

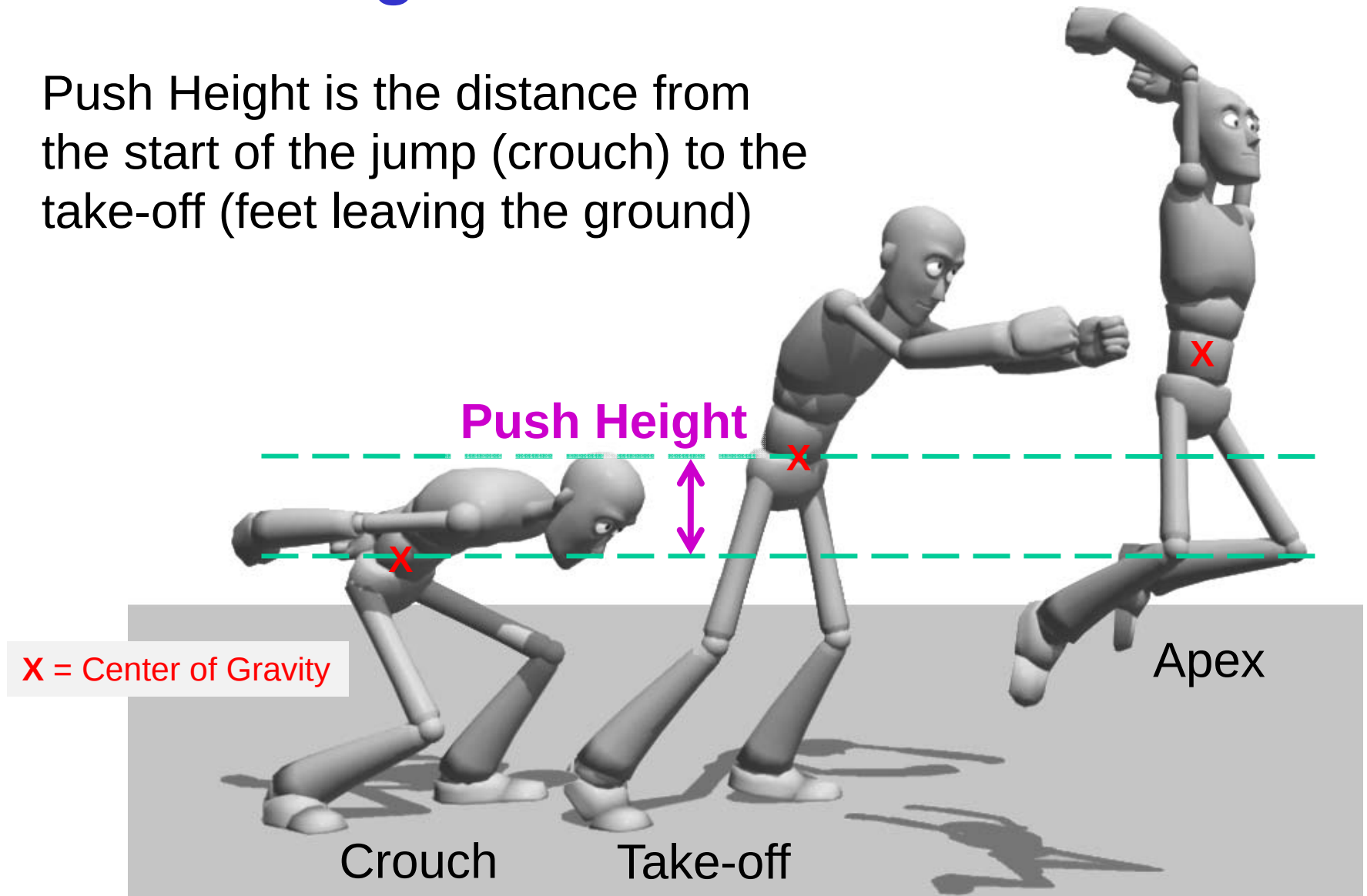
Pushing Off and Jump Magnification



National Science Foundation
WHERE DISCOVERIES BEGIN

Push Height

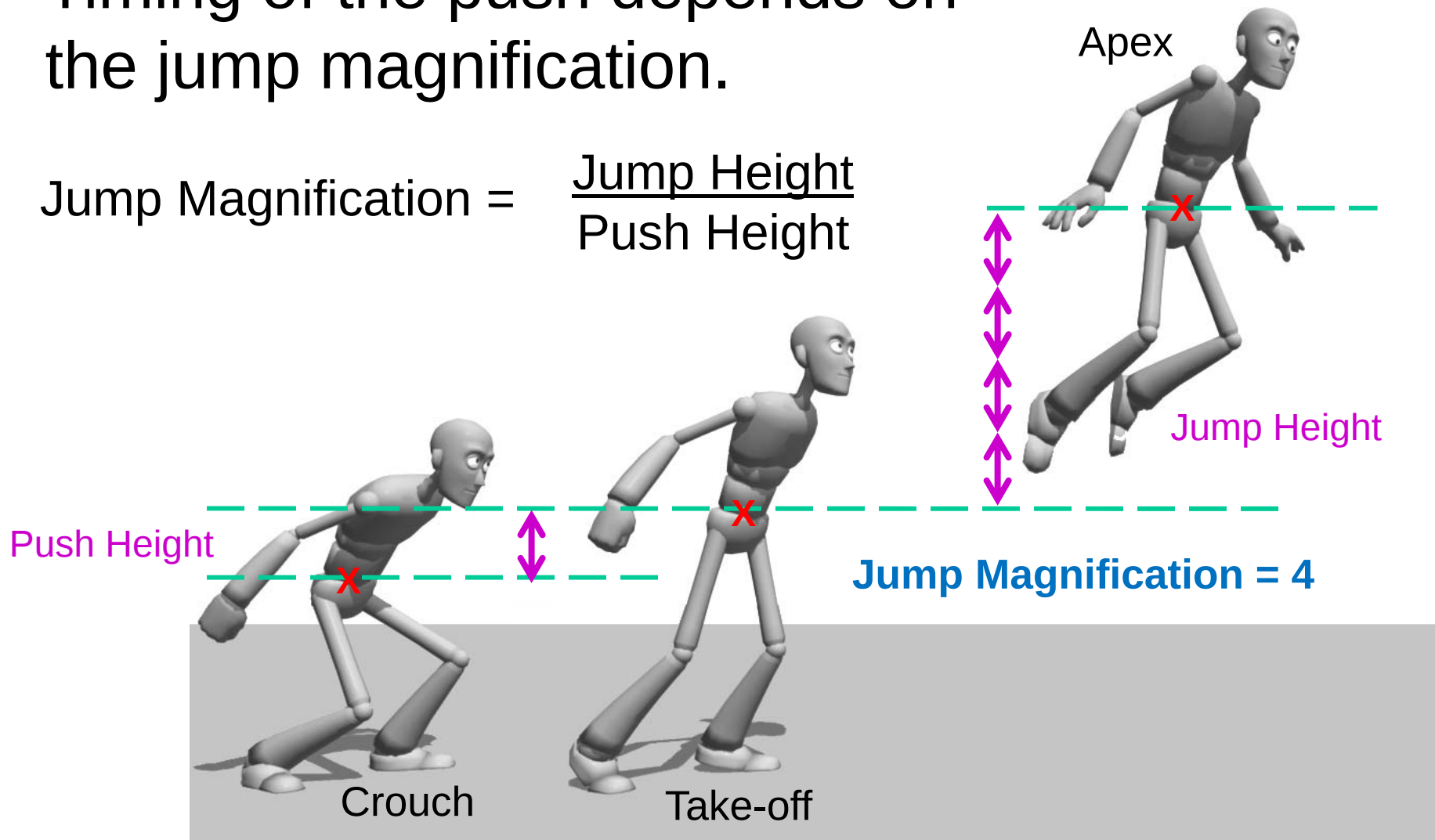
Push Height is the distance from the start of the jump (crouch) to the take-off (feet leaving the ground)



