

Machine Learning Explained

## **How would you solve these problems?**

- Estimating/Predicting the price of a house
- Detecting Spam Emails
- Recommending apps to people based on gender and age
- Predict whether one would be accepted at a university based on test score and previous grades
- Find the best k-locations for the franchises of your newly opened Pizza chain

# Price of a house



\$70,000



\$160,000

# Price of a house



\$70,000



?

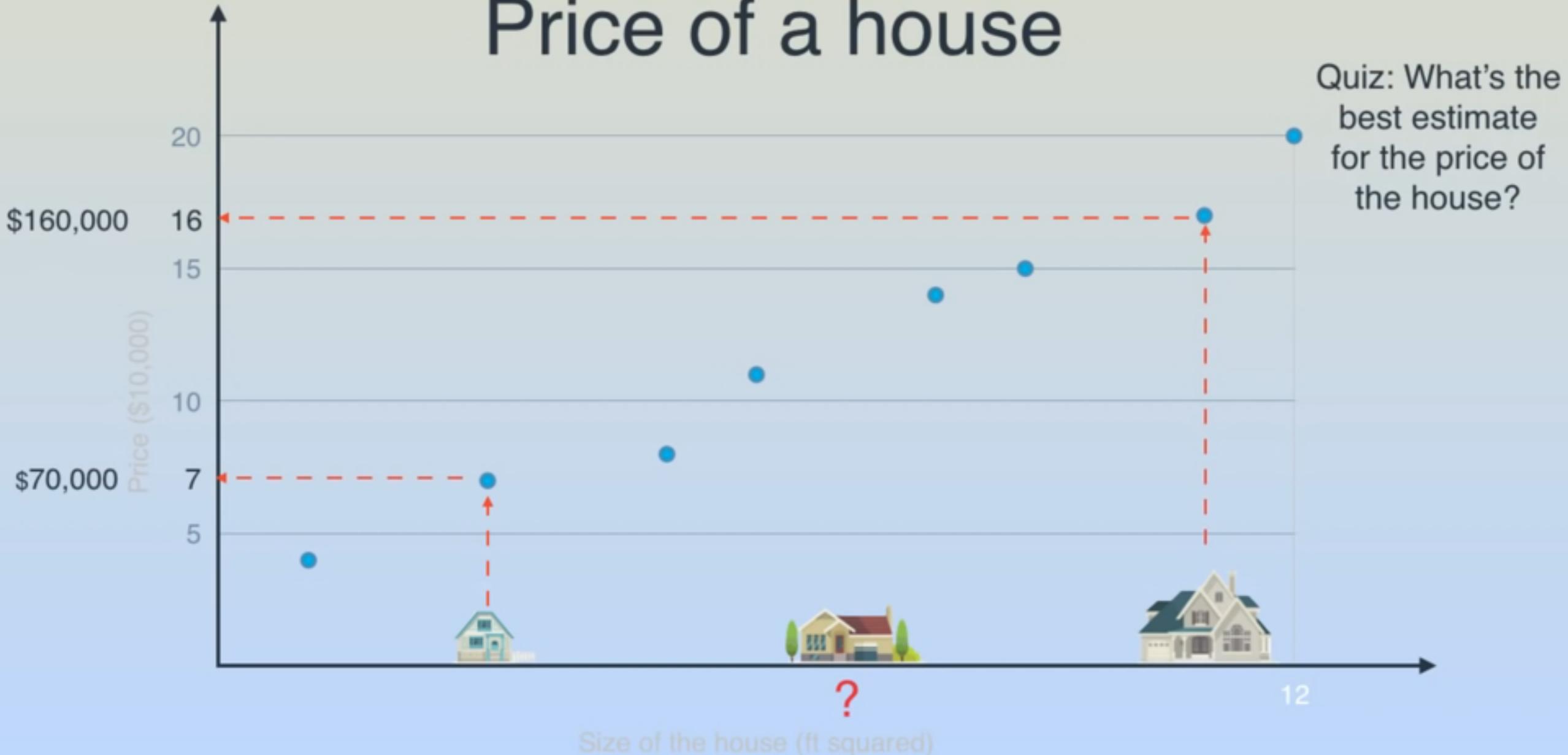


\$160,000

# Price of a house



# Price of a house



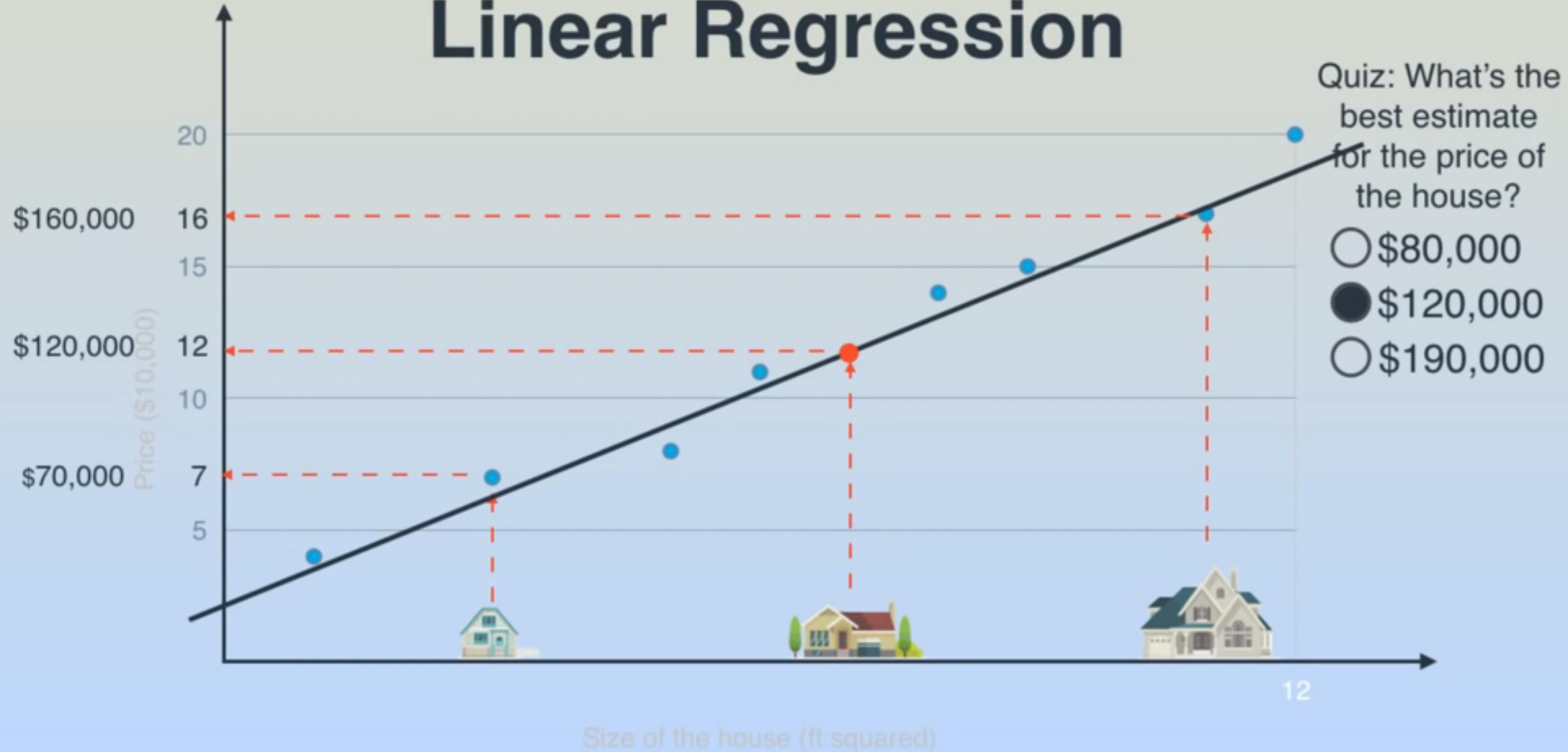
# Price of a house

Quiz: What's the best estimate for the price of the house?

- \$80,000
- \$120,000
- \$190,000



# Linear Regression



# Detecting Spam e-mails



# Detecting Spam e-mails

Spam



Non-spam



# Detecting Spam e-mails



“Cheap”

Spam



Non-spam



# Detecting Spam e-mails



“Cheap”

Spam



20

Non-spam



**Quiz:** If an e-mail contains the word “cheap”, what is the probability of it being spam?

- 40%
- 60%
- 80%

# Detecting Spam e-mails

-  “Cheap” → 80%
-  Spelling mistake → 70%
-  Missing title → 95%
-  etc...

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## Conclusion:

If the e-mail contains the word “cheap”,  
The probability of it being spam is 80%

# Naive Bayes Algorithm

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-  etc...

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# Recommending Apps

Gender	Age	App
F	15	
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M	32	
F	40	
M	12	
M	14	

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Quiz: Between Gender and Age, which one seems more decisive for predicting what app will the users download?

- Gender
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# Acceptance at a University



