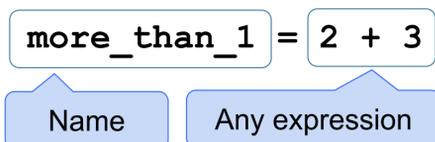


**Statements**

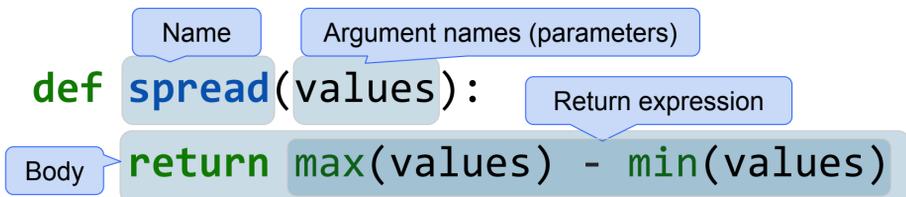


- Statements don't have a value; they perform an action
- An assignment statement changes the meaning of the name to the left of the = symbol
- The name is bound to a value (not an equation)

- < 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 Statements**

```
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

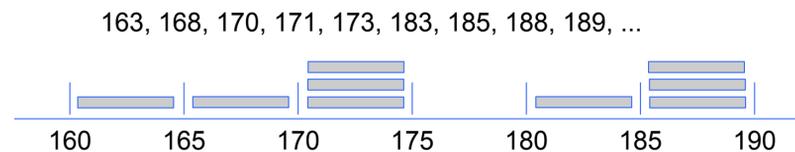
- After one time unit, a quantity **x** growing at rate **g** will be  $x * (1 + g)$
- After **t** time units, a quantity **x** growing at rate **g** will be  $x * (1 + g) ** t$
- If **after** and **before** are measurements of the same quantity taken **t** time units apart, then the growth rate is 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

**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



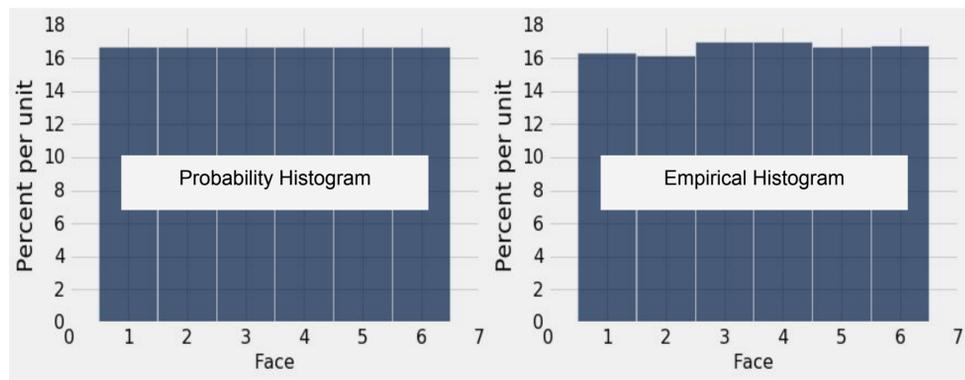
A **histogram** has two defining properties:

- 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

## Data 8 Midterm Study Guide — 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 list or array
sum(array)	Sum of all elements in a list or array; The sum of boolean values is the number that are True
len(array)	Length (num elements) in a list or array
round(num); np.round(array)	The nearest integer to a single number or each number in an array
abs(num); np.abs(array)	The absolute value of a single 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.
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. If item is another array, all of its elements are appended.
np.random.choice(array)	An item selected at random from an array.
np.random.choice(array, n)	An array of n items selected at random with replacement from an array.
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_columns	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 a list or 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 label of a column, or a column index.)
tbl.drop(col1, col2, ...)	A table without the dropped columns. (Each argument is the label 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. For unique values, use distinct=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)	A table with the counts of rows grouped by unique values or combinations of values in a column or columns.
tbl.group(column_or_columns, func)	A table that groups rows by unique values or combinations of values in a column or columns. The other values are aggregated by func.
tblA.join(colA, tblB, colB) tblA.join(colA, tblB)	Generate a table with the columns of tblA and tblB, 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. The cells of the grid contain row counts (two arguments) or the values from a third column, aggregated by the collect function.
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)  
are.not\_equal\_to(x)  
are.above(x) # val > x  
are.below(x) # val < x  
are.between(x, y) # x <= val < y  
are.contained\_in([x, y, z]) # val is either x, y, or z