Jump Magnification

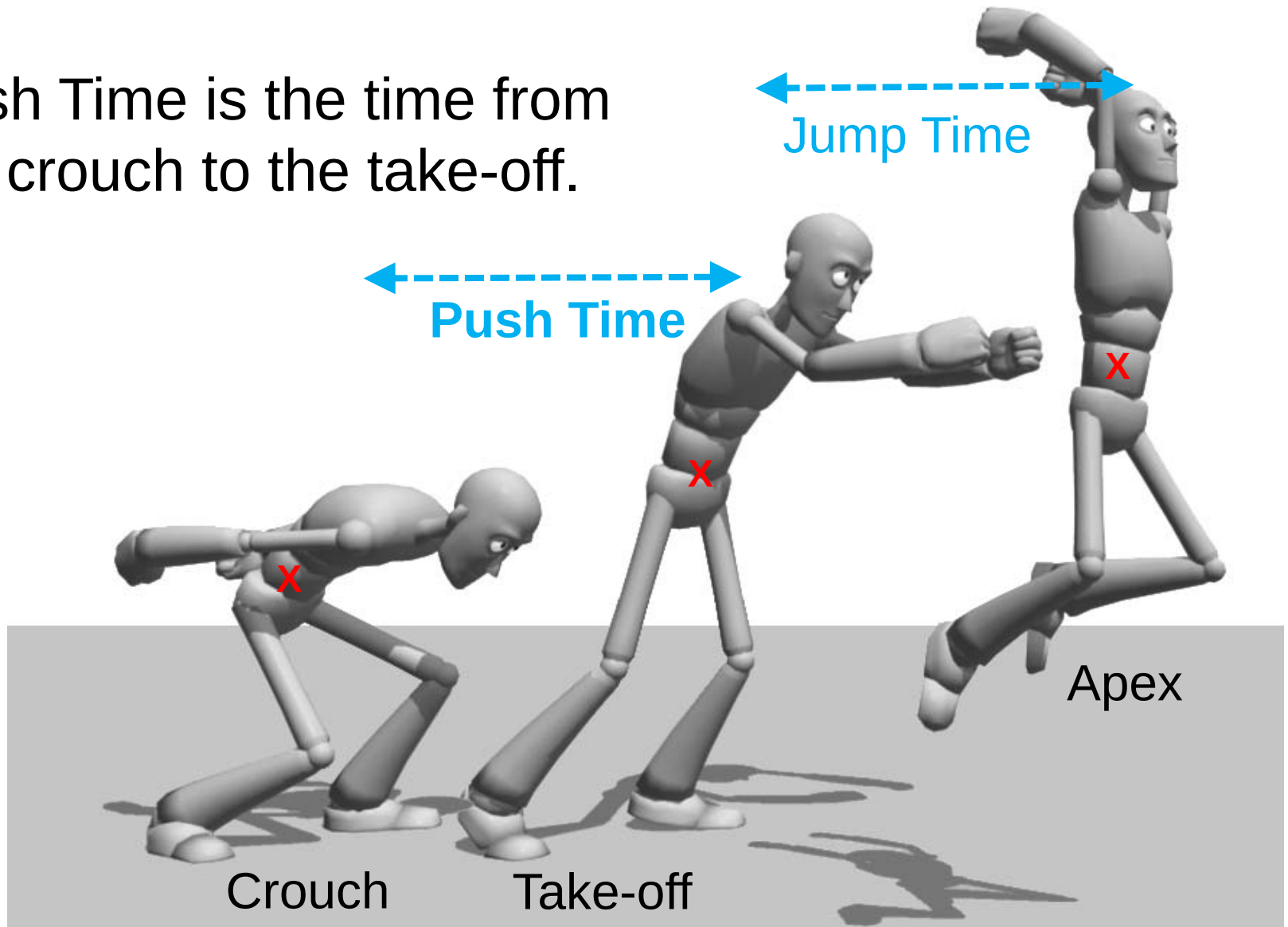
Timing of the push depends on the jump magnification.

