MIDDLE EAST TECHNICAL UNIVERSITY
DEPARTMENT OF COMPUTER ENGINEERING

CENG 111

Fall 2021

Take-Home Exam 4

REGULATIONS

Due date: 23:59, 8 February 2022 *(not subject to postpone).*

Submission: Electronically. You should save your program source code as a text file named `the4.py`. Check announcement on ODTUCLASS course page for the submission procedure.

Team: There is **no** teaming up. This is an EXAM.

Cheating: Source(s) and Receiver(s) will receive zero and be subject to disciplinary action.

PROBLEM

This THE is about the automation of the application of the Turkish inheritance law.

In the Turkish legal system, the *priority group* (PG) system is used for determining the legal heirship to a *deceased*[1] (D); a PG consists of a set of heirs $\mathcal{H} = \{h_1, ..., h_n\}$. If $spouse(D)$, the spouse of the deceased (D), is alive, the inheritance (I) will be shared between $spouse(D)$ and one of the PGs. If, on the other hand, $spouse(D)$ is not alive, the whole inheritance, I, belongs to one of the PGs.

There are some rules in the PG system:

R1. In order for the inheritance (in whole or in part) to pass from the current PG to the next PG, there must be no heir in the current PG (meaning also no descendants of those in that PG exist or are alive).

R2. The shares of the "first" heirs $\mathcal{H}$ in each PG are equal. In other words, denoting the shares of an heir h_i by $s(h_i)$, the shares satisfy the following rule: $s(h_1) = ... = s(h_n)$.

R3. The share of a departed heir, $s(h_i)$, in a PG passes to his/her descendants ($descendants(h_i)$[2] – also called "second" heirs), shared by them equally.

The list of PGs and their order for getting inheritance are defined as follows:

First PG heirs are the children of the deceased D. If $spouse(D)$ is alive, heirs in this PG share among themselves the three-quarters (3/4) of the inheritance I. In this inheritance process, if a child h_i has departed then his/her descendants will partake his/her share $s(h_i)$ (R3).

Second PG heirs are the parents of the deceased D. In order for an individual in the second PG to become an heir, there must be no single individual (alive) in the first PG (R1). If $spouse(D)$ is alive, heirs in this PG share among themselves a half (1/2) of the inheritance I. In case of a departed mother or father, their descendants partake among themselves the share of the departed mother or father (R3). In other words, the siblings of the deceased can also be the heirs in the second PG.

[1] Although the word 'deceased' is a synonym for words such as 'departed', and 'dead', for the sake of clarity, we will use 'deceased' only for the person whose inheritance is being distributed.

[2] A person p is a member of $descendants(h_i)$ iff. $h_i = parent(parent(...(parent(p))...))$, where $parent$ can be either $father$ or $mother$; i.e. there is a bloodline from h_i to p in the family tree.

Third PG heirs are the grandparents of the deceased D. In other words, the heirs of the third PG are the grandmothers and the grandfathers. In order for the people in this group to be heirs, there must be no individual (alive) in the first or second PG (R1). If $spouse(D)$ is alive, heirs in this PG share among themselves a quarter (1/4) of the inheritance I. If a grandparent h_i has departed then his/her descendants partake the share $s(h_i)$ (R3).

Inheritance Status of the Alive Spouse ($spouse(D)$) depends with which PG he/she is heir:

- If he/she is heir with the first PG then he/she gets (1/4) of the inheritance I.
- If he/she is heir with the second PG then he/she gets (1/2) of the inheritance I.
- If he/she is heir with the third PG then he/she gets (3/4) of the inheritance I.
- If no heir is found in all three PGs, $spouse(D)$ receives the entire inheritance.

If $spouse(D)$ is not alive, in contrary to the individuals of PGs, the descendants of the spouse do **not** become heirs.

How the descendants partake a share $s(x)$ for a person x depends on the closeness to x and whether other descendants are alive or not.

1. Assume that x has share $s(x)$.
2. Calculate the immediate partakers:

$$P = \{c \mid c \in children(x) \ \wedge \ (alive(c) = True \ \vee \ (alive(c) = False \wedge alive\_descendants(c) \neq \emptyset))\}$$

3. Each member of P has an equal share; i.e. $s(p) = s(x)/|P|$ for each $p \in P$.
4. For each $c \in children(x)$, if $alive(c) = False$ and $alive\_descendants(c) \neq \emptyset$, then repeat Steps 1-4 with $x \leftarrow c$ and $s(c)$.

