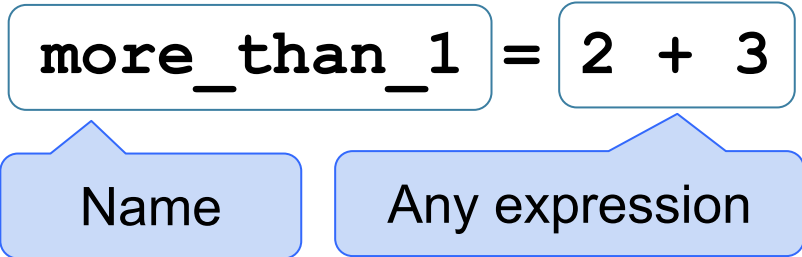


Statements

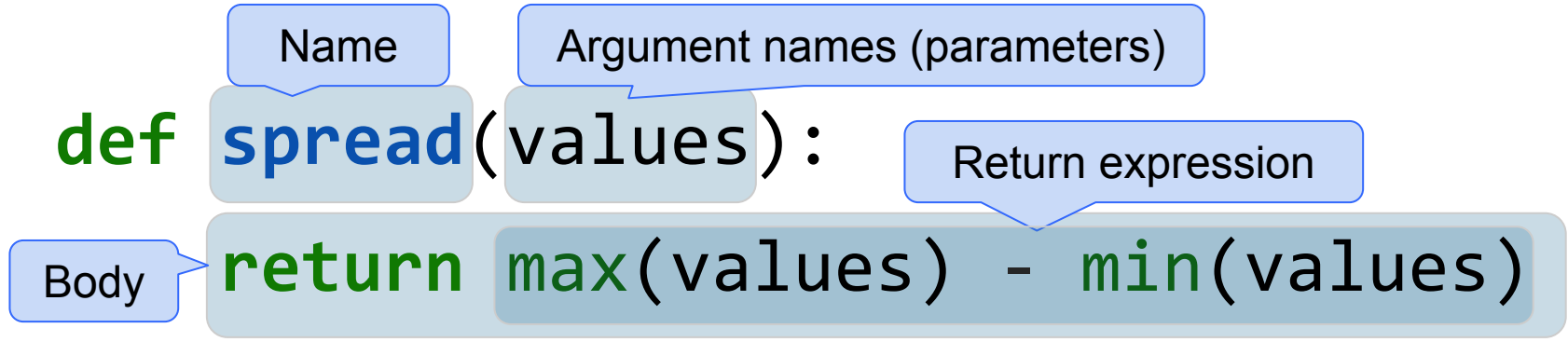


- Statements don't have a value; they perform an action
- An assignment statement changes the meaning of the name to the left of the = symbol
- The name is bound to a value (not an equation)

- < and > mean what you expect (less than, greater than)
- <= means "less than or equal"; likewise for >=
- == means "equal"; != means "not equal"
- Comparing strings compares their alphabetical order

Arrays - sequences that can be manipulated easily

- All elements of an array should have the same type
- Arithmetic is applied to each element of an array individually
- Elementwise operations can be done on arrays of the same size



```
for i in np.arange(12):  
    print(i)
```

The body is executed **for** every item in a sequence
The body of the statement can have multiple lines
The body should do something: print, assign, hist, etc.

Conditional Statements

```
if <if expression>:  
    <if body>  
elif <elif expression 0>:  
    <elif body 0>  
elif <elif expression 1>:  
    <elif body 1>  
...  
else:  
    <else body>
```

Growth Rate: the rate of increase per unit time

- After one time unit, a quantity **x** growing at rate **g** will be $x * (1 + g)$
- After **t** time units, a quantity **x** growing at rate **g** will be $x * (1 + g) ** t$
- If **after** and **before** are measurements of the same quantity taken **t** time units apart, then the growth rate is $(after/before) ** (1/t) - 1$

Total Variation Distance: Measures the difference between two categorical distributions

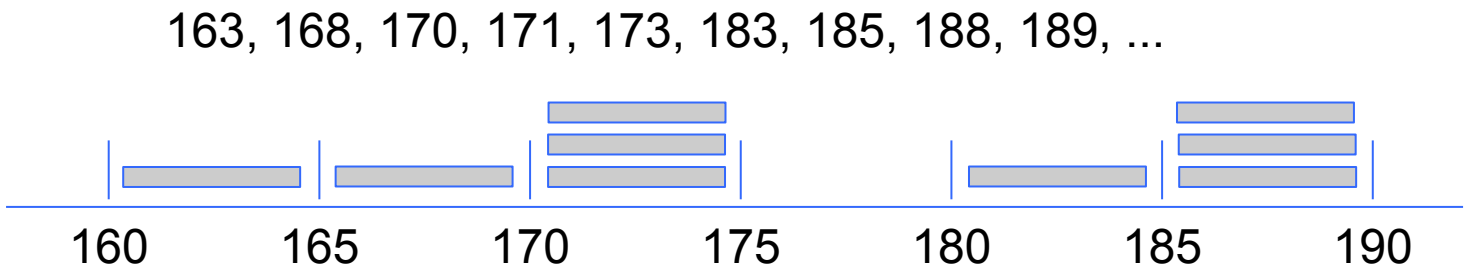
- For each category, compute the difference in proportions between two distributions
- Take the absolute value of each difference
- Sum and divide by 2

Values in Tables: Every column of a table is an array.

