exploding, colliding, bouncing, shooting, flowing, flying, growing, sprouting, following dancing, spawning, orbiting, simulating

Particles!

an 80K guest lecture by Kate Compton
Who am I?

Used to work on Spore as a VFX artist.

Used to work on SimCity scripting intelligent agents.

Avid game-jammer

Now a PhD in Games and Playable Media working on creativity tools for 3D-printing
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  Using particles to create the surfaces of procedural planets
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  Agents act like particles with their own forces
Avid game-jammer
  Particle-based gameplay is fast!
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  Particles???
Why do you care?

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Particles???

Particles can make your game bigger, cooler, faster, or more powerful, and they show up in more places than you might think.
Excited yet?
What is a particle?

In the physical sciences, a particle is a small localized object to which can be ascribed several physical properties such as volume or mass. The word is rather general in meaning, and is refined as needed by various scientific fields.

(Wikipedia)
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That are affected by some forces in the world.
What is a particle?

a small *localized object* to which can be ascribed several *physical properties* such as *volume* or *mass*

that are affected by some forces in the world

that exert some force or cause some effect on the world
What is a particle?

a small **localized object** to which can be ascribed several **physical properties** such as **volume** or **mass**

that are affected by some forces in the world

that exert some force or cause some effect on the world...

...even if it's just being displayed on screen
What is a particle?

a small *localized object* to which can be ascribed several *physical properties* such as *volume* or *mass*

*That can be simulated by running some generalized algorithms, rather than individual scripted logic.*
What is a particle?

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That can be simulated by running some generalized algorithms, rather than individual scripted logic.*

* This means we can have arbitrary numbers of particles, and treat them all the same.
What is a particle?

a small *localized object* to which can be ascribed several *physical properties* such as *volume* or *mass*

That can be simulated by running some *generalized algorithms*, rather than *individual scripted logic.*

* This means we can have arbitrary numbers of particles, and treat them all the same **
** That means "interestingness" comes from emergent behaviour.
What are particles good for?

This means we can have arbitrary numbers of particles, and treat them all the same **

** That means "interestingness" comes from emergent behaviour.
What are particles good for?

What are particles good for?

Diablo III
What are particles good for?

Games Industry definition of a particle system

No interaction with surrounding environment
No interaction with self
No effect on the world, just draw it on screen
What are particles good for?

Games Industry definition of a particle system

No interaction with surrounding environment
No interaction with self
No effect on the world, just draw it on screen

...but there's more out there
What are particles good for?

http://arts.brighton.ac.uk/study/postgrad/architecture-m-arch/student-work/air-flow-simulation-workshop
What are particles good for?

http://www.decarpentier.nl/boids
What are particles good for?
What are particles good for?

Planck Institute's *Millennium Simulation.*

"The *Millennium Run* used more than 10 billion particles to trace the evolution of the matter distribution in a cubic region of the Universe over 2 billion light-years on a side. It kept busy the principal supercomputer at the Max Planck Society's Supercomputing Centre in Garching, Germany for more than a month."

Planck Institute's *Millennium Simulation.*
Where are particles in games?
Where are particles in games?

...the other ones, that is....
Where are particles in games?

- Probably a particle
- Probably not a particle
Where are particles in games?

Particles?
Where are particles in games?

Particles?
Where are particles in games?

*Particles*?
Where are particles in games?

Particles?????
Building a particle system

Critical elements:

• An array of particles
• A function to update all of them
• A function to draw them
• Some forces

Optional:

a function to call when they collide
cleanup and maintenance functions to kill old particles, and spawn new ones

void update(float elapsed) {
    for (Particle p : particles) {
        // Add the distance that the particle will have travelled
        p.position += p.velocity * time;
    }
}
Building a particle system

**Critical elements:**

- An array of particles
- A function to update all of them
- A function to draw them
- Some forces

```c
void update(float elapsed) {
    for (Particle p : particles) {
        // Add the distance that the particle will have travelled
        p.position += p.velocity*time;
    }
}
```

**Optional:**

- A function to call when they collide
- Cleanup and maintenance functions to kill old particles, and spawn new ones
void update(float elapsed) {
    for (Particle p : particles) {

        // Change the velocity
        p.velocity += p.force*time;

        // Add the distance that
        // the particle will have travelled
        p.position += p.velocity*time;
    }
}
void update(float elapsed) {
    for (Particle p : particles) {

        // Change the velocity
        p.velocity += p.force*time/p.mass;

        // Add the distance that
        // the particle will have travelled
        p.position += p.velocity*time;
    }
}
Building a particle system

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Optional:

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```java
void update(float elapsed) {
    for (Particle p : particles) {
        p.force = new Vector(0, 0);

        // Apply all the forces to the particle
        for (Force f : forces) {
            p.force += f.calculateForce(p);
        }

        // Particle updates go here
        //...
    }
}
```
Done!

Time for demos!
Teaser trailer for CMPS179

- Ever wonder why people buy into Kickstarters?
- Ever wonder how Team Fortress has sold over $50,000,000 in hats? (as of 2011)
- Ever stop playing a game because it feels like all the choices are the same?
- Ever bid more than you wanted to on EBay, given to a charity you didn't really like, or spent more time in Farmville than you wanted?
- Ever worried that the game you worked so hard to make just isn't...fun?
Teaser trailer for CMPS179

What is **VALUE** and how does it affect the choices we make?
Teaser trailer for CMPS179

What is **VALUE** and how does it affect the choices we make?
Teaser trailer for CMPS179

How do we give players **CHOICES** that they actually care about?

And how do we guide the choices that they make?
Teaser trailer for CMPS179

Looking for a summer course to fulfill a breadth requirement?

Want a job someday?
   Valve just hired an ECONOMIST.
Teaser trailer for CMPS179

Ask for a permission code:

kcompton@soe.ucsc.edu
OR
galaxykate@gmail.com