Project_Study_2

The Use of Mathematics in computer Games

1. Artiticle review

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1. Subject

Computer Games

Many computer games use 3D graphics. Moving and animating these, as well as rendering colors, light and shadows, requires vectors, matrices and many other concepts from linear algebra and 3D geometry. Computer games also have to create realistic animations of water or moving and colliding physical objects. They often use numerical solutions to the appropriate partial differential equations, such as the Navier-Stokes equations to model liquid. Finally, computer programs have to model the artificial intelligence of non-playable characters.

- http://www.mathscareers.org.uk/video/advancing-the-digital-arts/
- http://www.mathscareers.org.uk/article/get-game/
- http://nrich.maths.org/1374

<Figure 1>

1. Introduction

The purpose of this article is to have a look at how mathematics is used in computer games.

The First Person shooter(FPS)

<Figure 2>

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Strategy Games
-Real Time Strategy(RTS)
-Turn Time Strategy

<Figure 2>

1. Introduction

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Simulation Games

<Figure 2>

2. First Person Shooter

advanced mathematics

↓

Incredible Graphic

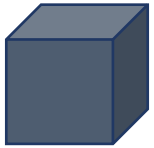
2.1 Geometry, vectors and Transformation

Geometry: The study of shapes of various sort.

Point : The simplest shape.

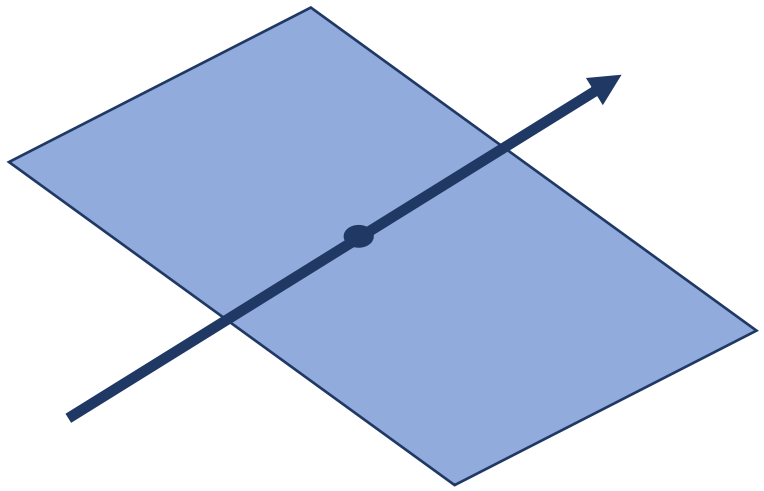
Straight line : The simplest shape joining two points together.

Plane : The complicated shape.



Solid : The complicated shape.

2.1 Geometry, vectors and Transformation

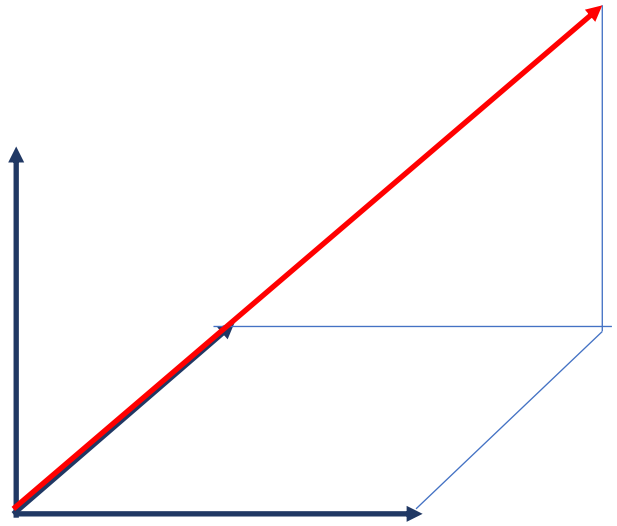


A plane and a straight line create an intersection

2.1 Geometry, vectors and Transformation

Vector ; (x, y, z)

