Modular AI

Description:

Modular AI is an inspector based visual behaviour designer.

Namespace:

Kitbashery.AI

Features:

- Implements competeing utility theory behaviours for dynamic AI behaviours.
- Zero string comparisons or calls to reflection.
- Behaviours can be fully configured during runtime.
- Not tied to a specific pathfinding solution.
- Fully extendable via code modules.

Built-in Modules:

UNITY PATHFINDING:

- Flee/Follow
- Wander
- Patrol

MEMORY:

- Remember players, AI agents or environment objects.
- Focus/target objects in memory
- Invoke custom events.

SENSORS:

- Eye level scans
- Physics Scan Options for 2D & 3D
- Integrated with memory

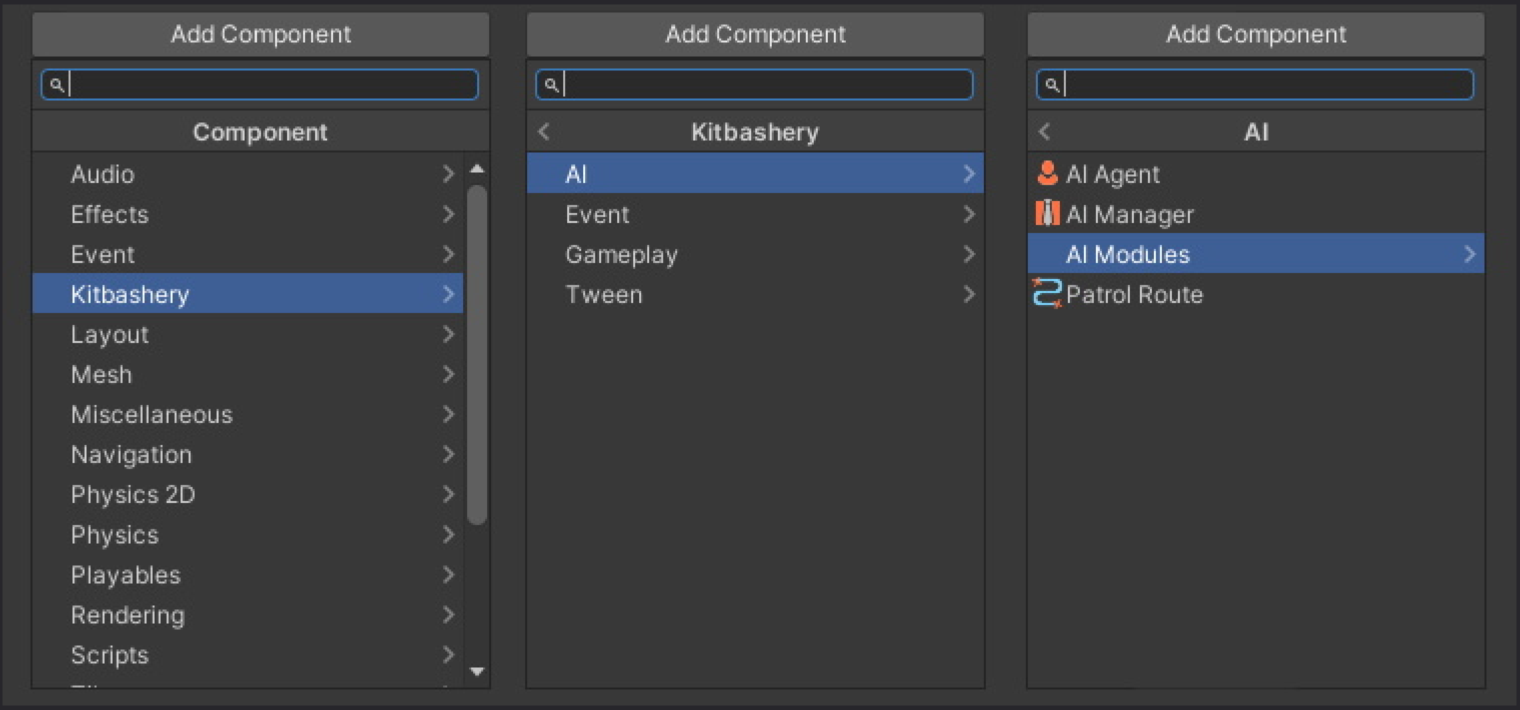
ANIMATION:

