Cycle counting in an infinite state graph

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For a given graph one can easily count closed walks by considering the power of the adjacency matrix. On the other hand counting cycles is more subtle as there are many possible degenerate closed walks that must be accounted. We give an approach to counting cycles in an infinite state graph where words correspond to $S \subset \mathbb{N}$ with $|S| = 2$ and directed edges $S \to T$ if $\{s-1 : s \geq 1 \text{ and } s \in S\} \subseteq T$. This particular state graph has connections with juggling as closed walks correspond to juggling patterns with 2 balls and cycles correspond to *primitive* juggling patterns with 2 balls.

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