- Point
- Direction



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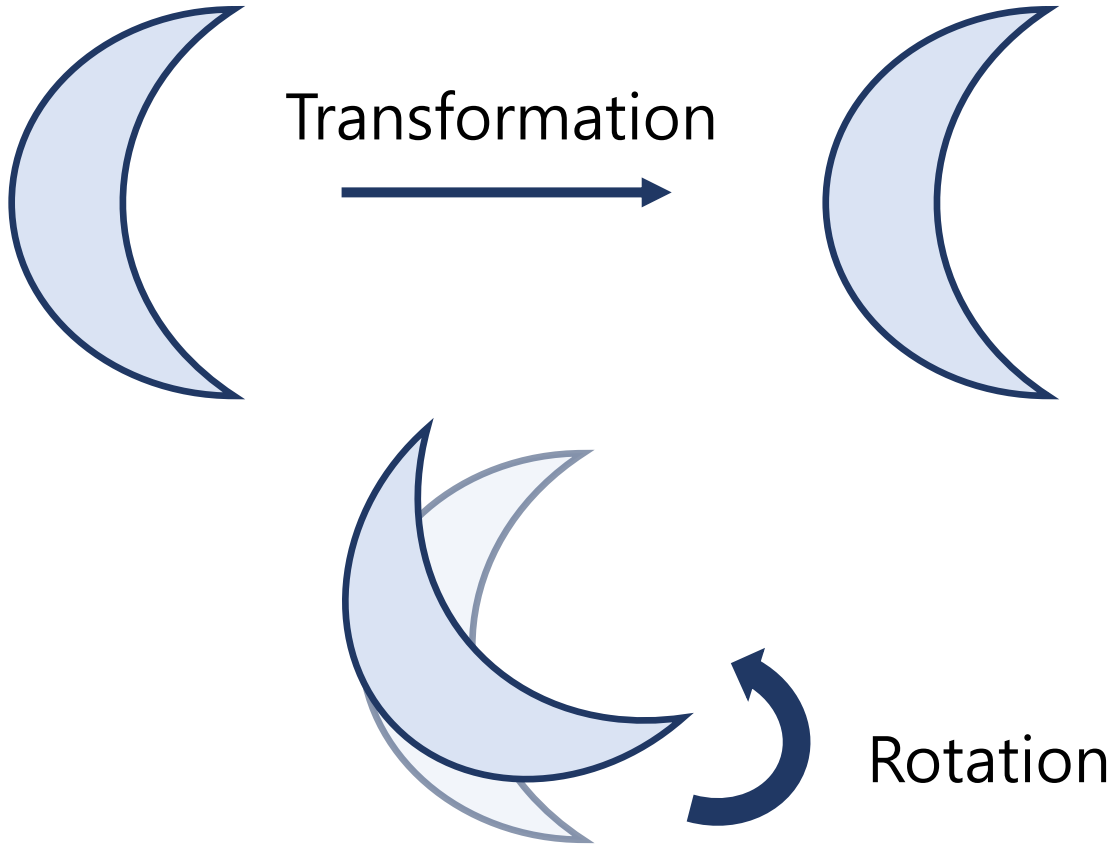
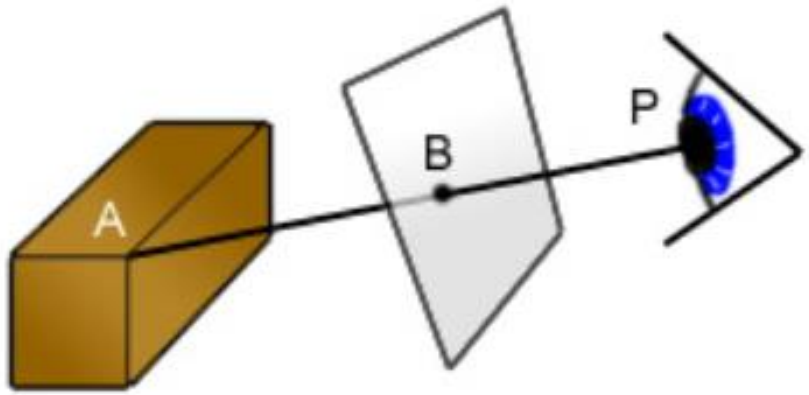


2.2 3D Graphics

A simple idea for three-dimensional graphics is to explain the world mathematically and be shown to people.



