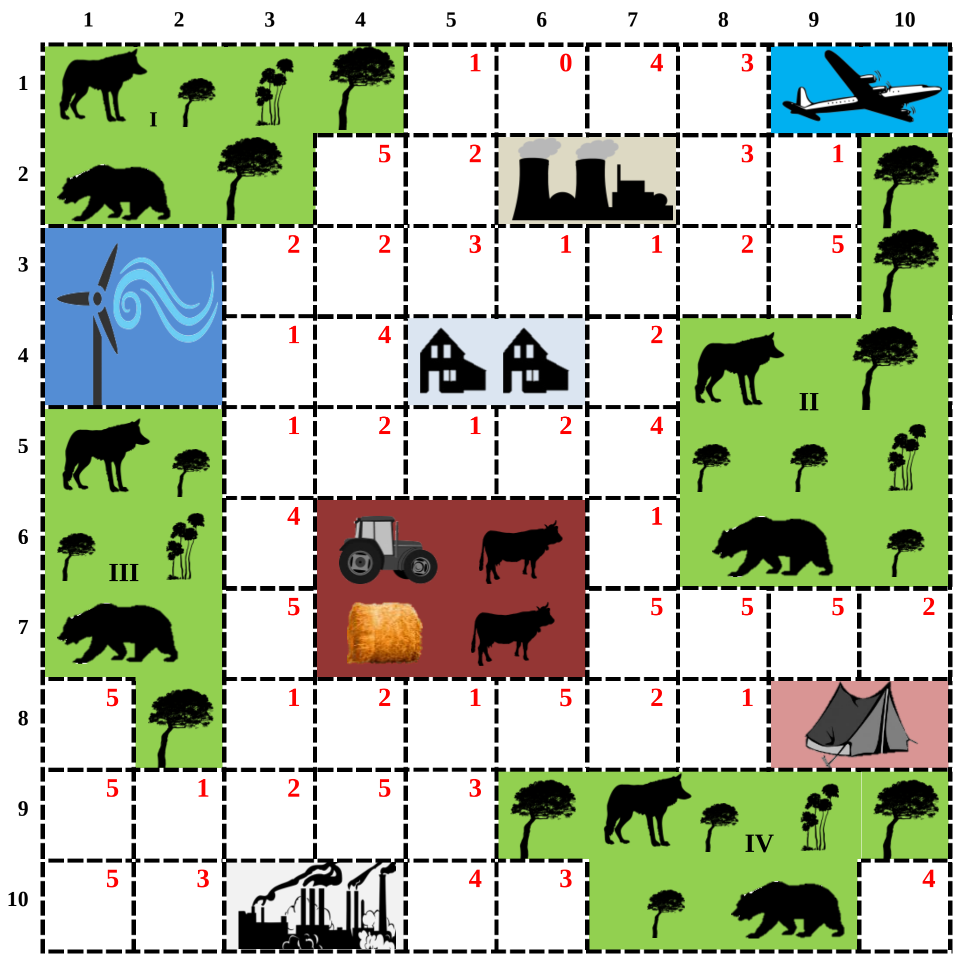
PUZZLE GAME ABOUT CONNECTIVITY AND BIOLOGICAL CORRIDORS

Alain Billionnet, cedric-ensiie, Paris, France

Landscape fragmentation prevents some species from moving as they should. This fragmentation, mainly due to urbanization, agriculture and forest exploitation, is a major cause of biodiversity loss. One of the options commonly envisaged to remedy this fragmentation - restore some connectivity - is the development of biological corridors. These corridors are natural spaces, usually linear. They allow species to move between different areas that are natural habitats for them.

