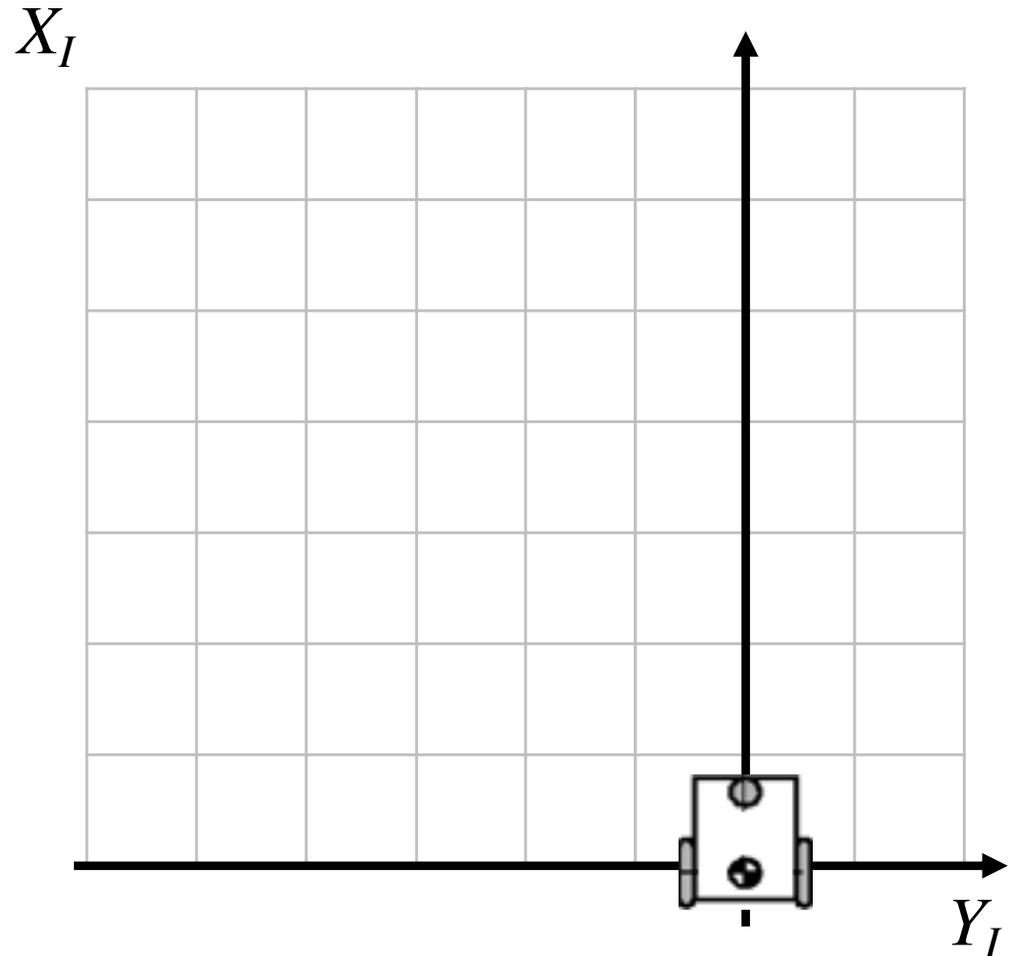


# Rotation matrices, quiz

$\theta$

$\xi_I =$

- Moves forward 2 meters.
- Turns 90 degrees to the right.
- Walks backwards 5 meters.
- Turns 45 degrees to the left.
- Walks forward  $1.4142 (\sqrt{2})$  meters.
- Rotates 53 degrees to the right.

