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Counting cycles in labeled graphs

Imagine a graph in which each edge is given an orientation and labeled with a letter a or b. Then, given a word w in those letters, you could try to start somewhere and follow the word w around the graph. If you manage to do this, and end up where you started, then you have made a w-cycle. A variant of the famous Hanna Neumann Conjecture from combinatorial group theory says that in any graph, the number of these w-cycles (for a fixed w) should be bounded by the first Betti number of the graph. I will present a proof of this statement. This is joint work with Dani Wise.