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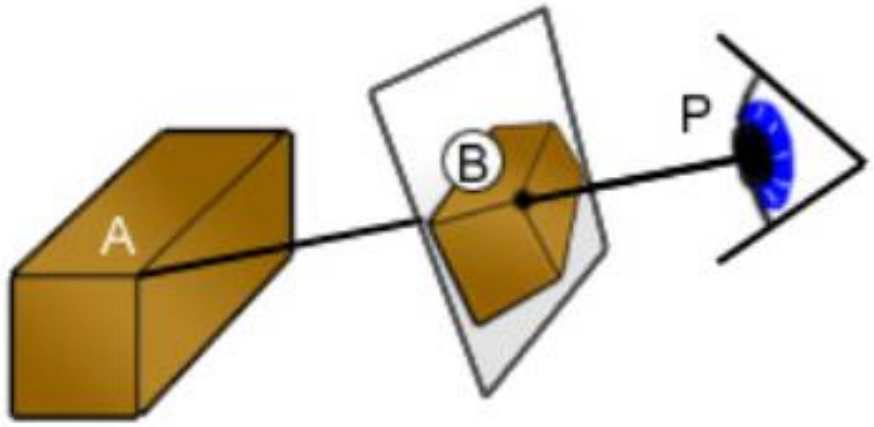
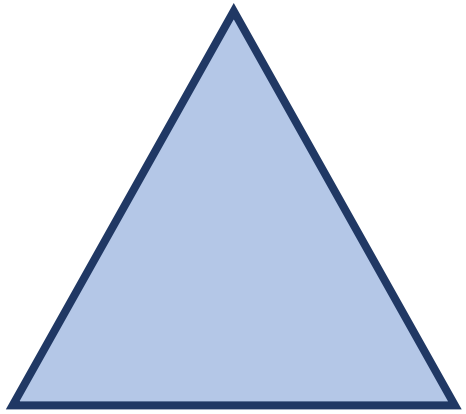
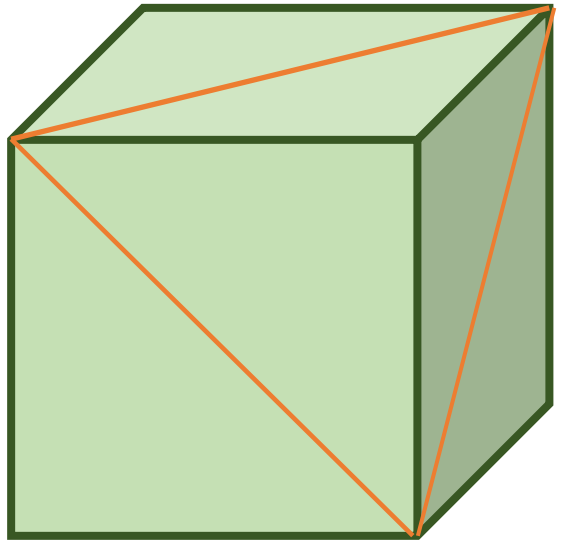


2.2 3D Graphics

Computers are similar to the previous method, but slightly different.





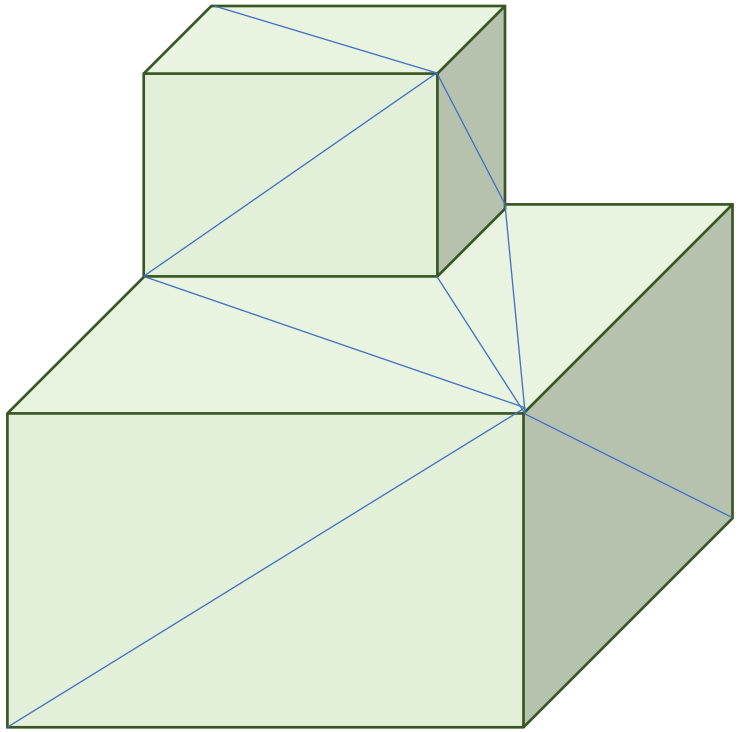
2.2 3D Graphics

Computers are similar to the previous method, but slightly different.