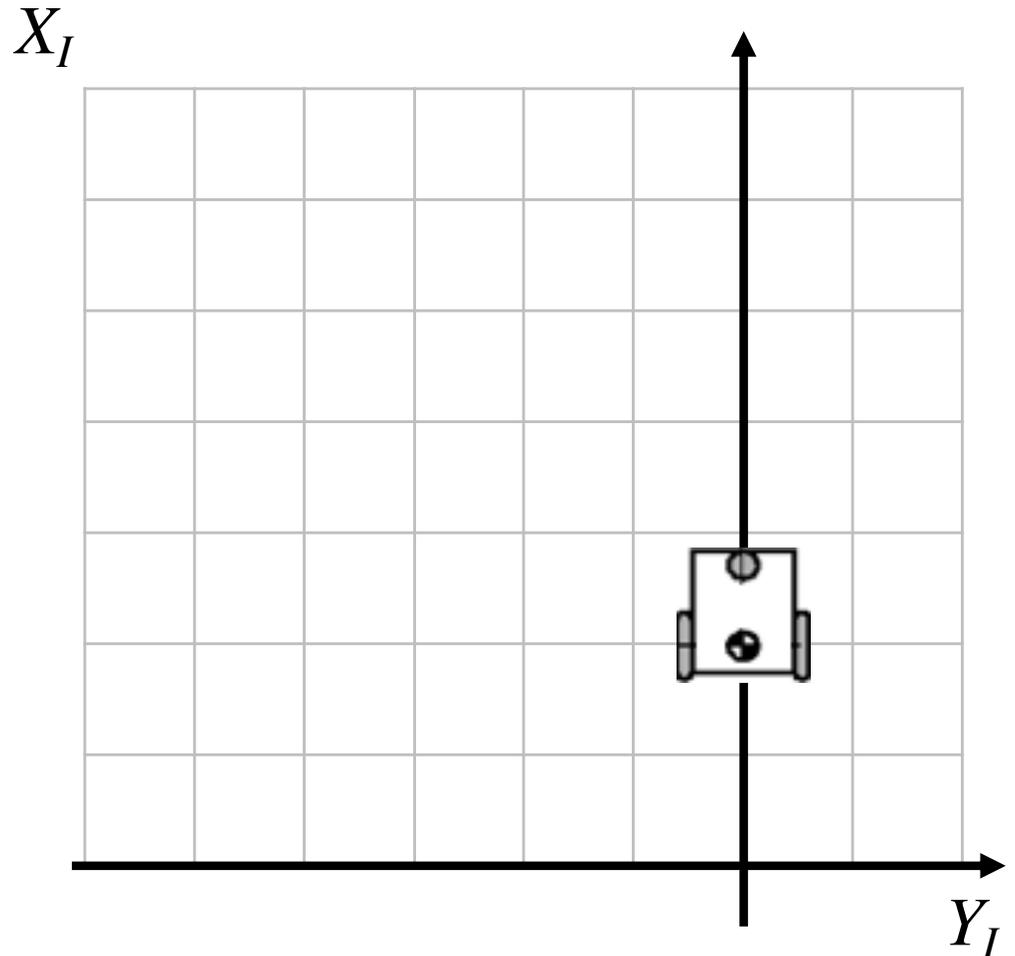


# Rotation matrices, quiz

$\theta$

$\xi_I =$

- Moves forward 2 meters.
- Turns 90 degrees to the right.
- Walks backwards 5 meters.
- Turns 45 degrees to the left.
- Walks forward  $1.4142 (\sqrt{2})$  meters.
- Rotates 53 degrees to the right.

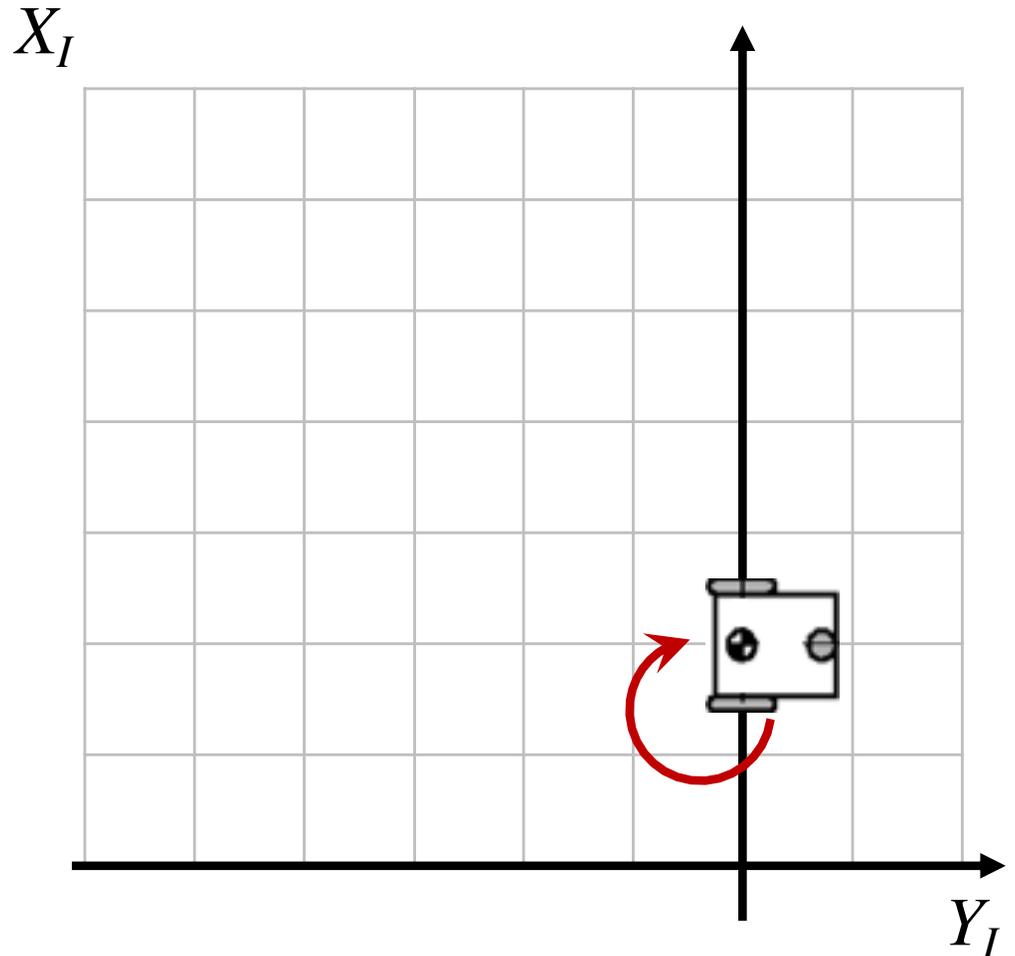


# Rotation matrices, quiz

$$\theta = 270^\circ$$

$\xi_I =$

- Moves forward 2 meters.
- Turns 90 degrees to the right.
- Walks backwards 5 meters.
- Turns 45 degrees to the left.
- Walks forward  $1.4142 (\sqrt{2})$  meters.
- Rotates 53 degrees to the right.

