

# **LINEAR ALGEBRA**

Hochschule Bonn-Rhein-Seig

- Divin and Santosh

# Where is Linear Algebra applied?

- Robotics
- Data Analysis
- Computer Vision

# **Vectors**



*y*



θ  
θ

*x*



*y*



*x*

0

0



*y*

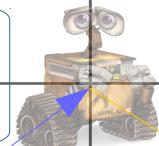


*x*

$\theta$   
 $\theta$

5  
4

3  
-2



*y*



$\theta$   
 $\theta$

*x*

5  
4

$\theta = -33.7^\circ$   
 $\ell = 3.6$



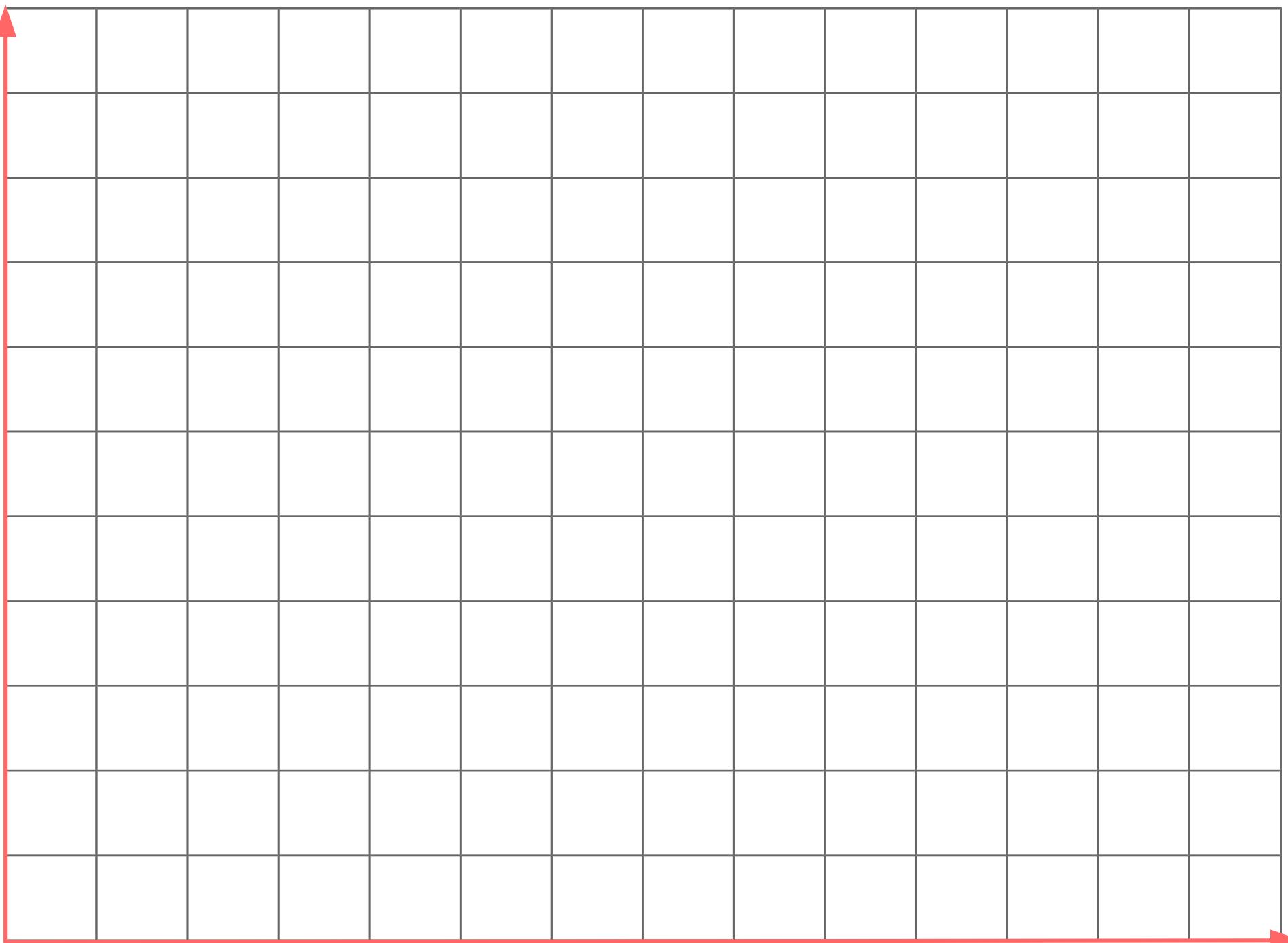
$\ell \cos(\theta)$   
 $\ell \sin(\theta)$

# **Vector Operations**

*y*



*x*



*y*



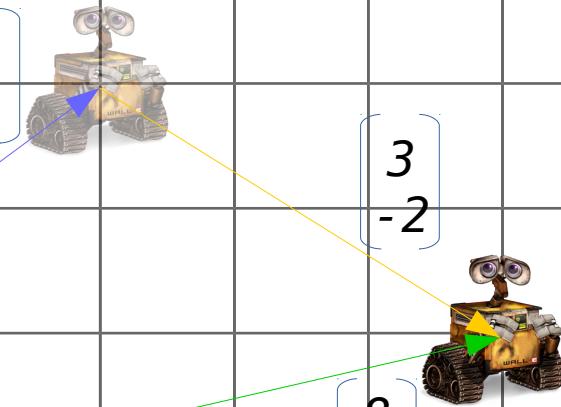
*x*

0  
0

5  
4

3  
-2

8  
2

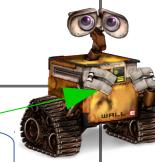


*y*

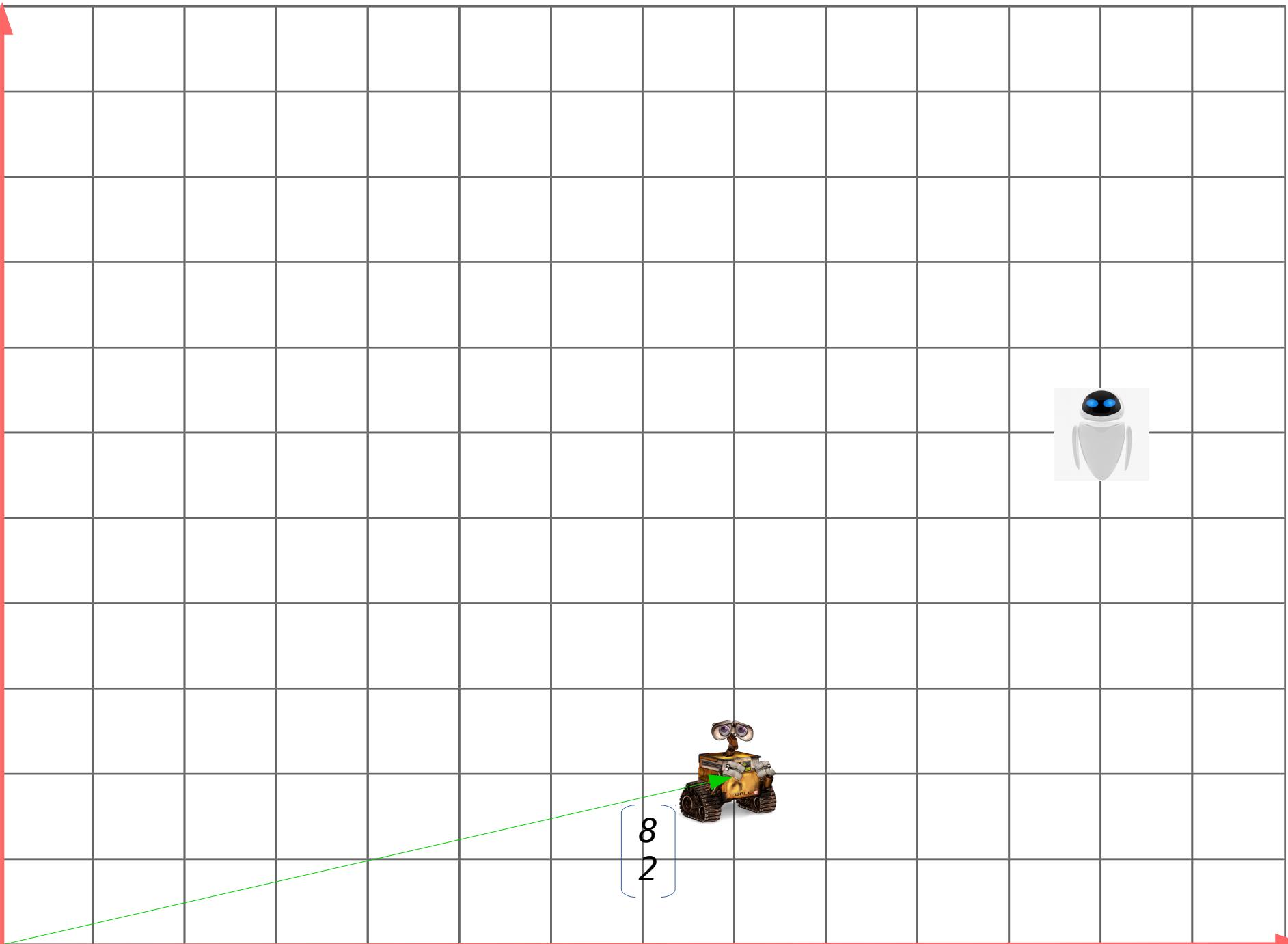


*x*

8  
2



0  
0

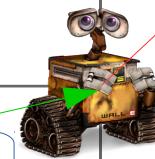


*y*



*x*

$\theta$   
 $\theta$



8  
2

$\ell=5.65$

$\theta=45^\circ$



[ ?  
? ]

