Data 605 - Week 2

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Contents

```
# Load library
#install.packages("pracma")
library(pracma)
```

Linear Algebra: Exercise C17

C17[†]   Working within the vector space $\mathbb{C}^4$, determine if $\mathbf{b} = \begin{bmatrix} 2 \\ 1 \\ 2 \\ 1 \end{bmatrix}$ is in the subspace W,

$$W = \left\langle \left\{ \begin{bmatrix} 1 \\ 2 \\ 0 \\ 2 \end{bmatrix}, \begin{bmatrix} 1 \\ 0 \\ 3 \\ 1 \end{bmatrix}, \begin{bmatrix} 0 \\ 1 \\ 0 \\ 2 \end{bmatrix}, \begin{bmatrix} 1 \\ 1 \\ 2 \\ 0 \end{bmatrix} \right\} \right\rangle$$

Handwritten:

Exercise C17:

①
$$b = \begin{bmatrix} 2 \\ 1 \\ 2 \\ 1 \end{bmatrix} \qquad W = \left\{ \begin{bmatrix} 1 \\ 2 \\ 0 \\ 2 \end{bmatrix}, \begin{bmatrix} 1 \\ 0 \\ 3 \\ 1 \end{bmatrix}, \begin{bmatrix} 0 \\ 1 \\ 0 \\ 2 \end{bmatrix}, \begin{bmatrix} 1 \\ 1 \\ 2 \\ 0 \end{bmatrix} \right\}$$

②
$$c_1 \begin{bmatrix} 1 \\ 2 \\ 0 \\ 2 \end{bmatrix} + c_2 \begin{bmatrix} 1 \\ 0 \\ 3 \\ 1 \end{bmatrix} + c_3 \begin{bmatrix} 0 \\ 1 \\ 0 \\ 2 \end{bmatrix} + c_4 \begin{bmatrix} 1 \\ 1 \\ 2 \\ 0 \end{bmatrix} = \begin{bmatrix} 2 \\ 1 \\ 2 \\ 1 \end{bmatrix}$$

③
$$c_1 + c_2 + c_4 = 2$$
$$2c_1 + c_3 + c_4 = 1$$
$$3c_2 + 2c_4 = 2$$
$$2c_1 + c_2 + 2c_3 = 1$$

Using R:

```
# Create the matrices

W <- matrix(c(1, 1, 0, 1, 2, 0 , 1, 1, 0, 3, 0, 2, 2, 1, 2, 0), nrow = 4, ncol = 4)

b <- matrix(c(2, 1, 2, 1), nrow = 4, ncol = 1)
```

```
# Bind the matrices together to create an argumented matrix
data <- cbind(W, b)
data
```

```
##      [,1] [,2] [,3] [,4] [,5]
## [1,]    1    2    0    2    2
## [2,]    1    0    3    1    1
## [3,]    0    1    0    2    2
## [4,]    1    1    2    0    1
```

```
# Using reduced row echelon form using Gauss-Jordan elimination
rref(data)
```

```
##      [,1] [,2] [,3] [,4] [,5]
## [1,]    1    0    0    0 -1.0
## [2,]    0    1    0    0  1.0
## [3,]    0    0    1    0  0.5
## [4,]    0    0    0    1  0.5
```

Conclusion:

Solving it by hand I wasn't able to get very far and still confused about what to do next. I was able to find an R library called pracma was able to solve the problem. Based on this, b is not a subspace of W.

References:

- https://cran.r-project.org/web/packages/pracma/index.html
- https://www.mathworks.com/help/symbolic/rref.html