- Idle, Walk, Run & Jump
- Attack, Death Animations
- Dynamic Hit reactions

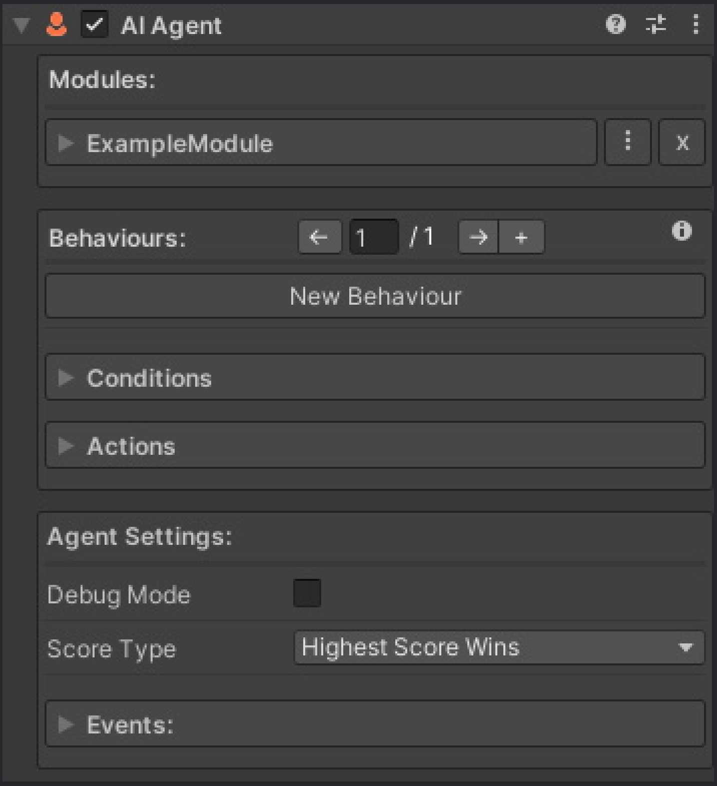
Getting Started:

To get started using Modular AI first create a GameObject with an AIManager component.

All Modular AI components can be found through the component menu:



Next create a new GameObject with an AIAgent component and add the modules you want to it. Modules contain code that defines behaviour logic the AI can use & can be configured using the inspector.



Debug Mode
Score Type Highest Score Wins

Utility Theory:

Modular AI uses utility theory for its AI behaviour logic. An AI agent can have as many behaviours as you want.

Behaviours:

Behaviours are comprised of conditions and actions and have a score value. The behaviour with the score that best meets the score type you set will execute its actions.

Conditions:

Conditions are true/false statements based on what the AI knows about the game world. If a condition meets its desired state then it will add its score to the behaviour's total score.

Actions:

Actions are executed in the order they are arranged if a behaviour's total score meets the score type better than any other behaviour.

Module Scripting:

Take a look at ExampleModule.cs for how to create your own modules.

CLASSES:

AIAgent.cs

Description:

Contains a list of behaviours that can be evaluated.

Usage Notes:

An AI agent's behaviour loop is updated by an instance of `AIManager` if a manager instance is not found one will be created.

