PROG1 P3 - Ant vs. SomeBees

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Introduction

In this report, we present our work on the third project of the programming course. It consisted in creating a game based on the famous one *Plants vs. Zombies©*. *Ant vs. SomeBees* was programmed using the Scala language, and the Scala-swing library for the graphic interface. This project was done using mostly the OOP paradigm, but also some FP. First, we will introduce the game and its features. Then, we will expose the class diagram, and the structure we decided to use to create this game. Finally, we will clarify some parts of the implementation.

1 Game overview

Ant vs. SomeBees is a tower defence like game. The terms are really simple : the player controls an anthill, which has five tunnels. An army of bees will try to invade it. The goal is to survive as long as possible by killing the bees entering the tunnels in waves. If a bee succeed to go through a whole tunnel, the game is lost. Each bee killed gives the player 5 points, the player score is printed in the bottom information bar.

Figure 1: Example of tunnel

Defending the tunnels In order to defend the tunnels, the player has the possibility to put some ants. This has a cost : food. The starting food amount is 2. The food amount is printed in the bottom bar. Each ant has specific cost, armour, and abilities. For example, the harvester ant collect 1 food per turn, while thrower ants can throw projectiles to attack bees. The bodyguard is a special unit, that can be put at the same place than another ant, in order to protect it.

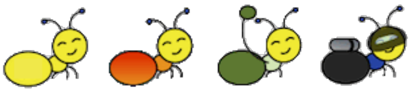


Figure 2: Some ants

Turns The game is divided in turns. The bees are continuously moving at each frame, but actions such as food collecting or shooting are performed at each turn.

Bee waves The first bee will come in after six turns, and one bee will appear at each turn from then on. The wave difficulty will increase : incoming bees will have greater armour, and damages up. There are two types of bees : the black ones, that can attack ants when they are right in front of them, and the red ones, that can shoot afar. A new bee appears in one of the five tunnels, picked up randomly.

Figure 3: Bees

Spells The player has also the possibility to use spells. This also costs food. Three spells were implemented.

	The freeze ability can be applied on a place of the tunnel, and has for consequence to freeze all bees within for three turns. Notice that they are unable to move, but not to shoot.
	The radar ability can be given to an ant. As long as the concerned ant is living, the player will be able to see the armour points of all bees in the specific tunnel.
	The upgrade spell is very powerful : it can be applied to an ant, in order to level it up. This doubles its damage power. Notice that it doesn't modify armour points, the player has to protect well its upgraded ants.

Table 1: Spells implemented

GUI The user interface contains a menu which allows the player to select a type of ant, or a spell. There is also a remove button, to delete existing ants. Notice that deleting an ant doesn't give back food. A message can be displayed in the bottom bar.

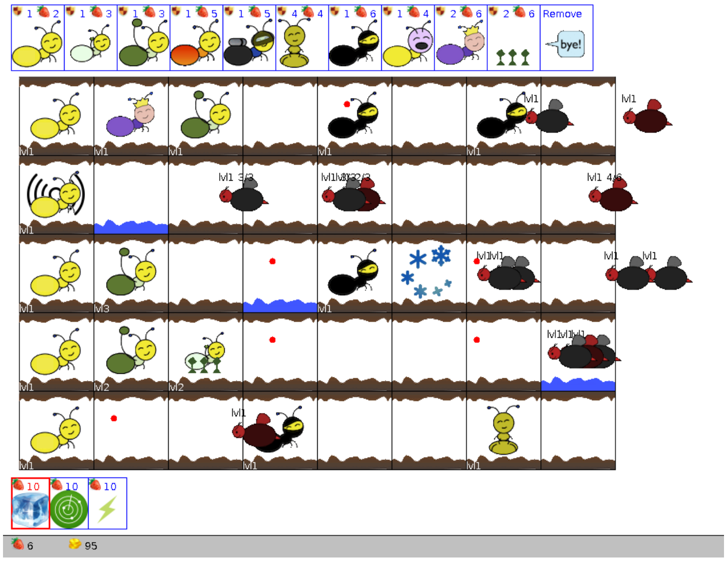


Figure 4: Graphic User Interface

2 Program's structure

The architecture of the program is based on a Model-View-Controller pattern. The View part displays the UI and warns the Controller of inputs. The Controller then decides what action should be done in response and asks the Model to do it. The latter, which only stores the elements of the game, executes the request. The game itself is composed of Places that contain Ants and Bees that fire Projectiles at each others. The overall interactions of the various parts of the program are shown in figure 5.

