The Operator Scaling problem asks whether a set of complex matrices can be jointly moved to a certain canonical (isotropic) position. This problem has a remarkable number of myriad incarnations: non-commutative algebra, invariant theory, arithmetic complexity, quantum information theory, analytic inequalities and more. We will describe an efficient algorithm solving all these related problems, and explain how their analysis combines ideas from all these areas. Through these connections, the algorithm can be shown to solve some non-convex optimization problems, some systems of quadratic equations, and some linear programs with exponentially many inequalities - all these, and concrete examples we will give, suggest that it might be a powerful algorithmic tool via reductions to these problems. No special background will be assumed! Joint on two joint works with Ankit Garg, Leonid Gurvits and Rafael Olivera. This talk is longer than usual and has a two-hour slot.