Computer Animation Algorithms and Techniques

Behavioral Animation:
Knowing the environment
Flocking

Behavioral Animation

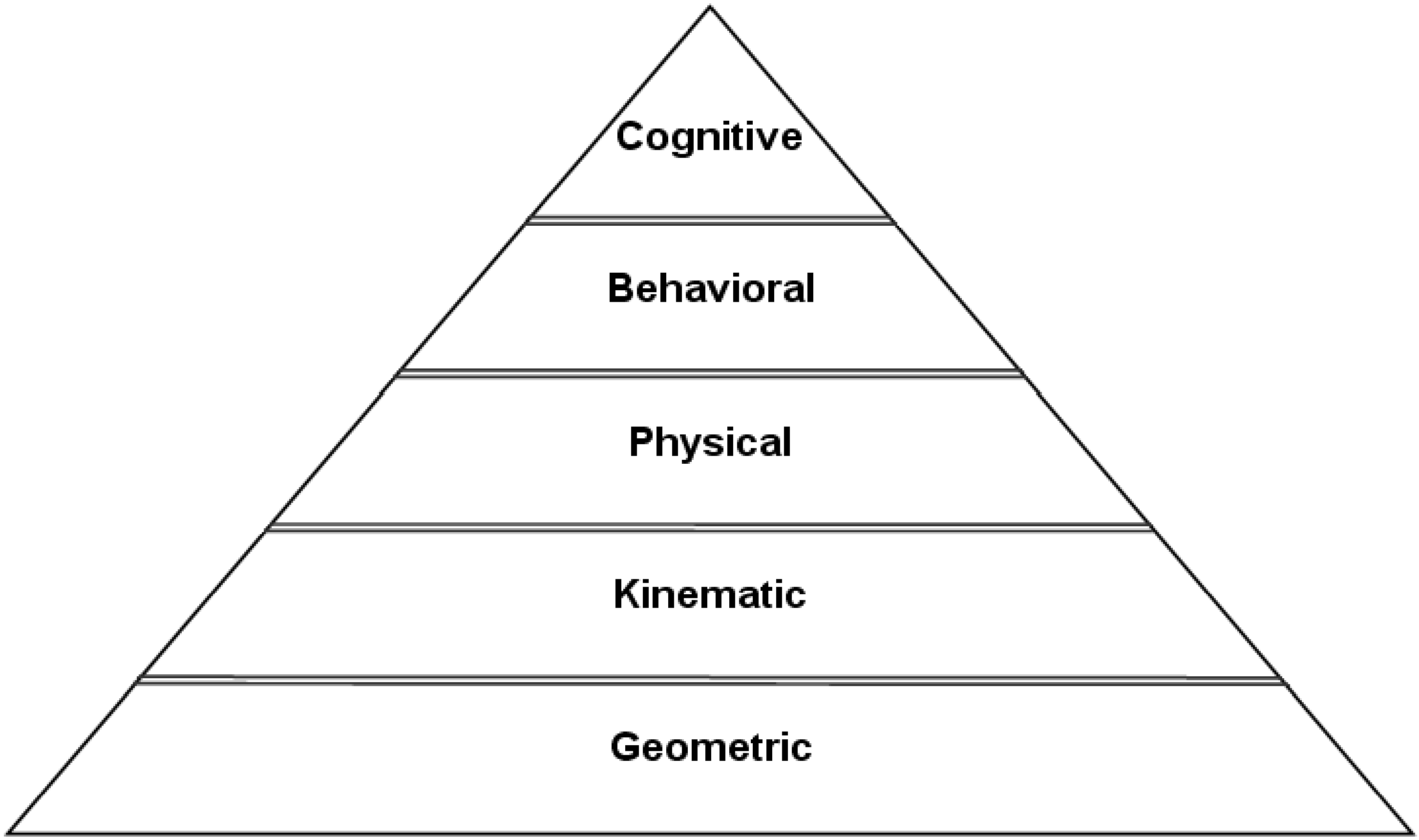
Knowing the environment

Aggregate behavior

Primitive behavior

Intelligent behavior

Crowd management


Cognitive
Behavioral
Physical
Kinematic
Geometric

Knowing the environment

Vision – what do you know about the present

Memory – what is recorded about the environment

More about AI than graphics

Vision

Geometric issue – what's in sight?
OR
Can I see X?

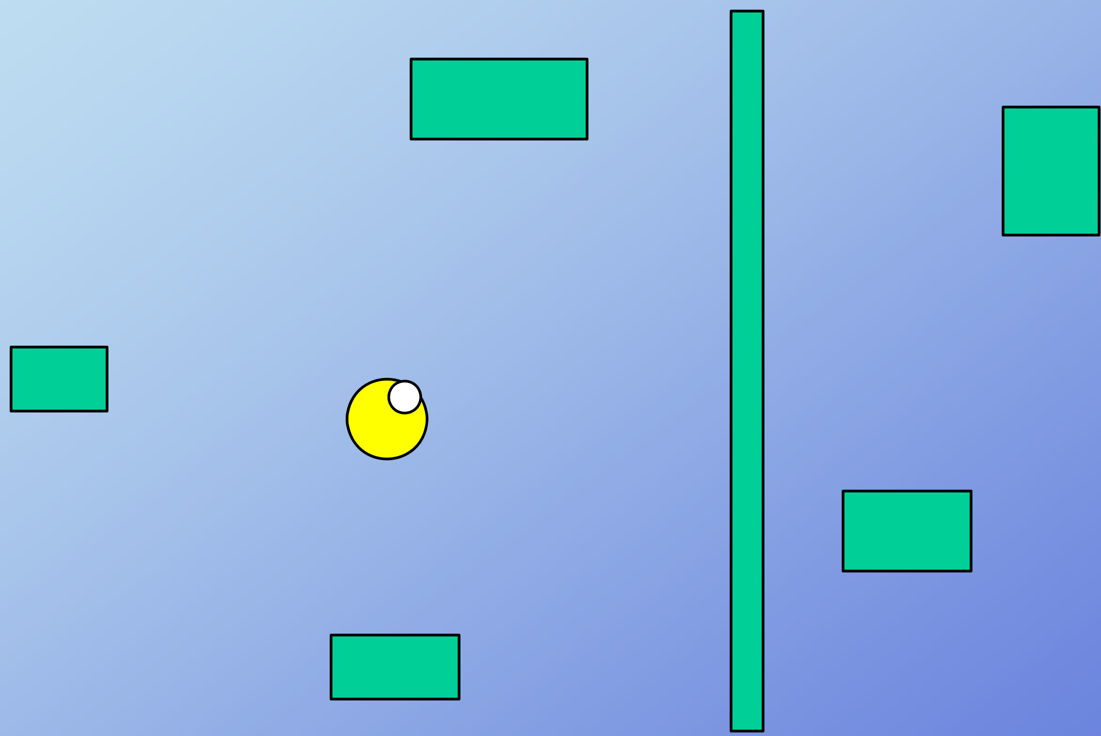
Computation v. accuracy

Perceptual issue – what do you see?