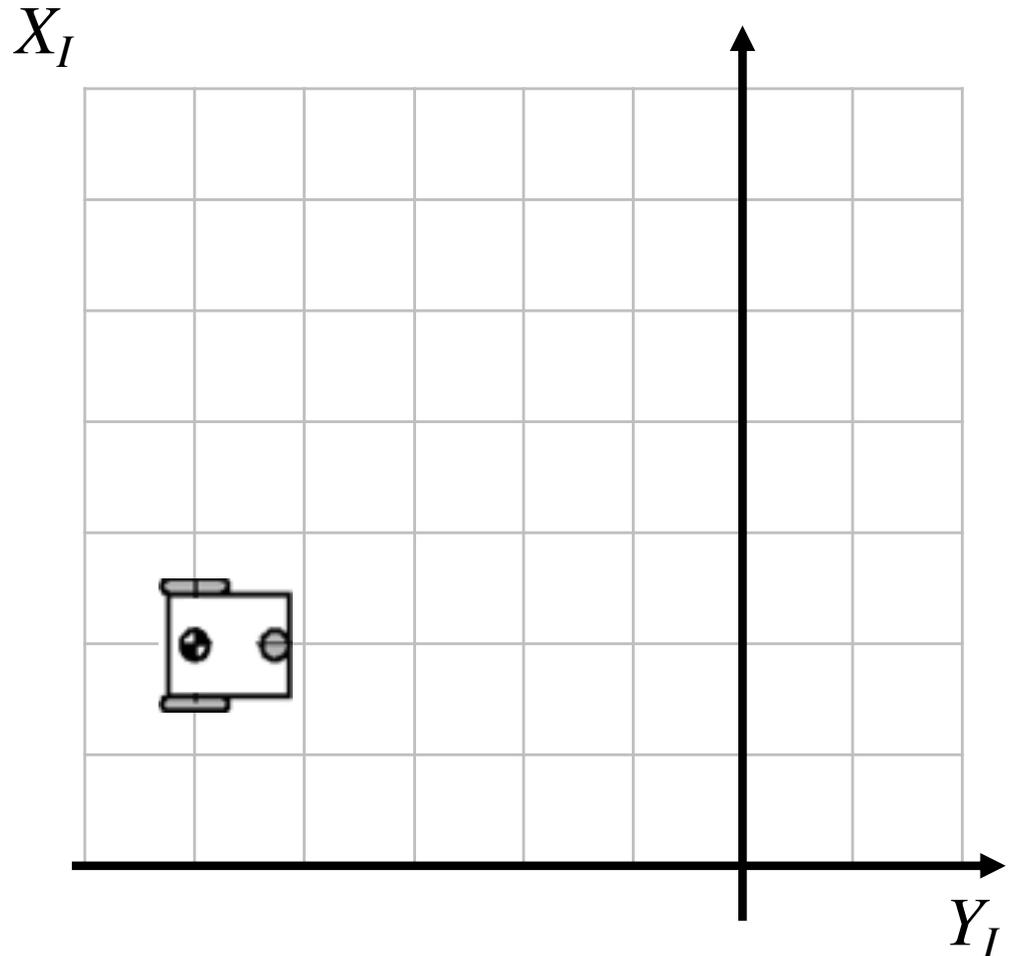


# Rotation matrices, quiz

$$\theta = 270^\circ$$

$\xi_I =$

- Moves forward 2 meters.
- Turns 90 degrees to the right.
- **Walks backwards 5 meters.**
- Turns 45 degrees to the left.
- Walks forward  $1.4142 (\sqrt{2})$  meters.
- Rotates 53 degrees to the right.

