Due date: 14.12.2020

CENG 461 — Assignment 1: Constraint Satisfaction Problems

Write a Python program that solves logic puzzles with the following properties:

- You are given some clues about 4 subjects.
- All subjects have 4 attributes.
- For each attribute, the values are all different for 4 subjects.
- For each attribute, the 4 possible values are given.
- The first attribute is always the only numeric one and takes unsigned integers.
- All attribute names and values are alphanumeric (e.g. no space character).
- There is a unique solution.

The scope of the puzzle (attributes and possible values) are given in 4 lines in data-*.txt files, each of which is as follows:

- `attribute,value1,value2,value3,value4`

Varying number of clues are given in clues-*.txt files in any order. The formal language for clues and the semantics is as the following:

- `if x=a then y=b`
  For any subject, if x attribute has the value of a, then y attribute has the value of b.
- `if x=a then not y=b`
  For any subject, if x attribute has the value of a, then y attribute does not have the value of b.
- `if x=a then either y=b or z=c`
  For any subject, if x attribute has the value of a, then either y attribute has the value of b or the z attribute has the value of c .
- `n(x=a) = n(y=b)`
  The numeric value of the subject with x=a is equal to the numeric value of the subject with y=b.
- `n(x=a) = n(y=b) + m`
  The numeric value of the subject with x=a is m more than the numeric value of the subject with y=b.
- `n(x=a) = n(y=b) - m`
  The numeric value of the subject with x=a is m less than the numeric value of the subject with y=b.
- `n(x=a) > n(y=b)`
  The numeric value of the subject with x=a is greater than the numeric value of the subject with y=b.
- `n(x=a) < n(y=b)`
  The numeric value of the subject with x=a is less than the numeric value of the subject with y=b.
- `one of {x=a,y=b} corresponds to z=c other t=d`
  There are 2 different subjects one with x=a, the other with y=b.
  For one of them it is the case that z=c, for the other one t=d.
- `{x=a,y=b,z=c} are all different`
  The subject with x=a, the subject with y=b and the subject with z=c are all different subjects.

x, **y**, **z**, **t** denote any attribute including the numeric attribute, **a**, **b**, **c**, **d** are values, **n** is the numeric attribute, **m** is an unsigned integer.

We share 3 pairs of text files each of which defines a puzzle. All the lines in these files, including the last lines, end with a Unix style newline character (Line separator is linefeed: "\n"). Locate these files in the same directory with your script. Your script should allow the user to choose a problem and then it should solve the problem. For example if the user enters **1**, your script should read **data-1.txt** and **clues-1.txt** and display the solution on the console. The rows should be sorted by the numeric values (which is always the first column) in an ascending order. The order of the columns should be the same as the order they appear in the data file.

An example run of a desired program is the following:

```
The problems available in this directory: 1 2 3
Choose a problem: 1

Here is the solution to the problem defined in data-1.txt and clues-1.txt.

years | owners   | breeds    | dogs
-------------------------------------
2006  | Douglas  | greatDane | Shadow
2007  | Fernando | pekingese | Harley
2008  | Anita    | dalmatian | Molly
2009  | Barbara  | bulldog   | Riley
```

You are free to modify the user interface as long as its functionality is the same. Do not forget to align the columns. Never use your local path in your submissions (We should be able to solve the problems as a user without editing your code!). Do not import any module which is not a part of "The Python Standard Library". We will test your code using 3 different but similar puzzles. Make sure that your code is general enough to solve all possible problems which satisfy the given assumptions. Submit a single file which is named as ceng461_hw1_<StudentId>.py (Angle brackets are not a part of the name). Your script will be tested on Linux.

See the appendix for example problems, their structures and correct solutions.

Appendix

Example 1

data-1.txt

```
years,2006,2007,2008,2009
owners,Anita,Barbara,Douglas,Fernando
breeds,bulldog,dalmatian,greatDane,pekingese
dogs,Harley,Molly,Riley,Shadow
```

clues-1.txt

```
if breeds=greatDane then years=2006
years(owners=Barbara) = years(breeds=pekingese) + 2
years(dogs=Molly) = years(breeds=pekingese) + 1
years(dogs=Riley) > years(dogs=Harley)
if owners=Douglas then not dogs=Harley
years(owners=Anita) = years(dogs=Shadow) + 2
if dogs=Riley then either owners=Douglas or breeds=bulldog
```

These clues are normally expressed in English as the following:

(You don't need to worry about the clues in English. We included them here to help you understand the problem.)

- The canine that won in 2006 is the great dane.
- The pekingese won 2 years before Barbara's dog.
- Molly won 1 year after the pekingese.
- Harley won sometime before Riley.
- Douglas' canine isn't Harley.
- Shadow won 2 years before Anita's dog.
- Riley is either Douglas' canine or the bulldog.

The solution for this puzzle:

```
years | owners   | breeds    | dogs
-------------------------------------
2006  | Douglas  | greatDane | Shadow
2007  | Fernando | pekingese | Harley
2008  | Anita    | dalmatian | Molly
2009  | Barbara  | bulldog   | Riley
```

Example 2

data-2.txt

```
years,2005,2006,2007,2008
players,Delbert,Lonnie,Perry,Steven
teams,Dodgers,Indians,Pirates,Tigers
hometowns,ChulaVista,Quimby,Ravendale,York
```

clues-2.txt

```
years(hometowns=ChulaVista) = years(teams=Indians) - 1
if teams=Tigers then not players=Steven
if hometowns=Quimby then not players=Steven
if teams=Tigers then not hometowns=Quimby
years(hometowns=York) = years(players=Steven) + 1
if years=2008 then hometowns=Quimby
years(hometowns=Ravendale) > years(players=Lonnie)
if hometowns=Ravendale then either teams=Tigers or players=Delbert
one of {players=Lonnie,players=Steven} corresponds to years=2006 other teams=Dodgers
```

The solution for this puzzle:

```
years | players | teams   | hometowns
-------------------------------------
2005  | Steven  | Dodgers | ChulaVista
2006  | Lonnie  | Indians | York
2007  | Perry   | Tigers  | Ravendale
2008  | Delbert | Pirates | Quimby
```

Example 3

data-3.txt

```
days,270,274,278,282
sailors,DebraDecker,TaraCarroll,VickyEstes,WendellOrr
boatTypes,catamaran,pilotCutter,schooner,sloop
boats,AlphaOne,BayHawk,Confluence,WaveDancer
```

clues-3.txt

```
if sailors=WendellOrr then boatTypes=pilotCutter
days(boats=BayHawk) = days(boatTypes=pilotCutter) - 4
{boats=AlphaOne,sailors=VickyEstes,sailors=TaraCarroll} are all different
{days=282,sailors=VickyEstes,boatTypes=pilotCutter} are all different
days(boatTypes=catamaran) = days(boats=WaveDancer) - 4
one of {sailors=DebraDecker,days=270} corresponds to boats=BayHawk other boatTypes=schooner
if boatTypes=sloop then either days=282 or boats=AlphaOne
```

The solution for this puzzle:

```
days | sailors     | boatTypes   | boats
-------------------------------------------
270  | VickyEstes  | catamaran   | BayHawk
274  | WendellOrr  | pilotCutter | WaveDancer
278  | DebraDecker | schooner    | AlphaOne
282  | TaraCarroll | sloop       | Confluence
```