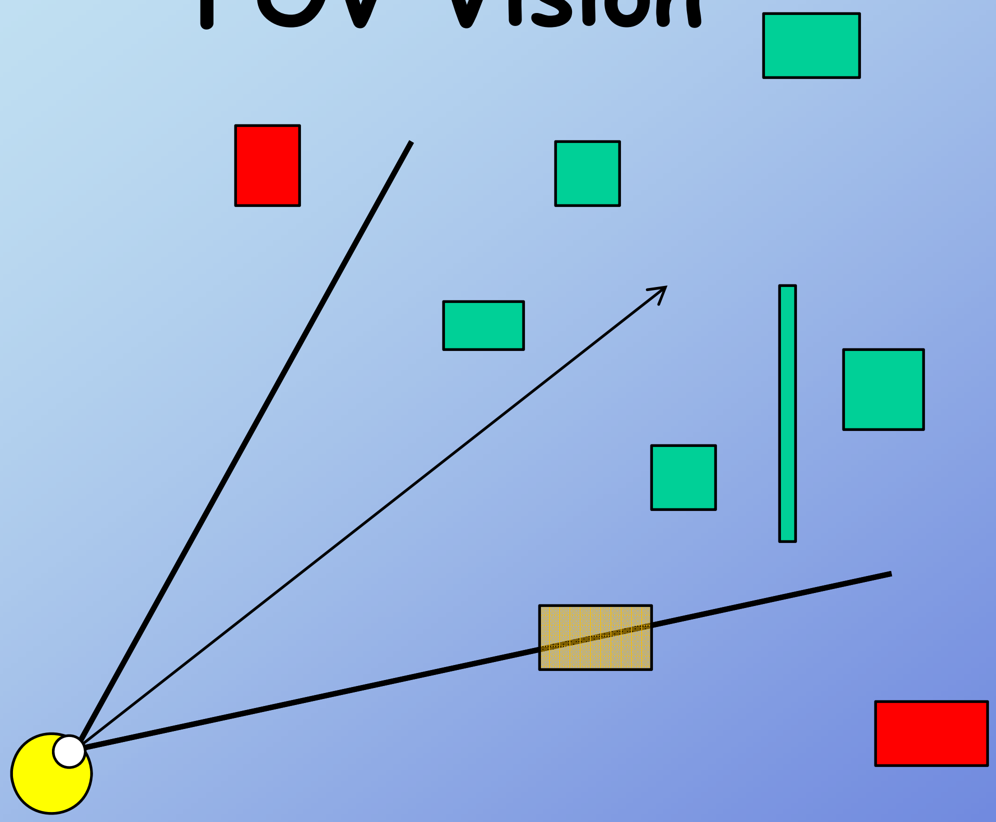
Cognitive modeling – necessary? At what level?

Omniscience

Everything in database is 'known'



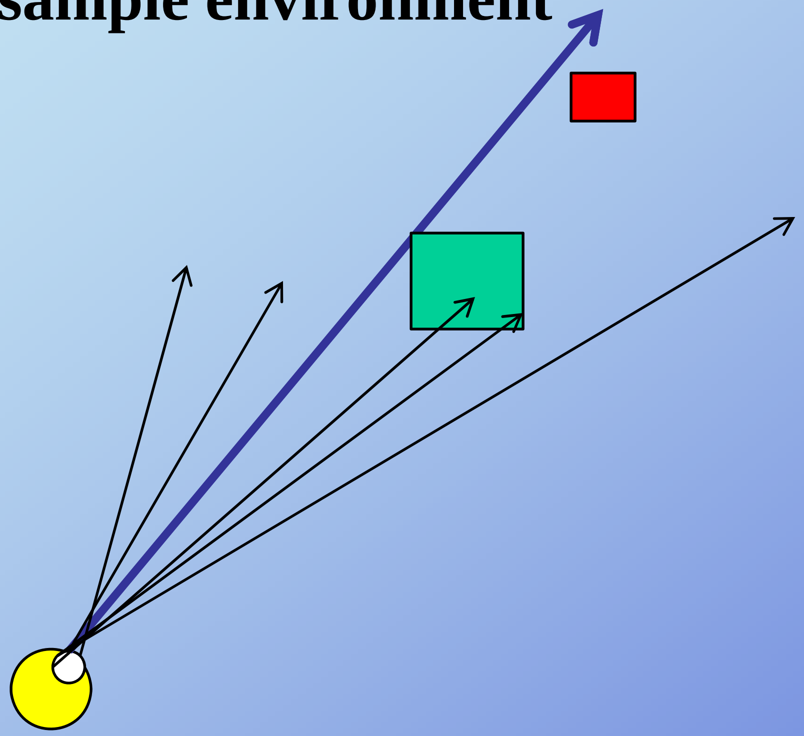
FOV Vision



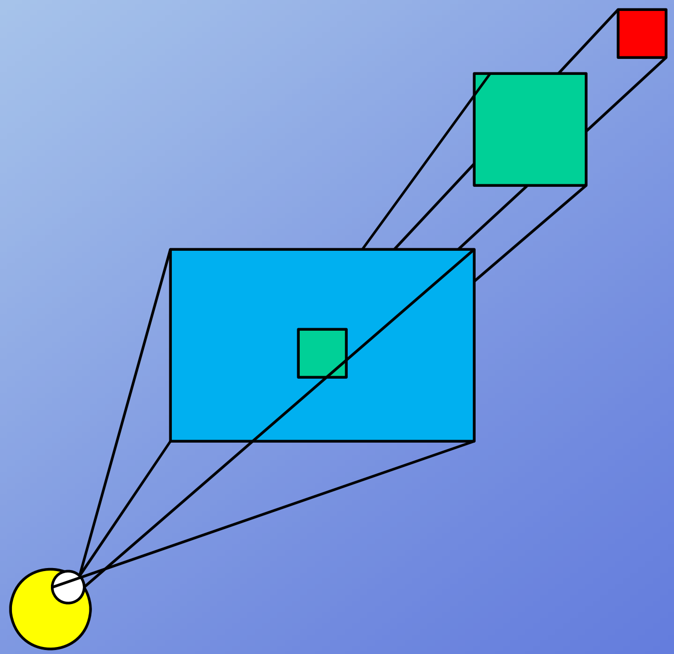
Use surrogate bounding volumes, or sample points

