Problems for Tutorial 7

1 Derangements

N people leave their hats in a coatroom. On the way out the person in charge of the coatroom hands their hats back to them in an arbitrary order. Use inclusion-exclusion to count the total number of ways in which the hats can be handed back to them such that no person gets his/her own hat back.

2 Counting Paths

- Find the number of paths from $(0,0)$ to (m,n), where $m,n \in \mathcal{N}$, such that each path is made up of a series of steps, where each step is either a step one unit to the right or one unit forwards.
- Prove that $\sum_{k=0}^{r} C(n+k,k) = C(n+r+1,r)$, where $n,r \in \mathcal{Z}^+$.