Lab A: Using Python as a Calculator

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2020 Summer — Calculus 1

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Jupyter Notebooks

A1. **RUN** the following "code cell" (gray rectangle with `In[ ]` next to it), by CLICKING the code cell and pressing SHIFT+RETURN. Notice that only the last result will display.

In [ ]:
```
1 + 2 + 3
50 - 3
100*5
```

A2. **RUN** the following. As always, only the last result displays, but the last result has 2 parts because of the comma.

In [ ]:
```
1 + 2 + 3
50 - 3, 1000*1000
100*5, 7*7
```

A3. The "+" on the toolbar adds a code cell. The "scissors" deletes a code cell.

Python arithmetic + - * / **

A4. **RUN** the following.

In [ ]:
```
3 + 10*5,  5**2,  27/10
```

A5. **EXERCISE.**
a) What does each of the 5 arithmetic operations do?
b) Do spaces around the 5 operations matter, or is it just style?

In [ ]:
```
# TYPE YOUR ANSWERS BELOW
#
#  a) + is
#     - is
#     * is
#     / is
#    ** is
#
#  b)
```

Python # and =

A6. **RUN** the following. You will notice python ignores everything after #

In [ ]:
```
# This is a comment
1 + 1 # This is also a comment
```

A7. **RUN** the following. Notice we assign variables using = Assignment itself does NOT produce output.

In [ ]:
```
a = 10
a
```

In [ ]:
```
b = 20
```

In [ ]:
```
a = 18
b = 21
c = a - b
c
```

A8. **RUN** the following. Notice you can assign multiple variables at once with a comma.

In [ ]:
```
x, y = 100, 500
x
```

In [ ]:
```
a,b,c = 3,4,5
a + b/c
```

A9. **RUN** the following. See that we can compute $\frac{(2-3)*-3}{-1+2}$ all at once (1st cell below), or we can assign variables to help us (2nd cell below).

In [ ]:
```
(2 - 3)*-3/(-1 + 2)
```

In [ ]:
```
top = (2 - 3)*-3
bottom = -1 + 2
top/bottom
```

A10. **EXERCISE.** Assign variables to help you compute $3 - \frac{3^2-2\cdot3}{2\cdot3-2}$

In [ ]:
```
# Type your answer below and press SHIFT+ENTER
```

Order of Operations

A11. **RUN** the following. Notice $a - b * c = a - (b * c)$, but they do not equal $(a - b) * c$.

In [ ]:
```
a,b,c = 3,4,5

a - b*c,  a - (b*c),  (a - b)*c
```

A12. **EXERCISE.** In each row, identify NON-equivalent choice. For example, the answer to (1) is $(a - b) * c$ because $a - b * c = a - (b * c)$

(1)	$a - b * c$	$a - (b * c)$	$(a - b) * c$
(2)	$a * (b - c)$	$(a * b) - c$	$a * b - c$
(3)	$a / b + c$	$a / (b + c)$	$(a / b) + c$
(4)	$(a + b) / c$	$a + (b / c)$	$a + b / c$
(5)	$a ** (b * c)$	$(a ** b) * c$	$a ** b * c$
(6)	$a * (b ** c)$	$a * b ** c$	$(a * b) ** c$
(7)	$a/b ** c$	$(a/b) ** c$	$a/(b ** c)$
(8)	$a ** b/c$	$(a ** b)/c$	$a ** (b/c)$
(9)	$(3 - 3) - 3$	$3 - 3 - 3$	$3 - (3 - 3)$
(10)	$(2 ** 3) ** 2$	$2 ** (3 ** 2)$	$2 ** 3 ** 2$
(11)	$6 / 3 / 2$	$6 / (3 / 2)$	$(6 / 3) / 2$

In [ ]:
```
# TYPE YOUR ANSWERS BELOW.
#
#  (1)   (a - b)*c
#  (2)
#  (3)
#  (4)
#  (5)
#  (6)
#  (7)
#  (8)
#  (9)
# (10)
# (11)
```

A13. **RUN** the following example, where we add 2 sets of parentheses which show the order of the 2 operations.

In [ ]:
```
1 + 3/5
```

In [ ]:
```
(1 + (3/5))
```

A14. **EXERCISE.** Add 4 sets of parentheses, which show the order of the 4 operations.

