

Beacon of Life

School of Computing

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Beacon of Life

BSc (Hons) Computer Games Programming

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8th May 2017

Abstract

On this project a simulation with some elements to make it a game of a city with humans has been developed. On this city the artificial intelligence who are going to generate the city and create new people. The player will have the role of a god watching all the movements of the humans in this world. The purpose of this project is to create a human-like artificial intelligence that can survive with the available resources and evolve from one generation to the next one. On this report, we will identify the different elements needed to create this artificial intelligence on unreal engine 4, which one are the problems that have to appear during this process, the first designs of this project, the methodology used to create the implementation and the final results.

Acknowledgements

I would like to thank my personal tutor **Dr. Julie Porteous** for all the support given throughout the project; I also appreciate the assets that have been used to create the city and the environment provided by **Synty Studios** and **Agustina Tonon**.

I want to thank **David Parra**, **Javier Pastor** and **Fernando Ferrando** for the assistance during this project and all the help provided during all the year.

The testers cannot be forgotten and I would like to thank **Jesus Ortega**, **Carlos Javier Sobrino**, **Miguel Robla** and **Minerva GM**.

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1. Introduction

It is a game with a multi-agent system able to keep itself in the habitat in which it is found seeking the necessary resources to live and cover their basic needs also they can alter the environment and learn new skills to make its life easier and enjoyable. The idea is to make the artificial intelligence able to learn new skills learning by themselves and even being able to give that knowledge to other artificial intelligence, and this will include the possibility of getting and store materials and the ability to create and destroy buildings. The game has been made using Unreal Engine 4.

2. Research and analysis

2.1. Software Methodology

The methodology employed is the prototyping methodology (see figure 1). As this project was going to be a project that needs to grow on a delimited period with a lot of tasks that can be finished partially while other tasks are not ready yet or just create a simple prototype that is going to grow and be better as the project continues evolving.

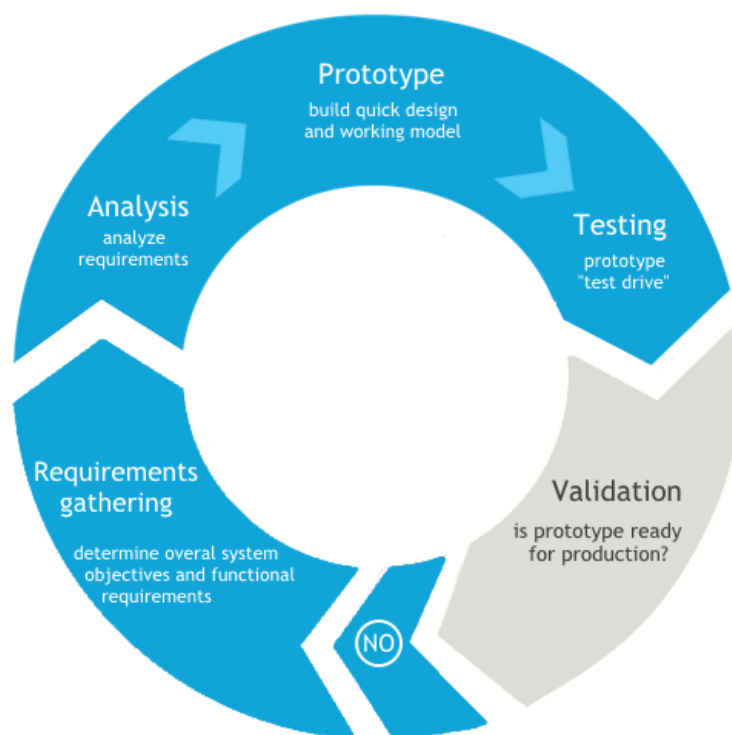


Figure 1: Prototyping Methodology, Virtue Intelligence (2015)

The process of working has been decided around this methodology creating this workflow (see figure 2).

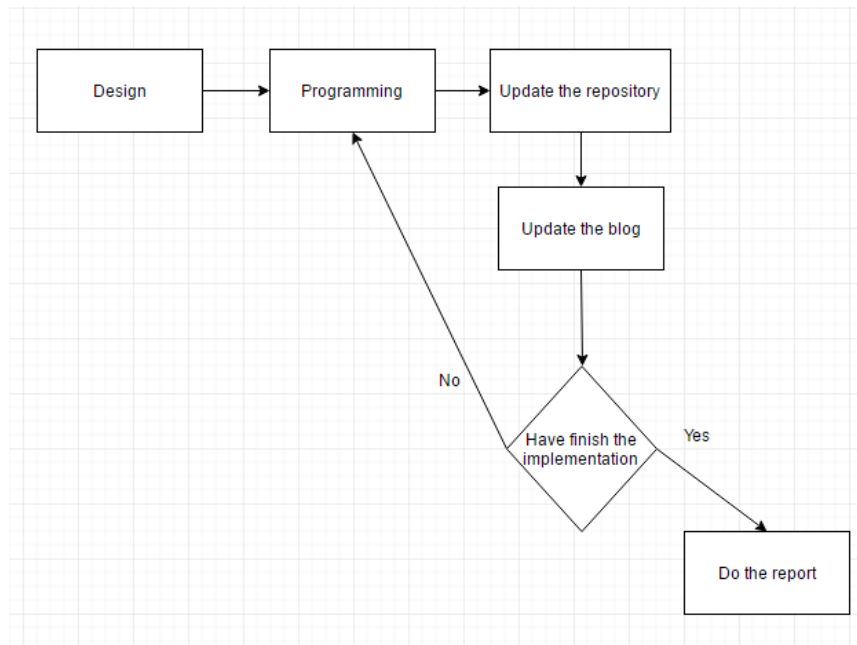


Figure 2: Workflow

2.2. Artificial intelligence

According to the idea of this project, the main topic is the artificial intelligence, so it was necessary to make a research of the techniques and methods to implement an appropriate artificial intelligence and what it is going to be needed to accomplish the project.

2.3. Multi-agent system

Inside the artificial intelligence research it has been found the 'multi-agent system' term, a term used to describe systems with more than one agent that have the possibility of interacting with each other. An agent is the representation of the artificial intelligence; it can have just a mind or even a physic representation of itself.

2.4. Hierarchy of needs

As this project will try to simulate the human life behaviour on a virtual environment, it is required to know how it works and how it takes a decision. During this research, a lot of approximations have been found but the one that has the best approach to what this project need was the hierarchy of needs of Maslow, A. (2013) (see figure 3).

