Derivation of tangent to a circle from a point outside the circle.

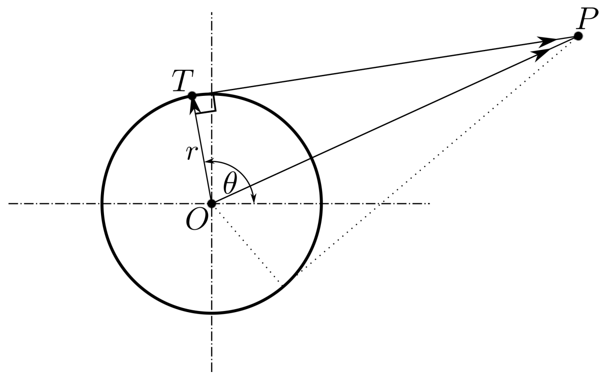

Figure 1: Tangent to a circle

$\left(\vec{P}-\vec{T}\right)\cdot\left(\vec{T}-\vec{O}\right)=0 \qquad \Longleftarrow$ Orthogonal vectors

$\left(\begin{bmatrix} x_P \\ y_P \end{bmatrix}-\begin{bmatrix} x_T \\ y_T \end{bmatrix}\right)\cdot\left(\begin{bmatrix} x_T \\ y_T \end{bmatrix}-\begin{bmatrix} x_O \\ y_O \end{bmatrix}\right)=0$

$\left(\begin{bmatrix} x_P \\ y_P \end{bmatrix}-\begin{bmatrix} x_O + r\cos(\theta) \\ y_O + r\sin(\theta) \end{bmatrix}\right)\cdot\left(\begin{bmatrix} r\cos(\theta) \\ r\sin(\theta) \end{bmatrix}\right)=0$

$\begin{bmatrix} x_P - x_O - r\cos(\theta) \\ y_P - y_O - r\sin(\theta) \end{bmatrix}\cdot\begin{bmatrix} r\cos(\theta) \\ r\sin(\theta) \end{bmatrix}=0$

$(x_P - x_O - r\cos(\theta))\, r\cos(\theta) + (y_P - y_O - r\sin(\theta))\, r\sin(\theta) = 0$

The above equation is solved by using Newton-Raphson method to obtain the two solutions.