

EVIL AGE AI PROJECT

Game Design Document

<https://gitlab.com/guillaume-haerinck/evil-age>



IMAC 3 - 2021

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PROJECT DETAILS

High concept

Simulation of a **medieval village being attacked** each night by a horde of monsters. Depending on the biome used to create the village and the actions of the player it will hold more or less night before being decimated.

Engine

Will be done with the latest version of Unreal Engine (4.6). A large part of the logic is done in blueprint, but also some C++ for learning purposes. Due to large asset size, it will be local only and not hosted on gitlab.

3C

Camera

The game is in full 3D, it is a top down view in god-mode like seen commonly in the RTS genre.

Character

You control the village, not the people in it. You can't tell monsters, knights or villagers where to go or what to do. However the village has resources like wood and money, and you alone decide how to spend it.

Controller

The game is playable with keyboard and mouse with common STR setup. You can click on interactive elements to select them, and a bottom window will display more details like buildings available for construction.

As many things are AI-controlled, we want to show in real time in a user-friendly way how the computer makes its choices (display stats and behavior tree on click for example).

This are the **non-free actions** you can do (will cost you resources) :

- Set construction area for buildings (to be constructed by the villagers)
- Improve stats of the buildings
- Spawn villagers or soldiers

This is how you **gain more resources** :

- Each night

- Villagers farming
- Gather time-sensitive resources (Plant & Zombie like)

Each of these actions are explained in-depth in the last parts of “Game and AI Systems”.

Inspirations

We borrow ideas from dark-fantasy and various RTS games.

Black and White

One of the first games by Peter Molyneux. It is an RTS where every action of the player is diegetic : your cursor is a floating hand in the world, and the villagers can see it. Another interesting feature is the fact that you have to educate a monster, make him grow into a powerful weapon, or a lazy thing, or maybe a villager helper, it's up to the player. [JDG made a video on it.](#)



What do we take from it ?

The idea of evolving creatures for our monsters, and the villagers that will do their daily life without the need of the player inputs.

FrostPunk

Frostpunk is an RTS survival where your purpose is to make the center furnace burn as long as possible to allow you villagers to stay alive. You will have to make difficult choices as the city governor.

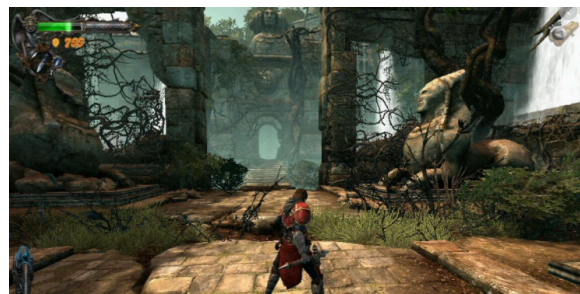
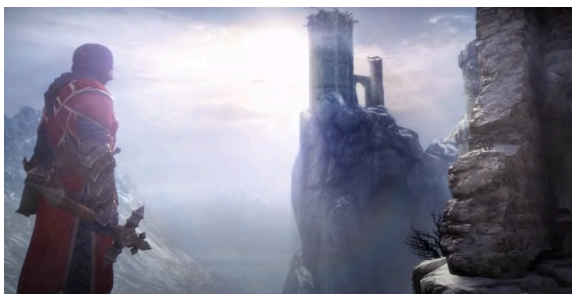


What do we take from it ?

The idea of a population striving to survive in a crude world. The construction of the village in a spiral around the center.

Castlevania : Lord of shadow

A 3rd person action-adventure game similar to God Of War but in a dark-fantasy setting. You play as Gabriel Belmont, a monk-knight on his quest to defeat the Lords of shadows.