Public Properties:

Type	Name	Description	Default Value
`AIModule[]`	modules		
`bool`	modulesChanged	Has the amount of modules changed?	false
`List<AIBehaviour>`	behaviours		

Type	Name	Description	Default Value
`UnityEvent`	preActionExecution	Events to be invoked before any behaviour actions are executed when `ExecuteWinningBehaviourActions()` is called.	
`UnityEvent`	postActionExecution	Events to be invoked after any behaviour actions are executed when `ExecuteWinningBehaviourActions()` is called. is called.	
`bool`	debugMode	Toggles debug information in the console while in playmode.	false
`DebugLevels`	debugLevel	How much information to log to the console while in debug mode.	DebugLevels.BehavioursOnly
`ScoreTypes`	scoreType	The condition a behaviour's score needs to meet for its actions to execute.	ScoreTypes.HighestScoreWins
`int`	scoreThreshold	The score a behaviour will need to beat in order for its actions to be executed.	0
`bool`	hasBrokenReferences	Has a module that this agent depends on been removed?	false

Public Methods:

Name	Summary	Parameters	Returns
UpdateAI			`Void`
ResetBehaviourEvaluation	Resets the initial score to beat and clears previously winning behaviours. Note: Call this if you change `scoreType` during runtime.		`Void`
ExecuteBehaviourActions		`AIBehaviour` behaviour	`Void`
AddNewEvent		`int` behaviourIndex, `BehaviourEvent` behaviourEvent	`Void`
ValidateBehaviours	Makes sure all components required by the behaviour logic has a component instance.		`Void`

Name	Summary	Parameters	Returns
FixBrokenReferences			`Void`
CheckForModuleChanges			`void`

Enumerations:

DebugLevels

`{ All, BehavioursOnly, ConditionsOnly }`

ScoreTypes

`{ AllScoresAboveThreshold, FirstScoreAboveThreshold, FirstScoreWins, HighestScoreWins, LowestScoreWins }`

AIAgentEditor.cs

Description:

Custom editor for AIAgent.cs

Public Properties:

Type	Name	Description	Default Value
`AIAgent`	self		The `AIAgent` being inspected.

Public Methods:

Name	Summary	Parameters	Returns
OnInspectorGUI			`override Void`

AIManager.cs

Description:

Consolidates `AIAgent` update loops improving performance.

Usage Notes:

- Default script execution order is -21 to load before AIAgents.cs.

Public Properties:

Type	Name	Description	Default Value
`static AIManager`	Instance		
`List<AIAgent>`	agents		

Public Methods:

Name	Summary	Parameters	Returns
Register		`AIAgent` agent	`Void`
Unregister		`AIAgent` agent	`Void`

AIModule.cs

Description:

A base class for all AI modules.

Usage Notes:

Components that inherit from this base class are automatically hidden in the editor. to prevent this comment out the `OnValidate() method:

```
        private void OnValidate()
        {
            hideFlags = HideFlags.HideInInspector;
        }
```

Doing so will show modules as regular components in the inspector. You may also wish to comment out the call to `DrawModules();` in the `OnInspectorGUI()` funciton in `AIAgentEditor.cs` this will prevent the custom module UI from being displayed.

Public Properties:

Type	Name	Description	Default Value
`abstract string[]`	conditions		
`abstract string[]`	actions		

Public Methods:

Name	Summary	Parameters	Returns
executeAction		`int` actionIndex	`abstract Void`
checkCondition		`int` conditionIndex	`abstract Void`

AnimationModule.cs

Inherits from:

AIModule.cs

Description:

This module contains actions and condtions to play animations via Unity's `Animator` component.

Usage Notes:

The tags "Player" and "Agent" are used by this module by default make sure they exist in your project settings if you use them.

