

**CS3911**

**Group 30**

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**Software Requirements Specification  
Document**

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## 1. Introduction

### 1.1 Purpose

This document contains the AI-Life system requirements and its analysis. Its purpose is to serve as reference for the system design; and its intended audience are system designers, project coordinator, project supervisor and the CA326 module demonstration panel.

### 1.2 Scope

The goal of development is to produce a system called AIMap.

This system will simulate a world including living and non-living elements, and interactions between the living elements and their habitat. The world in which these species reside will be represented as a map view, like games such as The Age Of Empires®. It is intended that AI games will be able to import this product as a map component inside their products.

The world biotope should be simple, and rules easy to add on the basis of the **five classic elements** of the world, so it could be possible to start with a small number of rules in an early increment of the program and to add more as needed.

**AI games** have common ways of interaction with theirs maps, this program should identify them and provide them.

The main goal of the project is to see the **emerging behaviour** of the world based on simple basic rules, although in the future species could be allowed to learn to adapt to those rules.

Living species that interact with each other in terms of **a food chain rule** should populate the world. This rule should be based on the basis of a nutritional value of prey and the predator's need to recover health lost by time and movement.

The **map** should be divided into segments so rules of animals movement and species spread can be based on this. Square cells in the beginning, and improved first to triangles and then hexagons.

Both **flora** and **fauna** should populate the world and will have special characteristics that will define how they can interact with the world, and other species.

Fauna and flora **interact with the biotope** through the state of the cell, which is influenced by the five elements.

Flora and fauna will interact with each other in terms **cell occupation**.

Fauna will also interact in terms of **producer-consumer**.

**Species** describe common **characteristics** of their individuals.

Species characteristics should depend on the age and on the health value, so a newborn, elder or wounded cow is not going to move as fast as healthy adult one.

**Interactions** should happen between **individuals** and later between full **communities**.

Cells will have different **graphical representation** depending on the state of themselves and the surrounding cells. On the other hand species individual graphical representation should depend not only on their state but also on their kind. The graphical representation should be in proportion to species sizes and cell altitude, and an inexperienced user should be able to recognise the entities of the world given their graphical representation.

### **1.3 Definitions, Acronyms, and Abbreviations.**

**Habitat:** all the non-living and living elements that are in the world.

**Edible:** subcategory of plants that animals eat on a whole and not only a part of it.

**Communities:** refers to different species that cohabit the world.

**Map:** refers to a visual representation of a world where communities reside.

**Cells:** refers to how the map is logically broken up.

**Biotope:** The set of all non-living elements that are part of the map.

**Species:** refers to different kinds of flora and fauna.

### **1.4 References**

[1] Dalmau, Daniel, *The Structure of a Game AI System*, 2004, New Riders (<http://www.informit.com/articles/article.asp?p=169492>).

[2] Tyrrell, Toby, *Computational Mechanisms for Action Selection*, 1993, University of Edinburgh (<http://www.soes.soton.ac.uk/staff/tt/AS/>).

[3] O'Connor, Rory, *Documentation Description and Guidelines* (<http://www.computing.dcu.ie/~roconnor/modules/ca326/documents.html>).

### **1.5 Overview**

The rest of the document is laid out as follows:

**Section 2** contains an overall description of the product; 2.1 details interfaces, memory constraints and a summarised functionality of the product; 2.2 contains use case diagrams, to describe the functionality of the product, and rules and characteristics upon which the overall AIMap is based. The rest of section two is concerned with users, constraints, assumptions, dependencies and the division of requirement into iterations.

**Section 3** contains details of system actors and all use case descriptions. It also contains additional requirements, which are rules for governing the system. The use cases depend on these rules. The rest of section 3 contains other key attributes, constraints and requirements.

**Section 4** contains the change management process to be implemented while developing the product, to aid in updating this document and overcoming change.

**Section 5** contains approval for this document, to be signed by the project coordinator and the project supervisor.

**Section 6** contains additional information to aid in the understanding of the functionality of the product. It contains examples of flora and fauna and their attributes.

## **2.1 Product Perspective**

This product has two purposes.

- 1: to used as a research tool in the area of AI to study animal behaviour and
- 2: to be used as the map component of another AIGame, giving the user a fully interactive experience, as resources in AI games do not usually interact with each other, only with the main characters of the game. Each game interface is different so the requirements of this AIMap will differ from game to game. The Game must be open software.

### **2.1.1 Preliminary study**

A study of the available computers in which it's going to run shows the following

Lab	CPU	RAM	Video Card
LG01	Pentium 3 ~500 MHz	261,676 Kb	ATI 3d Rage pro, 8Mb
LG25 LG26	Pentium 4 3Ghz	523,252 Kb	GeForce 4 MX 440, 64 Mb Bios 4.18.20.20.BB
LG27 LG28 L101 L201 L208	Pentium 3 Mobile ~650 MHz	261,348 Kb	Nvidea Riva TNT2 8Mb Bios 2.05.1704
L114	Pentium 4 3Ghz	523,252 Kb	GeForce 4 MX 440, 64 Mb Bios 4.18.20.20.BB
L125	Pentium 4 2.8 GHz	523,252 Kb	GeForce 4 MX 440, 64 Mb Bios 4.18.20.20.13
L128	Pentium 3 Mobile ~900 MHz	522,732 Kb	Intel 82815, 4Mb

This study concludes that the following constrains should be accepted

- Half of the computers in the computer building laboratories don't have more than 8 Mb of graphic memory

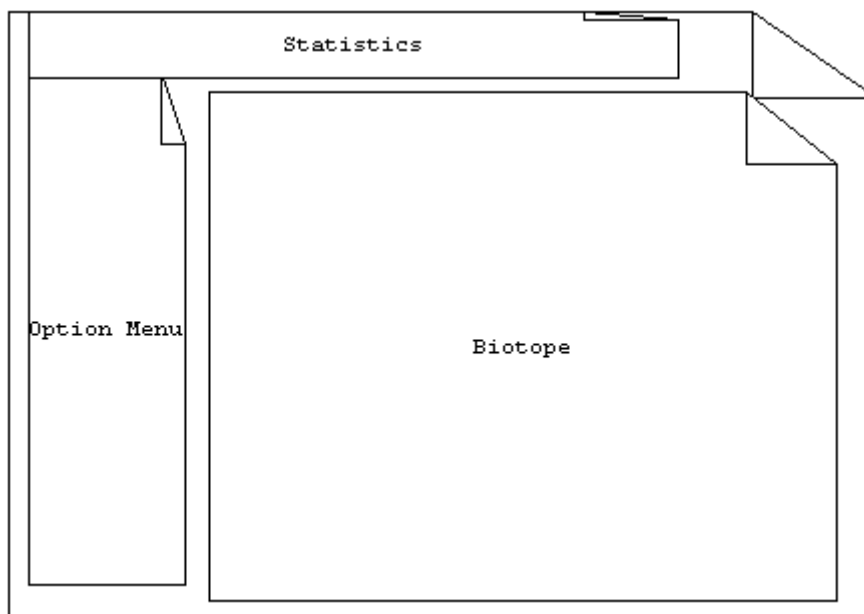
- 9/11 laboratories have Nvidia graphic acceleration so if a graphic acceleration is to be used the OpenGL library must be used and the version have to be the one provided by a Nvidia Riva TNT2 8 Mb bios 2.05.1704 the biggest.
- More than half of the computers have 256 MB RAM.
- 650 MHz is the most common speed.

### **2.1.2 System Interfaces**

The AIMap shall be the Map component of an external AI Game. The game will interface with the map by asking it to create a body for each entity in the biotope. Then it will ask for the state and perception of this particular body, and using this will instruct the body to take some action.

The concrete interface is left to the designers, as there's no particular game that will use are map component.

### **2.1.3 Interfaces**



**Figure 1 : What a running simulation may look like.**

The statistics menu may display statistics of the biotope and /or species for every time step, as per the Get Statistics use case below. This use case queries the system. The biotope is the graphical representation of the system, shown biotope characteristics and flora and fauna. It may be controlled by another AI Game that queries the system to realize actions to be taken. The option menu will allow a user to pause, stop and insert rules and elements into the biotope.

