Geometry of Polynomials Bootcamp **Winter 2019**

Real Stable Polynomials and Preservers

Speaker: Shayan Oveis Gharan *In-class exercise*

P1) For any integer $1 \leq k \leq n$, prove that the k-th elementary symmetric polynomial $\sum_{S \in \binom{[n]}{k}} z^S$ is real stable.

P2) Recall that MAP is the operator that only retains multiaffine (square free) monomials of a given polynomial, e.g., $\text{MAP}(1+x+3x^3y+2yz) = 1+x+2yz$. Prove that MAP is a stability preserver operator.

P3) Let $f(t) = \sum_k a_k t^k$ be a real rooted polynomial with nonnegative coefficients.

a) Prove that $\log f$ is a concave function of non-negative reals.

b) Prove that $f'(0) \geq \frac{1}{e} \inf_{t>0} \frac{f(t)}{t}$.

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P1) Consider the polynomial $p(x, y) = a + bx + cy + dxy$. where a, b, c, d are real numbers. Prove that p is real stable iff $bc \geq ad$.