Public Properties:

Type	Name	Description	Default Value
`UnityEvent`	animationEvents		
`Animator`	anim	The `Animator` component.	
`List<GameObject>`	players		
`string`	idleState		
`string`	walkState		
`string`	runState		

Type	Name	Description	Default Value
`string`	jumpState		
`string[]`	deathStates		
`int`	currentDeathState		-1
`string[]`	attackStates		
`int`	currentAttackState		-1
`string[]`	hitReactionStates		
`int`	currentHitReactionState		-1

Public Methods:

Name	Summary	Parameters	Returns
Idle			`Void`
Walk			`Void`
Run			`Void`
Jump			`Void`
Die		`StateOptions` option	`Void`
Attack		`StateOptions` option	`Void`
HitReaction		`StateOptions` option	`Void`

Enumerations:

FocusModes

`{ Nearest, Farthest, Random, First, Last }`

BehaviourEvent.cs

Implements:

`IComparable<BehaviourEvent>`

Description:

Represents an action or condition that will be executed or evaluated by `AIAgent`.

Usage Notes:

Contains two constructors one for defining the event as a condition and a shorter one to set the event as an action.

Public Properties:

Type	Name	Description	Default Value
`AIModule`	instance	The required module component instance that this event links to during runtime.	
`string`	moduleName	The assembly qualified name the required module instance.	
`int`	id	ID is the index of either an action or condition.	
`string`	name	The name of the event.	
`bool`	isCondition	Does this event represent a condition?	
`int`	score	The score value of the event if the event represents a condition.	
`bool`	state	The required state of the event if the event represents a condition.	

Constructors:

Summary	Parameters	Constructs
Constructs an event as a condition.	`string` eventName, `int` eventID, `AIModule` module, `int` conditionScore, `bool` conditionState	`BehaviourEvent`
Constructs an event as an action.	`string` eventName, `int` eventID, `AIModule` module	`BehaviourEvent`

Public Methods:

Name	Summary	Parameters	Returns
CompareTo	Required by IComparable.	`BehaviourEvent` other	`int`

ExampleModule.cs

Inherits from:

AIModule.cs

Description:

This class is an example template for creating modules.

Usage Notes:

- All classes that inherit from AIModule.cs should have the `[DisallowMultipleComponent]` attribute.
- Overrides for `conditions` and `actions` of AIModule.cs are required, however can be encapsulated in `#if UNITY_EDITOR` if you do not want to use them to build UI dropdowns for runtime behaviour editing.
- Make sure you don't have any AIAgents selected in the inspector when you make changes to the `conditions` or `actions` arrays this may break the dropdown for that inspected agent. See Issue #6 in modular AI's GitHub repo for more information. A workaround for this is to reset the module component.
- Do not rearrange the strings entered into an action/condition override array once they are in use in your project this will cause visual bugs in the editor.

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;

namespace Kitbashery.AI
{
    [HelpURL("https://kitbashery.com/docs/modular-ai/example-module.html")]
    [DisallowMultipleComponent]
    [AddComponentMenu("Kitbashery/AI/AI Modules/ExampleModule.cs")]
    public class ExampleModule : AIModule
    {
        #region Properties:

        [Header("ExampleModule.cs is a template script for programming reference.")]
        [Header("Example Inpector Header")]
        [Tooltip("Example Inspector Tooltip")]
        public int exampleVariable;

        #endregion
```

```
#region Modular AI Condition Overrides:

/// <summary>
/// Condition names used by the editor to set identifiers based on the index of
/// the selected string in this array.
/// </summary>
private string[] _conditions;
public override string[] conditions
{
    get
    {
        if (_conditions == null || _conditions.Length == 0)
        {
            _conditions = new string[3] { "example condition 1", "example condition 2", "example conditio
        }
        return _conditions;
    }
}

/// <summary>
/// Checks a condition based on an index that should match an action's name in this module's actions array
/// </summary>

/// <param name="conditionIndex"></param>
public override bool checkCondition(int conditionIndex)
{
    switch (conditionIndex)
    {
        case 0:

            // This is an example of returning a statement.
            return transform.position == Vector3.zero;

        case 1:

            // This is an example of how you could return a more complex statement.
            if (transform.position == Vector3.zero && (transform.position.y > 1 || transform.position.y <
            {
                return true;
            }
            else
            {
                return false;
            }

        case 2:

            // This is an example of how to return a boolean value from a method
            // (useful for managing more complex code such as loops).
            return ConditionExample3();

    }

    return false;
}

#endregion

#region Modular AI Action Overrides:

/// <summary>
/// Action names used by the editor to set identifiers based on the index of
/// the selected string in this array.
/// </summary>
private string[] _actions;
public override string[] actions

{
    get
    {
        if (_actions == null || _actions.Length == 0)
        {
            _actions = new string[2] { "do something", "do another thing" };
        }
        return _actions;
    }
}

/// <summary>
/// Executes an action based on an index that should match an action's name in this module's actions array
/// </summary>
/// <param name="actionIndex"></param>
public override void executeAction(int actionIndex)
{
    switch (actionIndex)
    {
        case 0:
```

```
                    // Do someting.

                    break;

                case 1:

                    // Do another thing.

                    break;
            }
        }

        #endregion

        #region Initialization & Updates:

        // All standard Monobehaviour updates can go here such as Start() and Update().

        #endregion

        #region Methods:


        public bool ConditionExample3()
        {
            for(int i = 0; i < 10; i++)
            {
                if(i > 5)
                {
                    return true;
                }
            }

            return false;
        }

        #endregion
    }
}
```

MAI_EditorUtility.cs

Description:

Utility class for drawing commonly used editor GUI elements for modular AI's custom inspectors.

Public Properties:

Type	Name	Description	Default Value
`static GUIStyle`	centeredBoldHelpBox		
`static GUIStyle`	wrappedMiniLabel		
`static GUIStyle`	miniLabel		
`static GUIStyle`	centeredMiniLabel		
`static GUIStyle`	upperLeftMiniLabel		
`static GUIStyle`	centeredLabel		
`static GUIStyle`	centeredBoldLabel		
`static GUIStyle`	middleLeftBoldLabel		
`static GUIStyle`	lowerLeftBoldLabel		
`static GUIStyle`	clippingBoldLabel		
`static GUIStyle`	rightAlignedLabel		
`static GUIStyle`	richText		
`static GUILayoutOption[]`	horizontalLine		
`static GUILayoutOption[]`	thickHorizontalLine		

Public Methods:

Name	Summary	Parameters	Returns
DrawHelpTitleToggle	Draws a bold title with a help button that toggles a help box. Useage example: `myBool = DrawHelpTitleToggle(myBool, "title", "message");`	`bool` toggle "Boolean to pass in and return.", `string` title "Text for the bold title.", `string` text "Text for the help box to display."	`static bool` "Returns toggle"