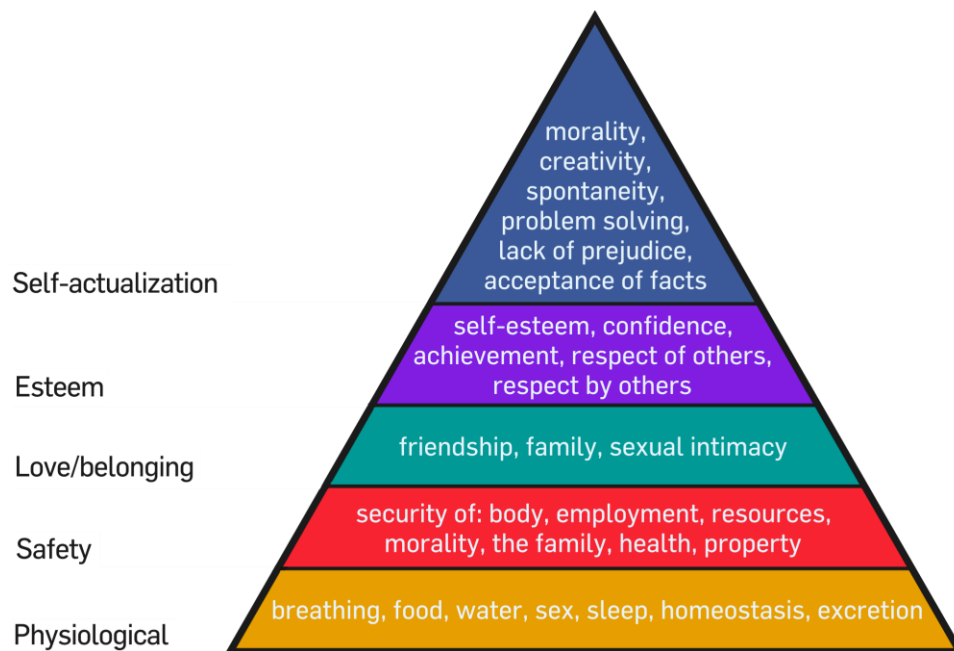


Figure 3: Maslow's hierarchy of needs, Jim2B (2016)

2.5. Engine – Unreal Engine 4

Once the theory research has been done, it is the turn to get information about how to implement all the ideas. During this decision, the idea of using the artificial intelligence provided by Unreal engine 4 seems to be the correct answer because it makes half of the job done and then it is not necessary to create an artificial intelligence system to develop the project.

2.6. UE4 – AI

While the research of the information on how to implement the artificial intelligence on the unreal engine 4, the words such as 'pawn', 'controller', 'behaviour tree', 'blackboard', 'task' and 'decorator' have been found to describe the artificial intelligence that unreal engine 4 provide to their developers.

2.7. UE4 – Pawn

The pawn represents the body of the agent that is going to be controlled by the controller.

2.8. UE4 – Controller

The controller is the mind of the agent. It will control a pawn that may have a body to control (some artificial intelligence do not need a body, but they will need a pawn to control even if that pawn has no body).

2.9. UE4 - Behaviour Tree

The behaviour tree is the tree of decisions of the agent. It will have two parts: Firstly, the decorators to decide which decision have to make the agent. Secondly, the tasks which are the representation of the

decisions. To accomplish this, unreal engine 4 provides two types of nodes: The sequences and the selectors.

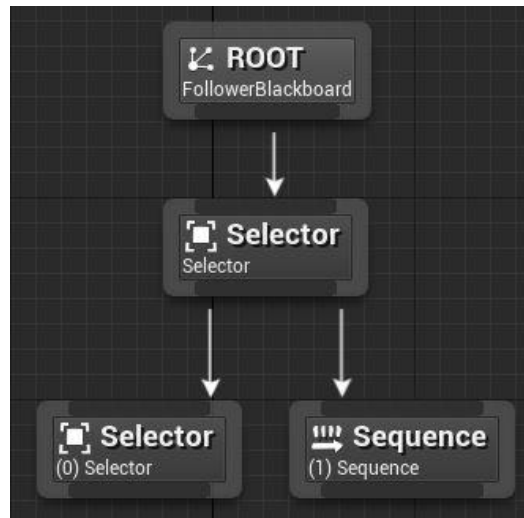


Figure 4: Behaviour tree, docs.unrealengine.com (2017)

According to the unreal engine documentation, (Docs.unrealengine.com, 2017), the selector node will execute their children from left to right and will stop running its children when one of their children succeeds. If a Selector's child succeeds, the Selector succeeds. If all the Selector's children fail, the Selector fails. On the other hand and according to the unreal engine documentation, (Docs.unrealengine.com, 2017), the sequence nodes will execute their children from left to right and will stop running its children when one of their children fails. If a child fails, then the Sequence fails. If all the Sequence's children succeed, then the Sequence succeeds (see figure 4).

2.10. UE4 – Blackboard

The blackboard is the place where some of the variables of the agents can be stored and can be shared with each others if it is needed (see figure 5).

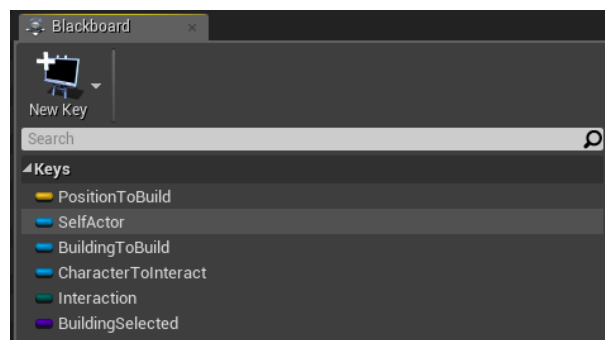


Figure 5: Blackboard, docs.unrealengine.com (2017)

2.11. UE4 – Task

A task is a small job that has to be completed by the agent. The task will return a Boolean. If the task has been completed successfully it will return true or if it fails during the process it will return false. The final result will indicate the next step to follow as an artificial intelligence on the behaviour tree. All the process that the artificial intelligence is going to make will be programmed on a task (see figure 6).

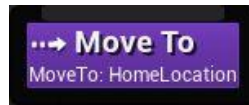


Figure 6: Task, docs.unrealengine.com (2017)

2.12. UE4 – Decorator

The decorators are the conditionals on a behaviour tree attached to the tasks and the composites. They decide whether or not it can be executed. A decorator can only return true or false (see figure 7).

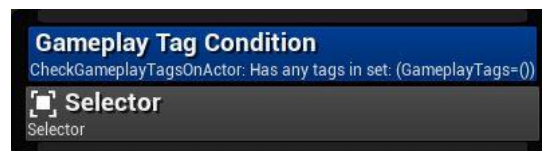


Figure 7: Decorator, docs.unrealengine.com (2017)

3. Design

3.1. Main idea

There were lots of ideas for the project. However, the majority of them were discarded at the start due to the time that each one required.

One of the initial ideas was the creation of a city from zero. Two agents will start building it by gathering elements of the environment and using them to create the buildings of the city.

The agents will interact with each other, and there will be a probability where both of them can generate new agents. The more agents, the faster the city grows.

3.2. Buildings

One of the ideas for creating the city was that the agents could have the ability to build new buildings. At the start, they will make simple ones. Later, new agents will appear with new skills for creating advanced buildings. They will make a contract with the people who have inferior skills for creating the new ones. Later on, the agents will set up their companies and have the other agents working for them, creating a job system for the city.

The idea of establishing an asset which has different levels of construction for making the people see how it goes during the building process was something interesting. Also, for the moment when the building was abandoned, the texture will be changed into one which makes it seem older.

3.3. Learning skills

The idea that the agents can acquire new skills forces the possibility of making one agent with the ability of teaching by mastering a skill. The teacher will instruct the other agents to learn by themselves and level up those more relevant to their life or just for the capacity to survive in the environment.

