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Task

Different kinds of plants live on a planet. If the nutrient of a plant runs out (its nutrient level becomes zero), the plant wastes away. There are three kinds of radiation on the planet: alpha, delta, no radiation. The different species of plants react to radiation differently. The reaction involves a change in the nutrient level of the plant and the radiation the next day. The radiation of the next day will be alpha radiation if the sum of the demand for alpha radiation over all plants is greater than the sum of the demand for delta radiation by at least three. If the demand for delta radiation is greater by at least three than the demand for alpha radiation, the radiation will be delta. If the difference is less than three, there will be no radiation. There is no radiation the first day.

Each plant has a name (string), a nutrient level (int), and a boolean that denotes whether it's alive. The plant species are wombleroot, wittentoot and woreroot. The different plant species react to the different radiations as follows. The level of nutrients changes first. After that, the plant can influence the radiation of the next day if it's still alive.

Wombleroot: Alpha radiation makes the nutrient level increase by 2, no radiation makes it decrease by 1, and delta radiation makes it decrease by 2. It demands alpha radiation by a strength of 10 regardless of the current radiation. This plant also wastes away if its nutrient level increases above 10.

Wittentoot: Alpha radiation makes the nutrient level decrease by 3, no radiation makes it decrease by 1, delta radiation makes it increase by 4. This plant demands delta radiation with strength 4 if its nutrient level is less than 5, with strength 1 if its nutrient level is between 5 and 10, and doesn't influence the radiation if its nutrient level is greater than 10.

Woreroot: Its nutrient level increases by 1 if there is alpha or delta radiation, and decreases by 1 if there is no radiation. Doesn't influence the radiation of the next day.

Simulate the ecosystem of plants and give the name of the strongest plant which is still alive after n days. Print all the data of the plants and the level of radiation on each day.

The program should read the data of the simulation from a text file. The first line contains the number of plants. Each of the next lines contains the data of one plant: its name, its species, and its starting nutrient level. The species can be: wom - wombleroot, wit - wittentoot, wor - woreroot. The last line of the file contains n, the number of days as an int. The program should ask for the filename and display the contents of the file. You can assume that the input file is correct. A possible input file:

```
4
Hungry wom 7
Lanky wit 5
Big wor 4
Tall wit 3
10
```

Analysis

Independent objects in the task are plants. They can be divided into 3 different groups: Wombleroots, Wittentoots, and Woreroots.

They all have a name and a nutrient level. It can be examined what happens when a certain type of radiation affects them. Crossing affects the plant and radiation in the following way:

Wombleroot:

Radiation	Level
Alpha	+2
Delta	-2
No radiation	-1

Wittenroot:

Radiation	Level
Alpha	-3
Delta	+4
No radiation	-1

Woreroot:

Radiation	Level
Alpha	+1
Delta	+1
No radiation	-1

Plants also have different demand of radiation:

Wombleroot: always demands radiation with strength 10

Wittenroot: demands delta radiation with strength 4 if its nutrient level is less than 5, with strength 1 if its nutrient level is between 5 and 10, and doesn't influence the radiation if its nutrient level is greater than 10