See Figure 1 for three examples.

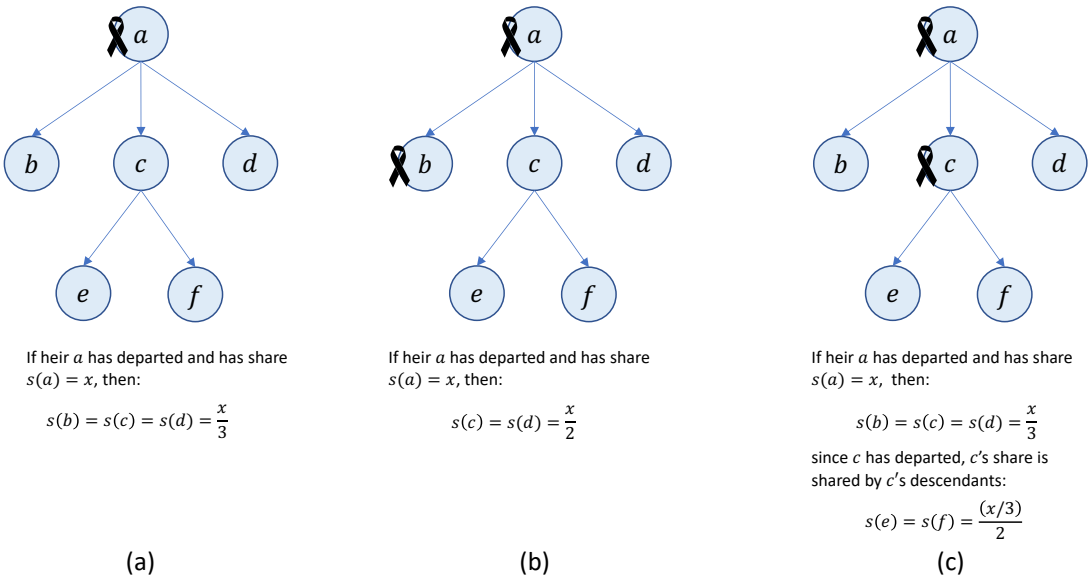

Figure 1: Three example scenarios for how descendants partake a share. A ribbon signifies a deceased/departed person.

YOUR TASK

- Write a function named `inheritance(Descriptions)`, which is provided as input `Descriptions`, a partial and unordered information about the members of the family.
- The input of the function, `Descriptions`, has the following format:

  `[Description_String_1, Description_String_2, ..., Description_String_N]`,

  where each `Description_String_`i can be any of the following:

  - `"CHILD mother_name father_name child_1_name child_2_name... child_n_name"`,
  - `"MARRIED individual_1_name individual_2_name"`,
  - `"DEPARTED individual_name"`,
  - `"DECEASED individual_name inheritance_value"`.

  Each individual's name (`..._name`), a lowercase word containing only letters from the English alphabet (no spaces) and underscores, is unique throughout the whole family. Words in a description string are separated by one or more blanks.
- The return value of the function is a single Python list, which consists of tuples of the form:

  `("individual_name", inheritance_share_value)`,

  where `inheritance_share_value` is a floating point number. The ordering of the tuples is unimportant.

SPECIFICATIONS

- All information in `Descriptions` may not necessarily be used in solving the specific inheritance problem.
- Sons-in-law, daughters-in-law adopted children are not considered as children and they do not qualify as heirs in any PG.
- Information may be provided in parts and unorganized. It is part of your task to combine them.
- You cannot assume, due to a `CHILD` assertion, that *mother* and $father$ are (still) married.
- The default vital status for any individual is alive. An explicit `DEPARTED` or `DECEASED` assertion is required to consider an individual dead.
- There will be one and only one `DECEASED` description.
- There will be no erroneous or missing input.
- `MARRIED` refers to the moment D (the deceased) passed away. Furthermore, it does not imply that the subject individuals are alive. It could be quite possible that both are dead.
- You can define as many functions as you like. Though, you cannot import any modules.