3.4. Artificial intelligence

As this is the main point of the project, this has had several changes during the implementation process. The initial design and the final result maintain the core of the idea which was to create an artificial intelligence. Since the artificial intelligence is placed into the world will try to survive. It is being used the Maslow's hierarchy of needs, Maslow, A. (2013). This approach indicates that there are five levels that every agent is going to follow.

The first one is physiological which is on the bottom of the pyramid, and they are all the needs the agent has at a physiological level and cannot be removed, or the agent will die.

Another step up into the pyramid, and we will find the safety level. This level handles all the security aspects that need the agent such as the safety of their body, employment, resources, family, property, etc.

The next level is the love/belonging that handles the friendship, family and sexual intimacy.

The last levels are the levels that are managing the esteem and self-actualization, but these aspects of the hierarchy are the one that has been decided to take less importance on this project.

3.5. Professions

When planning how to create the jobs of the agents the first idea was to make it with different levels that can grow while practicing the profession on a low level like just by gathering food the agent will level up the farmer profession.

3.6. User Interface

The user interface was something that has not been commented too much on the design, but the main idea was to create a user interface that looks like the Sims games, (Www2.ea.com, 2017).

3.7. Playability

The final result of this project is a game, so it needs playability and interactions from the player to the game to change the result of it. On the proposal, it has been decided that the playability will be made when the other parts of the implementation are finished. Then, that playability can be divided into two sections. The first one allows the player to create an agent and control that agent living its life. The second one let the role of God to the player opening a new set of possibilities like dropping food or drinks into the world. Creating, moving and destroying buildings. Even playing with the agents by allowing the selection of an agent to see the stats it has, moves that agent into other places of the world, killing agents, creating new agents and lastly changing their stats.

4. Implementation

4.1. Main idea

Some ideas of the design have been expanded during the implementation, and some other ideas have been removed due to different facts such as the lack of time or because it wasn't good enough for this project.

4.2. Buildings

The biggest problem with the buildings has been the fact that without an artist who creates all the assets, it is not an option to create the different levels of construction of every single building and the same when the building is abandoned and must be destroyed. The fact that this project has no artist has affected other aspects, but this one has been the one most affected by changes. To make it look great a pack of assets has been bought on the marketplace of the unreal engine 4 to give realism to the game (see figure 8 and 9).



Figure 8: Buildings BP



Figure 9: Buildings map

The other assets of the environment have been provided by Agustina Tonon (see figure 10) to fix the problem that before of that every single element of the game were boxes and it was sad. To add part of the states of the building, there is a mesh that will appear when the building is still under construction and it will disappear once the building has been built. On the other hand, once a building is abandoned the material of the building mesh is going to change to look left.



Figure 10: Environment

4.3. Learning skills

The idea of learning new skills while doing actions was an excellent idea but, it was rapidly discarded when the professions levels were removed so in the end version the learning ability has become something that the agents can do only to get a job, and it will be explained in detail late in the professions section.

4.4. Artificial intelligence

As previously mentioned the Maslow's hierarchy of needs, Maslow, A. (2013), has been used to give some rationality to the artificial intelligence but the deadline has arrived and in the end, the two last level of the pyramid cannot be possible to be realized due to the time left. The first three tiers have been completed (see figure 11).

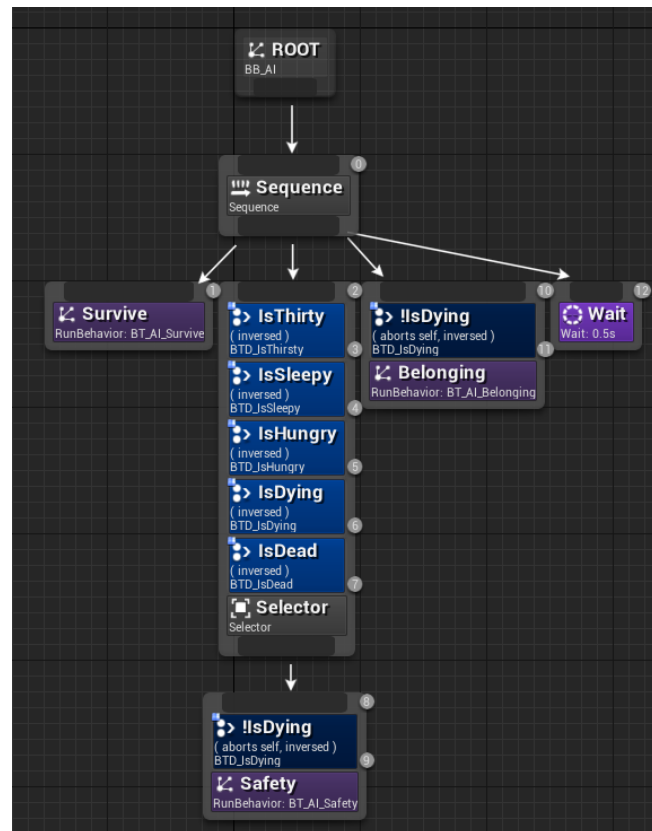
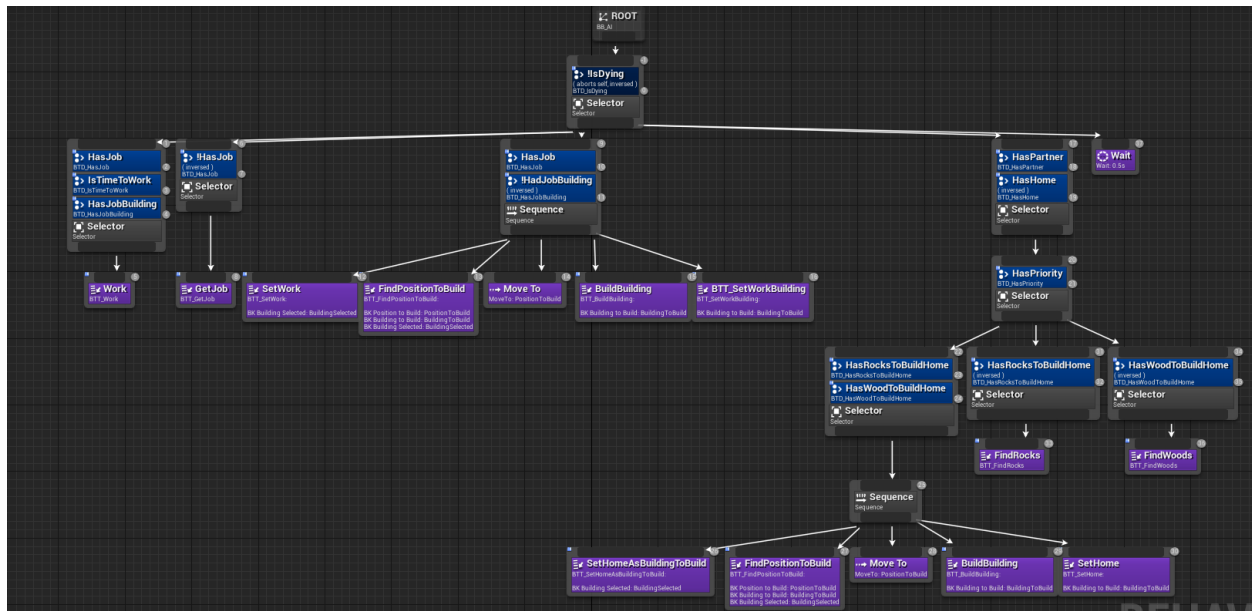
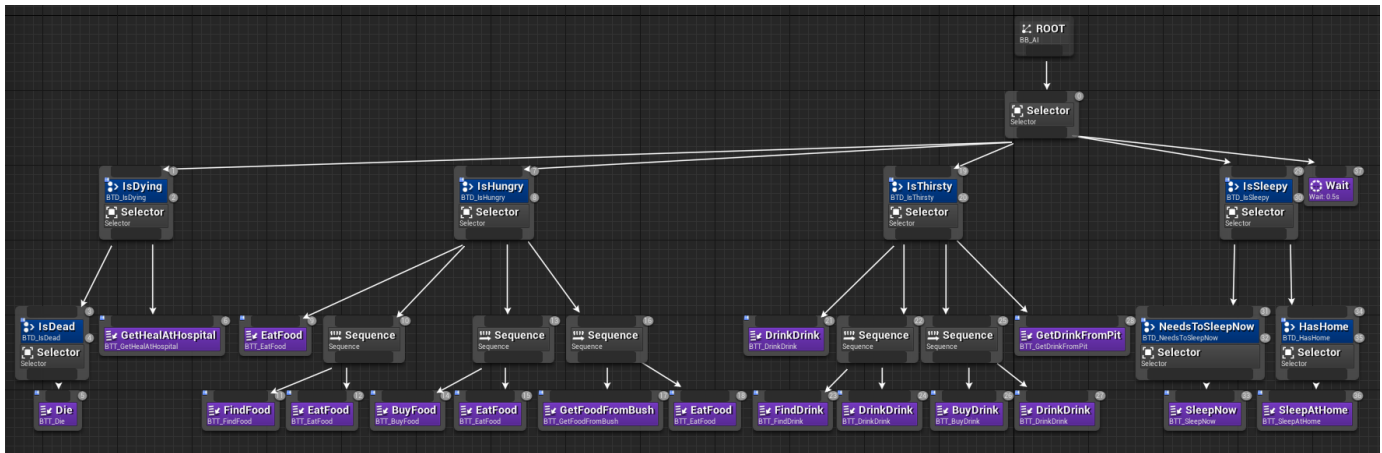