$$\text{Jump Magnification} = \frac{\text{Jump Height}}{\text{Push Height}}$$



Push Time

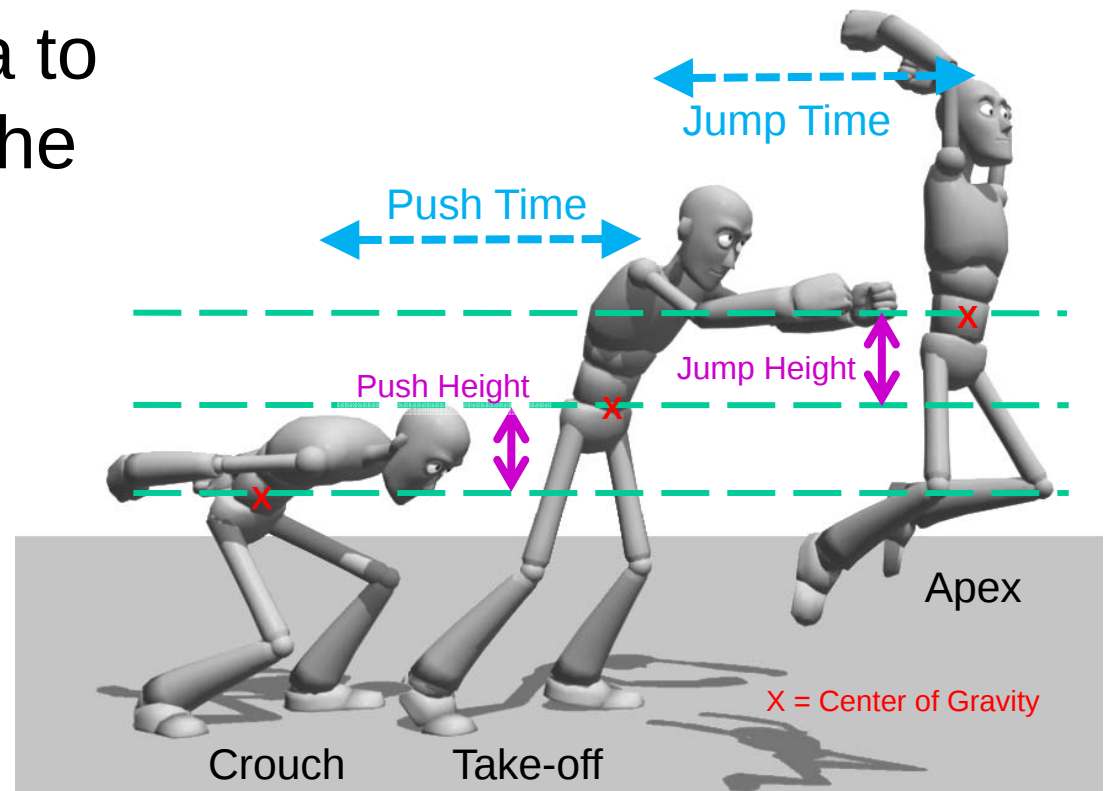
Push Time is the time from the crouch to the take-off.



Formula for Timing the Push

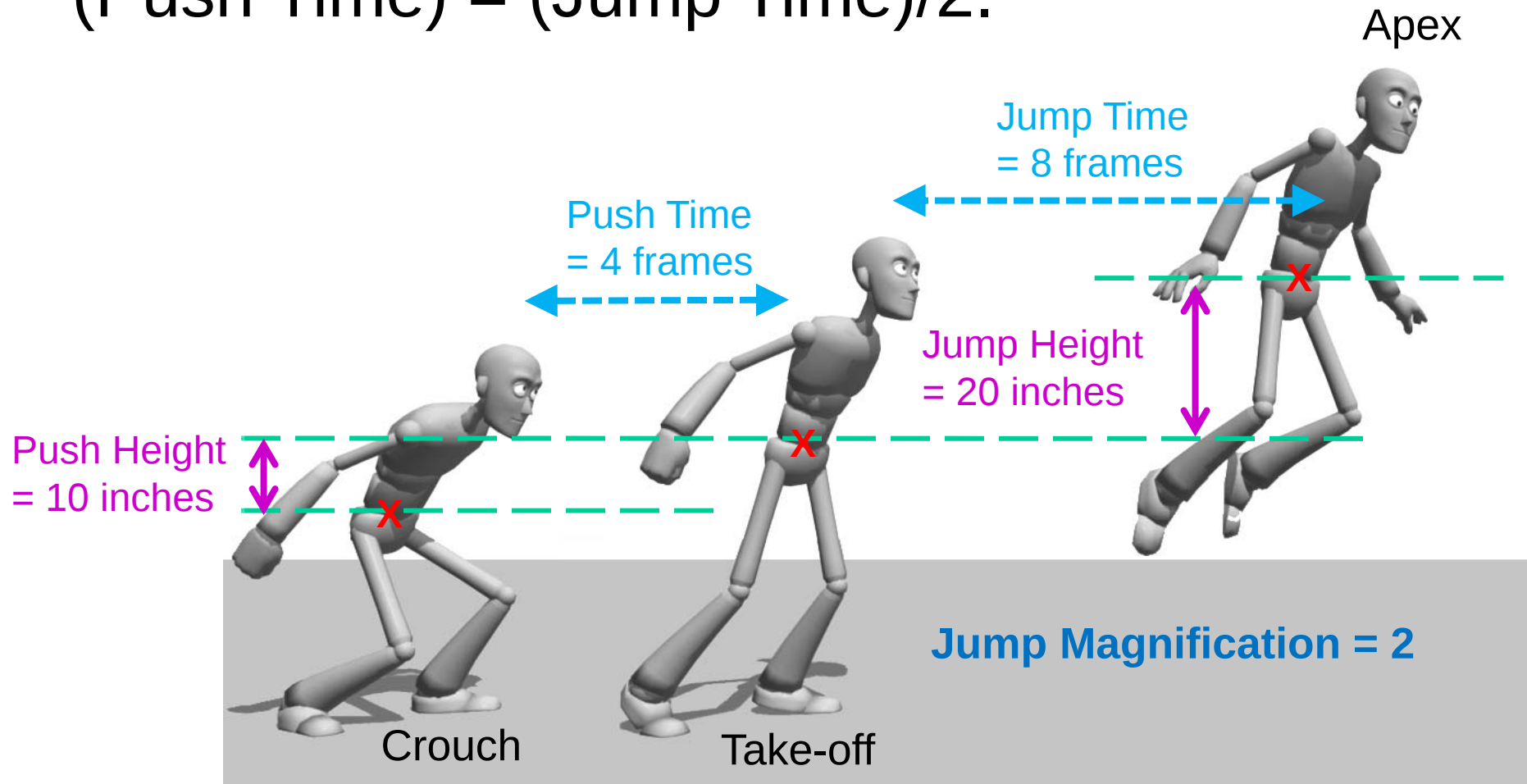
$$\text{Push Time} = \frac{\text{Jump Time}}{\text{Jump Magnification}}$$

Can use this formula to check the timing of the push compared with the jump time.



