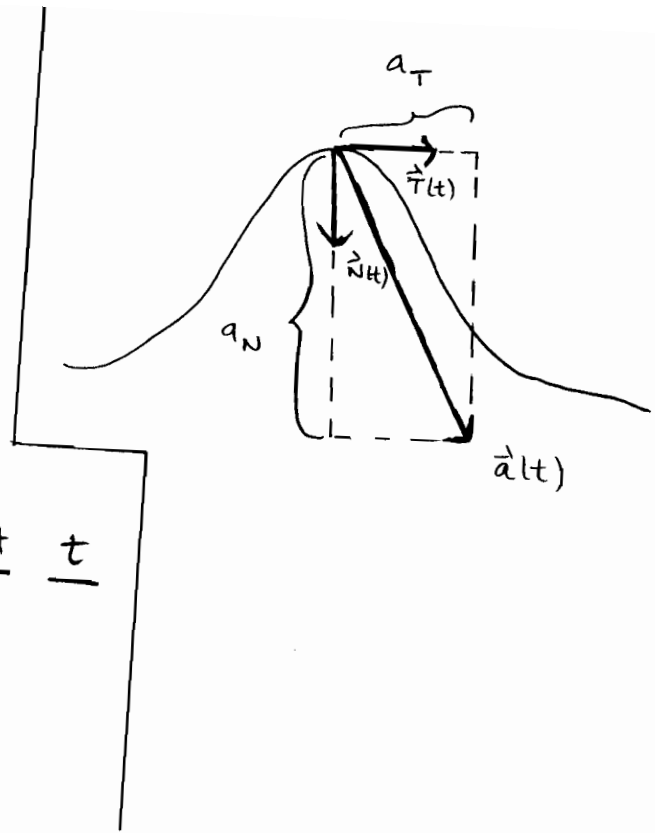


Unit Tangent vector $\vec{T}(t)$ at t

$$\vec{T}(t) = \frac{\vec{r}'(t)}{\|\vec{r}'(t)\|}$$

Principal Unit Normal vector $\vec{N}(t)$ at t

$$\vec{N}(t) = \frac{\vec{T}'(t)}{\|\vec{T}'(t)\|}$$



Tangential and Normal components of Acceleration

Tangential component

$$a_T(t) = \vec{a}(t) \cdot \vec{T}(t) = \frac{\vec{v}(t) \cdot \vec{a}(t)}{\|\vec{v}(t)\|} = \frac{d}{dt} [\|\vec{v}(t)\|]$$

Normal component

$$a_N(t) = \vec{a}(t) \cdot \vec{N}(t) = \frac{\|\vec{v}(t) \times \vec{a}(t)\|}{\|\vec{v}(t)\|} = \sqrt{\|\vec{a}(t)\|^2 - (a_T(t))^2}$$

$$\vec{a}(t) = a_T(t) \vec{T}(t) + a_N(t) \vec{N}(t)$$

Arc Length

$$s = \int_a^b \|\vec{r}'(t)\| dt$$

maybe easier to remember
↓

Curvature at t

$$K(t) = \frac{\|\vec{T}'(t)\|}{\|\vec{r}'(t)\|} = \frac{\|\vec{r}'(t) \times \vec{r}''(t)\|}{\|\vec{r}'(t)\|^3} = \frac{\|\vec{v}(t) \times \vec{a}(t)\|}{\|\vec{v}(t)\|^3}$$