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Test



Grades

# Acceptance at a University



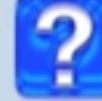
Test



Grades

Student 1  
Test: 9/10  Grades: 8/10

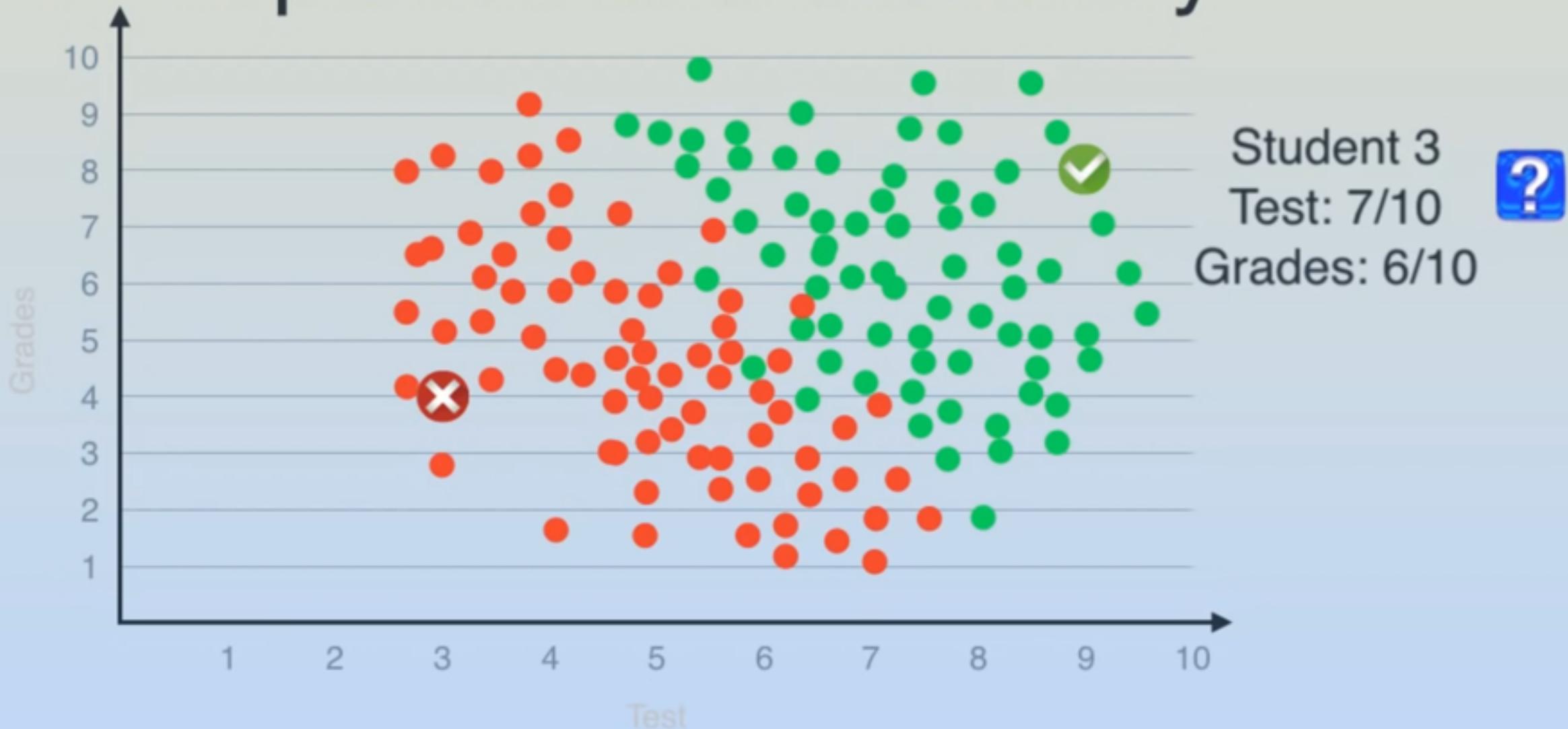
Student 2  
Test: 3/10  Grades: 4/10

Student 3  
Test: 7/10  Grades: 6/10

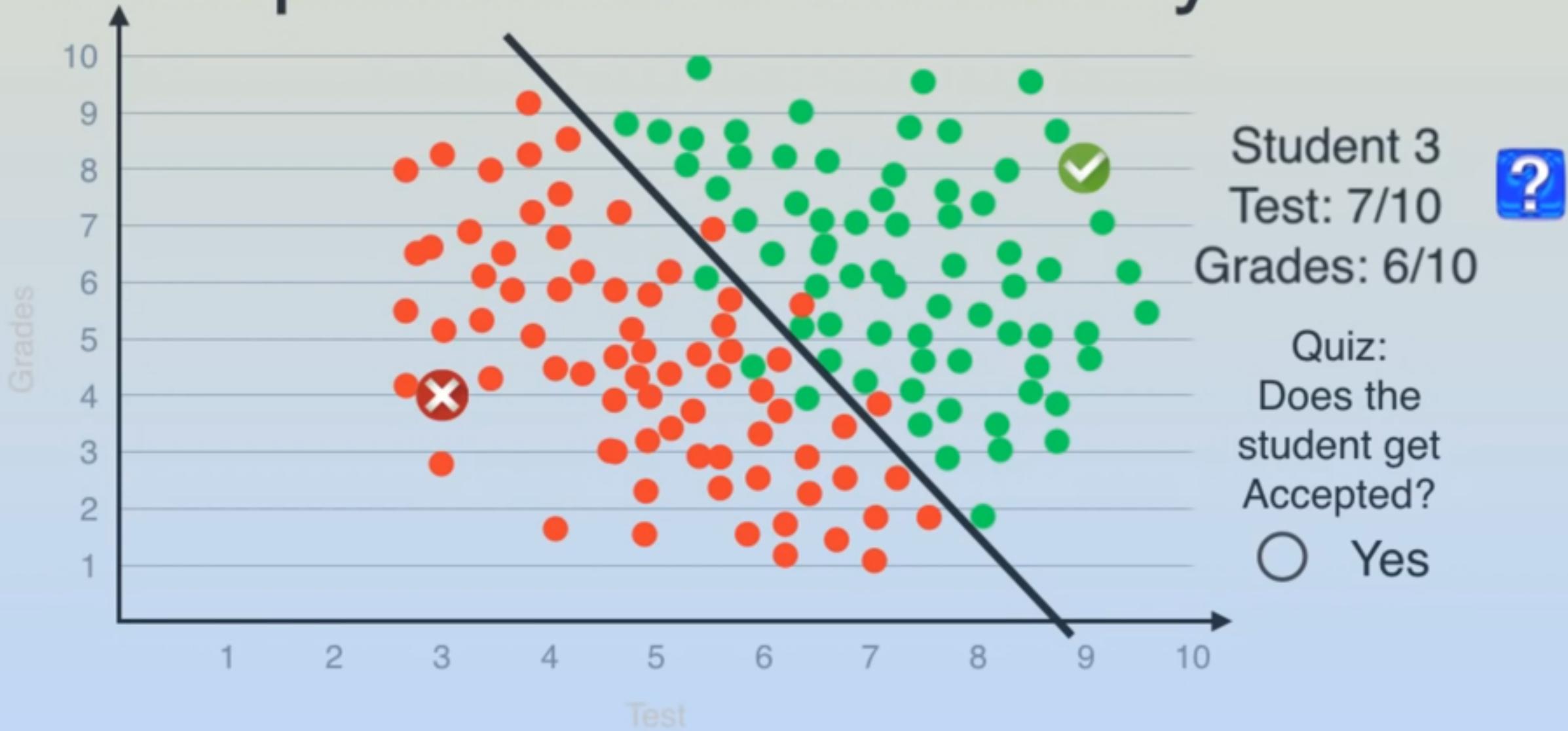
# Acceptance at a University



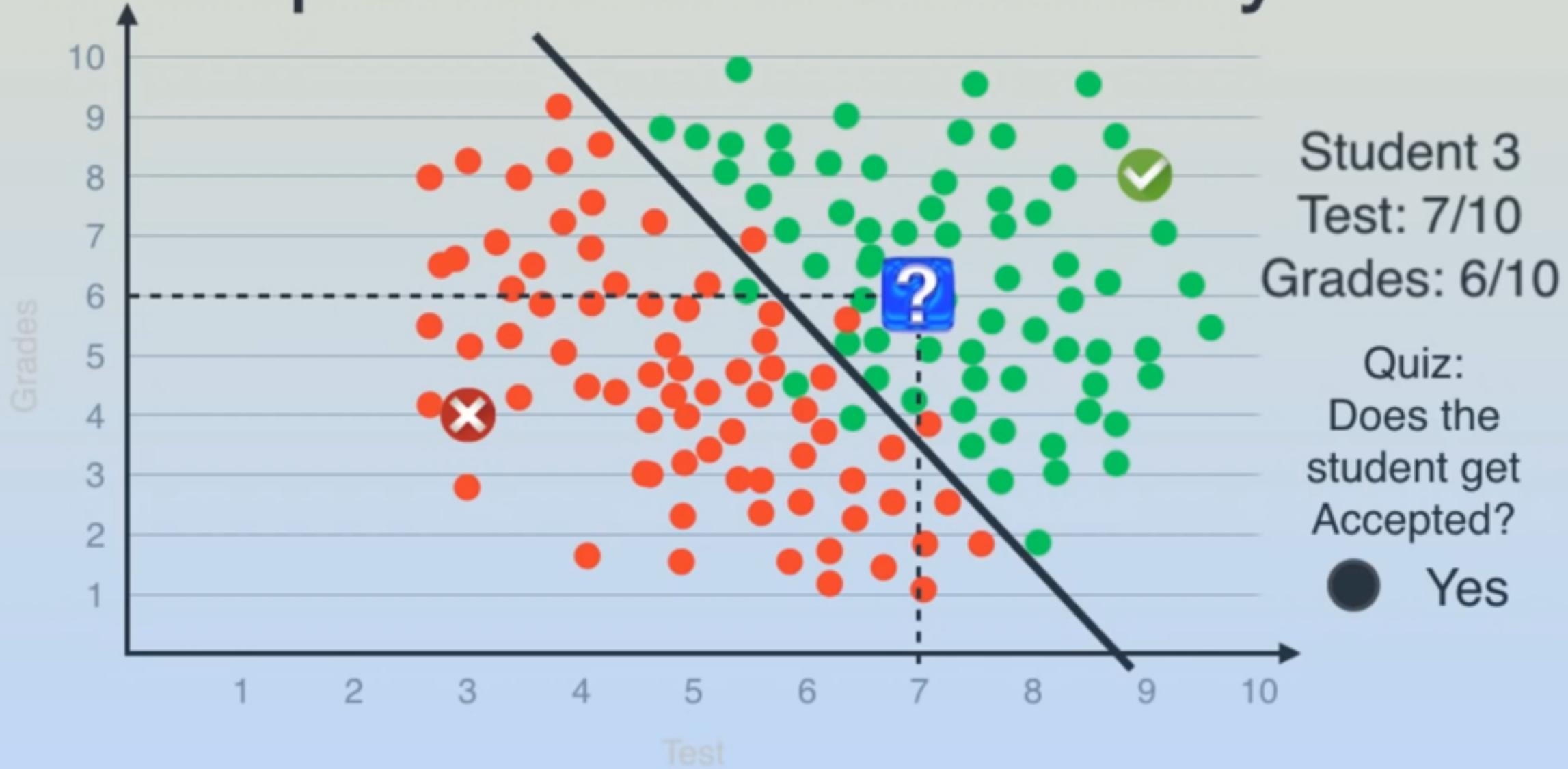
# Acceptance at a University



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# Logistic Regression