Occluded Vision

ray casting
sample environment



z-buffer
use object IDs as color

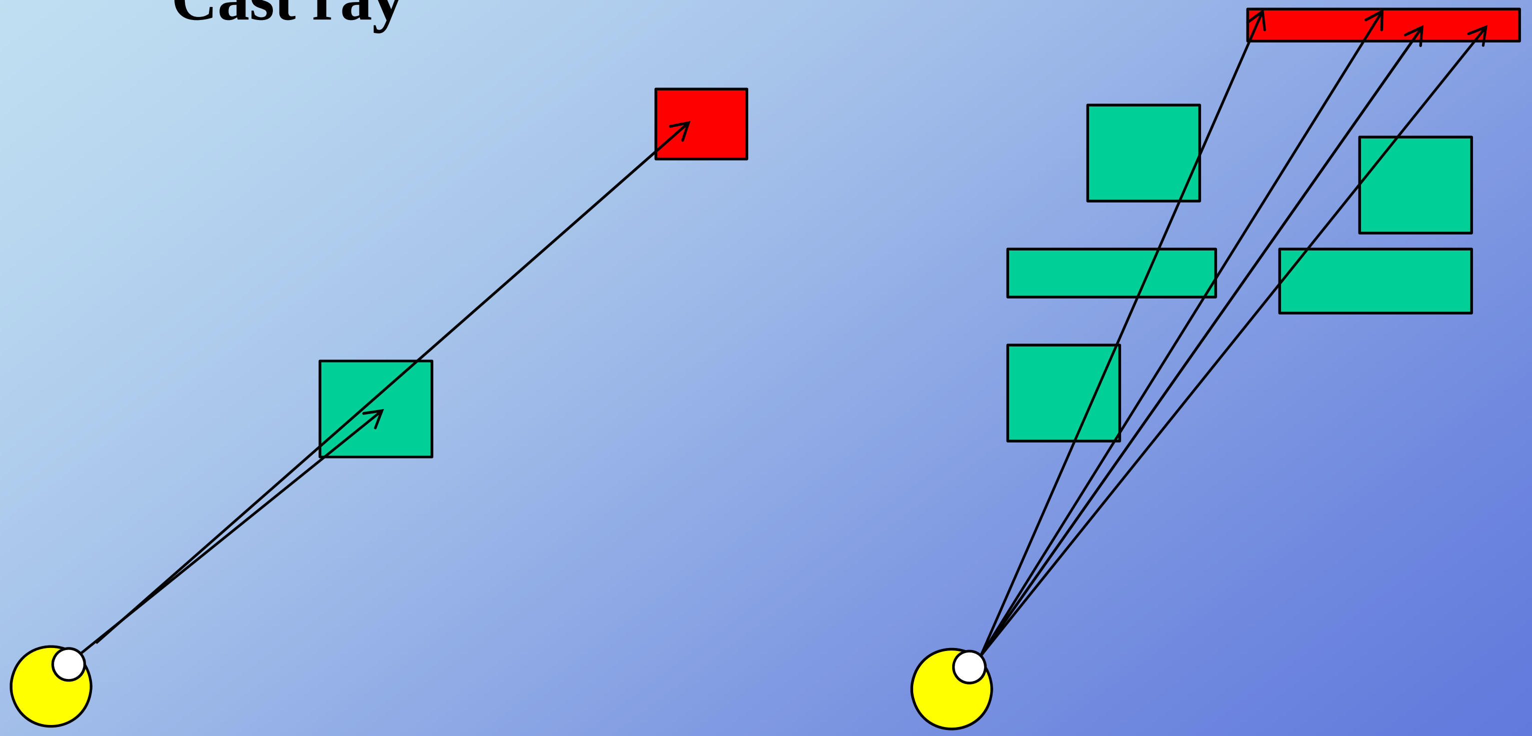


Use surrogate bounding volumes

Target-testing vision

Can I see X?
Cast ray

Sample object



Use surrogate bounding volumes

Object Recognition

Cognitive modeling
How much and what part is needed?

Application need?
Not yet addressed in literature
More AI than graphics

Other senses?

Hearing?
Smell?

Model sensors & signal propagation

Spatial occupancy approach?

Applications?

Memory

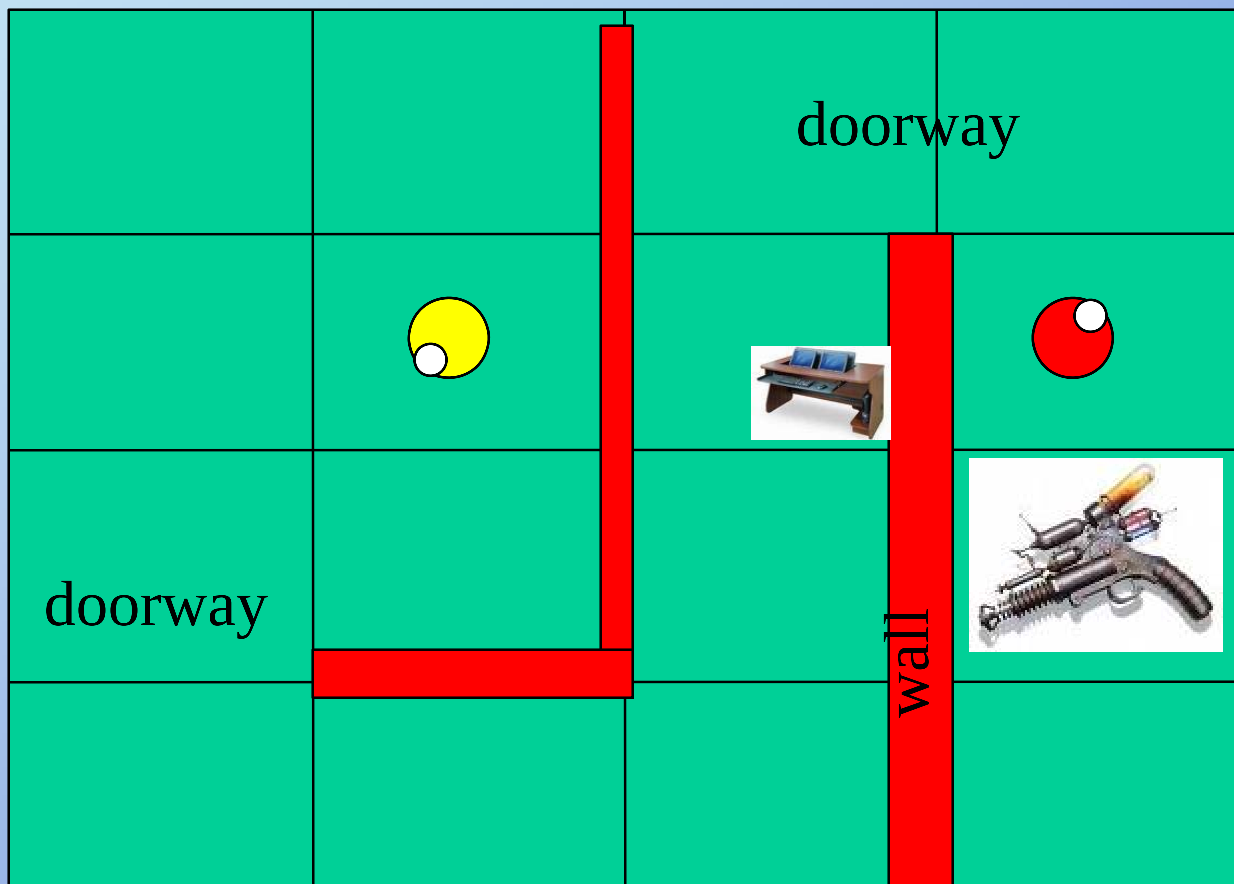
What is recorded about the environment

Spatial occupancy

Transience of objects: time-stamps

hierarchy: short-term, long-term

Spatial Occupancy   transiency



Aggregate Behavior: E pluribus unum Emergent Behavior

Typical qualities

Type	Elements	Physics Env/Others	Intelligence
Particles	10^2-10^4	Much/none	None
Flocking	10^1-10^3	Some/some	Limited
Crowds	10^1-10^2	Little/much	Little-much

Primitive Behavior - Flocking

Local control – for realism, the flock member only reacts to locally accessible information

Perception – FOV vision – angle can change with speed

Interacting with other members – stay with friends, avoid bumping into each other