Viking Helmet

2.2 3D Graphics

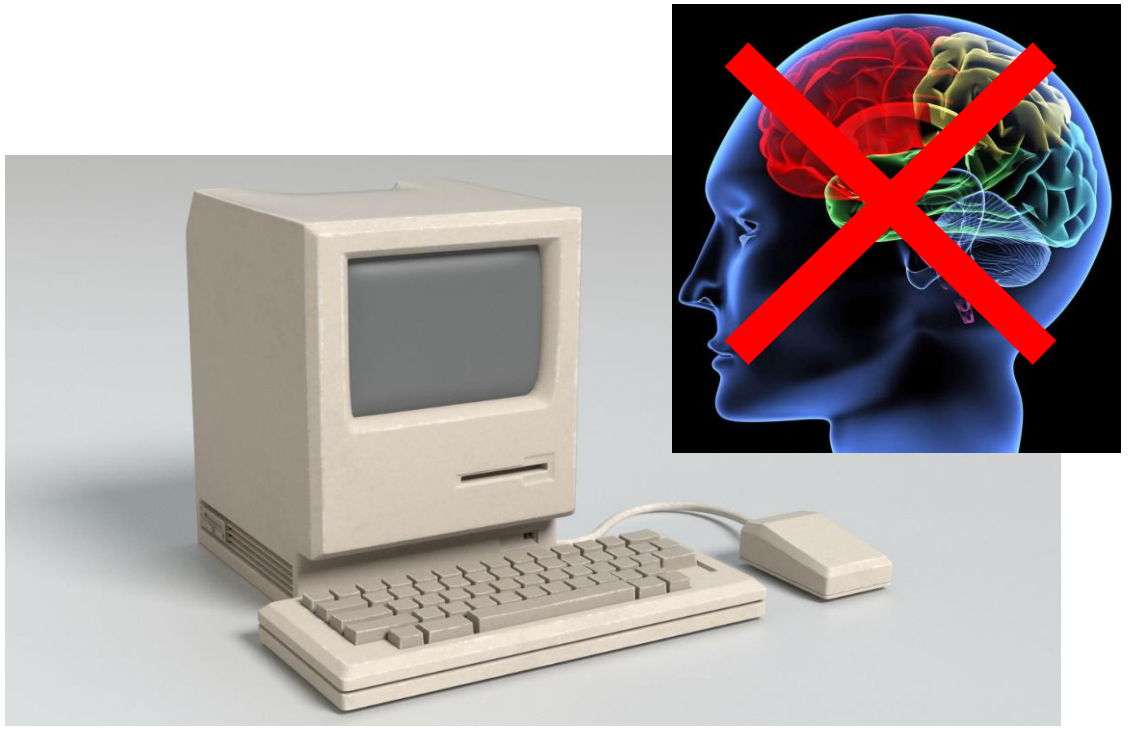
Exercise 3. [Making triangles] Draw a picture of a box with a smaller box stuck to the top of it, using only triangles..



3. Strategy Games

Strategy Games has simpler graphics than First person shooter.

