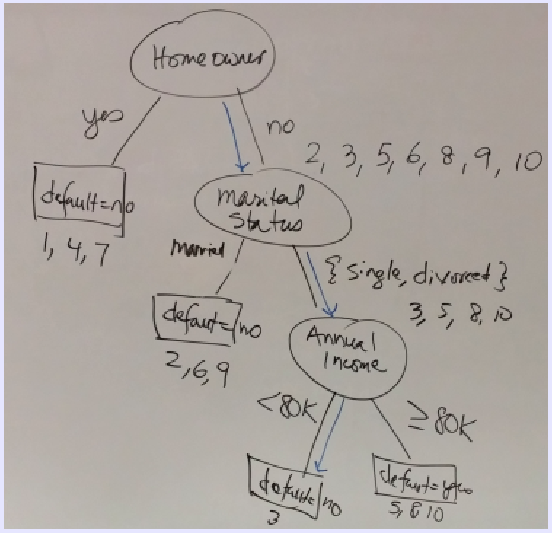
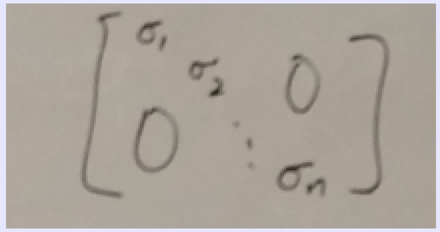
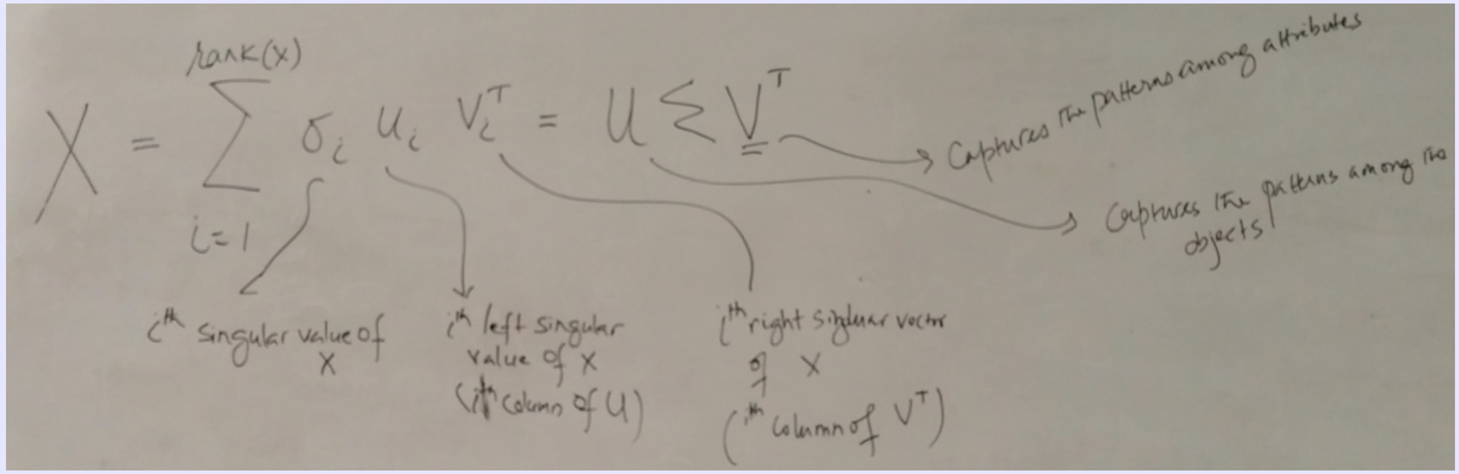
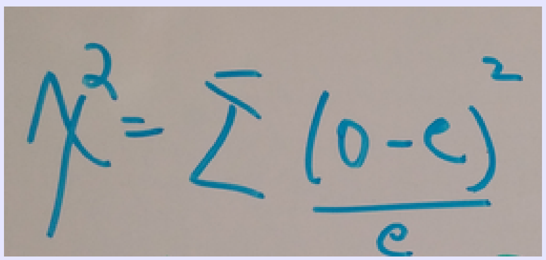
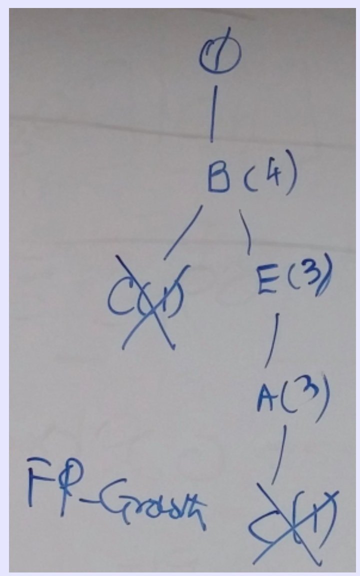
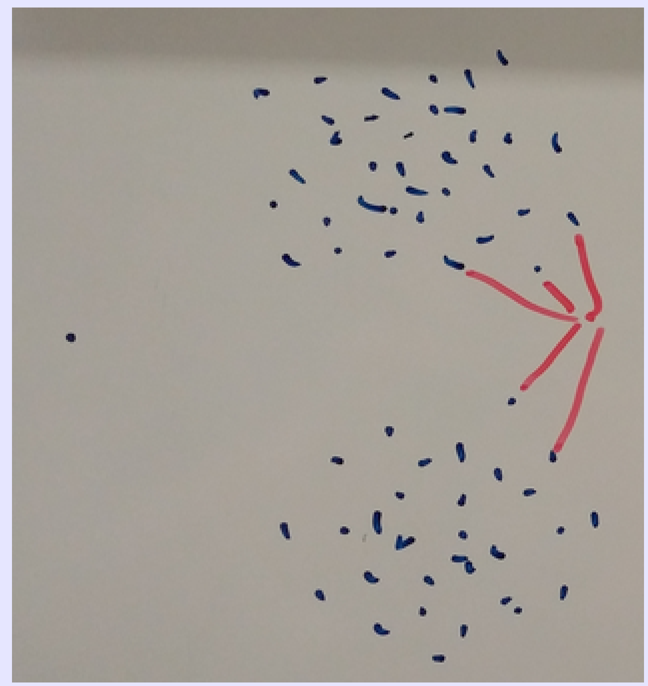










