Lecture 13

Collision handling

Fractals

Noise functions, terrain generation

Self-squaring fractals

Collision detection

Polyhedra-polyhedra in general NOT possible!

Multiple stages, broad phase/narrow phase

Simplify

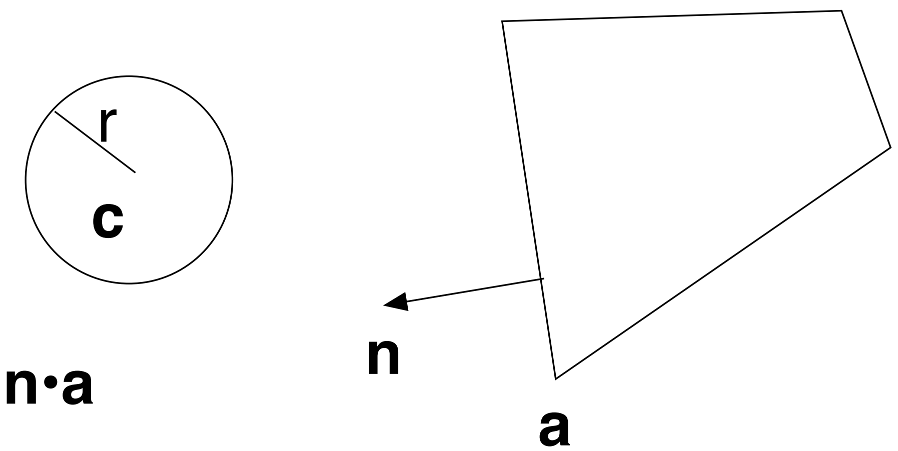
Split shapes to convex parts

Simple cases:

Sphere - sphere

Sphere - polyhedra

AABB - AABB



n·(**c** + r·**n**) > **n**·**a**

=>

r **> n · (a - c)**

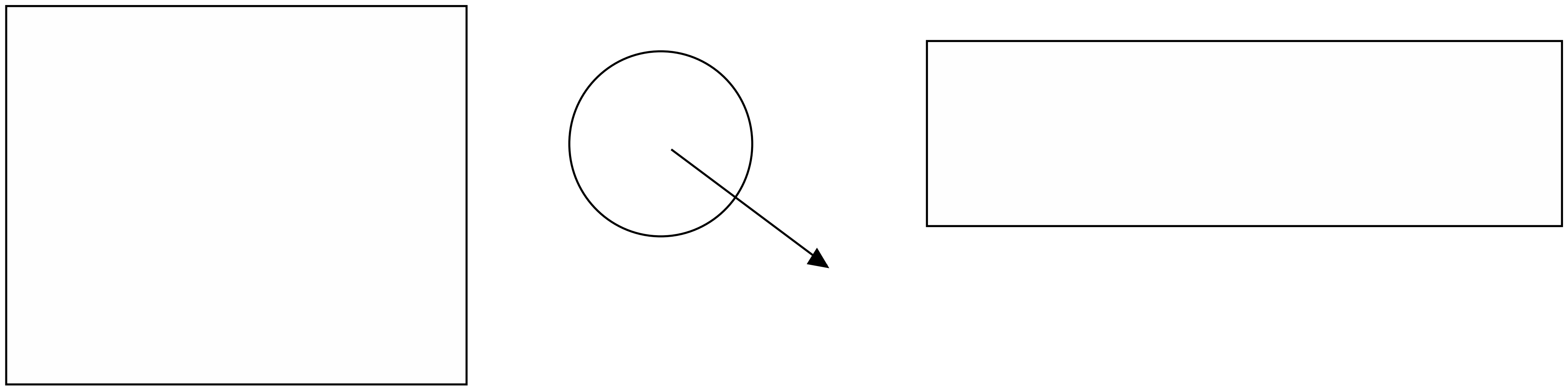
Distance from center to plane > r

Valid when a line through **c** along **n** intersects the polygon!

Collision detection & handling

Simple case: Axis aligned 3D maze

All walls are AABBs All objects are spheres/cylinders



Final notes on the simplified camera collisions:

Resolving: Pick the closest intersected plane as the one to ”hit”, and use that for collision handing. The smallest change is usually correct.

Conclusion: Don’t overdo it if you can fake it. Be ambitious, but don’t waste time on effects that nobody will notice.

Collision handling

What to do once a collision is found.

- **Separate**
- **Change velocities**
- **Deform**
- **Maintain constraints**

Full (narrow-phase) tests are hard to resolve.