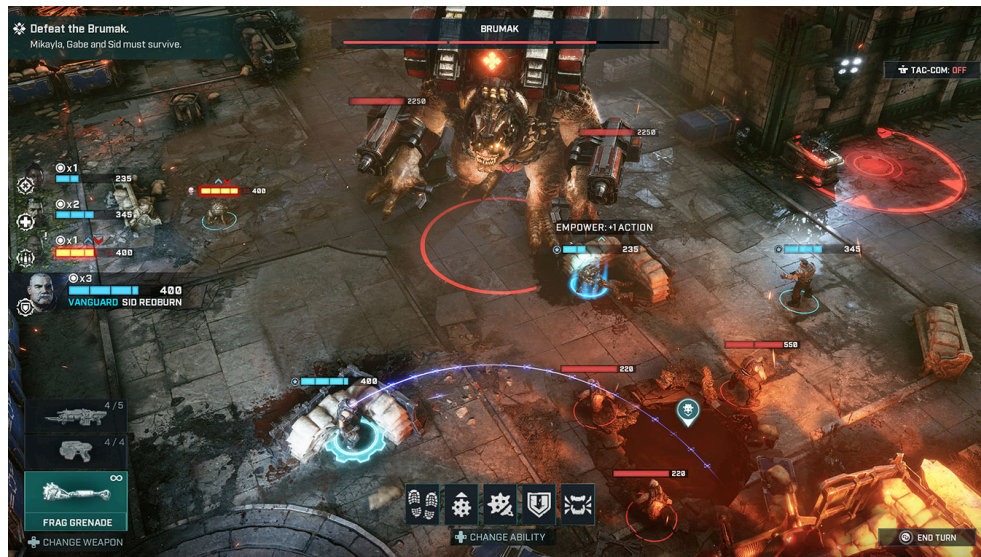
What do we take from it ?

The incredible setting of the game (similar to [Resident Evil Village](#)) of a dark world.

GAME AND AI SYSTEMS

The game is made of multiple systems that are communicating to each other to create a coherent experience. Through testing we will adjust the balance of said systems and give further details of the implementation choices.

Gameplay Ability system (GAS)

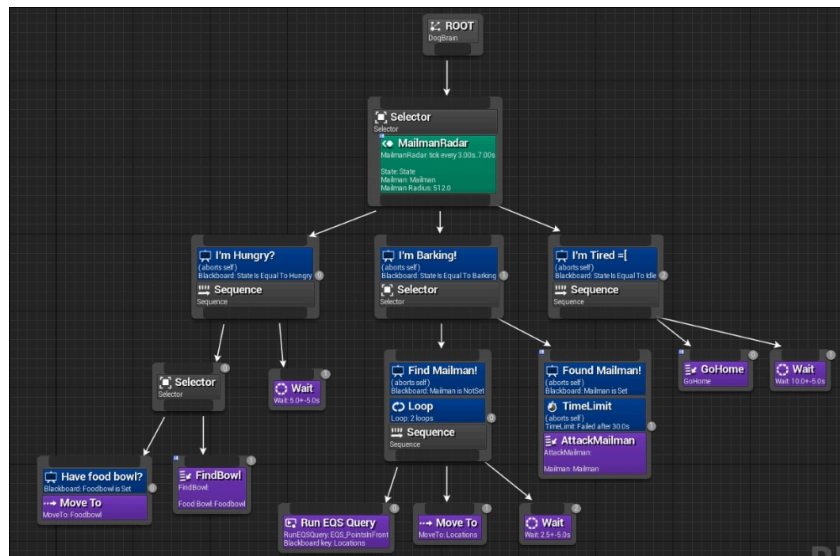


Extracted from Gears Tactics, which uses GAS

The Gameplay Ability System is a framework for building abilities like health management, damage, powerful skill, buff and attribute system. It has been used in AAA games such as Paragon, Gears Tactics and Fortnite among others. It cannot be used without a bit of C++ but there are [preconfigure projects](#) that can be helpful.

We may think that it is overkill for our project. In fact, this is not. Once the framework is in place, it is way easier to create our game since we're implementing level-based character skills with costs and manipulating attributes belonging to our monsters for the genetic algorithm. Once the framework is understood, it is actually a gain of time.

Behavior tree for villagers



BT sample from Unreal Engine

Villagers are **not aggressive**, their role is to **collect resources and build structures**. If they are attacked, they will try to escape. They can go on nightwatch to help knights.