Push Time Example

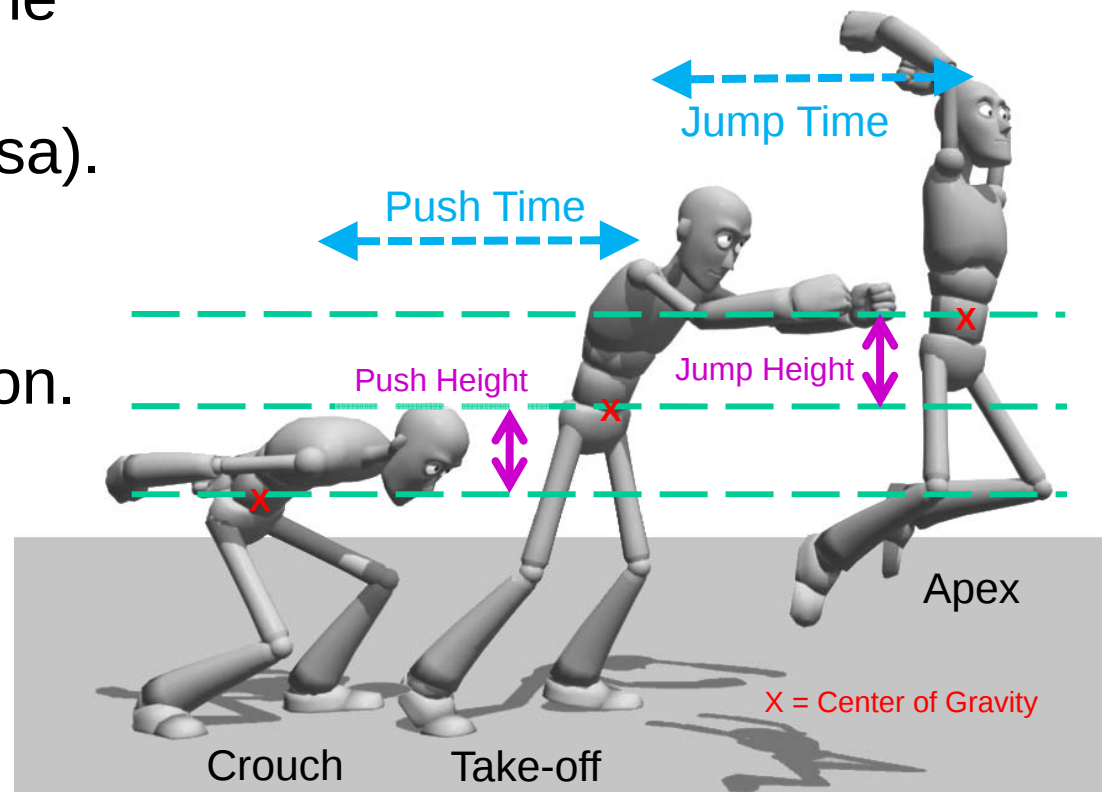
This jump magnification is 2 so
 $(\text{Push Time}) = (\text{Jump Time})/2$.



Planning a Jump

Animators can plan out a realistic jump by these steps:

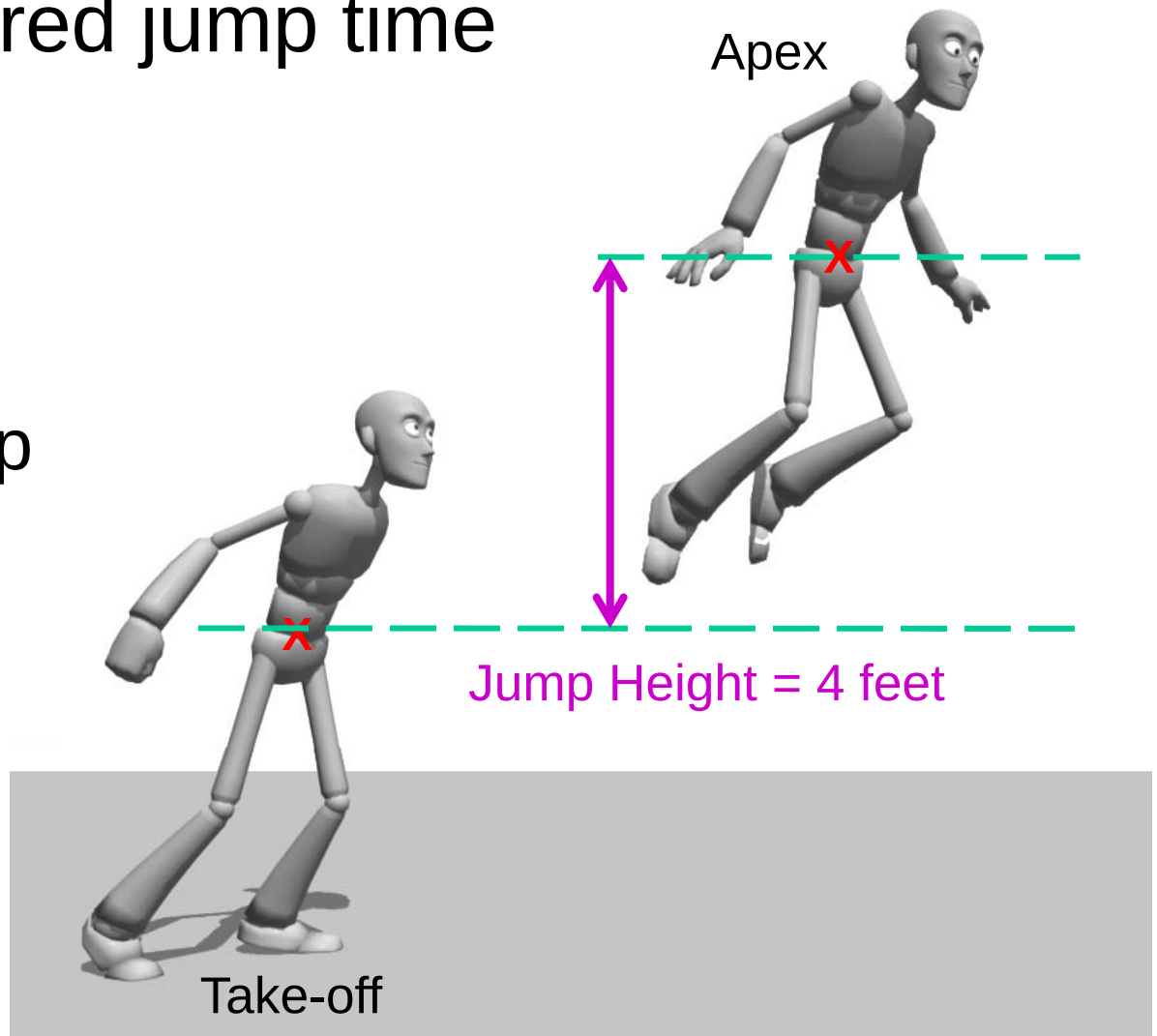
- 1) Pick the desired jump time or jump height.
- 2) Use the table to find the jump height given the jump time (or vice versa).
- 3) Pick the desired push height for the crouch.
- 4) Find jump magnification.
- 5) Determine the push time from the jump magnification.