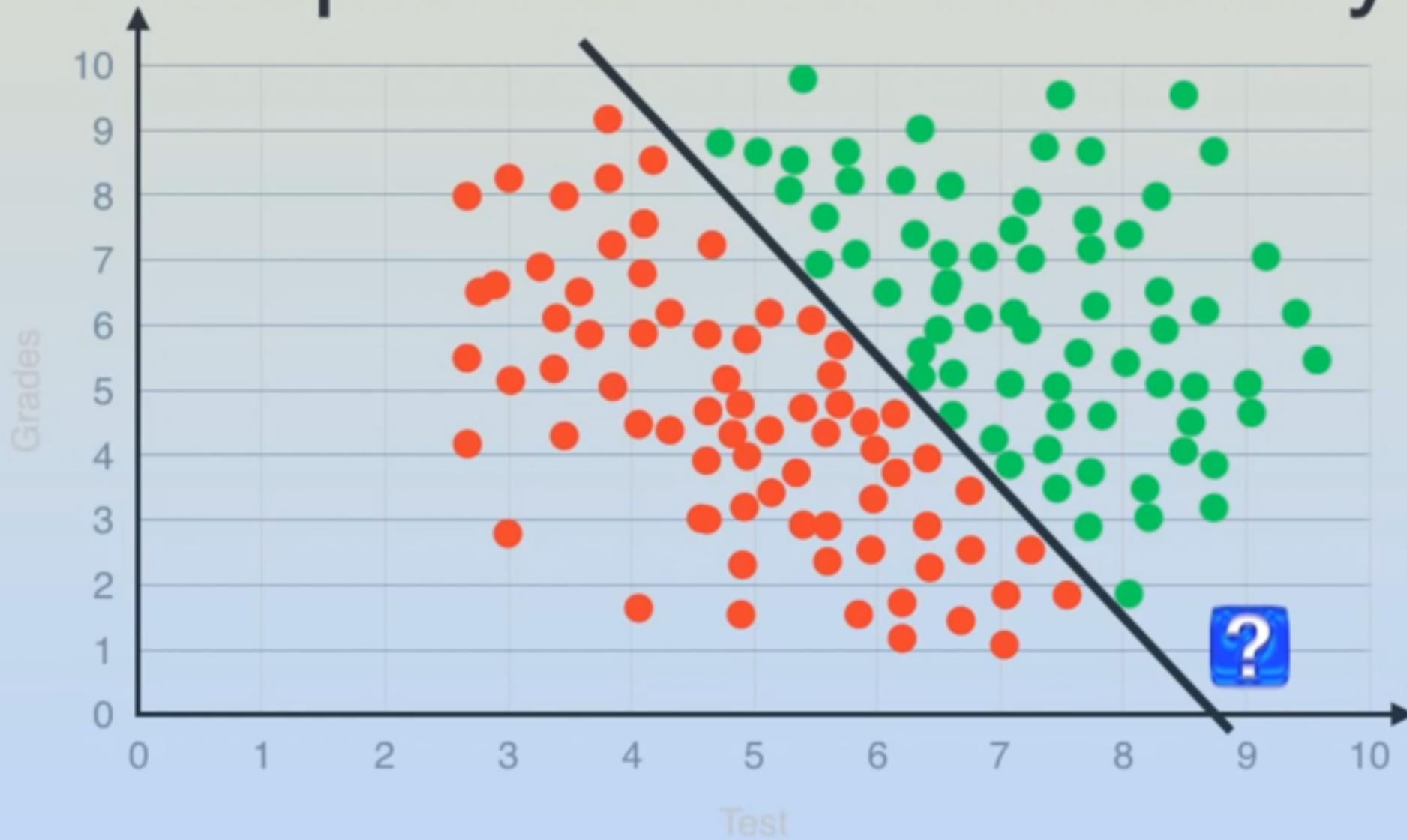


Student 3  
Test: 7/10  
Grades: 6/10

# Quiz: Does the student get Accepted?



# Acceptance at a University



# Logistic Regression

Errors: 2



Gradient descent

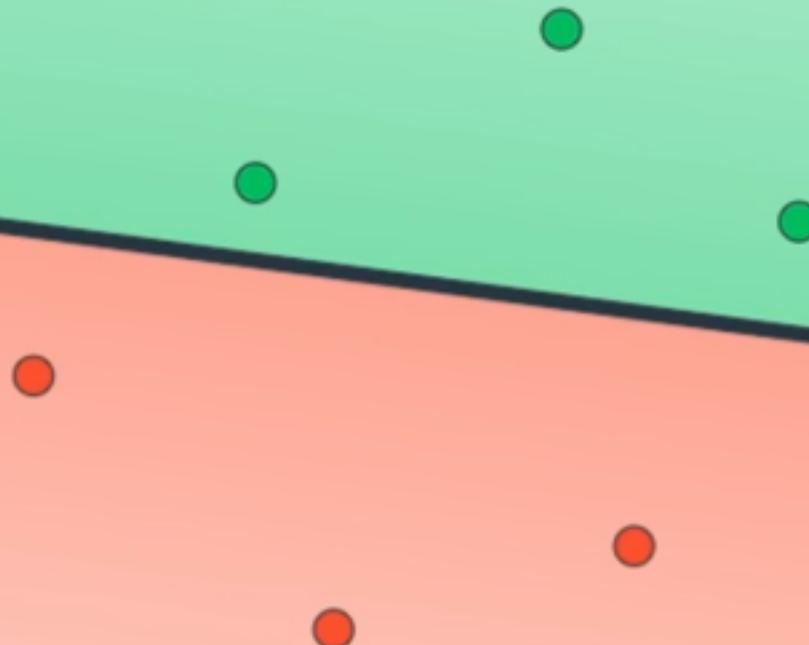


# Logistic Regression

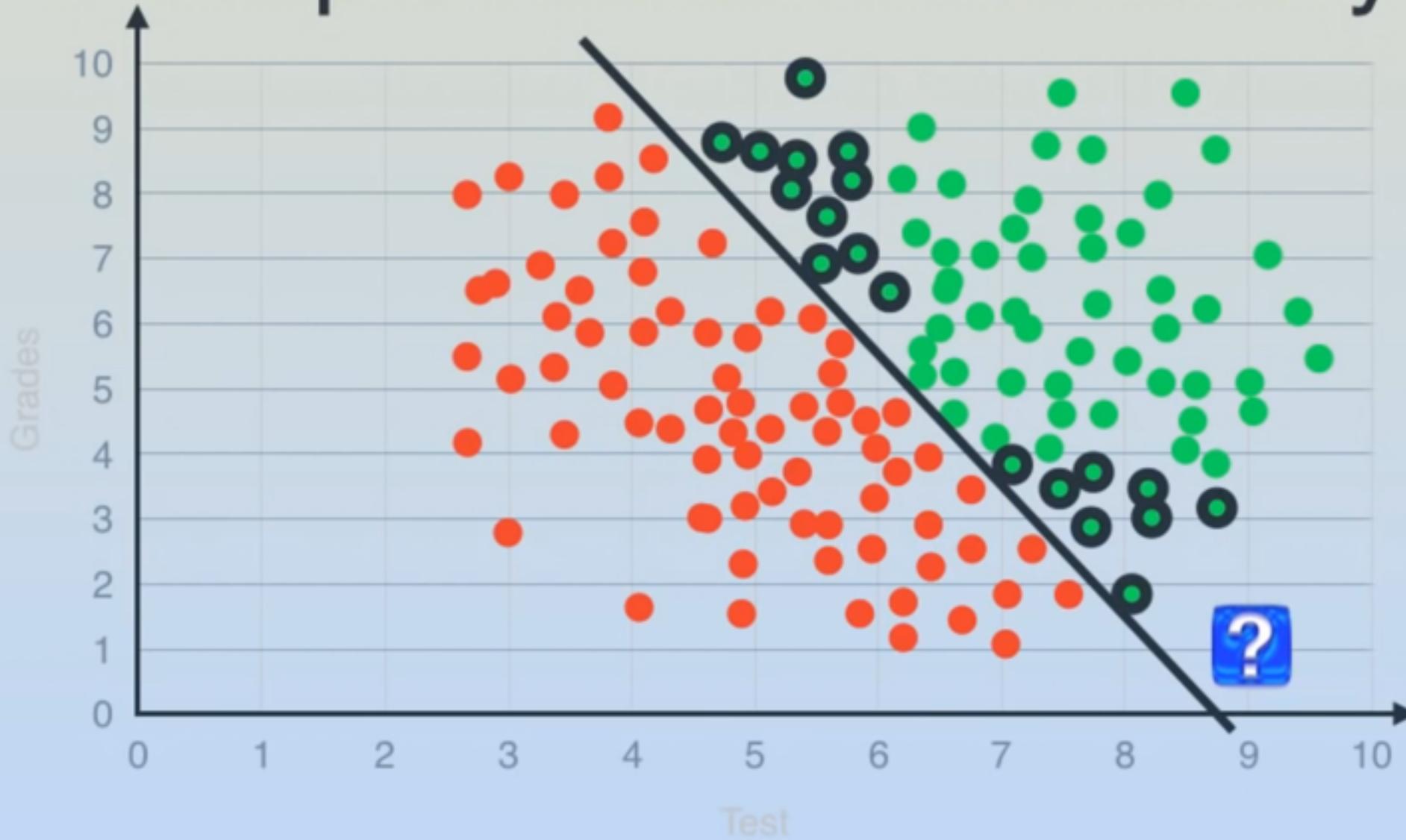
Errors: 0



Gradient descent



# Acceptance at a University

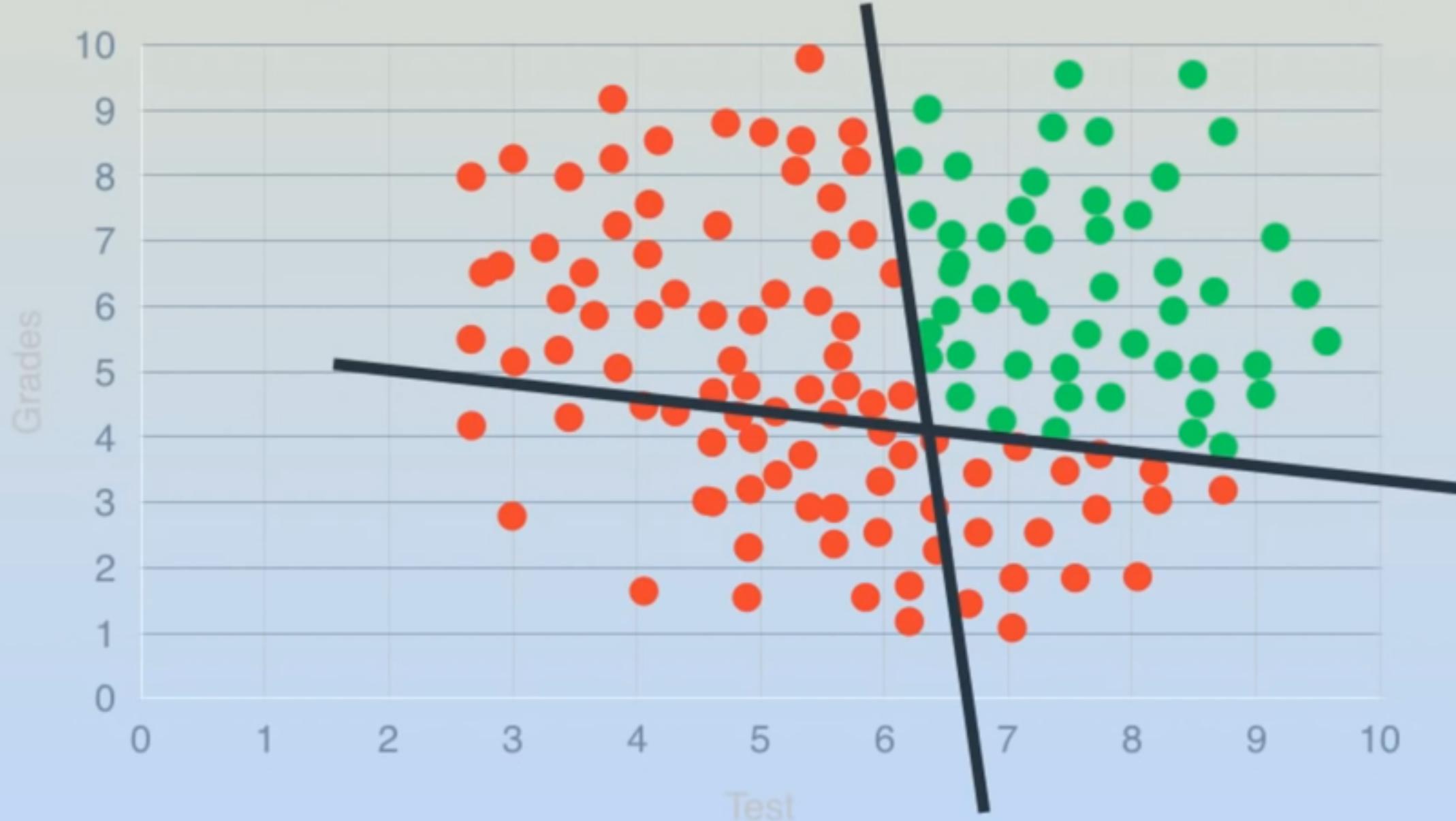


Student 4  
Test: 9/10  
Grades: 1/10

