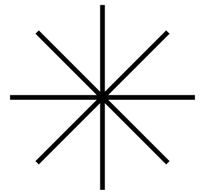

Rendering
Reality
Presentation by Sergi, Michal and Aren

The Roadmap



Week 2	Week 5	**Today**	Week 5+
Hardware and History (Apollo Guidance Computer)	The Dark Web and Cybersecurity	Computer Graphics (how machines simulate reality)	Algorithms, Hardware, and Web 3.0

The Matrix of Polygons

01

The Illusion

3D games are **not stored visually** in a computer, instead they are massive arrays of coordinate data stored in memory

02

Vertices and Edges

All objects and entities exist as **vertices** plotted in a 3D space, connecting to form polygons, almost exclusively **triangles** – being the most **efficient** shape to render

03

The Mesh

Millions of these triangles work together to stitch a **mesh**, acting as the **wire frame skeleton** of the digital world – a base for the textures, physics or lighting

Rasterisation

Translating Dimensions

A computer must calculate in real time how to flatten a 3D world onto a 2D grid of pixels

The Process

Rasterisation mathematically projects 3D models onto 2D planes

The Limitations

For the benefits of speed and efficiency, the cost is the incapability of naturally simulating light

The Physics of Light
Ray Tracing

01

Simulating reality

Instead of faking light projections, ray tracing **simulates** the **physical characteristics** of photons bouncing in an environment

02

How it works

The **render engine** shoots millions of digital light rays out of the virtual camera, **tracking** them and **calculating** their interactions

03

Computational Cost

Staggering **processing power** is required to **track** millions of bouncing photons over 60 times per second




Unreal Engine 5.2 - Next-Gen Graphics Tech Demo | State of Unreal 2023
IGN
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ENGINE
TECH DEMO
Watch on YouTube

Real Time Simulation

Observation

Light naturally bleeds around edges, changes colours based on colliding surfaces and accurate shadows and reflections generated







The GPU

Parallel Processing Monster

01

CPU Architecture

The main processor has **few**, very fast **cores**, optimised for executing **complex sequence**, **one** at a time – ideal for game logic and physics calculations

02

GPU Architecture

Graphics cards contain thousands of smaller, slower cores – ideal for **bulk** calculations, such as tracking pixel colours

03

AI Connection

This parallel processing structure is what spared the modern AI boom, as training data relies of the same matrix multiplication techniques used to push pixels

Optimisation Magic

Frustum Culling

Avoiding unnecessary work, the computer will **unload** or stop **rendering** objects outside the camera's field of view

Level of Detail

Dynamically shifting quality of rendering in relation to distance, the computer reduces its **load** on resolution that are not readily **observable**

AI Upscaling

Intentionally rendering a game at **lower resolutions**, and using AI to **predict** the missing pixels



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Future Trends: The Evolution of Data Science Innovation

01

Standardising the Code

In the early days of software development, studios had to code gravity, collision detection, and rendering mathematics entirely **from scratch** for **every single** release.

02

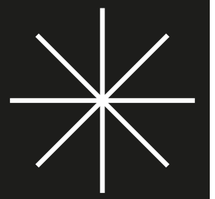
The Modern Engine

Software platforms like Unreal Engine 5 and Unity provide these **core** physics and lighting **systems** out of the box. This allows developers to focus entirely on art direction, storytelling, and gameplay mechanics.

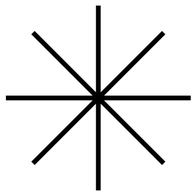
03

Beyond Gaming

These engines process data so efficiently and realistically that they are now heavily utilised outside of gaming. They are used to film movies using virtual sets, run aerodynamic simulations for cars, and create architectural physics models.



Wrapping Up & Summary



Computer science extends far beyond just writing loops or fixing bugs. It is about building complex systems that can simulate reality itself.

Next Week: We will be moving into the world of Competitive Programming, sorting algorithms, and the core art of problem solving.

Thank You For Listening!

"Computer science is no more about computers than astronomy is about telescopes." – Edsger W. Dijkstra

Presentation by “Sir Timbet Inyang”, PhD from MIT in game development and Mario