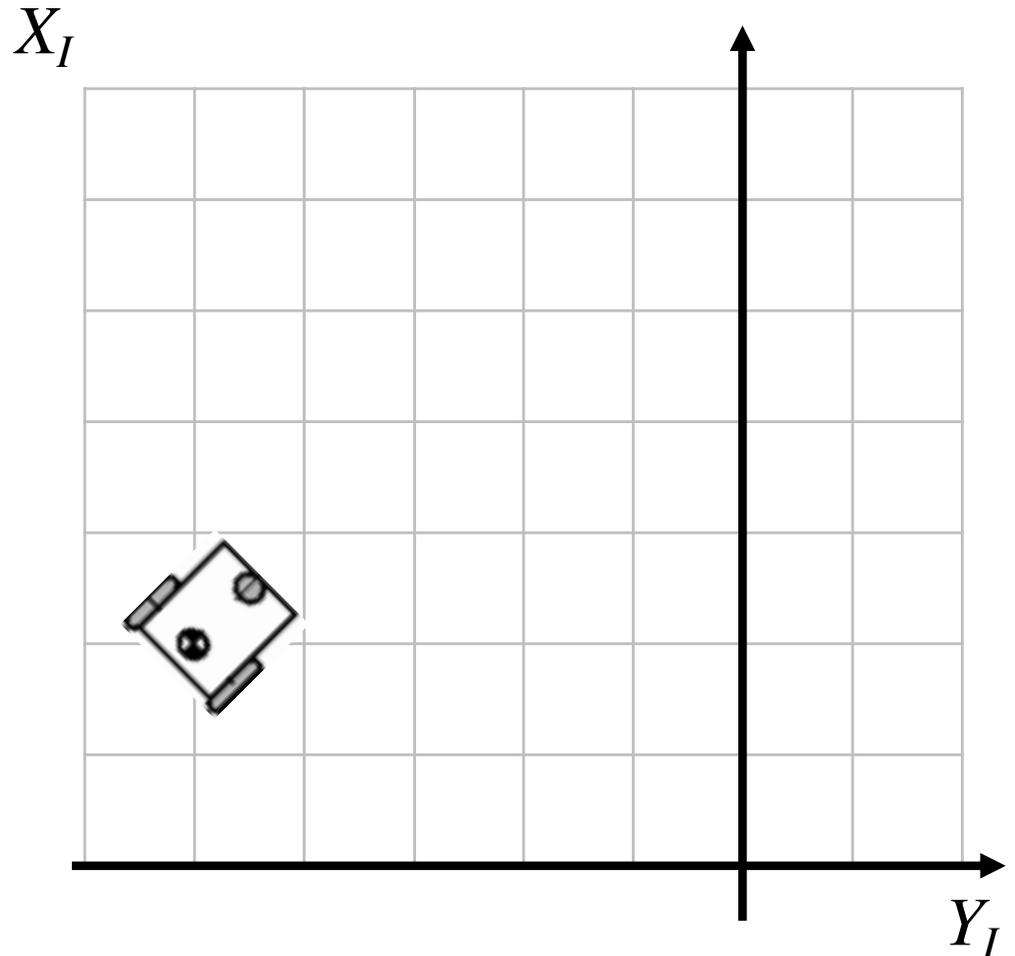


# Rotation matrices, quiz

$$\theta = 270^\circ + 45^\circ = 315^\circ$$

$\xi_I =$

- Moves forward 2 meters.
- Turns 90 degrees to the right.
- Walks backwards 5 meters.
- Turns 45 degrees to the left.
- Walks forward 1.4142 ( $\sqrt{2}$ ) meters.
- Rotates 53 degrees to the right.

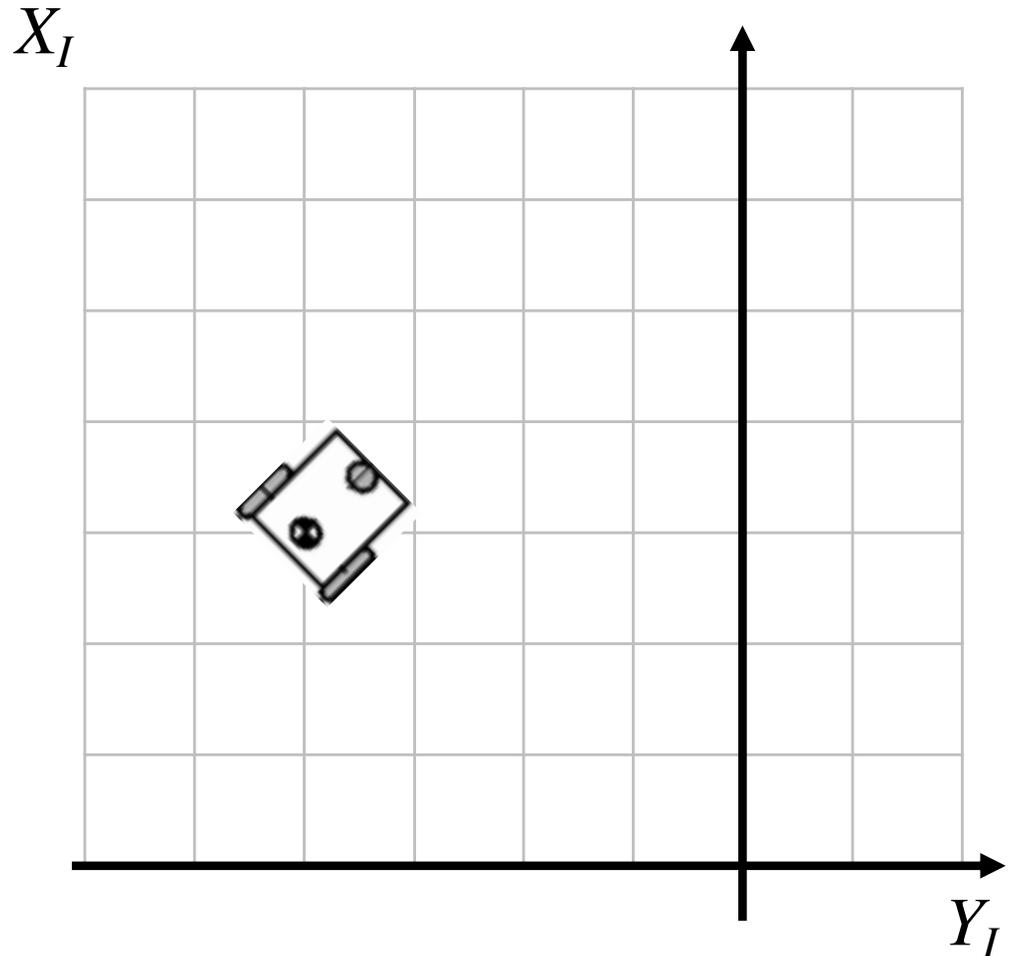


# Rotation matrices, quiz

$$\theta = 315^\circ$$

$\xi_I =$

- Moves forward 2 meters.
- Turns 90 degrees to the right.
- Walks backwards 5 meters.
- Turns 45 degrees to the left.
- Walks forward 1.4142 ( $\sqrt{2}$ ) meters.
- Rotates 53 degrees to the right.

