De Novo Design
De novo design [1] is an approach to rationally designing molecules which fit a desired property profile. De novo design is divided into three components: construction, scoring and search. Each must be carefully balanced to chart an effective path through the vastness [2] of chemical space to areas of interest.

Monte Carlo Tree Search
Monte Carlo Tree Search [4,5] is a best first tree search algorithm driven through random exploration of the search space. It is controlled by the UCT (Upper Confidence bounds applied to Trees), and has achieved good performance across a wide range of tasks [6]. The UCT allows for asymmetric tree growth to occur. The simulation stage mitigates against trapping in local minima.

Reaction Vector Based MCTS
Reaction Vector Based Monte Carlo tree search (RV-MCTS) attempts to alleviate both the issue of full enumeration and informed selection. Through search space minimisation and the inclusion of a simulation stage to “see” past local minima.

Benchmark
To test the RV-MCTS, we have built a small focused rediscovery benchmark. The benchmark is adapted from previous work by Neil et. al. [7]. It is composed of four molecules, whose literature synthetic schemes are known. These schemes are encoded and added to a larger set of medicinal chemistry reactions which act as “noise”. The MCTS is provided the starting materials, and reaction vector database.

Results & conclusions
The plot below shows the performance of the MCTS against a random search. MCTS outperforms random in all cases and successfully finds the goal in 75% of the benchmark problems.