Planning a Jump (1)

1) Pick the desired jump time or jump height.

In this example
the desired jump
height is 4 feet.



Planning a Jump (2)

2) Use the table to find the jump height given the jump time (or vice versa).

In this example the jump time is 12 frames from take-off to apex.

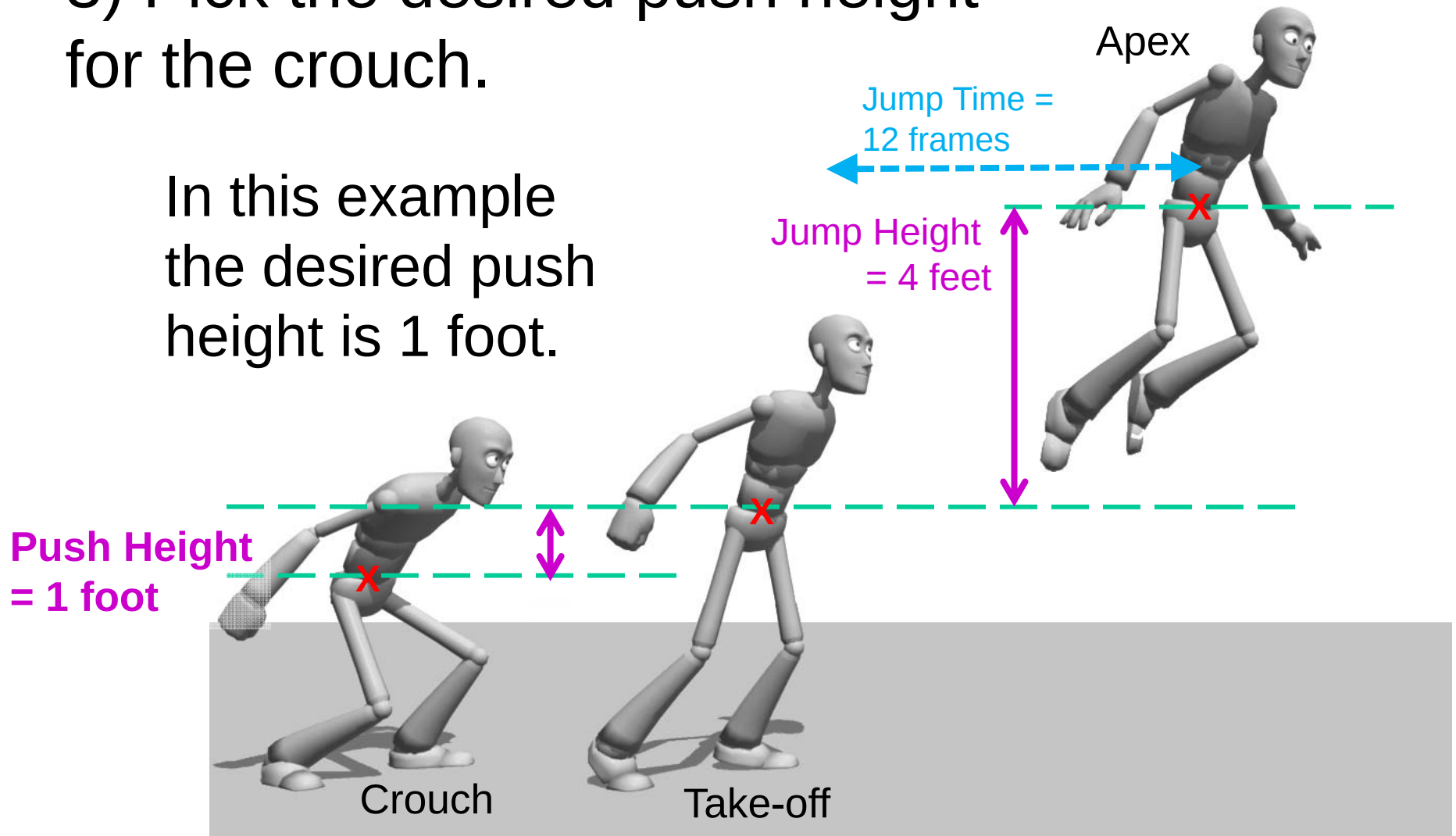


Jump Time (seconds)	Frames	Jump Height
$\frac{1}{24}$	1	$\frac{1}{3}$ inch
$\frac{1}{12}$	2	1 $\frac{1}{3}$ inches
$\frac{1}{8}$	3	3 inches
$\frac{1}{6}$	4	5 $\frac{1}{3}$ inches
$\frac{1}{4}$	6	12 inches
$\frac{1}{3}$	8	21 inches
$\frac{1}{2}$	12	4 feet
$\frac{2}{3}$	16	7 feet
$\frac{3}{4}$	18	9 feet
1	24	16 feet

Planning a Jump (3)

3) Pick the desired push height for the crouch.