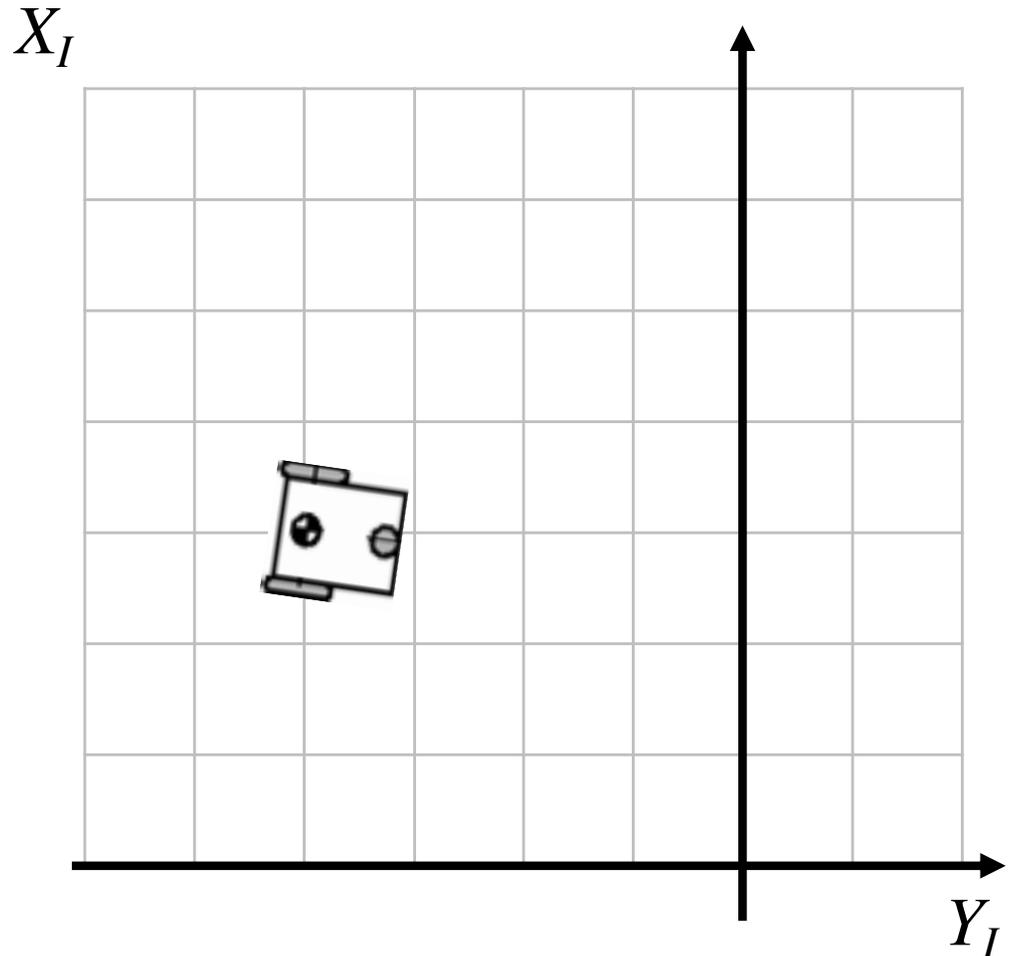


# Rotation matrices, quiz

$$\theta = 315^\circ + 307^\circ = 262^\circ$$

$\xi_I =$

- Moves forward 2 meters.
- Turns 90 degrees to the right.
- Walks backwards 5 meters.
- Turns 45 degrees to the left.
- Walks forward  $1.4142$  ( $\sqrt{2}$ ) meters.
- Rotates 53 degrees to the right.