# Acceptance at a University



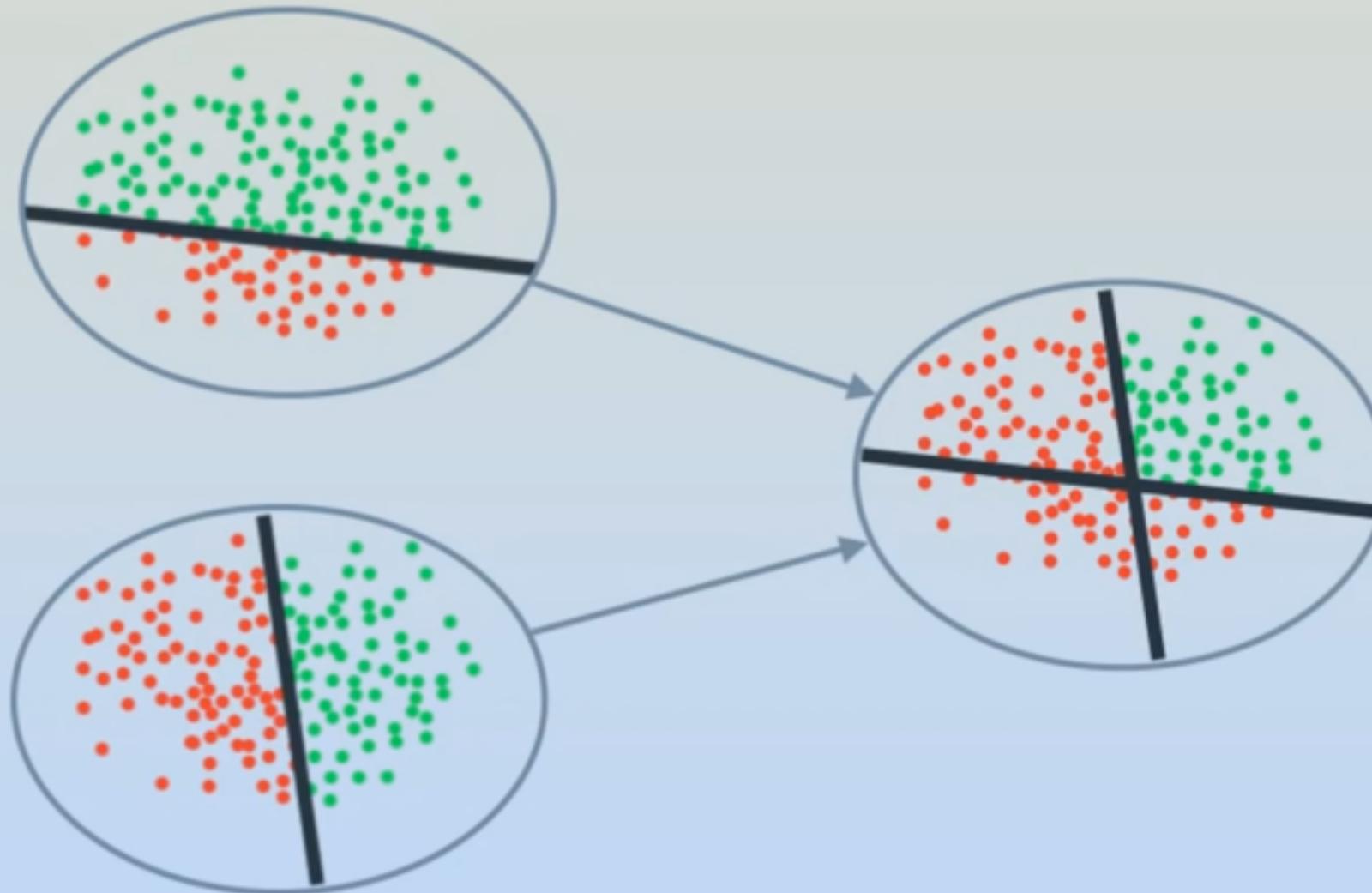
# Acceptance at a University



# Neural Network



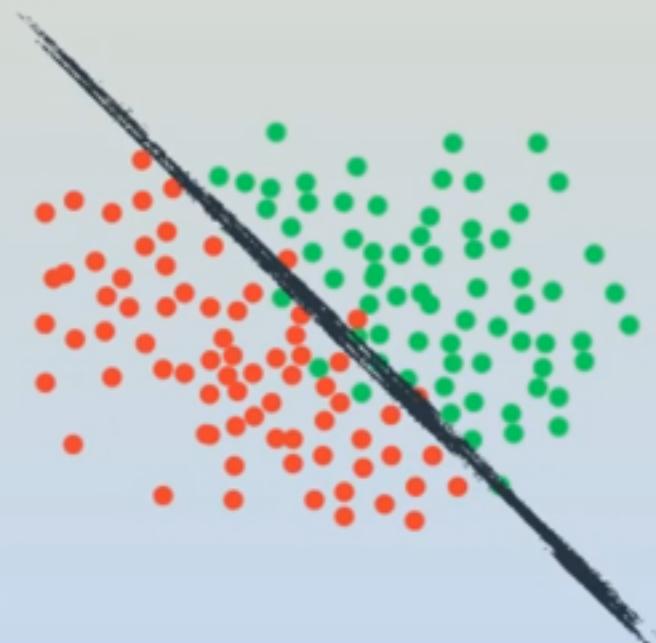
# Neural Network



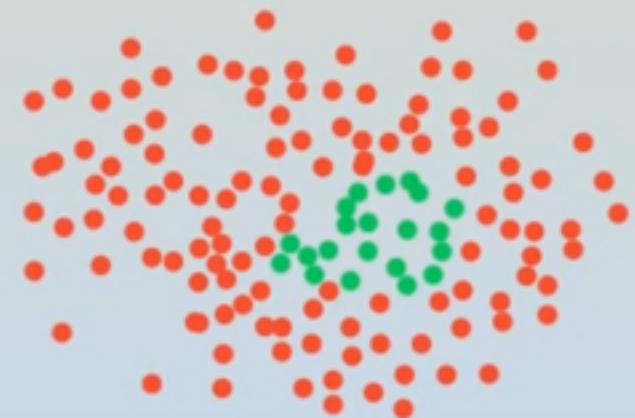
# Logistic Regression & Neural Networks



Logistic Regression



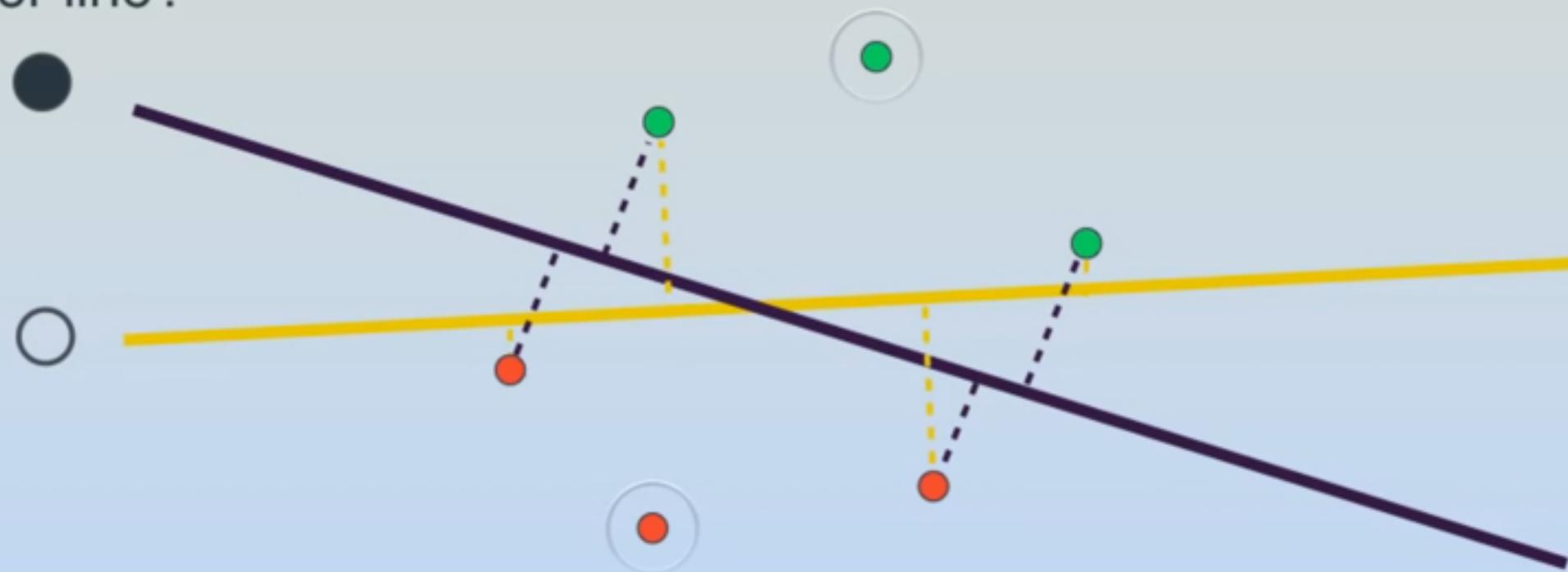
Neural Network



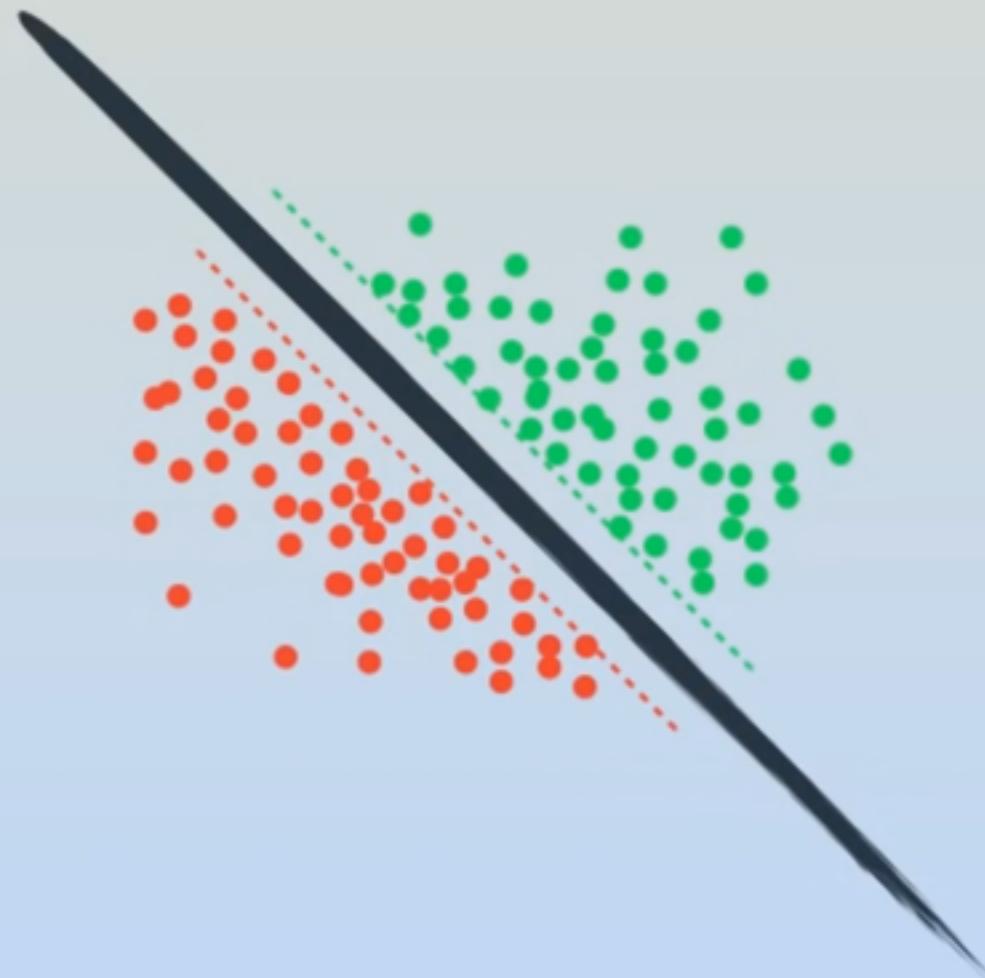
# Cutting data with style

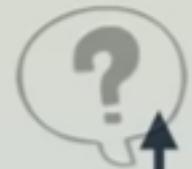
Quiz:

Which one is a  
better line?

