Blind Guide Redesign Patterns

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**Chosen project:**

Blind Guide - 2D slidescroller game made using the Unity3D engine and the C# programming language. The game was created by Wasili Prattis and his Project Game Development (second year HvA project) team.

The player plays the role of a ghostly guide dog that wants to help his owner get to his home. There are multiple objects along the way, which can all be cleared using the player’s special powers.

The blind guy can only take one hit during the entire game; taking a hit means game over.

All obstacles and enemies can die by one or multiple powers and some obstacles require a combination sequence of multiple attacks in order to be stopped

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# Singleton

# Flyweight

# State

In Blind Guide, the player can choose between three different abilities to use in order to destroy obstacles and enemies. Seeing as only one of these powers can be active at a time, it is required that the player keeps track of the current power in order to decide which power to activate when the player presses the ‘Use Power’ button.

We accomplish this behaviour by using the state pattern: we create an array of available powers and switch between these powers whenever the player presses the ‘Switch Power’ button. By having an integer that tells us which power we’re currently using, we can activate the correct power whenever the player attacks.

The first power the player can use is telekinesis. The player can pull certain objects, that are marked appropriately with a tag, towards him and then throw them away to prevent the Blind Guy from being harmed.

The second and third power the player can use are quite similar; the player can breathe fire or ice in order to burn or freeze objects. Seeing as these powers are quite similar, we only need to define one state for both and simply give the spawned object (flame or ice particles) a tag that will define its type. Objects decide what happens to them when collision with the attacks is registered.

## Structure

## Implementation

|  |
| --- |
| public class PlayerPowerHandler : MonoBehaviour {  PlayerPower[] powers;  int currentPower = 0;  public GameObject icePowerPrefab, firePowerPrefab;  void Start() {  //set the available powers  powers = new PlayerPower[] {  new PlayerPowerTelekinesis(this.gameObject),  new PlayerPowerBreath(this.gameObject, firePowerPrefab),  new PlayerPowerBreath(this.gameObject, icePowerPrefab) };  }  // Update is called once per frame  void Update() {  if (Input.GetButtonDown("Switch Power")) {  //deactivate current power  powers[currentPower].Deactivate();  //go to next power if available, otherwise pick the first  currentPower = currentPower < powers.Length-1 ?currentPower+1 :0;  //actiate the new power  powers[currentPower].Activate();  }  powers[currentPower].Update();  }  } |

The PlayerPowerHandler class keeps track of the current state and calls its update method every frame

|  |
| --- |
| public abstract class PlayerPower {  //keep track of player object  protected GameObject player;  public PlayerPower(GameObject player) {  this.player = player;  }  //frame-by-frame logic  public abstract void Update();  //call when power is selected  public abstract void Activate();  //call when power is deselected  public abstract void Deactivate();  } |

The base class for each power contains functions that must be implemented

|  |
| --- |
| public class PlayerPowerTelekinesis : PlayerPower {  private float pullDistance = 6.0f;  GameObject pulledObject;  public PlayerPowerTelekinesis(GameObject player) : base(player) { }  public override void Activate() {  //send a message to the player to trigger sprite switches and sounds  player.SendMessage("SwitchPower", "Telekinesis");  }  public override void Deactivate() {  //make sure the pulled object doesn't return when we switch back  pulledObject = null;  }  public override void Update() {  if (Input.GetButton("Use Power")) {  GravitationalPull();  }  if (Input.GetButtonUp("Use Power")) {  GravitationalPush();  }  }  //called when power is active  private void GravitationalPull() {  //find all pullable objects in the scene  GameObject[] pullableObjects =  GameObject.FindGameObjectsWithTag("PullableObject");  //iterate through each object  for (int i = 0; i < pullableObjects.Length; i++) {  //check their distance from the player  if (Vector3.Distance(pullableObjects[i].transform.position,  player.transform.position) < pullDistance) {  pulledObject = pullableObjects[i];  //pull object towards the player  pullableObjects[i].GetComponent<Rigidbody2D>().velocity =  (player.transform.position -  pullableObjects[i].transform.position) \* 10;  }  }  }  //called when power is deactivated  private void GravitationalPush() {  if (pulledObject != null) {  //throw object away, towards the mouse cursor  pulledObject.GetComponent<Rigidbody2D>().velocity =  GlobalGuide.AimTowardsMouse(pulledObject.transform.position)  \* 10;  }  }  } |