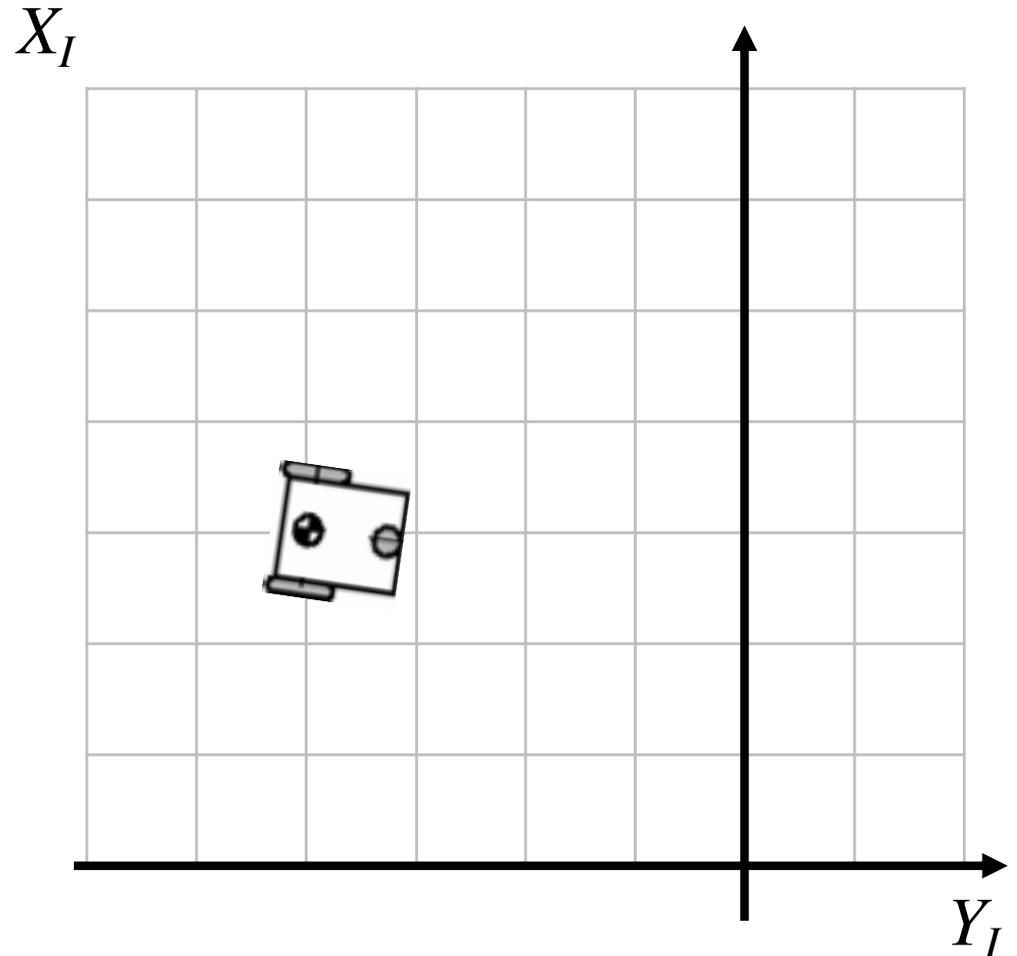


# Rotation matrices, quiz

$$\theta = 315^\circ + 307^\circ = 262^\circ$$

$$\xi_I = \begin{bmatrix} x \\ y \\ \theta \end{bmatrix}$$

- Moves forward 2 meters.
- Turns 90 degrees to the right.
- Walks backwards 5 meters.
- Turns 45 degrees to the left.
- Walks forward 1.4142 ( $\sqrt{2}$ ) meters.
- Rotates 53 degrees to the right.

