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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.*
- ***Wittenroot*** *: 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 until there is no radiation on two consecutive 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 program should ask for the filename and display the contents of the file.

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

Analysis[1]

Independent objects in the task are the plants. They can be divided into 3 different groups: Wombleroot ,Wittenroot and Woreroot.

All of them have a name and a power . It can be examined what happens when they face a type of radiation. Radiation effects on plants in the followingway:

Wombleroot:

Radiation	Power
Alpha	+ 2
Delta	-2
No Radiation	-1

Wittenroot:

Radiation	Power
Alpha	-3
Delta	+4
No Radiation	-1

Woreroot :

Radiation	Power
Alpha	+1
Delta	+1
No Radiation	-1

Radiation's Demand	Strength
Alpha	10
Delta	4 (< 5) 1 (5-10)
No-Radiation	0

[1] This part may be skipped. It is enough to show the tables of Influence in the Planning section

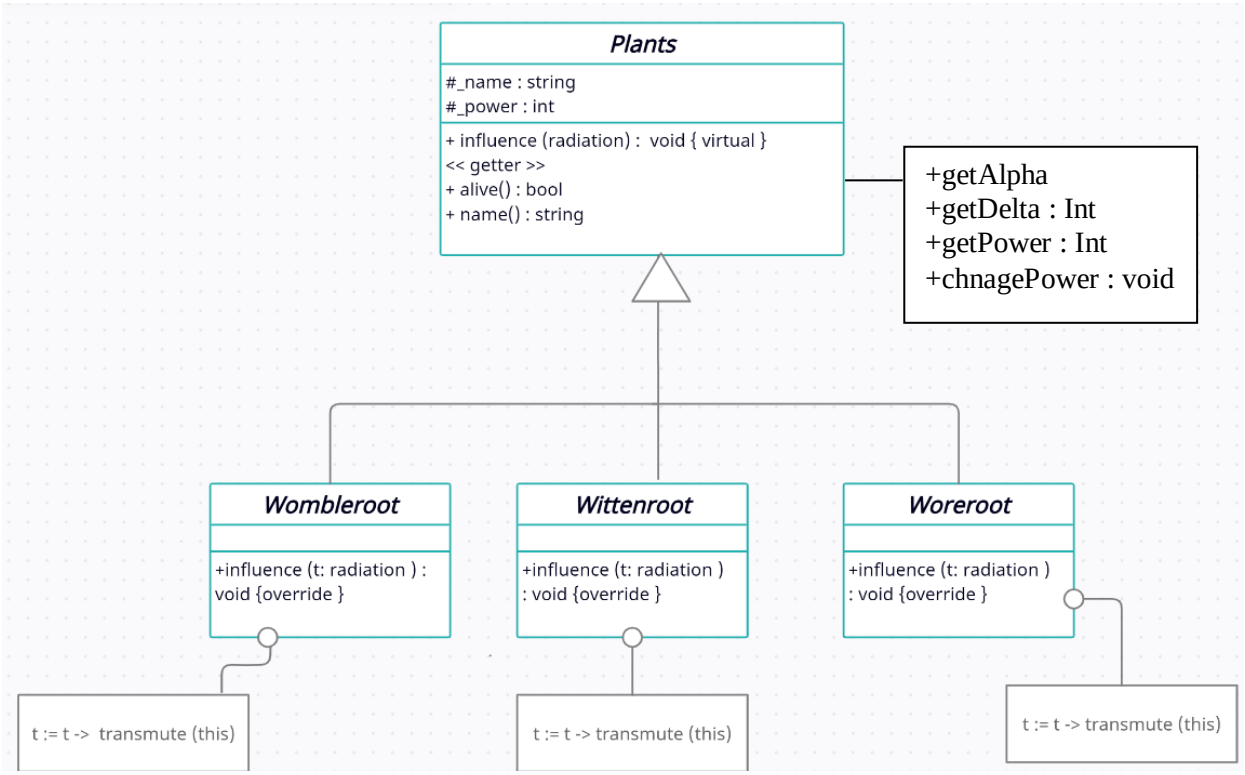
Plan[2]

To describe the Plants, 4 classes are introduced: base class *Plants* to describe the general properties and 3 children for the concrete species: *Wombleroot*, *Wittenroot*, and *Woreroot*. Regardless the type of the creatures, they have several common properties, like the name (*_name*) and the power (*_power*), the getter of its name (*name()*), if it is alive (*alive()*) and it can be examined what happens when it crosses a ground. This latter operation (*influence()*) modifies the power of the creature and transmutes the crossed ground. Operations *alive()* and *name()* may be implemented in the base class already, but *influence()* just on the level of the concrete classes as its effect depends on the species of the creature. Therefore, the general class *Plants* is going to be abstract, as method *influence()* is abstract and we do not wish to instantiate such class.