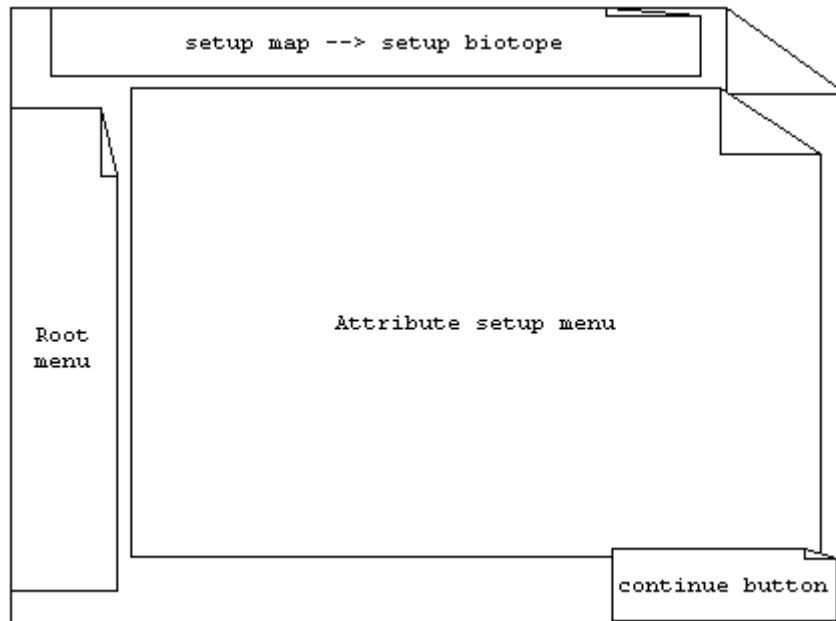


Figure 2 : What each setup menu may look like

This setup menu will be similar to all other setup menus. The continue button will instruct the program to save changes made by the user and also implement those instructions. When all is setup for a particular biotope, a Start Simulation button will become available. The root menu will allow you to return to previous step or save and quit.

#### **2.1.4 Hardware Interfaces**

This product does not control any hardware components.

#### **2.1.5 Software Interfaces**

The OpenGL library must be used and the version has to be the largest one provided by a Nvidia Riva TNT2 8 Mb bios 2.05.1704.

#### **2.1.6 Communications Interfaces**

The system does not use communication protocols because the system is run on one machine.

#### **2.1.7 Memory Constraints**

256 MB should be enough to run the system and accomplish all the requirements, but it can use up to 512 MB to run faster.

#### **2.1.8 Operations**

There are two general modes of operation:

1. **AI game component:** The system can be used in an AI game and all operation will be run for a period of time, then the AI game can be saved and stopped to carry on later, so the map should adapt to this living cycle.
2. **Environmental research:** A researcher in environmental issues can use the map or AI experimentation, having to adapt to customized setups of the map's initial components, long unattended runs, and information retrieval later.

### 2.1.9 Site Adaptation Requirements

If the graphic acceleration wants to be used, the following nvidia drivers of a graphic card must be installed. Those are any whose opengl acceleration is compatible with the one provided by a riva tnt2 8 MB bios 2.05.1704.

## 2.2 Product Functions

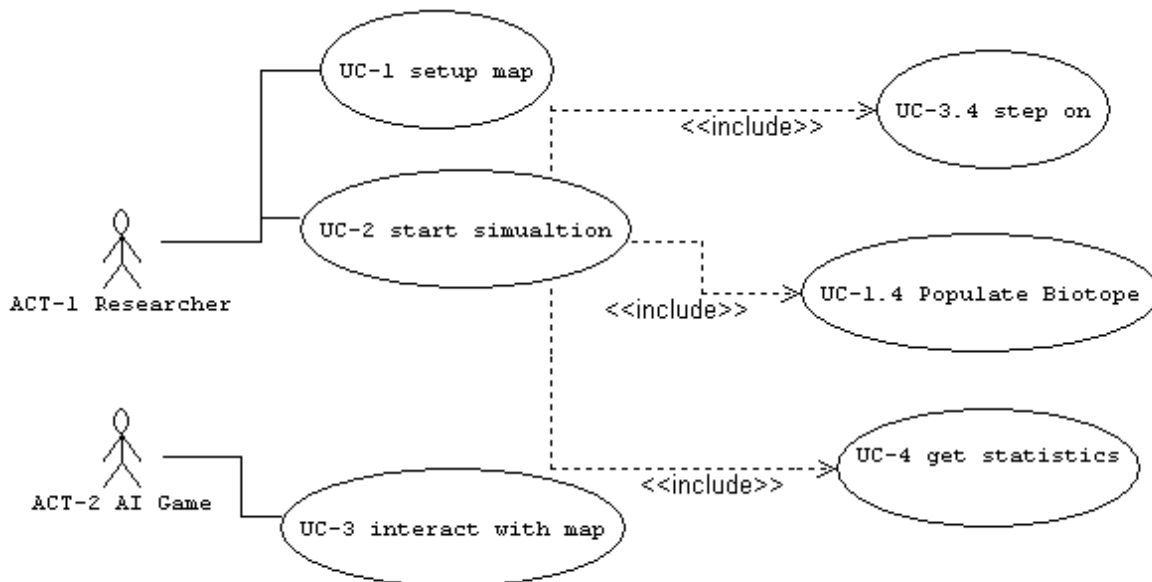


Figure 3 Context level use cases

A researcher wants to be able to setup the map before starting any class of simulation. After that he wants to be able to start the simulation and to stop it at any time to extract statistics from it.

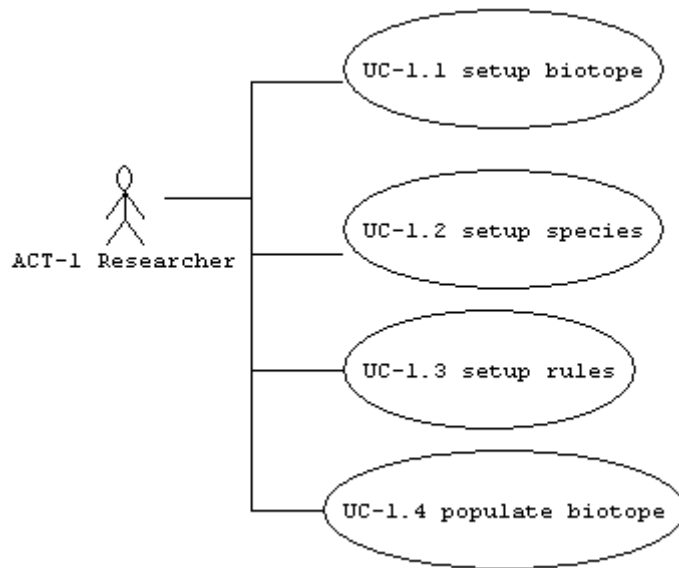


Figure 4 Setup Map

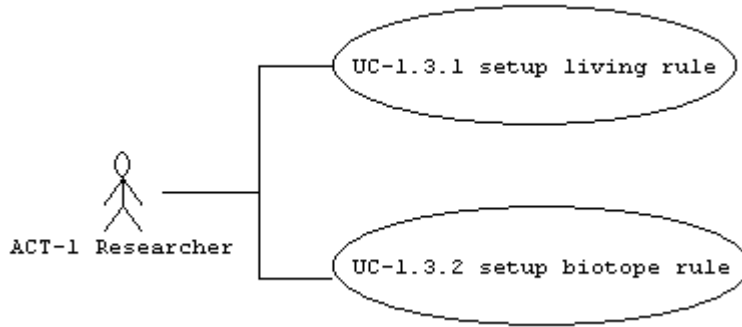
One of the parts of setting up the map is setting up the biotope. The simulated biotope is based on 5 main points, 4 from the classical world: water, air, fire and earth; and time, as researchers need to now when things are happening. Each cell on the map has associated values (from 0 to 1 in real numbers) where 0 indicates the lowest and 1 indicates the maximum. In this way setting up the biotope is reduced to setting up the arrangement of cells that form the 2 dimensions map and each cell characteristics. The arrangement setup includes deciding which cells are which cell neighbours and how many cells are in the map.

Also those characteristics indicate the state of each cell and are the basis of the external cell appearance based on a set of rules that depend on each of them.

