# Theme 1: Systems of linear equations

In this task we will study the connection between lines in two dimensions and planes in three dimensions.

Imagine we have two lines in the plane expressed as the following:

$$L\_{1}: 3x+2y=4$$

$$L\_{2}: x-2y=-1$$

1. Find a proper way to visualize the lines, in for example geogebra. What is the connection between the lines?
2. How would you find this connection without visualization? What method for calculating this would you use that you just learned about?

A set of two new lines are given as

$$L\_{3}: x+2y=2$$

$$L\_{4}: -x-2y=-3$$

1. What is the connection between these?
2. Can we generalize our findings to the general case of

$L\_{a}:a\_{1}x+a\_{2}y=a\_{3}$ $L\_{b}:b\_{1}x+b\_{2}y=b\_{3}$

Where $a\_{1}$, $a\_{2}$, $a\_{3}$, $b\_{1}$, $b\_{2}$ and $b\_{3}$ are coefficients that can be considered constant.

(You may skip this task if it takes too long time.)

1. Now imagine that we have three lines in the plane. Does it change anything? How would we describe the (general) situation mathematically? How would we visualize the possibilities? (may also be done in written form).
2. Could this problem be formulated on a matrix form?

Imagine we have **two** planes in space.

1. What are the possible relationships between the planes?
2. What if we extend this to **three** planes, which possibilities exist then? Discuss and try out some visualization.
3. Could we make a concrete example and “calculate” the relationship?
4. How many equations do we have, and how many variables for the two cases (two and three planes)?

Now we try to see these results in a more general light

1. Can you see a connection between the number of equations, variables, and number of solutions?
	1. For example: What is the difference between three lines in the plane and two planes in space? How will the matrix system for the two cases look like?
	2. In which cases are there a chance for infinitely many solutions? And for no solutions?