State	Description	Enter / Exit conditions
Construct	After the player has placed a building, it needs to be constructed during a certain time. Multiple villagers constructing will make it build proportionally faster.	<u>Enter :</u> Not evading and the construction area is in detection radius. <u>Exit:</u> Construction done or is attacked
Collect resources	There are static resource points gathered on the map. When the villagers are gathering them, it is directly added to the village (no need to move back to the village with it)	<u>Enter :</u> Not evading <u>Exit:</u> Is attacked or sunset
Evade	When a villager detect a monster or is attacked, he will run back at the village and go heal in a house	<u>Enter :</u> Is attacked <u>Exit:</u> Monster not in radius and heal above a certain value

Sleep / heal / childbirth	Villagers heal and sleep in houses of the village. They will sleep there at night. Each night, there is a certain probability that 2 villagers make a child.	<u>Enter:</u> Is night and not in nightwatch <u>Exit:</u> Is sunrise or house destroyed
On watch	If there are not enough knights they will take their place for the guard. If they see a monster they will run away and alert the knights.	<u>Enter:</u> Is night and in nightwatch <u>Exit:</u> Is sunrise or attacked
Survivor	If they are attacked in the village, but no knights is there to protect them, they will try to defend themselves	<u>Enter:</u> Is in village and not enough knights around <u>Exit:</u> Enough knights around

Behavior tree for knights

The knights are there to **defend villagers and the buildings**. During daytime they can escort villagers during their resource gathering. At night time they will guard the village. If there are enough guards to cover the village radius, the weakest ones will go sleep / heal until there is an attack.

State	Description	Enter / Exit conditions
Fight	If they see a monster inside the village they will fight it. If they see it outside, they will only fight if they believe they are strong enough	<u>Enter:</u> See monster and is in village or powerful enough <u>Exit:</u> Monster is dead or monster is evading
Evade	If they are too weak and not in the village they will try to protect themselves	<u>Enter:</u> Is not in village and health below a threshold or too many enemies <u>Exit:</u> Other knights as backup or healed
Escort	If they have enough health	<u>Enter:</u>

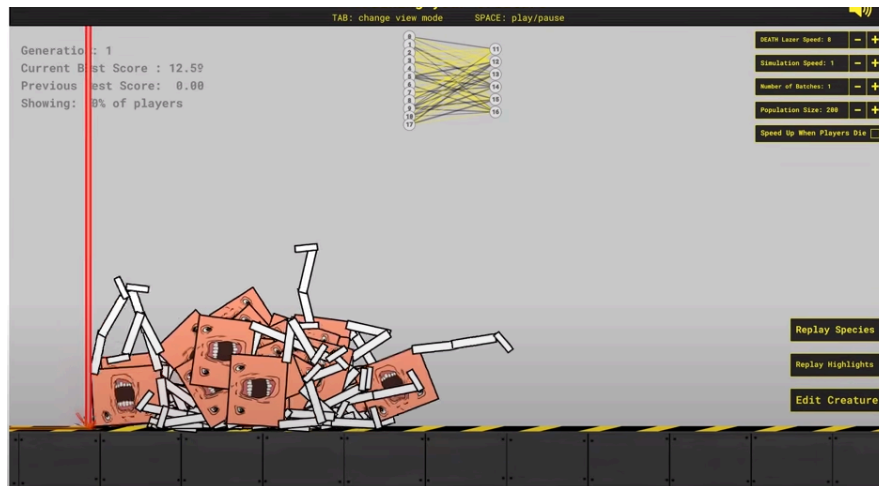
villager	they will escort villagers gathering resources	Is day, healed and villager is gathering resource <u>Exit:</u> Monster detected or is nighttime
Guard	Walk around the village to check for monsters. They will divide the space to cover by the number of knights available	<u>Enter:</u> Is nighttime and enough place on guard <u>Exit:</u> Is daytime or monster detected
Sleep / Heal	If they are not on guard, they will sleep at night.	<u>Enter:</u> Is nighttime and enough guards <u>Exit:</u> Is daytime or attack

Behavior tree for monsters

Monsters are there to **destroy buildings, villagers and knights**. They will mass-attack the village at night, but back up if they take too much damage. During the day, some of them are still in the woods to catch villagers during their resource gathering (but they will not venture into the village).