- **Categorical**
 - May or may not have an ordering
 - Categories are the same or different
 - Allows grouping by value (**group**, **pivot**, **join**)
- **Numerical**
 - Ordered
 - Allows binning by value (**bin**, **hist**)

Binning is counting the number of numerical values that lie within ranges, called bins.

- Bins include the lower bound and exclude the upper bound
- Values equal to the upper bound of a bin go into the next bin
- The upper bound of a bin is the lower bound of the next bin



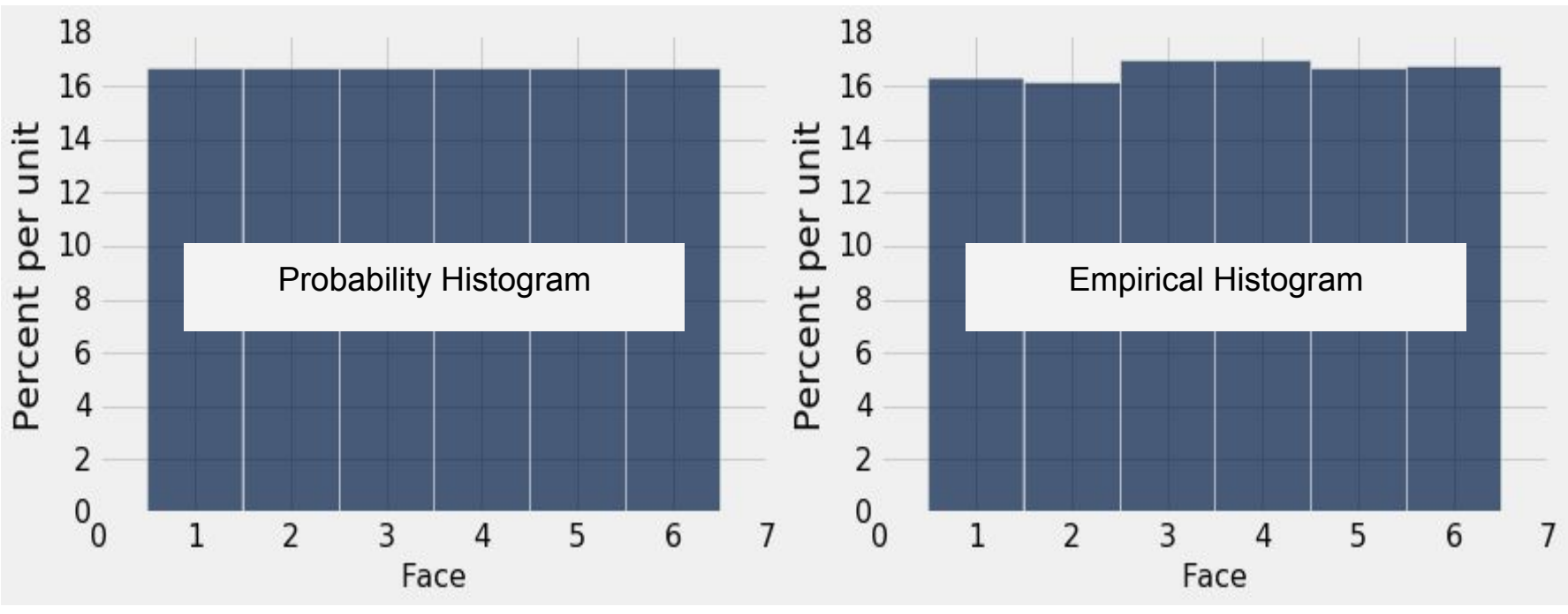
A **histogram** has two defining properties:

- The bins are contiguous (though some might be empty) and are drawn to scale
- The **area** of each bar is equal to the proportion of entries in the bin

Has total area 1 (or 100%)

Vertical axis units: Proportion / Unit on the horizontal axis

- A histogram of proportions of all possible outcomes of a *known* random process is called a *probability histogram*
- A histogram is a summary visualization of a *distribution*
- A histogram of proportions of actual outcomes generated by sampling or actual data is called an *empirical histogram*



Calculating Probabilities

Complement Rule: $P(\text{event does not happen}) = 1 - P(\text{event happens})$
Multiplication Rule: $P(\text{two events happen}) = P(\text{one happens}) * P(\text{other happens, given the first happened})$
Addition Rule: $P(\text{an event happens}) = P(\text{first way it can happen}) + P(\text{second way it can happen})$ IF it can happen in **ONLY** one of two ways

