**Physics Simulation**

**Methods Used**

The methods that I have used in this physics simulation differ from the traditional Forward Euler method. Two alternative approaches were chosen for implementing physics: Backward Euler and Semi-Implicit Euler. These methods can be explained by the calculations involved when employing them which I have detailed below:

**Semi-Implicit Euler Method**

The Semi-Implicit Euler method, or Symplectic Euler, could be better explained as an in between or intermediate point between the previously used forward Euler and the alternative Backwards Euler. This method calculates velocity and position at specific instances in time, in contrast to the repeated time cycles of the Forward Euler method or the advanced calculations of the Backward Euler method.

The procedure involves initially calculating the velocity using the Forward Euler formula: Velocityn+1 = Velocityn + (Accelerationn \* dt) and then the calculation for position: Positionn+1 = Positionn + (Velocityn+1 \* dt)

(*Game Engineering - Newcastle University*)

**Backwards Euler method**

The Backward Euler method, also known as Implicit Euler, involves calculating the derivative and incorporating it into the subsequent calculation. Initially, the velocity is determined as follows: Velocityn+1 = Velocityn + (Accelerationn+1 \* dt) Subsequently, this velocity is utilized to calculate the position: Positionn+1 = Positionn + (Velocityn+1 \* dt)

(*Game Engineering - Newcastle University*)

**Advantages to Semi Implicit Method**

Justification for Using Symplectic Euler Symplectic Euler is also known for its stability and comparatively faster implementation, making it a time-saving choice when multiple techniques are required for the game. Additionally, it is commonly employed in implementing rigid body movement, addressing the weaknesses associated with the Backward Euler method. While it carries a similar probability of error as the Forward Euler method, its advantages lie in its ease of implementation and reliability when combined with Backward Euler.

(*Integration basics* 2004)

**Advantages to Backward Euler**

Justification for Using Backward Euler Backward Euler is employed due to its remarkable stability, despite the associated computational slowdown. It offers high accuracy and is particularly effective in handling friction and drag calculations. Consequently, it is crucial for accurately simulating the behaviour of the grenade object, ensuring it remains within the screen boundaries when fired. In comparison to the Forward Euler method, Backward Euler significantly reduces the occurrence of substantial errors and demonstrates superior accuracy. These qualities are of utmost importance as the outcome of the game relies heavily on the behaviours of the grenades, determining the winners and losers.

(*Euler backward method*)

**Sources**

*Euler backward method* (no date) *Euler Backward Method - an overview | ScienceDirect Topics*. Available at: <https://www.sciencedirect.com/topics/engineering/euler-backward-method> (Accessed: 24 June 2023).

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