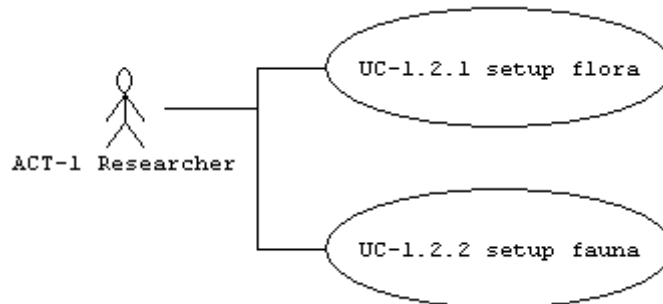
<b>Time</b>	Daylight Seasons
<b>Water</b>	Rivers Seas (depth changes with tides) Rain (optional) storms, lightning Cells have a formal value of this characteristic that depends on the distance to rivers (optional: and rain).
<b>Fire</b>	Temperature Burns things
<b>Air</b>	Wind (optional)
<b>Earth</b>	Altitude Terrain type (easier or more difficult to traverse and for plants to live (% of difficulty)) Terrain component: *Nutritional terrain (has a value) Consumed by plants growing

	<p>Increased by plants death and animals faeces and death</p> <p>*Ore terrain (easily customizable to adapt to games)</p> <p>Name</p> <p>Picture</p> <p>Value or amount</p> <p>One cell has one of all of them not a combination of them</p>
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**Table 1 Biotope characteristics and depending rules**



**Figure 5 UC-1.3 Setup rules**



**Figure 6 UC-1.2 Setup species**

Name	Flora
<b>Characteristics</b>	<p><b>Health</b></p> <p><b>Nutritional value</b> (decreases when being eaten, tree fruits)</p> <p><b>Growth speed,</b></p> <p><b>Age</b> (age = 0 increasing till max age or unnatural death)</p> <p><b>Size</b> (the bigger an individual is the slower it grows)</p> <p><b>Defence value</b> (define who can prey on them, in terms of how difficult is to eat them),</p> <p><b>Classification</b> (should be ordered in a modifiable hierarchy that starts in plants and animals and goes to cows, pines...)</p> <p><b>Possible living places</b> (range of altitude, temperature, water, terrain type allowance).</p>

	<p><b>Hunger</b> (will determine how much nutrition a plant needs)</p> <p><b>Thirst</b> (will determine how much water a plant needs)</p> <p><b>Reproduction season</b> (the season in which reproduction takes place)</p>
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**Table 2 Flora Characteristics**

Note that the amount of individuals that can live in one cell is determined by the cell value of water and space. So vegetables will compete for space and water until all the water and space is allocated. Also vegetables life is long in the case of big individuals and colonies of small ones. They will be regenerating forever, in terms of the game life, so they don't die unless conditions of the biotope change or they are eaten, destroyed, or whatever other unnatural death arrives.

Name	Fauna
<b>Characteristics</b>	<p><b>Health</b> (effects speed, size, max age, Decreases as cow gets unhealthy, goes up as cow gets better)</p> <p><b>Maximum age</b> (optional: depend on the real living place)</p> <p><b>Speed,</b></p> <p><b>Growth speed,</b></p> <p><b>Age,</b></p> <p><b>Size,</b></p> <p><b>Perception range,</b></p> <p><b>Fighting value</b> (defines what are they capable to prey on),</p> <p><b>Defence value</b> (defines what animals are capable of preying on them, increases with size and speed and health)</p> <p><b>Possible nutrition sources</b> (should be one in the type hierarchy and can prey that type of specie and all its subspecies)</p> <p><b>Classification,</b></p> <p><b>Preferred living places</b> (always be set)</p> <p><b>Non possible living places</b> (always be set)</p> <p><b>Hunger</b> (minimum amount of food needed per day and storage capacity)</p> <p><b>Eating speed</b> (this determines how quickly at animal gains nutrition from its food),</p> <p><b>Thirst</b> (minimum amount of water needed per day and storage capacity)</p> <p><b>Max perception range time</b> (weather animal feeds at night or not)</p> <p><b>Mobility</b> (flying, swimming, by foot – will determine that if a prey is moving and the predator do not share it's mobility at that moment the predator cannot prey it even if the defence value of the prey is much lower that the predator attacking value as the latter cannot follow it). The mobility has 3 values: walking, flying, swimming – all measured from 0 to 1.</p> <p><b>Usual amount of offspring</b> (has a value interval, for example-rabbits, [3,3])</p>

	<p><b>Pregnant with</b> (amount of unborn an animal has, mammals or birds or fish)</p> <p><b>Reproduction season</b> (the season in which reproduction takes place)</p>
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Table 3 Fauna Characteristics

Some flora and fauna examples of individual cases can be found in appendices 1 and 2.

The system needs to provide, to any AI game user, basic interfaces and explain them, so a game can be created using them. Those are registering new individuals, permitting an individual to perceive and to interact. This interface is a body in the map, a special entity neither flora neither fauna that must be told what to do before going on with the simulation.

For example: if a game wants to create a Wall of a castle, he will have first to make sure that this entity body occupies the whole cell so no other entity can be there. (See [1] and [2]).

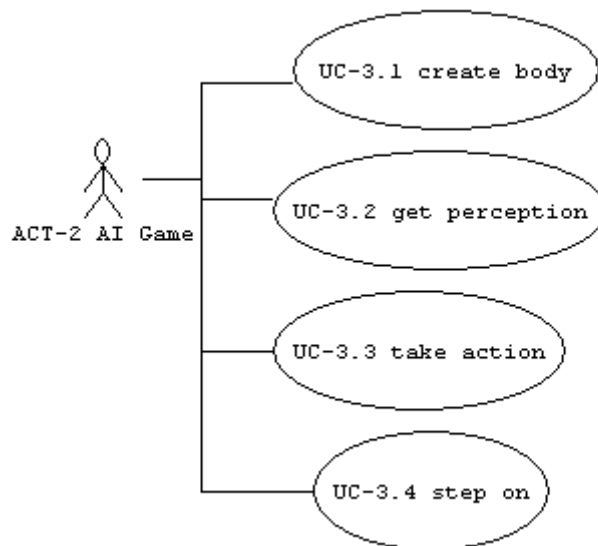


Figure 7 Interact with the map

## 2.3 User Characteristics

The intended users of this are:

1. Academics experimenting with AI, or researching specie interactions. They should have knowledge of AI and must know how the system works, as it will return results based on a researcher's decisions.
2. Game players. Game players will be able to import the AIMap to be the map component of the open source AI Game that they are playing, so that they can get complete interaction between resources of the game. They must be familiar with the setup of the map, but may leave all setting to default.

## **2.4 Constraints**

### **Parallel operation:**

When the system is being used by an AI game this and the game are going to work in parallel.

### **Higher-order language requirements**

The system has to be implemented in java or c++.

### **Reliability requirements**

Each step simulation in the world must be done by 1 second, in a Pentium 3 650Mhz, 256 MB ram, with a graphic card Riva TNT2 8Mb. The map makes all the AI graphical activity, the AI game is the brain of the bodies it has created and that make the AI game to work. The purpose of this component is to release from the AI game the responsibility of rendering the map and its content.

### **Criticality of the application**

The mark of the CA326 subject is bound to the development of this application.

### **Safety and security considerations**

The system should use ergonomic colours that do not damage the user eyes.

## **2.5 Assumptions and Dependencies**

The following has been assumed when writing the SRS:

1. They are open source games that can be run as a brain and let all the graphical rendering of the map and its components to this application.
2. The PCs that the system is going to run are the school of computing ones.

## **2.6 Apportioning of Requirements.**

The planning to be followed is detailed in appendix 3.

## **3.1 External Actor Descriptions**

### **3.1.1 Human Actors**

<b>ACT-1</b>	<b>Researcher</b>
Description	Is a human user that modifies the rules, population and map, so he can see emerging behaviour.
Notes	Thinks that the most time consuming operation is to setup the game. The main goal for him is to be able to experience the behaviour in a comprehensible way so he can study it and if needed, get back to the rules to see them.

**Table 4 ACT-1 Researcher**

### **3.1.2 Hardware Actors**

<b>ACT-2</b>	<b>AI Game</b>
Description	Is software written in the same language that the system and that is going to use the system as a component.
Notes	It could be that this component function is available through some technology that enables the final component to be reused not only by software written in the same language but is

	different also.
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**Table 5 ACT-2 AI Game**

**3.2 Use Cases**

**3.2.1 Use Case 1.1 Setup Biotope**

<b>UC-1.1</b>	<b>Setup Biotope</b>	
Preconditions	1	A researcher that knows how to use the system has asked it to setup the biotope of the map.
Description	1	If the map has already been setup the system shows all those changes and jump to the proper step.
	2	The researcher indicates the amount of cells that will compose the map.
	3	The system calculates each cell neighbours (see RQ-3).
	4a	The researcher set up the water value of each cell between 0 and 1.
	4b	The researcher set up the fire value of each cell between 0 and 1.
	4c	The researcher set up the air value of each cell between 0 and 1.
	4d	The researcher set up the earth altitude value of each cell between 0 and 1.
	4e	The researcher set up the earth terrain rough value of each cell between 0 and 1.
	4f	The researcher set up the earth terrain component of each cell between nutritional terrain and ore terrain. Then indicates the amount of it between 0 and 1. If the researcher indicated an ore terrain type, it also indicates a name and a picture associated with that ore terrain.
	4g	The researcher indicates the starting time of the system as a Gregorian date till hours.
Post conditions	1	The map biotope is setup.
Exceptions	1	In each step the user may decide to stop setting up the map. In that case the system will ask the researcher if he wants to save the changes before quitting. In this case the map biotope is not setup.
	2	In each step the user may decide to go to the previous step. The system will go to that step and remember all changes done till now. That way it will show the current step characteristics as they were before stepping back.
Notes	Steps from 3a to 3e can be done in any order Minutes and seconds are not relevant. In the beginning cells neighbourhood is determined by	

