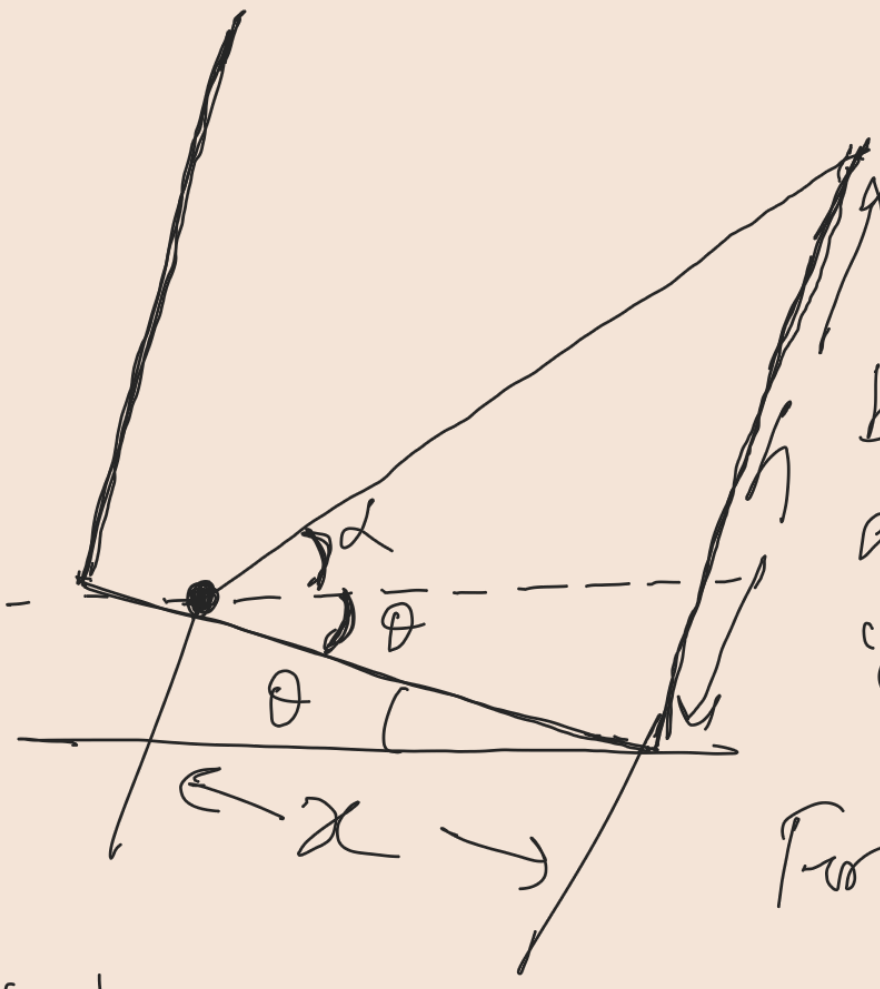


Let us first fix the box incline at particular 'θ'. Now, for a particular 'θ', there must be atleast on point on box floor, from where, with speed 'u' & assuming max range up the incline condition, Grasshopper is able to reach the top of incline. Then,

$$\frac{h}{\sqrt{h^2+x^2}} = \sin(\alpha+\theta) \quad \&$$

$$\frac{u^2}{g(1+\sin\alpha)} = \sqrt{h^2+x^2}.$$

So,

$$\frac{hg(1+\sin\alpha)}{u^2} = \sin(\alpha+\theta).$$

$$\frac{gh(1+\sin\alpha)}{\sin(\alpha+\theta)} = u^2.$$

Now, for a successful jump, the minimum value of the LHS must

be greater than u^2.
Differentiating, we have

$$gh\left[\cos\alpha \sin(\alpha+\theta) - (1+\sin\alpha)\cos(\alpha+\theta)\right] = 0$$

$$\sin(\cancel{\alpha}+\theta-\cancel{\alpha}) = \cos(\alpha+\theta)$$

So, $\frac{\pi}{2} - \theta = \alpha + \theta$

$\alpha = \frac{\pi}{2} - 2\theta$. On

back substituting,

$$\frac{gh(1+\cos 2\theta)}{\cos\theta} = u^2$$

$$2gh\cos\theta = u^2$$

$$\theta = \cos^{-1}\left(\frac{u^2}{2gh}\right)$$



max tilting of box.