*y*



$\theta$   
 $\theta$

*x*

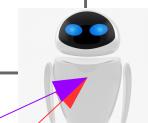
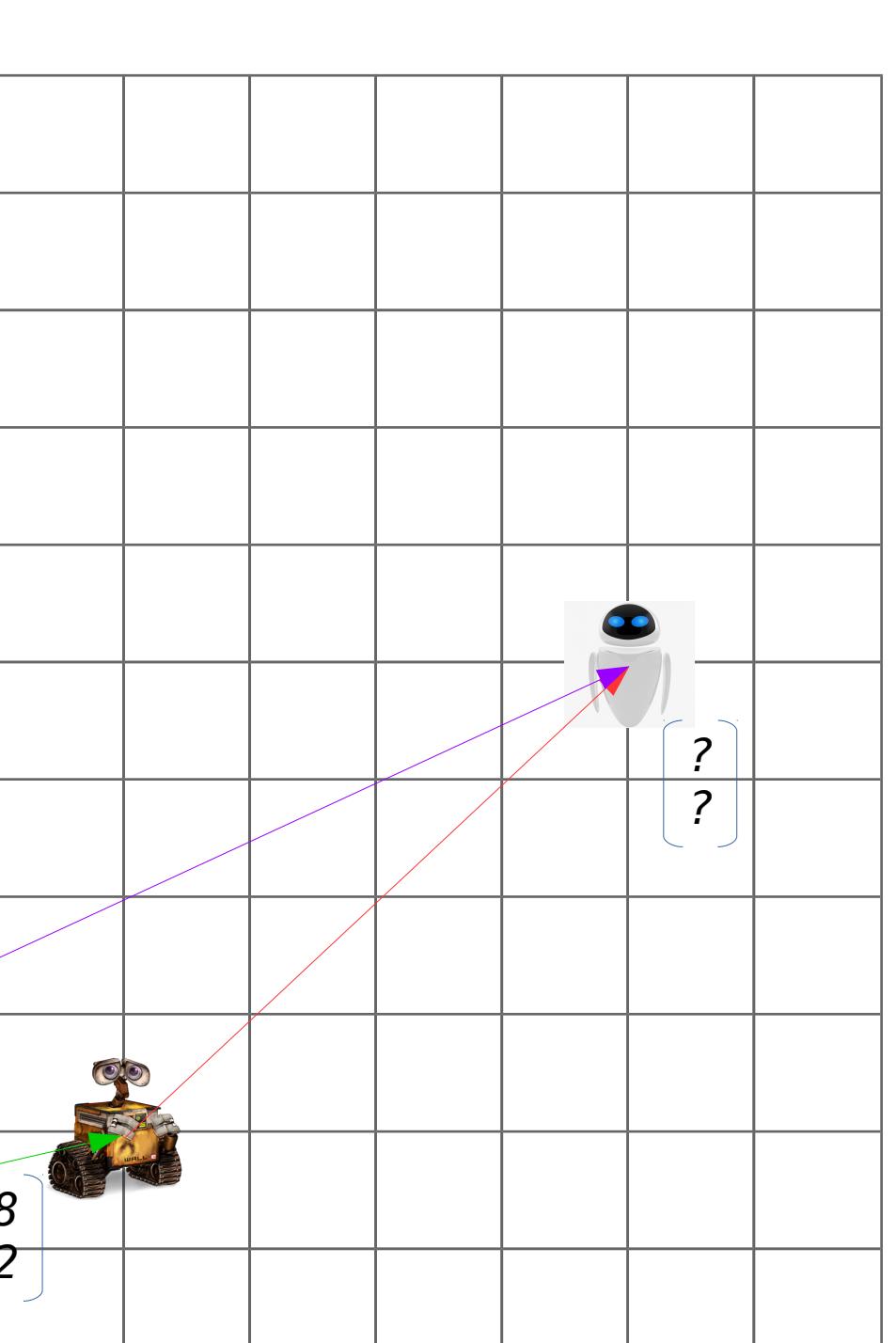
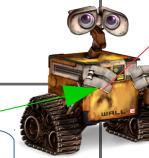
*y*



*x*

0  
0

8  
2



?  
?

8  
2

*y*

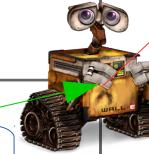


*x*

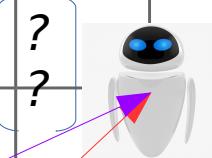
0

0

8  
2



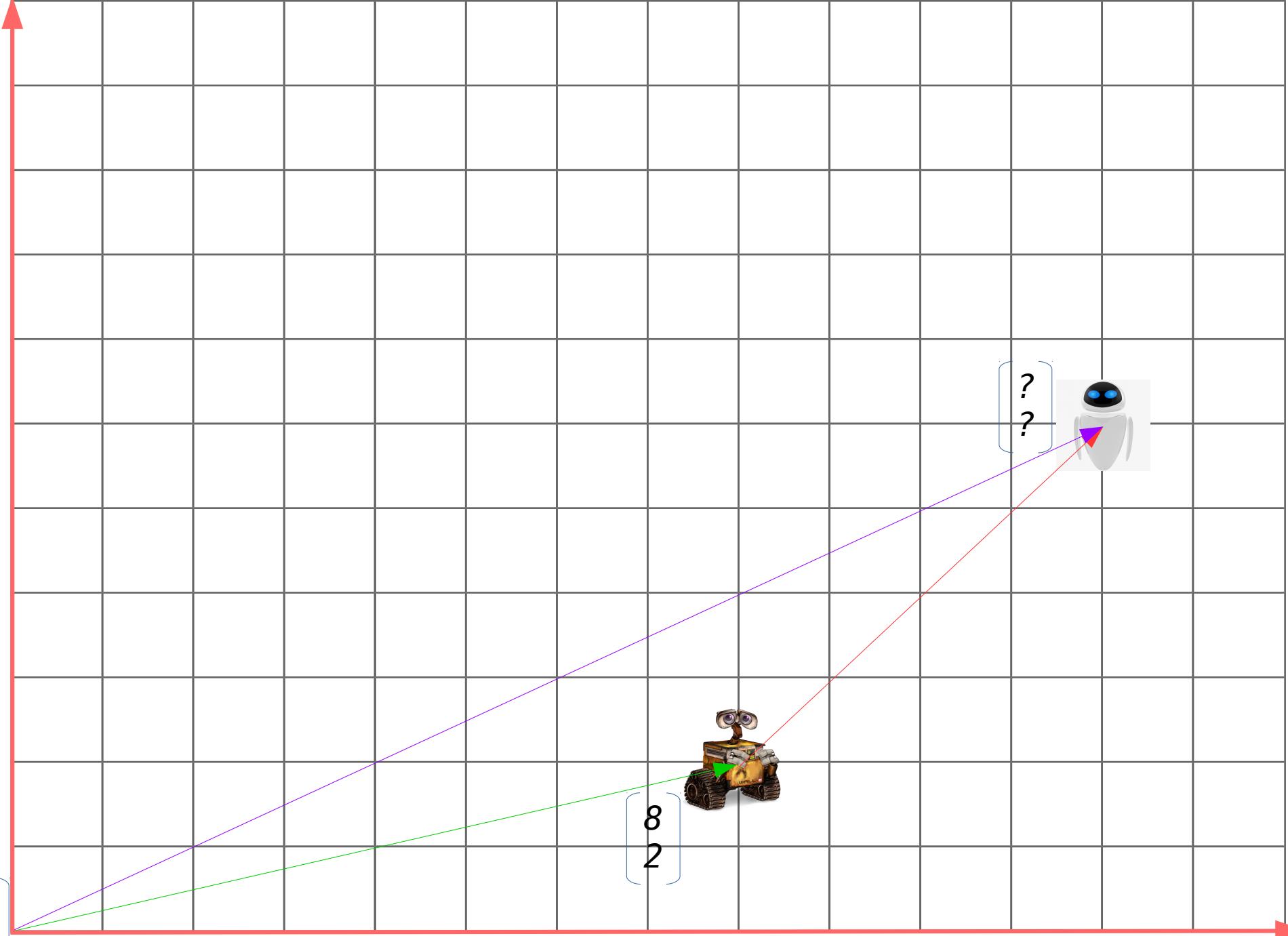
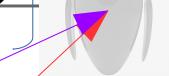
8  
2



?

?

?

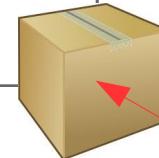


*y*

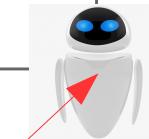
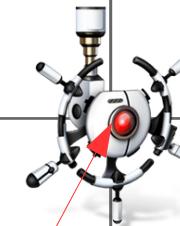
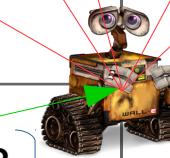


*x*

0  
0



8  
2

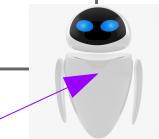
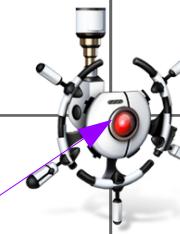
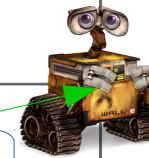
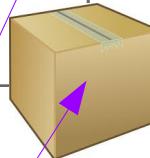


*y*



*x*

0  
0



8  
2

0  
0

# Scaling

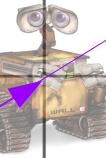
*y*



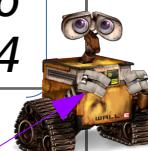
$\theta$   
 $\theta$

*x*

3  
2



6  
4

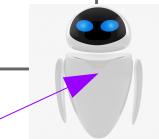
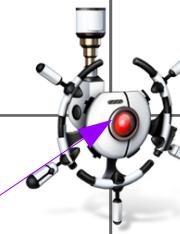
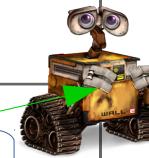
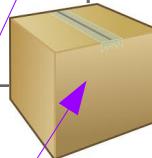


