# Data Analysis and Visualization

# Research Document

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# BONAFIDE CERTIFICATE

This is to certify that this record of course work is a bonafide work done by **Ajil Padathuparambil Pappachan**, ID No.: **2018UG03077**, in partial fulfillment of requirements for the **1st year B.Sc. Game Programming** during the academic year 2018 – 2019 and is the original work of the candidate.

Submitted for the **Data Analysis and Visualization** module assessment held on _____.

_____ _____

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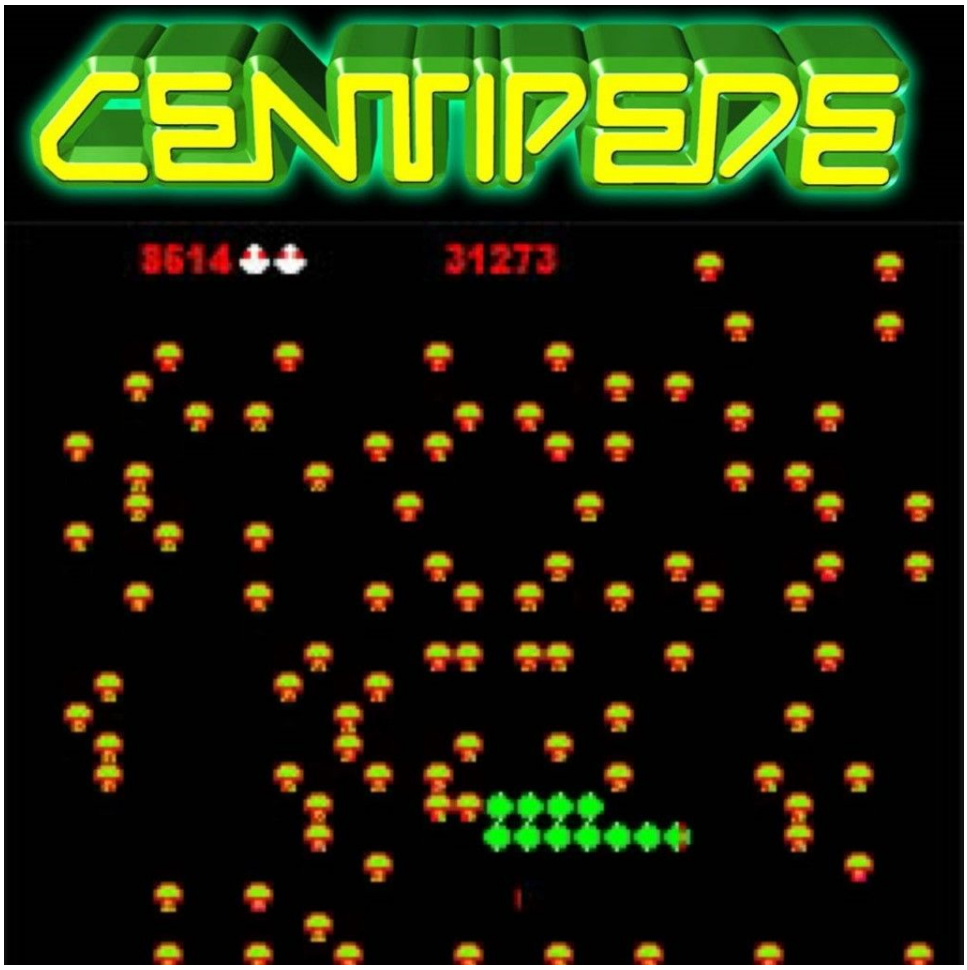



# Research on Centipede (Atari, 1980)

## Introduction

Centipede is a Retro Arcade Game produced by Atari, Inc. In June 1981. It is a vertically oriented fixed shooter arcade game. Designed by Ed Logg and Dona Bailey, it was one of the most commercially successful games in the golden age of Video Arcades. The player fights off centipedes, spiders, scorpions, and fleas, completing a round after eliminating the centipede that winds down the playing field.

Centipede was ported to Atari 2600, Atari 5200, Atari 7800, and Atari 8-bit family. Later, under the Atarisoft label, it was sold for the Apple II, Commodore 64, ColecoVision, VIC-20, IBM PC (as a PC booter), Intellivision, and TI-99/4A. Superior Software published the port for the BBC Micro.

## Gameplay Mechanics

The player is represented by a small, somewhat humanoid head, at the bottom area of the screen, where the player can move the character with a trackball and fire laser shots at a **centipede** advancing from the top of the screen down through a field of mushrooms.
The centipede starts at the top of the screen, traveling either left or right. When it hits a mushroom or the edge of the screen, it drops one level and switches direction. Thus, more mushrooms on the screen cause the centipede to descend more rapidly. The player can destroy mushrooms by shooting them, but **each takes four hits to destroy**. Shooting any section of the centipede creates a mushroom. Shooting one of the middle segments splits the centipede into two pieces at that point. Each piece then continues independently on its way down the screen, with the first section of the rear piece becoming a new head. If the head is destroyed, the section behind it becomes the next head.
If the centipede reaches the bottom of the screen, it moves back and forth within the player area and "head" segment centipedes are periodically added. This continues until the player has eliminated both the original centipede and all heads. When a centipede is destroyed, a new centipede forms at the top of the screen. However, every time a centipede is eliminated, the next one is one segment shorter and is accompanied by one additional, fast-moving "head" centipede.

