DigiPen
INSTITUTE OF TECHNOLOGY

CS 176
Advanced Scripting

Particle Systems

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Definition

What is a Particle System

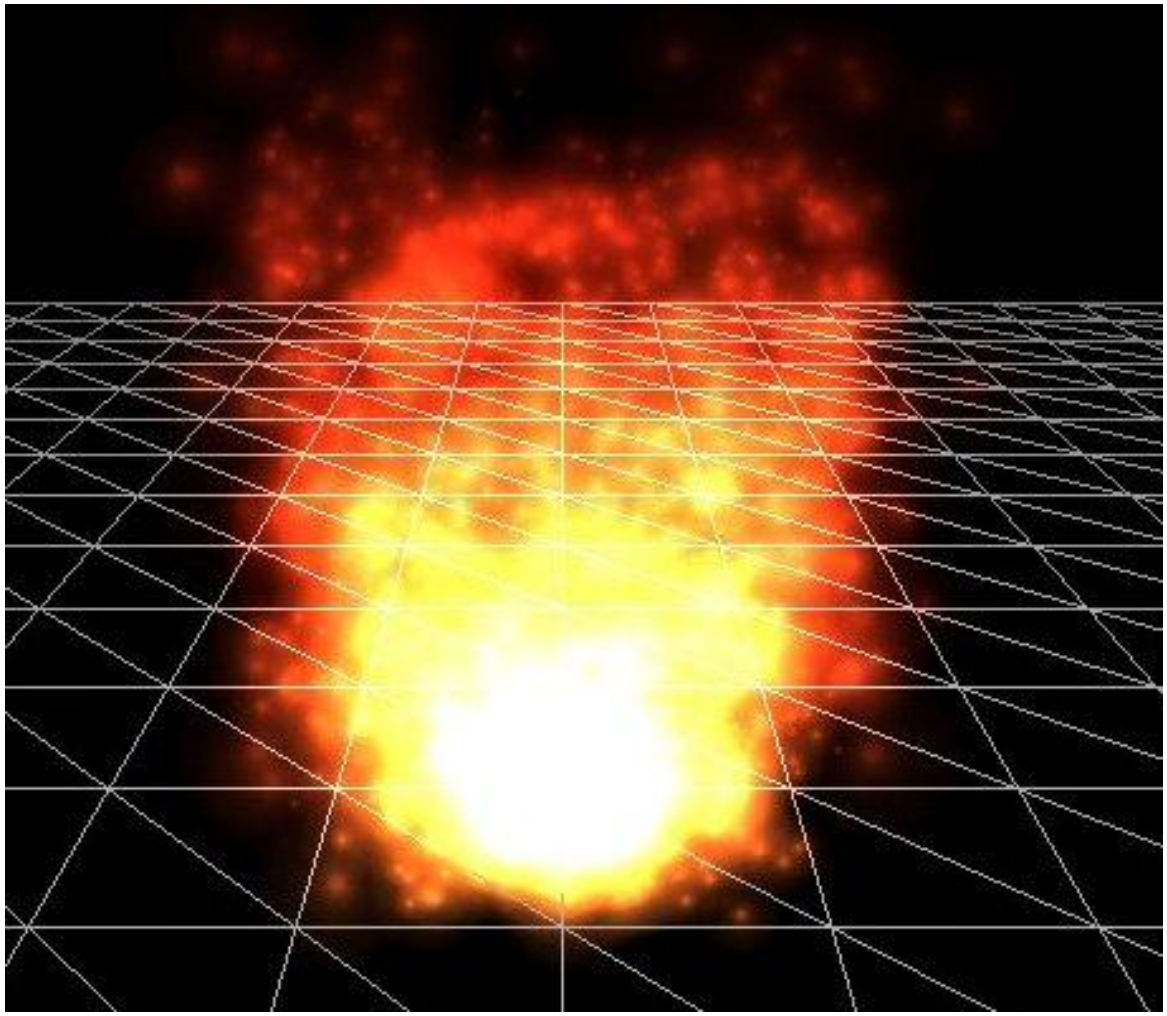
"A particle system is a collection of many many minute particles that together represent a fuzzy object. Over a period of time, particles are generated into a system, move and change from within the system, and die from the system."

– Reeves "Particle Systems—a Technique for Modeling a Class of Fuzzy Objects".