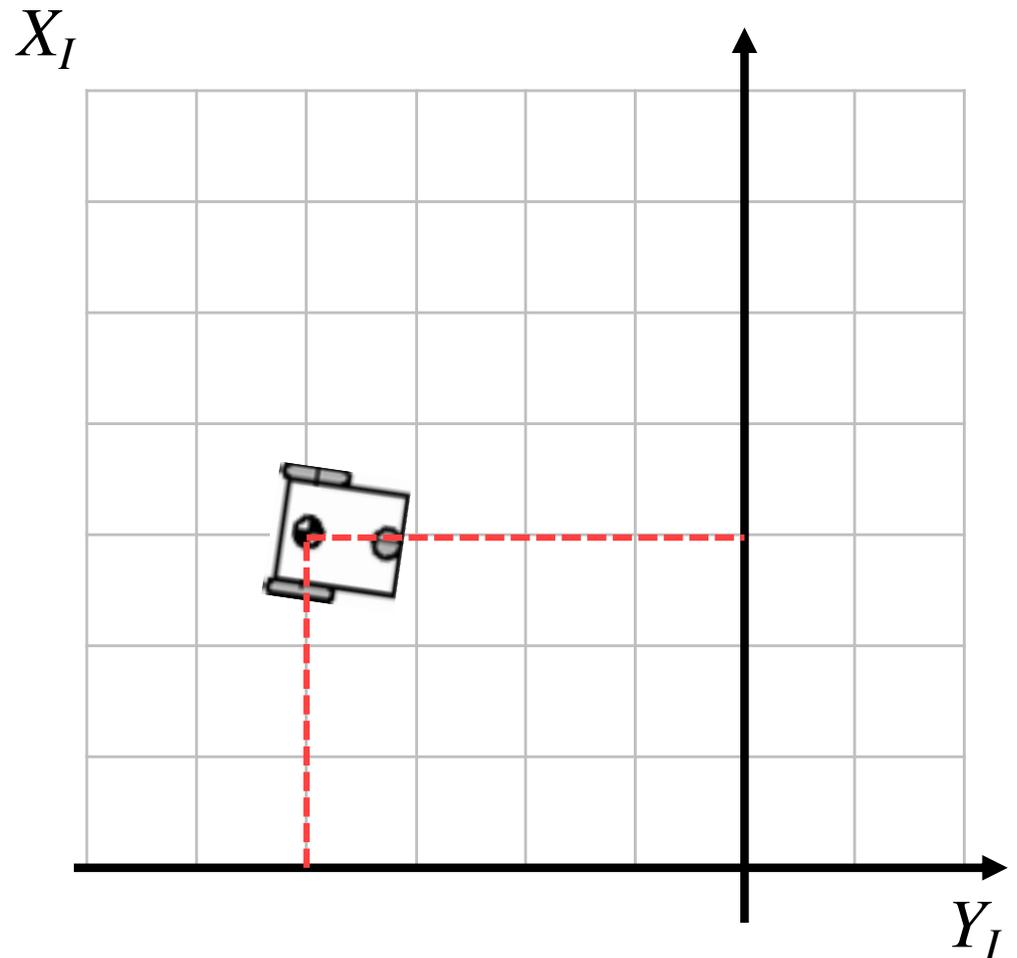


# Rotation matrices, quiz

$$\theta = 315^\circ + 307^\circ = 262^\circ = 131\pi/90$$

$$\xi_I = \begin{bmatrix} x \\ y \\ \theta \end{bmatrix} = \begin{bmatrix} -4 \\ 3 \\ \theta \end{bmatrix}$$

- Moves forward 2 meters.
- Turns 90 degrees to the right.
- Walks backwards 5 meters.
- Turns 45 degrees to the left.
- Walks forward 1.4142 ( $\sqrt{2}$ ) meters.
- Rotates 53 degrees to the right.

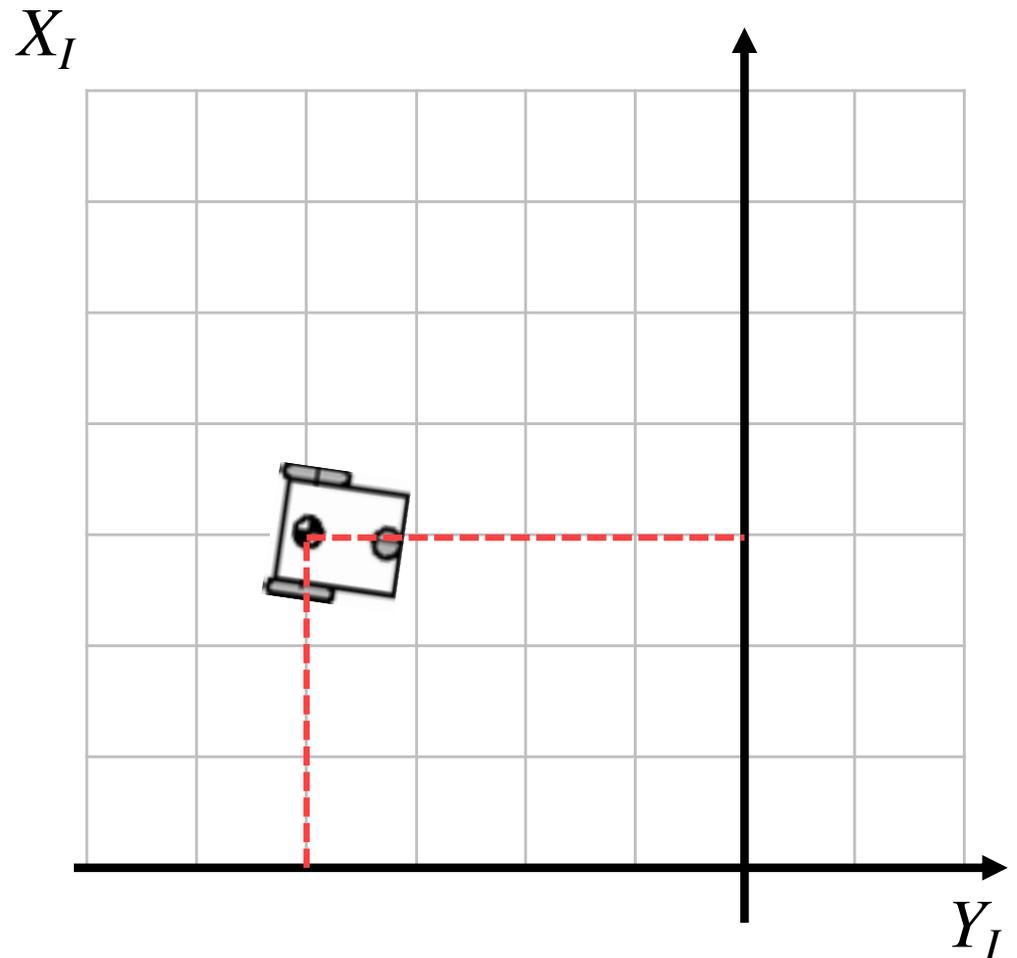


# Rotation matrices, quiz

$$\theta = 270^\circ + 45^\circ + 307^\circ = 262^\circ = 131\pi/90$$

$$\xi_I = \begin{bmatrix} x \\ y \\ \theta \end{bmatrix} = \begin{bmatrix} -4 \\ 3 \\ 131\pi/90 \end{bmatrix}$$

- Moves forward 2 meters.
- Turns 90 degrees to the right.
- Walks backwards 5 meters.
- Turns 45 degrees to the left.
- Walks forward 1.4142 ( $\sqrt{2}$ ) meters.
- Rotates 53 degrees to the right.