	<p>square cells in a map, later will change to triangular and hexagonal.</p> <p>The user may want to set each property over a graphical map showing all the cells, this graphical representation will depend on RQ-4 Biotope graphical representation.</p>
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**Table 6 UC-1.1 Setup Biotope**

**3.2.2 Use Case 1.2.1 Setup Flora**

<b>UC-1.2.1</b>	<b>Setup Flora</b>	
Preconditions	1	A researcher that knows how to use the system has asked it to add non-intelligent species to the biotope.
	2	The Biotope has been setup and the proper step is showing on the screen
Description	1	The researcher is allowed to select a specie from the list of non intelligent species, i.e. FLORA
	2	A set of default parameters are provided but some maybe changed by the researcher.
	3a	Set health or leave as default
	3b	Set nutritional value - may be the same as health, depending whether or not the plant produces fruit or leave as default
	3c	The system calculates the growth speed as $a \cdot \text{size} / b \cdot \text{age}$ . Note: a and b may be changed by a user later
	3d	Age: Default is 0 but maybe reset by researcher.
	3e	Initial size of one community cannot be changed.
	3f	Defence value maybe changed by researcher.
	3g	Classification cannot be changed but the 'edible' parameter maybe set to false.
	3h	Possible living places: these parameters are based on cell attributes. They maybe changed within reason for certain flora. Changes will affect health, growth speed, nutritional value etc.
	3i	Researcher sets Hunger value: Researcher set Hunger value. 2 variables here. Minimum amount of food needed per day (between 0 and 1) and storage capacity (between 0 and 1)
	3j	Researchers sets Thirst value in the same way as Hunger value above.
	3k	Researcher sets the season in which reproduction shall take place.
Post conditions	1	The specie is created and remembered by the system so it can be added to a biotope later. The user is asked if he would like to create another.

Exceptions	1	In each step the user may decide to stop adding species to the map. In this case the system will ask the researcher if he wants to save the changes before quitting. In this case the specie is not setup. The program returns to the start-up menu.
	2	In each step the user may decide to go to the previous step. The system will go to that step and remember all changes done until now. That way it will show the current step characteristics as they were before stepping back.
	3	The researcher may set all parameters to default.
Notes	Default values are as if the flora is young. All parameters are set a value between 0 and 1, except where specified.	

Table 7 UC-1.2.1 Setup Flora

### 3.2.3 Use Case 1.2.2 Setup Fauna

UC-1.2.2	Setup Fauna	
Preconditions	1	A researcher that knows how to use the system has asked it to add intelligent species to the biotope.
	2	The Biotope has been setup and the proper step is showing on the screen.
Description	1	The researcher is allowed to select a specie from the list of non intelligent species, i.e. FAUNA
	2	A set of default parameters are provided but maybe changed by the researcher.
	3a	Set health
	3b	Max living age – this will depend on living place etc. and cannot be changed. (Optional)
	3c	Age default is 0 and maybe changed up to a certain value depending on the animal.
	3d	Size of animal is the max graphical size that the animal can reach. Depends on classification. Cannot be changed.
	3e	Set max perception range (and, below, what hour this will occur). The value will decrease until the opposite hour where it will reach 0. The value will also decrease if the animal is feeding. Max perception must be twice the speed of any animal.
	3f	Defence value may be changed between certain values of size and speed values. Is calculated as $speed * size * health * a$
		Fighting value may be changed $speed * size * health * a$
	3g	Researcher set possible nutrition sources
3h	Classification cannot be changed	

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	3i	Preferred living places cannot be changed
	3j	Non possible living places cannot be changed
	3k	Researcher set Hunger value. 2 variables here. Minimum amount of food needed per day (between 0 and 1) and storage capacity (between 0 and 1)
	3l	Eating speed is calculated as $a*(size+age)$ .
	3m	Researcher sets thirst value in the same way as Hunger value above
	3n	Researcher sets max perception range time which is the time of day that the animal's perception will be at maximum and the time it will attempt to feed.
	3o	Mobility cannot be changed, but the values of each type will decrease as health deceases.
	3p	Researcher sets the usual amount of offspring one animal of a species can have. This is an interval, [a, b].
	3q	Researcher sets the season in which reproduction takes place.
	4	The system calculates speed as $a+age*b+health$ .
	5	The system calculates the growth speed as $a*size/b*age$ . Note: a and b may be changed by a user later.
Post conditions	1	The specie is created and remembered by the system, so that it maybe added to a biotope later. The researcher is asked if he would like to create another. The system remembers any changes made to the default parameters of species.
Exceptions	1	In each step the user may decide to stop adding species to the map. In this case the system will ask the researcher if he wants to save the changes before quitting. In this case the specie is not setup. The program returns to the start-up menu.
	2	In each step the user may decide to go to the previous step. The system will go to that step and remember all changes done until now. That way it will show the current step characteristics as they were before stepping back.
	3	The researcher may set all parameters to default.
Notes		All values are set between 0 and 1, except where specified.

**Table 8 UC-1.2.2 Setup Fauna**

**3.2.4 Use Case 1.3.1 Setup Living Rule**

<b>UC-1.3.1</b>	<b>Setup Living Rule</b>	
Preconditions	1	A researcher that knows how to use the system has asked it to setup the living rule.
	2	The Biotope and species have been setup and the proper step is showing on the screen.
Description	1	The researcher is asked to setup a food chain. The system will keep track of input values, and will not allow one specie prey on another if the preying animal's fighting value is less the prey's defence value.
	2	The user is asked to determine how much the difference between fighting value of a predator and a defence value of a prey has to be for a prey to survive an attack.
	3	The user is asked to determine how much health is lost for each species if he survives an attack.
	4	Also the user may change any specie coefficients, those a and b as outline in 'setup flora' and 'setup fauna'.
Post conditions	1	The rules are added to the system and the user is asked if he would like to add more.
Exceptions	1	In each step the user may decide to stop adding species to the map. In this case the system will ask the researcher if he wants to save the changes before quitting. In this case the specie is not setup. The program returns to the start-up menu.
	2	In each step the user may decide to go to the previous step. The system will go to that step and remember all changes done until now. That way it will show the current step characteristics as they were before stepping back.
	3	
Notes		

Table 9 UC-1.3.1 Setup Living Rule

**3.2.5 Use Case 1.3.2 Setup Biotope Rule**

<b>UC-1.3.2</b>	<b>Setup biotope rule</b>	
Preconditions	1	A researcher that knows how to use the system has asked it to setup an existing non-living rule.
Description	1	The system will ask him: the duration of weeks, the names of each week day, how many months a year have, each month name and duration in days, the duration of years in days, and the frequency of a special year and the number of its extra days. The default is a Gregorian calendar.

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	2	The system will ask for how many seasons, each season name and each season start and end day. It will also ask which are the summer season and its solstice and the winter season and its solstice, which are the humid season and wettest day and the dry season and the driest day. The default are the 4 occidental seasons inside a Gregorian calendar, other must be customized.
	3	The system asks the researcher whether he wants to setup the light duration, the temperature, the rain, the rivers, the tides, or any other already created rule.
	4a	If the researcher chooses to setup the light duration, the systems will asks him: the day duration in hours (24 hours) the minimum light duration and the maximum light duration.
	4b	If the researcher chooses to setup the temperature, the system will ask him whether he wants Celsius or Fahrenheit degrees, the minimum temperature and the maximum temperature.
	4c	If the researcher chooses to setup the rain, the system will ask for the maximum and minimum precipitation in millimetres.
	4d	If the researcher chooses to setup the rivers, the system will ask for the percentage of water that rivers loose in the dry season.
	4e	If the researcher chooses to setup the tides he will ask for the frequency of tides and the maximum and minimum level of seawater.
	4f	If the researcher chooses to setup any other already existing rule the system will ask whether that rule is season depends on the summer or dry season or the humid dry season, a maximum and a minimum value.
	5	The system asks if any other rule must be setup, if the researcher answer is yes jump to step 3.
Post conditions	1	The biotope rules are setup.
Exceptions	2	If the user chooses to step back the system will forget any season setup.
	1-5	If the user chooses to cancel the setup any change is forgotten.
Notes	<p>The exact light duration, temperature, rain intensity, rivers water and any other season dependent rule will depend on the exact season (light and temperature depend on the summer and winter season; meanwhile rain and river water depend on the humid and dry season) and day of the month in that season.</p> <p>All rules setup is general and the system will adapt them to each cell depending on that cell properties.</p>	

	Note that season could be setup in such a way that a whole season cycle is not a yearlong.
--	--

**Table 10 UC-1.3.2 Setup biotope rule**

**3.2.6 Use Case 1.4 Populate Biotope**

<b>UC-1.4</b>	<b>Populate biotope</b>	
Preconditions	1	A researcher that knows how to use the system has asked it to populate the biotope.
	2	The biotope has been setup.
	3	The species had been setup.
Description	1	The system shows the map including its biotope (see RQ-4 Biotope graphical representation), for this the system shows a different picture representation for each cell depending on the cell characteristics (see RQ-3). And shows the user all the species.
	2	The user indicates an species
	3	The user increases the amount of individuals of that species on one cell till the cell space is occupied or the user decides not to put any more.
	4	The system shows the user the map including the biotope and the species (see RQ-4 Biotope graphical representation and RQ-5 Species graphical representation).
	5	If the user chooses another species jump to step 3.
Post conditions	1	The map is populated by some individuals of a given species
Exceptions	3	If the user selects to populate a cell that is already full the system will tell the user and will do nothing.
	3	If the user selects to populate a cell in which the species cannot live the system will tell the user and will do nothing.
Notes	The altitude representation will depend on a different scale of % difference with each of the neighbours cells	

**Table 11 UC-1.4 Populate biotope**

**3.2.7 Use Case 2 Start Simulation**

<b>UC-2</b>	<b>Start Simulation</b>	
Preconditions	1	A researcher that knows how to use the system has asked it to start the simulation.
	2	The Biotope, species and rules have been setup.