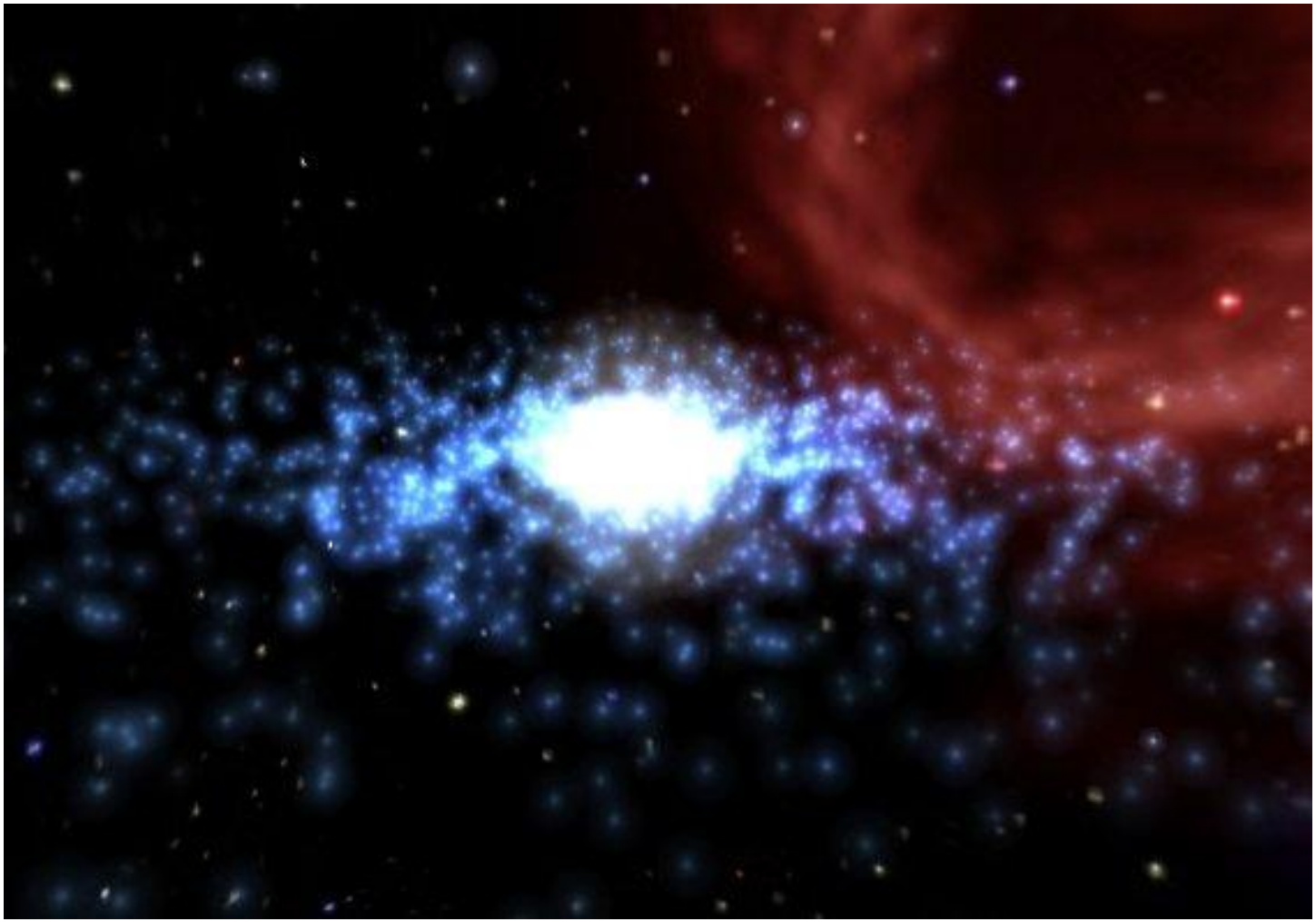
What is a Particle System

The term particle system refers to a computer graphics technique to simulate certain fuzzy phenomena, like fire, explosions, smoke, flowing water, sparks, falling leaves, clouds, fog, snow, dust, meteor tails, or abstract visual effects like glowing trails, magic spells, etc.

What is a Particle System



What is a Particle System



What is a Particle System

- Movement of particles is defined from forces and constraints (e.g. gravity)
- Stochastically defined attributes ***(non predicted)***, and that is to use random numbers to control particle attributes such as position, color, …
- Often rendered as individual primitive geometry (e.g. point, sprite object)

Uses of Particle Systems

- The use of Particle systems is a way of modeling fuzzy objects, such as:
  - Fire (explosions, …)
  - Clouds
  - Smoke
  - Water
  - Fog
  - etc…