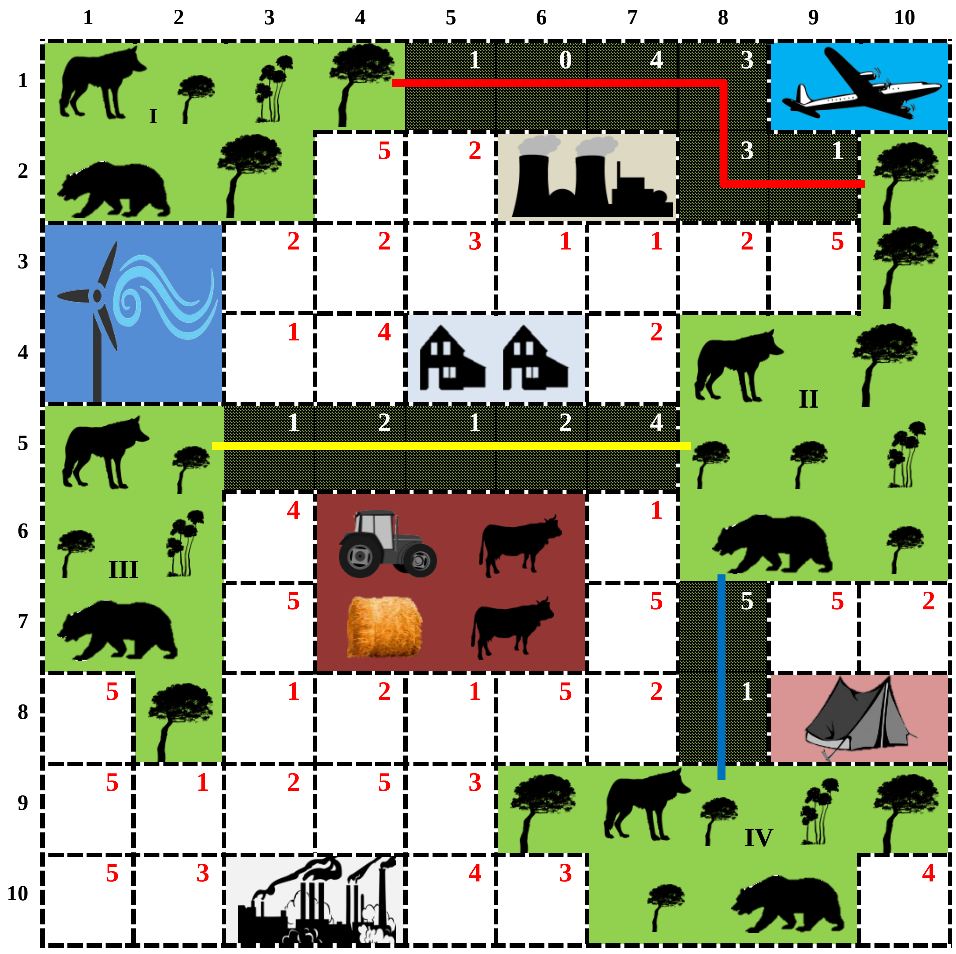
We are interested in a hypothetical landscape represented by a matrix of 10×10 parcels and with 4 reservoirs of biodiversity I, II, III and IV (see figure below). Each reservoir, represented in green, is a contiguous geographical area: all the species present in this reservoir can entirely visit it without leaving it. Apart from these reservoirs, the landscape has two types of parcels: parcels which, in a certain way, can be protected and thus contribute to the development of corridors, for example parcels (1,5), (1,6), (1,7), (1,8), (2,4), (2,6), and parcels that can no longer be protected and therefore cannot contribute to the development of corridors, for example parcels (10,3) and (10,4) on which an industrial zone is installed. The protection of each parcel has a cost indicated in red on the figure. This cost differs from one parcel to another and can cover many aspects: monetary costs (rent or acquisition, possible restoration, management of the parcel), ecological costs (ease of movement of species through the parcel, mortality risk, distance travelled) and also social costs (negative or positive social impact generated by the selection of the parcel to constitute a corridor).



PROBLEM

DETERMINE PARCELS TO BE SELECTED IN ORDER TO CONNECT AT THE LOWEST COST THE 4 RESERVOIRS BY A NETWORK OF BIOLOGICAL CORRIDORS

Two reservoirs are said to be connected if the species can move between these two reservoirs by passing only through protected (selected) parcels or through parcels belonging to a reservoir. The species can move progressively only from one parcel to an adjacent parcel, two parcels being adjacent if they share one common side. The figure below shows a network of corridors linking the 4 biodiversity reservoirs and the cost associated with this network is equal to 28 (sum of white costs). For example, to go from Reservoir III to Reservoir IV, the species will use the corridor designated by a yellow line and then the corridor designated by a blue line. There are other networks of corridors connecting the 4 reservoirs and whose cost is less than 28. **The question is to determine the optimal network (of minimum cost).**



This game is freely inspired by the research article: Williams, J.C., 1998. Delineating protected wildlife corridors with multi-objective programming. Environmental Modeling and Assessment, 3, 77-86.