Name	Summary	Parameters	Returns
DrawFoldout		`bool` value, `string` label	`static bool`
DrawCompactPopup		`string` label, `int` value, `string[]` options	`static int`
DrawComponentOptions		`Component` component	`static Void`

MemoryModule.cs

Inherits from:

AIModule.cs

Description:

This module contains actions and condtions to remember `GameObject`s and `AIAgent`s that it has been made aware of in the environment.

Usage Notes:

The tags “Player” and “Agent” are used by this module by default make sure they exist in your project settings if you use them.

Public Properties:

Type	Name	Description	Default Value
`List<GameObject>`	objects		
`List<AIAgent>`	agents		
`List<GameObject>`	players		
`GameObject`	objectFocus		
`AIAgent`	agentFocus		
`GameObject`	playerFocus		
`string`	focusTag		
`string`	agentTag		“Agent”
`string`	playerTag		“Player”

Public Methods:

Name	Summary	Parameters	Returns
FocusOnGameObject		`FocusModes` focusMode	`Void`
FocusOnAgent		`FocusModes` focusMode	`Void`
FocusOnPlayer		`FocusModes` focusMode	`Void`
AddObjectToMemory		`GameObject` go	`Void`
AddAgentToMemory		`AIAgent` agent	`Void`
FindAgentsInEnvironmentMemory	Finds all `AIAgent`s in `objects` and moves them to `agents`.		`Void`
FindPlayersInEnvironmentMemory	Finds all GameObjects tagged as a player in `objects` and moves them to `players`.		`Void`

Enumerations:

FocusModes

`{ Nearest, Farthest, Random, First, Last }`

PathfindingModule.cs

Inherits from:

AIModule.cs

Description:

Module that defines actions and conditions for a `AIAgent` to pathfind using Unity's built-in `NavMeshAgent`.

Usage Notes:

An AI agent's behaviour loop is updated by an instance of `AIManager` if a manager instance is not found one will be created.

Public Properties:

Type	Name	Description	Default Value
`bool`	debugMode	Toggles debug mode for displaying gizmos when the agent is selected.	false
`NavMeshAgent`	agent		
`Transform`	target	The target location for the agent to pathfind to.	
`MemoryModule`	memory		
`PatrolRoute`	patrolRoute	Positions representing a patrol route in the order they should be navigated to.	
`float`	fleeDistance	How far the agent should flee from a target.	16
`float`	followDistance	How far from a target the agent need to be to follow it.	4
`float`	wanderRange	How far can this agent wander?	4
`float`	wanderTime	How long the agent should wait until it wanders again.	1.5f, Minimum Value = 0
`float`	patrolWaitTime	The time the agent waits before moving to the next waypoint.	0
`int`	timesToPatrol	How many times the agent should patrol though its waypoint route. (0 = forever)	0
`PatrolTypes`	patrolType		0
`int`	timesPatroled		PatrolTypes.loop

Public Methods:

Name	Summary	Parameters	Returns