Simple particle physics (again)

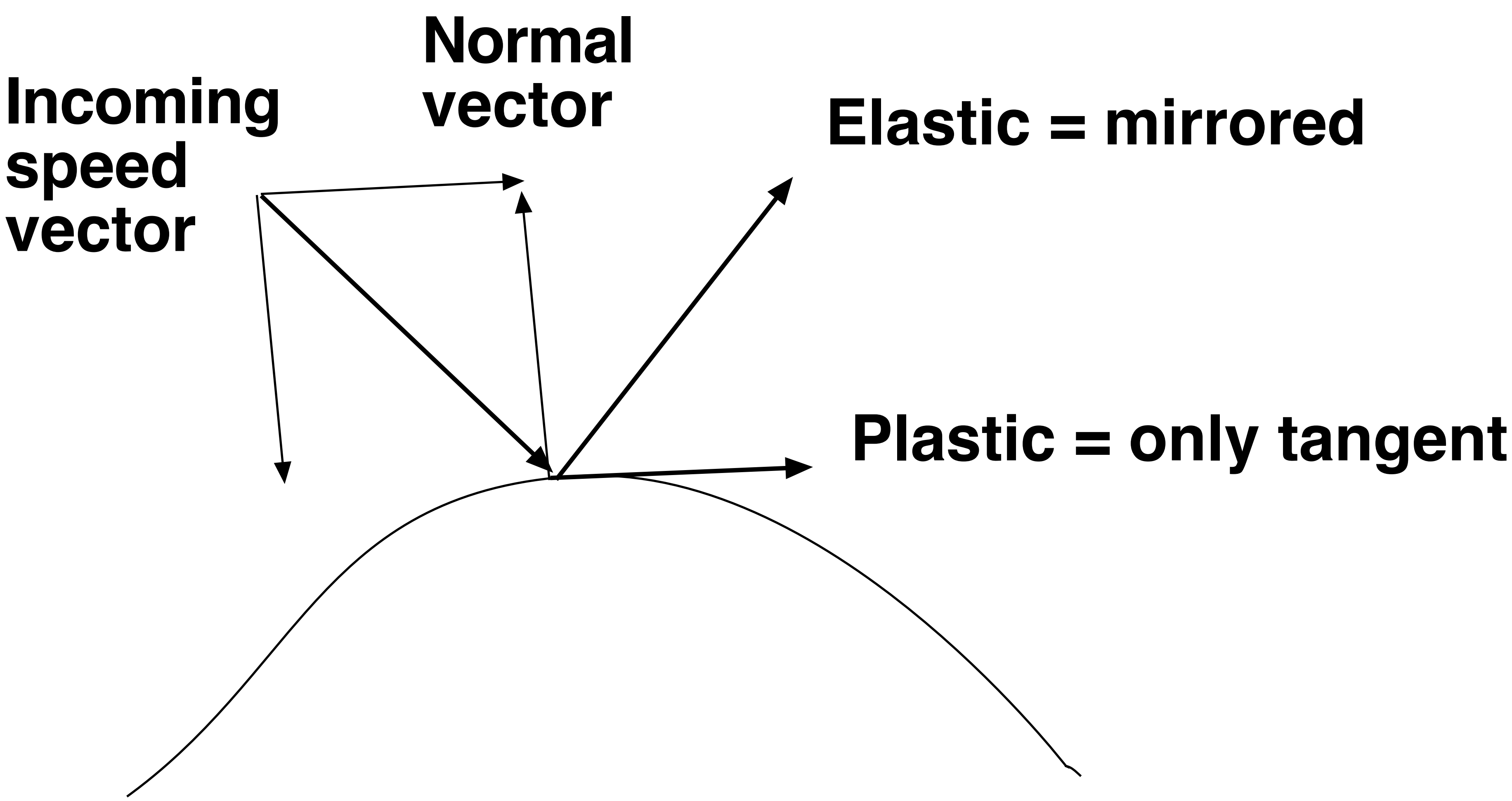
acceleration = gravity + forces/mass
speed = speed + acceleration
position = position + speed

$$a = g + \sum f/m$$
$$s = s + a$$
$$p = p + s$$

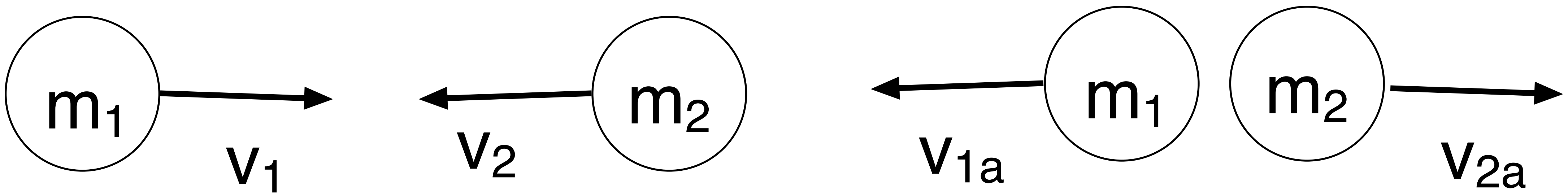
("Euler integration")