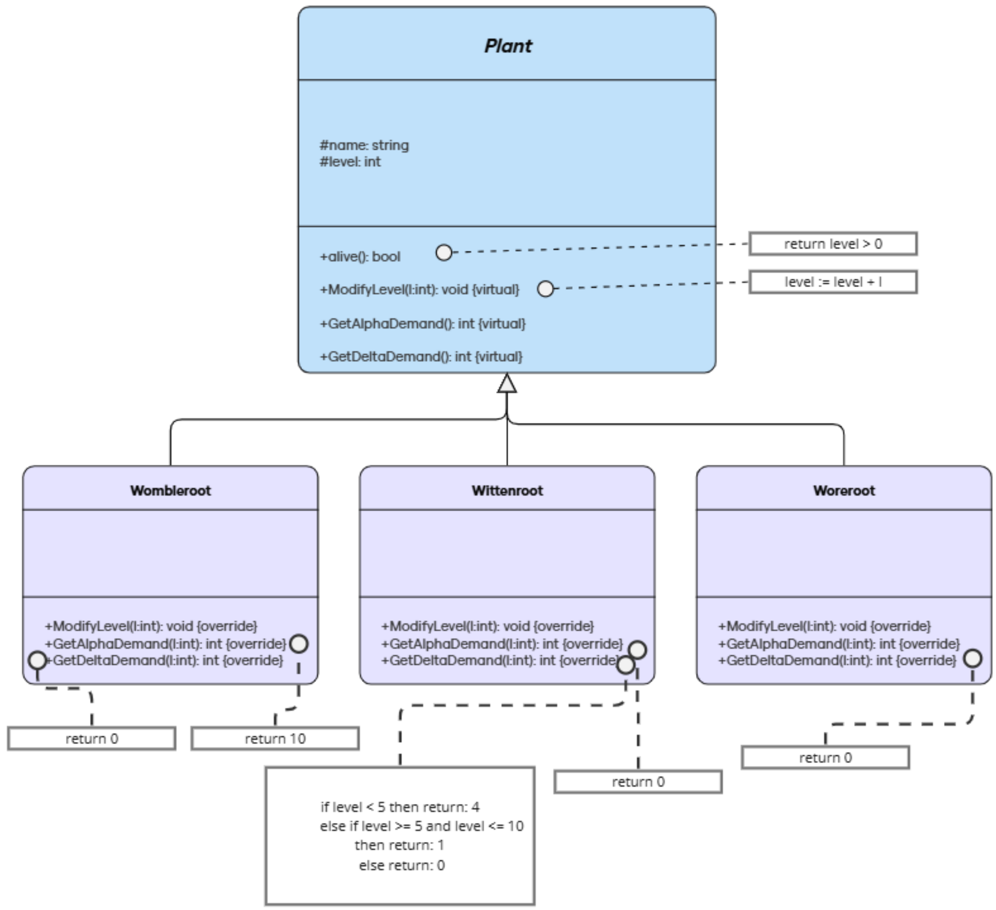
Woreroot: no demand

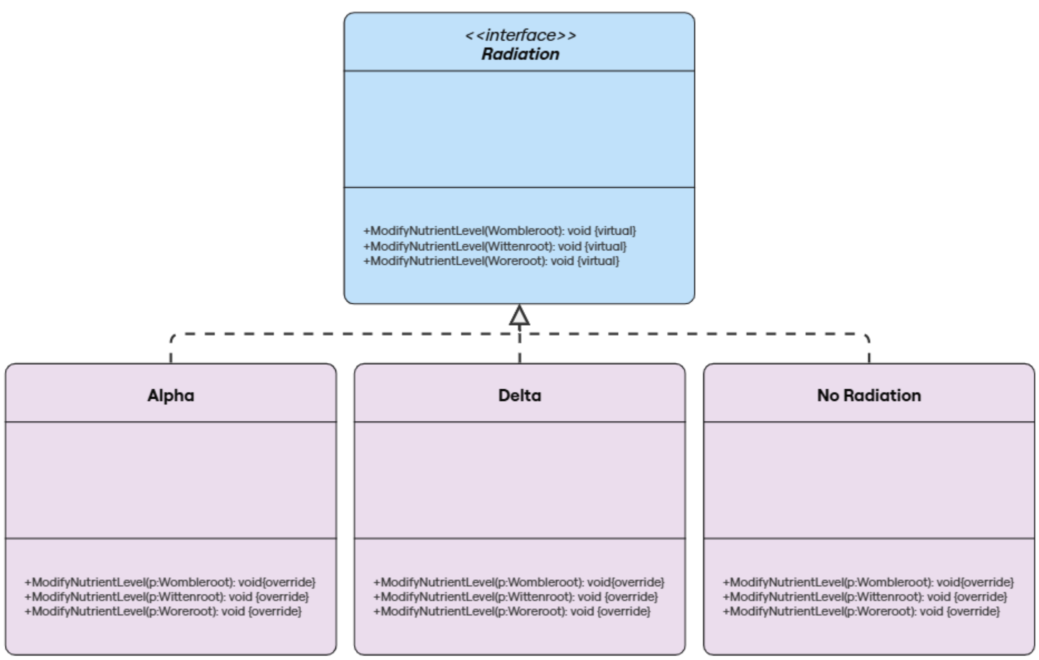
Plan

To describe the plants, 4 classes are introduced: base class Plant to describe the general properties and 3 children for the concrete species: Wombleroot, Wittentoot, and Woreroot. Regardless the type of the plants, they have several common properties, like the name (_name) and the level (_level), the getter of its name (name()), if it is alive (alive()) and it can be examined what happens when it is affected by radiation. The operation ModifyLevel() modifies the nutrient level of the plant, GetAlphaDemand() gets the demand of alpha radiation of the plant, GetDeltaDemand() gets demand of delta radiation of the plant. Operations alive() and name() may be implemented in the base class already, but ModifyLevel(), GetAlphaDemand(), and GetDeltaDemand() just on the level of the concrete classes as their effect depends on the species of the plant. Therefore, the general class Plant is going to be abstract, as methods ModifyLevel(), GetAlphaDemand(), and GetDeltaDemand() are abstract and we do not wish to instantiate such classes.

General description of the radiations is done by the interface Radiation from which concrete radiation types are realized: Alpha, Delta, and No Radiation. Every concrete radiation has three methods that show how a Wombleroot, Wittentoot, or Woreroot changes when going through radiation.

The special plant classes initialize the name and the level through the constructor of the base class and override the operation ModifyLevel() in a unique way. According to the tables, in method ModifyLevel(), conditionals could be used in which the type of the radiation would examined.