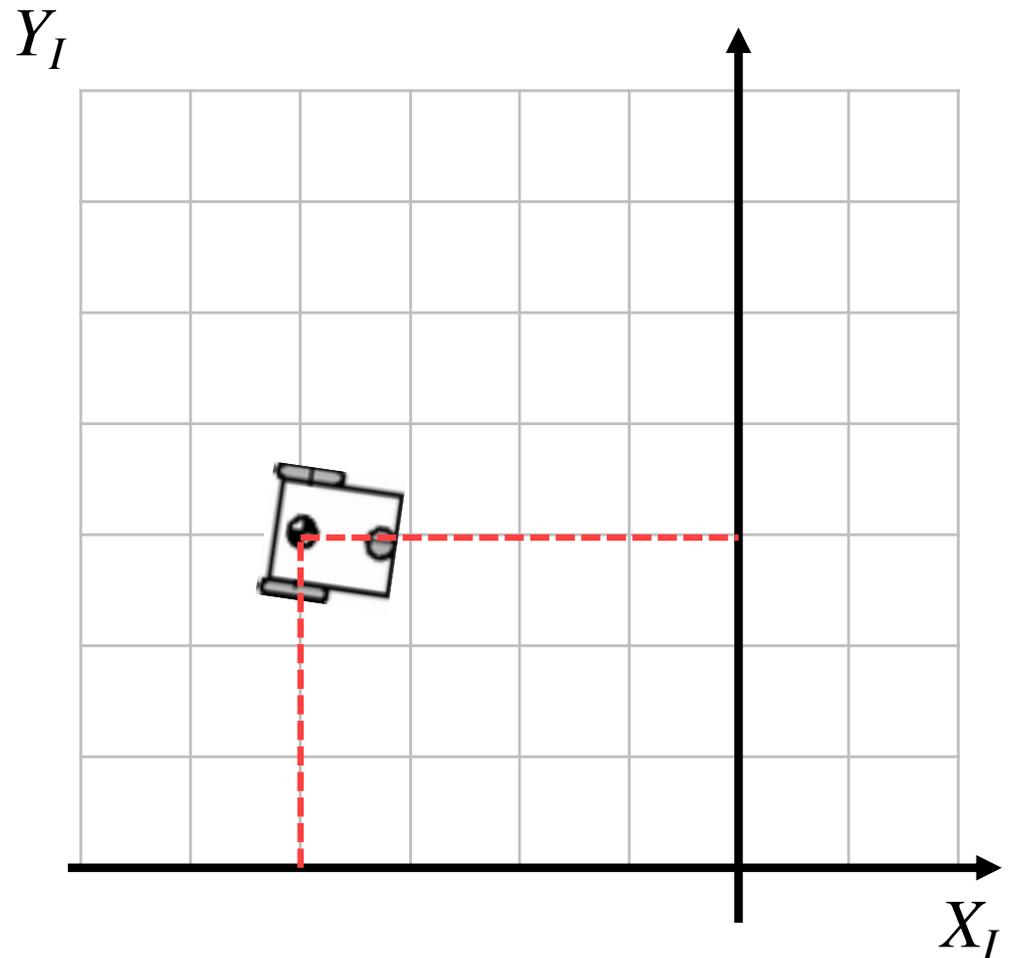


# Rotation matrices, quiz (Y axis)

$$\theta = 270^\circ + 45^\circ + 307^\circ = 262^\circ = 131\pi/90$$

$$\xi_I = \begin{bmatrix} x \\ y \\ \theta \end{bmatrix} = \begin{bmatrix} 3 \\ -4 \\ 131\pi/90 \end{bmatrix}$$

- Moves forward 2 meters.
- Turns 90 degrees to the right.
- Walks backwards 5 meters.
- Turns 45 degrees to the left.
- Walks forward 1.4142 ( $\sqrt{2}$ ) meters.
- Rotates 53 degrees to the right.



# Rotation matrices, quiz

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- What is the (solved) instantaneous rotation matrix of the robot below?

$$\xi_I = \begin{bmatrix} -4 \\ 3 \\ 131\pi/90 \end{bmatrix}$$

- *Okay, how do we get a matrix from this vector?*
- *We rotated counterclockwise around  $z$ , so...*
- *(Let's make some space)*

# Rotation matrices, quiz

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- What is the (solved) instantaneous rotation matrix of the robot below?

$$\xi_I = \begin{bmatrix} -4 \\ 3 \\ 131\pi/90 \end{bmatrix}, \quad R(\theta) = \begin{bmatrix} \cos \theta & -\sin \theta & 0 \\ \sin \theta & \cos \theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

- *We apply the z rotation matrix*

# Rotation matrices, quiz

- What is the (solved) instantaneous rotation matrix of the robot below?

$$\xi_I = \begin{bmatrix} -4 \\ 3 \\ 131\pi/90 \end{bmatrix}, R(\theta) = \begin{bmatrix} \cos 131\pi/90 & -\sin 131\pi/90 & 0 \\ \sin 131\pi/90 & \cos 131\pi/90 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

- *We apply the z rotation matrix*
- *Plug in theta...*

# Rotation matrices, quiz

- What is the (solved) instantaneous rotation matrix of the robot below?

$$\xi_I = \begin{bmatrix} -4 \\ 3 \\ 131\pi/90 \end{bmatrix}, R(\theta) = \begin{bmatrix} \cos 131\pi/90 & -\sin 131\pi/90 & 0 \\ \sin 131\pi/90 & \cos 131\pi/90 & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} -0.14 & 0.99 & 0 \\ -0.99 & -0.14 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

- We apply the z rotation matrix*
- Plug in theta...*
- This is it.*