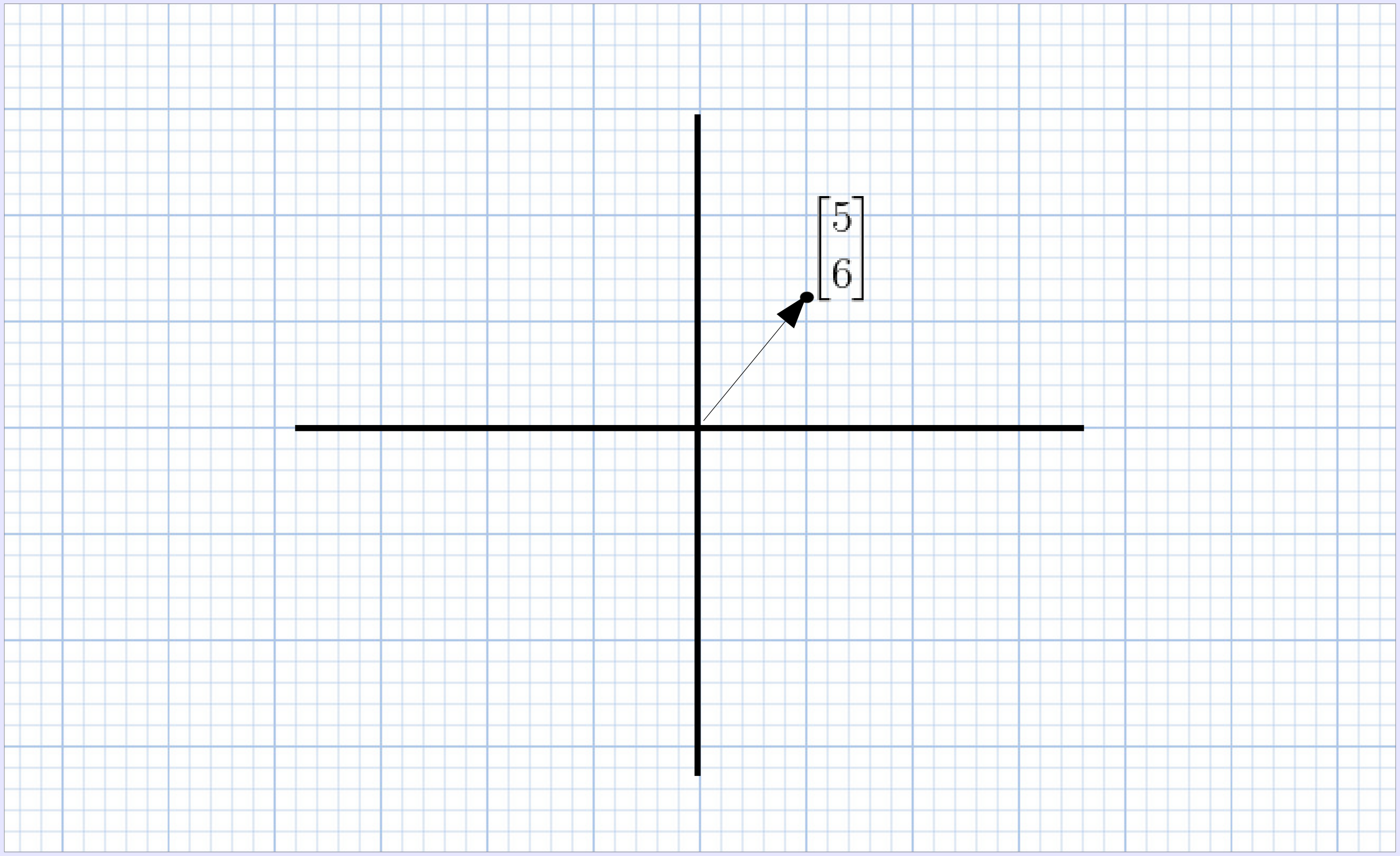


CS 422: Data Mining
Vijay K. Gurbani, Ph.D.,
Illinois Institute of Technology

Lecture: **The Perceptron**

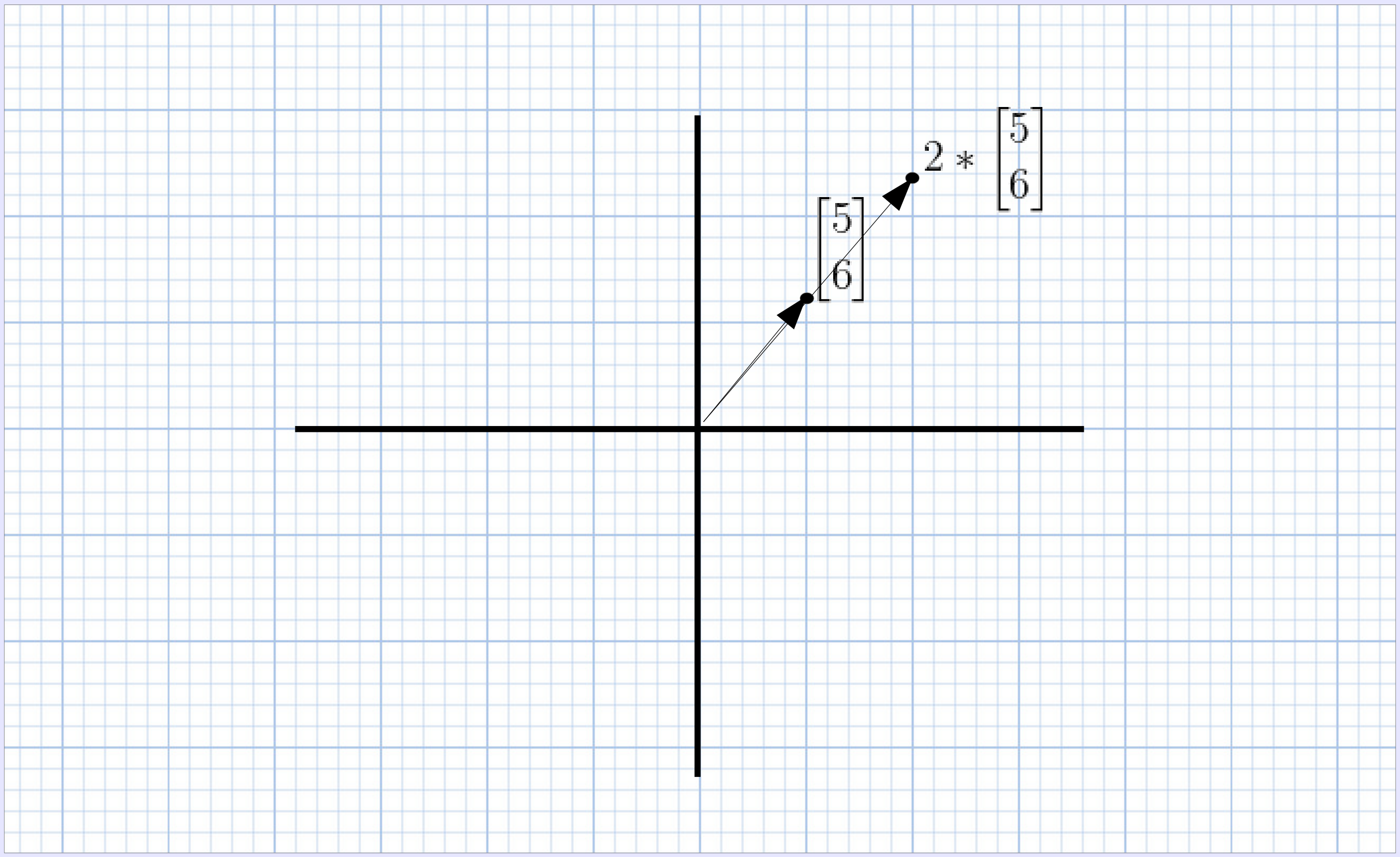
Recap: Matrices (Vector arithmetic)