*y*



*x*

0  
0



8  
2

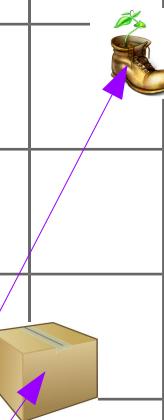
0  
0

*y*



*x*

0  
0



# Basis Vectors

*y*



*x*

$\theta$   
1

$\theta$   
 $\theta$

1  
 $\theta$

5  
4



5  
4

4



# **Linear Combination**

*y*



*x*

θ

θ

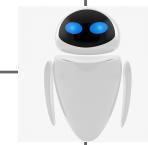
# **Matrix**

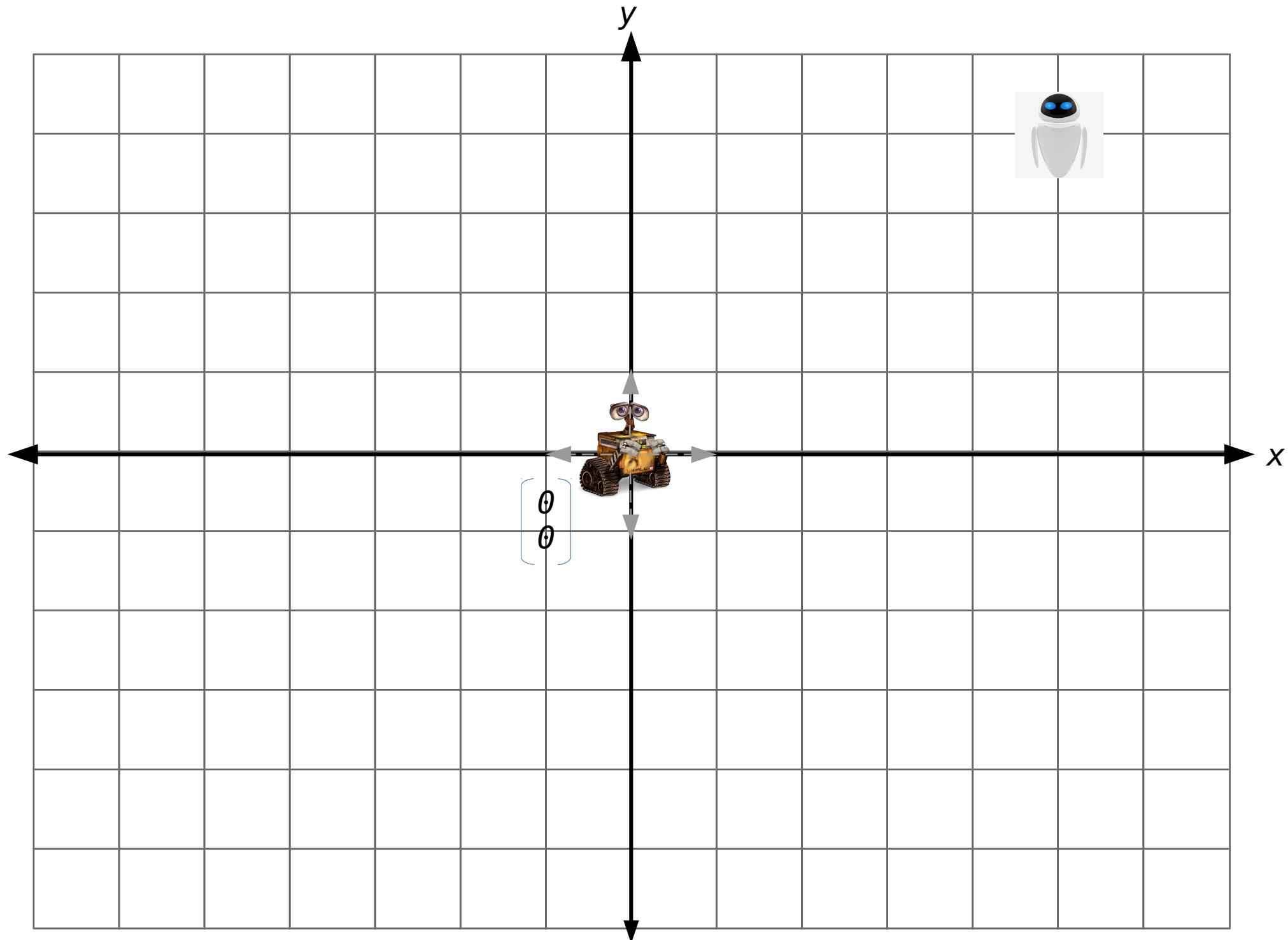
*y*

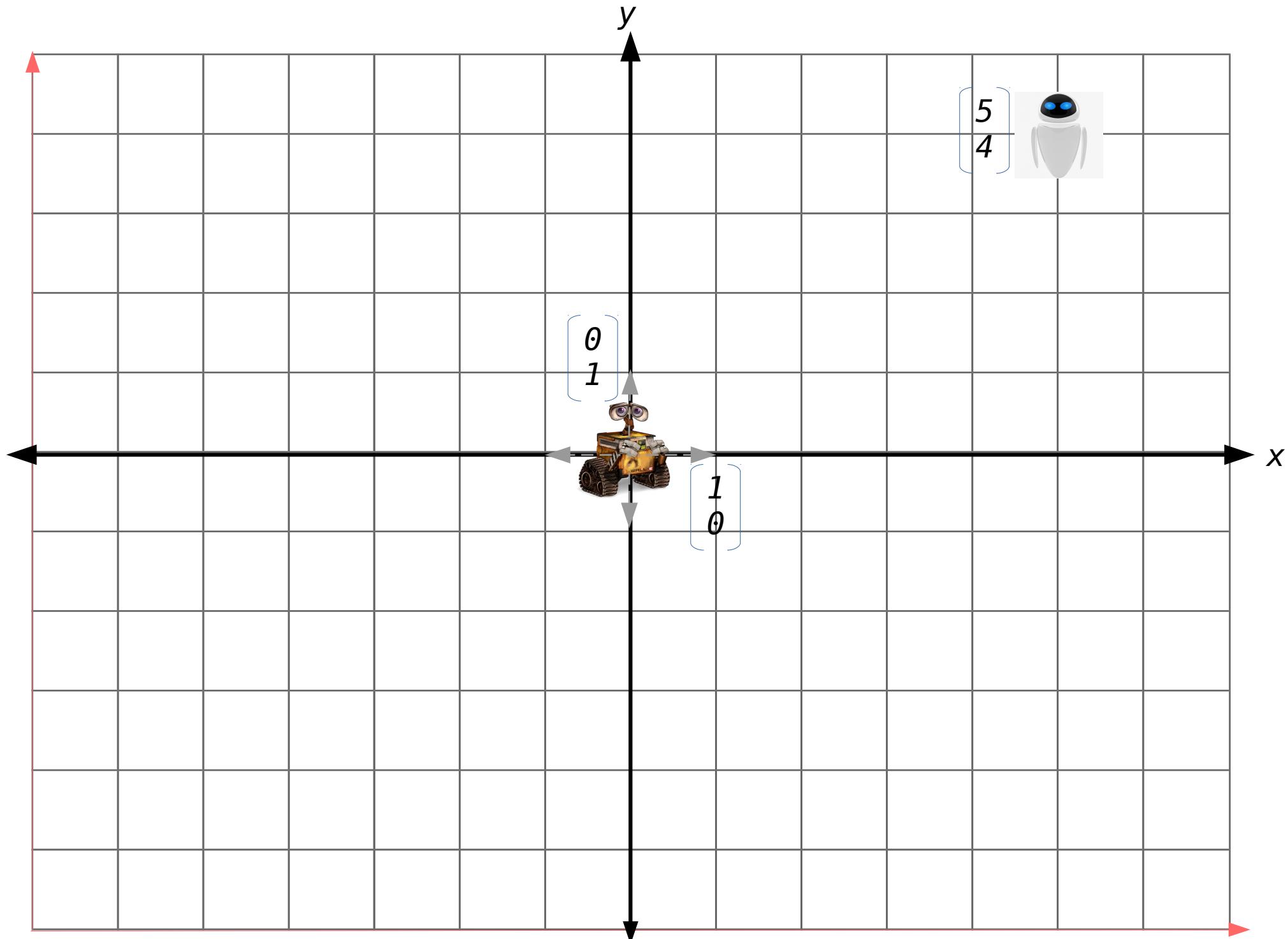


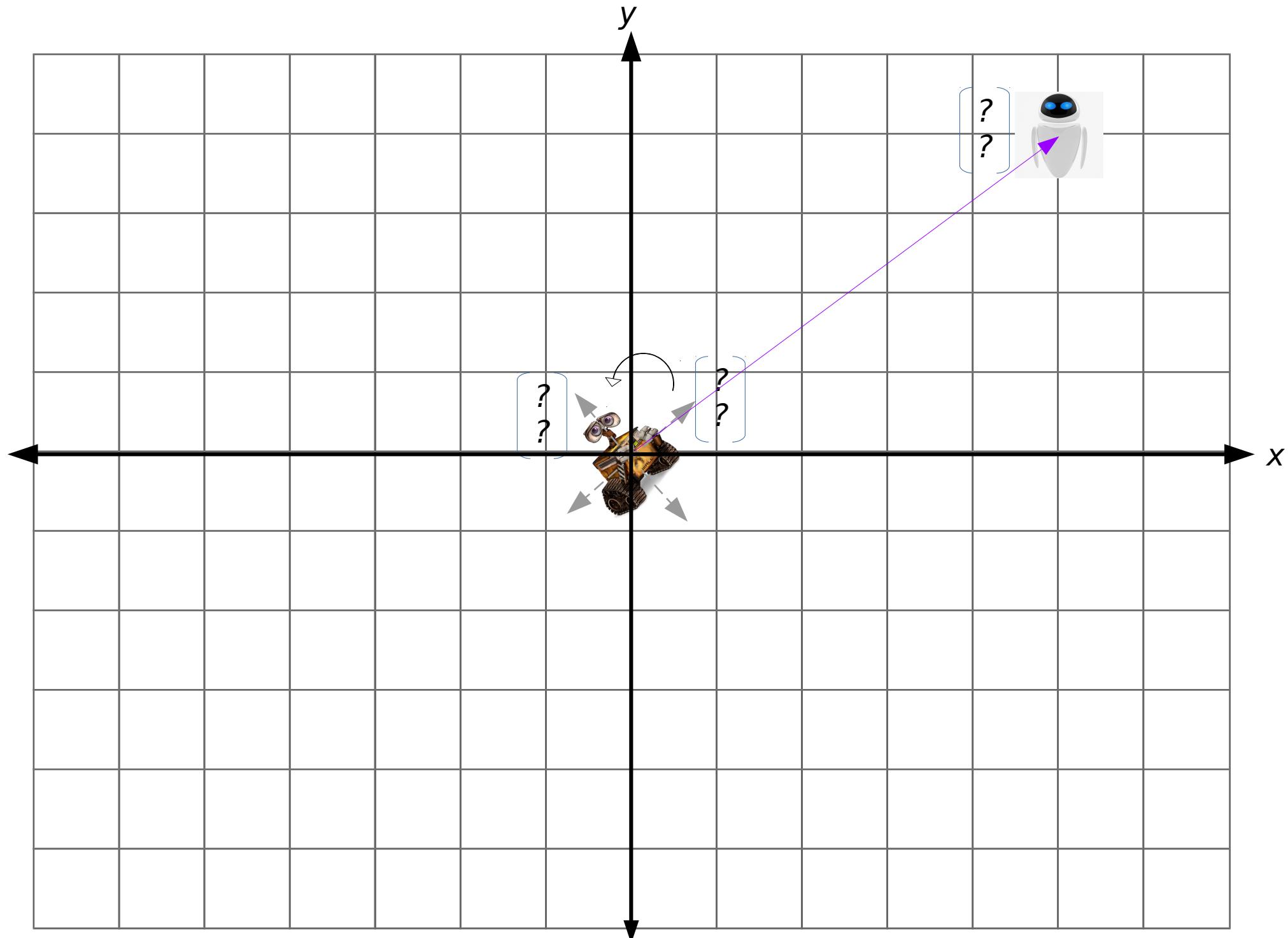
$\theta$   
 $\theta$

*x*



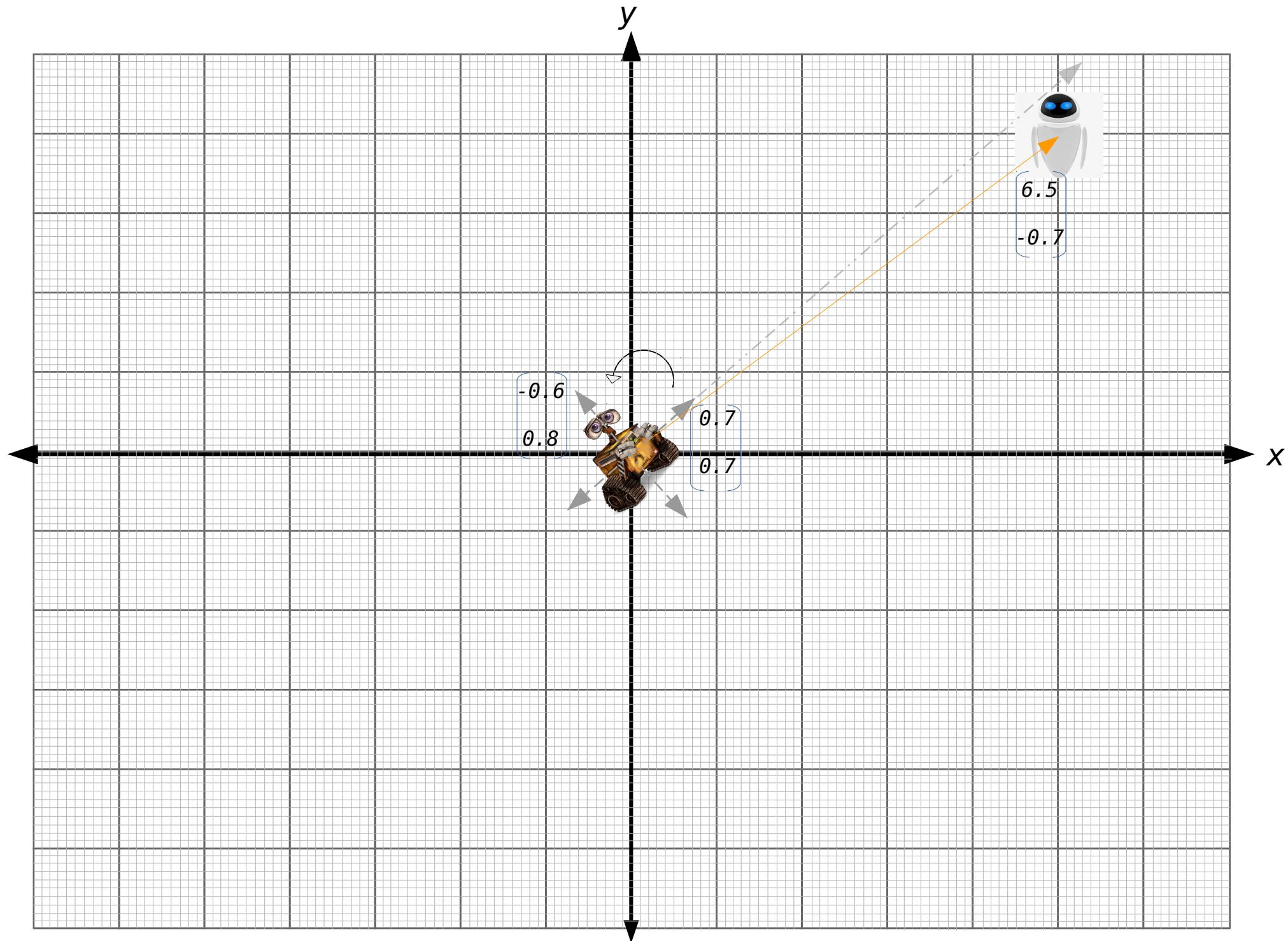






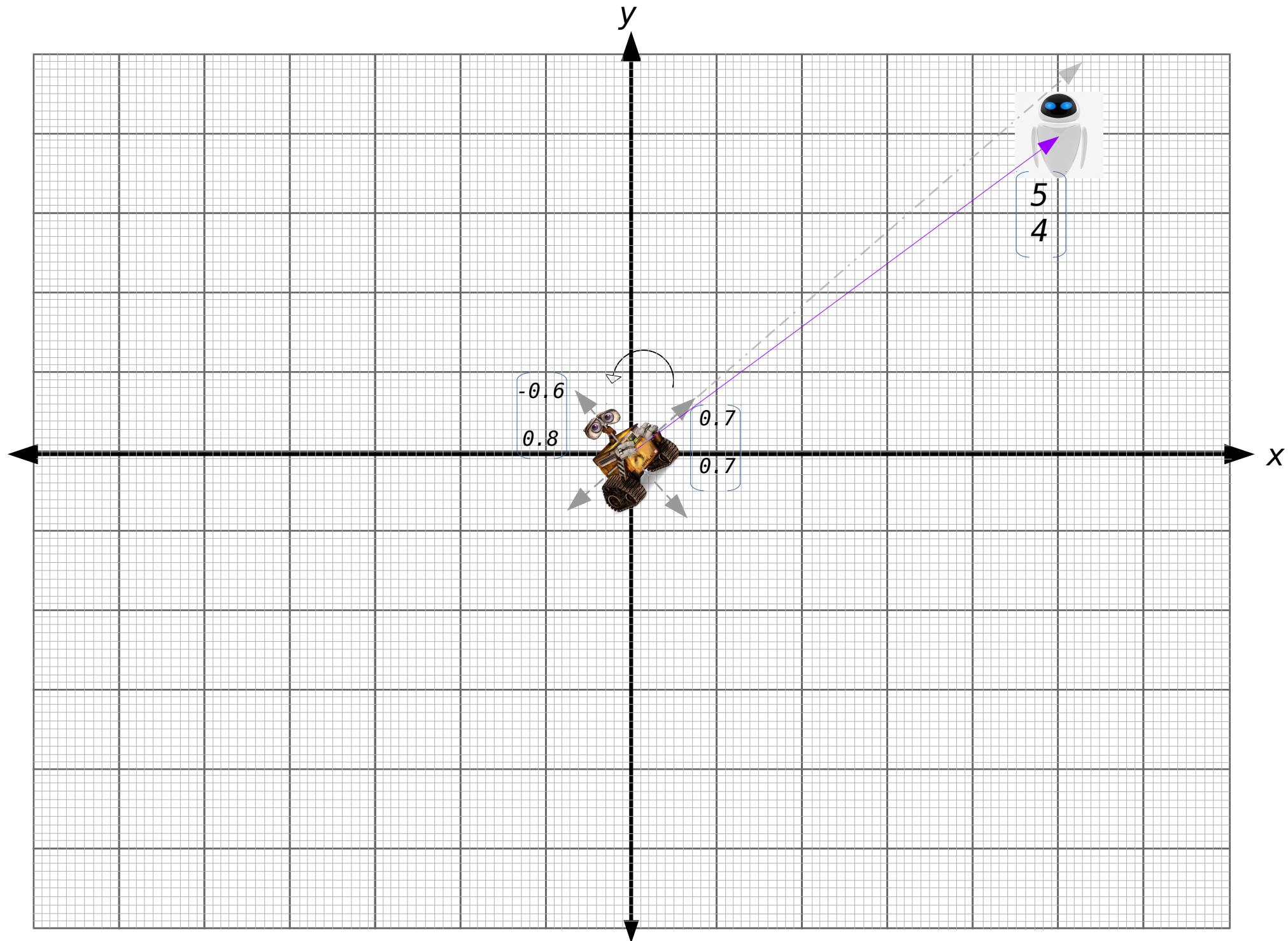
