Lab 5

COMP9021, Session 2, 2017

1 ☞ Most popular name

As in the fifth lecture, we use the data of the National Data on the relative frequency of given names in the population of U.S. births, stored in a subdirectory named `names` of the working directory, in files named `yob`*`xxxx`*`.txt` with *`xxxx`* (the year of birth) ranging from 1880 to 2013. Write a program `most_popular_name.py` that prompts the user for a first name, and finds out the first year when this name was most popular in terms of frequency of names being given, as a female name and as a male name.

Here is a possible interaction:

```
$ python3 most_popular_name.py
Enter a first name: notgivenyet
In all years, notgivenyet was never given as a female name.
In all years, notgivenyet was never given as a male name.
$ python3 most_popular_name.py
Enter a first name: Zed
In all years, Zed was never given as a female name.
In terms of frequency, Zed was the most popular as a male name first in the year 1894.
  It then accounted for 0.01% of all male names
$ python3 most_popular_name.py
Enter a first name: Zilpha
In terms of frequency, Zilpha was the most popular as a female name first in the year 1888.
  It then accounted for 0.01% of all female names
In all years, Zilpha was never given as a male name.
$ python3 most_popular_name.py
Enter a first name: John
In terms of frequency, John was the most popular as a female name first in the year 1880.
  It then accounted for 0.05% of all female names.
In terms of frequency, John was the most popular as a male name first in the year 1880.
  It then accounted for 8.74% of all male names.
$ python3 most_popular_name.py
Enter a first name: Rebecca
In terms of frequency, Rebecca was the most popular as a female name first in the year 1974.
  It then accounted for 1.03% of all female names.
In terms of frequency, Rebecca was the most popular as a male name first in the year 1975.
  It then accounted for 0.00% of all male names.
```

```
$ python3 most_popular_name.py
Enter a first name: Charlotte
In terms of frequency, Charlotte was the most popular as a female name first in the year 2013.
  It then accounted for 0.53% of all female names.
In terms of frequency, Charlotte was the most popular as a male name first in the year 1907.
  It then accounted for 0.00% of all male names.
$ python3 most_popular_name.py
Enter a first name: Madison
In terms of frequency, Madison was the most popular as a female name first in the year 2001.
  It then accounted for 1.23% of all female names.
In terms of frequency, Madison was the most popular as a male name first in the year 1881.
  It then accounted for 0.03% of all male names.
$ python3 most_popular_name.py
Enter a first name: Peter
In terms of frequency, Peter was the most popular as a female name first in the year 1887.
  It then accounted for 0.00% of all female names.
In terms of frequency, Peter was the most popular as a male name first in the year 1957.
  It then accounted for 0.54% of all male names.
```

2 ☞ The 9 puzzle (finding a solution is optional)

Dispatch the integers from `0` to `8`, with 0 possibly changed to `None`, as a list of 3 lists of size 3, to represent a 9 puzzle. For instance, let

```
[[4, 0, 8], [1, 3, 7], [5, 2, 6]]
```

or

```
[[4, None ,8], [1, 3, 7], [5, 2, 6]]
```

represent the 9 puzzle

4		8
1	3	7
5	2	6

with the 8 integers being printed on 8 tiles that are placed in a frame with one location being tile free. The aim is to slide tiles horizontally or vertically so as to eventually reach the configuration

1	2	3
4	5	6
7	8	

It can be shown that the puzzle is solvable iff the permutation of the integers 1, . . . , 8, determined by reading those integers off the puzzle from top to bottom and from left to right, is even. This is clearly a necessary condition since:

- sliding a tile horizontally does not change the number of inversions;
- sliding a tile vertically changes the number of inversions by -2, 0 or 2;
- the parity of the identity is even.

Write a program `nine_puzzle.py` with two functions:

- `validate_9_puzzle(grid)` that prints out whether or not `grid` is a valid representation of a solvable 9 puzzle;

- `solve_9_puzzle(grid)` that, assuming that `grid` is a valid representation of a solvable 9 puzzle, outputs a solution to the puzzle, with a minimal number of moves.