Figure 11: AI - Behaviour Tree

The first level is the physiological level. This level has been developed taking into account the food, water, and sleep needed. It needs to accomplish the realism the life stat has been added so while the agent has a low level of any of the physiological stats the life stat will decrease from 100 at the beginning of the life of the agent to 0, at that point the agent will die. To produce this life like, the healing stat will also decrease when it is lower, so a sick person will be more disease until it gets help. The support can be obtained by going to the hospital, but it has a cost that not all the agents can pay because they have only 100 gold at the beginning of their life, and at the moment they have no form to get more (see figure 12).

The second level of the pyramid, the safety level, has the security of the house and the security of the work. When the artificial intelligence has a partner but it has no house it will first of all check which of them is the older at the relationship, and that one will find and gather all the rocks and wood to create a home and then it will find a place to build the building. The security of the work will try to find a new job when the agent has no job. Once it has a job, it will find a place to build a building job so it can go there to work and lastly the part of work which is going to be different depending on the work that the agent has (see figure 13).



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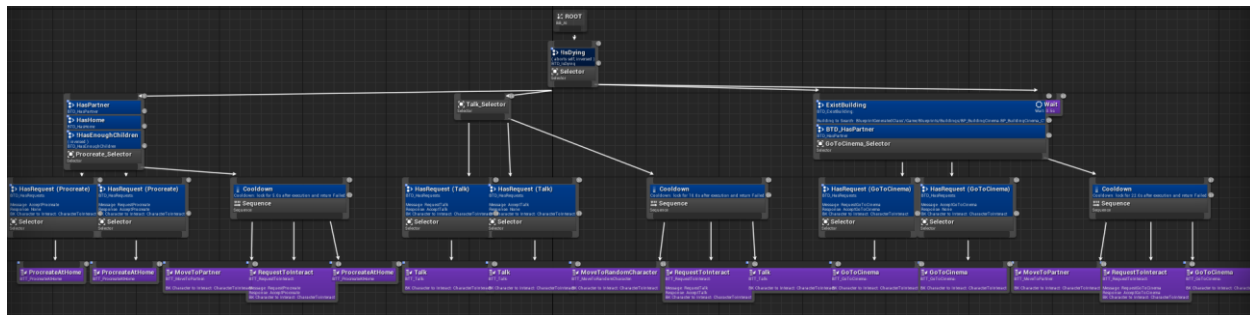


Figure 14: Belonging - Behaviour Tree

The procreate at home task is going to get together the two of the partner agents to the same place, and then if both agree to procreate they will go to the home to procreate, one both are in the home they will wait a few seconds to procreate and then exist the possibility to create a new life in consequence to the interaction and as both of the agents are processing this action it is possible to create zero, one or two agents at the same time.

Some of the problems have been due to the interaction between agents is not the best part of the artificial intelligence system of unreal engine 4, and therefore it has been used some time to think of an interaction design to use with the agents. The final result is not perfect, but it works within this limited interactions.

To get working the ‘system of interactions’ between agents first, it has to check if there is any request to a particular interaction. Then, send a response to that communication for instance when an agent wants to talk the first part of the behaviour is going to be the check on the list of interactions that other agents request with this agent. When it has no request, it will be the one who sends a communication to the other actor who can be a random friend or the partner.

The system is pretty simple once explained but to get it done there are some issues that have to be considered. There is not a thread control so an agent cannot edit any variable of another actor without the danger to have problems so there has been added to the system the state of the agent which can be none, speaking and listening. When the state is speaking no other actor can modify the messages of this actor because it is interacting at the moment and can produce conflicts into the variables. Then, when a player is speaking with another actor, it will be changed to talking. When an agent gets a request is this agent who removes the message while on the listening state on its list to prevent other actors to interact with the list at the same time.

4.5. Collisions

The agents cannot make collisions with another agent, building or environment element because it can cause bugs. Then, it has decided that it is easy to avoid some bugs that collisions can create and now with the project finished can be said that this method of allowing the agents go anywhere with no collision problems was a great decision that removes too many conflicts.

The only collision that is detected came from the buildings at the moment of deciding where to create them. When an agent wants to create a building it will generate a random vector that will indicate the direction where this building is going to be build from the town hall (the first building built). Once the direction vector is decided randomly the building is going to be moved in that direction until it will not collide with another building. If the building arrive to a position where the building does not collide with other buildings it will be decided the position to build that building. If the building continues colliding with other buildings at a determined distance from the town hall it will choose another random direction vector and then start again from the town hall (see figure 15). This process will repeat a only selected amount of times to prevent infinite loops.

