Northumbria University
NEWCASTLE

WELCOME MATHEMATICS CHALLENGE 2021

Hello and welcome to the start of your exciting time with us at Northumbria. This challenge aims to exercise your mathematical skills, stimulate your imagination and curiosity and possibly explore aspects of mathematics you have not experienced before.

Please, attempt the following problems and submit your solutions by October 2nd 2021 to antonio.moro@northumbria.ac.uk

CHALLENGE 1

A room is made of four walls, a floor and ceiling. A fly moves between these surfaces. If it starts from the floor or the ceiling it will reach with probability $1/5$ either one of the walls or the surface from which it has set off. If it starts from the wall it will reach with probability $1/5$ either one of the remaining walls, or the ceiling or the floor.

If the fly is initially on the ceiling, what is the probability to find it on the floor after k moves?

CHALLENGE 2

A *magic* square is a square made of $n \times n$ boxes each containing a real number in the interval $[0, 1]$, such that the sum along the rows and the columns is always 1. A *magic* square is *pure* if it can not be obtained as arithmetic mean of corresponding boxes of two distinct magic squares (two magic squares are distinct if they differ at least by one box).

Show that all pure magic squares are necessarily made of boxes with values either 0 or 1.

END OF CHALLENGE