# **Matrix Multiplication**



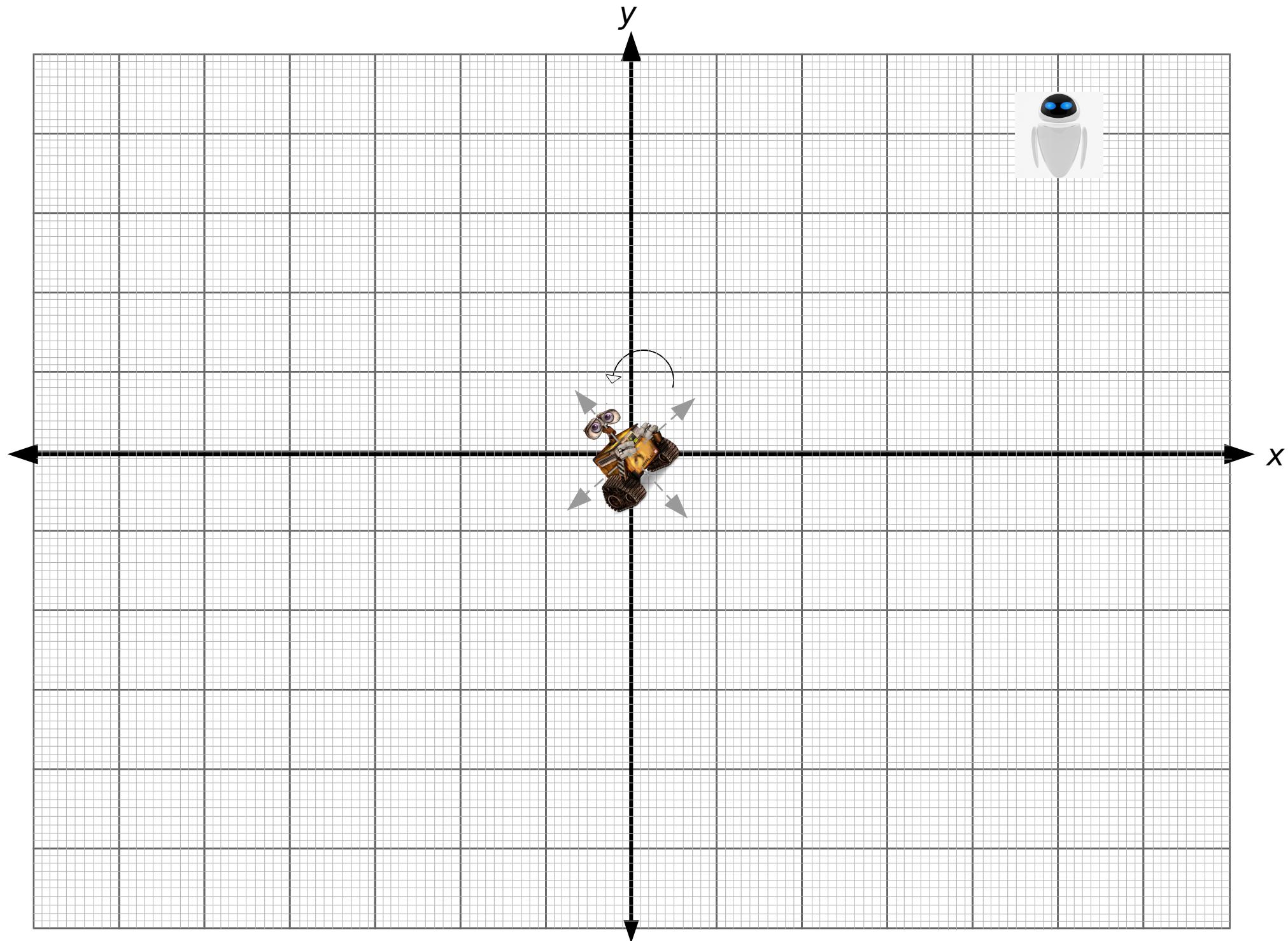


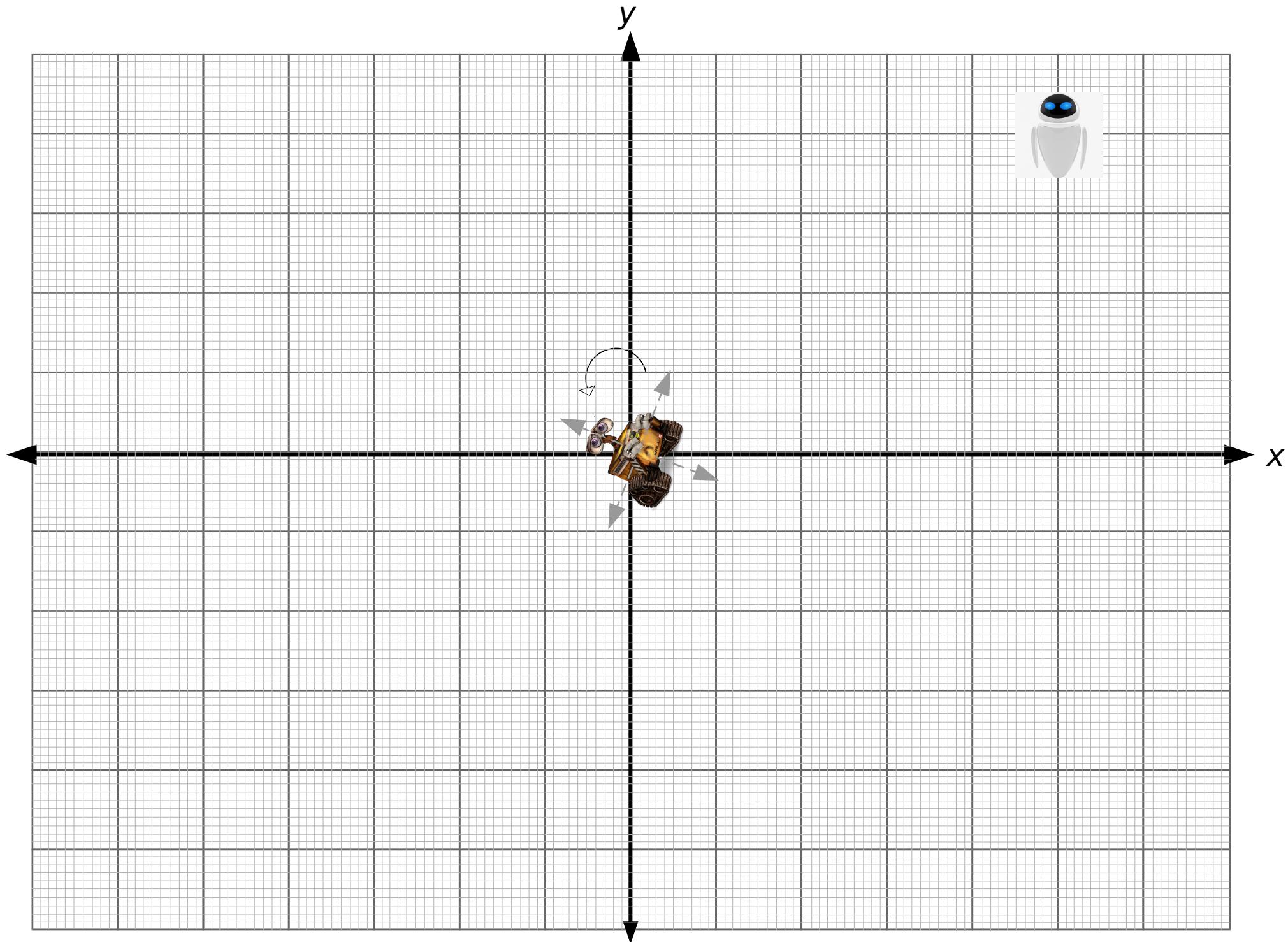
# **Inverse of a Matrix**





# **Composition**

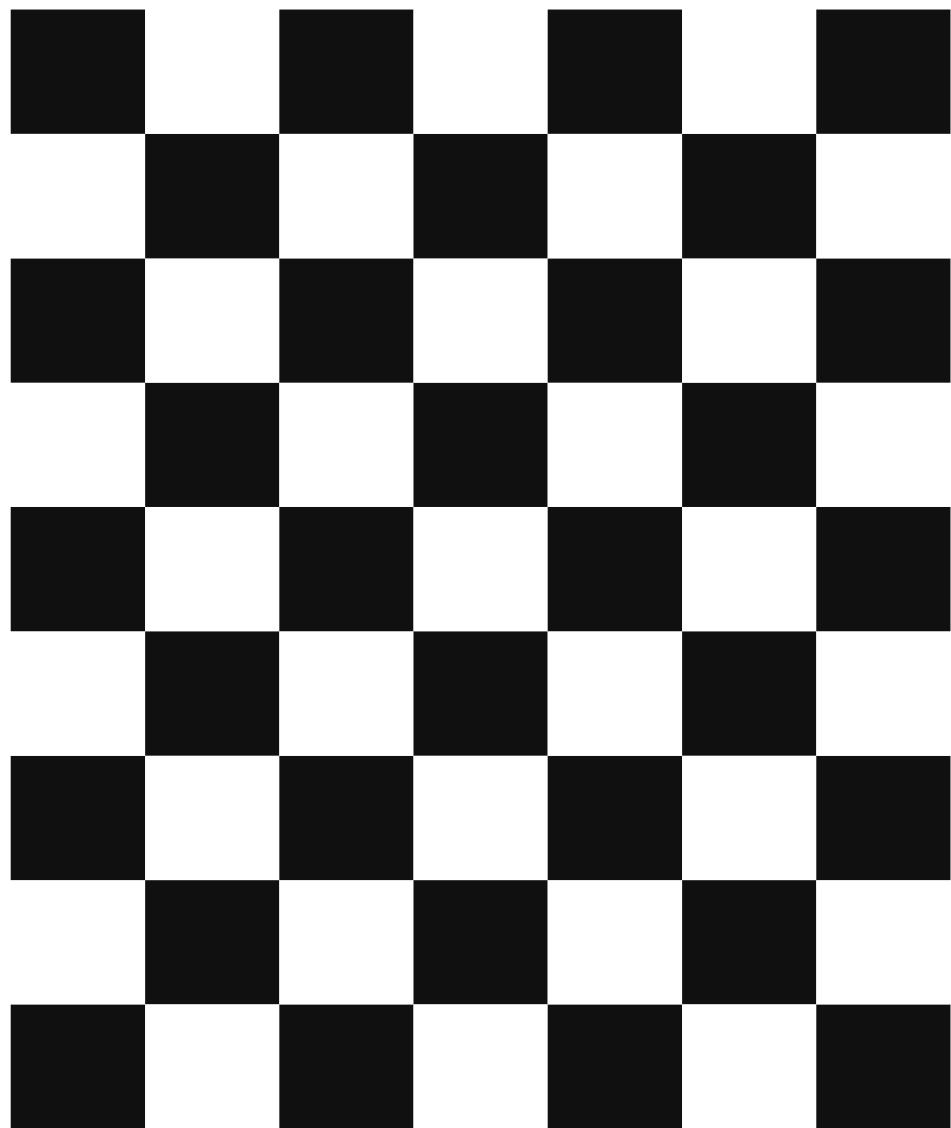


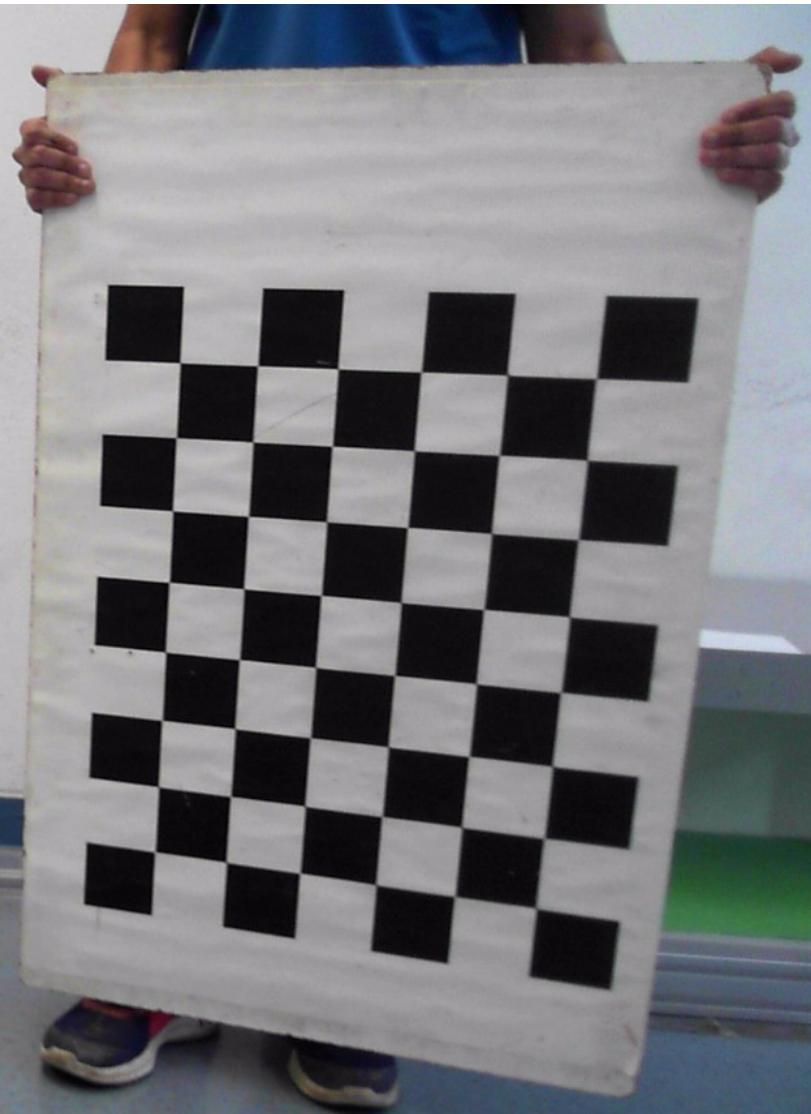
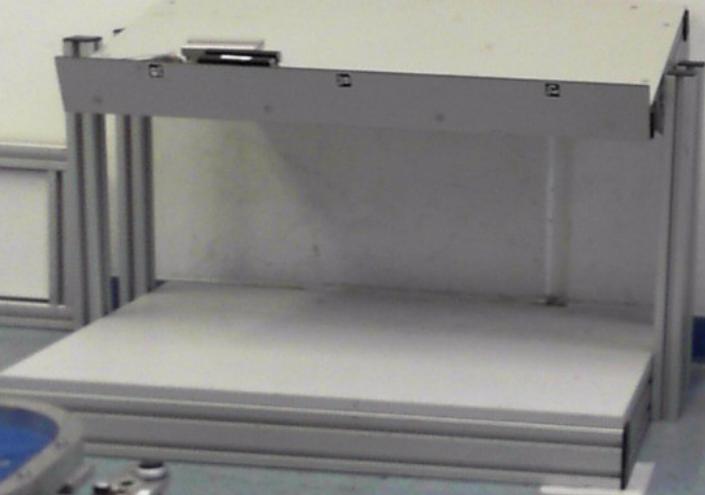