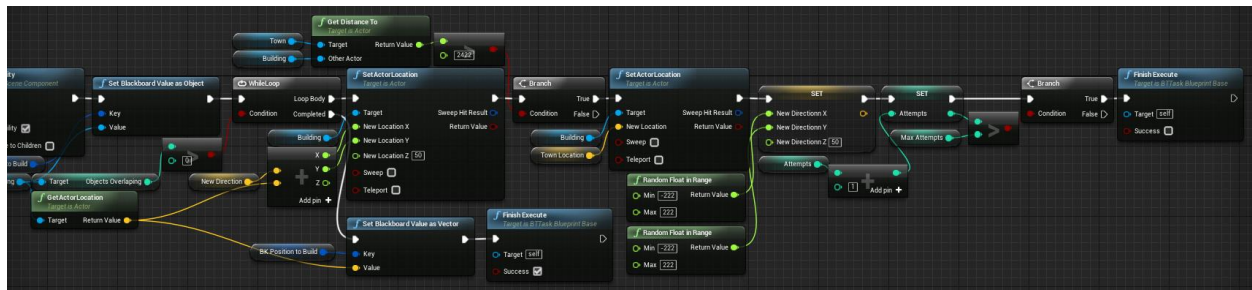


Figure 15: Position to build

4.6. Professions

This section has been the most removed section in the entire project. On the first designs, it has several levels of professions and more different professions. In the end, it has not been possible because it needs more time to develop all the jobs and all the level design to the professions and there is no time but if at any point this project continues this is a good point to start making improvements.

Some professions that cannot be in the end are the fireman and the police, two professions that need a reason to work that has not been developed so if they are added it will be only to stay there in the world but doing nothing, so it is being decided not to add more professions while the system is not fully developed because there are already some professions like the farmer that are doing nothing, and when the agents that have these professions have to go to work they only stay at the building waiting to finish the time to work, and that is all, so it has no point to add more with no functionality or at least no more than added to see more buildings.

The good part of this is that the prototyping methodology has proved to be a correct decision because it allows this project to continue with this prototype and move to other sections that can be more necessities with a prototype working even if it is limited.

The only two professions that have some kind of job to do are the cleaner and the doctor.

- The cleaner will clean the city from the abandoned buildings (see figure 16).
- The doctor will remove all the bodies of the dead agents (see figure 17).

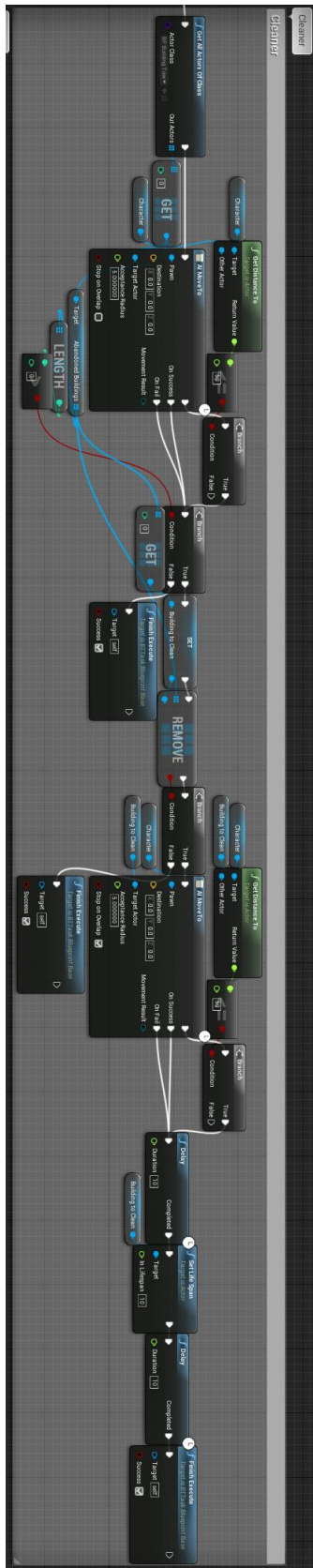


Figure 17: Cleaner

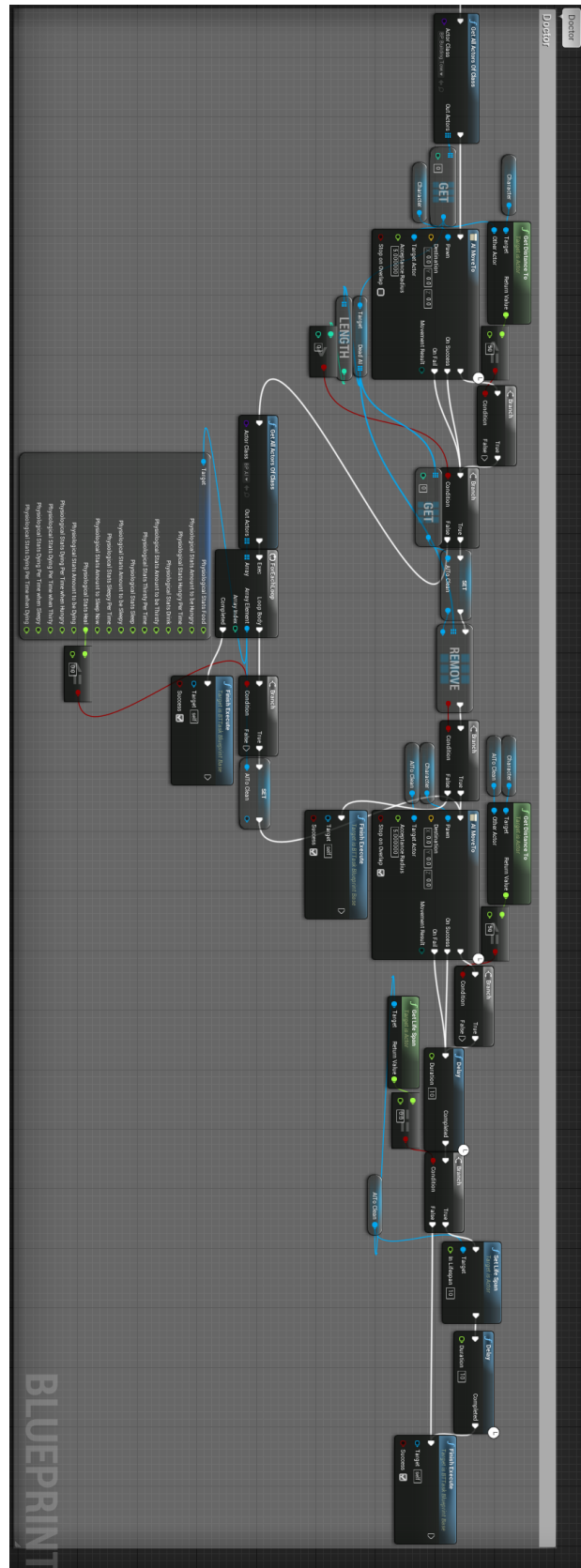


Figure 16: Doctor

4.7. User Interface

The problem with the user interface is the same of the buildings, the assets used to make it looks great must exist, and as a project done only by a programmer, this part has not been fully developed with a good design but the functionality shown is working (see figure 18).



Figure 18: User Interface

On the other hand as this was the last part of the project at the same time as the playability there are a number of elements removed that are not into the final version of the game but some information displayed has been added even when it was not planned because the project needed to show the full potential of the artificial intelligence created.