Flee			`Void`
FollowTarget			`Void`
Idle			`Void`
MoveToTarget			`Void`
StopPatrol			`Void`
Patrol			`Void`

Name	Summary	Parameters	Returns
Wander			`void`

PatrolRoute.cs

Description:

Defines a patrol route relative to its parent `Transform`.

Usage Notes:

An AI agent’s behaviour loop is updated by an instance of `AIManager` if a manager instance is not found one will be created.

Public Properties:

Type	Name	Description	Default Value
`Vector3[]`	waypoints	Waypoints that define a patrol route in the order they should be navigated to. Note: waypoints are fixed positions in world space.	
`Vector3[]`	route	The patrol route relative to it’s transform (waypoints in local space). Note: route move with the transform.	
`RaycastHit[]`	hits	Hits chached when randomizing waypoints.	

Public Methods:

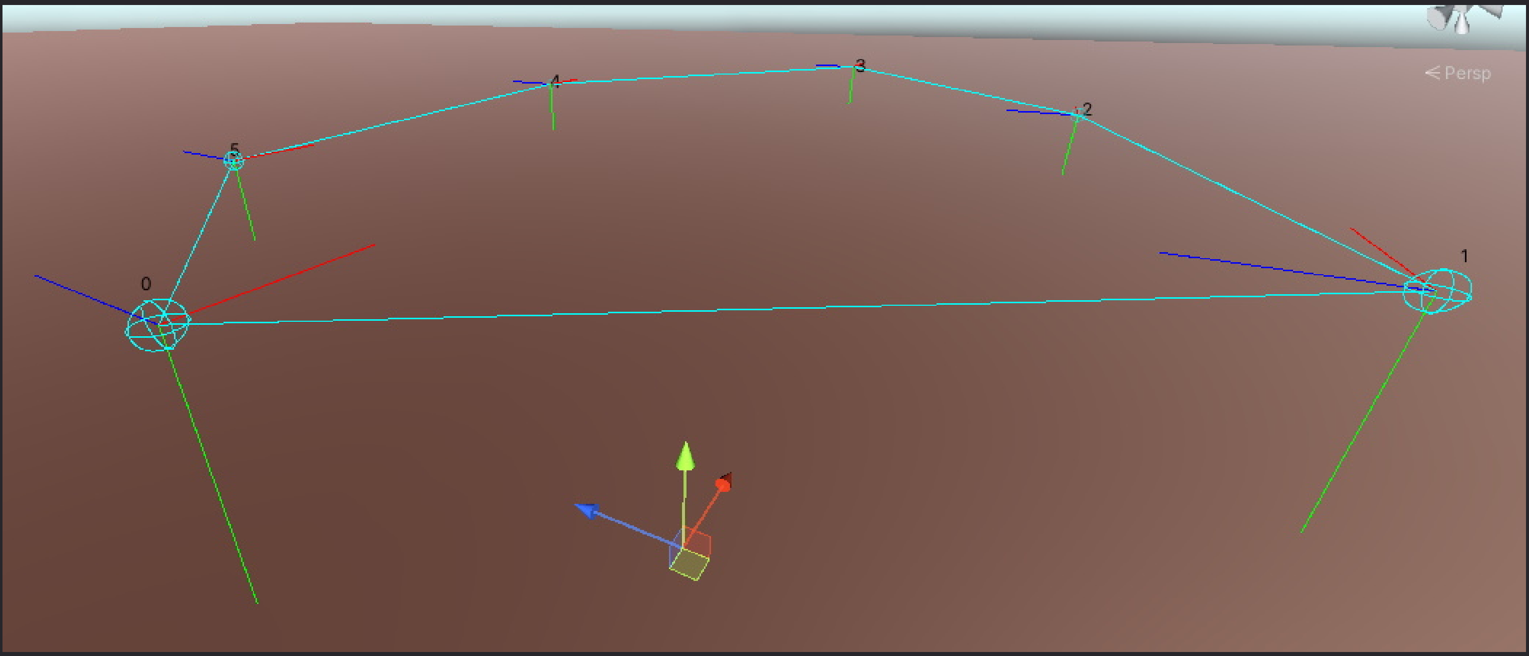
Name	Summary	Parameters	Returns
RefreshPatrolRoute	Refreshes the patrol route based on the current waypoint and transform position.		`Void`
RandomizeWaypoints	`float` radius, `float` maxDistance, `LayerMask` mask, `QueryTriggerInteraction` triggerInteraction		`Void`

Enumerations:

PatrolTypes

`{ loop, pingPong, randomize }`

Gizmo Preview:



SensorModule.cs

Inherits from:

AIModule.cs

Description:

This module defines actions and conditions for a `AIAgent` to be able to detect `GameObject`s in the environment.

Public Properties:

Type	Name	Description	Default Value
`bool`	debugMode	Toggles debug mode for displaying gizmos when the agent is selected.	false
`Transform`	eyes	Where to start the ray from when scanning via raycasts.	
`MemoryModule`	memory		
`LayerMask`	layerMask	Layers to scan for objects on.	-1

Type	Name	Description	Default Value
`QueryTriggerInteraction`	triggerInteraction	Should trigger colliders be ignored? See QueryTriggerInteraction in the Unity Manual.	QueryTriggerInteraction.Ignore
`SensorTypes`	sensorType		SensorTypes.sphere
`float`	scanRange	The scan range or bounds of the AI’s sensor; A minium of twice the NavMeshAgent’s height is recommended.	4
`float`	scanInterval	Determines the delay between scans.	0
`List<string>`	searchFilterTags	Scans of the environment will only add GameObjects with these tags to memory.	
`bool`	clearOldMemory	Determines if any existing memory should be cleared before each new scan. (may increase performance, but be careful that clearing memory doesn’t impact gameplay)	false

Public Methods:

Name	Summary	Parameters	Returns
Scan	Scans for `GameObject`s in the scene.	`ScanTypes` scanType	`Void`

Enumerations:

SensorTypes

`{ sphere, box, ray, _2D_circle, _2D_box, _2D_line }`

ScanTypes

`{ environment, players, agents, environmentFiltered }`

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