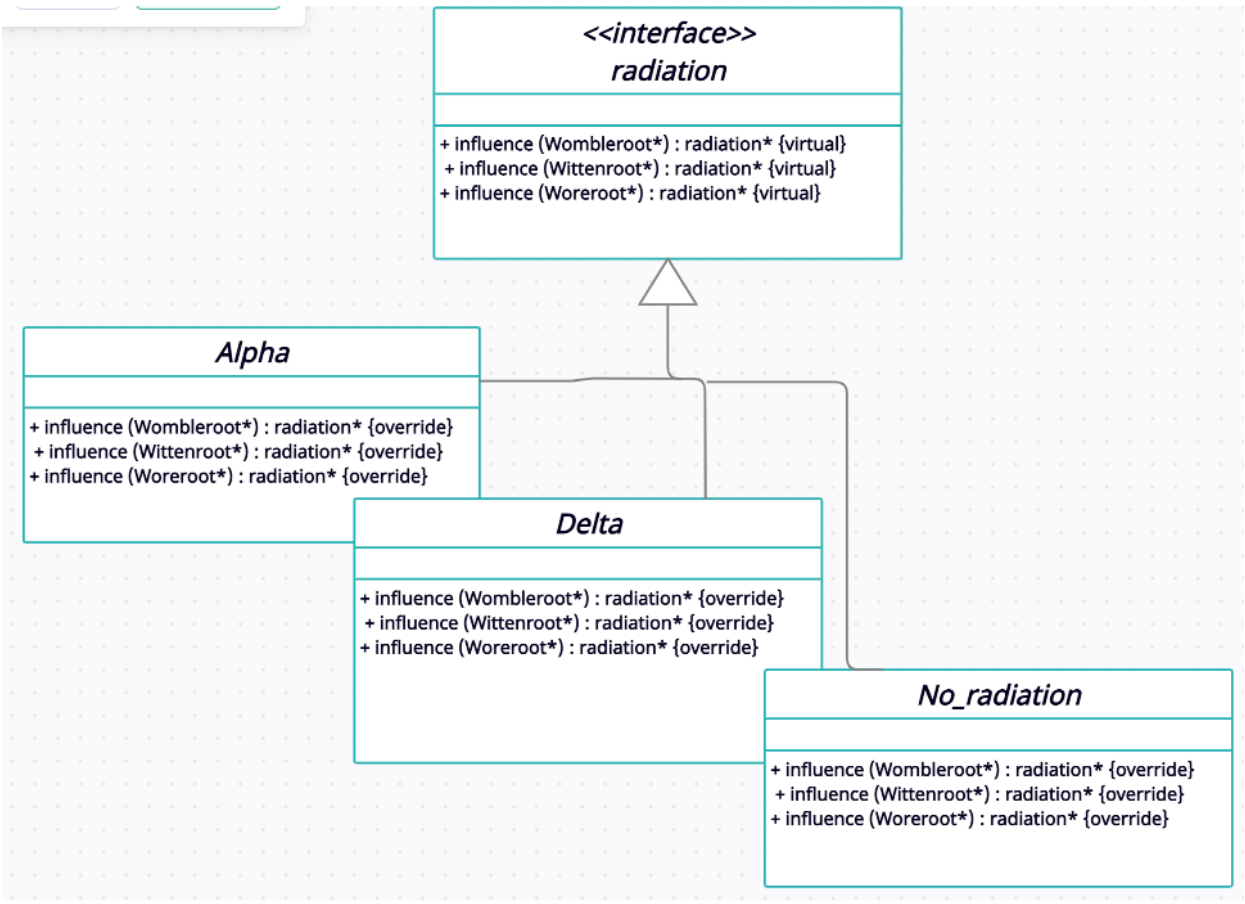
General description of the radiations is done the base class *radiation* from which concrete radiations are inherited: Alpha, *Delta*, and *No_radiation*. Every concrete radiation has three methods that show how a Womble root, a Wittenroot, or a Woreroot changes during radiation and how the power changes, too. Objects are referred by pointers.

The special plants classes initialize the name and the power through the constructor of the base class and override the operation *influence()* in a unique way. Initialization and the override are explained in Section Analysis. According to the tables, in method *influence()*, conditionals have to be used in which the type of the radiation is examined. Though, the conditionals are not effective if the program might be extended by new ground types, as all of the methods *influence()* in all of the concrete plants classes have to be modified. To avoid it, design pattern Visitor is applied where the Plants classes are going to have the role of the visitor.