Scalar multiplication with vector



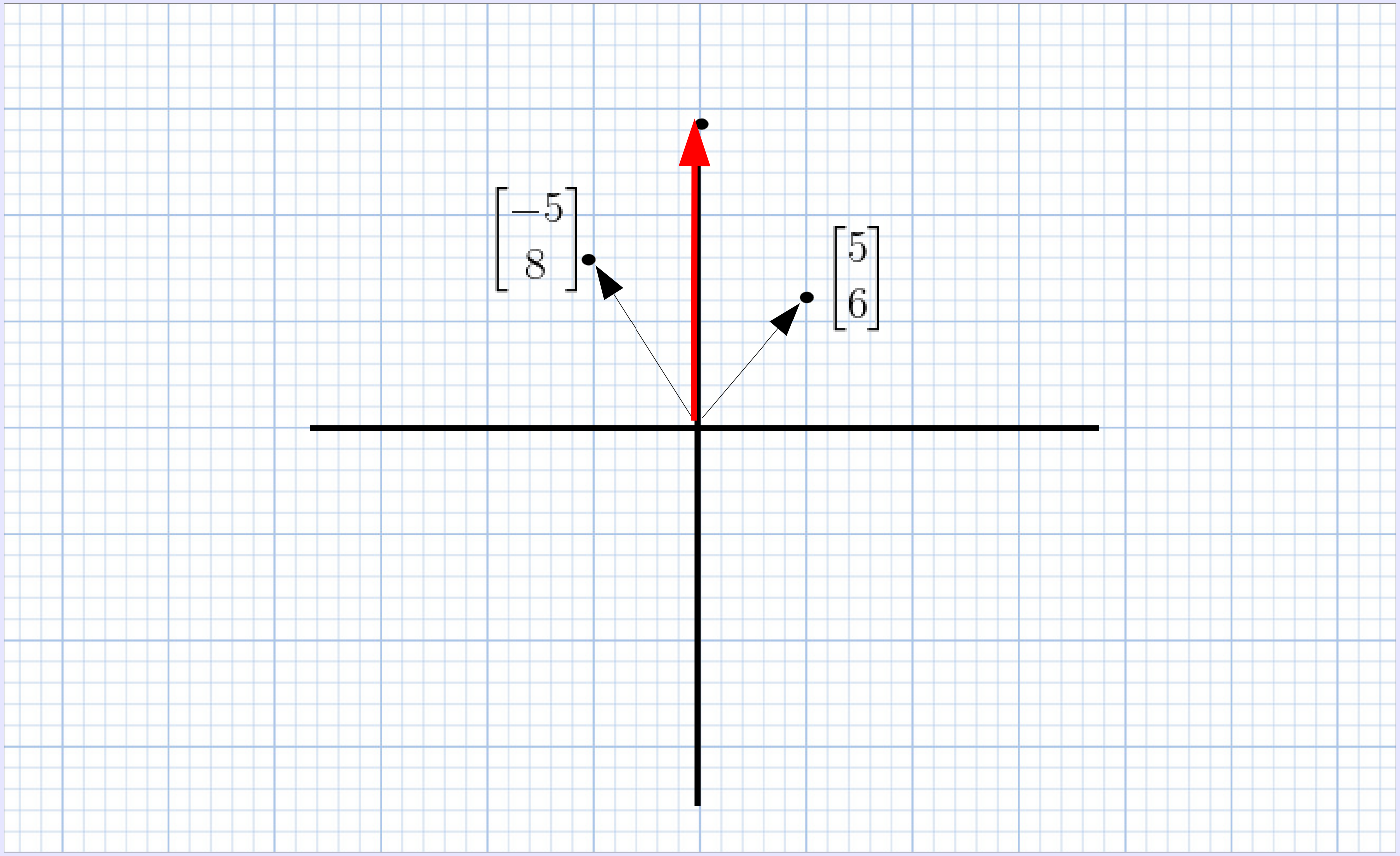
Recap: Matrices (Vector arithmetic)

