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Elliptic curves of unbounded rank and Chebyshev's bias

We establish an equivalence between quantitative unboundedness of the analytic rank of rational elliptic curves and the existence of highly biased elliptic curve prime number races. For this purpose we study the bias in the count of local points of a rational elliptic curve E created by its analytic rank. We show that conditionally on a Riemann Hypothesis and on a hypothesis on the multiplicity of the zeros of $L(E,s)$, large analytic ranks translate into extreme Chebyshev biases. Conversely, we show under a certain linear independence hypothesis on zeros of $L(E,s)$ that if highly biased elliptic curve prime number races do exist, then the Riemann Hypothesis holds for infinitely many elliptic curve L-functions and there exist elliptic curves of arbitrarily large rank.