COSC 3337 : Data Science I

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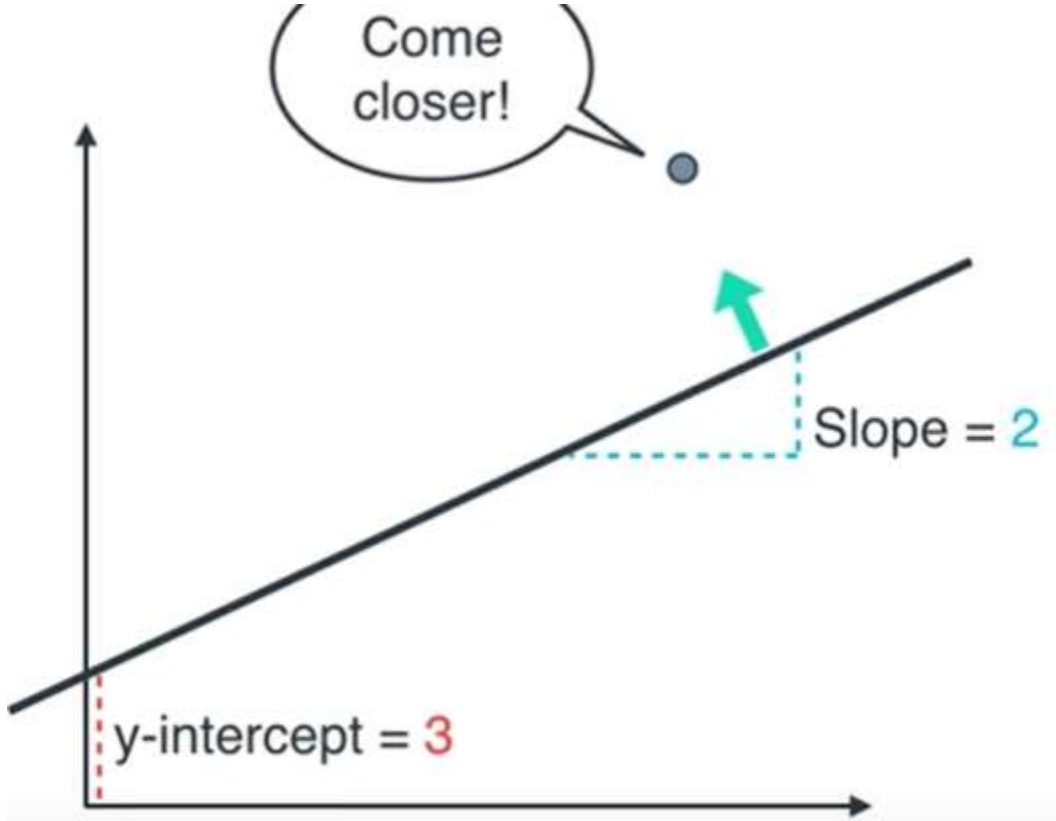
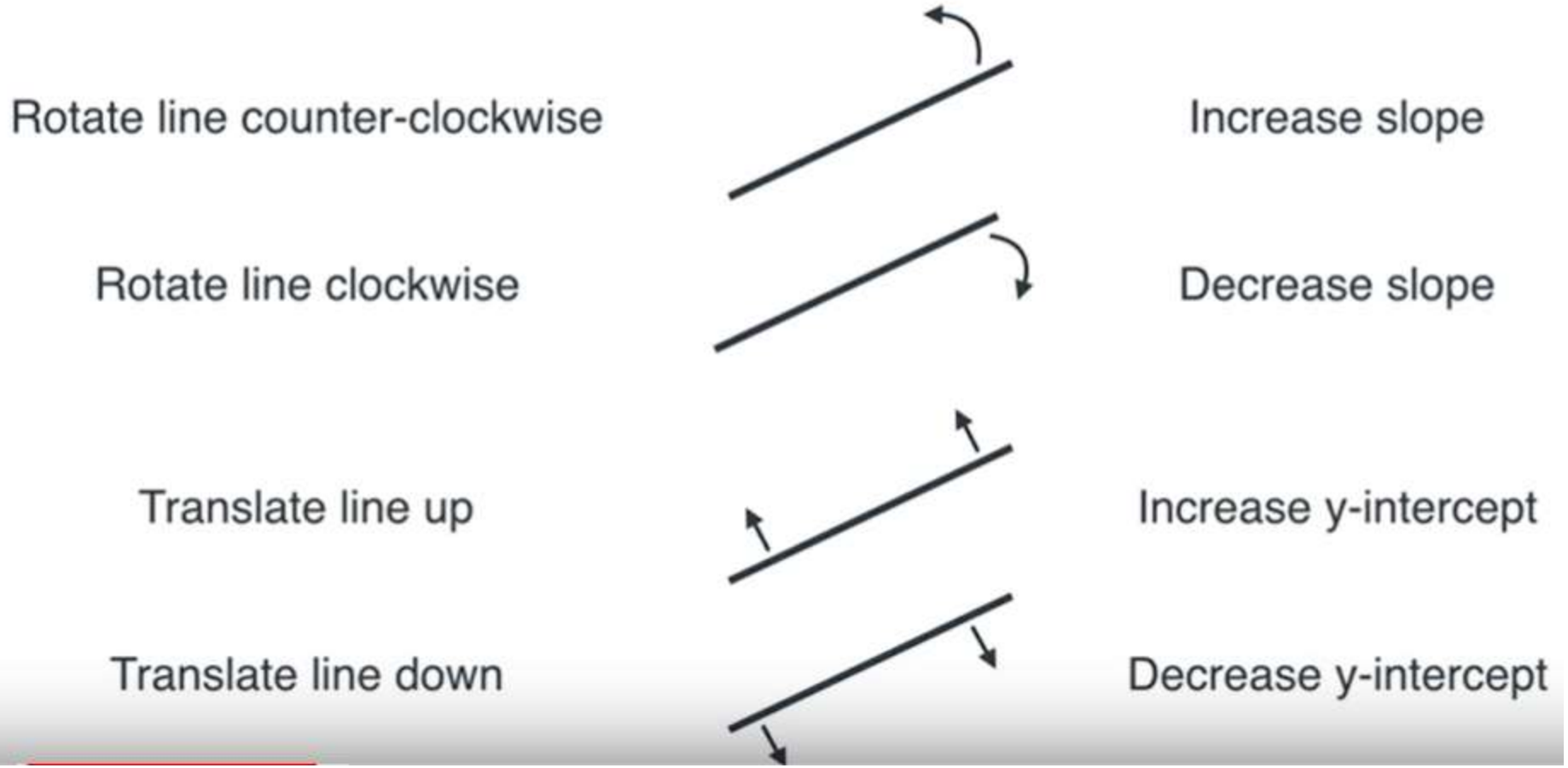
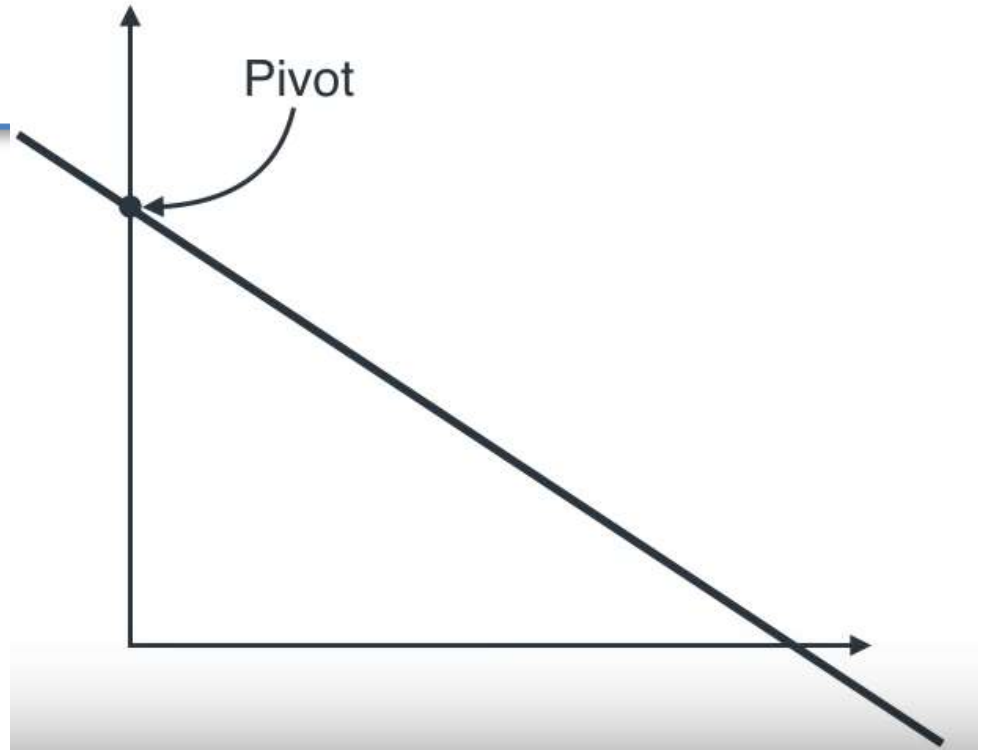
How to move a line

