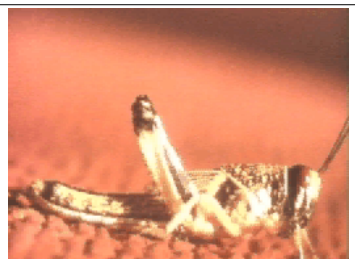
Lecture 2: Terrestrial Locomotion I
Simple Analyses of Ballistic Movement.

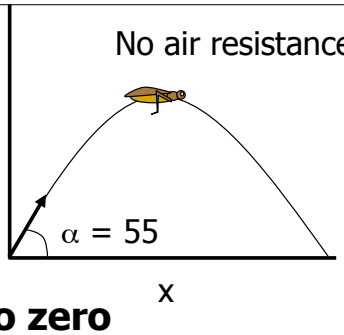
1. Recap: Jumping...
2. Current approaches for analyzing terrestrial locomotion.
3. Gaits and patterns of limb motion
4. Ballistic walking and the inverted pendulum

m= 3 10^{-3} kg

$|u_o|$ = 3.4 m/s

u_o= [u_o cos α, u_o sin α]





After take-off forces sum to zero

$$\sum F_x = m\frac{\partial v_x}{\partial t} = 0$$

$$\sum F_y = m\frac{\partial v_y}{\partial t} - mg = 0$$

$$x = tu_o Cos[\alpha]$$

$$y = tu_o Sin[\alpha] - \frac{gt^2}{2}$$

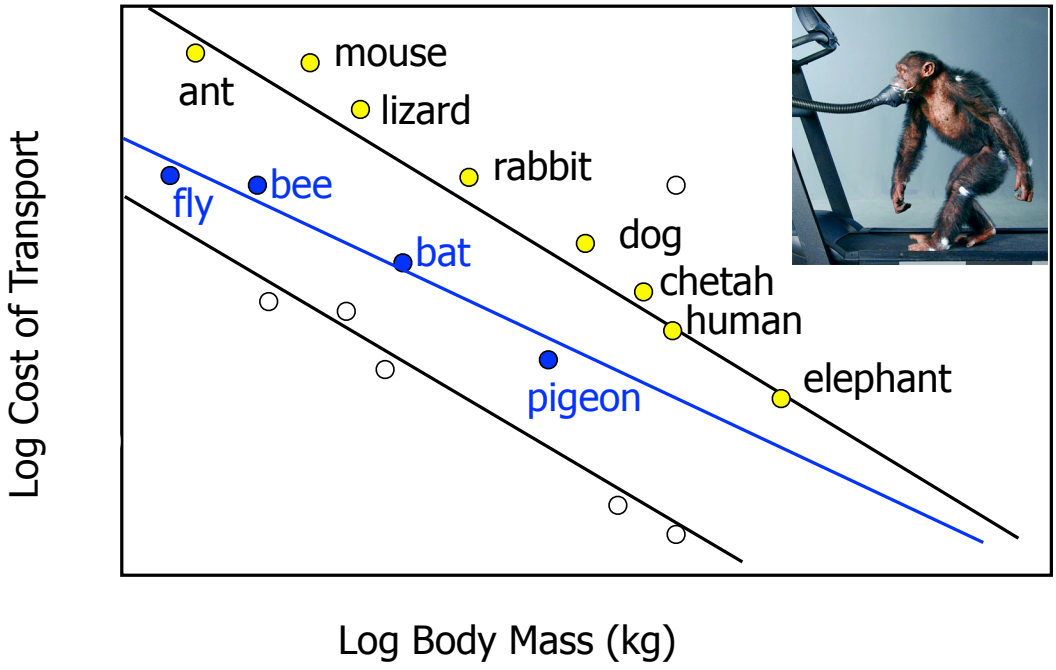
Finding how high?

$$y_{\max} = \frac{(u_o Sin[\alpha])^2}{2g}$$

Finding how far?

