1 Defining the polyline

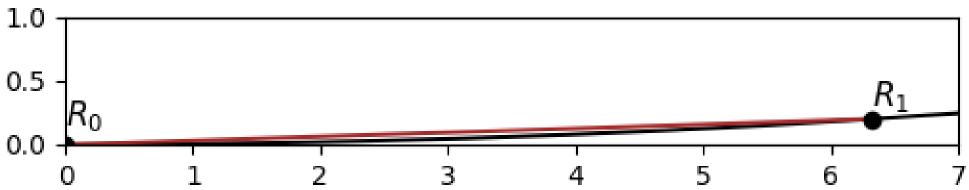
For this example we use a simple OpenDRIVE map consisting of a single road whose geometry is an arc starting at the origin and with radius 100 meter (i.e. curvature 0.01). In OpenDRIVE this would look like the following:

<geometry s=”0” x=”0” y=”0” hdg=”0” length=”100”>
<arc curvature=”0.01”/>
</geometry>

For OSI this arc has to be converted into a polyline. Naturally the first point R_0 of the reference line is the Origin $(0,0)$. The center of the circle is the point $M = (0,100)$. Since the maximum lateral devation in OSI from the OpenDRIVE reference line should be 0.05m, the angle of the next arc segment can be at most

$$\alpha = 2 \cdot \arccos(\frac{100-0.05}{100}) \approx 0.063248 \approx 3,6239^\circ$$

We use this angle to get the second point R_1 of the polyline with x-coordinate $100 \cdot \sin(\alpha) \approx 0.19995$ and y-coordinate $100 \cdot (1-\cos(\alpha)) \approx 6.3206$. This defines the first line segment s from R_0 to R_1. The s-coordinate of this point (i.e. the arc length) is $100 \cdot \alpha \approx 6.3248$. Note that this is slightly larger than the length of the polyline segment s, which is $\sqrt{(0.19995)^2 + (6.3206)^2} \approx 6.3238$.



2 Calculation using nearest point

Assume we want to calculate the s/t-coordinates of the point $P = (6,2)$ relative to the above defined reference line. If the type of the reference line is TYPE POLYLINE, we first need to calculate the nearest point P_1 on the polyline, which in this case is the orthogonal projection of P onto the segment s. P_1 is equal to

$$\lambda \cdot \begin{pmatrix} 6.3206 \\ 0.19995 \end{pmatrix}$$

for some λ, since it is on s and equal to

$$\begin{pmatrix} 6 \\ 2 \end{pmatrix} + \kappa \cdot \begin{pmatrix} -\sin(\frac{\alpha}{2}) \\ \cos(\frac{\alpha}{2}) \end{pmatrix}$$

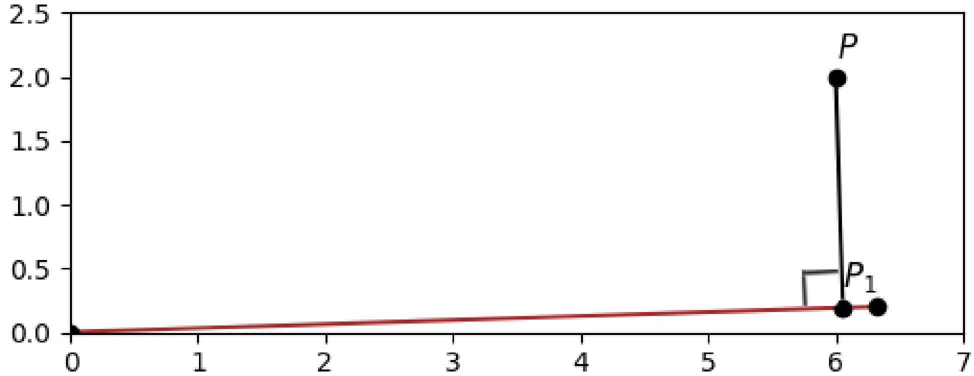
for some κ, because it is on the line through P orthogonal to s (and s has yaw $\frac{\alpha}{2}$). This gives the linear equation system

$$\lambda \cdot \begin{pmatrix} 6.3206 \\ 0.19995 \end{pmatrix} = \begin{pmatrix} 6 \\ 2 \end{pmatrix} + \kappa \cdot \begin{pmatrix} -\sin(\frac{\alpha}{2}) \\ \cos(\frac{\alpha}{2}) \end{pmatrix} \Leftrightarrow \begin{pmatrix} 6.3206 & \sin(\frac{\alpha}{2}) \\ 0.19995 & -\cos(\frac{\alpha}{2}) \end{pmatrix} \begin{pmatrix} \lambda \\ \kappa \end{pmatrix} = \begin{pmatrix} 6 \\ 2 \end{pmatrix}$$

Solving this yields $\lambda \approx 0.95833, \kappa \approx -1.8093$. So

$$P_1 = 0.95833 \cdot \begin{pmatrix} 6.3206 \\ 0.19995 \end{pmatrix} = \begin{pmatrix} 6.0572 \\ 0.19162 \end{pmatrix}$$

The s-coordinate of P_1 and therefore of P is $\sqrt{6.0572^2 + 0.19162^2} \cdot \frac{6.3248}{6.3238} \approx 6.0612$. The t-coordinate of P is $|P - P_1| = \sqrt{(6 - 6.0572)^2 + (2 - 0.19162)^2} \approx 1.8093$.



3 Calculation using t-axis

Now we want to calculate the s/t-coordinates of $P = (6, 2)$ for TYPE POLYLINE WITH T-AXIS. For this we first have to define a t-axis for every polyline point. Since our data source is OpenDRIVE, we use the t-axis definition from OpenDRIVE, i.e. perpendicular to the OpenDRIVE reference line. As the reference line is an arc, the t-axis in every point is the radius of the arc through this point. The t-axis at R_0 therefore is the y-axis, i.e. the t-axis yaw is $\frac{\pi}{2}$. The t-axis at R_1 has yaw of $\frac{\alpha}{2} + \frac{\pi}{2}$. The intersection point of the two t-axes is the center point M.

Using this the projection point P_2 on the polyline is the intersection of the line through M and P with the segment s. This gives the linear equation system

$$\lambda \cdot \begin{pmatrix} 6.3206 \\ 0.19995 \end{pmatrix} = \begin{pmatrix} 6 \\ 2 \end{pmatrix} + \kappa \cdot \begin{pmatrix} 0 - 6 \\ 100 - 2 \end{pmatrix} \Leftrightarrow \begin{pmatrix} 6.3206 & 6 \\ 0.19995 & -98 \end{pmatrix} \begin{pmatrix} \lambda \\ \kappa \end{pmatrix} = \begin{pmatrix} 6 \\ 2 \end{pmatrix}$$

with the solution $\lambda \approx 0.96678, \kappa \approx -0.018436$. So

$$P_2 = 0.96678 \cdot \begin{pmatrix} 6.3206 \\ 0.19995 \end{pmatrix} \approx \begin{pmatrix} 6.1106 \\ 0.19331 \end{pmatrix}$$

Now we get the s-coordinate $\sqrt{6.1106^2 + 0.19331^2} \cdot \frac{6.3248}{6.3238} \approx 6.1146$ and t-coordinate $|P - P_2| = \sqrt{(6 - 6.1106)^2 + (2 - 0.19331)^2} \approx 1.8101$.