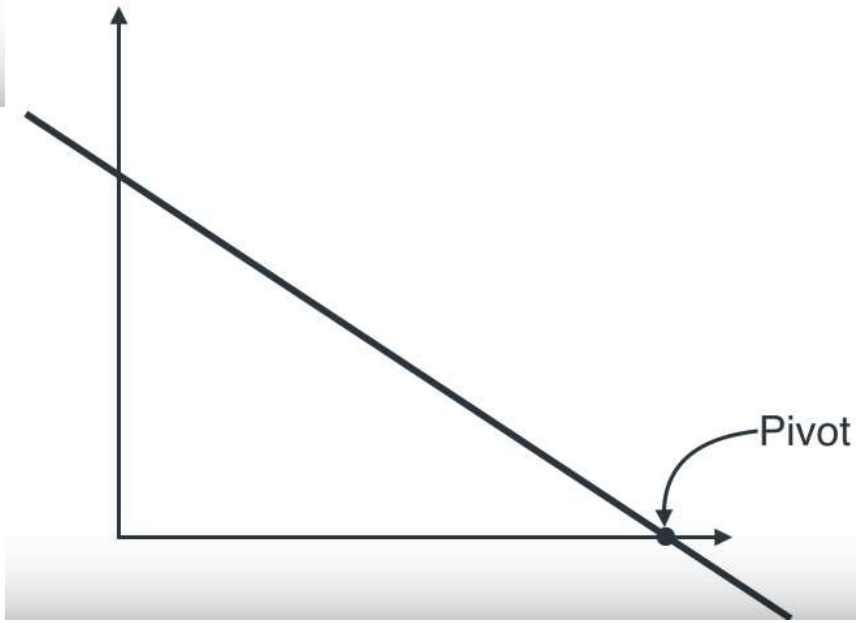


$y = 2x + 3$

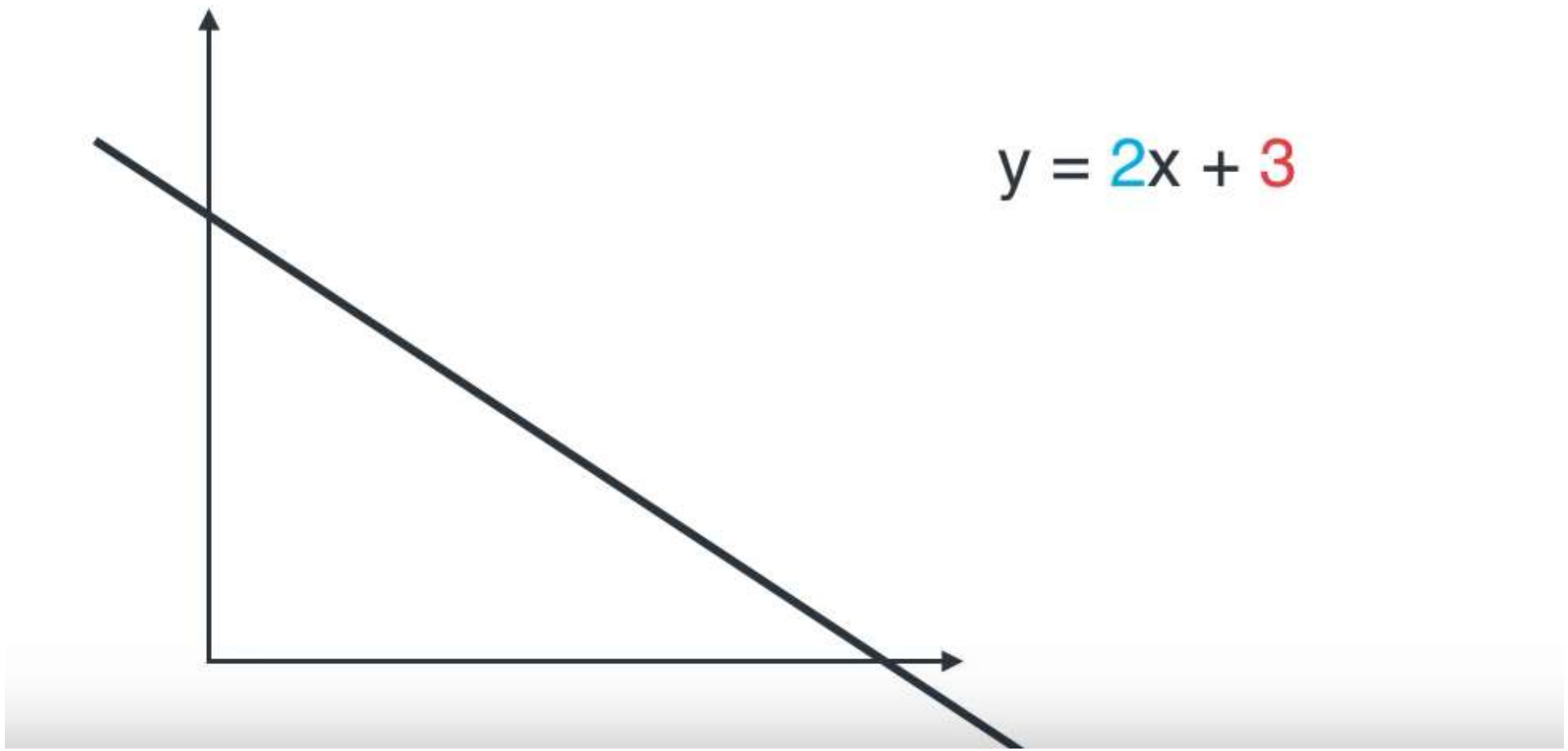
How to move a line




Pivot

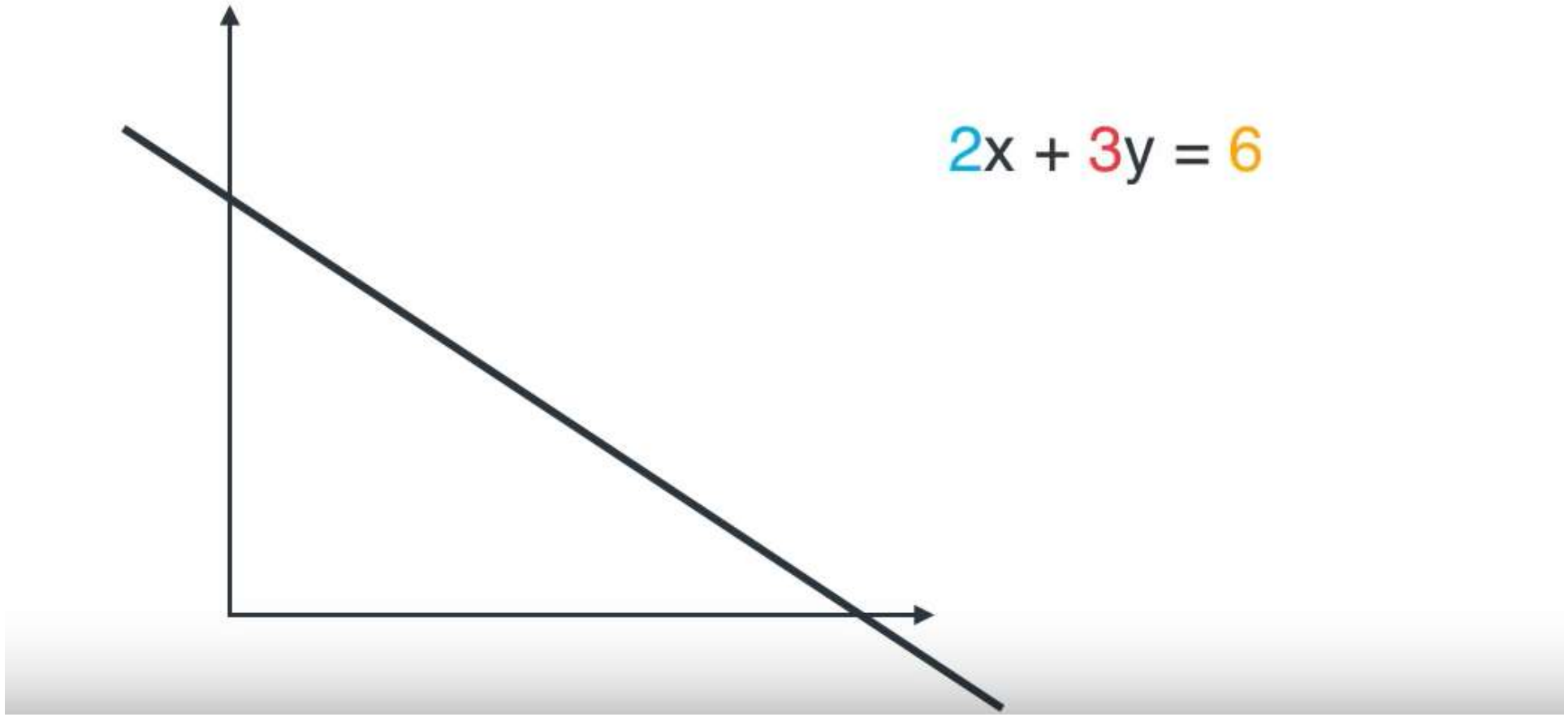

Pivot

Rotating and translating



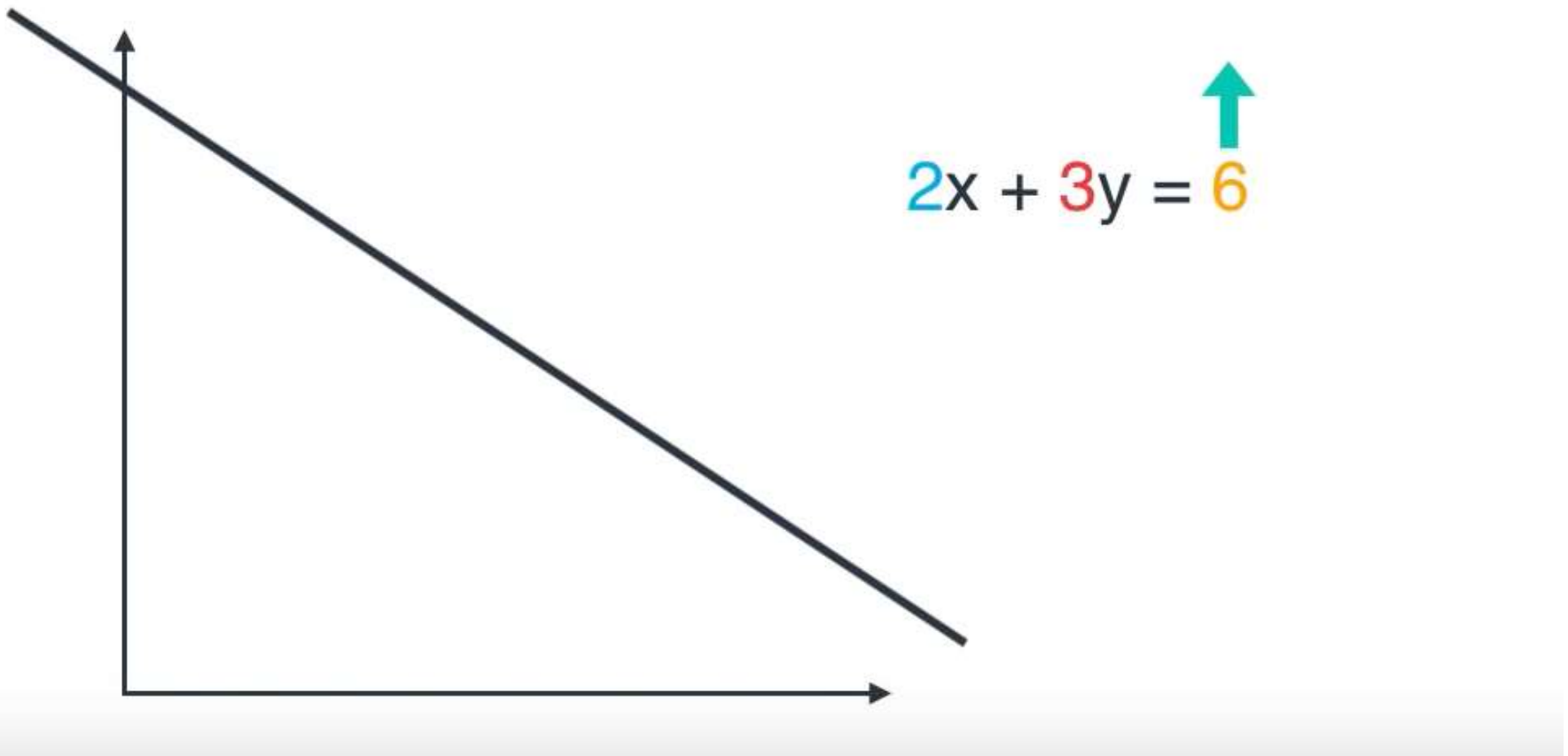
$$y = 2x + 3$$

Rotating and translating

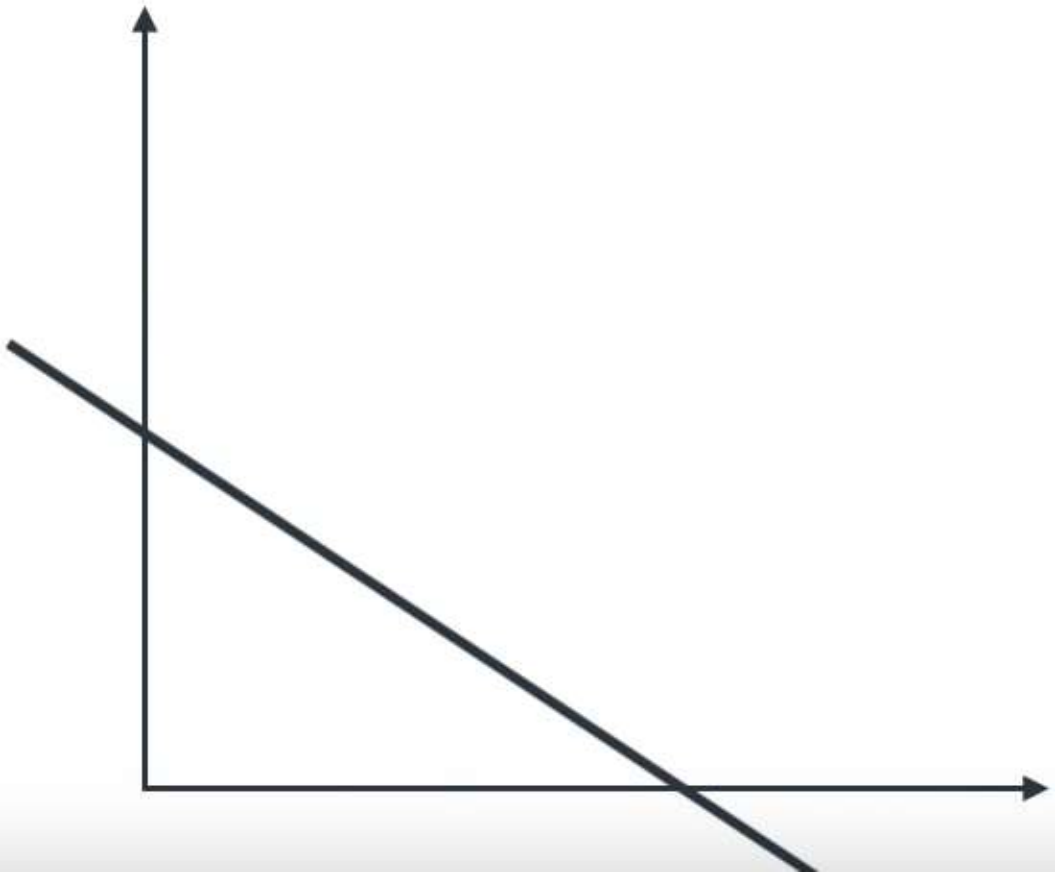


$$2x + 3y = 6$$

Rotating and translating

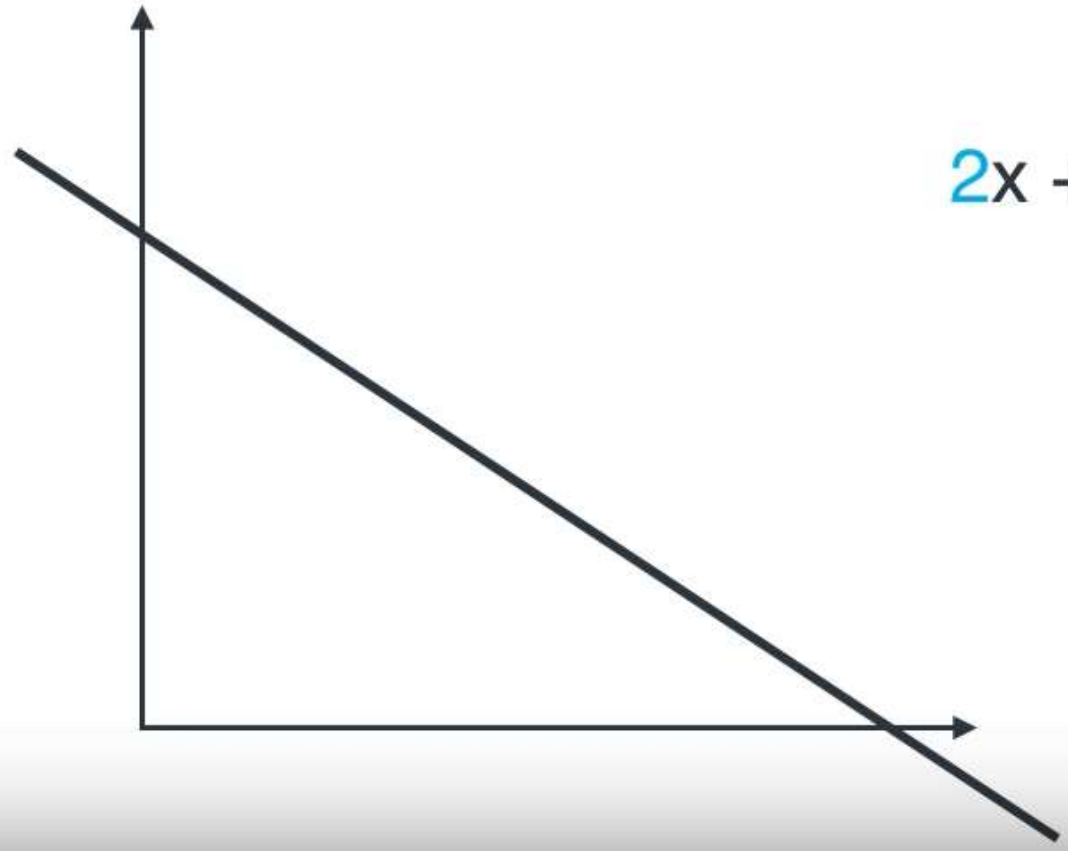


Rotating and translating



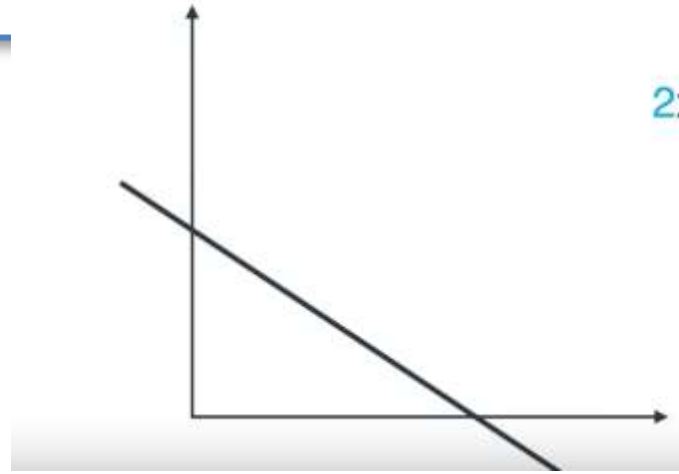
$$2x + 3y = 6$$

Rotating and translating



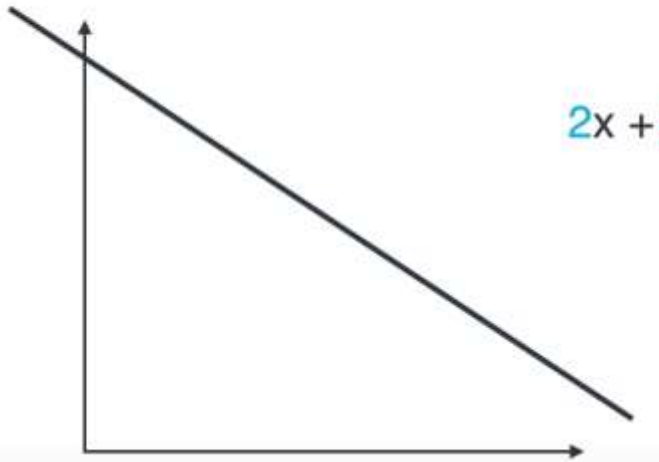
$$2x + 3y + (-6) = 0$$

Rotating and translating



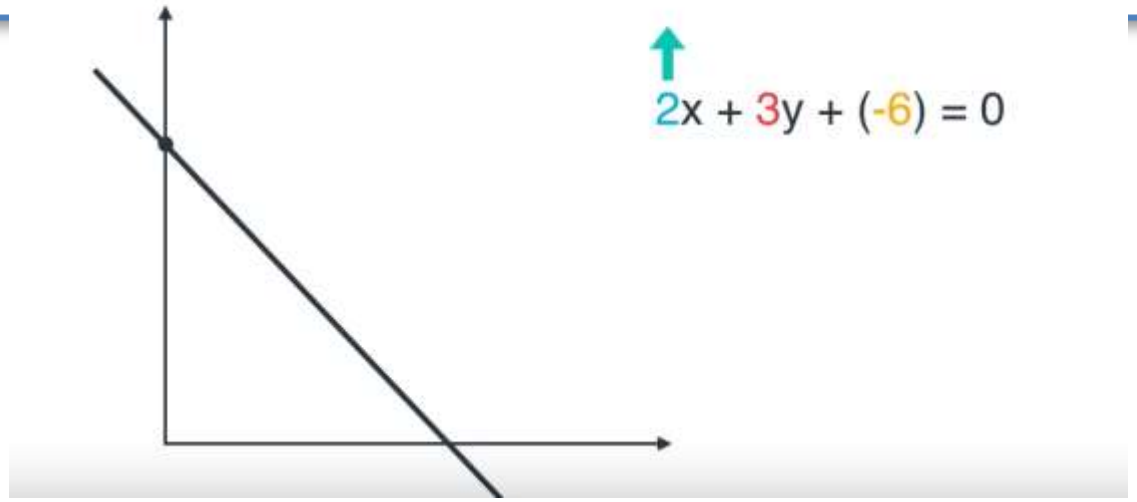
$$2x + 3y + (-6) = 0$$

Rotating and translating

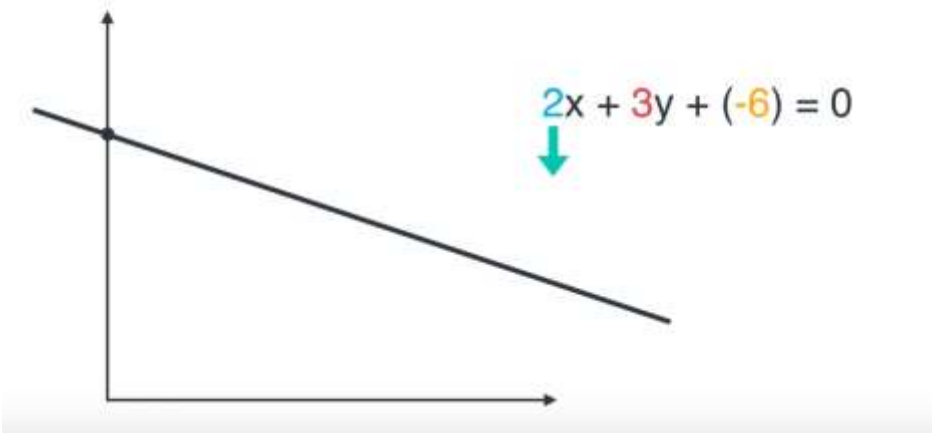


$$2x + 3y + (-6) = 0$$

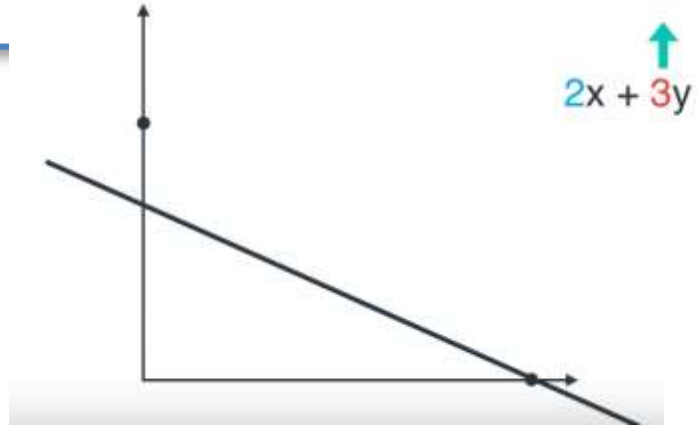