Testing a Hypothesis

Step 1: The Hypotheses

- A test chooses between two views of how data were generated
- *Null hypothesis* proposes that data were generated at random
- *Alternative hypothesis* proposes some effect other than chance

Step 2: The Test Statistic

- A value that can be computed for the data and for samples

Step 3: The Sampling Distribution of the Test Statistic

- What the test statistic might be if the null hypothesis were true
- Approximate the sampling distribution by an empirical distribution

Data 8 Midterm Reference Sheet — Page 2

In the examples in the left column, np refers to the NumPy module, as usual. Everything else is a function, a method, an example of an argument to a function or method, or an example of an object we might call the method on. For example, tbl refers to a table, array refers to an array, and num refers to a number. array.item(0) is an example call for the method item, and in that example, array is the name previously given to some array.

Example function call	Value of a call to the function
max(array); min(array)	Maximum or minimum of a sequence
sum(array)	Sum of all elements in an array
len(array)	Length (num elements) in an array
round(num); np.round(array)	Round number or array of numbers to the nearest integer
abs(num); np.abs(array)	Take the absolute value of number or each number in an array
np.average(array), np.mean(array)	The average of the values in an array
np.arange(start, stop, step) np.arange(start, stop) np.arange(stop)	An array of numbers starting with start, going up in increments of step, and going up to but excluding stop. When start and/or step are left out, default values are used in their place. Default step is 1; default start is 0.
np.count_nonzero(array)	Count the number of non-zero elements in an array (False counts as zero, True as non-zero)
array.item(index)	The item in the array at some index. array.item(0) is the first item of array.
np.append(array, item)	A copy of the array with item appended to the end.
np.random.choice(array, n) np.random.choice(array)	An array of items selected at random with replacement from an array. Default number of items is 1 if n not specified.
Table()	An empty table.
Table.read_table(filename)	A table with data from a file.
tbl.num_rows	The number of rows in a table.
tbl.num_column	The number of columns in a table.
tbl.labels	A list of the column labels of a table.
tbl.with_column(name, values) tbl.with_columns(n1, v1, n2, v2...)	A table with an additional or replaced column or columns. name is a string for the name of a column, values is an array.
tbl.column(column_name_or_index)	The values of a column (an array).
tbl.select(col1, col2, ...)	A table with only the selected columns. (Each argument is the name of a column, or a column index.)
tbl.drop(col1, col2, ...)	A table without the selected columns. (Each argument is the name of a column, or a column index.)
tbl.relabeled(old_label, new_label)	A new table with a label changed.
tbl.take(row_indices)	A table with only the rows at the given indices. row_indices is an array of indices.
tbl.sort(column_name_or_index)	A table of rows sorted according to the values in a column (specified by name/index). Default order is ascending. For descending order, use argument descending=True.
tbl.where(column, predicate)	A table of the rows for which the column satisfies some predicate. See “Table.where predicates” below.
tbl.apply(function, column)	An array where a function is applied to each item in a column.
tbl.group(column_or_columns, func)	Group rows by unique values or combinations of values in a column. Other values aggregated by count (default) or optional argument func.
tblA.join(colA, tblB, colB) tblA.join(colA, tblB)	Generate a table with the columns of self and other, containing rows for all values of a column that appear in both tables. Default colB is colA. colA is a string specifying a column name, as is colB.
tbl.pivot(col1, col2, vals, collect) tbl.pivot(col1, col2)	A pivot table where each unique value in col1 has its own column and each unique value in col2 has its own row. Count or aggregate values from a third column, collect with some function. Default vals and collect return counts in cells.
tbl.sample(n) tbl.sample(n, with_replacement)	A new table where n rows are randomly sampled from the original table. Default is with replacement. For sampling without replacement, use argument with_replacement=False. For non-uniform sample, provide weights=distribution where distribution is an array containing the probability of each row.
tbl.scatter(x_column, y_column)	Draws a scatter plot consisting of one point for each row of the table.
tbl.barh(categories) tbl.barh(categories, values)	Displays a bar chart with bars for each category in a column, with height proportional to the corresponding frequency. values argument unnecessary if table has only a column of categories and a column of values.
tbl.hist(column, units, bins)	Generates a histogram of the numerical values in a column. units and bins are optional arguments, used to label the axes and group the values into intervals (bins), respectively. Bins have the form [a, b).

Operations: addition 2+3=5; subtraction 4-2=2; division 9/2=4.5
multiplication 2*3=6; division remainder 11%3=2; exponent
2**3=8

Data Types: string ‘hello’; boolean True, False;
int 1, -5; float - 2.3, -52.52, 7.9

Arithmetic with arrays is elementwise:
make_array(1,2,3) ** 2 # [1, 4, 9]

Table.where predicates (x is a string or number)
are.equal_to(x) # [2, 3, 4]
are.above(x) # val > x
are.below(x) # val < x
are.between(x, y) # x <= val < y