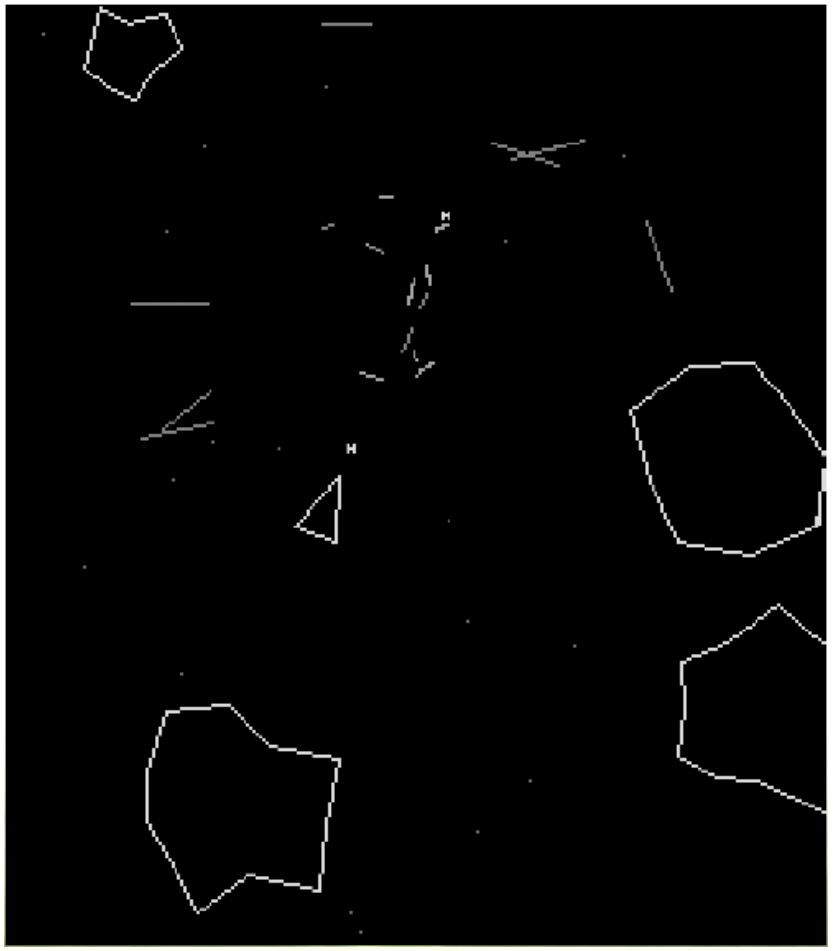
History

History of Particle Systems

- Spacewar
  - 1962
  - Second video game ever
  - Uses pixel clouds as explosions (random motion)

History of Particle Systems

- Asteroids
  - 1978
  - Uses short moving lines for explosions (physical particle simulation)



History of Particle Systems

- **Star Trek II: The Wrath of Khan**
  - **1983**
  - **Movie Visual FX**
  - **First CG paper about particle systems by William T. Reeves**
  - **This concept is still used today**
  - **Watch the trailer: http://www.youtube.com/watch?v=UJTi7KJPx_E**