Telekinesis pulls objects towards the player and throws them away towards the cursor

|  |
| --- |
| public class PlayerPowerBreath : PlayerPower {  private GameObject powerObject, powerPrefab;  public PlayerPowerBreath(GameObject player, GameObject icePowerPrefab)  : base(player) {  this.powerPrefab = icePowerPrefab;  }  public override void Activate() {  //trigger spreite switches, animations and sounds  player.SendMessage("SwitchPower", "Ice");  }  public override void Deactivate() {  //destroy the spawned power when we switch  GameObject.Destroy(powerObject);  }  public override void Update() {  if (Input.GetButtonDown("Use Power")) {  //spawn the power object  powerObject = (GameObject)GameObject.Instantiate(powerPrefab,  player.transform.position,  player.transform.rotation);  //make sure it follows the player position and rotation  powerObject.transform.parent = player.transform;  //place it slightly in front of the player  powerObject.transform.localPosition = new Vector2(-2.0f, 0.0f);  }  }  } |

Fire and ice attacks use the same behaviour and spawn a prefab containing animations and collision detection

|  |
| --- |
| public void OnTriggerEnter2D(Collider2D target) {  if (target.gameObject.tag == "IceAttack") {  IceDeath();  }  } |

Objects that can be killed by fire or ice check for a tag when they detect collision (built-in unity call)

# Strategy

Enemies in the game can have different behaviour depending on the situation. This means that we should be able to apply behaviour to enemies during runtime and that we should have a system that allows us to separate general behaviour from specific behaviour. Seeing as all enemies have either one of the following traits, we can easily accomplish this using the strategy pattern:

* Stationary collider object that kills the blind guy on collision
* Patrolling enemy that moves between to specified positions
* Projectile-throwing object that throws projectiles towards the blind guy
* Charing object that moves towards the blind guy at a certain speed

These behaviours can be contained within their own class, all inheriting from a base EnemyBehaviour class. Specific enemies then use these different behaviours to handle their behaviour without having to duplicate code each time two objects have the same behaviour.

## Structure

## Implementation

|  |
| --- |
| public class EnemySnowman : MonoBehaviour {  private EnemyBehaviour behaviour;  private GameObject blindGuy;  public GameObject projectile;  public Sprite moltenSprite;  private bool canSwitchAttack = false;  // Use this for initialization  void Start () {  blindGuy = GameObject.FindWithTag("Blindguy");  behaviour = new EnemyBehaviourPatrol(transform,  transform.position + transform.TransformDirection(Vector2.right)  \* 8.0f);  }    // Update is called once per frame  void Update () {  behaviour.Update();  //throw projectiles at the blind guy when he's near  if (Vector2.Distance(blindGuy.transform.position,  transform.position) < 10  && canSwitchAttack) {  behaviour = new EnemyBehaviourProjectile(transform, projectile);  canSwitchAttack = false;  }  }  void OnTriggerEnter2D(Collider2D coll) {  //switch to a collision object when we melt  if (coll.gameObject.tag == "FireAttack") {  //we can no longer attack  canSwitchAttack = false;  GetComponent<SpriteRenderer>().sprite = moltenSprite;  behaviour = new EnemyBehaviourStationaryCollider(  this.gameObject,  EnemyBehaviourStationaryCollider.CollisionType.Ice);  //make this a pullable object for telekinesis  this.gameObject.tag = "PullableObject";  GetComponent<Rigidbody2D>().isKinematic = false;  }  }  } |

The snowman only needs to know when to switch between different behaviours; the behaviour logic is handled in its own class

|  |
| --- |
| public abstract class EnemyBehaviour {  public abstract void Update();  } |

EnemyBehaviour base class only needs an Update method

|  |
| --- |
| public class EnemyBehaviourCharge : EnemyBehaviour {  private Transform transform;  private Vector2 velocity;  private float speed = 10.0f;  public EnemyBehaviourCharge(Transform callerTransform,  Vector2 chargeDestination) {  transform = callerTransform;  //calculate velocity once based on destination  velocity = (chargeDestination - (Vector2)transform.position).normalized;  }  public override void Update() {  //move with charge velocity  transform.position += (Vector3)velocity  \* Time.deltaTime  \* speed;  }  } |