4.8. Playability

The playability has been the last part of the project, and it has no all the parts mentioned on the designs, Despite of that, it is not a problem to finish this section as it was just an improvement to realize only if the other parts were done with time to continue with the implementation. The final version has no playability with an actor, so the player will not be able to create an agent and play with it. The other part of the playability the god part has half developed and half not.

The UI has some buttons to allow the player the possibility to change the speed of the game so the player can stop the game at any point or change the speed (see figure 19). The player will also have the possibility to spawn a new agent into the town hall building. A button that was not on the designs has been added that clean all the abandoned buildings of the world, it has been added because it exists a

possibility that the abandoned buildings become a large part of the world when there are only a few cleaners so this is a new improvement useful to the player.

The information show into the UI is the time since the game has started (it will move faster if the speed of the game accelerate and it will stop if the game is paused), the agents dead, the agents alive and all the agents born since the game started.

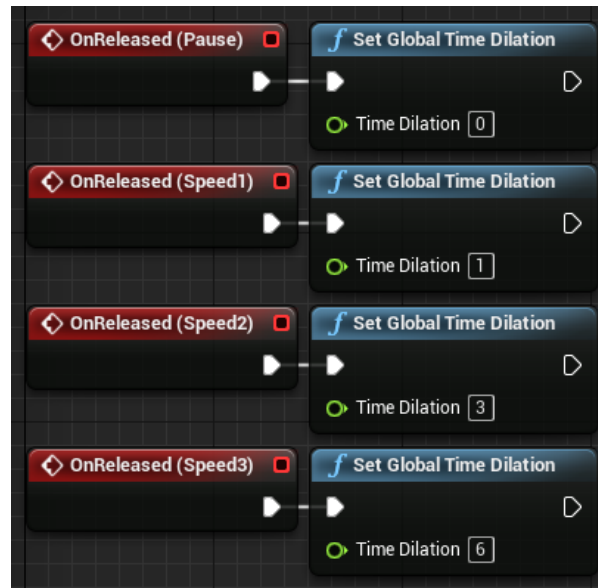


Figure 19: Game Speed

5. Test

The performance of the game has been tested on a computer with the next characteristics:

- Operating System: **Windows 10 Education**
- Processor: **Intel(R) Core(TM) i7-5700HQ CPU @ 2.70GHz, 2.70GHz**
- RAM: **8.00 GB**
- System type: **64-bit Operating System, x64-based processor**
- Graphic card: **NVIDIA GeForce GTX 950M**

The wanted result was to be able to create a city with at least 50 agents by working at 60 frames per second. The results were almost the desired but when the agents are near to the amount the performance start decreasing. This is not a real problem because this is a small reduction of frames per second (see figure 20). At the worst moments the game works at a 50 frames per second when the activity of the agents need more resources. As the maximum amount is locked the game is not going to increase that number so it will not be a problem.

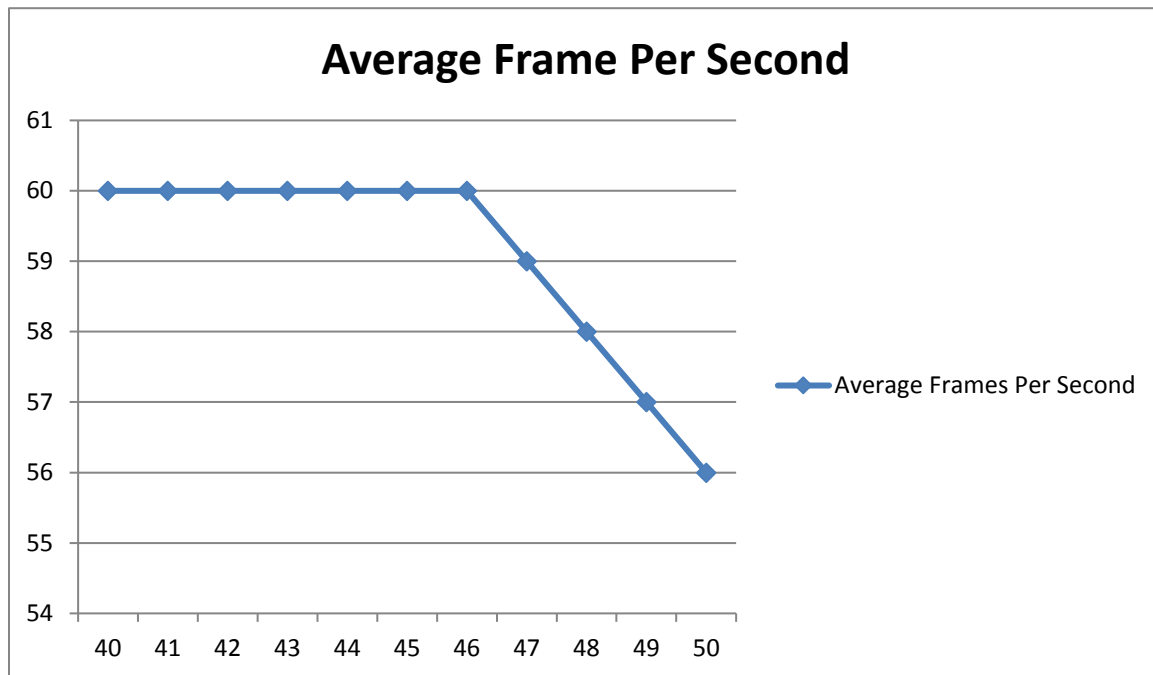


Figure 20: Average Frames Per Second

6. Evaluation

The first impression that a player has when playing the game is that it is not a game because the playability is almost none. As it is now at the last version the project can change the word 'game' to 'simulation' and no one will say it is incorrect because there are some elements to add to the playability, but they are not included into the playability so as a player it does not exist.

The user interface is very basic and has a style more close to a working app than to a video game while the buildings have assets with pixel art, the environment has the cartoon style, and the player is near to the realistic style which makes the game a mixed type of techniques and that is not the usual on a game so let the player decide if it has been a wrong decision.

At some point of the game, it looks like there are some agents bugged waiting for something when they should be dead but this is a problem with the interactions that has not been solved yet and it happens only a small amount of times due to interacting with a dead agent right at the moment it dies.

When the number of agents is 50 or more, the city looks very alive, and it looks great.

The city can be working by itself without dying unlimited which and at some point, it becomes hypnotizing by looking the buildings appear and disappear and the agents moving around the world.

7. Conclusion

In conclusion, the development of this project has been very successful until it has arrived at the point of the interactions between agents because this problem was not into the design part and that made the project take long than expected to result in some other parts not added in the final stage of the game.

The decision of use unreal engine 4 to produce this game has made faster all the implementation process than making it without an engine. The learning of how to use behaviour trees to create an artificial intelligence on unreal engine 4 is very fast and very easy to debug while developing that artificial intelligence. The engine provides the basic animations of the agents, plenty of assets to use and some templates to create a video game.

The process to create a video game is not something that can be easily done by just one single person, and it is less probable if that person has not the necessary skills to produce the assets necessities to the game as it has been my case.