Scalar multiplication with vector



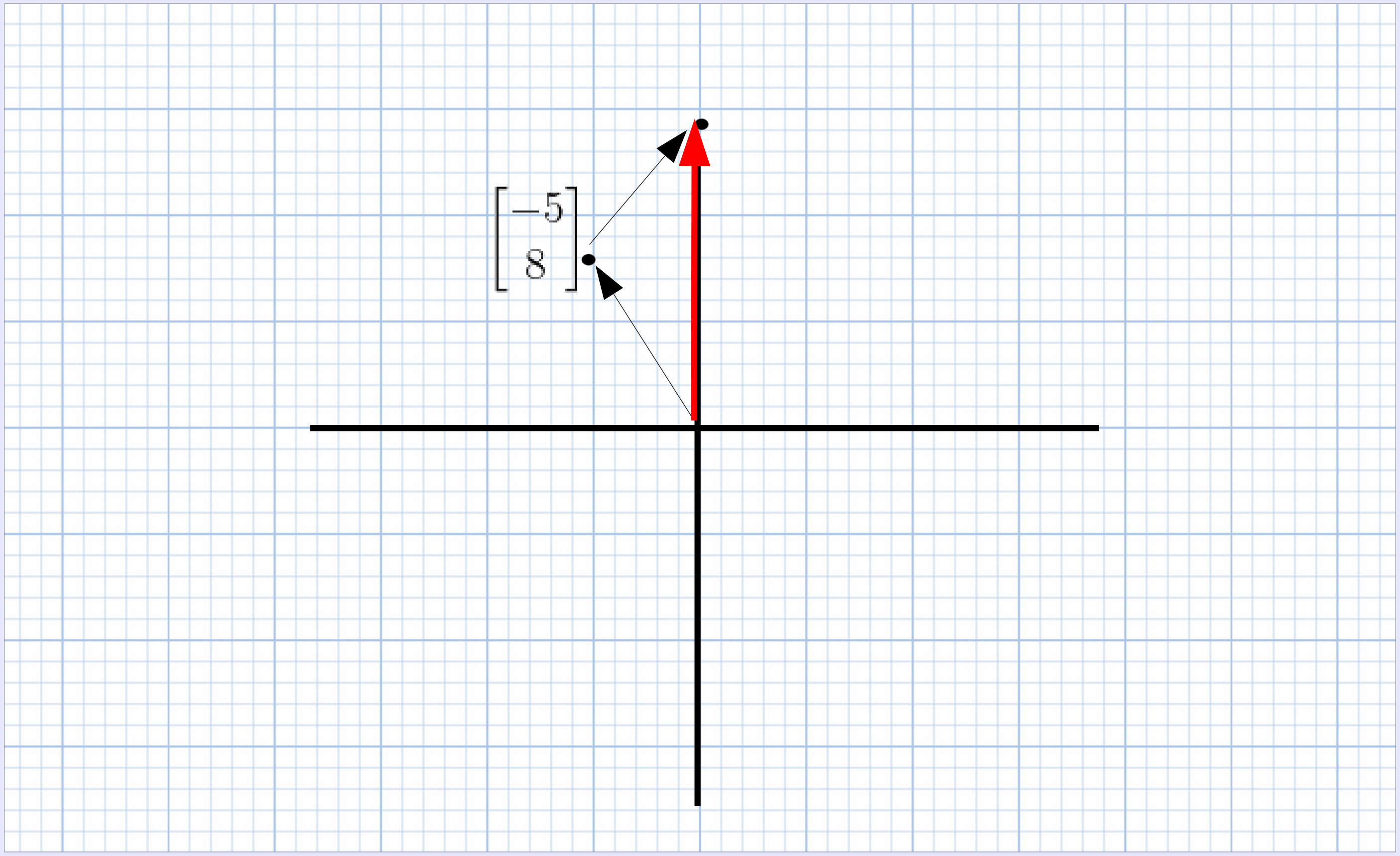
Recap: Matrices (Vector arithmetic)

Adding vectors $\begin{bmatrix}-5\\8\end{bmatrix}$ + $\begin{bmatrix}5\\6\end{bmatrix}$ = $\begin{bmatrix}0\\14\end{bmatrix}$



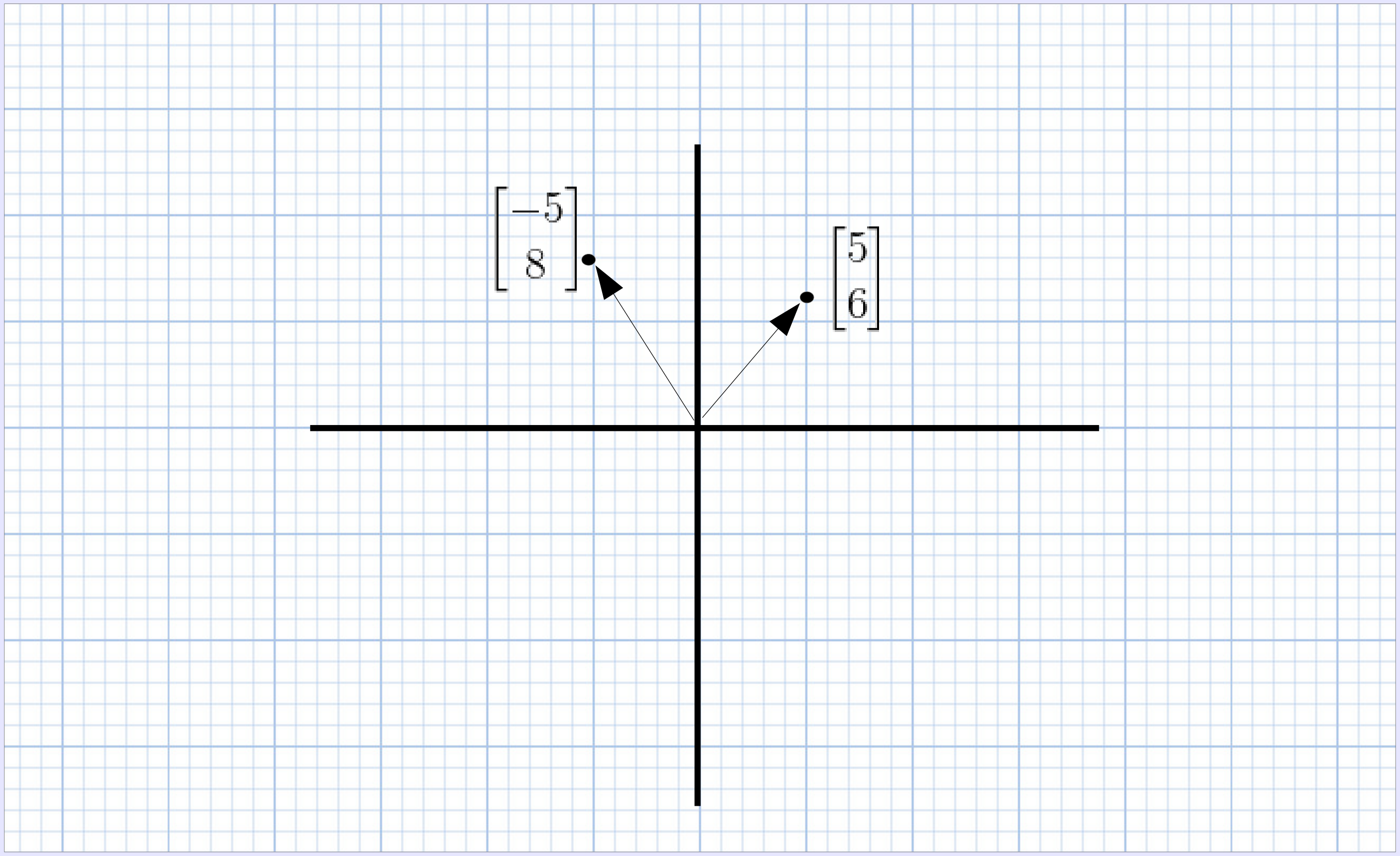
Recap: Matrices (Vector arithmetic)