Rotating and translating



Rotating and translating

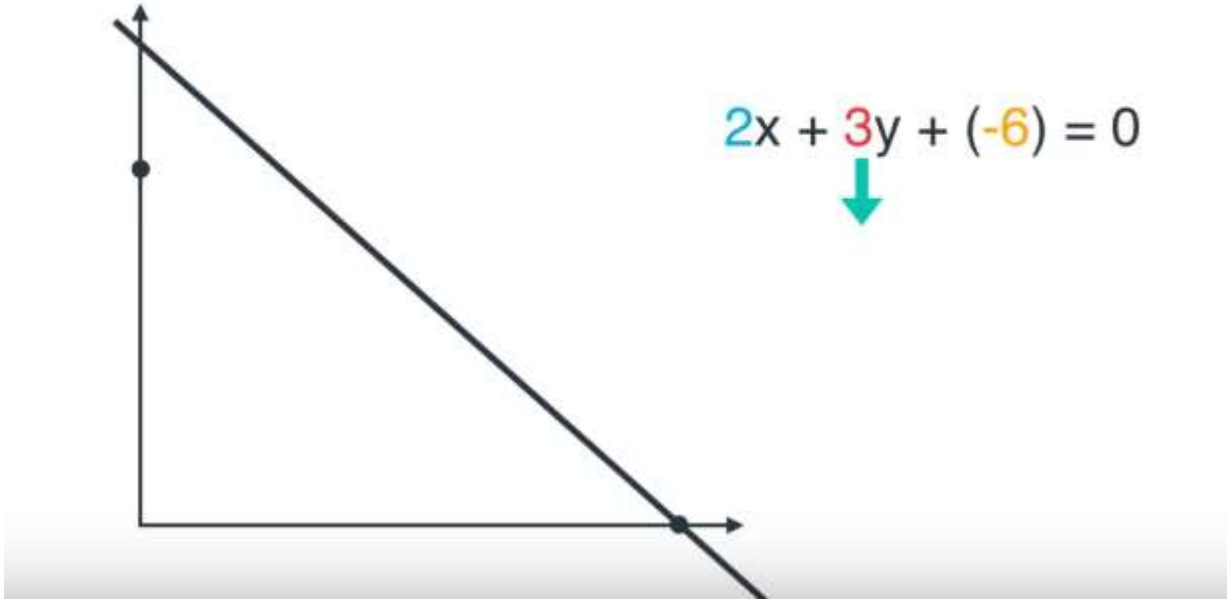


Rotating and translating



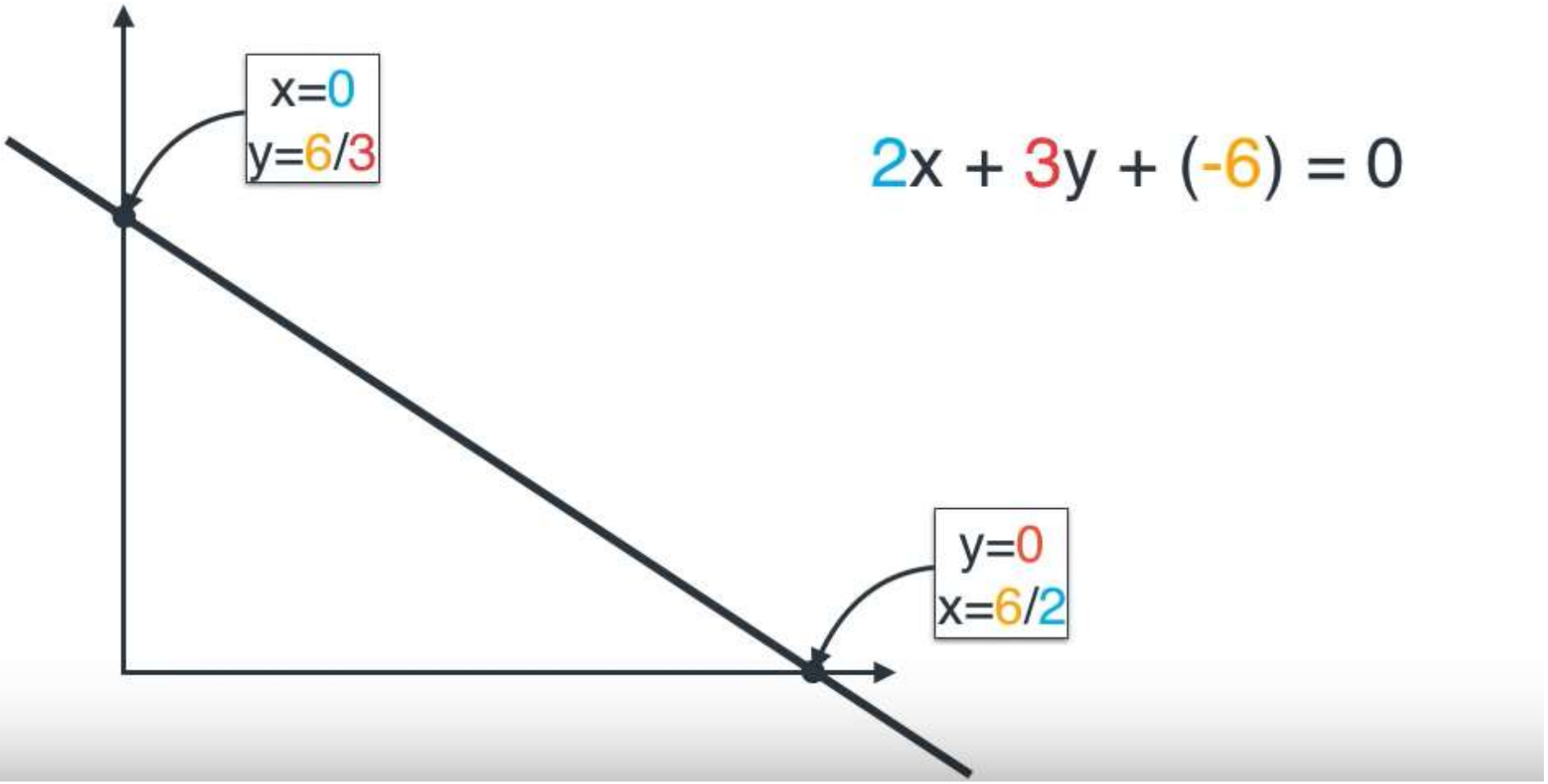
$2x + 3y + (-6) = 0$

Rotating and translating



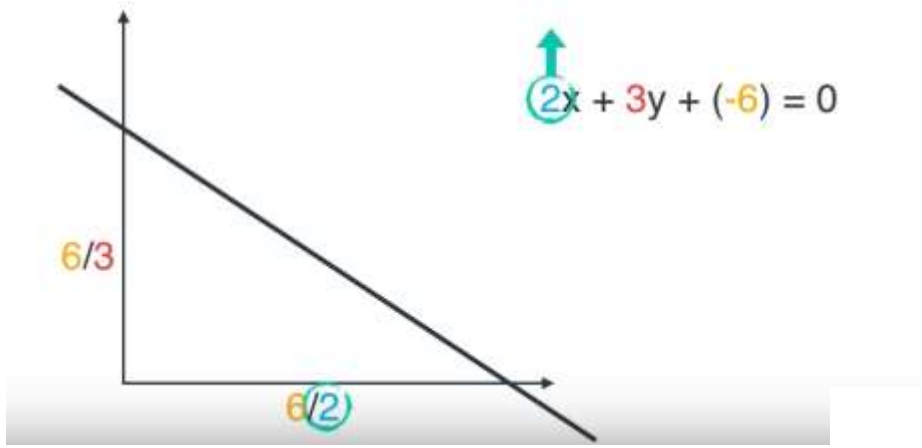
$2x + 3y + (-6) = 0$

Rotating and translating

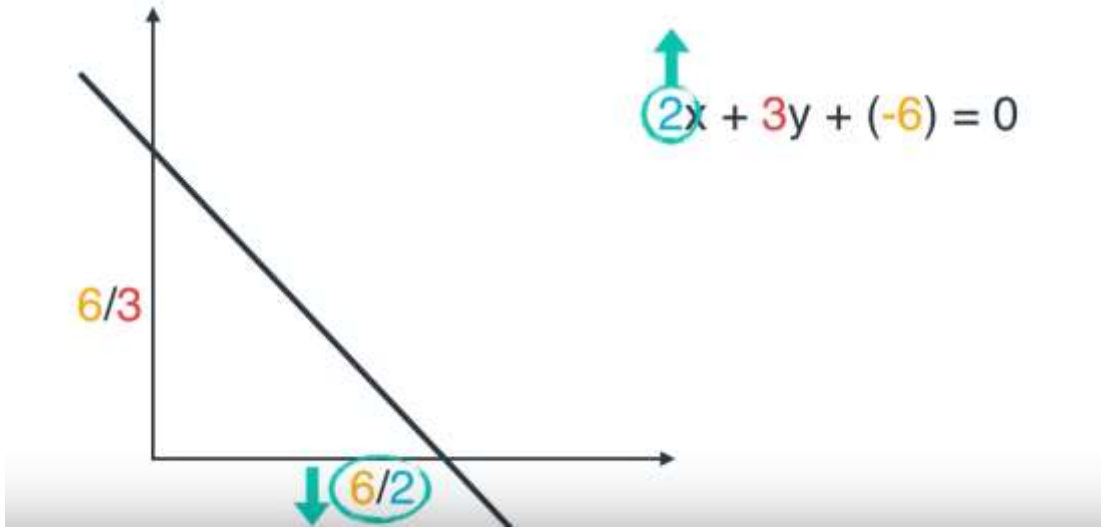


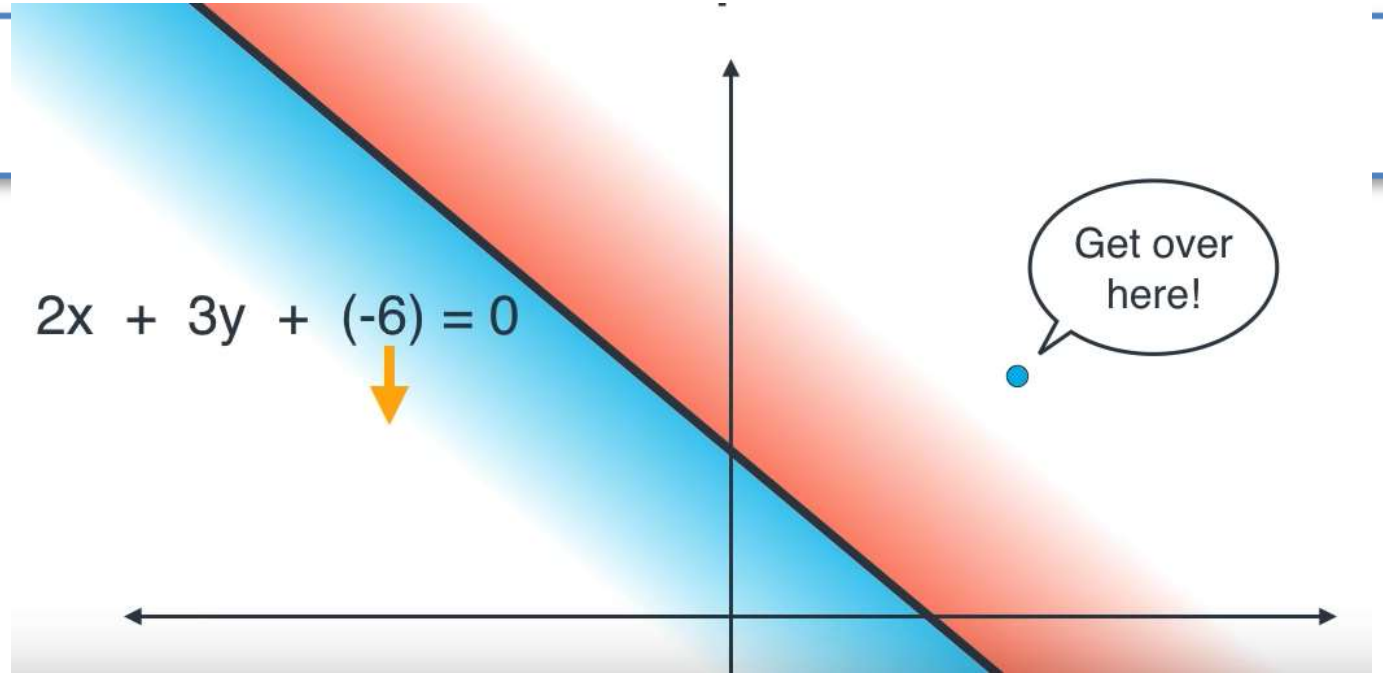
$$2x + 3y + (-6) = 0$$

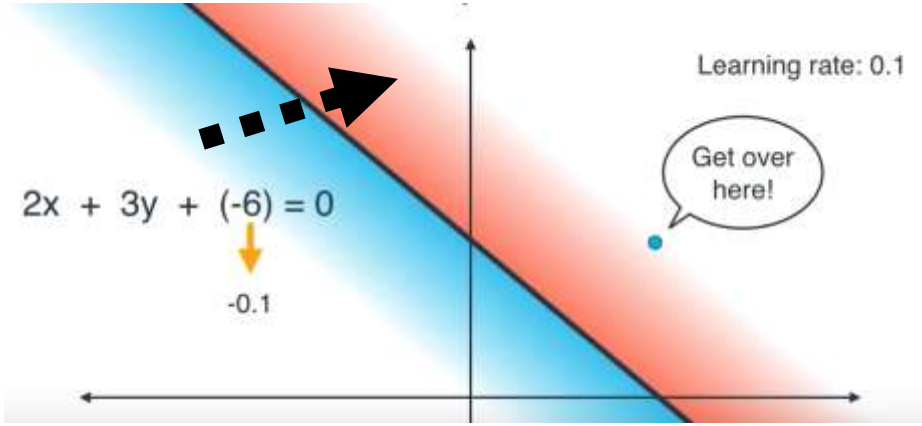
Rotating and translating

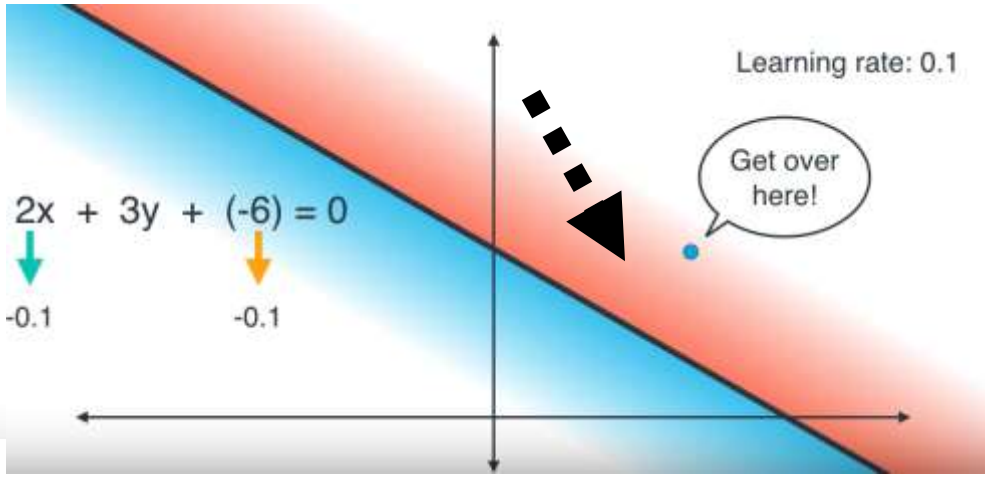


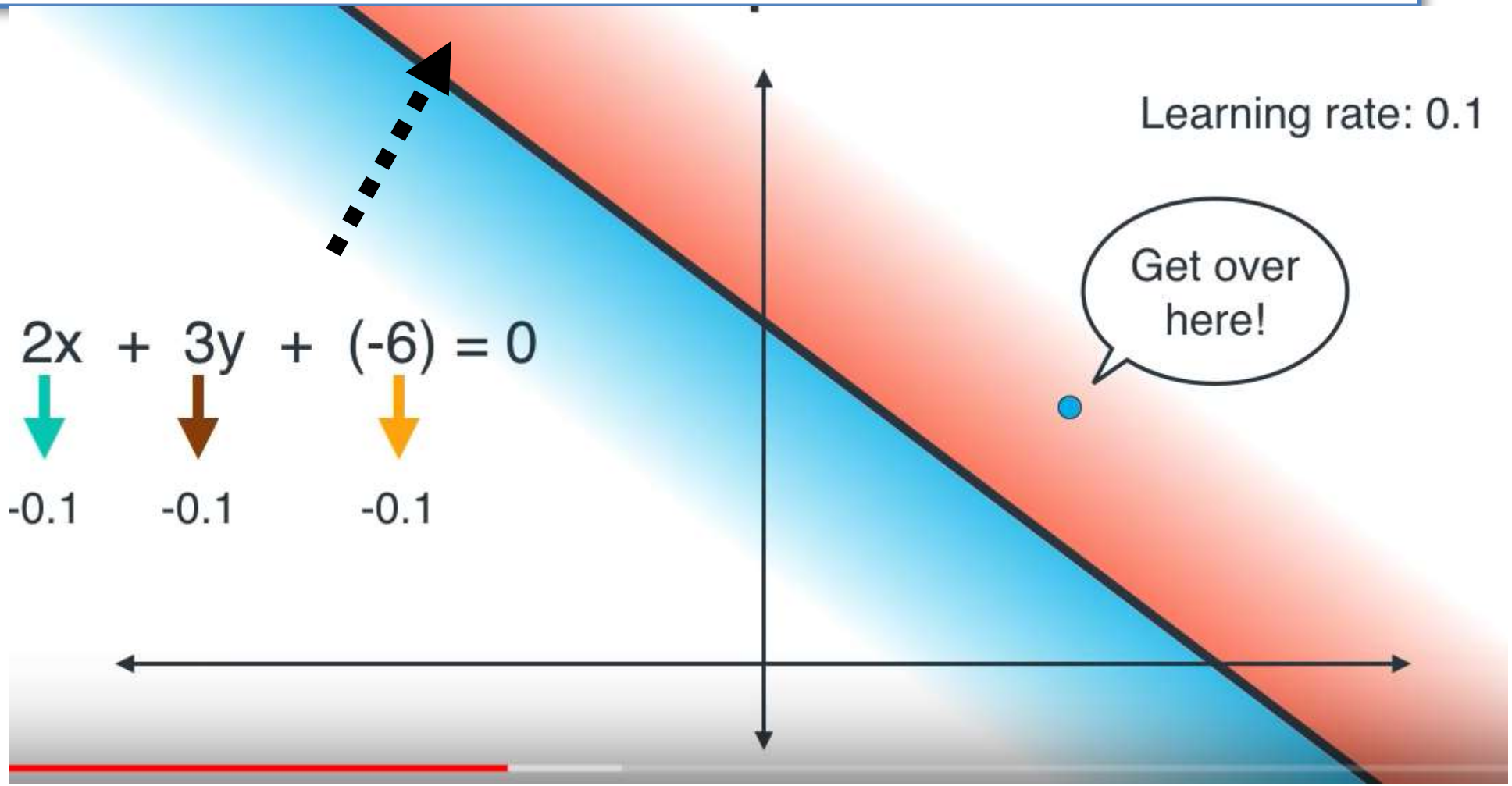
Rotating and translating

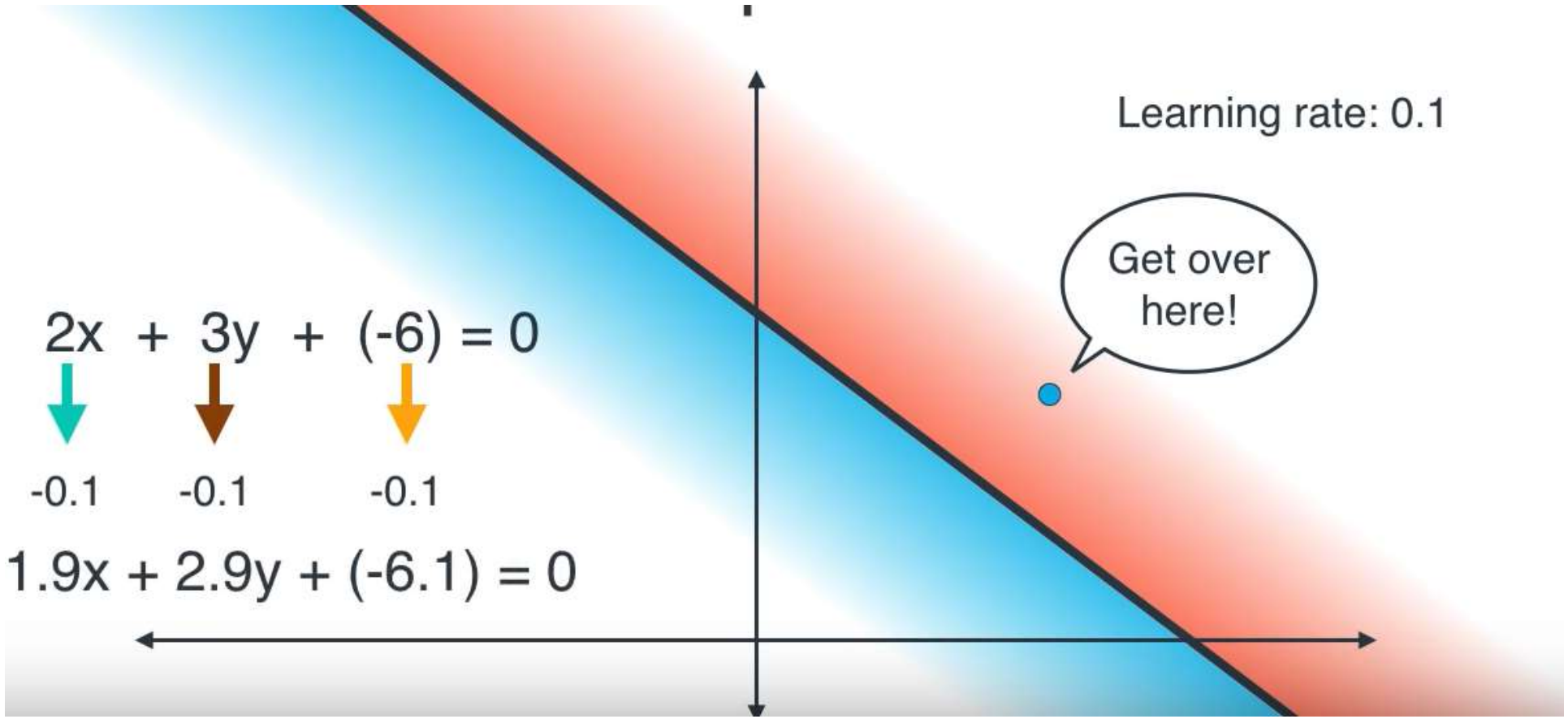


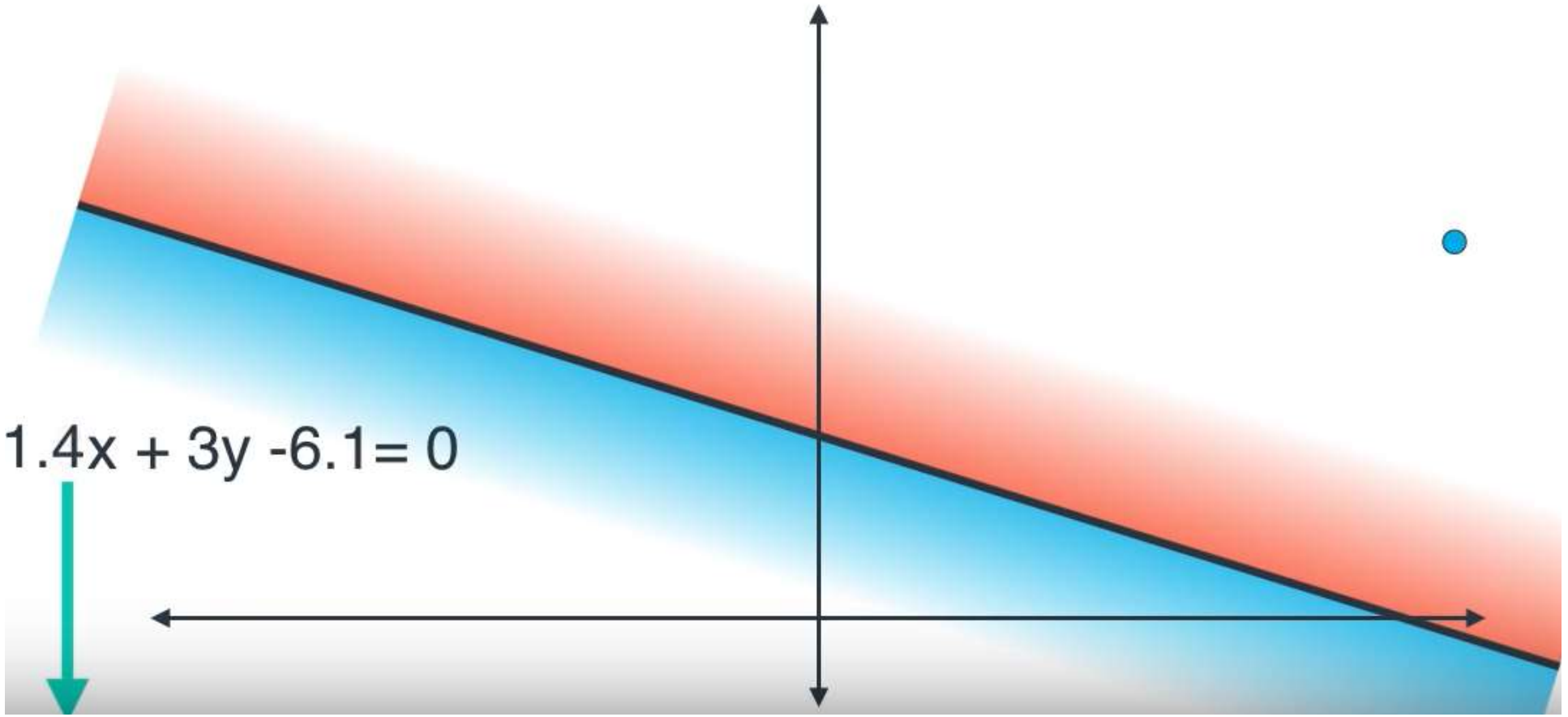

2x + 3y + (-6) = 0
Get over here!

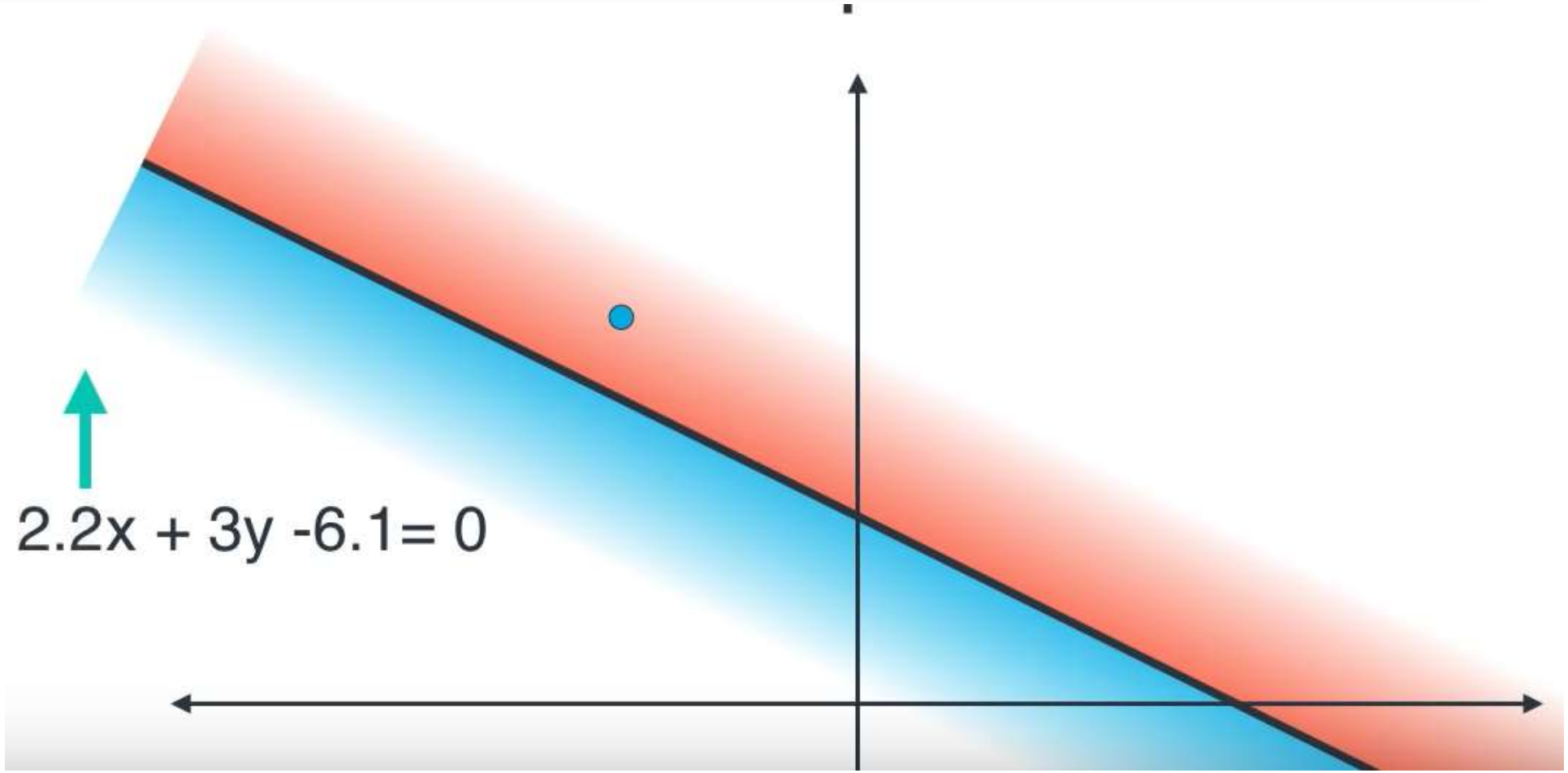

Learning rate: 0.1
2x + 3y + (-6) = 0
-0.1
Get over here!