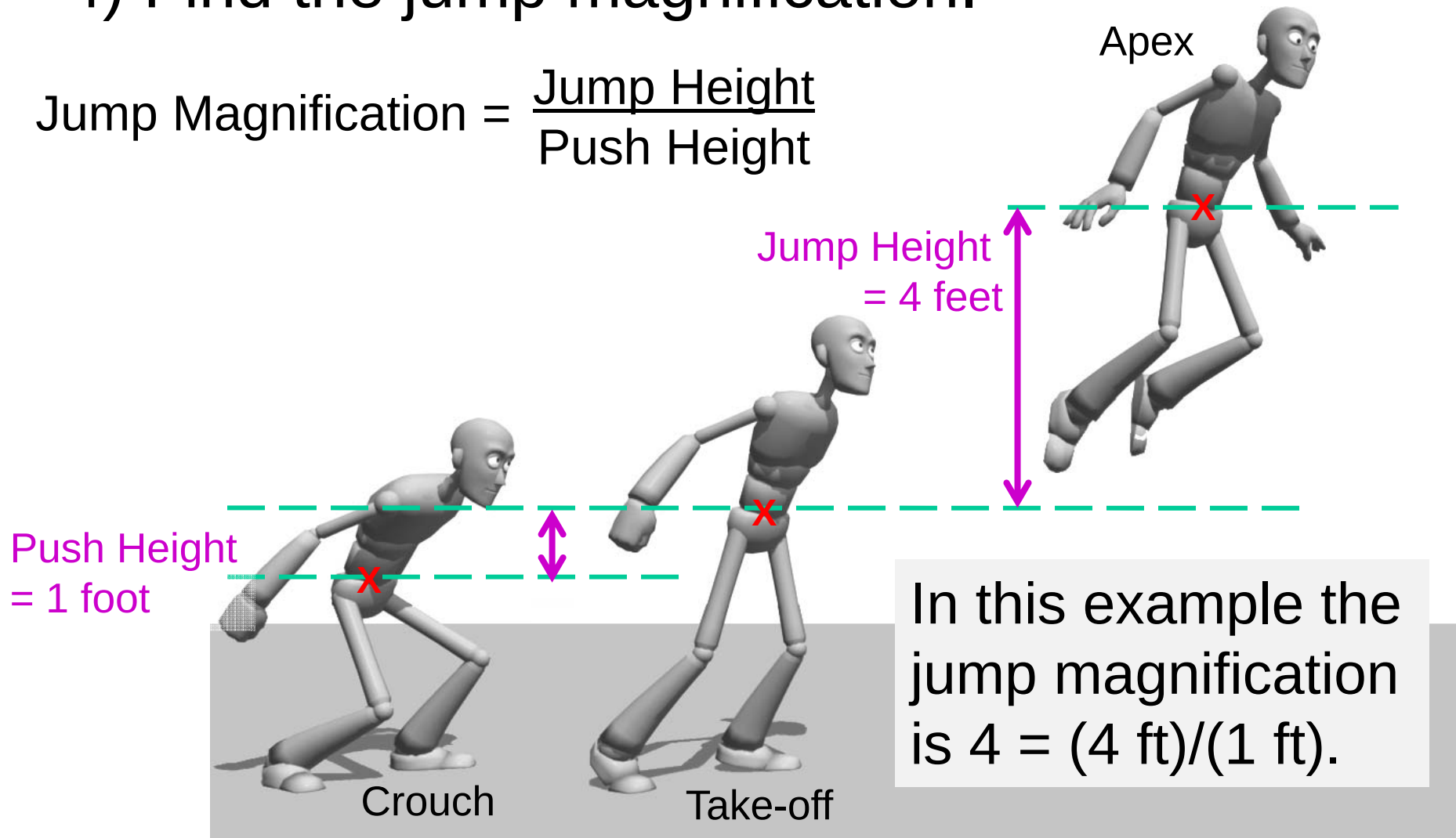
In this example the desired push height is 1 foot.



Planning a Jump (4)

4) Find the jump magnification.

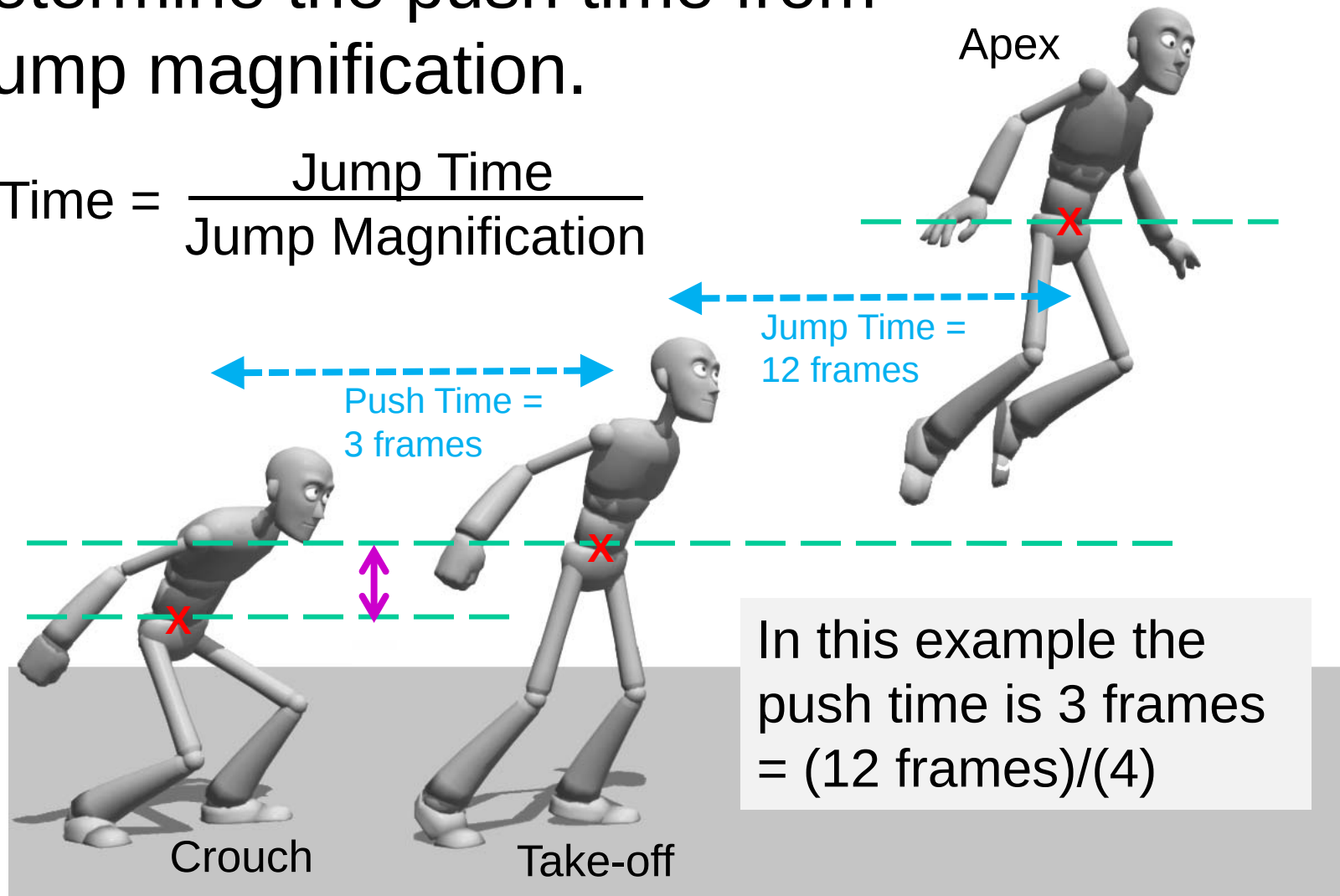
$$\text{Jump Magnification} = \frac{\text{Jump Height}}{\text{Push Height}}$$