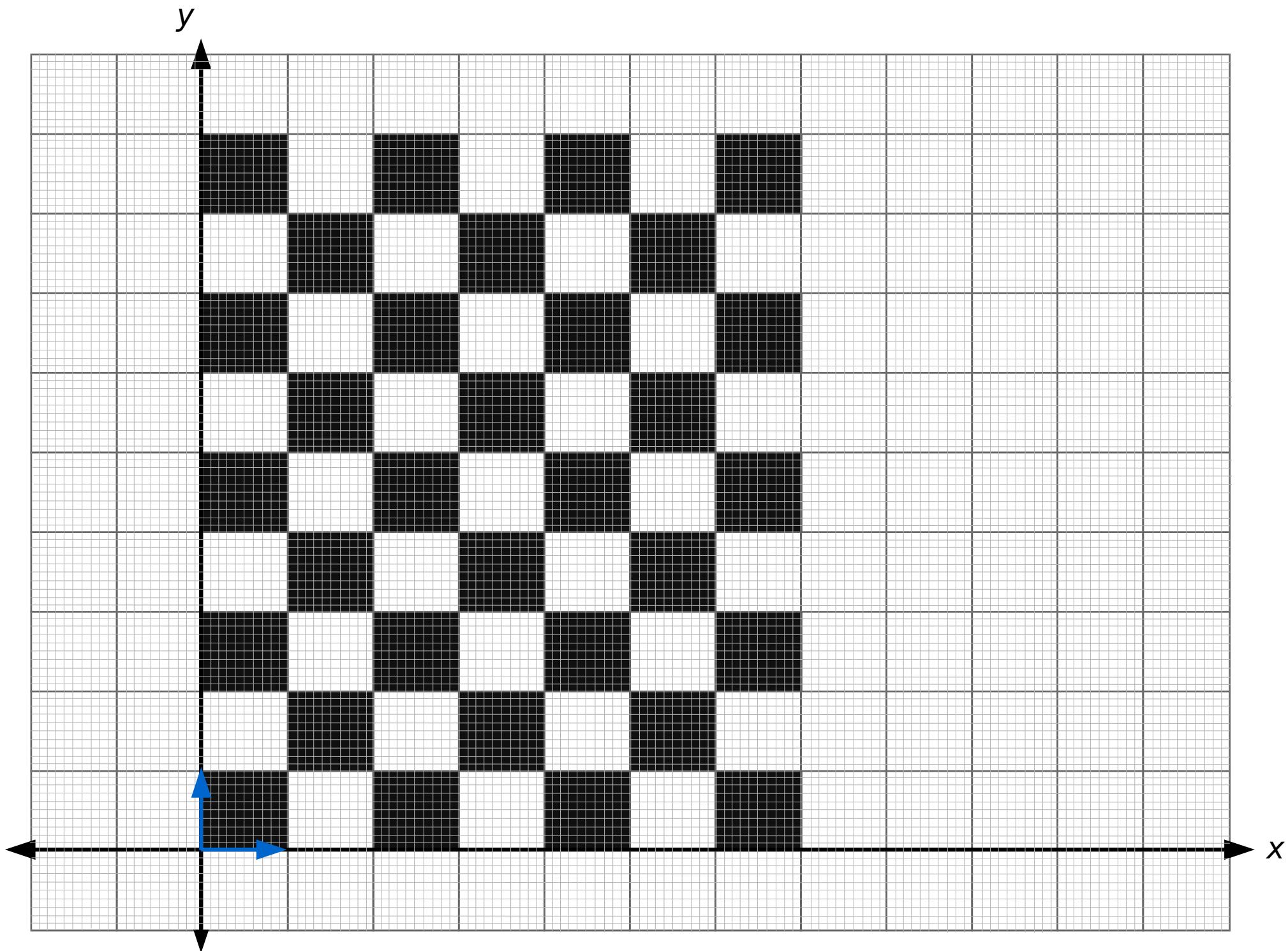


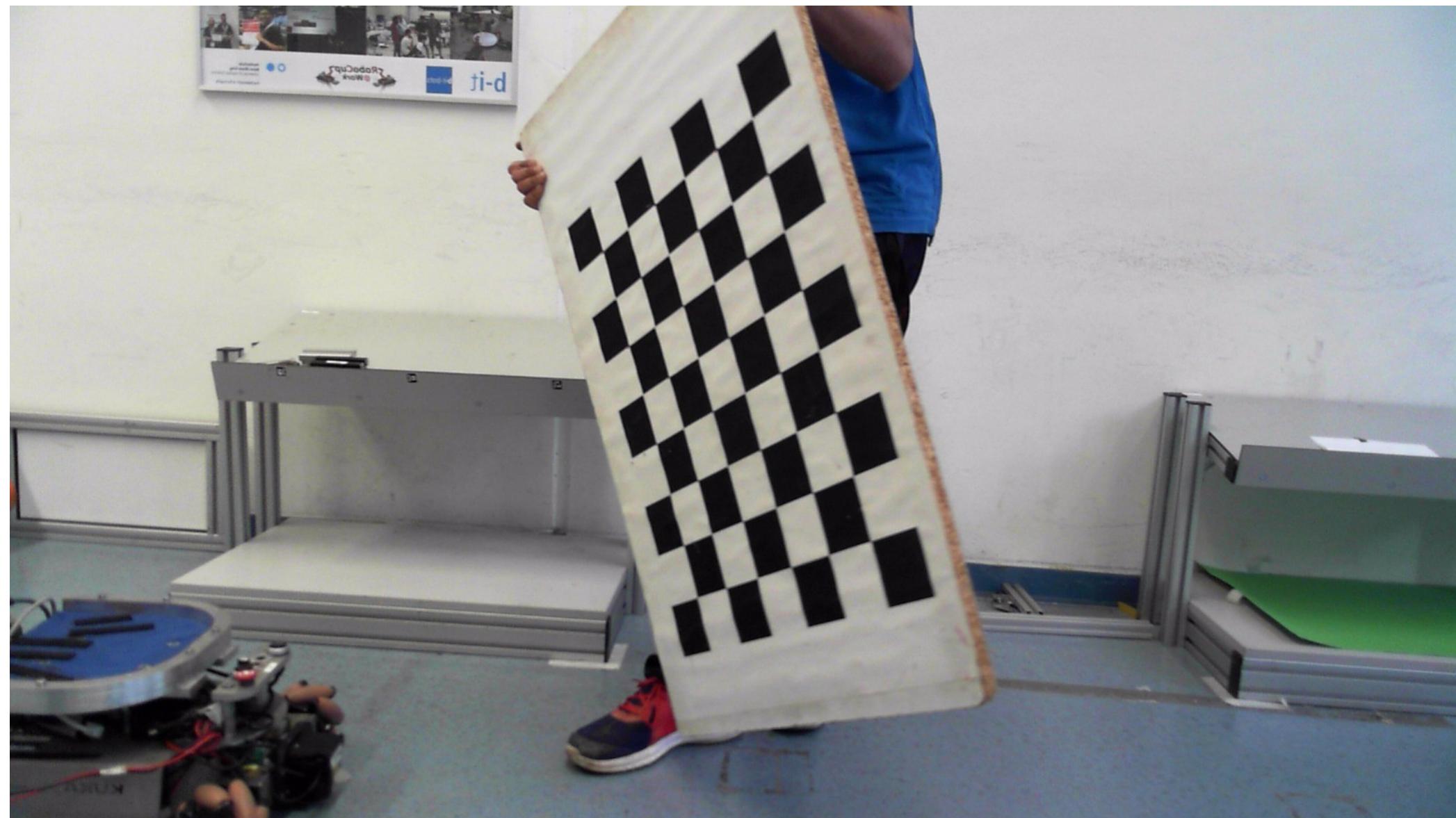
# Applications