Besides centipedes, other creatures that menace the player are **Fleas** that drop vertically, leaving additional mushrooms in their path. They only appear when fewer than five mushrooms are in the player movement area (However, the number required increases with level of difficulty); **Spiders** that move across the player area in a zig-zag fashion and occasionally eat some of the mushrooms; **Scorpions** that move horizontally across the screen and poison every mushroom they touch (these never appear in the player movement region). A centipede touching a poisoned mushroom hurtles straight down toward the player area, then returns to normal behavior upon reaching it.
A player loses a life when hit by a centipede or any other enemy, after which any poisoned or partially damaged mushrooms revert to normal. Points are awarded for each regenerated mushroom. The Player is awarded 1 and 5 points for destroyed and regenerated Mushrooms respectively, 10 and 100 points for shooting the body and head of the centipede respectively, 200 points for killing fleas, 300, 600, or 900 points for killing spiders (depending on how close to the player the spider is), and 1000 points for killing scorpions. Players earn extra lives per 10,000, 12,000, 15,000, or 20,000 points scored (up to 6 lives). 999,999 points is the maximum high score. **A game ends if all lives are gone**.

## Clones

Due to its huge popularity, Centipede was cloned many times for different systems:

### Arcade clones

- War of the Bugs or Monsterous Manouvers in a Mushroom Maze, by Food and Fun Corp./Armenia Ltd in 1981
- Jackler, by Konami in 1982

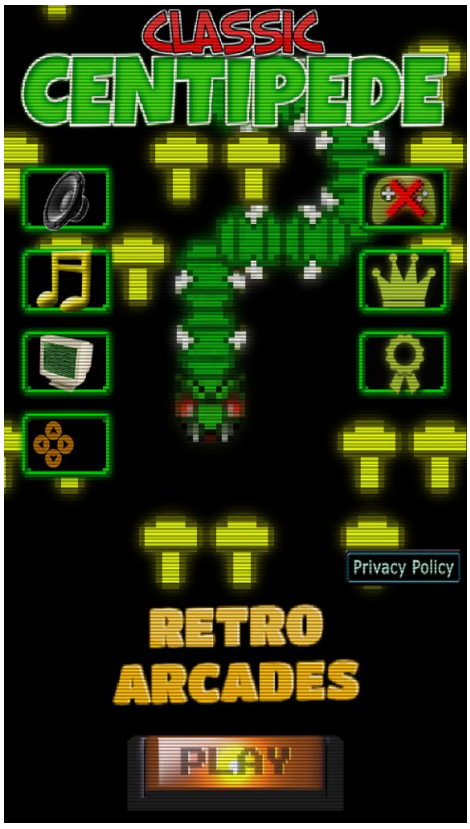
### Home system clones

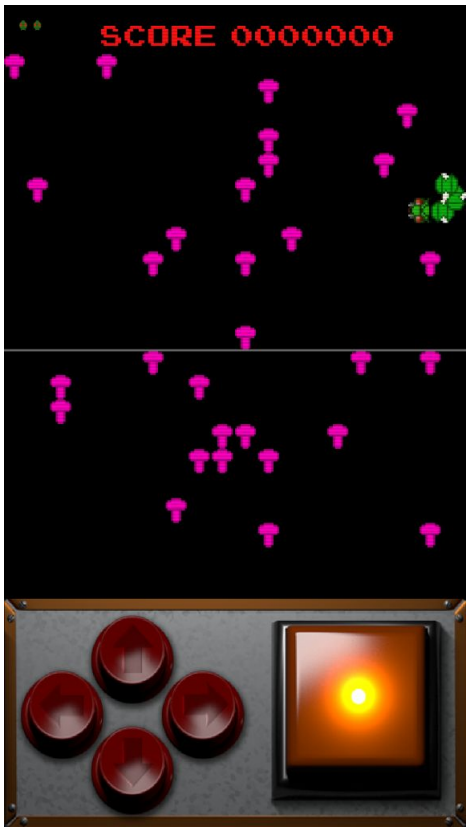
- Bug Attack, for the Apple II in 1981 by Cavalier Computer
- Arachnoid, for the VIC-20 in 1982 by UMI
- Arthropod, for the TI-99/4A in 1983 by North Hills
- Aqua Attack, for the BBC Micro as part of the Welcome disk/tape with the BBC Master
- Bug Blaster, for Commodore 64, BBC Micro, and Acorn Electron in 1983 by Alligata
- Bug Off!, for the Atari 8-bit family in 1982 by Adventure International
- Caterpillar, by Aardvark Software for the TRS-80 Color Computer
- Centi-Bug, for the ZX Spectrum in 1983 by DK'Tronics (titled Centipede on screen)
- Exterminator, by Nüfekop Software and Bubble Bus Software in 1982 for the VIC-20 and the C64
- Katerpillar Attack (Katerpillar, Kater-Pillar, or Katerpillar II) Tom Mix Software TRS-80 Color Computer, Dragon 32
- Maggotmania, in 1983 for the Commodore 64 by Commodore
- Megalegs, 1982 for the Atari 8-bit family by Megasoft
- Megapede, for the ZX Spectrum in 1983 by Computerware
- "Mouse Stampede" for the Apple Macintosh, by Mark of the Unicorn
- Myriapede, for the Atari 8-bit family in 1983
- Mushroom Alley, for the Commodore 64 in 1983 by Victory Software
- Spectipede, for the ZX Spectrum in 1983 by R&R Software
- Video Vermin, for the VIC-20 in 1982 by UMI
- Wiggle Worm, for the TRS-80 Color Computer in 1984 by Chromasette
- Decipede, a type-in version for the Commodore 64 published by COMPUTE!'s Gazette in January 1987
- Apeiron, for Mac OS in 1995 by Ambrosia Software
- Champ Centiped-em, for MS-DOS in 1997 by CHAMProgramming