Planning a Jump (5)

5) Determine the push time from the jump magnification.

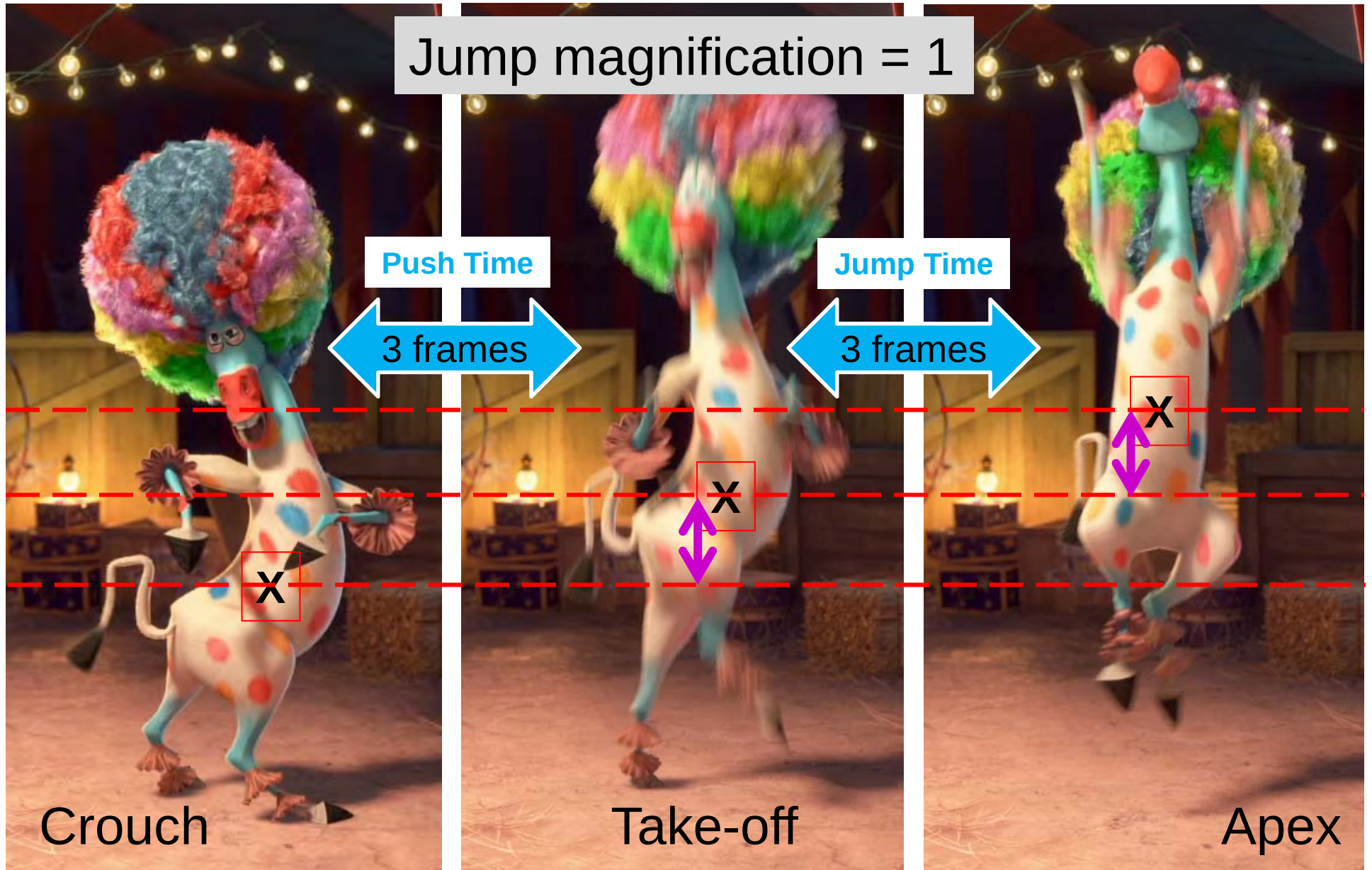
$$\text{Push Time} = \frac{\text{Jump Time}}{\text{Jump Magnification}}$$



Madagascar 3 (2012)

