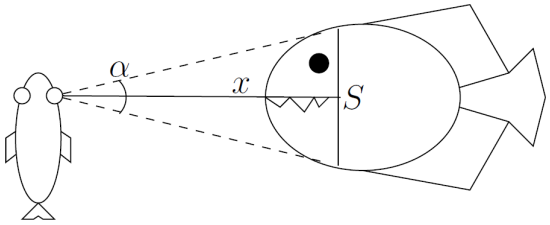
MATH 102:107, CLASS 35 (WED NOV 29)

In this problem, we study the escape response of *Danio rerio* (zebrafish). Zebrafish must react to what they see and decide to flee if a predator is approaching - but it would be a waste of time to react to the slightest movement. Larry Dill, a biologist at Simon Fraser University, hypothesized that zebra danio's escape response is triggered when the *visual angle* subtended by an approaching object changes rapidly enough. That is, when $\frac{d\alpha}{dt} > K_{\text{crit}}$, for some critical threshold K_{crit}.



(1) Suppose that a predator of size S is approaching at constant velocity v (take $v = -\frac{dx}{dt}$, because x is decreasing). When the predator is a distance x away, how quickly is the angle α changing? (First, write down an expression for α in terms of S, x, and familiar functions. Then take the derivative of both sides.)

(2) (Reaction distance) Imagine that S and v are constants. Plot $\frac{d\alpha}{dt}$ as a function of x. At what value of x will the zebrafish react to the approaching predator, i.e. when is $\frac{d\alpha}{dt} = K_{\text{crit}}$? Are there values of S and v for which the zebrafish will *never* react?

(3) (Predator design) Now we imagine that v and x are constants, and consider different-sized predators. Plot $\frac{d\alpha}{dt}$ as a function of S. For what values of S will the zebrafish react? (large S? small S? medium S?)

(4) Which is more likely to scare a zebrafish - a *large* predator, or a *fast* predator?

(5) If you were a predator, what would your strategy be to catch the zebrafish?