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## 0.1 Tan

The  $\tan(\theta)$  function is defined as:

$$\tan(\theta) := \frac{\sin(\theta)}{\cos(\theta)}$$

### 0.1.1 Behaviour around 0

$$\sin(0) = 0$$

$$\cos(0) = 1$$

$$\tan(0) := \frac{\sin(0)}{\cos(0)}$$

$$\tan(0) = \frac{0}{1}$$

$$\tan(0) = 0$$

### 0.1.2 Behaviour around $\cos(\theta) = 0$

$$\tan(\theta) = \frac{\sin(\theta)}{\cos(\theta)}$$

So  $\tan(\theta)$  is undefined where  $\cos(\theta) = 0$ .

This happens where:

$$\theta = \frac{\pi}{4} + \frac{1}{2}n\pi$$

$$\theta = \frac{1}{4}\pi(1 + 2n)$$

Where  $n \in \mathbb{Z}$ .

### 0.1.3 Derivatives

$$\tan(\theta) = \frac{\sin(\theta)}{\cos(\theta)}$$

$$\frac{\delta}{\delta\theta} \tan(\theta) = \frac{\delta}{\delta\theta} \frac{\sin(\theta)}{\cos(\theta)}$$

$$\frac{\delta}{\delta\theta} \tan(\theta) = \frac{\cos(\theta)}{\cos(\theta)} + \frac{\sin^2(\theta)}{\cos^n(\theta)}$$

$$\frac{\delta}{\delta\theta} \tan(\theta) = 1 + \tan^2(\theta)$$

Note this is always positive. This means:

$$\lim_{\cos(\theta) \rightarrow 0^+} = -\infty$$

$$\lim_{\cos(\theta) \rightarrow 0^-} = \infty$$