Description	1	The researcher selects what statistics he would like the system to return: for each time step (species and/or specie units and/or world statistics) and/or end statistics (max/min statistics for each specie, max/min statistics for the world).
	2	A time option is shown. The researcher may change this to speed up the simulation.
	3	The system will proceed has in UC 3.4 step on
	4a	The user may pause the simulation and change the time option.
	4b	The user may pause the simulation to repopulate the world as in UC 1.4 Populate Biotope.
	5	If the user has selected to view statistics each step each step statistics is shown as in UC 4 Get Statistics.
	6	If the user hasn't selected to stop the simulation go to step 3.
	7	If the user has selected to stop the simulation the system will proceed as in UC 4 Get Statistics to show the end simulation statistics.
Post conditions	1	The user has experienced the simulation of the world and got the statistics till the simulation ended.
Exceptions	1	If all species die the game simulation will stop.
	2	When a particular animal or plant dies, a message will be returned, and a cause of death highlighted.
Notes		

Table 12 UC-2.1 Start Simulation

### **3.2.8 Use Case 3.1 Create Body**

<b>UC-3.1</b>	<b>Create Body</b>	
Preconditions	1	An AI game, which wants to make its individuals interact with the map and be shown, has asked the system to create a body.
	2	The biotope has been setup.
	3	The species had been setup.
Description	1	The system asks the AI game the size, the speed (cells per second), the size, the perception range (cells distance), the fighting and defence values, the maximum health, the current health (set to the maximum health is not indicated) and a picture of the body.
	2	The system asks the AI game to select whether the body he's creating is to be treated as a living or not living body.
	4	If the AI game chooses a non-living body the system will remember that it's a non-living.

	5	If the AI game chooses a living body the system will ask for the nutritional sources, the classification, the non possible living places, the maximum age, the current age, the classification, the nutritional sources and the speed.
	6	The AI game indicates the starting cell of the body.
	7	The system will remember all those values and will add this body to the collection of bodies that are part of the map.
Post conditions	1	A body has been created in the map.
Exceptions	6	If the user selects to populate a cell that is already full the system will tell the user and will repeat the step.
	6	If the user selects to populate a cell in which the species cannot live the system will tell the user and will do nothing.
	1-7	If the AI game cancels the use case nothing is remembered and the use case is cancelled.
Notes	<p>The preferred living places, hunger, thirst, nocturnal are of no use to a body as it's used to determine where to move the body and the Ai game is supposed to implement that decision.</p> <p>All values are a number between 0-1 unless stated otherwise.</p>	

Table 13 UC-3.1 Create Body

### 3.2.9 Use Case 3.2 Get Perception

UC-3.2	Get perception	
Preconditions	1	An AI game has asked the system the perception of an existing body.
	2	The biotope has been setup.
	3	The species had been setup.
Description	1	The system identifies each cell inside the perception range of that body.
	2	The system queries the water, fire, air, altitude and roughness of that cell. If the cell is an ore terrain it will also query the name and amount, or if it's a nutritional terrain will ask the amount.
	3	For each of those values the system will return the AI game the exact value of the current cell and a composed value, between 0 and 1, in each for each of the possible movement directions, where the percentage of each cell contribution is $(\text{perception range} - \text{cell distance}) / \text{perception range}$ .

	4	The system will identify all the individuals in each of those cells, will ask the classification, the fighting and defence. If the classification determines that it can be eaten it will ask the nutritional value.
	5	The system will classify each individual as nutritional source, predator or indifferent, depending if the other individual is of a classification that is a nutritional source of this body, or this body is classified as a nutritional source of that individual, or if none of the previous is considered.
	6	If it's a prey it will calculate the difficulty of killing it as $1 - (\text{the other defence value} - \text{this body fighting value})$ . 1 will be chosen if this value is greater than 1.
	7	If it's a predator, and or an indifferent individual it will calculate the menace as $(\text{the other fighting value} - \text{the this body defence value})$ . A negative value is set to 0.
	8	For each cell and prey, predator and indifferent individual, the system will calculate the presence of each as the percentage of the cell space that the sum of each occupies. Then it will calculate for each direction a percentage of prey presence. Killing difficulty, and nutritional value, predator presence and menace, and indifferent individual presence and menace. The contribution of each cell is $(\text{perception range} - \text{cell distance}) / \text{perception range}$ .
	9	The system returns those values to the Ai game. And the exact values of killing difficulty and nutritional value for each of the preys present in the same cell than the body; together with the number and menace value of each type of predator and indifferent animal.
Post conditions	1	The game has got the perception of that body at the current step.
Exceptions		
Notes		<p>Cell distance and perception range are measured in number of cells. This way the contribution of each cell to the composed value is bigger the nearest it is and the bigger the amount, but the body doesn't know exactly where it is. This way to do it will make every value to be between 0 and 1.</p> <p>A difficulty of 1 indicates an impossible prey.</p> <p>A menace of 0 indicates a predator with no chance of hurting the body.</p>

**Table 14 UC-3.2 Get perception**

**3.2.10 Use Case 3.3 Take Action**

<b>UC-3.3</b>	<b>Take action</b>	
Preconditions	1	An AI game that wants a body to takes an action.
	2	The biotope has been setup.
	3	The species had been setup.
	4	That body hasn't been set to take an action in this step by now.
Description	1	The Ai game tells the system that a body is to take an action between: move to a direction (normal speed), run to a direction (double speed – quadruple health cost), attack an individual, eat an individual, drink, and sleep.
	2	If move to a direction is selected, the system will ask for a sequence of cells so that each cell is neighbour of the previous and the next, and the number of cells is not greater than the body speed.
	3	If move to a direction is selected, the system will ask for a sequence of cells so that each cell is neighbour of the previous and the next, and the number of cells is not greater than the body speed times 2.
	4	If attack and individual is selected the system will verify that that individual exists.
	5	If eat individual the system will check that that individual exists that is flora or that is dead.
	6	If drink is selected it's verified that the amount of water presence in the cell is greater that 0.4
Post conditions	1	That body has a correct next action.
Exceptions	2-3	If a check is not passed the system will inform the AI game and will exit the use case.
Notes	Bodies are not to mate as they are created by the AI game is to create them as desired.	

**Table 15 UC-3.3 Take action**

**3.2.11 Use Case 3.4 Step On**

<b>UC-3.4</b>	<b>Step on</b>	
Preconditions	1	A part of the system or another system asks the system to simulate one step of the world.
	2	The biotope has been setup.
	3	The species had been setup.
	4	All bodies have a next action.
Description	1	The system decides the action of each fauna individual as RQ –1 Fauna decision making.
	2	The world rules are resolved for each cell in the world (see RQ-7 living rules).