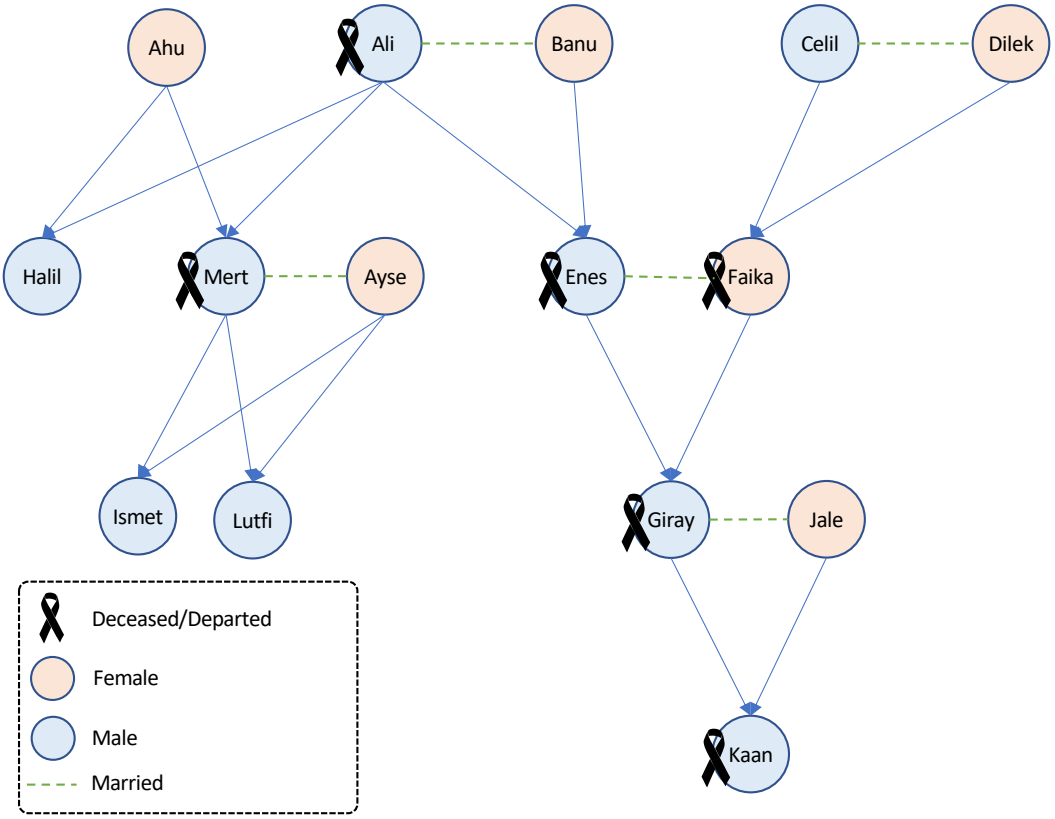

Figure 2: Example family tree for sample run.

SAMPLE RUN

We will use the tree in Figure 2 for the sample run.

```
>>> Descriptions = [
"CHILD jale giray kaan",
"CHILD faika enes giray",
"CHILD banu ali enes",
"CHILD ahu ali halil mert",
"CHILD dilek celil faika",
"CHILD ayse mert ismet lutfi",
"MARRIED giray jale",
"MARRIED faika enes",
"MARRIED ali banu",
"MARRIED celil dilek",
"DEPARTED ali",
"DEPARTED mert",
"DEPARTED enes",
"DEPARTED faika",
"DEPARTED giray",
"DEPARTED kaan"
]

>>> Example1 = Descriptions + ["DECEASED mert 100"] # First PG
>>> inheritance(Example1)
[('ismet', 50.0), ('lutfi', 50.0)]
```

```
>>> Example2 = Descriptions + ["DECEASED enes 120"] # Second PG
>>> inheritance(Example2)
[('banu', 60.0), ('halil', 30.0), ('ismet', 15.0), ('lutfi', 15.0)]

>>> Example3 = Descriptions + ["DECEASED giray 480"] # Third PG
>>> inheritance(Example3)
[('jale', 360.0), ('dilek', 30.0), ('celil', 30.0), ('banu', 30.0),
('halil', 15.0), ('ismet', 7.5), ('lutfi', 7.5)]
```

RECOMMENDATIONS

We will not provide you restrictions about how you represent the information about family. However, we can recommend the following:

- You can represent the "family tree" as a "tree-like" data structure. Be aware that this would not be the tree abstract data type in Computer Science since a node in the family tree can have more than one parent.
- You can choose any data type or mechanism (lists, tuples, dictionaries, objects of your own) to represent and aggregate the information about the family.

GRADING

- Your program will be evaluated black-box style with various inputs ranging from simple to complex.
- Slight differences in floating point results can occur; we will tolerate differences less than 10^{-8}.
- Partially correct share distribution will not receive partial grading.
- %50 of the test cases will be PG1, %30 of the test cases will be PG2, and the remaining %20 will be PG3.