TP: CIVILISATION-LIKE COMBAT MECHANICS

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1. Introduction

This TP aims to implement a non-trivial problem in Object-Oriented Programming. You will have to implement in Pharo or Java all the requirements included in this document.

2. Problem Context

The problem we require you to model is a simplification of the combat mechanics in turn-based strategy games like Civilization[1] or FreeCiv[2] as an open-source alternative.

2.1. General Rules.

- We have a game board made of a grid of cases, each case might contain (or not) one unit.
- Each unit has a given type (*e.g.* Archer, Marine, Pikeman, Knight, etc), a health and experience level.
- The health level is a percentage and goes from 0% to 100%.
- The experience level is a value from 1 to 3.
- Units in neighbouring cases can attack each other.
- The attacking unit will provoke damage to the defending unit and also it will receive damage from it.
- The amount of damage received from each of the units is calculated independently using two math formulas, one for the attacker and one for the defender.
- After the battle, the health of the attacker will be reduced by the amount calculated and the same will happen to the defending unit.
- If the attacking unit gets to zero or lower health it will removed from the board.
- If the defending unit gets to zero or lower health it will removed from the board.
- If the defending unit is removed from the board, the attacking unit will move into the case occupied by the defending unit.

2.2. **Defending Unit Damage Formula.** The calculation of the impact on the defending unit is calculated by the formula in Figure 1.

[1] `https://en.wikipedia.org/wiki/Civilization_(series)`
[2] `https://en.wikipedia.org/wiki/Freeciv`

$$Dd = Ap * Atm + Dti$$

FIGURE 1. Defending Unit Damage

Defending Unit Damage (Dd). It is the impact on the health of the defending unit. This value is calculated by the formula Figure 1 and depends on the attacking unit's offensive power, the attacking unit's type and the terrain occupied by the defending unit.

Attacking Unit Power (Ap). It is the power of the attacking unit type multiplied by the factor of experience. The factor of experience is equal to 1 for level 1, 1.5 for level 2, and 2 for level 3.

Defending / Attacking Unit Types Combination Modifier (Atm). This value depends on the combination of the types of defending and attacking units. Some units have benefits when fighting against other units. For example, If a Knight attacks a Warrior unit, the Knight has a modifier of 2, as the Knight can charge a Warrior unit. If a Knight attacks a Pikeman unit, the Knight has a modifier of 1 as the Pikeman can repeal the charge of the knight. For a complete list, see the table of units (Section 3).

Defending Unit Terrain Impact (Dti). The combat is performed in the case occupied by the defending unit. Each case has a given type of terrain, and each type of terrain provides its own Defending Unit Terrain Impact value. For a complete list, see the table of terrains (Section 4).

2.3. **Attacking Unit Damage Formula.** The calculation of the impact on the attacking unit is calculated by the formula in Figure 2.

$$Ad = Dp * Dtm + Ati$$

FIGURE 2. Attacking Unit Damage

Attacking Unit Damage (Ad). It is the impact on the health of the attacking unit. This value is calculated by the formula Figure 2 and depends on the defending unit's defensive power, the defending unit's type and the terrain occupied by the defending unit.

Defending Unit Power (Dp). It is the power of the defending unit type multiplied by the factor of experience. The factor of experience is equal to 1 for level 1, 1.75 for level 2, and 2.5 for level 3.

Defending / Attacking Unit Types Combination Modifier (Dtm). This value depends on the combination of the types of defending and attacking units. Some units have benefits when fighting against other units. For example, if a Knight attacks a Pikeman unit, the Pikeman has a modifier of 2 as it can repeal the charge of the knights. If a Knight

attacks a Warrior unit, the warrior has a modifier of 1, as it does not have any advantage in the defence. For a complete list, see the table of units (Section 3).

Attacking Unit Terrain Impact (Ati). The combat is performed in the case occupied by the defending unit. Each case has a given type of terrain, and each type of terrain provides its own Attacking Unit Terrain Impact value. For a complete list, see the table of terrains (Section 4).

3. Units

For this TP we are going to consider the following units:

Warrior. A basic foot soldier holding a sword

- **Attacking Unit Power:** 10
- **Defense Unit Power:** 10
- **Relations with other units:** N/A

Archer. A basic foot soldier with a bow and arrows.

- **Attacking Unit Power:** 20
- **Defense Unit Power:** 5
- **Relations with other units:** N/A

Pikeman. A soldier armed with a Pike. Effective against charges from the Knights.

- **Attacking Unit Power:** 5
- **Defense Unit Power:** 20
- **Relations with other units:** When it is attacked by a knight, it has a **Dtm** value of 2.

Knight. The Knight is a heavy cavalry unit.

- **Attacking Unit Power:** 20
- **Defense Unit Power:** 5
- **Relations with other units:** When charging on any non-Pikeman unit, it has a **Atm** value of 2.

4. Terrains

For this TP we are going to consider the following terrains:

Flat Terrain. This terrain does not have an impact on the combat. It has **Ati** and Dti equals to 0.

Hilly Terrain. This terrain makes it easier for the attacking part. It has an **Ati** of 0 and a **Dti** of 10. If the attacking unit is a Knight, the **Dti** is doubled.

5. Test Cases

For implementing the TP, you should at least implement tests for the following use cases. For all the cases, there should be asserts for the health of the units, and the discounted points for each of them.

- As a player, I want to make combat two warrior units of level 1 in a flat terrain.
- As a player, I want to make a Knight (level 2) attack a Warrior (level 3) in hilly terrain.
- As a player, I want to make a Knight (level 2) attack a Pikeman (level 3) in hilly terrain.
- As a player, I want to make a Knight (level 2) attack a Pikeman (level 3) in a flat terrain.
- As a player, I want to make an Archer (level 1) attack a Pikeman (level 3) in a flat terrain.
- As a player, I want to make an Archer (level 1) attack a Pikeman (level 3) in a hilly terrain.

6. Administrative Considerations

The TP should be sent by the 27/10/2023. Any later sending will be not taken into account. The TP should be sent as a single zip file with the content of the project.

For Pharo solutions, you can export the whole package doing right-clicking and selecting 'File Out' generating a single file with all the code of the package, that is the file to put in the Zip.

For Java solutions, it is important to Zip the entire project. You might include any other document you consider important to explain your solution, *e.g.* if you have taken any special consideration or understanding of a given point.

In all the cases, the delivered code should compile and work. Non-compiling code will be automatically rejected.

7. About Doubts and Different Interpretations

All the rules, descriptions and requirements on this document are open to different understanding. If a point is unclear or it raises different alternatives, you are free to choose the one that better suits you. The only condition is to explain in the affected part of the TP that you have taken a given direction and why you have done it.