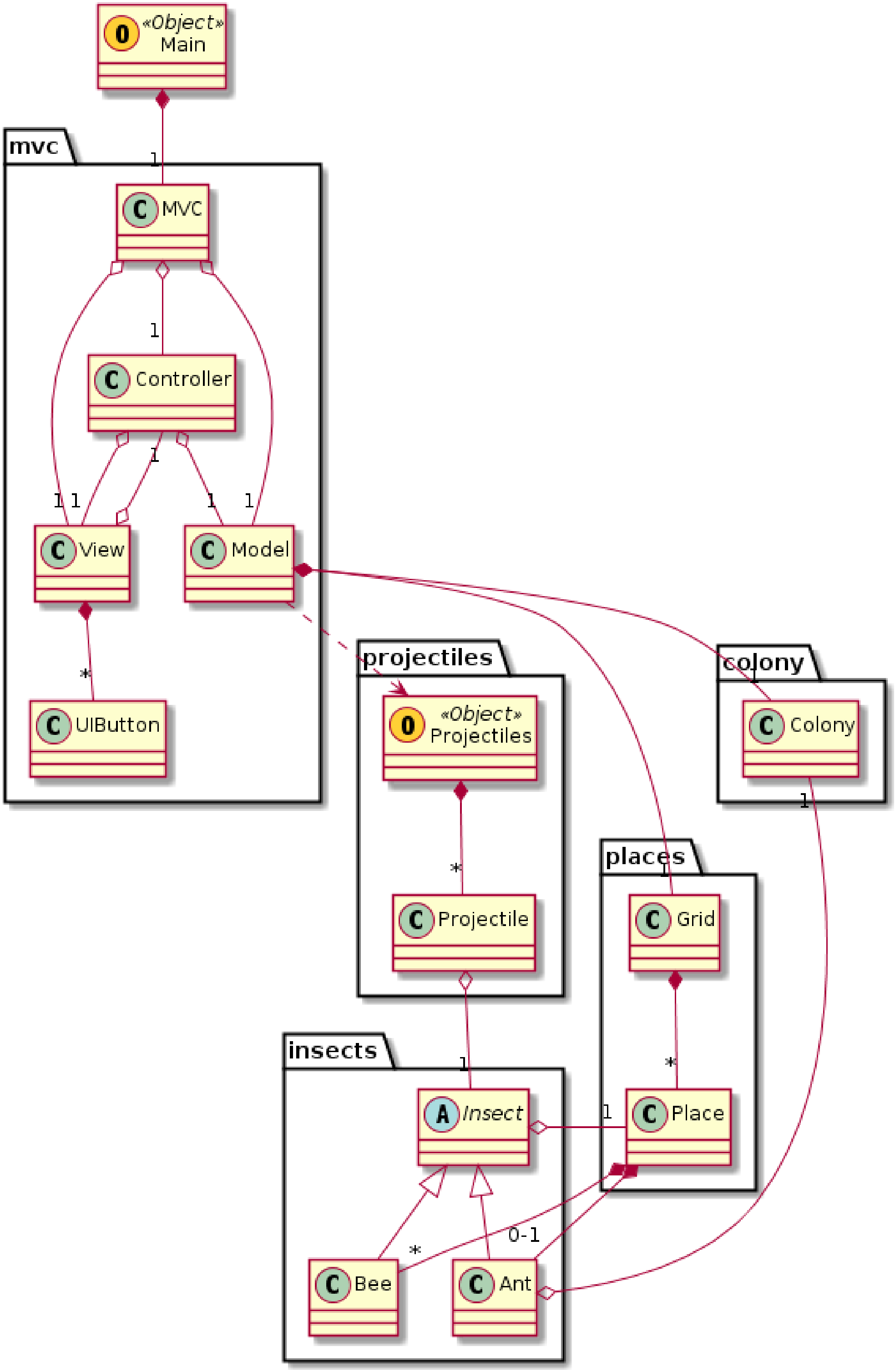


Figure 5: Global class UML diagram

2.1 Graphic User Interface

As we have previously said, the GUI, and thus the View part of the MVC, has two roles : displaying and warning the Controller of inputs. For the first part, it takes the elements of the game as parameters and draws them, along with the Buttons. Secondly, only clicks are used, so there is just to check that the click is on a valid area (i.e. on a Button or on a Place) and then tell the Controller that something has been clicked.