Adding vectors $\begin{bmatrix} -5 \\ 8 \end{bmatrix} + \begin{bmatrix} 5 \\ 6 \end{bmatrix} = \begin{bmatrix} 0 \\ 14 \end{bmatrix}$



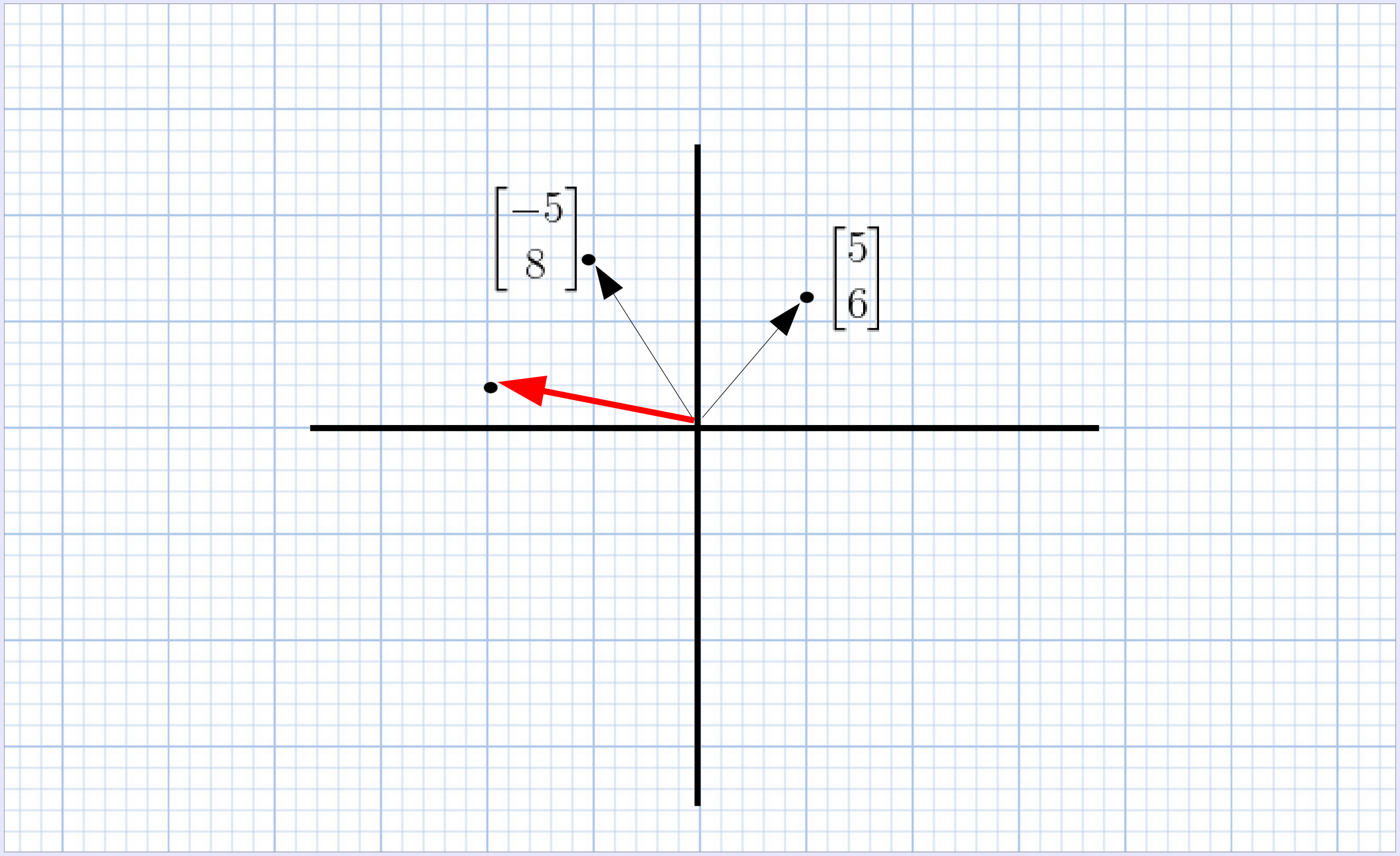
Recap: Matrices (Vector arithmetic)