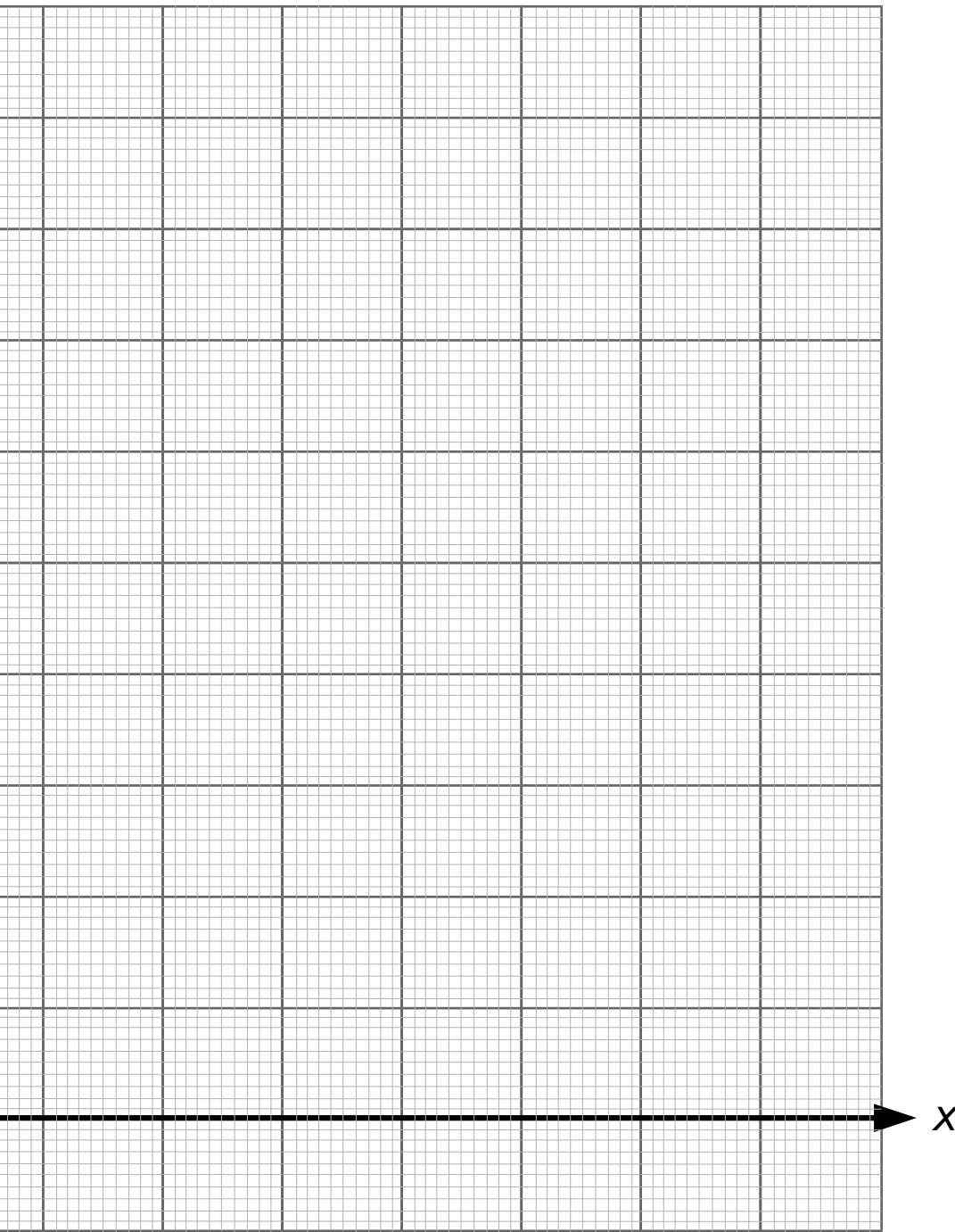
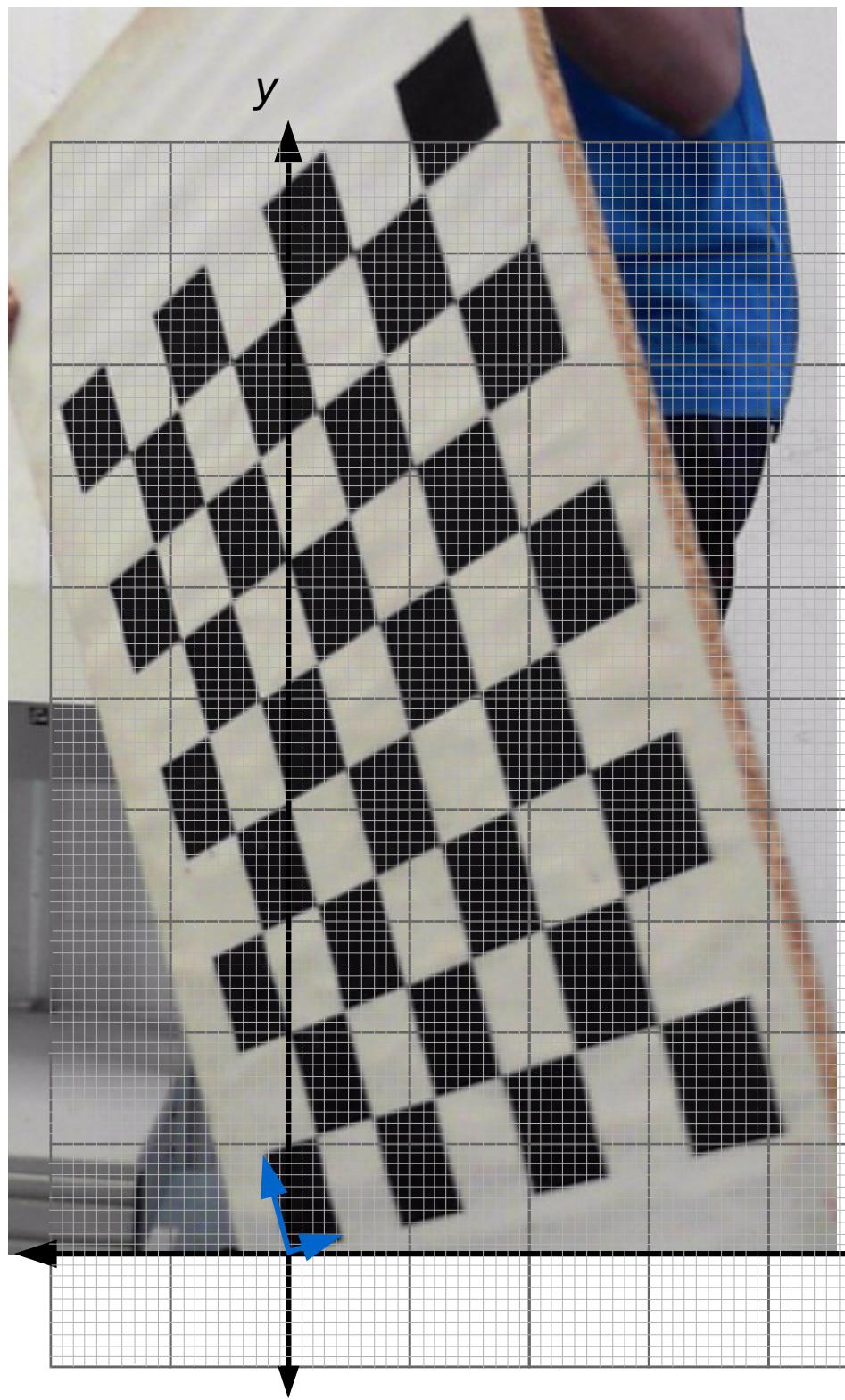
Computer Vision