(En.wikipedia.org, 2019)

## Modern Version of the Game

In August 2018, Retro Arcades released a modern version of the classic retro game titled “Classic Centipede” for the Android platform. None of the gameplay or design elements were changed. However, they added a virtual joystick for playing the game as if in the original Atari version of the game. Also, a Level system was added, and the player can advance to the next level by killing one centipede. The gameplay becomes increasingly difficult after each level.




(Classic Centipede, 2019)

# Importance of Physics and Math in Video Games

## Introduction

Physics and Math are used in video game development for the real-time computation of position and motion of objects in the game, as well as it's interactions with other objects. This "simulation" may be realistic, approximate, or intentionally distorted for effect. Video game physics improves immersion and can support new gameplay elements.

# Game Physics Concepts

## Static Motion

An object is said to be static if it does not have any motion.

## Kinematics

It is the study of the motion of objects without taking into account mass or force. Kinematics deals with the position of an object with respect to time. It works on the basic laws of motion:

**d = vt**

**v = u + at**

**d = ut + at2/2**

**v2 = u2 + 2ad**

*where:*

*t - (elapsed) time*

*d - distance (change in position)*

*v - (final) velocity (change in distance per unit time)*

*a - acceleration (change in velocity per unit time)*

*u - (initial) velocity*

## Dynamics

Since Kinematics does not explain why an object accelerates, to get a full, modern physics simulation, we need to take into consideration the mass of the object and the force acting on it. Dynamics works on the laws of motion established by Sir Isaac Newton:

1. **A body will remain at rest or continue to move in a straight line at a constant speed unless acted upon by a force.**
2. **The acceleration of a body is proportional to the resultant force acting on the body and is in the same direction as the resultant force.**
3. **For every action, there is an equal and opposite reaction.**

## Collision in Video Games

Since collision between objects plays a huge role in the position, motion, and state of an object, collision detection is a very important part of video game development.
There are two basic approaches taken by developers in this context:

**Overlap Testing** detects whether a collision has already occurred.
**Intersection Testing** predicts whether a collision will occur in the future.

# Application of Physics and Math in Video Games

***"Physics in games can make explosions and enemy deaths more spectacular and entertaining than canned animations, and it's great for things like projectile weapons and fire propagation. But physics can do so much more than provide eye candy--it can be a major tool for game design."*** *(Moss, 2019)*

- Believable gravity need not be realistic, and moreover, it need not affect everything in your world. Gravity can also be an enabler for level designs that think outside the box. (Gravity in the Mario Galaxy series)
- You can break and twist your own physics system if it allows for a compelling mechanic, but be sure to keep this behavior consistent or you'll create undue friction between the player and your design. (Portal's physics-twisting portal guns)
- A physics simulation can just as easily be the game as well as a supporting element to the game. Fluid dynamics, ragdolls, soft-body crash physics, and variable gravity all can drive the entire experience, and playing with the forces they exert is often compelling in and of itself. (Physics simulation as the game in Turbo Dismount)
- By designing a physics system that gleefully breaks immersion at the slightest sign of havoc or opportunity for chaos, Rockstar ensured that there's always fun to be had destroying, racing around, and exploiting Grand Theft Auto V's open-world sandbox. (Grand Theft Auto V's fudged vehicle and character physics)
- If over-the-top fun is a priority, design mechanics that throw realism out the window. But keep them real and in harmony with the world they inhabit — because as Just Cause 3 shows, a great physics-driven mechanic can be entrancing. (Gliding with Just Cause 3's wingsuit)
- Complexity arises naturally from a simple set of interactions between physics-driven character movement and a world that's been designed with careful consideration for the possibility of space. (Elasto Mania's springy, elastic bike movement and puzzle-platforming)
- Physics can be a formidable opponent, both steadfastly consistent and curiously unpredictable — as a slight change in input might have knock-on effects that lead to a massive change in outcome. (Building rockets to other worlds in Kerbal Space Program)

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