Learning rate: 0.1
2x + 3y + (-6) = 0
-0.1
-0.1
Get over here!

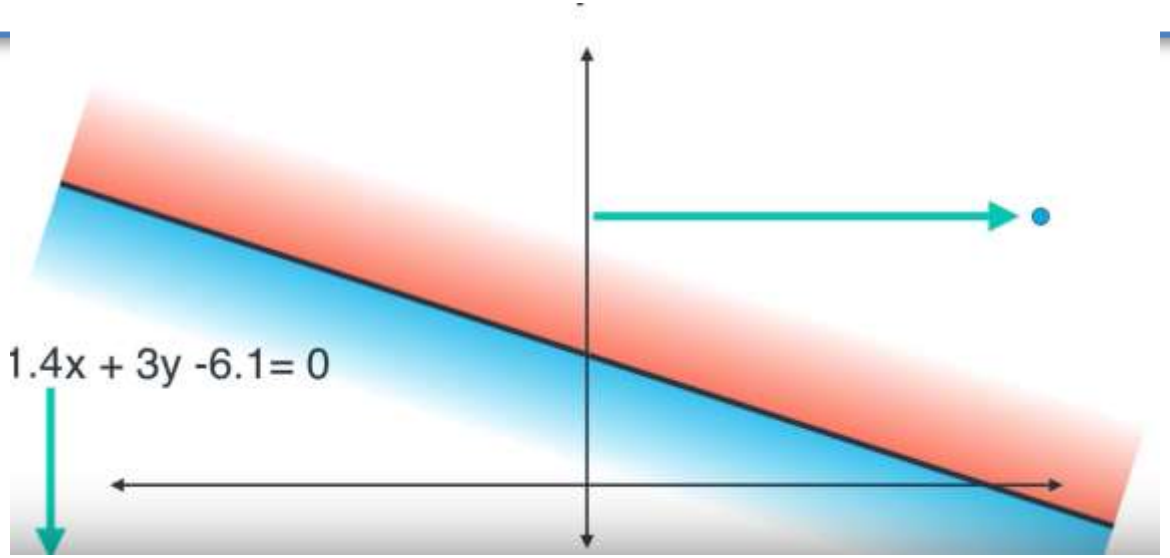

Learning rate: 0.1
Get over here!
2x + 3y + (-6) = 0
-0.1
-0.1
-0.1

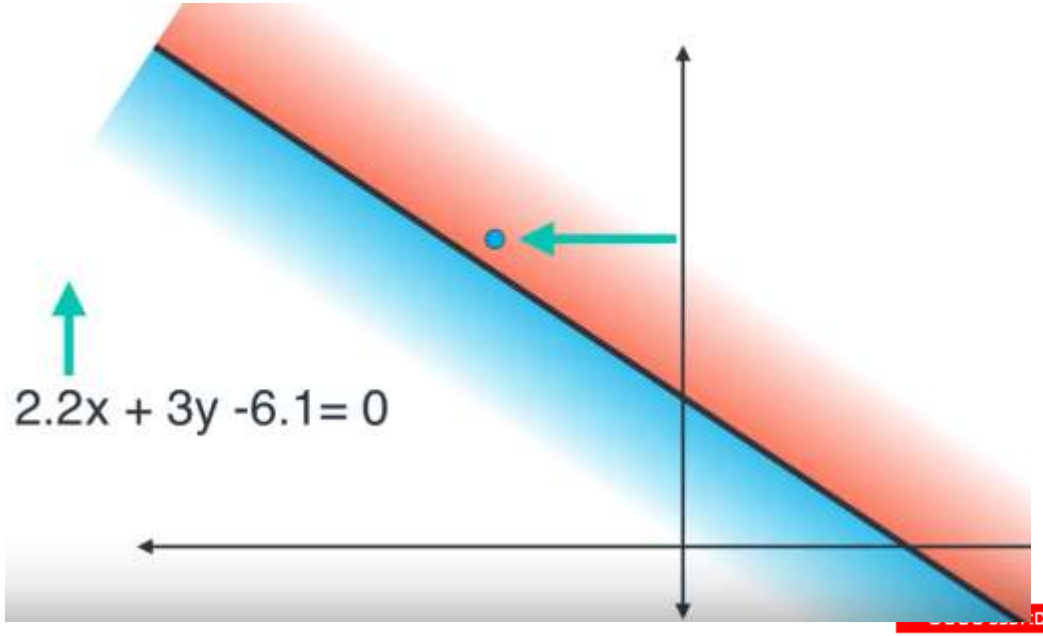

Learning rate: 0.1
Get over here!
2x + 3y + (-6) = 0
-0.1 -0.1 -0.1
1.9x + 2.9y + (-6.1) = 0

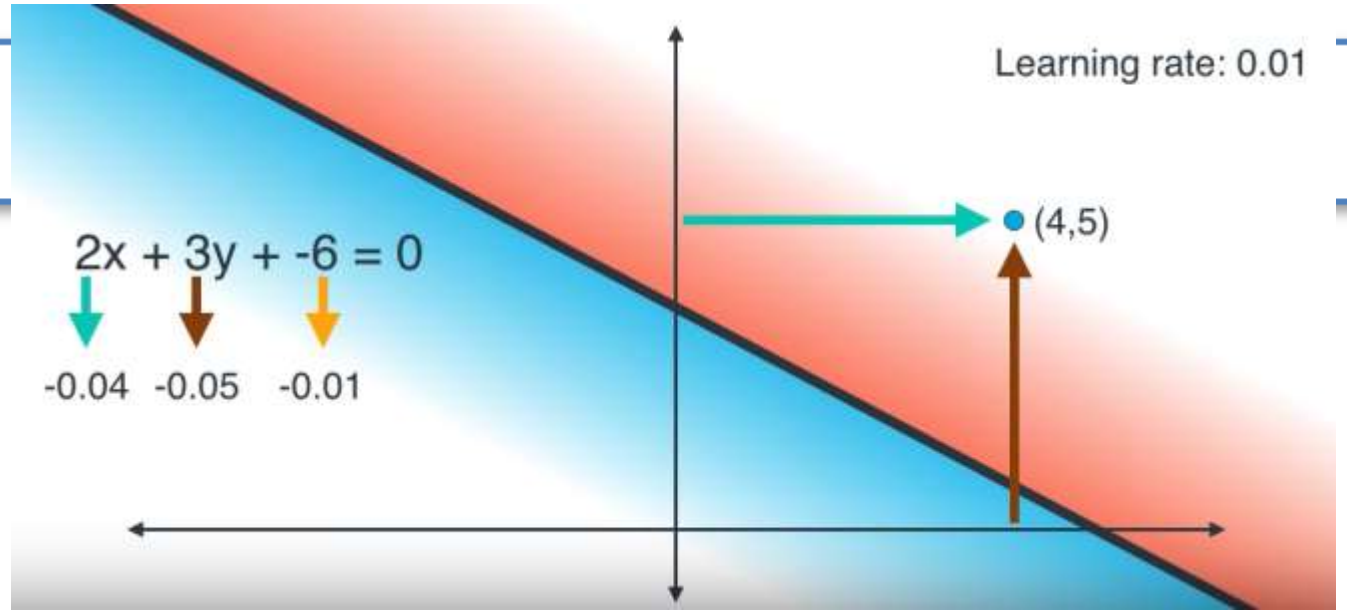

1.4x + 3y -6.1= 0

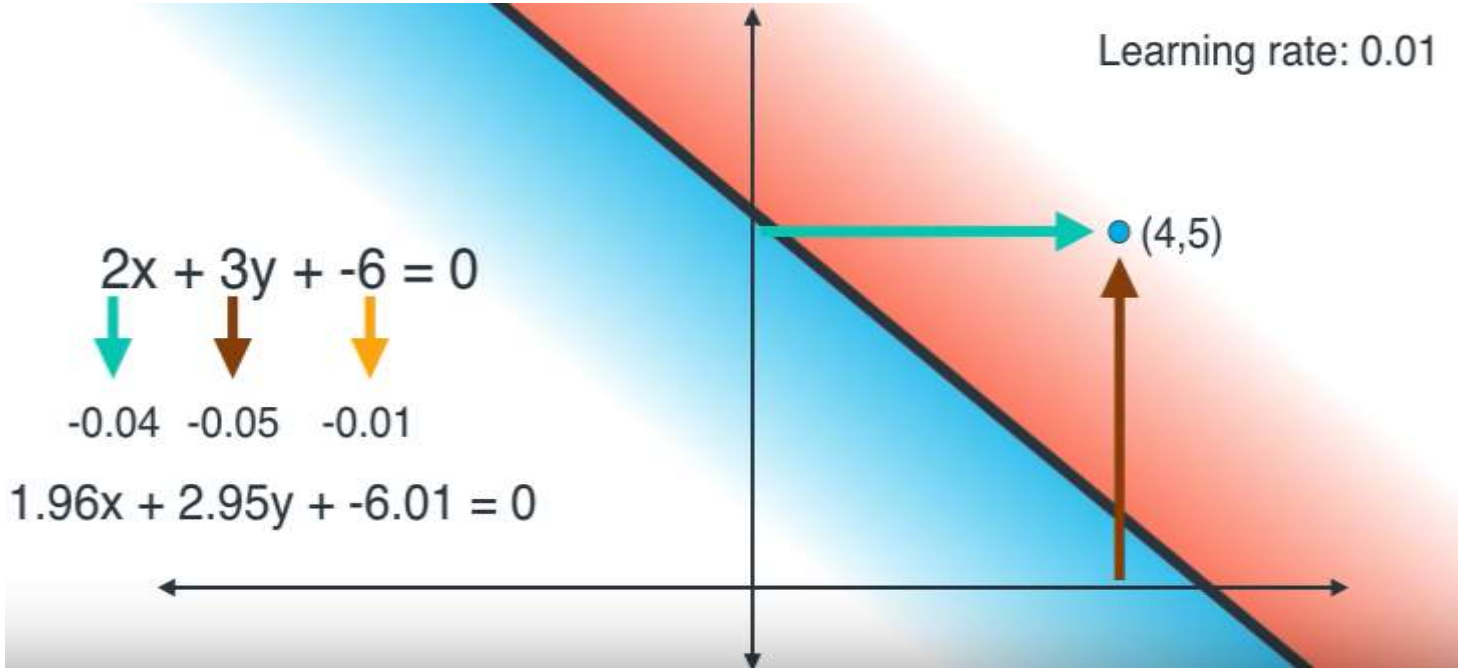

2.2x + 3y -6.1= 0

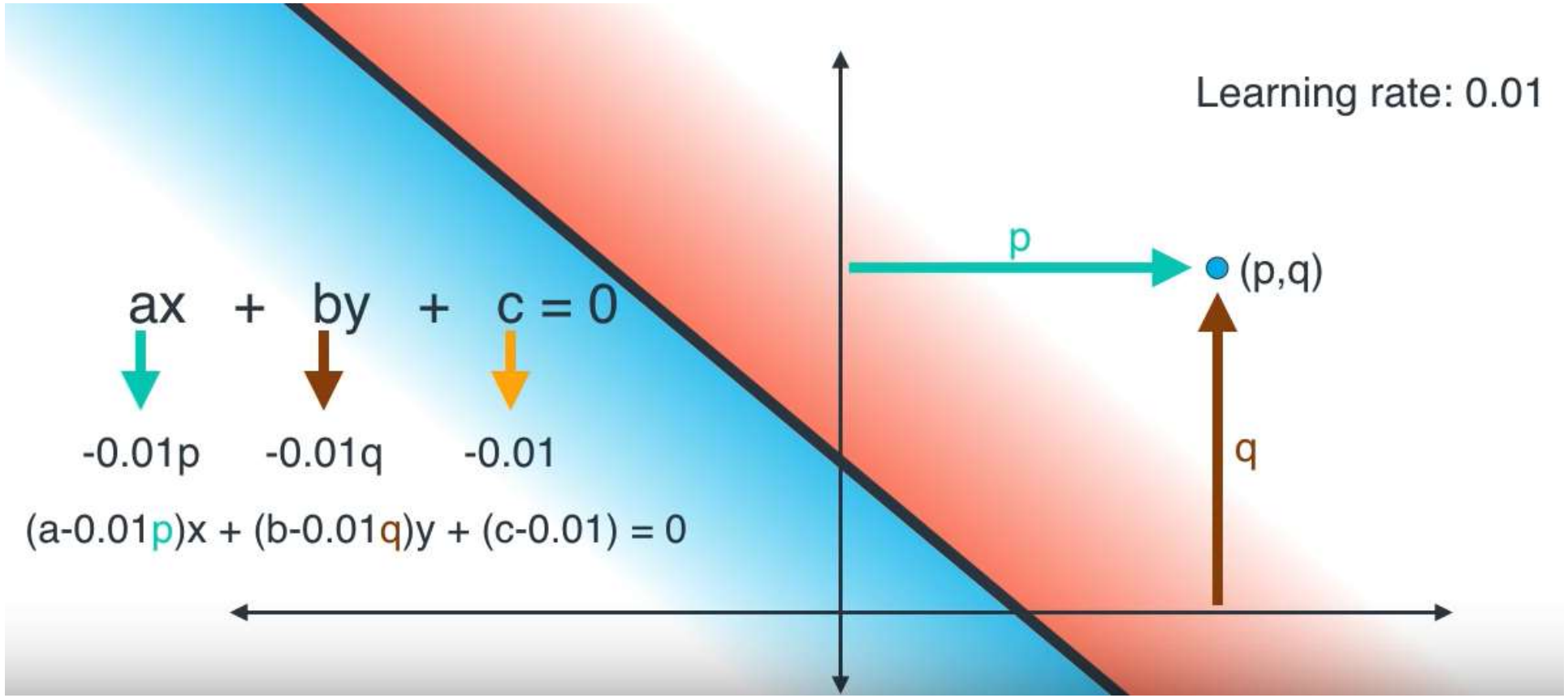
Not in the right direction!



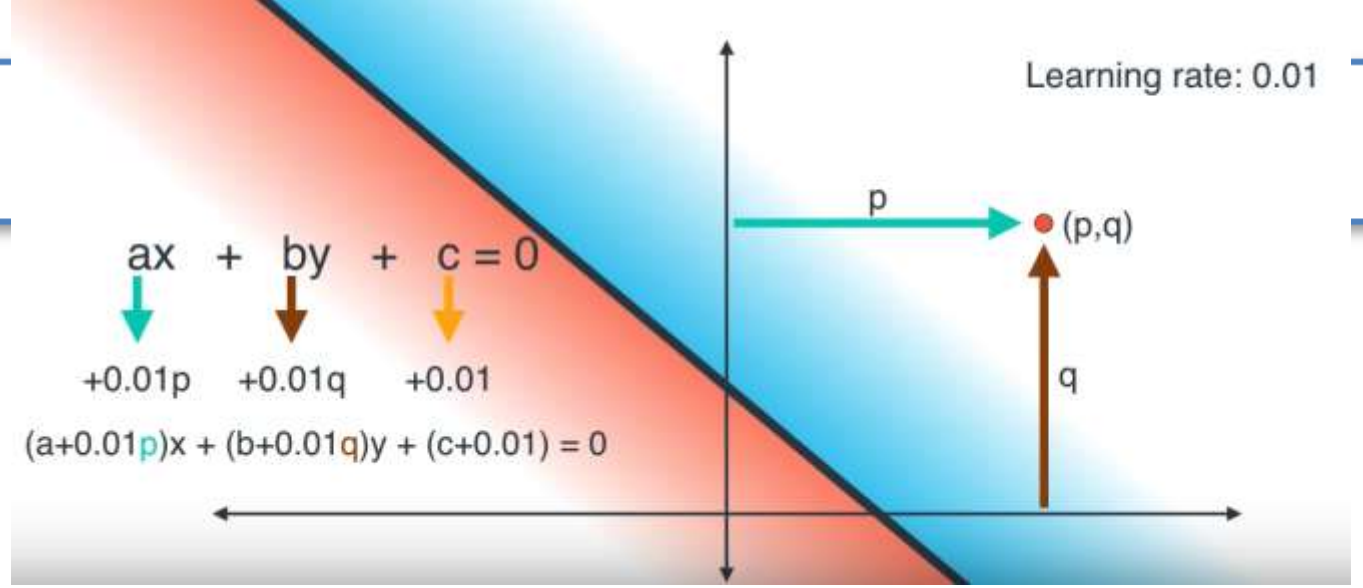



Learning rate: 0.01
(4,5)
2x + 3y + -6 = 0
-0.04 -0.05 -0.01

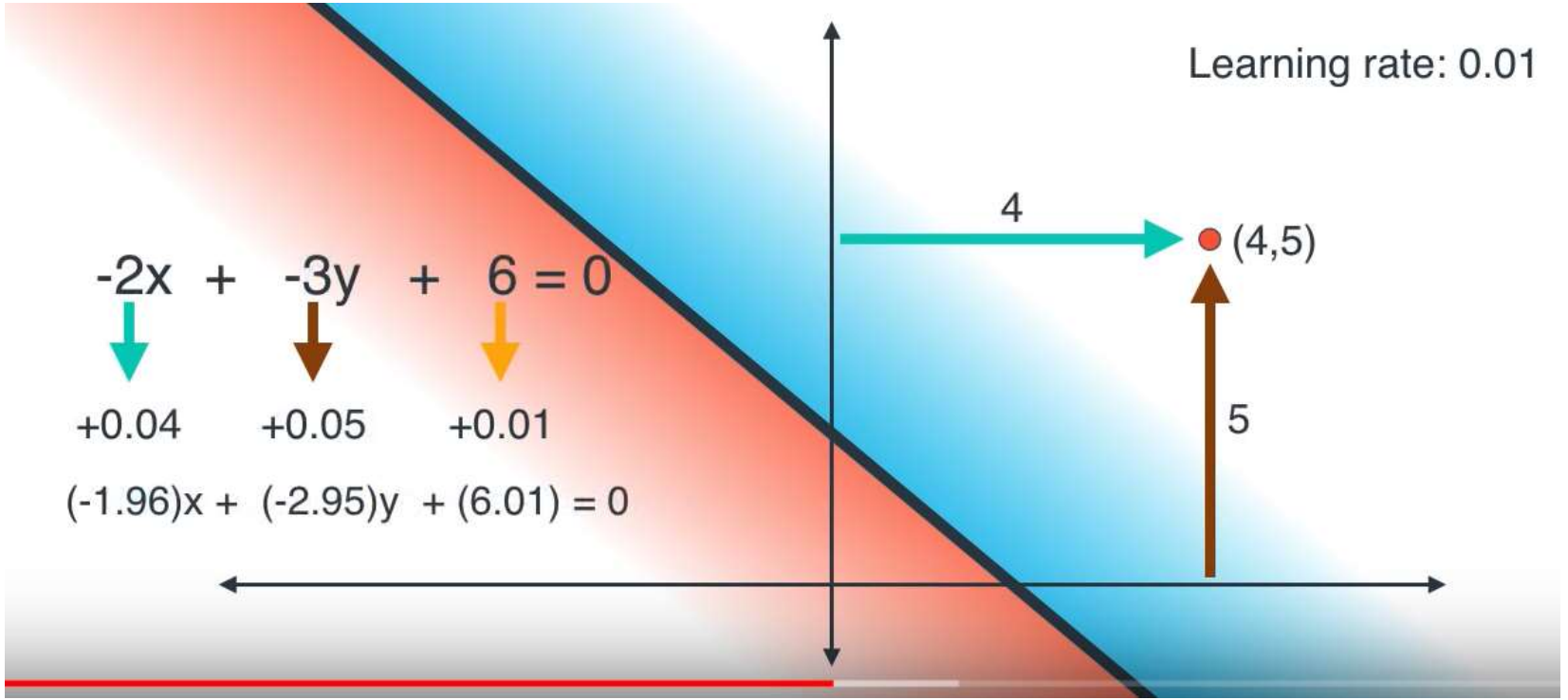

Learning rate: 0.01
(4,5)
2x + 3y + -6 = 0
-0.04 -0.05 -0.01
1.96x + 2.95y + -6.01 = 0