Charge behaviour can be used to make an object roll towards the blind guy

|  |
| --- |
| public class EnemyBehaviourProjectile : EnemyBehaviour {  private Transform transform;  private GameObject projectile, projectilePrefab;  private Vector2 target;  private float speed = 15.0f;  private float timer;  public EnemyBehaviourProjectile(Transform callerTransform,  GameObject projectileToThrow) {  transform = callerTransform;  projectilePrefab = projectileToThrow;  Throw();  }  public override void Update() {  //throw a projectile every couple of seconds  timer -= Time.deltaTime;  if (timer <= 0) {  Throw();  }  }  private void Throw() {  timer = 5.0f;  projectile = (GameObject)GameObject.Instantiate(projectilePrefab,  transform.position,  transform.rotation);  target = GameObject.FindWithTag("Blindguy").transform.position;  }  } |

Some enemies can throw projectiles at the player. Projectile logic is handled in separate projectile scripts, because some behave differently

|  |
| --- |
| public class EnemyBehaviourStationaryCollider : EnemyBehaviour {  public enum CollisionType { Fire, Ice, Normal }  public EnemyBehaviourStationaryCollider(GameObject caller, CollisionType type) {  //apply one of three different types of deaths  switch (type) {  case CollisionType.Fire:  caller.AddComponent<SetFlameDeath>();  break;  case CollisionType.Ice:  caller.AddComponent<SetFrozenDeath>();  break;  case CollisionType.Normal:  caller.AddComponent<SetDizzyDeath>();  break;  }  }  public override void Update() {  //collision is handled by the Set<Type>Death components  }  } |

A stationary collider needs to know what kind of death it should apply on collision

|  |
| --- |
| public class EnemyBehaviourPatrol : EnemyBehaviour {  private Transform transform;  private Vector2 destination, start;  private float speed = 3.0f;  public EnemyBehaviourPatrol(Transform callerTransform,  Vector2 patrolDestination) {  transform = callerTransform;  destination = patrolDestination;  start = transform.position;  }  public override void Update () {  //move towards patrol destination  if (Vector2.Distance(transform.position, destination) > 1.0f) {  transform.position += ((Vector3)destination  - transform.position).normalized  \* Time.deltaTime  \* speed;  }  //turn around if we reach the destination  else {  Vector3 current = destination;  destination = start;  start = current;  }  }  } |

When using the patrol behaviour, the player does not need to be attacked, the enemy simply movies between two points

# Prototype

# Mediator

Players in Blind Guide can unlock achievements by doing certain tasks. One such task is killing 10 obstacles in a row, without letting the player die. Doing so unlocks a certain animation for the object that was destroyed last. In order to accomplish this, we do not want the achievement tracker and the objects to be linked to each other. That’s why we implement a mediator pattern to serve as a middle-man.

The mediator will receive calls from obstacles when they are destroyed. The mediator will then tell the achievement tracker that an object has been destroyed and the tracker should be updated. If enough obstacles were destroyed in a row, the achievement tracker will tell the mediator that an achievement has been unlocked. The mediator can then tell the object that it should play an animation for unlocking the achievement.

The mediator can be expanded to also play a sound, send messages to the server if online achievement tracking is ever implemented, and anything else you can come up with. All this can be done without having to touch the achievement tracker or the obstacle code.

## Structure

## Implementation

|  |
| --- |
| public abstract class AchievementObject : MonoBehaviour {  //the prefab containing the animation to be played  public GameObject animationPrefab;  //trigger the animation sequence for an unlocked achievement  public abstract void AnimateAchievement();  } |

Other obstacles can have a component that inherits from this class to handle the unlocking of achievements

|  |
| --- |
| public class IceSpikeAchievementObject : AchievementObject {  public override void AnimateAchievement() {  //instantiate the object containing the animation to be played  Instantiate(animationPrefab, transform.position, transform.rotation);  }  void OnTriggerEnter2D(Collider2D coll) {  //this object can be destroyed by fire  if (coll.gameObject.tag == "FireAttack") {  //see if we should play an animation upon destruction  FindObjectOfType<Mediator>()  .ObjectDestroyedAchievementcheck(this);  }  }  } |

When the ice spike trigger an achievement, it creates an object that plays the animation without any other behaviour in the game

|  |
| --- |
| public class Mediator : MonoBehaviour {  public void ObjectDestroyedAchievementcheck(AchievementObject obj) {  //update the achievement tracker  FindObjectOfType<AchievementTracker>().UpdateObjectDestructionTracker(obj);  }  public void AnimateAchievementUnlock(AchievementObject obj) {  //play an animation because an achievement was unlocked  obj.AnimateAchievement();  }  public void ResetAchievementObjectTracker() {  FindObjectOfType<AchievementTracker>().ResetObjectDestructionTracker();  }  } |

