# The Mondrian Problem

The Mondrian problem is a beautiful open problem in combinatorics and number theory, named after the painter Piet Mondrian, known for his grid-based artwork.

## Problem Setup

Given an N × N square:  
1. Tile it completely with finitely many rectangles.  
2. Each rectangle must have integer side lengths.  
3. Rectangles must be pairwise non-congruent (i.e., no two rectangles can have the same dimensions up to rotation).  
4. No overlap, no gaps, no overhangs: the rectangles must exactly fill the N × N square.

## Definition of M(N)

For a valid tiling of an N × N square:  
• Let A\_max = the maximum area among the rectangles.  
• Let A\_min = the minimum area among the rectangles.

Define the defect of the tiling as: defect = A\_max – A\_min.  
  
Then M(N) is defined as the minimal possible defect over all valid tilings of the N × N square:  
  
 M(N) = min\_over\_valid\_tilings (A\_max) – A\_min).

## Notes

• The rectangles do not need to have equal areas. In fact, the problem is interesting precisely because of the tension between non-congruence and integer side constraints.  
• The search for tilings that minimize the defect is computationally challenging as N grows.

## Open Problem

The central open question of the Mondrian problem is:  
  
 Does there exist any N such that M(N) = 0?  
  
That is, is it possible to tile an N × N square with pairwise non-congruent, integer-sided rectangles, with no overlap, no gaps, no overhangs, such that all rectangles have exactly the same area?  
  
Despite extensive computational searches, no such N has been found to date. It remains an open problem whether such an N exists.

## Auxiliary notes and codebase goals

• Solving the Mondrian problem for largeish N is in itself a hard challenge without several optimisations. In this code base, we aim to use R + Rcpp (and as needed a jump to C) to provide fast, accurate solutions for the problem that given an N, output M(N) and also output all configurations that have this M(N) value