Modify speed and position in collisions

Simple particle-surface collision



Plastic and elastic collisions



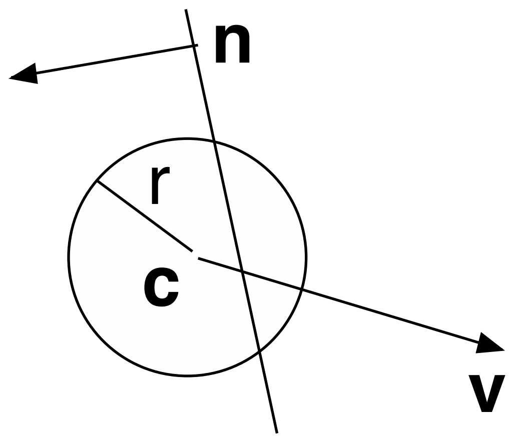
Preserve momentum

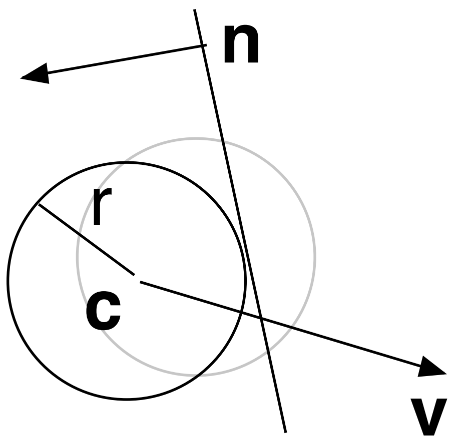
$$m_1v_1 + m_2v_2 = m_1v_{1a} + m_2v_{2a}$$

Elastic collisions also preserve kinetic energy

$$m_1v_1^2 + m_2v_2^2 = m_1v_{1a}^2 + m_2v_{2a}^2$$

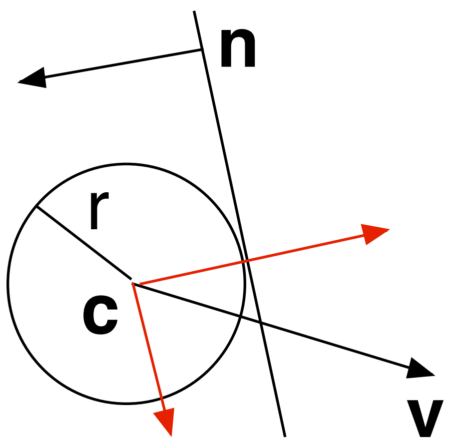
Collision handling sphere-polyhedra



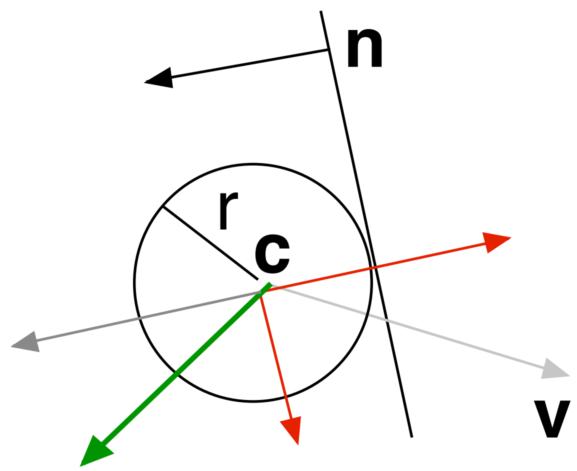


Assuming stationary polyhedra

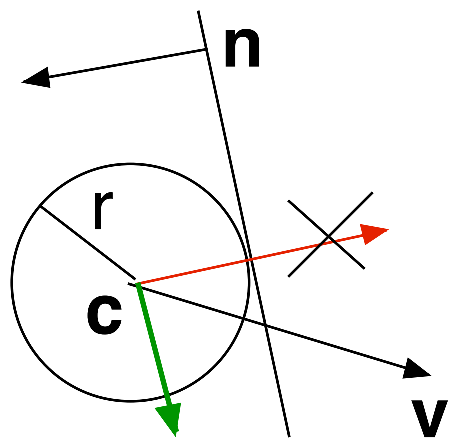
Separate - move object away along normal vector



