Lab 2

COMP9021, Session 2, 2016

1 ☞ Number of trailing 0s in 1000!

Note that if the value of a variable `N` is an integer, then `N // 10` "removes" the rightmost digit from `N`, that digit being equal to `N % 10`. Write a program `trailing_0s.py` that outputs the number of trailing 0s in 1000! (1000 factorial). Do not forget to check out the functions available in the `math` module. The output of the program should be of the form:

```
There are ... trailing 0s in 1000!.
```

2 ☞ Perfect numbers

A number is perfect if it is equal to the sum of its divisors, itself excluded. For instance, the divisors of 28 distinct from 28 are 1, 2, 4, 7 and 14, and $1+2+4+7+14=28$, hence 28 is perfect. Write a program `perfect.py` that outputs all 3-digit perfect numbers. There is actually a unique solution. The output of the program should be of the form:

```
... is a 3-digit perfect number.
```

3 ☞ Decoding a multiplication

Write a program `multiplication.py` that decodes all multiplications of the form

```
   *  *  *
x     *  *
----------
*  *  *  *
*  *  *
----------
*  *  *  *
```

such that the sum of all digits in all 4 columns is constant.

The expected output is:

```
411 * 13 = 5343, all columns adding up to 10.
425 * 23 = 9775, all columns adding up to 18.
```

4 Estimating the probabilities of hypotheses in the light of more and more evidence (moderately advanced, optional)

Write a program `bayes.py` that simulates the cast of an unknown die, chosen from a set of 5 dice with 4, 6, 8, 12, and 20 faces. To start with, every die has a probability of 0.2 to be the chosen die. At every cast, the probability of each die being the chosen die is updated using Bayes' rule (find out about it if you do not know it). The probabilities are displayed for at most 5 casts. If more than 5 casts have been requested, the final probabilities obtained for the chosen number of casts are eventually displayed.

Here is a possible output:

```
Enter the desired number of times a randomly chosen die will be cast: 2

This is a secret, but the chosen die is the one with 4 faces

Casting the chosen die... Outcome: 4
The updated dice probabilities are:
 4: 37.04%
 6: 24.69%
 8: 18.52%
12: 12.35%
20: 7.41%

Casting the chosen die... Outcome: 1
The updated dice probabilities are:
 4: 54.18%
 6: 24.08%
 8: 13.55%
12: 6.02%
20: 2.17%
```

Here is another possible output:

```
Enter the desired number of times a randomly chosen die will be cast: 5

This is a secret, but the chosen die is the one with 8 faces

Casting the chosen die... Outcome: 7
The updated dice probabilities are:
 4: 0.00%
 6: 0.00%
 8: 48.39%
12: 32.26%
20: 19.35%

Casting the chosen die... Outcome: 1
The updated dice probabilities are:
 4: 0.00%
 6: 0.00%
 8: 62.33%
12: 27.70%
20: 9.97%

Casting the chosen die... Outcome: 1
The updated dice probabilities are:
 4: 0.00%
 6: 0.00%
 8: 73.51%
12: 21.78%
20: 4.70%

Casting the chosen die... Outcome: 3
The updated dice probabilities are:
 4: 0.00%
 6: 0.00%
 8: 81.76%
12: 16.15%
20: 2.09%

Casting the chosen die... Outcome: 7
The updated dice probabilities are:
 4: 0.00%
 6: 0.00%
 8: 87.57%
12: 11.53%
20: 0.90%
```

Here is still another possible output:

```
Enter the desired number of times a randomly chosen die will be cast: 20

This is a secret, but the chosen die is the one with 6 faces

Casting the chosen die... Outcome: 1
The updated dice probabilities are:
 4: 37.04%
 6: 24.69%
 8: 18.52%
12: 12.35%
20: 7.41%

Casting the chosen die... Outcome: 4
The updated dice probabilities are:
 4: 54.18%
 6: 24.08%
 8: 13.55%
12: 6.02%
20: 2.17%

Casting the chosen die... Outcome: 6
The updated dice probabilities are:
 4: 0.00%
 6: 63.54%
 8: 26.80%
12: 7.94%
20: 1.72%

Casting the chosen die... Outcome: 6
The updated dice probabilities are:
 4: 0.00%
 6: 72.10%
 8: 22.81%
12: 4.51%
20: 0.58%

Casting the chosen die... Outcome: 5
The updated dice probabilities are:
 4: 0.00%
 6: 78.68%
 8: 18.67%
12: 2.46%
20: 0.19%

The final probabilities are:
 4: 0.00%
 6: 99.68%
 8: 0.32%
12: 0.00%
20: 0.00%
```

5 Drawing hypotrochoids and epitrochoids with turtle (advanced, optional)

Study the notes on cycloidal curves, and write a program `cycloidal_curves.py` that uses `turtle` to prompt the user to—check out `turtle.textinput()` and `turtle.numinput()`:

- choose between drawing either an epitrochoid (providing no input) or a hypotrochoid (providing any input),
- input the radius R of the fixed circle, indicating min and max admissible values,
- input the radius r of the rolling circle, indicating min and max admissible values,
- input the distance between the drawing point and the centre of the rolling circle, indicating min and max admissible values,

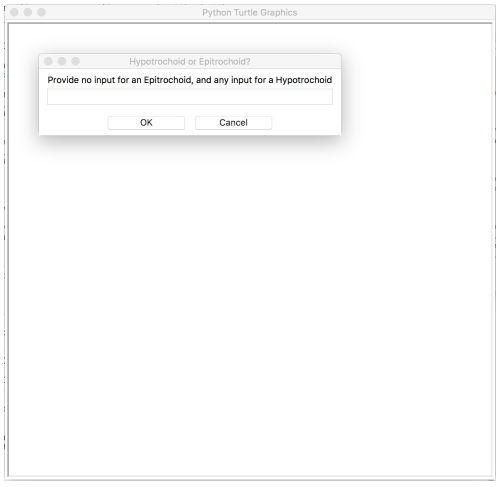
and then draws the chosen hypotrochoid or epitrochoid.