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- Virtue Intelligence, (2015), Methodology [ONLINE]. Available at: http://virtue-intelligence.com/wp-content/uploads/2015/12/img_soft_prototyping.png [Accessed 1 May 2017].
- Jim2B, (2016), Maslow's Hierarchy of Needs [ONLINE]. Available at: <http://worldbuilding.stackexchange.com/questions/36062/how-does-an-ai-keep-its-humanpets-happy> [Accessed 2 May 2017].
- Docs.unrealengine.com. (2017). Behavior Tree. [online] Available at: <https://docs.unrealengine.com/latest/INT/Engine/AI/BehaviorTrees/NodeReference/Composites/index.html> [Accessed 2 May 2017].
- Docs.unrealengine.com. (2017). Tasks. [online] Available at: <https://docs.unrealengine.com/latest/images/Engine/AI/BehaviorTrees/NodeReference/Tasks/MoveTo.jpg> [Accessed 6 May 2017].

References

- Bourse, Y. (2012) Artificial Intelligence in The Sims series. Available at: <http://yoannbourse.com/ressources/docs/ens/sims-rapport.pdf> [Accessed: 04 February 2017].
- Bourse, Y. (2012) Artificial Intelligence in The Sims series. Available at: <http://yoannbourse.com/ressources/docs/ens/sims-slides.pdf> [Accessed: 04 February 2017].
- Docs.unrealengine.com. (2017). Behavior Tree Node Reference: Composites. [Online] Available at: <https://docs.unrealengine.com/latest/INT/Engine/AI/BehaviorTrees/NodeReference/Composites/index.html> [Accessed 2 May 2017].
- Game AI Pro (no date) Available at: <http://www.gameai.pro/> [Accessed: 4 February 2017].
- GDC (2015) Emergent behavior in game AI. Available at: <https://www.youtube.com/watch?v=WEeKXx5Byxc> [Accessed: 4 February 2017].
- GDC (2016) Less is more: Designing awesome AI for games. Available at: <https://www.youtube.com/watch?v=1xWg54mdQos> [Accessed: 4 February 2017].
- GDC (2016) Remember to relax! Realizing relaxed behaviors for AI in AAA games. Available at: <https://www.youtube.com/watch?v=lyHG-EGuCWk> [Accessed: 4 February 2017].
- GDC (2016) Tales from the trenches: AI disaster stories. Available at: https://www.youtube.com/watch?v=__5whYgSTV0 [Accessed: 4 February 2017].
- GDC (2016) The simplest AI trick in the book. Available at: <https://www.youtube.com/watch?v=iVBCBcEANBc> [Accessed: 4 February 2017].
- GDC (2017) Classic game Postmortem - populous. Available at: <https://www.youtube.com/watch?v=VlaK6y5kdro> [Accessed: 4 February 2017].
- Maslow, A. (2013). A theory of human motivation. 1st ed. Lanham: Dancing Unicorn Books.
- Rabin, S. (ed.) (2015) Game AI Pro 2: Collected wisdom of game AI Professionals. Canada: Apple Academic Press.
- Schwab, B. (2009) AI Game Engine Programming. Second Edition. Cengage Learning.
- Teesside University - Library & Information Services (no date) Available at: <http://lis.tees.ac.uk/> [Accessed: 4 February 2017].
- Unknown. (2017). Saga The Sims - EA. [online] Available at: <http://www2.ea.com/es/sims> [Accessed 2 May 2017].

Appendix A

Beacon of life

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31/01/2017

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Simple Outline Description

The project is a game with a multi-agent system able to keep itself in the habitat in which it is found seeking the necessary resources to live and once they have covered their basic needs they can alter the environment and learn new skills to make its life easier and enjoyable. The idea is to make the AI able to learn new skills learning by themselves and even being able to give that knowledge to other artificial intelligence. This will include the possibility of get and store materials and the ability to create and destroy buildings.

If I have the time I have think about make the player able to create a character to interact with the artificial intelligence and be able to modify the buildings and the resources to see how the artificial intelligence changes its behaviour. Another subject that can be great to implementate would be the possibility of enemies and fight between them, player included.

Rationale for Project Choice

I decide to make this project because I like to create a virtual world and see how the AI interact on that world and evolve by learning how to survive by its own. I have played some games that have different type of god games and I have always wanted to create a game that has this concrete AI.

Areas of investigation

The main focus will be on the AI:

- **AI on UE4:** How to create AI and make it works on unreal engine 4.
- **Multi agent system:** I want to allow the AI to interact with the AI and the environment around the world.
- **Autonomous agents:** The agents must work without the input of the player and be able to "generate new objectives" by themselves.
- **FSM:** I will have to investigate how to make a finite state machine on unreal engine 4.
- **Messaging:** The AI will need to send messages to other agents to interact with them.

As I want to focus on the AI part I will reduce the effort on thins parts of the game:

- **Art:** I will use free assets.
- **Buildings:** They will be just an asset on the ground with a box form and no collision.
- **Terrain:** It will be just a plane with no elevations.

Background research

I have been interested in AI since quite long time and I decide to make this project an AI project because I consider now I know enough about how to create a life-like AI and I want to prove that I have all that knowledge.

I have watched some videos, articles and books that make me learn the basics about how to create AI and some tricks to make it right.

I have taken classes about AI the last year, I have done an AI project at the end of that classes and I have been doing the AI on the AGD class this year.

To create the product I will use **Unreal Engine 4** and use the blueprints combined with **C++** on **Visual Studio** and it will run on **windows** platform.

Literature Review

I have been searching in different books such as (Rabin, 2015) or (Schwab, 2009) to look into the different ways to approach the type of AI that I am looking to create and I have found that the type of game I want to create has two different genres, the first one is the **God** and the second one is the **Alife** as it show at the book (Schwab, 2009).

I have been looking into some papers to know how to simulate the feelings of the AI and I have found this interesting paper called "Artificial Intelligence in The Sims series" talking about the better example possible, the Sims game. The same person also made a presentation with some detailed images about the different states and how it affects the mood of the AI, it was very useful.

The last but not the worst place I did look into was the conferences and there are a lot of them all very interesting with great examples of what to do and better even what not to do when programming AI. I want to remark here the **GDC channel of YouTube** being an incredible teacher during this last years. All the videos are going to be at the references section at the end of the document.

Methodology

As I have already an idea of what I want to create and I have a mental image but I am not sure of how to achieve everything I will follow the **prototyping methodology**.

With this methodology I will have to create portions of the project that demonstrate some functionality and make changes when they are needed.

As I want to record of everything I have done and all that needs to be done I will use <https://trello.com/> to keep track of everything that is going on with the project.

On the other hand the code is going to be on an online repository to make sure that is accessible from any place when I needed and also I can go back to an early version if I needed so it will work as a backup too.

Research Ethics

I want everyone to be able to play this game so I will have to make sure it has nothing that is not allowed by **PEGI**.

I will try to stay at the PEGI 3 but if the development goes faster enough I may try to add sounds, better assets or animations, adult interactions or something else so maybe some change makes me turn to PEGI 7 or any of the other labels.

All the assets are going to be free but if the author/s wants to be on the credits or something else I will consider using that asset and then acting according to the author's condition.

