

## Bonus Quiz 10/16

$$M = \begin{bmatrix} 1 & 3 & -2 \\ 0 & 2 & -1 \\ -4 & -2 & 3 \\ 1 & 3 & 2 \end{bmatrix}$$

Find a basis for

- (a)  $\text{row}(M)$
- (b)  $\text{col}(M)$
- (c)  $\text{nul}(M)$

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$$\bar{M} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix} \text{ is the RREF for } M$$

(a) A basis for  $\text{row}(M)$  is  $\{[1 \ 3 \ -2], [0 \ 2 \ -1], [-4 \ -2 \ 3]\}$

(b) A basis for  $\text{col}(M)$  is  $\left\{ \begin{bmatrix} 1 \\ 0 \\ -4 \\ 1 \end{bmatrix}, \begin{bmatrix} 3 \\ 2 \\ -2 \\ 3 \end{bmatrix}, \begin{bmatrix} -2 \\ -1 \\ 3 \\ 2 \end{bmatrix} \right\}$

(c) As the  $\text{rank}(M) = 3 = \# \text{ columns}$ ,  
 $M$  is 1-to-1. Therefore,  $\dim(\text{Nul}(M)) = 0$   
and  $\text{Nul}(M) = \{\vec{0}\}$ . The basis for  
 $\text{Nul}(M)$  is  $\emptyset$ , the empty set.