	3	The biotope rules are resolved for each individual (see RQ-8 biotope rules).
	4	The system shows a map divided into cells in such a way that each cell is aside all its neighbours (see RQ-3) and will show a picture that meet the picture requirements in RQ-4 Biotope graphical representation, RQ-5 Species graphical representation and RQ-6 Moving fauna graphical representation.
	5	The system shows each individual of flora and fauna and all the bodies in current cell and with a picture that meets the requirements expressed in the RQ-4 Fauna representation pictures.
Post conditions	1	The system has simulated 1 step or hour of the world.
Exceptions	3	If a fauna action cannot be taken a log is created and the fauna action is ignored. The user is informed of a composed log of all fails at the end of the use case.
Notes	<p>Bodies are not to mate as they are created by the AI game is to create them as desired.</p> <p>The selected order should make healthier flora and more aggressive fauna to feed and drink first so it will survive over the weak individuals.</p>	

Table 16 UC-3.3 Step on

### **3.2.12 Use Case 4 Get Statistics**

<b>UC-4</b>	<b>Get Statistics</b>	
Preconditions	1	A researcher that knows how to use the system has asked it to start the simulation and the simulation has started.
	2	Simulate asks the system to return statistics to the user.
Description	1	<p>If the user has required each step statistics. The world statistics are returned: the temperature, humidity, and all other changeable attributes for each cell.</p> <p>(Optional) The statistics for each specie unit (e.g. 1 cow or a unit of grass) are returned: all its attributes excluding those that are set permanently, all its actions if it is an animal.</p>

	2	<p>If the user has required the end simulation statistics.</p> <p>The world statistics are returned: the max and min temperature, max and min humidity, and all other max/min values of changeable attributes for each cell.</p> <p>The statistics for each specie are returned: max and min number of the specie and at what time of simulation they occurred at, max and min resources consumed (if animals), max reason for death, max matings occurred, max attacks survived, max number of attacks.</p>
Post conditions	1	The user can analyse returned statistics that are shown on the screen.
Exceptions	1	Statistics will not be shown unless the user specifies what is to be returned in the 'Start Simulation' use case
Notes		

**Table 17 UC-4 Get Statistics**

### **3.3 Performance Requirements**

RQ-14	Speed
Related requirements	UC-3.4 Step on
Description	The system must finish the use case 'step on' in no more than 1 second and no less than 0.5 seconds.
Priority	Essential
Test	A simulation of 100 steps is taken on a random biotope 5 times. If the step duration average is within the interval the test is passed.
Notes	An ACT-1 Researcher or an ACT-2 AI game may ask the system to save the current status to be reloaded later.

**Table 18 Persistence**

RQ-21	Number of users
Related requirements	UC-3.4 Step on UC-4 Start simulation
Description	The system is going to be used by only one actor at a time.
Priority	Essential
Test	If the system can be used the test is passed.
Notes	

**Table 19 Number of users**

### **3.4 Logical Database Requirements**

There are no logical database requirements for this product.

### **3.5 Design Constraints**

#### **3.5.1 Standards Compliance**

##### **Report Format**

The report data format of all documents must be the one to be announced in [3], if the document is not defined there, the format is free although it's recommended a format similar to this document.

### **3.6 Software System Attributes**

#### **3.6.1 Reliability**

RQ-9	Simulation reliability
Related requirements	UC 4 Simulate
Description	Only 1 out of 50 runs can crash down without a human error.
Priority	Secondary
Test	Test 10 times: repeated 50 times: The system will be setup with a random distribution of biotope, and a random distribution of the species described in appendices 1 and 2.  The test will be passed if the average of crashes is 1 or less.
Notes	

**Table 20 Simulation Reliability**

RQ-10	Step on reliability
Related requirements	UC 3.4 Step on
Description	Only 1 out of 90 million runs can crash down without a user error.
Priority	Secondary
Test	A test system will be developed to act as an AI game. It will create a random map as in RQ-9 test and will add a random number of bodies. It will then order random actions to bodies during 90 million steps.  The test will be passed if the system do not crash down.
Notes	This is in order to run simulation step by step of 10000 years, which is the time that a typical AI game simulated run time, if a step is 1 hour. This is only tested once due to the amount of time required to test.

**Table 21 Simulation Reliability**

**3.6.2 Availability**

RQ-11	Unattended runs
Related requirements	UC-2 Start Simulation
Description	If an error makes the system crash, the next time it is run it has to be able to recover from that error, and keep on simulating from, at least, the beginning of the week that was being simulated.
Priority	Medium
Test	An error will be forced 10 times and will try to recover the system. If at least 9 times the system recovers before or at the beginning of the week the test is passed.
Notes	The system works on demand, so doesn't have to be available 24 hours a day.

**Table 22 Unattended runs**

RQ-12	Step by step crash
Related requirements	UC-3.4 Step on.
Description	If an error makes the system crash, the next time it is run it has to be able to recover from that error, and keep on simulating from an hour selected by the map. This hour can be between the beginnings of a day 1 week before the current one to the first hour of the day that was being simulated.
Priority	Secondary
Test	An error will be forced 10 times and will try to recover the system at the beginning of the crash day. If at least 9 times the system recovered the test is passed.
Notes	It would be advisable to restart from the last hour so the AI game could recover all at any point, but at least this must be achieved.

**Table 23 Step by step crash**

RQ-13	Persistence
Related requirements	All the use cases
Description	The system must be able to serialize its status and recover it the next time that it is launched if asked to do so. This serialization may be into a file that can be easily taken to different instances of the system.
Priority	Medium
Test	10 different current configurations of the system will be saved and the system will be asked to recover from them. If it recovers the exact configuration at least 9 times the test is passed.
Notes	An ACT-1 Researcher or an ACT-2 AI game may ask the system to save the current status to be reloaded later.

**Table 24 Persistence****3.6.3 Security**

The system is not a critical application. Furthermore, the data itself worth nothing, benefit comes from the interpretation of those data.

Because of this there're no security requirements.

### **3.6.4 Maintainability**

RQ-15	Map maintainability
Related requirements	UC-3.4 Step on. RQ-3 Cells Shape
Description	The map cells shape is going to change easily, so all characteristics and calculation that depend on the cells shape must be isolated inside a module that offers an interface.
Priority	Essential
Test	If the neighbourhood, health cost of moving, and movement distance are provided by a module, and that module is not used for any other purpose, the test is passed.
Notes	This is in order to make the system cell organization scalable.

**Table 25 Map maintainability**

RQ-16	Graphics maintainability
Related requirements	UC-3.4 Step on. RQ-4 Biotope Graphical representation RQ-5 Species Graphical representation RQ-6 Moving Fauna graphical representation
Description	The way to form a picture based on an cell or a species individual based on their attributes and/or the cell they are in has to be implemented as an interface implemented by a module
Priority	Essential
Test	If the picture selection of cells, species and moving fauna are provided by a module, and that module is not used for any other purpose, the test is passed.
Notes	This will allow changing a module to give a different graphic experience of the map.

**Table 26 Graphics maintainability**

RQ-17	Rules maintainability
Related requirements	UC-3.4 Step on. RQ-1 Fauna decision making RQ-2 Fauna action solution RQ-7 Living rules RQ-8 Biotope rules
Description	The module that implements the UC-3.4 has to use an interface to get the answer to the tables expressed in RQ-1, RQ-2, RQ-7 and RQ-8.
Priority	Essential, most important non functional requisite
Test	If the action selection, action resolution and living and biotopes rules enforcement is implemented by a module, and that module is not used for any other purpose, the test is passed.
Notes	The rules must be easily changed and improved, the system final behaviour is going to depend on them and the risk that the rules aren't ok is too high.

**Table 27 Rules maintainability**

**3.6.5 Portability**

RQ-18	Operating Systems
Related requirements	All
Description	The system must be usable in a Windows 2000 and/or Suse Linux 9.1 without any special configuration other than a basic graphic card. And host-dependent code can only be used in a graphic or speed related system module. If this is done this code has to be isolated in a module.
Priority	Essential
Test	The system will be run on a newly installed Windows 2000 or Suse Linux distribution. The system will be run on at least one machine in each of the of the computer laboratories reported in 2.1.6 If it runs a random simulation and does not crash, the test is passed.
Notes	The decision of which of the operating system is left to design, as other requirements may need one or the other. For example, graphic speed may ask one or the other.

**Table 28 Operating Systems**

RQ-19	Graphic library
Related requirements	All
Description	The system should get profit of any special graphic library available in the system.
Priority	Secondary
Test	The system will be run in a zero Windows 2000 or Suse Linux distribution with the appropriate hardware and graphic library installed.
Notes	To see the current hardware available by the client see point 2.1.6 Memory Constrains. The most desired configuration is opengl acceleration that is compatible with the one provided by a riva tnt2 8 Mb bios 2.05.1704

**Table 29 Operating Systems**

RQ-20	Developing Language
Related requirements	All
Description	The system has to be implemented in Java or C++
Priority	Essential
Notes	The final decision is postponed until the design as developing it in java may not meet speed requirements.

**Table 30 Developing Language**

ID	Characteristic	H/M/L	1	2	3	4	5	6	7	8	9	10	11	12
1	Correctness	M							*					
2	Efficiency	H										*		
3	Flexibility	H											*	
4	Integrity/Security	L	*											
5	Interoperability	L		*										
6	Maintainability	H												*
7	Portability	L				*								
8	Reliability	M						*						
9	Reusability	H									*			
10	Testability	L			*									
11	Usability	H								*				
12	Availability	M					*							

### 3.7 Other Requirements

#### 3.7.1 RQ-1 Fauna decision making

The following action decision taking is very simple and an essay so must be easily changed in the system to adjust them.