Subtracting vectors $\begin{bmatrix}-5\\8\end{bmatrix}$ - $\begin{bmatrix}5\\6\end{bmatrix}$



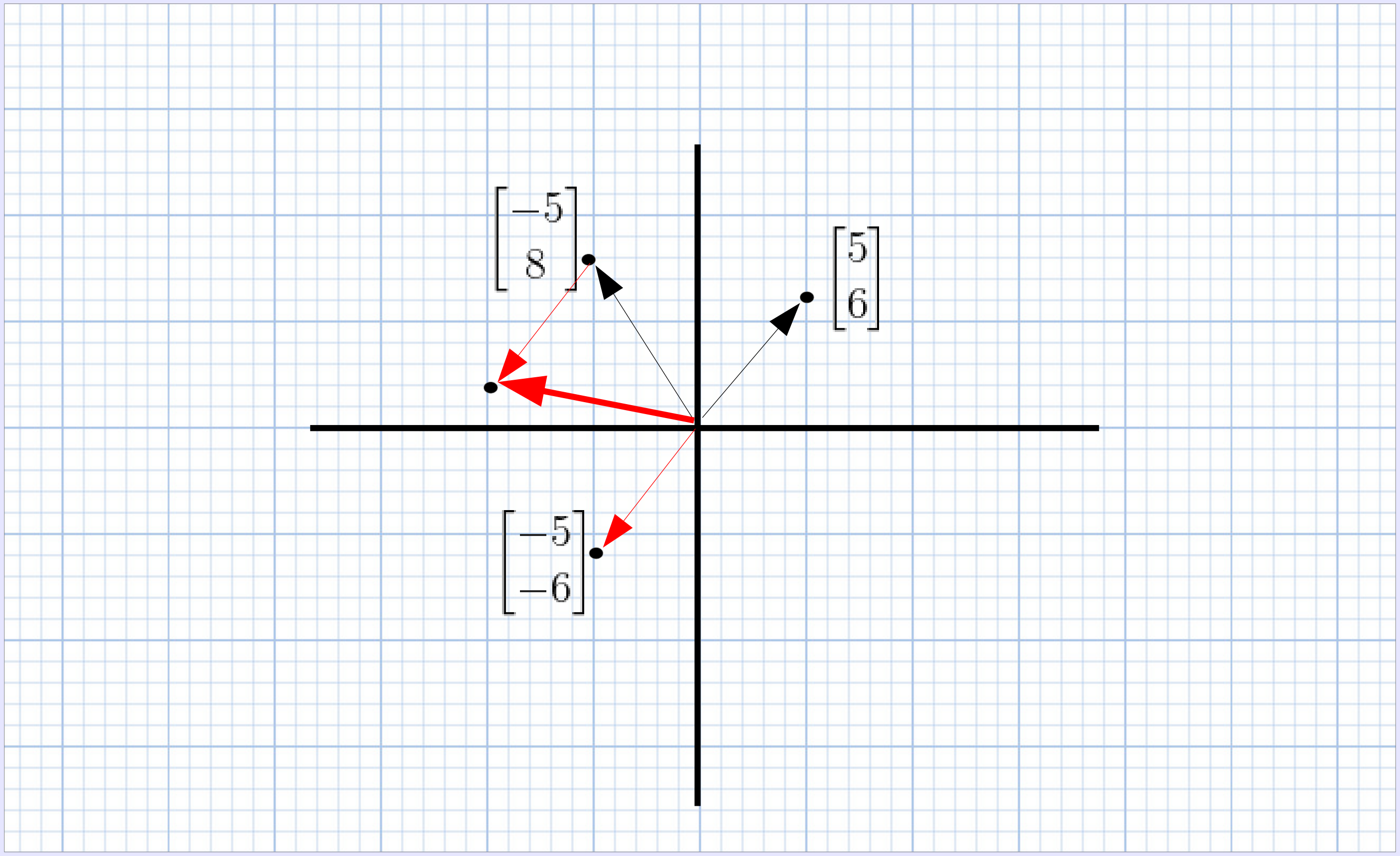
Recap: Matrices (Vector arithmetic)

Subtracting vectors $\begin{bmatrix} -5 \\ 8 \end{bmatrix} - \begin{bmatrix} 5 \\ 6 \end{bmatrix} = \begin{bmatrix} -10 \\ 2 \end{bmatrix}$



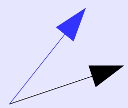
Recap: Matrices (Vector arithmetic)

Subtracting vectors $\begin{bmatrix}-5\\8\end{bmatrix}$ - $\begin{bmatrix}5\\6\end{bmatrix}$ = $\begin{bmatrix}-5\\8\end{bmatrix} + \left(-1 * \begin{bmatrix}5\\6\end{bmatrix}\right) = \begin{bmatrix}-5\\8\end{bmatrix} + \begin{bmatrix}-5\\-6\end{bmatrix} = \begin{bmatrix}-10\\2\end{bmatrix}$

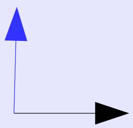


Recap: Matrices (Dot Product)

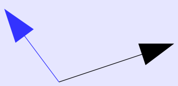
The dot product of two vectors $\vec{a} \cdot \vec{b}$ is the projection of $\vec{a}$ onto $\vec{b}$.
We want to see how much of $\vec{a}$ is pointing in the same direction as $\vec{b}$.