Split velocity along n

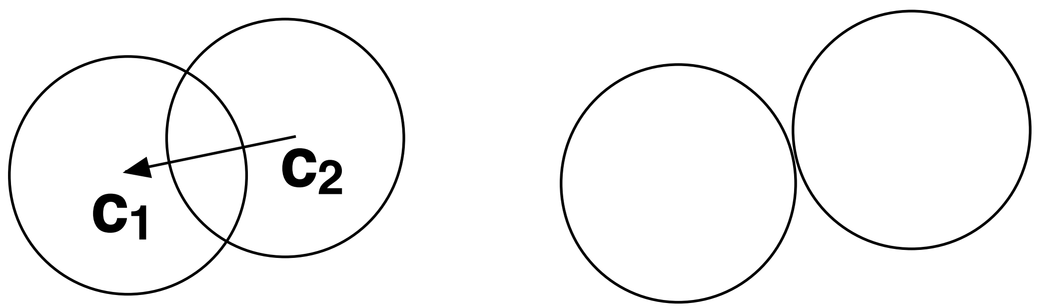


Elastic

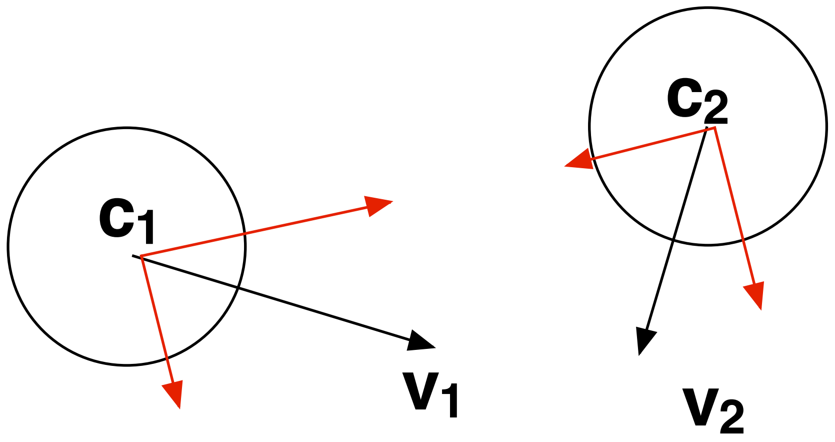


Plastic

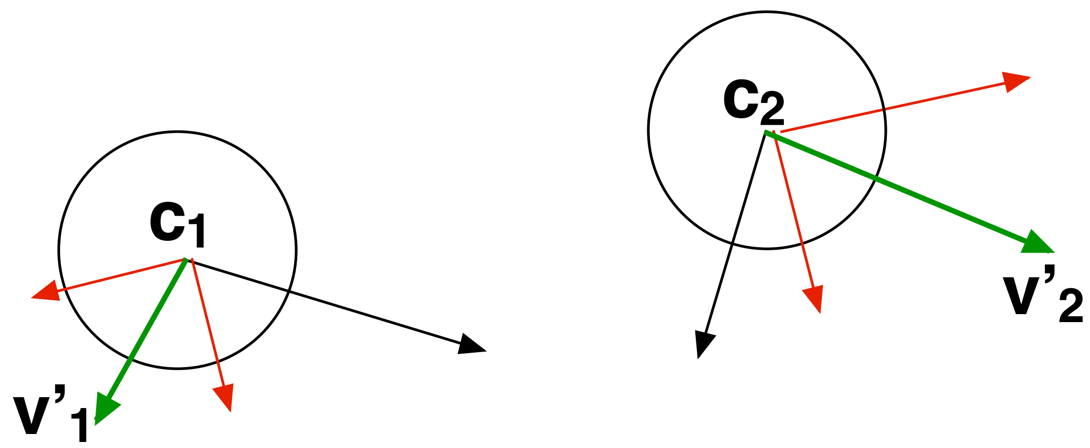
Collision handling sphere-sphere (simplified, point masses)



Separate - move object away along vector through centers



Split velocities along vector though centers (c_2-c_1)



Elastic: Exchange components along c_2-c_1

Beyond point-mass mechanics

Rigid body mechanics
Better integration
Stacking
Applying forces and backing time to avoid overlap
Deformable bodies
Breakable bodies

Conclusions, collision detection

Must focus on convex shapes

Simple collision detection with AABB or spheres. Spheres vs polyhedra also easy. Polyhedra vs polyhedra hard to do.

Global phase also important

Narrow phase expensive and complex