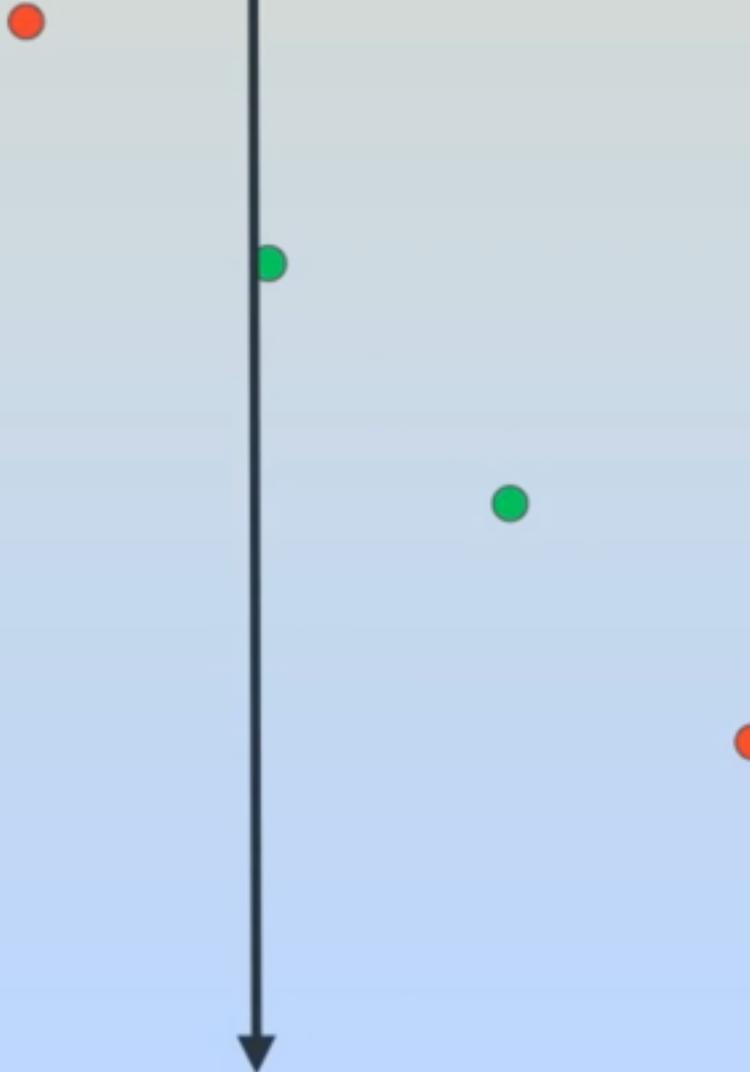


# Support Vector Machines

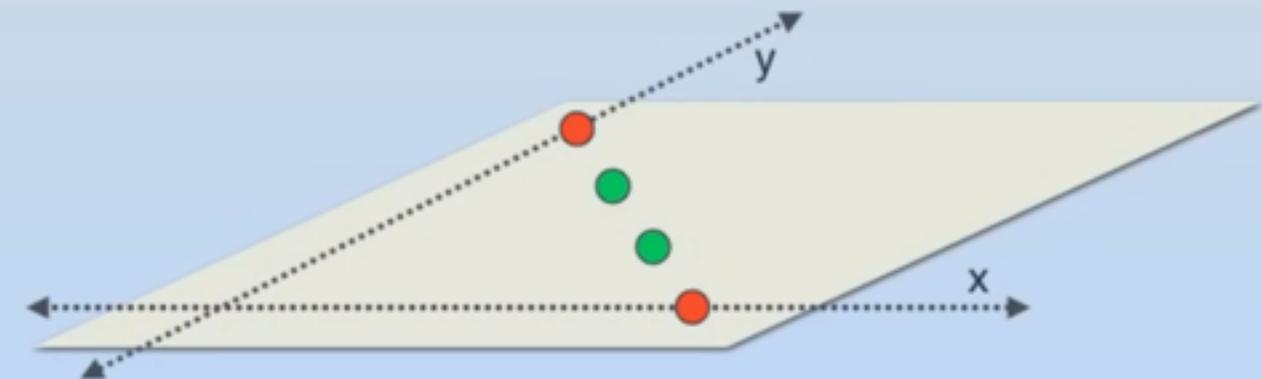
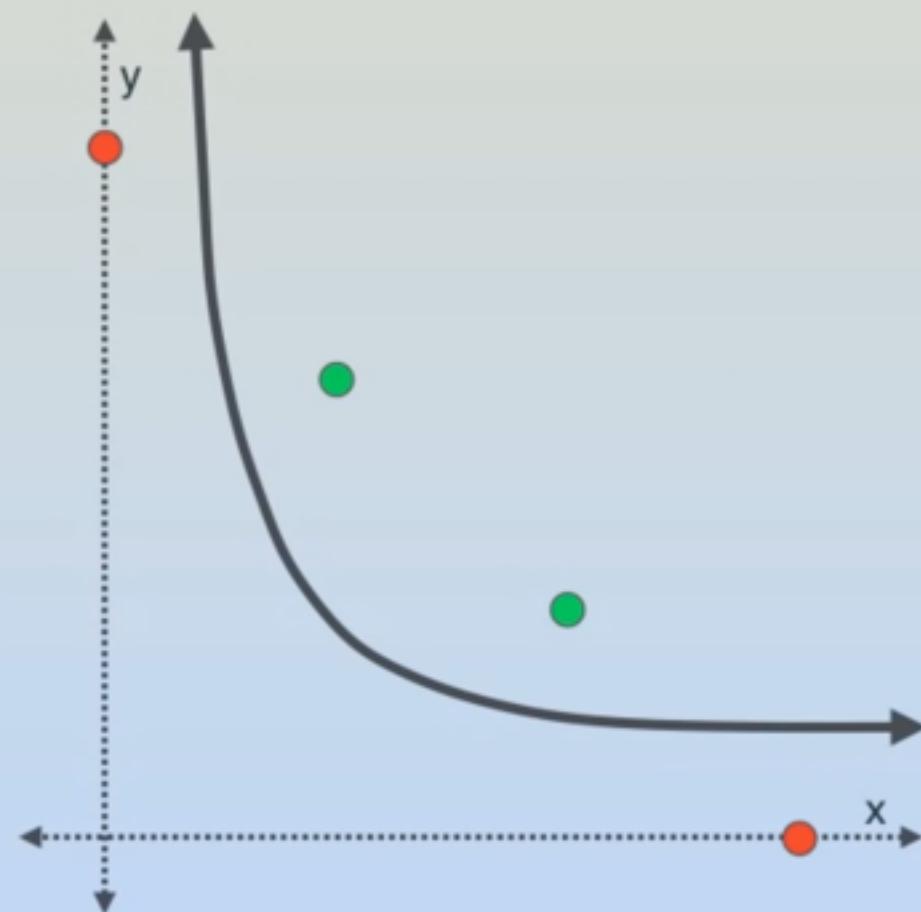




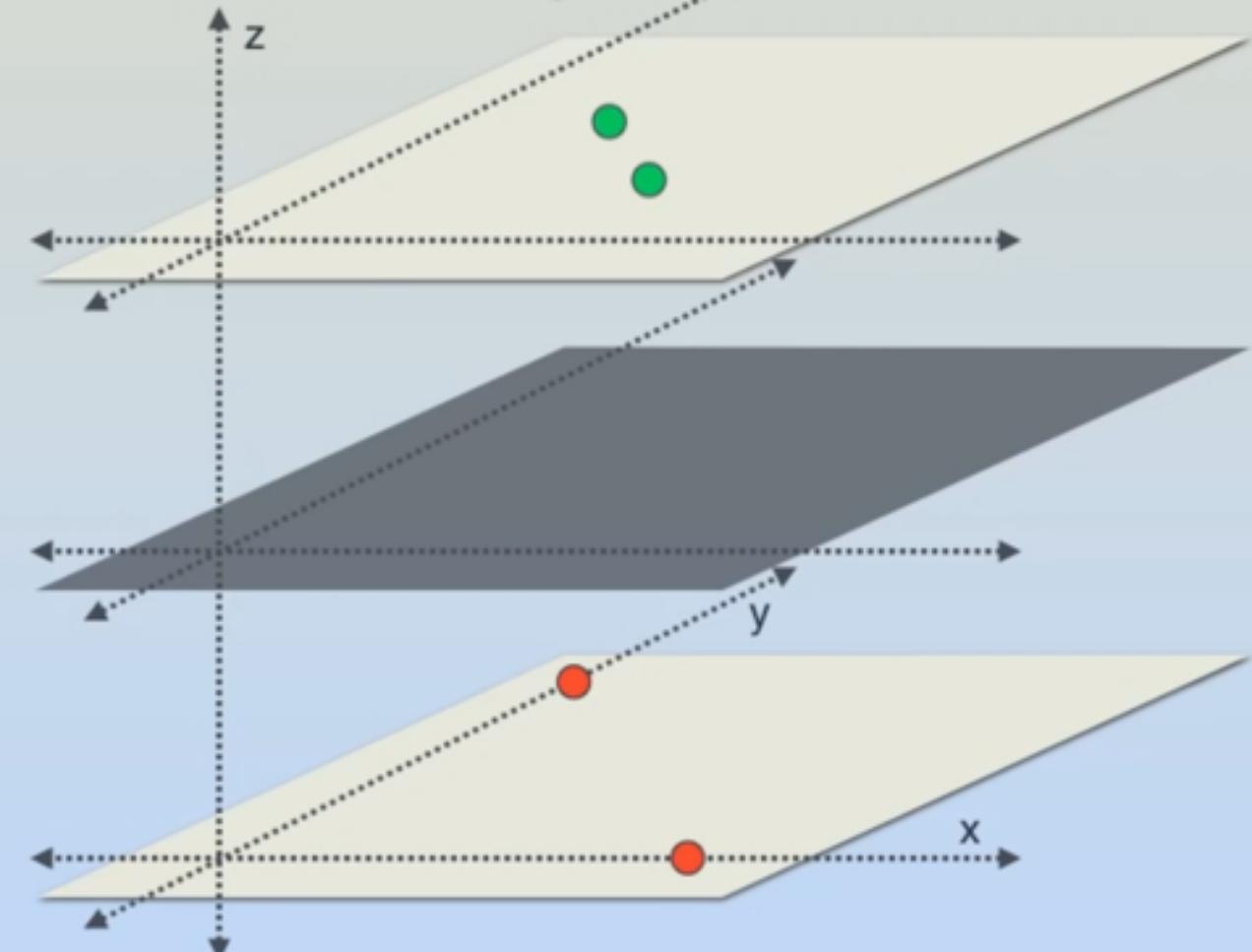
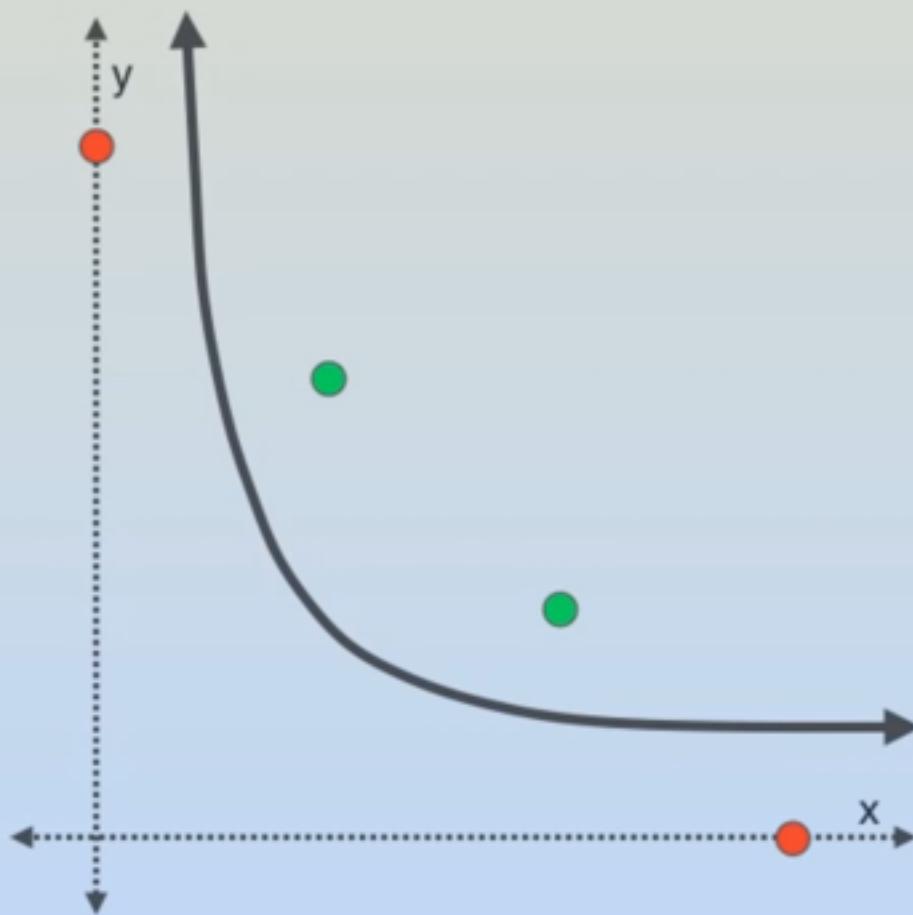
# When a line is not enough...