State	Description	Enter / Exit conditions
Attack	They will attack villager in sight if they know that there is no one around in day. At night they raid the village but will leave if the opposition is too strong. There is a priority system , knights are top priority, then it is villagers and finally buildings. It might evolve into something more complicated like breaking barricades to access the village.	<u>Enter:</u> Villager is in sight <u>Exit:</u> Target is dead or too many knights
Pursuit	In day when they see a villager wandering in the wood they will pursuit him	<u>Enter:</u> Villager is leaving but still in sight

	until he is dead or leaves the forest	<u>Exit:</u> Target is dead or too many knights
Evade	If they understand that they are too weak or about to leave the forest in daytime they will backup	<u>Enter:</u> Too many knights <u>Exit:</u> Enough monsters or is sunset



Genetic algorithm by [Code Bullet](#)

Genetic Algorithm for monsters

We introduce a genetic algorithm for our monsters to be **more adaptive** to the village evolution. Each day, a new generation of monsters is created based on the most successful creatures of the last night.

We rank these creatures based on their health, lifespan, strength, and number of kills. Each creature is generated from a distinct **distribution of points in a skill tree** (similar to when you start a new game in any RPG), this is their DNA.

Based on our template, we know that we will have to use 6 different classes : Population, Brain, Specie, Neuron, Synapse and Node in order to have a complete genetic algorithm.

DNA

It is represented as a fixed sequence of integers (can go above 1). The index in the sequence represents the entry in the skill tree. These values are set randomly for the first generation.

We select one of these method to generate the DNA between each generation :

- **Crossover** : get half of best parent 1 + half of best parent 2

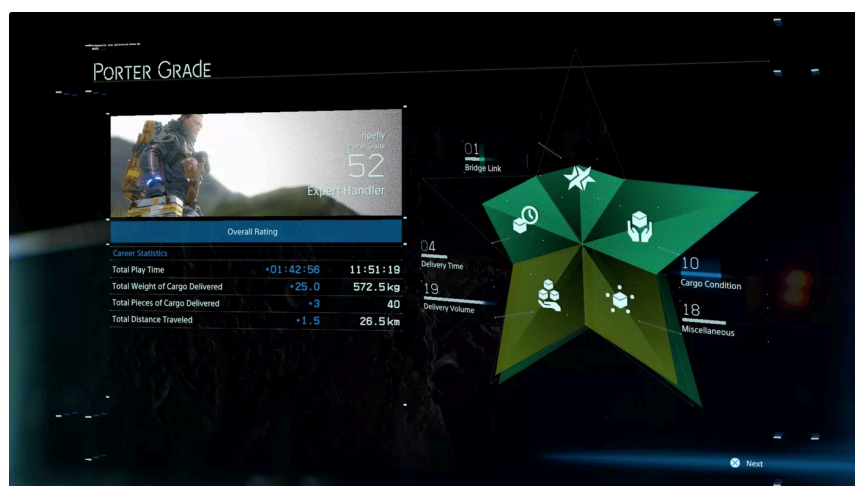
- **Mutate** : get best parents and tweak a value at a random index

The skill tree

The role of the skill tree is to read the DNA and give the characterization of the monster. The skill tree has as many entries as the length of the DNA sequence. We still have to figure out the precise components of this tree, but we will start with something simple :

- **Speed** : Will go faster. Above a certain threshold, unlock the ability to dive
- **Force** : Will make more damages. Above a certain threshold, unlock an temporary area attack
- **Detection radius** : Will see farther. Above a certain threshold, can go undetected by knights for a given time

There might be further improvements done in relation with the construction system (traps that only catch one type of monsters, barricades, etc).



Progression system in Death Stranding

Progression system for Knights and Villagers

Knights and villagers will gain experience points as they survive and do actions. They will become stronger as they stay alive for a longer time. We also introduce maluses through a sleep variable. If villagers are sleep-deprived they will move slowly and gather less resources. If knights are sleep-deprived they will do less damages. The sleep variable will regenerate as they go to sleep.



Day night cycle in Breath of the Wild

Day / Night cycle

During the day, villagers live their life as described above. When the night comes, they will try to get some sleep. Guards, on the other hand, will be posted on watch and will be alerted when monsters arrive. If there are enough knights in watch, some of them will go to sleep until there is an attack.

Monsters will mass attack the village and guards will be defending it. When the monster wave is over, guards can go to sleep. Guards that are Bastien Guyl not sleepy can escort resource-gathering villagers during the day.