The mediator connects the achievement tracker and the achievement objects and calls their functions when needed

|  |
| --- |
| public class AchievementTracker : MonoBehaviour {  //keep track of how many obstacles have been destroyed so far  static int objDestructionCount = 0;  bool objDestructionCountUnlocked = false;  //update the amount of obstacles detroyed so far  public void UpdateObjectDestructionTracker(AchievementObject obj) {  objDestructionCount++;  if (objDestructionCount > 10 && !objDestructionCountUnlocked) {  //play an animation sequence on the object we destroyed  FindObjectOfType<Mediator>().AnimateAchievementUnlock(obj);  objDestructionCountUnlocked = true;  }  }  //reset the destruction tracker  public void ResetObjectDestructionTracker() {  objDestructionCount = 0;  }  } |

The achievement tracker decides when an achievement unlock trigger should be called, based on the data is has collected so far

# Decorator

The player can pick up certain objects that act as a power-up to the blind guy. These objects can be found by killing objects or are hidden behind screen obstructions in the levels. Picking up one of these power-ups increases the blind guy’s health and sometimes also provides an extra boost to, for example, the blind guy’s speed or the view distance of the camera. Seeing as these power-ups should stack endlessly (limits will be in the form of object placement, not code) we need a way to add and remove power-ups during runtime.

We can accomplish this using the decorator pattern: we add a power-up whenever the player picks up a power-up object and we remove the last power-up when the blind guy takes damage.

By giving the blind guy a component that handles the power-up states, we can let scripts communicate to trigger collision events with power-up pickups and hostile obstacles.

## Structure

## Implementation

|  |
| --- |
| public abstract class BlindGuyBase {  public abstract int health { get; }  public abstract float viewDistance { get; }  public abstract float speed { get; }  } |

Base class for the blind guy stats and the blind guy power-ups

|  |
| --- |
| public class BlindGuyStats : BlindGuyBase {  public override int health {  get { return 0; }  }  public override float speed {  get { return 2.0f; }  }  public override float viewDistance {  get { return 5.5f; }  }  } |

BindGuyStats provides base values for the blind guy, which the power-ups can expand upon

|  |
| --- |
| public class BlindGuyPowerupBase : BlindGuyBase {  private BlindGuyBase blindGuy;  public BlindGuyPowerupBase(BlindGuyBase blindGuy) {  this.blindGuy = blindGuy;  }  //return the blindguy without the latest power-up attached  public BlindGuyBase Removed() {  return blindGuy;  }  public override int health {  get { return blindGuy.health; }  }  public override float speed {  get { return blindGuy.speed; }  }  public override float viewDistance {  get { return blindGuy.viewDistance; }  }  } |

The base class of the power-ups provides the base values of the player

|  |
| --- |
| public class BlindGuyPowerupHealth : BlindGuyPowerupBase {  public BlindGuyPowerupHealth(BlindGuyBase blindGuy) : base(blindGuy) { }  public override int health {  get { return base.health + 1; }  }  } |

Increase the health of the blind guy

|  |
| --- |
| public class BlindGuyPowerupSpeed : BlindGuyPowerupBase {  public BlindGuyPowerupSpeed(BlindGuyBase blindGuy) : base(blindGuy) { }  public override float speed {  get { return base.speed + 0.5f; }  }  public override int health {  get { return base.health + 1; }  }  } |

Increase the speed of the blind guy

|  |
| --- |
| public class BlindGuyPowerupViewDistance : BlindGuyPowerupBase {  public BlindGuyPowerupViewDistance(BlindGuyBase blindGuy) : base(blindGuy) { }  public override float viewDistance {  get { return base.viewDistance + 0.5f; }  }  public override int health {  get { return base.health + 1; }  }  } |

Increase the view distance of the blind guy so the player has more time to react to danger

|  |
| --- |
| public class BlindGuyHandler : MonoBehaviour {  BlindGuyBase blindGuy;  BlindGuyPowerupBase powerup;  BlindGuyAI blindGuyAI;    void Start () {  //create a new blind guy stats object  blindGuy = new BlindGuyStats();  //give the powerup a base to work with  powerup = new BlindGuyPowerupBase(blindGuy);  blindGuyAI = GetComponent<BlindGuyAI>();  }    public void AddHealth() {  /\* apply a new power-up and give the current  \* power-up as base to expand upon \*/  powerup = new BlindGuyPowerupHealth(powerup);  }  public void AddViewDistance() {  powerup = new BlindGuyPowerupViewDistance(powerup);  }  public void AddSpeed() {  powerup = new BlindGuyPowerupSpeed(powerup);  }  public void RemovePowerup() {  powerup = (BlindGuyPowerupBase)powerup.Removed();  }  void Update () {  //update blind guy values  blindGuyAI.health = powerup.health;  blindGuyAI.viewDistance = powerup.viewDistance;  blindGuyAI.speed = powerup.speed;  }  } |

Added to the blind guy as a component, this class handles all communication between power-ups and the components that use them

# Façade

# Observer

The player has the option to make the blind guy pause momentarily. The player character does this by letting out a loud bark, which makes the blind guy look around for a bit while he’s paused. Seeing as this is a loud bark, certain enemies should be able to hear this bark as well, and react to it. So, we want a way for certain objects to be notified whenever the player uses his bark function.

