$$\mathbb{P}(E_7 \cap F_4) \stackrel{?}{=} \mathbb{P}(E_7) \cdot \mathbb{P}(F_4)$$

A. Two fair dice are rolled, one after the other.

NOT INDEP

i. Let E_6 be the event that the sum of the dice is 6. Let F_4 be the event that the first die is 4. Are these two events independent?

INDEP

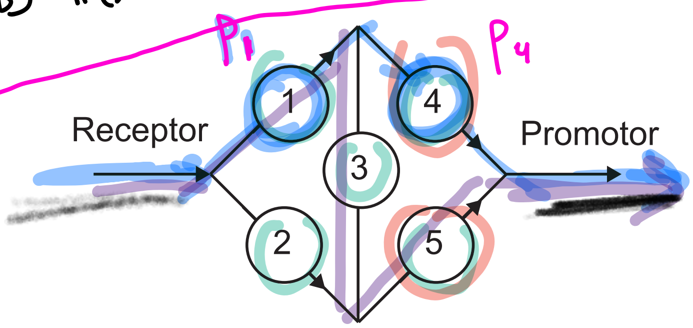
ii. Let E_7 be the event that the sum of the dice is 7. Let F_4 be the event that the first die is 4. Are these two events independent?

iii. Let E_i be the event that the sum of the dice is i. Let F_j be the event that the first die is j. For what values of i and j are these two events independent?

B. Consider a simple protein-protein interaction network with a receptor, five proteins numbers 1 to 5, and a gene promotor. You have determined that the proteins interact according to the figure below. In a population of cells, you find that each protein has a probability p_i of being functionally active in a given cell, where $i = 1, 2, 3, 4, 5$. A functional signal transduction requires at least one complete path

INCLUSION - EXCLUSION ↗ $\mathbb{P}(A \cup B) = \mathbb{P}(A) + \mathbb{P}(B) - \mathbb{P}(A \cap B)$

EXHAUSTIVE



PROMOTOR

from the membrane receptor ~~(R)~~ to the ~~transcription factor (TF)~~. Protein P3 can interact bidirectionally ~~with both P2 and P4 (acting~~ as a scaffold protein). Assume that the proteins are active independently of each other. Calculate the probability that signal transduction occurs successfully in this network.