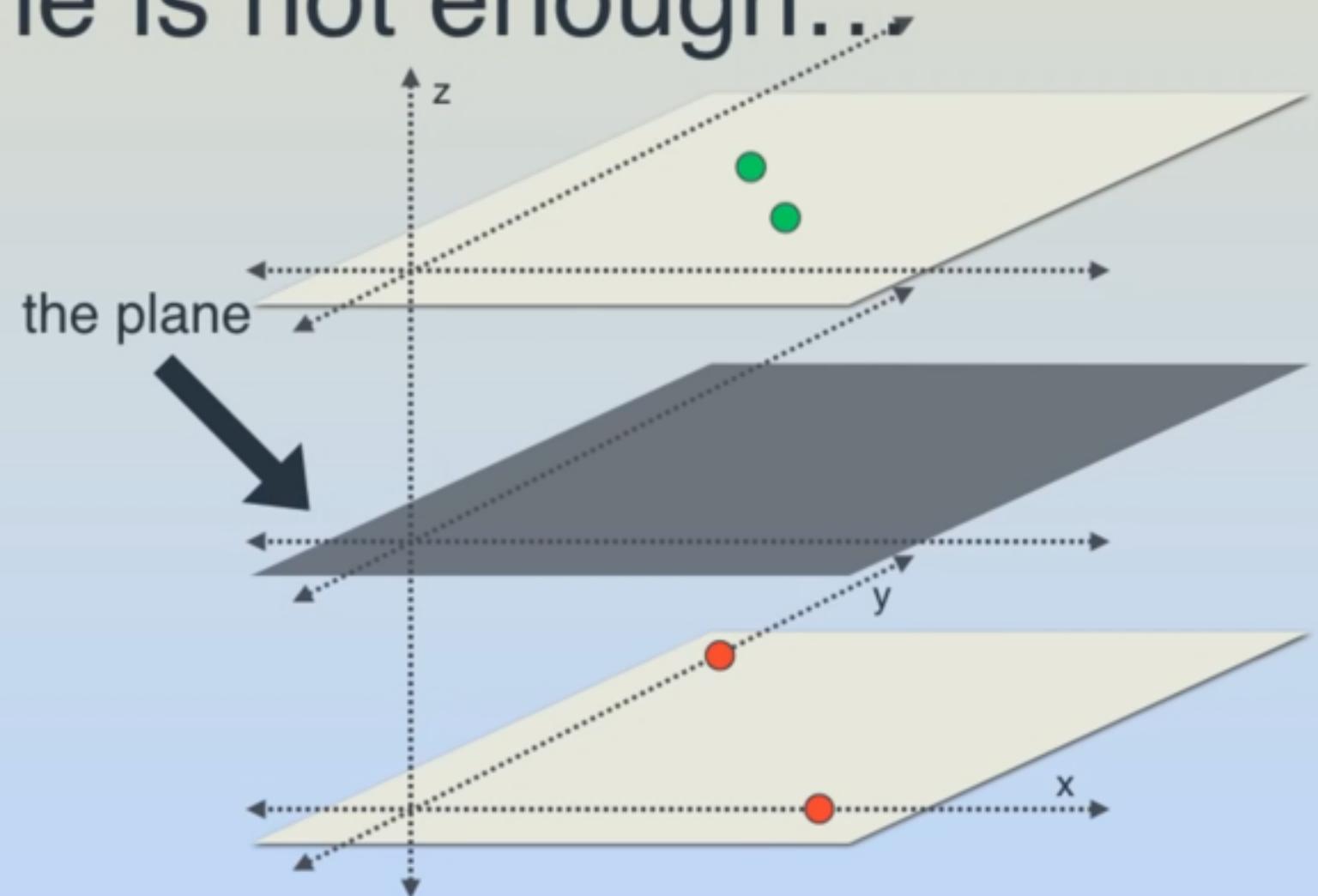
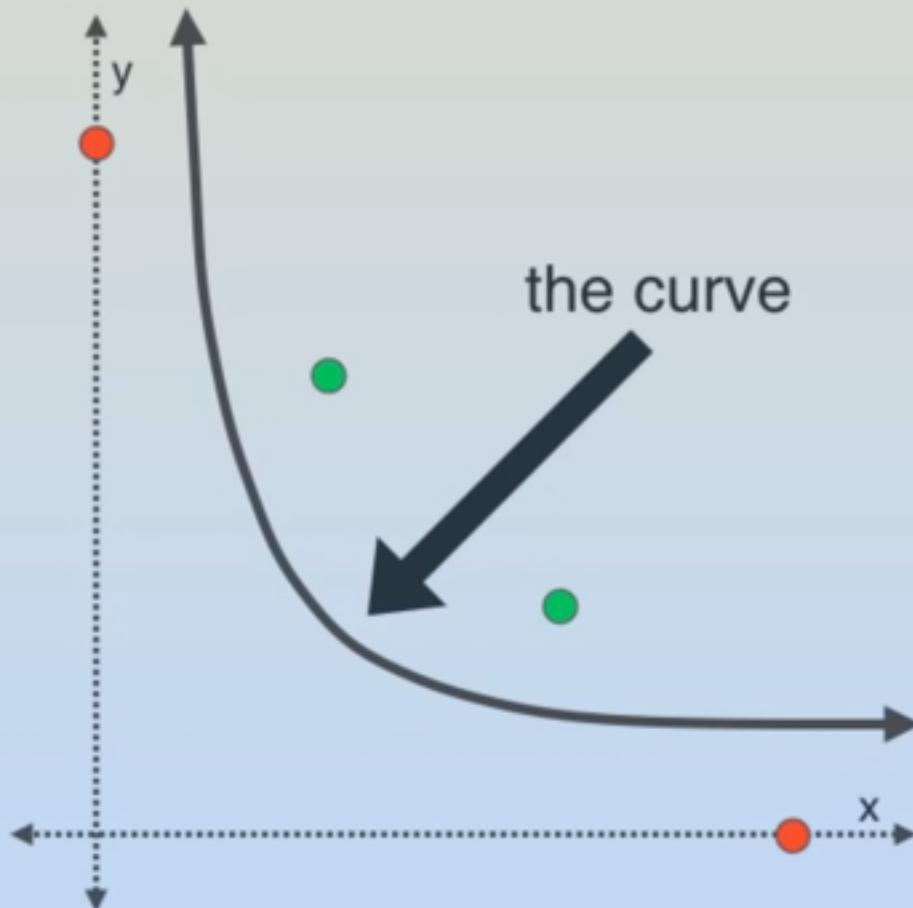
# When a line is not enough...



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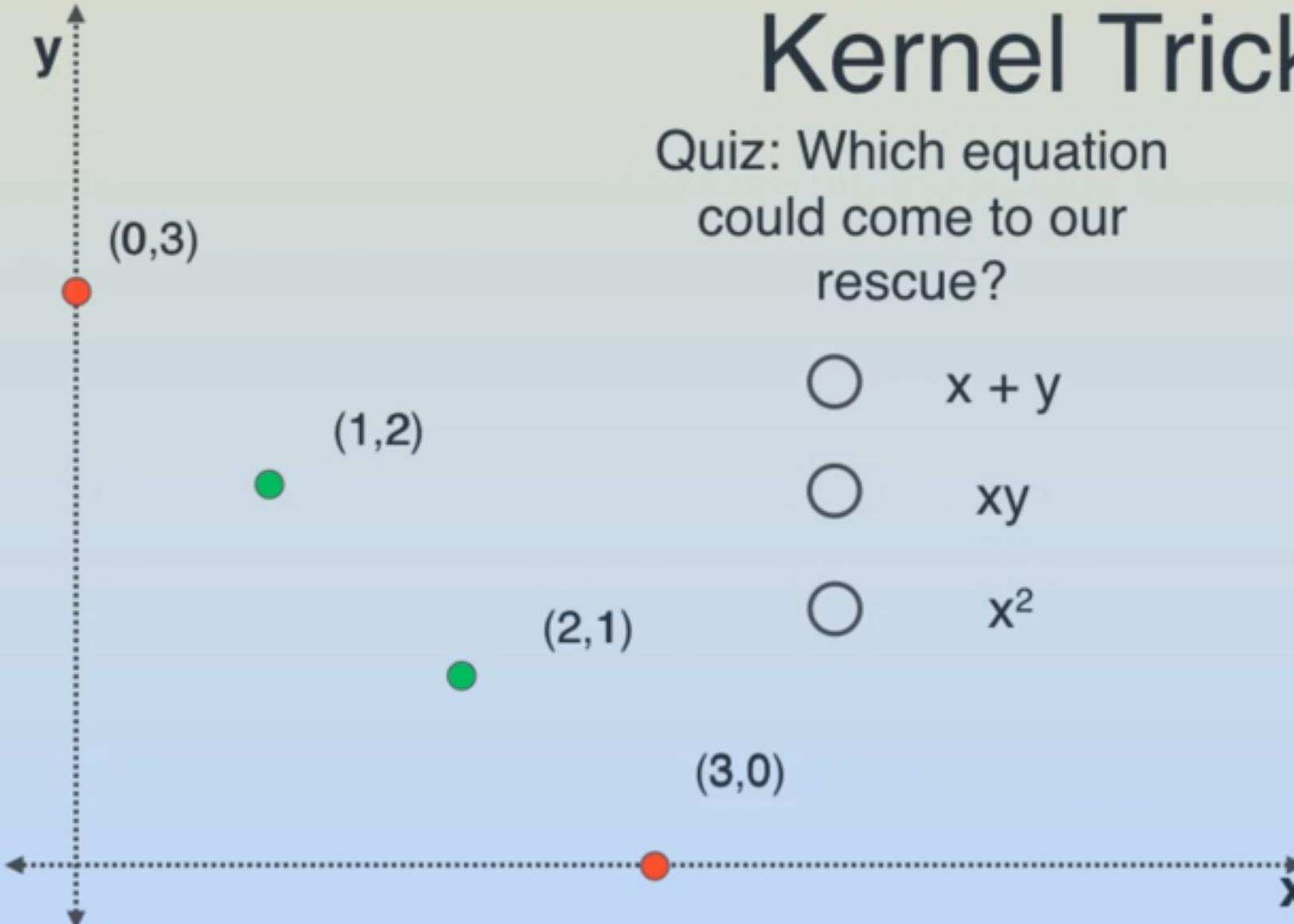


# When a line is not enough...



# Kernel Trick

Quiz: Which equation  
could come to our  
rescue?



$x + y$

$xy$

$x^2$

# Kernel Trick

Quiz: Which equation could come to our rescue?