<b>RQ-1</b>	Fauna decision making
<b>Related requirements</b>	UC 3.4 Step on
<b>Condition</b>	Action decided
If the perception is less than one square	Sleep
If there's a predator in reach run.	Run in the other sense.
Hunger and thirst are less than .2, health is more than .8 is the reproduction season and there are individuals of the same species close	Move to the nearest one.
Thirst is the biggest value, and there's enough (at least a marsh) water in the current cell	Drink
Thirst is the biggest value, there's not enough (at least a marsh) water in the current cell and there's enough water by perception reach	Move to the biggest amount of water.
Thirst is the biggest value, there's not enough (at least a marsh) water in the current cell and there's not enough water by perception reach	The action selected by the next highest value
Hunger is the biggest value, and there's a fauna nutritional source in the current cell	Attack it
Hunger is the biggest value, and there's a dead fauna nutritional source in the current cell	Eat it
Hunger is the biggest value, and there's a flora nutritional source in the current cell	Eat it
Hunger is the biggest value and there's no nutritional source in the current cell but there is in a cell in perception reach	Move to the nearest one preferring

	killed fauna to fauna, and fauna to flora.
--	--

**Table 31 Fauna decision making**

**3.7.2 RQ-2 Fauna action solution**

The following action decision taking is an essay so must be easily changed.

<b>RQ-2</b>	Fauna action solution
<b>Related requirements</b>	UC 3.4 Step on RQ –1 Fauna decision making
Action	Resolution
Sleep	The health is increased at a rate of 0.01 of the health per 1/12 of the day duration, the thirst and hunger values are increased at a rate of 0.001 per 1/12 of the day.
Move	The health is decreased in the x % of the size; thirst and hunger are increased in x/2 % of the size. X depends on the RQ-3 cells shape.
Run	The health is decreased in the $y=x*4$ of the size, thirst and hunger are increased in y/2 % of the size. X depends on the RQ-3 cells shape.
Attack it	If the attacker can hunt the prey at that moment (see RQ-7), the attacker health is decreased in the 2% of the size; thirst and hunger are increased in 1% of the size. Result = defender defence value – Attacker attack value. If the result is negative the defender health value is decreased in that amount. On the contrary, if it is positive, the result is changed to negative and another result is calculated attacker defence value – defender attack value, so the attacker health is decreased in the biggest negative of the two values.
Eat it	If the target is dead fauna and a nutritional source, that target size value is decreased in the eating speed of the feeding individual. If the target if flora, a nutritional source, and it produces fruits, the nutritional value of that flora is decreased in the eating speed of the feeding animal. If the target is flora, a nutritional value and it doesn't produce fruits, the health of that flora is of that flora is decreased in the eating speed of the feeding animal. In any case the hunger and the health of the animal is increased in the possible eaten amount.
Drink	If the water amount in this cell is greater than 0.2 the animal thirst is decreased to 0 and the health is increased in the drunken amount.
<b>Notes</b>	It depends on the RQ-1 because only decisions from RQ 1 are going to be made.

**Table 32 Fauna action solution**

**3.7.3 RQ-3 Cells shape**

The cells shape is going to evolve during the simulation. First square cells are going to be simulated, then triangular cells and at the end hexagonal cells. Each of them has different properties that are going to modify the world simulation.

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RQ-3.1	Square cells
Related requirements	UC 1.1 Setup biotope UC 1.4 Populate Biotope RQ-2 Fauna action solution UC-3.4 Step on
Neighbour cells	There are 8 neighbour cells for each cell has in a chessboard: the upper one (N), the upper left (NE), the left (E), the lower left (SE), the lower (S), the lower right (SW), the right (W) and the upper right (NW).
Health cost of moving	An animal loses 0.1% of the size if it's moving to the upper, left, right and lower cells for each cell it advance. But will (lose square root of two) * 0.1 if moving in diagonal as this distance is greater.
Movement distance	The moving N, S, E, W is considered 1 movement but moving SW, SE, NW, NE is considered square root of two movements.
Notes	Lot of movement possibilities but not all the same distance. To be used in the beginning, is the simplest one.

**Table 33 Square cells**

RQ-3.2	Triangular cells
Related requirements	UC 1.1 Setup biotope UC 1.4 Populate Biotope RQ-2 Fauna action solution UC-3.4 Step on
Neighbour cells	There are 3 neighbour cells for each cell: NW, NE and S one for each of the triangle sides.
Health cost of moving	An animal loses 0.1% health for each cell that it advances into.
Movement distance	All movements count as 1 movement.
Notes	To be done after the system is working as an improvement

**Table 34 Triangle cells**

RQ-3.3	Triangular cells
Related requirements	UC 1.1 Setup biotope UC 1.4 Populate Biotope RQ-2 Fauna action solution UC-3.4 Step on
Neighbour cells	There are 6 neighbour cells for each cell: N, NW, SW, S, SE, NE and N, one for each of the hexagon sides.
Health cost of moving	An animal loses 0.1% of the size for each cell it advance.
Movement distance	All movements count as 1 movement.
Notes	To be the last increment in cell representation.

**Table 35 Hexagonal cells**

**3.7.4 RQ-4 Biotope graphical representation**

Graphical representation of each cell depends on its attributes.

RQ-4	Biotope graphical representation					
Related requirements	UC 1.1 Setup biotope UC 1.4 Populate Biotope UC-3.4 Step on					
Element	0,.2	.2,.4	.4,.6	.6,.8	.8,1	
Water	-	Wet	Marsh	River (maximum negative altitude difference gives the direction)	Sea	
Fire	n/a	Some small flames	Many small flames	Some big flames	Many big flames	
Air	Force 1 to 3 (leaves rustling, ripples on lakes)	Force 4 to 5 (branches swaying, white horses)	Force 6 to 7 (big sea)	Storm Force 8 (fallen braches)	Strong Storm	
Rough	n/a	Some small rocks	Some big rocks	Many big rocks	A whole rock occupies the cell	
Ore terrain	Some small	Much small	Lots of little and some big	Lots of big	One occupies the whole cell	
Nutritional terrain	Some small	Much small	Lots of little and some big	Lots of big	One occupies the whole cell	
Altitude scale	-1,-.75	-.75,-.25	-.25,+.25	+.25,+.75	+.75,+1	
Altitude difference	Steep downhill	Downhill	plain	Uphill	Steep uphill	
Hour scale (see UC 1.7)	night	dawn	morning	midday	afternoon	dusk

**Table 36 Biotope graphical representation**

**3.7.5 RQ-5 Species graphical representation**

Graphical representation of the species

RQ-5	Species graphical representation					
Related requirements	UC 1.4 Populate Biotope UC-3.4 Step on					
Species Attribute	<=0	(.0,.25]	(.25,.5]	(.5-.75]	(.75,1]	
Health	dead	Dying	exhausted	tired	healthy	
Nutritional excess (only)	No fruits	Some small fruits	Many small fruits	Some big fruits	Many big fruits	

for fruits)					
Size (% of full size)	n/a	Value * 100	Value * 100	Value * 100	Value * 100
Mother with young	This depends on how many the mother gave birth to. If one birth, then 1 small animal of the same specie, if two births than 2 small animals etc. These animals are treated as one with their mother until a certain age.				

**Table 37 Species graphical representation**

**3.7.6 RQ-6 Moving fauna graphical representation**

Graphical representation of the Animal movements

<b>RQ-6</b>	Moving fauna graphical representation					
<b>Related requirements</b>	RQ-1 Fauna action making UC-3.4 Step on					
<b>Species Actions</b>	Sleep	Move	Run	Attack	Eat	Drink
<b>Description</b>	No movement / lying down	Slowly in any direction	Moves quickly in any direction	Attempts to kill another animal. Two animal fighting	Eats food	Drinks from a water source
<b>Notes</b>						

**Table 38 Moving fauna graphical representation**

**3.7.7 RQ-7 Living Rules**

<b>RQ-7</b>	Living Rules
<b>Related Requirements</b>	UC-3.4 Step on RQ2
Flora reproduction	In reproduction season for a particular species, the system will create offspring using a Gaussian probability for that specie, for every two individuals that are in the same or adjacent cells. Individuals are taken in exclusive pairs. One of them acts as ‘mother’ and those new plants are treated as one with the ‘mother’ until a certain age.
Fauna reproduction	As Flora reproduction above. Replace instances of the word ‘Flora’ with ‘Fauna’.
Flora updates	In order to decide which individual will eat and drink first, it first selects the specie with the fastest growing speed, and then the individual who is the healthiest.