3. Strategy Games

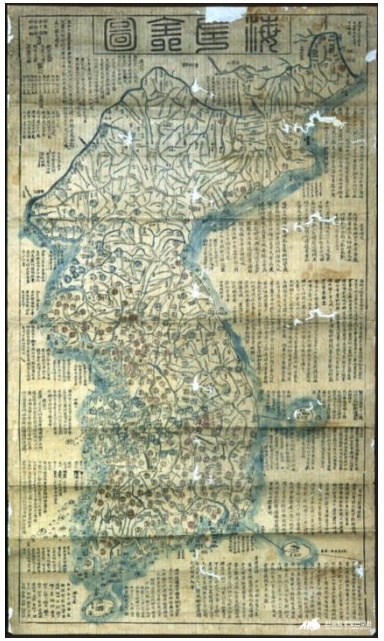


3.1 Nodes, Edge and Graphics

Node

Edge

Graphic



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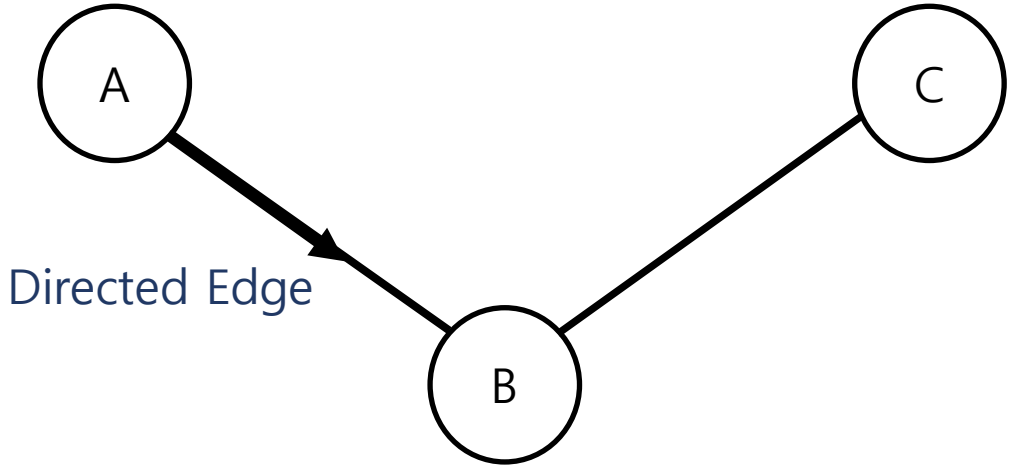
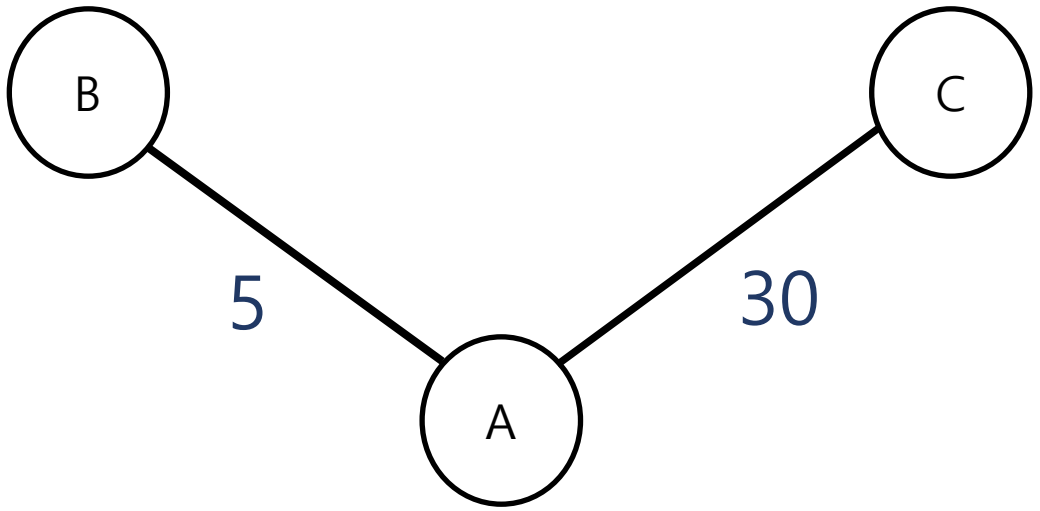


A → C (O)

C → A (X)

