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Abstract: The Leitch lab is focused on mapping chemical reaction space using high-throughput experimentation, and developing new catalysts and catalytic reactions for complex molecule synthesis. This talk will focus on our recent developments in two specific areas. First, we are applying high-throughput competition experiment studies to map the reactivity of substrates as a function of molecular structure for key transformations relevant to pharmaceutical synthesis. Combining these relative reactivity scales with easily calculated molecular descriptors, we have generated quantitative predictive models for nucleophilic aromatic substitution (S_NAr) and palladium-catalyzed cross-coupling. Applications of these models toward predicting reactivity and selectivity will be presented. Second, we are exploring the reactivity of bicyclobutane substrates as a platform for creating new multicyclic scaffolds relevant to drug discovery. Our recent work on a chemodivergent approach toward azabicyclohexanes and cyclobutenyl methanamides through the addition of imines to bicyclobutanes will be presented.