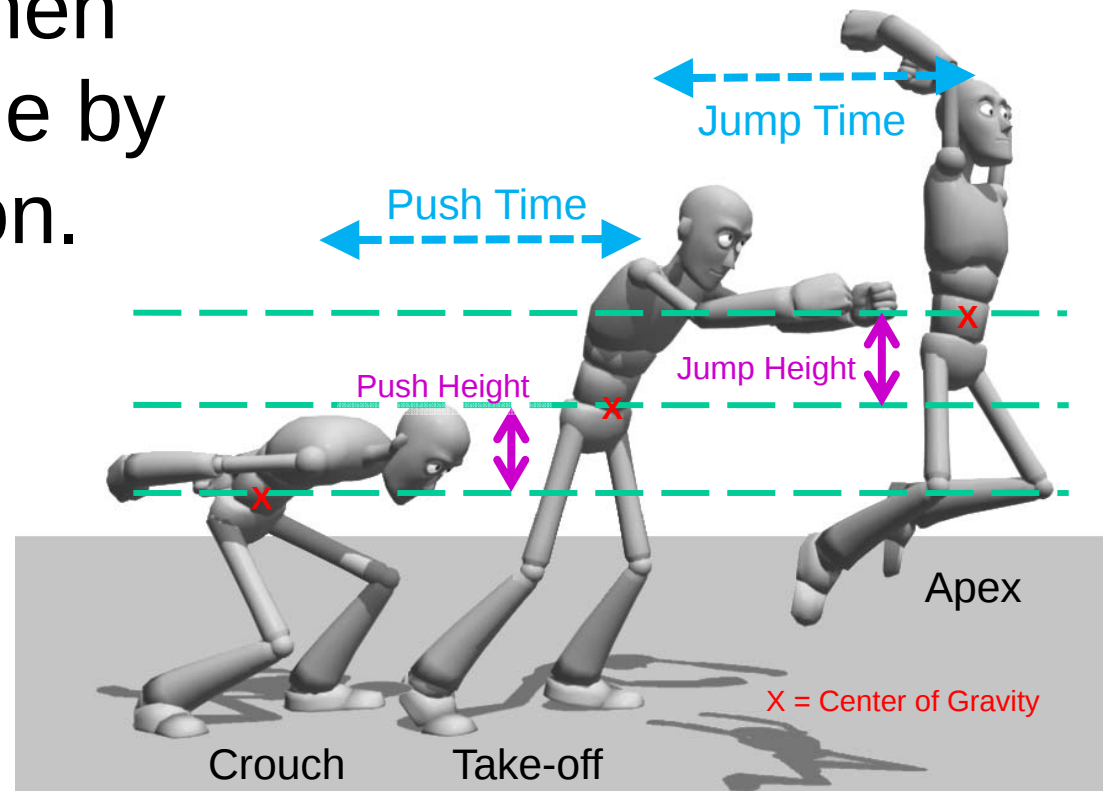


Madagascar 3 (2012)



Consistent Timing for the Push

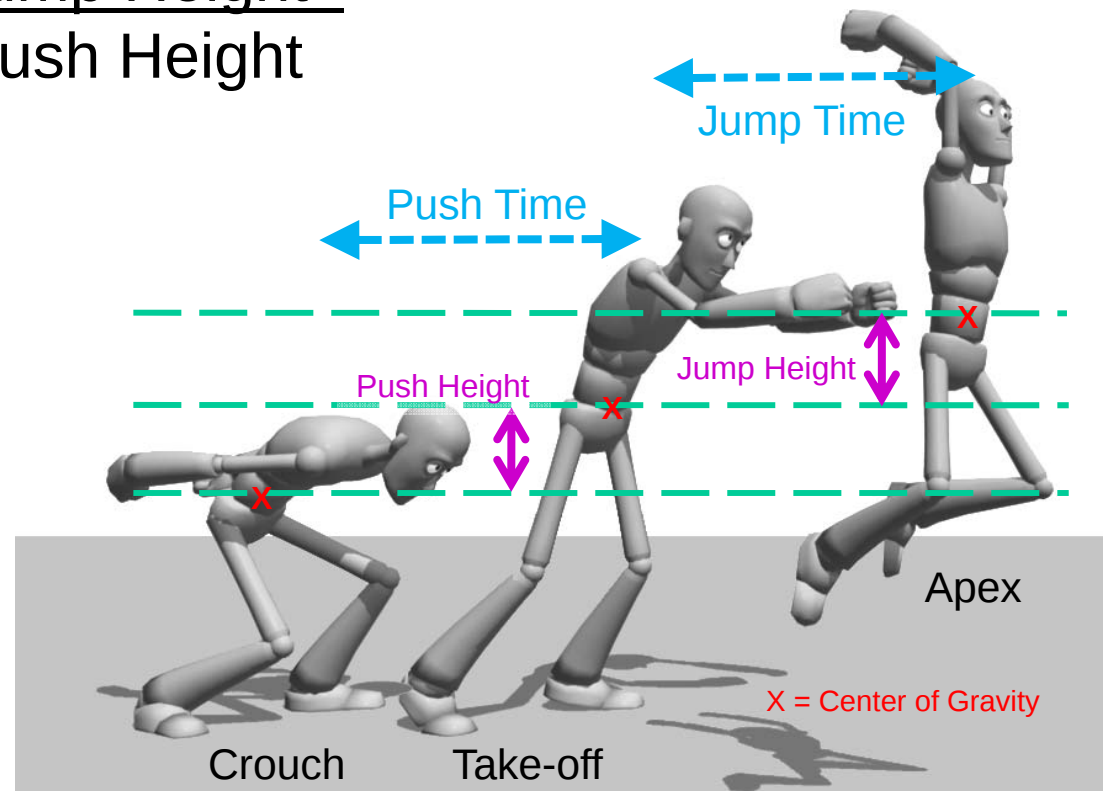
If the jump time is reduced to make the action snappy then cut the push time by the same fraction.



Consistent Ratios

Ratio of times equals ratio of heights.

$$\frac{\text{Jump Time}}{\text{Push Time}} = \frac{\text{Jump Height}}{\text{Push Height}}$$



Summary

- Push Height is the distance the center of gravity rises from crouch to take-off.
- Jump Magnification is the Jump Height divided by the Push Height.
- Push Time (crouch to take-off) is Jump Time divided by the Jump Magnification.
- Can plan out timing for a realistic jump.
- If Jump Time is reduced to make the action snappy then adjust the Push Time as well.
- Ratio of the times equals ratio of the heights