Here is a possible interaction:

```
$ python3
Python 3.6.2 ...
>>> from nine_puzzle import *
>>> validate_9_puzzle([[1, 2, 3], [4, 5, 6], [7, 8, 9]])
This is an invalid or unsolvable 9 puzzle
>>> validate_9_puzzle([[1, 2, 3], [4, 1, 6], [7, 8, 0]])
This is an invalid or unsolvable 9 puzzle
>>> validate_9_puzzle([[1, 2, 3], [4, 5, 6], [7, 8]])
This is an invalid or unsolvable 9 puzzle
>>> validate_9_puzzle([[1, 2, 3], [4, 5, 6], [7, 8, 0]])
This is a valid 9 puzzle, and it is solvable
>>> solve_9_puzzle([[1, 2, 3], [4, 5, 6], [7, 8, 0]])
Here is a minimal solution:

  1  2  3
  4  5  6
  7  8
>>> validate_9_puzzle([[1, 2, 3], [4, 5, 6], [None, 8, 7]])
This is an invalid or unsolvable 9 puzzle
>>> validate_9_puzzle([[1, 2, 3], [4, 5, 6], [None, 7, 8]])
This is a valid 9 puzzle, and it is solvable
>>> solve_9_puzzle([[1, 2, 3], [4, 5, 6], [None, 7, 8]])
Here is a minimal solution:

  1  2  3
  4  5  6
     7  8

  1  2  3
  4  5  6
  7     8

  1  2  3
  4  5  6
  7  8
>>> validate_9_puzzle([[4, None, 8], [3, 1, 7], [5, 2, 6]])
This is an invalid or unsolvable 9 puzzle
>>> validate_9_puzzle([[4, None, 8], [1, 3, 7], [5, 2, 6]])
This is a valid 9 puzzle, and it is solvable
```

```
>>> solve_9_puzzle([[4, None, 8], [1, 3, 7], [5, 2, 6]])
Here is a minimal solution:

  4     8
  1  3  7
  5  2  6

  4  3  8
  1     7
  5  2  6

  4  3  8
     1  7
  5  2  6

  4  3  8
  5  1  7
     2  6

  4  3  8
  5  1  7
  2     6

  4  3  8
  5  1  7
  2  6

  4  3  8
  5  1
  2  6  7

  4  3
  5  1  8
  2  6  7

  4     3
  5  1  8
  2  6  7

  4  1  3
  5     8
  2  6  7

  4  1  3
  5  6  8
  2     7

  4  1  3
  5  6  8
  2  7

  4  1  3
  5  6
  2  7  8
```

```
4  1  3
5     6
2  7  8

4  1  3
   5  6
2  7  8

4  1  3
2  5  6
   7  8

4  1  3
2  5  6
7     8

4  1  3
2     6
7  5  8

4  1  3
   2  6
7  5  8

   1  3
4  2  6
7  5  8

1     3
4  2  6
7  5  8

1  2  3
4     6
7  5  8

1  2  3
4  5  6
7     8

1  2  3
4  5  6
7  8
```

3 Extracting information from a web page (optional)

Write a program `SMS_titles.py` that extracts titles from a front page `SMH.html` of the Sydney Morning Herald, also provided under the name `SMH.txt`, meant to be saved in the working directory. You are provided with the expected output, saved in the file `SMS_titles_outputs.txt`, though you might do a better job and remove some of the titles (for instance, *The Lady who lives on the Moon* could go...). Make sure that the output does not include any unwanted HTML entity.

For this question, you can either use the `beautifulsoup` package (see the program `worldbank.py` from the first set of notes) or regular expressions.

4 Sierpinski triangle (optional)

Write a program `sierpinski_triangle.py` that generates Latex code, a `.tex` file, that can be processed with pdflatex to create a `.pdf` file that depicts Sierpinski triangle, obtained from Pascal triangle by drawing a black square when the corresponding number is odd. A simple method is to use a particular case of Luca's theorem, which states that the number of ways of choosing k objects out of n is odd iff all digits in the binary representation of k are digits in the binary representation of n. For instance:

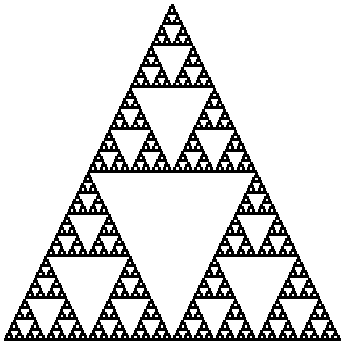
- $\binom{5}{3} = 10$, which corresponds to a white square as 10 is even; indeed, 5 is 101 in binary, 3 is 11 in binary, and there is at least one bit set to 1 in 11 (namely, the leftmost one), which is not set to 1 in 101;
- $\binom{6}{2} = 15$, which corresponds to a black square as 15 is odd; indeed, 6 is 110 in binary, 2 is 10 in binary, and all bits (actually, the only bit) set to 1 in 10 are set to 1 in 110.

