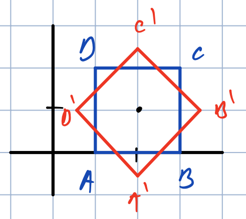
Rotation matrix: $\begin{pmatrix}\cos(\alpha) & -\sin(\alpha) & 0\\ \sin(\alpha) & \cos(\alpha) & 0\\ 0 & 0 & 1\end{pmatrix}$

Way to go: $T\cdot R\cdot T^{-1}$ → move to $(0,0,0)$, turn, move back

1

center $=(2,1,1)^T$

$|edge| = 2$



$A=(1,0,1)^T$
$B=(3,0,1)^T$
$C=(3,2,1)^T$
$D=(1,2,1)^T$

$$\circledast \quad \begin{array}{cccc} A & B & C & D \end{array}$$
$$\begin{pmatrix} 1 & 3 & 3 & 1\\ 0 & 0 & 2 & 2\\ 1 & 1 & 1 & 1\end{pmatrix}$$

$$T=\begin{pmatrix}1 & 0 & -2\\ 0 & 1 & -1\\ 0 & 0 & 1\end{pmatrix}$$

$$T^{-1}=\begin{pmatrix}1 & 0 & 2\\ 0 & 1 & 1\\ 0 & 0 & 1\end{pmatrix}$$

$$\begin{array}{cccc} A' & B' & C' & D' \end{array}$$
$$\begin{pmatrix} 2 & \sqrt{2}+2 & 2 & -\sqrt{2}+2\\ -\sqrt{2}+1 & 1 & \sqrt{2}+1 & 1\\ 1 & 1 & 1 & 1\end{pmatrix}$$

$$M\cdot\circledast = (A'^T\ B'^T\ C'^T\ D'^T)$$

$$M = T^{-1}\cdot R\cdot T$$

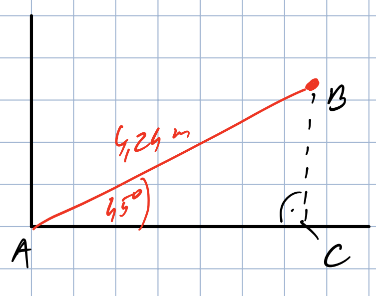
moving the plane, not the object

$$R=\begin{pmatrix}\cos(45^\circ) & -\sin(45^\circ) & 0\\ \sin(45^\circ) & \cos(45^\circ) & 0\\ 0 & 0 & 1\end{pmatrix}$$

$$T^{-1}\cdot R=\begin{pmatrix}1 & 0 & 2\\ 0 & 1 & 1\\ 0 & 0 & 1\end{pmatrix}\cdot\begin{pmatrix}\cos\frac{\pi}{4} & -\sin\frac{\pi}{4} & 0\\ \sin\frac{\pi}{4} & \cos\frac{\pi}{4} & 0\\ 0 & 0 & 1\end{pmatrix}=\begin{pmatrix}\cos\frac{\pi}{4} & -\sin\frac{\pi}{4} & 2\\ \sin\frac{\pi}{4} & \cos\frac{\pi}{4} & 1\\ 0 & 0 & 1\end{pmatrix}$$

$$R\cdot T=\begin{pmatrix}\cos\frac{\pi}{4} & -\sin\frac{\pi}{4} & 2\\ \sin\frac{\pi}{4} & \cos\frac{\pi}{4} & 1\\ 0 & 0 & 1\end{pmatrix}\cdot\begin{pmatrix}1 & 0 & -2\\ 0 & 1 & -1\\ 0 & 0 & 1\end{pmatrix}=\begin{pmatrix}\cos\frac{\pi}{4} & -\sin\frac{\pi}{4} & -2\cos\frac{\pi}{4}+\sin\frac{\pi}{4}+2\\ \sin\frac{\pi}{4} & \cos\frac{\pi}{4} & -2\sin\frac{\pi}{4}-\cos\frac{\pi}{4}+1\\ 0 & 0 & 1\end{pmatrix}=M$$

2



$A=[0,0]$

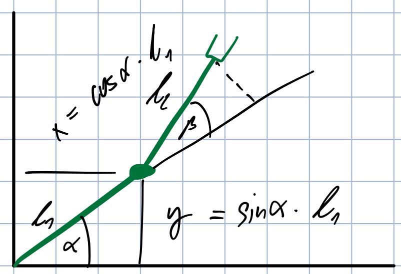
$B=[x,y]$

$$\sin 45^\circ=\frac{|BC|}{|AB|}=y \qquad y=\sin 45^\circ\cdot 4{,}24 \doteq 2{,}998$$

$$\cos 45^\circ=\frac{|AC|}{|AB|}=x \qquad x=\cos 45^\circ\cdot 4{,}24 \doteq 2{,}998$$

3

Transformation matrix for 2D RR manipulator:



$$\theta_1 = \alpha \,,\quad \theta_2 = \beta$$ --> pro lepší zápis

T = „MoveArmJointToOrigin" · „RotateTheJoint" · „MoveItBack" · „RotateAroundOrigin"

$$R \qquad B \quad \cdot \quad R^{-1} \qquad A$$

$$T = \begin{pmatrix} 1 & 0 & \cos\alpha \cdot l_1 \\ 0 & 1 & \sin\alpha \cdot l_1 \\ 0 & 0 & 1 \end{pmatrix} \cdot \begin{pmatrix} \cos(\alpha+\beta) & -\sin(\alpha+\beta) & \cos(\alpha+\beta) \cdot l_2 \\ \sin(\alpha+\beta) & \cos(\alpha+\beta) & \sin(\alpha+\beta) \cdot l_2 \\ 0 & 0 & 1 \end{pmatrix} \cdot \begin{pmatrix} 1 & 0 & -\cos\alpha \cdot l_1 \\ 0 & 1 & -\sin\alpha \cdot l_1 \\ 0 & 0 & 1 \end{pmatrix} \cdot \begin{pmatrix} \cos(\alpha) & -\sin(\alpha) & \cos\alpha \cdot l_1 \\ \sin(\alpha) & \cos(\alpha) & \sin\alpha \cdot l_1 \\ 0 & 0 & 1 \end{pmatrix}$$

$$\vdots$$

$$T = \begin{pmatrix} \cos(\alpha)\cos(\alpha+\beta) - \sin(\alpha)\cdot\sin(\alpha+\beta) & -\sin(\alpha)\cos(\alpha+\beta) - \cos(\alpha)\cdot\sin(\alpha+\beta) & l_1\cdot\cos(\alpha) + l_2\cdot\cos(\alpha+\beta) \\ \cos(\alpha)\sin(\alpha+\beta) + \sin(\alpha)\cdot\cos(\alpha+\beta) & \cos(\alpha)\cos(\alpha+\beta) - \sin(\alpha)\sin(\alpha+\beta) & l_1\cdot\sin(\alpha) + l_2\cdot\sin(\alpha+\beta) \\ 0 & 0 & 1 \end{pmatrix}$$