Plant
#name: string
#level: int
+alive(): bool
+ModifyLevel(l:int): void {virtual}
+GetAlphaDemand(): int {virtual}
+GetDeltaDemand(): int {virtual}
return level > 0
level := level + l
Wombleroot
+ModifyLevel(l:int): void {override}
+GetAlphaDemand(l:int): int {override}
+GetDeltaDemand(l:int): int {override}
Wittenroot
+ModifyLevel(l:int): void {override}
+GetAlphaDemand(l:int): int {override}
+GetDeltaDemand(l:int): int {override}
Woreroot
+ModifyLevel(l:int): void {override}
+GetAlphaDemand(l:int): int {override}
+GetDeltaDemand(l:int): int {override}
return 0
return 10
return 0
return 0
if level < 5 then return: 4
else if level >= 5 and level <= 10
then return: 1
else return: 0


<<interface>>
Radiation
+ModifyNutrientLevel(Wombleroot): void {virtual}
+ModifyNutrientLevel(Wittenroot): void {virtual}
+ModifyNutrientLevel(Woreroot): void {virtual}
Alpha
+ModifyNutrientLevel(p:Wombleroot): void{override}
+ModifyNutrientLevel(p:Wittenroot): void {override}
+ModifyNutrientLevel(p:Woreroot): void {override}
Delta
+ModifyNutrientLevel(p:Wombleroot): void{override}
+ModifyNutrientLevel(p:Wittenroot): void {override}
+ModifyNutrientLevel(p:Woreroot): void {override}
No Radiation
+ModifyNutrientLevel(p:Wombleroot): void{override}
+ModifyNutrientLevel(p:Wittenroot): void {override}
+ModifyNutrientLevel(p:Woreroot): void {override}

Specification

A = plants: Plant^n, radiation: Radiation, strongest: Plant

Pre = plants = plants_0 ∧ radiation = NoRadiation

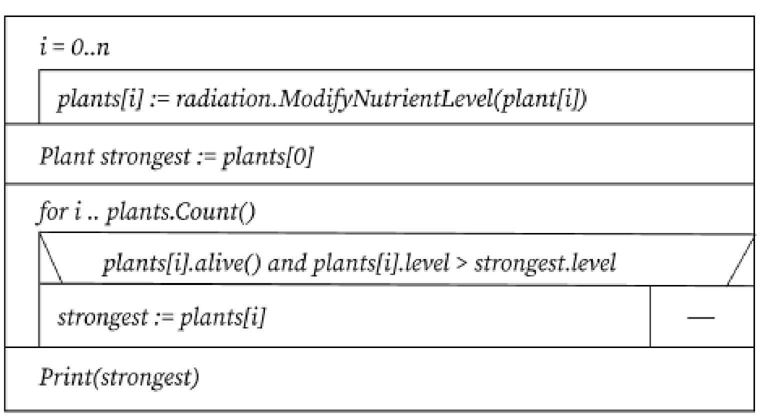
Post = plants = plants_n ∧ radiation = radiation_n ∧ ∀i∈[1..n]: (plants[i].level, radiation) = ModifyNutrientLevel(plants[i]) ∧ strongest = $\underset{e.isAlive()}{\mathrm{MAX}_{e \in n}}$ e.level

Concatenation of the plants (after n days of going through radiation) and transmuting the radiation step by step are two Summations. As all of them are based on the same enumerator, they can be merged into the same loop (i=1 .. n).

Analogy

enor(E)	i=1..n
f(e)	ModifyNutrintLevel(plants[i])
s	plants
H, +, 0	Plant* , ⊜ plants[i]

enor(E)	i=1..n
f(e)	<plants[i]> if plants[i].alive()
s	plants
H, +, 0	Plant*



Testing

Test Plant Radiation Reaction

1. Test the reaction of each plant type (Woreroot, Wombleroot, Wittentoot) to different types of radiation (Alpha, None).

- Length-based
  Test single plant reacting to radiation.
  Test multiple plants reacting to radiation.
- First and Last
  Test first plant's radiation reaction in a list of plants.
  Test last plant's radiation reaction in a list of plants.

Test Woreroot Radiation Reaction

2. Verify that the Woreroot's nutrients and life status correctly update according to its rules for each radiation type.

- Alpha Radiation
  Nutrient increases by 1.
  Plant remains alive.
- No Radiation
  Nutrient decreases by 1.
  Plant dies if nutrient falls to zero.

Test Wombleroot Radiation Reaction

3. Verify that the Wombleroot's nutrients and life status correctly update according to its rules for each radiation type.
   Alpha Radiation
   Nutrient increases by 2.
   Plant remains alive unless nutrient exceeds 10.

Test Wittentoot Radiation Reaction

4. Verify that the Wittentoot's nutrients and life status correctly update according to its rules for each radiation type
   Alpha Radiation
   Nutrient decreases by 3.
   Plant remains alive.

Radiation Demand

5. Verify that each type of plant demands the correct type of radiation based on its nutrient level and rules.
   Single Plant Demand
   Multiple Plants Demand