Interacting with the environment – collision avoidance is primary

Primitive Behavior - Flocking

Original work by Craig Reynolds

Global control – need control of flock

- **script flock leader**
- **global migratory urge**

Negotiating the motion

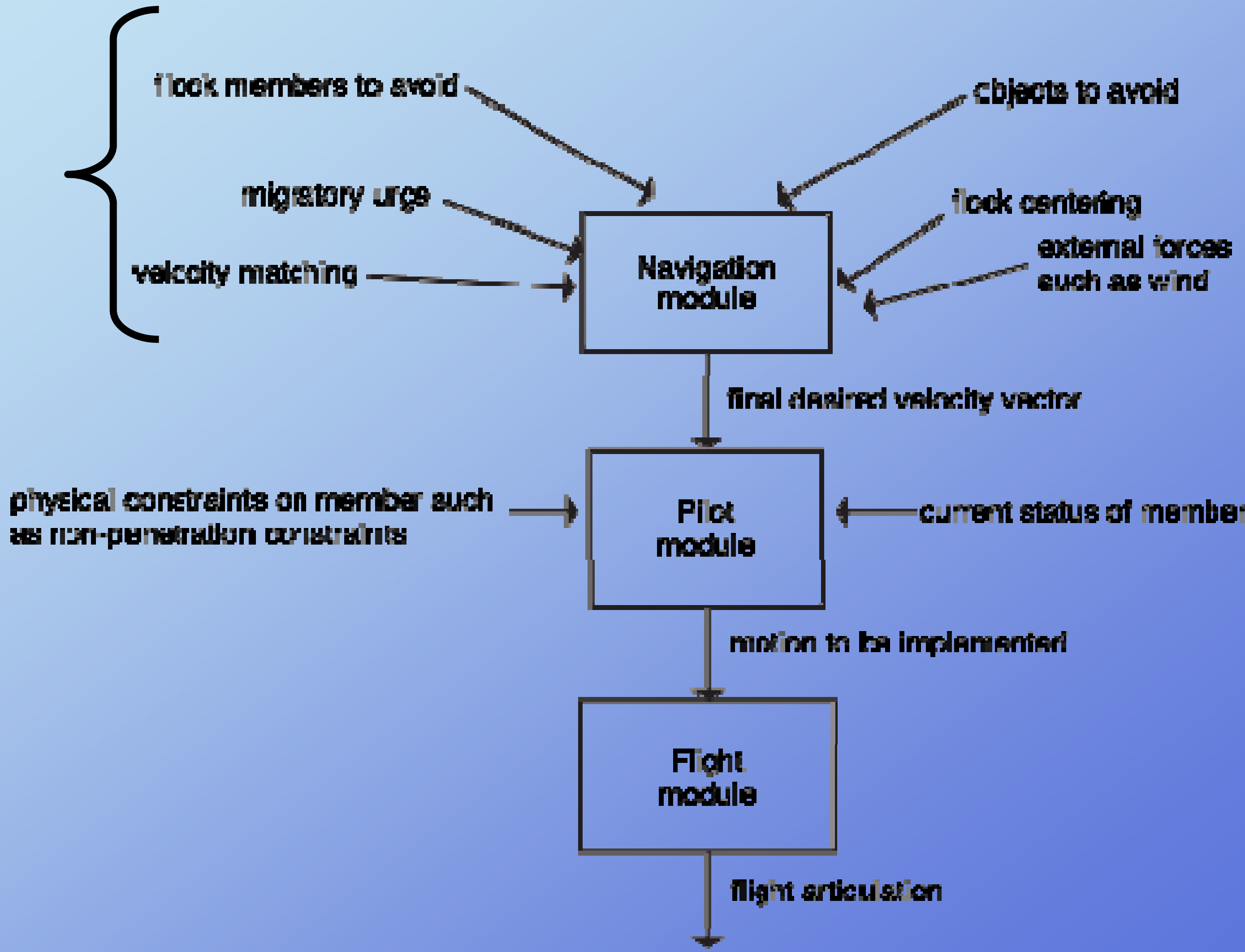
Collision avoidance – steer to avoid

Splitting and rejoining – difficult to tune parameters

Modeling flight – e.g., banking into turns

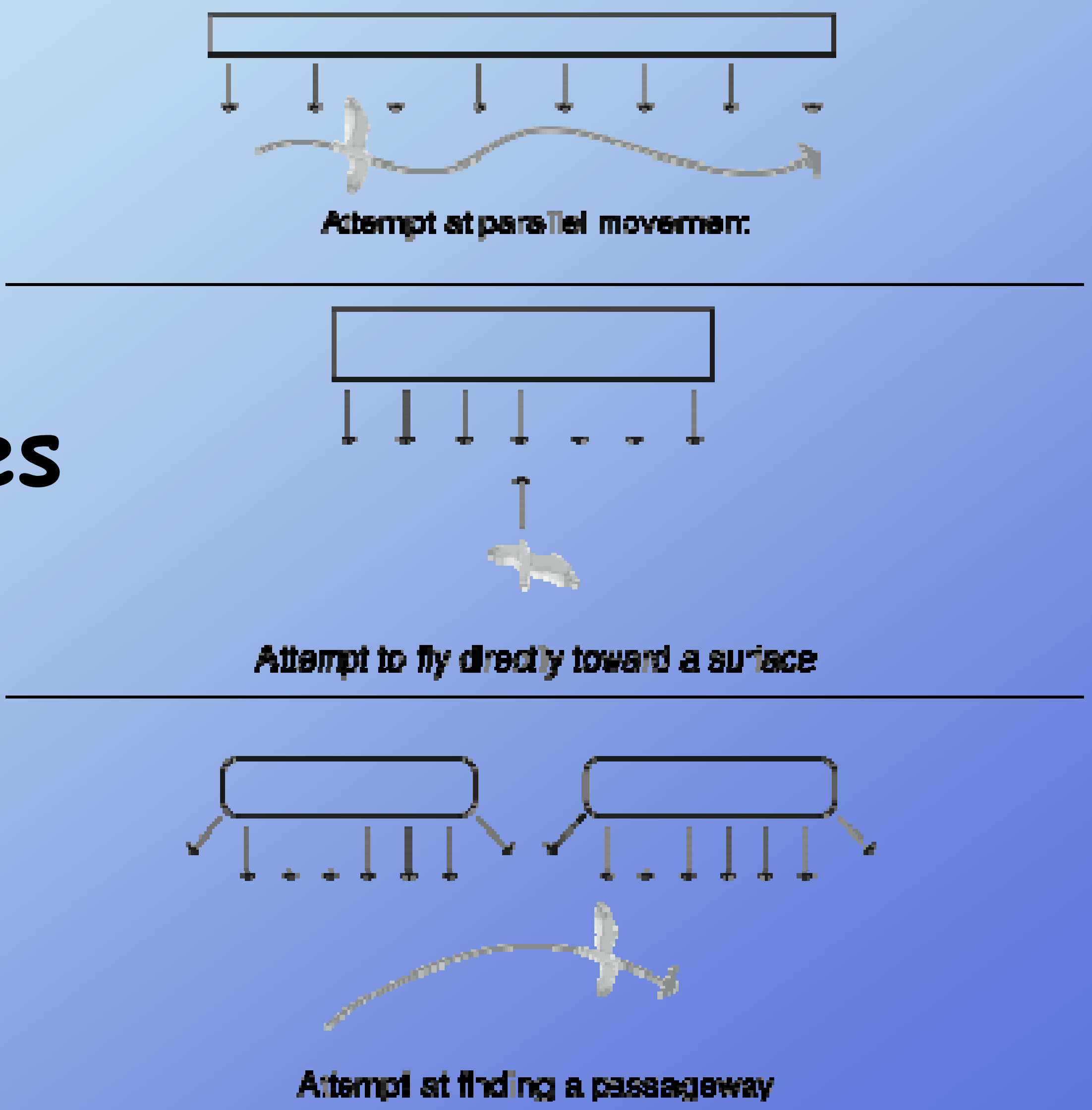
Negotiating the Motion

Forces
Or
"Reasoning"
(e.g. rule-based)