Townscaper, a village generation-based game

Village Generation

The village has a certain number of resources, buildings and villagers at each game start. Moreover the resources scattered in the forest are set at random positions.

We construct the village as a **spiral around a given center** (but do not influence building rotation). At each step around this circle, there is a probability to spawn a

building (from a given set of possible buildings). At each revolution, we increment the radius of our algorithm.

We do this for a given number of steps and given probability. There are collision checks in order to put buildings close to each other but with a given margin in space. Moreover each building type has variation in its style and surroundings, it is purely cosmetic.



Building being constructed in Age of Mythology

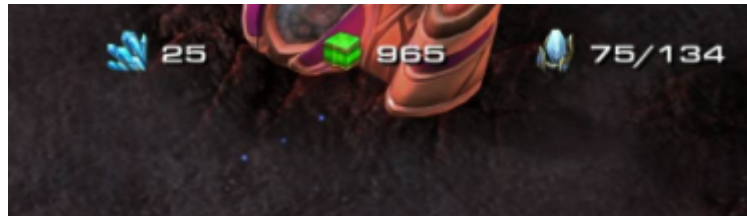
Building Construction

The building construction is classic. Each building cost resources. The player can select the building to construct on a gui screen at the bottom and place it only on the village area. Villagers will need to construct the building for it to be usable. Each building has a certain life, but can be repaired by the player and even improved.

This is subject to change, but this is are our building ideas. Ideally, it would work in combination with the monster genetic algorithm and would be all about trade-offs for the player, equilibrated like rock-papers-scissors.

Name	Cost	Description
House	20	Where villagers go to sleep. You can create new villagers there.
Barracks	50	Where knights go to sleep. You can create more knights here.
Watchtower	400	Give a bigger detection radius. For monsters to kill the person inside, they must destroy the tower first.
Barricade	?	A protective wall to place around the village. Some

		monsters can jump higher than it. Possible to make a door on it so that it blocks monsters but let through villagers and knights.
Spikes	?	Cost less than barricade but block both directions. Some monsters can jump higher than it.



Ressources HUD in Starcraft 2

Ressource handling

We have 2 ressources : **Faith and Gold**. Faith can only be acquired by the player while gold can only be acquired by the villagers (this way, it is not frustrating to see villagers dispatched to the wrong ressource).

Faith is acquired on click in a Plant vs. Zombie style. The idea is to deflect the player from courses of action so that he feels a bit overwhelmed. Some amount is given each night.

Gold is acquired by the villagers on mines. Each mine has a limited amount to give. While the first ones are in or close to the village, the other will be in the forest.



