

Game Physics and AI

Module Information

2022.01, Approved

Summary Information

Module Code	5111COMP
Formal Module Title	Game Physics and AI
Owning School	Computer Science and Mathematics
Career	Undergraduate
Credits	20
Academic level	FHEQ Level 5
Grading Schema	40

Teaching Responsibility

LJMU Schools involved in Delivery
Computer Science and Mathematics

Learning Methods

Learning Method Type	Hours
Lecture	22
Practical	33

Module Offering(s)

Display Name	Location	Start Month	Duration Number Duration Unit
JAN-CTY	CTY	January	12 Weeks

Aims and Outcomes

Aims	To explain the logical foundations and graph and tree-based approaches representing decisions and paths in games. To gain knowledge of mathematically modelling characters and the environment, using intelligent agent and multi-agent systems. To explain and describe the role of mathematical principles such as numerical analysis and solvers underpinning physical simulation and dynamics. To utilise game-industry standard middleware for the implementation of both domains.
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After completing the module the student should be able to:

Learning Outcomes

Code	Number	Description
MLO1	1	Enumerate and explain a range of fundamental Artificial Intelligence constructs and their data structures and algorithms.
MLO2	2	Apply differential and integral calculus and use numerical analysis to solve problems applicable to collisions and physics in gaming scenarios.
MLO3	3	Use a high-level language and appropriate middleware to integrate an Artificial Intelligence algorithm into a interactive 3D game application.
MLO4	4	Use a high-level language and appropriate middleware to integrate an rigid body dynamics simulation into a interactive 3D game application.

Module Content

Outline Syllabus	<p>ARTIFICIAL INTELLIGENCE:- What is AI?- Agents and Environments - Scripted vs. Procedural AI. - Specifying the Task Environment. Classifying Virtual Environments: Partial Observability, Stochastic, Episodic, Discrete/Continuous etc.- Logic: Predicates, First-Order Logic, Syntax and Semantics, Truth Tables, Axioms, Associativity, Commutativity, Modus Ponens etc.- Discretisation of Space.- Search Strategies. - Tree and Graph-Based AI Nodes for Virtual Environments.- Heuristic and Cost Functions. - Key Algorithms: Dijkstra, A* etc. - Weak AI: Can game characters act intelligently?- Perceiving and Acting in the Virtual Game Environment.- Finite State Machines and Extensions (Stack, Message, Concurrent etc). - Controlling entities in games, Pattern Movements, Steering Behaviours, Decision making.- Agent Coordination: Multiple Autonomous Agents vs Centralised Control (e.g. Swarm). - AI Game Architecture: Messaging Systems, Hierarchical AI.RIGID BODY DYNAMICS: - Foundations of Rigid Body Simulation: - Reference Frames.- Inertia and Momentum.- Linear and Angular Momentum.- Newtonian Mechanics.- Equations of Motion.- Degrees of Freedom.- Differential and Integral Calculus.- Kinetics and Kinematics.- Energy.- Numerical Analysis and Approximation techniques.- Physics Engine and Middleware Concepts: - Volume Approximation: Collision Primitives, AABB, OBB, k-Dop, Digital Content Creation Generated.- Scene Queries.- Kinematic Controllers (Character and Vehicle)- Impulses, Forces, Inertia.- Callbacks and Queries.- Programmatic control of linear and angular momentum.- Collision Filtering (Broadphase)- Composition of Primitive Volumes (Broadphase)- Joints and Constraints- Articulations/Ragdolls</p>
Module Overview	
Additional Information	<p>This module covers the two major sub-disciplines of games development which are used to convert real-time rendered 3D graphics into game applications – Artificial Intelligence and Rigid Body Dynamics (Game Physics). The module will begin with an overview of the underpinning theories of both fields and will focus on specific algorithms and technologies in each field and how they are applied to dynamically control both characters and the environment of a game application. Students will learn how to model AI in a game environment using discretisation techniques and how to model physics in a game engine environment using Numerical Solver-based techniques. Students will be working in a team collaboratively to implement components of AI and Game Physics for real-time application in the coursework. Game assets produced by other roles from other discipline will be provided to provide a simulated team working environment.</p>

Assessments

Assignment Category	Assessment Name	Weight	Exam/Test Length (hours)	Module Learning Outcome Mapping
Report	Implementation of AI & Physics	50	0	MLO3, MLO4
Centralised Exam	Examination	50	2	MLO1, MLO2

Module Contacts

Module Leader

Contact Name	Applies to all offerings	Offerings
Abdenmour El Rhalibi	Yes	N/A

Partner Module Team

Contact Name	Applies to all offerings	Offerings
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