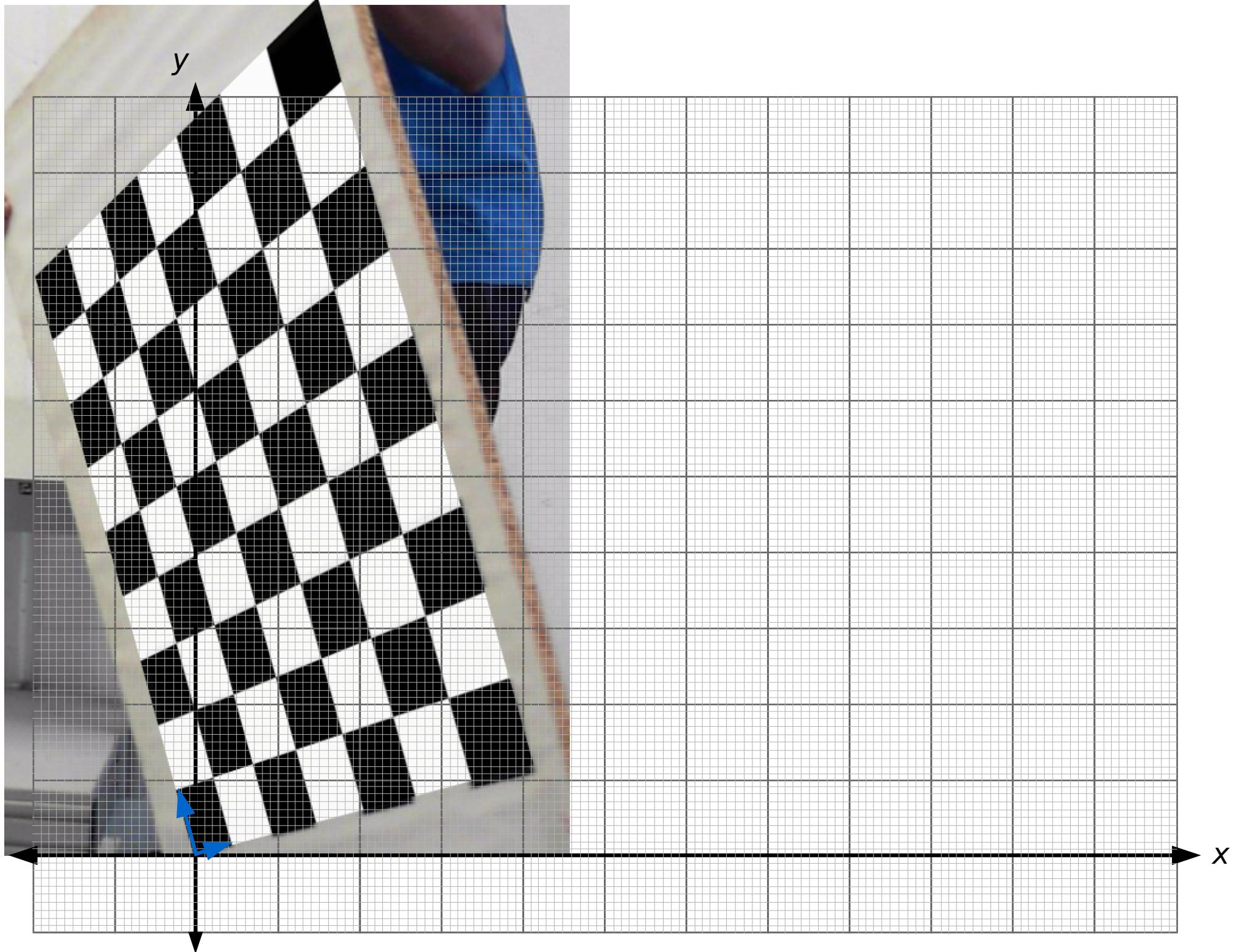


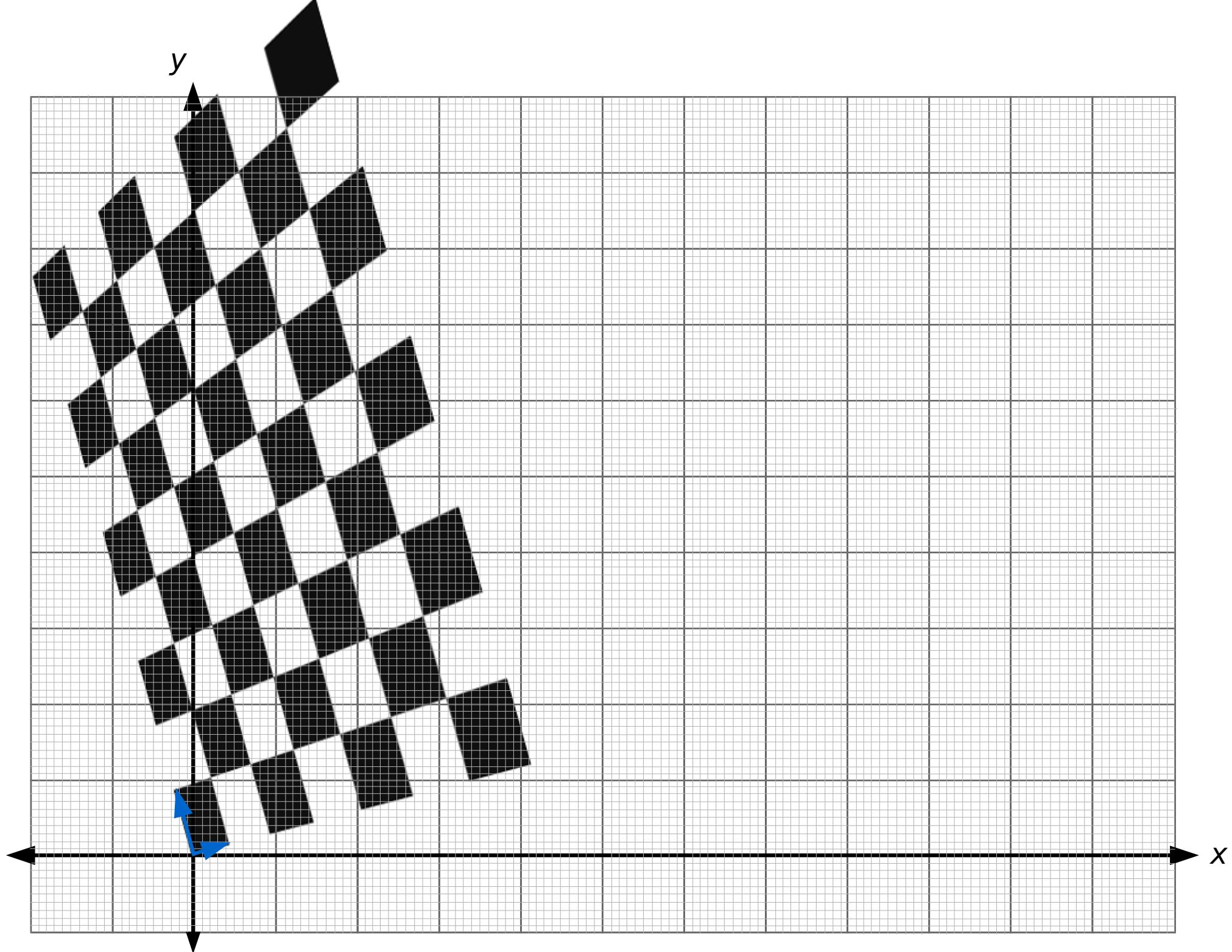






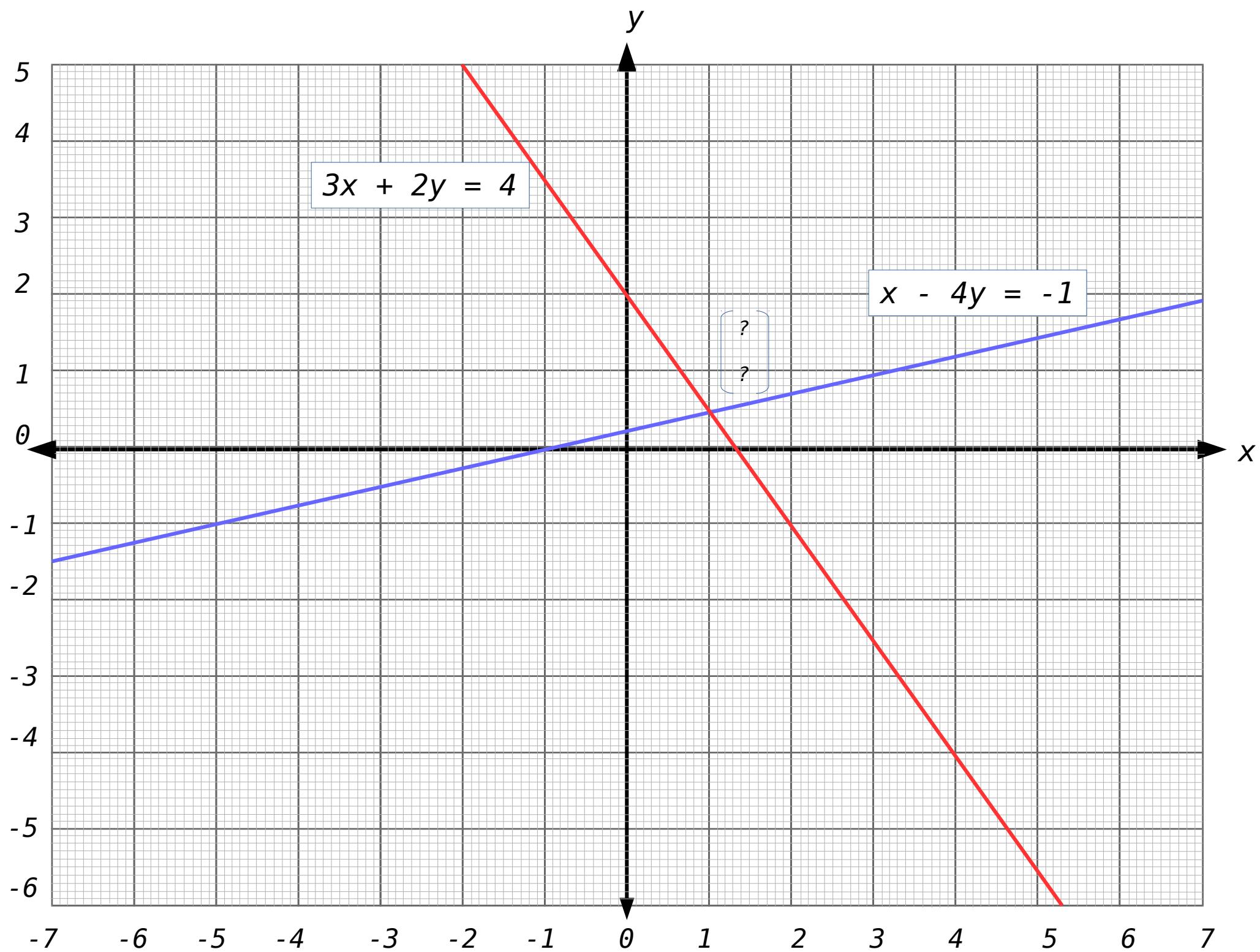






# Applications

System of Equations





# Applications

Data Analysis

*y*



*x*

θ

θ

# Determinant

*y*



*x*

θ

θ



# **Rank of Matrix**

*y*



$\theta$   
 $\theta$

*x*



# **Null and Column Space**

*y*



$\theta$   
 $\theta$

*x*