$$x_{\max} = 2u_o{}^2 Sin[\alpha]Cos[\alpha]/g$$

Cost (P/WV) of transport declines with body size



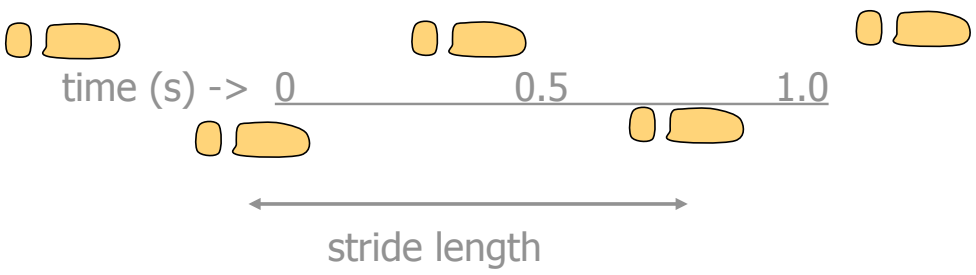
Movement Biomechanics

Patterns in time and space (Kinematics)

Forces (Mechanics)

Stability (Dynamics)

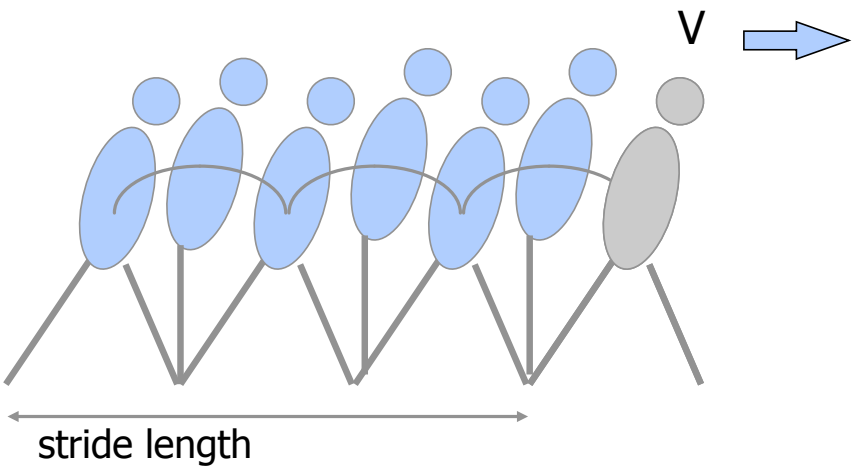
Power (Energetics)



GAITS

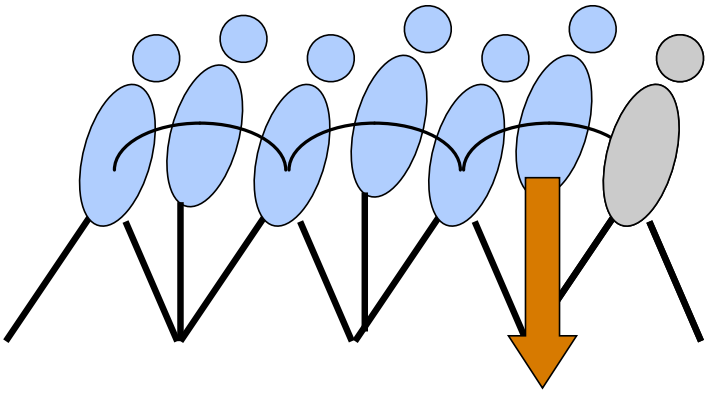
- stride length: distance between footfalls of the same foot
- stride frequency: number of footfalls per time
- duty factor: fraction of stride time that a foot is on the ground (human walking = 0.5 - 0.6, running = 0.35). Gaits with duty factors less than 0.5 imply airborne phases.
- relative phase: time a foot is set down as a fraction of the stride time.