2.2 Game engine

As it is turn-based, the game is run by two running timers : one for the frames and a second one for the moves of the insects. On each frame (60 per second) movements are executed, bees move to the right and projectiles get closer to their target. On each move (1 per second) the insects execute their actions like attacking.

The timers are maintained by the Controller which asks the Model to do the various actions. To do that the Model has only access to the grid of places (which form tunnels). So the Model mainly goes through the grid to find the places or the insects it's interested in and then executes the tasks.

3 Implementation clarifications

Insects Insects are accessed by the Place they are in. Because of that, when a new insect is created there is no need to put it in a variable as it will automatically in the constructor add itself to the Place it is in. Insects follow a simple inheritance pattern as seen in figure 6.

The behavior of the BodyguardAnt is a little special. It can protect another ant and so the ant it protects is in a field. Thus the ant protected can be accessed only by going through the BodyguardAnt. Because of that the behavior is simple as it only asks the protected ant to do its actions. Though, it makes the management of ants by Places a bit harder as bodyguards are a special case. For example if you want to add a bodyguard ant, you have to check if the ant that is in isn't another bodyguard, and then swap the new bodyguard with the ant while putting the ant as field to the bodyguard.

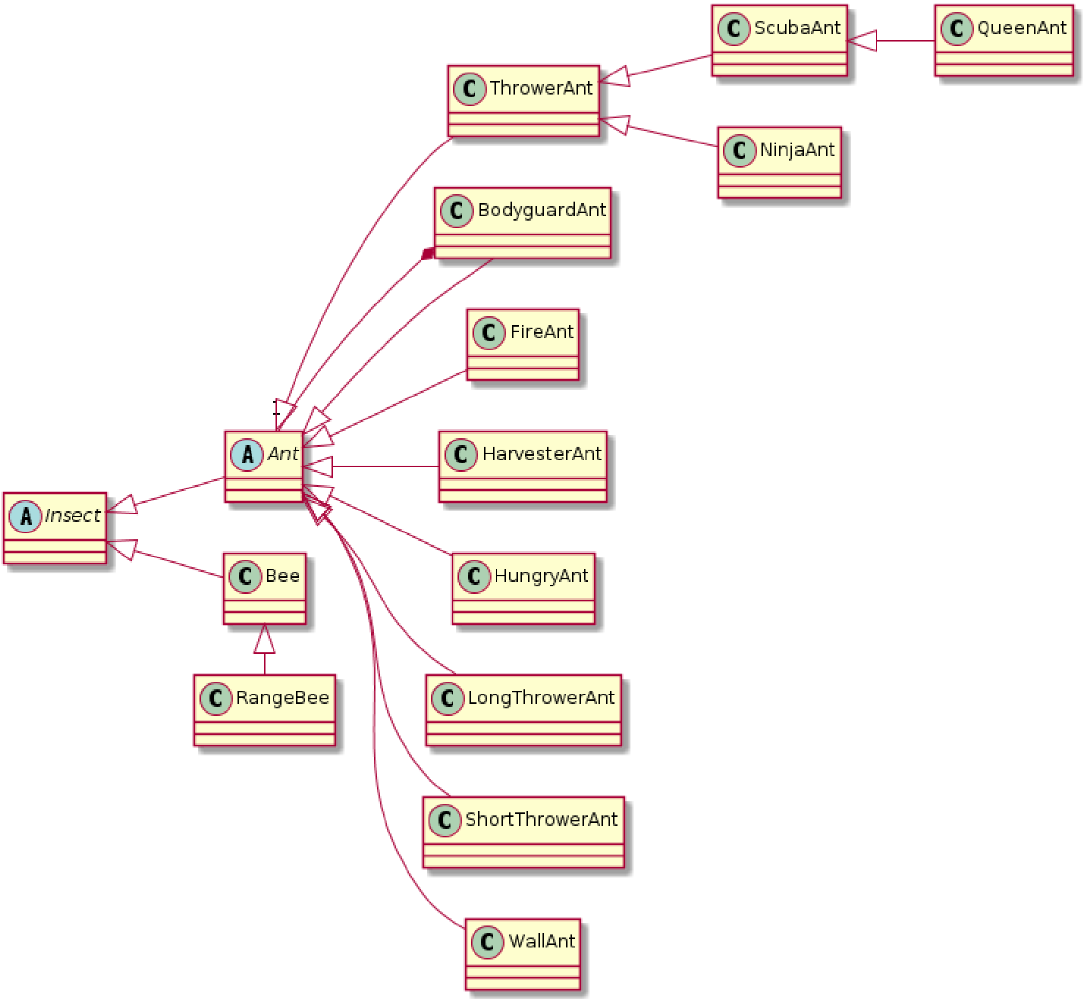
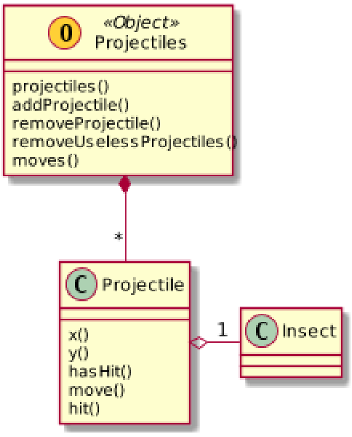