So your program has to generate a file named `Sierpinski_triangle.tex`, similar to the one provided; examine the contents of this file to see which text needs to be output.

The file `Sierpinski_triangle.pdf` is also provided, but if you want to generate it yourself from `Sierpinski_triangle.tex`, you need to have Tex installed on your computer (install it if that is not the case, see `http://www.tug.org/texlive/`), and then execute

```
pdflatex Sierpinski_triangle.tex
```

from the command line, or open `Sierpinski_triangle.tex` in the Latex editor that comes with your distribution of Tex, and it will just be a matter of clicking a button...



5 A calendar program (optional, advanced)

Write a program `calendar.py` that provides a variant on the Unix `cal` utility (in particular because it lets the weeks start on Monday, not Sunday), following this kind of interaction:

```
$ python3 calendar.py
I will display a calendar, either for a year or for a month in a year.
The earliest year should be 1753.
For the month, input at least the first three letters of the month's name.
Input year, or year and month, or month and year: 3194 Sept
    September 3194
 Mo Tu We Th Fr Sa Su
           1  2  3  4
  5  6  7  8  9 10 11
 12 13 14 15 16 17 18
 19 20 21 22 23 24 25
 26 27 28 29 30
$ python3 calendar.py
I will display a calendar, either for a year or for a month in a year.
The earliest year should be 1753.
For the month, input at least the first three letters of the month's name.
Input year, or year and month, or month and year: dEcEm 3194
    December 3194
 Mo Tu We Th Fr Sa Su
           1  2  3  4
  5  6  7  8  9 10 11
 12 13 14 15 16 17 18
 19 20 21 22 23 24 25
 26 27 28 29 30 31
```

```
$ python3 calendar.py
I will display a calendar, either for a year or for a month in a year.
The earliest year should be 1753.
For the month, input at least the first three letters of the month's name.
Input year, or year and month, or month and year: 3194
                                3194

       January                February                March
Mo Tu We Th Fr Sa Su  Mo Tu We Th Fr Sa Su  Mo Tu We Th Fr Sa Su
                   1  2      1  2  3  4  5  6      1  2  3  4  5  6
 3  4  5  6  7  8  9   7  8  9 10 11 12 13   7  8  9 10 11 12 13
10 11 12 13 14 15 16  14 15 16 17 18 19 20  14 15 16 17 18 19 20
17 18 19 20 21 22 23  21 22 23 24 25 26 27  21 22 23 24 25 26 27
24 25 26 27 28 29 30  28                    28 29 30 31
31

       April                  May                   June
Mo Tu We Th Fr Sa Su  Mo Tu We Th Fr Sa Su  Mo Tu We Th Fr Sa Su
                1  2  3                  1         1  2  3  4  5
 4  5  6  7  8  9 10   2  3  4  5  6  7  8   6  7  8  9 10 11 12
11 12 13 14 15 16 17   9 10 11 12 13 14 15  13 14 15 16 17 18 19
18 19 20 21 22 23 24  16 17 18 19 20 21 22  20 21 22 23 24 25 26
25 26 27 28 29 30     23 24 25 26 27 28 29  27 28 29 30
                      30 31

        July                  August               September
Mo Tu We Th Fr Sa Su  Mo Tu We Th Fr Sa Su  Mo Tu We Th Fr Sa Su
                1  2  3   1  2  3  4  5  6  7            1  2  3  4
 4  5  6  7  8  9 10   8  9 10 11 12 13 14   5  6  7  8  9 10 11
11 12 13 14 15 16 17  15 16 17 18 19 20 21  12 13 14 15 16 17 18
18 19 20 21 22 23 24  22 23 24 25 26 27 28  19 20 21 22 23 24 25
25 26 27 28 29 30 31  29 30 31              26 27 28 29 30
       October               November              December
Mo Tu We Th Fr Sa Su  Mo Tu We Th Fr Sa Su  Mo Tu We Th Fr Sa Su
                1  2      1  2  3  4  5  6            1  2  3  4
 3  4  5  6  7  8  9   7  8  9 10 11 12 13   5  6  7  8  9 10 11
10 11 12 13 14 15 16  14 15 16 17 18 19 20  12 13 14 15 16 17 18
17 18 19 20 21 22 23  21 22 23 24 25 26 27  19 20 21 22 23 24 25
24 25 26 27 28 29 30  28 29 30              26 27 28 29 30 31
31
```

In doing this exercise, you will have to find out (or just remember...) how leap years are determined, and what is so special about the year 1753...