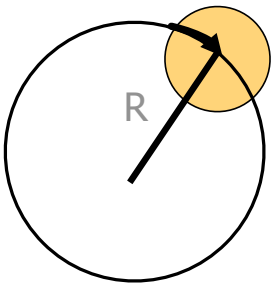
Simple Quantifiers of Movement on Land



stride frequency = number of strides/time
duty factor = fraction of stride time that a foot is on the ground

Simple Quantifiers of Movement on Land



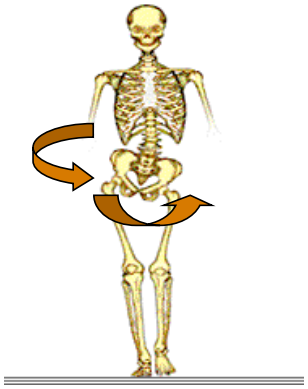


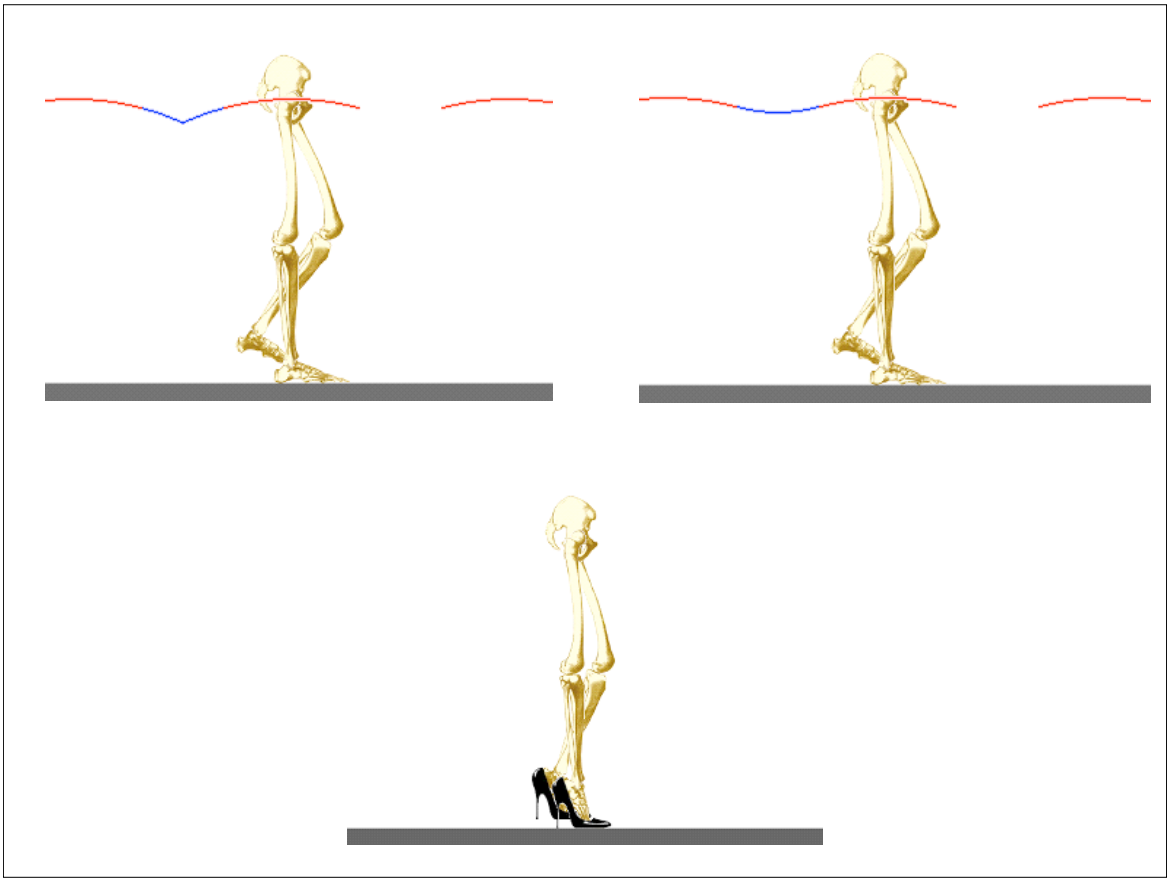
$V^2 = a\ R$

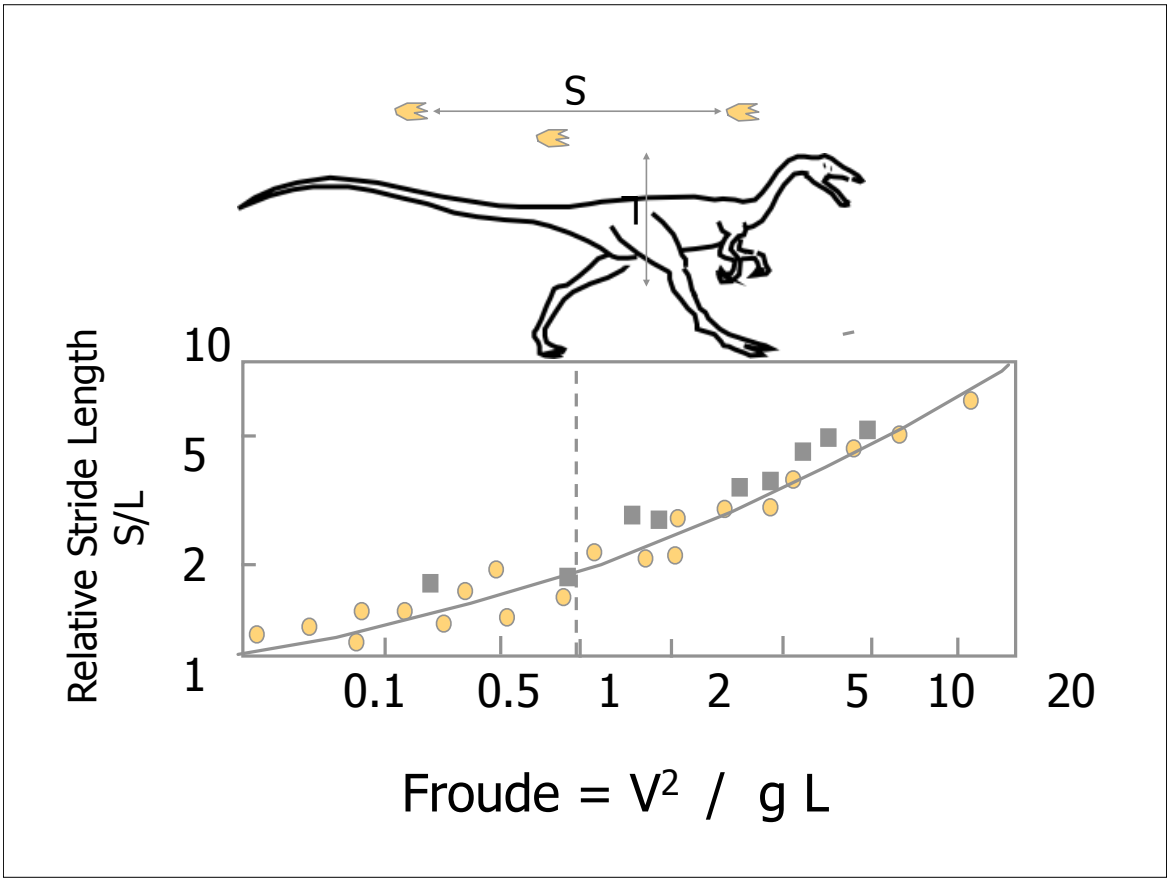
$V^2 < g\ L$

Modifiers of the radius of curvature

Lumbar flexion
Pelvic rotation
Pelvic tilt






S
L
Relative Stride Length
S/L
10
5
2
1
0.1
0.5
1
2
5
10
20
Froude = V2 / g L