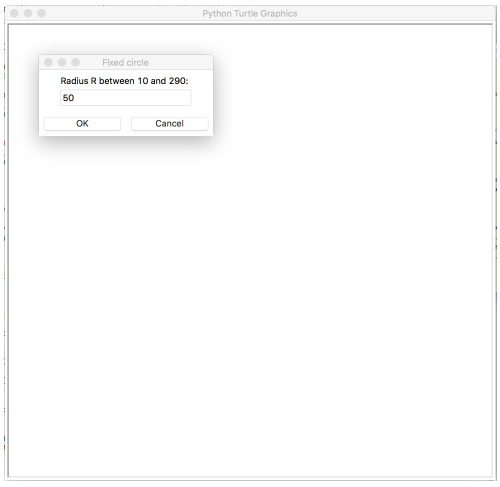
Denoting by *dim* the size of the window—check out `turtle.screensize()`—, we want:

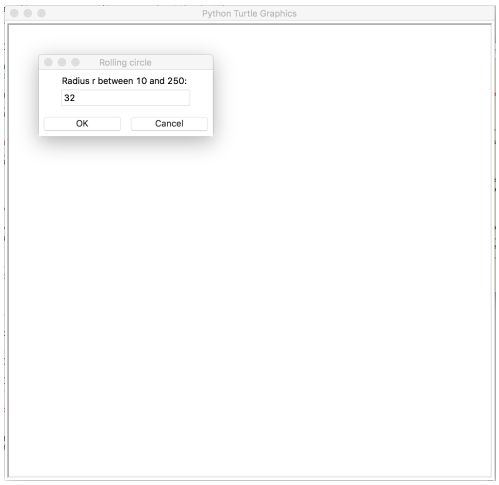
- R to be between 10 and $dim - 10$,
- r to be at least equal to 10 and such that the centre of the rolling circle is always at most *dim* away from the origin,
- d to be at least equal to 0 and such that the drawing point is at most *dim* away from the origin,
- epitrochoids to be filled in green and hypotrochoids in yellow,
- the top of the window to display—check out `turtle.title()`—one of:

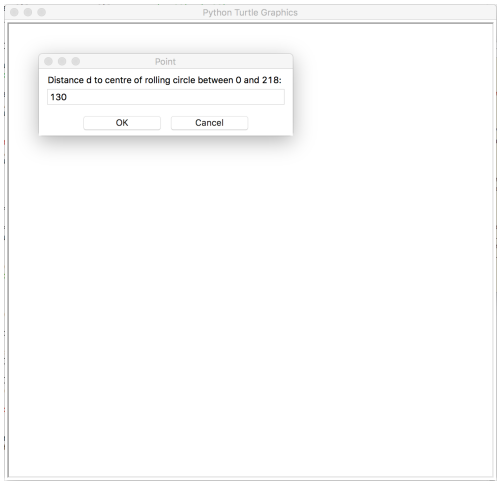
```
Epitrochoid for R = ..., r = ..., d = ... -- Period = ...
Hypotrochoid for R = ..., r = ..., d = ... -- Period = ...
```

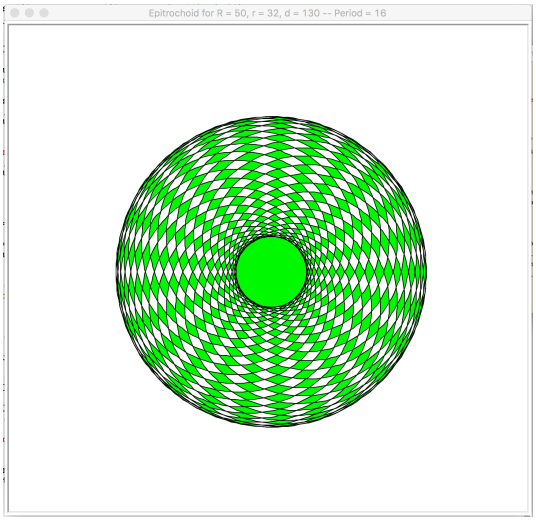
Here are screenshots of a possible interaction:











It is suggested to draw the curve moving by an angle of one degree from one point to the next.

The solution that will be provided will give the user the option to save the drawing as a postcript file—check out `turtle.getcanvas().postscript()`—after the picture has been drawn by pressing the `S` key—check out `turtle.listen()` and `turtle.onkey()`—, and using the `PIL` module, open this postcript file—check out `PIL.Image.open()`—and save it as a pdf—check out `PIL.Image.Image.save()`, naming it `Epitrochoid_R_r_d.pdf` or `Hypotrochoid_R_r_d.pdf`, before deleting the postcript file—check out the `remove()` function from the `os` module. But implementing that feature is even more optional, and cannot be experimented on the School computers as they do not have `PIL` installed...