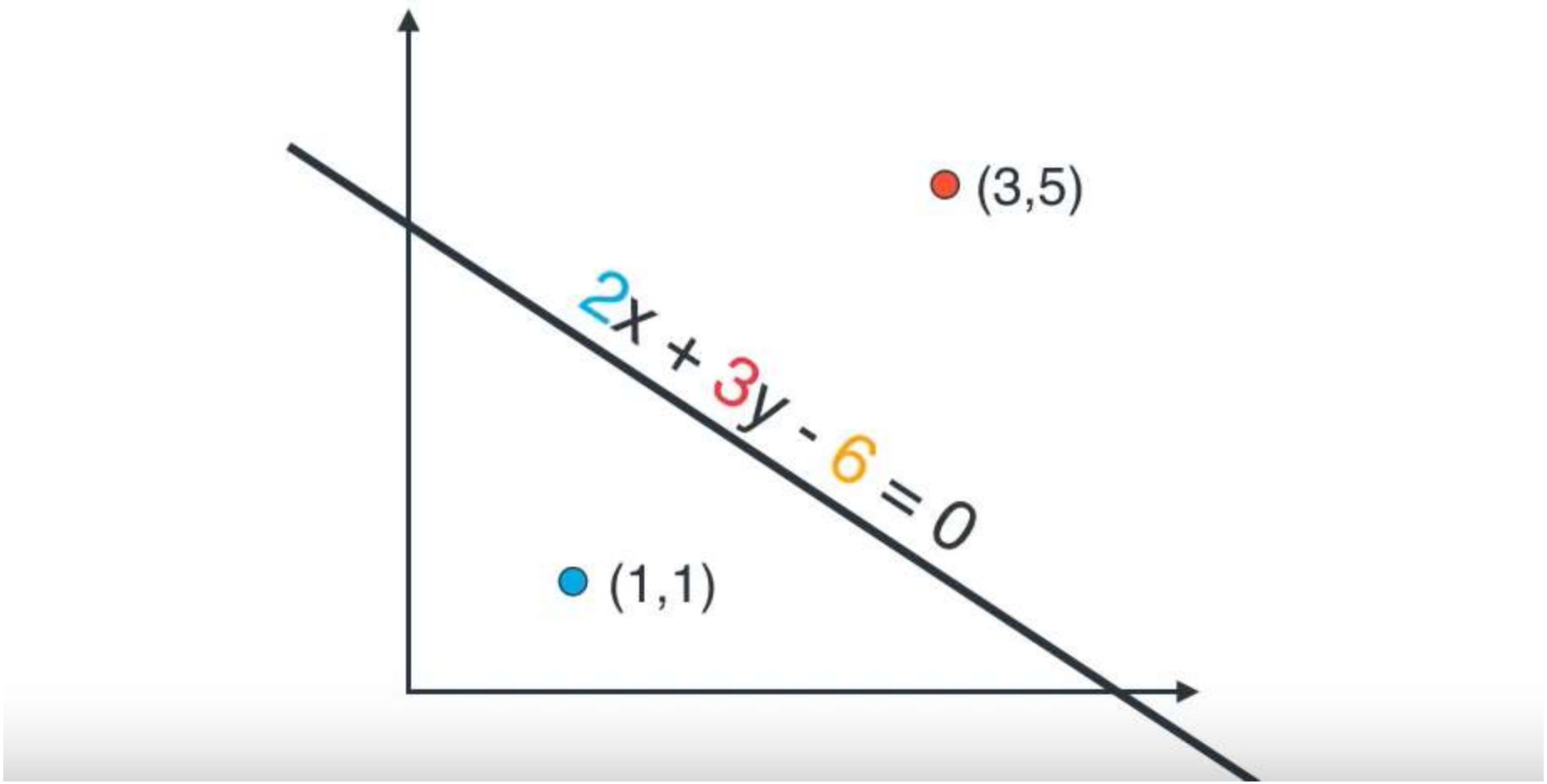
Blue dot in the red area➔ -0.01



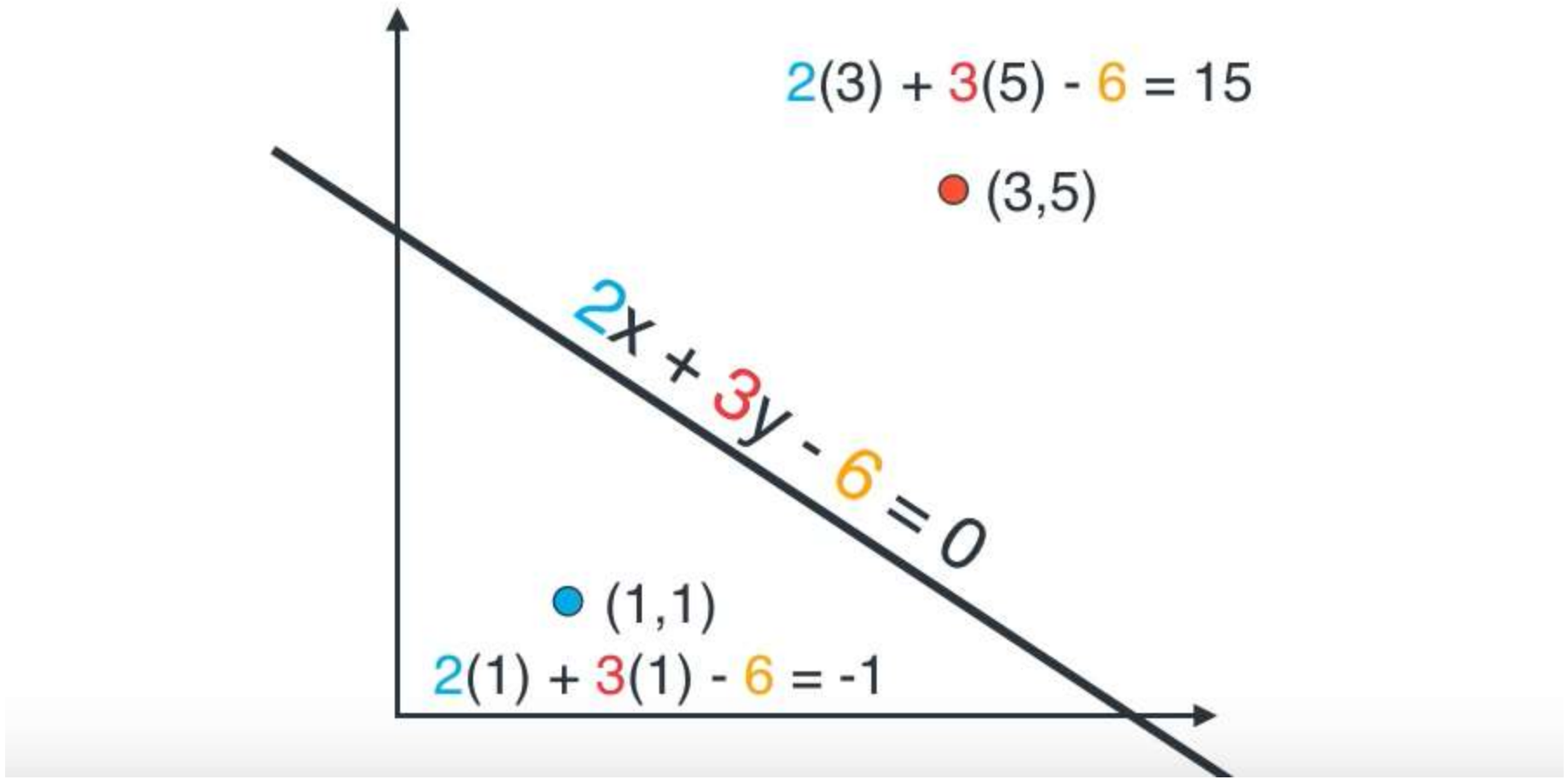
Red dot in the blue area➔ +0.01



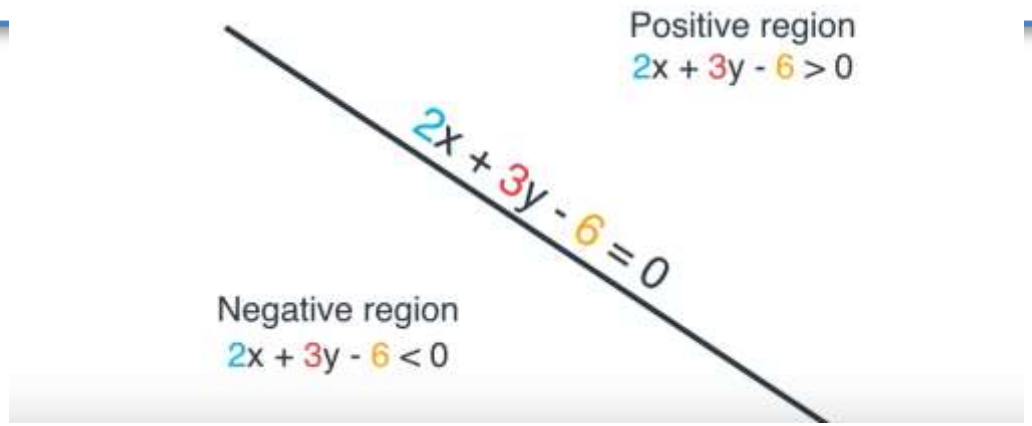
Positive and negative regions



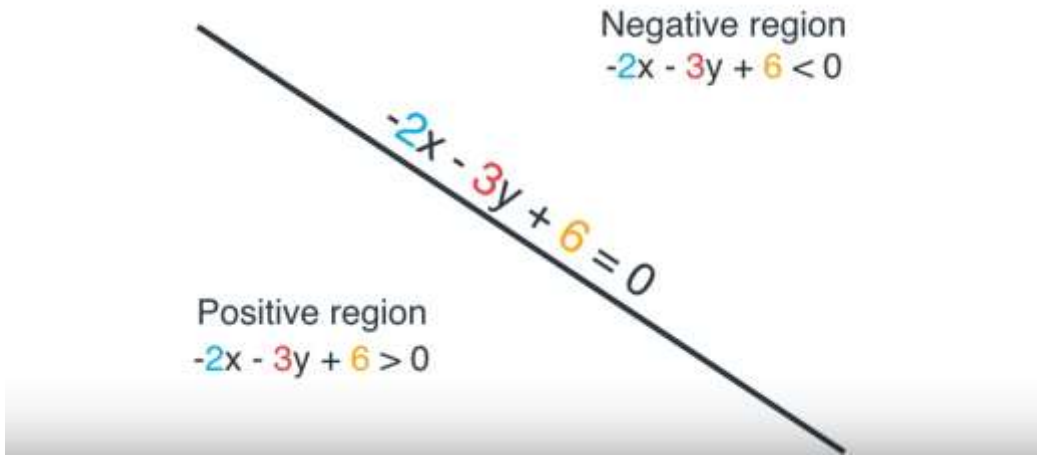
Positive and negative regions

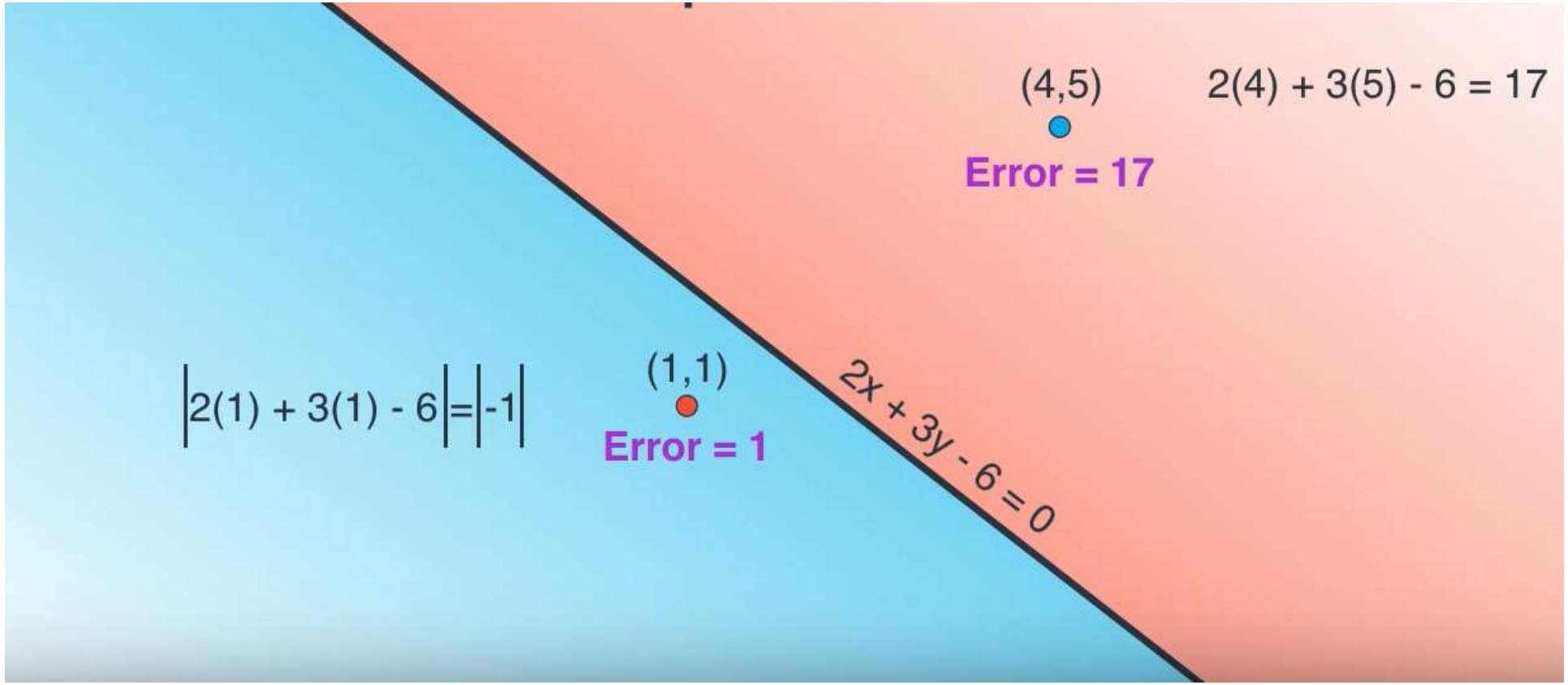


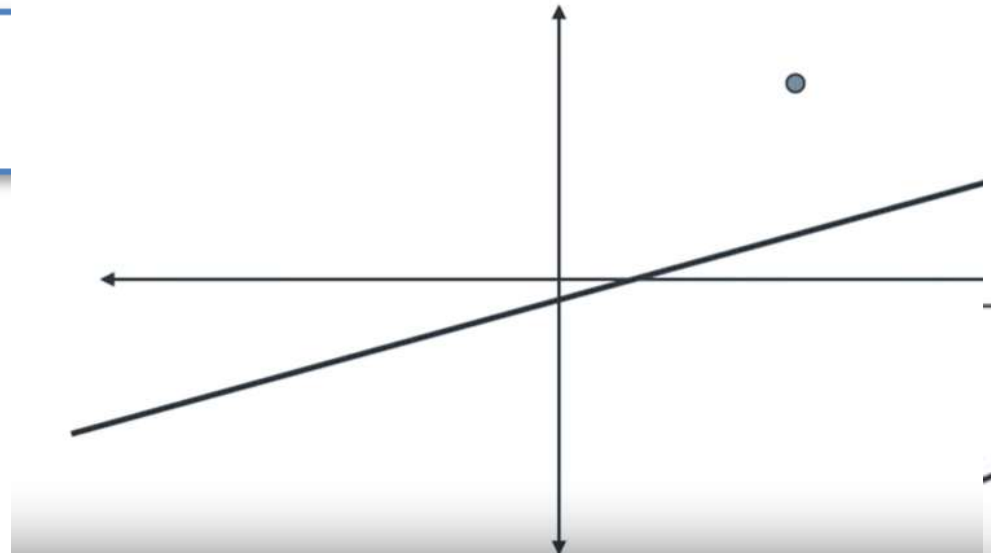
Positive and negative regions

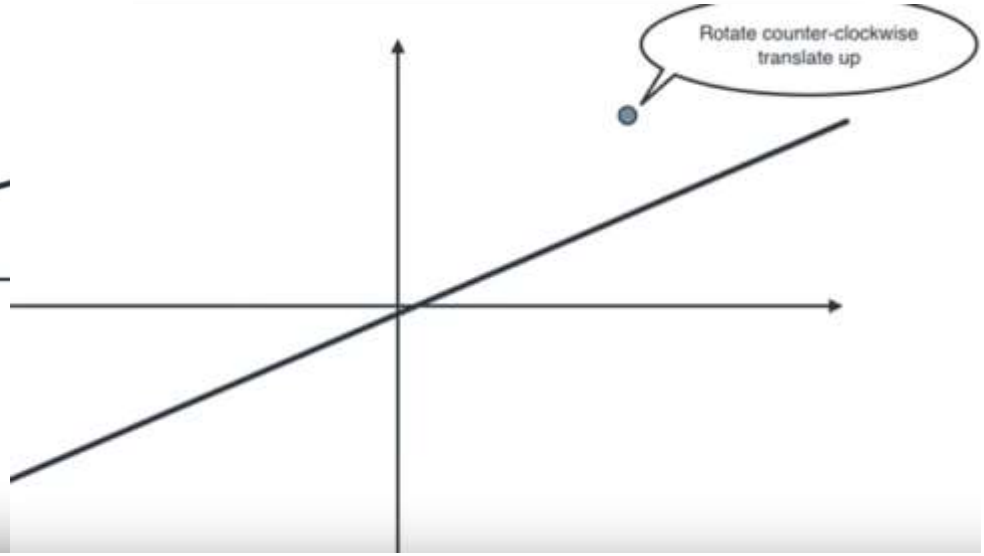


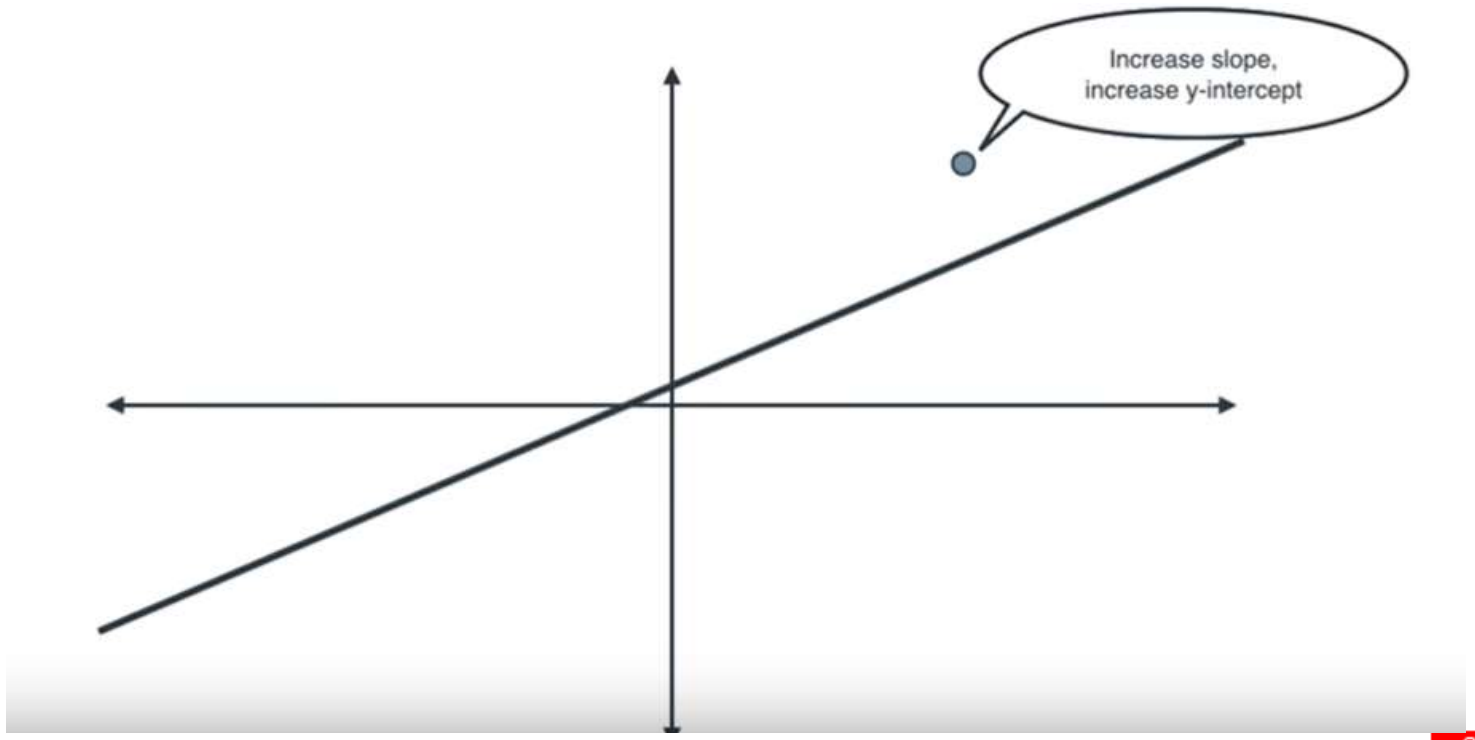
Positive and negative regions

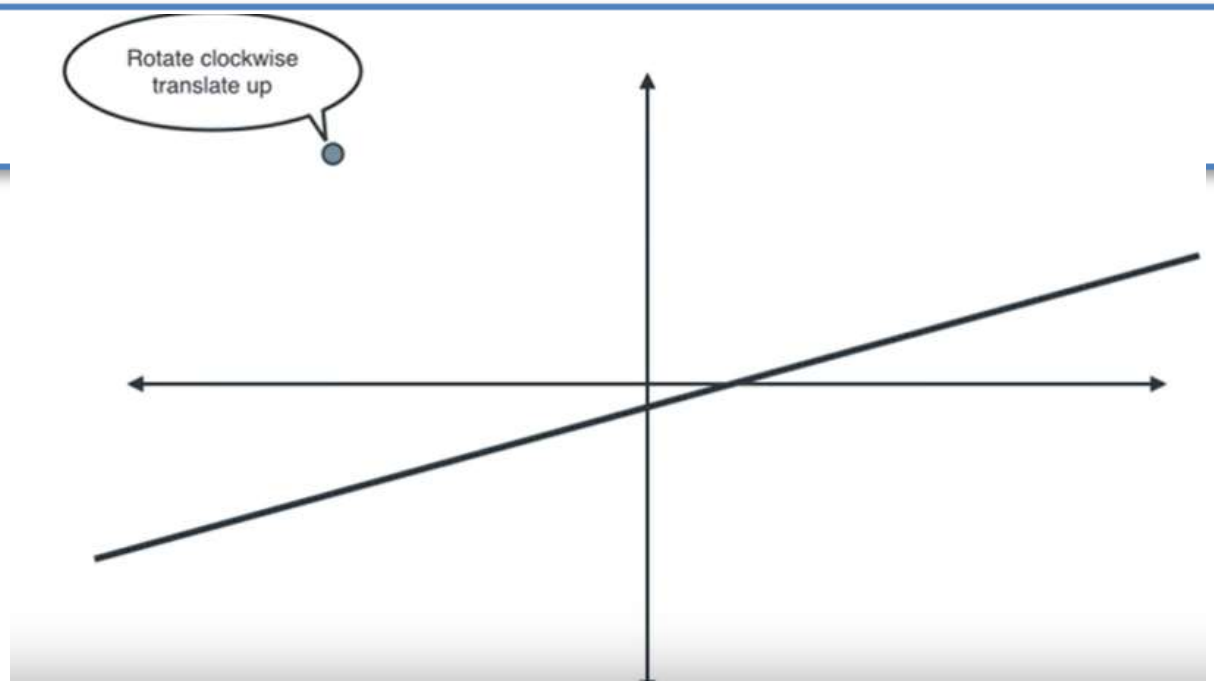


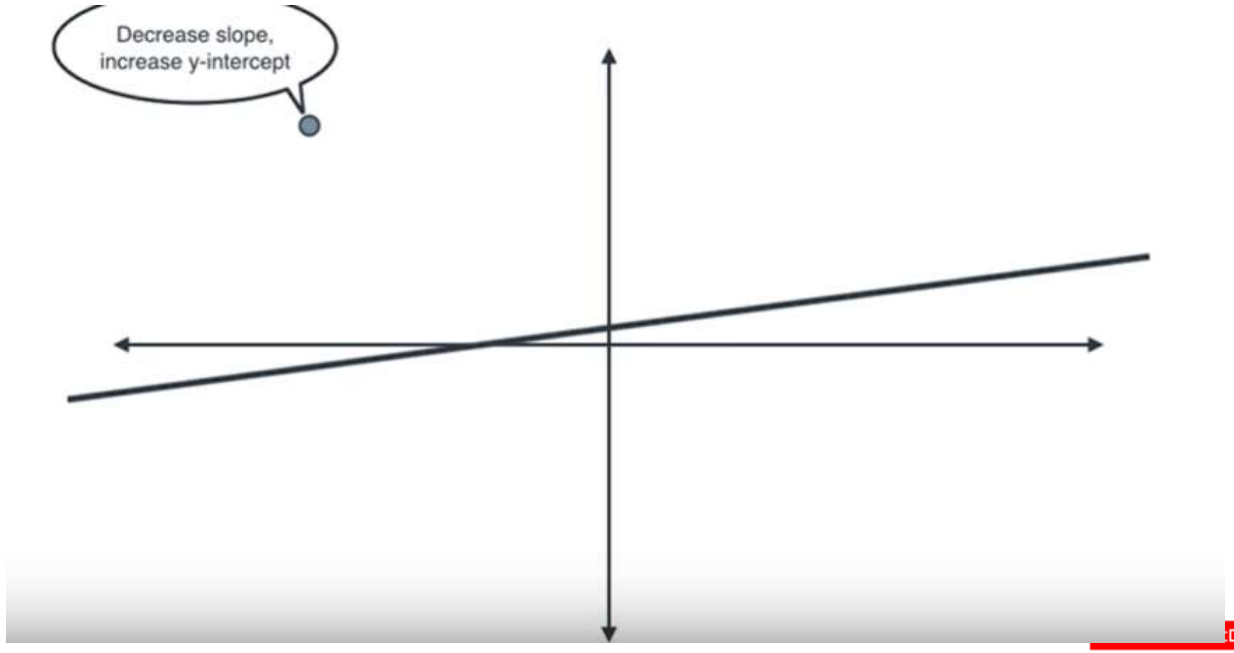

(4,5)
2(4) + 3(5) - 6 = 17
Error = 17
|2(1) + 3(1) - 6| = |-1|
(1,1)
Error = 1
2x + 3y - 6 = 0

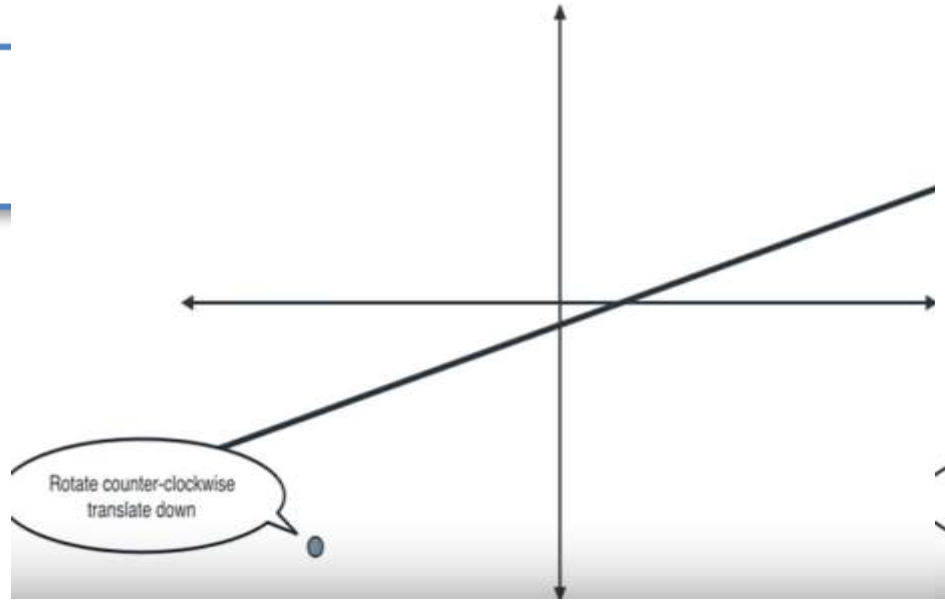


