Problem 3.1

We have three tiles, called \( a \), \( b \) and \( c \), placed in a squared ordered field that can contain exactly four tiles, as illustrated in the figure below. Tile \( X \) can be moved via the action \( \text{move}(X) \) either horizontally or vertically to occupy the adjacent free portion of the field. It cannot be moved diagonally and it cannot overlap another tile.

![Tile arrangement](image)

1. Formalize the actions \( \text{move}(X) \) in fluent calculus.
2. Formalize the state (A).
3. Give a plan that transforms state (A) to state (B).

Problem 3.2

Consider the decision variant of the knapsack problem:

Given a set of items \( \{i_1, \ldots, i_n\} \), each with a mass \( m_i \in \mathbb{N} \) and a value \( v_i \in \mathbb{N} \), can we include them in a collection so that the total weight is less than \( m \) and the total value is more than \( v \) ?

Specify a planning problem that has a solution if and only if the above problem can be answered with 'yes'.

Problem 3.3

Let \( I \) be an initial state containing, and \( G \) be a goal state and let \( \mathcal{A} \) be the set of actions of Blocks World as specified in the lecture.

Specify a propositional formula \( F_n \) such that \( F \) is satisfiable if and only if the planning problem has a solution of length \( n \).