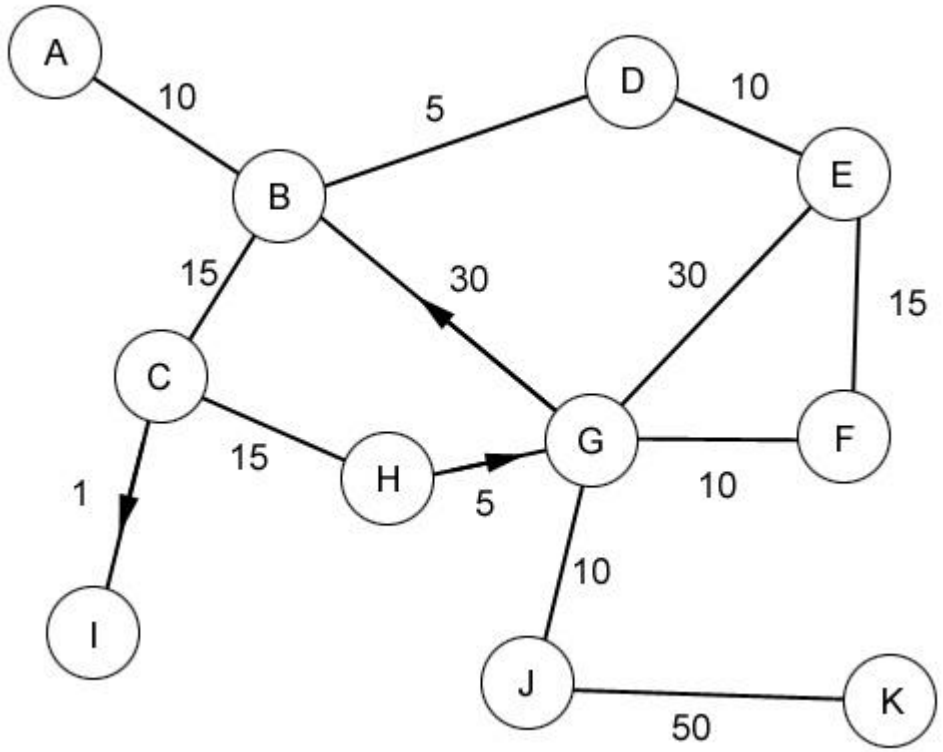
3.1 Nodes, Edge and Graphics

cost



3.1 Nodes, Edge and Graphics

Exercise 4 [Shortest Path] Work out the lowest cost way to get from A to K .



A→ B →C →H →J →K

3.1 Path Finding

Interesting Points → Nodes

4. Simulation Games

The most important thing in Simulation Games is to make it like the real world. Physical simulation is used for this purpose.

4.1 More on vector

Games in which physics is used use vectors.

- $V = (v_1, v_2, v_3), W = (w_1, w_2, w_3)$
- $V + W = (v_1, v_2, v_3) + (w_1, w_2, w_3) = (v_1 + w_1, v_2 + w_2, v_3 + w_3)$
- $a \times V = a(v_1, v_2, v_3) = (av_1, av_2, av_3)$
- $|V| = \sqrt{v_1^2 + v_2^2 + v_3^2}$

4.2 Physics

- Every object has a position. $\mathbb{X}$
- Every object has a velocity indicating its direction. $(\mathbb{v}; \dot{\mathbb{x}})$
- Every object has an acceleration that indicates a change in speed. $(a; \ddot{\mathbb{x}})$
- Every object has a mass.(It's not a vector.) (m)

4.2 Physics

- If an object starts at position $\mathbb{X}$ and has a constant velocity V, after t seconds, the position of the object is:

$$\mathbb{X}_t = \mathbb{X} + V \times t \ (\mathbb{X}_t : Position\ of\ object\ after\ t\ seconds)$$

- If an object starts at velocity V and has a constant acceleration a, after t seconds, the velocity of the object is:

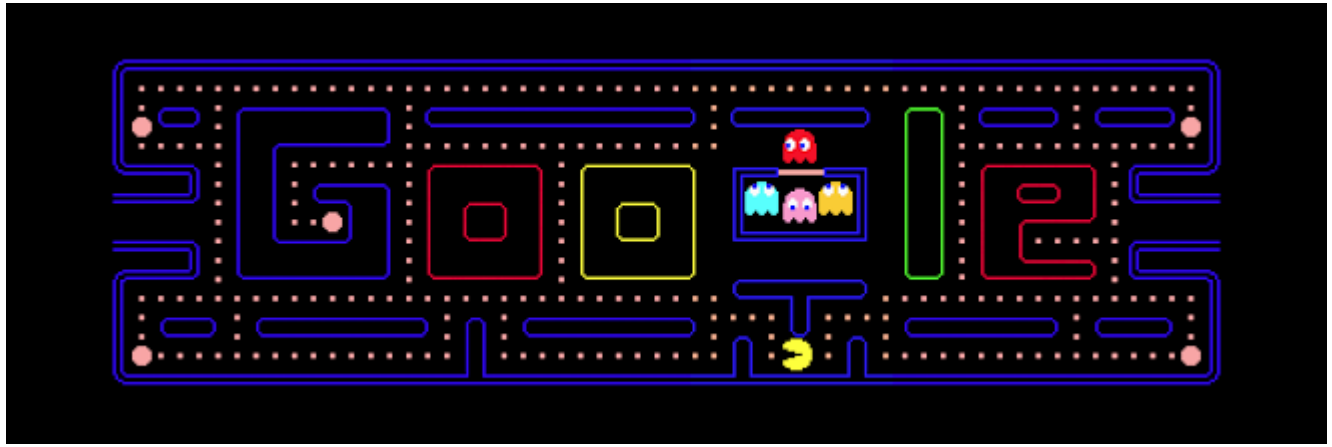
$$V_t = \mathbb{X} + a \times t \ (V_t : velocity\ of\ object\ after\ t\ seconds)$$

4.3 Simulation Games

- It's hard to apply physics realistically in real games. This is because we have to consider wind or friction caused by the air in the real world.
- There is no game with accurate physics. It is under constant study.

5. Conclusion

- So far, I have shown simple examples of where math is used when making computers.
- In fact, it is almost impossible to play a game without using math.
- Even Pacman uses some math!!



Thank you!