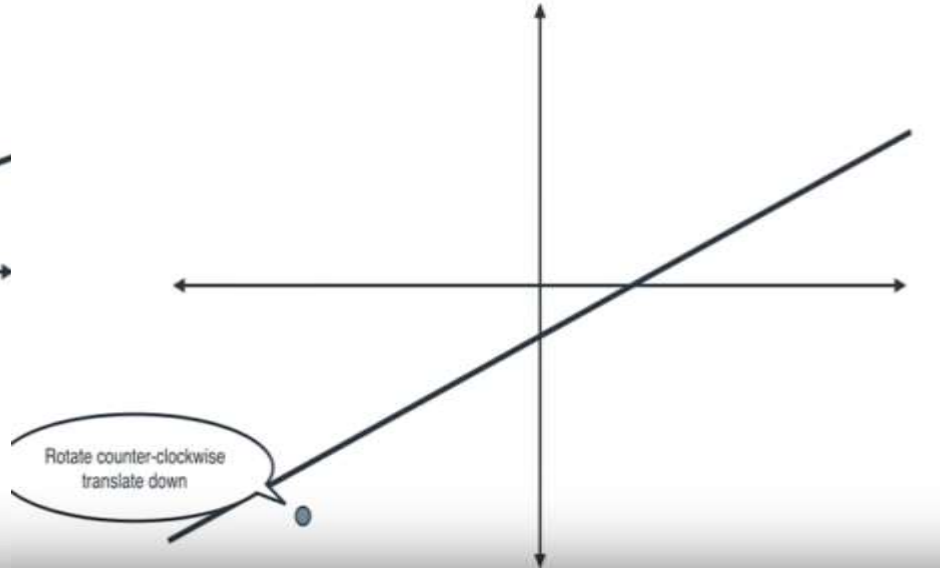

Rotate counter-clockwise
translate up

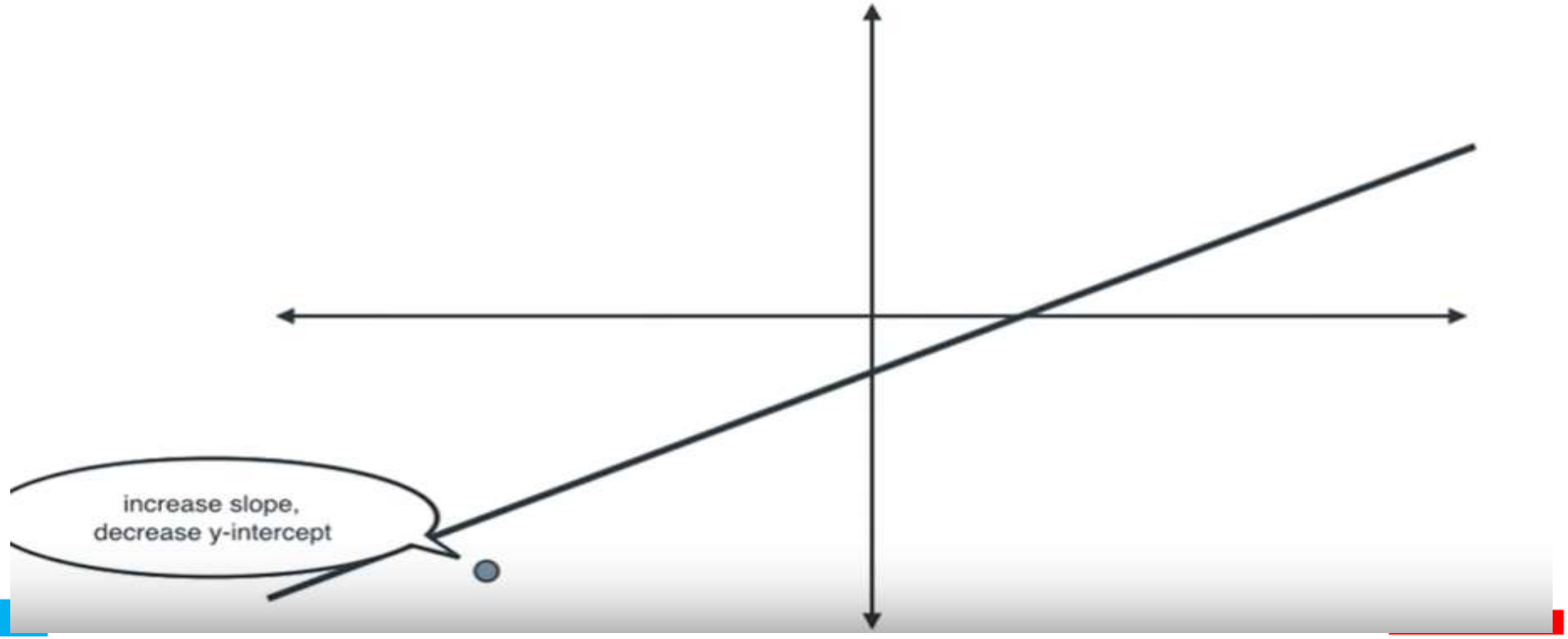

Increase slope,
increase y-intercept

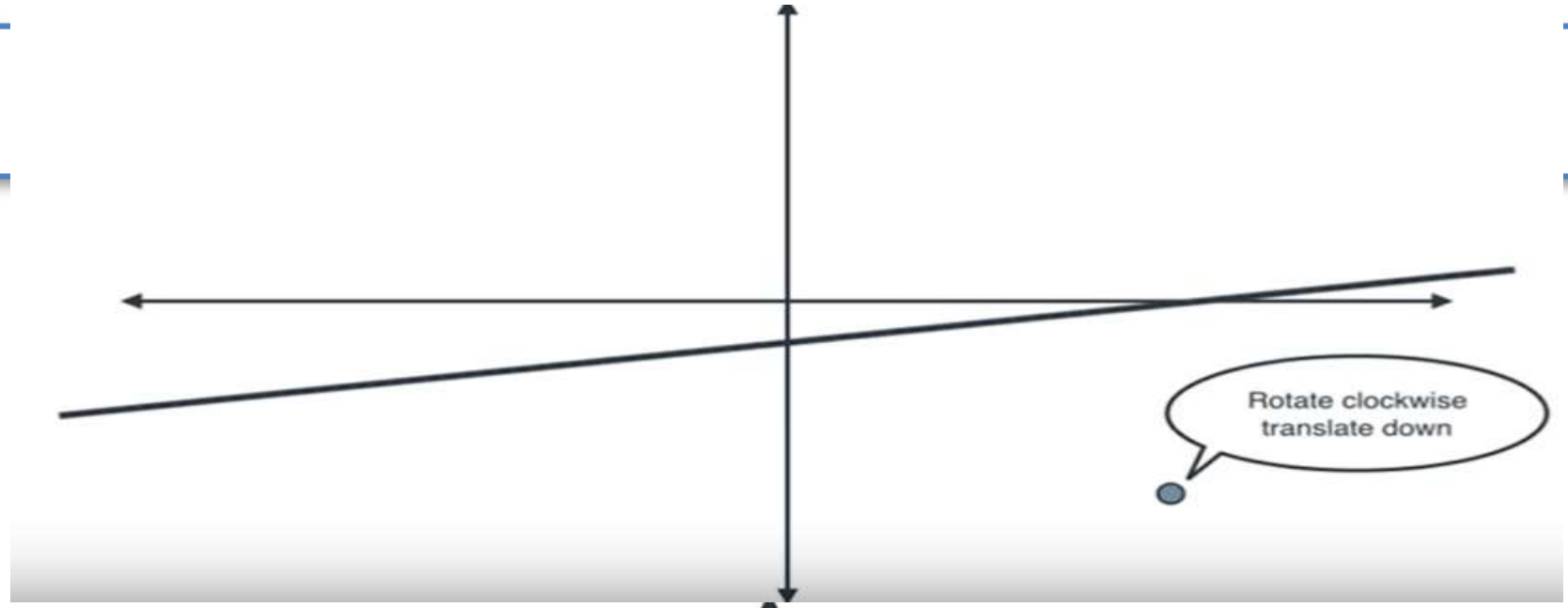

Rotate clockwise
translate up

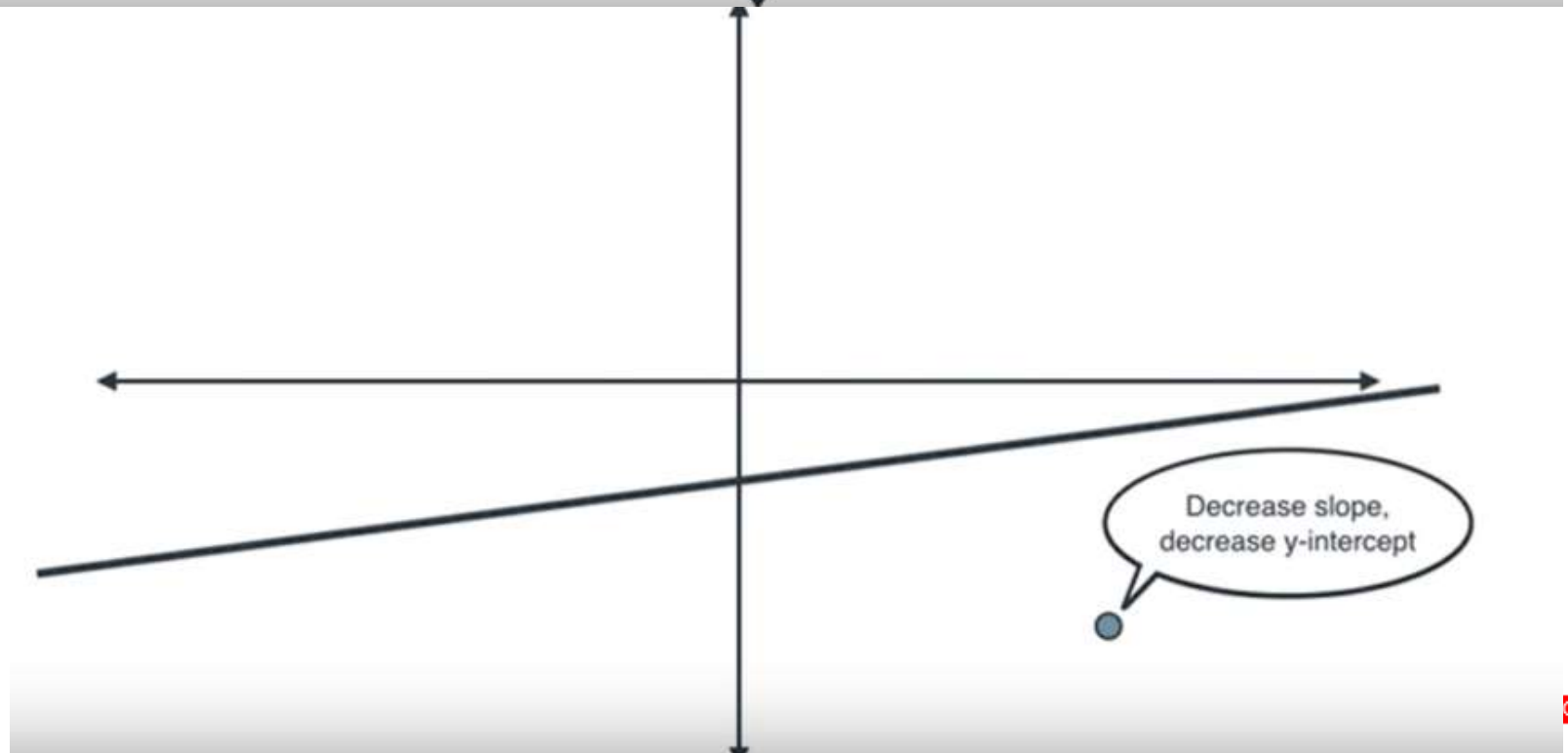

Decrease slope,
increase y-intercept


Rotate counter-clockwise
translate down

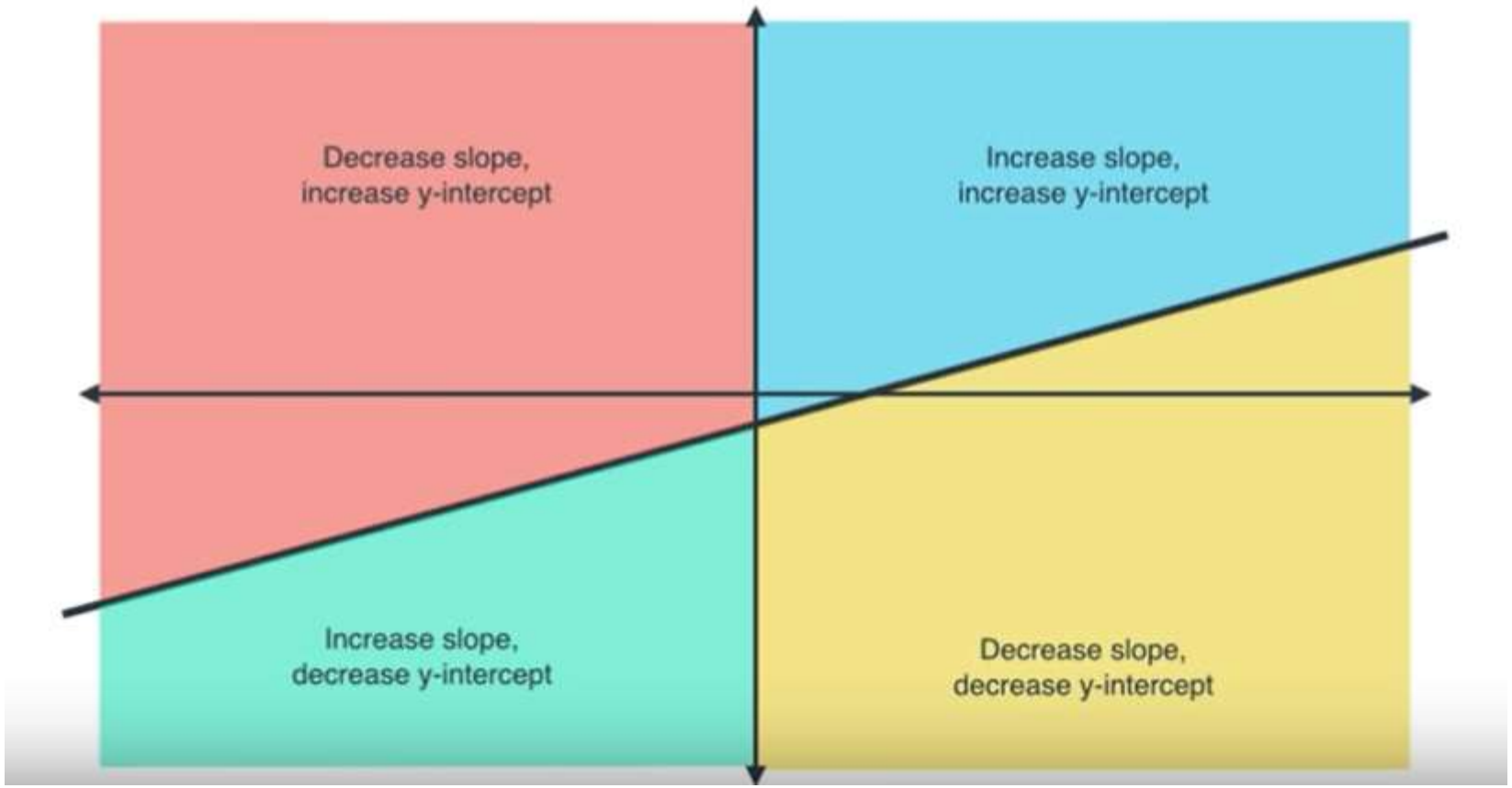

Rotate counter-clockwise
translate down

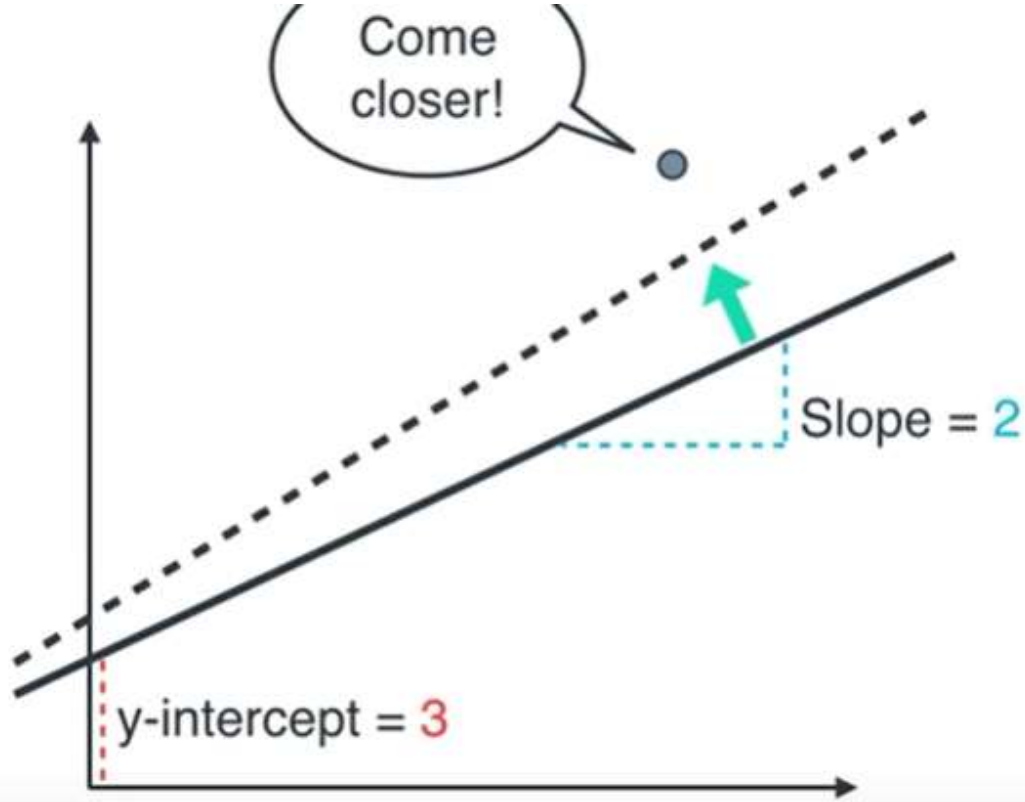

increase slope,
decrease y-intercept


Rotate clockwise
translate down


Decrease slope,
decrease y-intercept

Four cases


Decrease slope,
increase y-intercept
Increase slope,
increase y-intercept
Increase slope,
decrease y-intercept
Decrease slope,
decrease y-intercept