Dot product is positive if vectors are pointing in the same direction (geometrically, acute angle),



… 0 if perpendicular (right angle),



… negative if vectors pointing in nearly opposite direction (obtuse angle).

Mathematical interpretation of dot product: $\vec{a} \cdot \vec{b} = \sum_{i=1}^{n} a_1 b_1 + a_2 b_2 + ... a_n b_n$
(also called an "inner product")

Geometrical interpretation of the dot product: $\vec{a} \cdot \vec{b} = \|\vec{a}\| \left\|\vec{b}\right\| cos(\theta)$

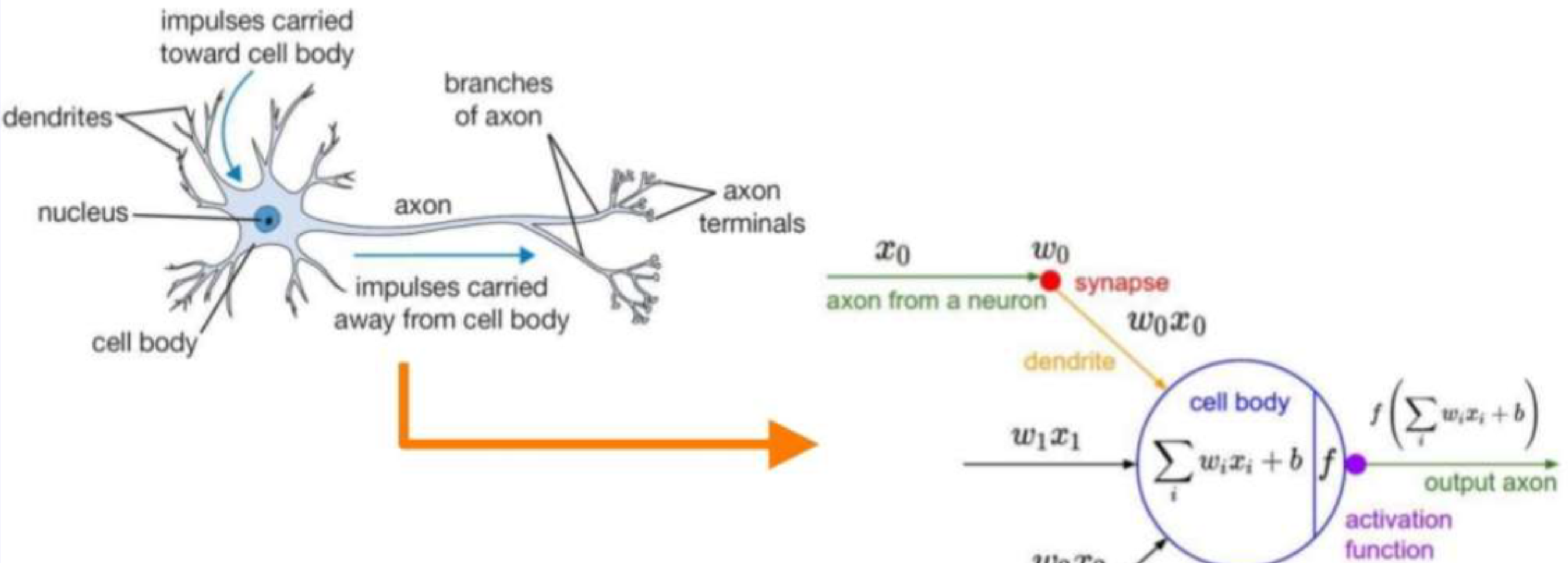
Ex: $\vec{a}$ = <1, 3, 2>; $\vec{b}$ = <5, 1, 8>

$\vec{a} \cdot \vec{b}$ = 24, $\|\vec{a}\| = \sqrt{1^2 + 3^2 + 2^2} = \sqrt{13}, \left\|\vec{b}\right\| = \sqrt{90}$

$$\theta = cos^{-1}\left(\frac{24}{\sqrt{13}\sqrt{90}}\right)$$

Introduction

- Neural networks: If computers are to think, why not model them after the human brain?



Graphic credit: Thomas da Silva Paula, "An Introduction to Machine Learning"

Introduction

- … Except, of course, the human brain is in a league of its own.

Organism	Number of neurons
Jellyfish	5,600
Fruit fly	250,000
Frog	16,000,000
Cat	760,000,000
Humans	