One power activated in Age of Mythology

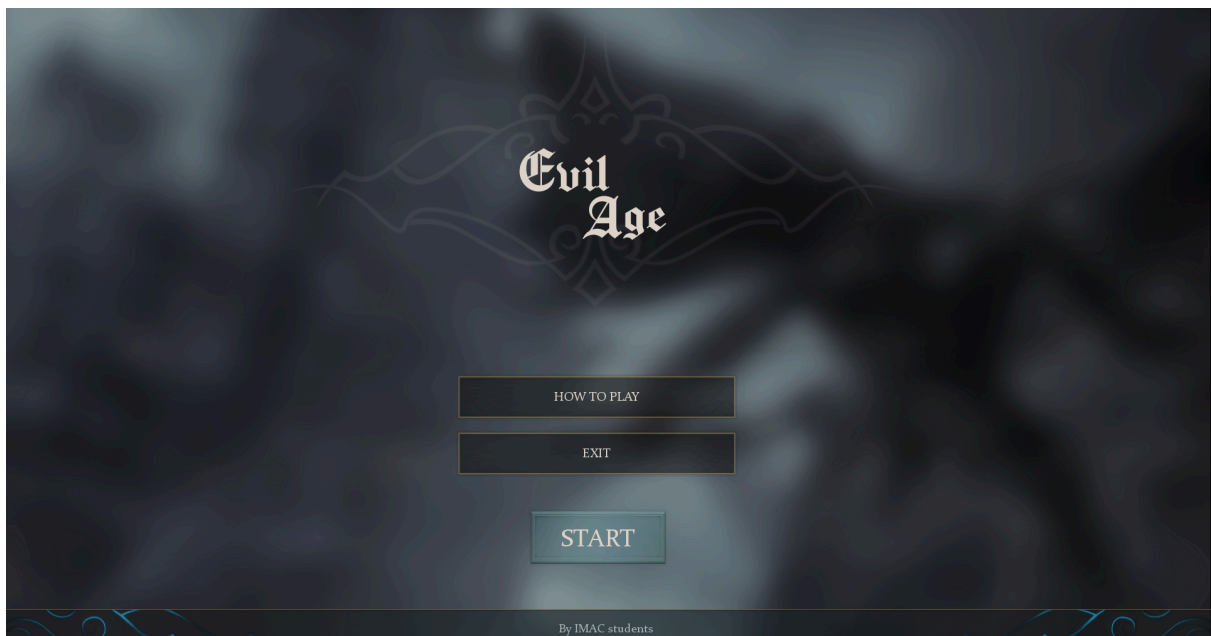
Player powers

Just like in Age-of-Mythology, the player can use costing powers to give his village a breath during an attack. Things like earthquakes, alerting knights of a position or fire tempest which will cost faith.

USER INTERFACE

Menu

Start



Main menu

When click on start, redirected to the main level

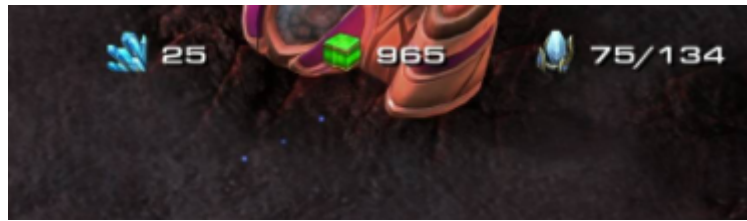
How to play

Explanation on how to play

Credits

By IMAC students

In-Game HUD



Ressources HUD in Starcraft 2



Ressources HUD in game

Ressources Count

Count for Gold and Faith. At the top right corner just like in Starcraft with icons.



The Asset used for the small window

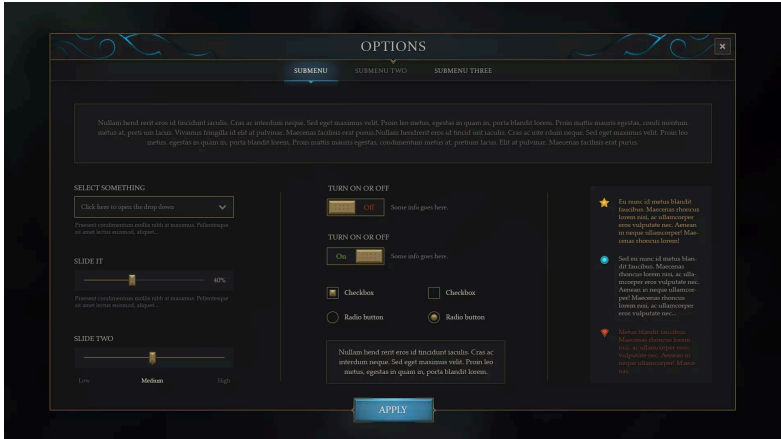
Entity Stats

On click on the entity, open a draggable small window. With :

- Name
- Life
- DNA (Attack power, defense, sight and speed)

Inspiration

We are looking at Gothic-type GUI, Dark fantasy.

Name	Illustration
Dungeon GUI	
Darkest Dungeon GUI	
RPG & MMO UI	

DEVELOPMENT STEPS

This is a rough development plan for the features of our game. From this we expect to have a compelling experience at each step of our process. A **progress indicator** is placed before each title.

[95%] A passive village

Monsters are attacking villagers randomly. Villagers are running away to their home when this happens

Part	Description
Assets	- Village in place from template with a surrounding forest - Monsters and villagers assets with their animations
General scripts	- Spawn villagers in village - Spawn monsters around the village - Villagers can enter their home
Monster IA	- Wandering - Pursuit of villagers if found - Attack of villagers if found
Villager IA	- Wandering - Running to hide in their home - Leave house when no one is around

[50%] They fight back

Villagers now have knights to keep them from being defenseless

Part	Description
Assets	- Knights and their attack animation - Weapons
General scripts	- Life bar for everyone - Handle attack animations and collisions
UI	- Life bar above head of NPCs
Monster IA	- Running away when in minority against knights
Knights IA	- Patrol around the village - Attack when seeing monsters

[60%] Genetic is beautiful

Monsters gain evolution through the genetic algorithm

Part	Description
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Monster IA	- DNA sequence - Handle generation spawning - Skill tree basics
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[85%] Player has a say

Players can earn resources through villagers' work and decide whether to spawn villagers or knights.