$$y = 2x + 3$$

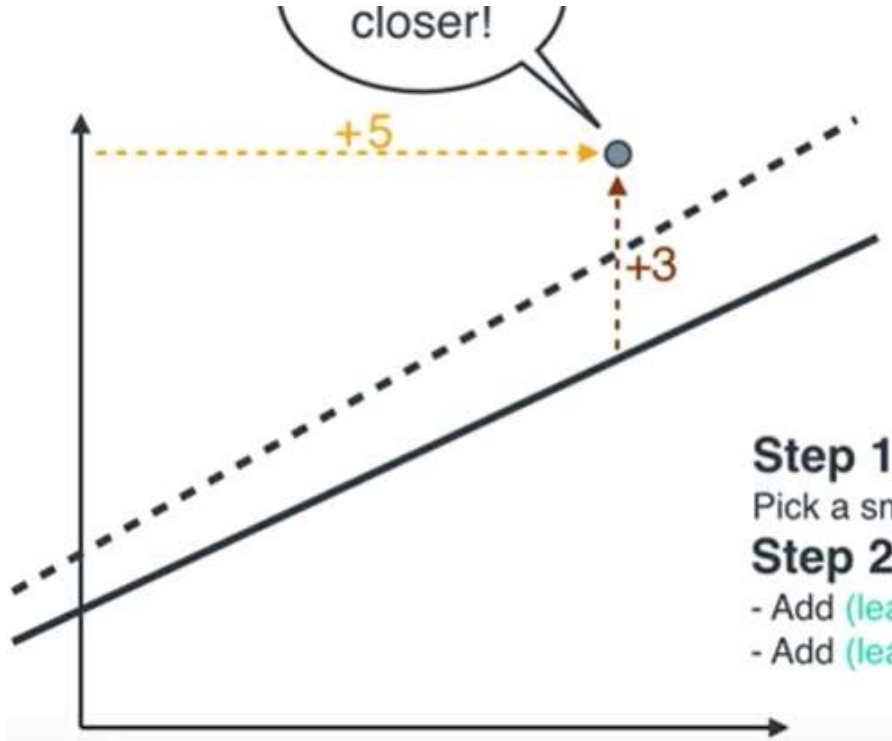
$+0.01$ $+0.01$

$$y = 2.01x + 3.01$$

Step 1: Pick a small number. 0.01 (learning rate)

Step 2:

- Add learning rate to slope
- Add learning rate to y-intercept



$$y = 2x + 3$$

$+0.15$ $+0.03$

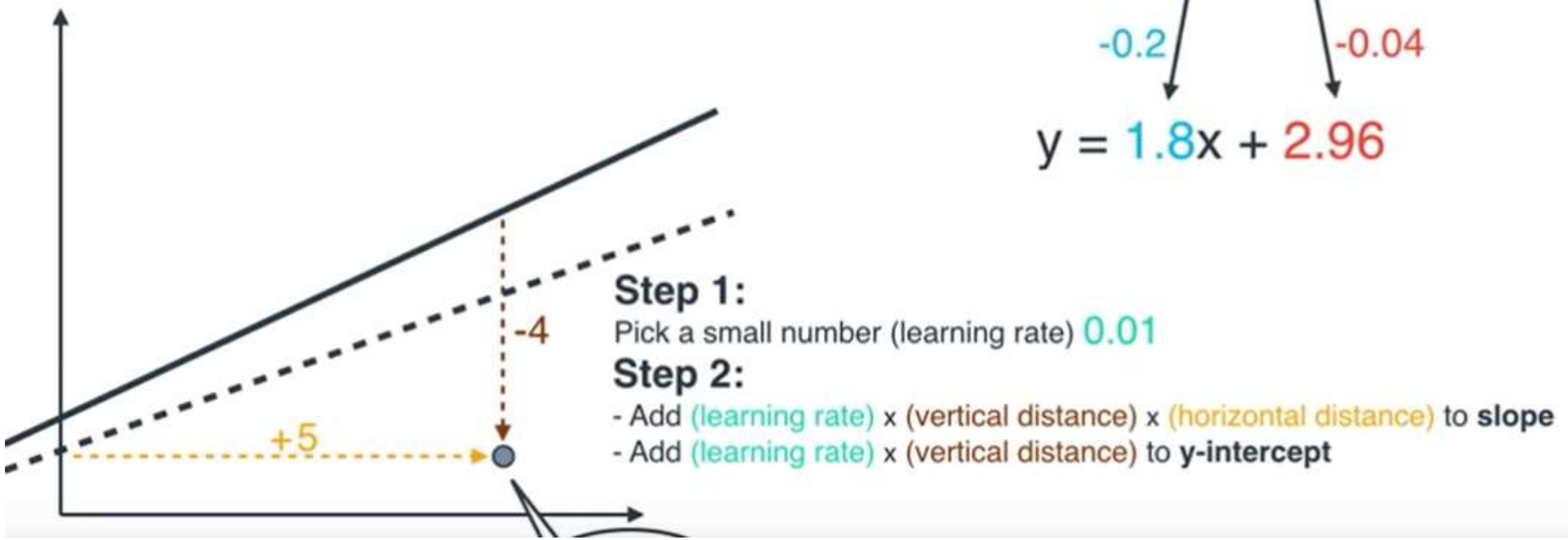
$$y = 2.15x + 3.03$$

Step 1:

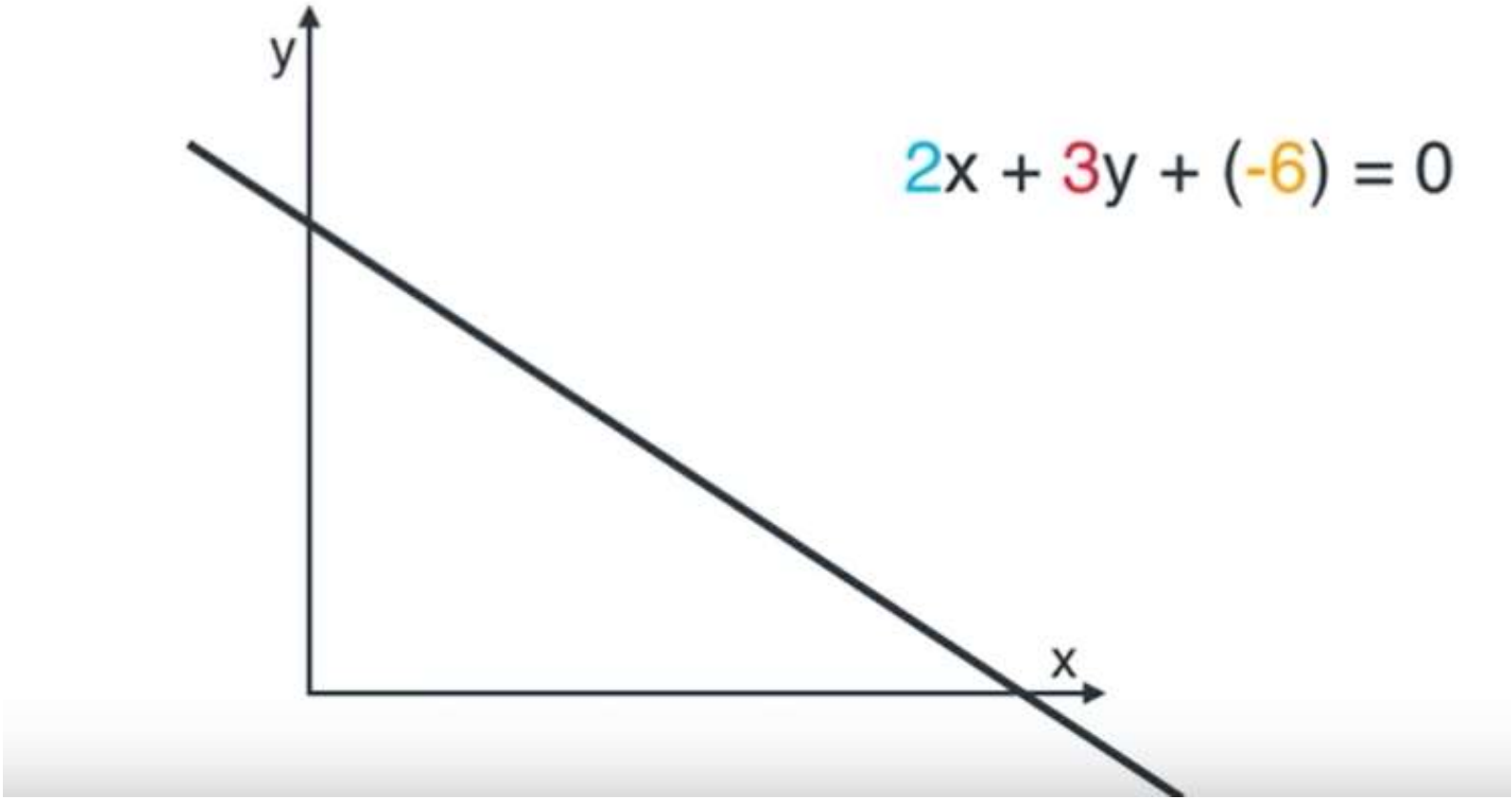
Pick a small number (learning rate) 0.01

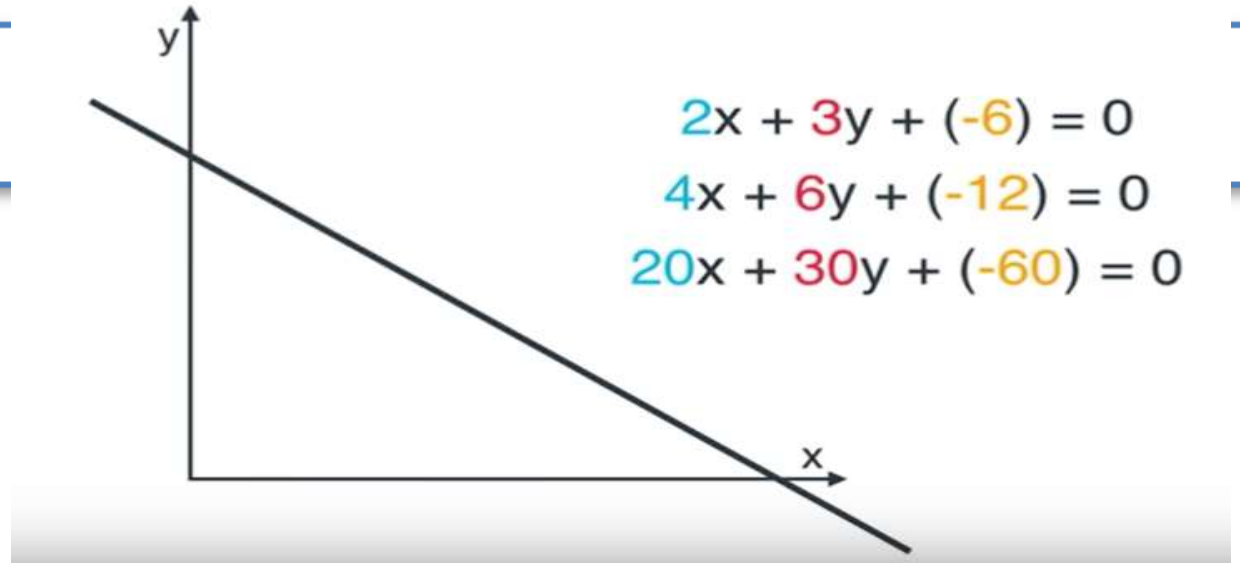
Step 2:

- Add (learning rate) x (vertical distance) x (horizontal distance) to **slope**
- Add (learning rate) x (vertical distance) to **y-intercept**

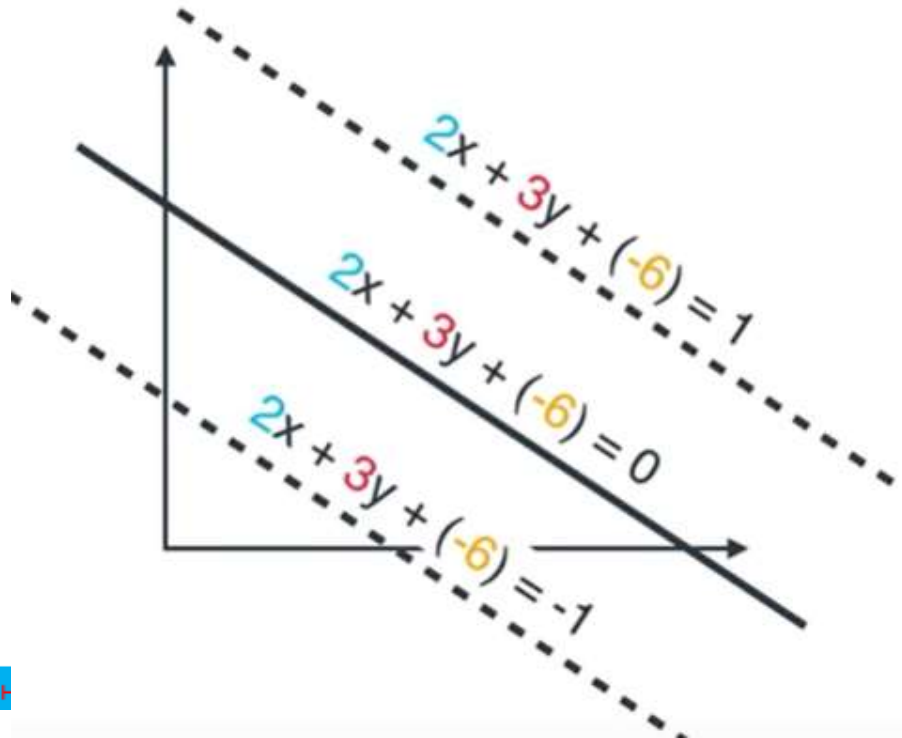

y = 2x + 3
-0.2
-0.04
y = 1.8x + 2.96
-4
+5
Step 1:
Pick a small number (learning rate) 0.01
Step 2:
- Add (learning rate) x (vertical distance) x (horizontal distance) to slope
- Add (learning rate) x (vertical distance) to y-intercept

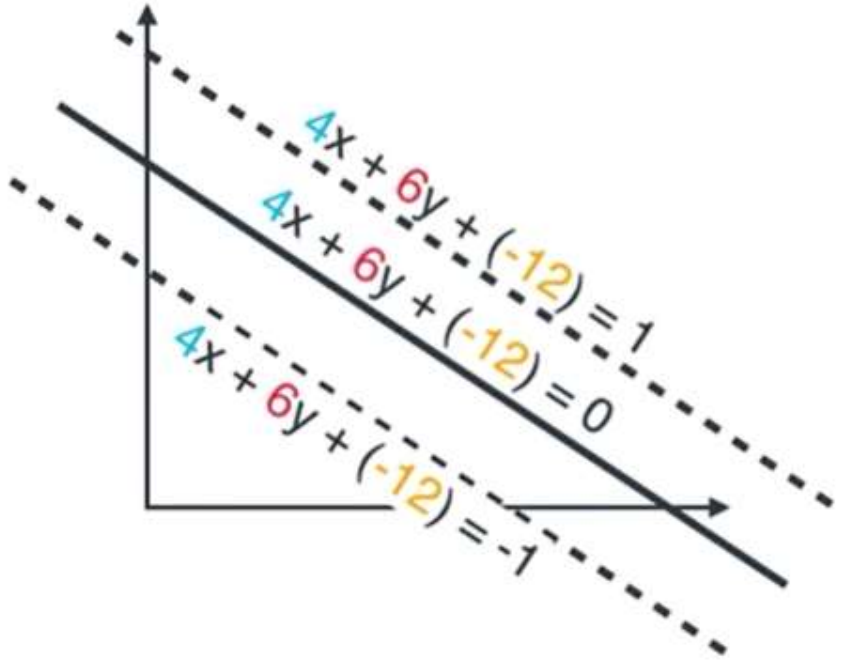
How to separate lines?