Basic Model of Particle Systems

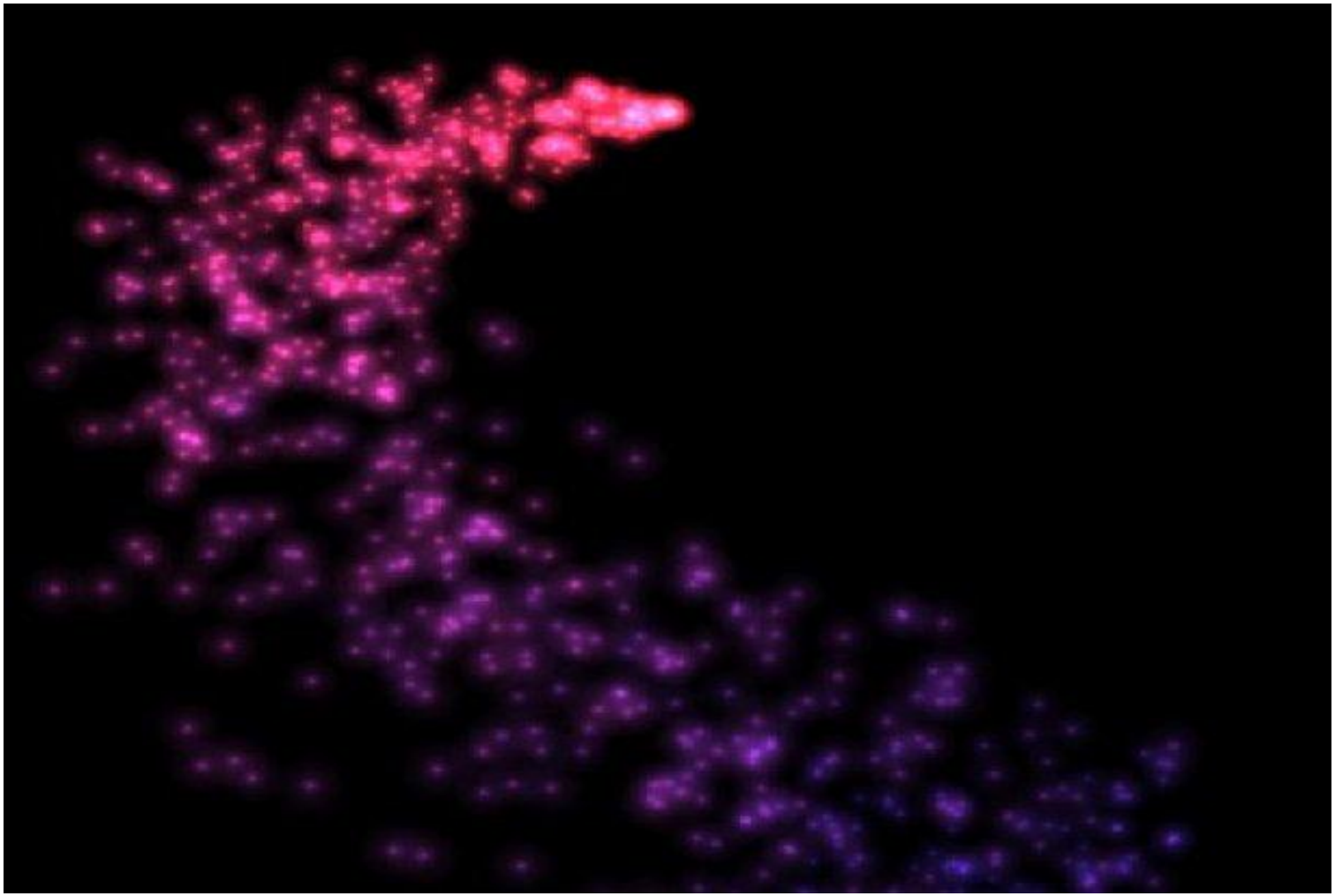
Particle Attributes

- Position
- Velocity
- Shape
- Size
- Transparency
- Lifetime
- Age
- etc…

Particle Dynamics

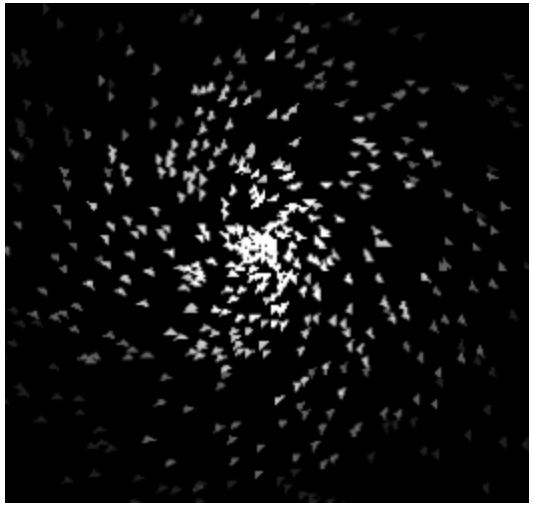
- Particles generation is usually determined by a stochastic process (random positions, colors, opacities, lifetime, etc…)
- Particles are moved using physics (forces, acceleration, velocity, etc…)
- A particle's color / scale / opacity change overtime (in order to get some nice effects)

Particle Dynamics



Particle Extinction

- The particle is destroyed when:
  - The lifetime reaches zero
  - The color is below a threshold (becomes invisible or fades out)
  - Running out of bounds



Particle System Properties

- Number of Particles
- Array of Particles
- Position
- Shape (Rectangle, Circle, Polygon, etc…)
- Forces
- Lifetime
- Age
- etc…

Particle System Methods

- Constructor
- Generate Particles
- Reset Dead Particle
- Update System
- Destroy
- etc…

Particle System Shapes

- Particle systems have generation shapes, which defines a region about its origin into which newly born particles are randomly placed. Some of the shapes are:

- Circle (position and a radius)
- Rectangle (position, width and height)
- Polygon (points or segments)
- etc…

Random Numbers

Random Numbers

- **In computer applications we use what is called pseudo-random numbers**
- **Pseudo because:**
  - Its based upon specific mathematical algorithms which are repeatable and sequential or pre-calculated tables to produce sequence of numbers that appear random
- **We are lucky that in ActionScript, algorithms are used in order to get a new random value at every run**

Random Numbers in Range

- How to get a random number in a range?

Range [25 – 75] so :

- The minimum random value we should get is Min = 25
- The maximum random value we should get is Min = 75
- Math.random() function gives us a random value between [0-1]

RN = Math.random()*(Max-Min) + Min

Demo

- 2D Particle System (C++)
- StarDust Particle System Engine (AS3)

The End ☺