- $x + y$
- $xy$
- $x^2$

	(0,3)	(1,2)	(2,1)	(3,0)
x+y	3	3	3	3
xy	0	2	2	0
$x^2$	0	1	4	9

(3,0)

x

y

(0,3)

(1,2)

(2,1)

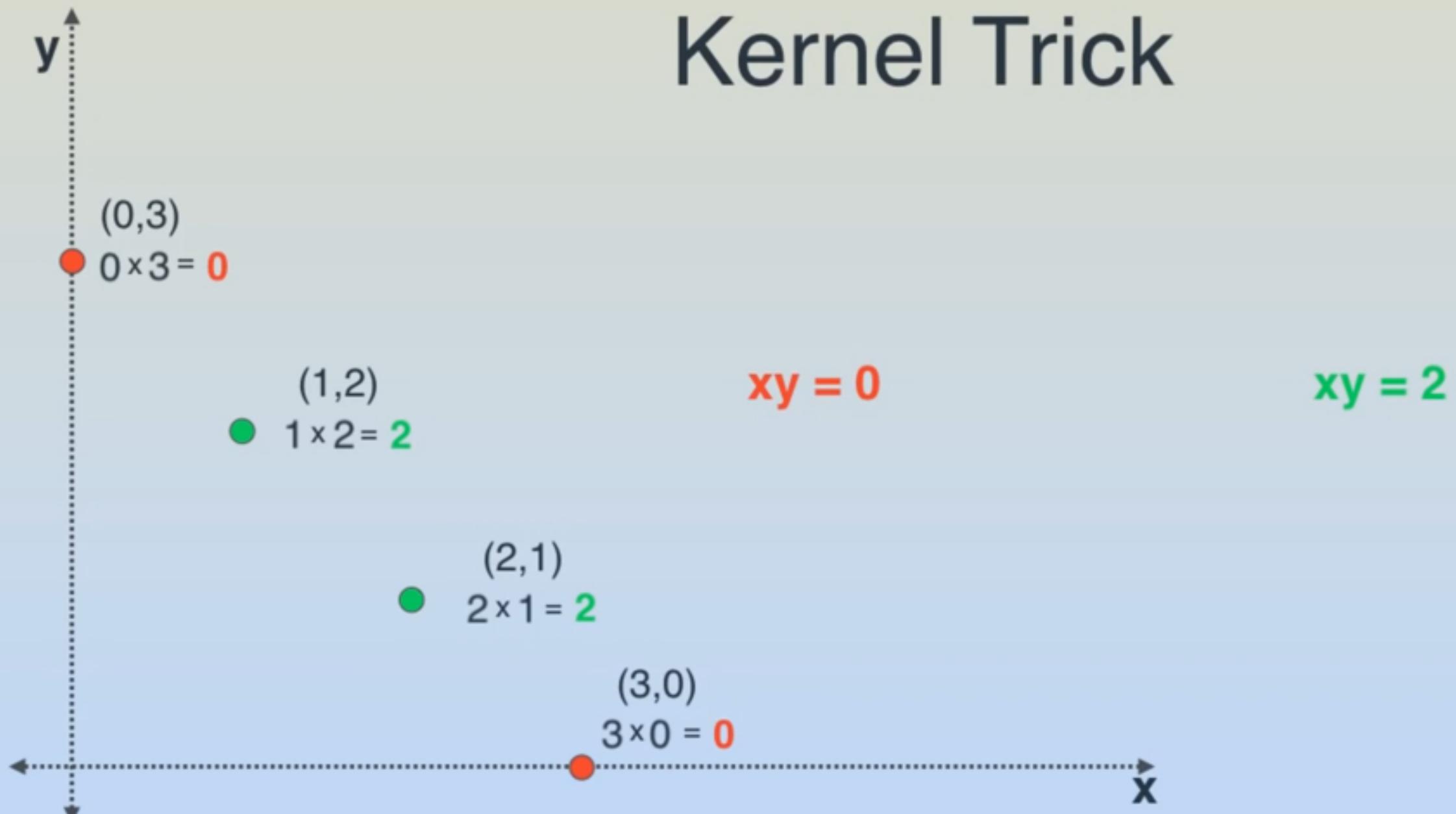
(3,0)



xy

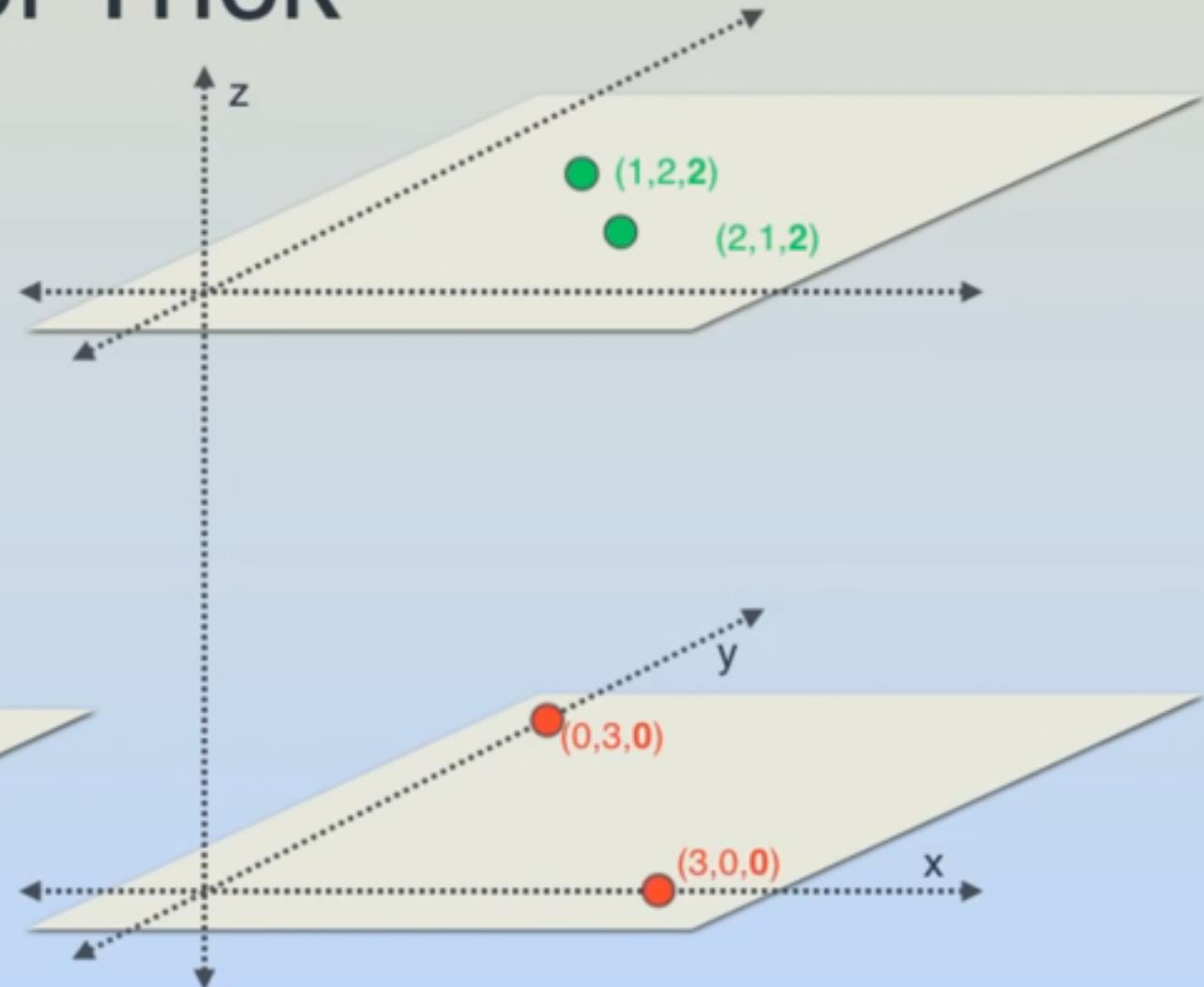


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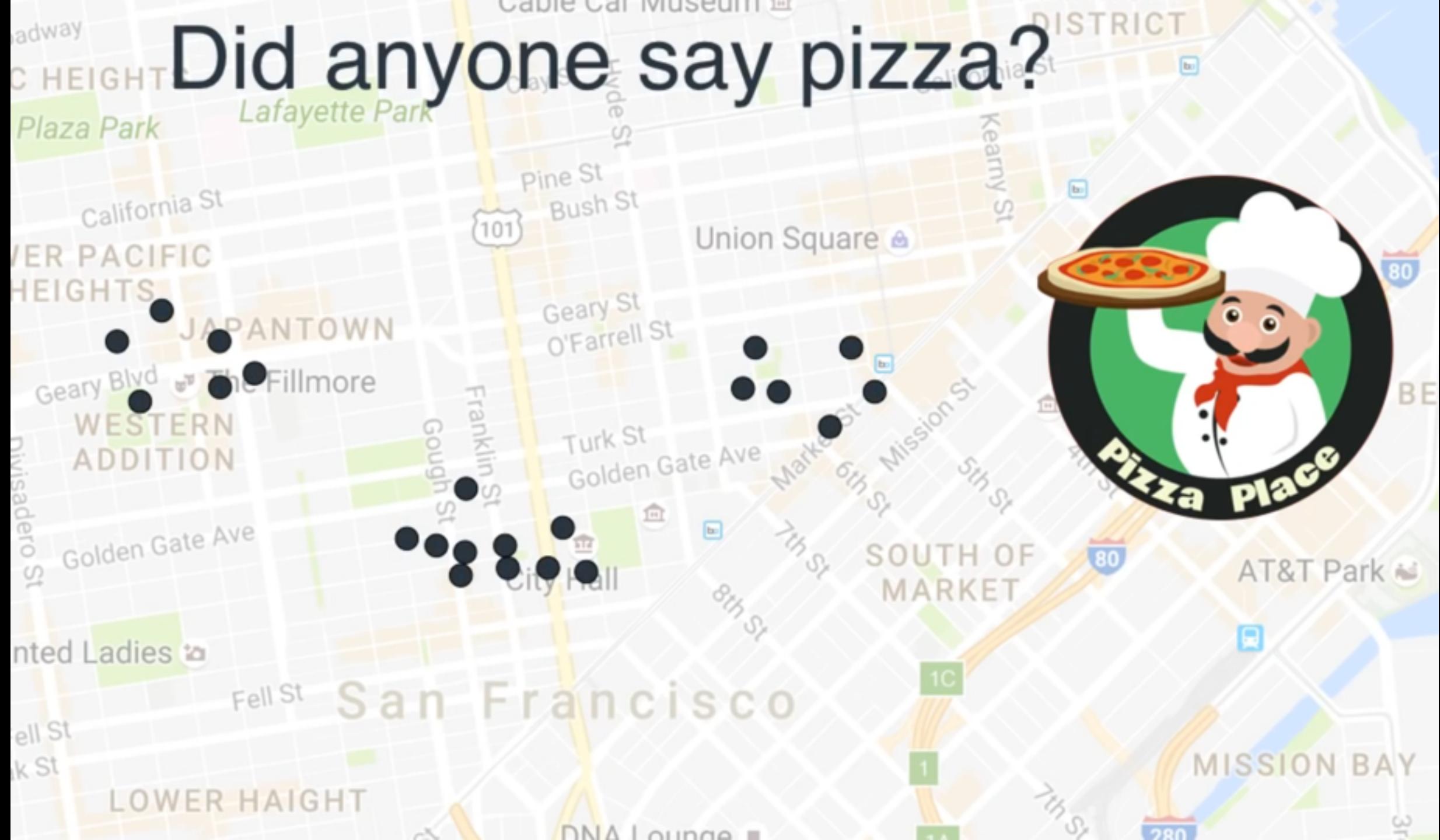