[2] Plain text explanation is not necessary for the student documentations



Methods *influence()* of the concrete plants expect a radiation as an input parameter as a visitor and calls the methods which corresponds to the species of the plants.



All the classes of the grounds are realized based on the Singleton design pattern, as it is enough to create one object for each class.

In the specification, it is necessary to calculate with the n+1 versions of the radiation as every plants get influenced by it. The 0^{th} version is the initial radiation is No_radaition. The facing of one radiation is denoted by function *influence* : $Radiation \times Plants^m \rightarrow Radiation \times Plants^m$ which gives the changed radiation of next day and energy level, too. i^{th} type of the Plant is denoted by $Plant_i$, which the program is not going to show, it is going to be just a temporal value of variable *Plant*.

A = $plants: Plant^m$, $radiation: radiations^n$, $alive: Bool$

Pre = $plants = plants_0 \wedge radiations = radiations_0$

Post = $radiations = radiations_n \wedge$

$$\forall i \in [1..n]: Plants[i], radiations_i = influence(Plants_0[i], radiations_{i-1}) \wedge$$
$$Plants[i].radition == plants[i-1].radiation == No\ Radiation.$$

Concatenation of the Plants (after facing the radiation) and influencing the next days radiations .

Analogy:

enor(*E*)	*i = 1 .. n*
f(*e*)	$influence(plants[i], radiations)_1$
s	*plants*
H, +, 0	$Plants^*$, $\oplus$, <>

first component of the value of function *influence()*

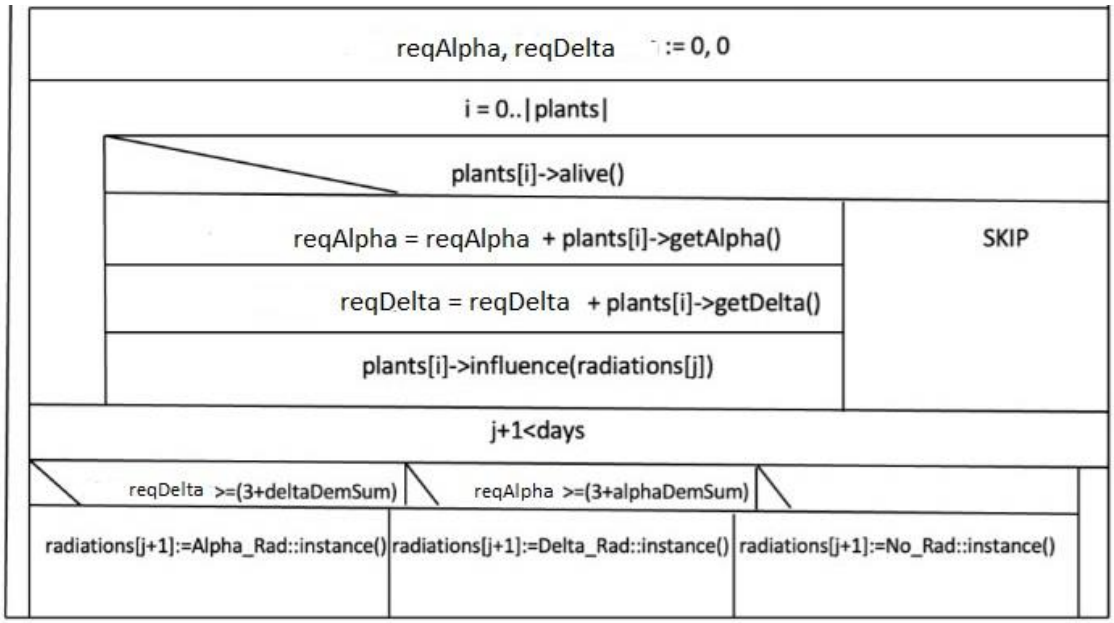
enor(*E*)	*i = 1 .. n*
f(*e*)	$influence(plants[i], radiations)_1$
s	*plants*
H, +, 0	$Plants^*$, $\ominus$, *radiation*

second component of the value of function *influence()*

$a \ominus b ::= b$

enor(*E*)	*i = 1 .. n*
f(*e*)	<*influence*[*i*]> if *influence*[*i*].*alive()*
s	*alive*
H, +, 0	$Plants^*$, $\oplus$, <>

Structogram to depict



Testing

Grey box test cases:

Outer loop (Summation)

1. length-based:
   - zero plants
   - one plants
   - more plants
2. first and last:
   - first plants survives or not the competition
   - last plants survives or not the competition

Inner loop (Summation)

1. length-based:
   - one plants on a Alpha radiation
   - one plants on a No- radiation influence properly
   - one plants on a Delta (survives or dies)

Examination of function influence()

Nine different cases depending on the plants and the radiations.