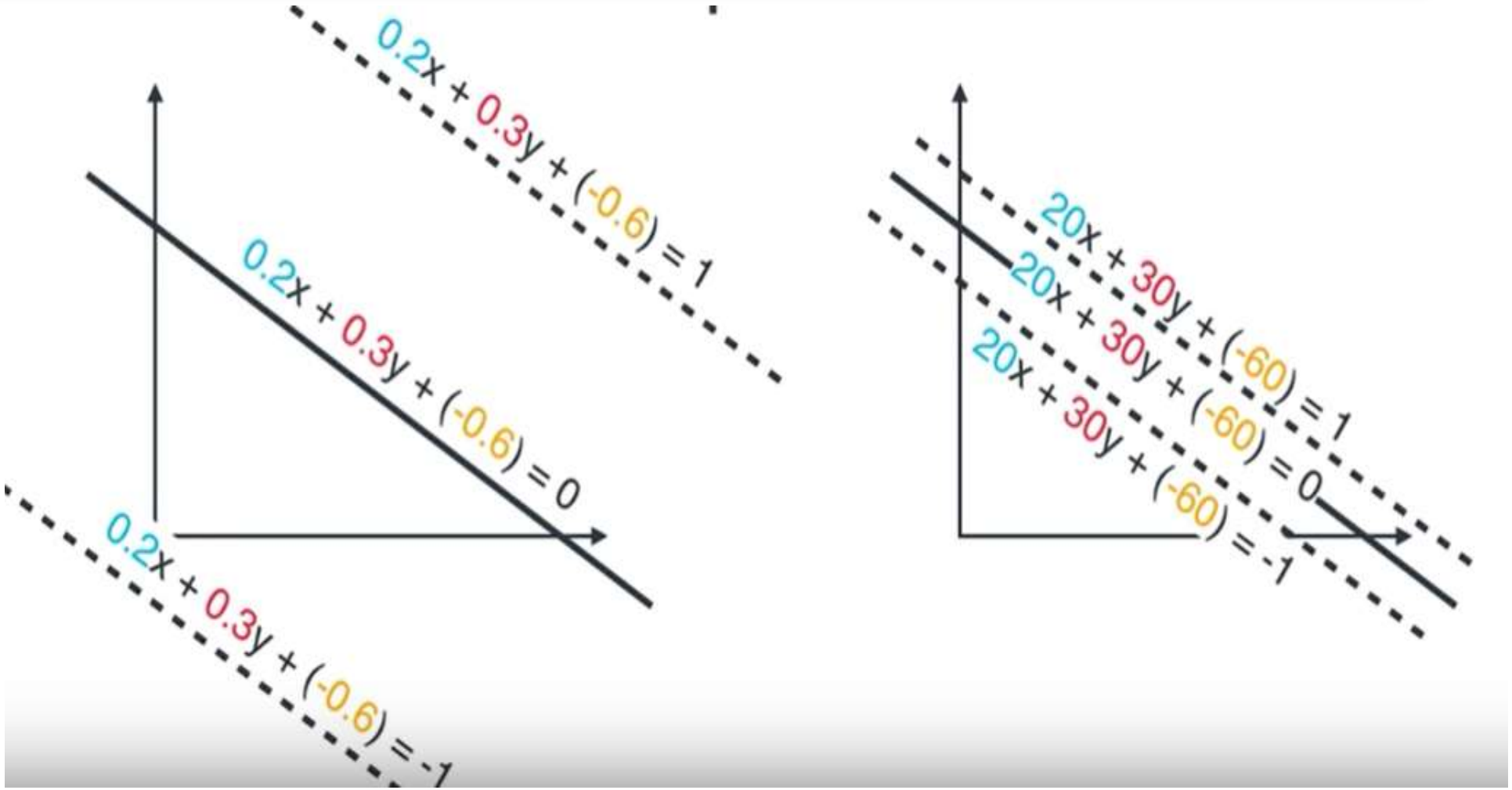


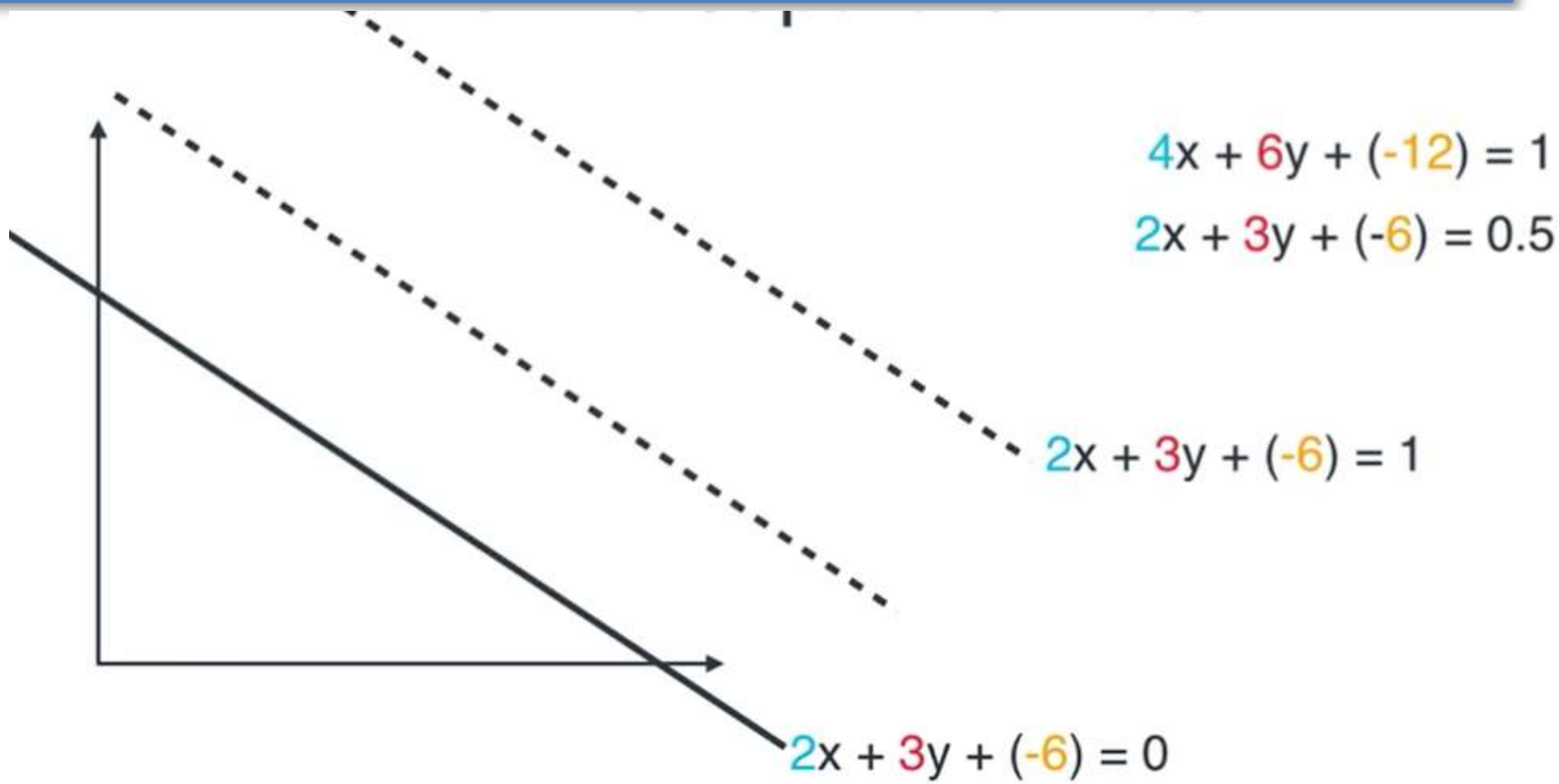


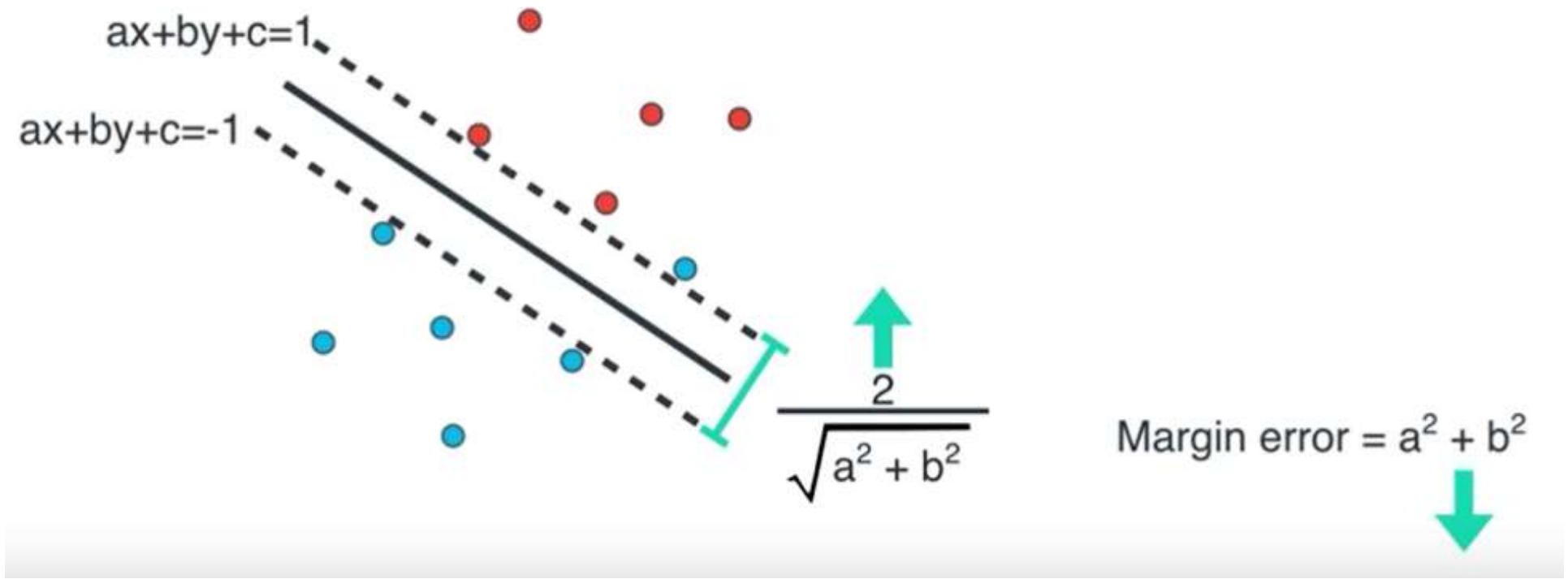
$$2x + 3y + (-6) = 0$$
$$4x + 6y + (-12) = 0$$
$$20x + 30y + (-60) = 0$$





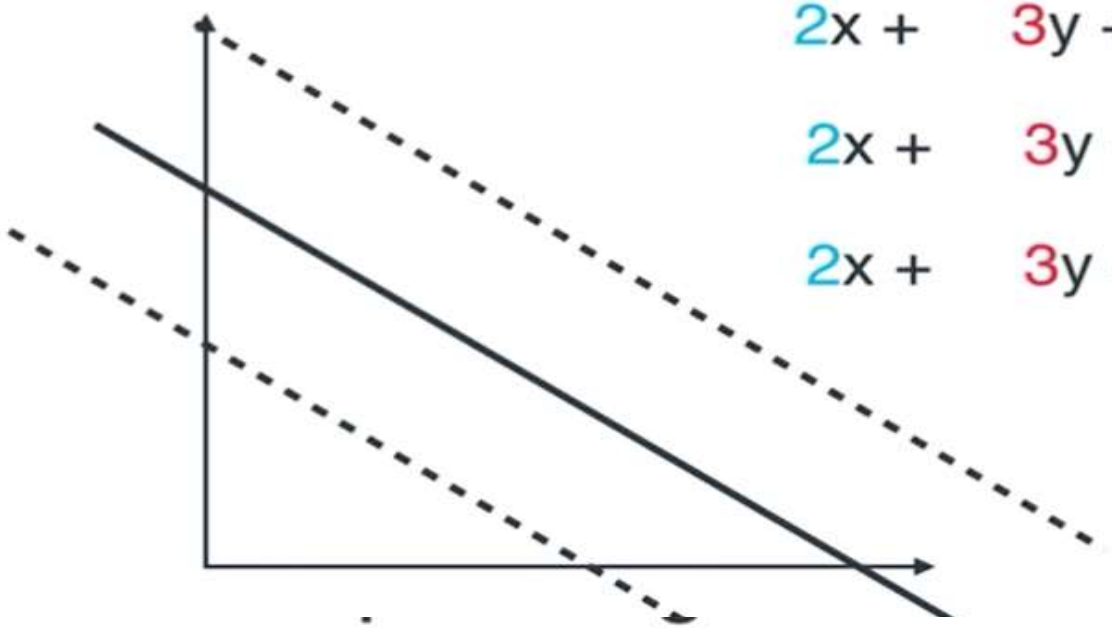

0.2x + 0.3y + (-0.6) = 1
0.2x + 0.3y + (-0.6) = 0
0.2x + 0.3y + (-0.6) = -1
20x + 30y + (-60) = 1
20x + 30y + (-60) = 0
20x + 30y + (-60) = -1


4x + 6y + (-12) = 1
2x + 3y + (-6) = 0.5
2x + 3y + (-6) = 1
2x + 3y + (-6) = 0


ax+by+c=1
ax+by+c=-1
2
$\sqrt{a^2 + b^2}$
Margin error = $a^2 + b^2$

Expanding rate

0.99

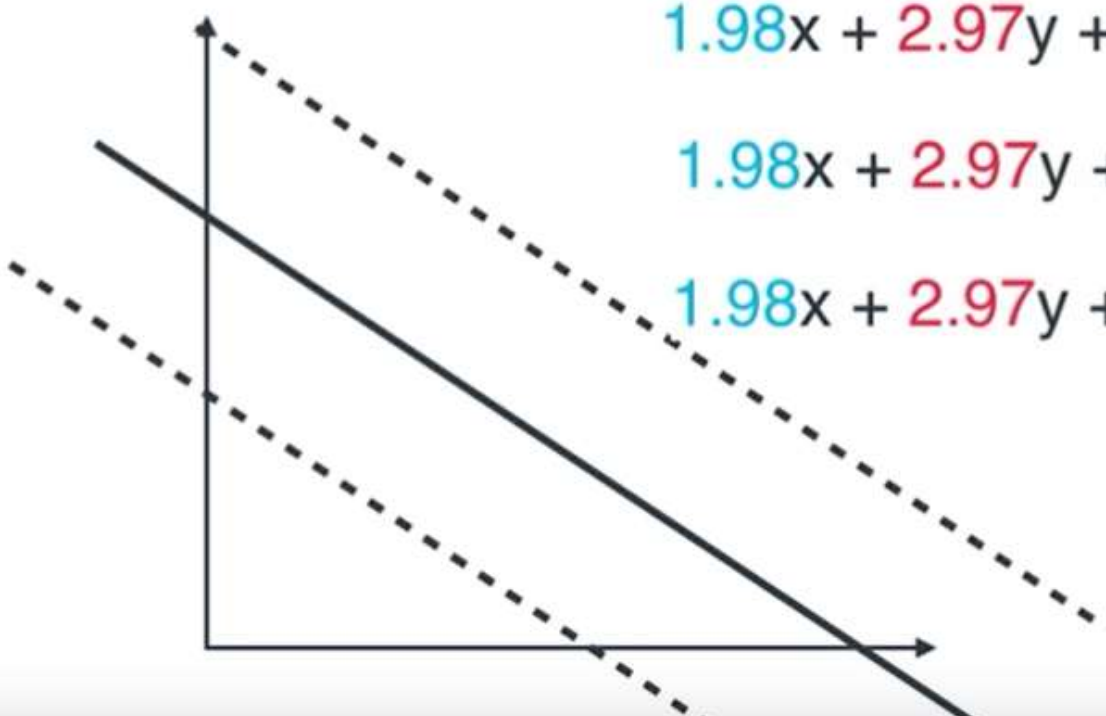


$2x + 3y + (-6) = -1$

$2x + 3y + (-6) = 0$

$2x + 3y + (-6) = 1$

Expanding rate

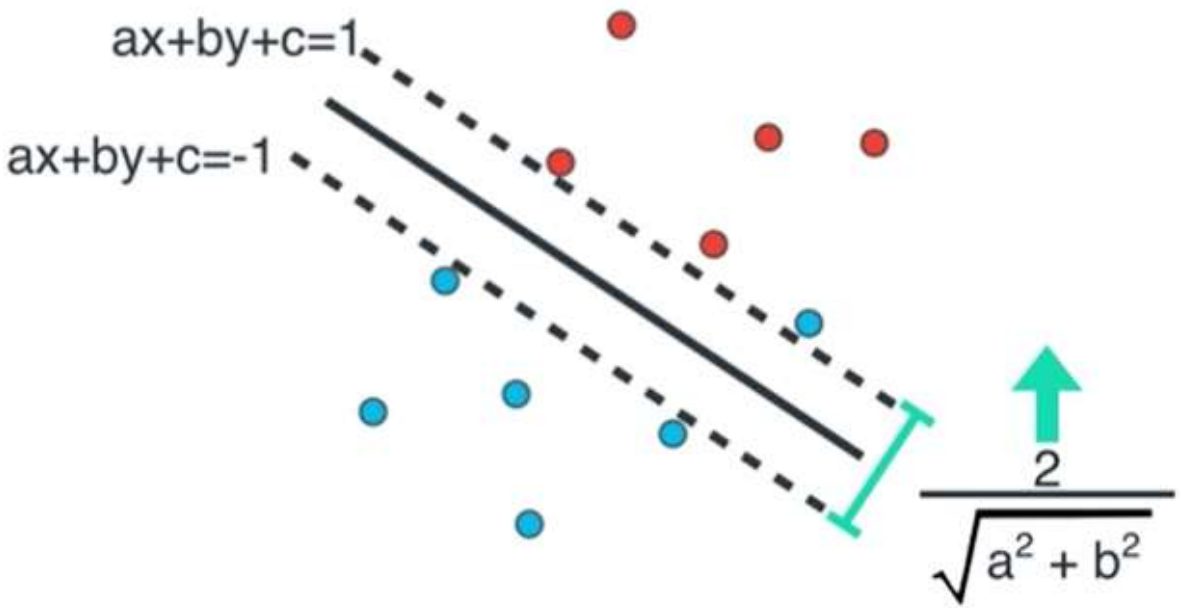


$1.98x + 2.97y + (-5.94) = -1$

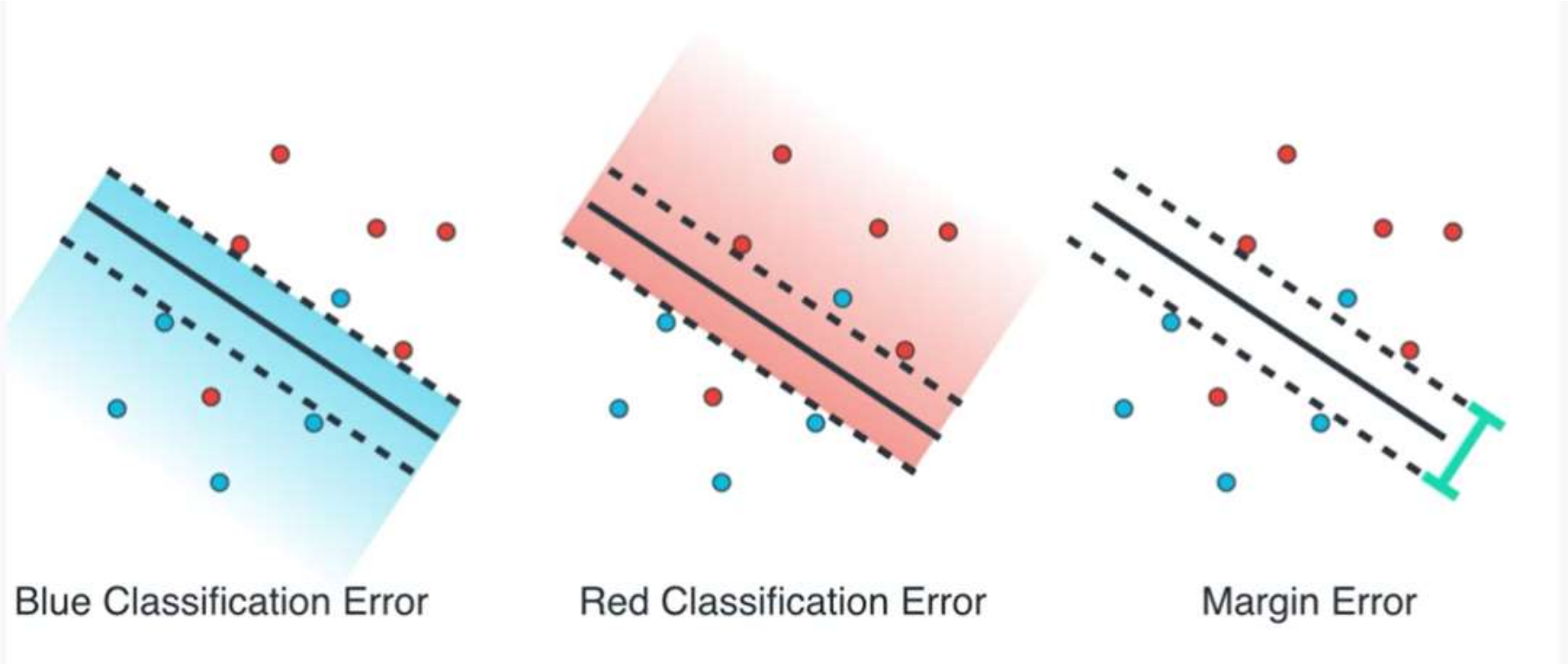
$1.98x + 2.97y + (-5.94) = 0$

$1.98x + 2.97y + (-5.94) = 1$

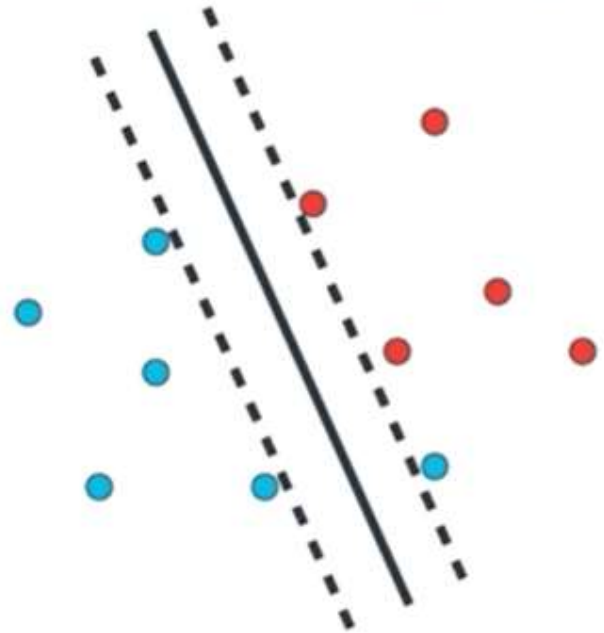
Margin Error



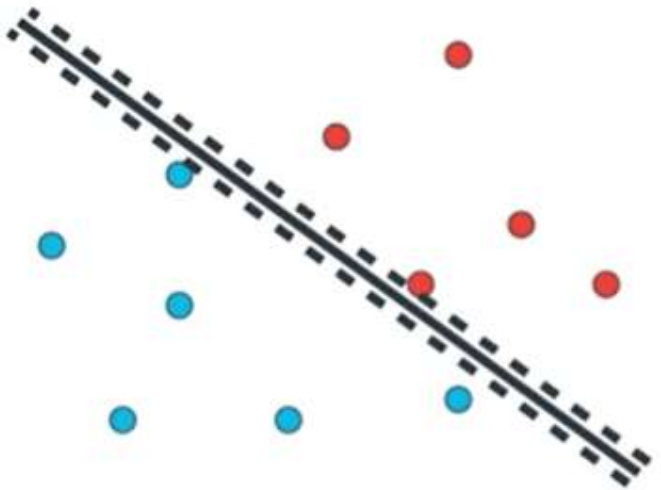
Margin error = $a^2 + b^2$


Blue Classification Error
Red Classification Error
Margin Error

Which line is better?



Classification Error + Margin Error



Classification Error + Margin Error

Which line is better?

Small C
Focus on margin

Large C
Focus on classification

$$C \cdot \text{Classification Error} + \cancel{\text{Margin Error}}$$