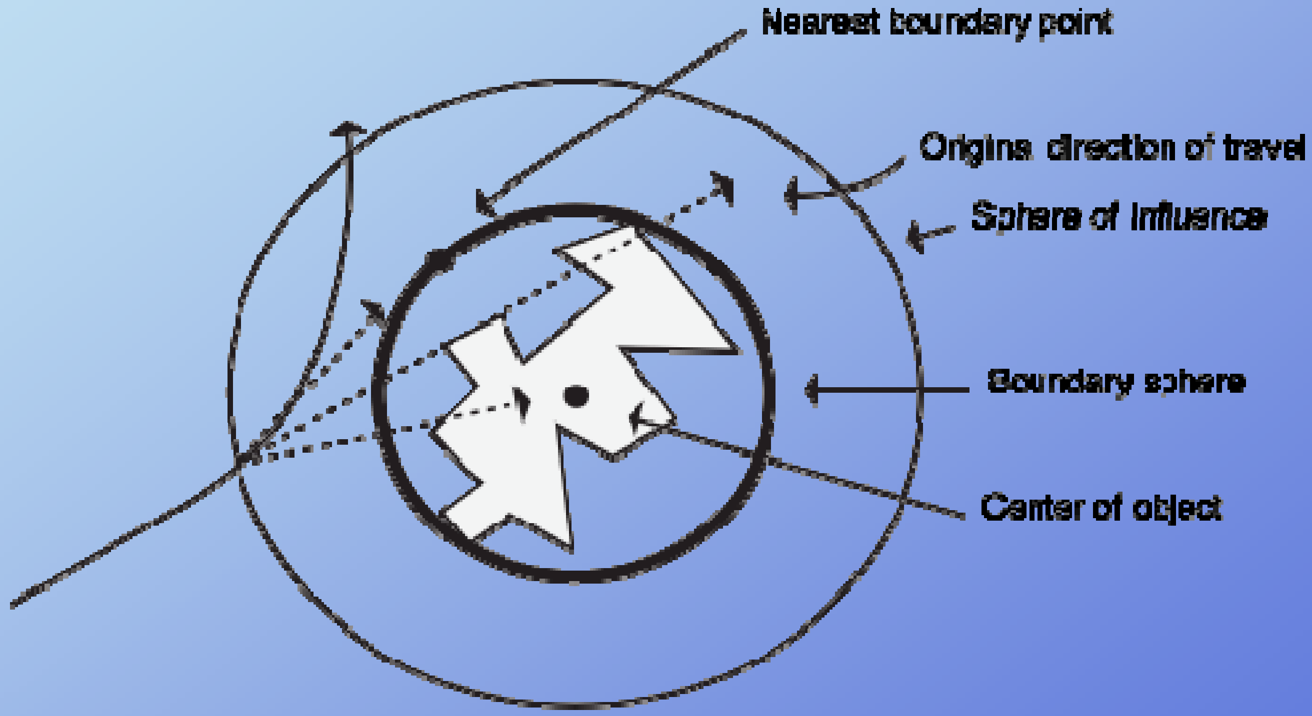


Navigating Obstacles

Problems with repulsive forces



Navigating using bounding sphere



Navigating
Testing for being on a collision path with (bounding) sphere

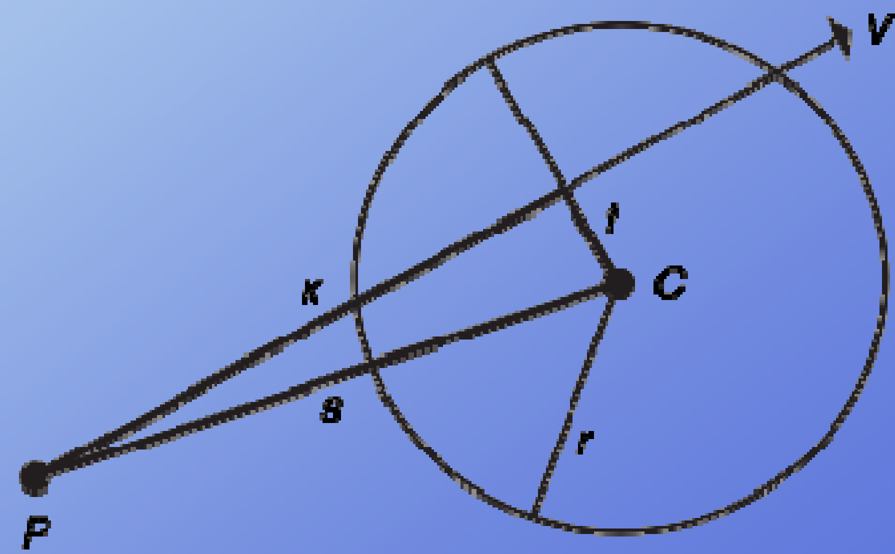
Given: P, V, C, r

$$k = (C - P) \bullet \frac{V}{|V|}$$

$$s = |C - P|$$

$$t = \sqrt{s^2 - k^2}$$

$$t < r$$



Finding closest non-colliding point

Calculate s,t

$$k = \sqrt{|C-P|^2 - r^2}$$

$$r^2 = s^2 + t^2$$

$$k^2 = s^2 + (|C-P| - t)^2$$

$$k^2 = r^2 - t^2 + |C-P|^2 - 2|C-P|t + t^2$$

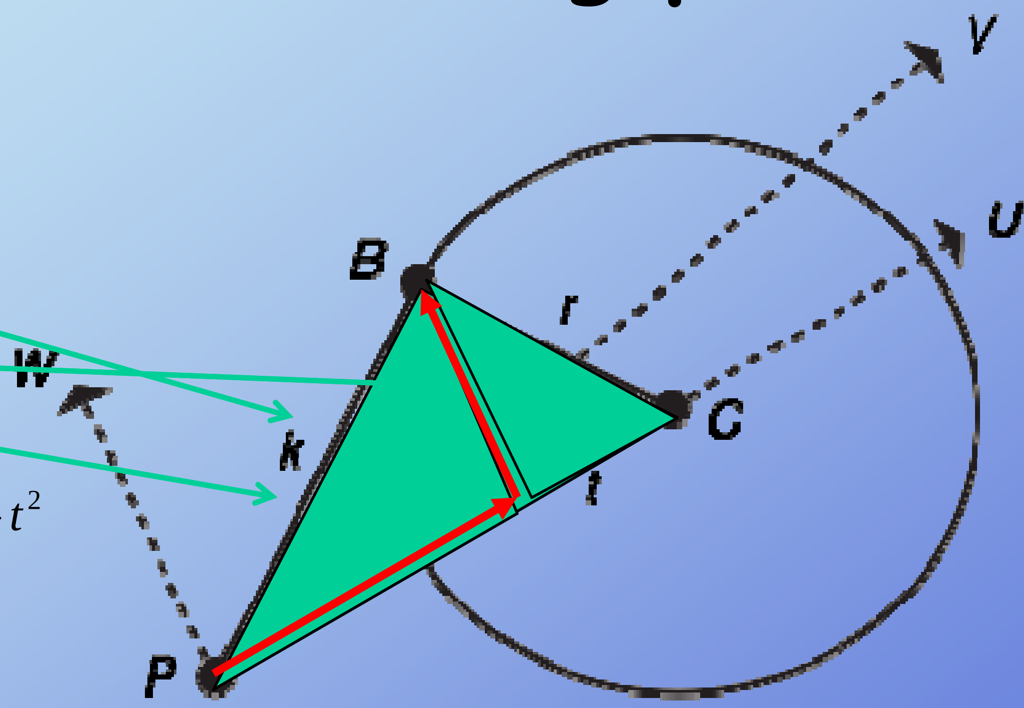
$$t = \frac{k^2 - r^2 - |C-P|^2}{-2|C-P|}$$