Part	Description
Assets	- Icons for money
UI	- Money count - Buttons to spawn knights and villagers on house selection
General scripts	- Handle money and UI logic - Gain money when farmers are farming - Spawn knights and villagers

[20%] Life fits the day and night

Day night cycles which gives a breath during day time to do chores.

Part	Description
Assets	- Day/Night cycle (maybe handled by default with Unreal) - Sun and moon for UI clock
UI	- Day/Night icon with clock
Monster IA	- Do not attack if it is day - Run away when day starts - Unspawn when they reach the forest

[0%] Beds are burning

Monsters attack houses and other buildings to destroy them. Players can repair them.

Part	Description
Assets	- Fire effects - Houses and buildings half destructed (shader ?)

General Scripts	- Handle life of buildings - Handle construction areas
UI	- Life bar for all buildings - Construct menu for the player
Monster IA	- Attack buildings

[0%] TODO

More steps (village generation, construction system, powers, villagers progression)

PROJECT MANAGEMENT

The first goal of this project was to learn a lot of new things on Unreal Engine and especially on the best practices and C++ side. That's why we worked together for a lot of the game features.

We switched the project to simple blueprint / C++ to a project that uses the GameplayAbilitySystem (GAS). We took a risk that impacted our project since understanding this library took some time. It reduced the tasks we could do for the V1.0. Still, even if it impacted the game development, we know that this is the best way to code what we wanted. We choose to prioritise learning over manufacturing.

At the very beginning of the project, we handled a lot of things with blueprints and we were working together, sometimes on the same computer. Guillaume then worked on the C++ side of the project, working on every little component that made the game, handling the GAS. He worked on monster's behavior. Laurine worked on the UI, the behavior of the knights, the map, some SFX and the day and night cycle. She wrote some code into C++ files too. We worked together for the other features, such as the genetic algorithm.

We learned a lot of new things in Unreal Engine and Laurine can now call herself an advanced beginner on Unreal Engine. Guillaume really enjoyed working and learning on how to combine C++ and Unreal Engine. It was a great experience and a project that we will pursue.

REFLECTIONS

Gameplay and system ideas to make the game fun or systems more coherent with each other. Just ideas, **probably too complex or unrealistic for this prototype.**

What if the player had to adapt the village to the monsters ?

What if, when exploring the woods in daytime, the player could discover the abilities of this generation of monsters, and make changes in the village buildings accordingly in preparation for the night ?

To do so, he would have to get back a decent amount of resources when destroying buildings, and it would have to be fast enough to construct new ones. The buildings would also need to be different enough and really disadvantaged if their type would not match the monster's type. The resources of the player should also be limited, so that he would have to make choices and can't rely and having all building types at once.

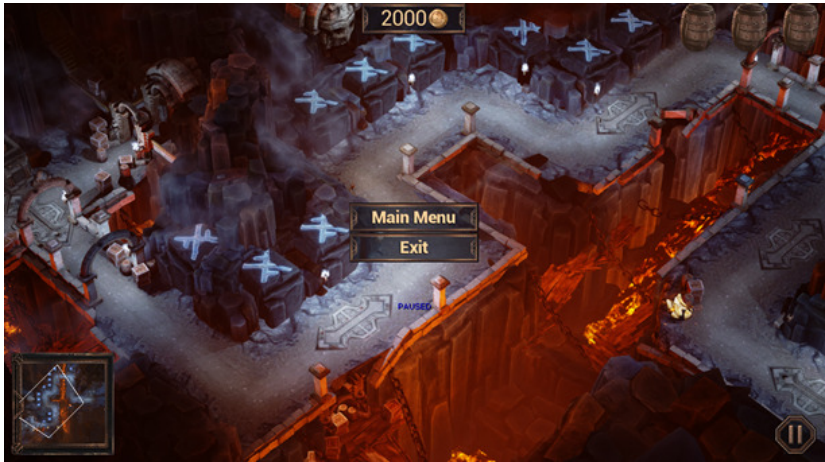
Things like to have towers to fight flying monsters, but weak against small enemies.