Fauna updates	In order to decide which individual will eat and drink first, it first selects the specie with the fastest speed, and then the individual who has the best fighting value. The action resolution is resolved as specified in the RQ-2 Fauna action solution.
Perception	The perception of an animal will be greatest at one part of the day, depending on its max perception value. At this time it will attempt to feed. Its perception will gradually decrease until the opposite hour (the 12 <sup>th</sup> hour). This will be the time when it will attempt to sleep around.
Growth speed	This depends on the age of an individual. Depending on the species it will increase until a certain age and then decrease until another age.
Mobility	The system must keep track of what mode of transport a predator or prey is using. A flying animal can catch walking animals, swimming animals and other flying animals. A walking animal can catch flying animals ONLY if they're walking, swimming animals (but cannot enter into too deep water) and other walking animals. Swimming animals can only catch other swimming animals.
Aging	When a particular individual reaches a certain age, its max health will start to slowly drop from a value of 1 to a value of 0. At this point the animal will die. As its max health drops, its health will still fluctuate as it feeds or is attacked, etc.
Health	Each specie attribute to be recalculated will be done so depending on the health of the individual: Speed: $a + \text{age} * b + \text{health}$ Fighting Value: $\text{speed} * \text{size} * \text{health} * a$ Defence Value: $\text{speed} * \text{size} * \text{health} * a$ Perception range: $\text{health} - \text{perception} ^ a$ Mobility (3 values): $\text{health} - \text{walk} ^ a$ , $\text{health} - \text{fly} ^ b$ , $\text{health} - \text{swim} ^ c$
Decomposing	When an individual dies, its body will

	decompose at a rate of 1 unit per time step, and this will increase the nutritional value of the cell by 1 unit per time step. Each unit is energy that is equal to the size of the individual.
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**3.7.8 RQ-8 Biotope rules**

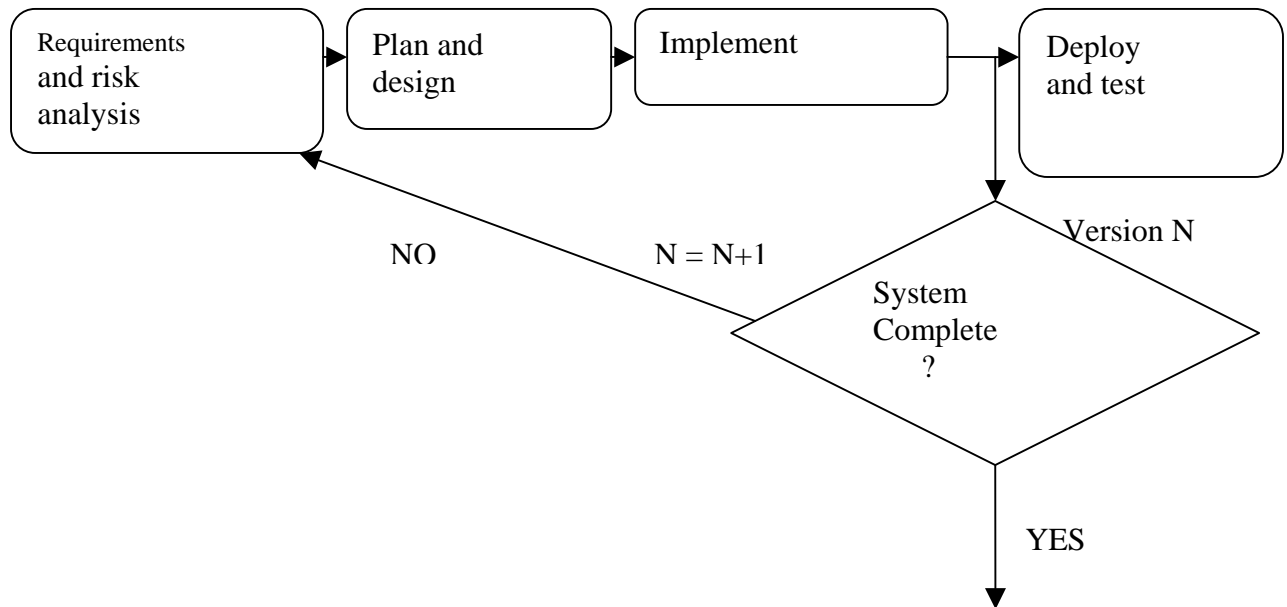
Those are the action to be applied to each cell depending on the world, that cell and it's neighbours previous state.

<b>RQ-8</b>	Biotope rules
<b>Related requirements</b>	UC-3.4 Step on
<b>Rule</b>	Consequence
Day & night	The system updates they light intensity so the next is true: Day is $\frac{3}{4}$ in the summer solstice and decreases gradually till reaching $\frac{1}{4}$ in the winter solstice.
Season temperature	The system updates they temperature so the next is true: It's the highest in the summer solstice, decreases gradually till reaching the minimum in the winter solstice, and so on.
Day and night temperature (optional)	The system update the temperature each step so the average of the temperature that day is bound to the season, and it gradually reaches it's maximum (day temp + (temperature difference /2) at midday and it's minimum in the middle of the night (day temp - (temperature difference /2).
Time and seasons	The system updates the that many hours each step as selected at the start of the simulation and force to change the day, week, month, season and year it's necessary.
Rivers selected by user	The system will transfer an amount of water to the next cell with the less altitude that is it's neighbour. This amount of water is proportional to the altitude difference of its water amount. In case a cell of water increases over 1 it will give the other water to its next higher altitude neighbour (has it will receive it from the previous one it should be ok). River start cells do not loose water only transfer it.
Lakes and sea (optional)	The system will check whether accumulations of water sizes inside the map or not to identify it as a lake or a sea, respectively.
Tides (optional)	The system will increase and decrease the amount of water in the cells so tides will flood until the high water mark and ebb until the low water mark.
Rain (optional)	The system will increase all the map cells amount of water each step 0.01 percent during a random period between (0-6 hours- Gaussian probability). The probability that this happen is a Gaussian distribution over time centred in the wettest day (probability of 1) and the extremes are the previous year driest day and next year driest day.
<b>Notes</b>	

**Table 39 Moving fauna graphical representation**

#### 4. Change Management Process

One major risk in developing a project is change. The process model to be used is an iterative lifecycle with increments.



This model has been selected due to the nature of the project, its high risk and the fact that requirements and plans will change on a weekly basis. Requirements shall be re-analysed after the completion of each iteration and the SRS will be updated if necessary.

#### 5. Document Approvals

*Identify the approvers of the SRS document. Approver name, signature, and date should be used.*

#### 6. Supporting Information

##### Appendix 1

Some flora examples:

<b>Grass</b>	Individuals represent a ¼ of cell grass population
Health	This value decreases as grass gets eaten.
Nutritional value	In this case the nutritional value is the same as the health as grass does not produce fruits.

Growth speed	The fastest of the initial set of species (90% to have room to include later a faster one)
Age	Keeps track of how old the colony is.
Size	¼ of cell but can live in a cell with trees
Defence value	0%
Classification	Plant – edible
Possible living places	Altitude=any Water, minimum of 60% else start loosing health or a maximum of 90% as doesn't grow inside rivers but does inside marshes. Temperature: between (0 and 30 C). Terrain Type: any difficulty

**Table 40 Flora example: Grass**

<b>Apple tree</b>	Individuals represent 1 tree
Health	The tree in itself has no species enemy, so this should depend only on cell condition.
Nutritional value	Only include the actual produced tree
Growth speed	Very slow (05%)
Age	Keep track of how old the tree is
Defence body value	Very high so nobody can prey them
Defence edible product value	Very low so everybody can eat the apples
Classification	Plant – edible product factory
Possible living places	Altitude= till 900 m Water, from 40% till75%; Temperature: between 5 – 25 C Terrain Type: till 30 % difficulty

**Table 41 Flora example: Apple Tree**

## Appendix 2

Some starting fauna species could be

<b>Cow</b>	
Health	Determined by hunger, thirst
Maximum age	10 years.
Speed	50% of max animal speed

Age	How long its been living
Size	¼ of a cell
Growth speed	
Perception range	3 cells during the day, same cell at night
Fighting value	Eat grass- 10%
Defence value	50%
Possible nutrition sources	Grass, water
Classification	Cow – edible
Preferred living places	Grassy areas with water source
Possible living areas	Water 20% > 50% Altitude < 700m Temp (0-20) Terrain type no greater than 25% difficulty
Hunger	10 kg of grass per day, can 4kg
Eating speed	3 kg per hour
Thirst	5 litres
Active hours	7am – 9pm
Mobility	By foot

**Table 42 Fauna example: Cow**

<b>Wolf</b>	Max 8 wolf in a cell
health	Determined by hunger, thirst
Maximum age	8 years.
speed	75% of max animal speed
age	How long its been living
size	Depends on age and health
Perception range	4 cells during the day 2 cells during the night.
Fighting value	60%
Defence value	30%
Possible nutrition sources	Any animal it can prey
Classification	Animal – carnivores
Preferred living places	Forest
Possible living places	Water (10% - 60 %) altitude < 900 m temperature ( 0 - 25) terrain type till 50 % difficulty
Hunger	1kg of meat a day but can store till 4kg of meat
Thirst	4 kg/hour
Water a day	1 litre of water a day but can store till 2 litres.
Active hours	12 am – 4 am
Mobility	By foot

**Table 43 Fauna example: Wolf**

### Appendix 3 Task Planning