We can accomplish such behaviour by using the observer pattern: we have a subject (the bark power event caller) and observers that are notified when the bark event is triggered. This allows multiple objects to be notified at the same time, without having to use the expensive built-in SendMessage method provided by Unity3D. We keep track of objects that want to be notified by storing them in a list inside the subject. Objects that want to be notified can then pass a callback method onto the observer, which will then be executed when the bark power event is triggered.

## Structure

## Implementation

|  |
| --- |
| public abstract class ObserverBase {  public abstract void Update();  } |

The observer base class provides an Update method.

|  |
| --- |
| public class BarkPowerObserver : ObserverBase {  //create a delegate for callbacks  public delegate void BarkCallback();  //callback function is stored in this delegate  private BarkCallback barkCallback;  public BarkPowerObserver(BarkCallback callbackFunction) {  //save the callback method  barkCallback = callbackFunction;  }  public override void Update() {  //execute the callback method  barkCallback();  }  } |

The bark power observer requires a callback method to be assigned when it is created. The callback is then executed when the player barks.

|  |
| --- |
| public abstract class SubjectBase : MonoBehaviour {  private List<ObserverBase> observers = new List<ObserverBase>();  public void Attach(ObserverBase ob) {  observers.Add(ob);  }  public void Detach(ObserverBase ob) {  observers.Remove(ob);  }  public void Notify() {  foreach (ObserverBase ob in observers) {  ob.Update();  }  }  } |

The subject base class has a list of observers and methods to add, remove and notify observers.

|  |
| --- |
| public class BarkPowerSubject : SubjectBase {    } |

The BarkPowerSubject class requires no extra code to work, but we still have it so we can more easily use it as a component in Unity.

|  |
| --- |
| public class EnemySnowman : MonoBehaviour {  private BarkPowerObserver barkObserver;  void Start () {  //create a new observer object and assign a callback function  barkObserver = new BarkPowerObserver(BarkEvent);  //add the observer to the list of subject observers for bark  FindObjectOfType<BarkPowerSubject>().Attach(barkObserver);  }  void BarkEvent() {  //attack the player when bark is triggered  AttackPlayer();  }  …  } |

The snowman reacts to barks and goes into attack mode when the bark is heard.

# Null Object

We are currently using the strategy pattern to define enemy behaviour at runtime, but what happens when we want an object to remain in the level but be harmless (have no behaviour)? One solution for this is to use a null object as a placeholder for enemy behaviour. We assign the null object as soon as the object is declared ‘dead’.

Using the null object, we can still ‘bring the object to life’ if we ever decide to implement such behaviour. We could simply accomplish this by detecting whether the user is casting a fire attack on a ‘dead’ fire-based object and then call it back to life without having to instantiate a new version of it.

## Structure

## Implementation

|  |
| --- |
| public class LavaFall : MonoBehaviour {  private EnemyBehaviour behaviour;  public Sprite frozenSprite;  void Start () {  behaviour = new EnemyBehaviourStationaryCollider(  this.gameObject,  EnemyBehaviourStationaryCollider.CollisionType.Fire);  }  void Update() {  behaviour.Update();  }  void OnTriggerEnter2D(Collider2D coll) {  if (coll.gameObject.tag == "IceAttack") {  //we don't want to destroy the object  behaviour = new EnemyBehaviourNull();  //we simply want it to no be harmful and change its sprite  GetComponent<SpriteRenderer>().sprite = frozenSprite;  }  }  } |

The lava fall object remains in the scene after it’s destroyed, but it has no behaviour; it’s just there as decoration

|  |
| --- |
| public abstract class EnemyBehaviour {  public abstract void Update();  } |

The EnemyBehaviour class again for reference

|  |
| --- |
| public class EnemyBehaviourNull : EnemyBehaviour {  public override void Update() {  //do nothing  }  } |

The null enemy behaviour does nothing in its update method