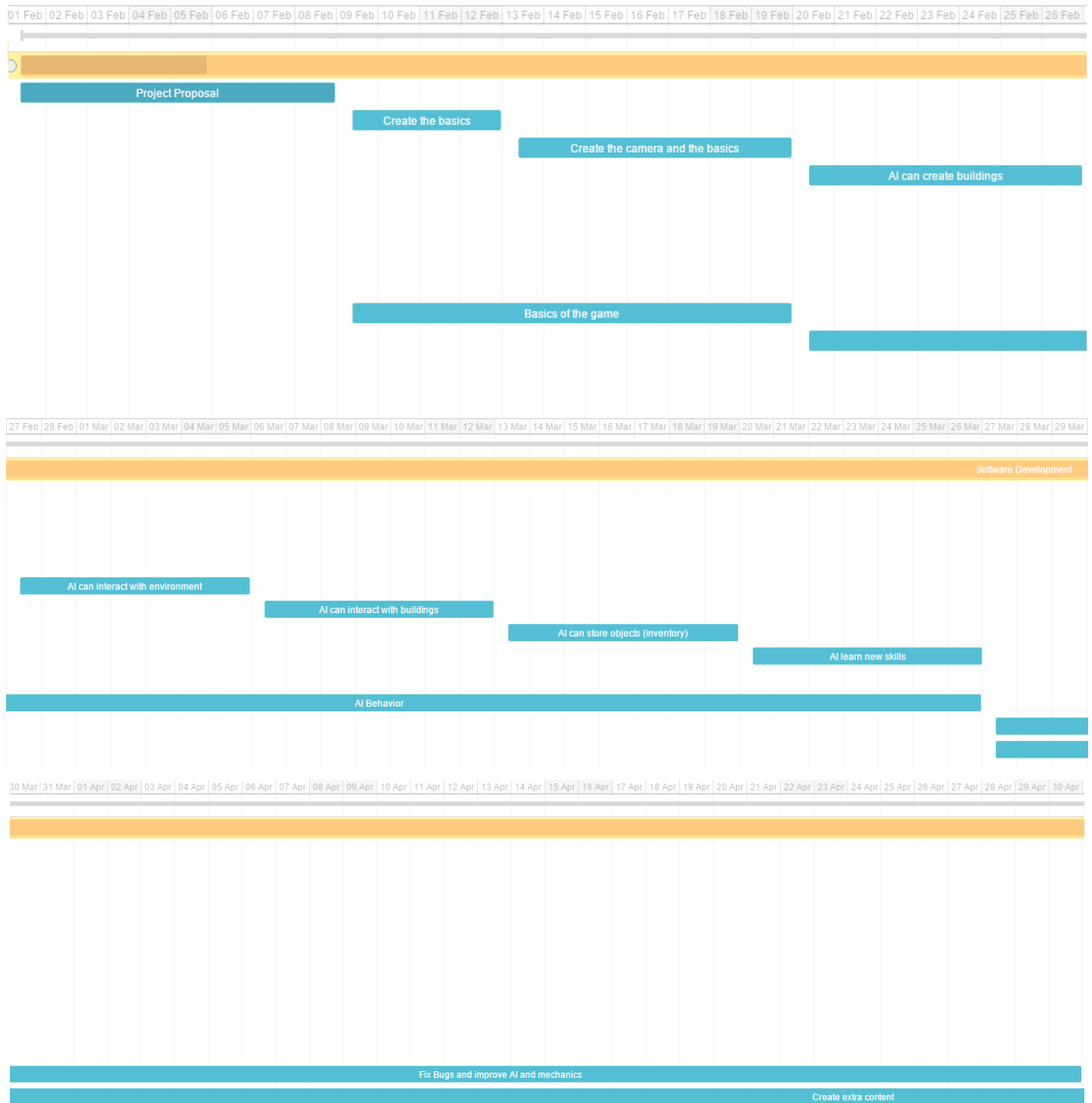
Project Plan

Most of the time I will follow this plan:

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
9:00 – 15:00	Classes	AI Study and work	Project Study and work	AI Study and work	Classes	Project Study and work	Sleep
16:00 – 22:00	Gym and free time	Project Study and work	Gym and free time	Project Study and work	Gym and free time	Project Study and work	Free time

I will intent to do all the basic things that are not the main focus of my project on February and then get focus on the AI parts of my project from there getting a beta version at some point before the end of March. Then I will use April to improve all the basic mechanics already created. In the end I will use May to fix the bugs and create some extra new content if I had time.

For more details you can look at the task plan on <https://trello.com/b/6zkSUD8M>



01 May	02 May	03 May	04 May	05 May	06 May	07 May	08 May	09 May	10 May	11 May	12 May	13 May	14 May	15 May	16 May	17 May	18 May	19 May	20 May	21 May	22 May
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The main reason I gave so much time in the end of the project to fix bugs and make improvements or add new content is because I want to take a break on the holidays but I am not sure when and how much time. That is also why I will try to work as faster as I can at the beginning of the project and all the task must be done very fast.

Project Deliverable(s)

On this project I will deliverer a videogame that shows a virtual world with AI that will try to survive while you play as a god with them.

The AI will be human like and will have feelings and motivations and will learn new skills that allow it to life better and evolve.

References

- Bourse, Y. (2012) *Artificial Intelligence in The Sims series*. Available at: <http://yoannbourse.com/ressources/docs/ens/sims-rapport.pdf> [Accessed: 04 February 2017].
- Bourse, Y. (2012) *Artificial Intelligence in The Sims series*. Available at: <http://yoannbourse.com/ressources/docs/ens/sims-slides.pdf> [Accessed: 04 February 2017].
- Game AI Pro (no date) Available at: <http://www.gameaipro.com/> [Accessed: 4 February 2017].
- GDC (2015) *Emergent behavior in game AI*. Available at: <https://www.youtube.com/watch?v=WEeKXx5Byxc> [Accessed: 4 February 2017].

- GDC (2016) *Less is more: Designing awesome AI for games*. Available at: <https://www.youtube.com/watch?v=1xWg54mdQos> [Accessed: 4 February 2017].
- GDC (2016) *Remember to relax! Realizing relaxed behaviors for AI in AAA games*. Available at: <https://www.youtube.com/watch?v=lyHG-EGuCWk> [Accessed: 4 February 2017].
- GDC (2016) *Tales from the trenches: AI disaster stories*. Available at: https://www.youtube.com/watch?v=__5whYgSTV0 [Accessed: 4 February 2017].
- GDC (2016) *The simplest AI trick in the book*. Available at: <https://www.youtube.com/watch?v=iVBCBcEANBc> [Accessed: 4 February 2017].
- GDC (2017) *Classic game Postmortem - populous*. Available at: <https://www.youtube.com/watch?v=VlaK6y5kdro> [Accessed: 4 February 2017].
- Rabin, S. (ed.) (2015) *Game AI Pro 2: Collected wisdom of game AI Professionals*. Canada: Apple Academic Press.
- Schwab, B. (2009) *AI Game Engine Programming*. Second Edition. Cengage Learning.
- Teesside University - Library & Information Services (no date) Available at: <http://lis.tees.ac.uk/> [Accessed: 4 February 2017].