In [ ]:
```
7 - 3 ** 2/9 + 4
```

In [ ]:
```
# Type your answer below and press SHIFT+ENTER
```

A15. **EXERCISE.** Assign `a,b,c = 4,5,8` and then evaluate $\frac{a^b - c/b}{c-a}, \frac{a^{c-b}}{c-b}, \frac{a^{3/2}}{b}, \frac{a-b(c-a)}{c-a}$

In [ ]:
```
# Type your answer below and press SHIFT+ENTER
```

Making python functions

A16. **RUN** the following.

In [ ]:
```
def g(x):
    return x**2

g(7)
```

In [ ]:
```
def h(n): return n + 100

h(7)
```

A17. **EXERCISE.** Make the function $P(x) = x^2 - 2x + 1$ and find $P(P(7))$.

In [ ]:
```
# Type your answer below and press SHIFT+ENTER
```

Built-in `%pylab` functions

Python	Math notation	Meaning
`abs(x)`	$\|x\|$	absolute value
`sqrt(x)`	$\sqrt{x}$	square root
`exp(x)`	e^x	exponential function
`log(x)`	$\ln x$	natural logarithm
`sin(x)`	$\sin x$	sine
`arcsin(x)`	$\sin^{-1} x$	inverse sine
`radians(x)`		converts degrees to radians

A18. **RUN** the code cells below. The command `%pylab` only needs to be run once per lab; it loads "built-in functions" (from python packages numpy and matplotlib).

In [ ]:
```
%pylab

sqrt(49)
```

In [ ]:
```
pi, exp(1), sin(pi/2)
```

A19. **EXERCISE.** Evaluate

1. $\sin 40^\circ$
2. $\sin^2 65^\circ$
3. $e^{(10-8.5)/3}$
4. $\arcsin(\sin(3\pi/4))$

Note. Python uses radians for all angle measurements, so you need to convert any degrees to radians.

In [ ]:
```
# Type your answer below and press SHIFT+ENTER
```

Making an array with `r_[ ]`

A20. **RUN** the following. (If you get an error, go back and run A17.) The function `r_[ ]` can make an array of numbers of your choice. We will need arrays for graphing (Lab B).

In [ ]:
```
x = r_[5,7,9,10]
x**2
```

A21. **EXERCISE.** Use `r_[ ]` to store the numbers 2,3,5,7,11 in an array named `x`. Find `x*x`.

In [ ]:
```
# Type your answer below and press SHIFT+ENTER
```

Making an array with `r_[a:b:stride]`

A22. **RUN** the following. In general, `r_[a:b]` will list integers from a up to but *not* including b. A missing a is the same as 0.

In [ ]:
```
r_[5:10]
```

In [ ]:
```
r_[:5]
```

A23. **EXERCISE.** Use `r_[a:b]` to make the array 1,2,3,4,5,6,7,8,9

In [ ]:
```
# Type your answer below and press SHIFT+ENTER
```

A24. **RUN** the following. In general, `r_[a:b:stride]` spaces out your numbers by the amount `stride` .

In [ ]:
```
r_[0:100:2]
```

A25. **EXERCISE.** Use `r_[a:b:stride]` to make the array $1, 3, 5, \ldots, 99$

In [ ]:
```
# Type your answer below and press SHIFT+ENTER
```

Making an array with `linspace(a,b,n)`

A26. **RUN** the following. Observe that `linspace(a,b,n)` lists n numbers from a to b inclusive. This is useful for generating a lot of evenly-spaced numbers, such as when graphing (Lab B). Observe that `linspace(a,b)` lists 50 numbers from a to b inclusive.

In [ ]:
```
linspace(0,10,6)
```

In [ ]:
```
linspace(0,10)
```

A27. **EXERCISE.** Use `linspace(a,b,n)` to make the array $1, 1.5, 2, 2.5, 3, 3.5, 4$

In [ ]:
```
# Type your answer below and press SHIFT+ENTER
```

A28. **EXERCISE.**
Convert average body temperature $98.6^\circ F$ to Celsius using $C = 5/9(F - 32)$.

In [ ]:
```
# Type your answer below and press SHIFT+ENTER
```

A29. **RUN** the following.
Notice that `x` and `y` are arrays,
`c_[x,y]` puts them into a table.

In [ ]:
```
x = r_[:10]
y = x**2
c_[x,y]
```

A30. **EXERCISE.**
Use `r_` to make an array of Fahrenheit values `x` $= -100, -80, -60, \ldots, 100$.
Make the corresponding array of Celsius values `y`
Use `c_` to put `x` and `y` into a table.

In [ ]:
```
# Type your answer below and press SHIFT+ENTER
```