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Directed cycle decompositions of complete digraphs

We consider the problem of decomposing the complete directed graph K_n^* into directed cycles of given lengths. We give general necessary conditions for a directed cycle decomposition of K_n^* into t directed cycles of lengths $m_1, m_2, \ldots, m_t$ to exist and provide a construction for creating such decompositions in the case where there is one 'large' cycle.

We give a complete solution in the case when there are exactly three cycles of lengths $\alpha, \beta, \gamma \neq 2$. Somewhat surprisingly, the general necessary conditions turn out not to be sufficient in this case. In particular, taking $\gamma \geq \beta \geq \alpha > 2$, we show that when $\gamma = n$, $\alpha + \beta > n + 2$ and $\alpha + \beta \equiv n \pmod 4$, K_n^* is not decomposable.

Joint work with A.C. Burgess and M.T. Javed