SOURCES

This project is also a learning project, so we will try to keep track of what helped us to build this experience.

Tuto

Link	Description
AI enemy behavior	Enemy AI behaviors with unreal behavior tree systems. How to set up a blackboard and a behavior tree with an AI controller class for the NPC. Use sequence nodes, move to task and a custom service to initialize the value of target location.
AI chasing player	Following the tuto above, when the patrolling enemy notices the player or another hostile NPC character, he will stop patrolling and keep looking in the suspicious direction.
Toom looman - Behavior trees	Tutorial on behavior trees for survival horror game
AI follow player	Basic AI follow
AI and enemy basic	Quick introduction to creating AI inside of the engine + enemy basis
Raywenderlich - AI intro UE4	Behavior tree introduction

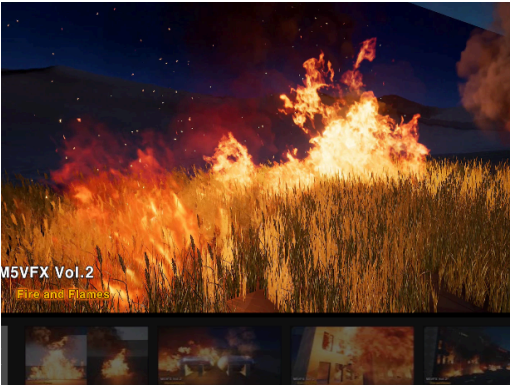
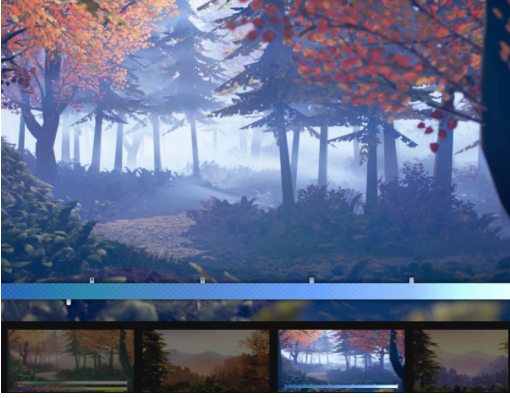
UE docs behavior	Documentation of UE about behavior tree
Genetic algorithm in Unity	Explanation of a genetic algorithm in Unity in order to learn to the population how to avoid dying
Genetic algorithm for enemies in games	Explanation on how to creative adaptive enemies with genetic algorithm
Basic UE genetic algorithm	Simulation of a car behavior with UE4's Advanced Vehicle template and template for genetic algorithm.
UnrealAI	Github organization where some UE AI projects are stored
Genetic Algorithm simple sample	Geek for Geeks article on basic genetic algorithm
Comprehensive GameplayAbilities Analysis Series	Tutorial of the GameplayAbilitySystem
GameplayAbilitySystem documentation	A complete documentation on how to understand and use the GameplayAbilitySystem
Unreal RTS (official)	
Tom Looman - ActionRogueLike	Action roguelike with custom behavior trees in C++

Assets

These are assets that were free for a period of time in Unreal Marketplace. We got them all, but we might not need them all.

Link	Description	Illustration
Cemetery - VOL.1	Graveyard	
Gothic Knight	Rigged 3D character	
Infinity blade : warriors	Rigged and animated 3d characters	
Infinity blade: Adversaries	Rigged and animated 3d characters	

Meadow environment set	Map with trees and herb	
Medieval kindgdom	A bit low-poly see video	
WaterMill environment		
VFX Attack Trails		

M5 VFX Vol2 Fire and flames		
Immersive Dark Ambient Music Pack		 Album Contains: - Main Theme Loop (1:11) - Low Intensity Loop (2:09) - Medium Intensity Loop (3:09) - High Intensity Loop (2:11) - Danger Loop (1:14) - Event Stinger (0:00) - Postive Event Loop (1:11)
Log Cabin		
Fog gradients		

[Advanced Magic FX](#)
[13 & 12](#)

