Liverpool John Moores University

Title:	GAME PHYSICS AND AI
Status:	Definitive
Code:	**5111COMP** (121233)
Version Start Date:	01-08-2021
Owning School/Faculty:	Computer Science and Mathematics
Teaching School/Faculty:	Computer Science and Mathematics

Team	Leader
Abdennour El-Rhalibi	Y
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Academic Level: FHEQ5 **Credit Value:** 20 **Total Delivered Hours:** 57

Total Learning Hours: 200 **Private Study:** 143

Delivery Options
Course typically offered: Semester 2

Component	**Contact Hours**
Lecture	22
Practical	33

Grading Basis: 40 %

Assessment Details

Category	**Short Description**	**Description**	**Weighting (%)**	**Exam Duration**
Artefacts	AS1	Implementation of AI and Physics Techniques in Real-Time.	50	
Exam	AS2	Examination	50	2

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.

Learning Outcomes

After completing the module the student should be able to:

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

Learning Outcomes of Assessments

The assessment item list is assessed via the learning outcomes listed:

Implementation of AI & Physics	3	4
Examination	1	2

Outline Syllabus

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 Automonous 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

Learning Activities

Lectures – to deliver the theoretical concepts on game physics and AI.

Practical – Tutor-led practical session in the computer laboratory.

Further exercises – additional exercises for students to work on in their own time.

Directed learning – provides additional reading to enable practical work to be completed.

Learning materials can be accessed digitally via University Virtual Learning Environment (VLE).

Notes

This module covers the two major sub-disciplines of games development which are used to convert real-time rendered 3D graphics into game applications – Artifical 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.