$$s = \sqrt{r^2 - t^2}$$

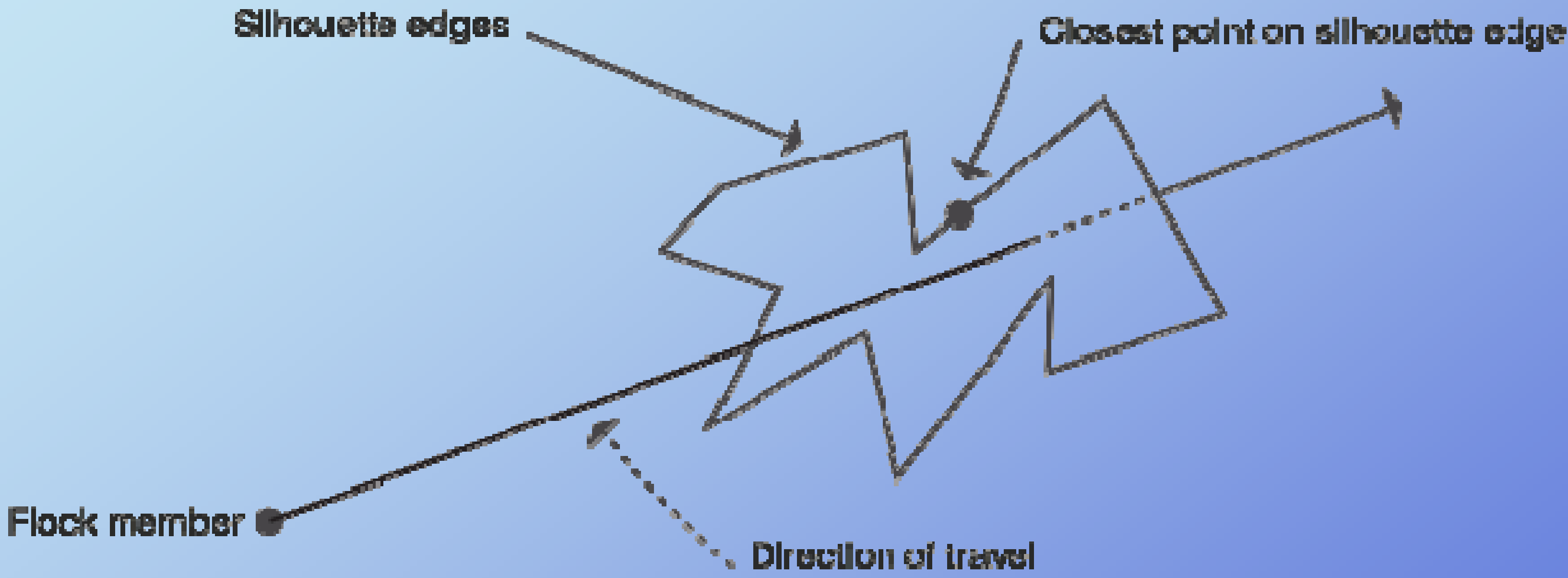
$$U = \frac{C-P}{|C-P|}$$

$$W = \frac{(U \times V) \times U}{|(U \times V) \times U|}$$

$$B = P + (|C-P| - t)U + sW$$

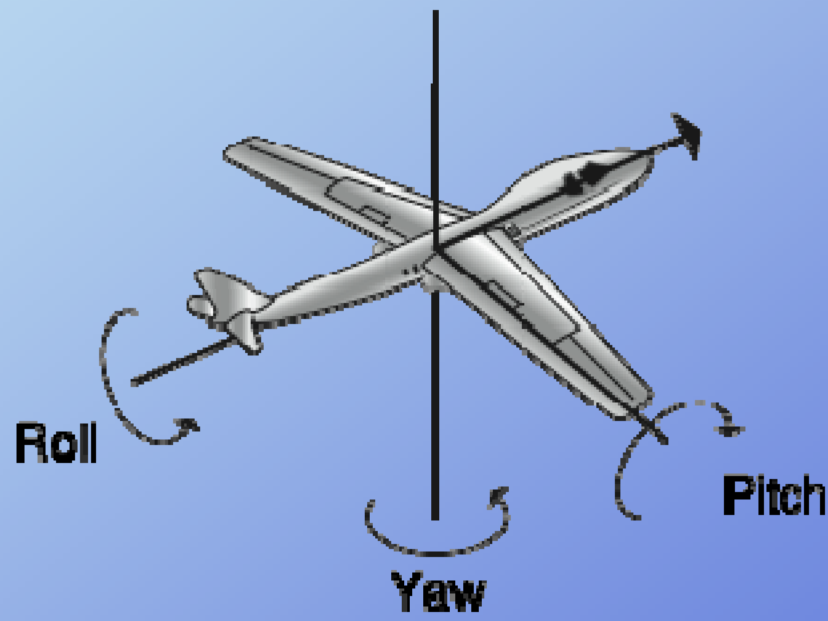


Navigating – finding a pass

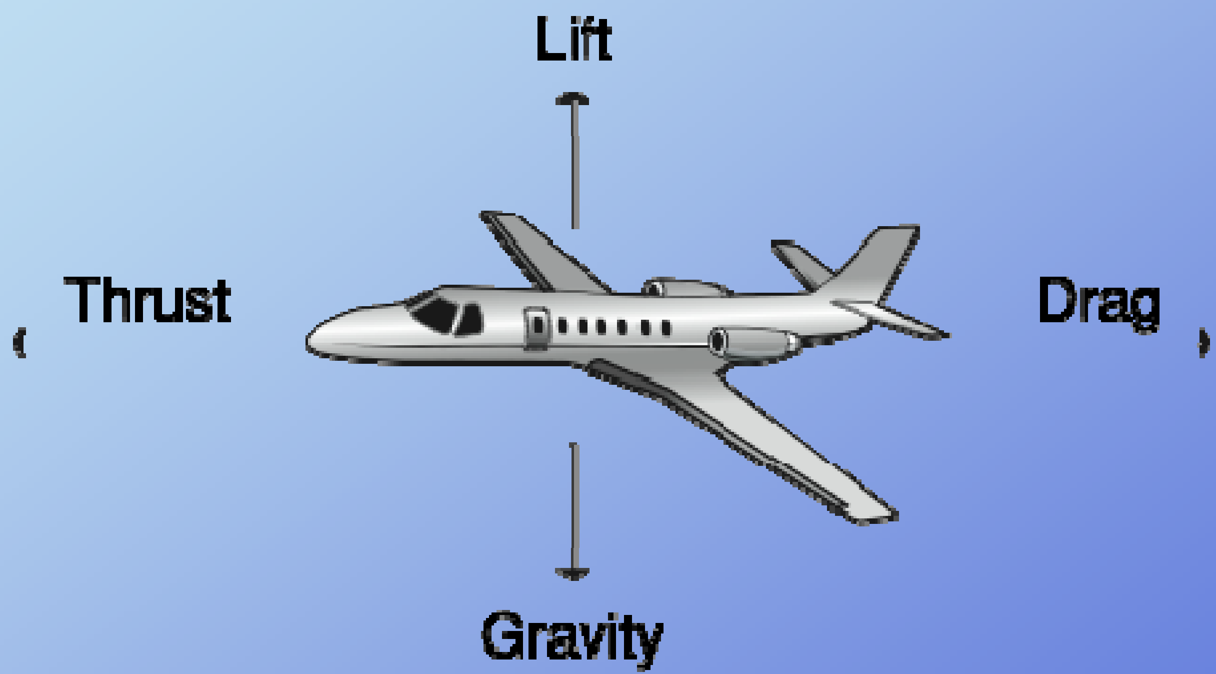


Vision Options:
Render in z-buffer
