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Generalized chromatic functions

We define vertex-colourings for edge-partitioned digraphs, which unify the theory of P-partitions and proper vertex-colourings of graphs. We use our vertex-colourings to define generalized chromatic functions, which merge the chromatic symmetric and quasisymmetric functions of graphs and generating functions of P-partitions. Moreover, generalized chromatic functions can refine the $(3+1)$ -free conjecture and the Tree Conjecture. We discuss several open problems related to the refinement of the conjectures.