1

np.append(array_1, array_2):

- new array with array_2 appended to array_1
- Elements of array_2 have to be of the same type as elements of array_1

Iteration

for statements

for is a keyword that begins a control statement

The purpose of for is to perform a computation for every element in a list or array