Sample environments with rays

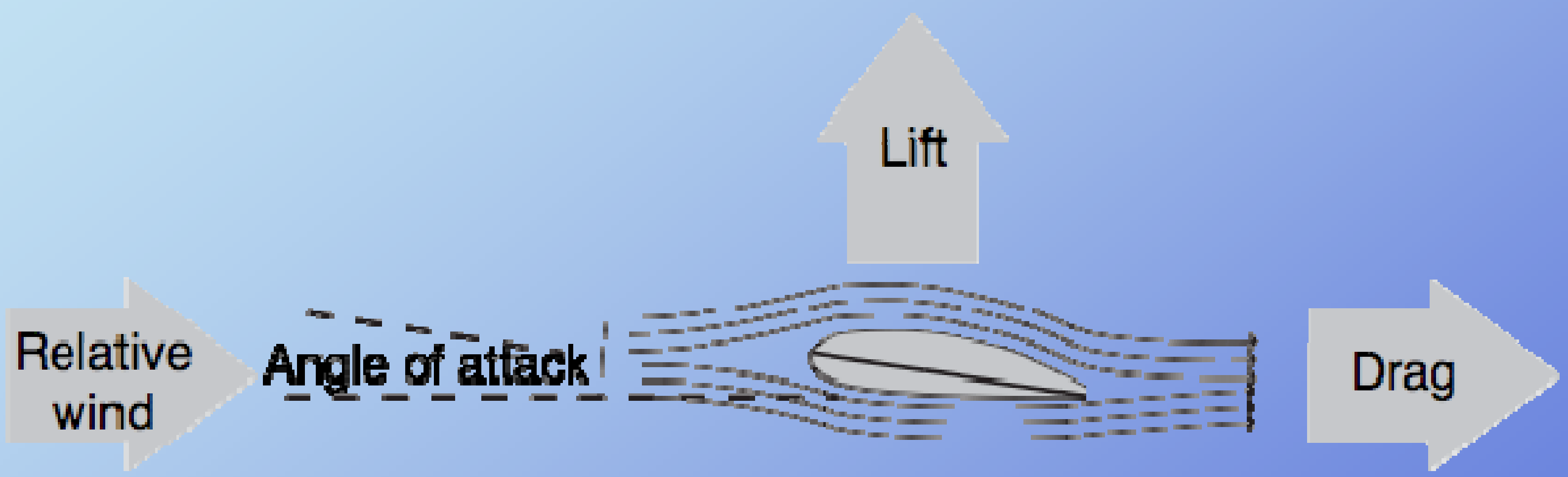
Modeling Flight –common in flocking



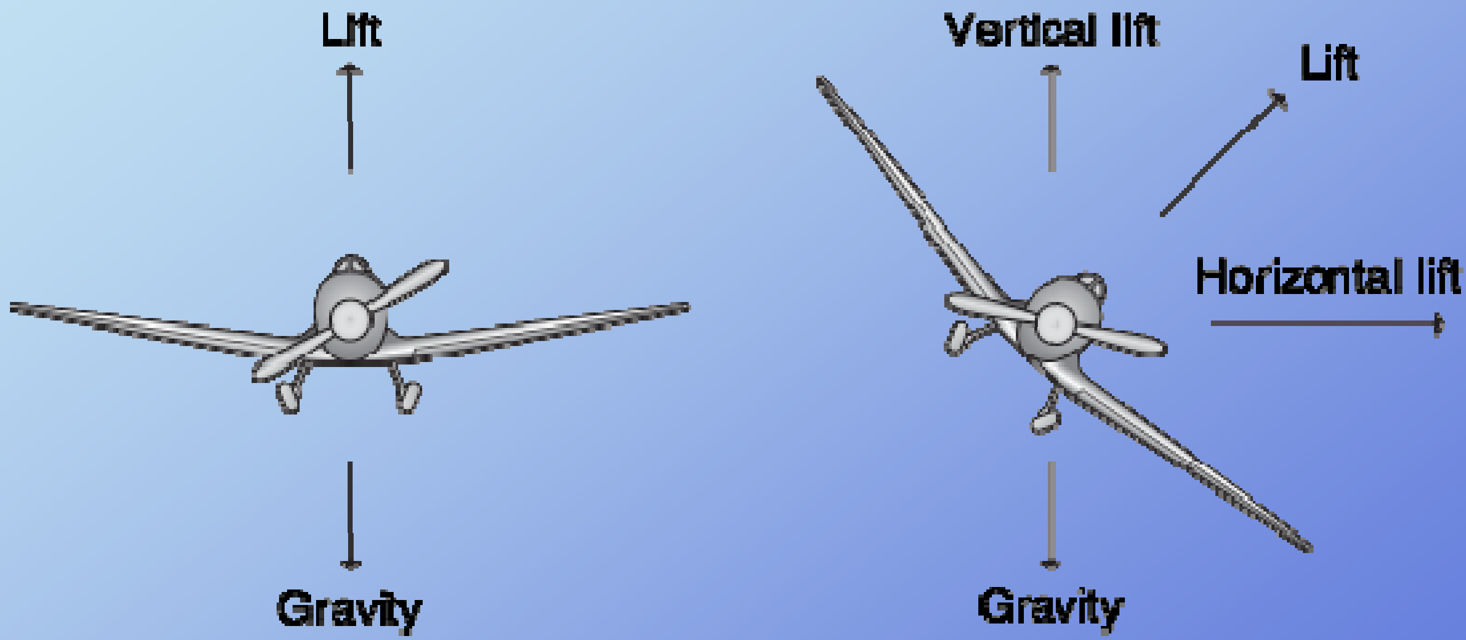
Modeling Flight



Modeling Flight



Modeling Flight



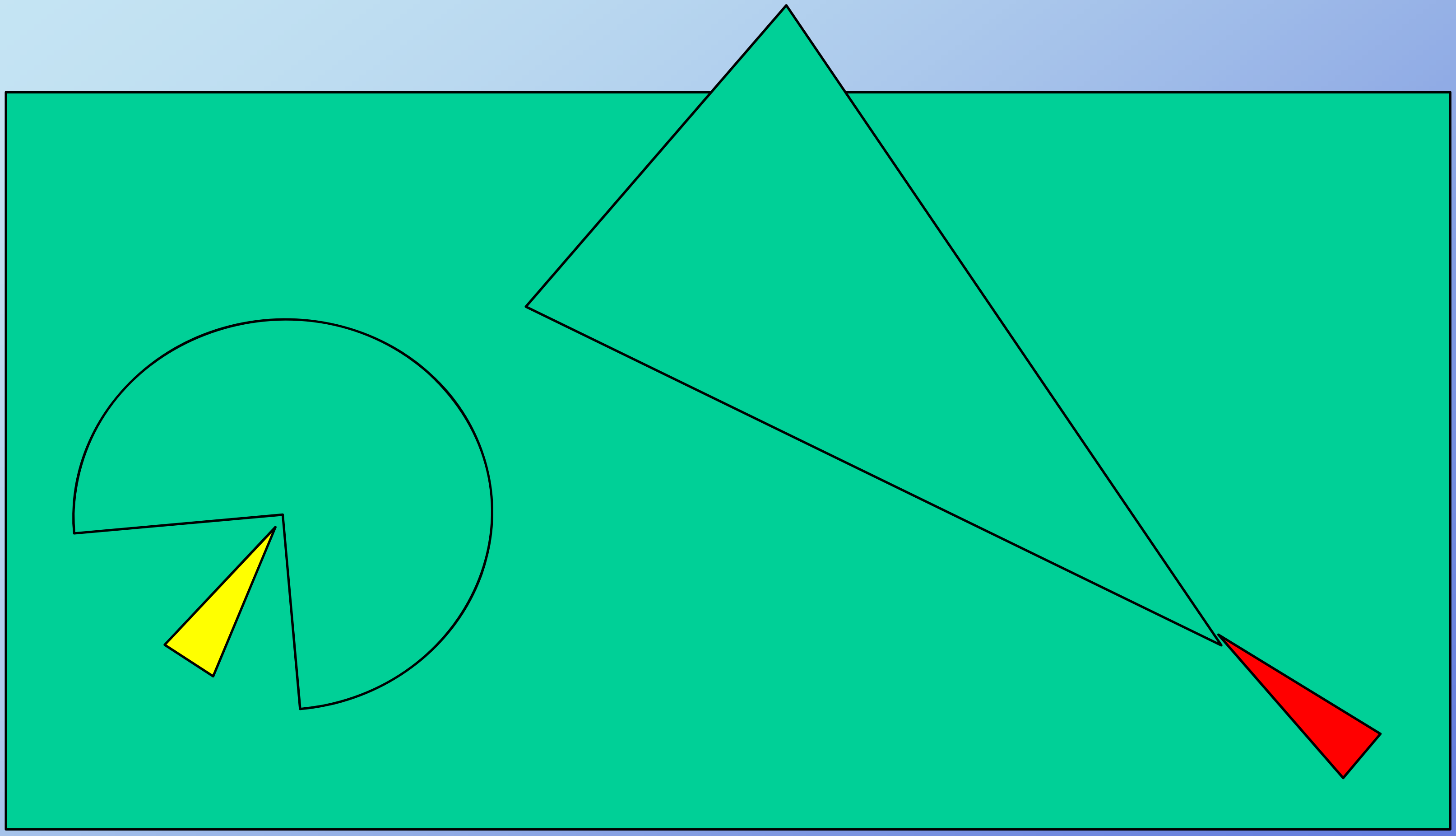
Primitive Behavior - Prey-Predator

unbalanced abilities

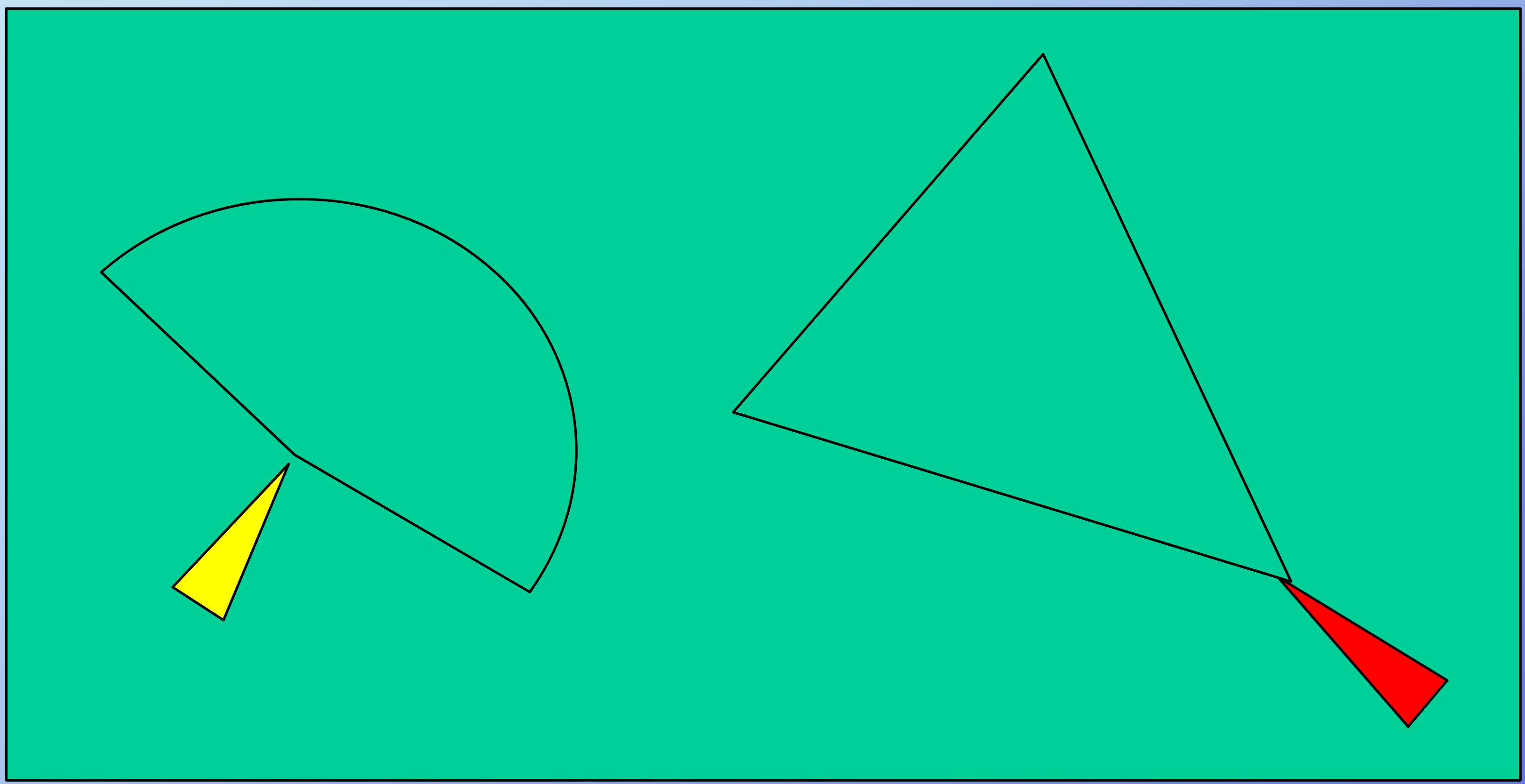
- vision - distance, movement, fov
- maximum velocity
- maximum acceleration
- maximum angular velocity maximum

angular acceleration

Prey-Predator - vision



Prey-Predator agility: speed and turning



Prey-Predator – hidden by forces

Using pure forces
May not prevent object penetration
Prey can be 'hidden' by environmental repulsive forces