Statements

```
more_than_1 = 2 + 3
```

Name: `more_than_1` — Any expression: `2 + 3`

- 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

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Name: `spread` — Argument names (parameters): `values`

```
def spread(values):
    return max(values) - min(values)
```

Return expression: `max(values) - min(values)` — Body: `return max(values) - min(values)`

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

```
(after/before) ** (1/t) - 1
```

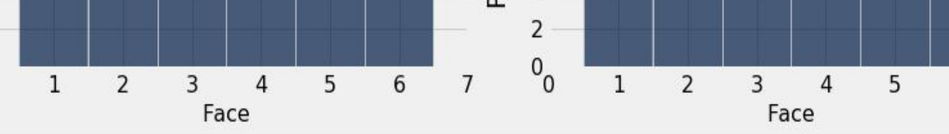
Values in Tables: Every column of a table is an array.

- **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

163, 168, 170, 171, 173, 183, 185, 188, 189, ...



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

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- 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(event does not happen) = 1 - P(event happens)

Multiplication Rule: P(two events happen) = P(one happens) * P(other happens, given the first happened)

Addition Rule: P(an event happens) = P(first way it can happen) + P(second way it can happen) IF it can happen in ONLY one of two ways

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 groupued 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
```