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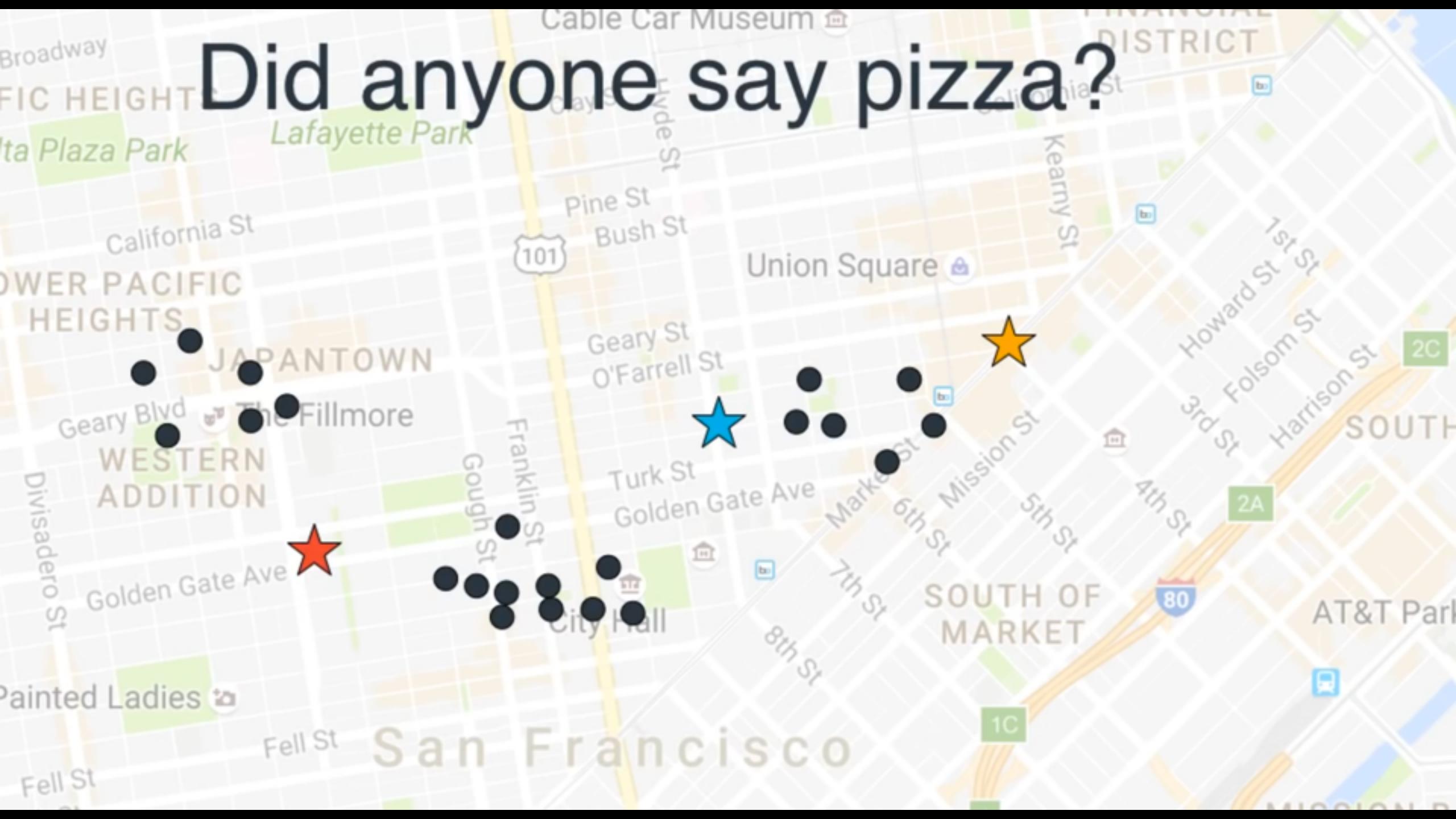
$(x,y)$	$\longrightarrow$	$(x,y,xy)$
$(0,3)$	$\longrightarrow$	$(0,3,0)$
$(1,2)$	$\longrightarrow$	$(1,2,2)$
$(2,1)$	$\longrightarrow$	$(2,1,2)$
$(3,0)$	$\longrightarrow$	$(3,0,0)$



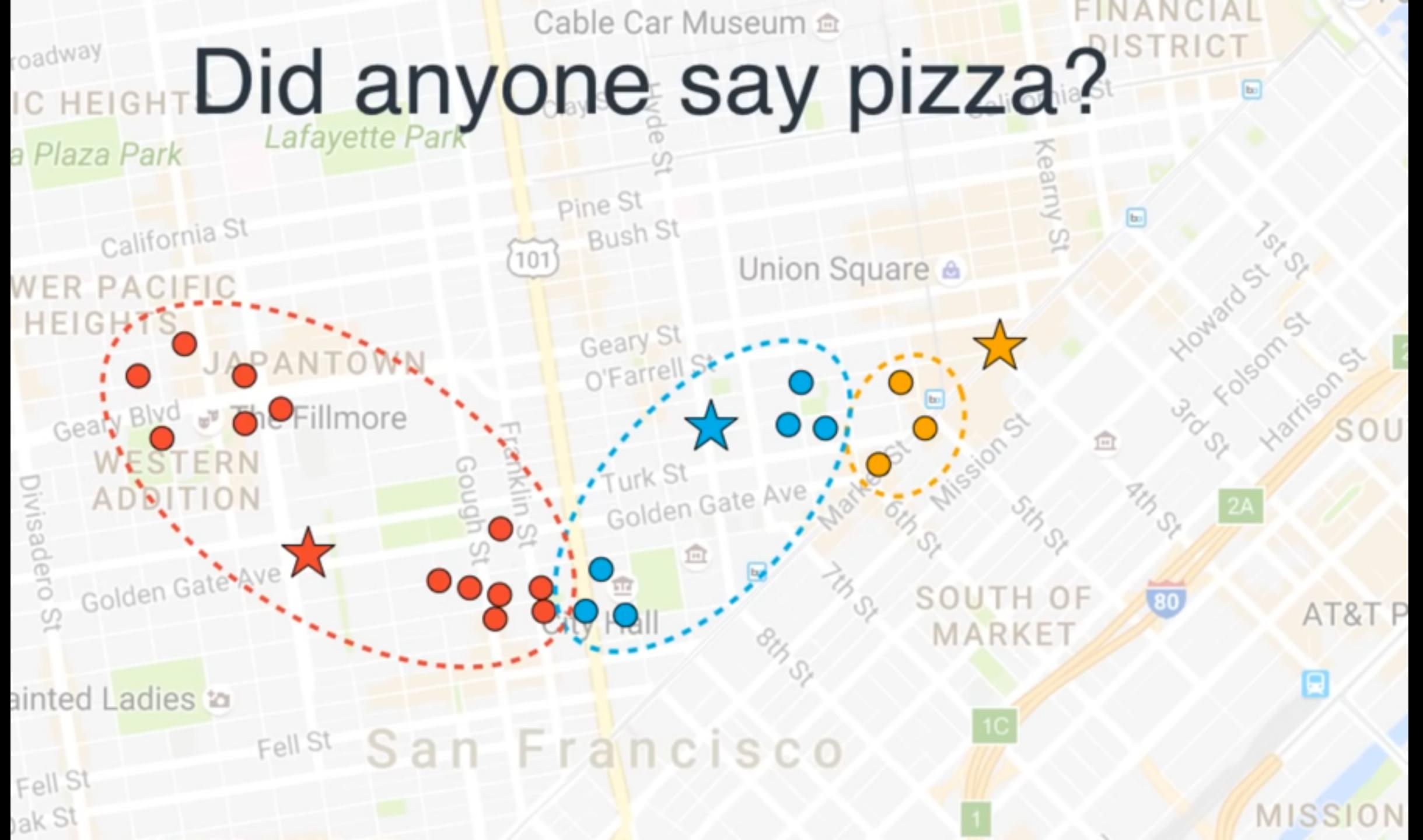
# Did anyone say pizza?



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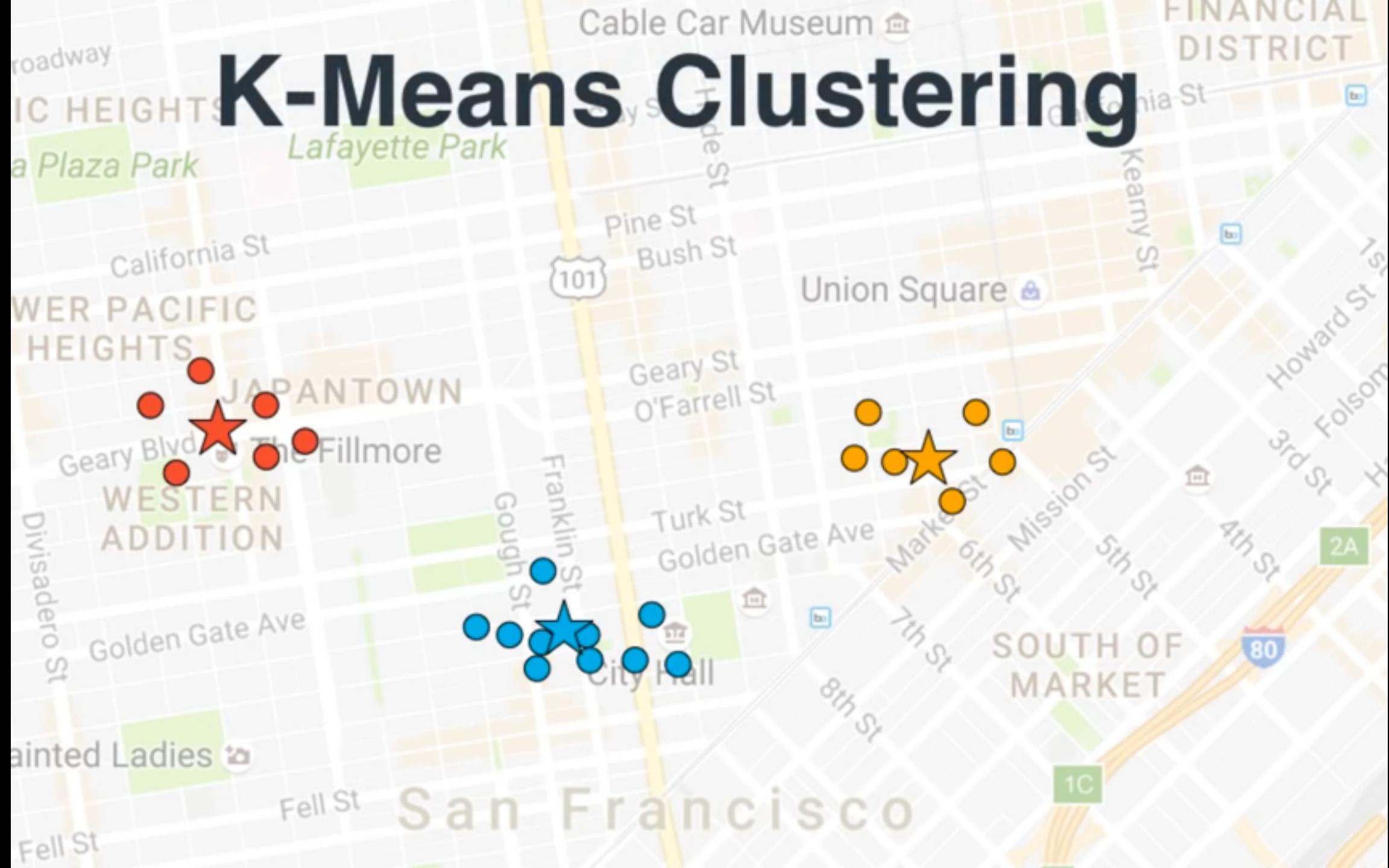
# Did anyone say pizza?



# Did anyone say pizza?



# K-Means Clustering



# Summary



Logistic Regression



Linear Regression



Naive Bayes



Neural Networks



Decision Trees



Support Vector Machines



Clustering