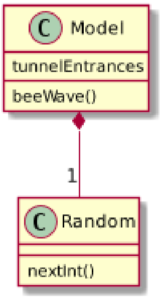
Figure 6: Insects inheritance

Throwing projectiles Apart from the instant kill of the Hungry Ants, all attacks are projectiles thrown at the enemy. To do that, a target is found by going through the entrances (or exits) of the tunnel, starting by the Place of the insect. Once there is a target (if there can possibly be one), a new Projectile is created with a position, a target, and the damages it should inflict on hit.



The constructor of a Projectile consists only on adding itself to list of projectiles of the object Projectiles. After that, on each frame, the object Projectiles is asked to move all of the projectiles. When a Projectile moves it sees if it has touched its target, and if so inflicts damages to the target and puts its field `hasHit` to true. Later on, Projectiles will be asked to remove the projectiles that have hit their target.

Bee waves To deal with the waves, we use a counter to know the wave number. The first wave is launched after 6 turns and one wave is launched on each turn from then. For that, the Controller part calls the Model function to launch a wave with the level of the bees and the number of the wave as parameters.



If the wave number is even, a range bee is launched, a classic bee otherwise. The bee is created with armour points calculated according to the bee level parameter. If the level is high enough, it also has a damage upgrade. We use a random generator to launch the bee in one of the possible tunnel entrances.

Button menu The player has the possibility to interact with the game. To manage this, we created a class to deal with selection buttons.

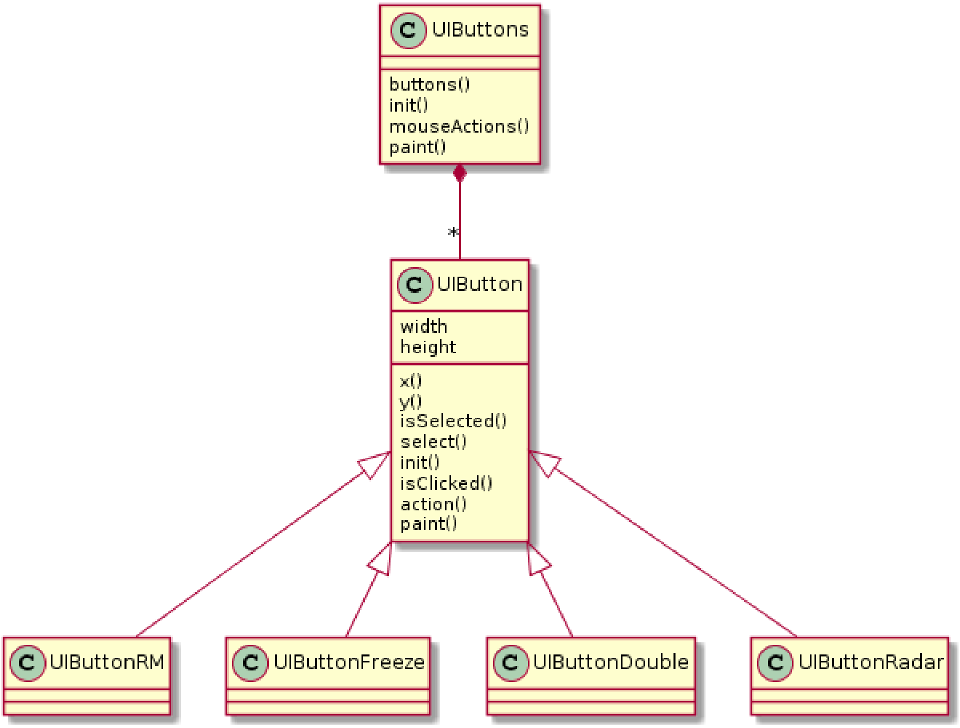
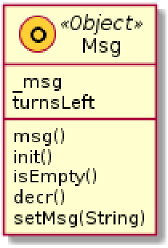


