Using Excel to Solve Systems of Linear Equations

File: `TL4_MatrixOperations.xlsx`
Save As: `TechLab4_YYYMMDD_LastnameFirstName.xlsx`

Purpose:

This lab is designed to increase your proficiency with Excel for data analysis. You will:

- Learn how to conduct matrix and vector operations in Excel.
- Calculate the inverse of a matrix, if it exists.
- Use Excel to solve a system of linear equations.

Task 1: Instructor Led

During a recent field exercise, three supply teams assembled different sustainment packages made up of fuel cans, food crates, and medical kits. Team 1 assembled 3 fuel cans, 5 food crates and 1 medical kit. Team 2 assembled 3 fuel cans, 2 food crates, and 2 medical kits. Team 3 assembled 4 fuel cans, 3 food crates, and 3 medical kits. Each team spent a different amount on their sustainment packages. Team 1 spent $200, Team 2 spent $210, and Team 3 spent $300. How much does each individual fuel can, food crate, and medical kit cost?

1. **Before opening Excel**:
    - Define your variables:

    - Write the full system of equations:

    - Write the system of equations in matrix-vector form.

2. Now open Excel and save your file.
3. In `B3` to `D3`, input the coefficients for the equation representing Team 1, or the first row of matrix A.
4. Fill in the rest of the A matrix in cells `B4` through `D5`, for the other two teams.
5. In cells `F3` to `F5`, input the cost for each team's sustainment package.
6. Write what you would do by hand to solve this system of equations using the matrix-inverse method.

7. Let's calculate A^{-1} using Excel. In cell `B8`, enter the following equation: `=MINVERSE(B3:D5)`. Note that the data we are selecting is the entire coefficient matrix A.
8. Write the resulting matrix here:

9. Now, multiply A^{-1} by vector, $\vec{b}$. In cell `F8`, enter the following equation: `=MMULT(B8#,F3:F5)`. Note, that `B8#` selects the cells representing A^{-1}.
10. Write the solution to the system of equation below:

11. What if, instead of assembling the original sustainment packages, Team 1 packages 6 fuel cans, 4 food crates, and 2 medical kits and Team 2 packages 3 fuel cans, 2 food crates, and 1 medical kit. Change your A matrix. What happens?

12. Similarly, what if Team 1 packages 1 fuel can, 2 food crates, and 3 medical kits. Team 2 packages 0 fuel cans, 3 food crates, and 3 medical kits. Finally, Team 3 packages 4 fuel cans, 5 food crates, and 9 medical kits. Change your A matrix. What happens?

13. Why do you think this is happening?

Task 2: Do it Yourself

WestForge Electronics manufactures five types of circuit components each week: sensor boards, controllers, power modules, communications cards, and I/O interfaces. Each component consumes time and material from three different production resources: SMT assembly hours, copper laminate sheets, and functional test hours. The company also faces two business rules based on customer contracts.

- The total SMT assembly time used across all five components was 280 hours per week. Each sensor board required 3 hours, each controller 2 hours, each power module 1 hour, each communication card 4 hours, and each I/O interface 1 hour.
- The total copper laminate material used across all components was 275 sheets per week. Each sensor board used 1 sheet, each controller 5 sheets, each power module 2 sheets, communications cards required no copper lamination, and each I/O interface used 3 sheets.
- The total functional testing time for all components combined was 225 hours per week. Testing one sensor board took 2 hours, one controller 1 hour, one power module 1 hour, one communications card 3 hours, and one I/O interface 2 hours.
- The combined number of sensor boards and controllers produced each week is 50 units.
- The production record shows that the company built twice as many communications cards as power modules.

How many components for each type are produced on average per week?

1. Define your variables.

2. Write the full system of equations.

3. Write the system of equations in matrix-vector form.

4. Using Excel, calculate the number of components produced on average per week using matrix-inverse method. Write your solution below.