Figure 7: User interface buttons

Each button has a method to tell if it is being clicked or not. If it is, then the action manager in the View part can call the action method of the right button, which then calls the right function in the Model part. We also have the possibility to re-initialize the button, because we want at most one button selected at each moment. Each button has its method to be drawn. We can define new buttons, such as the remove one, or the spells ones, which extend the main button class. It is only necessary then to override the definition of the paint and action methods to make it operational. Adding a new button to the menu is that way very simple. Buttons are gathered in a bigger class, which has a method to deal with the mouse actions. This throws a *ClickFound* exception when the click is located, to avoid useless searching.

Information bar Sometimes, the player is trying to make illegal actions, so it is necessary to display a warning. To do this, we created an object *Msg* in View part.



When a message needs to be displayed, for example when an exception *NotEnoughFood* or *NotEmptyPlace* is caught, we have a method to set a message. It modifies the number of turns left during which the message will be displayed. In the Model part, if the message isn't empty, this number is decreased by one at each turn, and the message is re-initialized when zero is reached.

Spells To implement spells, we had to add some fields and methods in the insect and place classes. For example, we need boolean fields in the place class to be able to draw an overlay when a place is frozen, or when the ant inside has the radar ability. The freeze spell used the same type of counter than the information bar, with a decreasing counter to unfreeze the place after a fixed amount of turns. The upgrade spell calls a method to increase the damage power of an insect. The radar ability modifies a boolean of all bees in the concerned tunnel, so that the drawing function knows it also has to print the armour points of those bees.

4 Possible improvements

Along with additions, the existing code can be enhanced. To give more than a glimpse of our vision we made a whole section for it.

Better MVC separation and events For now the MVC isn't perfect as there are visual elements in the code of the Model part. For example, bees have their coordinates as fields and move depending on a fixed speed. The speed, size of the sprite and that sort of problems belong to the View part. Changing this has multiple consequences. How can a bee know if it has reached another Place ? How can a projectile know it has hit its target ? A solution could be that instead of bees and projectiles checking themselves where they are, they would listen to events that come from the View part. The events would be very specific and thus make the code easier to understand. Another consequence is that there would be a better modularity and make the management of window size easier.

AI A possible extension would be to simulate an artificial intelligence, to manage the waves of bees. It would know the state of the game, and would choose at each wave the best tunnel to try to exploit the player weaknesses. There could also be additional types of bees that counter certain ants and the AI would have to chose the most appropriate.

Symmetrical game Another extension could be to adapt the code to make the game be symmetrical : each side would have the possibility to place defensive units, and also to launch offensive ones to capture the enemy base. Adding an AI in this type of game would then be difficult and very interesting.

Conclusion

To sum up, we made a tower defence game, using both object-oriented programming and functional programming. Our program is organized with a Model-View-Controller separation, and is quite modular. Although the structure could be improved, it is at the moment well-organized enough to empower the programmer to add new features easily which is paramount. Once that the core of the game is done, it must be simple to add new elements of gameplay, and to modify the graphic user interface. We developed our program in this particular intention.

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